

Shepherd Wheel Volunteer Manual

Resource Material for Volunteers

Extended and revised 2026



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Part A: Core Manual. Essential reading.

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Preface and Acknowledgements

Preface

This manual has two parts.

The core manual contains a welcome, a guide to volunteering at the Wheel, and a short overview. This is essential reading and should take no more than 15 minutes.

The supplementary sections provide further detail and will, we hope, be a valuable resource which you can peruse at your leisure.

Acknowledgements

We acknowledge the following as sources for images and contributions in this guide. Where not mentioned, images are either FoPV or public domain.

Picture Sheffield: p. 21, p. 29, p. 32, p. 36, p. 37

South Yorkshire History Society: p. 11, p. 24

The Swimming Magazine: p. 23

Peter Bayliss (author): *Shepherd Wheel, Overview*, published in the SPAB Mills book, 2026

Duncan Edwards: FAQ *Who Dug* p. 21 and FAQ *Square and Circular* p. 33; Appendix D: Horsepower calculations

1. INTRODUCTION

WELCOME TO THE SHEPHERD WHEEL VOLUNTEER GUIDES TEAM!

You are now one of approximately 20 guides coordinated by the environment charity **Friends of the Porter Valley (FoPV)**. We work in partnership with **Sheffield Museums Trust (SMT)** whose Heritage Engineers operate the **Shepherd Wheel** ensuring it can be seen working at weekends. This unique partnership was founded in 2008¹ when we obtained a National Lottery grant to restore the derelict millpond (dam), buildings and machinery. One key condition was that the museum would open for free at weekends and would be managed by a tri-partite partnership (**Sheffield Council** as the landowner is the 3rd partner). That partnership has functioned successfully ever since.

I hope you will find this Handbook useful and enjoyable. You will certainly find your colleagues keen to welcome and help you.

This unique working example of a water powered workshop is very popular, not just with local residents who love the Porter Valley but with visitors from all over the world (32% of our visitors who signed the Feedback book in the first six months of 2024 came from outside Great Britain). Overseas visitors are often introduced by Sheffields wanting to show off the roots of the city's industry in this green setting. Your task as a volunteer guide is to bring that history alive.

Some background

The **Porter valley** is a rich mosaic of built and green heritage and the Shepherd Wheel site might be considered a jewel in this fascinating landscape.

- Its millpond and water form a **nature reserve** recognised by **Natural England**, and is popular with naturalists and photographers.
- The workshops are within a **grade 2 listed building** which is also a **scheduled ancient monument**.

Together they constitute one of Sheffield's finest Museums.

The **Friends of the Porter Valley** is a substantial and active Friends group which, in partnership with the Council, manages the public parks and Nature Reserves along the Porter Brook. We are committed to the conservation, protection and restoration of the ecology, landscape and cultural heritage of the Porter Valley for the enjoyment of all and the benefit of future generations.

I am sure you will enjoy presenting this unique heritage to the visiting public and thank you for joining the team!

Ann Le Sage

Chair – Friends of the Porter Valley

¹ <https://www.heritagefund.org.uk/projects/shepherd-wheel-conservation-project>

2. EXPECTATIONS

Thank you for becoming a volunteer guide at this unique piece of Sheffield history. We hope you'll find greeting people from many parts of the country and abroad, as well as local inhabitants an enjoyable and interesting way of spending a couple of hours. As a largely open-air site in the middle of a park, visitor numbers can be variable and weather dependent. You will get regular dog walkers popping in for a chat, parents with young children calling in as part of their routine walk. At other times you will meet people who are interested in history, engineering or who are just passing by. Enjoy the many different conversations you will have, there is no script. Before your first shift read the guide book and memorise some key facts - you don't need to know everything on the first day as you have this guide to hand or you can refer questions to the engineer.

When a visitor arrives, greet them warmly and offer to answer any questions. Some will be happy just to look, have a brief chat, whilst others will want to know all that you are able to tell them. Some will know a great deal already whilst others will have no idea what they are looking at. Children tend to be fascinated by the Wheel itself; many older people comment on the fire as being similar to the one in their grandmother's kitchen. Some want to know about the horse power and the revolutions per minute. Older Sheffield people will often tell you that they visited with school many years ago. You may find that children enjoy learning new words such as 'overshot', 'goit', 'pentrough' and learning the difference between cutlery and flatware. Never be afraid to admit that you do not know the answer to a question – ask the engineer on task as they may know the answer, or if that doesn't work, post it on the volunteer WhatsApp group for future reference. One of your colleagues may be able to help.

Try to remember to ask for entries in the visitor's book. Gently refer to the card reader and the bucket for donations if you feel that is appropriate and suggest that they use the QR code when they have time.

Now, read on to find out who, what and how.

2.1 Who's who?

- a. **Chair of FoPV:** Acts as our liaison with SMT and attends their quarterly meetings on our behalf as well as working on all the other projects with which FoPV is involved.
- b. **Shepherd Wheel Rota Organiser:** Creates the schedule for volunteering at Shepherd Wheel.
- c. **SMT Volunteering Manager:** Looks after all the volunteering opportunities across SMT sites other than Shepherd Wheel.
- d. **SMT Head of Historic Engineering:** Has oversight of engineering operations across SMT sites and creates the rota for SMT engineers to attend Shepherd Wheel and other industrial museum sites (Kelham Island and Abbeydale Industrial Hamlet)
- e. **The SMT Historic Engineers:** One of them will be on task with you each weekend at the Wheel. They are responsible for opening and closing the premises; for starting and stopping the Wheel; for checking the water level in the dam and operating the sluice to increase or reduce inflow; for controlling the water level in the pentrough controlled by the lever from within the Hull; for building the fire in the fireplace and a number of other tasks relating to the upkeep of the site. They are responsible for health and safety while on site and have access all areas while volunteers should remain in areas accessible to the general public.

- f. **Fellow Volunteers:** there are over 20 volunteers whom you will meet, probably only at Shepherd Wheel shift handover to start with, but through WhatsApp exchanges and the occasional face-to-face meeting you will come to know most if not all.
- g. **SMT visitor survey volunteers** who may occasionally visit the Wheel to undertake the Arts Council survey conducted at all SMT sites.

2.2 What's involved?

- a. Being available for one of the two daily shifts (in winter) and three daily shifts (in summer). Each shift is two hours long. You will be contacted by email each month and asked about your availability. You do not have to opt for a regular or frequent slot. Some volunteers can offer only one shift per month, others more.
- b. Showcasing Shepherd Wheel and the surrounding site to the public. Helping bring to life the history of water-powered grinding along the Porter Valley, the engineering of the Wheel itself, and what it might have been like to work here.
- c. Working with the SMT engineer to keep the premises safe, clean and tidy

2.3 Induction

- a. To volunteer at Shepherd Wheel you will need to read through this manual and undertake some shadowing sessions (see 2.4e. below).
- b. Because the Wheel is operated by SMT, you can also apply to become a SMT volunteer and undertake a SMT volunteer induction and safeguarding training, although this is not a pre-requisite. Sessions are usually held at Kelham Island and there are several opportunities throughout the year. You will then have access to the SMT volunteer website and wider volunteering opportunities, should you so wish.

2.4 Getting started

- a. Make sure you have suitable clothing for your volunteer session (warm layers, waterproofs and sensible boots or shoes). It is chilly inside the stone building!
- b. You will need a mobile phone. Please ensure you bring it with you each time you are at the Wheel.
- c. At home you will need access to email and WhatsApp. You will be invited to the Shepherd Wheel volunteers WhatsApp group, our handy forum for news, information and making last-minute changes.
- d. Your email address, with your permission, will be added to the rota organiser's list and you will be invited to volunteer. Please respond promptly so that the rota can be drafted and circulated in good time. Summer hours comprise three shifts (10-12; 12-2; 2-4). Winter hours comprise two shifts (11-1; 1-3).
- e. For your first two sessions at the Wheel, you will be shadowing one of our experienced volunteers to get a feel for what is involved. If you feel comfortable and confident after that, you will then be able to go solo.

2.5 Tasks

- a. **First session of the day.** If you are scheduled for the first session of the day, please arrive ahead of the scheduled opening time.
You can, if you are able, assist with the opening of the Wheel. This involves:
 - i. opening the window shutters and securing them safely via hook and eyes on the outer wall (the engineer will show you how when you start).
 - ii. storing the metal 'closing pegs' under the bench by the fire.
 - iii. putting out the banners on pre-positioned posts.
 - iv. wheeling out the park footpath sign and stand (though this is heavy and should not be attempted unless you feel confident with moving heavy objects).
 - v. assisting the engineer to light the fire.
 - vi. opening the Visitor Book so that it is ready for comments to be entered.

- vii. checking the leaflet display and ensuring there are copies of the Visitor Guide available. If not, ask the engineer for more – they are stored in the room at the back.
 - viii. wearing the FoPV ‘Volunteer’ lanyard to identify you as a volunteer and taking charge of the number clicker which records the number of visitors during your shift.
- b. Last session of the day.** Please remain to assist the on-site engineer with closing the site, which takes approximately 15 minutes. You can, if you are able, assist with the following:
- i. all the items mentioned at the start of the day, in reverse order i.e. take banners in, shut the window shutters and put the metal pegs in while the engineer slots the retaining toggles into them from the inside.
 - ii. checking the donation box and write the total for the day in the book which the engineer holds and will countersign.
 - iii. returning the clicker to the engineer so that s/he can record the number of visitors for the day and put your lanyard back.
- c. All sessions.** Whatever session you are scheduled for:
- i. on arrival, obtain and display your FoPV ‘Volunteer’ lanyard.
 - ii. take charge of the clicker and try to ensure you click in every visitor to the site, adults, children and babies. This can be tricky during busy times and when you get engrossed in conversation, but do your best.
 - iii. make visitors feel welcome. Make sure they are aware of the different parts of the site (hulls, wheel and pond) and of the presence of a volunteer, and an engineer who will try to answer any questions they may have. Just a simple ‘Welcome to Shepherd Wheel. First visit?’ is a good way to start.
 - iv. If a visitor has shown interest and asked questions, ask them to make an entry in the Visitor Book. This is extremely useful data which tells of the remarkable reach and impact of the Wheel. In addition there is the QR code supplied by the Arts Council to learn more about visitors to our sites. You might say something along the lines of...
- “It would be great if you could leave informal comments in the file here and if you have time there is also a link on this QR code which helps the Arts Council understand more about visitors to our sites in Sheffield.”*
- v. SMT and Shepherd Wheel rely on donations for much of their work. Sometimes it’s a large donation from a significant sponsor. Other times it’s a small donation on site from visitors. At the Wheel there is an electronic screen for electronic donations and a bucket for cash donations. Cash donations are exclusively for use at Shepherd Wheel and are held by FoPV in the Shepherd Wheel reserve account. All donations made on the electronic device go to Sheffield Museums Trust to use across all museums. Please mention some of the things which donations have funded to give donors a sense of their investment in the Wheel – the hoist and the new drum are two good examples.
 - vi. On departure, thank visitors for their visit. If they have made a donation, thank them for that, too, and offer them one of the Shepherd Wheel ‘Visitor’s Guide’ booklets in appreciation of their support.

d. If you are unable to attend

- i. **A week or more before your shift.** Use the WhatsApp group to seek a fellow volunteer who is able to cover for you in exchange for a swap with one of their scheduled shifts
- ii. **On the day.** Contact the rota organizer on WhatsApp. S/he will advise on best solution.

e. Expenses.

- i. If you are a registered SMT volunteer, you will receive a claim form for each month in which you volunteer by email also explaining the policy on expenses. FoPV will pay pre-authorised exceptional expenses.

2.6 Health and Safety

a. Information and equipment

- i. The notice board in the main hull has the latest health, safety and emergency information. Please familiarise yourself with this. The reverse of your lanyard contains key contact information should you need it.
- ii. There is a risk assessment for visits to the site by members of the public. It is included as Appendix G.
- iii. The SMT engineer is the member of staff responsible for dealing with any and all incidents. The volunteer is there to assist as directed by the Engineer.
- iv. There are two First Aid kits. One is in the main hull and the other is in the Engineers' hut. The throw rope for water incidents is hung up in the WC.
- v. There is also an incident record book which is the responsibility of the Engineer.
- vi. If there are any personal limitations on your ability to assist with an accident or you have any health or mobility issues that we should bear in mind please contact the Chair.

b. Contacts, location and accessibility

- i. Please add the SMT Emergency phone number to your contacts: **07485 334728**. Phone, if you have to alert an engineer or other support staff.
- ii. The location of the Wheel is best described using 'WHAT3WORDS': **item.liked.upon**
- iii. Emergency vehicle access is only from Rustlings Rd/Oakbrook Rd junction S11 7AD
- iv. SMT have a useful [Powerpoint](#) that describes the location of the Workshop.
- v. Accessibility information is provided on [the SMT pages](#) for Shepherd Wheel.

c. Important: In the event of an accident

- i. Alert the on-site engineer who is First Aid trained and is also the responsible person. Follow their instructions.
- ii. If the on-site engineer is incapacitated, if possible enlist people to help you with the following:
 - **Assess the situation.** Call the emergency services immediately if it seems appropriate. Use WHAT3WORDS (**item.liked.upon**) for location.
 - **Close doors** to both hulls so machinery is inaccessible.
 - **Move the public** to the assembly point across the river in the clearing by the benches. It is essential that access to Shepherd Wheel is kept clear

for emergency service vehicles. **Call the off-site engineer** who will then take charge **07485 334728**.

d. **Training.**

- i. From time to time FoPV offer a one day Emergency First Aid course for volunteers plus a Safeguarding briefing.

2.7 Public access

- a. Shepherd Wheel is open to the public on weekends. In the summer, from 10 a.m. till 4 p.m., and in winter from 11 a.m. till 3 p.m.
- b. The nearest public toilets are at Endcliffe Park Café and Forge Dam. The toilet at Shepherd Wheel is for the use of engineers and volunteers only.
- c. Dogs are not allowed in the pond. During the most recent renovations the dam was desilted and a liner installed. Dogs scrambling out of the water damage the liner. They can also disturb nesting birds and waterfowl.

3. Overview: Shepherd Wheel Sheffield. SK317 854

The two major industries for which Sheffield is known throughout the world, steel and cutlery, both have histories heavily entwined in the use of water power provided by the five rivers that flow from the hills around the city. The earliest mills recorded date from the thirteenth century, being corn and fulling mills, owned by the Lords of the Manors and, until the Reformation in the 16th century, local abbeys. Some of these monastic establishments were early producers of local mined iron ore, and as the iron industry developed, so did the use of water powered machinery, with watermills soon being harnessed to drive trip hammers, bellows, slitting mills, and rolling mills, as well as grinding workshops for the growing cutlery trade, these last being known as 'Cutlers Wheels'. At the height of water power, the five rivers drove over one hundred water wheels, until in 1786 steam power arrived in Sheffield, no longer dependent on the vagaries of water levels in the rivers, and rapidly replaced many but not all the waterwheels. Of the survivors, only one cutlers' wheel remains, the Shepherd Wheel, which continued to produce blades until the early 1930's.

The Shepherd Wheel is a water powered 'Cutler's Wheel' situated on the Porter Brook, one of the five rivers in Sheffield. It stands in Whiteley Woods, part of a linear urban park, described by Patrick Abercrombie, one of the most influential British town planners of the 20th century, writing about the Porter Valley in 1924 as "the finest example... of a radial park strip... leading from a built-up part of the city direct into the country."

The Wheel today consists of two workshops or 'Hulls', the larger believed to date from around 1750, replacing an earlier building, and the smaller from around 1780/1790. The water wheel itself is overshot, 18ft in diameter and 6ft wide, with a frame of cast iron believed to date from around 1820, with steel buckets replacing the earlier wooden ones. Water is diverted into the dam via a weir and shuttle, and from the dam feeds into a pentrough and thence onto the wheel. (Fig 1) After passing over the wheel the water passes through a culvert to return to the brook 100 metres downstream. The output of the wheel when fully operational and running at 6 revolutions per minute has been calculated as approximately 13.3 horsepower. This would give the grindstones an optimum surface speed of 2,500 feet per minute, depending on the size of the grindstone, which in turn was dictated by the type of blades being produced.

The water wheel is mounted on an axle which passes into the main hull, and on which is mounted a crown wheel. This is eight feet in diameter and consists of an iron casting into which are fitted eighty individually made oak teeth set into the face. This gear wheel meshes with two metal pinions on stub axles which turn the motion through ninety degrees, thus transferring the power via two large diameter wooden drums and leather belts to the spindles and pulleys of the grindstones. At its peak the wheel could drive up to twenty stones and several 'glazing' wheels, the latter used to give the blades a last polish.

The earliest documentary evidence for a wheel on this site appears in a will of 1584, when it is called the Porter Wheel. It stood on land owned by the Earl of Shrewsbury, who was Lord of the Manor of Hallam. No record exists of the wheel's founding, but Allison in an article in the Transactions of the Newcomen Society in 1949-50 entitled "Water power as the foundation of Sheffield's industries", describes a contract for the construction of a cutler's wheel in 1549 in which the cutlers paid a lump sum to the Lord of the Manor and agreed to pay eight pence a year for manorial services. They could take a dozen oak trees from the waste for spindles etc. The constructor agreed to construct the dam and grinding hull for seven pounds. This may or may not refer to Shepherd Wheel, but it is fairly certain that this was the first grinding wheel on the Porter, and unlike many other wheels over

the centuries which were at times used for grinding cutlery, then corn, then back to cutlery, Shepherd Wheel was only ever used for the grinding of cutlery.

The wheel changed hands a number of times, with occasional 'down' periods, in 1749 being operated by Edward Shepherd, who had the wheel from 1759 to 1794, at a rent of three pounds and three shillings. and whose name has remained to the present in the name of the wheel Throughout its operational life Shepherd Wheel specialized in the grinding of table knife, pen and pocket knife blades. There is also residual evidence of file, scissor and razor grinding in later years.

Unlike many other wheels, Shepherd Wheel did not succumb to the introduction of steam power, but remained a water-powered workshop until it finally ceased production in the early 1930's. In 1927 it was inspected by the Factory Inspectorate, found to be unsafe and issued with a closure notice. By this time however, whilst continuing production, it was already acting as an unofficial museum, with passersby stopping to watch the work, visible through the open windows and doors. A protest was organized against the closure involving local dignitaries including the Lord Mayor, local MP's and Master Cutler which eventually reached the Prime Minister and was discussed in the House of Commons, with the result the wheel was allowed to continue with some provisos regarding safety.

By the early 1930's the larger hull had been abandoned and work continued using the smaller hull. By this time, it was difficult to compete with the larger factories in town, and the remaining grinders were of an age to retire, so the hulls were locked and handed back to the owners, by this time the City Council. One of the last men to work at the wheel was called Hind, and his family had been employed there for over a century, indeed in the late 17th century the wheel was operated by a Thomas Hynde though whether this was the same family isn't known.

After its closure, demonstrations were arranged from time to time by the Sheffield Trades Historical Society until 1940. It is notable that one such demonstration at Easter 1936 attracted over 1,000 visitors, both local and from elsewhere in the UK.

After 1940 the wheel fell into dilapidation until in 1957 the Council voted a sum of £500 for its demolition. However the Council for the Conservation of Sheffield Antiquities persuaded the Council to use the money for the restoration of the building, and itself undertook the repair of the waterwheel and the machinery. An appeal was launched and many local companies contributed generously but the amount raised only covered part of the labour cost and materials. However, over the following three years craftsmen from a local company, assisted by volunteers from the Sheffield Junior Chamber of Commerce worked on the restoration in their spare time. With enough water in the dam for just twenty minutes running, the wheel turned again in May 1962.

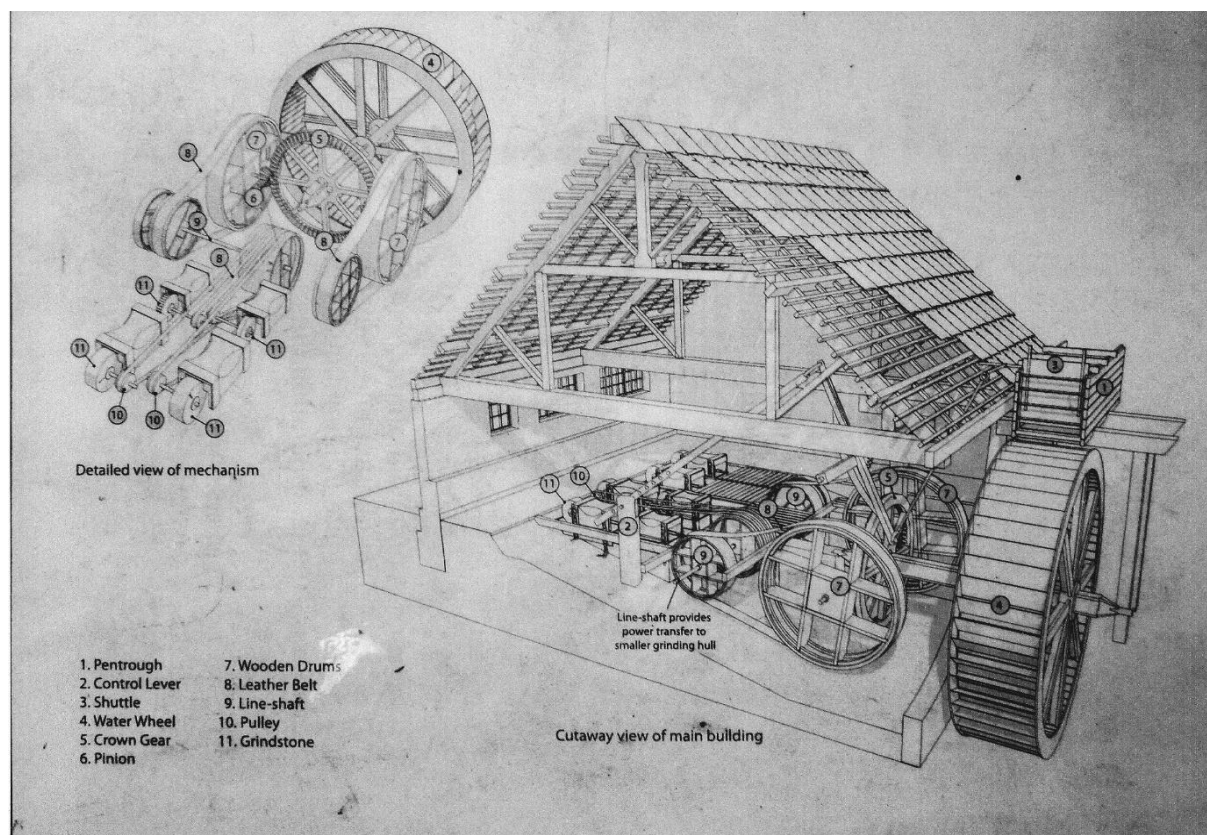
The wheel was open to the public at weekends and Bank Holidays until the 1980's, when it closed and was effectively abandoned until in 2008 a local organization the Friends of the Porter Valley (FoPV), undertook the task of fundraising to reopen the wheel to the public. With match funding available from the Lottery Heritage Fund, a tripartite group was set up with the FoPV, the City Council (the owners), and the Sheffield Industrial Museums Trust which oversaw the restoration of the wheel and dam, and the wheel once again turned in 2012, with an official opening by the then Deputy Prime Minister and local MP Nick Clegg.

Since then, the wheel has been open to the public at weekends, staffed by an engineer from the Sheffield Museums Trust and volunteer guides from the Friends of the Porter Valley.

Further reading: C. Ball, D. Crossley and N. Flavell eds. "Water Power on the Sheffield Rivers". South Yorkshire Industrial History Society 2006

Video of the restoration of Shepherd Wheel: <https://www.youtube.com/watch?v=7g5QVXor7OA>

Fig 1 Cutaway drawing of the main hull and machinery (courtesy of Sheffield Museums Trust)



Supplementary Sections

4. Geography and Geology

Introduction

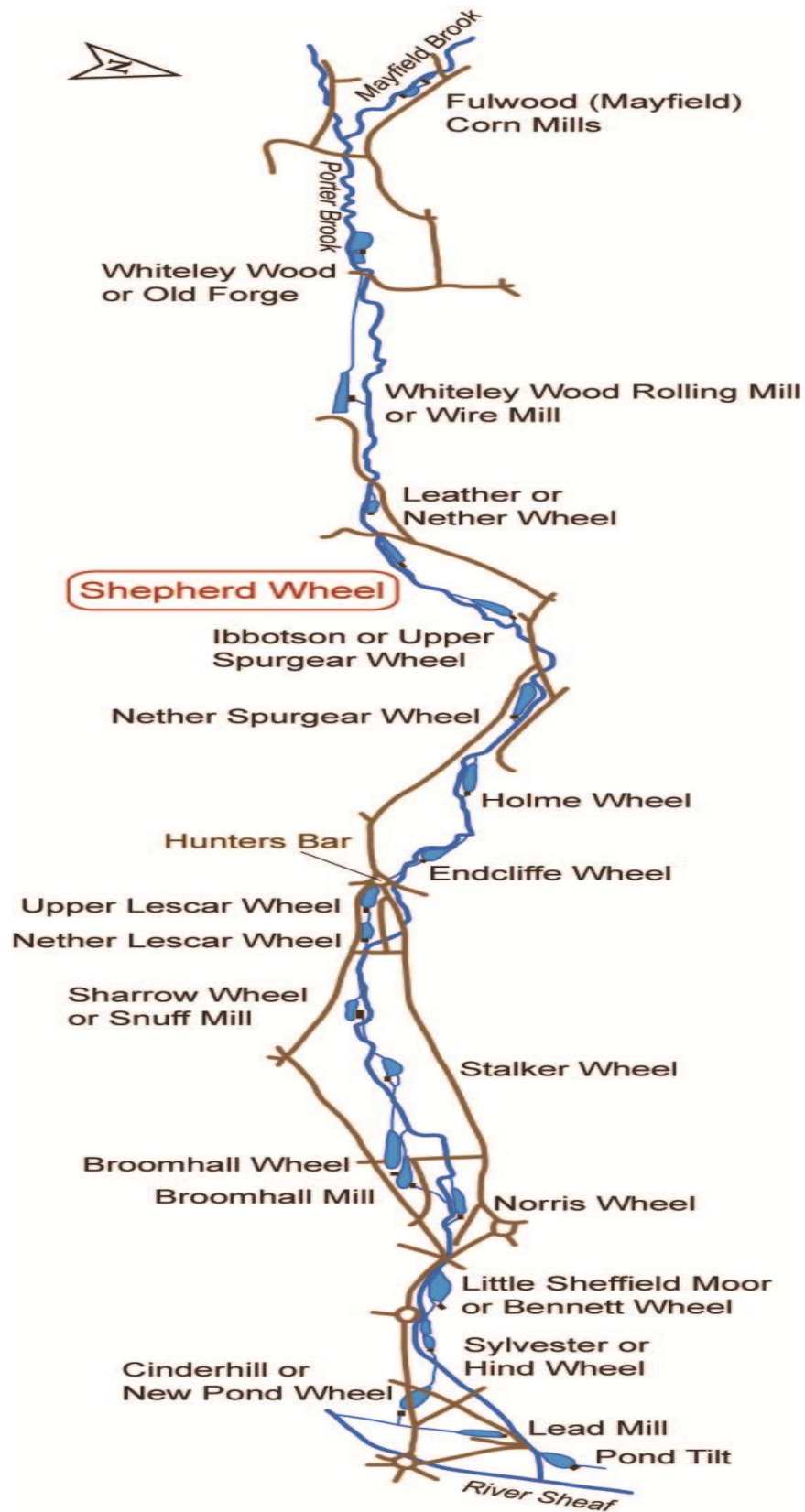
- Sheffield's five rivers (the Don, Rivelin, Loxley, Porter and Sheaf) provided the power, its hills and woods the raw materials for early industry to develop.
- The abundance of iron ore, sandstone (for grindstones) and materials for charcoal and, later, coal supported the development of the metal industries for which Sheffield became famous.
- Water supplied the power to a range of industries carried out on a small domestic scale in the centuries prior to the industrial revolution.
- Many of the industrial sites on the river banks produced cutlery and other edged tools.
- There were over 115 workshops of various kinds in existence along Sheffield's rivers by 1794 (for grinding corn, snuff, blades and to power tilt-hammers). Ponds ('impoundments') were constructed in the river valleys to contain the water flow. By the 19th century the ponds on the Porter Valley served 21 wheels (see illustration below, '*Sites on the Porter Valley*').
- In the early days cutlers used packhorse trails to transport raw materials and finished goods.
- The topography and natural resources suited the development of small-scale industry, but inhibited large scale development.
- Advances in technology– most notably steam-power - led to the development of large-scale urban factories in the nineteenth century and the decline of small-scale industrial sites.
- Shepherd Wheel is the only surviving example of the water-powered blade-grinding workshops on the city's rivers.

Useful additional resources for volunteers

FoPV leaflets: [The Geology of the Porter Valley](#) and [Reading the Landscape in the Porter Valley](#), and [Mining and Quarrying in the Porter Valley](#)

App: [The Porter in Your Pocket](#), an interactive map created by FoPV trustee Robert Peck available on the FoPV website

Illustration: Sites on the River Porter



**Sites on the River Porter – adapted from Ball, Crossley & Flavell (eds) 2006:
‘Water Power on the Sheffield Rivers’, SYIHS)**

4.1 Geography

a. The Rivers

In the early 1700s, Sheffield found itself in competition with Solingen in Germany and Thiers in France in the production of steel-edged blades. But Sheffield had an advantage. Not one, but five rivers with a good fall, fed by a steady supply of water. **These were gifts of geography.** David Hey in his *'Fiery Blades of Hallam'*, speaks of 'the crucial importance of water-power in the triumph of the local cutlery trade.'

- i. The Pennines, formed by glacial activity, are a watershed running down the spine of England. They are also a rain machine. As air comes in off the Atlantic it is forced to rise to traverse the Pennines. It is thus forced to release a lot of water vapour in the form of rain to clear the hills. Rain falling in the South Pennines finds its way to the sea either to the west, via Lancashire and Cheshire, or to the east, primarily via South Yorkshire. Above Sheffield the hills contain a lot of sphagnum moss, acting like a sponge, soaking up and then slowly releasing rainfall into the rivers which then flow into the Don catchment area. This has a moderating effect on the rivers – most of the time, at least. Not too much, not too little. Just right for the provision of a steady supply of water.
- ii. The rivers themselves have a gradient which is ideal for the operation of water wheels. Not too steep, not too shallow. Too steep, and there would be little chance of making full use of the power of the water before reaching the flatter area to the east of Sheffield. Too shallow and the number of wheels would be reduced because of the problems with water 'backing up' in the tail goit and acting as a brake on the turning wheel. The table below gives an idea of the number of waterwheels that could operate as a consequence of this combination of circumstances.

River	Fall in feet	Distance in miles	Wheels*
Don	160	8	30+
Sheaf	400	6	30+
Porter	450	4	19
Loxley	280	6	24
Rivelin	280	3	20

**Numbers are approximate. Different sources provide slightly different numbers. Safe to say that at the peak of water-powered activity, the five rivers had around 150 wheels in operation of which 101 were grinding hulls. See the map on the back of the Visitor's Guide.*

b. Natural resources

In addition to providing a steady supply of water and a profusion of rivers, geography also provided a terrain that supplied a number of natural resources for grinding hulls.

- i. Farm animals. Before the widespread use of oil as a lubricant, animal fat was the primary means of greasing moving parts. Growing out of the rural environment, grinding hulls had a ready and near supply of farms with livestock to provide animal fat. Horse hair was used and forced, using thin chisels, into leaking cracks in the pentrough to create a tight seal. The natural oils on the hair helped seal the crack.
- ii. Rabbit skin was used for making the glue to coat the outside of glazing wheels so that grit would adhere to the wheels.

- iii. The area had access to well-stocked woodlands. In spring 2024, SMT engineers replaced one of the large wooden drums in the hull. They used the same combination of wood as their predecessors – **oak** for strength in the cross beams, **ash** for flexibility in the rim, and **pine** on the edges of the rim to keep the belt running true (useful mnemonic: OAP). Pitch pine was also used for the buckets on the wheel because its resin rendered it relatively water-resistant. Finally, **hornbeam** was a relatively hard wood which more importantly had a spiral grain which meant it could take force (compression) from all angles making it perfect for teeth on the crown gear.

c. Geographical drawbacks.

The hills and moors that surrounded the city provided a natural barrier to trade. However, the establishment of turnpike roads in the middle of the eighteenth century followed by the Sheffield and Tinsley Canal in 1819 and then the railway in 1830 addressed the issue.

4.2 Geology

a. Mineral resources

The Porter Valley, like much of the surrounding area, sits on layers of sedimentary rock. Two of the most important deposits are sandstone and clay. Also occurring slightly further afield are seams of ironstone and coal. **These constitute the gifts of geology.**

- i. Sandstone provided the ideal type of stone for grinding. Not too coarse and not too soft. This was readily available at Brincliffe quarries whose 'Brincliffe Blue' features in much of the housing stock in the area, as well as many of the headstones in Ecclesall graveyard and the General Cemetery.
- ii. Ponds (or 'impoundments') were needed to store water. To ensure the water remained there, the ponds needed lining with impermeable material. Clay was locally available so this was put to use to line the pond walls (known as 'puddling').
- iii. Also available in the Porter valley was 'ganister', a form of clay ideally suited to creating crucibles in a blast furnace, as well as providing the bricks to line the furnace. Although ganister had no value for Shepherd Wheel, it did for places (such as Abbeydale) where crucible technology was used.
- iv. Similarly, the Tankersley seam of ironstone, although not of immediate use at Shepherd Wheel, would provide the raw materials for the furnaces at Attercliffe, Wadsley and Kimberworth that provided the steel that was then used to produce the blades that would be sharpened at Shepherd Wheel. However, this ironstone was of inferior quality when compared to that available from Scandinavia and Europe and, as means of communication improved, imports would increasingly provide the raw material for Sheffield's industry.
- v. There were two seams of coal in the immediate vicinity. One on the edge of the Pennines and another to the east of Sheffield. These would prove invaluable as coke superseded charcoal in furnaces. Small coal pits could also be accessed in the vicinity at Ecclesall and Crookes for the fire in the hull which was needed to dry blades after sharpening – as well as to try and impart some warmth to the grinders themselves, damp after a day spent over a wheel spinning in a trough of water!

4.3 Frequently Asked Questions

a. When and how did the industry start in Sheffield?

The rise of metal industries in Sheffield can be traced back to the medieval period, when the abundance of iron ore, sandstone (for grindstones) and the materials for making charcoal (later replaced by coal), together with a plentiful natural power source in the shape of five fast-flowing rivers (the Porter, Rivelin, Loxley, Don and Sheaf), attracted the construction of corn mills, forges and grinding workshops. Around two thirds of the industrial sites that grew up on the riverbanks produced cutlery and other edge tools. It was originally a part-time activity or cottage industry for the rural population who were familiar with the sharpening process from the treadle-wheel in the farmer's barn for sharpening scythes and other farming implements. It became increasingly specialized as time passed and by the mid-eighteenth century had become a skilled occupation in

enlarged grinding hulls (Mr. Shepherd expanded 'Porter Wheel' as the site used to be known in 1769), organized and managed by 'factors' such as Mr. Eyre who was in charge in 1800 overseeing and coordinating a system based on batch production. It was Sheffield's five rivers that gave rise to the growth of the city as a centre of industry.

A note on the sources of iron. *"The Tankersley seam of ironstone, which ran through Sheffield Park, was used by medieval cutlers and was certainly important in getting the industry established, but it does not account for the subsequent triumph of the Sheffield cutlery industry. Long before the Cutlers' Company was formed in 1624 local craftsmen were working with foreign steel, which they obtained from the Basque Country via Bilbao, from Germany via Cologne and the Rhine, and from Sweden via Danzig and other Baltic ports. Such was the reputation of Hallamshire cutlery that transport costs from long distances could be absorbed in the prices of their products."* (Hey, D., p. 167)

b. What were the limitations imposed by the geography?

Ponds were constructed in the narrow valleys to contain and regulate the water flow, which could be erratic, depending on the weather conditions. In times of drought or in freezing conditions, work could be stopped entirely. There were also occasional arguments between the operators of water wheels, in cases when a site drew off water leaving its neighbours short. The difficulties and dangers inherent in relying on water power were never more apparent than in 1864, the year of Sheffield's great flood, when all of the wheels on the Loxley were swept away.

The song [*The Grinders' Hardships*](#) written for the Grinders' Misfortune Society of Crookes, Sheffield' c. 1804 draws attention to some of the difficulties posed by relying on water power and can be heard on the wind-up listening box in the smaller hull:

*In summer time we can't work till water does appear,
And if this does not happen the season is severe:
Then our fingers are numb'd by keen winter frosts or snow,
And few can brave the hardships that we poor grinders do.
And few, &c.*

c. What remains of these industries?

Very little. The earliest wheel of which we have any details is Shepherd Wheel itself and the last commercially operated survivor was Wilson's Snuff Mill at Sharrow. The report of the CCSA (Council for the Conservation of Sheffield Antiquities) in 1956 came at a time when the decline of the wheels was already far advanced, and only the wheels at Sharrow Snuff Mill, Loxley Old Wheel and Storrs Bridge Wheel remained in use. Further examples of traditional industrial buildings in Sheffield may be seen in the Loxley and Rivelin Valleys (e.g. Mousehole Forge and the Malin Bridge Corn Mill) and, of course, at Abbeydale Industrial Hamlet, although the latter is larger than is typical of sites on the upper reaches of the Sheffield rivers.

The majority of weirs on the Don and Rivelin can still be seen (although buildings survive only at Mousehole Forge on the latter); the Loxley still holds weirs and two wheels (Malin Bridge and Matlock rolling mill); there are few survivors on the Sheaf (Abbeydale being by far the best), and the best sites on the Porter are located in the area shown on the map in the Shepherd Wheel leaflet.

d. Is water power still being used for grinding in Sheffield?

No. Wilson's Snuff Mill at Sharrow operates using electricity. Abbeydale Industrial Hamlet (Thursday to Sunday) and Shepherd Wheel (weekends only) still use water-power to operate the machinery, but this is at a much slower 'museum speed' than was used for grinding.

As well as being open to the public at the weekend, Shepherd Wheel, in common with the other industrial heritage sites, also plays host to pre-arranged school visits during the week.

e. Did they use the millstones that we see in the Peak District? (see also Appendix E)

No. The stones in the Peak District are typically millstone grit. This is a much coarser form of sedimentary stone. It was used for milling wheat or other grains, rather than grinding the edge of a blade, which required much finer grained sandstone.



Grinding wheels made from sandstone.

Sandstone was locally available (Brincliffe was the closest quarry). There is also an example of a carborundum grinding wheel at Shepherd Wheel. Carborundum is a synthetic material made from silicon carbide. It was invented and patented by Edward Acheson in the USA in 1894, so would have only featured at the very end of Shepherd Wheel's commercial life.

f. References

- Bayliss, P., Keeling, C., Axelby, G. 2018, **Walking the Porter Valley**, Arc Publishing, Todmorden, Lancs.
- Hey, D., 1991, **The Fiery Blades of Hallam. Sheffield and its Neighbourhood 1660 – 1740**, Leicester University Press, Leicester
- Symonds, J. (ed.), 2002, **The Historical Archaeology of the Sheffield Cutlery and Tableware Industry 1750-1900** ARCUS, Sheffield.

5. Social History

Who, What and When

- A wheel was probably here in 1536 owned by George Talbot, the Earl of Shrewsbury.
- The earliest documentary evidence of the wheel was in 1566 when it was left in the will of Roger Barnsley in the time of Elizabeth I.
- The name Shepherd Wheel comes from Edward Shepherd who was the tenant from 1749 to 1794.
- The Wheel was used for grinding the cutting edge of cutlery. A wide range of knives and also cutlasses in the First World War.
- Forks and Spoons were not processed here. Cutlery has to have a cutting edge. Spoons and forks are not cutlery but 'flatware'.
- The blanks were made elsewhere and after grinding were also completed elsewhere. An early example of batch production.
- Young boys were employed here. e.g. Sam Hinde started here in 1821 aged 10.
- The Wheel was mentioned in a report by The Children's Employment Commission on Dangerous Working Conditions, 1842.
- Working hours were dependent on the availability of water and daylight but perhaps 10 hours per day when possible.
- The workshop was dingy, noisy and dangerous. Sparks could get into eyes. The dust from the stone and the metal caused lung disease (silicosis). The water beneath the stone meant that the grinder was constantly wearing damp clothing which, with his working position, could leave him with rheumatism. A faulty stone could break causing serious injury or death. A broken stone could throw the grinder into the air; the chains on the saddle/horsing are there to give some measure of protection. There were no guards on the belts.
- Steam power arrived in Sheffield in 1786 and gradually replaced water power. Many of the new factories were huge and built to impress, often styled to resemble country houses.
- As steam power was introduced into the industry conditions worsened. As the hours worked were not governed by water available, working hours could be increased, more men were employed and dust levels increased. The average age of death was 35 years.
- The Wheel was worked commercially until the 1930s. A survey of water powered sites in 1935 shows the Wheel was not in use and the OS map of the same date shows that it is disused.

The History

As seen above the Wheel was left by Roger Barnsley to his son Thomas in 1566.

- In 1584 it appeared in the will of William Beighton, a cutler from Stumperlowe. The Beighton family were connected to the operation for over 70 years as tenants of Lord Gilbert Talbot the Earl of Shrewsbury.
- Upon Talbot's death in 1618 his estates passed to Thomas Howard, Earl of Arundel who became Duke of Norfolk in 1664.
- It is believed that the present large workshop was built in 1769/71 on the site of a smaller building, enabling more men to work here. The dam was also increased in size. The smaller workshop was probably attached in the late 1790s or early 1800s.

- From 1749 Mr Shepherd rented the property until his death in 1794. He employed 10 men. The freehold was sold to John Eyre in 1811. His first tenant was a Mr Hind whose family occupied it for succeeding generations, terminating in the 1930s when all production ceased.

The Grinder

Shepherd Wheel is a good example of a manufacturing unit operating a single process.

- The jobbing grinder would rent a 'trow' and was responsible for maintaining his horsing, belts and pulleys. He would also visit the quarry (Brincliffe was the closest) where he would discuss his needs with the quarrymen, select a stone and negotiate a price.
- He paid rent and worked in his own right, bringing in work and grinding for his customers. Later as the factory system developed, the hull would be operated by one man – a factor - who employed a team of grinders to work for him.
- The working hours for a grinder depended upon the water supply. A drought or a frozen dam could stop him working and as he would be paid on a piece work basis – no work = no pay.
- The Children's Employment Commission in 1865 mentions a 15 hour week for a boy (a fork grinder) but a dry summer meant that he often worked **only** 13 hours. Working after dark by candle light was permitted but considered dangerous!
- Workshops were dangerous. When 'racing' a new stone, the wheel would be operated dry and the dust produced from the stone would enter the grinder's lungs. In the 1920s legislation made employers liable to pay compensation to employees contracting silicosis. This inevitably led to a wholesale change to 'composition' or carborundum stones which produced far less dust. It also led to a call for wet and dry grinding to be done in different areas as dry grinding is far more hazardous.
- Wet grinding presented its own problems as the damp atmosphere and working in wet clothing often resulted in rheumatism. Wet floors were also dangerous.
- If a grinder forgot to lower the amount of water in his trow as he finished for the day this would cause an imbalance increasing the danger. As recently as 1977 a grindstone burst in a Sheffield workshop injuring the grinder.

The System of Supply and Delivery down the Years

From c 1100 to c 1700 in Sheffield the average cutler would make and finish the whole article himself, and would specialise in one or two areas, for instance a table-knife maker, pen and pocket-knife maker, pruning and grafting knife maker, or scissor maker.

They would be responsible for finding the work through a merchant or merchant's intermediary, for finding materials and for every process related to the item, doing everything from forging to grinding to polishing.

They made small runs of items so that it made renting a grinding trough viable

We can pick up the story in 1604 with Thomas Beighton, a cutler of Stumperlowe, the fourth tenant. He paid rent to the Earl of Shrewsbury and a water abstraction rate. He would have ground his own blades in the hull, and rented the other troughs out to others, who were effectively buying power from Thomas. They brought all their own equipment, seats ('horsings') and grindstones.

By the time Edward Shepherd took over the tenancy in 1749, the world had changed. The growth of the American Colonies, sugar plantations in the Caribbean and the global reach of the East India Company meant increased demand for a variety of implements. This was further boosted following Britain's success in the Seven Years' War 1756-63. A nascent middle class in England had an appetite

for ostentation and display, frequently marked by cutlery, crockery and clothing (Boulsover invents Sheffield Plate 1750; Wedgwood's first factory in Burslem 1759; Arkwright's Mill at Cromford, 1771; note also that Shepherd Wheel expanded twice in the late eighteenth century with the main hull being expanded around 1769 and the smaller hull then being added around the turn of the century). Edward Shepherd was no longer merely the tenant grinder. He had a team of grinders to work for him, and he would find the work and negotiate prices. Specialisation and batch production developed. The grinders still used their own equipment, seats and stones and would negotiate a price for their work from which Shepherd would deduct rent of the space, but crucially he found the work. So the grinders were still self-employed, and Mr Shepherd found the work for them and charged rent to use his premises. This is the origin of the 'little mester'. If Mr Shepherd had no work for them, they had the right to go and find their own.

In 1811 John Eyre purchased Shepherd Wheel outright and the developments of the eighteenth century reached their conclusion. Eyre was a 'factor' who not only owned Shepherd Wheel, but managed and supplied work to three other wheels in the valley, co-ordinating the different stages of production between them.

What Happened Next?

The development of steam-power and the growth of large-scale factories spelled the end for many small-scale grinding hulls nestling in the river valleys. As the wheels became redundant, they were repurposed.

- The corn mills in Mayfield became residential as did the button factory at Forge Dam.
- Forge Dam became a pleasure garden and boating lake.
- Wiremill was used by a model yacht society. The 'stepping stones' are the remains of the launching platform.
- Holme Wheel (the wheel above Endcliffe Park café) became a boating lake.
- Endcliffe Wheel became a swimming pool for men only! (see Footnotes p. 22ff)
- All the remaining dams above Hunter's Bar were included in the designs for the new parkland, drawn up by [William Goldring](#), a famed Victorian landscape and garden designer.
- Below Hunter's Bar most of the wheels and even the river itself have disappeared. Clues can sometimes be found in road names etc. eg Snuff Mill garage, The Lescar pub, The Leadmill, Ponds Forge.

FAQ

***Why is it called Shepherd Wheel?**

After Mr Shepherd who once worked here. He was neither the first nor the last, but it may be connected with the expansion he undertook to 'Porter Wheel' (the original name) in 1769.

***How many people worked here?**

Mr Shepherd employed ten men but at its peak, twelve worked in the large hull, and six in the small.

***Did children work in the cutlery industry?**

Yes - see the note above about Sam Hinde aged 10.

The Commission also mentions a girl aged 6 sitting on a high stool in order to reach her work.

***What would they do if one of the men got a spark in his eye?**

A spark or 'moit' would be painful and could lead to permanent damage. A colleague would give first aid in the form of licking the affected eye with his tongue.

***Did anyone have a fatal accident here?**

Yes – in 1901 a grinder called Samuel Hinde, aged 57 was racing a stone when it broke. It hit him on the head and he died 4 days later of his injuries. (See Footnote P21 for more details.)

***What is 'racing a stone'?**

Before a new stone could be used the grinder would need to be sure that it was smooth and flat all across and all round. He would set the stone turning and use an array of tools to scrape the surface until he was satisfied that it was fit for purpose.

***How long would a stone last?**

It depends on how much it was used, possibly 4-6 weeks. When it was worn down to about 2 feet it became known as a 'Cowk' and was too small for the work here. It would be sold on to a pocket knife grinder who was grateful that he had a stone that had been both balanced and raced. He would split it into two stones, use these for around two to three weeks then sell on to a razor grinder who would again split the stones to form even thinner working surfaces with which to hollow grind the old-fashioned open razor or as the Americans called them cutthroat razors. Grinders prided themselves in trying to make as much profit on the resale of stones as they could!

***How fast would the stone turn when in use?**

The maximum speed of the water wheel was 6 rpm giving a peripheral speed of 2,500 surface feet per minute (sfpm) on the grindstone. Steam powered wheels could increase this to 4,000 to 6,000 sfpm. Later electrical wheels could reach 15,000 sfpm.

***How many blades could they do in a day?**

A popular question asked by the public. The answer depends on a number of factors

- The type and size of blade or spring they were grinding.
- The quality of the hammering by the blacksmith in the forge
- The ability of the grinder

- The time of year – summer could work longer hours. Note that all the horsings face windows so that natural light from the window falls onto the working stone. The windows did not have glass in them.

Thus, rough estimates are as follows.

- Table knives, large pocket knives and springs for pocket knives – up to a gross a day (144).
- Smaller pen blades for quills – 80 a day. Fiddlier, harder to grip in grinding pliers
- Filleting knives and butcher blades – 5- to 60 a day. Needed the removal of a large amount of metal.

Some blades – particularly for pocket knives – would go back and forth up to eight times for different processes: first grind for removal of hammering marks; second and third grind for setting the tang and the shape of the spine; fourth grind to put in a Ricasso and a fifth and final finish grind.

***Who dug the ponds?**

The source of labour largely came from places like the workhouse. As early photos of the Sheffield Workhouse show there were huge numbers of men who were temporarily out of work and they were a source of manpower. Superintendants would be paid a sum, but the labourers would be fed and paid a small remuneration as well. Workhouses were largely run on charitable donations so feeding the people in the workhouse was costly, to be able to 'farm out' some of your residents reduced your overheads.

People often saw staying in a workhouse as a temporary stop-gap until they could find more permanent employment. Yes the conditions were harsh, but the workhouse was the only place you could go to before the social welfare system.

***Isn't it lovely that they had a fire to keep them warm?**

The fire was there to dry the blades as they were wet from the grinding process and before stainless steel was invented in Sheffield in 1913, they would go rusty. This Yorkshire range probably came from the farmhouse over the river when it was demolished. It would not be effective in keeping the men warm.



**Harry Brearley –
Inventor of Stainless
Steel.**

**Shepherd Wheel showing the
farmhouse, the bridge and the
ford.**



***Did women and girls work in grinding hulls?**

No. Grinding was a male preserve. At Abbeydale Industrial Hamlet, another of SMT's museum sites, women worked in the Hamlet, but on the opposite side of the courtyard from the grinding hulls, in the packing department. Elsewhere, women worked in their own skilled employ as buffer girls, polishing cutlery in workshops in the city centre.



Buffer Girls

***Where can I buy Sheffield cutlery?**

The Millennium Gallery, Kelham Island Museum, The Famous Sheffield Shop on Ecclesall Road, the David Mellor factory/shop/museum/café in Hathersage (unfortunately items bought here will not carry the 'Made in Sheffield' mark although Hathersage has a Sheffield post code and his first workshops were in Broomhall, Sheffield 10).

***Where can I learn more?**

- Take a walk from Hunter's Bar to Forge Dam. Friends of the Porter Valley have marked all the sites of other grinding hulls in the Upper Porter Valley with posts with historical information about years of operation and numbers of grinders working there.
- Use the '**Porter Valley in Your Pocket**' smartphone map and guide as you walk in the Porter Valley. This describes the features that you can see. The link is on the front page of the FoPV website (<https://fopv.org.uk/map>) or from the QR code available in Shepherd Wheel.
- A walk in the Rivelin Valley is interesting as many sites have information points.
- The Abbeydale Industrial Hamlet is also worth visiting to learn about crucible steel making and scythe manufacture and to see the water wheels.
- Visit the Ken Hawley Gallery at Kelham Island Museum.
- Read about the 'Name on a blade' project.
- Visit The Millennium Gallery in the city centre

Footnotes

Fatal Accident

On the 31st May 1901 a grinder called Samuel Hinde aged 57, who lived at 7 Ranmoor Road, was killed by a grindstone which broke as he was racing it. The stone hit him on the head and he died 4 days later of his injuries.

A report in The Sheffield Independent on 22/6/1901 stated that an inquest was held at The Ranmoor Inn. Mr H Warren, HM inspector of factories, attended the inquiry. Sam Hinde, son of the deceased, said that his father rented the wheel from the Corporation. About 10.30am the deceased was racing a grindstone which had been hung a short time earlier. The stone was 3ft 11inches in diameter and about 9 inches in width. It had been purchased from Messrs Ellis and Sons of Silverwood. Whilst the deceased was racing it, it suddenly broke in two, the back part of it hit the deceased on the head and knocked the tool with which he was working against his chest. The blow made him insensible. He was conveyed home, a doctor was called and attended him until his death on Tuesday night. After the accident a witness had heard the deceased say that he attributed the breakage of the stone to having had a fall before leaving the quarry. Thomas Wilfred Hinde, nephew of the deceased, also gave evidence. He said that the stone was only revolving at half the usual working speed and that the deceased had not been working on it for more than five minutes before the accident happened. In his opinion the stone had been dropped before it was sent to Sheffield.

The jury returned a verdict of "Accidental death".

Endcliffe Bathing Pool

In 1886 Sheffield Corporation purchased 20 acres of Endcliffe Wood for public use. The dam at Endcliffe Wheel was converted for use as a swimming pool for boys and men to bathe. However, the pool always attracted unwanted attention due to mud and debris washing into it from the adjacent banking.

In 1896 a local paper said that 'the water is almost stagnant, in some parts the floor is quite a foot thick with mud and refuse, whilst in other places there is nothing but glass and stones'.

In 1904 the paper stated that 'This pool would be a source of health-giving pleasure to hundreds of men and boys, were it only made clean and kept free from the rubbish which now pollutes it'.

Nevertheless, a group of swimmers calling themselves 'Water Rats' took to it all year round. To qualify as a Rat one had to swim winter and summer for a period of 6 years. There was even an office of 'King Rat' a position which was held in 1916 by Mr Walpole Hiller who had started in about 1894 although Mr C Foster had taken his first dip in 1891. There was a tradition of a Christmas Day swim starting at 9.30am and followed by mince pies, rum and coffee.



The Water Rats at Endcliffe Bathing Pool

Unfortunately, there were complaints about the behaviour of young women and girls who would position themselves with a view of the bathers and make lewd comments and behave badly.

In 1909 a newspaper report referred to 'A type of woman, and also girls, whose idea of modesty seems to be at a low ebb, persistently come behind the railings on the far bank, and also into the enclosure itself. Many of the men are nearly naked. And some of the boys quite so. A park keeper reports coarse language at times'.

The pool was closed for cleaning in 1938 and never reopened. It was filled in and its position is marked by a FOPV marker post close to the children's playground.

The Sheffield Outrages

The 1850s and 1860s in Sheffield was a time of great unrest amongst those employed in the cutlery trades. It was alleged that some employers were not paying the union rates of pay; some were taking on too many apprentices and not keeping them in employment when their training was complete. Some people were refusing to even become members of a union or neglecting to pay their subs. The unions decided to fight.

Led by William Broadhead of the Saw Grinders Union, a campaign of intimidation – '**rattenings**' - was conducted against all those who were deemed 'obnoxious to the trade'. Sometimes the victim would find that his belts had been stolen or cut, in order to prevent him working. Sometimes gunpowder would be slipped into the chimney at his works, or his home set on fire. Eventually the violence became murder.

In 1866 the government set up a Royal Commission on Trade Unions. The commission was able to give a free pardon to those who pleaded guilty and gave evidence. James Hallam admitted that he had been hired by Broadhead to take on murderous assaults, along with George Chance and Thomas Irwin Berstow. James Linley had been accused of taking on unlawful apprentices and had been shot dead whilst enjoying a beer in The Crown Inn (now known as The Crow). Thomas Fearnough had a can of gunpowder thrown into his cellar in retribution for taking on illegal apprentices. There were many such instances of this behaviour.



William Broadhead – General Secretary of the Saw Grinders Union, Sheffield, 19th century

Broadhead was found to have been the instigator and he emigrated to America in 1869 although he returned in 1870, having been unable to find work.

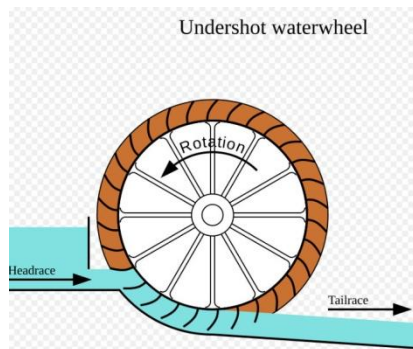
Rattenings continued on a much diminished scale. 56 cases were reported between 1867 and 1887. Finally in 1871 the Government passed a law giving trade unions legal status allowing funds to be collected. In 1875 peaceful picketing became legal allowing strikes to take place.

6. Engineering

6.1 Introduction: Types of waterwheel

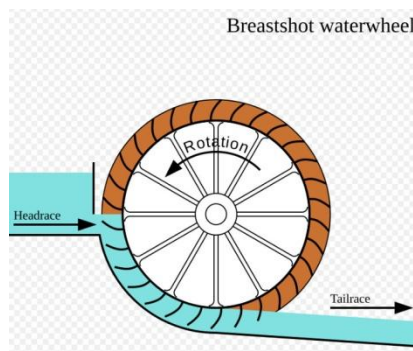
There are three principal types of waterwheel (all in-text numbers refer to the cutaway drawing on p. 27).

1. Undershot wheel



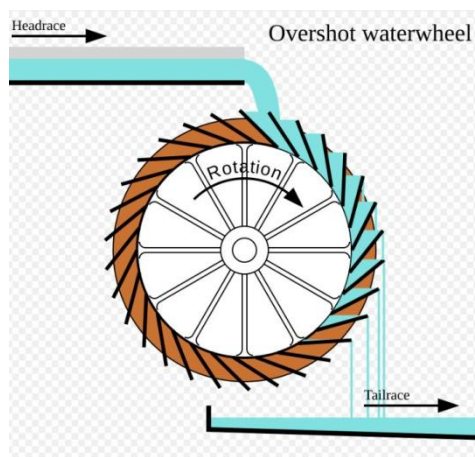
A flow of water passes under the wheel pushing against paddles. This is the least efficient type, being only 20% efficient. From the 18th century onwards design changes increased this to 50% to 60%. It would require only a relatively small head and fall of water.

2. Breastshot wheel



Water is held in a pentrough and the released flow rotates the wheel by falling water striking buckets near the centre of the wheel's edge. This type of wheel is more efficient than the undershot wheel, being 50% to 60% efficient.

3. Overshot wheel



Water is held in the pentrough (1) above the wheel and released to shoot over the top filling the buckets on the farther side and acting chiefly by its weight. This is the most efficient type, being 80% to 90% efficient. Shepherd Wheel is an example of an overshot wheel.

The engineering involved at Shepherd Wheel should be considered in two parts; water management, and the machinery of the Wheel itself.

6.2 Water management

Shepherd Wheel is one of twenty-one on the Porter Brook, and the operation of the waterwheel is dependent on what happens upstream. The water is stored in what are correctly called ponds, but in Sheffield they are all referred to as dams. Strictly speaking a dam blocks the flow of the entire river or stream, releasing it to flow downstream in a controlled manner. The only true dam on the Porter Brook is the Forge Dam, all the others are ponds.

Thomas Boulsover is thought to have built both Forge Dam works and the works at Wire Mill at roughly the same time. Forge Dam provides two routes by which water can continue downstream. The first is over the spillway, following which some passes through a shuttle and along a goit alongside the footpath to empty into the Wire Mill Dam, while the remainder follows the course of the river. The second is through the wheel pit behind the cafe where it used to provide the motive force for a wheel and then through the tail goit passing under the new children's playground and then rejoining the Porter. (Although now silted and with a shallow flow of water, this goit was originally 4ft 6in wide and 5ft deep and involved the removal of over 700 cubic yards of material.) Wire Mill originally had two dams, each driving a 35ft diameter waterwheel, which in turn drove a rolling mill. It later became used as a grinding wheel, then later as a Wire mill.



Thomas Boulsover – Inventor of Sheffield Plate, 18th century

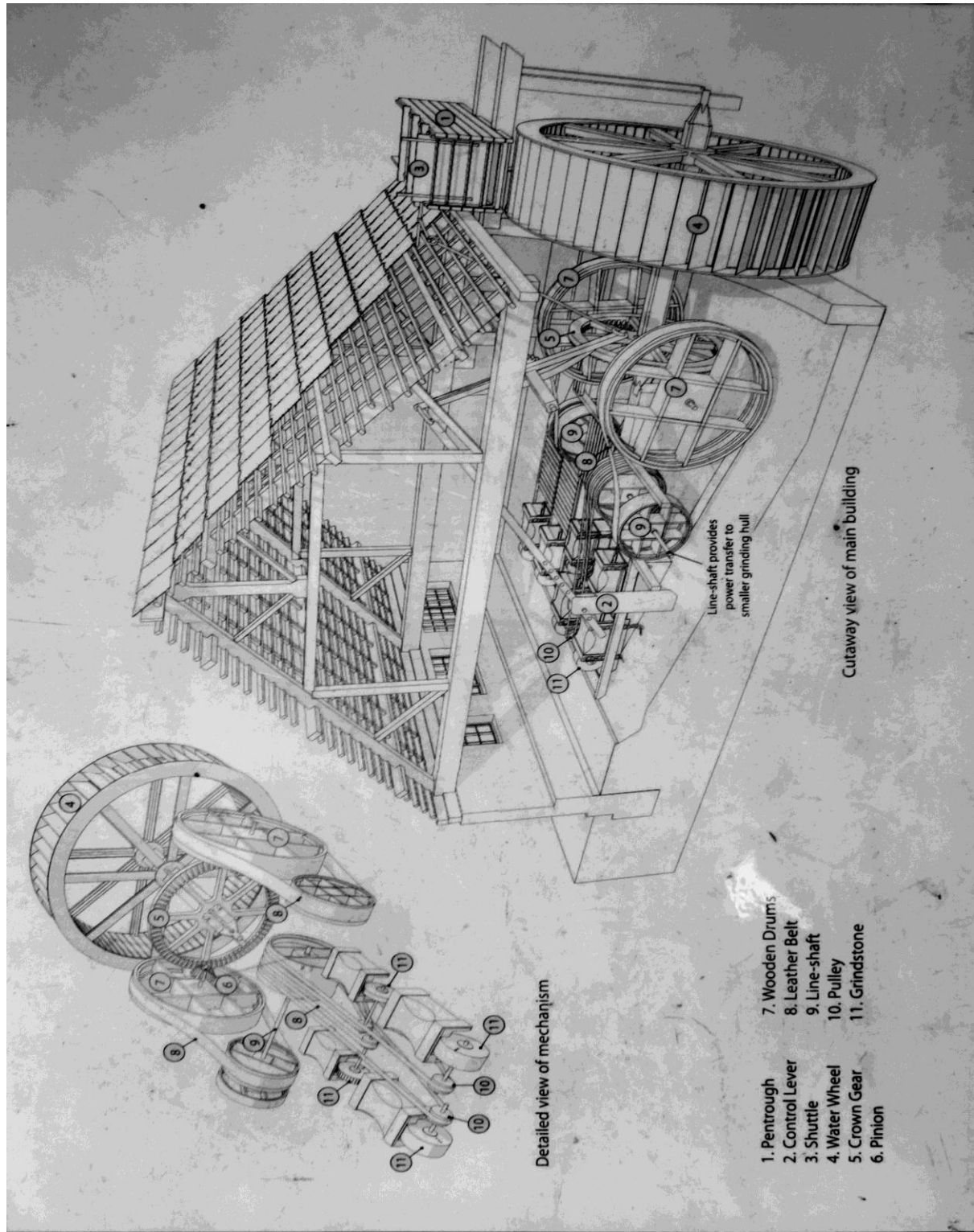
Crinoline wire for dresses was manufactured at Wire Mill



Immediately upstream from the Hangingwater Bridge was the Holme or Leather Wheel, whose dam was the now wooded area between the site of the wheel and the weir immediately below Whiteley Wood Road. This wheel was demolished in 1907 and the dam reduced to a goit with the remaining dam left to silt up. (This was one of two dams on the Porter with the name Holme meaning a damp place. It's other name, Leather Wheel is the subject of conjecture, There are two theories to explain the name: it may derive from the wheel being used in the grinding of oak bark for use in the tanning of leather, the other explanation suggests tanning was carried out on the site with its copious supply of water and the wheel as a source of power, No supporting evidence for either theory has been forthcoming!)

From this dam the water rejoined the Porter. It then reaches Hangingwater Bridge, where two weirs divert the water into Shepherd Wheel Dam via a shuttle. At the Wheel end of the dam there is an overflow by the building, and a further shuttle controls the flow of water into the pentrough (1).

Yet another shuttle (3), controlled from within the hulls (2), allows water to flow over the overshot water wheel. Having passed over the waterwheel the water returns to the Porter via an underground culvert to rejoin the brook some 100 metres downstream.



Cutaway view of main building, Shepherd Wheel

6.3 The Machinery

The Machinery in the Halls

Within the hull and on the same shaft as the waterwheel (4) is the Crown Wheel (5). This is fitted with wooden teeth, which mesh with an iron gear (7) on either side. The wooden teeth are held in place by wedges, so that wear is on the wooden teeth which can be more easily replaced without dismounting the crown wheel.

On the shaft of each metal gear there is a large diameter drum, (7) each of which drives a further drum (9) via a belt.(8) The belts would originally have been of bull hide, but are now a woven man-made material. The left-hand drum is connected to the various wheels in the main hull, and the right-hand drum drives a line shaft (9) which passes through the party wall into the smaller hull, where the arrangement of belts, pulleys and grindstones mirrors that in the main hull.

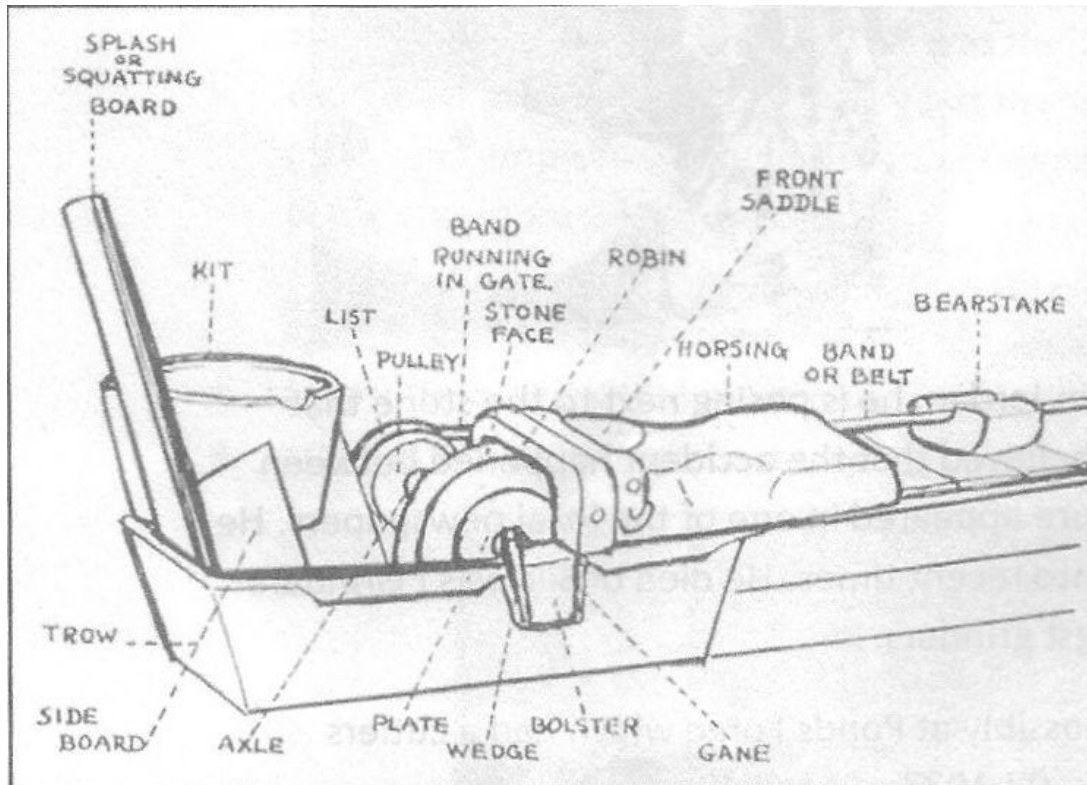
These drums via several belts are attached to pulleys (10) which are mounted on the same shafts as the grindstones, glazing wheels etc.

The speed of the grindstones can be varied by controlling the amount of water flowing onto the waterwheel, or by changing the size of the pulley. The pulleys split into two sections held in place by pins. Thus the pulley can be changed by disconnecting the relevant belt and splitting the sections and assembling a new one. The grindstones were originally of sandstone, locally quarried, the nearest sources to Shepherd Wheel being at Rivelin and Brincliffe, though the best quality stones are said to come from the quarry at Wickersley near Rotherham. Nowadays the stones have been replaced by carborundum wheels which are harder wearing and produce less dust.



The grinding at Shepherd Wheel was 'wet grinding'. The grindstones are mounted in a pit, in the bottom of which is water. The water level is adjusted so that the rotating grindstone touches the surface of the water producing a thin film on the surface of the stone. This is to keep the blade cool while being ground. If the blade becomes too hot it will soften. When the grindstone is not operating the water level has to be dropped so that the stone is clear of the water. This is done by simply placing a stone in the water to raise the level, and removing it to drop the level again. If the grindstone were left touching the water while not turning it could absorb water on the lower side and become unbalanced. When next revolving at speed, this in turn could cause the stone to fracture and 'explode' with potentially fatal consequences for the grinder.

The Grinder's workstation



The grinder half sat/half stooped on the saddle-like horsing and leaned forward, holding the work on the grindstone. Often the work would be held, in the case of pen or pocket knife blades, in a pliers-like tool, or in the case of larger blades a shaped piece of wood called a flatstick.

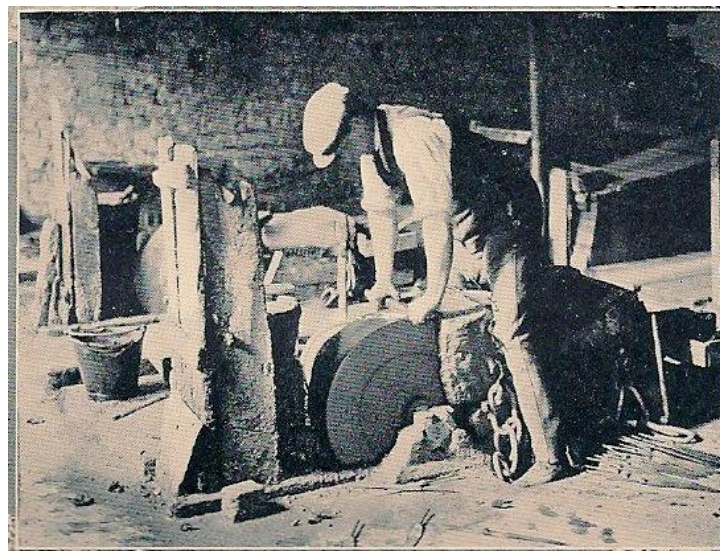


Table knife grinding at Shepherd Wheel.

6.4 The Grinding Process

1. A blade would undergo several stages between the blank and the finished blade. The blade would be forged and roughly shaped by a smith, then passed while still soft to the grinder. He would refine the shape and remove the hammer marks.
2. The blade would go back to the hammersmith for hardening and tempering.
3. The blade would come back to the grinder who would shape the spine and tang and grind the sharp edge.
4. Next the blade would be passed to an apprentice (usually aged between 14 and 20) who would use a **Glazing Wheel** to remove the scratches left by the grinding process. The Glazing Wheel was a wooden wheel, the circumference of which was covered in leather. This was then coated in glue and rolled in graded grit or silver sand.
5. The next stage involved using another wooden wheel similarly covered in leather and perhaps treated with a little oil/grease/fat. This would remove the excess metal on the edge of the blade after it had been sharpened to a fine edge. This process was called **Bearding**.
6. The final process was called **Whitening**. This would give the finished blade a 'frosted' finish. Most people could not afford to have **mirror finished** blades so frosting was considered the 'standard' finish. This was achieved using a wheel that was thinner, segmented and had a greater diameter than glazing wheels as a greater speed was required. Like the glazing wheel this had leather on its circumference but which used a mixture chalk and tallow applied to the leather.

(Whitening could also be done on a stone such as Brincliffe blue stones which were grey/blue in colour and softer than most sandstones, being closer to shalestone.)

Mirror polishing. Mainly used on high-end table knives and canteens of silver cutlery. A soft rouge brick (Ferric Oxide) with the consistency of a bar of soap and dipped in a medium such as paraffin or thinners or a thin clear oil applied to first calico and then swansdown (a very fine form of brushed cotton) mops that revolved on spindles driven by water wheels or later steam driven line shafts.

The horsing has chains attached to the sides. These are used as part of the process requiring the horsing to be raised and lowered on blocks. This was because the size of the grindstone would vary as it wore down, and the grinder needed to maintain his working position relative to the grindstone. For example, a table knife grinder would begin with a stone 4 to 5 feet in diameter so the height of the horsing would need to be set accordingly. As the stone wore down the diameter reduced so the height of the horsing would be adjusted by removing blocks. The purpose of the chains was to prevent the horsing and thus the grinder being thrown backwards in the event of a stone fracturing. As the height of the horsing changed, so the chains could be adjusted link by link.

During wet grinding (as at Shepherd Wheel) the waste thrown off in the grinding process, consisting of a mixture of stone fragments, metal fragments and water are caught by the splash or squatting board. This material (called swarf) then solidifies and can be seen as a piece of rough reddish material, the colour due to the metal content.

Forks, needles, brace bits and spindles were entirely dry ground, while scissors and razors went through both processes. Dry grinding was much quicker, and men were paid by the piece, so when during the 19th century wage rates were reduced dry grinding became more common.

6.5 Life Expectancy

In 1865 the Sheffield Public Hospital recorded that the average age of living fork grinders was 29, scissor grinders 32, edge tool and wool shear grinders 33, and table knife grinders 35.

Many people visiting Shepherd Wheel will have heard stories about the short life expectancy of grinders. While it's true grinding was a hazardous business, the short life of a grinder was attributed to what was called Grinder's Asthma. This in fact was a form of silicosis caused by breathing in the tiny fragments of stone dust from the grindstone. At Shepherd Wheel the work done was wet grinding (see above). This along with ventilation greatly reduced the amount of dust. We know of two grinders at Shepherd Wheel who were interviewed in 1865 who began working there aged 9 and 10, who at the time of the interview were aged 44 and 54 respectively. The grinders whose life expectancy was 30 to 35 were predominantly involved in dry grinding, usually in large workshops driven by steam power, with no dust extraction or ventilation, leading to a buildup of dust in the atmosphere. In 1843 a study of 97 grinders employed in dry grinding of forks found that only 30 reached the age of 30.

(The amount of metal fragments produced in grinding is illustrated by razors. A dozen razors weighing 2lb 4oz when roughly forged would be reduced to 1lb 15 oz on the dry stone and to 1lb 10oz on the wet. Thus in shaping the dozen razors 10oz of steel would be released, and the stone of 7inches diameter would be reduced by about an inch.)

6.6 Maintenance

A new grindstone received from the quarry would have to be balanced and the surface levelled and prepared by a process called 'Racing'. This involved running the dry stone and holding a piece of steel against the surface until all unevenness was removed. The surface would then have very small chippings removed across the surface.

A similar process would be repeated perhaps several times a day to remove imperfections and tiny fragments of steel as the surface wore down,

All the numerous bearings would be greased every day. Originally mutton fat would be used but later mineral oil lubricants would take over.

The axles of the grindstones sat on bearings made of lead. As these wore out they would be replaced and the scrap old bearings melted down to cast new ones.



Preparing a grindstone.

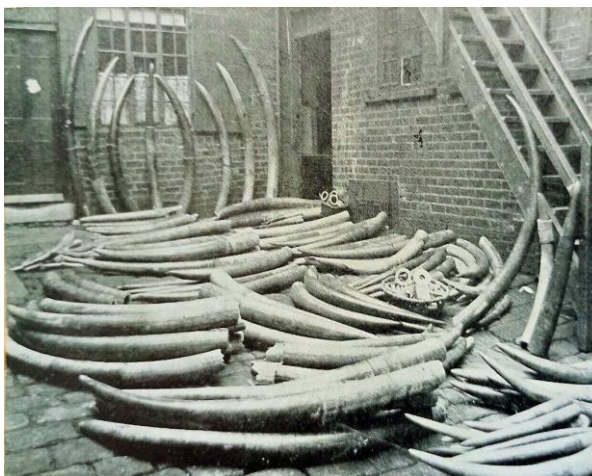
(This is actually at Ibbotson wheel but illustrates the process. A tool like the one being used can be seen on the horsing at Shepherd Wheel.)

According to *The Grinder's Song* (among other sources) the actual water wheel would have to be stopped, sometimes several times a day, for maintenance and running repairs. Where the wheel had to be stopped for a period, there was frequently an informal reciprocal arrangement between owners of the wheels that the grinders could use any spare trows at neighbouring wheels until their own was running again.

6.7 What came next?

Blades would be sold to a hefter, whose job it was to fit the handles. This was a separate trade, and was regulated as early as 1590 under rules laid down and adjudicated by the Earl of Shrewsbury, Lord of the Manor of Hallam. The regulation stated that "No cutler or hefter of knives to supply chapmen with unhefted blades and no blacksmith to make or sell blades. Cutlers were forbidden to heft blades themselves."

The handles of everyday domestic cutlery and flatware would be made of cow horn or cow bone. The top of the market tableware would have handles of African ivory, and at one time Sheffield was the biggest importer of ivory in the UK and possibly Europe.



Delivery of African ivory at John Merrill & Co Sheffield

6.8 Engineering FAQ's

Q: How fast do the grindstones turn?

A: Since the grindstones vary in size and wear down with use, what the grinder was interested was the surface speed of the stone, measured not as revolutions per minute but in feet per minute. Depending on the type of work the speed would vary between 2500 and 4500 feet per minute.

Q: How big is the waterwheel and how much power does it generate?

A: The waterwheel is 18ft in diameter and 6ft wide, and generates approximately 13 horsepower. N.B. When this was in full operation the waterwheel would be turning at approximately 6 times the speed you see. See Appendix F for calculations.

Q: Why don't you use the waterwheel to generate electricity?

A: Several years ago the City Council commissioned a survey into the viability of generating power from the Sheffield rivers. The report concluded that of the 5 rivers, only the Don was capable of generating economically viable power. Since then turbine design has advanced, but Shepherd Wheel is a scheduled ancient monument and governed by very strict rule as to what can and can't be done. (Incidentally that's why we are allowed to burn coal in the fireplace despite air quality rules!)

Q: Why don't they use the grindstones you see scattered around the edges in the Peak District?

A: The grinders used sandstone grindstones as they were made up of fine particles whereas those in the Peak District are gritstone which is much coarser and frequently contains pebbles or quartz grains. See Appendix E for more detail.

Q: Why the fireplace?

A: The fire served several purposes. The blades were of steel, and after being ground would be wet. If they weren't completely dried then they would quickly rust. (Stainless steel wasn't invented until 1913 by adding a small amount of chromium). The blades could be placed in front of the fire (or in the oven!) until they were completely dry. In addition, the grinders' clothing would be wet from the water thrown off by the grindstone, and the wooden rail would be a convenient place to dry them.

Q: How does the water get back into the dam after it has passed over the waterwheel?

A: It doesn't. The dam gets its water from the brook at the far end of the dam. Once it has passed over the wheel it is returned to the brook. It's then available for the process to be repeated at the waterwheels further down the valley.

Q: Why do some grindstones have a square hole and others a circular one?

A: Square shafts were originally used to stop the stones spinning as they would on a round shaft. The problem with square holes was the weak point at each corner of the holes where cracks would appear prior to a break. The cracks would often appear as the square holes were chiselled out. Square holes also tended to limit the size of the stone you could use.

The problem of putting large grindstones on round shafts we think was solved in the late 1700's and early 1800s when methods for putting large 'screw threads' half way down a shaft were found. This meant you could put a large stone with a round hole onto a round shaft and put a round iron (later steel) plate either side and then tighten the whole assembly with a large nut either side, to stop the stone spinning on the round shaft.

Appendices

A: Glossary

Glossary: key terms used in this guide

Cutlery – any implement with a blade for cutting food

Flatware – typically, forks and spoons. See <https://www.cutlery.uk.com/cutlery-vs-flatware/> for a detailed account of the development of the usage of the terms ‘cutlery’ and ‘flatware.’

Goit or **goyt** – a channel dug to allow water to enter a pond or to escape back to the river having turned a wheel. The head goit grants entry, the tail goit escape. Wire Mill has the most impressive head goit. Shepherd Wheel the best tail goit.

Grinding Hull – the building in which grinding took place. Shepherd Wheel has two hulls – a larger and a smaller. The word ‘hull’ is thought to derive from Old English for ‘pigsty’!

Impoundment – an old term for a pond, a space dug to hold water.

Moit – a fragment of sandstone or steel that flew off in the grinding process and could embed itself in the eye of the grinder.

Pentrough – the box above the wheel into which water from the pond was released before flowing onto the wheel.

Ricasso – unsharpened section of the blade just above the guard or handle. This can offer greater blade strength at a key point, and allow the user to grip it providing greater control.

Shuttle – a device which could be raised or lowered to admit or exclude water. Thus a head goit had a shuttle which was raised to admit water into a pond and a shuttle was also used to allow water to flow over a wheel from a pentrough. Such a device in a pentrough may also be called a ‘penstock.’

Swarf – the collective term for small particles thrown off the blade and the stone in the course of grinding. Most of it ended up on the swarfboard in front of the grinder (the nearest grinding stone to the visitor in Shepherd Wheel has just such a board), although occasionally some would end up in his eye (see **moit** above)

Weir – has many uses (flood control, aid to navigation etc.). In the context of waterpower, it is a raised obstruction built on the bend of a river to deflect some of the water into a head goit and then to a pond. Although much of the evidence of the existence of water-powered grinding hulls has gone from Sheffield’s river, the weir is the element that most frequently remains.

B: Shepherd Wheel - Timeline

- 1086 Domesday Book shows the population of Sheffield as 14 households, 5 villagers, 5 smallholders and 4 slaves. It also records a waterwheel in Leeds
- 1297 Robertus the Coteler's tax return shows that the industry was here
- 1400 Chaucer writes in 'The Reeve's Tale' about a miller: "*A Scheffeld thwitel bar he in his hose.*"
- 1536 George Talbot, The Earl of Shrewsbury owns the Wheel**
- 1566 The Wheel 'In Portere Field' is left by Roger Barnsley to his son Thomas in his will**
- 1584 The 'Potar Wheel' is now operated by the Beighton family until 1637**
- 1587 Court case with the Earl of Shrewsbury v Nicolas Strelley over ownership of the Wheel**
- 1624 Sheffield Cutlers Company established by Act of Parliament
- 1637 The Wheel is now used by William Beighton, Ralph Pursglove and William Forrest**
- 1664 – 1679 The Wheel, now owned by the Duke of Norfolk, is not operating**
- Late 17th century The Wheel is operated by Joseph Hynde**
- 1698 The Marshall family take over the Wheel until 1741**
- 1743 The Wheel is operated by Henry Hall**
- 1749 Edward Shepherd takes over at the Wheel with which his name becomes synonymous**
- 1750 Thomas Boulsover "invents" Sheffield Plate
- 1765 James Watts invents the steam engine
- 1773 Sheffield Assay office is opened
- 1786 Steam power comes to Sheffield (Proctors on the River Sheaf)
- 1794 Mr Shepherd's son in law (Thomas Kinnersley) in charge, followed by Anthony Thompson, then John Eyre takes over**
- 1811 John Eyre buys the freehold of Shepherd Wheel and the Hinde family are his tenants until it closes in the 1930s**
- 1845 Opening of the railway to Manchester giving Sheffield access to the port of Liverpool and the American trade
- 1847 'Rattening' takes place at Upper Spurgear Wheel
- 1851 Sheffield has 10,400 cutlers. At The Great Exhibition Sheffield exhibitors win 60 medals
- 1852 A report shows that 70% of grinders cannot write their own name
- 1856 Henry Bessemer developed The Bessemer Converter
- 1857 The Factory and Workshops Act introduces reduced working hours, prohibits the employment of children and introduces disease compensation schemes.
- Composite grindstones not containing silica are also brought into use
- 1859 *The Outrages* cause huge industrial problems; cutler James Linley is shot dead
- 1860 Steelmakers are admitted into membership of The Cutlers Company
- 1890 Shepherd Wheel transfers to Sheffield Council. The Hinde Family are still tenants**
- 1900 Sheffield Council buys Whiteley Woods
- 1901 Samuel Hinde dies following an incident at SW when a stone he was racing broke**
- 1911 The number of people employed in the steel industry now exceeds those employed in cutlery
- 1913 Harry Brearley invents/discovers Stainless Steel
- 1920 Legislation makes employers liable for health and safety of employees
- 1930s Commercial production at Shepherd Wheel ceases; the Master Cutler obtains permission for occasional open days to demonstrate the grinding process**
- 1957 The Council votes £500 for demolition of Shepherd Wheel but is persuaded to use it as a restoration fund**
- 1962 Shepherd Wheel opens to the public following restoration; sadly it eventually closes and becomes semi derelict**
- 2010 – 2012 The Friends of Porter Valley, the Council, the Lottery Fund, Sheffield Industrial Museums Trust and others complete a conservation project enabling Shepherd Wheel to open to the public once more**
- 2012 The newly restored Shepherd Wheel is officially opened**
- 2022 The Friends of Porter Valley are presented with The Queen's Award for Voluntary Service**

C: How the Wheel was Saved

When Shepherd Wheel was born again

By the early 2000s the grinder's workshop known as Shepherd Wheel had ground to a halt. The building, the machinery and the dam all needed a substantial rebuild..... but were facing the threat of demolition like virtually every vestige of Sheffield's old Waterpower History.

Sheffield's cutlery roots lie in its V-shaped western valleys with their reliably flowing waters, sandstone quarrying, workable ironstone deposits and harvestable timber. If there hadn't been a successful knife making industry here in the Middle Ages, Sheffield might have had a very different industrial and social history in the 19th and 20th centuries and never earned the moniker of City of Steel.

The Friends of the Porter Valley charity raised funds and lobbied Sheffield Council in 2009 to restore the Shepherd Wheel to working order again. It had often been referred to as the jewel in the Valley and eventually a consortium of Council, Industrial Museum and Friends of the Porter Valley was awarded a Heritage Lottery Grant to drive through the work. Key players were Dr David Crossley who had written the seminal work on Waterpower history; members of the FoPV; the Chair of the Sheffield Industrial Museum; and representatives of the Council. This tri-partite structure worked well and on 12 May 2012 the Shepherd Wheel was officially reopened by the Deputy Prime Minister and Hallam MP the Right Hon. Nick Clegg.



The crown gear before restoration



The plaque commemorating the reopening

Additional Resources:

Watch the video on this link: <https://youtu.be/7g5QVXor7OA>

... or with this QR code



See [a carousel](#) of pictures from the restoration (scroll to the bottom of the page):

D. Peak District Grindstones

There was an industry producing millstones/grindstones in Hathersage from at least the 16th Century, making Hathersage one of the main millstone producing centres in Britain.

In 1590 there were 13 makers in Hathersage earning 10d per week. This was comparable to other craftsmen, but they were only paid for finished stones. (In the 1851 census Hathersage had 8 millstone makers, 3 masons, 2 stone getters and 1 stone cutter. 2 of them were 10 year old boys.)

A maker could produce 12 pairs of stones per year, or roughly one per fortnight.

Process

1. Find a suitable boulder on the ground.
2. Haul into position with bars and chains until propped up at an angle.
3. Dress by chipping away with pick, hammer and chisel.

The stones produced depended on the type of milling or crushing for which it was intended, and the quality of the stone.

Most earlier stones have a domed surface and rounded edges. From the 16th Century stones were exported via the port at Bawtry to merchants in East Anglia.

The trade was at its most prosperous in the 17th Century because wars in Europe interrupted trade with France and Germany.

- Millstones from the Rhine and Paris were preferred as they had superior milling edges and the ability not to colour wheat flour but became unavailable in the 17th Century. Peak millstones made grey flour.
- Oats, barley, rape, beans and animal fodder used Peak stones as discolouration didn't matter.

In the 18th Century white wheat bread became more popular and the Peak industry declined, though revived by the Napoleonic wars interrupting French and German availability.

Some Hathersage and Burbage stones were used for grinding, but pebbles embedded in the stone could easily cause it to explode.

Grindstones from the area were also coarser and not suitable for fine work such as carried out by Sheffield knife grinders, though some were used in Hathersage for grinding needles.

The stones lying around in the Peak District are mostly unfinished or broken. Others are finished but failed to find a buyer. They range from roughouts to almost finished.

Flat edged stones appear later than round edged, and date from the 19th Century. They were used for a variety of milling and crushing work. Most country mills had French or German stones for wheat, and Peak stones for everything else up to the end of the 19th Century. They were also used for crushing lead ore, pulping wood and crushing pigment for paint. These pulping stones were shipped to Scandinavia, Russia and North America.

The Scandinavian paper mill industry collapsed in the 1920's and the last stones sold to a Swedish paper mill were in 1939.

The surviving stacks of flat edged stones date from the 1930's to the 1950's.

(Digested from Sheffield's Golden Frame, the moorland heritage of Burbage, Houndkirk and Longshaw by Bill Bevan)

Working out the Horsepower of Shepherd Wheel

D.G. Edwards - Engineer

Shepherd Wheel's Effective Horsepower = 13.34 HP

How to work it out

Aperture Size at the front of the pentrough through which water falls onto the wheel. = AS
6 feet across and 2 inches high

1 foot Head of Water (1h) is $\sqrt{\text{square root}} 2 \times g$ (acceleration due to gravity) $\times h$
= $\sqrt{2 \times 32(32\text{ft/second}^2) \times 1} = 8$

Q = volume of water per second, Q = $\sqrt{2gh}$.

M = (coefficient of discharge through pentrough)

Therefore **Velocity of Water** coming out of aperture in feet per second = **VWS**
= the square root of the **Head of Water** in the Pentrough $\times$ (coefficient of discharge)
= $\sqrt{\text{square root}}$ of AS - $\sqrt{6}$ feet = 2.4494×5.4

Velocity of water in Feet per Minute (VWM) = feet per second $\times 60$ seconds

Quantity of Water in Cubic feet per minute falling onto the wheel = **Q**

We can find this by multiplying the aperture size by the amount of water coming out of it in feet per minute.

So to find the **Theoretical Horsepower** of the wheel we multiply the quantity of water

Falling onto the wheel by the velocity of water per second and then divide the answer

By the amount of water it takes to make 1Horsepower (HP)

divided by the weight of 1lb of 1 cubic feet of water. Wow, so here goes:

33000 ft.lb/min (1HP)

62.5 (weight in 1lb of 1 Cu ft of water) = 528

Theoretical Horsepower = $\frac{795.2 \times 13.227}{528}$ = 19.92 Theoretical Horsepower

528

Effective Horsepower is taking friction, leakage, spillage and other losses into account

19.92 EHP $\times$ 0.67 efflux coefficient = 13.34 Effective Horsepower

13.34 EHP



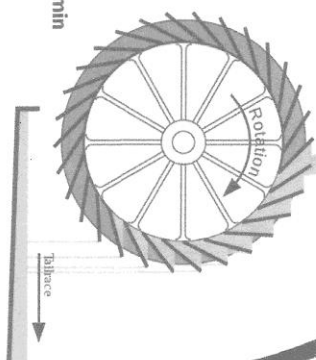
AS - 6ft x 0.167ft = 1.002 ft sq

M = AS $\times$ 8 $\times$ 0.67 = a $\times$ 5.4

VWS - 2.4494×5.4 = 13.227 ft per sec

VWM - 13.227×60 = 793.62 ft per min

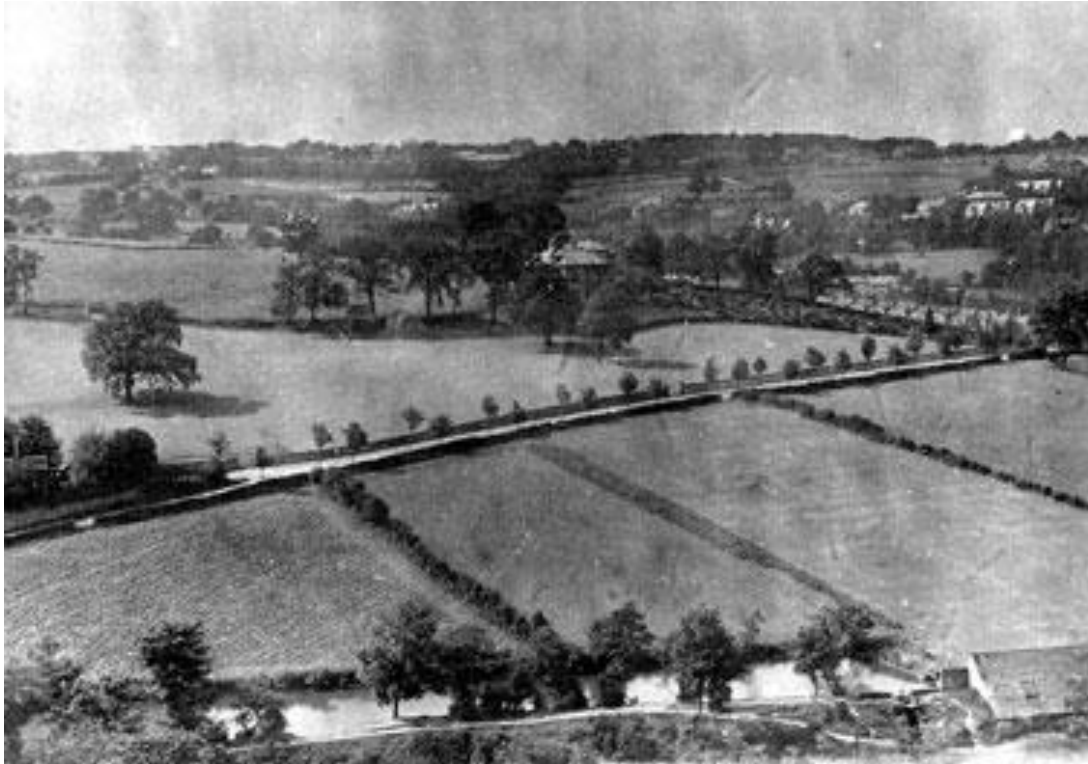
Q - 1.002×793.62 = 795.2 Cu ft per min



An engineer of the time, called Mr Fairbanks, had worked out that most of the waterwheels in Sheffield worked with an output power of between 2 – 15 HP and believed that 4 HP would drive 6 heavy stones. Shepherd Wheel could run 10 – 12 stones.

He worked out the Efflux Coefficient of 0.67 to take into account spillage, friction etc.

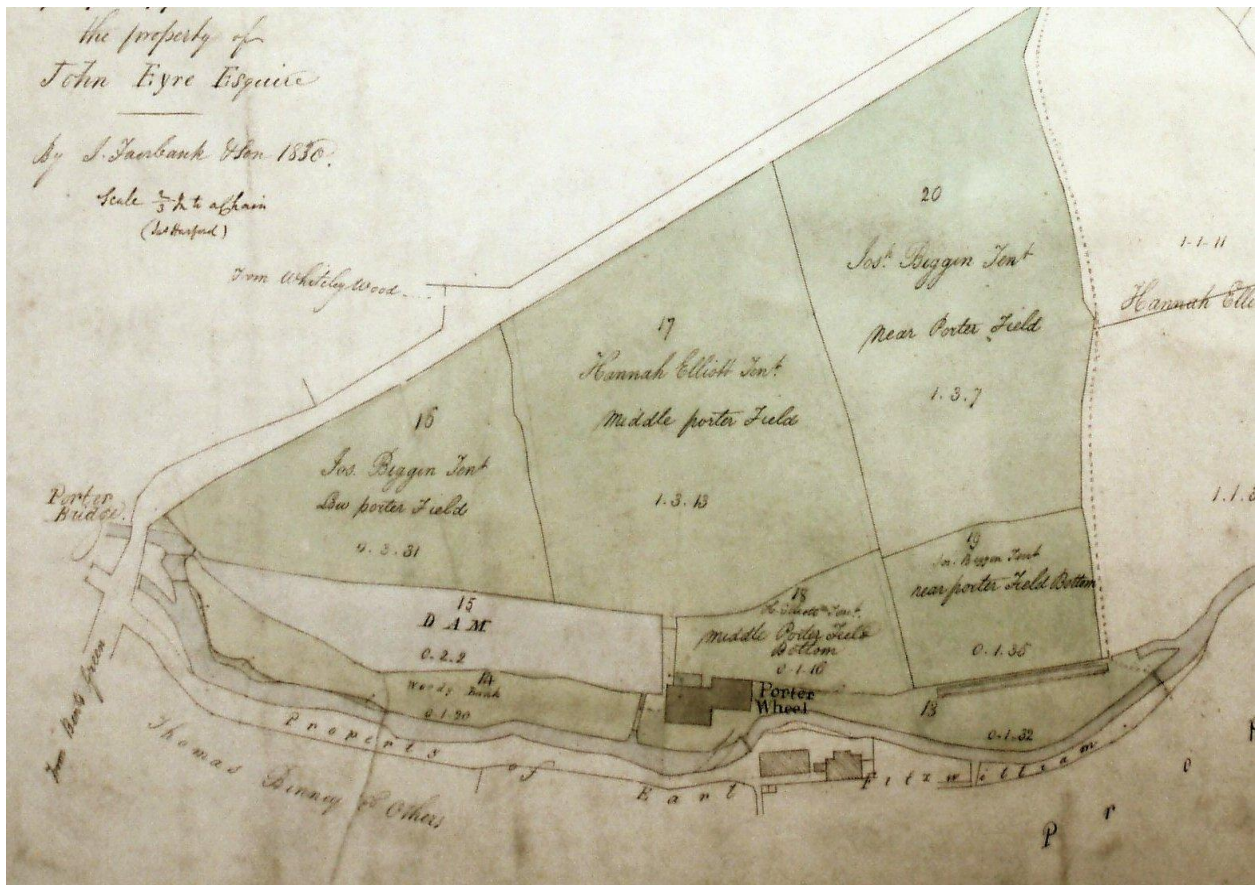
F. Historic pictures and maps



Photograph of Shepherd Wheel, seen in the bottom right hand corner, and Hangingwater Road, taken in 1893. The fields behind the pond are now allotments. The steep-sided wooded valleys in which early industry developed made it difficult for expansion on a large scale.



Photograph of the farmhouse that was once opposite Shepherd Wheel



This map of 1830 shows the location of Porter Wheel, the former name of Shepherd Wheel, in relation to Porter Field, named in the earliest references to the Wheel.

Shepherd Wheel in the Porter Valley

Explore the valley and see if you can discover the evidence of Sheffield's early industries along the way...

WHITELEY WOOD WORKS

The Old Forge at Forge Dam, the Wire Mill and the Leather Wheel were all initially constructed in the 1760s as part of Thomas Boulsover's Whiteley Wood Works. The works were used for the manufacture of saws and edge tools, and comprised forges, a rolling mill and a grinding workshop. In the 19th century, the rolling mill was used to produce wire, hence the current name of Wire Mill Dam.



Boating on Forge Dam around 1900. The pond is unusual in that it dams the whole valley, rather than having water directed into it via a head race. The water returns to the river over a large overflow weir to the east of the dam.



IBBOTSON (UPPER SPURGEAR) WHEEL

A cutter's grinding workshop built in the 1750s. Named after Joseph Ibbotson, who worked at the wheel from 1759 to the 1820s. The weir, sluice and pond survive, though there are no traces of the buildings.



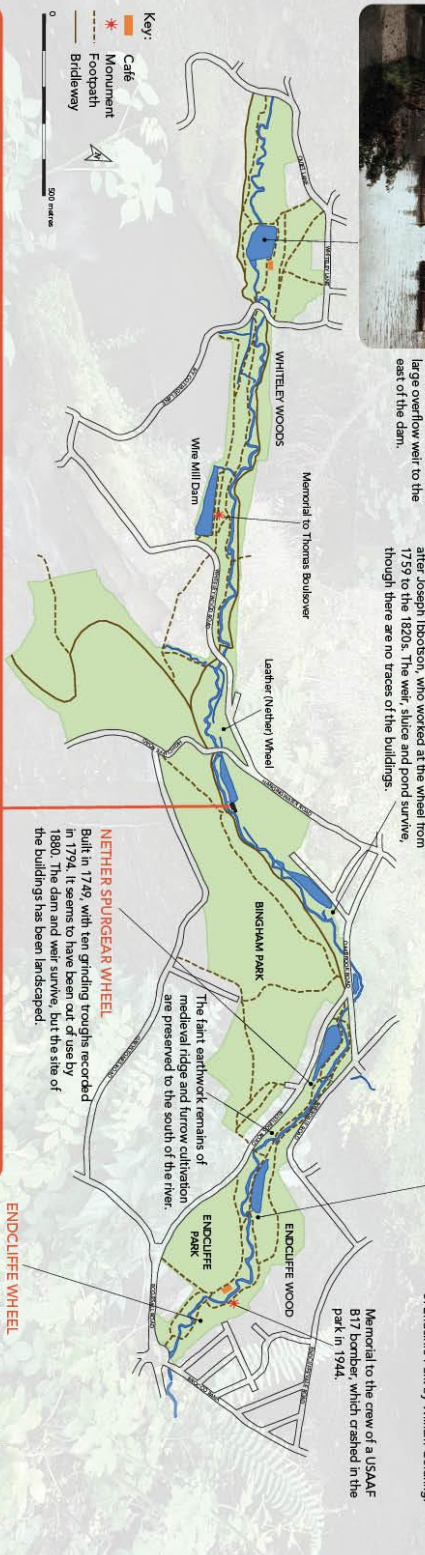
HOLME (SECOND ENDCLIFFE) WHEEL

An early 18th-century grinding workshop, which had four grinding troughs in 1763, but had been expanded to eleven by 1794. There are no surviving traces of the buildings. The dam was used as a boating lake in the early 20th century.



The overflow from Holme Wheel is one of several which were converted into waterfalls as part of the late 19th-century landscaping of Endcliffe Park by William Golding.

Memorial to the crew of a USAAF B17 bomber which crashed in the park in 1944.



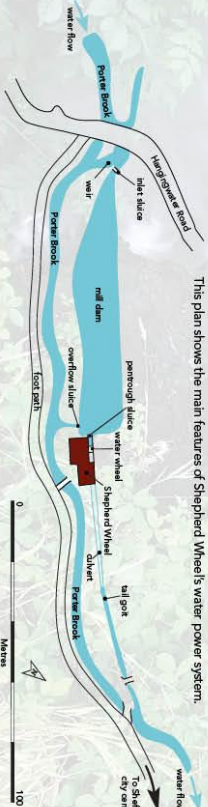
NETHER SPURGEAR WHEEL

Built in 1749, with ten grinding troughs recorded in 1794. It seems to have been out of use by 1880. The dam and weir survive, but the site of the buildings has been landscaped.

SHEPHERD WHEEL

The only surviving water-powered grinding workshop in the Porter Valley. First recorded in 1566, it was used for grinding table, pen and pocket knives. It was originally known as Porter Wheel and its current name comes from Edward Shepherd, the leaseholder from 1749 to 1794. Shepherd built the larger western workshop in 1769. The eastern workshop was probably built in the late 1790s.

This plan shows the main features of Shepherd Wheel's water power system.



ENDCLIFFE WHEEL

First recorded in 1709, there were ten grinders working here in 1794. By 1903 the dam had been converted into a bathing pool. It has since been filled in and grassed over, though the weir survives.

Photo reproduced courtesy of Philip Swarth.

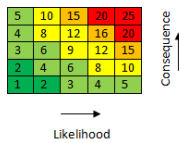
Thanks to Sheffield Archives and Local Studies Library South Yorkshire Industrial History Society, Philip Swarth, and the Friends of the Porter Valley for providing assistance with historic images.

The Shepherd Wheel leaflet interior, showing a walk up the Porter Valley with points of interest along the way, including evidence for the early industrial sites along the river.

G. Risk Assessment

Sheffield Museums

Risk Assessment



- 20-25** STOP activity and take immediate action
- 15-16** URGENT ACTION – take immediate action and stop activity if necessary.
Maintain controls rigorously
- 8-12** ACTION – improve within specified timescale
- 3-6** MONITOR – look to improve at next review
- 1-2** NO ACTION – but ensure controls are maintained and reviewed

Task: Shepherd Wheel Public visitors		
Persons affected: The visiting public on weekends		
Person completing assessment: Eddy Foster with KWDE	Signed:	Date: 01/11/2021
Line Manager: Kirstie Hamilton	Signed:	Reviewed date: 06/10/26
		Date:

L = Likelihood
C = Consequence
RR = Risk Rating

Sheffield Museums

Risk Assessment

Hazard	Resulting effect	Before control			Control Measures	After control		
		L	C	RR		L	C	RR
Slips trips and falls	Bumps bruises	2	2	4	The ground in all public areas is good and fairly level with only two steps in the rear yard that could cause a fall from a low height (less than 1 meter) If there is ice or snow then salt is available or leave the back yard closed to the public.	1	2	2
Open fire	Skin burns to hands	3	2	6	The main hull fire has a fire guard in front of it and the fire in the small hull is never lit.	2	2	4
Open water at the dam	Drowning/ waterborne disease	1	5	5	The view of the council who own the dam is that it is situated in open park land and that risks associated with open water are understood by visitors to the park. The water's edge is away from the path and the water is shallow. Should anyone fall in the water whilst staff are on site then there is a rope available to mount a rescue without staff entering the water. Staff should NOT enter the water!	1	5	5
Climbing the gabion wall	Falls from 1 meter could cause broken bones bruising, abrasions	2	3	6	The yard is supervised by volunteer staff to stop children doing this. The yard is locked out of open hours.	1	3	3
Vegetation growth. Narrowing of the paths by the hull	Nettle stings	3	1	3	SMT staff will monitor this and inform the council department responsible for clearance before it becomes a hazard.	2	1	2

L = Likelihood
C = Consequence
RR = Risk Rating