



Calton, Iara Nave (2026) *A historical geography of mills in Scotland: innovation, adaptation, and inertia during Scotland's Industrial Revolution*. PhD thesis.

<https://theses.gla.ac.uk/85800/>

Copyright and moral rights for this work are retained by the author

A copy can be downloaded for personal non-commercial research or study, without prior permission or charge

This work cannot be reproduced or quoted extensively from without first obtaining permission from the author

The content must not be changed in any way or sold commercially in any format or medium without the formal permission of the author

When referring to this work, full bibliographic details including the author, title, awarding institution and date of the thesis must be given

Enlighten: Theses

<https://theses.gla.ac.uk/>
research-enlighten@glasgow.ac.uk

A historical geography of mills in Scotland: innovation, adaptation, and inertia during Scotland's Industrial Revolution

Iara Nave Calton

Submitted in fulfilment of the requirements of the degree of Doctor of Philosophy (PhD)

School of Geographical and Earth Sciences

College of Science and Engineering

University of Glasgow

31 July 2025

Abstract

Mills have been an important feature of the Scottish landscape for centuries, beginning with the simple rural grain mill and developing into the iconic looming factories of the Industrial Revolution. The objective of this thesis was to chart the historical geography of mills in Scotland, with a primary focus on water-powered mills during the period of industrialisation from the late-eighteenth century through to the early-twentieth century. To achieve this objective the thesis has three overarching aims. First, to document mill distributions at a national scale. Second, to examine the geography of mills through their physical, social-political, and economic contexts, questioning the development paths of economic activity within given localities. Third, to consider the ways that locational decisions were governed by processes of inertia.

The approach taken was to reconcile macro- and micro-scale research, to map the various types of mill found in Scotland, followed by case studies from the cotton spinning industry, focussing on the Rothesay Cotton Mills, New Lanark Mills, Deanston Mills, Catrine Mills, Ballindalloch Mill, and Spinningdale Mill.

This thesis quantifies and presents the geographical distribution of mills in Scotland based on the First and Second edition Ordnance Survey maps and Historic Environment Scotland's Canmore database. It then argues that natural endowments of the landscape shaped mill geographies and that water retained importance throughout the Industrial Revolution. It also argues that mill owners were making locational choices grounded in innovative economically and empirically-based decisions that, through adaptations to mill infrastructure and business practices, manifested in a dynamic form of inertia acting upon mill geographies. This thesis contributes to scholarship on industrialisation in Scotland, working with historic maps, and furthers our knowledge of the number, location, and history of industrial heritage assets.

Table of Contents

Abstract	2
Table of Contents	3
List of Tables	7
List of Figures	8
Acknowledgements	13
Author’s Declaration	14
Abbreviations and conventions	15
Glossary	17
1. Introduction	19
1.1 <i>Definitions</i>	21
1.2 <i>Thesis aims</i>	22
1.3 <i>Thesis outline</i>	25
2 Water to one’s mill: Literature review	28
2.1 <i>Introduction</i>	28
2.2 <i>Historic siting of watermills</i>	32
2.3 <i>Industrial Revolution and industrial geography</i>	35
2.3.1 <i>Was the Industrial Revolution revolutionary?</i>	36
2.3.2 <i>Why did the British Industrial Revolution take place?</i>	38
2.3.3 <i>Classic industrial location theory</i>	42
2.4 <i>Industrial inertia</i>	47
2.5 <i>Diffusion of innovations</i>	48
2.5.1 <i>Diffusion theory</i>	50
2.5.2 <i>Adopter and innovation attributes</i>	52
2.6 <i>The era of steam?</i>	54
2.6.1 <i>Development and diffusion of steam</i>	54
2.6.2 <i>Spatial Patterns</i>	57
2.6.3 <i>Cost</i>	59
2.6.4 <i>Persistence of waterpower</i>	61
2.6.5 <i>Energy scarcity</i>	61
2.7 <i>Entrepreneurs, institutions, networks, and law</i>	64
2.7.1 <i>Institutions and laws</i>	65
2.7.2 <i>The Scottish entrepreneur</i>	67
2.7.3 <i>Structure of the firm</i>	68
2.8 <i>Planned industrial villages and the advent of the factory system</i>	70
2.9 <i>Conclusion</i>	74

3. He who avoids the mill gets no flour: Methods and Sources	76
3.1 <i>Introduction and research design</i>	76
3.1.1 Introduction.....	76
3.1.2 Research design	76
3.2 <i>Mapping mills through Historical GIS</i>	83
3.2.1 Creating a mills database	84
3.2.2 Mill classification.....	87
3.2.3 Preparing the data for analysis	97
3.2.4 Analysis using GIS	100
3.3 <i>Fieldwork – methods and sources</i>	103
3.3.1 Archives	104
3.3.2 Site Visits	110
3.3.3 Local histories.....	111
3.3.4 Historic maps	112
3.3.5 Ordnance Survey Name Books.....	114
3.3.6 Statistical Accounts of Scotland	116
3.3.7 Digitised newspapers	117
3.4 <i>COVID-19 Pandemic</i>	118
3.5 <i>Conclusion</i>	121
4. Run of the mill: The distribution of mills in Scotland c.1850–1900	123
4.1 <i>Introduction</i>	123
4.2 <i>Overall Distribution</i>	125
4.3 <i>Motive Power</i>	132
4.3.1 Waterpower.....	132
4.3.2 Windmills.....	159
4.3.3 Steam Mills	167
4.4 <i>Industry</i>	176
4.4.1. Grain Mills	183
4.4.2 Sawmills.....	186
4.4.3 Paper Mills	188
4.4.4 Textile Mills.....	193
4.5 <i>Conclusion</i>	208
5. His mill will go with all winds: Micro-histories from the cotton industry.....	211
5.1 <i>Introduction</i>	211
5.2 <i>Isle of Bute and the Rothesay Cotton Mills</i>	213
5.2.1 Location and water supply	213
5.2.2 Local economy and population demographics	216
5.2.3 Ownership and management.....	218
5.2.4 Buildings and facilities	222
5.2.5 Successes and failures.....	225
5.3 <i>New Lanark</i>	230
5.3.1 Location and water supply	230
5.3.2 Local economy and population demographics	232

5.3.3 Ownership and management.....	234
5.3.4 Buildings and facilities	241
5.3.5 Successes and failures.....	244
5.4 <i>Deanston</i>	251
5.4.2 Local economy and population demographics	253
5.4.3 Ownership and Management	255
5.4.4 Buildings and facilities	258
5.4.5 Successes and failures.....	264
5.5 <i>Catrine</i>	270
5.5.1 Location and water supply	270
5.5.2 Local economy and population demographics	272
5.5.3 Ownership and management.....	274
5.5.4 Buildings and facilities	278
5.5.5 Successes and failures.....	283
5.6 <i>Ballindalloch</i>	286
5.6.1 Location and water supply	286
5.6.2 Local economy and population demographics	288
5.6.3 Ownership and management.....	290
5.6.4 Buildings and facilities	294
5.6.5 Successes and failures.....	296
5.7 <i>Spinningdale</i>	298
5.7.1 Location and water supply	298
5.7.2 Local economy and population demographics	300
5.7.3 Ownership and management.....	303
5.7.4 Buildings and facilities	307
5.7.5 Successes and failures.....	309
5.8 <i>Conclusion</i>	312
6. I am loath to change my mill: Trajectories of Scottish watermills.....	314
6.1 <i>Introduction</i>	314
6.2 <i>Industrial location</i>	315
6.2.1 Transport.....	315
6.2.2 Energy	324
6.3 <i>The mill industrialist</i>	333
6.3.1 Pathways to industry	333
6.3.2 Size and longevity of partnership	337
6.3.3 Mobility and networks	342
6.4 <i>The mill as place</i>	346
6.4.1 Places of collaboration or contestation	346
6.4.2 Experimentation and control in the mill community	350
6.5 <i>Afterlives</i>	355
6.6 <i>Conclusion</i>	363
7. All is grist for the mill: Conclusions.....	366
References.....	374

<i>Contemporary sources</i>	374
University of Glasgow Archives & Special Collections.....	374
Bute Museum and Archives.....	376
Other repositories.....	376
Digitised newspapers	377
The Statistical Accounts of Scotland	378
Ordnance Survey Name Books.....	379
Maps and Plans	380
National Record of the Historic Environment (previously Canmore).....	382
Other	383
<i>Secondary sources</i>	385
Appendices	427
<i>Appendix 1. Biographies of mill owners, managers, investors, and facilitators described in the text</i>	427
<i>Appendix 2. Heritage terms</i>	434
<i>Appendix 3. Survey dates of the Ordnance Survey County Series mapping 1st and 2nd editions (Adapted from NLS, 2025d)</i>	437
<i>Appendix 4. Newspaper searches</i>	438
<i>Appendix 5. Mill distribution maps</i>	439
<i>Appendix 6. Mill data according to historic county.</i>	443
<i>Appendix 7. Mill categories</i>	444

List of Tables

Table 3. 1. Spatial datasets used and their sources.	101
Table 3. 2. List of mills georeferenced based on primary and secondary literature.	103
Table 3. 3. Site visits.....	111
Table 4. 1. All mills separated by time period.....	125
Table 4. 2. Elevation of mills.....	131
Table 4. 3. Motive power of mills.....	132
Table 4. 4. Number of watermills of each type divided by date and total numbers.	133
Table 4. 5. Comparison of estimates of windmill numbers in Scotland.....	166
Table 4. 6. Steam mills according to period and industry.	168
Table 4. 7. Population of major towns (data from Great Britain Historical GIS Project, 2003–2023b).	192
Table 4. 8. Number of mills in different branches of the textiles industry.....	201
Table 5. 1. Changes in ownership and management of Rothesay Cotton Mills.	220
Table 5. 2. Key events in the ownership of New Lanark.....	235
Table 5. 3. Population of New Lanark (Donnachie and Hewitt, 2015; Minnery, 2019).	250
Table 5. 4. Population of the parish of Kilmadock.	254
Table 5. 5. Extract from inventory and valuation of fixed and loose plant at Deanston Spinning and Weaving Mills for 1904.....	262
Table 5. 6. Managers of the Catrine Cotton Works and Bleaching Works under James Finaly & Co. 1801-1951 (from Brogan, 1951).	278
Table 5. 7. Extract from inventory of Catrine Mills 1904.	281
Table 5. 8. Ownership of Ballindalloch Cotton Mill.	291
Table 5. 9. Opening shareholders in the Balnoe Company.....	306
Table 6. 1. Innovation attributes (based on Rogers, 2003) and an example of each attribute type in relation to the steam engine.....	329
Table 6. 2. Pathways taken by mill owners and notable investors or managers.....	335
Table 6. 3. Shared characteristics of mill owners and investors.....	336
Table 6. 4. County of origin of mill investors.....	343
Table 6. 5. New Lanark’s criteria for Inscription as a World Heritage Site (based on UNESCO, 2019).	356
Table 6. 6. Adaptive reuse of mill sites in Scotland.	361

List of Figures

Figure 3. 1. Scottish water mills website: Interactive map viewer and supplementary information pages.....	84
Figure 3. 2. Process of developing the GB1900 and Canmore data into the mills dataset.	84
Figure 3. 3. Gaps in GB1900	85
Figure 3. 4. Two examples of Canmore records.....	86
Figure 3. 5. Depiction of watermills on the OS maps. Examples of wheel symbols and labels, dams, and lades.	90
Figure 3. 6. Depictions of steam powered mills	92
Figure 3. 7. Springbank Mill in Dunblane.	92
Figure 3. 8. Depictions of the corn mill at Millhaugh (Alyth, Perthshire) on the 2 nd edition OS map at the scale of Six-Inch and 25 Inch.....	93
Figure 3. 9. Examples of disused mills on the OS maps which are not always labelled.	95
Figure 3. 10. Close up of Dundee, on the 2 nd edition, 25 Inch OS map.	97
Figure 3. 11. Easton Mill: an example of two mills of the same estate labelled differently ...	99
Figure 3. 12. Letter book saved from the waste bin and kept within the records of James Finally and Co.....	107
Figure 3. 13. Extract from Deanston annual statements, 1859–1871. Incidental charges related to carriage of goods, coals, and water power. Timetable of hours worked and stoppages.....	108
Figure 3. 14. Full page and close up of the month of May 1902 from <i>Catrine's Weather Report</i> book, Rothesay Average Temperature and extremes for 1856. Record of river gauge, thermometer and barometer kept by Deanston for 1866.	108
Figure 3. 15. Correspondence and papers concerning Glasgow Water Co and legal cases: letter from Deanston to James Finlay & Co ‘about supply of water’ dated 30 December 1852, providing a detailed description of the waterpower available at the mill, written during a dispute with a prospective municipal water corporation.	109
Figure 3. 16. Sketch of the damhead and lade at Deanston in notebook from 1852; formal Deanston Grounds plans October 1845.	109
Figure 4. 1. Historic counties and regions of Scotland.....	124
Figure 4. 2. Cumulative distribution of all mills in Scotland (1850s, 1990s, PU).....	125
Figure 4. 3. Number of mills in Scotland by historic county.....	127
Figure 4. 4. Mills present in c.1900 and Royal and Parliamentary Burghs with a population of over 5,000 people in 1911 (population data from Great Britain Historical GIS Project, 2003-2023b).	128
Figure 4. 5. Comparison of mills located in Bishop and Muñoz-Salinas, 2013 and the OS/Canmore dataset.....	129
Figure 4. 6. Elevation of mills, in metres.....	131
Figure 4. 7. Cumulative distribution of watermills according to whether they were horizontal, vertical, or tidal mills.	134
Figure 4. 8. Types of vertical water wheel (Bishop and Muñoz-Salinas, 2013: 197).	135

Figure 4. 9. Mill landscape on the River Kelvin in Glasgow.	137
Figure 4. 10. Walk Mill c.1895.....	137
Figure 4. 11. Examples of mill lades.	139
Figure 4. 12. Diagram of a long profile of a mill dam, lade, and wheel showing the higher dam and longer lade required for a stream with a lower gradient (Bishop and Muñoz-Salinas, 2013: 198).	139
Figure 4. 13. Plans of proposed alterations to watermill infrastructure at Greenland Mills on the Water of Leith and Stoneywood Paper Works on the River Don	140
Figure 4. 14. Manderston Mill depicted on the 1 st edition OS map.....	141
Figure 4. 15. Close up of Kirkfield Saw Mills. Kirkfield Burn Easton mills (pink dot) on Dunsyre Burn.	143
Figure 4. 16. Mills located next to waterfalls: (a) Wauk Mill at Sloc of Dess, Aberdeenshire (b) Craig Mill on Cuaf Water, Dalry, Ayrshire (c) Corn Mill on Falls of Dochart, Perthshire (d) Craig Mill, White Cart in Lanarkshire.	144
Figure 4. 17. Natural weir comprising a ridge of resistant rock where the River Kelvin in Glasgow reaches Partick used by Bishop Grain Mills depicted in 1857 and present day satellite imagery; Margaret’s Mill in Renfrewshire, located below a waterfall on the Green Water that formed a natural break in gradient to build on.	145
Figure 4. 18. Reconstruction of a horizontal mill (locally known as a click or clack mill) at Dounby, Orkney. Depiction of Dounby Mill on the 1880 OS map.....	149
Figure 4. 19. Cumulative distribution of horizontal watermills.....	151
Figure 4. 20. A chain of twelve mills on Burn of Scousburgh, Shetland.	152
Figure 4. 21. Four horizontal mills at Hamnavoe, Shetland.	153
Figure 4. 22. Examples of a very remote horizontal mill on North Uist, Ross and Cromarty and mills near a sheepfold, Sandness.....	153
Figure 4. 23. ‘Drawing of a tide mill from Faustus Verantius, <i>Novae machinae</i> (1615), plate 1’ (reproduced in Minchinton, 1979: 784).....	156
Figure 4. 24. Stages of a tide mill operating (Eling Tide Mill Experience, 2018).	156
Figure 4. 25. Ayre Mill c. 1881. Located on the edge of the town of Kirkwall where a small channel enters the closed off marshy loch previously known as the Peerie Sea.	158
Figure 4. 26. Comparison of tide mill distribution as recorded in Gauldie (1981), Shaw (1980), and OS/Canmore.	159
Figure 4. 27. Close up of Berwickshire (left) and the coast of Forfarshire and Kincardineshire (right) showing location of windmills in relation to watercourses and confirmed water-powered sites.....	161
Figure 4. 28. Cumulative distribution of windmills from the OS/Canmore and their industrial function.	164
Figure 4. 29. Remains of three former Scottish windmills/windpumps. Wind-powered threshing mill in Ellon, Aberdeenshire; Savocho tower pumping mill in Lonmay, Aberdeenshire; windpump in St Andrews and Deerness parish, Orkney.....	166
Figure 4. 30. All known ‘traditional’ Scottish windmills based on Donnachie and Stewart (1967) and based on Douglas and Oglethorpe (1984; 1986).....	167
Figure 4. 31. Steam mills displayed according to whether they used additional power sources	169

Figure 4. 32. Culcreuch Mill and its associated lade and reservoir	169
Figure 4. 33. At Redford Flax Factory in Drycart Parish (Fife) a steam engine was used to power a centrifugal pump to take water from the River Ore into a reservoir ('an oblong excavation forced with stone') where water could be held for use by flax spinning mill.	170
Figure 4. 34. Underwood Mill (Paisley) installed a pumping engine of the Newcomen or Savery type in the 1790s to take water from a reservoir to a mill wheel (Nisbet, 2003: 178)	170
Figure 4. 35. Cumulative number of steam mills by historic country recorded from the OS/Canmore.....	172
Figure 4. 36. Location of canals and railways (1851); collieries (1900); steam mills in relation to the main coalfields in Scotland's Central Belt.....	173
Figure 4. 37. Pre-1800 steam mills (Data based on Kanefsky, 2024.....	174
Figure 4. 38. Early Engine Database (orange) against cumulative OS/Canmore data (red) showing continuity in areas with clustering of steam mills.....	175
Figure 4. 39 Cumulative mills dataset displayed according to industry.....	177
Figure 4. 40. Cumulative mills dataset displayed according to individual industries or groups of industries.....	178
Figure 4. 41. Mills at Haugh, Mauchline.....	180
Figure 4. 42. Distribution of snuff mills in Scotland (left) and in Juniper Green (Water of Leith) with snuff mills interspersed with those of a different function (right).....	182
Figure 4. 43. Cumulative grain mills from the OS/Canmore (wind-, water-, or steam-powered). Steam-powered grain mills only present in the 1900s displayed against the 25 most populated Royal and Parliamentary burghs in 1911.....	186
Figure 4. 44 Location of sawmills (cumulative) and ancient long-established and semi-natural woodlands (1750–1880).....	188
Figure 4. 45. Cumulative paper mills from the OS/Canmore.....	192
Figure 4. 46. Distribution of paper mills from directories in 1832 (Oliver, Boyd, and Robert Weir) and 1845 (Sommerville), and the 1850s from the 1 st edition OS maps.....	193
Figure 4. 47. Industrial textile mills: Model of an eighteenth-century water-powered textile mill. Maker: Phillip Veale, 1790; engraving showing different stages in producing cotton fabric from the series 'Progress of Cotton'. Maker: J. R. Barfoot (1785–1825).....	194
Figure 4. 48. Distribution of textile mills in the 1850s, 1900s, and cumulative.....	195
Figure 4. 49. Production stages. Cumulative distribution of yarn and textile processing mills; Cumulative distribution of fabric finishing mills displayed according to function.....	198
Figure 4. 50. Mills along the Dighty Water from its source at Lundie Loch to mouth at Tay Estuary displayed according to their presence on the OS maps.....	199
Figure 4. 51. Cumulative distribution of textile mills: coarse fabrics, wool, cotton.....	200
Figure 4. 52. Woollen mills in Ochill Hillfoots region of Clackmannanshire and Stirlingshire.....	205
Figure 4. 53. Cumulative distribution of woollen mills according to motive power from the OS/Canmore.....	205
Figure 4. 54. Map of Hawick in the borders showing at least four steam-powered mills.....	206
Figure 4. 55. Craigfoot Mill in Tillicoultry in the Hillfoots woollen area. The wooden lade constructed to deliver water from Tillicoultry Burn to the Mill is depicted.....	206

Figure 5. 1. Location of the six case study mills.	211
Figure 5. 2. Timeline of mill opening.....	212
Figure 5. 3. Map of Bute with principal lochs labelled. survey of Loch Fad and Kirk Dam	215
Figure 5. 4. Diagram of the waterpower system in the modified lint mill.....	223
Figure 5. 5. Layout of the Rothsay Cotton Mills (labelled as <i>Cotton Works</i>) with Broadcroft Mill to the south; Rothsay Cotton Mills under the ownership of Salmond	224
Figure 5. 6. Examples of Thom’s Self-Acting Sluices used on Bute.	227
Figure 5. 7. Historic location of mills in Lanark.....	232
Figure 5. 8. Portrait of David Dale as featured on The Royal Bank of Scotland’s £5 notes from 1966; Richard Arkwright by Mather and Brown, 1790; Robert Owen by Ebenezer Morley; Henry Birkmyre II (1832–1900) c.1875 unknown artist	235
Figure 5. 9. Left: A waterwheel in situ at New Lanark. The waterwheel was positioned in a stone-lined wheel pit below the former mill no. 4. A tail race exiting southwest from the wheel pit returned water to the Clyde. Right: Engraving of New Lanark mills and planned village c. 1799 by Robert Scott.....	244
Figure 5. 10. Caithness Row; Robert Owen’s Institute: engraving by G. Hunt, 1825	244
Figure 5. 11. Location of Deanston relative to Doune and Stirling.....	252
Figure 5. 12. Location of mill features in proximity to Deanston.	253
Figure 5. 13. Deanston (Deinstane) and Doune (Down) depicted on the Roy Military Survey of Scotland (1747–55).....	254
Figure 5. 14. Benjamin Flounders; Portrait of James Smith of Deanston, 1842, by Alexander Craig.....	258
Figure 5. 15. Cross section and fourth floor plan of the Deanston Spinning Mill.....	260
Figure 5. 16. Present day exterior of the spinning mill building beside the River Teith.....	260
Figure 5. 17. Machinery inside the weaving shed.	260
Figure 5. 18. Waterwheel at Deanston c. 1930.....	261
Figure 5. 19. Map of Deanston in 1862 displaying from left to right: the lade, workers housing, school, manager’s Deanston House, cotton works with gasometer.	263
Figure 5. 20. Locations of Deanston, Loch Lubnaig, Loch Katrine, Glasgow.....	268
Figure 5. 21. Location of Sorn and immediately surrounding parishes within Ayrshire. Catchment boundary of the River Ayr.....	271
Figure 5. 22. Mills in close proximity to Catrine (represented by pink circles).....	272
Figure 5. 23. Portrait of Claud Alexander (1752–1809), with his brother Boyd, attended by an Indian Servant by Johann Zoffany R.A; Portrait of Archibald Buchanan (1769–1841) by Henry Raeburn.	277
Figure 5. 24. Twentieth century view of the Catrine Mills complex.....	279
Figure 5. 25. Map depicting the Catrine Voes reservoir system.....	280
Figure 5. 26. Photograph of Fairbairn’s Catrine wheels and technical drawing.....	282
Figure 5. 27. Parishes of the county of Stirlingshire.....	287
Figure 5. 28. Endrick Water at Ballindalloch; catchment boundary of the Endrick Water and approximate location of the Dundaff Moor reservoir	288
Figure 5. 29. Mills near to Balfron.	290

Figure 5. 30. Culcreuch Mill in 1862 with mill lade taking water to/from the Endrick Water.	290
Figure 5. 31. Robert Dunmore of Kelvinside, 1744–1799. Merchant in Glasgow.....	292
Figure 5. 32. Photograph of Ballindalloch Cotton Mill.	295
Figure 5. 33. The village of Balfron depicted on the 2 nd edition OS map showing the locations of the former print field, Ballindalloch house, Printers’ Row, and the disused Ballindalloch Mill.....	296
Figure 5. 34. Parishes of the county of Sutherland.....	299
Figure 5. 35. Spinningdale Cotton Mill and other pre-nineteenth century mills.	302
Figure 5. 36. Spinningdale Burn passing through Spinning village in 1874.	303
Figure 5. 37. Plan of mill building based on a survey of 1966.	308
Figure 5. 38. Ruins of Spinningdale Mill c.2001	312
Figure 6. 1. Location of canals constructed in Scotland for the purposes of transport, industry, and drainage. Inset: canal network across Britain.	318
Figure 6. 2. Western portion of the Caledonian Canal from Glen Albyn to Loch Lochy	320
Figure 6. 3. Map of the Port Dundas area of Glasgow c.1808 prior to industrialisation in the area and Map of the Forth & Clyde Canal from Temple in the west to the St Rollox chemicals complex in the east.....	321
Figure 6. 4. Timeline of mill ownership for the chosen case study mills.....	341
Figure 6. 5. Network of mills and ownership.	344
Figure 6. 6. Catrine village in 1895. The main roads of the village diverge outwards from the Twist Mill at the centre.	353
Figure 6. 7. Lade Park in Rothesay, featuring circular stone structures to represent the wheels of mills past; logo of Balfron Primary school (Balfron Primary, 2022); signage and mosaics representing mill stones and wheels on the water of Leith walk. Place names associated with historic mills in Edinburgh and Leith.	357

Acknowledgements

Thank you to the AHRC for funding this project and providing enriching cohort development activities around the UK. To the staff at the University of Glasgow Archives and the Bute Museum and Archives for sharing your knowledge and creating such welcoming spaces to conduct research. Thanks to my curlers, cyclists, runners, and ravers. To the new friends that listened to me talk about mills outside Subby at 3am. Thanks to Nicole for being my first friend at the University and to Rhiannon, my most recent pal. To Josephine and the other residents of room 304 and my study pals in the ARC and library. Andrew, Em, David, Gabriel, Peter, and Raquel: my team of proofreaders. Thanks especially to my mum who read the entire thesis and helped with the enormous task of checking my references. To Professor David Green for not only sending me the advertisement for this PhD project, but for introducing me to historical geography as an undergraduate at KCL. Thank you to Professor John Hume for providing advice early on in the process and to Mark Watson for sharing your boundless knowledge of mills during excursions around Scotland. To Dr Tara Jonell for mills chats, interesting rabbit holes, and for the feedback on two of my final chapters. A huge thanks to all of my supervisors, Dr Miles Oglethorpe and Chris Fleet at HES and the NLS, and Professor Simon Naylor at University of Glasgow. Thank you to Professor Chris Philo for joining the supervisory team. Thank you to the whole team for your patience and support, for the coffees, the guidance, and most of all the reassurance that I was capable of producing a finished thesis.

I dedicate this thesis to the memory of Professor Paul Bishop whose curiosity and passion for the landscape around him spurred this project into being.

Author's Declaration

I declare that, except where explicit reference is made to the contribution of others, this thesis is the result of my own work and has not been submitted for any other degree at the University of Glasgow or at any other institution.

Signature: ...

Printed Name: Iara Nave Calton

Abbreviations and conventions

Abbreviations

AHRC – Arts and Humanities Research Council
AI – Artificial intelligence
ASL – Above sea level
CDA – Collaborative Doctoral Award
CDP – Collaborative Doctoral Partnership
DEM – Digital elevation model
EEG – Evolutionary Economic Geography
GIS – Geographical Information System
HGIS – Historical Geographical Information System
HES – Historic Environment Scotland
HP – Horsepower
LiDAR – Light Detection and Ranging
NEG – New Economic Geography
NEG II – New Economic Geography II
NLS – National Library of Scotland
NHP – Nominal horsepower
NRHE – National Record of the Historic Environment
NSA – New Statistical Account
OCR – Optical character recognition
OS – Ordnance Survey
OSA – Old Statistical Account
OSNB – Ordnance Survey Name Book
PU – Period Unassigned
SCHC – Scottish Cultural Heritage Consortium
SQL – Structured Query Language
UofG – University of Glasgow

Conventions

Single quotation marks are used except where reproducing an original source that uses double quotation marks.

Quotations are reproduced in their original formatting including the use of italics and underlined words.

Units of measurement are given according to the metric system other than where the original source used the imperial system. Currency is represented as: £ pounds, *s* shillings, *d* pence.

Numbers great than twelve are written in numerals.

The referencing system used is Harvard style. An exception applies to contemporary source material – archival materials, the Ordnance Survey Name Books, the Statistical Accounts, and maps – which are placed in footnotes, as are records from Historic Environment Scotland's Canmore database. This system allows accurate referencing without excessively disturbing the flow of the text.

Glossary

Unless otherwise stated, definitions are derived from the glossary of the Mills Archive Trust (2025a) and Britannica (2025a).

Additional definitions of specific types of mill can be found in Appendix 2 (Heritage terms).

Back watering	The drag caused by the immersion of the lower part of a waterwheel in relatively static water.
Beetling	Finishing process where cloth is pounded by wooden hammers called beetles to give the fabric sheen (National Trust, 2025).
Blacking	Charcoal powder.
Calender	Finishing process - to smooth, coat, or thin the material (paper or fabric) which is passed through a set of heated rollers.
Calico	Plain woven fabric that is unbleached/dyed.
Carding	The stage before spinning where fibres are disentangled and straightened.
Dressing (flax)	The process of removing the straw from the fibres. Consists of breaking (or retting), scutching, and heckling.
Factor	‘An agent or steward who manages land or house property for its proprietor; one who has charge of the administration of an estate’ (DSL, 2025a, n.p.).
Feuar	‘One who holds land in <i>feu</i> .’ (DSL, 2025b, n.p.)
Flax	One of the oldest textile fibres used for linen yarn.
Head of water	The difference in height between the level of the water above the wheel (at the mill pond) and water level immediately downstream of the wheel (at the tail race) (Paton and Brown, 1960).
Hackling / heckling	The last step in flax preparation. Flax is pulled through heckling combs to straighten and clean the fibres.
Heddle	Part of a loom used in weaving. The ‘heddles’ are moveable rods, cords, wires, or steel bands used to separate the warp threads.
Journeyman	‘A journeyman; an artisan who, having served his apprenticeship, works for days' wages for a master of craft.’ (DSL, 2025c, n.p.).
Lint	Scottish term for linen: a fibre, yarn, and fabric made from the flax plant.
Madras	A lightweight fabric with typically patterned texture and a tartan check design.
Mangler	A machine used to flatten fabric.
Mill lade / lead / leat	Channel that delivers water to the millwheel.
Mill pond / dam	Area of water held back by a dam or weir.
Mule	Spinning machine invented by Samuel Crompton in 1779.

Muslin	A plain-woven cotton fabric made in various weights.
Piecework	Employment in which the worker is paid a fixed rate per unit produced.
Printing	A finishing process of decorating textile fabrics by pigments and dyes in patterns.
Putting-out system	Also referred to as the domestic system whereby businesses subcontracted work to individuals and households.
Reeling	A reeling machine consists of a revolving framework around which yarn is wound.
Roving	A twisted roll or strand of fibres that have been carded (and possibly dyed) ready for spinning. A roving machine further elongates the fibres.
Scouring	Textile preparation process that cleans fibres prior to dyeing. The process removes impurities so the textile becomes cleaner and more absorbent.
Scutching	Removal of the fibre from the retted flax straw
Spindles	A tool in the shape of a spike used for spinning or winding fibres.
Spinning	Twisting of fibres to form yarn.
Spinning jennie/jeanie	A machine with multiple spindles used for spinning cotton or wool.
Sucken	‘The lands subject to the thirlage of a mill’ (DSL, 2025d, n.p.).
Suckener	‘A tenant bound to grind his grain at the mill of a sucken’ (DSL, 2025d, n.p.).
Tail race/water	The downstream section of the mill lade or the water leaving the mill.
Turkey Red	A red dye extracted from the root of the madder plant (Wertz, 2014).
Tweed	A tightly woven dyed wool.
Vitriol	Oil of vitriol, also called sulphuric acid, manufactured in Great Britain since the 1730s. Initially used as an apothecaries’ nostrum, later important in industrial applications (Clow and Clow, 1945).
Warp	Lengthwise yarns.
Wash mill	Used in the bleaching process. Similar machinery as the waulk mill from which it is thought to have evolved (Nisbet, 2009).
Water frame	A water-powered spinning machine capable of producing cotton yarn for warp, patented by Richard Arkwright in 1769.
Waulking / fulling / plash mill	Treading and pounding of cloth using large wooden feet driven by a waterwheel (Nisbet, 2009).
Weaving	Production of fabric by interlacing two sets of yarns.
Weft	Crosswise yarns.
Winding	The process of putting yarn onto bobbins (a cylinder or spindle on which yarn is wound).
Worsted	Fabric made from worsted yarn that is lightweight with a coarse texture.

1. Introduction

Oh! listen to the water mill, through all the livelong day,
As the clicking of the wheels wears hour by hour away;
How languidly the autumn wind does stir the withered leaves
As in the fields the reapers sing, while binding up their sheaves!
A solemn proverb strikes my mind, and as a spell is cast,
“The mill will never grind again with water that is past.”
– Sarah Doudney, *Lesson of the Water Mill*

Mills and the people associated with them have achieved iconic status, immortalised in poetry, paintings, and idioms. The watermill especially features as a ‘centrepiece of community life throughout the world and history’ (Archer *et al.*, 2017: 13). Evidence exists to suggest that humans used water-powered mills 2000 years ago (Shaw, 1984). Waterwheels were introduced to Scotland in the 1200s, remaining a common sight into the twentieth century. Mills have always been as much a product of their social and political situation as of their physical landscape. The earliest water-powered mills were built by and for monasteries and abbeys, later passing into ownership of the towns and baronies (Gauldie, 1981: 22). They were also embroiled in relations of power. Kings were known to give land, and the mills associated with them, to loyal followers, and legal systems dictated which mills could be used by the poor (Gauldie, 1981: 23–24). Grain mills formed core parts of local economies, essential in food production, and providing employment. The local mill would once have been a central part of daily life and the economy of a proximate town or village (Lucas, 2006), while early rural waulk mills provided places of work and social gathering, where women would talk and sing with one another (Houston, 1989: 138).

Mills are not only embedded in regional histories and cultural identities, their remnants persist physically in the landscape, still quietly impacting hydrological functions of rivers (Walter and Merritts, 2008). Mills are often associated with a romanticised, idyllic past across Britain, as in the poem above, but they are also intimately associated with the heavy-industrialising city engulfed in smog. Mills were central to the period commonly referred to as the British Industrial Revolution. Scotland played a central role in industrialisation, where key steps were made in technological and process innovations – the contributions of Joseph Black to the chemical revolution and William Cullen’s discovery of chlorine for use in linen bleaching were followed by James Watt’s modifications to the atmospheric steam engine. Scotland’s entrepreneurs rapidly embraced new technology from England, particularly in relation to cotton spinning, fitting up and implementing Hargreave’s Spinning Jenny,

Arkwright's Waterframe, and Crompton's Mule in their own mills. Scotland's mill owners also adopted new forms of organisation in mill design and social order, so that west central Scotland sat alongside Lancashire's 'Cottonopolis' as one of Britain's most important cotton textile-producing regions. Furthermore, mills in Scotland were a core link between the country and the British imperial project.

Former industrial mill sites are increasingly being recognised as having cultural significance in the present day at the scale of local communities, regions, the nation, and even to have international importance. The perceived value of this heritage is reflected in the designation of mill buildings and landscapes as UNESCO World Heritage sites, from the Tomioka Silk Mill complex in Japan and mill network of the Kinderdijk-Elshout region in the Netherlands, to the UK's three designated mill landscapes: The Derwent Valley Mills, Saltaire industrial village in West Yorkshire, and Scotland's New Lanark. Mills and their hinterlands have long fascinated the public as feats of mechanical and social engineering. The Isle of Man's 22 m wide Great Laxey Wheel, or 'Lady Isabella', for instance, has drawn tourists to the mine site for over 170 years (Trinder, 2013), and the New Lanark Cotton Mills received constant streams of visitors to its attempted utopian community in the nineteenth century. The centrality of mills to Scotland's past and present justify their study.

Mills represent a socio-cultural asset, but despite their traces around us in everyday life they are not always understood as such by the public (Di Stefano *et al.*, 2023). Before embarking on this project, engaging with the literature, and commencing my own mapping exercise, I could not begin to envision the scale of Scotland's milling history and heritage. When I have recounted the subject of my thesis to acquaintances over the past years, almost without fail I have received a response of 'Mills? Oh, you mean windmills?'. And, yes, I did mean windmills, but I was also referring to the 5,000 plus other mills, to the history of the ruined flint mill I pass daily in the park, to the origin of the name of the housing scheme up the road, to the building that now produces the whiskey I spot on the pub shelf, and the corn mill that once stood adjacent to the archive where I spent many days immersed in data collection.

1.1 Definitions

The title of this thesis uses the word ‘mills’ and it is important from the outset to clarify what I mean by this. One methodological point is too important to delay until later in the thesis and that is the question of what constitutes a mill. The interpretation that I have adopted in this thesis is a mill as a space satisfying the following specific criteria. A mill encompasses a site where materials and goods are processed, produced, or moved in a mechanised manner. A mill should have a mechanical device that, with external motive power, produces repetitive motion in a rotary, reciprocating, or oscillating manner. Textile manufacture, for example, had multiple stages, some of which were conducted on machinery and others performed by hand. A combination of processes could take place on separate floors of the same building, some of which would be classed as mechanised mill work and others not. One of these processes being mechanised is sufficient to warrant the title of mill.

The decision not to refer to a specific type of mill in the title was twofold, even though, as will become apparent, my main focus is indeed on watermills, meaning mills where the external motive power was water, irrespective of what products emerged from these mills. The first reason is that ‘mill’ best reflects the terminology used by the contemporary sources supporting this research, which generally did not use ‘watermill’. This lack of clarification in sources, both in contemporary and secondary literature, is problematic, and an issue that will be returned to in later chapters. The second reason is that other types of mill will feature throughout the thesis, albeit in far smaller numbers. That said, this is indeed a study first and foremost about watermills. Studies of mills often open with a comment on the importance of both water and wind (*e.g.* Langdon, 1991; Lucas, 2006), but it was primarily the watermill that dominated the Scottish landscape for centuries. It should also be noted that when this thesis uses ‘watermills’, it can be assumed to refer to what I am calling the ‘typical’ type of Scottish watermill *i.e.* a mill using water from a river or a pond to propel a vertically arranged wheel. To reduce potential confusion, when I am referring to another mill type (horizontal watermills, tidal watermills) or another power source (windmills, steam mills, and very rarely horse- or hand-powered mills) this specificity is always made clear. Similarly, the subject matter of this thesis spans across numerous industries and functions. However, cotton spinning emerges as a particular empirical focus at various points in this thesis. Cotton textiles has ‘embodied the Industrial Revolution’ (Riello, 2022: 87) and the sector has been

particularly implicated in debates around the transition from waterpower to steam power (Malm, 2016), one of my core areas of investigation.

Given the ubiquitousness of mills throughout history, the word has of course taken on separate figurative uses. These were not used as working definitions during the research but relate to some of the themes that have appeared during the process. I would encourage the reader to keep in mind the idea of a ‘mill’ as a ‘formative or conditioning process, environment, etc., *esp.* one regarded as somewhat mechanistic, laborious, or homogenizing’ and a ‘means or mechanism by which something is created or developed; a crucible, a melting pot’ (Oxford English Dictionary, 2025a; 2025b: n.p.). By this I mean that mills were among the places where changes to social order and discipline manifested during the Industrial Revolution, and their contribution to social change should be considered alongside their function within the economy. These social processes in turn influenced the locational geography of Scotland’s mills.

1.2 Thesis aims

The objective of this thesis is to produce a historical geography of mills in Scotland. It broadens our knowledge of Scottish mill histories and industrial archaeology by documenting and discussing mill locations and their uses over the last two and a half centuries. It is therefore a thesis about these ‘idyllic’ rural mills as well as about the ‘dark Satanic Mills’ so famously personified by William Blake (1810). Among theories of industrial location – which seek to determine the optimal locations of economic activities – the concept of industrial inertia describes a tendency for industries, once settled, to remain at a given geographical location (Todd, 1983). This thesis challenges notions of locational inertia as a limiting or negative process. It instead provides evidence for and argues that, in the case of Scotland’s mill industries, adaptation and innovation translated into a positive version of inertia, or a ‘dynamic inertia’, as I will term it. Mills in Scotland have retained their geographical distributions, locating at the same sites sometimes for centuries due to natural endowments, cultural norms, or prior investments of fixed capital, even when these sites were no longer logical according to location theories. To do so, mill owners employed highly innovative adaptations to technology or operational practices, often according to advanced scientific and business principles, enabling mills to stay put rather than relocate.

This thesis is first and foremost a work of historical-geographical scholarship, concerned with tracing, verifying, and mapping the spatial distributions of human phenomena. It combines the more traditional, empirically-oriented, historical-geographical analysis (Pacione, 2011: 1), concerned with mapping, quantifying, categorising, and describing, epitomised by works such as H. C. Derby's *Domesday Geography* (1977), with research that is informed by theory (Moodie and Lehr, 1976). The deceptively simple issue of *where* something is located is at the forefront throughout, as questions of *why* they were located in certain places and the implications of their locations are built into understandings of industrialisation, energy transitions, and the other considerations that will be outlined now.

The first overarching aim (1) of this thesis is to document the changing geographies of milling at a national scale. Within this aim, the thesis asks how much we are able to know about the extent and distribution of mills at certain points in time, and how their distribution has changed. This is achieved by documenting in a Geographical Information System (GIS), the distribution of mills across Scotland as mapped on the mid-nineteenth- and early-twentieth-century 1st and 2nd edition Ordnance Survey (OS) maps and recorded in Historic Environment Scotland's (HES) 'Canmore' database of buildings, monuments and archaeological sites in Scotland. Making direct use of the collections of both HES and the National Library of Scotland (NLS) to enhance knowledge of mill locations and the industries where they were deployed, the sub-aims here are hence to (1a) quantify and map historic mill sites in Scotland, categorising them according to their source of motive power and the industry they served. Using the data derived from the maps and Canmore, I will show where there was continuity of mill distributions between the earlier and latter parts of the Industrial Revolution. I will also (1b) evaluate the possibility of compiling a complete catalogue of mill sites using these data sources, appraising the suitability of historic maps for accurately identifying and cataloguing features of the built environment such as mills.

The second overarching aim (2) is to examine the geography of mills through their physical, social-political, and economic contexts; questioning the contribution of geography to what economic geographers sometimes call the 'development paths' of economic activity within given localities (Krugman, 1999). To address this aim, the previously mentioned mapping work is combined with micro-histories of six mills engaged in the cotton industry to address the following questions: (2a) What was the relationship between transportation routes (canals, rivers, roads) and the location of mills, asking if mills shaped transport geographies or the

other way around; (2b) How, and to what extent, did natural endowments in the form of rivers, coal, and geomorphological features shape mill geographies? Did the importance of these natural endowments for mill locational decisions change over time?; (2c) How significant was an energy transition from water to steam for the development and shaping of mill numbers and geographies? I question whether conclusions regarding the availability of water for powering industry during the Industrial Revolution are applicable to Scotland and provide insight as to the characteristics of the purported transition in terms of timing and scale. A further issue (2d) is whether common features can be identified amongst the people who owned Scotland's mills. Using the partners of the companies in charge of my case study mills as a focus, I ask who were the industrialists driving forward the cotton industry and what was the influence of socially constructed laws and institutions on their decision making? This leads into a final issue here (2e) regarding the social, economic, and cultural role played by mills and their hinterlands in people's lives, most observable in the case of planned industrial villages, and lingering as post-industrial heritage around us in the present day.

The final overarching aim of this thesis (3) is to consider the ways that locational decisions were governed by processes of inertia. I will argue that a combination of physical, economic, and social conditions – often mixing together in specific places and impacting on specific mills – acted upon processes and decisions regarding mill location. These combinations encouraged a path dependency that manifested through what I will term, a *dynamic* form of inertia, whereby many mills remained in operation – occupying the same location over long periods of time – not through a refusal to change, a state of stasis arising purely because of prior sunk capital into mill infrastructure. Instead, I argue that deliberate adaptations permitted continuity on the same site, which might be thought of as positive decision-making to stay in a location, as opposed to a lack of decision-making.

This thesis was undertaken as a Collaborative Doctoral Award (CDA) between three institutions: the University of Glasgow (UofG), HES, and the NLS. The CDA was funded through the Scottish Cultural Heritage Consortium (SCHC). The aims of this project therefore reflect the desire to meet the objectives of all three partners. Part of HES's mission as an institution is to enhance 'knowledge and understanding of our [Scotland's] cultural heritage... to protect and conserve it, both now and for future generations' (HES, 2025: n.p.). Furthermore, the project aims to further the interpretation of industrial development within Scotland. Meanwhile, strategic priorities of the NLS include the objectives of ensuring

engagement with users and reuse of their collections. This project's emphasis on understanding the settings and operations of mills feeds directly into the SCHC Research Theme of understanding and valuing the historic environment. Such understanding will lead to increased valuing and preservation of these wider historical environmental settings.

1.3 Thesis outline

Chapter 2 situates the thesis within the existing literature on mills, providing the theoretical foundations for the chapters that follow. The chapter begins with an anatomisation of research specifically on mills, from an academic perspective and beyond, the majority of scholarly interest in mills coming from outside historical geography. I then take, as introduced earlier, a classic historical geography emphasis on the location of historical watermill sites. The chapter then branches out to the broader themes of industrialisation, briefly highlighting the vast debates surrounding the extent and causes of the British Industrial Revolution before looking at theories within work on the geographies of industrial location and processes of inertia. Recognising the energy transition debate as a key theory within the Industrial Revolution literature, the development, diffusion, and adoption of steam engines is examined. The diffusion of steam is then placed in the context of the energy transition from organic or renewable sources of power, such as water and wood, to steam (Wrigley, 2010), that is, to a 'fossil economy' (Malm, 2016: 11). I then introduce literatures on the making of entrepreneurs in Scotland and in the British textiles industry more generally, contextualised within the institutions that enabled their ambitions. The final section of the chapter situates mills within the changes that industrialisation, and the changing geographies of mills, exerted on the social order.

Chapter 3 explains the research design and justifies the combination of GIS and archival work to produce a mixed methods study. Introducing historical GIS (HGIS) the chapter then outlines the process of creating and using a database of historic mills in Scotland using historic OS maps and HES's database of buildings and archaeological sites across Scotland. It describes the selection of archives and some of the pertinent materials held within the collections of the University of Glasgow Archives and Bute Museum and Archives. It then outlines the other sources relied upon heavily in this thesis. Many of the methodological decisions for this thesis were shaped by the COVID-19 global pandemic that caused closures

and significant disruptions to the UofG, HES, NLS, and resources stored elsewhere. The chapter ends by outlining these difficulties and the adaptations made.

Chapter 4, the first of two substantial empirical chapters comprising the heart of this thesis, is where I address the changing geographies of mills at a national scale as well as beginning to address the influence of transportation and natural endowments. The chapter presents a visual and textual description of the geographical distribution of mills in Scotland, with a primary focus on those that were functional from the mid-nineteenth to early-twentieth centuries. The suitability of the methodology is assessed throughout, often in comparison to estimations made by other scholars. The chapter begins with a general overview of mill distribution. It then outlines the technologies, locational characteristics, and distribution of inanimate sources of motive power used by mills in Scotland. The third section of the chapter charts the distinct geographies of specific industries that were heavily reliant on waterpower during the Industrial Revolution in Scotland: grain milling, sawmills, paper mills, and within the textile industry, coarse linen mills, woollen mills, and of course, cotton mills.

Chapter 5 gives a case study of the cotton industry, focusing on six mill sites opened in the last quarter of the eighteenth century. Beginning with one of the earliest cotton spinning mills in Scotland at Rothesay, the chapter then moves to the world-famous New Lanark, through the mills purchased by Glasgow-born international merchants, James Finlay & Co., and ending with the curiously-located Highland mill at Spinningdale. The chapter examines the physical and economic geography of each mill and their surroundings, the ownership, the fixed capital invested, and highlights significant moments in the lifespan of the mills. As the chapter develops, numerous matters in relation to environmental and societal conditions, processes of technological adoption, and mill entrepreneurs (their backgrounds, networks, and decision-making on mill location) are gradually brought to the fore, and their implications are then discussed in the remainder of the thesis. The chapter ends with only a brief summary, its conclusions synthesised in greater detail in the following chapter.

Chapter 6 is a synthesis of the materials and findings drawn out of the two empirical chapters before it. The themes within this chapter are grouped into three sections. The first thinks about mills' spaces, considering the factors of industrial location, especially the influence that natural endowments and human-made amenities held over mill location, namely transportation networks. The chapter here also provides a treatment of motive power and

energy transitions during the Industrial Revolution. The second section takes a more cultural geographical perspective to analyse how place is manifested at mills, thinking about the influence of cotton mill entrepreneurs whose decisions about mill siting and mill operations is fundamental to this study. I explore their knowledge bases and networking, social influence and wealth, and their enactment of power and discipline upon the mill workers. Lastly, the chapter asks what happened, or what might still happen, to these sites when they are no longer places of active industry, reflecting on how their geography changes with differing forms of ‘heritagisation’ that sees mills protected, restored, adapted, abandoned, or ruined.

The structure of this section of the thesis (chapters 4–6) is unusual in that I present a macro-level overview (4), followed by micro-studies specifically of watermills within a single industry (5), before returning to consider all mill types again (6). In order to address fully the claims and questions presented in section 1.2, it was necessary to go beyond the cotton industry and bring in evidence from the national-scale mapping work. Chapter 6 also moves from primarily considering the spatial geographies of mills in the empirical chapters, to the temporal. Although temporality and change is present in all of the chapters, it is central especially to the issues of energy transitions, longevity of mills, past and present preservation or loss of mill sites, and in processes of inertia.

Chapter 7 returns to the aims and questions set out in this introductory chapter, offering final concluding points regarding the possibility of producing a catalogue of mills during the Industrial Revolution. The chapter also questions what the implications of such a project might be for some of the prevailing theories regarding industrial location in Scotland and suggests that a dynamic form of industrial inertia has acted upon or within the Scottish mill to shape their geographies.

2 Water to one's mill: Literature review

2.1 Introduction

This thesis draws on and contributes to the large empirical literature on mills and the even more extensive body of work related to industrialisation. In producing a historical geography of mills it has also been necessary to draw upon wide-ranging disciplines and subdisciplines from the fields of history of science and technology, through to geomorphology, sociology, engineering, business studies, and heritage studies. The chapter will consider each, beginning by reviewing other academic work that studies mills.

A global history of early mills has been chronicled by historian of technology Adam Lucas (2005; 2006), accompanied by localised studies such as that of Langdon (2004) on medieval mills in England and Rynne (2009) for Ireland. Others have charted historical developments of watermill technology (Reynolds, 1983; Müller and Kauppert, 2004; Pujol *et al.*, 2010; Capecchi, 2013; Lewis *et al.*, 2014; Christopher and Gutiérrez, 2018), the transfer of milling technology between countries (Pearson, 1996), the potential implications of past watermill technology for renewable energy in the present (Pujol and Montoro, 2010), horizontal mills (Lucas, 1953; Grano and Bishop, 2017), and windmill history and technology (Hills, 1994; Rossi *et al.*, 2017) and their distribution in Scotland (Douglas and Oglethorpe, 1984; 1986). The most detailed studies of mills on historic maps in Britain are those of Bignell (2013) and Bishop (2021; 2022) on the early Ordnance Survey maps, while some work has been done on representation of industry on large-scale county maps (Smith, D. 1989; 1990). Jennifer Tann, researcher of technological diffusion, has contributed to knowledge of early steam engine use with her extensive work with the Boulton & Watt archives,¹ along with John Kanefsky and economic historians including G. N. von Tunzelmann (1978). Kanefsky's (1979a) work on quantifying motive power in Britain has culminated in a database of eighteenth-century steam engines (Kanefsky, 2024) which I will use as a point of comparison in Chapter 4. Von Tunzelmann (1978) uses a social savings methodology to suggest that the impact of the Watt engine (and its imitations) on economic growth during the Industrial Revolution may have been more limited than previously thought. Studies such as these are of direct relevance to

¹ The engineering company of Matthew Boulton and James Watt operating out of the Soho Foundry near Birmingham, England, the world's first purpose-built manufactory for building complete engines (Williams, 1999).

my aim of examining the energy transition from water to steam for the development and shaping of mill numbers and will be returned to in Section 2.6.

The topographical and geomorphological settings of watermill location in relation to landscape and industrial location has been described for Bavaria in Germany (Hammer, 2008), Ireland (Rynne, 2009), Basilicata in Italy (Grano *et al.*, 2016), the Algarve in Portugal (Barão *et al.*, 2014), Gloucestershire in England (Tann, 1965), and Britain (Jonell *et al.*, 2024), among many other locations. For the setting of mills specifically in Scotland we can look to Bishop and Jansen (2005), Bishop and Muñoz-Salinas (2013), and Jonell *et al.*, (2023). Driven by the work of Downward and Skinner (2005) on the geomorphological legacy of England's mills, a key area of inquiry over the past 20 years has focused on fluvial dynamics and impacts of functioning or abandoned mills, including changes to sedimentation and erosion, and mill dam failure/removal (Walter and Merritts, 2008; Bishop *et al.*, 2010; Grano *et al.*, 2016; Fajer, 2018; Maaß and Schüttrumpf, 2019). Much recent scholarship has taken an interest in the ecological and economic legacies of historic mills in the present-day fluvial system. Barraud (2017) documents the environmental controversy that can result between the desire to remove mill dams to restore continuity in the river versus mills as places of living heritage with dimensions of affective and emotional attachment. Meanwhile a renewal of interest in mapping the location of historic mills is taking place for the purpose of identifying potential hydroelectric power sites (Podgórski and Szatten, 2020) or for exploring the previously neglected biodiversity potential of old industrial mill ponds (Wood and Barker, 2000). Mills are also receiving recognition as actors in the evolution of anthropogenic cultural landscapes in Scotland (Collinson and Baxter, 2022) and across Europe (Brykała and Podgórski, 2020; Hognogi *et al.*, 2021; Dragan *et al.*, 2024). Studies such as Pouso-Iglesias *et al.* (2023) and Di Stefano *et al.* (2023) demonstrate how geomatic and graphic modelling techniques can document and valorise sites that represent socio-cultural assets but are not understood as such by the public. Although not a new topic, in the last few years there has been a drive to contextualise British industry and heritage within a global perspective that recognises the tangled histories of industrial mills, empire, and enslaved labour (Mullen, 2022a; Bond, 2023; Campbell, 2024).

Turning specifically to Scotland, the most significant attempts to document the history or geography of mills are historian Enid Gauldie's (1981) study of grain milling between 1700–1900 and historical geographer John Shaw's doctoral thesis (1980) and resultant book *Water*

power in Scotland, 1550–1870 (1984). Shaw provided the only mapping of mills at the national-scale in Scotland. From the field of industrial archaeology there is the work of industrial archaeologist John Hume, who published a two-volume account of Scotland's industrial heritage including descriptions and locations of many former mill sites (1976). In addition to surveys and textual descriptions, Hume took over 25,000 photographs of late- and post-industrial sites including numerous Scottish mills that are held within the archives of HES. Other studies conducted on mill engineering, architecture and machinery include those of Mark Watson (1990; 1992), whose catalogue of Dundee jute mills will be returned to in Chapter 4. Writing in 1979, Shaw (1980) commented on a lack of work on Scottish milling other than local or thematic studies by Anders Jespersen, W.H.K. Turner, John Butt, John Hume, and Ian Donnachie. At the local and regional level, there have been attempts to improve knowledge of mill numbers and distribution. An important body of work considering mills in Scotland comes from contemporary local antiquarian societies (for example Goudie, 1886) and modern local history rather than academic publishing (more will be said on the benefits and critiques of this work in Chapter 3), including the work of historian Stuart Nisbet (2009), who has produced numerous articles for Scottish Local History Forum and Renfrewshire Local History Forum on mills and the textile industry in the West of Scotland. Other notable regional scale studies within Scotland include those of Paul Bishop (2011a; 2011b; 2019) on the west Central Belt and Turner's work on the textile industry in the east and central regions (1952; 1953; 1957a; 1966; 1982a) and Perthshire (1957b).

Since the work of Shaw in the 1980s, published attempts to identify, categorise, and analyse mills on the country-scale have been limited. Bishop and Muñoz-Salina (2013) produced a map of 1,712 mill sites in Britain derived from the OS 1:50,000 gazetteer but do not distinguish between mill types or functions. Building on the work of the *Scottish water mills website* (Nave Calton and Fleet, 2021) – the context and scope for which is discussed in detail in Chapter 3 – Jonell *et al.* (2024) created a database of historic mills using cartographic data for the entire landmass of Great Britain. Both of these works address the previous lack of geographic continuity across national borders within Britain. In a similar vein to this thesis, Jonell *et al.*'s project also provides visualisations of the spatial distribution of mills. Many of these key literatures will be returned to as a point of comparison or source of data within the first empirical chapter in this thesis, Chapter 4.

Before moving on to the next section of this literature review, I will return now to a question posed in the introduction of this thesis: what is a mill? Mokyr *et al.* (2022: 1923) make a rare acknowledgement of the interchangeability of the terms ‘mill’ and ‘factory’, noting that they were synonymous because water was the most common power source at the start of the Industrial Revolution. My interpretation of the way the terms have been used by others in the secondary literature is that a factory has generally been used to refer more to the organisational structure of labour than to the machinery contained within the building or site. Thus, some mills may be factories, and some factories may be mills. The addition of the term ‘works’ adds a further level of complexity and potential confusion. Sources do not always specify the precise process that is taking place in a mill or factory, adding to the great challenge inherent in defining a place as a mill. The first recorded use of the word ‘factory’ or ‘manufactory’ in English to refer to a location where a product is made, dates to a letter written in 1618. In this definition, the Oxford English Dictionary (2025c) notes that it may refer to just one building or collectively to a range of buildings used for manufacturing, assembling, or processing materials. To complicate the matter further Chapman (1992: 159) uses the words mill and factory interchangeably within the same sentence: ‘...most country mills built a row of cottages near the factory’; while Watson (1990: 25) stated that in Dundee:

“The mill” is where jute fibre is prepared and spun into yarn and “the factory” is where cloth is woven. The mill is further sub-divided into “the Low Mill” where the fibre is softened, carded and drawn out, and the “High Mill” where it is spun, twisted, reeled and wound. The distinction originally also applied to the buildings.

The choice of language has significant implications for this thesis, which will be made clear in later chapters when relevant. The rest of this chapter will introduce literatures related to the locational geography of mills and the geographies of mill entrepreneurs. Only watermills are covered in Section 2.2, with a focus specifically on literature covering mills that used the flow of the river rather than tide. Steam mills receive a detailed treatment later in Section 2.6. Windmills and tide mills were present in Scotland and will feature later in the thesis, however they do not represent a significant portion of mill numbers nor do they have relevance to the cotton industry in Scotland which is the focus of the second empirical chapter. In Section 2.3 debates surrounding the British Industrial Revolution are introduced, followed by theories of industrial location and the concept of industrial inertia (Section 2.4). Next, the concept of diffusion of innovations is summarised (Section 2.5) before returning to empirical literature concerning the diffusion of steam (Section 2.6) and of energy transitions more generally. It is necessary to engage quite deeply with literature on steam power given its centrality to the

Industrial Revolution. Steam has also been prominent in debates on the apparent energy transition that, to some, lies at the heart of the Industrial Revolution. Understanding the patterns of steam's diffusion is also central for interpreting how it affected the distribution of watermills and whether one displaced the other. The final two sections review work on the development of the industrial 'entrepreneur' (Section 2.7) and their role in the creation of industrial villages (Section 2.8).

2.2 Historic siting of watermills

This section summarises the state of knowledge on watermill sites. The section begins with a general overview of 'typical' mill locations, then focusses more specifically to the local scale and what the literature suggests made Scotland suitable for waterpower.

Some authors argue that mills have always been sited with a great deal of consideration (*e.g.* Gauldie, 1981; Hammer, 2008). Gauldie (1981: 22) describes monks selecting the earliest Scottish mill sites 'with care' to ensure 'a regular and smooth-flowing water supply'. However, the literature is inconclusive regarding how much prior planning was truly given to early mill locations, with some authors struggling to identify a logic to the distribution of mills in specific studies (*e.g.* Tann, 1965). Previous studies conducted in Europe have suggested that mills are frequently found in high density clusters. Watermill density in the Po Valley region of Italy, reached 209 mills per 20 km radius (Parrinello, 2018: 658). Likewise, in Gloucestershire in England, watermills were found in clusters, which Tann (1965) identifies were next to steep gradients. Although Tann believes the co-location of mills and such geological features in Gloucestershire might be coincidental, elsewhere, such groupings are thought to reflect deliberate locations of mills to take advantage of physical endowments. Turner (1958: 101) suggests this to be true of the simple lateral distributions of mills along rivers in Perthshire, Scotland. Turner also observes that where a site was large enough and particularly desirable, mills might locate on opposite sides of the same stretch of river. Depending on the size of the river and reliability of the water supply, such a configuration was possible either with or without any formal arrangements for sharing the resources between the mills (Turner, 1958: 101–2).

Returning to Tann's study of Gloucestershire, many mills were in suboptimal situations. There was seemingly no preference in mill building for the seemingly more logical fast-flowing streams in the west of the region versus the meandering rivers of the eastern Cotswolds (Tann, 1965). Similarly Witkowski (2022: 17) says of the River Skawa catchment in Poland that the location of watermills was 'not well-thought-out'. Witkowski concluded many of the mill sites were placed on rivers with low potential energy, leaving the possibility for hydropower in the region underutilised.

Watermills have been present in Scotland for the grinding of corn since the seventh century (Ritchie and HES, 2013). The particular suitability of Scotland for waterpower has been highlighted by studies on mills that emphasise its combination of climatic and geological endowments, namely high rainfall and steep river channels. Paton and Brown (1960) observe that the areas with highest rainfall correspond with mountain districts which have steeper gradients, thus two desirable attributes for waterpower tend to occur together in Scotland. However, these conditions do not overlap with the most convenient areas for human settlement. Additionally, Paton and Brown (1960) have stressed that for the successful operation of a watermill it is the reliability of the water source, and therefore of the rainfall, that is of greater importance than the total amount of rain. As such, mills in areas with high average annual rainfall could still fail due to seasonal variability (Connah, 1994: 13). Scotland receives large quantities of annual rainfall, however, around 60% of the annual total tends to occur in winter, creating periods of low flow and drought for certain rivers in the drier summer months, although regions fed by snow meltwater may see maximum flow rates in the spring and early summer. Taking the wider river basin into consideration Turner (1982a: 81) suggests the presence of lakes upstream in the river catchment can alleviate problems with seasonal lack of water. Bishop and Muñoz-Salinas (2013) use GIS analysis of Scottish rivers to suggest that catchments under 200 km² were capable of supplying water to the average mill.

Geomorphologist Paul Bishop has proposed that Scottish watermills were preferentially located near to knickpoints, which are an abrupt break in slope or channel elevation in the longitudinal profile of a river (Bishop *et al.*, 2005). Bishop's suggestion has been tested and demonstrated to be true for numerous mills in Scotland (Jonell *et al.*, 2023). This has been noted for other regions, such as Gloucestershire in England (Tann, 1965), where there are high densities of mills in areas with a sudden steepening of stream gradient, although this was

not consistent across all regions where the river steepened. In Scotland, these knickpoints and steeper reaches are in general more likely to be found in the northern parts of the country where glacio-isostatic rebound is still occurring (Bishop and Jansen, 2005). In part because of these natural knickpoints and the generally higher rainfall and runoff, Bishop and Muñoz-Salinas (2013) suggest that mills on Scotland's east coast were less reliant on dams for storage and so dams were generally smaller than those found in southern England. In terms of geology and positioning within the hydrological system, mills in Scotland are usually located within the first 10 km of the drainage network and stable bedrock channels are preferable to dynamic alluvial rivers (Bishop and Muñoz-Salinas, 2013). Meanders also offered an attractive location for the siting of a mill because it was comparatively straightforward to divert water in these locations (Turner, 1958). Turner (1958: 101) identifies Westfield and Craig mills on the Ericht and Stanley on the Tay as particularly striking examples of using a bend in the river to create a powerful fall of water. The presence of these proposed locational characteristics will be further explored in Chapter 4.

While there is broad agreement over these characteristics of typical mill sites, the literature diverges over whether there were sufficient sites to meet historic power demands for industry. The existing literature can often tend to make overgeneralised, sweeping statements regarding the number of mills or remaining availability of waterpower. Research suggests that mill numbers multiplied during the medieval period, with subsequent problematic crowding in places. Many early mills using waterpower functioned without recourse of artificial channels or embankments for to do otherwise would, for Scotland's ecclesiastical mills, have been 'sinful' and against 'God's order' (Morison, 1801, quoted in Gauldie, 1981: 23). Research has suggested that once processes of economic growth and industrialisation took hold, mill sites in certain regions of the world struggled to operate for want of water; with a lack of understanding of hydrological systems contributing to mill owners building in locations that were not ideal (Crane, 2001: 2). As early as the eighteenth century, steam was envisioned by some as the future for powering mills and more broadly manufacturing, ready to take society on a new path, free from the restraints of older sources of power:

WATER is seldom convenient; wind is a feeble precarious agent; and muscular force is very expensive, and very limited; but steam is free from each of these imperfections, and is superior to all in strength and duration. (Cooke, 1795: 401)

The issue is argued to have been exacerbated during the Industrial Revolution, as mills expanded in physical size and power demands, until ‘even the best sites on the best rivers were found to be inadequate so that efficiency had to be improved and supplementary methods of generating power developed’ (Cardwell, 2003: VII 41). The ‘best’ sites may indeed have been occupied and at their limit for power in some places, however, to say that in the eighteenth century ‘there were literally no headwaters left without a mill’ (Quaranta and Wolter, 2021: 2) is an overstatement and dismisses the untapped potential for expansion of waterpower in many locations, at least from the perspective of physical endowments highlighted in the literature in the preceding paragraphs. Shaw (1984: 543) for instance, argues that shortage of water was not such a problem in Scotland, where suitable river sites were numerous enough that it was considerations other than the physical landscape that ultimately determined mill distribution.

Estimates of overall numbers of mills are lacking at the country level for Britain. For England alone, 5,642 mills were recorded in the Domesday survey in 1086, which covered all but the northern areas of England (Hodgen, 1939: 274). It is claimed this figure doubled to around 12,000 by 1300 (Langdon, 1991: 424, quoting Holt, 1988). Reynolds (1983) estimated there were 20,000 mills for the whole of Britain with an upper limit of 15,500 functioning mills by the start of industrialisation. Müller and Kauppert (2002; 186) propose the same figure of 20,000 mills operating in England alone in the nineteenth century. In Scotland, Shaw (1984: 24) believes ‘something like 4,000’ corn mills were in use by 1550. These ideas of characteristic mill locations such as knickpoints will be returned to in Chapter 4 as will the question of mill numbers, with an attempt to quantify Scottish mills in the mid-nineteenth to early-twentieth centuries.

2.3 Industrial Revolution and industrial geography

The main temporal focus of these thesis overlaps with a period of significant social, economic and structural change in Britain that is commonly referred to as the British Industrial Revolution. When referring to Britain, the term is broadly used to describe the period between roughly 1760 and 1840 and is sometimes referred to as the classic Industrial Revolution (Coleman, 1992). The term ‘industrial revolution’ was first used in France in the 1820s and by German philosopher Friedrich Engels in the 1840s to describe a period of far-

reaching transformation in his '*Condition of the Working Class in England in 1844*' (Engels, 1892). Since then, the Industrial Revolution – capitalised to signify it as the first historical instance of a conversion to an industry-based society (Landes, 1969) – has gained an almost mythical status in British history (Coleman, 1992). The existing literatures on the Industrial Revolution are substantial. In this thesis it is only possible to engage with elements of these. The principal interest in this context is where inquires surrounding the Industrial Revolution intersect with the fields of inquiry of industrial and historical geography and where they pertain to mills and milling in Scotland.

What the Industrial Revolution was and what drove it forward have been debated vigorously since the nineteenth century. Three main debates surrounding the Industrial Revolution in Britain can be identified (Stearns, 2015): was it actually 'revolutionary'; what were the social impacts; and why did it happen (and why in Britain)? All three of these debates have relevance to the questions examined in this thesis. The topic can be approached from numerous angles. Mokyr (1999: 9), for instance, divides existing scholarship on the Industrial Revolution into four broad schools of thought: The Social Change School; The Industrial Organisation School; The Macroeconomic School; and The Technological School. Some of the debates and theses from these schools will be introduced in this section while others find their place naturally later in the chapter within the treatments of diffusion of technological innovation and steam power (Sections 2.5 and 2.6), in the advent of the factory system (Section 2.7), and in the debates on mill entrepreneurs, networks, and the influence of institutions and laws (Section 2.8). The discussion will be organised around the three main questions, beginning in the next subsection with whether the Industrial Revolution was revolutionary, including an initial consideration of social impacts (returned to in Sections 2.7 and 2.8), followed by proposed theories for why the Industrial Revolution took place.

2.3.1 Was the Industrial Revolution revolutionary?

The traditional interpretation of the Industrial Revolution (for instance the views of Ashton, 1948; Landes, 1969) suggests that the term defined a set of broad, far-reaching changes that affected much of Britain's economy and society. As summarised by O'Brien (2000: 122) this approach, that was popular in the 1950s and 1960s, proposes that the Industrial Revolution was industry led, featured a sudden economic 'take off' (not social change), was driven by private individuals rather than the state, and was British. The traditional view contends that Britain was transformed into the 'workshop of the world, not just the cotton factory of the

world' (Temin, 1997: 80). By the early-1970s an alternative dominant school of thought was questioning the traditional viewpoint, prompting economic historians including N. F. R. Crafts and C. K. Harley to perform revisionist macroeconomic research (Harley, 1982; Crafts, 1983; Crafts and Harley, 1992). In the revised calculations of researchers in the 1980s and 1990s, growth was argued to have been localised to a few industries, and the contribution of manufacturing industries other than textiles, iron, and transportation were shown to be minimal (Temin, 1997).

In terms of the speed of change, Hudson (1992) observes that many authors in Britain in the 1800s referred to events during the period in question as sudden, violent, and radical. Many scholars now see the Industrial Revolution as a period of sustained growth with technological inventions taking decades to increase economic productivity (e.g. Mokyr, 2002). Economic historian Sir John Clapham (1939) questioned whether prior to the 1830s *any* industry had gone through a complete revolution. Clapham reported antiquated forms of industrial organisation and technology persisted in Britain, describing 'backward district[s]' where 'even the mule only began to come into use about 1828' (1939: 144) and decades passed before steam was fully applied to all its potential uses while waterpower persisted (Mokyr, 2018). Murray (1978) and Nuvolari *et al.* (2011) have both identified similar patterns for Scotland. In the wool-producing regions of Scotland, for example, investment in weaving technology was much slower than other parts of the textile industry such as cotton (Nuvolari *et al.*, 2011). From the point of view of the workers, many were reluctant to leave their trade, which carried craft status, for factory life (Murray, 1978). This applied to developments in both water and steam technology, discussed later.

Outside of purely economic or technological changes, there were structural transformations that marked Britain as unique and having gone through a revolution (Crafts and Harley, 2004). Rapid urbanisation swept across Britain (Stearns, 2015) resulting in dramatic demographic changes. For example, the population of Glasgow increased from 77,000 in 1801 to 275,000 in 1841 as growing industries attracted migrant workers in significant numbers from pre-famine Ireland and workers from the Scottish Central Lowlands and Highlands who were displaced by the agrarian revolution (Murray, 1978; Knox, 1999). By the late-1830s, more than 30% of handloom weavers in Scotland were Irish-born (Knox, 1999). The demographic make-up of the workforce was altered when factory work performed

by young women began to replace some of the work of the male profession of handloom weaving (Murray, 1978).

For Agnes Heller and other Marxist writers such as Steve Marglin, Ellen Leopold, and Eric Hobsbawm, the Industrial Revolution was less important than the onset of capitalism that occurred in the fifteenth to sixteenth centuries (Heller, 2011: 176, Scott, 2011). From this perspective, the events of the eighteenth and nineteenth centuries continued the progress of the previous period of capitalist manufacture and can be seen merely as a climax in the history of capitalism. The revolutionary aspect of industrialisation was the supposedly drastic disruption to political and social systems – revolutionary changes in relations of production and the exploitation of workers. Heller (2011: 178) argues that non-Marxist revisionist accounts of the Industrial Revolution that focus on continuity, do not give enough attention to workers and labour conditions, including the transition from workers using tools to machines making use of workers, where the movements of the machines determined the movements of the workers (Knox, 1999). However, other scholars note that the transition to the factory system did not always lead to dramatic transformations to working conditions (Trinder, 2013). The average size of firms remained relatively small, especially in the case of companies producing consumer goods where a medium sized workshop was the norm (Trinder, 2013). Even the large factories were not an entirely new phenomenon, existing before the Industrial Revolution (Ashton, 1934). For example, a five-storey, water-powered silk mill was built in Derby by John and Thomas Lombe around 1721 and remained functional for almost two centuries (Chaloner, 1953). Cotton was the only industry to really embrace the large factory system, but new organisational structures and work disciplines were forming across the manufacturing and service sectors (Berg and Hudson, 1992). Stephen Marglin (1974) agrees with Heller (2011: 187) that what changed in the Industrial Revolution was not an increase in efficiency through factory work but changes to social hierarchy and discipline of labour. The firm and the factory will be returned to in Sections 2.7 and 2.8.

2.3.2 Why did the British Industrial Revolution take place?

According to Humphries and Schneider (2019: 126), the prevailing thesis for why the Industrial Revolution occurred in Britain is due to what Robert C. Allen called the ‘high wage economy’. Allen’s thesis centres around a high wage, cheap energy economy in Britain that

encouraged the development of technologies to reduce costs of production by substituting expensive labour for machines (Allen, 2015: 2). Fundamentally, inventions such as the steam engine and Hargreaves' spinning jenny 'resulted in great increases in productivity' and 'also radically changed factor proportions, substituting energy and capital for labour.' (Allen, 2009: 136). Allen (2015) contrasts their own high-wage concept with an 'old view' that sees the Industrial Revolution and the mechanisation of factory work as resulting from low wages and an abundant supply of female and child workers (Humphries, 2010; Humphries, 2013). This view sees the Industrial Revolution as reliant on cheap (and docile) female and child workers (Humphries, 2013: 170), with many machines invented to be worked by this specific subsection of the labour force (Berg, 1994: 147), enabling children to carry out work previously restricted to adult men due to the strength required (Humphries, 2010: 33–34). Allen claims their view is a result of taking a global perspective on the Industrial Revolution. Even a labourer living at the subsistence level could still be consuming meat, bread, and beer; items which would seem luxurious to their counterparts in other regions of the world (Allen, 2015). This ability to buy comparatively luxurious items is what is meant by the reference to a high-wage economy. Acceptance of this definition of a high-wage economy can be used to counter doubts about the applicability of this concept to regions of Britain other than England. For example, Scotland was a low-wage economy compared to England (in part due to the availability of a large labour force) and Scotland's grain prices were more expensive (Knox, 1999), but Allen (2009) countered this by pointing out that workers in Scotland were still better paid than in France. Other criticisms of the concept include opposition to Allen's methodology for calculating real wages. Humphries and Schneider (2019) recently provided new evidence to argue against the inclusion of spinners in the argument for a high wage economy. Humphries (2013) suggests that Allen used a patriarchal perspective, reliant upon a potentially incorrect notion of a male breadwinner family.

A brief summary of the high-wage thesis has been provided as one important example of alternative theories of the Industrial Revolution and attempts to contextualise Britain's situation within a global context. However, economic indicators such as wages will not form a thread of investigation in this thesis. An alternative theory of 'proto-industrialisation', on the other hand, will receive a more detailed treatment, as it is relevant to the concept of industrial inertia and locational lock-in.

An alternative theory for why the Industrial Revolution happened is ‘proto-industrialisation’. Based on a study of eighteenth-century Flanders by Franklin Mendels (1972), the concept of proto-industrialisation was developed to describe a phenomenon of the early modern period that saw industry appear in the countryside prior to more urbanised areas, and to explain how these cottage industries evolved into modern industrialisation. Proto-industrialisation focuses almost solely on the ‘putting-out’ system for cotton – a system where merchants provided materials to producers who usually worked in their homes or small workshops, returning the finished product to the producer in exchange for piece-rate wages (Littlefield and Reynolds, 1990). Mendels’ concept positions proto-industrialisation as the first phase in the two-stage process of industrialisation (Hudson, 1992). A revised version of the concept, written from a neo-Marxist perspective and published by Kriedte, Medick, and Schlumbohm in 1977, believes it to be the second phase of a transformation that takes society from feudalism to capitalism (Coleman, 1992). The concept received considerable attention in the 1970s and 1980s and has been adopted by researchers from a variety of disciplines and applied to numerous regions and time periods. According to the version proposed by Mendels there are five main features of proto-industrialisation (Houston and Snell, 1984; Coleman, 1992): (1) the region should be the unit of reference; (2) economic growth in the region involved peasant workers producing handicraft goods, generally on a seasonal basis, following the agricultural cycle, and providing an essential supplement to income; (3) the market for these goods was outside the region in which they were produced; (4) there was symbiosis between rural industry and the development of commercial agriculture in the region, whereby peasants supplemented incomes with domestic industrial activities; and (5) towns were incorporated into the process as the location from which merchants directed the manufacturing activities of the rural areas.

Proto-industrialisation has received substantial criticism, notably from Coleman (1983: 446), who states that proto-industrialisation may be ‘a concept too many’. The concept calls for the use of precise criteria and the use of a very specific hypothesis yet aims to be applicable across a wide geography and time, which is a contradiction (Coleman, 1983). The absence of a clear definition of ‘region’ is also considered problematic, since rarely is the location of industry situated within a homogenous geographical area (Whyte, 1989). Many examples do not fit the strict landscape criteria either. In northwestern Europe, a key aspect of the concept was that cottage industries developed in a pastoral context or in upland areas where agriculture was unable to provide sufficient employment compared to other regions (Houston

and Snell, 1984). The problem with this pastoral aspect of the concept is that rural textile-producing areas were frequently based around river valleys (Coleman, 1983: 441), which Houston and Snell (1984: 478) demonstrate with the example of the town of Kilmarnock. Kilmarnock is in the Western Lowlands of Scotland, in a fertile arable region well suited to agriculture, but calico-printing and shawl-making were important sources of income in the late-eighteenth century; therefore, infertility of land cannot explain what drove peasants to take up additional employment in this example. The ability of proto-industrialisation to provide future factory labour is further called into question by the attitudes of cottage industry workers, who are thought to have been averse to factory work (Houston and Snell, 1984). Most power-loom weaving labour came from outside handloom weaving families, and empirical studies have demonstrated there was often a separation between proto-industrial regions and later locations of factories (Houston and Snell, 1984; Marfany, 2010). For others (*e.g.* Trinder, 2013), the biggest shortcoming of the concept is that there was no clear-cut progression from the domestic industry system to a new factory system. For many industries, their domestic practices had long histories and while some such as spinning of textile yarns saw a nearly complete disappearance, other practices experienced little change and continued into the late-nineteenth century.

Despite its limitations, the term and concept of proto-industrialisation was and is still used by researchers (*e.g.* Tuckett and Whatley (2023: 39) in the context of Scotland's linen industry) and there is a risk that the concept's contributions are being lost amongst the critical literature (Eley, 1984: 521). The concept of proto-industrialisation stimulated research into economic activity in early modern Europe, but it is more common now to consider proto-industry as a strategy for historical research rather than as a distinct historical period (Marfany, 2010). It is suggested that value may still be gained by using proto-industrialisation to investigate the connections between economic processes, institutional frameworks, and spatial patterns (Whyte, 1989; Marfany, 2010), especially if considered under the wider banner of industrial inertia (returned to in Section 2.4). Chapter 5 will deploy this approach, so that early in each case study I will consider the population and economic situation, including any existing artisanal industries present in each region prior to the settlement of the cotton spinning mills.

2.3.3 Classic industrial location theory

In this subsection, the focus will move from debates within history towards a more geographical focus, and concepts of industrial location. Industrial activity is rarely distributed entirely evenly, but neither is it observed to be random. Industrial location theories exist to address the question of where certain economic activities take place and their spatial distribution (Hassink and Gong, 2019: 1). A ‘classic’ theory of industrial location within geography developed from the late-1920s to 1960s. The theory branched from two moderately rigid approaches, those of ‘least cost’ from the work of Alfred Weber (1929) and the ‘market area’ approaches of August Lösch (Lösch *et al.*, 1954). The resulting classic location theory is based upon principles of neoclassical economics (Smith, N., 1989: 152) and assumes that economic circumstances, combined with personal or business objectives, affect the decision-making of humans and results in the spatial arrangement of industry (Smith, 1971: 5). Market approaches assume that firms gain a monopoly of their spatially differentiated market area (Ohta *et al.*, 1990: 95). This fails to account for the way an advanced industrial economy may develop areas of geographical specialisation, such as the way clothing or car manufacturing industries may cluster yet still serve a national or international market (Smith, 1966: 98–99). Thus, Smith (1966: 99) argues that a cost-based approach is more realistic for understanding industrial location in Britain.

Theories of least cost predict that the most desirable site to put a manufactory will be the most profitable, meaning the one where combined costs of production and marketing are lowest (Rogers, 1952: 57). There are numerous interrelated inputs or factors that an entrepreneur requires when locating a manufacturing plant, the availability of which is highly dependent on their spatial mobility *i.e.* whether a factor is tied to a specific place or is mobile (Smith, 1971: 28). Mobile factors are then subdivided into those that are perfectly mobile and those that can be transported for a price. Although there are numerous interrelated considerations for a manufacturer: under the classical model of industrial location, land, capital, and labour are generally considered the core ‘factors of production’. The first of these, land, includes the area needed for the factory itself, storage, space for equipment for power generation (an engine, wheel, turbine house, ponds for water storage) and room for potential future horizontal expansion (Manley, 1938). Firms may require land with specific characteristics, such as a knickpoint for a suitable fall of water, or an unobstructed elevated site for a windmill. Some of these factors are unalterable by humans and therefore will

always have a controlling influence on planning decisions (Manley, 1938: 501). In other circumstances it may be possible to create desirable land characteristics through human intervention, with sufficient resources, though this increases costs compared to them existing naturally (Smith, 1971: 33). Other related considerations relevant to a prospective mill owner might be price of land, power sources, and materials – which are either extractive or components that have been made elsewhere – and existing transportation connections.

Transport is frequently considered ‘the most important single determinant of plant location’ (Smith, 1971: 69). Transportation technologies are said to shape the spatial structure of economic activities (Redding and Turner, 2014: 2; Alvarez-Palau *et al.*, 2024: 1224). Traditional models of industrial location directly link spatial differentiation with availability of transport and its associated costs (Hall *et al.*, 2006). Therefore, in theory, improvements in transportation should stimulate economic growth. It has been argued that increased access to infrastructure in the form of turnpike roads and inland waterway networks at the beginning of the nineteenth century can be linked to growth and changes of distribution of populations through market access (Alvarez-Palau *et al.*, 2024) and employment growth in services and manufacturing (Bogart *et al.*, 2018). However, when other historical cases are examined, transport is often found to take on a ‘lagging rather than leading role’ (Maw *et al.*, 2012: 1495). The opposite may in fact be true: that mill settlements have contributed to the shaping of transportation networks (Brykała, and Podgórski, 2020). The importance of transport in more recent history and present-day locational decisions has been further questioned as the sub-disciplines of transport and economic geography have grown apart (Hall *et al.*, 2006: 1402). With enormous improvements in transport and infrastructure in the twentieth century particularly, and an even more recent surge in information and communication technologies, the connection between transport and economy was changed and has received less interest from within economic geography. Turning specifically to mills, Hammer (2008: 329) states watermills in eighth- to ninth-century Bavaria ‘must have been sited with transportation as a primary criterion’, and Ciliberto (2010: 494) observes cotton spinning firms in Blackburn, England, located their mills close to the canal. Others have suggested that co-location of cotton spinning and weaving mills in industrial districts allowed them to overcome otherwise prohibitive costs of transporting materials to weavers (Leunig, 2001: 446).

The second factor, capital, is divided into financial and fixed. Financial capital is the form of capital needed to locate an industry and can be more forthcoming in certain places. In the

textile industry, during the Industrial Revolution in Britain, for example, financial backing for newly-invented machinery was easier to obtain in established textile manufacturing regions where investors were already familiar with the likely profits or risks (Smith, 1966: 100; Smith 1971). Local supplies of capital are often most important for firms that are small or starting out where local reputation and credit scores are known by friends, family, and banks. Financial capital is mobile, unlike land, but setting up in a new location may require stronger social networks. The fixed-capital component is less spatially mobile, consisting of machinery, building, and physical plant. Pre-existing fixed capital does however have the potential to attract mobile capital and enterprise. Re-use of old industrial buildings after previous owners have vacated the premises can reduce the initial costs of entry into an industry. Through the successive reoccupation of sites existing patterns of industrial location are maintained, a trend that is referred to as ‘industrial inertia’ (Smith, 1971; 39), which will be returned to in Section 2.4.

Third, labour requirements of a firm will make certain geographical locations more suitable than others. A firm might opt to locate in an urban area if they need a large labour force or find it beneficial to settle where there is already an established industrial expertise – workers already trained in specific skills. Storper and Walker (1983: 4) argue that many economists and location theorists undervalue labour by reducing it to a ‘true’ commodity, when in fact labour is embodied in humans and is thus a ‘pseudo-commodity’. Idiosyncratic and sentient, the pseudo-commodity of labour power can influence processes of capital accumulation (Herod, 2010: 18). Labour is mobile in the sense that workers can move between geographical locations and amongst industries, and labourers can be attracted by the firm with higher wages, preferable working conditions, benefits such as health care or recreational facilities, and housing. The provision of housing in industrial villages was a common feature of manufacturing in Britain, where the characteristics of the land (supply of raw materials and power) were given priority in deciding mill location (Smith 1971: 45).

Summarising the dominant critiques of location theory, Neil Smith (1989: 153–5) identified four main criticisms. Firstly, classic location theory takes the firm as the focus of study, abstracting it from its relationship to the capitalist economic system. Furthermore, the theory is ahistorical and relies on neoclassical assumptions of spatial equilibrium in the landscape. The last critique is that by adopting a positivist conceptualisation of space, location theory dismisses the importance of social relationships between actors. Diverging from the classical

model, dynamic qualities of the economic environment such as institutional controls and entrepreneurial behaviour are now recognised as helping to guide development (Taylor, 1975).

Previously considered less important than the other factors mentioned, institutional bodies and policies including local taxes may contribute to an individual's perception of subjective concepts such as local business climates (Smith, 1971: 54; Leitham *et al.*, 2000). A final element that is especially difficult to model is chance and personal preference in locational decisions. Personal preference is linked to the term 'historical accident', which is used to include various random factors that influence location decisions (Smith, 1966). For example, entrepreneurs tend to start firms in locations they already live in and within sectors they have prior experience of. This often results in clustering of firms, even if benefits of economies of agglomeration are not present (Sorenson, 2018: 534). Associated with this are behavioural economic geography approaches to location that try to explain deviations from patterns predicted by the classic economic-geographic models of location (derived from Weber and Lösch described at the start of this subsection) by proposing that decision-makers are not boundlessly rational, acknowledging that their capacity to analyse and use information has limitations (Claus and Claus, 1971: 522; van Dijk and Pellenbarg, 2000: 194). Behavioural approaches to location emerged from the work of scholars such as Pred (1969) and his two dimensional 'behavioural matrix' model that measures 'information' (the quality and quantity of information available to the decision maker) against 'ability to act' (the ability of the decision-maker to use available information towards reaching an optimal solution). Thus, chosen locations for industry are often acceptable (profitable) rather than optimal (Rodrigue *et al.*, 2013).

Recent paradigms within economic geography give even greater prominence to the role of the firm and the entrepreneur in processes of industrial location. The last 35 years have seen two paradigm shifts both referred to in the literature as new economic geography. The first, generally described as new economic geography (NEG) or geographical economics refers to the shift beginning in the 1990s by Paul Krugman (1991) to fuse existing ideas within mainstream economics with space and time (Garretsen and Martin, 2010: 129). NEG aims to explain regional variation according to the effects of spatial agglomeration and regards space as 'pre-given and absolute' (Hassink and Gong, 2019: 1). The second usage, referred to by some as new economic geography II (NEG II) incorporates concepts from other branches of

social sciences, addressing criticisms that older concepts within economic geography ignored the realities of non-economic factors. NEG II looks to the influence of formal and informal institutions, the interactions between actors in a network, and power relations upon economic activity, but has received its own criticism for its reliance on qualitative methods and lack of formal models (Hassink and Gong, 2019: 4–5). By the 2000s, another paradigm emerged – evolutionary economic geography (EEG) – from an ‘evolutionary turn’ that sees the economy under capitalism as constantly transforming in structure (Kogler, 2015: 705). EEG gives consideration to innovation and co-evolution of firms alongside endogenous explanations of industrial development. Therefore, a growing number of studies within regional studies and economic geography have been applying network theory to interpret interactions between organisations (Glückler, 2007; Ter Wal and Boschma, 2009). Crucially EEG introduces historical sensitivity into economic modelling, expanding the framework to recognise that time and history influence the economic geography of a given region and explaining exactly how they have done so (Henning, 2019: 602). A critical avenue for the inclusion of historical dynamics into economic geography comes with the notion of ‘path dependence’ (Martin and Sunley, 2010). Defined as ‘the dependence of economic outcomes on the sequence of previous outcomes, rather than simply on current intentional action and exogenous causal elements’ (Puffert, 2023: 1), path dependency describes the persistence of a certain behaviour even after the conditions that initially created the behaviour have changed (Fouquet, 2016: 2). The notion of path dependency is commonly used to understand the mechanisms of ‘inertia’ present within economics, industry, and society more widely.

The classic ‘factors of production’ (and their spatial distributions), form a key line of enquiry within this thesis, especially regarding land, power, transportation, supplies of capital, and labour. In Chapters 5 and 6 I take behavioural aspects of locational decision-making into consideration, mapping out the ownership history of six mills and making observations about the background and characteristics that could have influenced their business decisions. From the literature on new economic geographies, I take forward a consideration of networks of firms and entrepreneurs connecting mills, although it is important to clarify that I do not perform Social Network Analysis. These networks, derived from micro-histories, are considered qualitatively, focussing on actors with direct responsibility for setting up or managing mills. I also use the concept of path dependency, framed under ‘inertia’, which is explored further in the next section of this chapter.

2.4 Industrial inertia

Industrial inertia, referred to also as historical lock-in effect, implies that decisions made at a point in time can shape the future geography of a place or entity. This idea of inertia follows-through from classic industrial location theory. Inertia does not mean that things never change, however where strong forces of inertia are acting, responses to changing circumstances will be slow (Teixeira, 2003: 7). Mokyr (1992) applies inertia in the context of technological systems and social resistance to progress that can slow down adoption of innovations. Physical infrastructure is considered possibly the strongest industrial lock-in, capable of ‘defining the geography of a country and the behaviour of an economy for centuries and even millennia’ (Fouquet, 2016: 2). Geographers have taken interest in the concept of industrial inertia and its manifestation for manufacturing industries, for instance, the locational patterns of the steel industry in the United States (Rodgers, 1952: 60). In this case, large investments were made in immobile equipment and plant in the early industrial regions that prompted steel firms to resist relocating despite cheaper freight costs elsewhere. Chapman (1970: 237) identifies many cotton mills during the Industrial Revolution that acquired and refitted the sites of worsted and linen mills, or non-textile mills, when those previous industries experienced local decline. In addition to explaining locational patterns (Rodgers, 1952), the concept of inertia can be applied to other aspects of industry such as innovation or organisational inertia (Lazerson and Lorenzoni, 1999), and intangible consumer inertia (Fishman and Rob, 2003: 25).

Geographer W. H. K. Turner began in the 1950s to explore the idea of inherited spatial characteristics of industry through detailed case studies of textile regions of Scotland.² Inertia does not have to manifest in the direct use of previous facilities; a prior industry could also leave its legacy by promoting the use of a site in a certain way. Turner (1958: 104) exemplifies this with a description of the lade system at Stanley Mills in Perthshire:

... Dempster’s cotton mill of 1785 took the place of John Nairne’s corn mill. This had derived power from a lade tunnelled through the meander core. Dempster cut another lade for his mill, in 1823 the Buchanans tunnelled another, and a century later a new cut was made from the junction of these two; but the idea behind this sequence goes back more than two centuries to the small mill originally built for grinding corn by Lord John Nairne in 1729.

² For a fuller review of Turner’s work see Jones *et al.*, (2023).

Especially when approaching the later period of industrialisation at the end of the nineteenth century, original natural endowments became less important. However, in a similar vein to the concept of proto-industrialisation, industry might stay in the same location due to the build-up of human capital in the region and subsequent knowledge spillovers. For example, Turner (1958: 99) provides another account of an inertia that saw small woollen mills develop from earlier artisan production. Crafts and Wolf (2014: 1134) explain this correlation to be due to a combination of the sunk cost of fixed capital investment and the existence of beneficial effects of agglomeration, forming a ‘channel through which original advantages could have legacy effects’. Crafts and Mulatu (2005) propose this as an explanation for the cotton textiles industry in Lancashire. Steam mill location was initially driven by abundance of coal but even when original advantages lost their relevance, the region retained economies of scale in the pool of local technical knowledge and industry-specific expertise. The clustering of complementary activities (finishing, processing, marketing) added further incentives to remain in the location. Many regions with a history of earlier textile invention were indeed preferred locations for concentrations of mills in the nineteenth century (Craft and Wolf, 2014: 1134; Jonell *et al.*, 2024). Mokyr *et al.* (2022: 1896) argue for a symbiosis between locations of early grain mills in England and later sites applying water to fulling, then to other industrial processes, with their hypothesis being that the locations that already had highly skilled millwrights were at an advantage for adopting other advanced and complementary machinery and technology. They argue this persistent locational inertia, determined by the original geographical endowments of the land, is evident from the thirteenth century through to the start of the industrial revolution (Mokyr *et al.*, 2022). The concept of industrial inertia - such as the re-use of mill locations even after the initial factors of production have lost relevance – is an important theme that will be investigated in the thesis.

2.5 Diffusion of innovations

The industrial revolution was not the Age of Cotton or of Railways or even of Steam entirely; it was an age of improvement. (McCloskey, 1981: 118)

Over the last two decades the idea that cultural context determined technologically-driven economic growth has gained popularity (Engerman, 2004; Allen, 2009). The concept of the

Enlightenment has been developed into ‘Industrial Enlightenment’ to explain the rapid technological advances in the late-eighteenth and early-nineteenth centuries (for example by Mokyr, 2002; Jones, 2008; Berg, 2013). While more than one interpretation of the concept of the Enlightenment exists, the Enlightenment can refer to the period after the Scientific Revolution and prior to the Industrial Revolution during which a ‘knowledge economy’ developed in Europe (Jones, 2008; Lenman, 2009). After the end of the American War, people travelled around Europe, described as transferring knowledge across space as they moved and creating an information-rich continent (Jones, 2008). These were not just the wealthy, leisured elites of society. They were also workers, journeymen, and craftsmen, travelling as they searched for employment (Jones, 2008). In Britain, the knowledge these workers possessed was not necessarily gained through the formal institutions of schools. Informal mechanisms of learning and knowledge exchange were crucial in delivering highly skilled craftsmen with practical ability (Mokyr, 1990). Lenman (2009) describes a simultaneous expansion of printing and publishing industries that facilitated the distribution of popular scientific literature in the form of periodicals and encyclopaedia. Technical innovations and ideas were exchanged through informal lectures, meetings in coffee houses, technical pamphlets, and scientific societies such as the Edinburgh and Glasgow Philosophical Societies in Scotland (Mokyr, 2005: 312; Trinder, 2013). The role of institutions and networks in Scottish cotton firms will be returned to in Section 2.7.

The preceding sections have engaged primarily with the economic-geographical aspects of the Industrial Revolution. From the point of view of Meisenzahl and Mokyr (2012: 443) the Industrial Revolution was the first instance of technological innovation being a key driver of economic growth. This section will review and consider literature that understands the Industrial Revolution as a period of progress of technology, ideas, and social organisation. In this section a detailed treatment is presented of the literature on the concept of diffusion of innovations. The discussion is warranted here because the concept has been favoured repeatedly by economic historians and human geographers when trying to account for how all manner of phenomena (inventions, technologies, practices) seemingly spread from place to place across a landscape (Hägerstrand, 1966; Pedersen, 1970; Pred, 1975). The concept therefore has direct relevance to interpreting the development of mills over time, especially during the period of rapid industrialisation from the late-eighteenth century onwards. Terminology and models of diffusion have been popular in charting the diffusion of steam engine technology but can also offer ways of thinking about innovations in waterpower, the

imitation of mill architecture, and the factory system of labour organisation. It is important to make clear that the approach and design of the research presented in this thesis is not testing a model of diffusion. However, there are concepts and terms that have utility for the project that will be highlighted and taken forward: imitation; partial-use; adopter categories; and innovation attributes. The development of diffusion research, including its use in geography, will be summarised, followed by typologies that can be usefully applied to water and steam power technologies.

2.5.1 Diffusion theory

The concept of diffusion was introduced through the work of European anthropologists and ethnologists during the second half of the nineteenth century. These researchers undertook systematic studies of diffusion, with the goal of producing an all-encompassing model of social change, similar to the laws being discovered in the natural sciences (Kinnunen, 1996). The concept then entered sociology with the work of Gabriel Tarde in *Les Lois de l'Imitation* (1890). Prompted by an observation that certain crimes seemingly reproduced through society in waves similar to diseases or epidemics, Tarde questioned whether this might be a general feature in society (Marsden, 2000). Tarde then proposed that self-propagation was the ultimate aim of a society (Marsden, 2000). According to this explanation, as individuals constantly interact, they imitate one another, either instinctively, forced, or deliberately, resulting in similarities between their beliefs and desires (Tosti, 1897; Djellah and Gallouj, 2014). This process of imitation can be equated with what we now refer to as 'adoption' (Rogers, 2003). A frequent criticism of Tarde is that his work was of an overly individualistic nature, almost entirely omitting the explanatory possibilities of collective influences (King, 2016). Nonetheless, Tarde's vision of society as 'a complex and contingent network of social and biological assemblages with no overarching logic, trajectory, or direction' (King, 2016: 47), has earned him the title of 'founding father of diffusion research' (Kinnunen, 1996: 432), and later of actor network theory (Latour, 2012), despite not using these terms himself (Valente and Rogers, 1995).

Diffusion theory and research has since been approached from many disciplinary perspectives. The first notable attempt to study diffusion using empirical data came from the field of rural sociology with Ryan and Gross's (1943) investigation of hybrid seed corn utilisation in the American Midwest. Hybrid corn offered a more efficient and therefore

economically beneficial farming technique, making its adoption rational during the economic recession of the 1930s, despite the limiting factor of lack of access to credit in this period. However, knowledge of this innovation advanced much more rapidly than adoption. Ryan and Gross describe the ‘early adopters’ of the new corn as a ‘community laboratory’, allowing ‘non-adopters’ to witness the experience of other farmers before taking on risk themselves. Another important finding relevant to this thesis was that adopters tended to opt for ‘partial use’ of the new hybrid corn to begin with, reserving the rest of their land for traditional seeds, and increasing the percentage of new seed crop in later years. This strategy continued even for the majority of the later adopters, a finding that reflects the fact that some people do not fully trust the experiences reported by others and want to carry out their own experimentations before fully committing to an innovation (Ryan and Gross, 1943).

In the second half of the twentieth century, researchers continued to develop concepts to explain the spatial dimensions of diffusion, the communication channels through which knowledge of an innovation spreads, the relationship between culture and diffusion, and degrees of innovativeness within a social system. Geographers emphasised the role of space in the diffusion process. Torsten Hägerstrand’s *Innovation diffusion as a spatial process*, (1953, English translation 1967) has been ‘of fundamental significance’ (Cliff *et al.*, 1992: 545), especially for human geographers in the 1960s and 1970s (Kandler and Steel, 2009). To understand and predict the spatiotemporal aspect of the diffusion, Hägerstrand simplified diffusion into links and nodes, suggesting that social circles (interpersonal connections with friends, acquaintances, families *etc.*) represent an essential link for the diffusion of an innovation. This is referred to as the ‘neighbourhood effect’. At the start of the diffusion process, an innovation tends to be concentrated in small clusters then typically spreads within the vicinity of the initial adopters (the ‘neighbours’), before spreading further afield (Hägerstrand, 1966). An early simulation of agricultural innovation in central Sweden confirmed face-to-face communication was critical to the diffusion process despite the existence of mass media because farmers placed greater trust in the legitimacy of the opinions of people they knew (Blaikie, 1978). This work highlighted another idea that accounts for adoption in geographically distant locations, namely that diffusion occurs within an urban hierarchy, starting with the largest and working down to the smallest (Hudson, 1969). Hence, when an innovation is introduced to a new country, it is likely to be adopted first in a major metropolis, followed by the next level of lower-order urban centres, which may be geographically distant.

2.5.2 Adopter and innovation attributes

Adoption of a new idea or technology within a community can be difficult (Rogers, 2003: 18). The time lag between invention and widespread adoption is therefore often significant, prompting numerous researchers to investigate the speed at which technology disperses and the factors which aid or hinder it (Cliff, 1981; Abbott and Yarbrough, 1999). The presence of a lag, or to use the term again, an inertia, calls into question the validity of theories of social ‘inevitability’ or sociological or economic determinism. If there is indeed ‘little doubt’ that entrepreneurs ‘were certainly very much influenced by economic and social factors’ (Musson, 1972; 53), why were inventions such as the power-loom or high-pressure steam engine not immediately adopted by the majority?

A popularised idea amongst diffusion research is that adopters and innovations can be classified according to common attributes. Within a social system, potential adopters of an innovation decide to adopt at different times and some members of a population will be more predisposed to the adoption of innovations than others (Martínez and Polo, 1996). A typology put forward initially by Everett Rogers (2003, first published 1962), proposed separating a population into five idealised adopter categories using their speed of adoption, which indicates their degree of ‘innovativeness’ (Table 2.1). Since noncumulative adoption is assumed to form a bell or S-shaped curve, the majority of people will fall into the middle categories.

Table 2.1. Adopter categories (based on Rogers, 2003; Kauffman and Techatassanasoontorn, 2009; Riverola *et al.*, 2016).

Category (% of population)	Characteristics
Innovators (initial 2.5%)	Actively seeks out knowledge of innovations, has extensive interpersonal networks, exposed to mass media, willing to accept higher degrees of risk and uncertainty. Likely to possess the financial resources and cognitive ability to comprehend the complexities of the innovation.
Early adopters (13.5%)	Shares some characteristics of innovators but to a lesser degree. More integrated in the local social system than innovators, making this the most important category for opinion leadership (influencing others). Respected by others in the social system, the early adopter decreases uncertainty about an innovation for their less innovative peers.
Early majority (34%)	Willing to adopt but may spend a much lengthier time deliberating before making a decision. Members of this group do not want to be first or the last to adopt.
Late majority (34%)	Sceptical and cautious towards innovations. Adoption may be a result of necessity, through peer pressure, or because a new innovation has become the industry standard.
Laggards (the final 16%)	Traditional values and scepticism about change. Resistance may be a result of precarious economic or social status and a need to limit risk. Waits to see the innovation adopted and used successfully by others before adopting themselves. Isolated within a social network and unlikely to possess any opinion leadership.

The behaviour associated with non-use (*i.e.* not adopting an innovation) has received far less attention than successful adoption (MacVaugh and Schiavone, 2010; Wolverson and Cenfetelli, 2019). There is frequently an implicit assumption in diffusion literature that adoption by 100% of the target population is attainable (Dobson and Jackson, 2017). However, non-use consists of more than simply delaying adoption. Indeed, it can be a deliberate choice (Kahma and Matschoss, 2017). According to Satchell and Dourish (2009: 11), whether someone resists or eagerly embraces an innovation, they are ‘responding to and shaping cultural interpretations of technology, even though they do so in different ways; their perspectives each play a role in the cultural appropriation of technologies’. There are many reasons why one might put off the adoption of a technology. In recognition that looking beyond just adoption can provide a fuller picture of the diffusion process, Satchell and Dourish (2009) offer the five types of non-use presented in Table 2.2 in addition to the temporary state of non-use that is described by the ‘laggards’ classification.

Table 2.2. Categories of non-adoption (based on Satchell and Dourish, 2009).

Category	Description
Active resistance	Refuses absolutely to adopt. Puts up active resistance. Reasons might include a preference for an alternative technology; political, environmental, or health concerns; fear of losing control over certain aspects of work or life.
Disenchantment	Involves a reluctant or perhaps partial use of a technology. Often associated with nostalgia for a changing existence.
Disenfranchisement	The innovation is inaccessible in some way. This may be due to geographical or socioeconomic barriers.
Displacement	Non-use is explained by someone else nearby adopting the technology and offering some form of relationship through which others can use it.
Disinterest	The innovation is simply not of interest, or irrelevant.

Innovations themselves may also have characteristics that lend themselves to diffusion. Rogers (2003) proposed five attributes for predictors of successful adoption, according to whether an innovation is perceived to have ‘relative advantages’ over another innovation; whether the innovation has ‘compatibility’ with the adopter’s values and needs; the ‘complexity’ of skills required for adoption; and the potential to try out or see others using an innovation prior to committing to its adoption (‘trialability’ and ‘observability’). Reiner (2011) notes that since a community may not be homogenous in terms of beliefs, technical skills, or social circles, perceptions of an innovation may differ between community members.

Concepts will be taken from the diffusion studies to understand where certain firms fitted within the overall adoption spectrum – with regards to new forms of motive power (steam engines, hydroelectricity), or innovations to existing technology (waterwheels) – particularly the ideas of early adopters, laggards, non-adopters, and innovation attributes. There has been substantial interest in the diffusion of steam engine technology which will be described in the following Section 2.6.

2.6 The era of steam?

2.6.1 Development and diffusion of steam

The application of diffusion research to the stationary steam engine has attracted much academic interest, most of which has focused on Britain. This interest is unsurprising considering James Watt’s adaptation to the steam engine has been hailed a defining moment

in human history on Earth and for Britain's fortunes in particular, with consequences so momentous it has been proposed as a marker for the start of the Anthropocene (Crutzen and Steffen, 2003; Diogo and Simões, 2016).³ That said, the steam engine as we think of it today took time to develop, emerging as the result of a series of breakthroughs that built upon prior technological innovations. Such incremental improvements, or 'micro-inventions', are as much a core feature of industrialisation as heroic leaps of discovery ('macro-inventions') such as Richard Arkwright's waterframe or Henry Cort's puddling process for iron (Mokyr, 1990: 13; Nuvolari, 2004; Mokyr, 2009: 113).

The origins of creating motion from steam are thought to date to Hero of Alexandria in the first century AD (Kitsikopoulos, 2013), though it was not until the eighteenth century that a usable engine for manufacturing processes was created. Under the system of free market capitalism, for an invention to become a reality a financial incentive is usually required (Hanlon, 2020: 302–8). In the case of the steam engine, this incentive was mining and extractive industries. The first notable innovation in coal-powered steam technology was Thomas Savery's 'The Miner's Friend', patented in 1698 (Spear, 2008). The limited depth to which it could operate (32 ft) and the volatility of a boiler creating high-pressure steam, however, prevented Savery's engine from far-reaching diffusion (Hanlon, 2020). The first working atmospheric steam engine with any commercial success was installed in a coal mine in 1712 by Thomas Newcomen, the outcome of a decade-long process of research and development (Spear, 2008; Allen 2009). Capable of raising water almost 130 ft, Newcomen's machine was a vast improvement on Savery's (Hanlon, 2020: 304). The engine extracted water from the mine by pumping it to the surface, as well as lifting buckets of coal (Morgan, 1999). This was an opportunity to greatly increase coal extraction (a good supply of coal being essential for steam engines in the future). However, these engines required enormous quantities of coal to operate. Hanlon (2020) observed that the Newcomen engine therefore found its greatest success in regions such as the Midlands of England, where coal was comparatively cheap, but less so in areas or indeed other industries where coal was transported at significant costs. Thus, Allen (2009) notes the location of collieries dictated the diffusion of the Newcomen engine.

³ The use of the concept 'Anthropocene' as a new epoch characterised by the domination of human influence on the Earth has generated significant debate. Crutzen and Stoermer (2021) propose the final quarter of the eighteenth century, *i.e.* the start of the classic British Industrial Revolution as the start.

The steam engine now provided a viable alternative to other power sources (Cardwell, 2003) but was still not a replacement for the waterwheel in most industries. Manufacturing required smooth motions to drive machinery, and a waterwheel's continuous turning provided this. In contrast, the beam of the Newcomen engine moved with an irregular rocking movement that simply was not comparable (Allen, 2009). An initial solution combined the Newcomen engine with waterpower, but rather than directly turning machinery, the engine would usually be used to return water that had already passed over a waterwheel back upstream into a reservoir to be used again. This could alleviate problems associated with otherwise reliable rivers with reduced flow in the summer months (Allen, 2009). In 1769, James Watt received a patent for discovering that steam could be used more efficiently by using a condensing vessel separate to the main cylinder (Scherer, 1965; Hills, 1989). Calculations suggested Watt's improvement made the atmospheric engine up to three times more efficient, but it was still only suitable for pumping water (Hills, 1989). The origins of a usable rotative engine may have begun with a patent applied for by Matthew Wasborough in 1779, with the addition of a flywheel to the steam engine (Hills, 1989). Following this, engines were finally developed with a motion smooth enough to install in textile mills.

Even so, data suggests it was not until the middle of the nineteenth century that steam had significantly overtaken waterpower in some of the major industries in Britain, including production of cotton (Shaw, 1984; Ashworth, 2008: 266). In fact, the extent to which this was the case is widely debated in the literature as is the timing of steam's takeoff. Equally debatable is the reason why steam was preferred over other sources of motive power. Where the literature is widely in agreement is that diffusion did not occur homogeneously (Nuvolari *et al.*, 2011). Since the late-1970s in particular, economists and historians of science and technology have sought to present a quantitative picture of the diffusion of the steam engine both in terms of timing and geography. However, charting the path of diffusion of steam is complicated given the incremental technological advances, each engine model being sufficiently different in the earlier stages to have its own characteristic diffusion path. Frenken and Nuvolari (2004: 240) describe how different evolutions of engine design or 'speciation', to borrow the term from biology, were applied more successfully in certain industries compared to others.

The earliest studies traced diffusion based on numbers of engines, such as an early attempt at quantifying engines in Britain by Harris (1967: 138, 147), which extrapolated upon previous

regional and model-specific counts in contemporary and modern sources, to suggest that approximately 1,200 steam engines were constructed in the eighteenth century, noting the substantial demand for what was initially an expensive technological innovation.⁴ The most recent survey of British engines (Kanefsky, 2024) increased this total to over 2500 confirmed engines and a further 200 possible engines up to the year 1800. Kitsikopoulos (2016: 75, 87) contends that assessing diffusion according to number of engines is misleading as it masks the vastly increased potential power output of individual engines over the eighteenth century. The average power of an engine increased from 5.6 hp in 1706–1719 up to 27.4 hp in the years 1760–1773. This is relevant when considering whether an engine had the capacity to displace a waterwheel in particular situations such as at the mills introduced in Chapter 5.

Cumulative adoption of engines, when studied at the county level up to 1800 in Britain, displays an S-shaped profile (Nuvolari *et al.*, 2011: 300–307), as predicted by theories of diffusion. Nuvolari, Verspagen, and von Tunzelmann (2011) identified counties that were ‘pioneers’ and others that followed the characteristics of ‘laggard’. The Scottish counties studied by Nuvolari *et al.* fell into a middle ground between pioneers and laggards, with a slightly late start to diffusion, taking off after 1760. This supports earlier research by von Tunzelmann (1986: 77), which also implies that adoption of steam was later and slower in Scotland compared to England, certainly until 1800 at least. The number of engines installed in the main Scottish manufacturing districts appears to have trailed behind those of northern England. The can also be seen with the Lanarkshire coal mining region versus Cornwall according to the data on the number of engines in 1800 presented by von Tunzelmann (1986).

2.6.2 Spatial Patterns

That innovations might disperse through neighbouring regions has been observed and investigated in multiple locations. Franck *et al.*, (2017) demonstrate that by the 1860s, France exhibited an unequal distribution of steam engine use that dispersed downwards from the north of the country. Both adoption rates and total horsepower output of steam engines in a department tended to decrease with distance from Fresnes-sur-Escaut, at the northern tip of France, where steam was first used successfully for industry in the country (Franck *et al.*,

⁴ Their estimate is increased to 1,330 engines employed during the century. The difference between construction and employment results from engines that were purchased and subsequently sold and relocated elsewhere being counted more than once. The difficulties inherent in identifying a new versus a rebuilt engine are discussed by Kanefsky and Robey (1980: 164).

2017: 19–20). These findings are supported by Le Chapelain and Wilke (2025) who discovered spillover effects between neighbouring regions. Similarly, Nuvolari *et al.*, (2011: 299) tested spatial autocorrelation of engine adoption in Britain, concluding that the tendency for counties with high numbers of Newcomen engines to be neighbouring was statistically significant. The same did not apply for all engine types however. They propose that Boulton & Watt engines were less influenced by local conditions than other engine manufacturers.

In terms of diffusion through sectors of the economy, the literature implies the process was uneven, with textiles at the forefront of adoption. Within textiles it was the cotton industry that drove mechanisation and the need for ever greater inanimate power (Musson, 1976). Other sectors within the textiles industry such as wool textiles transitioned to steam far more slowly than cotton. This was not uniform for the whole of Britain but wool producing regions of Scotland certainly fitted this slower pattern (Jenkins and Ponting, 1982; Nuvolari *et al.*, 2011). Such conclusions align with the view that industrialisation in Britain was characterised by narrow changes, limited to certain industries.

Musson (1976: 415) highlighted the paucity of research into steam's diffusion beyond 1800, suggesting that the dominant focus on the eighteenth century was due in part to 'the "heroic" theory of historical evolution' that places Newcomen and Watt as the centre of attention along with the relative paucity of sources other than the collection of papers associated with Boulton & Watt. Using the Factory Inspectors' Returns, Musson found that steam had overtaken water by a ratio of around 24:1, accounting for 976,940 hp and 55,620 hp for steam and water respectively by 1870 (Musson, 1976: 438). There are undeniable issues underlying use of the Returns that will be discussed in the following chapter. Addressing the continued disparity in research between pre- and post-nineteenth-century economic impact of steam in Britain, Crafts (2004) applied a growth accounting methodology, coming to an almost identical overall conclusion as Musson that steam's period of greatest growth and impact was from the mid-nineteenth century and not in the early Industrial Revolution (Musson, 1976: 436; Crafts, 2004: 349). The difficulty in accurately estimating both the existence of steam engines and perhaps even more so, their use, is indicated by the fact that Musson's data suggests approximately 1,200 steam engines of all kinds were in use in Britain by 1800. This is a significantly lower figure than the 1,634 Newcomen and Boulton & Watt engines that were constructed in the eighteenth century according to Nuvolari *et al.* (2011). Less is known about the many engines produced by other makers, particularly from 1780 onwards, when

many iron foundries began supplying small engines for factory use (Kanefsky, 2024). This is especially problematic for places like Scotland, especially if Tann's remark is true that manufacturers preferred to buy from local engineering firms in Glasgow rather than the Birmingham based supplier (Boulton *et al.*, 1981: 275).

2.6.3 Cost

In terms of *why* steam was adopted, cost is commonly cited. To refer back to the debates on why the Industrial Revolution happened, the process of coke smelting provides an example of a transition to coal occurring due to cost as much as scarcity. Allen (2009: 235) said the invention of the coke smelting process was 'biased' towards using a cheap input (coal) to reduce another more expensive input (wood) just like the spinning jenny replaced labour with capital (Allen, 2009). Coal was significantly cheaper than wood as an energy source in Britain (Allen, 2009) so it made sense to use coal for smelting iron. When coal introduced too many impurities to the product, technologies had to be invented to remove them and allow the continued use of this cheaper fuel source (Allen, 2009). As was explained earlier, the coal-powered steam engine, which went on to become 'symbolic' of industrialisation (Pollard, 1990: 17), prior to powering machinery, was used in mining to extract even more coal (Allen, 2011). Coal was able to be a backstop technology, substituting the more expensive charcoal.

As mentioned under industrial location theories, costs vary between places. Both water-powered and steam-powered industry potentially incurred transport costs of some sort. Since waterpower was available only at fixed locations, its use generally involved transport charges on materials and products. Meanwhile, steam power could be generated anywhere, but a location away from a source of coal involved transport charges on the fuel. Third, capital costs formed a greater part of the total costs for waterpower than for steam power, and the choice between the two at any location was affected by the interest rate (Temin, 1966: 197–198). Atack *et al.* (1980) was one of the first studies to apply economic simulation modelling to the question of the relative costs of steam power and waterpower in the USA. Atack *et al.*'s results showed relative costs varied over time and across geographic regions but that where water remained cheaper (*e.g.* Lowell, Massachusetts), adoption of steam was low, while there was early and widespread adoption of engines in the Cincinnati area where there was an almost zero probability of water being cheaper than steam. Nuvolari *et al.* (2011: 300)

also examined diffusion paths and factors driving diffusion in the last quarter of the eighteenth century, finding that the local price of coal was a critical factor in the diffusion of steam in Britain. However, focussing only on cost can fail to sufficiently consider other factors. Nuvolari *et al.* (2011) only included economic/industrial or demographic factors and there is no consideration of physical endowments (beyond the existence of local coal). Using data from engines and wheels installed at collieries, Kitsikopoulos (2023: 221) shows that even by the mid-nineteenth century, steam had not dipped below the average cost of waterpower. This then calls into question the cost hypothesis and subsequently why steam would be favoured at all.

Atack *et al.* (2008) develop the cost theory further, adding a previously mostly neglected dimension: firm size. They suggest that larger factories, measured by the number of workers employed, were the most likely to use steam in the period 1850–1880 in the USA and explain the correlation through the scalability of steam – it was typically easier to generate more horsepower by purchasing a larger engine and combining it with multiple boilers than to increase the output of waterpower. The capital required for such expansion would however be substantial and likely only profitable to firms with high outputs and presumably larger workforces (Atack *et al.*, 2008: 188). The role of the threshold (minimum) level of output is applied to adoption of early engines in mining and iron industries in Britain by Kitsikopoulos, 2016: 70–71) who suggests that a smaller firm’s ability to purchase an engine was restricted while prices were high and options for borrowing credit limited. Such cost hypotheses can be applied to other expensive innovations such as mill machinery or the most modern waterwheels.

Bottomley (2024) cautions that placing importance on cost runs the risk of this being treated as the only significant difference between the two power sources. As sources of power, water and steam were competitors, but depending on circumstances, not exact substitutes. Urban sanitation and water supply in the nineteenth-century English town of Bury St Edmunds provides one example where steam and renewable options were not interchangeable (Bottomley, 2024: 19). Bottomley’s argument is that the power requirements were too great for horses, and the gentle topography of the land was unable to provide the fall needed to use waterpower, meaning steam was considered the best solution for the Bury St Edmunds water supply – it was not a simple cost-based decision. As Harris notes (1967: 148), to be adopted

while new and expensive especially, steam needed to remove bottlenecks to economic expansion that water was unable to overcome.

2.6.4 Persistence of waterpower

Mokyr *et al.* (2022: 1923) tell us that waterpower was still important in the early-nineteenth century. Attempting to calculate the amount of horsepower generated by waterpower in mills at any point in time would be painstaking and few have attempted such a challenge (von Tunzelmann, 1978: 125). Despite the lack of precise figures, evidence points to waterpower continuing to vastly outnumber steam in terms of power output across Britain in 1800. At this date water generated over three quarters of power for cotton mills (von Tunzelmann, 1978: 179) and waterwheels continued to be installed at existing and entirely new enterprises. Innovations from the leading millwrights and engineers of the time were needed to keep pace with increasing power demands. Throughout the eighteenth and nineteenth centuries major improvements to waterwheels were being made by millwrights and engineers. Notable in Britain was John Smeaton's work on the efficiency of the overshot and breastshot wheels and introduction of iron axels and gearing in the 1750s (Musson, 1976: 418), the addition of a governor to control speed by Thomas Hewes (Tann, 1974 :86), and major innovations in the engineering of water systems such as those of Robert Thom (a focus of Chapter 5).⁵ Meisenzahl and Mokyr (2012: 444) go as far as to suggest that with the technological progress being achieved in waterpower, an Industrial Revolution likely would have happened had the steam engine not existed.

2.6.5 Energy scarcity

Fouquet (2016: 1) suggests there is often 'a positive feedback between energy resources, infrastructure and industrial development, locking an economy into specific consumption patterns'. The topic of the diffusion of steam has found itself embedded within wider current debates on industrialisation and energy transitions, some of which position coal and the steam engine as essential for economic growth. In economics, the production function is an equation that represents the relationship between inputs (such as capital or labour) and the amount of product obtained as the output (Acemoglu, 2009). Classical economic models such

⁵ John Smeaton (1724–1792), dubbed the 'father of civil engineering', was known for studying, designing, and consulting on watermills, windmills, horse mills, steam engines, canal navigations, dams, bridges, and more (ICE, 2025). Thomas Hewes (1768–1832), Manchester based master-millwright and machine maker, briefly employed William Fairbairn who will feature later in this thesis (Byroms, 2015: 46).

as production function tend to ignore the role of energy in economic growth (Stern, 2011). However, the First Law (conservation of mass/energy) and Second Law (entropy law) of thermodynamics tell us that energy is consumed in economic processes. Energy must therefore be an essential component of economic production and needs to be considered a factor of production just as much as labour or capital (Ayres, 1998). Stern and Kander (2012) present a theoretical model to explore the ability of energy to constrain or enable growth. Their results show that, as in the traditional Malthusian-Ricardian model, economic growth will decrease if population increases without an increase in the quantity of energy. For per capita growth to continue one needs a greater energy supply, higher quality fuels, or the invention of energy augmenting technology. All three of these requirements were met during the Industrial Revolution, for example, in the utilisation of coal, the ability to access more coal by using steam engines to pump water from mines, and Watt's addition of the separate condenser, which improved the efficiency of steam engines (Allen, 2009).

A similar argument was offered by Wrigley (2010; 2013) from a perspective of economic and demographic history that defines the major milestones in human use of energy as the generation and use of fire through the Neolithic food revolution and finally the transition to a fossil fuel reliant economy. Wrigley judged the Neolithic food revolution a radical change, as the development of settled agriculture allowed human populations to expand significantly and urban societies were able to form as a result. The existence and expansion of these 'organic' economies, referred to as such because they use energy generated by plant photosynthesis, was hindered by a lack of energy. With restricted energy supplies in the Low Countries, capital accumulation faced rapidly diminishing returns (Stern, 2011). The thesis is that plants and animals are poor at converting solar energy to useful work and so the Industrial Revolution would have been near impossible without the utilisation of coal and the steam engine's mechanical energy to shatter the constraints placed on industrial production through reliance on organic energy. This theory contradicts Meisenzahl and Mokyr's (2012) suggestion that waterpower could have driven the Industrial Revolution.

This argument could be interpreted as scarcity forcing society to change its energy source. Another key point of reference in this debate is the 'timber famine' prior to the industrial revolution. Population growth in Britain stimulated the demand for wood for both domestic and industrial use, and the looming prospect of depleted forests necessitated the invention of technologies that utilised an alternative energy source (Reynolds and Cutcliffe, 1997;

Steinmueller, 2013: 1739–40). Although in the case of mills the transition was from water (or from small amounts of wind and animal power) to coal, the scarcity narrative also implies that waterpower resources were becoming scarce in specific regions of Britain such as Greater Manchester (Jonell *et al.*, 2024). Steinmueller (2013: 1740) describes how a society's 'anticipation of crisis sets in motion forces of innovation to produce a different path of development in order to overcome the crisis'.

However, Jonell *et al.*'s (2024) calculations imply that technically, even the most clustered textile regions of Scotland did not exceed 17% of their waterpower potential in the 1840s. Researchers have recently revisited and challenged the view that a shortage is needed to trigger the creation of alternatives (Steinmueller, 2013: 1747). One such researcher that has taken issue with the idea that scarcity led to industrialisation and the diffusion of steam is Andreas Malm. In their work on the hypothesis of 'fossil capital', Malm (2012a; 2016) claimed that Wrigley's thesis could only work if coal was replacing plant-based fuels (either directly through wood or indirectly as fodder to feed animals). But the Industrial Revolution happened initially with a factory system based on water with coal-based technologies eventually taking over previously water-powered processes. From an ecological Marxist perspective, the decision to switch to coal as the primary energy source was the product of capitalist relations that allowed owners to take their factories to locations where they would find cheap and disciplined workers and went hand in hand with the desire to automate production. The introduction of steam power gave capital mobility, as illustrated through the example of the British cotton industry (Malm, 2016, 121–164), thus conceptualising the transition as opportunity-led as opposed to scarcity-led. Under this view, the use of coal freed industry from the 'envirotechnical system' (Pritchard, 2011: 1) that was waterpower. No longer did spatial properties of the ecological and technology systems, of the human and non-human, need to converge (Pritchard, 2011: 1; Parrinello, 2018: 655). Nature's coal could be abstracted and taken wherever it was required to generate the accumulation of capital. Aside from powering machinery, the application of engines to steam vessels permitted the trading and transportation of 'unprecedented quantities' of natural resources from the colonies to the factories and vice versa (Malm, 2012b: 118).

For the USA, Rosenberg and Trajtenberg (2004: 62–63) also observed concurrent processes of steam engine adoption and a rural-to-urban shift of factories. Corliss steam engines contributed to a 'dynamic interaction between industrialisation and urbanisation'. Free to

locate where they pleased, manufactures flocked to urban areas to benefit from agglomeration economies, encouraging a positive loop whereby further industrial activity and population was attracted. Rosenberg and Trajtenberg found that watermills, located in more remote, sparsely populated areas did not encourage such economic clustering. Locational freedom has been viewed as ‘an unparalleled advantage’ (Atack *et al.*, 1980: 293) but this freedom was not absolute. Distance and price of coal still posed a constraint on steam mills as did the persisting necessity of process water, resulting in new patterns of water use rather than entirely new patterns of location along the Manchester canals (Maw *et al.*, 2012). Therefore, while the mobility factor and the ‘fossil capital’ thesis does provide a compelling argument for the initial switch to a fossil fuel, in application of the concept to Scotland, more consideration needs to be given to the varied landscape and persistent success of some water-powered manufacturers even after the advent of steam.

In summarising sections 2.6.1–2 the literature implies that steam technology developed and was adopted incrementally. In Chapter 4 I examine if steam was still concentrated in certain industries and geographical areas after the 1850s, as was the case in the earlier era. From the perspective of certain economic historians, cost was an important consideration in adoption decisions and larger firms may have been most capable of adopting expensive, new technologies. In chapter 6 I give consideration to fuel costs and firm size in relation to decisions of mill owners to transition to steam or stick with waterpower. In this thesis cost is considered alongside non-economic factors such as the viewpoint of Malm (2016), that mobility and the freedom from the physical constraints of land may have been important.

2.7 Entrepreneurs, institutions, networks, and law

This section introduces literatures on the making of the British entrepreneur during the Industrial Revolution. Recognising that mills and their owners were a product of the cultural context in which they existed, the intention is to situate entrepreneurs within institutional policies and networks that facilitated their ambitions. The intention is to remind the reader that even the most unremarkable watermill in rural Scotland, when contextualised in its wider geography, might link to processes going on elsewhere in Scotland, Britain, or even perhaps to a place in the British empire. Attention is then turned to characteristics of entrepreneurs

themselves and their firms, centred on the work of historian of Scottish business Peter Payne, and economic and social historians Stanley Chapman and Anthony Cooke.

2.7.1 Institutions and laws

Business behaviour is conditioned by a combination of external institutional forces and by the social and cultural environment of which they are part, which are, in turn, conditioned by historical factors. (Rose, 2000: 133)

Britain's industrial growth in the eighteenth century onwards owed much to its social system (Wilson, 1957: 102). The relevance of local business climates was highlighted earlier under industrial location theories and the business climate in Britain in the late-1700s and the 1800s has been understood as one that promoted trade and allowed entrepreneurs to feel secure in their investments (Wilson, 1957). This assured atmosphere was derived in part through formal institutions and the creation of laws by governments. Geographers of law contend that law has a geography that is shaped by space and place and conversely; that law shapes space (Blomley and Clark, 1990: 436; Legg and Prior, 2023: 235). It was Matthews' (1984: foreword) belief that geographers had neglected law 'as a guiding element in many facets of natural resource use and landscape evolution', especially in relation to water. The relevance of law as an institution and to the geographies of mills is obvious if we take Blomley *et al.*'s (2001: xv) view that:

law is constitutive of social relations and relational identities: husband, boss, owner, citizen, felon, slave, neighbor, debtor, judge. Law is constitutive of the institutional world within which we act. It is literally constitutive of the nation state, the community, the firm, the market, and the family. To some extent each of these domains – and their boundaries – are what they are in large part because of their legal definition.

Complex regulatory and property regimes have been applied to mills throughout the centuries. Carvajal Castro and Escalona (2024: 227) interpret medieval watermills of the Iberian Peninsula as a 'proxy of power relations' within the local communities. However, laws and regulations can be laid down in principle without action. Adams (Adams and Whyte, 1978: 198) cautions that Whittington made a 'classic mistake' by assuming that an Act making enclosure compulsory in 1647 resulted in changes to organisation of land. Rather, it is a matter of how laws are responded to and upheld. Furthermore, social order and interactions between particular communities of people are dictated as much by informal codes of conduct as they are by governments and legal rules (Rose, 2000: 297).

I will again borrow lightly from the field of sociology and ideas of networks to understand business decisions. While aspects of the theoretical literature on industrial location have suggested individual preferences to influence both location decisions and diffusion of innovations and technology, the same can be said for characteristics of the firm. Sociologists understand economic activity to be socially situated. Embedded within networks, economic choices cannot be understood solely based on individuals (Rose, 2000: 8). The analysis of networks and movements of goods, people, and ideas have long interested geographers. That social relationships form an integral part of life has been well documented and theories of social networks have been developed to allow analysis of such connections. Networks are not random links – people are more likely to form and maintain relationships with those with whom they have social proximity *i.e.* spatial proximity or common interests (Sorenson, 2005: 57). Lazerson and Lorenzoni (1999: 370) imply that strong inter-firm networks can help to avoid stagnation that can accompany industrial inertia. They expand on this by suggesting actors accrue benefits by being within a distinct community and refer to ‘external pollinators’ that distribute knowledge and skills through a network. Rose (2000: 306) identifies informal links between families engaged in cotton manufacturing within the Lancashire region. Formal, institutionalised meetings between these individuals, or nodes, in the network, at the Manchester Royal Exchange and Chambers of Commerce, reinforced these ties. The ‘gentlemanly capitalist’ thesis proposed by Cain and Hopkins plays down the importance of provincial manufacturers, and the Industrial Revolution in general, for economic development in Britain. It was the ‘gentlemanly capitalists’ within the service sector of London and England’s southeast that held ever increasing prestige and social capital. The industrialists on the other hand were ‘less well integrated into the policy-making structure and could never manage to speak with one voice on major issues’ (Cain and Hopkins, 1987: 5). Kumagai (2010) countered this with the example of Kirkman Finlay, a high-profile merchant-manufacturer and leading figure in political discourse in Scotland (and owner of three mills in Chapter 5). Kumagai demonstrates a more complicated dynamic between the metropolitan elite and the provincial entrepreneurs.

The networks that are of relevance to this thesis go beyond the local and national scales. Pomeranz (2000) has stressed that it was Europe’s privileged access to overseas resources that led to its commercial dominance during the Industrial Revolution. Britain benefitted from having an empire which provided access to a supply of raw materials and a market for

finished products. However, O'Brien (1988) has argued that the role the empire played in the British economy should not be overemphasised, recalling Adam Smith's argument in the *Wealth of Nations* (1776) that colonies were detrimental because they placed an economic burden on the British taxpayer and increased the threat of political instability and war (O'Brien, 1988). However, many industrial cities prospered from trade from Britain's colonies. For example, Lenman (2009) describes Glasgow, with its position on Scotland's west coast, as well placed to benefit from imported goods from the colonies including cotton, sugar, coffee, and rum. Lenman's argument is that, crucially, tobacco had to land on British soil before being sold on to another country, and this rule proved significant to Glasgow's economy and the city's development as a hub of commerce that would benefit later industries.

2.7.2 The Scottish entrepreneur

The entrepreneur in Scotland is referred to interchangeably through the secondary literature and contemporary sources as the proprietor, owner, capitalist, investor, and managing partner, because rarely did their role fit under one label. The remit of the late-eighteenth and early-nineteenth-century entrepreneur was much broader (Crouzet, 1985: 9–11). They had to be capable of performing the role of the 'complete businessman' (Mantoux, 2006: 377); individually taking on roles that would later be performed by and associated with the company as a whole. The entrepreneur was often required to act as merchant and salesperson, performing administrative and clerical work while also providing services like the creation of housing and transportation infrastructure that would now be covered by taxes and institutions (Pollard, 1964). However, as the number of people possessing specialist technical and commercial expertise grew, specialised engineers, accountants, and local and international selling agents could be hired. In the larger firms, functions were increasingly divided so that the people administering and running the production facility were separate from the board that made overall strategic decisions (Payne, 1988: 11–13). This huge shift in organisational structure separated the actors with technical expertise from those with the capital and authority to enact change in the company.

Anthony Cooke (2009) sought to fill a gap where Scottish cotton masters were researched less than other entrepreneurial groups like their predecessors the 'Tobacco Lords' (Devine, 1975) or the associated 'Sugar Aristocracy' (Mullen, 2022b) and the West India Merchants

(Devine, 1978; Cooke, 2012). Cooke's study of 52 textile merchants in Scotland uncovered their restricted geographical origin; 76% of the sample being born in Glasgow, Govan, or Paisley, and only one merchant born outside Scotland. This physical proximity assisted in the formation of a close-knit financial and mercantile community in Scotland. Similarly integrated networks have been identified in other textile regions in Britain such as the English Midlands (Chapman, 1992: 198). Considering social status, Chapman (1992: 20–22) stresses that despite many textile manufacturers beginning as apprentices, these were not rags-to-riches stories, with Berg (1993: 19) cautioning that firms that went on to be large and successful 'constantly retold myths of humble beginnings'. Familial connections were of insurmountable importance in accessing capital for start-up or expansion costs and even land on which to build a mill (Chapman, 1992: 20–21).

A disproportionate number of highly successful, prominent entrepreneurs were also members of religious non-conformist groups including the Society of Friends (Musson, 1972; Payne, 1988; Kavanagh and Brigham, 2018). The 'Quaker success story' (Prior and Kirby, 1998: 115) has been attributed to superior levels of education in Quaker schools: eighteenth-century Quaker education was known to promote empirical skills important in business, such as good record keeping (Pratt, 1980: 16). However, the apparent dominance of such groups may well be explained not by education or the principles and practices of religions but because of the extended communities to which non-conformists belonged (Turnbull, 2014). Membership to these communities provided access to credit that aided the survival of their firms, and with them, their records (Payne, 1988: 22; Prior and Kirby, 1998: 116); credit referring both to money and the reputation of a businessperson (Simonton, 2013: 219). This again stresses the importance of social and financial networks to the success of eighteenth- and nineteenth-century businesses.

2.7.3 Structure of the firm

Characteristics of the firm and preferences of entrepreneurs have been theorised to influence both locational choices and adoption decisions. It is suggested for example that larger firms tend to adopt technology faster than their smaller counterparts (Noori, 1987). Large firms may need coordination among various demands or managerial hierarchies but may have more resources and skilled labour to assess and then implement the new technology. They may also be at less financial risk and more capable of withstanding fluctuations in business cycles

(Noori, 1987: 10). Risks of adoption may be too great for a small or medium enterprise unless there is a real need for the change, and capacity in the form of human capital (Sawang and Unsworth, 2011).

The typical structure and legal status of Scottish companies transformed over the Industrial Revolution. Prior to the twentieth century, the usual structure of a firm in Scotland was individual proprietorship or more commonly, a small co-partnership, often between family members. Under these structures, the founder(s) bore all the financial risk associated with the mill but likewise took all the profit (Smith, 1971). Formation of a joint-stock company required state consent under the Bubble Act of 1720. The passing of the Bubble Act made it illegal for non-chartered companies to trade. The Act applied to Scotland but according to Payne (1988) had little effect because the formation of companies with transferable shares was still permitted under Scottish common law (The Insolvency Service, 2011). Nonetheless, common law partnerships were still preferred in Scotland due to their flexibility and perceived lower financial risk. From the 1860s onwards, a legal structure was in place that opened the possibility for the development of a corporate economy (Payne, 1988: 17) and limited liability companies became common in textiles after 1900. This delay in organisational change has been attributed partly to aging partners from original family businesses retaining control and maintaining the traditional structure (Lenman and Donaldson, 1971: 9).

Payne has analysed the longevity of companies formed in Scotland in the second half of the nineteenth century. Of 2,936 companies incorporated between 1856 and mid-1895, 311 (almost 10%) were still operating in 1960 (Payne, 1980: 18). Textiles, clothing, and fabrics were the sectors that tended to have the longer lifespans with an average length of life of 21.1 years for limited companies in the second half of the nineteenth century (Payne, 1980: 99–100). When interpreting results of studies such as these it is important to consider the sample bias towards successful entrepreneurs and firms (Payne, 1988 ; Cooke, 2009). Large-scale, successful firms may be the known rather than the norm. Berg identified a landscape of small- and medium-scale producers in Britain co-existing and co-dependent with large firms through systems of subcontracting and joint ventures (Berg, 1993: 19–20). Firms that were successful could use their profits to invest in shares in other companies. A comparison of the investment portfolios of two textile firms in the early-1900s (Lenman and Donaldson, 1971: 13–15) found the smaller of the two had a more local portfolio of safer investments in local

authority bonds and government stocks while the larger firm held shares in an impressive 64 companies, three quarters of them American, including multiple railway corporations.

Analysis implies trade cycles were one common influence on the creation and ending of firms. Referring to linen manufacturers in the Dundee region, Lenman and Donaldson (1971) suggested that many firms would go bankrupt during the cyclical depressions in the trade although a slightly more complicated relationship existed. Returning to Payne's study, the number of companies formed annually in Scotland correlated with movements in the general trade cycle but downturns in trade did not match the dates that companies voluntarily wound themselves up. The explanation offered by Payne (1980: 24) involves 'a complex combination of entrepreneurial expectation, the self-interest of company directors, and legal factors'. Payne proposes that for a limited company especially there was financial benefit to delaying the insolvency process until shareholders pulled out, so by the time the company was forced into liquidation, the economic climate had often changed towards a cyclical upturn.

Building on these literatures, I consider whether laws and other forms of institutions shaped the locational decisions of mill owners. In my examination of the cotton industry in Chapter 5 I will consider the backgrounds and characteristics of business owners and managers, and the firms they operated within.

2.8 Planned industrial villages and the advent of the factory system

Rural industrial villages, also referred to in contemporary sources as factory villages, settlements or colonies, were by no means exclusive to Scotland, with notable examples including mill communities at Cromford, Derbyshire; Springfield Mill in Belfast; the Peels' mills in Bury; or Graniteville Mill Village in the southern US. What distinguishes Scotland's planned villages is the context of the specific social and economic changes prior to and during their formation. The revolutionary objectives of some planned villages led Adams and Whyte (1978: 201) to include them as evidence in support of Scotland experiencing an 'agricultural revolution'. The industrial villages were part of a wider trend of planned villages that had in fact started many decades earlier in relation to the intellectual movement of the

Enlightenment. Defined by Philip (2006: 107) as ‘a settlement that was founded or substantially rebuilt in the eighteenth and early-mid nineteenth centuries with the support or approval of the landowner’, as many as 600 planned villages formed in Scotland between 1730 and 1850 (Philip, 2006: 105). Industrial villages were a subsection of these and are often treated as such in the literature.

Detailed local studies of individual villages and of regions exist *e.g.* Duncan (1979) on Newtyle in Forfarshire; Butt’s (1966) account of Gatehouse of Fleet; Dunlop (1982) on Pulteneytown and Caithness; and Leiper (1995) on the Endrick Valley, while more generalised studies by Lockhart (1978; 1982; 2001) focused on the Northeast. Lorna Philip (2003; 2005; 2006) partially addressed the regional imbalance in the research by concentrating on Dumfries and Galloway in the Southwest. Other accounts include Scottish examples within broader discussions of industrialisation in Britain as a whole (Pollard, 1964). Houston (1948) and Smout (1970) have offered discussions of the functions of villages, and along with Caird (1964), these authors have explored the place of planned villages and landowners in shaping economic growth and the countryside in Scotland. Philip (2005: 83) concluded that prior descriptions of functional characteristics of planned villages were too simplistic but they are sufficient to provide context for this thesis. The four types of planned village (described in Philip, 2005: 85 after Houston, 1948) are broadly classified as: villages designed in connection with agriculture and the interests of estates; villages associated with fishing or coastal trade; villages associated with tourism and wellbeing; and villages associated with manufacturing. The last of these includes isolated inland settlements with water-powered mills and the coastal developments of the British Fisheries Board (Philip, 2005). Planned manufacturing villages were sometimes steered by outside entrepreneurs instead of landowners (Smout, 1970). The literature suggests planned manufacturing villages were most characteristic of the West Central region and established mainly between 1780 and 1800 (Smout, 1970). Other regions also became associated with textiles but mostly at a smaller scale, like Douglstown with its flax spinning mill in Angus.

The British Fisheries Society planned settlements in the Highlands to provide a place to live and permanent employment for the displaced poor. These villages aimed to stimulate a rural economy in the Highlands as part of the process of agricultural reform and improvement that was taking place (Maudlin, 2007). Landlords did not want mass emigration, they wanted people moved to less productive land (*i.e.* land that could not make as much money from

cattle or sheep grazing) (Maudlin, 2007). This was tied in with the government's aim to prevent further rebellion in the Highlands by occupying people with year-round employment (Lockhart, 2001). The explicit purpose of absorbing displaced labour was given for the creation of some planned villages of the Northeast but not of those in the south, although they may still have assisted in discouraging out-migration from Galloway in the 1770s (Philip, 2005).

Given the sheer number of planned villages it is no surprise that not all were successful in their aims. Where the local economy was dependent on industry, it was common to experience financial loss or even bankruptcy during periods of cyclical slumps and poor trade; this was the fate of Archiestown in Morayshire and Spinningdale in Sutherland (Lockhart, 1986: 169; Lockhart, 2012: 21). That being said, Philip notes many locations in Dumfriesshire and Galloway that were capable of substantially growing their populations and retaining regional economic importance. Gatehouse of Fleet for example, developed from an estate village to a site of manufacturing and commerce, obtaining in 1795 the status of Burgh of Barony (Phillip, 2005: 96). One important aspect in the formation and success of a planned village was attracting residents to it. Lockhart (1986: 167) discusses the tactics used by landowners to do so. Firstly, landowners focused on the local area by targeting families of tenants already on the estate, advertising the plans at local markets. Secondly, they made use of the printed press, advertising to reach people both locally and further afield. Planned villages were able to absorb some of the displaced labour from Highland land clearances (Lockhart, 1986). Lockhart does not say a great deal about what they call 'factory villages' but found that they typically received migrants from longer distances than other planned villages. Leases for land were offered on attractive terms to encourage initial migration, prices rising once the village was established (Leiper, 1995: 123).

Altruism and paternalism are suggested as at least partial motivations for some landowners to establish these villages. Wilson (1957: 14) praises the 'process of social amelioration' started by the likes of Robert Owen and continued in the early-twentieth century by the Levers and Cadbury with their housing schemes. But Philip (2006: 106) points to the fact there was always the potential for economic benefits for the company too. Sidney Pollard (1964: 529) argues against the idea that settlements were created as model communities, proposing instead that the pressure of needing to create a village and implement control moulded the entrepreneur's outlook on society. Some have commented on a rural/urban dichotomy in the

minds of the ruling classes. Aside from the physical need for a rural location, there was the opinion from proprietors, or a ‘bourgeois infatuation’ to quote Malm (2016: 160), that rural landscapes could provide the necessary conditions to maintain a healthier, morally superior, more docile workforce. The Highlands in particular had been framed by the Romantic Movement, with its idealised views of Nature, as a place where one could seek peace and solitude (Devine, 1989), the very antithesis of the depravity of the industrial city. The countryside was viewed by some entrepreneurs and social commentators of the time as the solution to saving the urban poor from slums (Siméon, 2017: 31) while protecting the mill owners from the threat of combinations (Malm, 2016: 110).⁶ Goff (2019) identifies how such sentiments were echoed beyond Scotland and the British Isles by William Gregg, owner of the Graniteville Mill in southeastern USA, who felt it would be impossible to control a city workforce given their poor moral habits of drinking and gambling (Gregg, 1855, quoted in Goff, 2019: 56). Similarly, Cerarols and Luna (2020: 108) describe the Catalanian Casal Rosal industrial colony where textile workers could be sheltered from political unrest and the perceived negative influence of Barcelona.

They may have been rural in their setting but the character of planned textile villages was distinctly industrial (Turner, 1958: 109), manifested in the physical layout and design with boarding houses for orphaned apprentices and communal dining halls, and in the character imposed through paternalistic control. Commenting on the morphology of planned villages, Lockhart (1978: 95) observed that many had a deliberate layout, with commonalities including rectangular plots and grid pattern streets. The ordered, geometric layouts of the new villages were in striking contrast to the spatial patterns of old settlements (Maudlin, 2007: 455). However, workers were not free from judgement in the countryside. Moralising judgements were made against residents of industrial settlements when the workers did not conform to the expectations of outsiders (Philo, 1998); neither were they away from the harsh systems of discipline employed by the factory masters. The factory village offered its own tools for control. Remote locations necessitated the provision of facilities for the workforce at the expense of the owners since there was little pre-existing infrastructure. Pollard (1964: 522) explains that factory village housing could be weaponised as a form of discipline: if the company owned the housing they could deduct rent directly from wages, reward good work

⁶ Combinations refers to the joining together of workers to form a trade union to seek changes to employment conditions. In response to fears of strikes, the Combination Acts 1799 and 1800 were passed making trade unionism illegal until their repeal in 1824 (Smith, 2015).

with superior accommodation, or punish with threats of evictions. Stein (1995: 293) views the use of mechanisms of control as the defining characteristic of the factory system in the Industrial Revolution, more so than any economic indices. The cotton factory village as a place of control and discipline, and the influence this may have had on locational decisions is returned to in Chapter 6.

2.9 Conclusion

This chapter has provided a review of the interdisciplinary bodies of literature this thesis is situated within. This review has also highlighted knowledge gaps surrounding mill numbers in Scotland, particularly for the period post-1870, which this thesis aims to directly address through the mapping work presented in Chapter 4. Beyond the work of Shaw (1984), most studies have focused on a limited geographical area or the history of individual mills and industrial mill villages. The theoretical basis of this thesis is grounded in theories of industrial location as well as debates related to the British Industrial Revolution, such as the importance of economic versus institutional and cultural factors in development paths. The literature presented in this chapter states that the location of industry is a result of a combination of ‘classic’ inputs or factors of production, especially land, capital, and labour, with the optimal location being one which incurs the lowest costs. Recent paradigms from within behavioural and evolutionary economic geography have stressed the role of institutions, the entrepreneur, and historical accident that may result in a less than optimal decision when measured against criteria of classic inputs and cost. These factors have been used to guide the research and the presentation of findings in the case studies in Chapter 5 which each include a discussion of the local physical geography, population and economy, fixed and movable capital, and ownership. Recent work within human ecology by Malm (2016) has brought new Marxist perspectives to debates on energy transitions, including arguments based on examples from the British cotton industry. The applicability of some of these claims to Scotland will be questioned based on the evidence provided in this thesis. Additionally, it has been noted in Section 2.4 (Turner, 1958; Chapman, 1970; Mokyr, 1990) that a resistance to change, or a ‘lock-in’ effect, is often observable in industry, and through the repeated re-use of mill sites and infrastructure. This concept of inertia will act as a connective thread throughout the thesis – in relation to mill location, technological innovation, and business decisions – forming a key component of the aims and conclusions of this work.

The following chapter will outline in detail the methodological approach that was taken to data collection and describe critically the types of sources used. To evaluate both the classic and evolutionary aspects of industrial location geographies, the use of a mixed methods approach and a range of source materials is necessary.

3. He who avoids the mill gets no flour: Methods and Sources

3.1 Introduction and research design

3.1.1 Introduction

This chapter will introduce the research design, methodologies, and sources that were used to produce data in the thesis. Section 3.1 introduces the research design and the use and applications of HGIS within geography and related disciplines. In Section 3.2 the process of creating a national scale mills dataset for Scotland, compiled from georeferenced maps, crowdsourced data, and heritage records is described which forms the basis for the first empirical chapter of this thesis (Chapter 4). Section 3.3 introduces the fieldwork components of the research, here referring predominantly to the in-person archival visits, supported by site visits and consultation of digital archives, that together produce the second empirical chapter (Chapter 5), based around a series of case studies. Each of the main types of sources are also evaluated, discussing their origins, format, and limitations. Despite roughly separating the methods in two, many of the sources in fact overlapped and were used in both methodologies. To facilitate clarity, this chapter will alternate between discussion of sources and methods because each source required particular methodological approaches for consideration. The global coronavirus (COVID-19) pandemic greatly altered the vision of the project, changing the methods that could be applied and affecting the ease with which certain aspects of the research could be conducted. In the final section of this chapter I will reflect on these challenges and how they were navigated.

3.1.2 Research design

3.1.2.1 Collaborative research

This PhD was undertaken as part of the AHRC's Collaborative Doctoral Partnership (CDP) scheme that partners non-higher education institutions and Universities with the aim of supporting collaborative interdisciplinary research training between academia and cultural, creative, and heritage organisations (UKRI, 2025). In the case of this project, HES and the NLS collaborated as partners alongside the UofG. These projects have characteristics unique

to the CDP. As such, there was the opportunity, and expectation, that the collections of the partner organisations would be incorporated into the research. I was also assigned supervisors from UofG, HES, and NLS, bringing a wide breadth of cross-disciplinary knowledge to the project: historical geography (Simon Naylor and Chris Philo); geomorphology (Paul Bishop); industrial heritage (Miles Oglethorpe); and historic mapping (Chris Fleet). The research design for the project was thus developed with guidance from all supervisors and with key resources from each institution.

3.1.2.2 Reconciling the general and the particular

The intention of this research design is to investigate the historical geography of mills across Scotland with a particular focus on their locational geography, sources of motive power, and the actors that created and operated them. The sub-discipline of historical geography is concerned with applying geographical questions to the past, and of how the past influences the geographies of the present day and may impact the future (Van Lieshout and Newman, 2023). Many studies by historical geographers, working at the scale of ‘micro-histories’, have documented stories of individual people, places, objects, and landscapes (Naylor, 2008: 265–266). Micro-histories prioritise telling detailed stories, documenting the agency of individual people and events, and can be employed to test macro-scale paradigms (Kumekawa, 2024). Such qualitative, micro-scale studies have traditionally dominated research within the discipline (Harris, 2025), but there has been a recent move within the field to bring together qualitative and quantitative research. By combining qualitative and quantitative data, the general and the unique, the connections between ‘human and social phenomena’ and spatial data can be more robustly identified and compared (Yeager and Steiger, 2013: 4). Harris (2025) for example, integrated traditional biographical methods of archival methods and interviews with computational methods of GIS and Social Network Analysis to map and analyse a database of trainee African diplomats. To study and classify traditional dwellings in Southwestern China, Wang and Hu (2024) also used a mixed methods approach, combining field surveys of villages, GIS analysis, and a literature review of historical records. Through analysis of digital elevation models (DEMs) Wang and Hu characterised the typical elevation range of traditional dwellings and used density calculations to quantify clustering of dwelling types and regional characteristics. By combining different research techniques, mixed methods studies have the capability to ‘add context, envision multiple truths, play different sources of data off each other’ potentially producing ‘complementary explanations for phenomena’ (Elwood and Cope, 2009: 18–19).

For this thesis, the research was designed with this cross-disciplinary, mixed method approach that permitted the study of the general and the particular. The creation of a national mills dataset provides an overall picture of the geography of mills in Scotland at static moments in time and generates quantitative mill number data. By first presenting and discussing the national-scale geography of mills, the micro-scale qualitative case studies that follow are contextualised. The case studies then allow a deeper examination of the processes, networks, and patterns, displayed by the mapping.

3.1.2.3 Historical Geographic Information Systems (HGIS)

Mapping remains one of the most common tools for analysis in historical geography. Ever since H. C. Darby's classic cartographic illustrations of *Domesday Geography*, maps have held on to their fundamental position in historical geography (Harley, 1989: 80–81). Emerging technologies have more recently permitted analysis and consideration of cartographic sources and their data in digital contexts and frameworks. Specifically, a GIS framework allows researchers to combine spatial and attribute data in a relational database that aid in the collection, processing, analysis, and presentation of the data (Lloyd *et al.*, 2012). HGIS, used to refer to the application of geospatial technologies to historical research (Knowles, 2005: 7), frequently includes temporal characteristics or attributes of the data (Gregory and Southall, 2000). HGIS emerged in the mid-1990s and early-2000s, with the Great Britain Historical GIS, one of the earliest notable uses. The project aimed 'to create a comprehensive, consistent and accurate cartographic record of the changing administrative and reporting units of the UK' while being 'driven by the demands of statistical interpretation' (Gregory *et al.*, 2002: 37). As part of a wider 'spatial turn' within the humanities, large-scale projects utilising HGIS considered and mapped various data at the national scale, including census, administrative boundaries, and gazetteer data. HGIS has since evolved to answer local scale questions and to include more types of sources (*e.g.* newspapers, personal stories) (Trepal *et al.*, 2021).

A recent line of enquiry within HGIS centres on which type of data can be considered and analysed. GIS is recognised as suiting the analysis of geometric properties such as topology (Couclelis, 1999: 31) but the recent, rapid adoption of its use in the humanities has thrown up epistemological and ontological questions (Giordano and Cole, 2020). GIS developed in fields that more commonly use quantitative data with absolute parameters whereas historical data are often qualitative, including inherent gaps, uncertainties and errors that are not easily

quantified (Gregory and Ell, 2007). GIS already encompasses data of a qualitative nature in names and types of things (buildings, roads, natural features *etc.*) that can be queried in relational databases through SQL (structured query language). Even the more 'complex attribute and spatial queries require logical thinking and spatial imagination rather than statistical or mathematical skills' (Pavlovskaya, 2006: 2013). Some researchers are pushing the capabilities of GIS for qualitative data further. For example, Knowles *et al.* (2014) sought to map the evolution of SS camps over time as well as over space, opting to use a GIS to allow them to simultaneously explore and compare characteristics of the camps. Giordano and Cole (2020) further proposed a new model of GIS of place that allows for uncertainty, movement, and different scales at which experiences take place, creatively combining archive and text data with spatial analysis. In this thesis, HGIS has been used in a fairly traditional way in the sense that descriptive data are attached to spatial data and used to produce static two dimensional maps. However, HGIS also served to facilitate the research process. HGIS was not only a tool for visualisation and creating finished maps but allowed the filtering of layers as a way to explore and test data. It should be noted that maps produced in the research process are not impartial, each map having an intention. In historical geography maps are used to present an argument and persuade the viewer of its validity, illustrating the data to convey a point (Harley, 1989).

3.1.2.4 Micro-histories

The nature of archives is well-documented: they are collections that are fragmentary, characterised by gaps and silences, and yet, simultaneously abundant (McGeachan *et al.*, 2012: 171). Selecting six case studies for detailed research was used as a strategy to manage the amount of empirical material that would be collected. A review of the existing literature on mills, and industrialisation in Scotland more generally, highlighted potential locations, industries, and actors (individuals and companies). The initial expectation was that case studies would be of industrial regions rather than focusing on specific mill sites. Renfrew, Greenock, and Dundee were considered suitable locations due to the concentrations of industrial activity in each during the time period of focus of the thesis. Preliminary scoping visits to the University of Dundee and University of Glasgow Archives confirmed the direction of focus: water-powered cotton textile sites distributed across Scotland. Ballindalloch, Catrine, Deanston, New Lanark, Rothesay, and Spinningdale mills were selected. This was in part a response to the strong foundation of literature on the cotton spinning industry in Scotland, and the breadth of archived materials available. As was noted

in the previous chapter, there is a bias in archival material towards the more successful businesspeople and companies and as such there is a wealth of contemporary and secondary material on the cotton industry, including Catrine, Deanston, and New Lanark Mills. I was aware that primary sources related to Ballindalloch and Spinningdale were more limited, however, I felt they were important comparisons as less ‘successful’ mills. Spinningdale, for instance, rather than being placed alongside its contemporary cotton spinning mills across the country, receives passing mention in literature on industrial villages (*e.g.* Lockhart, 2012) and there is one scholarly article by Cooke (1995) dedicated to Spinningdale, in the context of improvement and the Highland clearances.

I chose to look at a single industry to allow the investigation of commonalities and differences between mills grouped together under cotton spinning. The pre-eminence of the textile industry merits its selection for more detailed investigation. Although Butt (2015, n.p.) cautions that ‘[o]ne must not exaggerate the importance of cotton to the British economy’, textiles, and cotton especially, was a driver during the Industrial Revolution. Cotton stimulated other industries such as ‘civil and mechanical engineering, aided the development of the chemical industry, and was significant in the growth of wholesale and retail trade’ (Butt, 2015, n.p.). Textiles was also the dominant sector for power use alongside mines and metals, making a subset of textiles a suitable subject to investigate the supposed energy transition from water to steam, one of the questions asked by this thesis. There are of course a number of excellent regional studies of cotton mills (Nisbet, 2003; 2004; 2009), multiple books about New Lanark and its owners (Donnachie, 2000; Donnachie and Stewart, 2015; Siméon, 2017), local histories of Rothesay (Earls, 1945; Nisbet, 2004) and references to the mills of James Finlay & Co. in Malm’s work (2016), all of which I draw upon in my own study. What I perceived to be missing, however, was scholarship that brought together and synthesised these geographically dispersed, and in some respects, seemingly disparate mills. By combining the macro and micro levels of mapping with case studies, and approaching the histories of these mills from a geographical perspective, the aim is that new dimensions and narratives will be teased out, furthering our understanding of watermills and the Industrial Revolution in Scotland, and also to open up questions based around the concept of ‘inertia’, particularly in a ‘dynamic’ form.

The inclusion of Rothesay was important as an example of a mill that pivoted between water and steam power very early on, and as the site of a novel water engineering scheme. What

has not been included that would make a richer study are any mills that went directly to steam power. There are of course always arguments in support of a broader or more narrow approach to research. By restricting the study to six mills and missing the pioneering adopters of steam I focus on the experience of the ‘non adopters’ and the ‘laggards’ (Rogers, 2003). The case studies exemplify the industry while aiming to encapsulate its geographical and temporal breadth, including mills on the mainland and islands, following on from Chapter 4, which maps mills across the entirety of Scotland. This allowed exploration of the impacts of locational factors such as geographical isolation versus market access. It was also my intention to consider the longevity of mills, so the inclusion of three mills that operated into the twentieth century allows for the examination of inertial processes. Additionally, presenting my findings as case studies permits the demonstration of the complicated history of mills changing hands, which could not be illustrated as clearly or in the same level of detail using maps alone. Although the starting point of reference for these micro-histories was the mill itself – the buildings, machinery, physical surroundings, and local economy – a further rationale behind the choice of these case studies was selecting watermills that display substantive interconnections between the ‘entrepreneurs’ and the capitalist enterprises involved in their operation. After writing the micro-histories of the mills, a list of 61 key actors was compiled that included all known mill owners, along with named financial investors, and some key managers and facilitators (meaning those known to have influenced the cotton industry or the direction of the mill via inventions, seeking out industry for their land, or collaborating on major infrastructure). Short biographies were produced (Appendix 1) predominantly using secondary literature and individuals were categorised according to shared characteristics. Connections between these actors were mapped as an exploratory research tool. Networks are acknowledged as a useful tool, stimulating questions within historical research and assisting the researcher to identify threads and patterns in their narrative (Kumekawa, 2010). However, there is no set way to visualise a social network dataset and the ‘ambiguity’ of network visualisations renders them ‘unfit for hypothesis confirmation’ yet useful for exploratory analysis of a data set (Venturini *et al.*, 2021: 2). In this thesis, the connections between actors were mapped as an exploratory research tool. I focussed on a sample of actors based in Britain. Although it is important to recognise that the cotton textiles industry was interconnected, with changes taking place at home and across the world, intertwined in a web of movement of goods and people (Morris, 2018), this global network can only be lightly touched upon within this thesis.

Regarding the selection of source materials, strategies taken by others looking at the history of mills include Pastor *et al.*, (2021) who used commercial directories and acts of registrations and taxation in their study of woollen mills in Portugal. In their case, they found limited pre-existing bibliographical references to the particular mills of interest. Insurance records are also frequently cited (Chapman, 1969; 1970), providing valuations and detailed descriptions of the mills and their equipment that can be used from an economic history perspective to infer capital formation. Where they were recorded in a company archive, insurance records have been used in this thesis for additional information, but not as the first point of call. Chapman (1970) also used fieldwork, sales ads in newspapers, and plans in the Boulton & Watt archives in their research of the cotton industry. Records from the Board of Trustees were looked at by Nisbet for Renfrewshire, but were found to be very incomplete, listing only three lint mills in Renfrewshire prior to 1800, a figure that Nisbet expanded to 18 through further exploratory work (Nisbet, 2009). Malm (2016) also consulted the collections of James Finlay & Co. (UofG Archives) and Robert Thom (Bute Museum) in their *Fossil Capital* thesis. By asking different questions of the collections and using a mixed methods approach I hope to draw new threads out of the materials.

The Factory Inspector's Returns have proven popular as a source over the past 50 years, especially for estimating total contribution of waterpower and steam power to Britain's economy (*e.g.* Musson, 1976; Jonell *et al.*, 2024). These studies acknowledge the limitations of the Returns, criticisms of which include that they were inconsistent, geographically incomplete, and had a narrow legislative remit (Bottomley, 2024: 22). Therefore, many estimates for steam power's contribution to economic growth may not even be broadly accurate due to the continued reliance on the flawed Factory Returns as the main source for the mid-nineteenth century. Bottomley (2024: 10) demonstrates the extent of these flaws by comparing data for Suffolk from the Factory Returns against an engine census produced from an assortment of sources. The Factory Return for 1850 recorded three engines capable of a combined 17 nominal horsepower (nhp) versus Bottomley's census of 66 engines with 697 combined nhp.⁷ Kitsikopoulos (2023: 229) acknowledges that problems with data from the Returns means we need to view the results of their study as 'reflecting general trends as opposed to precise trajectories'. Given the known problems with the Returns, they are not

⁷ Nominal horsepower was calculated based on the technical dimensions of the steam engine. An alternative measurement used was 'indicated' horsepower derived from the steam pressure acting on the piston of the engine. These both referred to the power capacity of the engine – 'power available' – but another descriptor in contemporary texts is 'power in use' (Kanefsky, 1979b: 363–364).

being used as the first port of call, though they do feature in the research, since the Acts altered the working practices of some of the mills studied. In this thesis, archive collections related to specific companies were selected and combined with searches of newspaper archives for publicity material, reports about the mills (including articles on notable managers or visitors, patent announcements, workplace accidents, fires, sales adverts). Secondary published sources were used in combination with unpublished archival materials, a strategy that is not uncommon in historical research (*e.g.* Kanefsky and Robey's (1980: 162) methodology for researching steam engines). It would have been impossible to visit every relevant archive (more will be said on this in section 3.4), especially for six mills, so by using this research design I chose to combine different types of sources.

3.2 Mapping mills through Historical GIS

Before describing the mapping side of the methodology, a quick note on the choice of sources. The HGIS portion of the research was conducted in collaboration with my CDP partner institutions. OS maps were used because they are held within the NLS's map collections and have been digitised. They also provide an appropriate medium for identifying and assigning mills to a particular place and time (with the acknowledgement of caveats discussed in 3.3.4). Modern, rather than historic, land maps and models are a popular alternative for mapping mill data. Pacina and Havlicek (2015) successfully identified residual features of watermills in the Czech-German borderland by combining aerial imagery including LiDAR (Light Detection and Ranging) with old maps and field surveys. Images derived from LiDAR have the potential to penetrate vegetation, recognising small surface level variations, revealing archaeological features and micro-terrain otherwise hard to detect. For mills with extant remains, geomatic surveys can verify conditions of mills, and the data integrated into databases to guide strategies of heritage preservation (Di Stefano *et al.*, 2023). Remote sensing could identify archaeological sites but used alone would not allow dating of sites to a particular interval of time as with the historic maps. Use of the data from the GB1900 project constituted an exciting avenue of research since digitised text from maps has rarely been used as a data source in research (The Alan Turing Institute, 2022). It also made sense to use Canmore, while also within the collection of one of the partner institutions (HES) because it essentially already held a database of many mill sites. I decided to combine the HGIS work with a more traditional historical geography method of archival research.

3.2.1 Creating a mills database

The dataset used in this thesis was derived from the *Scottish water mills website*. I created the website's data and accompanying resources during a six-month long work placement with the NLS. The placement was facilitated and funded by the Student Development Fund component of AHRC's CDA and overseen by Chris Fleet, Map Curator at the NLS. The placement aimed to use maps and data from the library's existing collections to create a publicly accessible output: an interactive map of mill sites in Scotland (Figure 3.1). The process of creating the data for the mills website and the stages taken to enhance and adapt the dataset for this thesis will be described in this section and are visualised in Figure 3.2.

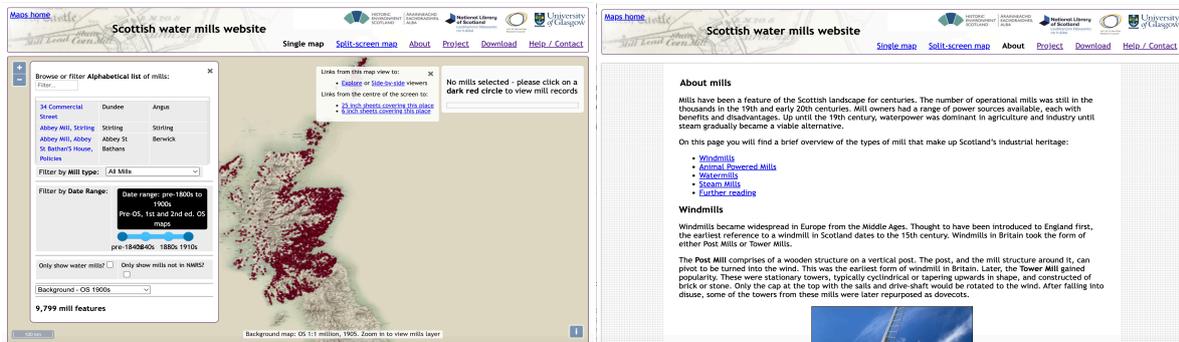


Figure 3. 1. Scottish water mills website: Interactive map viewer (left) and supplementary information pages (right) (Nave Calton and Fleet, 2024).

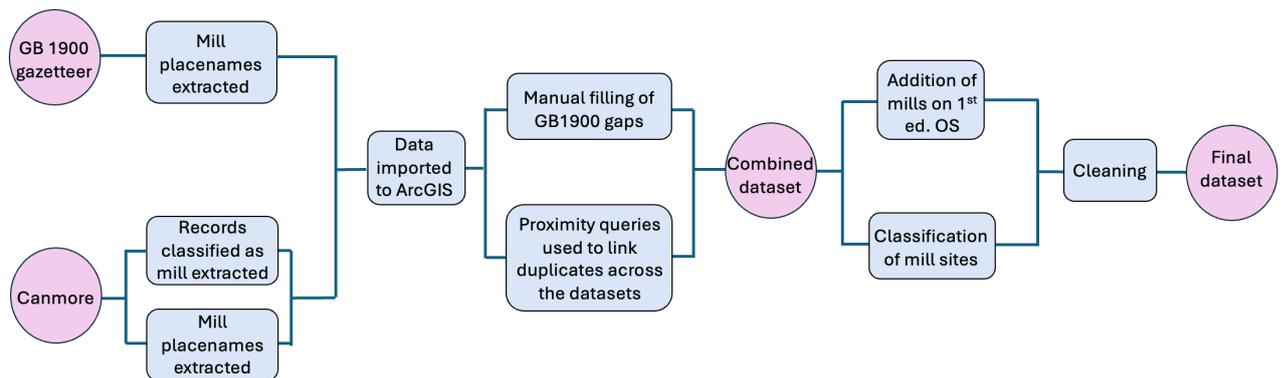


Figure 3. 2. Process of developing the GB1900 and Canmore data into the mills dataset.

To create the website, data was combined from two existing sources, the GB1900 project database and Canmore. The GB1900 project, taking place between 2016 and 2017, aimed to

transcribe all text strings from the Ordnance Survey 2nd edition Six-Inch to the mile (1:10,560 scale) County Series maps for England, Scotland, and Wales, using online volunteers. The resulting GB1900 gazetteer data, which can be freely accessed and downloaded through the Vision of Britain website (Great Britain Historical GIS Project, 2003–23a), contains more than 2.5 million georeferenced text strings including placenames and features recorded on the maps. The raw data was queried to extract and download all placenames that included the word ‘mill’ (also ‘miln’) as well as features that might be related to a mill (‘dam’, ‘lade’, ‘lead’).⁸ From GB1900, 10,637 mill related records were extracted. This methodology used similar approaches to the work of Bishop and Muñoz-Salinas (2013) who extracted and mapped mill locations based on the Ordnance Survey 1:100,000 gazetteer.

I was aware the GB1900 dataset occasionally contained gaps where text strings had been missed by the volunteers. Displaying the data in a GIS showed large areas near Cromdale, Glemuick, and Balmoral without any data points (Figure 3.3). These areas were manually examined to add missing mill features observed on the 2nd edition Six-Inch map, using map text rather than visual cues like the later mill identification work.

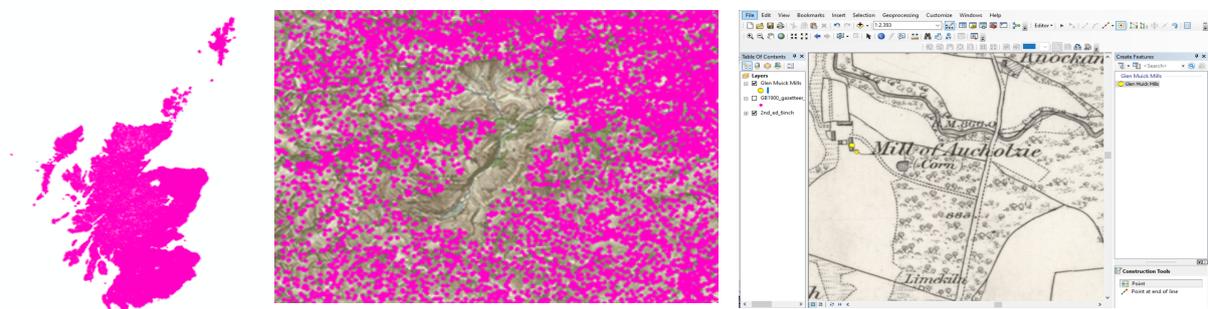


Figure 3. 3. Gaps in GB1900: (left) All GB1900 data points (without any filters/queries) displayed as pink circles. Data is missing from white areas in the northeast of Scotland; (middle) close up of the Glen Muick area; (right) manually adding Mill of Aucholzie, Glen Muick in ArcMap.

The second dataset, Canmore,⁹ provided by staff at HES, records archaeological, architectural, and industrial heritage features across Scotland, sourced through a combination of archaeological and architectural surveys and desk-based research, including the use of OS

⁸ *Miln* was a common alternative Scots spelling for mill prior to the eighteenth century. Place names with Norse origin are also common in Gaelic-speaking districts (Scottish Geographical Magazine, 1913) but there were no results for *mylla*. *Muileann*, the Scots Gaelic spelling, returned only Muileann Eiteag Bàgh in Argyllshire (classified as hydrography and translating literally to white pebble mill bay (MacEachen *et al.*, 1922)), Muileann Gaoithe in Buteshire (a landform), and the hamlets of Moulinearn in Perthshire and Aberdeenshire.

⁹ As of 24th June 2025, HES retired some of their web services including Canmore. The NRHE ID numbers referred to in this thesis correspond to the Unique identifier (UID) on the new trove.scot website.

maps. Canmore records are assigned a classification(s) according to the type of site and period they relate to (Figure 3.4). Two sets of records were extracted using the same search terms as for GB1900 (mill or miln with lade, lead, dam). The first query extracted records that had been assigned the classification of mill (4,705 records). The second search included sites that had mill in their name and returned 6,959 results, capturing additional mill sites and also place names (*e.g.* Millquarter Plantation, Shawsmill Bridge, Park Mill). The two searches totalled 11,664 records.

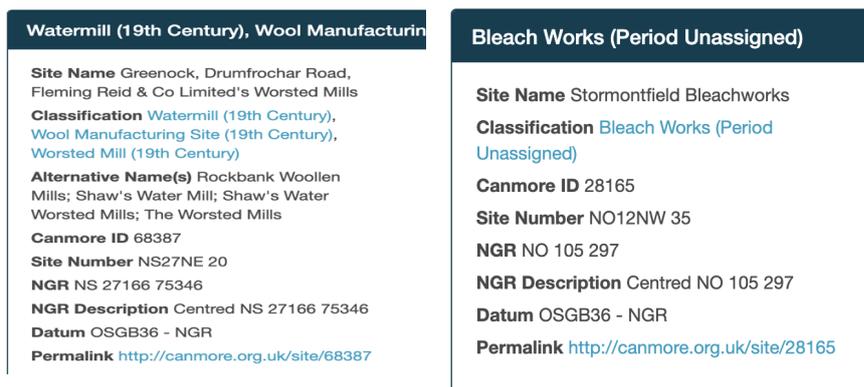


Figure 3. 4. Two examples of Canmore records.¹⁰

The GB1900 and Canmore datasets were imported into ArcMap Desktop Version 10.8.1. The next stage was to identify duplicates using proximity queries in the GIS before combining both datasets into a single file. By identifying points within a certain distance of each other, records likely to be the same mill could be linked. Initial testing showed around 4200 mills from Canmore matched those in GB1900. This exercise was not fully reliable since if mills were located next to each other, as was common in crowded industrial urban areas, multiple mills would be incorrectly linked. Secondly, some points did not have an accurate geolocation due to errors with the coordinates recorded in Canmore or due to the way that GB1900 was compiled requiring volunteers to create a data point where the text was located on the map rather than at the feature it referred to.

After the GB1900 gaps were filled and duplicates linked, a new combined dataset of 14,509 records of mills and associated features was created. The majority of the placement was then used to expand the dataset to include mills present at the time of the OS 1st edition Six-Inch

¹⁰ Screenshots of two records as they appeared on the Canmore website at the time the research was conducted (<http://canmore.org.uk>. Accessed: 01/04/2024). The records can now be found at trove.gov under NRHE ID: 68387 and NRHE ID: 28165.

mapping (c.1840s–1870s) and to categorise mills. The method chosen to do this was to manually work through the records, viewed against the digitised OS maps, checking for a presence or absence on the maps, assessing the mill type and the power source. GIS software was used so that data points could be viewed and edited simultaneously. It was decided that placenames that included the word ‘mill’ would be excluded from the data if there was no indication of a real mill on the site. Placenames often signal a historic mill site but given the size of the dataset, further research could not be conducted to investigate these. For the same reason, weirs and millstones were also excluded unless there was a confirmed mill.

Background georeferenced layers of the 1st and 2nd edition Six-Inch to the mile OS map series were added to ArcMap as Web Map Tile Service (WMTS) layers supplied by NLS. The 25 Inch to the mile (1:2,500) 2nd edition mapping, where available, was imported into ArcMap too, to give greater detail where there was uncertainty over the presence of a mill. A larger scale map could not be added for the 1840s–1870s because no georeferenced layer of the 25 Inch mapping for this period has been created yet. However, sheets that did exist were viewed when necessary using the NLS Map Finder.

Other researchers have preferred to use individual OS map sheets. Bishop *et al.* (2017) recorded lime kilns by systematically moving a ‘window’ across the printed map sheets. Mitchell (2020) in comparison opted for digitised individual sheets that offer the best quality compared to zooming into the image in a GIS. Image quality is important when examining small details in symbology and Mitchell’s methodology facilitated systematic coverage of the whole of Scotland. Using GIS, on the other hand, allowed overlaying of multiple layers, that proved to be an enormous benefit. The 1st edition Six-Inch to the mile, 2nd edition Six-Inch to the mile, and 2nd edition 25 Inch to the mile map layers could be viewed or hidden instantly, and point and descriptive data could be added directly to the GIS shapefile that resulted in a much faster process comparatively. It is acknowledged however that there will inevitably be sections of the maps that were not scrolled over in the GIS and mills potentially missed.

3.2.2 Mill classification

For each potential mill site, I aimed to record the following information based on the map image and associated Canmore records where available:

- (1) Presence (or lack of) an active mill on the 1st edition (c.1850) and the 2nd edition (c.1900). If the mill was on neither map, or was out of use, it was recorded as *Period Unassigned*
- (2) Motive power(s) *i.e.* water (horizontal, vertical, tide), wind, steam, hand, horse
- (3) Industry and goods produced *e.g.* Grain (corn, flour, barley...), textiles (cotton spinning, bleachfield, hessian...)

Mill identification was at times a difficult process that was learnt and improved upon during the placement. Meetings were held online with Chris Fleet and Paul Bishop, who was working concurrently on OS map symbology, to share images of mill symbols and discuss sites where the presence of a mill carried high levels of uncertainty. Field investigations can be used alongside GIS to assess mill and dam characteristics (*e.g.* Donovan *et al.*, 2016; Buchty-Lemke and Frank Lehmkuhl, 2018 for assessing fluvial legacies) but as the project was conducted in 2020 to 2021 when there was a national lockdown and consequently there were restrictions limiting travel, the ground truthing of even a small sample of sites was not possible. Prior visits to mill sites including Baldernock Sawmill (Milngavie) and North Woodside Flint Mill (Glasgow) provided an understanding of what the mill infrastructure and landscape might look like on the ground versus historic maps.

3.2.2.1 Ordnance Survey directives

Evidence of directives that may have existed to guide surveying staff in the nineteenth and early-twentieth centuries is extremely limited. In part, this is due to the loss of some Ordnance Survey archives, but also reflects the emergence of OS policies to standardise terminology as work progressed during the nineteenth century. In the case of mills, it is not even known if there were set standards for surveyors to adhere to. Therefore, it is difficult to say with certainty whether regional differences or changes between editions in the labelling or depiction of a mill have significance behind them. This includes the use of the words ‘Windpump’, ‘Windmill (Pumping)’, and ‘Windmill’. Or the varied terminology used for the channel that brings water to a mill (Figure 3.5 g, h, i). Lades for example will also be named ‘mill race’, ‘mill lead’ or ‘aqueduct’. In the case of aqueducts it seems fair to assume the channel ran at or above the ground level but that does not mean that a lade could not refer to a piped channel too. Some differences most likely reflect local language, the preferred word for certain features changing in different regions.

Terminology, spelling, and names also regularly changed between the 1st and 2nd editions but without knowledge of the OS's directives it is not possible to be sure of the reason for variations. That the surveyors likely used local terminology is suggested by the case of Gilcomston Lead in the town of Aberdeen that was recorded in the Ordnance Survey Name Books (OSNB) (discussed shortly) with the descriptive remark:

A small stream or millrace called "Lead" Commencing at "Gilcomston Dam" and passing "Leaside", Supplies Gilcomston Brewery, and Continues till its confluence with the Burn, which passes Broadford Works, Lead, is the mode of Spelling adopted in this place –¹¹

We do not know if this was common practice. For this research, a problematic manifestation is not knowing how or what exactly the surveyors classified as 'mill' versus 'factory' or 'works', an issue that goes beyond the OS maps, as mentioned in the introduction of this thesis. Whether surveyors opted for the name given to them by local authorities or were following criteria applied nationally is essential to producing an accurate estimation of mill numbers, but this information is not available. A further complication arises from the use of 'mill' singular versus the plural 'mills' as there were different contemporary norms for this. According to the OSNB entry for Stockbridge Mills, the norm in Edinburgh was to consider each wheel or steam engine as a separate mill.¹² Whereas there were places, for example the New Lanark Mills (one of the case studies in Chapter 5) that referred to each building as a mill.

¹¹ OS Name Books - Aberdeen county - Volume 1 - City of Aberdeen - 1865-1871, OS1/1/1: 192.

¹² OS Name Books - Midlothian county - Volume 94 - Parish of St Cuthberts, OS1/11/94: 28.

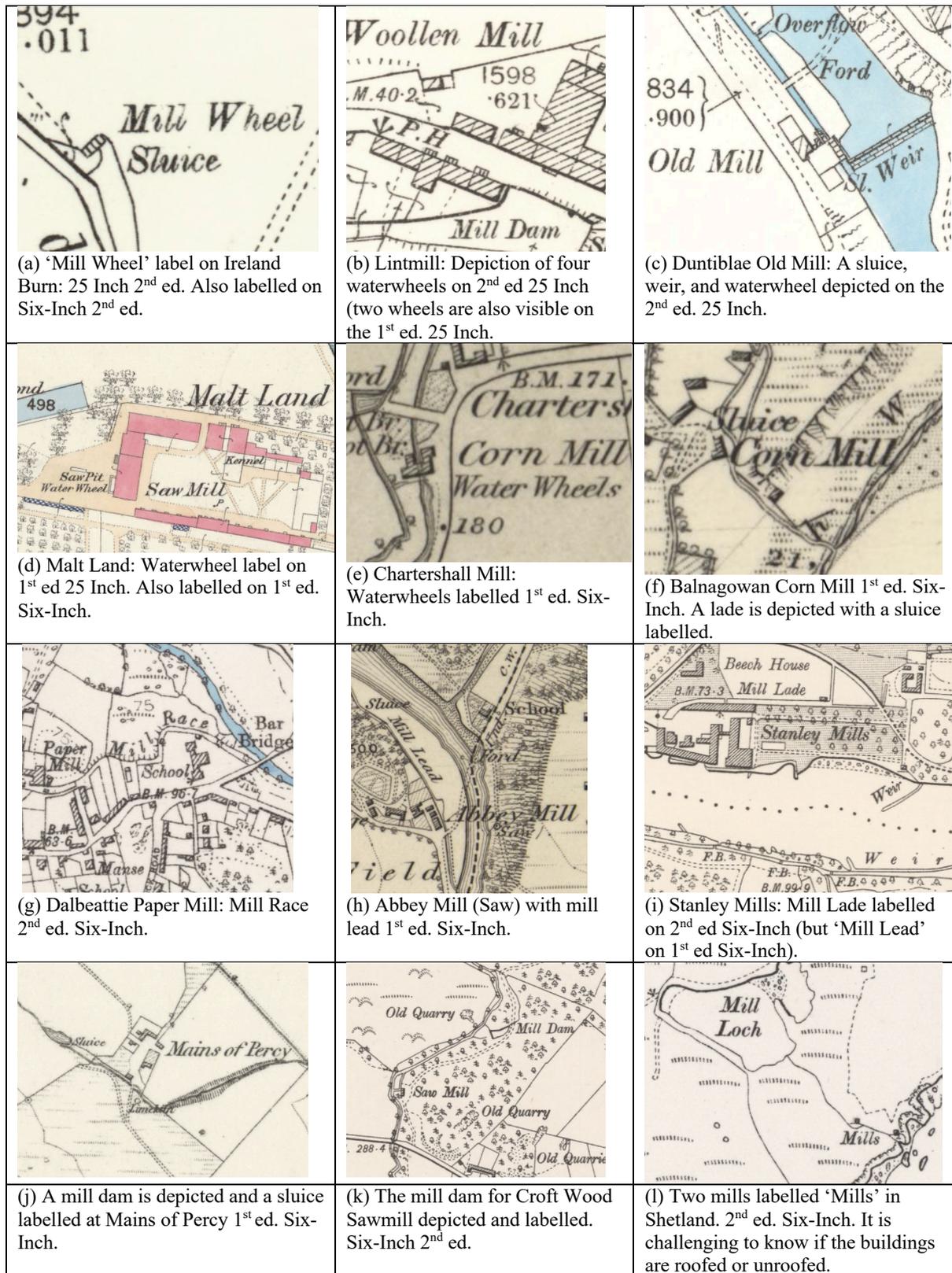


Figure 3. 5. Depiction of watermills on the OS maps. Examples of wheel symbols and labels, dams, and lades.¹³

¹³ (a) Ordnance Survey, 25 Inch to the mile, Orkney CVII.5 (Revised: 1900, Published: 1902); (b) Ordnance Survey, 25 Inch to the mile, Argyllshire CCLVII.11 (Revised: 1898, Published: 1899); (c) Ordnance Survey, 25

3.2.2.2 Symbology and labelling

Frequently, a mill was labelled as ‘Mill’ on both editions of the mapping with the product written in brackets *e.g.* ‘Mill (corn)’. The source of power is not given on the map text other than for windmills. A small number of sites were found to be labelled with the word ‘Waterwheel’ on the 1st edition OS maps and others with a waterwheel symbol on the 25 Inch 1st and 2nd edition maps. The presence of a wheel symbol confirms the mill was at one time water-powered, but the absence of a symbol does not equate to an absence of waterpower because wheels may have been enclosed in the buildings or simply not depicted (Figure 3.5).¹⁶ Similarly, symbols used for windmills by the OS were sometimes annotated but usually not. Symbology sometimes varies across sheets or even within the same individual sheet (Bignell, 2013: 28).¹⁷ By the 2nd edition mapping it was common for traditional windmills to be labelled and for pumping mills to be differentiated by the text ‘Windmill (Pumping).’¹⁸ Steam engines powering mills were not depicted and only very rarely were they labelled on maps (Figure 3.6). Another method considered was looking for the presence of chimneys (Figure 3.7), but again, early mapping of chimneys was sporadic and could not be relied upon.

Inch to the mile, Dumbartonshire XXXIII.7 (Revised: 1896, Published: 1898); (d) Ordnance Survey, 25 Inch to the mile, Argyllshire and Buteshire, CXXXIII.5 (Inveraray) (Surveyed: 1868, Published: ca. 1871); (e) Ordnance Survey, Six-Inch to the mile, Stirlingshire, Sheet XVII (Surveyed: 1860, Published: 1865); (f) Ordnance Survey, Six-Inch to the mile, Argyllshire, Sheet LXXII (Surveyed: 1871-72, Published: 1875); (g) Ordnance Survey, Six-Inch to the mile, Kirkcudbrightshire Sheet XLIII.NE (Revised: 1894, Published: 1895); (h) Ordnance Survey, Six-Inch to the mile, Berwickshire, Sheet X (Surveyed: 1857, Published: 1862); (i) Ordnance Survey, Six-Inch to the mile, Perthshire, Sheet LXXIV (Surveyed: 1864, Published: 1867); (j) Ordnance Survey, Six-Inch to the mile, Forfarshire, Sheet XXIX (Surveyed: 1862-64, Published: 1865-1867); (k) Ordnance Survey, Six-Inch to the mile, Perth and Clackmannan Sheet LI.SE (Revised: 1899, Published: 1901); (l) Ordnance Survey, Six-Inch to the mile, Zetland Sheet XXIII (Revised: 1900, Published: 1902). Courtesy of the National Library of Scotland.

¹⁶ For a more detailed discussion of waterwheel symbology in OS mapping see Bishop (2021).

¹⁷ This holds true especially for the OS Old Series maps (1800s-1840s) that Bignell (2013) looked at in *Mapping the Windmill: The Ordnance Survey in England*. The later Six-Inch and 25 Inch maps were more standardised, but variations still occurred.

¹⁸ A basic explanation of windmill typology is given in Chapter 4.



Figure 3. 6. Depictions of steam powered mills. Steam engine label for the threshing and cleaning mill at Barsalloch (top left); Balgonie flax and tow spinning and weaving mill, near the Leven in Fife, powered by a 60–70 hp waterwheel and 35 hp steam engine (top right); Sheuchan Mill, a ‘large corn Mill and a farina Mill worked by waterwheel and by steam engine’ (bottom). At Balgonie and Sheuchan the presence of waterpower is clear from the systems of lades and reservoirs but there is no confirmation from the maps alone that steam is used.¹⁹

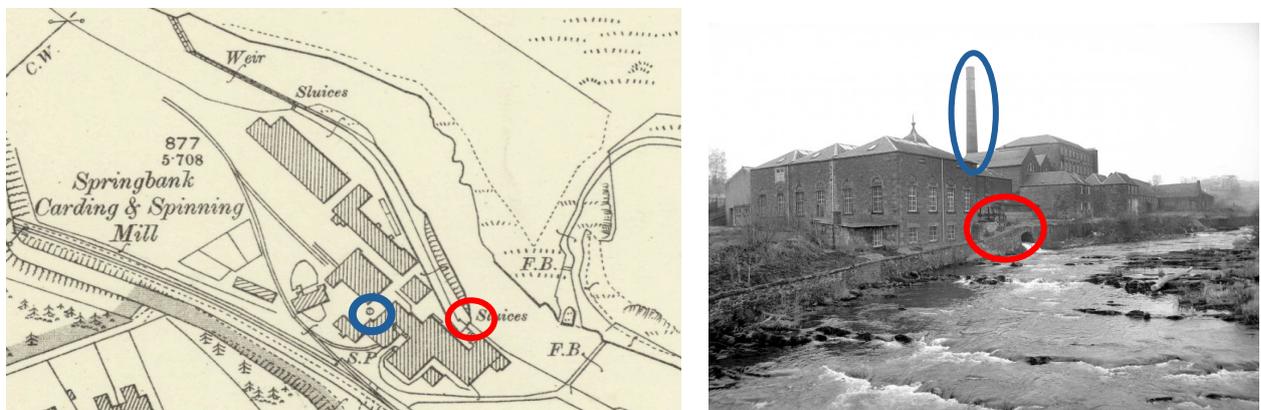


Figure 3. 7. Springbank Mill in Dunblane. At the time of 1st edition, the mill was worked ‘chiefly by steam’. This is one of a small number of examples where a chimney was depicted as well as the water system on the map (left). In the photo (right) dated 1969, the chimney (blue) and tailrace (red) for the water (by this date a hydroelectric turbine) are visible.²⁰

¹⁹ Barsalloch: Barsalloch: Ordnance Survey Six-Inch to the mile, Wigtownshire, Sheet 20 (Surveyed: 1846-48, Published: 1850); Balgonie: OS Name Books - Fife and Kinross-shire - Parishes of Markinch and Wemyss - 1853-1855, OS1/13/95, Ordnance Survey, Six-Inch to the mile, Fife, Sheet 24 (Surveyed: 1854, Published: 1856); Sheuchan: Ordnance Survey, 25 Inch to the mile, Wigtownshire XI.15 (Revised: 1893, Published: 1895). Reproduced courtesy of the National Library of Scotland; OS Name Books - Wigtown county - Volume 35 - Parishes of Leswalt, Portpatrick, Stranraer and Inch- 1845-1849, OS1/35/35: 8.

²⁰ Ordnance Survey, 25 Inch to the mile, Perth and Clackmannanshire CXXV.15 (Revised: 1899, Published: 1900). View online: <https://maps.nls.uk/view/82899909>. Reproduced courtesy of the

Surrounding features such as lades, sluices, aqueducts, dams, or weirs were used to infer whether a mill was water-powered. The corn mill in Alyth, Perthshire is one of the clearer examples (Figure 3.8). At the Six-Inch scale, the placename ‘Millhaugh’ is written but there is no labelled mill. However, there is a weir diverting water from the main river channel into a second channel labelled as ‘Mill Lade’ so the existence of either a present or past watermill is to be assumed. Examination of the 25 Inch map confirms the roofed building at the end of the lade was a mill for the purpose of grinding corn, with a sluice and aqueduct to deliver water to the mill wheel. It is also possible to identify different types of windmills in a similar way using their context. For example, a windmill located next to a water channel was more likely to be a water pumping mill than a corn grinding mill (Bignell, 2013). There are situations where multiple mills are depicted on a map though only one descriptive label is given. This was common for the small horizontal mills in the Northern and Western Isles, as shown in Figure 3.51, and was also used at the smaller scale mapping where two mills, a corn and sawmill for example, were in close proximity and under the same ownership.

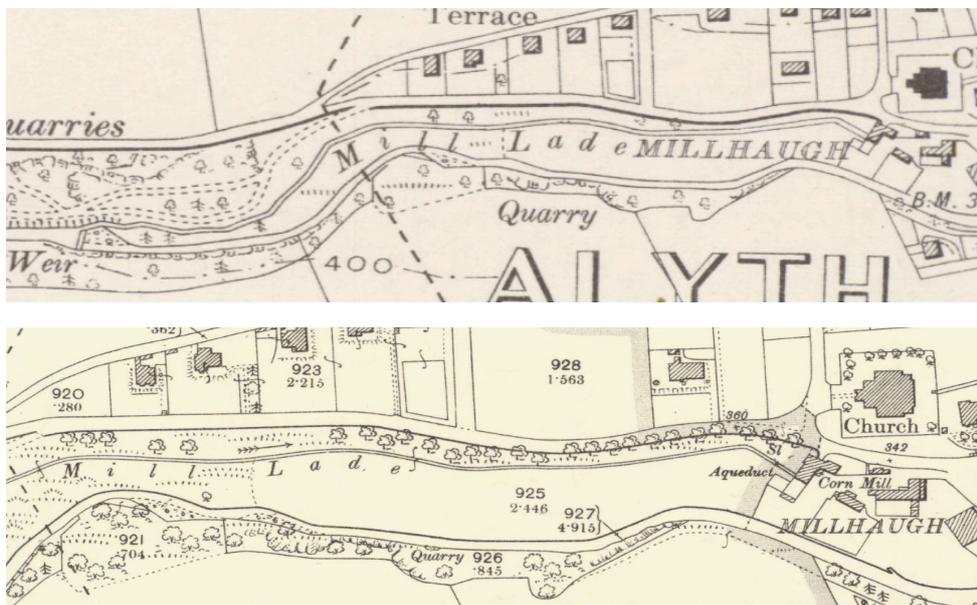


Figure 3. 8. Depictions of the corn mill at Millhaugh (Alyth, Perthshire) on the 2nd edition OS map at the scale of Six-Inch (top) and 25 Inch (bottom).²¹

National Library of Scotland; NRHE image ID: SC 699163 (General view from ESE); OS Name Books - Perth county - Volume 25 - Parish of Dunblane, OS1/25/25: 42.

²¹ Ordnance Survey Six-Inch 2nd edition Perth and Clackmannan Sheet LIII.NW (Revised: 1898, Published: 1901); Ordnance Survey 25 Inch 2nd edition, Perth and Clackmannanshire LIII.6 (Revised: 1898, Published: 1900).

3.2.2.3 Incorporating other sources

Relying on the Six-Inch OS maps alone left a lot of subjectivity as to whether a mill was present. It was quickly evident that additional crucial information could often be gained by reviewing the larger scale 25 Inch map or supplementary sources. The main resources used here were online Canmore records and the OSNB alongside occasional web searches. An occasional inconsistency of OS maps that needed cross-referencing of sources was recording of when a mill was disused. An initial assumption made was that if a mill was depicted as a roofed building and also labelled as a mill, without the text '(disused)' placed after it, then it must still have been functional at the time of the survey. This proved to be untrue in some instances. Using the OSNB revealed that labelled and depicted mills could have ceased to operate many years prior to surveying. The descriptions of the OSNB indicate that sometimes a former mill building that was still present along with all the usual mill infrastructure (*e.g.* lades), and not converted to another use, would be mapped as such, without the textual label specifying it was out of use (Figure 3.9). Sometimes the OSNB explicitly stated the power source of the mill which was especially enlightening when multiple power sources were in use. Although a valuable research tool, searching for specific sites in the OSNB was time consuming. Therefore, searches were reserved for mill sites with high uncertainty and a distinctive mill name that could be easily located.

A general knowledge of the literature on mills, specifically in relation to Scotland, was essential. For example, I found no difference in the depiction or description of horizontal versus vertical wheeled watermills on the OS maps but from prior research and reviews of literature I knew horizontal mills were generally smaller and to expect the majority of mills on Orkney and Shetland to be horizontal and conversely, knew which areas were highly unlikely to have a horizontal mill. Therefore, unless there was specific evidence to suggest otherwise, the assumption was usually made that a waterwheel was vertical.

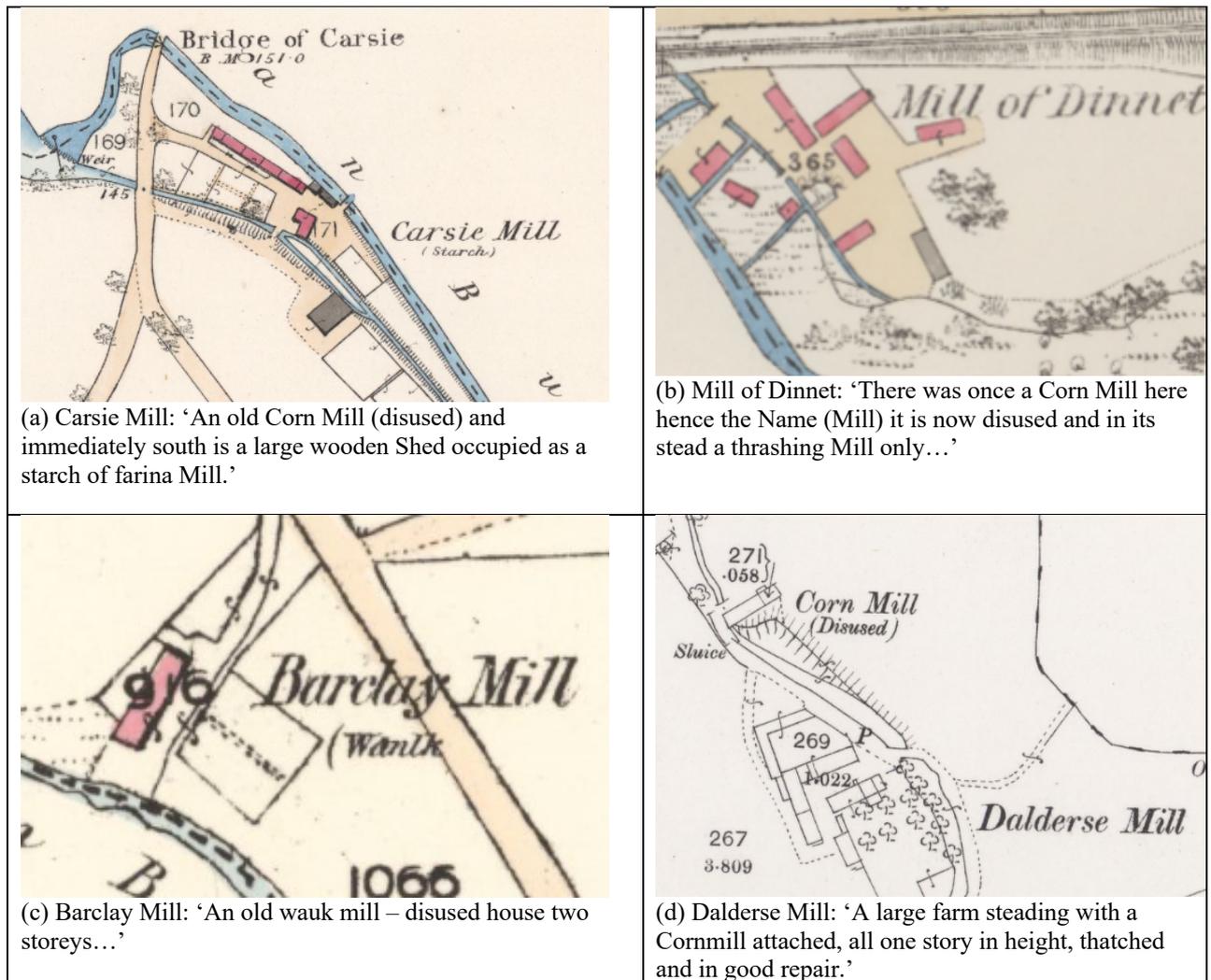


Figure 3. 9. Examples of disused mills on the OS maps which are not always labelled. The OSNB gives more clarity on the situation of disused mills. In this figure, the map image of each mill is displayed with an extract of the description below. Where another mill was installed the map does not marked the disused one.²²

Mill sites recorded on Canmore but not present on either of the maps required a separate temporal category. These were recorded as 'Period Unassigned'. Care had to be taken when a Canmore record suggested a mill was functional in the nineteenth or twentieth centuries but was not confirmed by the map. If a mill was not explicitly labelled there was very little to

²² (a) Carsie mill: Ordnance Survey 25 Inch, Perth and Clackmannanshire LXIII.11 (Lethendy) (Surveyed: 1863, Published date: 1866); OS Name Books - Perth county - Volume 42 - Parishes of Kinloch, Lethendy, Clunie and Caputh, OS1/25/42: 52; (b) Mill of Dinnet Aberdeenshire LXXXI.16 (Aboyne and Glentanner) (Surveyed: 1865 to 1867, Publication date: 1868); OS Name Books - Aberdeen county - Volume 4 - Parish of Aboyne and Glentannar, OS1/1/4: 40; (c) Barclay Mill: OS Name Books - Ayr county - Volume 37 - Parish of Kirkmichael, OS1/3/37: 100. Ordnance Survey 25 inch 1st edition, Ayrshire XLV.5 (Kirkmichael) (Surveyed: 1856, Published: 1857); (d) Dalderse Mill: Stirlingshire XXIV.16 (Combined) (Surveyed: 1859, Published: 1894); OS Name Books - Stirling county - Volume 11 - Parish of Falkirk, OS1/32/11: 22. Reproduced courtesy of the National Library of Scotland.

indicate whether a mill was indeed present at the time, especially if the mill was using steam so had no associated lades or dams. Therefore, unless the Canmore record was accompanied with approximate dates of operation, a subjective decision was made.²³ This was most commonly an issue in heavily built up urbanised areas where it was standard practice to not label all industrial premises (Figure 3.10). On reflection, it would have been beneficial to have pre-1st edition and post-2nd edition categories, rather than the ‘Period Unassigned’ category only, as well as a record of mill structures that were still there but not in active use. This is one of the difficulties in using data that was originally designed for another purpose. Originally, a simple yes or no box for whether the mills were present on the map was sufficient for the intended use.

In the future, machine learning and Artificial Intelligence (AI) may be capable of identifying text strings or pictorial definitions of mills from map images. The Alan Turing Institute’s *Machines reading maps* project aims to interpret digitised historic maps with the use of AI. They hope to refine Optical Character Recognition (OCR) for gazetteers and patch-based object-based computer vision tools to further classify map text and symbols and how it links with other geospatial data (The Alan Turing Institute, 2024). However, machine learning is unlikely to offer an improvement in accuracy as it will be based on the same OS map sources and the challenges described in this chapter regarding reliability of the maps will still apply.

²³ Canmore records usually assign a broad period *e.g.* medieval/twentieth century. The record may have additional textual entries that include specific dates of operation. Canmore also uses ‘Period Unassigned’ as a category.



Figure 3. 10. Close up of Dundee, on the 2nd edition, 25 Inch OS map. Of the seven mills recorded in Canmore for this map extract, only two are labelled. Many of Dundee's mills were early adopters of steam and as such there is no external associated mill infrastructure to help identify them.²⁴

3.2.3 Preparing the data for analysis

Prior to analysis, a lengthy process of data 'cleaning' took place. Cleaning rarely receives a description in research outputs despite often being one of the most time-consuming stages in data-intensive research (Rawson and Muñoz, 2019: 279). The cleaning process had three parts: (1) reorganising the data to fit a new purpose, (2) correcting errors, and (3) formatting the data for GIS. For this, the database was kept in Microsoft Excel so changes could be made easily.

Reorganisation and scope of data

The aim of the collaborative project with the NLS was to create a publicly accessible online map interface displaying mills in Scotland. The data was therefore originally collected and arranged so the website could be searched or filtered according to the name of a mill, mill type,²⁵ whether it was water-powered, its presence in the Canmore database, or using a slider to view mills based on time range. The database retained alternative names and spellings such as wauk/waulk/lint mill or mill lade/lead, and it classified grain and flour mills separately

²⁴ Background layer: OS 25 Inch 2nd edition, 1892-1905.

²⁵ 'Mill type' here was based on the map text or Canmore record.

despite flour being a subcategory of grain. While this information would be useful for researchers of language, or those interested in an in-depth study of grain milling and the different products within this industry, this level of detail was not required for this project. Names and spellings were therefore standardised to correspond with the heritage terms provided by HES (Appendix 2). Hiding diversity by removing it has implications for the resulting data set and its future uses (Rawson and Muñoz, 2019: 287) so it was important to consider the research questions and what data was needed to answer them before cleaning the database. It was logical to use the heritage terms to maximise the potential for the data to be used by HES and other heritage organisations afterwards. Therefore, loss of diversity in the data also had the benefit to future users in mind, as well as practical considerations for the current project.

Threshing mills were removed from the dataset at this point unless the mill had a dual function that took precedence *e.g.* a corn and threshing mill located in the same complex of mill buildings, sharing waterpower. This was the case at Kilry where a single waterwheel turned a corn mill, barley mill, hoisting tackle, and a threshing mill (Thomson, 1800: 132). The other circumstance for retention was when the threshing mill was also a windmill since that specific combination was a rare mill type in Scotland. Thousands of water-powered threshing mills are present on the OS maps and, although they are often not labelled as such, they can be identified by the presence of a mill dam or lade located in the vicinity of a farm. The huge prevalence of these ‘farm mills’ has interesting implications for researchers of agricultural history (Bishop, 2022). Robertson & Roberson (n.d.) identified 995 farm threshing mills in the catchment of the River Don alone, 566 of which were watermills. This compares to 412 non-farm watermills in the same catchment. Whin mills were also excluded because they were animal powered. Animal powered mills were only included where there was a supplementary power source of water, wind, or steam, as in the unusual case of the pinn mill in Ayr ‘worked by water...machinery & horse power’.²⁶ Animal mills did feature in Scottish industrialisation, including nineteenth-century cotton mills but since they were not regularly labelled on the OS maps a different methodology entirely would be needed to capture their existence.²⁷ The visible disuse of threshing mills or transition away from waterpower between the 1st and 2nd edition surveys justifies attention but they do not fall

²⁶ OS Name Books - Ayr county - Volume 22 - Parish of Dalrymple - 1855-1857, OS1/3/22: 32.

²⁷ For depictions of horse gins see Bishop, 2022: 11–20.

under the remit of this project which focuses on what I term commercial or community mills *i.e.* those mills producing a product for sale or those grain mills which served a community whether by choice or law (thirlage). This differs slightly from the convention of thinking of mills as either ‘industrial’ or ‘agricultural’ that has been commonly used in milling literature since the 1960s (Lucas, 2006: 3–4).²⁸ To separate or exclude grain mills from the data would discount the changing but important role grain mills took in the industrialisation process in Scotland. Sawmills within in the dataset could be classified among these non-commercial farm mills as many were located on estates, often next to threshing mills. The decision to include those kinds of sawmills takes into account that a threshing mill would be used on a small scale whereas a sawmill could be for use either on the estate or for commercial sawing, which could be impossible to distinguish from the map. Although there is no guarantee that my interpretation is correct, it appears the surveyors were instructed to record sawmills since they are often labelled even when there was probably a threshing mill at the same site not labelled (Figure 3.11).

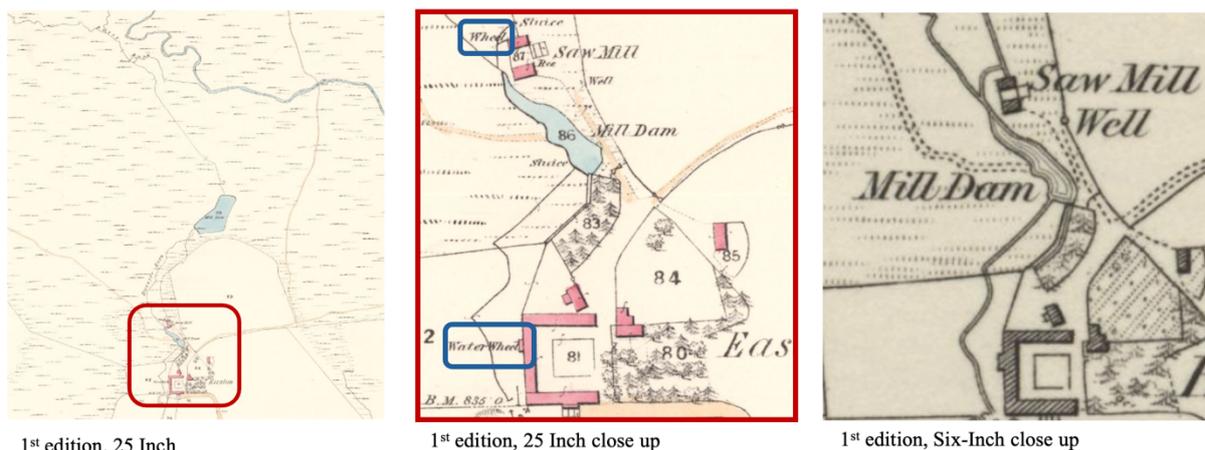


Figure 3. 11. Easton Mill: an example of two mills of the same estate labelled differently. The 1st edition 25 Inch map (on the left and centre of this figure) displays a large mill dam (presently known as Loch Hart) created along the course of the Dunsyre Burn. At the southern end of the dam, a sluice gate released water back into the channel of the burn which shortly afterwards had another sluice gate and separated into two channels one of which delivered water to a ‘Wheel’ at the sawmill. Further downstream another mill dam was created from which water was delivered to a ‘Water Wheel’ at a mill that is this time unlabelled but presumed to be a threshing mill given its situation on a farmsteading. The Six-Inch map (right) labels only the ‘Saw Mill’ and ‘Mill Dam’.²⁹

²⁸ This convention sees grains mills assigned as ‘agricultural’ while essentially all other mills that process anything other than grain are ‘industrial’. Suitable as this may be for the early era of milling, the distinction is recognised to be arbitrary and does not recognise large scale grain milling as an industrial process (Lucas, 2006).

²⁹ OS Name Books - Lanark county - Volume 24 - Parish of Dunsyre - 1858-1861- OS1/21/24: 11, 22; Ordnance Survey, Six-Inch to the mile, Lanarkshire, Sheet XXI (Surveyed: 1859, Published: 1864). View

Removing errors

Displaying the data on a map as a whole, and then according to different categories, highlighted possible errors in the data. Anomalies (*e.g.* data located off-shore, mills in locations that disagree with the existing literature) were checked and corrected if needed.

Preparation for GIS

A final cleaning stage, equivalent to proofreading a document was necessary to allow processing and visualisation in the GIS. Conducting basic tasks such as counting how many mills there were of a certain type required uniformity in the text strings. The GIS used was case sensitive so variations such as ‘watermill’ versus ‘Watermill’ had to be standardised as did any variations in spelling (‘water mill’) or incorrect spellings due to typos.

3.2.4 Analysis using GIS

The project was migrated to QGIS (version 3.36 Maidenhead) which is open source, can run on most computer operating systems, and is capable of performing the functions required for this project. As is the first stage in most GIS analysis, a base map was downloaded, allowing the visualisation of the data within an outline of Scotland with historic administrative regional boundaries (counties and parishes). The completed mills dataset was imported into QGIS and transformed into a shapefile with the projection OSGB36/British National Grid EPSG:27700. Using the built in QGIS toolbox functions, hillshade and elevation were calculated. Hillshade maps were derived using a digital terrain model (DTM). For hillshade, two copies of the DTM were layered over each other and the symbology and render type altered to visualise altitude. Elevation data of mills was calculated using raster analysis. Contour lines were created from the DTM using the QGIS *contour* plugin. The interval between lines was set to 100 m to aid in the visualisation of the elevation data. Supplementary datasets (Table 3.1) were obtained or created to layer over the base map to provide context and enable additional analysis.

online: <https://maps.nls.uk/view/228779059>; Ordnance Survey, 25 Inch to the mile, Lanarkshire XXI.15 (Dunsyre) (Surveyed: 1859, Published: 1860). View online: <https://maps.nls.uk/view/74954167>; Reproduced courtesy of the National Library of Scotland.

Table 3. 1. Spatial datasets used and their sources.

Data description	Source	Reference
Railway lines (1851)	1851 England, Wales and Scotland Rail Lines	Satchell <i>et al.</i> , 2023
Scotland outline	GB outlines	Ordnance Survey, 2024
Collieries (c1900)	GB1900 gazetteer	Great Britain Historical GIS Project, 2003-2023a
DTM (21 st century)	2016 UK Centre for Ecology and Hydrology (CEH) 50-m Integrated Hydrological DTM (IHDTM)	EDINA, 2022
Rivers (21 st century)	OS Open Rivers ³⁰	Ordnance Survey, 2023
River catchment boundaries	National River Flow Archive	NRFA, 2025
Canals (historic and present day)	Extracted from OS Open Rivers. Missing historic stretches of canal manually digitised	Ordnance Survey, 2023
Ancient woodland (from either the 1750 Roy maps or 1 st Edition OS maps)	Ancient Woodland Inventory	NatureScot, 2025
Parish and county boundaries for 1860 and 1950	NLS Boundaries viewer	NLS, 2025a
Localities (21 st century)	Settlements and Localities Digital Boundaries – Localities 2020 centroids	National Records of Scotland, 2024
OS map backgrounds (1 st and 2 nd edition)	NLS ‘Viewing our Georeferenced Maps Guide’	NLS, 2025b
1911 population statistics	1911 Census of Scotland, Population, Ages and Conjugal Condition, Occupations, Birthplaces, Housing, Gaelic-speaking, Table 20: “Burghs in Order of Population”.	Great Britain Historical GIS Project, 2003-2023c
Tool	Source	Reference
Batch conversion of BNG to latitude/longitude	BATCH CONVERT TOOL	UK Grid Reference Finder, 2011
Georeferencing	BatchGeo	BatchGeo, 2024

Finding relevant pre-existing data that correlated to both the time period and geographical area of study can be difficult, especially data that are already georeferenced for use in a GIS. A common problem encountered when interpreting historical data is that places often undergo alterations to their geographical boundaries or a locality may cease to exist entirely (Gregory, 2002). Scotland was historically divided into parishes, burghs, counties, or regions

³⁰ OS Open Rivers data is based on high resolution OS large-scale data that has been simplified by omitting certain rivers such as small river channels.

at different points in time and the understanding of each of these divisions is not consistent. Shennan (1892) identified that in late-nineteenth-century Scotland the word ‘parish’ had six different meanings and the word ‘county’, eleven. The Local Government (Scotland) Act 1889 and 1894 rationalised governance units and brought new changes to county and parish boundaries. Boundary commissioners were appointed to carry out tasks such as adjusting counties so that none had detached parts and providing that the 64 parishes situated in multiple counties were in only one county going forward (Shennan, 1892). Counties of Orkney and Zetland were created, and Ross and Cromarty were united as a single unit. Other counties experienced internal rearrangements or boundary changes such as Dumbartonshire, which was extended to include New Kilpatrick that was previously in Stirlingshire. In the first half of the twentieth century five counties changed names but both old and new names were used concurrently in maps and textual documents, making it difficult to identify a precise moment of name change (NLS, 2024).³¹ Burghs and counties then ceased to be used for government purposes from 1975. The result of these repeated changes is that it is incredibly challenging to find corresponding historic demographic and other types of data. Using county boundaries for a different time period would result in different statistics of mill numbers (for example, mills in New Kilpatrick would be assigned to either Dumbartonshire or Stirling depending on which boundaries were used).

Comparing data with radically different boundaries or data that was derived from different sources can be highly problematic. Values and meaning assigned to certain things in a society change over time too (Martin *et al.*, 2002: 82; Lloyd *et al.*, 2012). The consequences for this project and its readers are clear. Almost every dataset used in this project relates to a different moment or interval in time. The railway data relates to 1851, the mills data set covers 1843 to 1905 (OS mapping) and dates both earlier and later (Canmore data). Since the data were not input into a model or another quantitative assessment, it was deemed that perfection was not essential but that transparency about such discrepancies is required. Given the suggested importance of inland waterways for the development of industry (Maw *et al.*, 2012), I opted to create a shapefile of Scottish canals by extracting canals from the modern day river dataset and manually adding stretches that no longer exist using the OS 1st edition mapping. The five main canals in Scotland were opened to commercial and passenger traffic within a 32 year

³¹ Edinburghshire to Midlothian; Elginshire to Moray; Forfarshire to Angus; Haddingtonshire to East Lothian; Linlithgowshire to West Lothian.

period (1790–1822) and closed at different dates in the twentieth century (Pratt, 1922). Again, this has the potential to be deceptive when mapped if the origins of the data are not specified. Thus, it is the intention of this chapter and the above Table 3.1 to fully inform the reader of the origins and circumstances of the data.

To allow comparisons between my data and those of previous studies (Table 3.2), existing lists of mills were input into Excel and georeferenced first using Google Maps to find the coordinates of a site, then the online tool, BatchGeo, to convert latitude and longitude to British National Grid. Data was then imported into QGIS and converted into shapefiles. Once all the data were in the GIS further geoprocessing could take place by filtering and combining the layers.

Table 3. 2. List of mills georeferenced based on primary and secondary literature.

Subject	Source
Tide mills	Gauldie, 1981
	Shaw, 1980; 1984
Windmills	Donnachie and Stewart, 1967
	Douglas and Oglethorpe, 1984
	Douglas and Oglethorpe, 1986
Paper mills	Sommerville, 1845
	Oliver, Boyd, and Robert Weir, 1832
Steam mills	Kanefsky, 2024

3.3 Fieldwork - methods and sources

Documents, whether they are in textual, visual or audio format, are usually the only sources available to historical geographers (Moodie, 1971) and rarely will a single source provide all the information (Ogborn, 2003: 19). Examining a range of sources gives a fuller picture of a topic and by linking them they might bring new outlooks (Ogborn, 2003: 19). This section describes the experience of ‘fieldwork’ in the form of archive and site visits and the main sources consulted for this thesis. The main primary sources of local histories, historic maps, the Ordnance Survey Name Books, *Statistical Accounts of Scotland*, and digitised newspaper collections are then discussed.

3.3.1 Archives

The dual production of knowledge involved in the process of making and working with the archive means that the nature of the archive must always be incorporated into the historical and geographical knowledge that is produced from it in some way. (Ogborn, 2011: 93)

Frequently archival researchers, including historical geographers, do not offer descriptions and reflections on their research practice, possibly assuming the process to be straightforward and obvious (Lorimer, 2009: 251; Moore, 2010: 262). But every collection is unique, their contents varied, and there is no single one-size-fits-all methodology for archives (Harris, 2001: 331). Archives are places of knowledge production, and the choices made during research result in a ‘selective silencing’ (Decker, 2013: 156) and so some description of the process is justified. The contents of archives are often the result of unsystematic collecting practices (Withers, 2002) and there is potentially far too much material in existence. Although research in archives ‘always depends on serendipity’ (Decker, 2013: 169), it is necessary, nonetheless, to have an idea of where your research will go and the sources you will use prior to starting. However, it is best not to have too many preconceptions or set desired outcomes because ‘immersion in the archives will almost certainly change’ these, while unexpected collections can lead the research to ‘a different, more rewarding line of inquiry’ (Harris, 2001; 331–332), an experience I found to be true.

The strategy adopted for this research was to focus on the archives of individual companies or mills that I would develop into case studies. Collections were identified using Archives Hub, an online service for cross-searching archival descriptions from UK repositories (Archives Hub, 2025). The majority of the empirical material used in the case study-based portion of this thesis was collected from Glasgow University Archives & Special Collections (which includes the Scottish Business Archive) where I spent multiple days between January and March 2020. First, I viewed items from the collection *Records of James Finlay & Co Ltd, textile manufacturers, tea planters and merchants, Glasgow, Scotland*. The entire collection spans 30.5 metres of shelf space, so focus was restricted to the subsection of *Catrine, Deanston, production records* which covered the years 1787–1968 and included 12 pieces related to Ballindalloch. Understanding the development of this company from a family business into a limited firm with international output and subsidiaries could have interesting implications for understanding the broader context of financial and social networks supporting the mills or the motivations of the owners, but given the time constraints of a

thesis I had to be selective and focused primarily on the records pertaining to the specific mills of interest. The second major collection from the University of Glasgow Archives was *Records of Gourock Ropeworks Co Ltd, rope makers and textile manufacturers, Port Glasgow, Inverclyde, Scotland*, the last manufacturer located at New Lanark. Although the Gourock Ropeworks Co. only took over New Lanark in the 1870s, the archives hold records pertaining to much earlier periods.

To research Rothesay cotton mill I visited the Isle of Bute and the Bute Museum on 23rd and 30th November 2021. Archival material related to the Cotton Mills and Robert Thom (one of the mill owners) were not digitised and the catalogue could not be viewed in advance. The entire collection was brought out at once to work through creating a challenging balance between thoughtfully engaging with the physical materials versus the desire to see as much as possible under time restrictions (see section 3.4). Working with physical archives potentially gives access to the immense knowledge base of the archivists (Wideman, 2023). As the only researcher present at Bute Museum I had the opportunity to build rapport with the archivist while speaking both about my research and my trip to the island, resulting in an offer to drive me to visit ‘the cuts’ and an emailed collection of photographs she had not been able to find while I was there in person. Visits were also conducted to the National Records of Scotland and the University of Dundee archives for more general documents in relation to mill buildings such as letters by millwrights, building and water engineering plans, and steam engines. Rare books were viewed at special collections of the UofG and NLS and physical maps were consulted in the NLS Map Room. These collections provided supporting material for Chapters 4 and 6. The NLS moving image archive, which holds footage of mill buildings, machinery, and life at mill communities, was also consulted. While films were not formally used in the thesis, videos, like site visits, assisted in comprehension of the subject.

Photography was permitted in most of the archives visited. The process of photographing materials has been considered as simply relocating part of the archives into essentially another archive belonging to the researcher now and delaying the process of interpreting the material and making notes (Harris, 2001). When returned to months or even years later, the materials are extracted from their original context. However, the ability to recreate the archive at home became a necessity when what were initially planned as reconnaissance trips became the only opportunity to view collections. Archives are sites of power relations and a series of active choices. What is found in the archive is a result firstly of what documents

were felt necessary to be created, then to be kept by the creators/original keepers of the documents, and then by the repositories where they are preserved in the years later. The decisions I made in the search room about which items to take hurried photos of in the days leading up to the national lockdown would then partly dictate my final choice of case studies and the stories I tell through them. This serendipitous nature of archives was demonstrated when I requested a ledger book earmarked for destruction by one person, saved by another (Figure 3.12).

The collections held materials that dipped into many aspects of the running of the mills and the lives of the workers and managers. Items included accounting records (ledgers, profit and loss accounts, journals, cash books, order books, receipts), personnel records (lists of workers, labour indentures, registers associated with the Factory Acts), correspondence (letter books and loose letters), production records (orders, produce report books, personal notebooks of managers), property records (minutes, articles of association, title deeds, plans), miscellaneous (weather reports, visitors books, local history publications), and reports (*e.g.* Thom's description of his self-acting sluice system).

Accounting records (Figure 3.13) gave insight into the locational constraints of the mill. From these records we can pinpoint who the firm was doing business with and where customers or suppliers were located. Information can be found regarding specific costs incurred (of carriage, fuel, wages, raw materials, maintenance *etc.*), maintenance costs of motive power systems and so on. These specific details can be used to review the business systems and accounting practices and the way they are used by a firm: the way an accounting system is used 'may suggest rationalisation for personal behaviour and character traits not ascertainable from other sources' (Dryen, 1969: 4).

Letter books and personal notebooks of owners or managers are particularly useful in understanding why certain decisions were made. The discovery of in-depth meteorological records in multiple collections were unexpected but formed a large and important part of the archive material. These were found in multiple formats from comments made in notebooks to formal systematic records in designated books for monitoring. Records for Deanston were graphed whereas Catrine kept tabulated numerical and descriptive records (Figure 3.14). Such records provide evidence of the local climatic and hydrological conditions at the time as well as interesting insight into the use of systematic scientific monitoring. Combined with

meteorological records, the production records (*e.g.* quantity of raw materials used and goods produced in a given day, speed of operation of machinery) very often reflected the state of the power supply due to weather conditions or breakages.

Mills were frequently involved in disputes over land and water rights, records of which would be held in legal records. In the business archives I found documents related to disputes that were not the official court records (Figure 3.15). Looking directly at the company's internal documents gave insight into the concerns of the proprietors and the calculations they used to base legal objections on. Valuation rolls, Title deeds, or legal documents such as sasines,³² give detailed accounts of company inventories and the value of buildings, equipment and products, and descriptions of lands owned or leased. In conjunction with maps, plans, and technical drawings, from these we gain knowledge of the extent of the mill, and the capital invested into it at various moments in time (Figure 3.16).

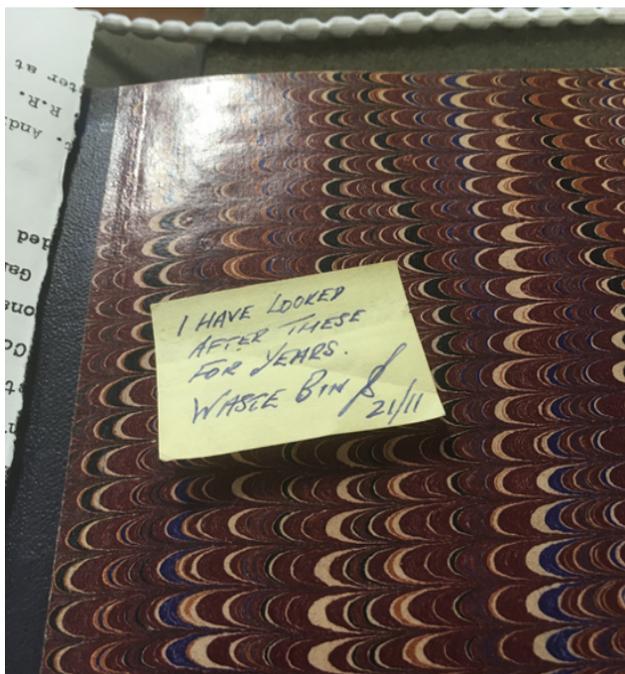


Figure 3. 12. Letter book saved from the waste bin and kept within the records of James Finlay and Co.³³

³² Sasines were records of property possession and transactions used in Scotland from the seventeenth to twentieth centuries.

³³ AM Brown Institute Catrine, 1897-1967. Courtesy of University of Glasgow Archives & Special Collections, Records of James Finlay and Co Ltd collection, GB 248 UGD 091/1/5/2/10.

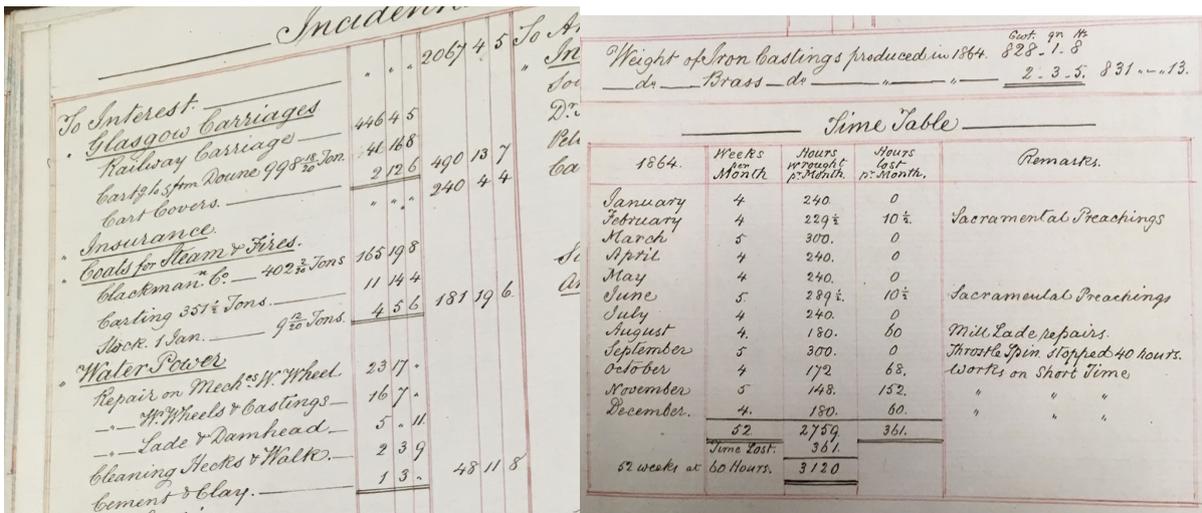


Figure 3. 13. Extract from Deanston annual statements, 1859–1871. Left: Incidental charges related to carriage of goods, coals, and water power. Right: Timetable of hours worked and stoppages.³⁴

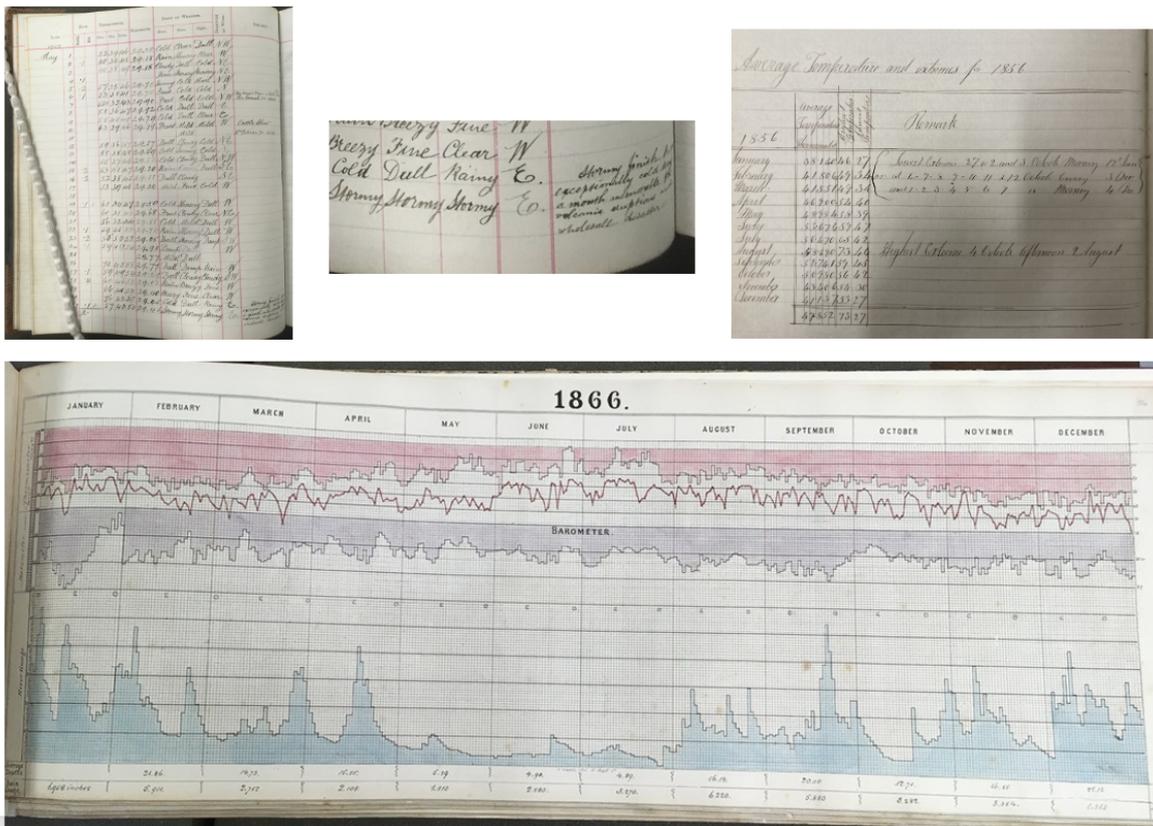


Figure 3. 14. Top row, left to right: Full page and close up of the month of May 1902 from Catrine's Weather Report book, Rothesay Average Temperature and extremes for 1856. Bottom row: Record of river gauge, thermometer and barometer kept by Deanston for 1866.³⁵

³⁴ Deanston annual statements, 1859-1871. Courtesy of University of Glasgow Archives & Special Collections, Records of James Finlay and Co Ltd collection, GB 248 UGD 091/1/5/3/13/5.

³⁵ Weather reports for Catrine Area Vol.1, 1898-1911. Courtesy of University of Glasgow Archives & Special Collections, Records of James Finlay and Co Ltd collection, GB 248 UGD 091/1/5/2/8/3; Rothesay Spinning

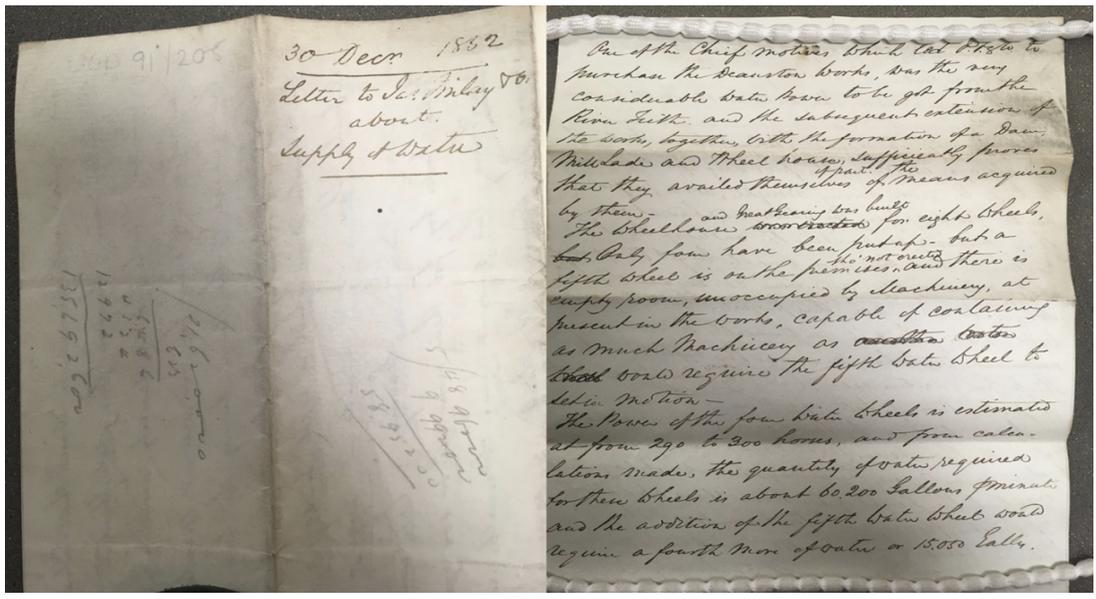


Figure 3. 15. Correspondence and papers concerning Glasgow Water Co and legal cases: letter from Deanston to James Finlay & Co ‘about supply of water’ dated 30 December 1852, providing a detailed description of the waterpower available at the mill, written during a dispute with a prospective municipal water corporation.³⁶

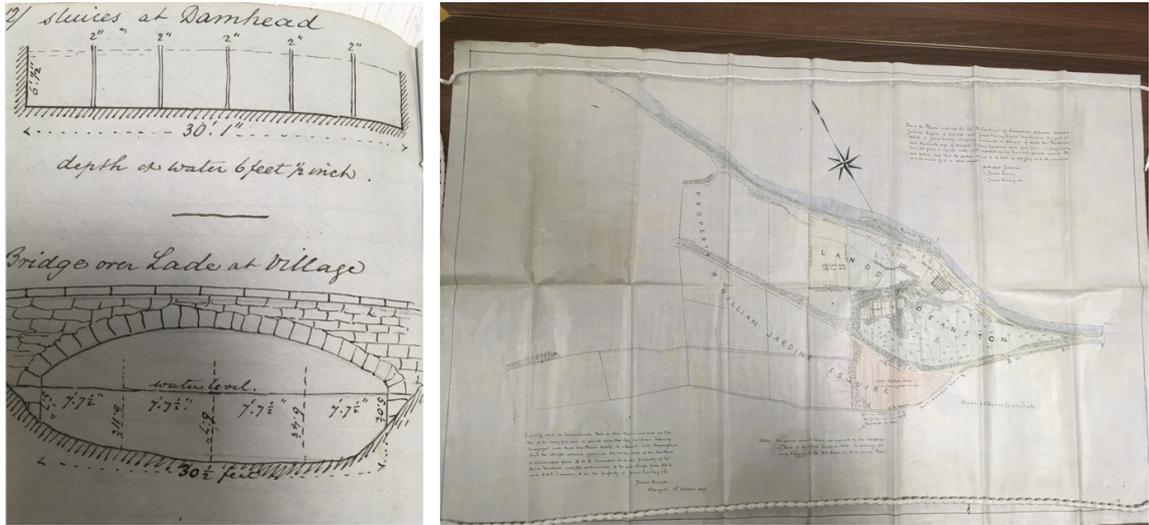


Figure 3. 16. Sketch of the damhead and lade at Deanston in notebook from 1852 (left) and formal Deanston Grounds plans October 1845 (right).³⁷

Company (1848–1875) Book of rainfall from 1848-1875. Bute Museum Archives; Deanston river gauge, 1831-1870. Courtesy of University of Glasgow Archives & Special Collections, Records of James Finlay and Co Ltd collection, GB 248 UGD 091/1/5/3/13/2.

³⁶ Correspondence and papers concerning Glasgow Water Co and legal cases. Courtesy of University of Glasgow Archives & Special Collections, Records of James Finlay and Co Ltd collection, GB 248 UGD 091/1/5/3/6/1.

³⁷ Notebook from 1852. Courtesy of University of Glasgow Archives & Special Collections, Records of James Finlay and Co Ltd collection, UGD91/1/5/3/13/1; Deanston Grounds plans October 1845. Courtesy of University of Glasgow Archives & Special Collections, Records of James Finlay and Co Ltd collection, GB 248 UGD 091/1/5/3/12/5/1.

3.3.2 Site Visits

Visiting mill sites became a small but important aspect of the project even though much of the research could have been conducted without stepping beyond the archive or even entirely as a desk based project on a computer. None of the sites were functional mills at the time of visiting so, as was articulated by Richard Byroms in their own doctoral thesis on millwright William Fairbairn, mills now ‘lack the bustle, noise, smell, smoke and dirt of their operational days... their life and atmosphere gone’ (2015: 34). However, the act of undertaking fieldwork can inspire and provide important context for research, connecting the researcher to their subject. It was Carl Sauer’s belief that:

geography is first of all knowledge gained by observation, that one orders by reflection and reinspection the things one has been looking at, and that from what one has experienced by intimate sight comes comparison and synthesis. (Sauer, 1956: 295–6)

With the availability of digital materials, or physical archival records stored far from where they were created, the researcher risks never visiting the people and places they write about and missing out on ‘experiential learning’ (Hodder and Beckinham, 2022: 1304). Jennifer Tann (1970: 184) writes emphatically of the potential for new questions to arise when field work and documentary research are carried out as complementary activities. Numerous records survive of the diameter of the buckets on waterwheels, the horsepower of an engine, volume of water held by a dam, and so on, but it is difficult to comprehend their meaning or sense the legacy that mills have left on the landscape from descriptions alone. Entering the World Heritage Site of New Lanark village the researcher is faced with the true scale of an industrial mill site: the rows of houses, the three surviving mill buildings, the exposed lade cutting through the village, and, at the extremity of the site, the original eighteenth-century weir, all constructed to utilise the natural resources of the location. At the other extreme, visualising how small a mill might be was just as useful to understand how they fit within the landscape. Approaching the reconstructed click mill at Dounby in Orkney via the gently sloping land and ducking your head to physically step inside the compact 4.5 m by 2 m drystone structure provides appreciation of the value and limitations such a feature offered the local community.

Site visits (Table 3.3) ranged from large mills preserved at great expense and now open to the public as museums of industrial and cultural heritage (Stanley Mills in Perthshire, Verdant Works in Dundee) to those that have been converted to other uses (the residential home at

Baldernock Mill and Clackmannanshire Council office in the Kilncraigs building that uses the façade of a mill). Other locations where only traces of the buildings or infrastructure remained required the use of imagination and detective work to locate. These experiences aided with telling the in-depth stories of the mills in Chapter 5 but were also key for Chapter 4, where working with a dataset of thousands of points, it was easy for the mills to become lost from their context. Although the outcome of these site visits in terms of the final thesis are mostly presented as illustrative photographs, future studies are encouraged to make greater use of the material culture of mill sites. Observing and asking questions about physical remains can check the reliability of documentary records and produce new evidence, but at present, physical evidence is often neglected in studies of industrialisation (Timmins, 2021: 4–5).

Table 3. 3. Site visits

Type of site	Name
Specific mill sites	Cotton mill: New Lanark, Deanston, Stanley, Catrine, Ballindalloch Horizontal mill: Dounby Click Mill (Orkney) Tide mill: Ayre Mill (Orkney) Sawmill: Baldernock Sawmill (Dumbartonshire) Corn / flint mill: North Woodside Mill (Glasgow)
Industrial towns or regions	Paisley: including Clarks and Coats Thread Mill Rothesay Dundee: including steam-powered Verdant Works Water of Leith Fife: Kinghorn, Kirkcaldy, Leven, Markinch Clackmannanshire Perthshire: Blairgowrie, Stormontfield, Perth
Altered mill landscapes	Greenock: Loch Thom, Shaws Water Works, and Greenock Cuts Isle of Bute: Thom’s Cuts

3.3.3 Local histories

Falling between secondary literature and primary sources, local histories were used heavily in informing the empirical chapters of this thesis, providing for instance, evidence of dates of operation of mills and working practices. The private archives and, often hard to source, research outputs of Britain’s thousands of active local history societies have been undervalued by academics (Cosson, 2017: 45). Some of these are published works that are also curated amongst the archival collections such as the Catrine, Sorn & District Local History Group’s publication commemorating 200 years since the founding of the cotton mills

(Dalziel *et al.*, 1987).³⁸ Locally produced pamphlets, books, and journals should be among the first ports of call for researchers of industrial history (Palmer and Neaverson, 1998: 108–111; Pastor *et al.*, 2021: 80). These are often written by people who possess a direct connection to the subject and familiarity with the area in question that a researcher could not possibly gain in the short duration of a doctorate. Ex-Provost Sharp’s piece for the second issue of the *Proceedings of the Buteshire Natural History Society* in 1908 incorporated first hand experiences as the owner of Broadcroft Spinning Mill and those of his grandmother who trained and worked as a piecer in the town’s original flax mill. Accounts such as Sharp’s warrant a place in an expanded conception of the archive.

This proximity of local researchers to their subjects is a mixed blessing. Local histories have been accused of lacking subjectivity and a tendency to fetishise and romanticise (Cheape, 1984: 22; Kammen, 2003: 146). Cheape (1984: 11) cautions us against taking past accounts as truth without questioning the cultural context and motivation surrounding their creation, no matter how tempting it can be when there are no alternative sources. Local histories of the nineteenth and some of the twentieth centuries were often characterised by a lack of clear questions or narratives (Tiller, 2020: 16) and were based on a narrow pool of source material (Kammen, 2003: 146). Tiller (2020: 19–21) defends the modern-day researcher of local history who, in comparison to earlier counterparts, has access to a plethora of online resources and frequently employs a systematic methodology and style not dissimilar to academic outputs. The value of these types of grassroots history warrants recognition. Cosson (2017: 48) encourages us to consider researchers of local history as ‘the producers and organisers of cultural material production’. By challenging traditional academic monopolies on historical research, local historians bring alternative but equally valid approaches to the practicing of history (Nash, 2005).

3.3.4 Historic maps

The importance of historic maps, including those produced by the OS as primary sources for the historical geographer has long been recognised. However, Harley in 1964 claimed that while maps were the most common tool for analysis in historical geography, they remained neglected as sources, a sentiment that was expressed again four decades later by Roper

³⁸ A cotton tale 200 years of Catrine and Sorn Parish, 1987. Records of James Finlay & Co, Catrine, Deanston, production records. University of Glasgow Archives & Special Collections. GB 248 UGD 091/1/5/2/8/5.

(2003) in an article titled bluntly *Historical Mapping is Still Under-valued and Under-used*. Even now the systematic study of maps, including those of the OS, is arguably underutilised (Hosseini *et al.*, 2021) leaving a methodological gap that this study contributes to reducing. The previous section of this chapter described the use of four map series from the OS used to produce a large dataset of mill locations and characteristics in Scotland. Supplementary map images, mostly provided by the NLS digital and physical collections, directly feature or were used to inform this thesis ranging from estate maps to bathymetrical surveys and engineering plans.

The combination of text and images within maps set them apart from other sources, and the user must read them ‘according to a specific visual grammar’ (Hosseini *et al.*, 2021: 285). Furthermore, maps are recognised as socially constructed portrayals of incomplete, situated knowledges that cannot be assumed objective or accurate (Pinder, 2003: 172). The historical context within which a map was created and used, needs to be considered just as one would for any other historical source (Hosseini *et al.*, 2021). In the case of OS maps, Ordnance Survey formed in 1791 in response to the military’s need for reliable maps covering areas at threat from rebellion or attack, later evolving into an independent government department. Its remit expanded by the mid-nineteenth century to include mapping for the purpose of civil engineering works and infrastructure planning. Following the methodology applied to Ireland in the 1820s, a full trigonometric survey of mainland Britain began in the 1850s including triangulation and the systematic recording of placenames in ‘name books’ (McMaster, 1991). Surveying commenced at the scale of Six-Inches to the mile but a dispute in Parliament, known as the Battle of the Scales, interrupted the process, with an agreement reached after twelve years that a scale of 25 inches to the mile should be used for representing cultivated areas (Wilson, 1891; Harley, 1964). Six Scottish counties had already been completed by this time which partly explains why less of Scotland was mapped at the larger scale compared to England and Wales. The physical geography of the country accounts for the remaining gaps – mountainous and moorland areas of the Highlands were left at Six-Inches. Detailed instructions for the OS surveyors do not survive for the nineteenth century but their working practices can be inferred from the maps. Not all symbols can be clearly identified from the OS Characteristics Sheets (NLS, 2025c), keys, and legends. Therefore, for certain features, we must rely heavily on the map’s text to draw out meaning (Southall *et al.*, 2017). Despite some contemporary criticism over the nature of recording of certain types of sites (Davidson, 1987), the overall accuracy of early OS maps is thought highly reliable and any errors in

surveying or due to map projection are unlikely to be problematic for most historical research (Oliver, 2013).

The repeated revisions and new editions published by the OS, conducted for the whole of Scotland, allow the creation of a dataset covering multiple time intervals. This permits you to view mapped changes in the landscape and built environment over time (Frajer and Geletič, 2011). However, another difficulty faced when using historic OS maps at the country scale relates to the different survey dates (Appendix 3). Even within a county, surveying was conducted over many years. Aberdeenshire for example, was surveyed for the 1st edition mapping across seven years from 1864 to 1871. Wigtownshire began in 1843 and despite taking four years, finishing in 1847, was still completed 31 years before Orkney was begun in 1877 (finishing in 1878). So, when the data in the following chapters is referred to as ‘c.1850’ for the 1st edition and ‘c.1900’ for the second edition it in fact represents a much broader time scale with data from the earliest mapped counties potentially being outdated and incorrect by the time the others were finished.

The benefit of OS maps for identifying mills has been recognised by others but used on a smaller scale. Scott (2022) used the OS Six-Inch 1st and 2nd edition maps as well as the Canmore website to identify latter nineteenth-century mills and dye works in a local study of the woollen industry in the Scottish Borders region. *The Historical Journeys along British Rivers* project by Tom and Alastair Robertson (n.d.) compiled mill data by working systematically through 16 Scottish river catchments on the OS Six-Inch to the mile 1st edition mapping, starting at the main channel and going upstream, recording mills along the river and its tributaries. Use of slightly different methodologies such as these for locating mill sites will produce different results. For the given catchments, the results of the Robertson project display a good correlation with the data presented in Chapter 4 of this thesis. However, Robertson’s systematic methodology was able to record some mills that had closed prior to the OS 1st edition mapping as well as numerous threshing mills not identified in the Scottish water mills project.

3.3.5 Ordnance Survey Name Books

The Ordnance Survey Name Books, known as ‘original object name books’ emerged unexpectedly as a key source for the project. The OSNB contain the surveyors’ notes

regarding names and places depicted on the 1st edition Six-Inch map sheets. They include human made objects (*e.g.* buildings, settlements, bridges, canals) as well as notable natural features (*e.g.* hills, rivers), and archaeological sites (Williamson, 2021: 44). Many of the OSNB for England and Wales were destroyed by an air raid in 1940 but fortunately, the majority of the records for Scotland survived and have been digitised (Davidson, 1987).³⁹

The names and descriptions recorded were collected by the surveyors, who received their intelligence from local residents. Reverends, local proprietors, and school masters were deemed the most reliable authorities. These verbal sources were complimented by written ones in the form of the *New Statistical Account*, gazetteers and valuation rolls, and less conventional sources such as inn sign boards (Williamson, 2015). Occupiers of a property were consulted on occasion but the preference to use the knowledge of certain demographics may well have missed traditional or local names and other valuable information about a place. As with the drawing of the maps themselves, there was regional variation in the level of detail recorded. The adjacent Overhall and Tweedie Mills in Stonehouse, Lanarkshire, illustrate this.⁴⁰ The surveyor recorded Overhall's motive power, the source of the water, an indication that improvements were being carried out, details of the infrastructure (the lade), and the number of workers. Whereas all we learn of Tweedie Mill is that it was in use, the type of grain produced, and the owner's name. When a place was listed more than once, either in the same or different parishes if it was near the boundary, they could receive a more detailed entry in one book than another.

A barrier to use of the Name Books is the lack of consistency in arrangement of the books beyond the county level. Some counties were organised according to parish, others include several parishes within the same volume, or a parish can also be split across volumes (Williamson, 2021). Resultingly, locating a feature from the map in the corresponding name book, does not guarantee a nearby feature would also be recorded on the same or following pages making it harder to locate mills without unique names. That said, aside from the value of the additional textual records, the name books enabled a deeper understanding of the OS maps. Finding discrepancies between, for example, what appeared on the map to be a working watermill to in fact be disused, merely using 'Mill' as a placename, reminded me of

³⁹ The digitised images and crowdsourced partial transcriptions of the text can currently be searched and viewed at the Scotland's People website under 'Virtual Volumes' (<https://www.scotlandspeople.gov.uk/>).

⁴⁰ OS Name Books - Lanarkshire - Volume 55 - 1858-1861, OS1/21/55: 14.

the need to be critical and not automatically use the maps at face value. While it would have been much faster to create the dataset using the map images alone, the OSNB were essential meta-data as much as a source in their own right.

3.3.6 Statistical Accounts of Scotland

Said to be the ‘most frequently quoted of all Scottish historical sources’ (Mitchison, 2015: n.p.) it would be difficult to not use the *Statistical Accounts of Scotland* in a study of industry in eighteenth- and nineteenth-century Scotland. Data extracted from the *Accounts* has been used quantitatively (Vint, 2018) and qualitatively (Anton, 1958) for the study of topics from migration (Watson, 2004), to wages (Bowley, 1900; Morgan, 1971), education (Anderson, 1983), agricultural practices (Carlyle, 1979) specific industries such as chemicals (Clow, 1945), and wool dying (Burnett *et al.*, 2003), to name a handful of examples. The development of the *Statistical Accounts of Scotland 1791 – 1845 Online Service* (University of Edinburgh Library, 2024a) has been an invaluable resource, providing remote and fee free access to scanned pages covering all 938 of Scotland’s parishes. The accounts for the parishes in which each of my case study mills were located were read to provide background knowledge on the physical geography and the local economy of the area.

The account now referred to as the *Old Statistical Account (OSA)* was conceived in the wake of Alexander Webster’s census of Scotland (1755) when the ideology of improvement was rife (Plackett, 1986). Spearheaded by Sinclair, a landowner from Caithness, and the first President of the Board of Agriculture, the *OSA* was published in 21 volumes between 1791 and 1799. Sinclair, himself a lay member of the General Church of Scotland, deemed parish ministers to be the most appropriate source of information for a survey such as this. Each parish minister across Scotland was written to with 171 questions, requesting both descriptive and quantitative data for the parish. Some ministers were unkeen to co-operate in the endeavour so supplementary reports from surveyors had to be paid for by Sinclair (University of Edinburgh Library, 2024b).

The second or *New Statistical Account (NSA)* followed in 1845 and then in 1951–1992 the *Third Statistical Account*, both undertaken separately from the *OSA* and Sinclair. The *NSA* was published by Messrs Blackwood of Edinburgh primarily as a means of generating income for The Society for the Benefit of the Sons of the Clergy of the Church of Scotland

though it still retained the objective of gathering and sharing knowledge that might result in ‘improvement’ (Hill, 2017). The questions asked by the *OSA* and *NSA* were much the same, covering geography, natural history, population, industry, and miscellaneous topics.

The purpose of the accounts as tools for ‘improvement’ and an exercise of science and data gathering will have guided the questions and the responses received. The choice of clergymen as experts must also be considered critically. Ministers were arguably a sensible source in certain ways: they were familiar with the area since they resided there at that moment in time and would know the character of the parishioners that frequented their churches. But their position in the parish did not guarantee knowledge of all areas and this is reflected in the variable quality and length of answers. Relying on the clergy created a top-down telling of local history (Tiller, 2020: 15) and unobjective moralising judgements frequently find their way into the descriptions of residents, similar to views of the middle and upper classes of society regarding the character of the poor, that appear in other contemporary sources.

3.3.7 Digitised newspapers

Searches were conducted across two digital multi-title newspaper databases hosted online by Gale Centage. Searches were limited to the *Burney Collection* and the *British Library Nineteenth Century* newspapers because of the sheer number of results returned from these databases alone. An understanding of the historical and cultural context was important for keyword searching (DiCenzo, 2015). Through trial and error, search terms were refined to return a manageable number of results (Appendix 4). Gale’s search function returns results as a list including a small image of the newspaper page, the title of the section in which the search term was found, the name of the publication and location, the date, volume, page number, and entry type *e.g.* article or advertisement. You can also view a ‘keyword preview’ for a zoomed in image of the key word that was searched. Results were most commonly from the advertisements section when a mill was up for sale or advertising products for sale – indicating what a mill made and the geographical range of their market. News pieces recounted fatal accidents, weather events, and biographical pieces on socially prominent mill entrepreneurs. The other area where newspapers were important were the summaries given of the evidence around the approval of private bills, including the debates between committees which were required before the implementation of large scale infrastructure projects like railway construction or municipal water supplies.

Use of digital archives is limited by accuracy of software and completeness of collections. OCR software allows a digital image to be turned into searchable text transcript. Its accuracy is highly dependent on the quality of the physical item that has been digitised. OCR technology struggles significantly with certain typefaces, especially those used in the eighteenth century, text that is too close together, faded text, text with variability in formatting, when scanned pages were not flat, and from images produced from microfilm rather than original paper copies (Mussell, 2008; King *et al.*, 2016). OCR accuracy for *British Library Nineteenth Century* and *Burney Collections* respectively is just for 83.6% and 75.6% for characters or 68.4% and 48.4% for ‘significant words’⁴¹ (Tanner *et al.*, 2009). The inaccuracy of the technology was evident in my research when, for example, researching the Balnoe Linen Company in the British Library newspaper archives, a search for ‘Balnoe Company’ returned just two results, both advertisements in the *Caledonian Mercury* in May 1800, reporting the dissolution of the Company. A more general search for ‘Balnoe’ returned 149 items but the OCR software had incorrectly identified and highlighted words such as ‘balance’, ‘Baines’ or ‘James Blackmore’ in place of the ‘Balnoe’. This search did return another hit for the *Caledonian Mercury* advert, from 3rd April 1800. Despite the advertisement containing identical text and formatting in all three instances, the OCR did not pick up the word Company in the April publication. An important consideration is that the use of digital newspapers for this project was inevitably influenced by the decisions of archivists and institutions regarding which titles to digitise. A decision making process that is not always transparent for the researcher and can be influenced by commercial demand for access to the resource (Brake, 2012). However, these issues of what to collect and keep exist with physical archives too.

3.4 COVID-19 Pandemic

Lorimer (2009) reflected that methods often take on an opportunistic, dynamic form, and are adapted as circumstances change. Methods morph through iterations and may have to ‘make-do’ (Lorimer, 2009: 258). This was very much the case for this thesis, initially envisioned as an archive-based study in theory and a multi-methods project in practice, bringing together several approaches from across the field of historical geography. Some of the directions taken

⁴¹ The authors defined significant words as ‘content words for which users might be interested in searching excluding stop-listed words, such as “the”, “he”, “it”, etc.’ (Tanner *et al.*, 2009, n.p.).

were in part pragmatic. A doctorate has restraints on time, and funding, and this thesis was affected by the unexpected and entirely unpredictable disruption of the global COVID-19 pandemic. It would be impossible to discuss the methodology without acknowledging the impact that 16 months of national/local restrictions on movement and in-person interactions, including but not withstanding three periods of national lockdown between March 2020 and July 2021, had on the project. Beyond the general disruption and adaptation to different ways of living and working, there were specific changes that had to be made to the thesis in response to the dynamic situation.

The *Scottish water mills website* was originally envisioned as a standalone project. In response to uncertainty surrounding the easing of travel restrictions and the reopening of libraries and archives, it was proposed that the database being created should be incorporated into the PhD, testing a new methodology for the identification of mill sites on a national scale. Following discussions and the approval of my supervisors at UofG, NLS, and HES, the placement was extended from three to six months and the focus adjusted to prioritise the recording of mills.⁴² Substantial additional work to the dataset was done outside of the placement including the editing and cleaning processes of the database described earlier. Over 1,000 extra mill sites were checked and analysed so the dataset covered the entirety of Scotland because the placement length was insufficient to finish all the counties. This was important since extrapolating data from a subset of finished counties would not be suitable for mills given Scotland's diverse geomorphology and unevenly distributed population. These were important considerations since the literature suggested known links between geographical endowment and watermill location.

A national scale dataset was not in the original research design for this thesis. I originally planned to focus on a sample of counties, aligned to the case study locations, and use maps from other makers to complement the data from the OS map series including county maps, estate maps, and town plans and views, many of which needed to be viewed in person at map libraries. Eventually it was decided the project needed to be able to be completed fully online from my home during the periods of strictest controls on movement, so the decision was taken to use only the OS maps. This change resulted in the loss of a broader temporal aspect

⁴² A second phase working with HES to improve the Canmore database was initially envisioned. This component became unfeasible under the restrictions of the pandemic.

to the dataset. The OS maps begin in the mid-nineteenth century when much of the literature suggested that the transition from water- to steam-power, as well as industrialisation of towns, and adoption of the factory system of work had already taken place, so a key period of change is missed. On the other hand, focussing on c.1850 until the early-1900s covers a period less discussed in the existing literature on Scottish milling, Shaw's *Water power in Scotland* (1984) for example, ends in 1870. Other projects have begun to do similar work, using the increasingly digitised map collections mentioned. Tara Jonell's *Mills of Britain* (2024), informed by the methodology of the *Scottish water mills website*, incorporated mill data from early county maps, and the Roy Military Survey of Scotland map and gazetteer.

I originally had bigger ambitions for the project's archival work. Some of my chosen case studies would have been included regardless of the pandemic but would have been supplemented by others and materials from other archival collections. Hoping to place greater focus on the narrative of the transition from water to steam, I intended to include an early adopter of steam within my case studies, where the most likely candidate(s) would have been one or more of Dundee's mills. A brief trip to the University of Dundee archives early in March 2020 was intended as a scoping exercise of both the collections and the industrial archaeology of the city. Further visits were not possible, and I did not have sufficient data to build a case study. The visit was nonetheless beneficial, equipping me with greater knowledge of the mill landscape in the East of Scotland including an appreciation of the scale and architecture of steam-powered textile mills.

Archival sources for Spinningdale were limited but I would ideally have consulted the Highland Archives (estate papers and plans) and NLS (estate papers) to supplement secondary literature and digitised sources had this been possible. Meanwhile, archive collections for New Lanark are held across 13 UK repositories and there are further related collections such those held in the Lanark Search Room, part of the New Lanark visitor centre. On a site visit with my supervisor in March 2020, I had the opportunity to discuss my project with Helen Martin, Collections and Exhibitions Officer of New Lanark Trust, who offered to reach out to me with relevant materials. However, due to the national lockdown two weeks later, the Trust staff were moved to remote working conditions with no access to the offline materials held in the archives. When I returned to my research in October of 2021 following a leave of absence to undertake an internship, the nationally imposed COVID-19 restrictions had lifted, therefore I expected research facilities to have resumed normal work, but this was

not the case. The inclusion of Rothesay was in part due to the luck of being granted access to the archives one week prior to their closure for the winter, where I was the first researcher to be permitted a personal visit to the archives since the pandemic began.

Overabundance of material is a common double-edged sword (Hodder, 2017: 454) and it is hard as a researcher to not fear that you have missed something important in the materials you did not view. However, assessing every repository, or even every record within a single collection, would never have been possible, even without disruptions. I was lucky to have collected abundant relevant material in my time at the archives combined with the enormous fortune that the majority of supplementary contemporary sources (sections 3.3–3.7) had been digitised. As Harris noted, ‘it is easy enough to be taken over by the archives, to attempt to read and record all their relevant information’ (2001: 331). The inability to travel and see further material allowed me to process and reflect on the insights that could be derived from the data I already had available to me. This was a valuable learning process to stop chasing an impossible goal of knowing everything. Although it would be inaccurate to describe the pandemic as less than an enormous challenge in many ways to the thesis and to life during the impacted years, this does not mean the methodology and the project has been inadequate. Compromises were at times necessary. However, the restrictions imposed by the pandemic encouraged a responsive and more imaginative attitude to the methods and reasoning than might otherwise have been employed. While the archival work of the project had to be reduced, the final result is a more novel combination of two very different approaches to the study of Scotland’s mills that can reaffirm knowledge while bringing new insights to each approach and, more broadly, Scottish milling.

3.5 Conclusion

This chapter has outlined the research design of this thesis and the cross-disciplinary approach taken to achieve its aims. The context of undertaking a CDA project that faced significant disruption resulting from the COVID-19 pandemic and the necessary adaptations that entailed have been explained. The reader should now have sufficient understanding of the methodology and sources that underpin the data presented, and the synthesis of the resulting themes, in the following three chapters.

The next chapter will show the results of the HGIS component of the thesis. This first empirical chapter will present the data while simultaneously providing a critique on the methodology. So as not to disrupt the flow of text or overload the reader with images, not all of the maps produced during analysis are presented in the chapter. Those that have been incorporated within the main body of the thesis were selected because they were most appropriate for illustrating the point at hand, whether that might be with a simple point map or a more complex image overlaying different data. A full database of maps displaying mills according to motive power, industrial function, and time (1850s, 1990s, cumulative) is located in Appendix 5 for reference.

4. Run of the mill: The distribution of mills in Scotland c.1850-1900

4.1 Introduction

This chapter describes the historical geography of mills in Scotland at a national scale, visualising and describing overall patterns and trends that can be observed. Following the methodology detailed in the previous chapter, the data is organised around the dates of the surveying of the 1st and 2nd edition Ordnance Survey Six-Inch to the mile (or 1:10,560) County Series maps. The 1st edition was surveyed between 1843 and 1882 and the 2nd edition from 1892 to 1907.⁴³ Going forward, data associated with the 1st edition mapping may be referred to as ‘1850s’, with the 2nd edition dataset referred to as ‘1900s’. Data that was not associated with either map and not assigned a date in Canmore has been classified as ‘Period Unassigned’ (PU).

First, a general description of the overall distribution of mills will be given, with a discussion of the main characteristics of each region for which Scotland has been divided into the Highlands and northwest, northeast, central, and south regions (Figure 4.1).⁴⁴ Next, the mills are separated by their source of motive power: water (mills with vertical waterwheels, horizontal wheeled mills, and tide mills), windmills, and steam-powered mills. In the final section, industries will be examined in further detail, including textile mills, ahead of the second empirical chapter that will delve in-depth into six case studies from the cotton industry. Some repetition is inevitable in this chapter, though it has been structured to keep this to a minimum. The aim of this work is not to replicate the format of John Shaw’s (1980; 1984) immense work that described and mapped every major industry using waterpower in Scotland and many minor uses from 1550–1870. To this end, the chapter will not deal with a detailed history of every type of mill, instead focusing on examples that prompt interesting questions to explore further in Chapters 5 and 6.⁴⁵ Beginning halfway through what Shaw (1984) termed the ‘Age of Steam’ (1830–1870), and focusing mainly on the mid-nineteenth to early-twentieth century, the chapter aims to provide an overall picture of the state of the

⁴³ See Appendix 3 for survey dates of each historic county.

⁴⁴ This has been done according to geographical location combined with similar traits observed at a highly coarse level. Other divisions could be used such as the modern day Local Authority Regions. More specific descriptions of locations will be given in the later sections on mills types and industry.

⁴⁵ A complete list of all mill products encountered in this research, and the heritage category they have been assigned to, is in Appendix 6.

traditional sectors in the latter period of industrialisation in Scotland. As will be illustrated and discussed, the application of waterpower in Scotland was certainly far from over in the late-eighteenth century. Comparisons with the results of Shaw and others are interwoven throughout the chapter with reflections on the merits and challenges of cataloguing mills using maps and Canmore, a second party database. It should be kept in mind that mills frequently underwent changes to their technology and purpose, such that they could utilise multiple sources of motive power and manufacture more than one product at once. Therefore, the totals given in each section might exceed the total number of mills in the dataset as a whole. For example, a cotton mill that was powered by a vertical waterwheel and a supplementary steam engine would be classified under ‘Textile Mills’ for industry and both ‘Watermills’ and ‘Steam mills’ for motive power.

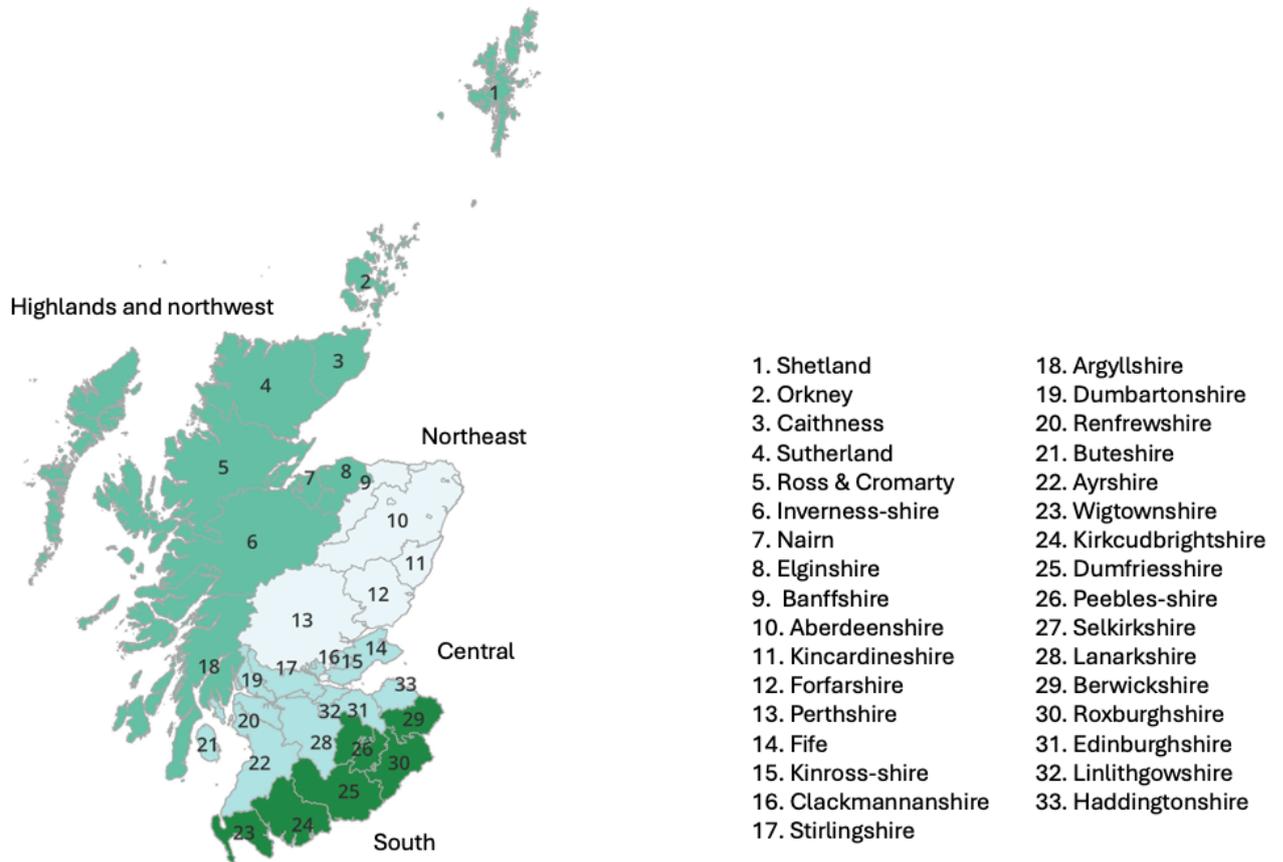


Figure 4. 1. Historic counties and regions of Scotland

4.2 Overall Distribution

Across all time periods, 5,837 mills were recorded in Scotland (Figure 4.2, Table 4.1). As will be discussed throughout this chapter, their distributions are the result of a dependency on both human and natural influences: terrain, hydrological conditions, transport networks, natural resources, and population distribution are all overserved to be determinants of mill locations.



Figure 4. 2. Cumulative distribution of all mills in Scotland (1850s, 1990s, PU).

Table 4. 1. All mills separated by time period

Date	Number of mills
All mills present in 1850	3,698
All mills present in 1900	3,630
Period Unassigned	1,396
Mills only present in 1850	914
Mills only present in 1900	877
Mills present in <i>both</i> 1850 <i>and</i> 1900	2,711

Between the 1850s and 1900s the total number of mills recorded decreased by 68. Just under half (16) of the historic counties experienced a decrease in mill numbers between the two time periods. Surprisingly perhaps, Orkney was one of the counties to experience the opposite phenomenon, seeing a proportionally large increase in its number of mills, with 95 mills present in the 1900s, an increase of 23 mills or 32 % compared to the 1850s, many of them a type of windmill unique to Orkney. Data on changing mill numbers should be approached with caution however, as according to Gauldie (1981: 106–107), from the eighteenth century onwards it was often the case that a single mill with greater capacity would replace two or three older grain mills. This mirrors some of the issues with quantification of steam engines too.⁴⁶ Conversely, increases in numbers could be due to working from the 2nd edition map text.

Out of the four regions of Scotland (defined in Section 4.1), the Highlands and northwest comprise some of the counties with the lowest densities of mills (Figure 4.3). The region includes four of the five largest counties in terms of geographical size (Inverness, Argyll, Ross and Cromarty, and Sutherland), but these same counties had the lowest population densities and rank at the bottom (30–33) for density of mills per km².⁴⁷ Shetland was an exception, having the highest number of mills (633) of all counties in Scotland. This proliferation of mills, mostly small horizontal grain mills, was partially related to customs and the needs of a dispersed population that will be discussed further in section 4.3.1.2. This region was the least diverse in terms of industrial functions – nearly all of the mills with a confirmed function were grain mills although there were also a small number of mills engaged in textiles or sawmilling. Conversely, the full spectrum of industries had located within Scotland’s central region by the time of the 1st OS survey, including less common industries such as a small group of mills working with stone located in Ayrshire, and the growing metal and chemical industries. The number and diversity of mills in this region is accounted for by the location of major centres of population, commerce, and finance in Glasgow and Edinburgh, and the ports at Port Glasgow and Greenock for the import and export of raw materials and finished goods (Price, 1954). All types of fabrics were produced in the central region, although Glasgow (in Lanarkshire) and the neighbouring area of Renfrew was the country’s centre for cotton manufacture.

⁴⁶ See Chapter 2 for a discussion of the problems noted by Kitsikopoulos (2016).

⁴⁷ Appendix 6 contains a table of mill numbers, population, and the size of each county for the 1850s, 1900s, and overall (cumulative).

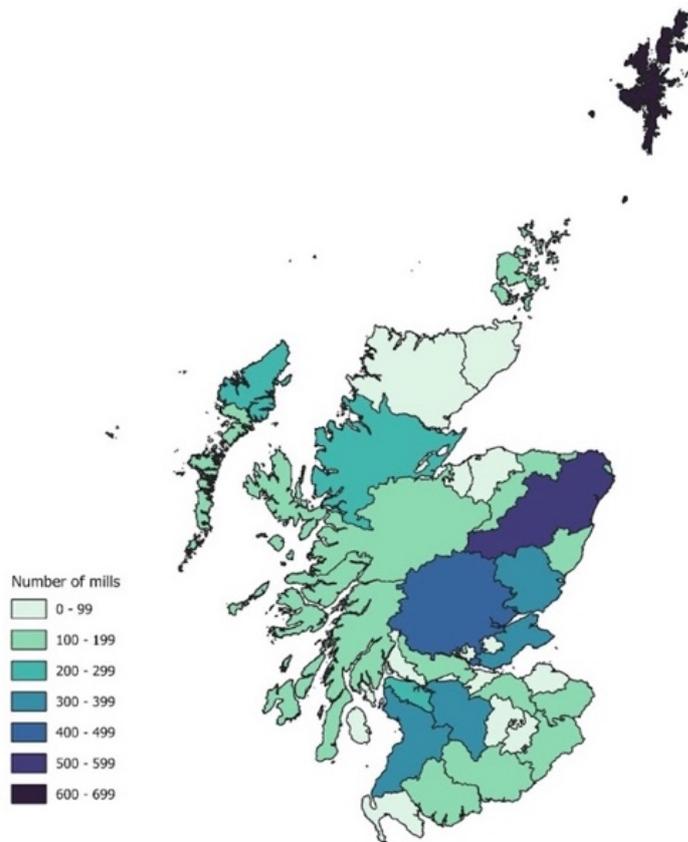


Figure 4. 3. Cumulative number of mills by historic county.

Industrialisation was not limited to the central region – the northeast region developed its own distinct industries including an important regional cluster of the paper making industry in Aberdeenshire (Hills, 1988) and the areas of Forfarshire (now called Angus), Kincardine, north Fife, and the east of Perthshire were considered Scotland’s linen area (Lenman and Donaldson, 1971). Textile bleaching and dyeing, trades dependent on the jute industry, also settled in the northeast. In the south of Scotland, the highest densities of mills were found in Berwickshire and near the border with England. The Borders region of southern Scotland is especially associated with a long tradition of domestic spinning and weaving and woollen mills (Scott, 2022).

Figure 4.4 shows two opposing characteristics of mill distribution in the 1900s: firstly, the map shows clusters of industry near to burghs with larger populations, although caution should be used when interpreting correlations between population and mill numbers since the size of individual mills is unknown. More crucially, what this map also demonstrates is that some, but not all, industry had moved to the towns and cities: there was still a place for the

rural mill across much of Scotland at the start of the twentieth century, even if its relative economic importance was lessening in comparison to its urban counterparts.

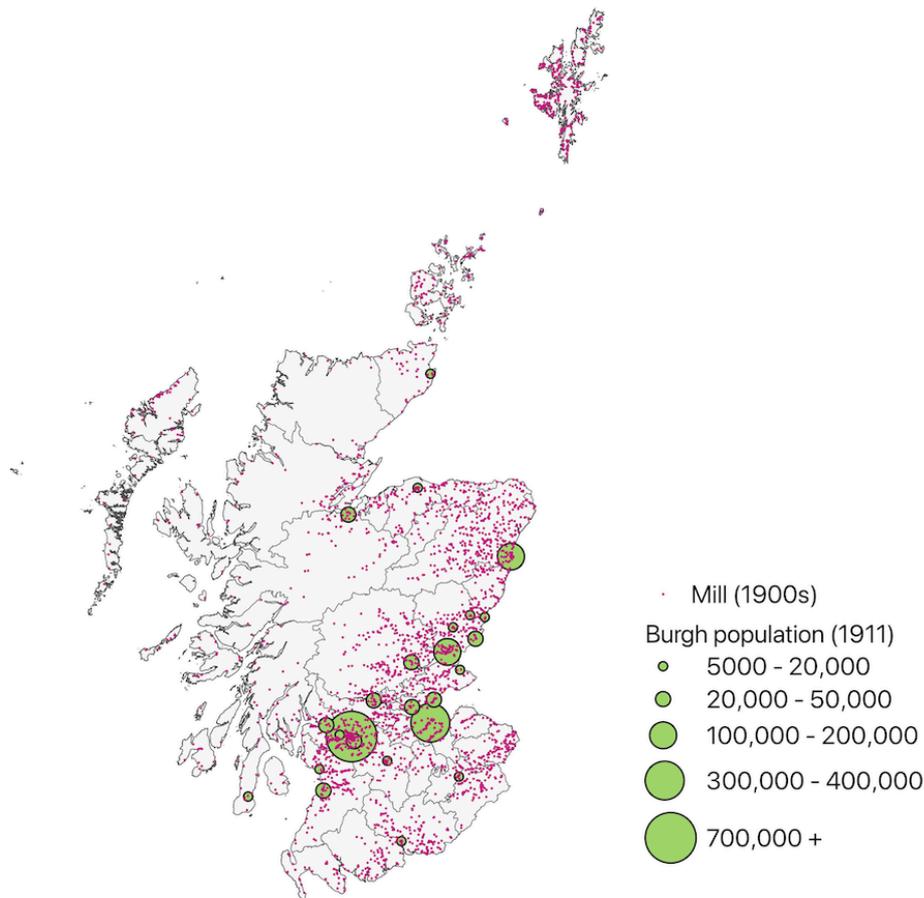


Figure 4. 4. Mills present in c.1900 and Royal and Parliamentary Burghs with a population of over 5,000 people in 1911 (population data from Great Britain Historical GIS Project, 2003-2023b).

The results from this dataset can be compared to that of Bishop and Muñoz-Salinas (2013) who derived their map of 1,050 Scottish mills by using the Ordnance Survey 1:100,000 gazetteer to plot locations with ‘mill’, ‘millton’, ‘milltown’, or ‘miln’ in their name. Even when accounting for the exclusion of Shetland from Bishop and Muñoz-Salinas’ data (where I recorded 633 mills), there remains a discrepancy of over 4,000 mills. Notable absences include the western coastline of Ross and Cromarty, the Isle of Lewis, and the inner Hebrides including Skye.

That said, comparing Bishop and Muñoz-Salinas’ data against maps produced from the combined OS/Canmore dataset (Figure 4.5), the two maps display a similar overall pattern,

Moorfoot Hills area of Edinburghshire.⁴⁹ This mill was not present on either edition of the OS maps and is described as ‘Unlocated’ on its Canmore record suggesting this might be an error. The highest confirmed mill was therefore a watermill on the Invercauld Estate in Aberdeenshire at 456 m, located on the side of the Felagie Burn. As the settlement does not appear on Roy’s map of 1747–55 or the 1st edition OS map, the mill, recorded via a physical survey, is thought to have been functional in the late-eighteenth century and likely abandoned c.1800 after the area was used for sheep farming and the human population resettled.⁵⁰ The other mills above 400 m were: a watermill on a post medieval farmstead at Kirkmichael (Perthshire) at 430 m elevation;⁵¹ another in Kirkmichael parish at 402 m on a tributary of the Allt a’ Ghlinne Bhig, thought to be a horizontal mill;⁵² and a washing mill for lead ore in the mining fields of Leadhills marked as disused in 1896 on the 2nd edition of the OS map and not depicted at all on the 1st edition map of 1858.⁵³ These mills at especially high elevations were located in the northeast in areas that experienced past glaciation (Jenkins, 1985). The general lack of mills at elevations greater than 250 m mirrors settlement patterns and presumably also the upper limit of where grain was historically cultivated (Bishop and Muñoz-Salinas, 2013). Jonell *et al.* (2024: 3) refer to a conceptual ‘Mill Line’ (derived from evidence for arable/grazing land) at approximately 300 m asl in Britain above which topographic, historic land-use/ land-cover, hydrological, and settlement conditions were ‘severely disadvantageous’ for historic mills.

⁴⁹ NRHE ID: 211523 (Arniston, Joseph's Mill).

⁵⁰ NRHE ID: 273001 (Braemar, Balloch).

⁵¹ NRHE ID: 29611 (Gleann Beag, Cro Na H-Airighe).

⁵² NRHE ID: 29596 (Gleann Beag)

⁵³ Ordnance Survey, 25 Inch to the mile, Lanarkshire XLIX.3 (Revised: 1896, Published: 1897). View online: <https://maps.nls.uk/view/82895037>. Reproduced courtesy of the National Library of Scotland; Ordnance Survey, 25 Inch to the mile, Lanarkshire XLIX.3 (Crawford) (Surveyed: 1858, Published 1861). View online: <https://maps.nls.uk/view/74953901>. Reproduced courtesy of the National Library of Scotland.

Table 4. 2. Elevation of mills

Metres above sea level	No. of mills
0 to <50	3,101
50 to <100	1,283
100 to < 150	729
150 to < 200	371
200 to < 250	243
250 to < 300	55
300 to < 350	38
350 to < 400	12
400 to < 450	3
450 to < 500	2

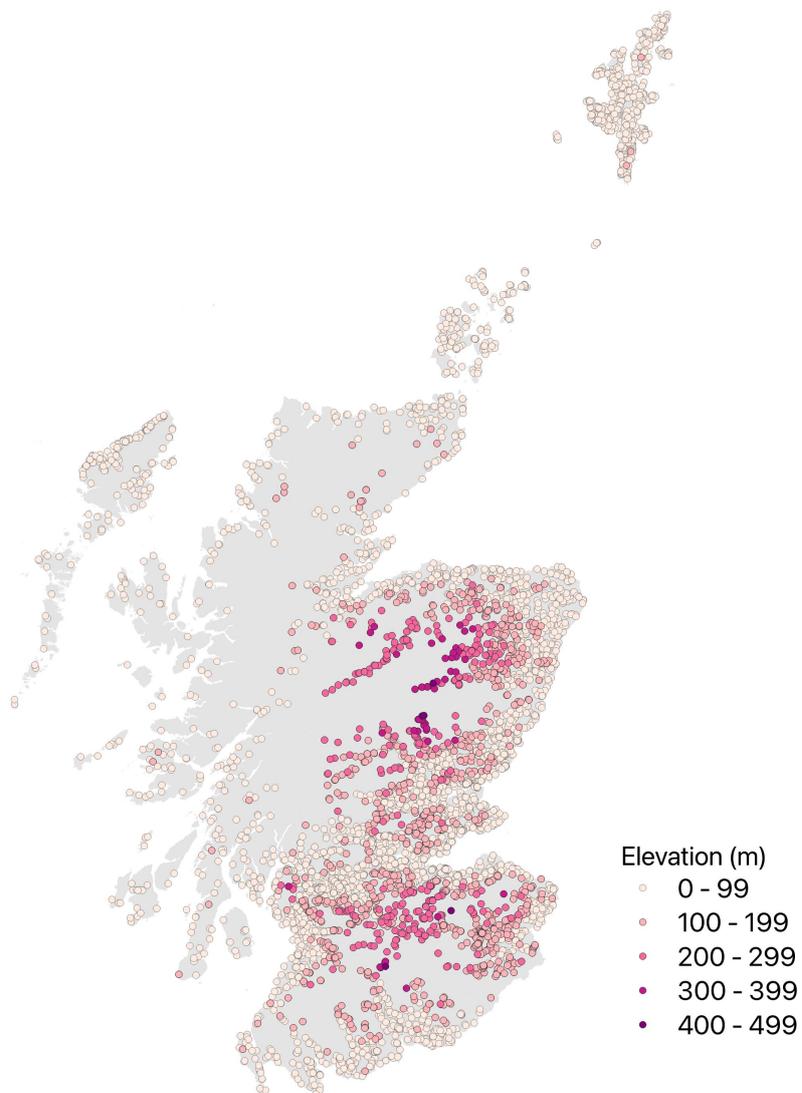


Figure 4. 6. Elevation of mills in metres.

4.3 Motive Power

The three sources of motive power recorded by this dataset that will be considered in this chapter were water, wind, and steam (Table 4.3). A power source was determined for all but 1,734 of the recorded mills. Watermills have been separated into those with a vertical waterwheel and those that used horizontal waterwheels. A third category considers the geography of watermills that utilised the flow of the tide rather than that from a river. Of the 4,103 mills for which a motive power was identified, 88% utilised waterpower. The data suggests wind and steam mills were present in similar numbers to one another: 7% (284) and 6% (247), respectively. However, underestimation of steam power use in mills is likely and will be discussed shortly.

Table 4. 3. Motive power of mills.⁵⁴

Motive power	Total number of mills
Watermills	3,630
Windmills	284
Steam mills	247
Unknown	1,734

A final category of waterpower that this dataset does not capture, but still forms an important element of the story of changing power use in Scotland, is that of the introduction of water turbines that began in the late-nineteenth century. For example, Alexander Pirie and Son's Aberdeen paper mill supplemented their waterwheel with two condensing steam engines and three Hercules turbines in the 1880s (Bartlett, 1980: 28) and as will be discussed in the following chapter, the technology was embraced by major cotton mills including Deanston where turbines were installed c.1900 to power the gas works and c.1940s for the textile mills. For each type of mill, in addition to mapping and describing their distributions, a short overview of the technology will be given, and illustrated descriptions of the characteristics typically found in Scotland based on observations collected from interpreting the OS maps.

4.3.1 Waterpower

Within Scotland, 3,637 watermills in total were identified (Table 4.4, Figure 4.7). Watermills were ubiquitous across Scotland and correspondingly, when mapped, their distribution is

⁵⁴ The total may exceed the overall number of mills because mill sites that changed their power source over time *e.g.* a vertical mill constructed at the site of an earlier horizontal mill, are counted more than once.

nearly identical to that of the full mill dataset displayed in Figure 4.2. In the 1850s, 2,968 watermills were present. From those, 764 mills (26%) closed prior to the 1900s but 2,204 continued as operating mills (either as the same mill or with a new mill on the same site) into the 1900s. The majority of these remained watermills although five were recorded as having switched to steam power and the power source was no longer discernible for 72 of the mills. From the 1900s maps, 213 watermills were not evident on the 1850s maps, suggesting they were new enterprises, established between the OS survey dates. Canmore recorded a further 577 watermills that most likely all pre-date the OS maps. The vast majority of these were what can be considered the ‘typical’ Scottish watermill – with a vertical waterwheel and gearing to provide motive power and water directed to the wheel in a flowing motion from a river or pond, rather than the rise and fall of the tide. A large portion of this section will be dedicated to describing two subcategories of watermill that make up a small percentage of the total mill numbers: the horizontal watermill typical of the Northern Isles and Outer Hebrides, and tide mills which could utilise a horizontal wheel but had an even more restricted geography. This is not because the vertical wheel mill located on non-tidal rivers is of less interest or importance to the historical geography of Scotland. Rather, their ubiquitousness means that the vertical wheeled watermill was the standard in Scotland, transcending all the regions and industries that receive attention elsewhere in this chapter.

Table 4. 4. Number of watermills of each type divided by date and total numbers.⁵⁵

Water Type	Date			Total
	1850s	1900s	PU	
Horizontal	339	225	199	542
Vertical	2,672	2,225	374	3,144
Tide	1	1	4	5

⁵⁵ The total may exceed the overall number of mills because mill sites that changed their power source over time *e.g.* a vertical mill constructed at the site of an earlier horizontal mill, are counted more than once.

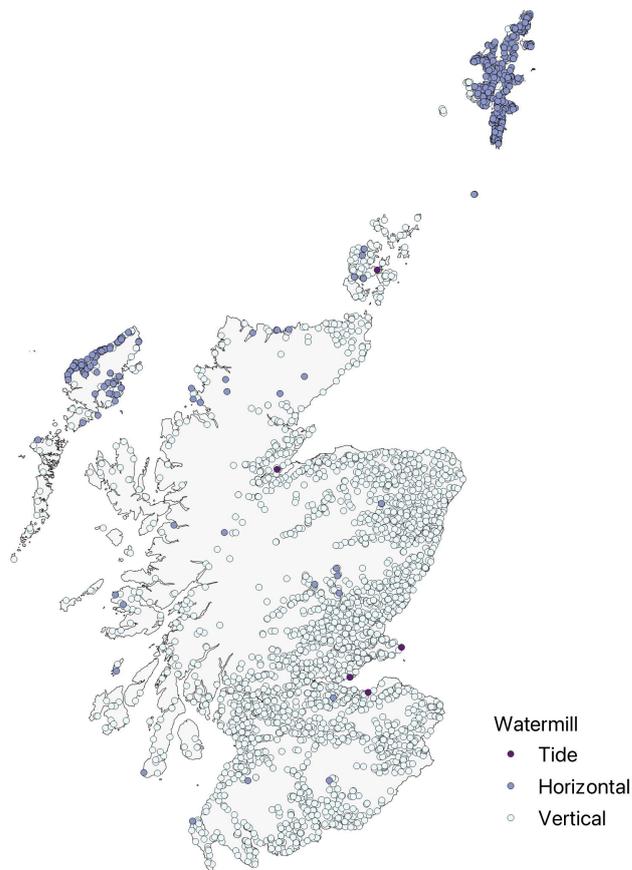


Figure 4. 7. Cumulative distribution of watermills according to whether they were horizontal, vertical, or tidal mills.

4.3.1.1 Vertical Watermills

The precise genealogy and date of first use of the vertical watermill is uncertain. Globally, the earliest artefactual evidence for a vertical wheel dates to the 1st century B.C. in Italy, while in Britain, archaeological remains of Roman water-powered mills have been found in England belonging to the 2nd or 3rd century A.D. (Reynolds, 1983: 18–41). In the earliest watermills, which were all grain mills, a shaft connected the waterwheel to a horizontal axle and series of gears that then drove a millstone in a rotating motion, grinding the grain. There are three common types of vertical waterwheel (Figure 4.8), named according to the location the water makes contact with the wheel (Howard, 1983; Lucas, 2006: 30). The overshot wheel uses the mass of the water to turn the wheel. Water reaches the overshot wheel at its top, filling buckets with water, gravity pulls down the buckets, and the wheel is driven round. Usually, water will be diverted from the river to the wheel's top via a lade or aqueduct. A channel called a tail race (or tail lade) returned the water to the stream after it passed the

waterwheel.⁵⁶ A slight variant to the overshot wheel is the pitchback, where the wheel rotates instead in the same direction as the tailrace which reduces backwatering.⁵⁷ Undershot wheels use the force or impulse of the water hitting the paddles or blades of the wheel to turn it. The breastshot wheel functions as a hybrid of the other two designs. Water strikes the breastshot wheel at its middle, so both the force of the movement of the water, and the weight of it falling are used.⁵⁸ Overshot and breastshot were the most commonly used wheel types. Overshot wheels are generally considered to be the most efficient variety however they require more complex, and therefore usually more expensive, engineering in their construction. Operation of a watermill can never be 100% efficient because it will experience loss of mass/flow of water from splashing or leaking and loss of the energy held by water due to friction.

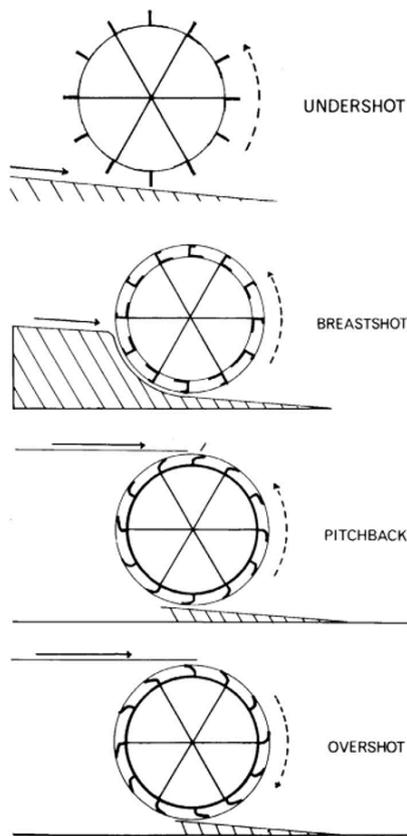


Figure 4. 8. Types of vertical water wheel (Bishop and Muñoz-Salinas, 2013: 197).

⁵⁶ It was possible for a downstream mill to power their wheel from the tailrace of an upstream mill. For example, East Mill on the River Eden used tail water of Strathmiglo Bleachfield (Jespersen, 1966: 240).

⁵⁷ Sometimes also referred to as a backshot wheel, balancer wheel, or high breastshot wheel, the latter because it shares the same direction of movement as the breastshot wheel (Mills Archive Trust, 2025b).

⁵⁸ The superior efficiency of the overshot waterwheel was demonstrated by multiple European engineers, mathematicians, and physicists in the 1750s, including British engineer John Smeaton (Reynolds, 1979: 270).

The type of wheel used should depend on the characteristics of the river, the landscape, or the potential resources available to divert the water. Nominal head or head of water is the term used to describe the difference between the water level of the channel delivering water to the wheel, and the level of water when it is discharged (Jonell *et al.*, 2024). An overshot wheel requires a larger head compared to a breastshot or undershot wheel, so in mountainous areas for example, an overshot wheel could normally be used (Ferguson, 2005).⁵⁹ Undershot wheels on the other hand are best suited to sites with very low heads of water. Having said this, cultural traditions and preferences have sometimes played a greater role than technical knowledge of efficiency when choosing a wheel type (Howard, 1983). In this chapter all vertical wheels are classed as one because this study did not distinguish between overshot, breastshot, or undershot wheels on OS maps. Even when a wheel was depicted on the maps there was insufficient detail to identify the height at which the water reached the wheel (shown previously in Figure 3.4).

Mill landscape and infrastructure

To operate, a watermill generally required more than a wheel, mill building, and the machinery. A mill landscape consisting of weirs, sluice gates, ponds, lades, and tail-races had to be constructed to support the consistent running of the mill (Figure 4.9). Weirs, also often referred to in contemporary sources and the OS maps as dams (also sometimes a caul in Scotland), were placed across riverbeds to raise the water level, increasing the head of water at the point where it was diverted to the mill. Where the dam was placed adjacent to a reservoir, a mill pond (referred to often interchangeably as a mill dam) was formed to retain water for use when water levels were lower such as periods of drought. Mill dams/ponds could be artificially constructed or use an existing body of water. The Walk Mill corn mill in Kinross for example (Figure 4.10) held water from the Craigow Burn in a disused quarry repurposed as a dam. Two channels left the dam, one using a sluice to direct water to the mill wheel as and when required. A substantially sized dam such as this would provide a reserve capable of supplying multiple mills, either as a more regular supply during the day or a strategic reserve during dry periods. The overflow channel reduced the probability of

⁵⁹ The suggested minimum head of water for an overshot wheel varies between sources. Howard (1983: 27) for instance, states that a head of at least 3.7 m is required whereas Reynolds (1983: 11) gives a range of 3–12 m. Müller and Kauppert (2002: 179) suggest a head of 2–7 m is suitable for an overshot wheel and 1–2 m for an undershot wheel.

flooding. If the amount of water available was not sufficient to meet the needs of a mill, dams could be enlarged to increase capacity, as will be seen in multiple instances in Chapter 5.



Figure 4. 9. Mill landscape on the River Kelvin in Glasgow. A weir (a) was constructed across the river. A sluice gate (b) controlled intake of water from the river into the lade (c) that delivered water to a wheel at the North Woodside Flint Mills (d).⁶⁰ A short tail race returned water to the natural river channel (e). Closed in the late-1950s this was the last functioning watermill in Glasgow.⁶¹

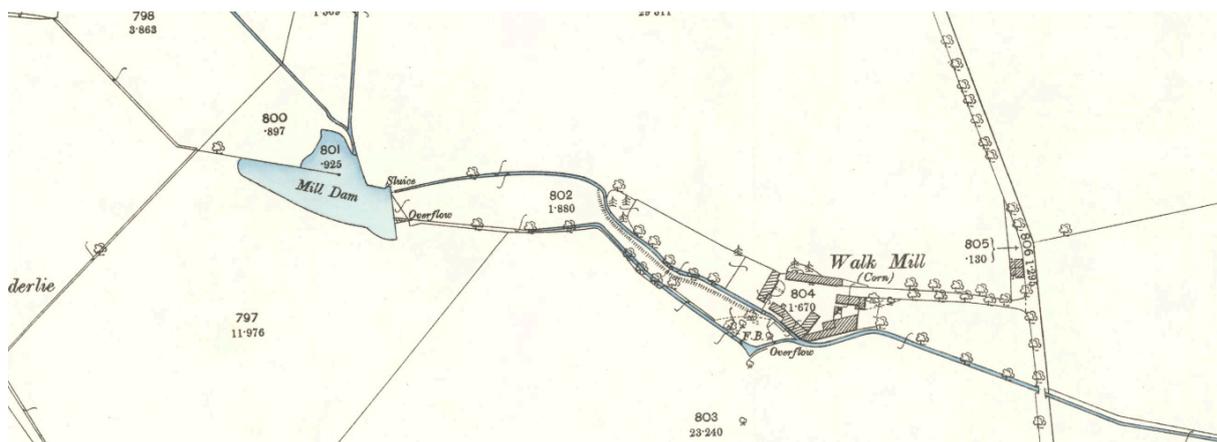


Figure 4. 10. Walk Mill c.1895.⁶²

⁶⁰ Ordnance Survey, 25 Inch to the mile, Lanarkshire VI.6 (Govan) (Surveyed: 1857 to 1858, Published: 1860). View online: <https://maps.nls.uk/view/74955250>. Reproduced courtesy of the National Library of Scotland.

⁶¹ NRHE ID: 44016 (Glasgow, 125 Garriochmill Road, North Woodside Flint Mill).

⁶² Ordnance Survey, 25 Inch to the mile, Kinross-shire XVIII.9 (Revised: 1895, Published: 1896). View online: <https://maps.nls.uk/view/82888470>. Reproduced courtesy of the National Library of Scotland.

Unless a mill was built directly upon the banks of the river, water needed to be conveyed to the wheel along a conduit known as a lade (Figure 4.11).⁶³ As was explained in the literature review (2.2), in part because of the abundance of natural knickpoints, Bishop and Muñoz-Salinas (2013) suggest that Scottish mills were less reliant on dams for storage and that dams were generally smaller, and often more akin to weirs (Figure 4.12). They found that shorter lades were equally preferable because as water passes through a lade energy is lost to friction with the lining of the channel, reducing the maximum potential efficiency of the waterpower system (Paton and Brown, 1960: 24). While this conclusion may hold true for many of the country's smaller mills, there are numerous examples of lades that were impressive feats of engineering in themselves (Figure 4.13). Like weirs, lades could be incredibly difficult and expensive to construct, costing the proprietor thousands of pounds in initial costs and maintenance. Lades could be cut into the earth and lined with stones or concrete or placed at or above ground level like an aqueduct. They were either left exposed or piped and could run through or underneath buildings when required. Some lades were metres wide, similar to small canals, requiring retaining walls and embankments to ensure their stability (Fairbairn and Pole, 1877: 87). The length of a lade was not proportional to the distance of the mill from the river. The lade began at the point from which the proprietor wanted to draw water – sometimes a knickpoint or weir, and the lade then frequently, though not always, ran along the contour of the main river channel.

⁶³ As was noted in Chapter 3, the terminology used varied regionally and temporally. For instance, at Bervie in Kincardineshire, the OS map used 'mill lead' on the 1st edition and 'mill lade' on the 2nd edition. In Roxburgh there is an example of 'mill stream'. Other contemporary references also refer to mill leats or conduits.



Figure 4. 11. Examples of mill lades. From left to right: exposed lades at Stanley Mills (cotton mill, Perthshire), Lower City Mills (grain mill, Perth), lades piped in stone for Chapel Farm (threshing mill, Dumfriesshire) and Croftamie (sawmill, Dumbartonshire). Timber lades/aqueducts were occasionally used as at Mill of Doune (grain, Kilmadock) or Craigfoot Mill (woollen, Tillicoultry) but are less likely to have survived. 3rd and 4th images courtesy of Paul Bishop.

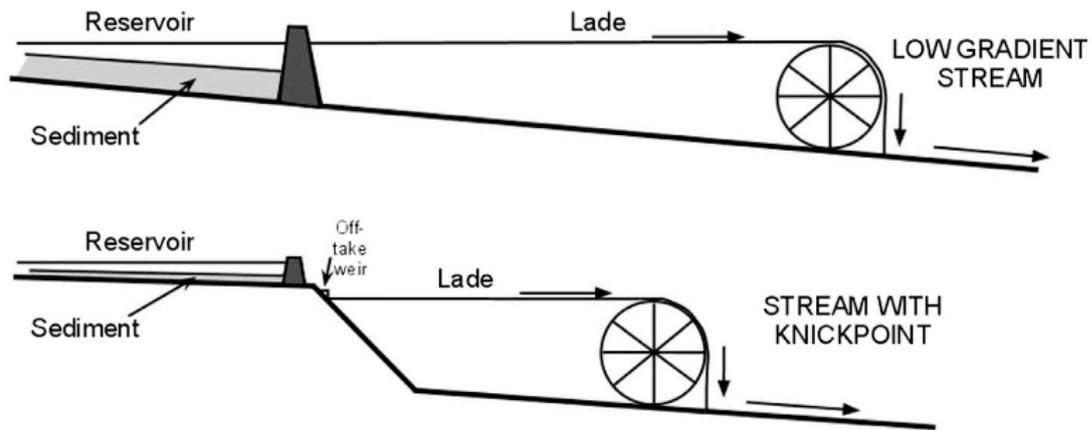


Figure 4. 12. Diagram of a long profile of a mill dam, lade, and wheel showing the higher dam and longer lade required for a stream with a lower gradient (Bishop and Muñoz-Salinas, 2013: 198).

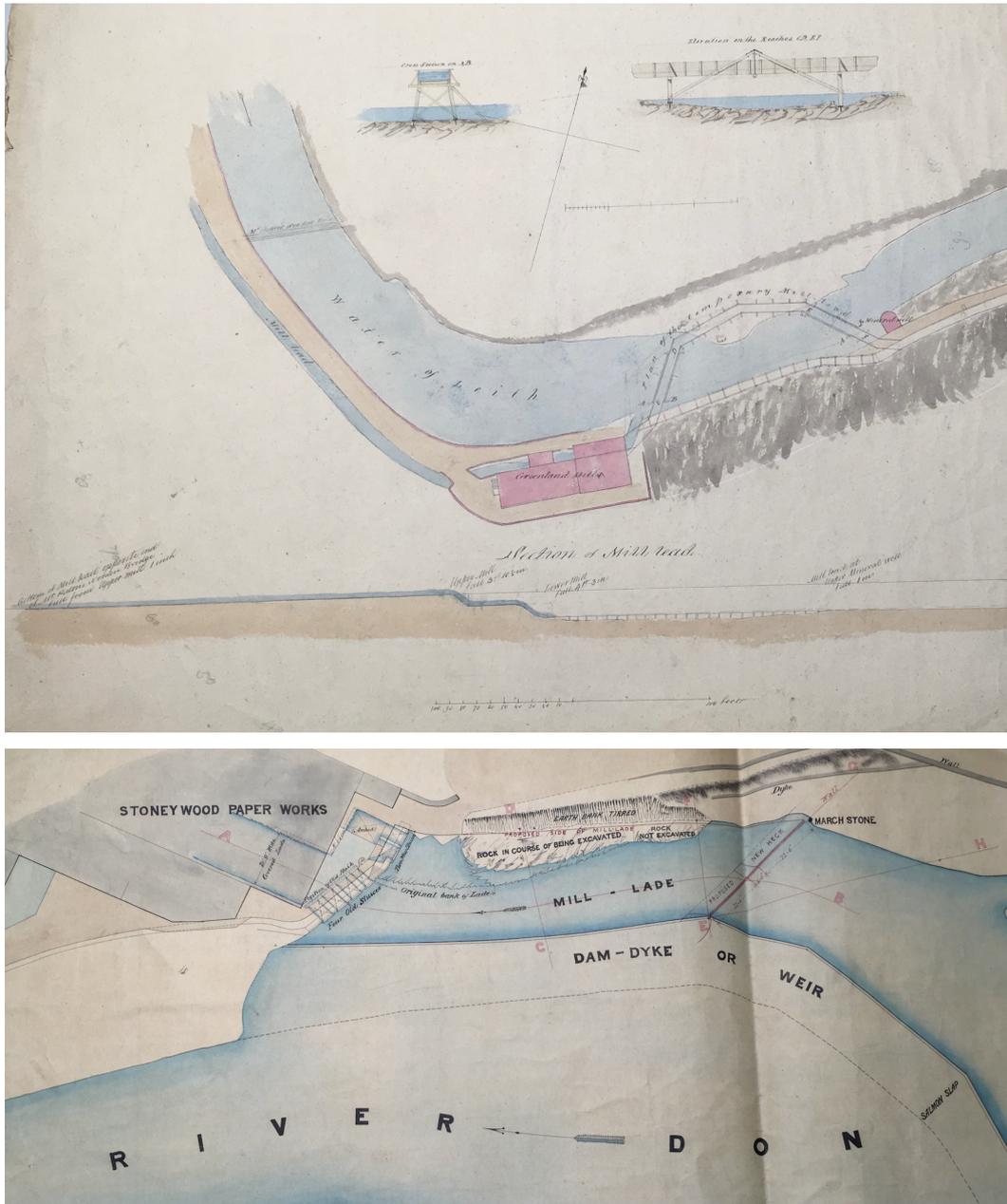


Figure 4. 13. Plans of proposed alterations to watermill infrastructure at Greenland Mills on the Water of Leith⁶⁴ (above) and Stoneywood Paper Works on the River Don (below).⁶⁵ At Greenland a temporary lade, taking the form of an aqueduct, was proposed so it could pass over the river. Whereas at Stoneywood the exposed lade ran alongside the Don, separated by an artificial weir, then was covered as it entered the Works. Alterations to the lade required extensive human engineering of the landscape including excavation of rocks.

⁶⁴ Drawing - Plan at Greenland Mills - Edinburgh, Leith, Water of - surveyed by John Steedman., 1927. MS.5848 (97) National Library of Scotland. Plans chiefly made by Messrs Stevenson, the Edinburgh civil engineers. (MSS.5843-5896). Reproduced courtesy of the National Library of Scotland.

⁶⁵ Gordon Jenkins, George (1876) Stoneywood - Plan and sections of intake mill-lade at Paper Works. MS.5862, No.126. National Library of Scotland Plans chiefly made by Messrs Stevenson, the Edinburgh civil engineers. View online: <https://maps.nls.uk/view/218518580>. Reproduced courtesy of the National Library of Scotland.

Some lades in Scotland reached considerable lengths and are observable on the OS maps. The lades at New Lanark and Deanston Mills for instance were ~434 m and ~1,697 m long respectively. One of the most impressive lades in Scotland was Perth's 'Town Lead' which spanned an enormous 6,706 m from the weir over the River Almond near Huntingtower Haugh until it discharged back into the river at Perth Bridge in the town centre. Along the way the lade served the Huntingtower Bleachfield (at 240 m from its start), Huntingtower Corn and Barley Mill (at 589 m), Ruthven Flour Mill (at 897 m), Ruthvenfield Printworks (1,518 m), and Tullocks Bleaching and Dying Works (4,213 m), finally reaching the City Corn Mills at 6,278 m after which point the lade branched in two, the northern branch passing another dyeworks, a tan works, and Mill St. Mill (function unknown) in quick succession.⁶⁶ These semi-artificial mill landscapes could be substantial even for a mill with a relatively low output. Manderston Mill, described as only a small corn mill, was served by two mill lades originating from separate mill ponds to the east and south of the mill. After passing through the corn mill, they merge into a single lade that transported water onwards to Edrom Mains farm to power a threshing machine (Figure 4.14).⁶⁷



Figure 4. 14. Manderston Mill depicted on the 1st edition OS map.⁶⁸

⁶⁶ Measurements and mill names derived in QGIS from the OS background map layers.

⁶⁷ OS Name Books - 1856-1858 – Berwickshire - Volume 15 - 1856-1858, OS1/5/15: 60.

⁶⁸ Ordnance Survey, Six-Inch to the mile, Berwickshire, Sheet XVI (Surveyed: 1857, Published: 1862). View online: <https://maps.nls.uk/view/228776932>. Reproduced courtesy of the National Library of Scotland.

Preferential locations within the landscape

The majority of vertical watermills were located within very close proximity of a river.⁶⁹ Around 88% were located within 200 m of a watercourse, with 62% (1,947) of the total found to be within just 50 m of a watercourse. Only 7% of vertical watermills were sited 500 m or farther from a natural watercourse. Manually assessing a sample of mills over 500 m from water confirmed that those watermills were still located near to water, but that the watercourse was a very small natural stream or one that was artificially altered. For example, Kirkfield Saw Mills in Lanarkshire on the Kirkfield Burn: ‘A small stream which after a course of about 2 miles empties itself into the River Clyde a little below Kirkfieldbank’⁷⁰ or the Dunsyre Burn and Easton mills (Figure 4.15). Water for the Dunsyre Burn was drawn from the Bassy Burn, another ‘small stream’. It appears that additional water was added via a sluice gate on the West Water, ‘a large stream’: approximately 950 m north of the first mill dam, water was sent from West Water along a channel which intersected the Bassy Burn then becoming the Dunsyre Burn.⁷¹ This discrepancy between the results of the GIS analysis and what is recorded on the maps illustrates one of the problems when combining modern and historical data because rivers that once supported mills may have had their channels diverted or culverted. The OS/Canmore dataset and the examples highlighted in this chapter suggest that small streams were favoured as well as larger watercourses for watermill sites in the nineteenth and early-twentieth centuries.

⁶⁹ Analysis was conducted with proximity queries using the free version of the OS Open Rivers dataset. The watercourses have been generalised from OS large-scale data resulting in the omission of smaller river channels and simplification of geometry. Additionally, many watercourses were engineered and altered between the OS 1st and 2nd edition mapping, and the creation of the OS Open Rivers dataset. The dataset therefore does not always align with the exact course of rivers on the background maps.

⁷⁰ OS Name Books - Lanark county - Volume 44 - Parish of Lesmahagow - 1858-1861, OS1/21/44: 35.

⁷¹ OS Name Books - Lanark county - Volume 24 - Parish of Dunsyre - 1858-1861, OS1/21/24: 29.



Figure 4. 15. Left: Close up of Kirkfield Saw Mills. Right: Kirkfield Burn Easton mills (pink dot) on Dunsyre Burn. Watercourses from the OS Open Rivers dataset are displayed in blue, showing a gap where the Dunsyre Burn was marked on the OS map but not included in the Rivers shapefile.⁷²

Where possible, natural features of the river were often taken advantage of to minimise the need for human engineering. For example, by placing a mill shortly below a waterfall. Literature suggested that historic mills in Britain have frequently been sited on or in close proximity to a knickpoint (Wooldridge and Kirkcaldy, 1936; Bishop and Jansen, 2005). Although this research has not included a systematic study nor a computational analysis of river gradients, many examples of mills located at knickpoints were observed. This is presented anecdotally, the number of mills at such locations has not been quantified in this thesis, but some clear examples of mills utilising gradient changes can be seen in Figure 4.16. For example, at the foot of the Soc of Dess waterfall, a weir was placed to form a mill dam that served a waulk mill via a sluice and lade. A small artificial channel returned the water into the burn after it had been used at the mill (Figure 4.16a). Drawing water from the river immediately after a step change in the river's long profile could give sufficient elevation for water to be delivered to the top or middle of a wheel, allowing the use of the more energy efficient overshot or breastshot wheel technology. Locating on a stretch of river with a steeper gradient also made it easier for water to be returned to the river after passing the mill (Jespersen, 1966: 237). A study of mills on the River Eden in Fife observed that tail races were longer on the lower portion of the river due to the 'poor gradient, and ample water flow' compared to further upstream (Jespersen, 1966: 237). A natural knickpoint was a convenient

⁷² Ordnance Survey, Six-Inch to the mile, Lanarkshire Sheet XXXII.NW (Revised: 1909, Date Published: 1912). View online: <https://maps.nls.uk/view/75651417>. Reproduced courtesy of the National Library of Scotland.

place to locate a watermill but not a necessity. Weirs could also act to amplify an existing knickpoint (Jonell *et al.*, 2024: 2): where a river was narrowed to a gorge it was easier to build a weir, or a mill could use natural weirs formed at the site of falls in the river (Figure 4.17) (Hume, 2017).

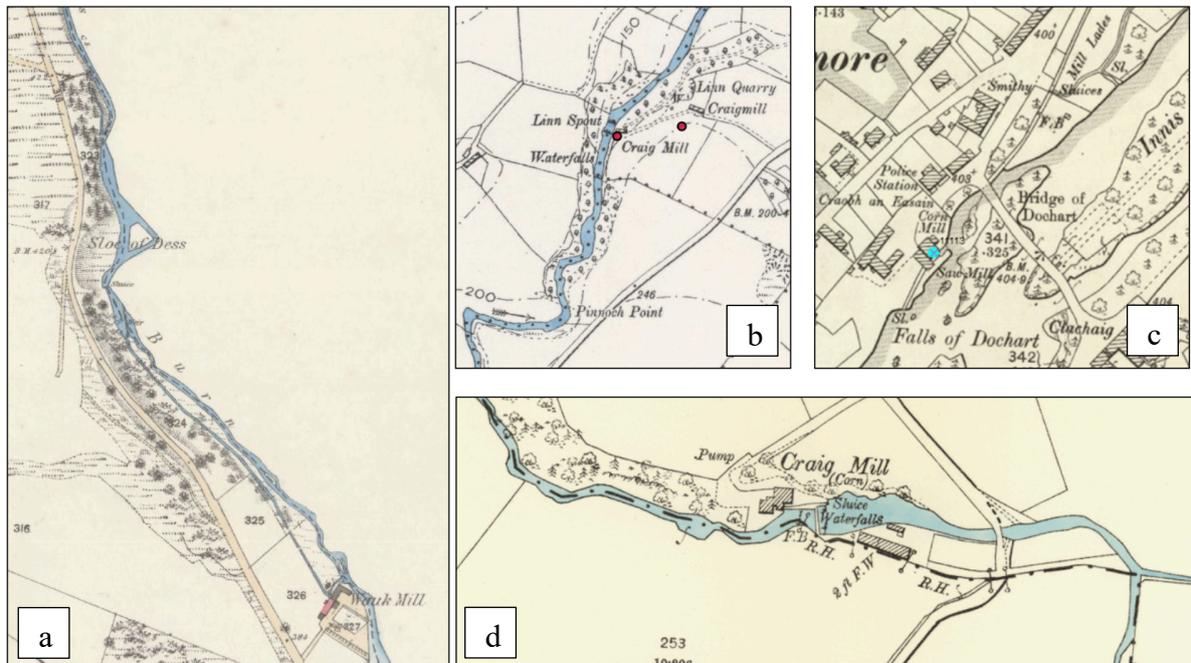


Figure 4. 16. Mills located next to waterfalls: (a) Wauk Mill at Sloc of Dess, Aberdeenshire (b) Craig Mill on Cuaf Water, Dalry, Ayrshire (c) Corn Mill on Falls of Dochart, Perthshire (d) Craig Mill, White Cart in Lanarkshire.⁷³

⁷³ Ordnance Survey, 25 Inch to the mile, Aberdeenshire, LXXXII.12 (Combined) (Surveyed: 1865, Published: 1868). View online: <https://maps.nls.uk/view/74477974>; Ordnance Survey, Six-Inch to the mile, Ayrshire Sheet XI.NE (Revised: 1895, Published: 1897). View online: <https://maps.nls.uk/view/75494193>; Ordnance Survey, 25 Inch to the mile, Perth and Clackmannanshire LXXX.2 (Revised: 1898 to 1899, Published: 1900). View online: <https://maps.nls.uk/view/82898766>; Ordnance Survey, 25 Inch to the mile, Lanarkshire XVI.15 (Revised: 1895, Published: 1897). View online: <https://maps.nls.uk/view/82892919>. Reproduced courtesy of the National Library of Scotland.



Figure 4. 17. Top: Natural weir comprising a ridge of resistant rock where the River Kelvin in Glasgow reaches Partick used by Bishop Grain Mills depicted in 1857 (left) and present day satellite imagery (right) (Google Earth, 2025). Bottom: Margaret's Mill in Renfrewshire, located below a waterfall on the Green Water that formed a natural break in gradient to build on.⁷⁴

Fluvial interferences

Studies have demonstrated that the construction of watermills and their associated infrastructure impacts local fluvial processes (Buchty-Lemke and Lehmkuhl, 2018). An active mill may result in the slowing of incoming water when it is diverted into the mill lade or stored by a dam which can then create a sediment trap, accumulating sediment upstream of the mill (Downward and Skinner, 2005). The impact of mill dams on the upstream river system has been observed to extend for several kilometres, even reaching upstream tributaries without dams (Merritts *et al.*, 2011). In some cases, where watermills occur in a chain along a river, impoundment of water can occur at each mill weir. Depending on the proximity of the mills, backwater effects between mills can overlap, which would result in issues with

⁷⁴ Ordnance Survey, 25 Inch to the mile, Lanarkshire VI.5 (Govan) (Surveyed: 1857 to 1858, Published: 1860). View online: <https://maps.nls.uk/view/74955247>; Ordnance Survey, 25 Inch to the mile, Renfrewshire, VI.8 (Kilmacolm) (Surveyed: 1857, Published: 1858). View online: <https://maps.nls.uk/view/199436371>. Reproduced courtesy of the National Library of Scotland.

waterwheel efficiency (Maaß and Schüttrumpf, 2019: 16). On East Coast rivers in the United States, Walter and Merritts (2008) estimated as much as a 60% reduction in velocity in the region immediately 1–3 km upstream of milldams could occur on low gradient rivers. Such backwater effects not only exacerbated issues of sedimentation on the riverbed and behind weirs in many rivers, but also increased vulnerability of land to flooding (Walter and Merritts, 2008).

Abandonment of a mill can result in changes to the channel by affecting sediment erosion and deposition if a mill dam or weir is removed or fails (Pizzuto and O’Neal, 2009; Buchty-Lemke and Lehmkuhl, 2018). Studies of mill landscapes in Germany and the Netherlands (Maaß and Schüttrumpf, 2019) support the evidence that morphological effects of watermills can be long lasting. It has been proposed that anthropogenic influence on alluvial sedimentation and stream channel formation has resulted in Britain too since the widespread introduction of watermills (Walter and Merritts, 2008: 300–3). However, the extent of morphological interference is dependent on the design of the mill’s infrastructure. If the reservoir for a mill is placed within the lade, as was common in the Basilicata region of Italy, the effect on sediment load will be minimal compared to English watermills that commonly placed a high weir wall directly in the river channel to increase the fall of water (Bishop and Muñoz-Salinas, 2013; Grano *et al.*, 2016). Mills in Scotland only required a comparatively small dam, with fewer consequences in the event of failure (Bishop *et al.*, 2010; Bishop and Muñoz-Salinas, 2013), reiterating the preferential geomorphological situation for waterpower in Scotland.⁷⁵

Although many studies are conducted with current or future effects on river systems in mind, backwater effects were felt by other river users historically. There are numerous historic references to backwater issues with mills, so it is plausible that most eighteenth-century prospective mill owners would have been well aware of these issues prior to selecting a mill location. For instance, a milldam on the Conestoga River was torn down in 1731 to stop it interfering with the fishing industry (Walter and Merritts, 2008: 301) and the lease for a historic mill along the River Cherwell in England obliged the miller to store sufficient water for agricultural uses on the adjacent land (Downward and Skinner, 2005: 144). To illustrate

⁷⁵ Beyond these studies there are few evidence based observations of the impact of mills on watercourses in Scotland or northern Britain.

the distance the effects could reach, on the St Croix River, Maine, USA, in 1902 a gauging station had to be moved a mile and a half downstream to escape the backwater effects of a paper mill and its dam (Babb *et al.*, 1912: 48). The River Kelvin in Glasgow, home to around 30 watermills at one time or another, with nine dams created in a 7 km stretch, unsurprisingly suffered from backwater problems, causing the owner of South Woodside Mill to take legal action against the Clayslaps Mills (Nisbet, 2019). Water supposedly gathered at the bottom of the waterwheel of the upstream South Woodside Mill, slowing the wheel's motion after Clayslaps raised their dam. Clayslaps' owner was forced to reduce the dam height by 6 inches as a result of the litigation. Even as some mills began to turn to steam power, either as their main or a supplementary power source, locations on rivers (and artificial waterways such as canals) remained important, and often crowded, with mills still requiring water for processing. The calico-printing mills of Maryhill and Partick abstracted from the Kelvin for preparing cloth and washing out excess dye, returning it contaminated to the river mixing with effluent already released from the papermills upstream. Scotland is said to have some of the most polluted rivers in Victorian Britain, including some of those passing through areas mentioned in this chapter due to clustering of mills: the Dighty, Esk, Kelvin, and lower Clyde (Wohl, 1983: 237). The concern around this can be seen in the introduction of the earliest legislation relating to river pollution in Britain in 1388. Problems became so severe that a Royal Commission on the Prevention of River Pollution was set up in 1864, followed by the 1876 Rivers Pollution Act that prohibited disposal of waste from mines and factories into rivers, although such laws were poorly enforced (Wohl 1983; Solomon and Thomson, 2009). Meanwhile, others used the same river water for cooling, producing vast heat pollution (Hume, 2017). This continued relevance of water for industrial location, albeit sometimes for different uses, is examined further in Chapter 6.2.

4.3.1.2 Horizontal watermills

The horizontal water mill had a 'very limited and very interesting distribution in Western Europe' (Lucas, 1953: 1). Referred to locally as Norse, click, clack, or *muileam dubh* (black) mills, the horizontal watermill was an important feature of certain Scottish regions well into the early-twentieth century.⁷⁶ These mills justify a discussion of their own since in many ways they are incomparable with the vertical-wheeled watermills that make up the bulk of

⁷⁶ On the Isle of Mull, the horizontal mill may have been known as a 'black' mill although Goudie believes this to be a misprint (Goudie, 1886).

this dataset. The horizontal waterwheel, like the undershot vertical wheel, uses the impulse of water that is directed through a trough or chute onto the vanes of the wheel to move it (Howard, 1983). The wheel

consists of a vertical shaft from the lower end of which projects a number of vanes, blades or paddles against one side of which a stream of water is directed to turn the shaft. The upper end of the shaft passes through a floor or stage supporting the stationary lower millstone through the hole in which the shaft continues and is attached to the rynd or bar of metal fixed in the upper stone. As the shaft revolves it carries the upper stone round with it, performing the grinding. (Lucas, 1953: 1)

Unsuitable for use on rivers with larger volumes of water or unpredictable flow regimes, horizontal wheels are best suited to smaller watercourses with steep gradients (Shaw, 1984; Hammer, 2008). Not requiring gearing, this type of mill could be constructed entirely of wood and was easy to build and maintain. Therefore, the capital investment required for a horizontal mill was typically low, rendering them an appropriate technology for communal use by peasants (Hammer, 2008). It has been commonly suggested that the horizontal wheels constituted the initial phase of water-powered milling technology. However, research in the final decades of the twentieth century and into the twenty-first century on the history of milling has revised this view, leading Lucas (2006) to suggest that some sort of vertical wheels were in use up to six centuries earlier than horizontal wheels. Grano and Bishop (2017: 118) are of the opinion that the horizontal mill ‘quite clearly performed the task(s) demanded of it perfectly adequately, and its users evidently preferred it’. The horizontal ‘click mill’ near Dounby on the Orkney mainland, is a rare example of a horizontal mill built relatively recently (c.1822) to replace an older mill on the same site and continuing to grind grain into the 1880s (Figure 4.18). The mill building at Dounby (reconstructed by HES) consists of one room with the millstones and machinery. Below this is a basement or ‘under-house’, as they were known, where a horizontal wheel with, highly unusually, two rows of paddles are positioned. The construction is similar to horizontal mills of Lewis and Shetland though the Dounby mill is thought to be an advancement on the design of the others (Collie, 2009: 34). Despite its small dimensions (4.5 m by 2 m), the machinery could grind up to 25 kg of grain in an hour.⁷⁷ Use of a mill of this sort may have been preferred over travelling to a more efficient vertical mill while roads and transportation were still extremely poor in rural areas (Collie, 2009).

⁷⁷ NHRE ID: 2269 (Dounby, Click Mill).

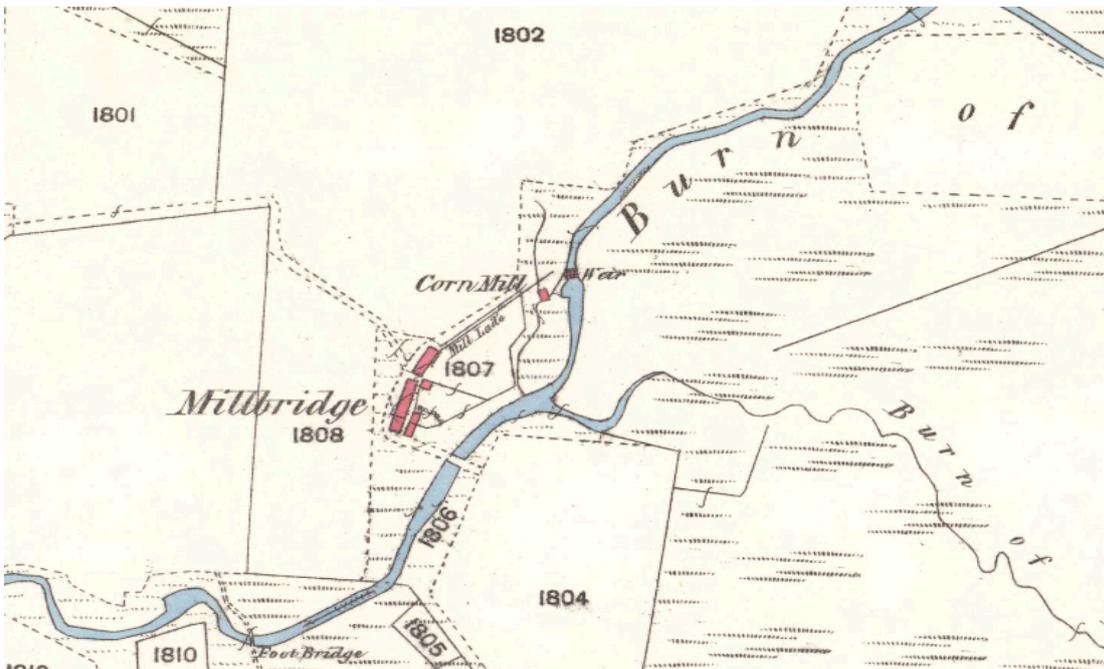
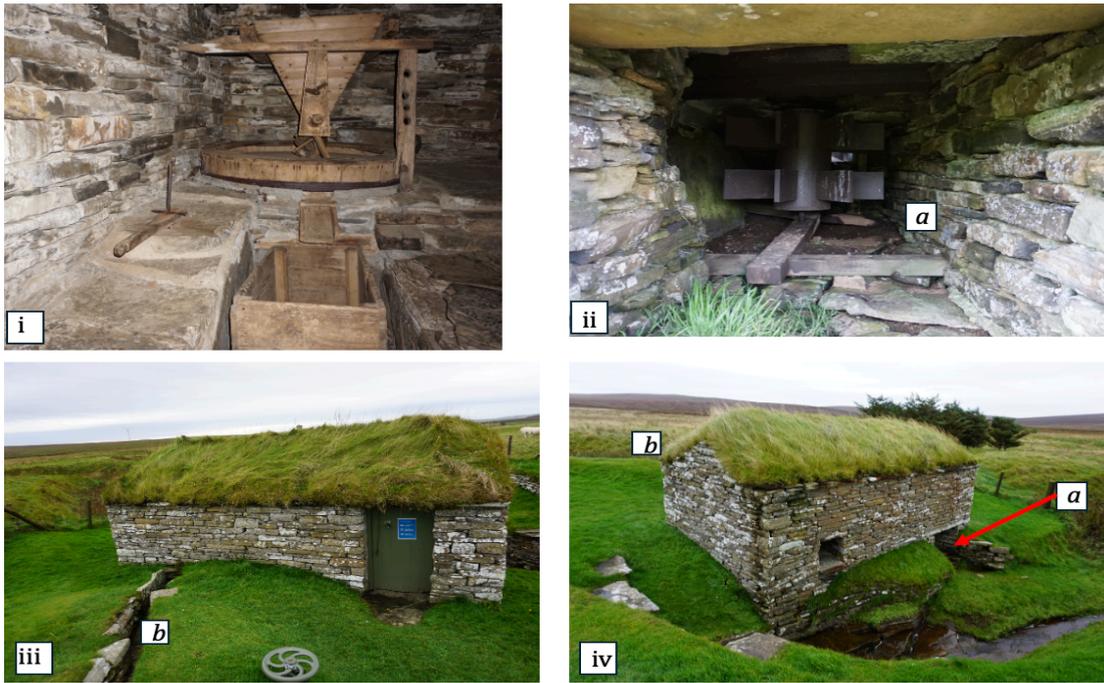


Figure 4. 18. Top: Reconstruction of a horizontal mill (locally known as a click or clack mill) at Dounby, Orkney. Locations: i hopper and mill stone, ii horizontal waterwheel (a), iii front of mill exterior showing entrance and lade (b), iv rear mill exterior with location of wheel. Bottom: depiction of Dounby Mill on the 1880 OS map.⁷⁸

There were 542 horizontal mills identified across Scotland (Figure 4.19). Just over three quarters of these (415) were located in Shetland, where, by Goudie's (1886) account, it was only in the 1880s that the vertical style mill, common on the mainland, was experimented

⁷⁸ Ordnance Survey, 25 Inch to the mile, Orkney XCV.6 (Birsay)(Surveyed: 1880, Published: 1881). View online: <https://maps.nls.uk/view/75135585>. Reproduced courtesy of the National Library of Scotland.

with on Shetland. Although the horizontal mill was by then showing signs of becoming a past object, they remained essential to life and to the economy of the mill owners. The second largest concentration of horizontal mills was found in Ross and Cromarty, specifically the Isle of Lewis, which had 93 of the county's 96 horizontal watermills. As Robert Finlayson, a minister on Lewis reported in 1833:

The mills in Lewis are probably the greatest curiosity a stranger can meet with on the island. There is scarcely a stream along the coast, on any part of the island, on which a mill is not to be seen.⁷⁹

The remaining 6% were scattered across the country in Sutherland (8 mills), Orkney (5), Inverness-shire (5) Perthshire, (4), Argyllshire (4), Wigtown (1), Midlothian (1), Dumfries (1), Ayrshire (1), and Aberdeenshire (1). These mills were almost all used for the grinding of grain. Despite the assertion by contemporary nineteenth-century authors (such as Goudie, 1886) that horizontal mills must have been common on the Orkney islands also, only five were confirmed there.

To understand the existence of such a large number of grain mills in the Northern Isles as late as the 1870s we can look to the ownership of the mills. Shetland's mills were individually owned, free from the Scottish system of thirlage (Gauldie, 1981: 117), while Orkney operated in a middle ground where some mills did serve estates and were subject to sucken but the building of independent mills was still permitted (Goudie, 1886: 282).

The majority of horizontal mills were placed on streams so small that although they were recorded on historic OS mapping, they are only identified by high resolution satellite data and not the OS Rivers network used in this analysis.⁸⁰ This was the case for both horizontal mills on islands and on the mainland such as the mill at Gleann Beag in Kirkmichael, Perthshire, on an unnamed tributary of the Allt a' Ghlinne Bhig.⁸¹ This is a characteristic in common with early-seventh-century to tenth-century mills of Ireland and Yorkshire (England), that were fed by natural springs (Rynne, 2009).

⁷⁹ *NSA, Lochs, Ross and Cromarty*, Vol. 14, 1845: 164.

⁸⁰ The OS Rivers shapefile used for data analysis were too coarse to include the majority of Shetland's burns.

⁸¹ NRHE ID: 29596 (Gleann Beag).

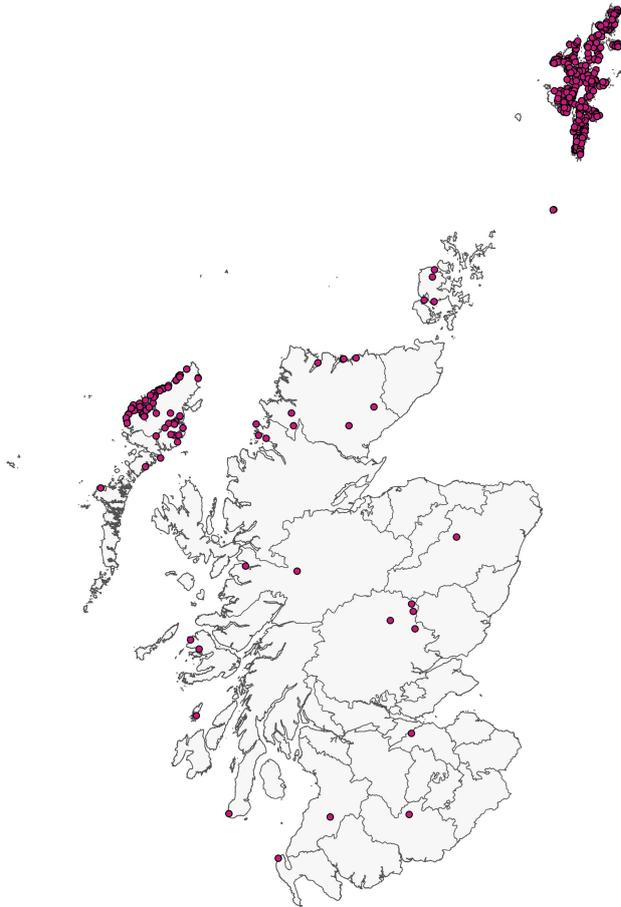


Figure 4. 19. Cumulative distribution of horizontal watermills.

Closely examining the Lewis and Shetland horizontal mills on maps illuminates their consecutive placement in strings along small burns. Where this occurred, the water was dammed above the mill and diverted to the lower chamber of the mill house via a sluice and a lade. The water would re-enter the natural stream, rendering it available to work the next mill further downstream. Based on the OS maps, chains of as many as twelve mills could be placed in extremely close proximity along what was barely larger than a small stream (Figure 4.20). On Mid and South Yell for instance, there were three mills on the Burn of Evrawater near the settlement of Hamnavoe (Figure 4.21). From west to east there is a straight-line distance of 25 m between the first two mills and just 19 m before the third. A further 311 m southeast on Burn of the Gardins, yet another mill was found. This proximity is explained by the cultural practice surrounding milling in these regions where grain mills would either be owned by a single family or by small groups of households if they were living near to each other. There was no permanent miller and the door would often be left open (O'Reilly, 1902).

Arrangements would be made by neighbours to share the mill, ensuring opportunities for all to grind their corn, simultaneously acting as a site of social gathering: ‘often these hours are whiled away with songs and tales and jests, when more than one are present...’ (Goudie, 1886: 258). This displays a similarity to horizontal mill ownership elsewhere in Europe. The practice of shared use also occurred in the Rudăria commune in western Romania, where the horizontal mills to this day sit within an old system of property rights, outside the modern legal system. Instead of owning the mill as property, families in Rudăria were entitled to a day or a timeslot that was theirs to use the mill (Trifan, 2023; Bârliba, *et al.*, 2024: 24).

Horizontal mills were predominantly sited at low elevations: 94% were located below 50 m asl. There were 32 horizontal mills between 50 m and 200 m asl, and five higher than 200 m asl. The elevation of Scottish horizontal mills demonstrate similarity with those historically found in Ireland. Rynne (2009) found the most common elevation to be between 91 and 150 m above sea level, though with many at the much lower elevation of 30.5 to 70 m asl. As with Scotland, isolated examples of horizontal mills situated higher (150 to 274 m asl) were known in Ireland also. Though this was perhaps not universal, as observed in Norway the Norse mill tended to be scattered in hills in inaccessible locations (Bennett and Elton, 1898). Rynne’s study of Ireland also addressed the assumption that horizontal mills were likely to be found in close proximity to settlements where people lived or near places of worship in the medieval period. Although this is found to be true, mills were also found in agricultural land. The patterns of Irish mills are again mirrored somewhat in Scotland where we see horizontal mills in very isolated locations (Figure 4.22).



Figure 4. 20. A chain of twelve mills on Burn of Scousburgh, Shetland.⁸²

⁸² Ordnance Survey, 25 Inch to the mile, Shetland LXV.9 (Dunrossness) (Surveyed: 1878, Published, 1880). View online: <https://maps.nls.uk/view/75115194>. Reproduced courtesy of National Library of Scotland.

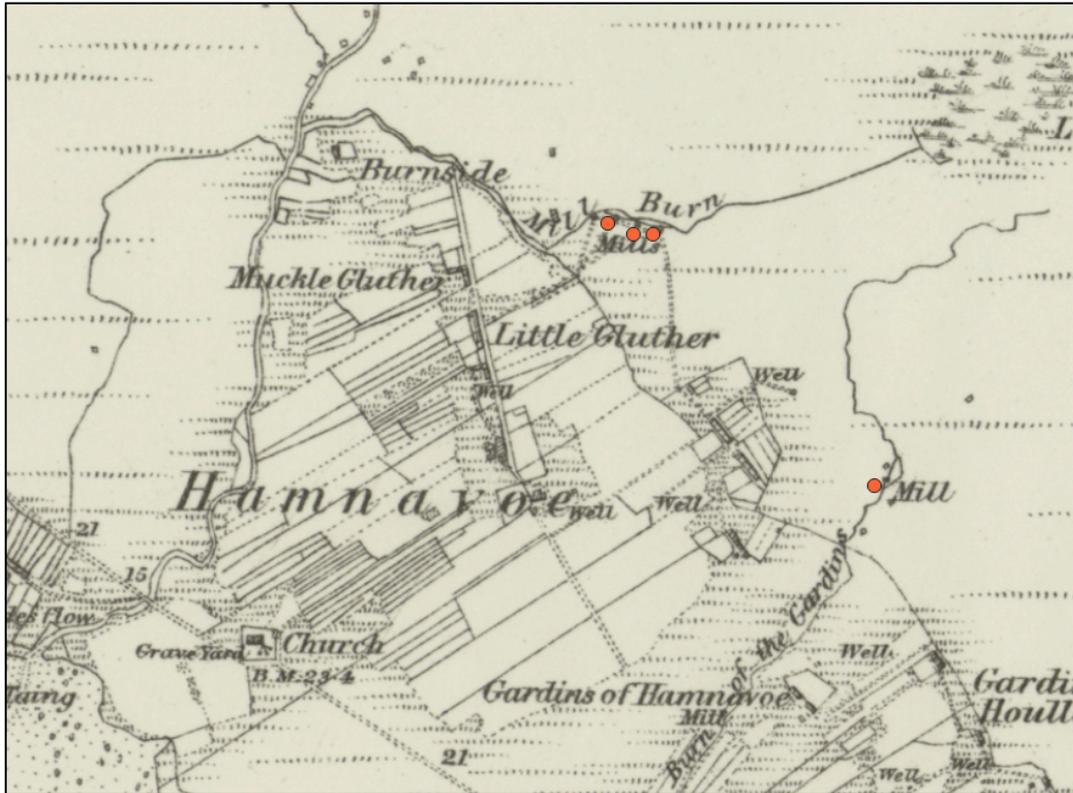


Figure 4. 21. Four horizontal mills at Hamnavoe, Shetland.⁸³

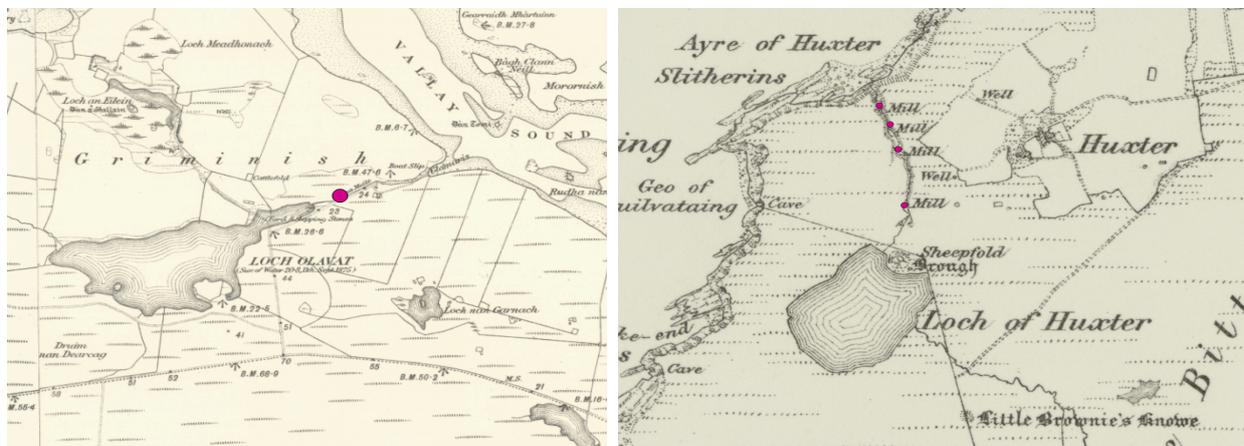


Figure 4. 22. Examples of a very remote horizontal mill on North Uist, Ross and Cromarty (left) and mills near a sheepfold, Sandness (right).⁸⁴

Of the isolated examples of horizontal mills used on the mainland, details are scarcer. Those further south went out of use much earlier and their entire existence carries far less certainty than the northerly island mills. The mainland horizontal mills were mostly identified by site

⁸³ Background map: OS Six-Inch 1st edition, 1843-1882. Reproduced courtesy of National Library of Scotland.

⁸⁴ Background map: OS Six-Inch 1st edition, 1843-1882. Reproduced courtesy of National Library of Scotland.

surveys, recorded in Canmore rather than OS maps. Those surveys identified the remains (or trace) of the mill and considered the surrounding features rather than using written evidence as sources. For instance, the remains of a probable lade and millwheel found in 1884 Wigtown were recorded as a possible mill.⁸⁵ A particularly unusual example is that of Craig Castle in Aberdeen where an archaeological excavation suggested a dovecot had been created in the foundations of a medieval horizontal watermill. However, a later survey did not find corroborating evidence.⁸⁶ One horizontal mill in the central region could have been the Restalrig paper mill on the now subterranean River Tumble (or Tummel) in Edinburgh (Thomson, 1974: 20).

There were 382 horizontal mills present in the 1850s, 257 in the 1900s, and 142 were *PU*, which were all pre-1850s unless missed by the OS surveyors because there is no literature to suggest the construction of new horizontal mills during the twentieth century in Scotland. There were 240 mills present in both the 1850s and 1900s. The addition of 17 new mills between the 1850s and 1900s was unexpected and may be accounted for by the fact that the type of wheel is rarely distinguished on the OS maps. Surveyors provided very little indication of whether a horizontal mill was still functional. It may be possible to discern from each sheet if the building was roofless, but depicting that may have been challenging for such small structures on Six-Inch to the mile sheets. In general though, the figures correspond well with those of other authors. Sir Walter Scott, after a visit to Shetland in 1814, estimated there to be around 500 horizontal mills on those isles (Goudie, 1886: 261). Given that Scott was accompanying engineer Robert Stevenson on a trip to inspect lighthouses, rather than a detailed survey of the landscape (HES, 2024) this figure should be used for guidance only. However, Shaw, also estimates 500 mills, this time based on the 1st edition OS mapping. The 52 watermills recorded in the OS/Canmore dataset for the parish of Sandsting and Aithsting on the west of Shetland's Mainland, matches almost exactly the 50 estimated by Reverend John Brydon,⁸⁷ approximately 30 years prior to the OS surveying of Shetland (1877–1878). The discrepancy between Shaw's figure of 150 horizontal mills on Lewis on the 1st edition OS map and my much lower number of 93 (and our overall totals) is likely due to my methodology of working from the 2nd edition maps rather than a systematic review of both editions. For the mainland of Scotland, although the number of horizontal mills certainly

⁸⁵ NRHE ID: 60425 (Cairnside).

⁸⁶ NRHE ID: 17242 (Craig Castle, Dovecot And Mill).

⁸⁷ *NSA*, Sandsting and Aithsting, Shetland, Vol. 15, 1845: 115.

never reached anything comparable to that Lewis and Shetland, a more thorough consideration of regional linguistic variation might illuminate further examples. For example, the placename Clockmill Road in Edinburgh is likely to have been picked up by my search whereas Clickimin in Peebles, which could also refer to a historic mill, would not be. Contemporary literature would likely reveal further mis-categorised horizontal mills such as on the Water of Leith where it was said one could hear ‘the occasional clack of an adjoining mill’ (Stoddart, vol. I; 101, reproduced in Cruden, 1948:44).

4.3.1.3 Tide Mills

Tide mills, also known in Scotland as sea mills, were once found on numerous estuaries in Britain (Trinder, 2013). They could be useful in coastal areas where rivers became too large (both in depth and width) for existing technology to place a bridge or dam, or the velocity was too slow to provide sufficient power (Reynolds, 1983: 66–67). These mills harness the up and down movements of the tide, or the tide induced current, to turn a wheel (Charlier, 2005). The configuration for a tide mill varied but a common structure used a dam and sluice gate located at the mouth of the river with the waterwheel (horizontal or vertical) located on the seaward side of the dam. At high tide the gate would open, allowing water to flow into and fill a reservoir behind it (the mill pond). When the tide ebbed, the gate would automatically close, trapping the water at the level of the high tide. When the water level on the other side of the dam had receded enough to expose part of the wheel (usually two to three hours later), water from the dam could be directed to strike the blades of the wheel and turn it (Figures 4.23 and 4.24). Tide mills tended to avoid problems of water shortages related to seasonality or upstream effects of other water uses and they did not freeze over (Reynolds, 1983: 67), but they could sustain damage from storm surges or exceptionally high tides (Lucas, 2006: 87). Another obvious downside was that the schedule of the tides did not correspond to a typical working day for humans. This conflicting need to both use the mill and protect the mill from the tides was an important consideration for its location: ideally located away from the river’s mouth, on a tidal creek, or at a site that had shelter provided by headlands or nearby islands (Royle, 1982: 243).

THIS IMAGE HAS BEEN REMOVED BY THE AUTHOR OF THIS THESIS FOR COPYRIGHT REASONS

Figure 4. 23. ‘Drawing of a tide mill from Faustus Verantius, *Novae machinae* (1615), plate 1’ (reproduced in Minchinton, 1979: 784).

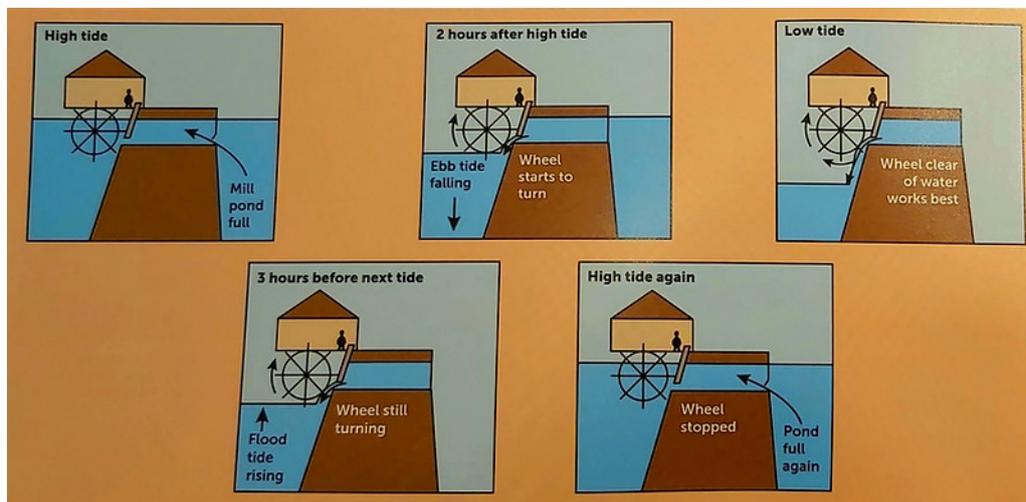


Figure 4. 24. Stages of a tide mill operating (Eling Tide Mill Experience, 2018).

Even though Great Britain as a whole was estimated to have had around 140 tide mills (Charlier and Menanteau, 1997), tide mills are rare in Scotland: during their contemporary operation and now in terms of the heritage remains, which may exist as ‘undated traces’ along the northwest coast (Charlier *et al.*, 2004: 318). Five tide mills were identified in the OS/Canmore dataset. Two of these were in the Highlands, one being in Kirkwall on Orkney’s Mainland, and another on the northeast coast of the Scottish mainland at Knockbain in Ross and Cromarty. A further three mills were located in the central east region of Scotland in Fife and East Lothian, the latter of which was likely to have comprised of a pair of sixteenth-century mills. All were located directly at the coast, at tidal inlets or mouths of rivers (rather than on tidal stretches of river further inland). The Ayre Mill in Kirkwall was the only tidal

mill to feature on the OS mapping (Figure 4.25), the others were recorded through surveying by HES suggesting they were out of use prior to the 1850s. As it was still depicted and labelled on the 2nd edition mapping (revised in 1900), Ayre Mill possibly worked into the early-twentieth century. The mill made use of the Peerie (or Peedie) Sea, a shallow sea inlet, separated from Kirkwall Bay by a single spit (Lee, 2018: 170) so probably did not require significant costs to turn the bay into a reservoir for the mill. The OSNB provides insight into the mechanics of the mill: ‘By the aid of pullies, the wheel can be raised or lowered to catch the flow & ebb of the tide’.⁸⁸ What is particularly unusual in this example is the combination of tidal energy with a steam engine to power the mill. Unfortunately, the surveyor’s entry in the OSNB did not elaborate on whether steam or water was the more prominent source nor when or why there was a need for both. The use of tide mills on the firth of the River Tay was contemplated by manufacturers in Dundee in the 1780s (Neilson, 1788 reproduced in Boulton *et al.*, 1981), although none were constructed.

From the limited documentary evidence, it appears that Scottish tide mills were relatively small, comprising at most four stones for grinding, when compared to much larger mills in mainland Europe. For example, in Cadiz, Spain, a single mill was known to have 24 millstones operating (Alonso del Rosario *et al.* 2006). Scottish tide mills also appear to have existed in isolation rather than developing as part of networks or clusters. In terms of their industrial function, it is likely that all of the Scottish tide mills were used primarily for grinding grain. Shaw (1980: 8–9) refers to the tide mills at Inverdivot being used for grinding flint at the end of eighteenth century. It is also suggested that a tide mill at Burntisland was used as a sawmill although Shaw states this is uncorroborated and the *NSA* explicitly mentions a corn mill utilising the tide in that location. Thought to have been constructed in the seventeenth century, the Burntisland tide mill was owned by the estate of Wemyss. It last appeared on a map in 1843 and was said to work up to 14 hours per day.⁸⁹

The number of tide mills seems very low considering Scotland possesses 18,680 km of coastline (Angus *et al.*, 2011). Distribution of tide mills is generally thought to be accounted for by physical geography in terms of the hydrology and shape of the coastline, *e.g.* an inlet or estuary that can be obstructed, as well as human made influences of the development of a harbour or port (Charlier and Menanteau, 1997: 188). Charlier and Menanteau (1997) suggest

⁸⁸ OS Name Books - Orkney - Volume 12 - Parish of Kirkwall and St Ola - 1879-1880, OS1/23/12: 40.

⁸⁹ *NSA*, County of Fife, Vol. 9, 1845: 416.

a minimal tidal range of 2 m is required for the successful operation of a tidal mill, making Scotland, with its mean spring tidal range of 4–5 m (marine.gov.scot, 2018) more than suitable. On the other hand, Scotland’s energetic wave resources and a wave climate (the average distribution of wave characteristics such as wave height and period) that exhibits inter-annual variability (Neill *et al.*, 2017: 11), potentially place mills at risk of damage. An analysis of Scotland’s coastline would be required to determine whether it was the physical landscape or other considerations that defined tide mill use (better suitability to non-tidal mills or were suitable sites far from populated places for example).

The figure here of five mills is fractionally lower than other sources such as Gauldie (1981) who identified six tide mills in Aberdeen, Kirkwall, Burntisland, Musselburgh, Port Allen (Firth of Tay), and Petty (Inverness). Shaw (1980) adds additional mills at Culbin and Blackness (Figure 4.26). It is hard to say for certain the number of mills as they are often referred to as being in pairs and there are insufficient records generally to establish whether this referred to two wheels working four millstones at the same mill, as was the case at Petty (Shaw, 1980), or whether they were entirely separate operations.

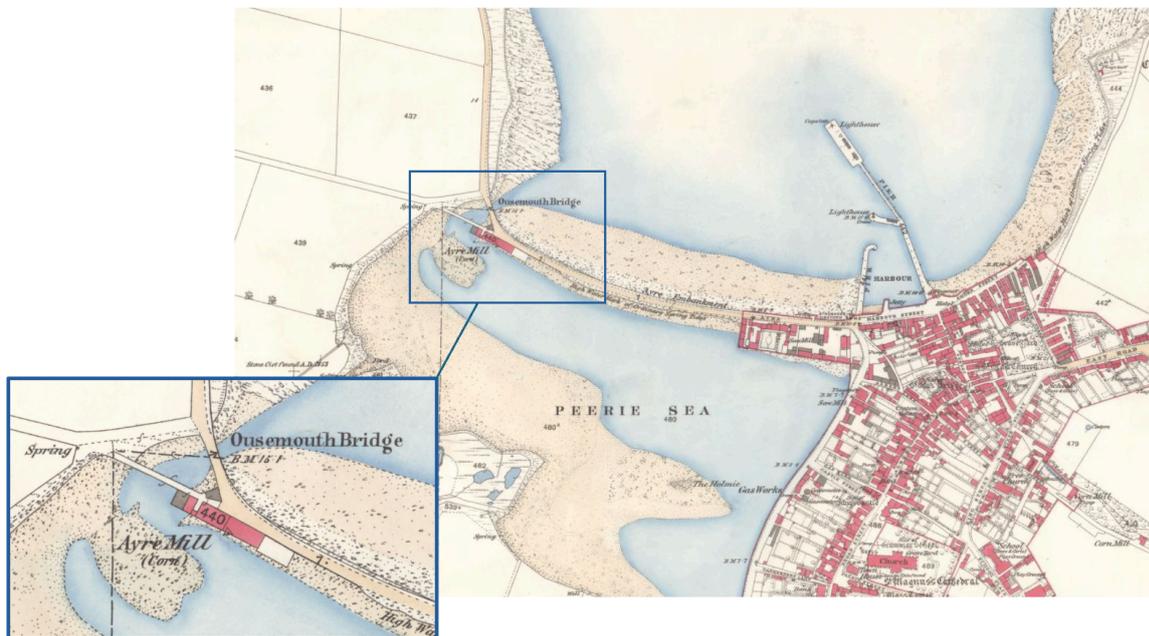


Figure 4. 25. Ayre Mill c. 1881. Located on the edge of the town of Kirkwall where a small channel enters the closed off marshy loch previously known as the Peerie Sea.⁹⁰

⁹⁰ Ordnance Survey, 25 Inch to the mile, Orkney CVIII.3 (Kirkwall & St Ola) (Surveyed: 1880, Published: 1881). View online: <https://maps.nls.uk/view/75136044>. Reproduced courtesy of the National Library of Scotland.

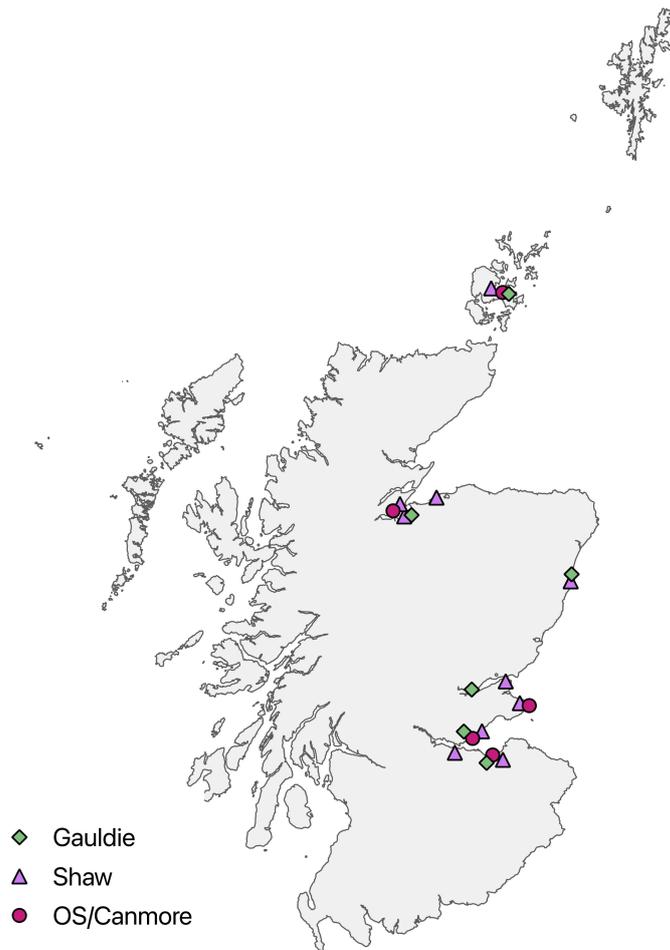


Figure 4. 26. Comparison of tide mill distribution as recorded in Gauldie (1981), Shaw (1980), and the OS/Canmore.

4.3.2 Windmills

In *Treatise on Mills and Millwork* published originally in 1861, engineer, Sir William Fairbairn stated that within his own living memory ‘the whole of the eastern coasts of England and Scotland were studded with windmills’ (Fairbairn and Pole, 1877: 276). Despite this, windmills have been dismissed as never being particularly common in Scotland (*e.g.* McLaren, 1946; Shaw, 1980: 538). It is certainly true that their numbers were small in comparison to England, especially if the claim is true that ‘[b]y 1750, there were approximately 10,000 wind powered machines in the United Kingdom’ (Fleming and Probert, 1984: 166). However, windmills were a more extensive feature of the Scottish landscape than many authors have acknowledged (Donnachie and Stewart, 1967: 299).

There were 284 windmills recorded across Scotland using the OS/Canmore. Of these, 25 appear on the 1st edition OS map but only 23 as functioning windmills since two mills had already been converted to use steam engines instead of wind. Of these, only eleven were still recorded as windmills on the 2nd edition. An additional mill, Provost Mill, a grain mill in Annan, Dumfries, was featured and functional on both maps but had been entirely rebuilt as a steam-powered mill prior to the 1850s. On the 1900s map, there are 159 new windmills featured, taking the total at that time to 172. Though again, some had been converted to use alternate motive powers by that time, including a prior wind-powered threshing mill at East Barns in East Lothian that was converted to work by steam. This increase in the number of windmills is partly explained by the introduction of the pumping mill which will be discussed shortly. There were 100 windmills only present in Canmore, including 13 recorded as *Old Windmill* by the OS surveyors, indicating that a windmill had been operational before but was now out of use as a mill entirely. Windmills were found in 27 of Scotland's counties. The areas with the greatest number of mills being Aberdeenshire (31 mills), Berwickshire (40), Orkney (47), Forfarshire (27), and clusters in Fife and Kinross, and Edinburgh. One of the Orkney Mills, Peckhole on North Ronaldsay, was the last known working windmill in Scotland. Peckhole functioned from the eighteenth century until 1908 when it was replaced by a diesel engine-powered meal mill to its immediate northwest.⁹¹ Outside of Orkney there were a small number of other island windmills on Fairisle and Havra, one on North Uist, one on Muck (according to local tradition rather than documentary evidence),⁹² and two on Coll.

Windmills in Scotland (and Britain more generally) tended to be erected in isolation: there is no evidence of chains of windmills like those common in mainland European countries such as Belgium, Spain, or Portugal. However, where a site was deemed particularly suitable, occasionally, it would be used for wind-powered machinery multiple times. For instance, after the Gunsgreenhill windmill stopped the grinding and threshing of corn prior to 1900, another windmill was constructed a short distance away to pump water from a pond in the early-twentieth century.⁹³ As with water-powered mills, geographical conditions had a strong influence on the location of windmills. Windmills were typically located in areas of the country with lower levels of precipitation, which in Scotland occurs along the east coast (Rivington *et al.*, 2020). Precipitation is generally lower in the east and highest in the west

⁹¹ NRHE ID: 3672 (North Ronaldsay, Peckhole Windmill).

⁹² NRHE ID: 291353 (Muck, Rubh' A' Chroisein).

⁹³ NRHE ID: 60207 (Eyemouth, Gunsgreen, Pumping Windmill).

where prevailing south-westerly winds from the Atlantic arrive at the Highland and Grampian mountain ranges to condense and form rain. The areas with the highest windspeeds also correlate roughly with areas of high rainfall in the north and west (Met Office, 2025). The relative paucity of windmills in the north or west regions was however, logical, firstly because the region was well suited for waterpower and secondly because too high wind speeds posed a risk of damage to a windmill and its sails. The most attractive locations for windmills were therefore exposed areas with high but not the *highest* winds. There is however, not a great difference between the average elevation of windmills in Scotland compared to mills of all power sources, the median elevation being 50 m asl for windmills (mean of 67 m) compared to the median of 45 m asl for all mills. Twelve windmills were located above 200 m asl, one in Stow, Midlothian, and the other in Lauder, Berwick, which at 294 m asl, was the maximum known elevation for a Scottish windmill. Although, as a whole, the areas where windmills were located were not unsuitable for waterpower, when the local area is examined more closely, they frequently were farther from larger watercourses (Figure 4.27). No attempt has been made here to quantify the potential available waterpower of streams in the manner that Jonell, *et al.* (2024) have, but purely from observations the question is raised of whether these sites were lacking streams sufficient for the desired power needs. More detailed analysis might assess if these areas would have required substantial engineering to create a water-powered mill, exceeding the skills and financial resources required for wind power.

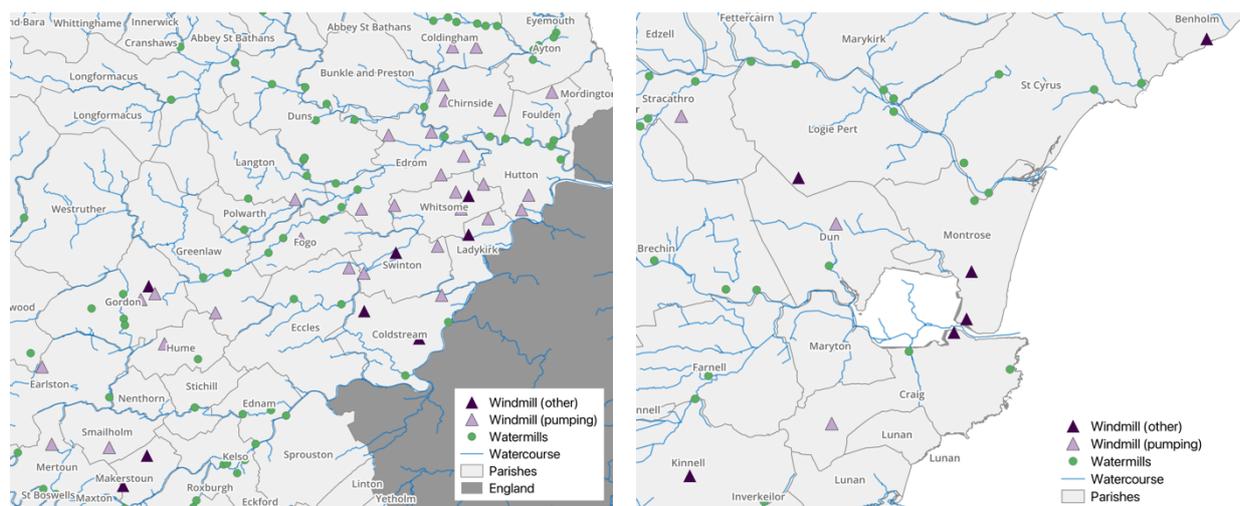


Figure 4. 27. Close up of Berwickshire (left) and the coast of Forfarshire and Kincardineshire (right) showing location of windmills in relation to watercourses and confirmed water-powered sites.

Early windmills could only function when the wind blew in a particular direction. Later, they were developed so that the body or top (cap) could be moved and rotated into the wind. There were two methods for this. In one, known as a 'post mill' or 'German windmill', a wooden structure was arranged on a vertical post, and the entire structure could pivot to turn towards the wind (Fairbairn and Pole, 1877). Later, the 'tower mill', or 'Dutch mill', gained popularity. These were stationary towers, typically constructed of brick or stone, with a moveable cap with sails at the top. A standard set of sails carried four vanes made of thin strips of wood or canvas. When wind blew perpendicular to the sails, rotational movement was generated and transmitted via gearing to the machinery within the mill (Fairbairn and Pole, 1877: 274–283). The characteristic Scottish windmill was a vertical tower mill, bar the odd 'experimental' horizontal windmill (Donnachie and Stewart, 1967; Hume, 1976), at least five post mills, and ten were wind-powered machines of a design specific to Orkney (Douglas and Oglethorpe, 1984; 1986). British engineers including Smeaton wrote on the horizontal windmill and they were a subject of interest for the Society of Arts, but they were never adopted on a wide scale (Bennett and Elton, 1898). Horizontal windmills were discovered in three locations by Donnachie and Stewart (1967) at Havra, Dunbar, and Elie. The first two are also mentioned by Fairbairn (Fairbairn and Pole, 1877: 274) but none were documented by the OS or Canmore. The windmills in Orkney tended to be 'amateur' and non-permanent, designed to be capable of being taken down and reinstalled at a different time or location as required (Donnachie and Stewart, 1967). In terms of ownership, as with watermills, some windmills were owned by the burghs and others were private ventures. However, unlike watermills, tenants may not have been obliged to pay thirlage to windmills in Scotland (Walker *et al.*, 1987: 29). If this was the case, then perhaps this difference in the law could have acted as motivation for landowners to give preference to the building of a watermill on their land, if feasible, rather than a windmill.⁹⁴

There were 145 windmills most likely used in the production of grain (Figure 4.28). Documentary evidence confirmed 20 were used for grinding grain (meal, barley, and corn) and ten to be wind-powered threshing mills. Though the others were not confirmed, their function can be inferred based on the literature on windmills and the assumption that a more unusual function would likely have been documented by the OS surveyor as being of

⁹⁴ Walker *et al.* (1987: 29) state that thirlage legally only applied to watermills in Scotland. However, in practice, some laird's did bind their tenants to a windmill *e.g.* in Dunbarny parish: 'inhabitants were "thirled" to the wind-mill that stood a little to the west of Dunbarny House' (*NSA, Dunbarny, Perth, Vol. 10, 1845: 818*).

particular interest. Some would have a kiln attached to the stone tower of the mill or located separately nearby. The previously mentioned Orkney mills were usually farm windmills, used to power agricultural machinery held inside a barn. The only windmills recorded in this dataset that were not associated with grain, agricultural functions, or pumping water, were two sawmills located 76 km west of Fraserburgh at Garmouth and in Airth. The wind-powered sawmill found its way to Scotland in the early-seventeenth century (Shaw, 1980: 648) and persisted in very small numbers into the mid-nineteenth century. The most notable example was the Garmouth mill, where the Glemore company had both a watermill and a windmill in the 1790s to power sawmills with as many as 40 frames in each (Shaw, 1980: 48). The Garmouth windmill fell out of use, being replaced by a steam-powered mill prior to the OS survey in 1861. Other sources have identified wind-powered sawmills at Peterhead (Aberdeenshire) and Ceres (Fife), and a woodturning mill at Crieff (Perth) that operated from an unknown date until 1854 (Porteous, 1912: 189; Shaw, 1980).⁹⁵ Unusually, one windmill in Stoneykirk in Wigtown, was classified by Canmore as a textile mill. Described as ‘a round tower, possibly the base of a turret post mill or a wind-driven scutch mill’, dating to the 1770s or 1780s, it was marked as a ruin in 1847.⁹⁶ This mill was unique given that almost all lint mills in Scotland were otherwise powered by water (Turner, 1972: 129) and the location strikes as odd given that there were no textile mills identified by the OS/Canmore in the surrounding area. The *OSA* did claim that Stoneykirk grew more flax than the surrounding parish but the Dumfries and Galloway region in general was not one of Scotland’s major flax producers.⁹⁷

⁹⁵ The owner, William Anderson, also feued a sawmill nearby. It was said that he ‘found some difficulty in conducting his work’ so erected a windmill that was ‘considered a great novelty’ (Porteous, 1912: 189).

⁹⁶ NRHE ID: 60593 (Stoneykirk, Windmill). Scutching was part of the process of preparing flax prior to spinning.

⁹⁷ *OSA*, Stoneykirk, Wigtown, Vol. 2, 1792: 5; See Turner (1972: 131) for a description of the geography of flax cultivation in Scotland including a map of all parishes in the *OSA* that note flax growing.

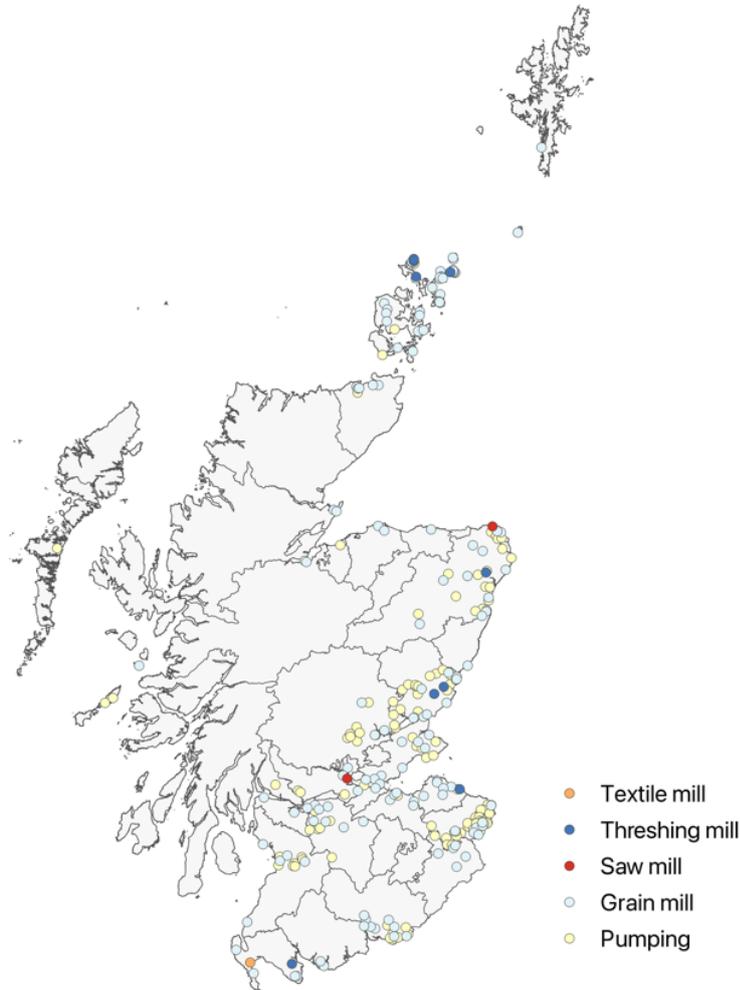


Figure 4. 28. Cumulative distribution of windmills from the OS/Canmore and their industrial function.

Pumping mills are included as a sub-group under tower mills, often sharing similar architectural structures for their base (Figure 4.29). Despite differences to what may typically be thought of as a mill, the wind engine or windpump is worth including as they could perform some of the same functions as water- or steam-powered mills such as wood sawing, driving of farm machinery, well pumping, draining, irrigation, and electric lighting (Hills, 1994: 262). The pumping windmill gained popularity in the twentieth century but was not a modern invention. The Dutch adapted grain grinding windmills for pumping in the early-sixteenth century in response to the need for land reclamation. To give an idea of the capability of these mills, a single windmill in the Netherlands was recorded in the draining of an entire small lake (<6 km²; Hoeksema, 2007: 116). Evidence suggests the technology had reached Scotland by the 1700s. The Savoch Windmill (Aberdeenshire),⁹⁸ built in the late-

⁹⁸ NRHE ID: 21089 (Savoch Tower Pumping Mill).

eighteenth century, is thought to have pumped water for its entire existence and the ‘Old Windmill’ described at Achscrabster Quarries on the 2nd edition OS map pumped water until c.1860.⁹⁹ In the late-1800s and early-1900s, the most common use of wind in Scotland was on farms to extract water from wells and springs in rural areas (Douglas and Oglethorpe, 1984). On the 2nd edition OS sheets, a new annotation allowed for a clearer distinction between pumping and other types of windmill: ‘Windmill (Pumping)’. Prior to this, annotations and pictorial representations on the maps suggest only the presence of the traditional style of windmill. Of the 102 pumping windmills recorded in Scotland in 1900, 100 were entirely new - only two had functioned as windmills in the 1850s (Savoch and Gunsgreenhill). After a brief period of more rapid adoption in the first half of the twentieth century (as evidenced by the 1900s maps) pumping windmills suffered from obsolescence when diesel- and petrol-powered machinery took their place (Douglas and Oglethorpe, 1984).

The first detailed survey of windmills in Scotland was conducted by Donnachie and Stewart (1967) through site visits and recorded sources including private communications and maps. Donnachie and Stewart estimated a total of 90 to 100 windmills were built in Scotland for which some sort of record has been found (Table 4.5; Figure 4.30a). Of these mills, about 50 were operating in the late-eighteenth century, the greatest number of ‘traditional’ windmills functioning at any one time in Scotland. Compared to the OS/Canmore dataset, Donnachie and Stewart’s survey is less complete in terms of numbers, though their inventory gives a richer picture of the diversity of windmills uses. They describe, for instance, a windmill in Leith for the refining of lead-ore and another in Elie for grinding indigo. Douglas and Oglethorpe (1984; 1986) expanded on this research, recording 66 windmills (Figure 4.30b). There is a significant discrepancy between the total number of mills in my dataset and that of other sources (Table 4.5) though the geographical distribution corresponds between them. In part it is likely that some studies (Donnachie and Stewart, 1967; Hill, 1995) did not include all pumping windmills. According to Hills (1994), the American design of wind pumping engines began to influence the British agricultural market from the 1870s (which coincides with the timing of the 2nd edition OS survey) and these may not have left archaeological remains. The only attempt to catalogue wind pumps in Scotland are those of Douglas and Oglethorpe (1984 ; 1986) who found 371 sites with wind pumps. Their surveys, conducted between 1981–1982, used the 1:50,000, 1st and 2nd ed OS maps as well as maps from earlier

⁹⁹ NRHE ID: 7927 (Achscrabster Quarries, Windmill).

periods, previous published studies, and communications with owners of sites of wind pumps. These communications with site owners confirmed the OS maps did not provide a record of every single pump. A clear benefit of their data is the additional detail, including the classification of mill types (wind powered machines, turret mills *etc.*), that was not capable from the maps or the Canmore classification.



Figure 4. 29. Remains of three former Scottish windmills/windpumps. From left to right: Wind-powered threshing mill in Ellon, Aberdeenshire; Savoich tower pumping mill in Lonmay, Aberdeenshire; windpump in St Andrews and Deerness parish, Orkney.¹⁰⁰

Table 4. 5. Comparison of estimates of windmill numbers in Scotland

Source	Number of windmills
Hills (1994)	100
Donnachie and Stewart (1967)	90–100
Douglas, G. J., and Oglethorpe, M. (1984; 1986)	434 (66 traditional windmills and 368 windpumps)
Canmore	189 (178 traditional and 11 windpumps)
1 st and 2 nd edition OS maps	198 (84 traditional windmills and 114 windpumps)
1 st and 2 nd edition OS maps combined with Canmore	284 (159 traditional windmills and 125 windpumps)

¹⁰⁰ Trove.scot image ID: SC 446041 (Hilton, Windmill View from N); Trove.scot image ID: SC 507691 (Savoich Tower Pumping Mill General View); Trove.scot image ID: SC 1923092 (General view). Reproduced courtesy of Historic Environment Scotland.

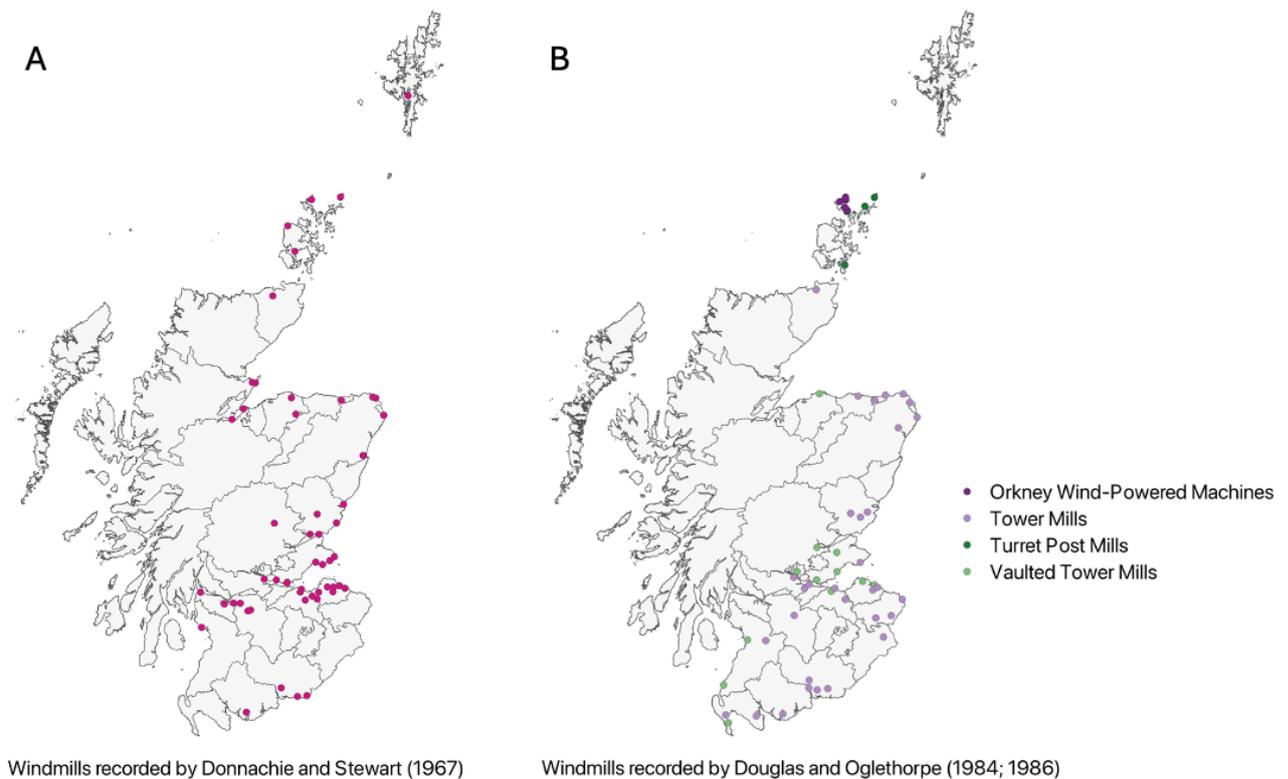


Figure 4. 30. All known ‘traditional’ Scottish windmills based on (A) Donnachie and Stewart (1967) and (B) based on Douglas and Oglethorpe (1984; 1986). Only windmills which the authors recorded as certain are mapped.

4.3.3 Steam Mills

Steam engines work by heating water in a boiler until the water evaporates into steam. The steam is then released at high pressure into a chamber containing a piston which is moved when the steam expands and puts pressure against it. Releasing the steam from the chamber via an exhaust vent results in the piston returning to its starting position. The process is repeated, achieving a back-and-forth motion that, by connecting the piston to rods and cranks creates rotational force to power machinery (Britannica, 2025b). In total, 247 steam mills were identified, 203 which were operating in the 1850s and 215 operating in the 1900s (Table 4.6). Over two thirds of the steam mills (175 mills) were present in both periods, with 29 recorded in the 1850s that were not recorded again in the 1900s, and 38 new steam mills in the 1900s.

Table 4. 6. Steam mills according to period and industry.

Number of steam mills in each industry	Date			Overall number
	1850s	1900s	<i>PU</i>	
Textile	148	158	8	180
Wood	17	16	2	25
Grain	29	21	2	36
Paper	3	8	0	8
Other (chemical, animal, metal, alcohol, unknown industry)	3	8	0	11

The lack of a significant increase between these two periods may, in part, be due to the representation of sites on the OS maps. Alternatively, this could be an indicator that growth in steam power use had already stagnated or even reversed by this time. In Dundee, for example, the steam engine began to be phased out in favour of electricity from as early as 1903 (Turner, 1952: 117). Some mills opted to use steam from their initiation, while some transitioned from one technology to the another, and others utilised multiple power sources together. Just two mills were wind-powered prior to their conversion to steam-power while 78 sites (~31% of all steam mills) are known to have used both water- and steam-power during their operational lifetimes (Figure 4.31). Water- and steam-power could be used for different purposes at these sites, such as at Deanston Mills (the third case study in Chapter 5) which used an engine to power a machine works and a waterwheel for carding machines. Alternatively, an engine could supplement waterpower as an auxiliary backup for a primary waterwheel (*e.g.* Culcreuch Mill in Figure 4.32) or be used to recirculate water back to the waterwheel or reservoir, preventing water shortages (*e.g.* Redford Flax Factory and Underwood Mill, Figures 4.33 and 4.34).

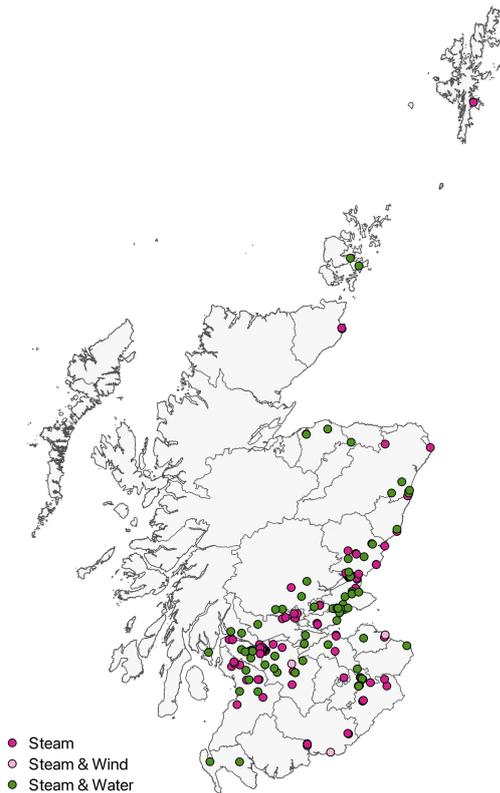


Figure 4. 31. Steam mills displayed according to whether they used additional power sources. Where a mill is shown to have used two motive powers they were not necessarily in use during the same time period.



Figure 4. 32. Culcreuch Mill and its associated lade and reservoir: described in the OSNB as a ‘large Cotton Spinning Mill four and six Storeys high...worked by a Waterwheel of Sixty horse power, there is also an auxiliary Steam Engine of the same power, in case the water runs short, but this is very seldom the case the water of the Endrick affording a regular and good supply and for the last 12 months the mill has only been delayed 10 hours for the want of water’.¹⁰¹

¹⁰¹ Ordnance Survey, 25 Inch to the mile, Stirlingshire XXI.4 (Fintry) (Surveyed: 1861, Published: 1862). View online: <https://maps.nls.uk/view/74983326>. Reproduced courtesy of the National Library of Scotland; OS Name



Figure 4. 33. At Redford Flax Factory in Drycart Parish (Fife) a steam engine was used to power a centrifugal pump to take water from the River Ore into a reservoir ('an oblong excavation forced with stone') where water could be held for use by the flax spinning mill.¹⁰²

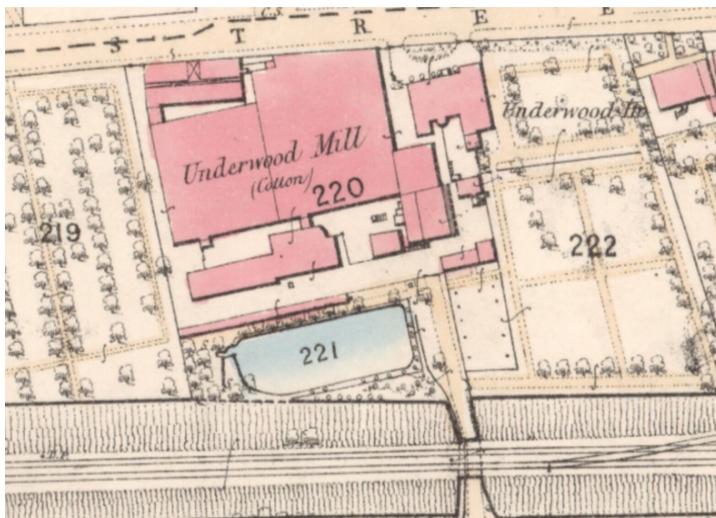


Figure 4. 34. Underwood Mill (Paisley) installed a pumping engine of the Newcomen or Savery type in the 1790s to take water from a reservoir to a mill wheel (Nisbet, 2003: 178). The OSNB notes a 60 hp engine by the mid-1850s (roughly correlating to when the map displayed in this figure was surveyed) although it is not specified if it was used for recirculating.¹⁰³

Books - Stirling county - Volume 13 - Parish of Fintry - 1858-1861, OS1/32/13: 7. NRHE ID: 159738 (Fintry, Culcreuch Mill).

¹⁰² OS Name Books - Fife and Kinross county - Volume 12 - Parishes of Abbotshall, Auchterderran, Dysart and Wemyss - 1853-1855, OS1/13/12: 16.

¹⁰³ Ordnance Survey, 25 Inch to the mile, Renfrewshire XII.2 (Abbey, Middle Church, High Church and Low Church) (Surveyed: 1858, Published: 1860). View online: <https://maps.nls.uk/view/74964128>. Reproduced

Forfarshire took the lead in adoption of steam in terms of total numbers of mills using steam (Figure 4.35), driven by the jute and flax industry in Dundee, with 60 steam-powered mills in that city alone. A more modest figure of 19 steam mills were recorded for Glasgow, including Govan. Most impressive were the 14 steam mills in the Paisley area to the southwest of Glasgow (Paisley, Neilston, and Eastwood parishes). The location of many of the steam mills overlapped with the Midland Coal Valley (Figure 4.36). There appears also to be some correlation between hotspots of engines and locations with railway lines, and these also correspond with human influences such as densely populated places. However, the building of railway lines and stations (which could facilitate faster and cheaper transportation of coal) did not automatically result in a transition to steam power. For instance, the stretches of the Glasgow and Southwestern railway line between Cumnock to Gretna Green and from Lanarkshire to Gretna Green, were both almost devoid of steam-powered mills. On the other hand, the steam mills on the northeast coast were a substantial distance from any railroads or even collieries but could have received coal via sea. Inverness Harbour was already an important location for trade of goods and was improved in the early-nineteenth century to accommodate the increase in traffic. By the 1830s, vessels from ports in the Moray Firth carrying coal from Brora colliery were regularly stopping at the Kyle of Sutherland (Wheeler, 1963). The relationship between coal, transportation networks, and mill location is returned to in Chapter 6, section 2.1.

An important consideration when deciding to use steam would have been access to coal. Ayrshire, Lanarkshire, and Fife were the centres of Scottish mining activity, reflecting the location of accessible coal seams. Outside the region there were only isolated deposits of coal. The Brora colliery in Sutherland was the only Highland source of coal. The locations of known steam mills in c.1900 can be compared to colliery locations for the same time period in Scotland and northern England (Figure 4.36).¹⁰⁴ The mill in closest proximity to any colliery was Dawsholm Paper Works in Glasgow located 0.39 km from the Garscube Colliery. The average distance between a steam mill and a colliery was calculated as about 23 km. There were 60 sites located within 5 km from a colliery and 42 steam mills were between

courtesy of the National Library of Scotland; OS Name Books - Renfrew county - Volume 19 - Town of Paisley - 1856-1857, OS1/26/19: 59.

¹⁰⁴ Colliery locations were derived from the GB1900 gazetteer of place names on the 2nd edition 6-inch to the mile OS mapping.

5 –20 km from a colliery as the crow flies. In reality, the distance that coal would need to be transported was much further due to the transportation links that were available at the time. A mill manager might not even choose to use the most local coal mine as there were different quality of coal available. Newcomen engines installed at mines could operate on the lowest quality, unsellable coals, whereas a higher standard coal was preferred as fuel for an engine for manufacturing (von Tunzelmann, 1986).

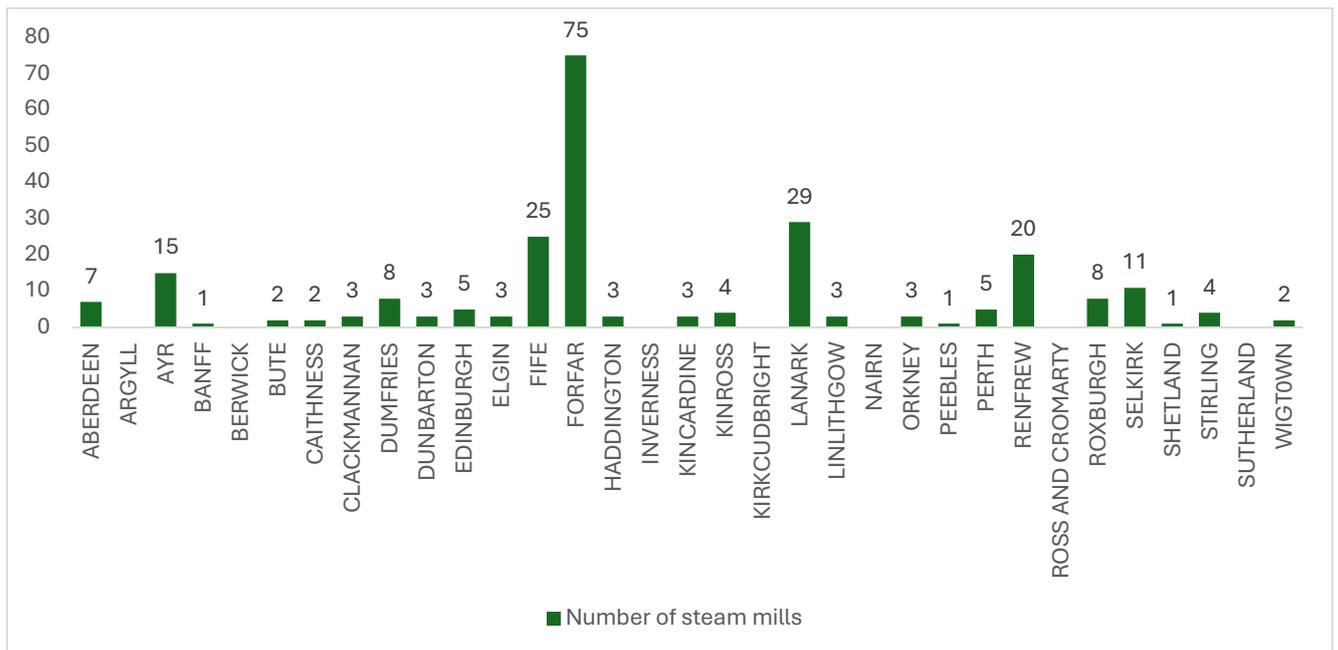


Figure 4. 35. Cumulative number of steam mills by historic county recorded from the OS/Canmore. The number of mills does not equate to the number of engines *e.g.* at New Lanark there were at one point four mill buildings powered by multiple wheels but just one steam engine. Conversely a mill site could have multiple engines.

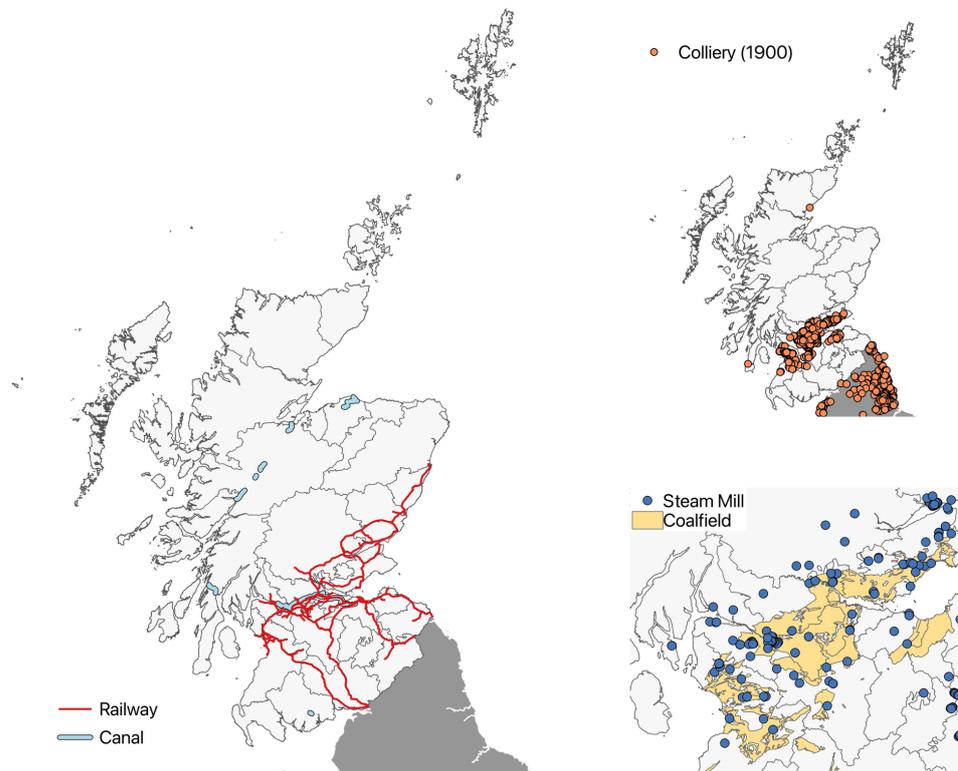


Figure 4. 36. Left: Location of canals and railways (1851); Top right: collieries (1900); Bottom right: steam mills in relation to the main coalfields in Scotland’s Central Belt.

Use of steam engines in mills increased significantly in the 1900s compared to the previous century. The *Early Engine Database* (Kanefsky, 2024), a project recording steam engines constructed in the United Kingdom prior to 1801, lists only 38 mills in Scotland with steam engines between 1765 and 1800. This is out of a total of 369 Scottish engines, where the majority were located predominantly at mines, quarries, or metalworks. There were 25 pre-1800 engines used at cotton mills, eight installed at flax mills, and others at a bleachworks, grain mill, paper mill, tannery, sawmill, and woollen mill (Figure 4.37). The difference in total numbers of mills with steam engines suggests the key period of transition occurred in the intervening period between datasets (1800 – c.1850). However, the spatial distribution of engines would suggest that the earliest engines were installed in locations that would become hotspots for steam, namely Dundee, Glasgow, and Renfrew (Figure 4.38).

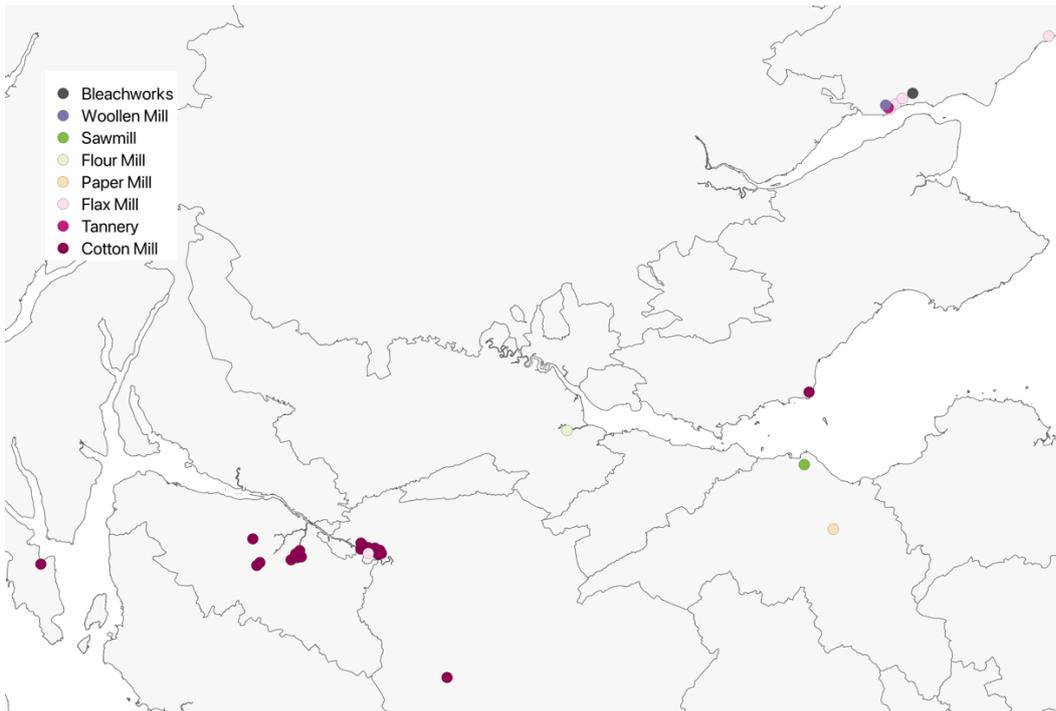


Figure 4. 37. Pre-1800 steam mills (Data based on Kanefsky, 2024. Where accurate coordinates were not known, the location was estimated).

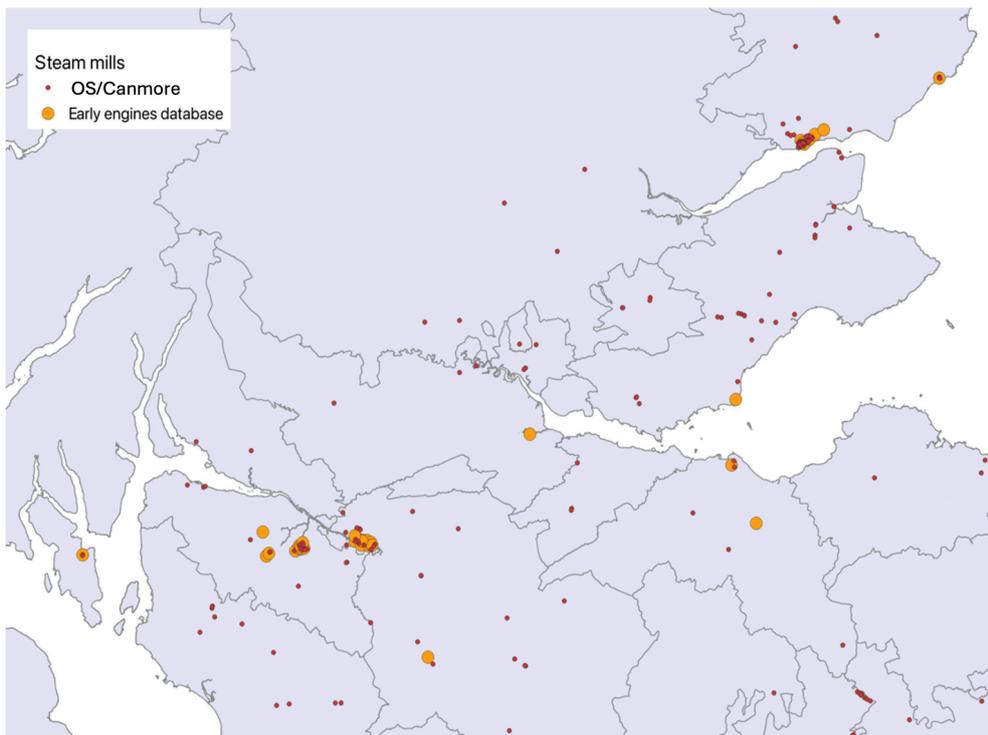


Figure 4. 38. Early Engine Database (orange) against cumulative OS/Canmore data (red) showing continuity in areas with clustering of steam mills.

As mentioned, when steam was adopted, it did not always replace a waterwheel powering machinery. The *Early Engine Database* provides additional information related to the purpose of the engine that the OS/Canmore mill database at present lacks. Five early engines were installed for the initial purpose of recirculating water at cotton mills and a bleachfield. Kanefsky (2024) found one engine used as a backup power source for Houston Cotton Mill, Johnstone, installed in 1793. The rest of the early engines, where the information is known, were used to directly drive grain milling or textile machinery.

It is important to note that the number of engines has certainly been underestimated by this research. Some of the mills described in the following chapter (Chapter 5) converted to steam, yet none were necessarily identified as using a steam engine from the OS maps or Canmore classifications alone. Steam mills are among the categories most likely to have suffered from underestimation due to exclusion of the terms ‘factories’ and ‘works’ when extracting data from GB1900.¹⁰⁵ Rosemount Works,¹⁰⁶ a tape and wincey manufactory in the town of Aberdeen that was steam-powered from its inception in 1864 provides just one example of a steam mill missed due to the term *works* rather than *mill* and discovered outside of the data collection stage of the research.¹⁰⁷ An idea of the extent of the underestimation is gained by comparing Mark Watson’s inventory of jute and flax in the Dundee region. His record of ‘nearly every mill and most power-loom and ancillary works in Dundee and Lochee’ (Watson, 1990: 11) lists 125 mills, at least 79 of them steam-powered.¹⁰⁸ This demonstrates the need for combining multiple sources of evidence and/or collaborating with other researchers to create a more comprehensive database, in the case of steam mills especially. However, there is still value in the OS/Canmore data for identifying areas with greatest uptake of steam and for recognising general patterns of distribution, even if the data do not necessarily bring us closer to estimates for total engine numbers or hp sought by von Tunzelmann, Nuvolari, and other economic historians referred to in Chapter 2.

¹⁰⁵ See Sections 3.2.1 and 3.2.2.2 of the methodology in Chapter 3.

¹⁰⁶ OS Name Books - Aberdeen county - Volume 1 - City of Aberdeen - 1865-1871, OS1/1/1: 190.

¹⁰⁷ Wincey: the Scots name for plain or twill-woven cloth, usually of wool and cotton.

¹⁰⁸ This was derived from Watson’s (1990) descriptions of the industrial archaeology of the mills. Of these, 79 were described as having engines or engine houses.

4.4 Industry

Whether it was an innovation of the Romans or part of a medieval technological revolution, is debated (Lucas, 2005), but advancements such as the incorporation of cranks were made to milling technology that allowed water - and other sources of inanimate – power to be applied to industrial processes beyond grain milling. Waterwheels could then be used to provide rotary motion with millstones (flour mills, ore grinding, tanning mills, sugar mills *etc.*), without millstones (rolling mills, turning mills, silk mills *etc.*), or for a reciprocating motion via a cam or crank (*e.g.* saw mills or hammers for hemp mills, paper mills, and fulling mills) (Reynolds, 1983: 70). Modifications took the waterwheel from a device limited to specific tasks to a general purpose technology for providing motive power across the spectrum of industry. Lucas (2006) estimates that in the medieval period, about 90% of mills in England were used for grinding grain and the other 10% used for various industrial processes (Lucas, 2006). Of that 10%, around 9% were used for the fulling of cloth. It would be reasonable to assume similar proportions for medieval Scotland, but over time, this changed considerably, such that, by the nineteenth century, nearly every corner of the economy applied mills in various ways to conduct work (Figures 4.39 and 4.40). What is most striking is the sheer diversity of uses for mills in Scotland. Here, textile mills alone have been divided into 27 subcategories and mills which ground grain could be divided into five primary types (corn, meal, flour, barley, farina) (Appendix 7).

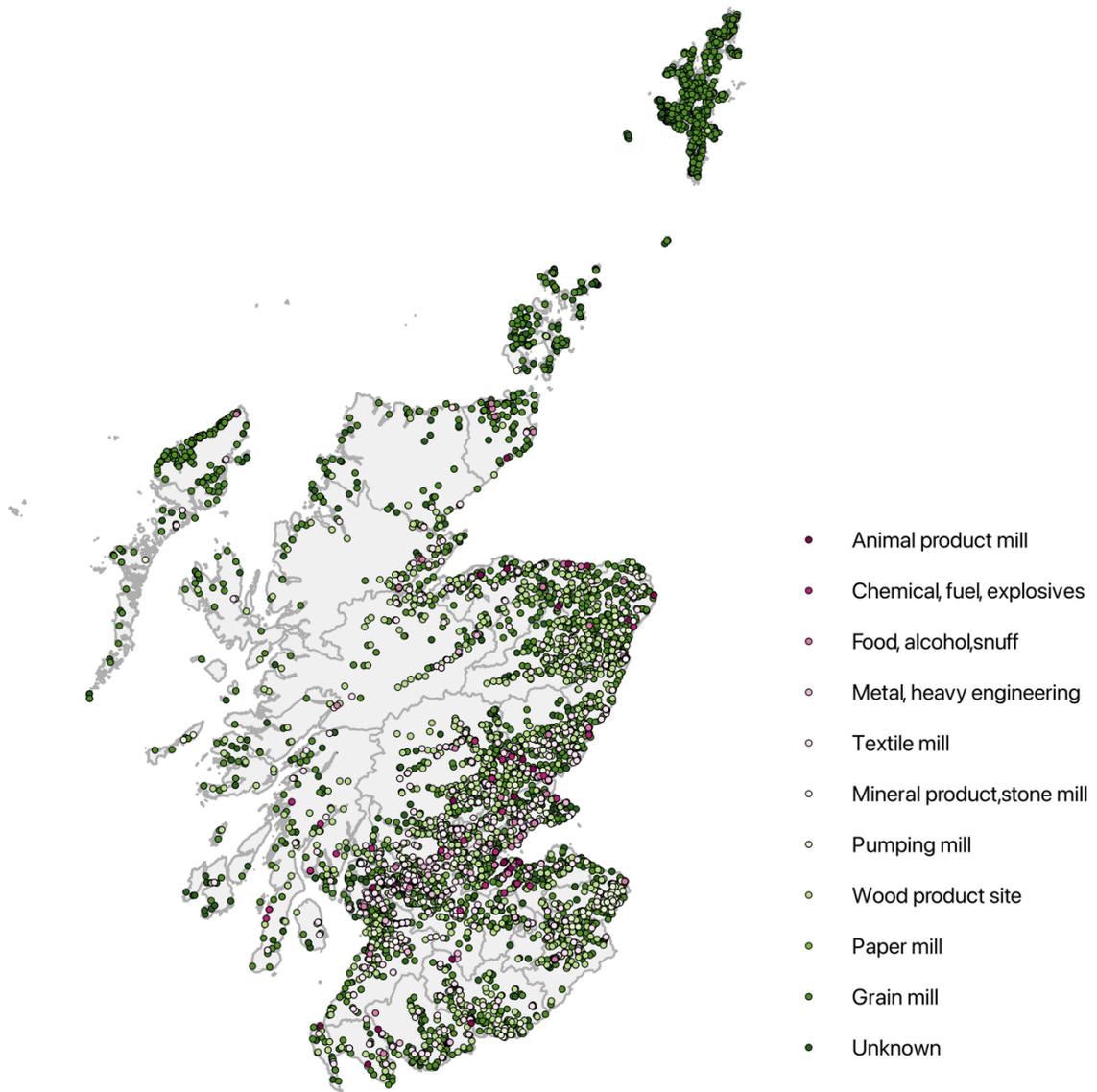


Figure 4. 39 Cumulative mills dataset displayed according to industry.



Figure 4. 40. Cumulative mills dataset displayed according to individual industries or groups of industries.

Just as the motive power sources might change, the industry, buildings, and ownership of mills also changed frequently. The idea of the re-use of mill buildings, making use of prior capital investment, was introduced in Chapter 2 (section 2.2.3). The majority of bobbin mills in the northeast of Scotland, for instance, are thought to have occupied former corn mill or textile (specifically lint and waulk) mill buildings (Gilliatt, 2018:1). The following chapter includes an examination of such changes in detail for six mills in the cotton industry. It was also not uncommon to find more than one industry taking place at the same mill location. There were 365 mills found to have operated within two separate industrial functions during their existence but only 21 permitted three industries. Separate industrial function here refers to seemingly unrelated functions recorded at the same location by Canmore or the OS maps, or those that were complementary (wooden bobbin making and cotton thread for instance). This figure would rise substantially if mills producing multiple products using the same function were included *e.g.* a mill for grinding corn, barley, and farina.¹⁰⁹ These multi-purpose mills included Waterford Mills, in the parish of Forres, Elgin, where there was a bone mill, flour mill, and chemical works, all within a four-storey mill building powered by steam. The proprietor of the bone and flour mills was recorded as Robert McKessack, whereas the chemical works had a separate owner, James Thompson Wilson, a resident of Edinburgh.¹¹⁰ Leven Mills in the county of Fife comprised an impressive four industrial functions.¹¹¹ Described in the 1850s as '[a]n extensive pile of buildings Containing a flour, Flax, Spinning, Saw and Bone Mill propelled by Water Power, held under a lease of 99 years', the mill had reduced its range of products by 1893, focusing on oilcake and bone. Of the remaining mills, 4472 conducted work in only one of the primary industrial functions. Whilst this does not mean that they did not change function during their history, it suggests that if they did, the majority did not stray far from their original functions. There were a further 989 mills for which an industrial function could not be identified.

The least common category identified was mills working with (rather than quarrying) stone, all powered by water. These were: a whetstone mill in Ayr for dressing and polishing stone from Dalmore Quarry, a task accomplishable with a 10 hp waterwheel; a manufactory within

¹⁰⁹ Farina mills made potato starch for use by bakers and in textile finishing. They have been grouped with grain milling rather than textiles in recognition of their frequent concurrence with processing of grains.

¹¹⁰ OS Name Books - Morayshire - Volume 13 - Parish of Forres - 1868-1871 OS1/12/13/1: 3.

¹¹¹ OS Name Books - Fife and Kinross-shire - Volume 98 - Parishes of Scoonie - Markinch and Wemyss - 1853-1855, OS1/13/98: 14. The text on the 1st edition OS map lists only 'Flour, Flax & Spinning'. The Descriptive Remarks of the OSNB record the additional industries. Flax and spinning were counted as one as they both fall under textiles.

a small house in Falkland, Fife, for making slate pencils; and another simply named ‘slate mill’ in Rescobie, Angus. A final stone mill at Haugh in Mauchline, Ayr, was the result of a more unusual transformation of a corn and sawmill into a curlingstone mill between the 1st and 2nd edition OS surveys. This mill also provides a particularly interesting example of unrelated industries co-locating together and sharing natural water resources and artificial infrastructures such as mill lades (Figure 4.41). The mill lade first reached the woollen mill employing around 30 people in spinning yarn for the Kilmarnock carpet manufactory, then provided water to the curlingstone mill, about 160 m downstream, and then finally to the Ballochmyle Creamery just before the lade rejoined the main river channel.¹¹² The creamery may have been constructed on the site of a pre nineteenth-century mill given the presence of ‘ruins’ recorded at its location on the 1st edition OS map. While many industries in the region changed over time, the suitability of this location for water-powered manufacturing did not.

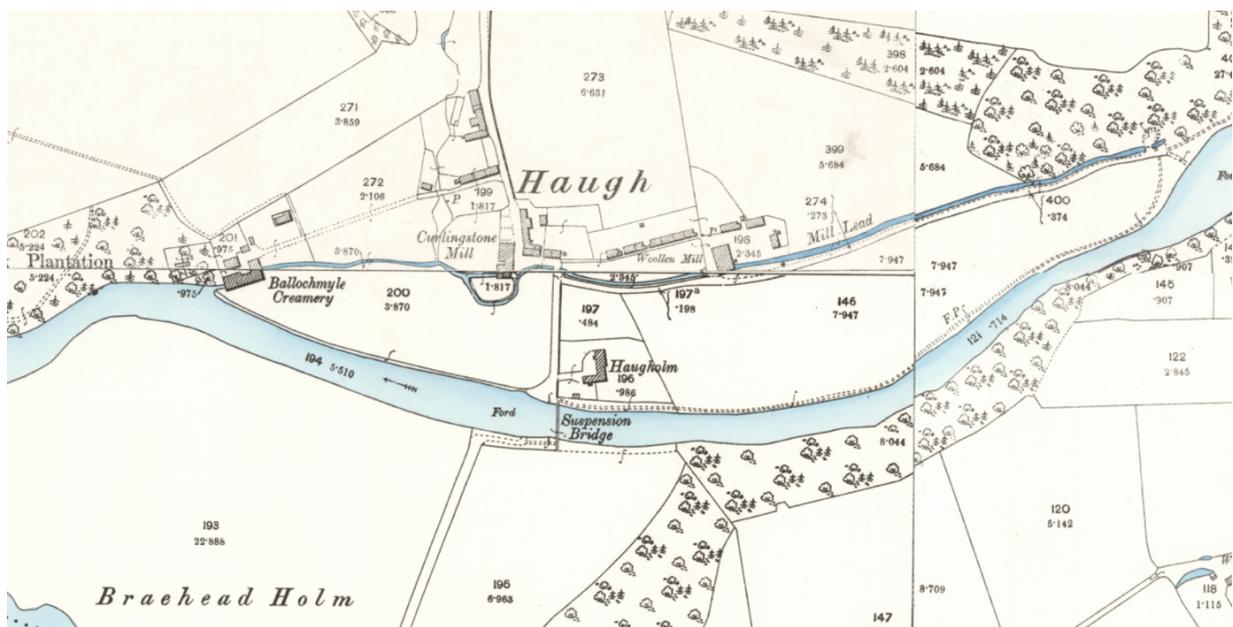


Figure 4. 41. Mills at Haugh, Mauchline.¹¹³

Certain industries in Scotland were highly specialised and localised, where some developed independently while other small industries were shaped by the growth of other sectors. Bobbin or pirn mills (the Scots term) are an example of a co-dependent industry, set up to supply textile manufacturing. Although only 17 mills were identified with this function,

¹¹² NSA, Mauchline, Ayrshire, Vol. 5, 1845; NRHE ID: 295838 (Haugh, Woollen Mill).

¹¹³ Ordnance Survey, 25 Inch to the mile, Ayrshire XXVIII.12 (Revised: 1895, Published: 1896). View online: <https://maps.nls.uk/view/82867731>. Reproduced courtesy of the National Library of Scotland.

Gilliatt (2018) found 88 bobbin mills between 1830 and 1980 in the north of Scotland (which they define as north of Perth).¹¹⁴ Both figures are an enormous increase compared to the five bobbin mills documented by Shaw for the years 1848–1880 (Shaw, 1980: 747), potentially indicating a growth in output from the textiles industry. The large number of bobbin mills in the Highlands was in part to supply the demand from Dundee textile mills, but bobbins were also taken to the thread-making centre of Paisley – ‘The Town that Thread Build’ (Fagan, 2023: 121) – where vast local demand outstripped supply. In the Midland Valley/Central Belt of Scotland, there were also pirn mills on the islands of Bute and Arran. Pirnmill on Arran operated from 1780 to the 1840s, mostly supplying the market in and around Paisley and was at one point run by the Clarks of Paisley, one of the major thread companies. Although Pirnmill had a good location for markets in Renfrewshire, the supply of raw materials was inconsistent enough to stop production in the 1840s due to shortages (Weir and *Ayrshire Archaeological and Natural History Society*, 2020). The shortage of wood locally may explain why another Paisley manufacturer, Messrs Carlisle of Paisley, established a steam-powered bobbin mill at Inverfarigaig in 1848 that transported its products to Paisley by water on the Glasgow paddle steamer (Gilliatt, 2018). This was an astute investment considering the essential nature of bobbins to thread-making and textile weaving. The New Lanark Mills, without their own bobbin supply, struggled to meet promised orders of cotton goods in the summer of 1881 due to a shortage of bobbins.¹¹⁵ The locational geography of bobbin mills therefore reflects a combination of access to raw materials and the market for the product.

A final small industry with a curious geography will be mentioned here: snuff mills.

Introduced around the 1740s, the industry never took off since much of the tobacco imported to Scotland was exported again rather than processed for use domestically. Shaw (1980) mapped 36 snuff mills in Scotland between 1730–1850 but only six operational snuff mills were recorded on 1900s OS maps, the industry for processing tobacco having seemingly died out by this time. Most snuff mills operated in the east of Scotland near Edinburgh or near Glasgow in the west. Their concentration ‘reflects both the sources from which their raw material was derived and the markets to which their products were destined’ (Shaw, 1980:

¹¹⁴ Gilliatt’s research was conducted primarily through online research including many of the same core sources as this thesis: OS maps, OSNB, newspaper articles, the *NSA*, Canmore. They complemented documentary sources with personal accounts from local residents and historians (2018: 15).

¹¹⁵ Titled Letter book No. 1, 1881. Records of Gourock Ropeworks Co Ltd, rope makers and textile manufacturers, Port Glasgow, Inverclyde, Scotland. University of Glasgow Archives & Special Collections. GB 248 UGD 042/7/9/2.

691). Snuff mills are thought to have mostly been of modest size, with fairly low power requirements and only requiring two or three employees. All snuff mills were water-powered excepting one at Cupar (Fife), which used an auxiliary steam engine in the 1830s (Shaw, 1980: 688). Availability of coal may still have been a locational consideration for all snuff mills because the tobacco needed to be dried prior to grinding. Nisbet has suggested this was the primary incentive for the location of the Netherlee snuff mill to the south of Glasgow (Nisbet, 1994: 2).

What is most interesting about Scotland's snuff mills that warrants further investigation is the apparent locational tie with the paper industry. In the Juniper Green area along the Water of Leith (Figure 4.42), five snuff mills were interspersed among other mills that included five paper mills within a four kilometre stretch of the river. Three of the Renfrewshire mills converted milling premises from snuff milling to paper milling or vice versa in the eighteenth century (Nisbet, 1994: 3), and the owner of a paper mill purchased the Stoneywood snuff mill in Aberdeen in 1810 (Shaw, 1980: 689). Whether this is coincidental, driven by external changes in markets, or if there is another social reason, is not yet known. Since there was no overlap between the technology used in either of the two industries other than their motive power, Nisbet (1994: 3) suggested that 'the snuff trade was a convenient diversion during lulls in the paper market'. However, such a motivation is not yet backed by primary evidence and so at this time remains merely conjecture.



Figure 4. 42. Distribution of snuff mills in Scotland (left) and in Juniper Green (Water of Leith) with snuff mills interspersed with those of a different function (right).

Larger industries developed their own, often distinct, geographies, and four of the industries that developed around the use of water (grain, saw, paper, and textiles) will be explored in more detail in this final section of the chapter.

4.4.1. Grain Mills

The milling of oats and bere feature the earliest application of waterpower in Scotland (Shaw, 1980: 16). From ancient times onwards, grain mills could ‘be counted in thousands’ on ‘every stream of any strength and some that were little more than trickles carrying a mill at almost every turn’ (Gauldie, 1981: 66). The distribution and numbers of grain mills has been closely tied with legislation and state policies over time. The earliest water-powered grain mills were associated with abbeys, monasteries, and estates. A mill was a reliable source of revenue and a way to attract new tenants to settle on land in the late-eighteenth century and once built, the owner of the land could enforce its use through thirlage (Gauldie, 1981: 65–66). The precise rules varied but in essence, thirlage obliged tenants to take their grain to a certain mill and to pay a proportion of their grain as a tax in kind (multures). The ruling classes ensured the necessity of the watermill by prohibiting the use of querns, an apparatus for milling grain by hand, punishable by hefty fines for those found to be in possession of one (Shaw, 1980: 19). The legislation applied until the Thirlage Act 1799 (c.55 39 Geo 3) allowed landowners to apply for the removal of thirlage in favour of annual rents payments. At the end of the seventeenth century into the eighteenth century, much of Scotland’s population was still growing grain for personal consumption on a subsistence basis (Smout and Fenton, 1965: 74), a pattern that changed over the course of the Industrial Revolution. A further defining policy, initiated with the Corn Law of 1815, was introduced in the interest of farmers and landowners. This law restricted and placed tariffs on the importation of foreign cereals except during periods when British grain prices rose above established thresholds (McLean and Bustani, 1999: 819). The 1815 and subsequent Corn Laws therefore promoted a prolonged need for homegrown grain and local mills to process it, stunting the growth of the town mill until the Laws were repealed in 1846. A wider knock-on effect enacted by the repeal was a redistribution of resources instead towards manufacturing industries and labourers into the factory system instead of agriculture. To restore economic equilibrium, increased exports were needed to pay for increased food imports (Irwin and Chepeliev, 2021: 4).

The reduction in number of grain mills over the following century also reflected changing agricultural practices that included a shift from cultivating oats and barley to instead growing potatoes as the main crop in the Highlands (Withers, 1998: 37) and in the rise of larger town mills in the nineteenth century (Gauldie, 1981: 74). This is especially evidenced by a fall in the number of rural mills from the 1700s and 1800s. The number of grain mills continued to diminish in the twentieth century following competition with cheaper imported grain and flour. The total number of grain mills recorded by OS maps and Canmore reach 2,502 mills (Figure 4.43), half the number of grain mills Shaw (1980: 291) suggested were in existence by 1730. In this instance, a higher estimate is likely more accurate. Given the long history of grain milling, the earliest known water-powered mill for grinding oats and bere dating to the twelfth century (Shaw, 1980: 16), many country grain mills would have long been abandoned, falling into ruin, and any significant structural remains disappeared prior to the OS surveying. Town mills were owned and operated by a company rather than for an estate and were much larger both in terms of building size, number of employees, and in processing capability for grain. For example, Regent Flour Mills in Glasgow, built in 1887 at a cost of £16,000 to replace an older mill lost to fire, was a five-storey building with an adjacent six-storey storage warehouse (Hume, 2017).¹¹⁶ Regent Flour Mills most likely relied on foreign grain, Glasgow being ideally located to receive imports from England and Ireland (Gibson and Smout, 1995).

For the mid-nineteenth century, Shaw's figures and mine are slightly more aligned. Shaw (1980: 291) suggests ~3,000 water-powered grain mills in 1830, where, according to my dataset, by the 1850s there were a total 2,072 grain mills (2,017 of these confirmed as water-powered). This number falls further to 1,596 in total (1,540 water-powered) in the 1900s. The figure for 1900 still constitutes a substantial number of mills, many of them appearing to be located on rural farmsteads. The drop in numbers aligns with what would be expected given the aforementioned rise in town mills, shift to imported grain, and change from subsistence-based tenant farmers to labourers employed by other sectors. It was common for different types of grain, for example, barley and corn, or different products like flour and farina, to be ground at the same mill. This was most common at a larger mill with multiple sets of millstones because the two stones needed be set a particular distance apart from each other to achieve the desired coarseness for each product. There were also numerous instances of grain

¹¹⁶ NRHE ID: 150929 (Glasgow, Bunhouse Road, Regent Flour Mills).

mills being combined with unrelated industries such as the 147 grain mills located at the site of a sawmill.

By the 1850s steam was often a necessity for a town flour mill to remain a viable business (Gauldie, 1981: 75). Rural mills could also benefit from an increased power supply to cater for growing populations in the surrounding parish. A rising population coupled with competition from a nearby water-powered corn mill is thought to have been the reason for the conversion of the 1830s Carluke High Mill from wind-power to steam, for example. My data confirms 36 total grain mills as users of steam-power (28 from the 1850s, the remainder built later) but with only twelve of those applying steam-power alone (Figure 4.43). The others are thought to have utilised water either before or simultaneously with steam. Hume (2017) suspects the Regents Mills (flour) and Bishop's Mills (milled products for animal feed) in Glasgow used waterpower into the twentieth century. Nearly all the recorded steam-powered grain mills were town mills, with the two exceptions being Ore Mills, and Denbrae Mill.¹¹⁷ Denbrae Mill had three pairs of mill stones and was located approximately 2 ½ km from St. Andrews (Fife), so it remains plausible this mill may have supplied residents in the town.

¹¹⁷ The OSNB gave the following description of Ore Mills: 'A good, Farmhouse with outbuildings and a few cottages occupied by Laborers Also a corn and Flour Mill worked by Steam and Water'. Denbrae was described as: 'A corn mill on the Kinness burn... worked both by Water & Steam, all kinds of grain are ground in it. it is the property of Dr. Watson of Denbrae and is tenanted by Peter Barclay.' (OS Name Books - Fife and Kinross county - Volume 12 - Parishes of Abbotshall, Auchterderran, Dysart and Wemyss - 1853-1855, OS1/13/12: 25; OS Name Books, Fife and Kinross county - Volume 60 - Parish of St Andrews and St Leonards - 1853-1855 , OS1/13/60: 15).

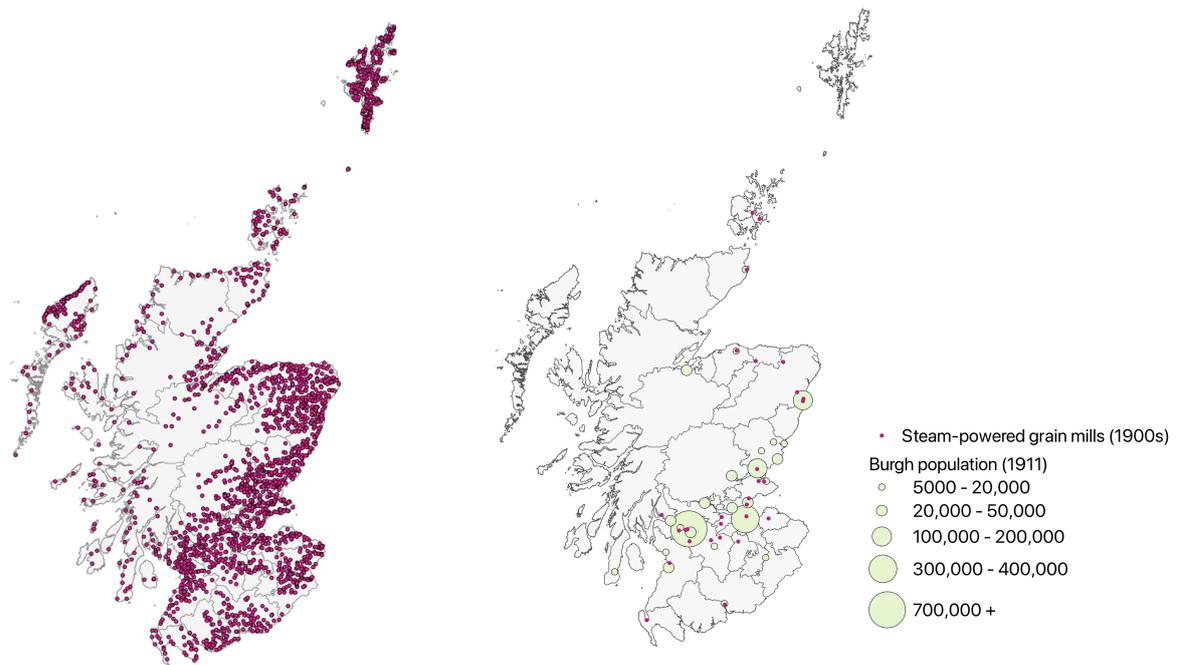


Figure 4. 43. Left: Cumulative grain mills from the OS/Canmore (wind-, water-, or steam-powered). Right: Steam-powered grain mills only present in the 1900s displayed against the 25 most populated Royal and Parliamentary burghs in 1911.¹¹⁸

4.4.2 Sawmills

The introduction of sawmills¹¹⁹ to Scotland probably did not happen until the early-seventeenth century (Shaw, 1980), remaining in ‘virtual absence’ until the 1820s (Cooney, 1991: 42). Up to this point, Scotland imported most of its timber primarily from Norway until the increasing cost of foreign timber became so great that using local sawn wood became a favourable alternative. In line with the classical theories of industrial location that prioritise resources and transportation, the distribution of sawmills generally reflects the location of raw materials and ports. A mill could make use of either natural woodland or plantations, or set up near a port to receive imported timber. Following these locational necessities, the earliest sawmills were found in the woods of the eastern Highlands. The value of wood grew such that by 1815, provision of coppicing became the most lucrative income to some Highland estates, valued above growing of crops in some regions (Lindsay, 1977). Figure 4.44 shows sawmills in large numbers near the coasts of Aberdeenshire, Banffshire, Elginshire, and Nairnshire. Sawmills were also located further inland within these regions,

¹¹⁸ Burgh population data from the 1911 census (Great Britain Historical GIS Project (2003-2023b)).

¹¹⁹ ‘Saw Mill’ written as two words on the OS maps.

along stretches of natural woodland, notably one from Aberdeen stretching westwards into the Cairngorms and another beginning in Banffshire. Apart from Glasgow and its surrounding industrial areas, the sawmilling industry also developed in the border counties of Roxburghshire and Dumfriesshire. While the occurrence of sawmills in the most northerly parts of the mainland and islands was not unheard of it was much rarer. Afforestation over the mapping interval was not necessarily profitable in these remote areas and tree growth was slower on smaller exposed islands.

Small, often water-powered mills were common on rural estates, while larger steam-powered mills more commonly located in cities near to industrial shipping areas, although this tended to be a more generalised pattern than a rule. Killearn Mill in Stirlingshire provides an interesting exception. Constructed on a farmsteading, the Killearn sawmill was originally worked by a 13 hp waterwheel in 1863 but was moved prior to the 1900s to a new building 0.5 km south, worked by steam and adjacent to the newly constructed Blackburn Siding.¹²⁰ The new mill could make use of the siding for loading and unloading freight along the Glasgow-Aberfoyle railway line, suggesting the influence of transportation networks towards the end of the Industrial Revolution, a theme that will be expanded on Chapter 6. Sawmill numbers rapidly increased in the second half of the eighteenth century, peaking in the early-nineteenth century, partially in response to population growth and the continuing trend of the enclosure of agricultural land which required materials for fencing (Gauldie, 1981: 111). A total of 1,176 individual mills for sawing wood were identified across all time periods. There were 655 sawmills present in the 1850s and 921 by the 1900s. Only 86 (7.3%) of the known sawmills were not present in one of those periods.¹²¹ Sawmills were very frequently located within or in close proximity to other mills, particularly with grain mills. There were 97 mills categorised as both grain and sawmills simultaneously at the same site and a further 50 mills that switched between the two industrial function categories prior to the 1900s. When the Killearn Mill sawmill relocated and converted to steam, a water-powered corn mill took its place on the original site. Sawmills were sometimes added to existing mills during additions. Commonly built as a lean-to on an existing building, these sawmills helped to generate extra income and assist in various projects of agricultural improvement (Gauldie, 1981). The Mill

¹²⁰ OS Name Books - Stirling county - Volume 15 - Parish of Killearn - 1858-1861, OS1/32/15: 45.

¹²¹ The true numbers of sawmills would be even higher if 'portable' saw mills that did not leave archaeological footprints were included. Such 'portable' mills were introduced to reduce wastage and need for transporting discarded portions of logs. They were moved by steam engines, using wood as fuel, and temporarily set up near the site of felled trees (Edlin, 1969: 90).

of Glenbuchat (Glenbucket), a water-powered oatmeal mill on the Water of Buchat, added a sawmill to provide cut timber for cottages on the estate in the 1870s, around 40 years after the mill's original construction (The Mill of Glenbuchat, 2022). In some cases, such as in Baldernock Mill (Dumbartonshire), the retrofitted sawmill outlasted the older corn mill, demonstrating the effects of the repeal of the Corn Laws in the nineteenth century (Bishop *et al.*, 2010).

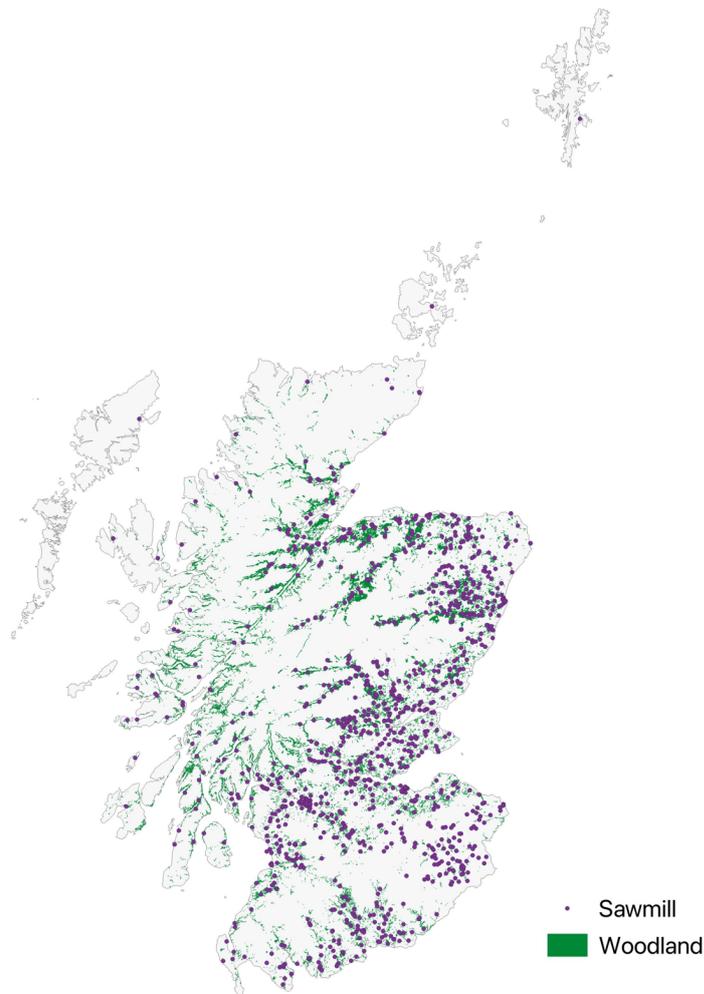


Figure 4. 44 Location of sawmills (cumulative) and ancient long-established and semi-natural woodlands (1750–1880).

4.4.3 Paper Mills

There were 72 paper mills identified in the dataset, located predominantly in the Central Belt and near the financial capital of Edinburgh in particular (Figure 4.45). The paper making industry in Scotland dates to the end of the sixteenth century, but although the first paper mill began work in 1590 at Dalry, Edinburgh, the growth of the paper industry in Scotland was

initially very limited (Coleman, 1957). The number of paper mills constructed in Scotland pre 1700 is estimated around twelve (Thomson, 1974), but the need for paper products drastically increased into the nineteenth century and Scottish entrepreneurs responded by growing the domestic paper industry. Demand grew for several reasons including increased printing of newspapers, periodicals, books, and advertisements, and a rise in letters being sent by post (Hills, 1988: 119–123). By the mid-nineteenth century Scotland was one of the three core paper producing regions in Britain along with the Southeast and North of England (Magee, 1997: 9). Among other paper mills located in the Central Belt, mills along the River Esk region, are notable. The parish and planned village of Penicuik is known as the location of one the first cotton mills in Scotland, but the area's dominant industry was paper making, beginning with the Valleyfield Mill in the late-1700s. Making use of the Esk that runs through and divides the parish, Penicuik was claimed to be as productive as the whole Kingdom of Ireland in paper making in the nineteenth century.¹²²

In addition to market considerations, two factors were essential in the location of paper making: water and people. Water availability was crucial for power and vital in the process of pre-processing fibres for paper: washing, boiling and pulping of rags. Therefore, improvements to steam engine technology made little difference to the distribution of paper mills. In 1843 the ratio of steam to water was estimated to be just 1:14 and where steam was utilised it usually supplemented a waterwheel (Hills, 1988: 159). The benefit of proximity to populated places was not only about access to a workforce. More importantly, since chemical bleaching was not used, white paper had to be made from white fibres, typically obtained from old ships' sails and from clothing (Hills, 1988: 126–7). Paper mills therefore needed to either be located near people to collect worn out rags or have a reliable supplier to source and transport rags to the mill. Although Edinburgh and the Central Belt may have dominated in terms of the number of mills in a particular region, a small group of mills in the northeast became the most productive of the country. As Scotland's third largest town for much of the nineteenth century (Table 4.7) with the Rivers Don and Dee flowing through the city, Aberdeen was an astute location for the paper industry. It was Alexander Pirie & Sons' mills in Aberdeen that led the way in terms of output for Scottish paper mills, producing 'all kinds of fine paper' including writing paper and envelopes in the 1860s, specialising in the latter in

¹²² *NSA*, Penicuik, County of Edinburgh, Vol. I, 1845: 45.

the twentieth century.¹²³ The firm had an output of c.3,300 tonnes of paper in the early-1870s, produced across four paper-making machines and increased to six machines by 1913. Their mills included: a main site at Stoneywood Works, established 8 km outside Aberdeen in the early-eighteenth century; Woodside Works, used mostly for preparation of rags; and Union Works in the centre of the city (Bartlett, 1980: 20). So successful was Aberdeen that the last of the northern mills, Stoneywood, entered administration only recently, resulting in the loss of over 300 jobs in September 2022 (Companies House, 2023).

Compared with other industries, archival records available for paper mills are particularly good. Beyond maps, comprehensive records of paper mills were compiled due to the excise tax placed on paper, and, as is the case with many other mills, from insurance policy documents (Thomson, 1974). Records are slightly less clear post 1861 when the excise duty on paper was removed (Bartlett, 1980) but up to that point a fairly confident record of paper mills can be made. A list of paper mills in Scotland published in 1832 by Oliver, Boyd, and Robert Weir gives a total of 76 mills, of which 19 were ‘converted to other purposes’ or ‘silent’, and not operating as paper mills at the time of publication.¹²⁴ Altogether this suggests 57 operational mills (Figure 4.46). In an updated list by A. F. Sommerville published in 1845, 79 paper mills are listed, a marginal increase in cumulative total mills (three) by that time, with 33 mills converted or silent, leaving a total of 46 operational (Sommerville, 1845). These mills were engaged in the production of a broad spectrum of paper products: mill boards, bonnet boards, writing and printing paper, laid paper, grey, coloured, tea, brown, news, blotting, and cartridge paper (Bartlett, 1980: 19). My data for the 1850s found 48 operational papermills, suggesting that the industry remained relatively stable in the second half of the nineteenth century. The main differences in spatial distribution over time are the closure of three papermills in Perthshire prior to 1845, and the establishment of a small paper industry in Forfarshire.

From the 1840s, geographical restrictions on paper making were altered by technological innovations and government policies. Firstly, the necessity for rags was removed by using esparto grass, straw, and wood pulp instead (Simmonds, 1870), shifting the geographical

¹²³ OS Name Books - Aberdeen county - Volume 66 - Parish of Newhills, OS1/1/66: 28.

¹²⁴ National Museums Scotland, Paper mills list / letter, T.1973.10, 1832 Oliver, Boyd, and Robert Weir.

need to places with wood mills or good transport links to receive these raw materials.¹²⁵ Secondly, the Forestry Commission, established in 1919, recognised the economic value of paper and, wanting to expand the domestic industry, encouraged the growth of plantations. The paper industry has since relied mostly on this new timber rather than historic forests or imported woods (Edlin, 1969). Cruickshank (1965: 255) has suggested that once strict environmental controls and planning legislation were introduced in the twentieth century, it was challenging for papermills to find alternative sites:

The locational pattern in existing industrial and favoured agricultural regions has been frozen, and only sites with direct access to water sources and direct discharge of wastes to the sea are available for future expansion under present cost structures.

An unusual mill captured by my dataset, W. S. Atkins and Partners' Pulp and Paper Mill, was a complete outlier in its location being at Annat, near Fort William in the western Highlands. Paper making was one of the few modern industrial processes that managed to successfully establish itself in the Highlands in the twentieth century (Edlin, 1969). This mill opened only in 1963, the product of an initiative to promote employment in a remote region and support the viability of the local railway line.¹²⁶ In this sense it shares similar incentives driving the establishment of certain eighteenth-century mills such as at Spinningdale, the final case study in the following chapter.

¹²⁵ Esparto is a coarse grass that was introduced into Britain as a paper making material around 1840, gaining popularity from c.1855 when both the demand and cost of rags was high (Simmonds, 1870).

¹²⁶ NRHE ID: 103570 (Fort William, Corpach, Scottish Pulp And Paper Mills); NRHE ID: 556411 (Fort William, Corpach, Scottish Pulp And Paper Mills).

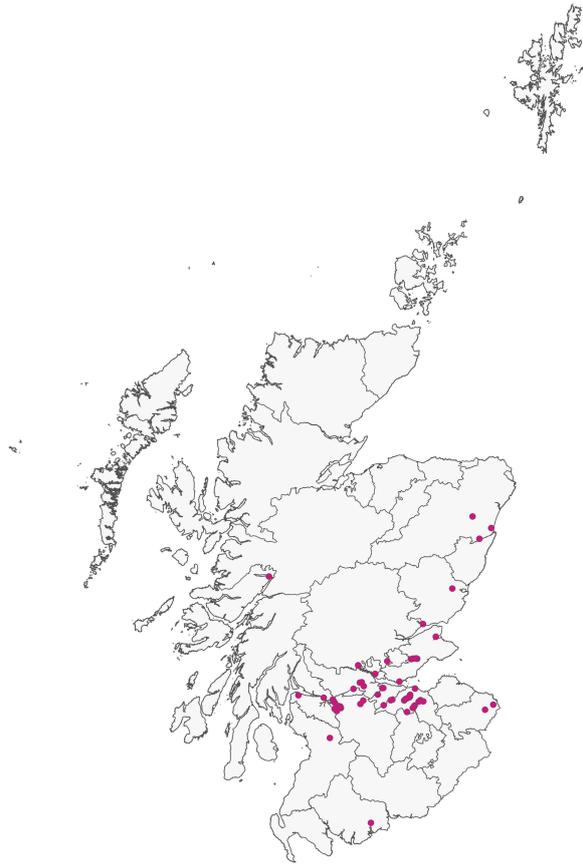


Figure 4. 45. Cumulative paper mills from the OS/Canmore.

Table 4. 7. Population of major towns (data from Great Britain Historical GIS Project (2003–2023b)).

Year	Population			
	Glasgow	Edinburgh	Dundee	Aberdeen
1801	94,939	93,112	24,036	29,881
1811	126,254	115,601	27,334	38,403
1821	168,689	154,324	28,318	48,337
1831	228,830	179,125	41,906	62,018
1841	308,275	184,319	56,722	68,937
1851	390,373	212,976	65,104	77,879
1861	459,081	213,005	93,388	79,070
1871	NA	NA	NA	NA
1881	629,464	296,680	142,158	110,481
1891	NA	NA	NA	NA
1911	1,004,268	436,456	167,310	180,075

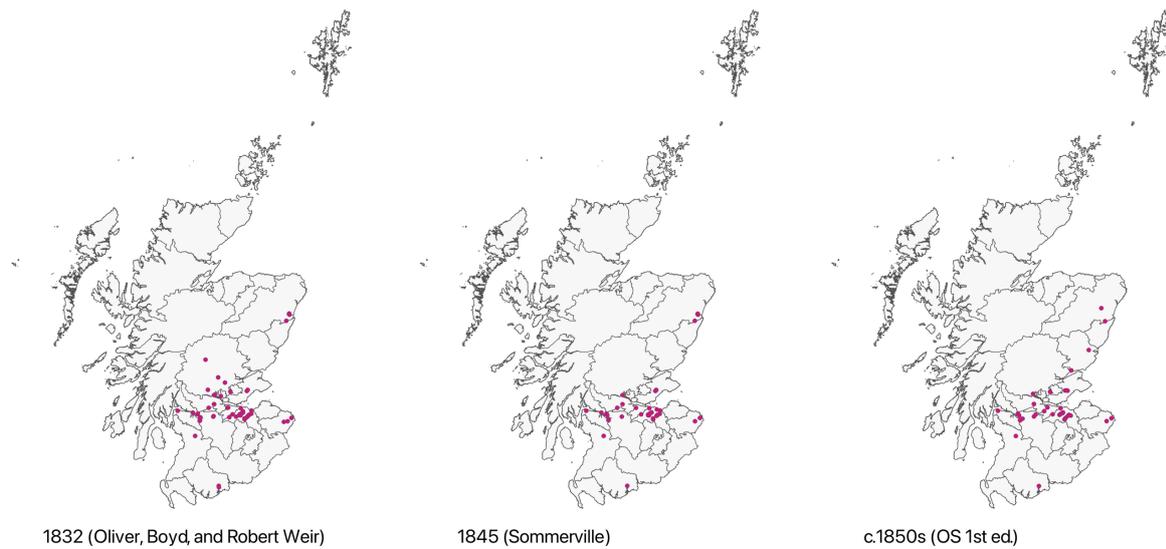


Figure 4. 46. Distribution of paper mills from directories in 1832 (Oliver, Boyd, and Robert Weir) and 1845 (Sommerville), and the 1850s from the 1st edition OS maps.

4.4.4 Textile Mills

The earliest known mechanisation of a process in textile production was the fulling mill at the start of the twelfth century, an innovation that could be considered ‘an ‘Industrial Revolution’ in its own right’ (Shaw, 1984: 45). Lint mills were the next widespread application of waterpower to textiles, used for the processes of scutching, washing, and beetling (Reynolds, 1983: 137). Silk mills, present in Britain from at least the 1700s, but which may have applied the rotary motion of waterwheels to the twisting process elsewhere as early as the fourteenth century, also played an important part in paving the way for large scale textiles industry (Reynolds, 1983: 79). Reynolds describes Thomas Lombe’s six-storey silk mill in England’s Derwent Valley as a precursor for the water-powered factory style mills of the late-eighteenth century (the focus of the following chapter).

As changes occurred to the way labour was organised and rapid technological advancements were made, mills were constructed on larger scales (Shaw, 1984: 319), that were capable of accommodating hundreds of workers and the machinery they operated.¹²⁷ In cotton textiles, the improvements of Arkwright, Hargreaves, and Crompton and the introduction of machines for carding, roving, and spinning, ‘inaugurated a new system of operations, and created a new demand for power and the means of transmitting it to the different machines required in the manufacture’ (Fairbairn and Pole, 1877: 8). A large waterwheel(s) located at ground level could power machines for different purposes (carding engines, picking engines, drawing and roving frame, jennies, mules *etc.*) across multiple storeys of a mill’s buildings through a series of shafts and gears mounted on the ceiling of each floor that brought the motive power from the waterwheel to the machinery (Figure 4.47).



Figure 4. 47. Industrial textile mills: Left: Model of an eighteenth-century water-powered textile mill. Maker: Phillip Veale, 1790 (Science Museum Group, 2025a); Right: engraving showing different stages in producing cotton fabric from the series ‘Progress of Cotton’. Maker: J. R. Barfoot (1785–1825) (Science Museum Group, 2025b).

There were at least 1,051 mills directly involved in the textile industry (Figure 4.48) according to the OS/Canmore. Broadly looking at the textile industry between the 1850s and 1900s, there was no significant change in either mill numbers or distribution. This suggests that the textile producing regions had already been formulated and settled by the mid-nineteenth century and that these dominant regions were persisting into the start of the

¹²⁷ One of Scotland’s largest flax mills at Port Glasgow employed 442 workers in the 1830s, Stanley Mills (cotton) in Perthshire had nearly 1,200 workers in the mid-nineteenth century, and the Anchor Mills complex (thread) in Paisley employed over 3,500 in the 1880s (Turner, 1982b: 9; Groome, 1885: 377; Reilly, 2009: 2); OS Name Books - Perth county - Volume 71 - Parish of Redgorton, OS1/25/71: 10; Nisbet, 2009: 2).

twentieth century, locked-in to some extent by processes of industrial inertia (introduced in Chapter 2.4). There were 734 textile mills recorded in the 1850s, where 197 of these closed prior to 1900. Into the 1900s, 537 mills survived in some form (either unchanged or as a new mill at the same location) and a further 214 mills opened between the 1850s and the 1900s. In total, the OS maps record a total of 751 mills recorded by the 1900s. In the second half of the nineteenth century a slight reduction of mills is recorded in Wigtownshire, Kirkcudbright and Dumfriesshire, and in Dundee. Although it remains difficult to draw conclusions, the drop in textile mill numbers may be due to the previously mentioned difficulties in identifying mills in heavily built-up areas that were less likely to be labelled on OS 25 Inch and Six-Inch to the mile map sheets.

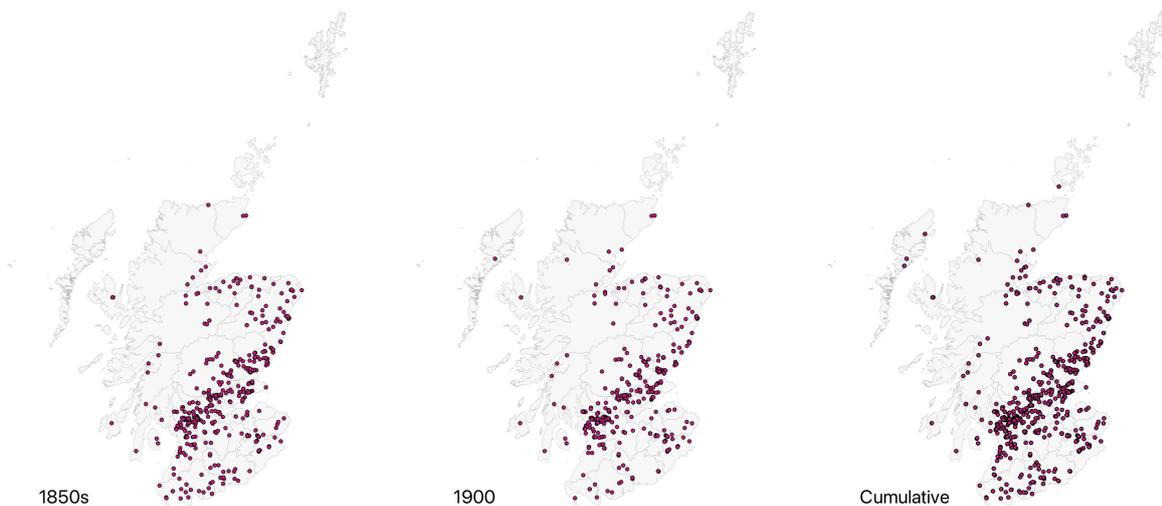


Figure 4. 48. Distribution of textile mills in the 1850s, 1900s, and cumulative.

The textile industry predominantly took place on the mainland though there were pockets of industry on the islands as well. Isolated mills include the one textile mill located in the Orkney islands, a flax mill on Hoy in the parish of Walls and Flotta that predates the 1st edition OS map where only an ‘Old Mill Pond’ is recorded.¹²⁸ The name Waulkmill Bay on the south coast of Orkney’s Mainland suggests the presence of a fulling mill too at one time however, documentary evidence of this was not found. The Isle of Bute on the other hand developed a successful cotton industry, attracting investors and owners from outside the island. The close geographical proximity to the ports and populations of the mainland and the

¹²⁸ NRHE ID: 94944 (Hoy, Disused Mill).

ability to easily transport raw and finished materials were more important here than the geomorphology of the land as will be seen in Chapter 5.

4.4.4.1 Production stage

When classifying textile mills, they are commonly divided according to the specific textile fibres they process - cotton, jute, flax, and so on. Following this, I consider here the stage of the manufacturing process that the mill focused on. The manufacturing process began with the *production and processing of yarns and threads* as the first stage. Yarn processing and fabric processing were the dominant production stage taking place in textiles mills, and they have been grouped together because they often took place at the same location. The second reason for this choice reflects the inability to distinguish between a spinning mill and weaving mill on the OS maps, whereas finishing mills were generally labelled clearly as *bleaching, dying, fulling* or *calender works* and so on. The second stage saw the yarns spun or woven into a fabric, referred to here as *fabric processing*. Then in the third and final stage, *finishing*, fabric was finished and made ready for use by bleaching, dying, or transformed into a specialised product (e.g. sails, clothing). Looking at the production stages and whether or not mills were integrating multiple textile manufacturing processes offers an insight into changing patterns of industry and the transition from the proto-industry of the ‘putting-out’ system, to complete production taking place in an individual mill, and to later having multiple stages controlled by one company at one or multiple large-scale sites. Weaving sheds for instance, began to be added to textile spinning mills around the 1830s creating integrated sites (Historic England, 2024). Some sites conducted multiple stages of textile production at the same location. This became more common in the second half of the nineteenth century. Watson (1990: 103–109) documented ten separate public press packers and calenders in Dundee in 1851, dropping to seven by 1864 when many jute mill owners expanded and installed their own calender works. The expansion and integration of many jute firms in the region happened despite the temporary downturn in trade during and after the American Civil War (Menzies and Chapman, 2003: 236). Similarly, where a mill was fortunate enough to have sufficient space and access to clean water, dyeing was moved in-house. Cox Brothers in Dundee were one such strategically located jute mill able to set up a dyeing department.

One of the difficulties in considering the production stages of textile mill enterprises at the national scale is that companies that conducted multiple processes may have been spread across several different buildings, different streets, or even counties. This was the case at the

Broadford Works (linen) in Aberdeen where yarns produced on machinery in the company's principal works buildings were woven into coarse cloth in the separate handloom factory. The two buildings were on opposite sides of Maberly Street. Much of the cloth was afterwards taken to the bleachfield two miles away at Rubislaw prior to sale. The bleachfield was owned by the same proprietor as the linen works, Richards & Co., who also possessed a large vitriol works.¹²⁹ Cotton manufacturer and merchant James Finlay & Co. (whose Scottish mills feature in Chapter 5) sent fabrics from their Deanston Mills in Perthshire to their mills at Catrine in Ayrshire for bleaching. A useful, if challenging, further line of enquiry would be to connect these physically separate mill buildings that were linked by ownership.

Mills conducting textile finishing processes had a more concentrated distribution compared to yarn and textile processing (Figure 4.49). Finishing was mostly absent from the northwest region of the country. Bleaching was generally restricted to the central and northeastern regions, corresponding to the areas with greatest concentrations of cotton and coarse fabrics production. Bleachfield distribution similarly followed a pattern that was influenced earlier by grants by the Board of Trustees to sites in the east of Scotland (Nisbet 2009). The Dighty Burn near Dundee developed into the most significant location of bleaching (Figure 4.50). The approximately 20 km long Dighty Burn has its source area around Lundie Loch. There were 27 functioning mills recorded along the Dighty Burn on the 1850s OS map. Based on the maps and their text, by the 1900s, four plash mills and three bleachfields had closed entirely and three of the plash mills had changed to focus on bleaching instead. All of the mills were water-powered and before the 1850s, the Dighty Burn included a flax spinning mill and a mill for the 'beetling and pressing of linen cloths'.¹³⁰ Due to the size of the Dighty Burn, the mills were located close together, but they were not small units. Claverhouse Bleachfield for instance, employed 200 people by around 1857.¹³¹ Several mills had the same owner, such as Harestone and West Balmuir plash mills and Balmuir flour mill that were the property of Webster Esqre, if operated by different managers.

An observation on the use of the OS map labels can be made here. The term plash mill (also referred to as fulling or waulk mills) generally refers to the process of increasing the thickness and compactness of cloth through soaking, beating, and shrinking, whereas a

¹²⁹ OS Name Books - Aberdeen county - Volume 1 - City of Aberdeen - 1865-1871, OS1/1/1: 83, 118.

¹³⁰ OS Name Books - Forfar (Angus) county - Volume 67 - Parish of Mains and Starthmartine, OS1/14/67: 47.

¹³¹ OS Name Books - Forfar (Angus) county - Volume 67 - Parish of Mains and Starthmartine, OS1/14/67: 39.

bleaching mill was used to clean and remove impurities from cloth, often in preparation for dyeing. Fountainbleau Mill in Mains Parish, Forfarshire was labelled as a ‘Plash’ mill on the 1st edition map but the description in the OSNB says the name ‘applies to a Plash or Bleaching Mill’. It is not clear why it has been described as plash *or* bleaching. Similarly, Honeygreen Mill is recorded as ‘Plash’ on the map but as ‘a small Bleaching Mill’ in the OSNB descriptive remarks.¹³² Again, the reason for using both terms is unclear.

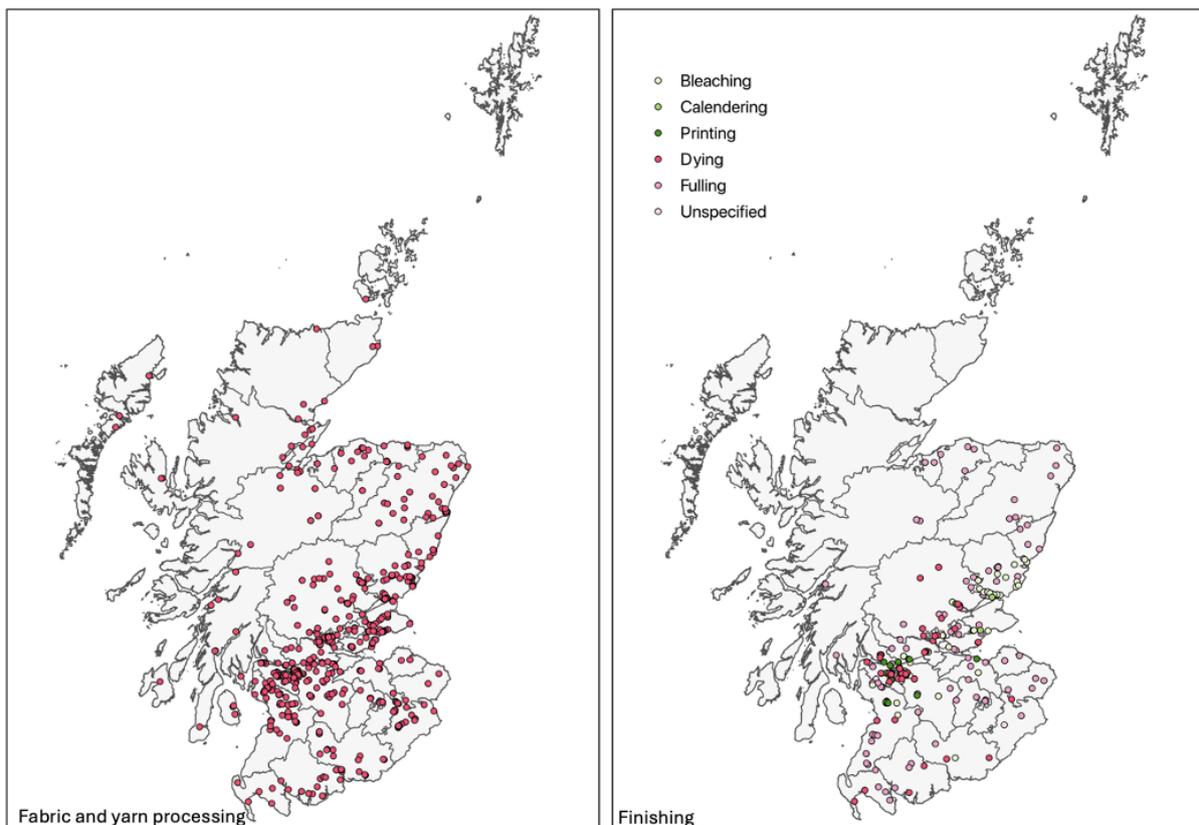


Figure 4. 49. Production stages. Left: Cumulative distribution of yarn and textile processing mills; Right: Cumulative distribution of fabric finishing mills displayed according to function.

¹³² OS Name Books - Forfar (Angus) county - Volume 67 - Parish of Mains and Starthmartine, OS1/14/67: 55, 57.

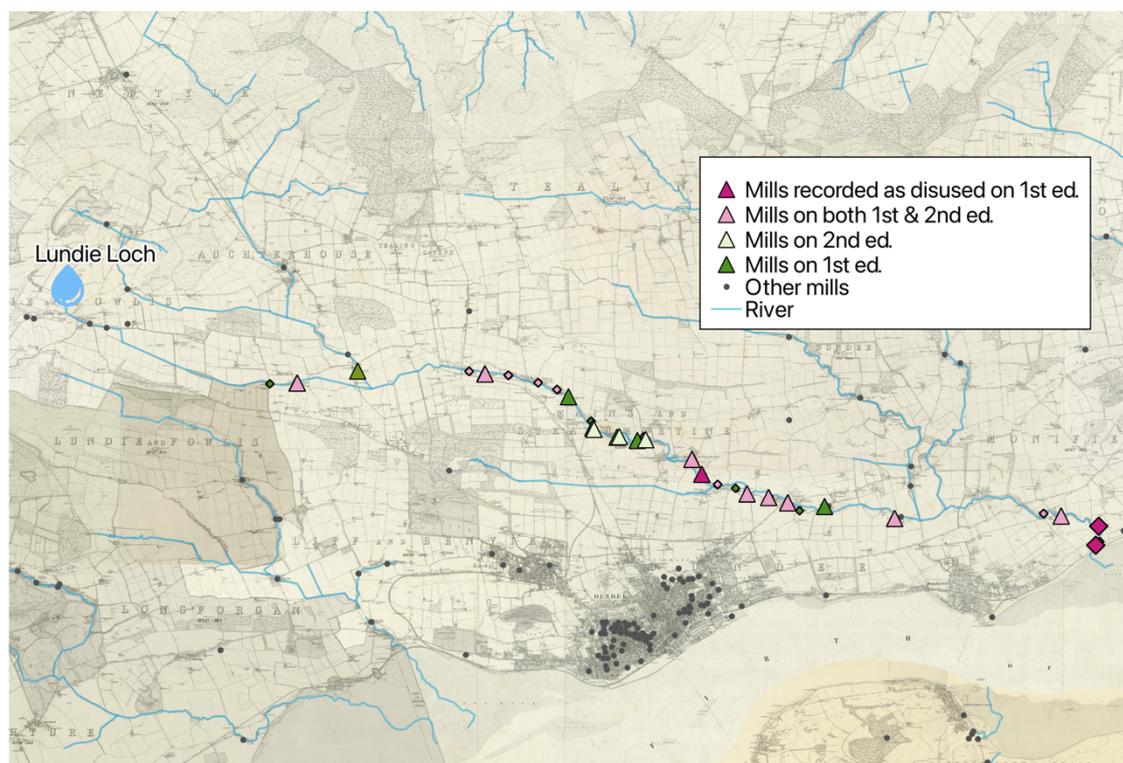


Figure 4. 50. Mills along the Dighty Water from its source at Lundie Loch to mouth at Tay Estuary displayed according to their presence on the OS maps. Finishing mills along the Dighty are represented as triangles and other mill types as diamonds. Mills located elsewhere are represented as grey dots.¹³³

4.4.4.2 Fabrics

Distinct regions for different types of fabrics developed in Scotland (Figure 4.51). Woollen Mills, the category of fabric with the greatest number of mills record by the OS/Canmore (Table 4.8), followed the same general pattern as the overall textile industry though their distribution was less concentrated in comparison to other types of fabrics. By the nineteenth century, the coarse fabrics (made from jute, hemp, flax) industry congregated in the east, centred around Dundee, whilst cotton mills displayed a clear clustering in the Central Belt, specifically in the regions surrounding Greater Glasgow. The Greater Glasgow region was the only area with a very strong presence of all three fabric groups, attesting to its importance as a port and centre of finance and business, all factors important for establishing a successful manufactory. Silk manufacturing also concentrated in Glasgow, Paisley, and rural Ayrshire, and Renfrewshire (Murray, 1978). Only three silk mills were recorded using the OS/Canmore

¹³³ Background layer: OS Six-Inch 1st edition, 1843-1882.

(in Paisley, Larkhall, and the Port Dundas area of Glasgow), perhaps reflecting the fact that silk manufacturing in areas such as Paisley was replaced by muslin after 1790 (Murray, 1978). In the latter part of the eighteenth century, deviations to spatial distributions were still taking place. New technological inventions progressed certain industries, increasing their popularity, and prompting individual mills or areas to switch to a more lucrative material. Companies operating mills could sometimes be short lived but capital investments sunk into the sites could be reused and given a second, third, fourth life. Processes of industrial inertia were especially evident in the textiles industry where initial capital outlays to enter the industry could be prohibitively large (Chapman, 1970). Watson (1990: 29) gives multiple examples within Dundee including a cotton mill built around 1792 in Guthrie Street that was rapidly repurposed as one of the town's first flax mills in 1793, and another early Dundee flax mill established in 1799, East Mill, used the premises of an earlier 1792 tannery. One of the earliest cotton spinning mills in Scotland, Rothesay (returned to in Chapter 5), made use of the building of a former lint mill (Shaw, 1980: 463). By the time the OS began its survey, the general spatial patterns and the main centres for textile manufacturing were fairly firmly settled.

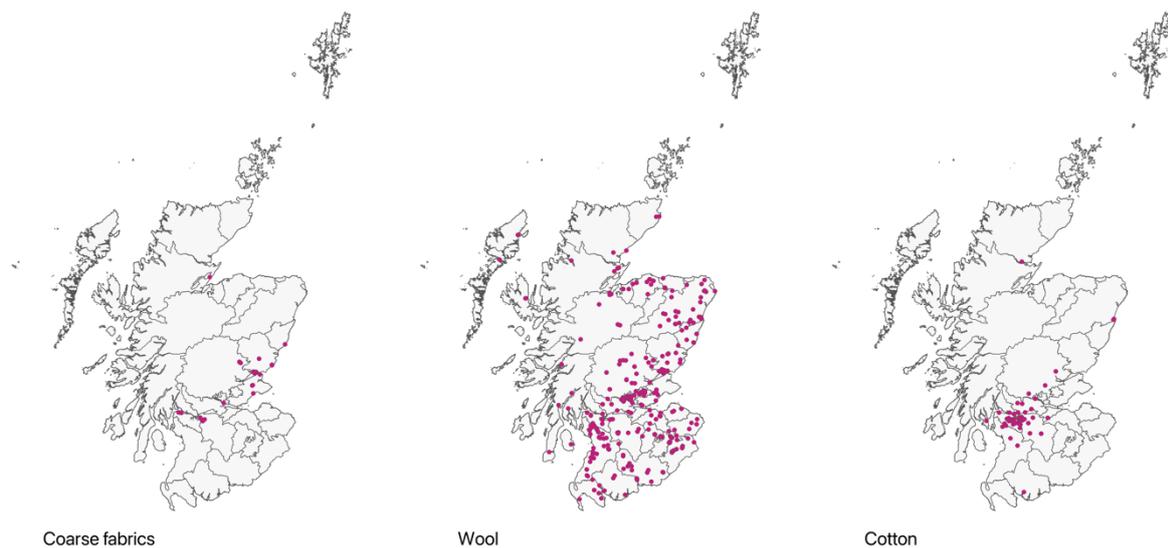


Figure 4. 51. Cumulative distribution of textile mills: coarse fabrics (left), wool (centre), cotton (right).

Table 4. 8. Number of mills in different branches of the textiles industry

Time period	Cotton	Wool	Coarse fabrics ¹³⁵	Clothing
All	116	383	82	9
1850	101	240	43	5
1900	76	242	57	10
PU	7	59	4	2

Coarse fabrics

This section refers primarily to mills working with flax, and then from the nineteenth century, primarily with jute. Flax can produce a coarser or a finer linen fabric depending on which fibres from the plant are used. They have been grouped together here firstly because the OS map text does not provide this level of detail and secondly because this chapter is intended to offer an overview of broad trends at the country level. Coarse cloths were important to the Scottish economy prior to the Industrial Revolution. In 1614, linen cloth and yarn contributed almost two fifths of Scottish textile production (Turner, 1966: 31). What is usually referred to as a ‘lint’ mill in Scotland was a mill where fibres from the flax plant were separated and then heckled and spun into linen goods. Lint mills used stampers or rollers to break down flax and then scutched the flax by holding it against revolving blades. Both processes were powered by water and contained within modest mill buildings, similar in size to a cottage (Nisbet, 2009: 6). The linen industry was initially sustained and its distribution governed by supplies of locally grown flax and imported plants from Latvia, Russia, and the Netherlands (Turnock, 1975: 166; Tuckett and Whatley, 2023: 40). The first known mechanised lint mills using waterpower in Scotland date to c.1726 at Saucel in Paisley, Renfrewshire, and Drygrange, Berwickshire (Shaw, 1984 171). The State, in the form the Act of Union and the establishment of the Board of Trustees for Fisheries and Manufactures (1727) and the British Linen Company (1746), was central to the development of the modern linen industry (Turner, 1966: 30). Operating out of Edinburgh, the Board of Trustees and British Linen Company were, in the words of Tuckett and Whatley (2023:39):

representative of unionist endeavour and were instrumental in the proto-industrialisation phase of Scottish linen manufacture and trade that relied on and contributed to transnational, colonial and eventually imperial networks.

¹³⁵ Fabrics and products produced primarily from jute, flax, or hemp.

The Union permitted increased trade between Scotland and the colonies and, accordingly, promotion and production of coarse fabrics to meet the needs of colonial plantations (Turner, 1966: 30). The Board invested in the development of flax milling technology and provided financial encouragement, in the form of grants, for cultivating flax and building mills. Many of these early flax mills had a short life although some were refitted for new purposes.

Bervie Mill (c.1787) was Scotland's first water-powered mill for the spinning of flax (Turner, 1982b: 81). This mill was in Kincardineshire in the east of Scotland, where the linen industry was already aggregating and developing intense specialisation. By the mid-1850s, flax, hemp, and jute mills were restricted almost entirely to Forfar, Fife, and Perth (Bremner, 1869: 231). Many linen mills outside this region were already in disuse or identifiable only through place names by the time of the 1st edition mapping. Many landowners, never truly interested in flax, rapidly lost interest in their mills when subsidies stopped (Nisbet, 2009: 5). Furthermore, agricultural changes favoured growing of crops other than flax, which served to reduce the availability of local raw materials and created a greater dependence on imported flax. Baltic and Russian flax were preferred over Irish or British grown fibres for processing on steam-powered machinery, placing eastern ports at an advantage (Miskell and Kenefick, 2000: 176.¹³⁶ Thus, concentration was further encouraged around Dundee which benefitted from its port and comparatively good inland connections later on including rail from the 1830s.

In the first half of the nineteenth century, the core industry in Dundee was making linen from Russian flax and hemp (Beckles, 1968: 90) until the Crimean War in the mid-1850s disrupted flax supplies and created high demand for jute sacking (Tuckett and Whatley, 2023). Dundee, already acting as a regional centre of commerce for some time, also benefited from a supply of skilled workers ready to migrate to the town to fill newly established and expanding mills (Miskell and Whatley, 1999: 179). The extent of the number of mills in Dundee specifically and their preference and rapid adoption of steam power has been highlighted in section 4.3.3. Following a rush to switch to jute production, Dundee briefly held a global monopoly on jute in the 1870s and 1880s (Menzies and Chapman, 2003: 235). That said, in the coarse linen mills of the 1850s to 1900s it was common to work with more than one raw material. Over a

¹³⁶ In England, Leeds developed as the centre of linen manufacturing thanks to its proximity to the east coast port at Hull (Miskell and Kenefick, 2000: 176).

third of the mills identified combined jute and flax, and a small number were also recorded by the OS maps as processing hemp. Many of these mills produced sacking while others focused on carpet, rope, or sailcloth. The ‘outliers’ on the distribution map include two sailcloth and ropework manufactures in the Port Glasgow¹³⁷ and Gourock areas of the West of Scotland that were outside of the core linen producing region, serving two other notable ports instead. The latter, the Gourock Ropework Co, was situated on Fall no. 7 of the Shaws Water Works scheme, names that will be revisited in the following chapter in the context of New Lanark Mills and water engineering by Robert Thom.¹³⁸

Wool

Although the distribution of woollen mills, including fulling (or waulk) mills, across Scotland was ubiquitous, agglomeration of labour-intensive craft industries like woollen textiles are a common outcome of industrialisation processes (Scott, 2022: 137). Small woollen centres of clustered activity developed, most notably in the Borders (including Galashiels, Selkirk, Hawick, Jedburgh) and the Ochil Hills around the villages of Alva and Tillicoultry and to their south in the town of Alloa (Figure 4.52). Also known as the Hillfoots, the area was already well established as a region of woollen manufacturing by the 1780s (Turner, 1953). The Hillfoots may have had a woollen trade dating back to the mid-sixteenth century, coinciding with a period when parliament encouraged native textile industries by limiting the import and export of raw wool (Park, 1984: 3), another example of institutional policy influencing mills. The treaty of the Union of 1707, which had negative consequences for certain industries in Scotland, had minimal impact on the woollen trade in the Hillfoots (Park, 1984: 3). When industrialisation took place, the area was well suited for the expansion of woollen manufacturing as there was space for building mills and a supply of skilled labour already connected with the production of woollen goods. Unlike the cotton and flax industries whose numbers peaked within the first quarter of the nineteenth century, wool continued to persist in traditional woollen regions and arguably expand ‘in areas where cotton or linen working had been given up’ (Turner, 1964: 84).

As the industry grew and technology advanced, tasks previously performed by hand such as scouring and carding, became increasingly mechanised. Shaw (1984: 285) suggested that, as

¹³⁷ NRHE ID: 355053 (Port Glasgow, Ardgowan Street, Glen Mills).

¹³⁸ NRHE ID: 351496 (Greenock, Gourock Rope Work).

a generalisation, the situation of many woollen mills in upland catchments with reliable water flows and minimal competing uses for water supplies, permitted wool to remain reliant on water longer than other branches of textiles in Scotland (Figure 4.53). More locally, water supply was less reliable. Streams in the Stirling and Hillfoots area for instance, were insubstantial but initially compensated for by storage in natural reservoirs, allowing the industry to rely on water initially. Programmes of land drainage of areas of morass in the early-nineteenth century interfered with the natural water storage capacity of the land, reducing the regularity of river flows. This unreliability of water, an expansion of the industry, and the availability of coal locally, prompted a transition to steam in Alloa and towns in the Hillfoots that began prior to 1830 (Park, 1984: 7–8; Shaw, 1984: 285). Written sources confirm that initially steam tended to be used in conjunction with water in the Hillfoots with nine mills at Alva using both water and steam in the 1860s (Park, 1984: 11) although this dual use was not discernible from OS maps and Canmore. Steam was first applied to the woollen mills of the Borders region slightly later than elsewhere: for example, the number of steam woollen mills in Hawick rose from one in the late-1830s (Shaw, 1984: 286) to four by the turn of the century (Figure 4.54). Craigfoot Mill, in Tillicoultry (Figure 4.55) presents a prime example of locational inertia resulting from sunk capital. According to Park's (1984: 39) study of woollen mills in the Hillfoots, Craigfoot Mill initially did not need waterpower (hand-driven carding machines and jennies still being common in the early-1800s) so was built in 1806 away from Tillicoultry burn and at an elevation above the level of the water. When power was required in the 1820s, rather than relocate the mill, its owner embarked on an expensive project to erect a damhead and divert water to the mill (Park, 1984: 39).

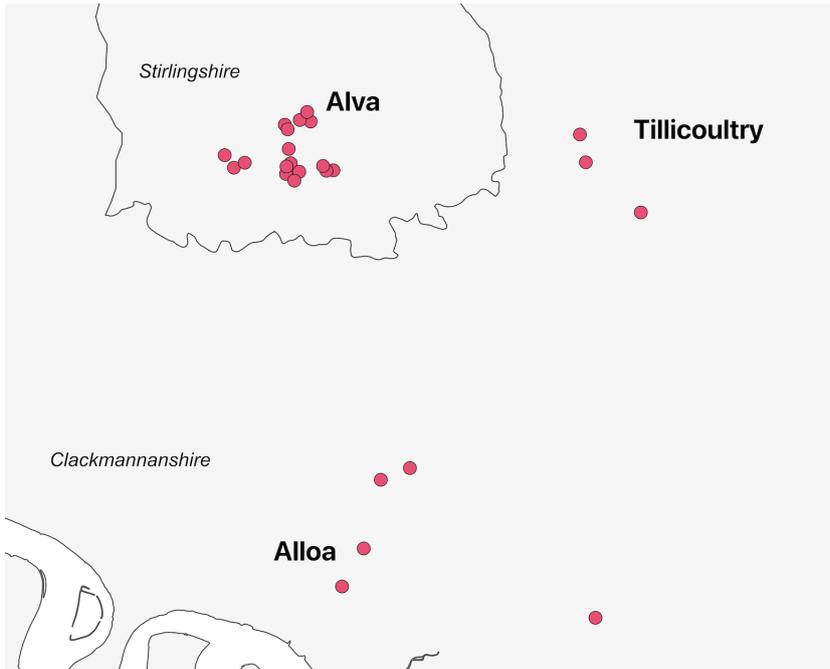


Figure 4. 52. Woollen mills in Ochill Hillfoots region of Clackmannanshire and Stirlingshire.

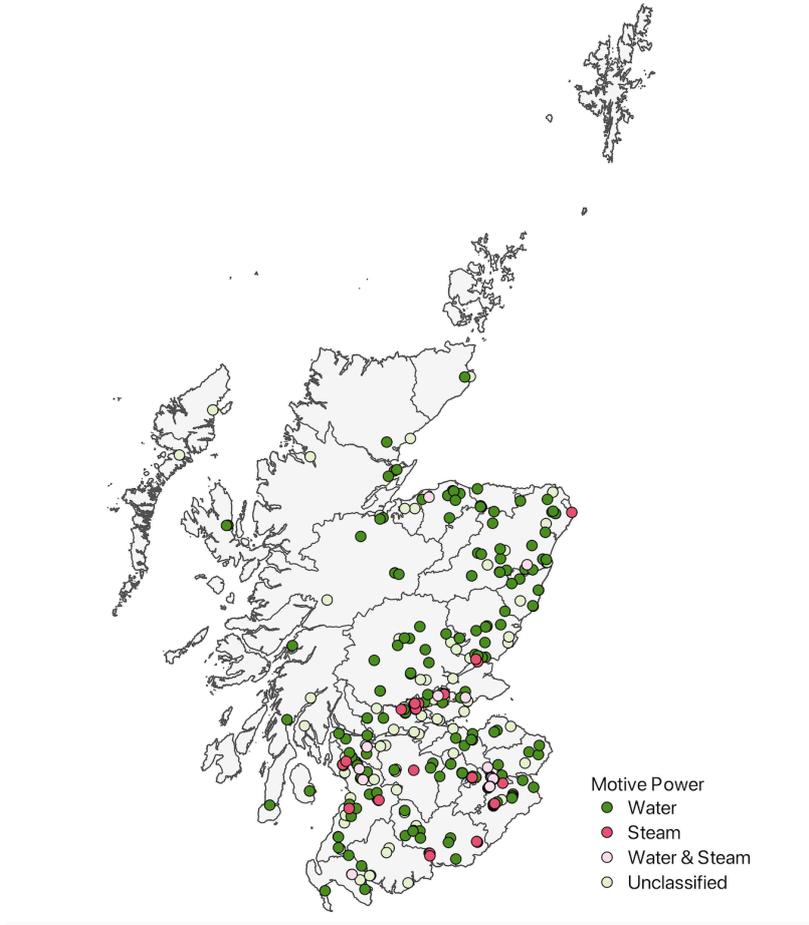


Figure 4. 53. Cumulative distribution of woollen mills according to motive power from the OS/Canmore. Mills in upland catchments or without adequate/cheap coal tended to use waterpower.

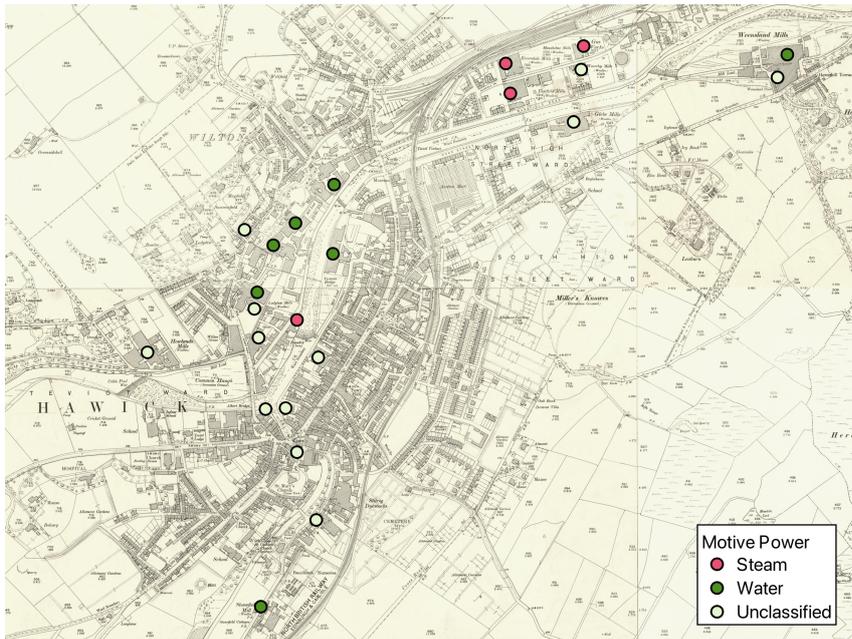


Figure 4. 54. Map of Hawick in the borders showing at least four steam-powered mills.¹³⁹



Figure 4. 55. Craigfoot Mill in Tillicoultry in the Hillfoots woollen area. The wooden lade constructed to deliver water from Tillicoultry Burn to the mill is depicted.¹⁴⁰

¹³⁹ Background layer: OS 25 Inch 2nd edition, 1892-1905.

¹⁴⁰ Ordnance Survey, 25 Inch to the mile, Clackmannanshire CXXXIV.5 (Revised: 1899, Published: 1900). View online: <https://maps.nls.uk/view/82875129>. Reproduced courtesy of the National Library of Scotland.

Cotton

Mechanisation of processes used in the production of cotton textiles came relatively late, after 1750 (Reynolds, 1983). In Scotland, the first two water-powered cotton mills (following Richard Arkwright's factory in Derbyshire, England)¹⁴¹ were constructed at Penicuik (1771) and at Rothesay on the Isle of Bute (1772). These enterprises were followed by Busby (1778), Dovecothall (1779), Johnstone Old Mill (1782), and Laigh (1785) (Nisbet, 2009: 9). The spatial distribution of the cotton industry generally followed locations where 'proto-industry' or a 'textile tradition' (Farnie, 1979: 46) had earlier concentrated spinners and weavers who worked out of their homes. Many cotton mills relocated spinning into the mill building while continuing to use the putting-out system for auxiliary tasks such as weaving. After a flurry of mill building in the late-1770s and 1780s, very few new cotton mills were constructed after the mid-1790s, and cotton's relevant importance compared to other industries began to decline (Shaw, 1984: 327).

Referring to the United Kingdom as a whole, Crafts and Wolf (2014: 1135) describe the cotton industry during the Industrial Revolution as 'increasingly spatially concentrated', but prior to the nineteenth century, the cotton textile regions of Scotland were not yet as defined as they would become. Shaw describes opposite trends of a Glasgow based nucleus of cotton mills and a simultaneous dispersal to peripheral regions. Turner (1982b: 5) has suggested that in the early-1800s, cotton was expanding into new markets and into new locations (new for cotton but with a history of other fabrics), whereas by the 1830s, growth had decelerated, abandoning the peripheral regions, as observed in Dundee. The industry contracted, allowing Glasgow and its entrepreneurs to dominate (Turner, 1982b: 6). The *OSA* stated that in Glasgow 'cotton mills, bleachfields, and printfields, have been erected on almost all the streams in the neighbourhood' with sufficiently powerful streams for waterpower.¹⁴² According to a Factory Inspector in 1834, 134 cotton mills were in operation in Scotland at that time, almost all located within 25 miles of Glasgow (Crowe, 1927: 160). But it was Renfrewshire that dominated as Scotland's cotton capital in the early-1800s. Already in c.1795, over half of the country's 67 water-powered cotton mills, recorded by Nisbet (2003: 17) were in Renfrewshire, capitalising on the pre-existing skills of workers previously

¹⁴¹ Arkwright will feature in Chapter 5 as a partner in New Lanark and an acquaintance of other featured mill owners.

¹⁴² *OSA*, Glasgow, Lanark, Vol. 5, 1793: 502.

engaged in making fine linens (Shaw, 1984: 317). The impact of cotton on Paisley was so great as to make it one of Scotland's largest towns and cities in terms of population at the end of the eighteenth century due to the number of employees working amongst its dense congregation of mills. Shaw's study (1984) suggests approximately a quarter of Scotland's cotton mills were in Renfrewshire alone. By my figures, the proportion was nearer to one third. Of a total of 120 cotton mills recorded by the OS/Canmore, 55 (47%) were in Lanarkshire and 36 mills (31%) in Renfrewshire. However, compared to Shaw, several cotton mills that opened 1790–1799 in the Borders are missing from the OS/Canmore dataset, distorting the overall picture, and giving the central counties slightly greater importance than they had in reality. The OS/Canmore data shows that cotton had stopped expanding (both in terms of numbers and geographical spread) by the 1850s and remained static into the 1900s.

There were some notable geographical outliers including the Stanley Mills and Deanston Mills in Perthshire, and Catrine in Ayrshire (the latter two featuring in Chapter 5). In the northeast there were four large mills in Aberdeen, collectively employing over 2,000 workers in the 1830s (Coull, 1963; 81). They included the five-storey Woodside Mill erected on the banks of the River Don. To the southwest were two water-powered cotton mills of 55 hp at Gatehouse of Fleet in Kirkcudbright. One of the most distant mills from the central region was Spinningdale in the Highland county of Sutherland (which will also be discussed in detail in the following chapter). Very few new cotton mills were established after the 1850s. Nine additions were recorded for the processing of cotton fabric into the 1900s, with all but one in the vicinity of Glasgow. Four of these late mills were in Glasgow itself, another four in Govan, Renfrew, and Dumbartonshire, and the last mill in Auchterarder, Perth. In terms of motive power, Scotland's cotton spinning industry was divided in the contest between water and steam power. Waterpower use persisted (albeit sometimes in a modified form of hydroelectric power), right until the twentieth-century post-war decline of Scottish cotton manufacturing. The locational geography of cotton mills and their use of water forms a key line of enquiry in the remaining chapters.

4.5 Conclusion

This chapter has provided estimates of mill numbers in Scotland derived from the 1st and 2nd edition OS maps and HES's Canmore database, giving an overview of the state of mills in a

time period previously not covered at the national scale. The results presented in this chapter have corroborated the national scale patterns observed by other major studies on mills and industrial geography for Scotland (particularly Shaw, 1984; Bishop and Muñoz-Salinas, 2013), demonstrating that the watermill remained ubiquitous throughout the nineteenth century, while specific industries developed and maintained their own regional distributions. No conclusions can be made from this dataset about the overall ratio of water to steam as we do not have estimates of power outputs for the mills. However, in terms of the number of mills using one source or another, water remained in the lead. The geographical distribution of steam mills was, according to the OS/Canmore data, still fairly restricted compared to the watermill, but after 1800 steam had successfully diffused across industries.

Controls on mill location due to geomorphology, climate, and land cover classes, that were stated in the literature review (Chapter 2), were reaffirmed in this chapter with illustrative examples: the paucity of mills at elevations above ~250 m asl (consistent with areas less suitable for grain cultivation) (Section 4.2) and instances of mills sited below knickpoints to utilise the change in gradient (4.3.1.1). The control of climate on windmills is also evidenced by their presence in greater numbers in eastern regions that experience lower rainfall and more moderate windspeeds (4.3.2). Human controls were also incredibly influential on mill location and numbers. It would be easy to dismiss the use of less complex horizontal mills as ‘primitive’ (Lucas, 1953: 3), or as a technological relict and lack of progress. However, the persistent use of the horizontal wheel was associated with local customs and used because horizontal mills could meet the needs of the families and communities they served. Here we have the first specific example I will present in this thesis of what I am terming a dynamic form of inertia: personal (or in this case cultural) preference (Smith, 1966), combined with reasoned decision making – not a lack of technical ability, or an unwillingness to change – keeping these mills functioning with a certain technology in a certain place.

Furthermore, institutional controls also influenced mill locations and numbers, for instance, through government incentives to encourage flax cultivation and mill building. The second example in this chapter was the enforcement of thirlage and the Corn Laws, the removal of which, along with wider changes to population distribution and employment structure, with increasing numbers of people employed in manufacturing rather than agriculture (Murray, 1978; Knox, 1999), and increased imports instead of home-grown grain, facilitated the advance of the town grain mill. That being said, a crucial argument here is that there was still an important role for the rural mill: mill numbers had reduced significantly compared to

Shaw's estimations for the 1700s, but the country grain mill continued to number in the thousands at the turn of the twentieth century.

Scotland's mills covered a wide breadth of industrial functions that in the nineteenth century ranged from traditional water-powered grain milling to large scale textile factories and chemical works. The newer industries supported the modernisation and continuation of traditional ones, and in some cases the co-location or vertical integration of industrial processes and functions. For instance, the OS maps show that bleaching remained concentrated in its traditional regions of the central region and east linen region, but new locational possibilities were also facilitated once the use of sulphuric acid reduced the amount of land required per unit of output for a bleachfield (Gittins, 1979). In the nineteenth century, indoor bleaching works were added to existing mill complexes such as the Catrine Mills (discussed in the next chapter).

As noted by Shaw (1984: 182) in relation to lint mills 'it would be quite a daunting task to assess the number'. I would agree and extend this statement to all types of mill. It is evident that there is a great benefit to using historical map and gazetteer data to extend our records of the presence of heritage features such as mills. However, for greater accuracy, they should be combined with secondary sources. It was hoped that Canmore could provide a sufficient complimentary source, but the data collection process has shown that there are significant gaps between Canmore, the OS maps, and other primary and secondary sources. The dataset is, however, a good overall representation of mills that were operating between 1843 and 1905. Further reflection on the methodology used and possible consequences of the results for the heritage sector will be presented in the conclusion of this thesis (Chapter 7).

Chapter 5 will examine the geography of Scotland's mills through a focus on the cotton industry, presenting micro-histories of six mills founded in the last quarter of the eighteenth century. The information presented here in Chapter 4 has provided the reader with context on desirable topographical conditions for different types of mill, as well as introducing the full supporting mill landscape of the mill pond, lade, weir, and sluices, that often require human engineering to facilitate the consistent operation of a watermill. Backwatering effects and resulting litigation between water users was also introduced, as was the co-location of industrial functions, and re-use of mill sites. As will be seen, these were all influential in mill locational decisions and the ability to remain in place later once a mill was established.

5. His mill will go with all winds: Micro-histories from the cotton industry

5.1 Introduction

This chapter will explore the geographies of early water-powered cotton mills through six micro-histories. An explanation of the choice of these mills was provided in Chapter 3. All six mills were created within a 14 year period, during the heyday of water-powered cotton spinning in Scotland. The mills discussed here were distributed across the Scottish Lowlands, Highlands, and Islands (Figure 5.1) and all six were originally powered solely by water. Over their operational lives some of these mills persisted with only water-power while others required the assistance of a steam engine or pivoted from steam back to water as the dominant motive power. The subject of motive power was of vital importance to the owners of these mills, who spent enormous sums of money (for the period) to engineer the landscape to secure the necessary water to turn their wheels. Rather than just representing buildings housing machinery, some of these mills developed into complete communities, the mill and the local people symbiotically sustaining the existence of the other. The case studies will be presented in chronological order according to the year that they were founded (Figure 5.2).

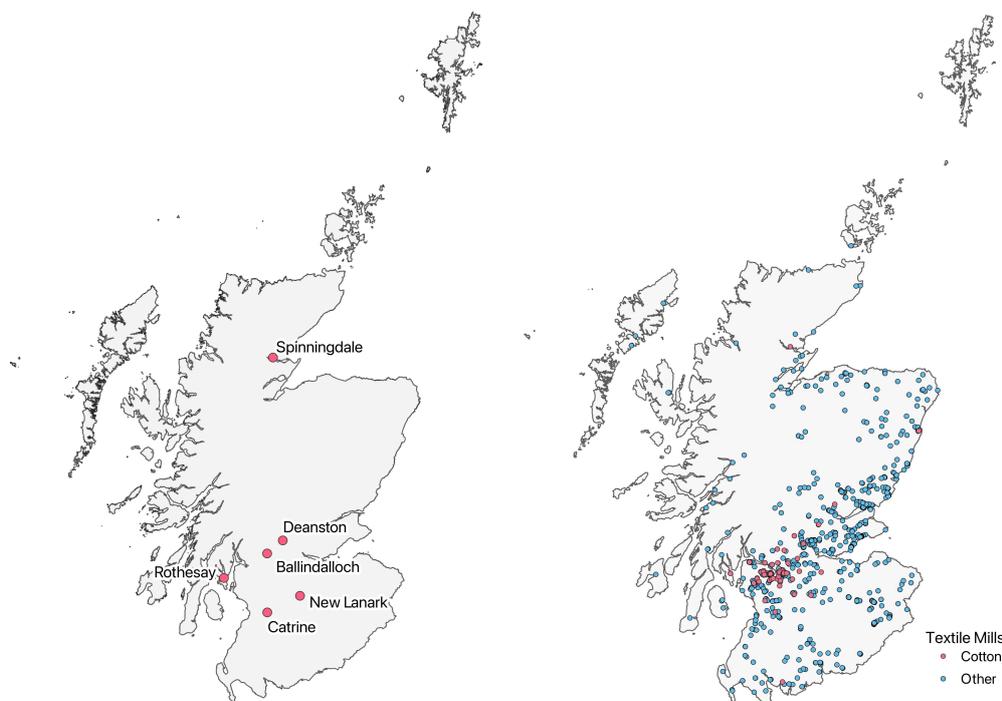


Figure 5. 1. Location of the six case study mills (left) in relation to cotton mills and other textile mills in Scotland (right).

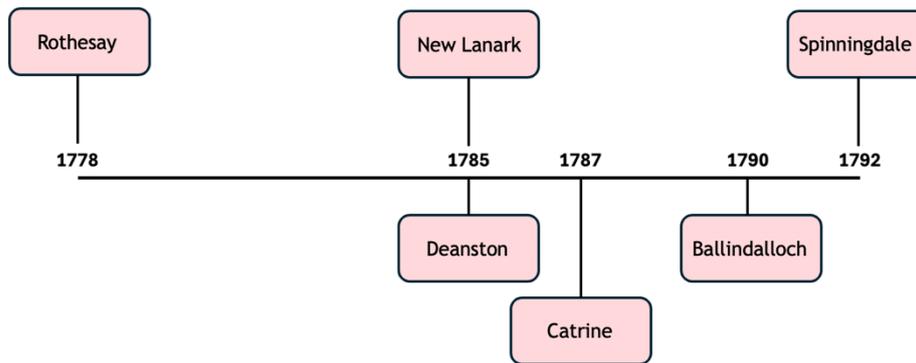


Figure 5. 2. Timeline of mill opening

The chapter commences in 1778 with the **Rothesay Cotton Mills** which hold the claim of being one of the two earliest cotton spinning mills in Scotland. At their peak the mills could accommodate 16,000 spindles and employed 700 workers. In 1813 a civil engineer, Robert Thom, invested in the mills and embarked on an elaborate plan to double the available waterpower. The mills warrant consideration due to their island location, the extensive scheme of engineering works undertaken, and as an example of a site that alternated between water and steam power on more than one occasion. The most famous mill in this chapter, and arguably in the whole of Scotland, **New Lanark**, then follows. New Lanark was a small eighteenth-century village founded in 1785, later developing into a ‘model’ industrial community. New Lanark grew to contain four mills and over 2,000 people living and working in the village. Textile production continued at New Lanark into the 1960s, after which efforts to save the village as a site of industrial and social heritage began. Next, the cases of mills at **Deanston**, **Catrine**, and **Ballindalloch** are presented. These three mills in the Lowlands, Central Belt, and the southern tip of the Highlands had different origins but all came to be under the ownership of James Finlay & Co., a firm of international cotton merchants.¹⁴³ Deanston was established by Messrs Buchanan of Carston in 1785 as the Adelphi Cotton Works. In 1793 the mill faced bankruptcy and was sold to Benjamin Flounders who operated the mill until approximately 1804 after which it was obtained by James Finlay & Co. as their third Scottish cotton mill. Cotton was produced here, powered by water from the River Teith, for a period of 180 years. Catrine Mills in East Ayrshire was

¹⁴³ As noted in the introduction to Chapter 4, there are various distinctions of the regions of Scotland. Withers (1998) for instance, divides Perth into both the Highlands and Lowlands.

founded in 1787 as a partnership between David Dale and Sir Claud Alexander. The village of Catrine grew from a couple of cottages to a thriving village of over 1,000 inhabitants by the end of the eighteenth century. In the nineteenth century, a water-powered bleaching works was added to the mills, along with two enormous waterwheels, informally known as the ‘Lions of Catrine’. These were the most powerful wheels in Scotland at the time, attracting tourists to the small Scottish industrial village. Manufacturing persisted at Catrine until the 1960s when production eventually ceased. Ballindalloch was a cotton mill with a planned village in the parish of Balfron, Stirlingshire. Built in 1790, the mill survived almost a century under multiple owners. The chapter ends with the cotton mill at **Spinningdale**, in Sutherland, the most remote of the mills considered in this chapter. Conceived by the former Scottish MP Sir George Dempster, the mill was built in 1792 and operated under the Balnoe Company until 1804, coinciding with a period of time when numerous planned villages were attempted in the Highlands, including on the shores of Sutherland, Cromarty, and Caithness, to rehome displaced crofters. Spinningdale worked briefly under new ownership before being destroyed by fire in 1806.

For each mill the physical characteristics of the location will be described followed by the regional economic situation. Then the entrepreneurs and managers behind the mills and their possible motivations are examined. The fourth section of each study looks at the fixed capital of the mill buildings, motive power infrastructure, and auxiliary facilities, or lack thereof. The case studies conclude with a reflection on some of the successes and challenges encountered through time, with a particular interest in the ‘inertia’ – and in the decision-making tied into that inertia – that kept the mills operating in the same location for long periods. Sometimes this inertia appeared to defy economic logics, such as resisting a possible shift from an isolated rural site to the populated urban centres, or a transition away from water to steam-power.

5.2 Isle of Bute and the Rothesay Cotton Mills

5.2.1 Location and water supply

One of the first mills in Scotland to engage in water-powered spinning of cotton was at Rothesay on the Isle of Bute. The thirteenth largest of Scotland’s inhabited islands,

measuring 24 km in length with an area of 120 km² (Philip *et al.*, 2013), Bute was located in the Firth of Clyde, separated from the Scottish mainland by a narrow stretch of water known as the Kyles of Bute. The influence of the Gulf Stream, an ocean current that brings warm water to Western Europe, gave the island its temperate climate, mild enough for exotic plants to thrive in the gardens of the Earl of Bute's Mountstuart House (Met Office, 2023).¹⁴⁴ Annual rainfall in the eighteenth and nineteenth centuries at Bute's primary settlement, Rothesay, was recorded at an average of 48.5 inches,¹⁴⁵ a figure lower than across the west of mainland Scotland, and lower than the levels recorded for the twentieth century (Munro, 1973). Spring typically brought the driest months, and autumn the wettest, for the island.

Bute was low-lying, with sheltered harbours, and gently sloping fertile land which made it an appealing, less insular, and more hospitable location compared to Scotland's other islands (Munro, 1973; Hannah, 2012). The main bodies of water on Bute were all located in the southern portion of the island, near to Rothesay (Figure 5.3). Loch Fad, a mile south of Rothesay, measured 2 miles in length by $\frac{1}{4}$ of a mile in width and had a drainage area of 2 miles². At the northern end of Loch Fad was a body of water known as the Kirk Dam measuring $\frac{3}{4}$ of a mile in length with an area of 54 acres, volume of twelve million cubic feet, and a drainage area of 3 miles². Historically, Kirk Dam was separated from the main loch by an embankment, although water could pass between the two. Communication between the Kirk Dam and the sea at Rothesay Bay was via a dam and mill lade flowing from the northern end of the Dam (Murray and Pullar, 1910), the original source of water for the mills of Rothesay. Loch Ascog, which was 1 mile long, 106 acres in area, and located $\frac{1}{2}$ a mile from Loch Fad, also contributed to the water supply, as did the smaller Loch Quien, although not until the nineteenth century. There were no major rivers on Bute, only some minor streams. The Balskyte Burn flowed through Rothesay on the eastern side and at present still runs under what is now Castle Street and Watergate, but has been culverted so is no longer visible. The Water of Fad, flowing to sea along the west of the town, was also partially culverted and straightened to aid its use as a mill lade (Argyll & Bute Council, n.d.). Lochs Fad and Ascog drained towards the north of the island whereas Loch Quien drained towards the south of the island (Ferrier, 1966).

¹⁴⁴ *NSA, Rothesay, Bute, Vol. 5, 1845.*

¹⁴⁵ *Rothesay Spinning Company (1828-1847) Book of rainfall from 1828-1847. Bute Museum Archives.*

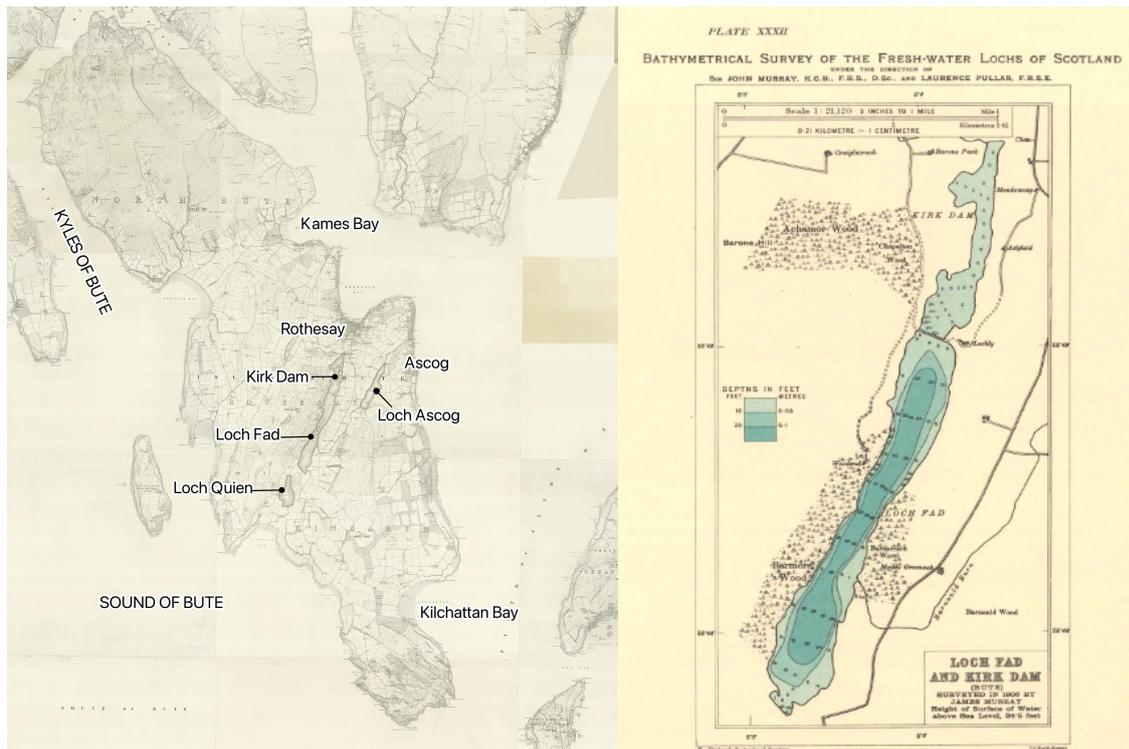


Figure 5. 3. Map of Bute with principal lochs labelled (left) and survey of Loch Fad and Kirk Dam (right).¹⁴⁶

Historical descriptions of Bute refer to corn mills at Greenan, Ambrismore, Scalpsie, Etrick Burn, Scoulag, Kilchattan, and Rothesay (Hewison, 1893; Earls, 1945). The Rothesay corn mill, known as King’s Mill, was an appendage of the castle located on the lade on John Street and functional from at least the fifteenth century (*Aberdeen Journal*, 1827; Hewison, 1893). King’s Mill was included in the lease granted to the proprietors of the Rothesay Cotton Company and continued to operate until a fire forced its closure c.1945 (Ferrier, 1966). An example of locational continuity, where a site deemed suitable for a watermill centuries earlier was selected again for use during the Industrial Revolution. At the peak of the cotton industry, Rothesay had five cotton mills including two power-loom cotton factories. One of these was Broadcroft Mill, located directly behind the Rothesay Cotton Mills and comprising three large buildings for the spinning of cotton cloth with over 23,000 self-acting spindles. When Broadcroft was put up for sale in 1880, all the machinery was powered by two Compound Engines (*Glasgow Herald*, 1880).¹⁴⁷ In 1855 in Rothesay there were 43,000

¹⁴⁶ Background layer: OS Six-Inch 1st edition, 1843-1882; Murray and Pullar (1910) *Loch Fad and Kirk Dam* (Vol. 5, Plate 32). Royal Geographical Society, surveyed 1906, published 1908. View online: <https://maps.nls.uk/bathymetric/chart/2019>. Reproduced courtesy of National Library of Scotland

¹⁴⁷ OS Name Books - Bute county - Volume 7 - Parish of Rothesay - 1855-1864, OS1/6/7.

spindles and 1,015 looms, employing 1,215 and generating £30,000 in total (Sharp, 1908). A steam-powered woollen mill was also founded in Rothesay in the nineteenth century, the only woollen mill on the island (*Glasgow Herald*, 1892). Rothesay Cotton Mills had economic competition, but not for water resources, as the other textile mills were all powered by steam.

5.2.2 Local economy and population demographics

Bute was one of seven islands that together made up the former historic county of Bute, with Bute being the main island and administrative centre of the county (Munro, 1973: 12). Bute's only town, Rothesay, developed around a medieval castle dating to the thirteenth century (Hannah, 2012) and was granted Royal Burgh status in 1401, before gaining further importance in the fifteenth century under the rule of James IV as a strategic location in the King's policy of bringing the Highlands and Islands under royal control (Hume, 1987). Bute's proximity to the mainland and the regularity of ferry services prevented it experiencing geographical isolation despite being an island (Philip *et al.*, 2013). Located only 29 km from Greenock, Bute boasted numerous safe, sheltered harbours and small ports at Rothesay, Kaimes, the Keils of Bute, and St Ninians Bay.¹⁴⁸ Around 1800, the main communication with the mainland was a ferry service from Rothesay to Ardyne and another to Greenock. A regular ferry service at Kilmichael on the northwest of the island transported people and goods to Argyllshire from the seventeenth century until the Second World War (Proudfoot and Hannah, 2000). Internal transport on the island was of minimal importance to industry, the key factor being Rothesay's well-maintained port, meaning the Cotton Mills, ten minutes by foot from Rothesay Pier, was extremely well placed for trade.

When the lease for the first cotton mill was signed in 1778, the burgh of Rothesay had a population of 1,525, a figure that grew substantially to 1,983 by 1784 and 2,607 by 1790 while the overall population of the island declined slightly over the same period.¹⁴⁹ The *NSA* for Rothesay reported that the burgh's population had further increased to 4,924 by 1837. These increases in town residents and depopulation of the countryside were in part due to the employment opportunities of the cotton industry, but also reflected changing agricultural practices on the island.¹⁵⁰ Given that there was no other major manufacturing industry on the island, the local residents, characterised as 'industrious' by the parish minister provided

¹⁴⁸ *OSA*, Rothesay, Bute, Vol. 1, Edinburgh: William Creech, 1791.

¹⁴⁹ *OSA*, Rothesay, Bute, Vol. 1, 1791.

¹⁵⁰ *NSA*, Rothesay, Bute, Vol. 5, 1845.

sufficient workers for the Rothesay Cotton Mills.¹⁵¹ There is no evidence of the mills needing to advertise and obtain workers from elsewhere to the same extent as some other mills of this size, such as New Lanark, although Nisbet (2004) identifies one claim of struggles recruiting skilled workers, but possibly with the motivation of downplaying the valuation of the mills.

Bute is interesting in that its physical proximity and economic links to Glasgow and the Central Belt of Scotland render it akin in many ways to Central and Lowland Scotland, whereas much of the island's character would be associated with the Highlands (Munro, 1973). For instance, in the 1790s Gaelic was still the commonly spoken language, although this fell out of use in the following century. Wages were low at 6*d* to 8*d* a day for a labourer but this rose soon after the mills were established, reaching 1*s* or even 18*d* per day (Senex, 1860). By 1840 a spinner here could expect to earn up to £1 4*s* a week (men) or 8*s* 9*d* a week (women), while those in a power-loom factory received as much as £1 10*s* per week.¹⁵²

Organised manufacture on Bute predates the Cotton Mills. There was a spinning school in Rothesay in 1733 and, while still on a small scale, a linen industry was able to make use of locally grown flax and the lade that passed through the town (Ferrier, 1966; Munro 1973: 87). In the 1740s the Board of Trustees for Manufactures gave financial support to lint mills, encouraging the establishment of two such mills on the island, one at Rothesay with ten looms, and another at Kames (Nisbet, 2004). Proposals were put forward to rebuild and enlarge Rothesay's lint mill as part of a larger plan to grow textiles manufactures on Bute, but this did not happen (Nisbet, 2004). However, thanks to the Earl of Bute's keen interest in improvements, several developments related to other resources and industries on the island occurred in the second half of the eighteenth century. Rothesay became a customs house station and the fishing industry was expanded, including successful herring and salmon fishing. As well as supplying the Rothesay market, some of the catch, in particular cockles from St Ninian's Bay, were sold to Glasgow, providing income to many of the parish poor. In the late-nineteenth century the island grew in popularity as a destination for tourism and wellbeing, where those suffering from ailments could enjoy the milder climate (Weber, 1899). Rothesay also had a flourishing shipbuilding industry, a distillery, ropeworks,

¹⁵¹ *OSA*, Rothesay, Bute, Vol. 1, 1791: 305.

¹⁵² *NSA*, Rothesay, Bute, Vol. 5, 1845.

cooperages, a tannery, nail and candle-making, and at Kingarth a brick and tile works was founded in 1849 by the Marquess of Bute (Munro, 1973: 95).

A significant barrier to Bute's economic development was that the island lacked coal. Attempts to locate coal began in the 1660s and Lord Mount Stuart later brought skilled men over from Newcastle to try to exploit coal seams on Bute, but had no success (Munro, 1973: 22).¹⁵³ Coal was therefore expensive as it had to be imported from Glasgow or from Ardrossan, Salcoats, or Ayr by ferry with additional 'oppressive' duties in the form of river-dues and tonnage duty.¹⁵⁴ In 1840 coal arriving at Rothesay's port would cost 10s 6d per ton.¹⁵⁵ There is no evidence to suggest coal was ever envisioned as the primary power source for the early cotton industry on the island.

5.2.3 Ownership and management

At the time when cotton spinning was introduced to Rothesay, much of the land on Bute was in the possession of John Stuart (1713–1792), third Earl of Bute and Britain's first Scottish prime minister (Geddes, 2012). Stuart was a keen agricultural improver, influenced by his time spent with the Dukes of Argyll. A key period of improvements happened under the Earl while Peter May (1722–1795) was his factor (Geddes, 2012). In the late-1760s proposals were made, as already noted, to improve Bute's textile industry by encouraging the growing of flax and the spinning and weaving of fibres (Nisbet, 2004). A letter between May and the Sheriff Clerk of Rothesay in 1777 shows that there was already interest in developing the textile industry on Bute (Munro, 1973). Earlier that same year May wrote:

[t]he situation of Bute is favourable for Trade and Commerce – several attempts have already been made to establish and promote the Linen Manufacture in Bute, but a great deal yet remains. (quoted in Munro, 1973: 88)

May was succeeded by Robert Oliphant or 'Rossie' as he was known after his estate, Rossie, in Perthshire. In addition to his position as Commissioner for the Earl, Rossie was Postmaster General and a Commissioner for the Board of Trustees for Manufactures (Nisbet, 2004). From his connections with the Earl of Hopetoun, Rossie heard that a group of English manufacturers from Sheffield, headed by James Kenyon, wanted to set up cotton spinning in

¹⁵³ *OSA*, Kingarth, Bute, Vol. 1, 1791: 313.

¹⁵⁴ *OSA*, Rothesay, Bute, Vol. 1, 1791: 306.

¹⁵⁵ *NSA*, Rothesay, Bute, Vol. 5, 1845.

Scotland in a similar vein to Cromford Mills – a mill dependent on waterpower.¹⁵⁶ To emulate or ‘imitate’ this model mill (to borrow the language of Tarde (1980) and the early diffusion theory literature), Kenyon was presumably in search of a site with reliable natural watercourses. Rossie wrote to Lord Bute in April of 1778 informing him of the group of prospective industrialists. Rossie persuaded the group to visit Rothesay and see for themselves the supposedly generous supply of water, and to appreciate the proximity of the island to Greenock, and therefore Glasgow and Paisley, where their products could be sold on (Sharp, 1908). An agreement between Kenyon & Co. and the Earl of Bute was signed on 19th August 1778 for a lease of 99 years for a Cotton Manufactory (Earls, 1945). Kenyon, a watchmaker by trade, brought five men with knowledge of Arkwright’s machinery and their families with him to Bute (Nisbet, 2004). Kenyon was assisted in financing the company by investors from Glasgow, including banker Robin Carrick (Turnock, 1982).¹⁵⁷ The mills were nonetheless put up for sale only seven years later, for unknown reasons, in the first of many changes in ownership (Reid, 1864) (summarised in Table 5.1). Some sources state David Dale, founder of three mills discussed later in this chapter, purchased Rothesay Cotton Mills in 1785 (*Financial Times*, 1938; Hodge, 2009),¹⁵⁸ but there is no evidence to support this claim. Dale expressed interest in purchasing the mills, as did another yarn merchant, John Cochrane, but it seems clear that a sale was not agreed with either party (Nisbet, 2004).

The mills were eventually purchased by a Mr Peter Fisher who brought on Robertson Buchanan (1769–1816) as managing partner. Buchanan began his working life as an apprentice to a house-carpenter, later training and working as a millwright in Glasgow and London. After returning to Scotland, he moved to Rothesay in 1791 to manage and invest in the Cotton Mills. During his time on Bute, Buchanan invented a ‘pump which is not liable to choke’, for which he received a patent in 1796 but realised very little financial gain (Tredgold, 1841: 44). In the same year he wrote papers for inclusion in *Repertory of Arts and Manufactures*: one on the improvement of cattle mills and another on preventing carding machines from injuring the health of those employed to attend on them. He also published a collection of essays entitled *Practical Essays on Mill Work and Other Machinery*. Buchanan’s decision to retire in 1801 was influenced both by his declining health and the

¹⁵⁶ Richard Arkwright’s cotton spinning mill in Matlock, Derbyshire.

¹⁵⁷ Robert Carrick, manager of Ship Bank and ‘one of the most widely known business men of his day’ (Stewart, 1881: 186). Carrick was a partner in at least two textile related companies including Henry Hardie & Co., linen drapers and Brown, Carrick & Co., muslin manufacturers, bleachers, and merchants.

¹⁵⁸ *NSA*, Rothesay, Bute, Vol. 5, 1845.

stress brought by managing the mill, which was at that time failing, though the specific details of the financial struggles are unknown (Tredgold, 1841: 45).

Table 5. 1. Changes in ownership and management of Rothesay Cotton Mills.

Date	Event
1778	August: Kenyon & Co. sign 99 year leased from Earl of Bute. September: Interim manager Mr Clayton is accommodated in Rothesay & English workmen move into Bishop's house.
1785	Mills advertised for sale in the <i>Glasgow Mercury</i> .
c.1785	Peter Fisher and Robertson Buchanan are proprietors/managers as Fisher, Buchanan & Co.
1801	Messrs Anderson, Bannatynes, Dunlop & Fullerton are the proprietors.
1813	William Kelly and Robert Thom partner to purchase the mill.
1826	Kelly retires, sells his share to Thom.
Unknown	Mr Struthers joins Thom as a partner.
1835–1858	Mr Prentice is manager.
Late-1830s	Thom retires, Struthers purchases the mills with Mr Duncan Salmond.
1860	Struthers retires, Salmond is the sole proprietor under Duncan Salmond & Co.
1866	Mr Salmond puts mills up for sale.

By 1801 the business had been purchased by Messrs Anderson, Bannatynes, Alex. Dunlop and Fullerton, and it was under their ownership that the mills went bankrupt in 1812 (Sharp, 1908). Highly pertinent to the broader themes of this thesis, is the belief that the primary cause of the company's failure on this occasion was their use of steam power, and the price of coal (Malm, 2014). Despite the presumed potential of Rothesay for reliable waterpower, based on the enthusiasm of Lord Bute's factor and the longstanding King's corn mill, the Cotton Mills struggled with their energy supply. The mills, originally solely water-powered, became very *early adopters* of, and heavily reliant on two steam engines from 1800. This experimentation with steam at Rothesay came much sooner than at any of the other mills that will follow in this chapter. Under this theory, production was no longer profitable due to coal, although according to Lord Bute's current factor, Archibald Moore, the company's failure was part of a wider problem facing cotton mills across Britain (Munro, 1973: 92).¹⁵⁹ Moore feared the mills would struggle to find a buyer let alone reach anywhere near their asking price, 'unless some favourable change takes place on the Continent' (Moore, 1812, quoted in Munro, 1973: 92).¹⁶⁰ This led to suggestions that the building might better serve another

¹⁵⁹ Control of the land had passed to the 3rd Earl's grandson, John Chrichton-Stuart, 2nd Marquess of Bute.

¹⁶⁰ The prosperity of mills in Scotland was connected to wider geoeconomic and geopolitical processes that influenced prices and the ability to import/export materials and finished products. In this instance Moore was referring to the Continental System of blockades imposed between 1806–1813 in the Napoleonic Wars (Crouzet, 1964).

function. George Robinson, a ship owner and merchant in Rothesay, advised Lord Bute that he ought to try persuading the Government to buy the mills to house French prisoners of war (Sharp, 1908).

Despite the ongoing crisis in the cotton industry, in 1813 the mills were taken over by William Kelly and Robert Thom. Kelly had been joint manager of the New Lanark Mills alongside James Dale, as will be discussed later, a position he lost following the take-over by Robert Owen who hastily replaced Kelly with Robert Humphreys (Owen's colleague from Manchester) (Gorb, 1951: 139). After being let go, Kelly moved to Glasgow where he received the title of burgess (Donnachie and Hewitt, 2015). Shortly afterwards he entered into a partnership with Thom, acting as managing partners of the Blackburn Mill on the River Almond in East Lothian.¹⁶¹ Robert Thom (1774–1847) grew up in Tarbolton, Ayrshire, assisting with agricultural tasks on his father's farm. Having learnt the trade of a wright, he relocated to Glasgow in the 1790s to work and soon developed an interest in cotton spinning (ICE, 1848). Thom worked during the day, but in the evenings attended lectures on subjects such as Natural Philosophy and mathematics at the Andersonian Institution, now the University of Strathclyde, where his attention was turned to mechanics and the laws of fluids.¹⁶² Thom was offered a position managing the cotton mills at Pollockshaws in south Glasgow prior to moving to Blackburn Mill (ICE, 1848). It is unknown whether Kelly and Thom were acquainted prior to working together at Blackburn, nor do we know if the pair immediately gave up ownership of Blackburn when they invested in Rothesay. Under Thom, substantial engineering works were undertaken on Bute in an attempt to turn around the mills' fortunes and to fully utilise the natural water resources of the island. Thom lamented that the best engineers had all been drawn in by the glamorous steam engine and were too quick to give up on water as a motive power:

It is not to be inferred that I think lightly of the great effects produced by the steam engine. I merely wish to draw a little attention to another source of national wealth which has hitherto been very much neglected ... Such indeed has been the eclat of the steam engine hitherto that whenever a work became scarce of water, either from being

¹⁶¹ Blackburn was a cotton mill founded in 1793 by Glasgow businessman Charles Hamilton. The mill was located in the village of Blackburn, established by sugar plantation owner, George Moncreiff around the year 1770. Blackburn Mill operated until a fire in 1877 after which it was rebuilt and briefly repurposed as a paper mill (Kirkbright, 2018). The supply chains of cotton and sugar were of course connected to colonial projects of plantations and the labour of enslaved people.

¹⁶² Anon. (1829) Account of a new system of water power, invented by Robert Thom, esq., Rothesay Cotton Mills (Communicated by a Friend of the Inventor). *Mechanics Magazine*, 307, 306–317, Bute Museum Archives.

enlarged or from a dry season, nothing was to be heard but the general cry, ‘Put up a steam engine and be independent of water.’ This cannot last, and therefore, instead, we may soon expect to hear substituted ‘Get water if you can, and be quit of these smoky and expensive engines’.¹⁶³

Thom’s decision to engineer the landscape (described shortly) and stay with an older form of power (albeit with innovative modifications) at the original site of the Rothesay Cotton Mills rather than relocate, thus reflects *dynamic* decision making, that came as a result of careful reflection on the issue of motive power. The mills did not stay at Rothesay out of idleness or desire for the status quo but because it was perceived to be an astute decision for the future.

Kelly retired from the partnership in 1826 (Donnachie & Hewitt, 2015), leaving Thom as the sole owner until he brought a new partner, a Mr Struthers, into the business. By 1840 Thom too had left the mills, with the intention of retiring at his estate at Ascog on Bute, and Struthers partnered with Duncan Salmond. Salmond was the sole owner in 1866 when the mills were once again advertised for sale in the *Glasgow Herald* (1866a; 1866b), after which records of the mills’ ownership are scarce.

5.2.4 Buildings and facilities

Once the lease between Kenyon & Co. and the Earl of Bute had been signed in 1778, machinery for spinning yarn was placed in the old lint mill so that production could begin as soon as possible.¹⁶⁴ The lint mill was powered by a single waterwheel at the side of the building that turned an under-floor drive connected to the belts of the water frame (Figure 5.4). Initially there were just two machines placed in the mill, as this was all the old building had capacity for, comprising as it did only two storeys and measuring just 12 m by 4 m, barely bigger than a standard worker’s cottage (Scot, 1930: 294; Nisbet, 2004). This machinery was nonetheless sufficient for the company and its workers to train and experiment with the new technology ahead of production starting in earnest in the newer mill. Despite its seemingly modest scale, 300 spindles worth of yarn could be produced weekly on the two water frames (Nisbet, 2004). The first purpose-built spinning mill on the island, referred to later as the ‘Old Mill’, was built in the style of Arkwright’s mills and was 40 m by

¹⁶³ Thom, R. (1829) Brief Account of the Shaws Water Scheme and Present State of the works, Columbian Press, Greenock, 1829. Bute Museum Archives.

¹⁶⁴ The mill at Penicuik, established by Peter Brotherstone, November 1776, was the first purpose-built cotton spinning mill to be built. However, yarn was first spun at the Lint Mill in Rothesay.

10 m and five storeys high. The date at which production transferred to this building is estimated to have taken place in late-1780 or early-1781 (Nisbet, 2004). At this time the owners also erected a machine shop so that the machinery for the mills could be made on site, since there was nobody producing cotton machinery for sale in Scotland at the time (Sharp, 1908). When the mills were advertised for sale in 1785, they were said to include carding, roving, and spinning machinery, with almost 1,000 spindles for producing cotton twist and 20 spinning jennies for fine wefts (Reid, 1864).

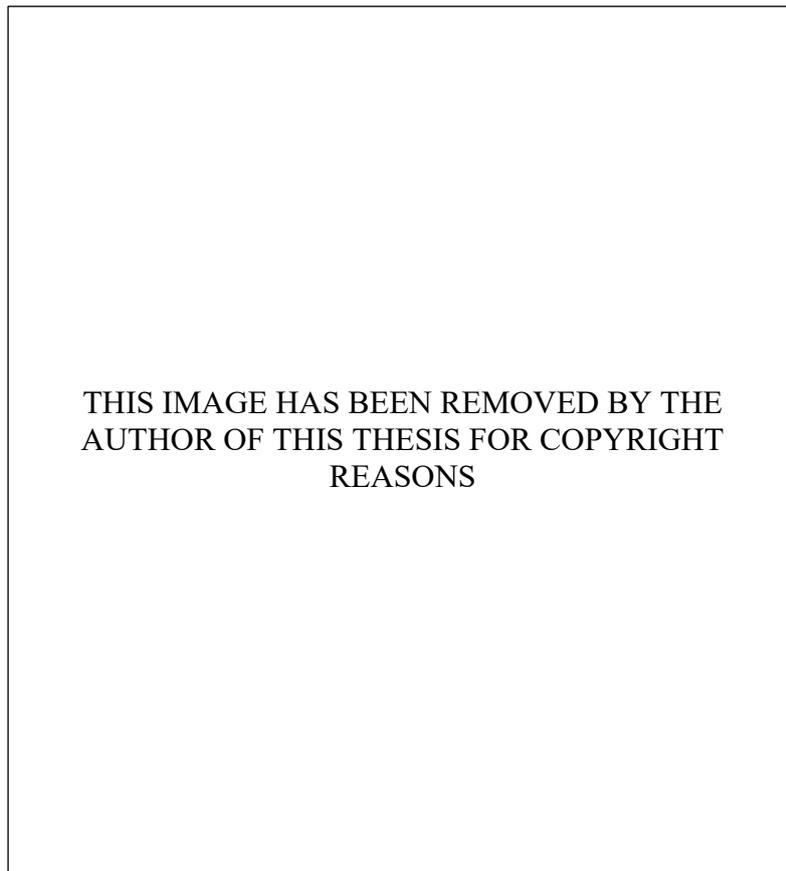


Figure 5. 4. Diagram of the waterpower system in the modified lint mill (Nisbet, 2004).

A later proprietor, possibly Peter Fisher, erected a second purpose-built mill. The ‘New Mill’, which replaced the lint mill entirely, was completed in 1791. Built perpendicular to the Old Mill, facing Mill Street, the New Mill was six storeys high and 45 m in length (Figure 5.5). The machinery fitted in this mill was partly made on site as before but also came from the respected machine maker William Dunn of Glasgow (Sharp, 1908). Under Fisher, Buchanan & Co., the mills were valued at £4,800 by the Sun Fire Office insurance company in 1795 (Chapman, 1971). As well as the spinning mills, the company had hand looms dispersed

throughout the county: at the peak of the industry in the mid-nineteenth century, there were 200 looms spread between Rothesay (113), Port Bannatyne (25), Cumbrae (27), Largs (10), Lochgilphead (13), and Tarbet (12) (Sharp, 1908).



Figure 5.5. Left: Layout of the Rothesay Cotton Mills (labelled as *Cotton Works*) with Broadcroft Mill to the south¹⁶⁵; Right: Rothesay Cotton Mills under the ownership of Salmond (Courtesy of Bute Museum).

As the industry was located in a town, there was not the same need for the proprietors to provide housing and facilities on the scale of the rural mills encountered later in this chapter. For the mill owners, ‘an excellent Dwelling House contiguous to the Works, capable of accommodating a large family, with a good Garden’ was available (*Glasgow Herald*, 1866a), and for workers a 12-bay block of terraced single-storey cottages were erected by the Cotton Mill Society in 1805 on John Street (HES, 2023a). Additional planned workers’ housing was constructed on Colmshill Place and Colmshill Street between 1780 and 1825 (HES, 2010). Given the relatively small size of the town of Rothesay, there was still the same convenience of workers living near the mills as there would be in an industrial village location. The final owner of the neighbouring Broadcroft Mill in the late-nineteenth century recalled that workers were woken ahead of the 5.30 am start to the working day by a man passing through the streets with a horn (Sharp, 1908). The proprietors of Rothesay Cotton Mills funded a school for their child and adult workers (Fowler, 1836–1837: 259). There would, at one time, have existed a shop associated with the Cotton Mills where workers could spend their wages. Countermarked Spanish dollars dating from 1820 to 1821, during a shortage of silver coinage

¹⁶⁵ Ordnance Survey, 25 Inch to the mile Argyllshire and Buteshire - Buteshire CCIV.6 (Rothesay) (Surveyed: 1863, Published: 1864). View online: <https://maps.nls.uk/view/75119689>. Reproduced courtesy of the National Library of Scotland.

(Hodge, 2009), imply that for a year at least the owners provided a store or an arrangement with local businesses to allow the use of their mill coins. The Rothesay Cotton Mill Society was established in 1792 (Bute Museum, 2025) and there was a brass band directly connected to the mills (Sharp, 1908). Beyond this, little is known of the working or social lives of the employees.

5.2.5 Successes and failures

A turning point for the mills came in 1815 when Thom began his extensive water engineering scheme on the island.¹⁶⁶ The scheme was necessary to counter the otherwise insufficient water supply on the island for the needs of industry at that time: the potential for water to meet demand was there, but human intervention was necessary to realise it. The scheme consisted of an ingenious series of aqueducts (referred to as cuts or water-cuts), reservoirs and self-acting sluices to divert available water from elsewhere on the island to Loch Fad, and then deliver it to mills when required while also regulating against floods. Thom achieved this entirely without tunnelling through any of the island's hills. Instead, aqueducts travelled around obstacles and up and down valleys (Sharp, 1908). At least five cuts were designed and four of them were constructed, totalling 6 and $\frac{3}{4}$ miles: the Lovers' Walk Cut; the Birgidale Cut; the Quien Cut; and the Drumreoch-Barnauld Cut. These last two required the most extensive engineering. Accompanying the Quien Cut, following the contours of the Quien Hill, an auxiliary reservoir was constructed at Kilmory Butts, while the 5 mile long, U-shaped Drumreoch-Barnauld Cut incorporated two natural streams, capturing water that would otherwise have drained to the south of the island to Kilchattan Bay and Stravanan Bay. In sections of the course of this latter cut the fall was extremely small, at times, just 1 ft over a distance of 1,200 ft (Ferrier, 1966).

Following the construction of the scheme, the Rothesay Cotton Mills had drainage of around 4,000 Scotch acres available to them.¹⁶⁷ Just over half of this (2,119 acres) drained naturally into Loch Fad and the Kirk Dam, while the rest was intercepted and transported by catch water drains. The additional water was stored in auxiliary reservoirs that were created at Dickson's Dam, Dhu Loch, and Kilmorie Moss. The embankment at Loch Fad was further

¹⁶⁶ The engineering works on the island took place over a nine year period between 1813 and 1822. A detailed description of all sections of the works is provided by Maclagan (1996).

¹⁶⁷ Thom, R. (c1846) Description of the Rothesay Scheme by Robert Thom for Ian MacCagan. Unpublished manuscript, Bute Museum Archives.

extended by several feet in 1818, as was that of Kirk Dam, to increase the capacity of the reservoirs. When the Kirk Dam was only required for King's Mill, it had a capacity of 2,000,000 cubic feet of water held behind an embankment of 7 ft in height. The project was a success, leading Thom to list both steam engines for sale (*Glasgow Herald*, 1820). In 1821, a new 25 ft high embankment was constructed, and the lade between the Kirk Dam and Loch Fad was deepened to assist with drainage and prevent the gathering of stagnant water and marshy conditions. The result was a reservoir with capacity for 43,200,000 cubic feet of water. This was the most expensive element of the project, costing a total of £1,317 for all components of the embankment, including tunnels and sluices. In all, the available power to the mills was doubled, providing the equivalent to a steam engine of 60 hp working twelve hours a day, all for a total cost of only £3,000. This solved the first of the company's problems, the shortage of water.

A second issue was flooding. The lade was the only method for water from Loch Fad and Kirk Dam to drain to the sea, which meant that when the water levels were too high the banks surrounding the lade would be inundated, as would the wheel pits of the mills. Thom resolved this problem too using self-acting sluices (Figure 5.6). The fall of water at the mills was also increased by doubling the width of the mill lade. By doing so the water moved at a slower pace to the mill and lost less height than it previously would have. The water could now flow from the lade's surface onto the wheel.¹⁶⁸

For Thom, such schemes were not purely about producing profit. When speaking of the advantages to be gained, Thom stressed also the humanitarian aspects, for he believed that situating industry in less crowded rural locations rather than large cities had benefits for the mill workers too (Earls, 1945). Even though Thom never gained the fame that some of his contemporaries received, such as was meted out to James Watt or William Fairbairn,¹⁶⁹ he received praise from numerous sources for his feats of engineering. The *Aberdeen Journal* (1827) declared that Thom's system 'promises to effect a great change in manufacturing

¹⁶⁸ Thom, R. (c1846) Description of the Rothesay Scheme by Robert Thom for Ian MacCagan. Unpublished manuscript, Bute Museum Archives.

¹⁶⁹ Sir William Fairbairn, first baronet (1789–1874) was born in Roxburghshire. He served as an apprentice mill-wright in Newcastle upon Tyne, afterwards relocating to Manchester to work and start his own business. Fairbairn is well known for his millwrighting work in water-powered mills but he also diversified into other branches of engineering, for example, experimenting with boilers and investigating metal fatigue. He was president of the Institution of Mechanical Engineers and the Manchester Literary and Philosophical Society, as well as having active involvement in other societies (Burnley and Brown, 2008; Byroms, 2015).

industry,' and Thom received the silver medal of the Royal Society for the Encouragement of Arts, Manufactures, and Commerce for his self-acting hydraulic apparatus. According to the *Transactions* of the Society, Thom's apparatus saved the Rothesay Cotton Mills £600 annually by removing the two steam engines (Pering, *et al.*, 1822). Thom was asked to consult on various other schemes to supply or increase water to Paisley, Ayr, Glasgow, Edinburgh, Dundee, Preston, Cranstonhill Waterworks (for domestic as well as industrial uses), and he was also an engineer for the Durham water company and contributed to a commission for water for Belfast (*Belfast News-Letter*, 1837).

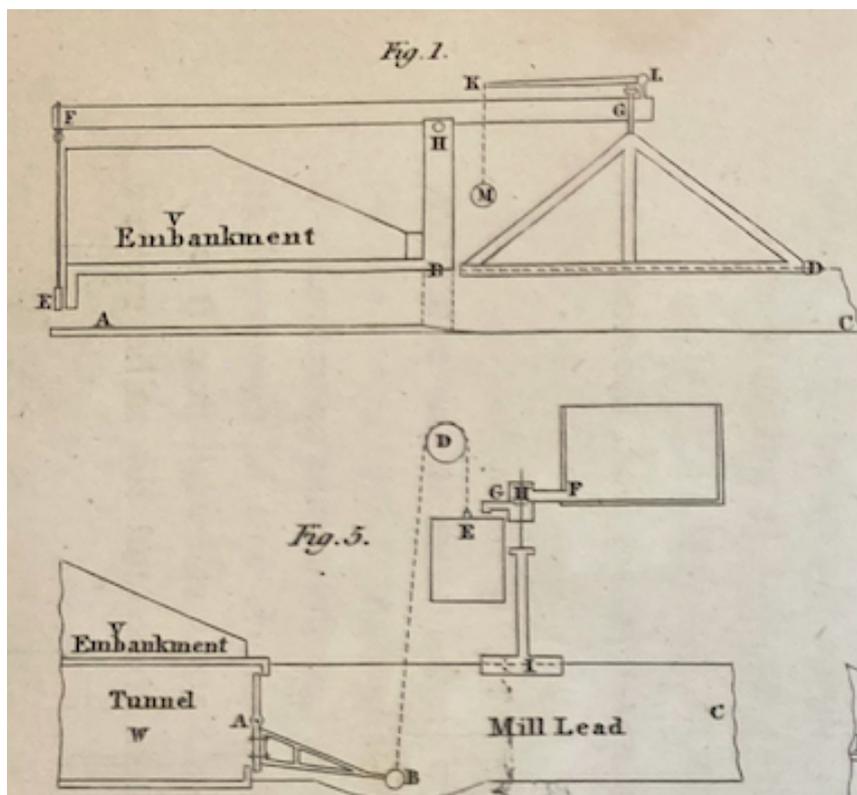


Figure 5. 6. Examples of Thom's Self-Acting Sluices used on Bute. Diagram of a Lever Sluice and a valve and lever sluice. The sluices were designed to open/close only when the water reached an assigned height.¹⁷⁰

The most famous of Thom's projects was for the Shaw's Water Company in Greenock. Greenock's port was of national importance (Hume, 1976), but the town suffered water shortages due to its topography, having no pre-existing natural water courses for industry. Greenock also lacked desirable manufactures, in particular a shortage of cotton mills (Malm,

¹⁷⁰ Thom, R. (1829) Brief Account of the Shaws Water Scheme and Present State of the works, Columbian Press, Greenock, 1829. Bute Museum Archives.

2014). George Robinson of Greenock asked Thom to design something on a similar vein to that of Bute and Thom proposed a system of artificial reservoirs and aqueducts where the water was divided between 33 factories allowing a fall of 50 hp each. There was great concern at the time regarding water engineering after a flood-related accident at Greenock in 1835, during which the embankment of Beith's Dam gave way, resulting in the deaths of 40 people and sustaining damages exceeding £6,000. Thom still believed that it was possible to build a secure artificial reservoir, safe from bursting, so long as proper construction and materials were used, as addressed at length in his essay on the collection and storage of water.¹⁷¹ A more detailed description of the Greenock scheme will not be given here, but it is important to note that its aims were never fully achieved.¹⁷² The scheme was successful as a feat of engineering, however, it took years for all the falls to be let (and the planned westerly line of falls was never actually built) (Shaw, 1984). Thom believed that he had solved waterpower's primary problem of temporal fluctuations and spatial restrictions, but his engineering could not yet fully account for weather extremes or facilitate the social interactions required between a group of capitalists – inherently self-interested – for a collective undertaking of this kind (Shaw, 1984; Malm, 2014).¹⁷³

The ability to undertake a scheme of this nature on Bute owed a great deal to the cooperation of the landowner, the Marquis of Bute.¹⁷⁴ Referring to other schemes, Thom lamented the 'short-sighted resistance' of proprietors of land that in some instances 'cause the total abandonment of the schemes even where the chief advantage was ultimately to be their own'.¹⁷⁵ Thom reflected that his experience with the Marquis of Bute could not have been more different:

There his Lordship in the most liberal manner, gave every assistance ... such liberality is unfortunately rare and that the greater part of mankind seldom have the sagacity to discover that they would best serve their own interest by attending a little more to the interest of the public at large.

¹⁷¹ Thom, R. (1843) Copy of minutes of evidence as corrected by Mr Thom. Ascog Oct 15 184. Health of Towns Commission 1843. Bute Museum Archives; Thom, R. (c1847) Extract from Robert Thom's essay on the collection and storage of water. Final draft probably dating C1847 [from Upper Clyde Water Board]. Bute Museum Archives.

¹⁷² See Clark (1976) and Malm (2014).

¹⁷³ In 1852 there was a severe drought and Loch Thom ran dry, causing the mills to stop for six weeks, and £350,000 worth of capital to be idle (Shaw, 1984).

¹⁷⁴ The same as the Earl of Bute. The title changed and the 4th Earl, John Stuart, was known as the 1st Marquis of Bute.

¹⁷⁵ Thom, R. (no date) On Collecting and Storing Water for moving power & for supplying towns, including detailed descriptions of works executed and a variety of Reports on Water operations generally. Unpublished manuscript, Bute Museum Archives.

This amicable relationship did not last. Possibly the biggest setback for Thom followed the diversion of the Scoulag Burn into the cuts in 1819. Ten years later a lengthy legal battle ensued because the cut had interfered with the water supply to the Marquis of Bute's residence at Mount Stuart. The Marquis claimed that the terms of the original lease granted to the mill owners by Lord Bute had been broken. The lease gave permission to obtain water to supply the works but stipulated that they could not enter the park pleasure grounds belonging to Lord Bute to do so. However, it was decided by the court that the mills' owners had not exceeded their rights and that they could continue to use the water (Moncrieff, 1829). The relationship was now strained and in 1832 Thom was in another dispute with the Marquis. This time his mills were not directly affected, but Thom was speaking out against threats that had supposedly been made by Bute's factors to tenants who did not go along with measures of improvement (presenting Thom as one of the more sympathetic mill capitalists) (*Morning Chronicle*, 1832). Duncan Salmond & Co. also found themselves appearing before the Court of Session as defendants, accused by a group of proprietors in Rothesay of having 'excessive accumulation of water' in their reservoir.¹⁷⁶ Further examples of successful collaboration or disputes over water will be encountered in the later case studies and will recur in Chapter 6.

Another problem was that the advanced water engineering still required regular physical maintenance. For example, the connection between the lochs and the dam were prone to become sanded up, limiting the amount and flow of water that could get through to the dam. The system could also be interfered with, as happened in September of 1874 when 'some evil disposed person' blocked the channel, preventing communication between the Loch Fadd and Kirk Dam.¹⁷⁷ Thus, although the need for a 'waterman' to manually perform tasks such as opening the sluices was obviated, detailed monitoring was needed. From 1828 Thom maintained uninterrupted hourly observations of rainfall, temperature, including high and low extremes, and the average height of the barometer.¹⁷⁸ Records of rainfall had been recorded by the previous mill owners from 1800 before being taken over by the Buteshire Natural History Society in 1875, allowing Rothesay to claim to have the longest continuous meteorological records in Scotland (Munro, 1973: 25).

¹⁷⁶ Bute Museum Archives (1995) Correspondence between researcher and Bute Museum Archives.

¹⁷⁷ Rothesay Spinning Company (1839-1875) Water book 1839 to 1875. Bute Museum Archives.

¹⁷⁸ Rothesay Spinning Company, (1800-1845) Tabulated record of local rainfall 1800-1845. Bute Museum Archives.

Even with these meticulous records and revolutionary water-cuts, at times there was still a reliance on steam. The company's 'water book', beginning from 1839, kept recordings of when a cut was let off, water sluices opened or shut, and when a steam engine was used. The first four years refer only to water-related features, but from 1843 an engine had indeed been installed again and was being used regularly. On 31st August 1843, it was recorded that the 'engine set on in connection with the water wheel' until it was disconnected nearly four weeks later on 26th September. The engine was connected to the wheel again on 9th October to drive the New Mill with the next entry referring to the engine stopping eleven days later on 20th October.¹⁷⁹ In a sales advertisement for the mill in 1866, the price included a 30 hp condensing engine for use when water was scarce (*Glasgow Herald*, 1866b).

The mills' fortunes in its final years are unclear. Although the industry was declining, there were still around 600 people employed in spinning and weaving in Rothesay in the 1870s (Munro, 1973: 95), but a decade later textile processing had ceased in all five of Rothesay's mills. By the late-nineteenth century, the original cotton mills reached a point where their age and original design limited the possibility for further modernisation (Sharp, 1908) and combined with the general decline in the demand for British produced cotton goods Bute's industry died down.

5.3 New Lanark

5.3.1 Location and water supply

This second case study was and remains Scotland's most famous cotton mill. The mills and village of New Lanark were created in Lanark parish in the central Lowlands of Scotland. Lanark was fairly remote from any substantial commercial districts, being 40 km from Glasgow, 49 km from Edinburgh, 56 km from Stirling, and 76 km from the town of Ayr,¹⁸⁰ making it, in certain respects, a less than obvious location for a major industrial enterprise. It was instead the physical resources in the form of flowing water that would attract entrepreneurs to this location.

¹⁷⁹ Rothesay Spinning Company (1839-1875) water book 1839 to 1875. Bute Museum Archives.

¹⁸⁰ *NSA*, Lanark, Lanark, Vol. 6, 1845.

The most substantial river in the parish is the Clyde, which flows through Lanark from the east to the southwest and is augmented by the Douglas Water. The Clyde, Scotland's third longest river, has a catchment surface area of 3200 km² (Clyde River Foundation, 2023). Its source is in the Lowther Hills in the upper region of the Scottish Borders. From there it winds its way through rolling hills into Renfrewshire and the urban centre of Glasgow where its estuary begins, concluding at Greenock (Karunaratna, 2011; Smedley *et al.*, 2017). In the nineteenth century the Clyde developed into one of Scotland's most important industrial rivers with mills located along much of its course and a longstanding shipbuilding industry and ports at its lower reaches (Gibb, 1983: 115–118).

South of Lanark town, to the southeast of Glasgow, the character of the River Clyde changes notably from a meandering channel to one that is narrow, fairly straight and dropping in gradient by 55 m in the space of just 1.8 km (McEwen and Werritty, 1997: 34–35). As a result of disruption to the previous course of the river by glacial erosion, a new channel was cut resulting in a gorge and a number of notable waterfalls, collectively known as the Falls of Clyde. The first fall at Bonnington Linn (10 m high) was followed by the famously picturesque Cora Lin with a fall of 27 m, Dundaff Linn (3 m) and Stonebyres Linn (24 m) (Gordon, 2012). The decision was made to place the New Lanark Mills on the banks of the Clyde, below Dundaff Linn, the smallest of the falls.

The land selected for the mills possessed very little value for agricultural activities (Hume, 1971), the ground at that time being a rocky morass, covered in thick brushwood and better suited to the grazing of wild animals than human activity (Davidson, 1828). Steep wooded hills surrounded the deep glen on all sides, limiting accessibility to the site.¹⁸¹ The entry for Lanark in the *OSA* recalls that the climate of the parish included regular droughts and frost in spring and heavy rains in the summer months.¹⁸² These rains are described in the context of their effects on crops, but such weather conditions would also impact the smooth running of a mill.

Other mills operated in the parish (Figure 5.7) without creating competition for New Lanark in terms of water supply or markets for their products. A water-powered sawmill at Cora Lin

¹⁸¹ *NSA*, Lanark, Lanark, Vol. 6, 1845.

¹⁸² *OSA*, Lanark, Lanark, Vol. 15, 1795.

was the closest mill on the Clyde. Many of the other mills were on the significantly smaller River Mouss (Mouse), a tributary of the Clyde passing north of Lanark, including Mouse Mill (a water-powered grain mill), Lockhart Mill, Jerviswood Mill (built around the eighteenth century as a water-powered linen mill with additional sawmill), and Cleghorn Mill (another water-powered grain mill). The Mouss was known to struggle, particularly in the summer months, to provide sufficient power for these mills.¹⁸³ In terms of substantial industrial sites, there was the Corehouse Brick & Tileworks and Clydefall Carpet Work located downstream, but both of these were powered by steam and there is no evidence of interference to water flow caused by any of these mills.

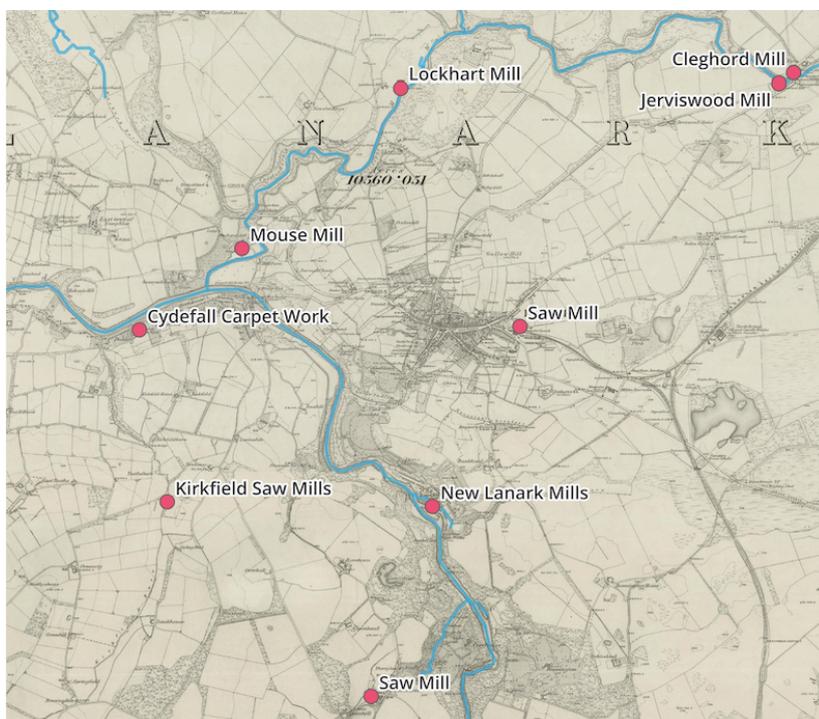


Figure 5. 7. Historic location of mills in Lanark.¹⁸⁴

5.3.2 Local economy and population demographics

Lanarkshire was to become the most important industrial centre of Scotland, containing most of the country's heavy industry (Hume, 1976) but in the late-eighteenth and early-nineteenth centuries the majority of the county was rural. At the time that New Lanark was founded, Lanark was the only town in the parish and there existed just three hamlets of notable size at Cartland, Nemphlar, and Hyndford Bridge.¹⁸⁵ The population of the parish of Lanark stood at

¹⁸³ *NSA, Lanark, Lanark, Vol. 6, 1845.*

¹⁸⁴ Background layer: OS Six-Inch 1st edition, 1843-1882.

¹⁸⁵ *NSA, Lanark, Lanark, Vol. 6, 1845.*

2,294 in 1755.¹⁸⁶ The number of residents more than tripled to 7,672 by 1831 in part thanks to the establishment of the New Lanark Mills and village, but also due to the improvement of agriculture, industry, and trade across the entire parish.

Aside from agriculture, the largest profession in the parish of Lanark in the early-nineteenth century was weaving, which engaged 873 persons. Agents in Lanark town supplied residents of the smaller adjacent settlements with raw materials through the domestic ‘proto-industry’ putting-out system. Wool and flax spinning were also at one time important to Lanark’s economy, forming the primary employment for women in the area (Davidson, 1828). The main craft professions were shoemakers, masons and wrights, and stocking-makers.¹⁸⁷ The presence of these proficient craftspeople allowed the mills to hire skilled workers locally from within the parish, but the original population was nowhere near sufficient to meet the labour needs of a large cotton mill. Other than labour, the supplies required for a thriving industrial community were mostly available locally within the county or wider Central region of Scotland. Flour, candles, soap, and small metal products such as locks, hinges and tacks, could all be obtained from merchants within Lanarkshire (Donnachie and Hewitt, 2015). Although no coal had been found within the parish, it could be transported from neighbouring regions from a distance of only 10 to 14 km: Ponfeich Coalworks was 11 km away and the price per cwt was 4*d* to 4 ½*d* in 1835 (Davidson, 1828).¹⁸⁸

Communications would have been very poor at the time when the mills were established. Connections would improve slowly starting with the new Clydesdale Road, to link Lanark with Glasgow via Hamilton, commenced in 1792 (*The World*, 1792). In the first half of the nineteenth century there were two bridges across the Clyde, the first located 1.5 km down river of the mills at Lanark town and the other 3 km below it, plus five bridges over the Mouss. 24 km of turnpike road were constructed and stagecoaches and carriers travelled daily from Lanark to both Edinburgh and Glasgow, but, unfortunately, there was still no canal or rail transport at this time.¹⁸⁹ Lanark town was connected to the rail network by the Caledonian Railway in 1867, but, due to the challenges of its location in a river gorge, New Lanark itself would never have its own station. Although difficulties with access would prove

¹⁸⁶ *OSA*, Lanark, Lanark, Vol. 15, 1795.

¹⁸⁷ *NSA*, Lanark, Lanark, Vol. 6, 1845.

¹⁸⁸ Cwt was a measure for the weight of coal. 36 Cwt being equal to one ton, 1 cwt equalled 28 kg (DSL, 2025e). *NSA*, Lanark, Lanark, Vol. 6, 1845.

¹⁸⁹ *NSA*, Lanark, Lanark, Vol. 6, 1845.

problematic for owners of the mills, this did not deter the hundreds of visitors who flocked annually for both pleasure and business to the romantic Falls of Clyde and the remarkable mills (Davidson, 1828; Minnery, 2019).¹⁹⁰

5.3.3 Ownership and management

Although most often associated with the socialist reformer Robert Owen, who will be discussed shortly, the ownership and management of New Lanark Mills and village underwent multiple changes during its history (Table 5.2 and Figure 5.8). For the first 13 years of its existence, New Lanark was under the control of David Dale (1739–1806), named already in the Rothesay case. Dale was born in Stewarton, Ayrshire. His father, William Dale, was a grocer and his grandfather an agricultural worker, so there was no pre-defined path into the cotton industry for the younger Dale. Instead of joining his father David Dale was sent to Paisley to undertake a handweaving apprenticeship, after which he went on to be a journeyman in Hamilton and Cambuslang, most likely giving out and collecting yarn (McLaren, 2015). Dale started his own business at the age of 24, operating from Glasgow's High Street to import French yarn from Flanders (McLaren, 2015). Dale had entered the market at a time when cotton, one of the core trades of the growing imperial economies reliant on slavery (Devine, 2011: 45), was beginning to take off, allowing Dale to make a substantial profit and build a reputation for himself among Glasgow's business elite. His marriage to Anne Caroline Campbell in 1777 further strengthened Dale's financial and social status and assisted him in gaining a position in the Chamber of Commerce and an appointment as a joint agent for the new Glasgow branch of the Royal Bank of Scotland in 1783 (McLaren, 2015).¹⁹¹ Dale invested in numerous businesses across Scotland, including his Turkey Red dye factory with George Macintosh,¹⁹² and cotton mills at Catrine, Blantyre, Kimore, Spinningdale, Newton Stewart, and Stanley (Paton, 1890), two of which will be encountered in case studies further on.

¹⁹⁰ Visitor's books, 1795-1962. Records of Gourrock Ropeworks Co Ltd, rope makers and textile manufacturers, Port Glasgow, Inverclyde, Scotland. University of Glasgow Archives & Special Collections. GB 248 UGD 042/7/1.

¹⁹¹ Anne Campbell's father, John Campbell of the Citadel, was a director of the Royal Bank of Scotland (Butt, 2006).

¹⁹² George Macintosh (1739-1807), born in Roskeen in Ross and Cromarty, worked as a clerk at a tannery in Glasgow before running the Dunchattan Cudbear Dye Works in Dennistoun in Glasgow. At the Dunchattan Works the workforce consisted of Gaelic speakers from the Highlands, who mostly lived on site. Macintosh's next Glasgow mill, located on French Street, was a collaboration with David Dale and the French dyer, Pierre Jacques Papillon. This mill became famous for producing 'Turkey Red' dye (Stewart, 1881; Wertz, 2014).

Table 5. 2. Key events in the ownership of New Lanark

Date	Event
1785	Partnership between David Dale, Richard Arkwright, and George Dempster.
1786	Partnership is dissolved. David Dale retains all shares.
1799	Partnership formed of Robert Owen, Barton, Atkinson, purchase the mills from Dale as the Lanark Twist Company. Owen assumes management on 1 st January 1800.
1810	Owen, Barton, Atkinson partnership dissolved. Owen retains ownership.
1813	Owen finds new partners in London including John Walker and purchases New Lanark at auction.
1824	Owen leaves New Lanark to set up New Harmony in Indiana, USA.
1825–1881	Charles and Henry Walker of Walker & Co. (sons of John Walker) own New Lanark.
1881–1968	Mills become the Lanark Spinning Company, owned by Birkmyre and Somerville. 1903 the Lanark Spinning Company merges with the Gourock Ropework Company and starts trading under their name.
1970	Mills are sold to aluminium extraction company MetEx for scrap metal.
1974	New Lanark Trust is established and a Compulsory Purchase Order sees ownership of the site transferred to the Trust in 1983.



Figure 5. 8. Left to right: Portrait of David Dale as featured on The Royal Bank of Scotland’s £5 notes from 1966 (NatWest Group, 2022); Richard Arkwright by Mather and Brown, 1790 (English Heritage, 2025); Robert Owen by Ebenezer Morley (National Portrait Gallery, 2023); Henry Birkmyre II (1832–1900) c.1875 unknown artist (ArtUK, 2022).

Dale earned a reputation as a compassionate proprietor in comparison to others at the time. In his role as a bailie Dale was known as the ‘Benevolent Magistrate’ (Hodder, 1890) and an appointment in 1791 as chairman of the newly founded Glasgow Society for the Abolition of the African Slave Trade suggests unease over the issue of slavery (Morris, 2018). Despite this apparent concern, Dale was very much benefitting from the British Empire through the import and export of materials processed in his mills and the growth of Glasgow as a place of commerce through its links with the highly lucrative tobacco trade.

Although only a minor actor, and one that is frequently left out of the overall story of New Lanark, George Dempster (introduced fully in relation to Spinningdale Mill) may be to thank

for the formation of these mills by bringing together David Dale and Richard Arkwright through Dempster's invitation for Arkwright to visit Scotland and enter into business. The name of Preston born industrialist and inventor Sir Richard Arkwright (1732–1792) (Figure 5.8) has already appeared in this thesis in relation to his innovations in cotton machinery and cotton mill at Cromford in Derbyshire (among others throughout the Midlands and North of England).¹⁹³ First, Arkwright was convinced to lend his involvement in Stanley Mills in Perthshire (McLaren, 2015) and then to consider a second site. It was reported in the *OSA* that, following his initial visit to the site that became New Lanark, Arkwright declared 'Lanark would probably in time become the Manchester of Scotland; as no place he had ever seen afforded better situations or more ample streams of water for cotton machinery'.¹⁹⁴ This quote emphasises, again, the importance of water as a factor for industrial location in Scotland's bid to imitate the pioneering success of the North of England in cotton spinning.

Consequently, an agreement was entered into between Dale, Arkwright, and Dempster whereby Dale offered the capital and Arkwright provided his patented spinning machinery (Dunhill, 1964). This short-lived partnership came to an abrupt end in 1786, the same year that production started at New Lanark, when Arkwright removed himself from the partnership. The precise reason for Arkwright's departure is unknown, although one story suggests that it was the result of an argument over the placement of the village bell tower (Cooke, 1979a: 197). This might be nothing more than an anecdote that has persisted but the pair may well have argued over something, given that Arkwright had a reputation for being ill-mannered and Dale was said to be stubborn from time to time. In December 1786 the three partners (Dempster, Dale, Arkwright) met at Cromford, in Derbyshire, England, and Arkwright officially left the partnership. Fortunately, a business relationship continued at the very least and Arkwright continued to accept workers from New Lanark and Stanley Mills for training at his Cromford Mill. Dempster, who returns in the story below of Spinningdale, also separated from New Lanark at this time, turning down Dale's offer to pay £1,000 for his shares.

As Dale aged, he began to dispose of his investments and hence the second stage in the mills' history began when Robert Owen moved to New Lanark. Robert Owen (1771–1858) was

¹⁹³ Arkwright, who later became known as the 'father of the English factory system', was connected to ten cotton spinning mills in Nottingham alone between 1769 and 1784 (Chapman, 1965: 532).

¹⁹⁴ *OSA*, Lanark, Lanark, Vol. 15, 1795: 46.

born in the then small market town of Newtown, Wales. His father, also Robert, was engaged in various jobs including as a saddler, post-master, churchwarden, and, when Robert Owen junior was born, as a shopkeeper. Aged ten, Owen left Newtown for London to join an older brother, and through familial connections an apprenticeship with a successful linen and woollen drapers in Lincolnshire was soon found for him (Donnachie, 2000). Following another stint in London, Owen was offered a position with John Satterfield & Co., silk mercers and linen drapers in Manchester, and at seventeen years old he moved to this fast growing town with a population of 50,000 and an emerging textile industry (Chaloner, 1954: 79).

It was here that Owen made the transition from merchant to manufacturer and met his future business partners. While working for Satterfield, Owen met John Jones. With a loan of £100 from Owen's brother, he and Jones opened a warehouse for the making of mules for the cotton industry with Jones as the mechanic and Owen responsible for book-keeping, buying and selling (Chaloner, 1954: 79). When this partnership fell through, Owen responded to an advertisement from Peter Drinkwater, who required a superintendent for a mule factory. Despite his young age and lack of prior experience, Owen received the position and was entrusted with the management of the steam-powered Piccadilly Mill and its 500 workers. Drinkwater also asked Owen to give regular supervision to his other mills in Northwich, meaning that Owen became exposed to large water-powered mills during this period (Donnachie, 2000). Drinkwater held views in relation to working conditions in his mills that were similar to Owen's and may possibly have influenced the latter's future management of New Lanark. For example, although working hours were longer (6 am to 8 pm) than in mills such as Cromford, Drinkwater was concerned about sanitation, light, and ventilation from windows.

Owen's next venture, at the age of 25, was with the Chorlton Twist Company, fine cotton spinners (1796–1800), which he founded with another Manchester-based merchant, John Barton, and three partners with links to London, John Atkinson and William and Richardson Borradaile (Siméon, 2017: 14). His role in the company required him to visit clients in Glasgow, and it was on one of these trips to Scotland that Owen met David Dale's daughter Caroline, who suggested that Owen visit New Lanark (Donnachie, 2000). Interested not only in the New Lanark Mills but also wishing to marry Caroline, it was arranged for Owen to meet Dale, providing an opportunity for Owen to enquire if the mills were for sale. Receiving

a positive response, Owen returned to Scotland with Atkinson and Barton on 22nd July 1799 and arrangements were made to transfer the mills to the newly formed Lanark Twist Company. The sale was for the land, village, and mills of New Lanark, with a price of £60,000 agreed to be paid at £3000 per year, over 20 years, with interest at five per cent (Donnachie, 2000).

Owen possessed grand visions for New Lanark. The isolated factory community appeared to provide the perfect setting to experiment with his theories regarding human character and social reform, enacting a supposedly humane version of new industrialised capitalism, but his time as manager would be turbulent. The first alteration to the partnership came in 1810 when Owen fell foul of his business partners over his more radical ideas for the New Lanark community (Dunhill, 1964). Unperturbed, Owen formed a new partnership with Atkinson, Glasgow-based merchant Robert Dennistoun, and Alexander Campbell of Hallyards and Colin Campbell (sons in law of Campbell of Jura).¹⁹⁵ The group bought the company's assets for £80,000 in an agreement signed on 5th October 1810. The involvement of the new partners in the tobacco and sugar industries – and hence in global movements of products and people – meant that the partnership was incredibly well connected in the business world and internationally, and ensured ready access to supplies of cotton (Siméon, 2017: 51). The capital stock was set at £182,000 divided into 26 shares, of which Owen held ten, and any decisions were to be decided via majority vote. This partnership lasted only three years, being officially dissolved on 31st December 1813 (*Caledonian Mercury*, 1814).

Anticipating that he was at risk of losing his position as manager, and in need of new investors for his social project, Owen travelled to London with his pamphlet outlining *A New View of Society* (1813) and acquainted himself with eminent men holding humanitarian beliefs. These were Quakers William Allen, Joseph Foster, and John Walker; Baptist physician, Joseph Fox; a future major of London, Michael Gibbs; and philosopher Jeremy Bentham (Escott, 2011; Stansfield, 2018).¹⁹⁶ Owen's new partnership successfully outbid his old partners at auction to purchase New Lanark for £114,000 (Gorb, 1951).

¹⁹⁵ Archibald Campbell of Jura was a wealthy improving landowner and a relative of David Dale via Dale's marriage to Anne Caroline Campbell.

¹⁹⁶ Bentham is of course a figure now well-known to historical and social geographers because of his plan for an 'ideal prison-house', the Panopticon, with its spatial arrangements designed to ensure observation of, and exertion of power over, inmates. This model was meant to be applicable to a range of facilities including hospitals and schools, but also manufactories (Philo *et al.*, 2017).

Conflict occurred again in 1817 due to Owen's public statements and lack of provisions for religion in the village (Siméon, 2017). Tensions between Owen and his partners finally came to a head in the 1820s after complaints from residents regarding Owen's educational reforms. The Board decided that Owen would not be allowed to oversee the school anymore and, when Owen refused to follow the wishes of the other partners, he was temporarily suspended from his managing role on 9th November 1823 (Siméon, 2017). Following continued pressure from his partners, Owen ultimately stepped down from his role at New Lanark in 1824, focusing instead on his political career and communitarian visions. Believing that his communistic ideas would be better received across the Atlantic, Owen moved to America to put his ideas into practice at New Harmony, Indiana (Hendrickson and Owen, 1944: 211). The bond between Owen and New Lanark was severed in 1827 when he returned to Scotland to arrange his retirement and sold his remaining shares in the enterprise (Holyoake, 1859).

Possession of the village passed on to Charles and Henry Walker, sons of John Walker, under the name of Walker & Co. (Stansfield, 2018). At some point during the 1840s, the Walker family gained full control of New Lanark as Robert Owen & Company, William Allen, and Michael Gibbs all eventually removed themselves from the business (Donnachie and Hewitt, 2015). The Walkers were Quakers and, in accordance with their beliefs, tried to keep the mills running under humanitarian conditions: they continued with the mills' school and created a fund for the provision of medical care (Davidson and Arnold, 2011). Under the Walkers, the management of New Lanark seems to have been left primarily to salaried staff rather than to the owners. Profits saw a substantial drop after Owen departed, although this fall was certainly accounted for, at least partially, by the economic crisis caused by the American Civil War and 'Cotton Famine' (Donnachie and Hewitt, 2015).

Despite remaining a viable business through these periods of economic depression, the Walkers lost interest in the mills and made their first attempt to sell them in the 1850s. Repeated advertisements for New Lanark can be found in regional newspapers, including the *Glasgow Herald* and the *Manchester Times*, between February 1851 and October 1853. A public auction took place in February 1852, with a reserve price of £40,000 set but no bids offered (*Glasgow Herald*, 1852). In the 1880s Charles Walker Jr attempted another sale, receiving interest from at least two parties. One of these was McGregor, Donald & Co,

proposing an offer of £18,000 cash to introduce lace-making to New Lanark.¹⁹⁷ The other, successful, bid came from Henry Birkmyre for Gourock Ropework Co., internationally known manufacturers of rope, sails, and canvas (Calcluth, 2017).

Gourock Ropework Co. dated back to 1736 when it was founded as the Port Glasgow Rope & Duck Co. in Port Glasgow, Inverclyde. The Birkmyres entered the textile industry through Henry Birkmyre Sr (1762–1844) who was a handloom weaver in Renfrewshire and later sailcloth manufacturer for the Gourock Ropework Co. Birkmyre Sr gained a foreman role, later progressing to a partner, followed by his son William (Calcluth, 2017). It was Birkmyre's grandson, also Henry Birkmyre (1832–1900), who purchased and managed the New Lanark Mills through a partnership with his brother-in-law, Robert Galbraith Somerville, a partner in the Port Glasgow timber firm, Somerville and Co. The pair formed the New Lanark Spinning Company and paid £20,000 for the mills on 16th May, 1881 (NLT, 2022). The purchase was a speculative one for the company: Gourock Ropeworks Co. had many subsidiary companies in the West of Scotland (Greenock Ropework Co., Govan Ropeworks) and overseas in New Zealand, Argentina, Australia, and Africa, while Birkmyre Jr held investments in shipping and fishing companies. Production was diversified, with cotton being spun into fishing nets on site and the spinning of synthetic materials introduced to the mills (Slaven and Checkland, 1986; Minnery, 2019). To aid in the transition to these new materials and products, skilled workers and equipment were transferred from elsewhere in Scotland.

The partnership between Birkmyre Jr and Somerville dissolved in 1888, and Birkmyre Jr had sole ownership of the mills and village for six years until a new partnership was formed with his own sons, James, and John Jr Birkmyre (Slaven and Checkland, 1986), possibly with Somerville continuing in a managerial role. Financial and social success was limited under the Birkmyres. Housing stock was allowed to deteriorate and profits were low due to, according to Birkmyre Jr's uncle William, improper management. There was also a clash once again between proprietor and inhabitants over religion when Birkmyre Jr, a United Presbyterian, tried to limit the provision of Gaelic and Church of Scotland services in the village.

¹⁹⁷ Titled Letter book No. 1, 1881. Records of Gourock Ropeworks Co Ltd, New Lanark Mills material. University of Glasgow Archives & Special Collections. GB 248 UGD 042/7/9/2.

It is interesting to note that, as with many of the other businessmen encountered in this chapter, there was a political connection in this family as well. Both Henry Birkmyre Jr and his son John were involved in local government, while another son, William, opted to be a Member of Parliament for Ayr Burghs rather than joining the New Lanark partnership (Slaven and Checkland, 1986). Birkmyre Jr retired from active involvement in the business in 1895 and his sons purchased New Lanark after their father's death, keeping the mills running until textile production finally ceased in 1967 (*Glasgow Herald*, 1900; Slaven and Checkland, 1986). The company housing needed substantial investment and was sold to New Lanark Association in 1963, marking the first time in its history that the mills and village were under separate ownership. Despite investing in a final programme of modernisation in 1963, after a prolonged period of declining profits and demand for products, Gourrock Ropework Co. restructured its production and closed the New Lanark Mills, resulting in the loss of 350 jobs (Dunhill, 1964; Minnery, 2019).

5.3.4 Buildings and facilities

Construction of the first mill commenced in April 1785, with spinning beginning eleven months later. There are no records of the design of the original mill (no. 1)¹⁹⁸ or its waterwheel, but it was likely to have been four or five storeys with at least one overshot or high-breastshot wheel located at the centre (Hume, 1971), valued at £4,800 by the Sun Fire Office insurance company (McLaren, 2015). A second mill building, no. 2, was erected in the summer of 1788, though it was another year before production at New Lanark could expand because no. 1 mill was gutted by fire that same year. The reconstruction of no. 1 mill was hastily completed in 1789, with a new design featuring Palladian windows similar to some of Dale's mills, to be mentioned shortly, at Catrine and Spinningdale. The construction of two more mills promptly followed. All four mills were powered by the same aqueduct that delivered water to the waterwheels (Trinder, 2013).¹⁹⁹ The combined insurance value of the four completed mills in 1795 was £7,600 (Hume, 1971). Other buildings included storage sheds and the Mechanic's Workshop and Dyeworks that were added in 1806, significantly reducing reliance on outside help for machine-making, castings, and millwrighting. The company also had an office and warehouses in Glasgow where raw cotton was delivered prior

¹⁹⁸ This is the numbering system used in contemporary documents.

¹⁹⁹ *OSA, Lanark, Lanark*, Vol. 15, 1795.

to transport to the mills, at which point it was then stored awaiting processing in outhouses along the river known as Waterhouses (Siméon, 2017; NLT, 2022).

The mills began entirely powered by water, so a mill dam was constructed half a kilometre from the village. The available power would be gradually increased over the mills' history. From possibly just one waterwheel when production first started, there were already three wheels by 1795. In the early-1850s, when the Walkers first put the mills up for sale, this number had tripled to nine wheels supplying up to 400 hp (*Manchester Times*, 1852). Steam power was only utilised at New Lanark relatively late, from 1873. By the 1880s, despite no major increase in the number of buildings and machinery, the available power had more than doubled. Ten waterwheels (Figure 5.9) with a combined force of 800 hp were now supported by a 200 hp steam engine driven by two double-flue circular steam boilers, giving the mills a combined maximum potential power output of 1,000 hp (*Glasgow Herald*, 1881). The first engine came from William Hunter & Company of Glasgow for a cost of £800, or £1,170 including the boiler and engineering for installation. It was replaced c.1881 with a new engine in a new engine house (Donnachie and Hewitt, 2015). The steam engine was scrapped in the mid-twentieth century because shortly after the introduction of steam, another technology was experimented with: electricity.²⁰⁰ A water turbine was installed in 1884, and a second in 1898, to provide electric lighting to the mills and village and to power some of the machinery. The two turbines together could generate more power than all ten waterwheels (Donnachie and Hewitt, 2015). Twentieth-century modernisation of the mills included the installation in 1931 of a Boving twin runner Francis turbine in the basement of mill no. 3 to generate hydroelectric power, so that the mills were once again powered by the Clyde.

As well as the industrial buildings, an entire planned village was created, owned, and managed by the proprietors of the mills (Figure 5.9). The land now occupied by the mills and the village together totalled 41 acres (*Glasgow Herald*, 1881). Accommodation for workers was provided in the village predominantly in tenements rather than cottages, which were more common for rural cotton spinners, in a sense bringing aspects of the urban to the countryside. The first housing to be built was Braxfield Row with 36 houses, half the houses with two apartments in each and the other half one-apartment houses plus wash-houses in the basement of the buildings (NLT, 2022). This was followed by Mantilla Row in 1790 and then

²⁰⁰ Trove Reference: SC 755078.

Long Row and Caithness Row (Figure 5.10) in 1792. Named after the place of origin of some of the Highland workers, Caithness Row added five two-apartment houses and 20 one-apartment houses to the village's housing stock (NLT, 2022). Accommodation was modest, but superior to what most crofters in the rural Highlands would have occupied (Siméon, 2017). The final major alteration to housing was New Buildings, a large tenement row built to replace earlier degraded single story cottages. As well as housing, this row contained a surgery, WCs, and halls for Sunday Schools and the village's Gaelic church services (NLT, 2022).

Mill no. 4 was not fully operational for spinning when first erected and so was initially used for storage, a workshop, and a boarding house for the child workers sent without parents from orphanages in Glasgow and Edinburgh (Carlson, 1992). When the machinery was installed in 1813 it was no longer necessary to use any floors for sleeping because Owen had gradually stopped taking on orphaned apprentices (Trinder, 2013). For the managers of the mills, a separate house was built and another for Dale's family to spend the summer. Not all workers were accommodated in the factory village: 255 of the 1334 employees lived in the wider burgh of Lanark rather than in New Lanark village in 1795.²⁰¹ In his work diary, Owen at times, refers to the 'Lanark people'.²⁰² Even though the number of non-residents dropped in the mid-nineteenth century to around 70, an apartment for these workers to spend their mealtimes was provided (*Caledonian Mercury*, 1855). In the early-1800s, a cooperative village store opened, stocked with goods available at cost price for residents, stocked by a company owned farm where 30 cows were kept to produce milk and a garden provided fresh vegetables (Donnachie and Hewitt, 2015).

What particularly sets New Lanark apart from other planned industrial villages was the New Institution for the Formation of Character, devised by Robert Owen (Figure 5.10). The Institution, officially opened in 1816, was designed to house a store cellar, kitchen, dining and recreation hall, school, lecture room with observation gallery for visitors to witness classes, and a church, although some features were never completed (Hume, 1971). The public kitchen and dining hall were delayed in part due to the response from village residents, some of whom wished to retain greater autonomy. The suggestion of communal company

²⁰¹ *OSA*, Lanark, Lanark, Vol. 15, 1795.

²⁰² Robert Owen's Diary, 1813-1822. Records of Gourock Ropeworks Co Ltd, New Lanark Mills material. University of Glasgow Archives & Special Collections. GB 248 UGD 042/7/24.

meals was, for many, overstepping the boundaries of work and their individual lives (Siméon, 2017).

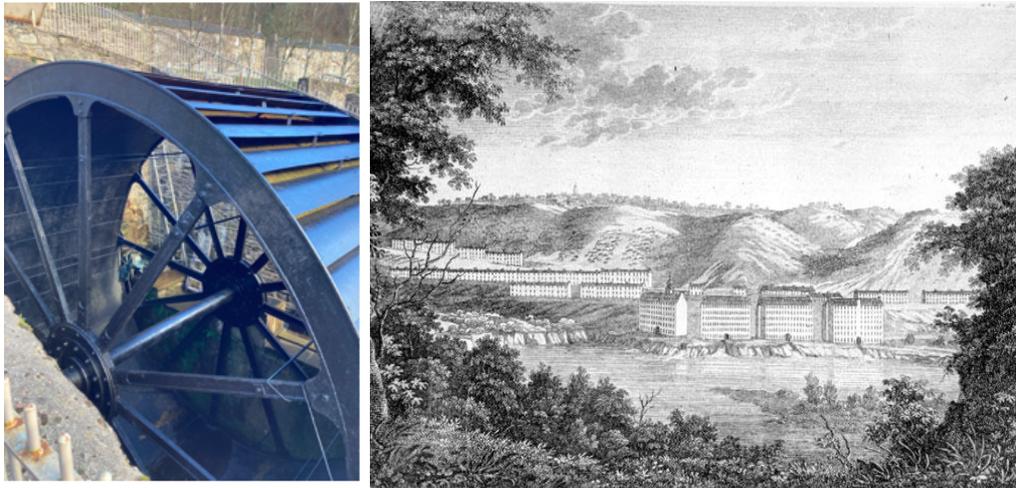


Figure 5. 9. Left: A waterwheel in situ at New Lanark. The waterwheel was positioned in a stone-lined wheel pit below the former mill no. 4. A tail race exiting southwest from the wheel pit returned water to the Clyde. Right: Engraving of New Lanark mills and planned village c. 1799 by Robert Scott (NLT, 2022).

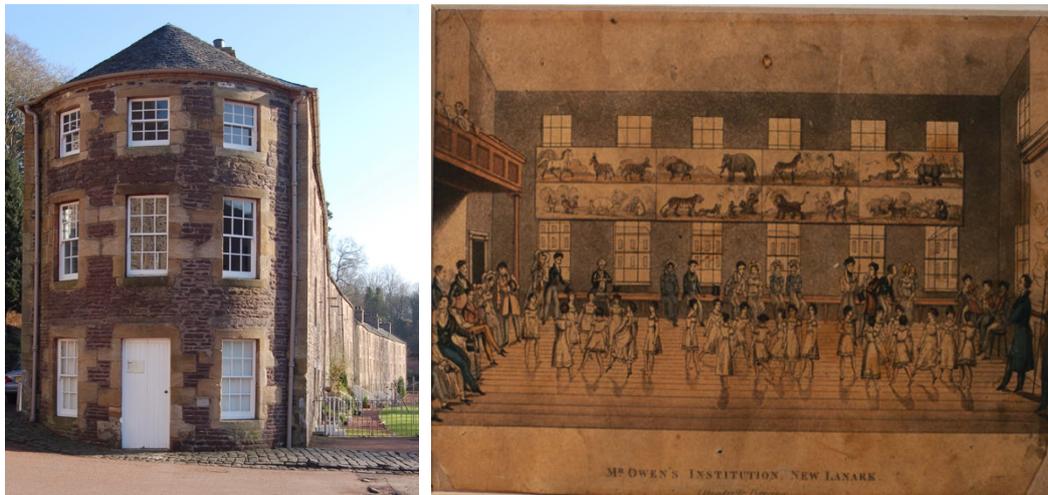


Figure 5. 10. Left: Caithness Row (Courtesy of Miles Oglethorpe). Right: Robert Owen's Institute: engraving by G. Hunt, 1825 (Robert Owen Museum, 2023).

5.3.5 Successes and failures

In common with many large cotton mills of the time, motive power was frequently an issue and, of course, a prime, sometimes contested, factor of industrial location. Most of the ground on which New Lanark was built was owned by Robert Macqueen, Lord Braxfield, who feued the land to David Dale for £32 10s (McLaren, 2015). An additional feu duty of £17 7s 8d was

paid to the Incorporation of Shoemakers in Lanark, but neither of these covered rights to the infrastructure required for waterpower. As was already seen in case study of Rothesay and will appear again in the discussion of Deanston especially, rights to use or abstract water could cause great conflict. For a £5 annual rent, Sir John Lockhart Ross, owner of the land immediately up-river of the mills, permitted the excavation of a mill lade through his property. These arrangements seem to have been relatively simple business transactions without much issue.

The construction of a weir, however, was to cause great tension between New Lanark and its neighbours. The weir, necessary to act as a dam to hold water and raise the head of the fall, was initially built to an extent of 95 ½ ft (around two thirds of the channel width), but as the mills expanded Dale wished to extend the weir to the opposite bank (Hume, 1971: 217–218). The Edmondstone sisters, owners of the Corehouse estate on the opposite side of the river, were opposed to these plans, especially after construction when workers used the weir as a bridge to reach the other side of the river when the water levels were low. To placate their neighbours, Dale arranged for a gap to be made in the weir to prevent crossing, but under Owen's management the gap was hastily refilled, angering the Edmondstones (Hume, 1971). Owen tried to negotiate with the sisters, proposing an annual rent of £12 in exchange for permission to erect a dam, but the sisters were aware that the water rights were worth a great deal more than this. A notice was served to the Lanark Twist Company to remove the weir in 1807, but Owen attempted to delay while alterations were made to the lade and tailrace in the hope of reducing the mills' reliance on the weir (Hume, 1971). Despite Owen's efforts, the company eventually had to pay Anne Edmondstone the substantial sum of £200 for a year's rent of the dam dyke in 1813.²⁰³

On multiple occasions the river ran so dry that it was reported in newspapers. On the morning of 12th January 1797, for the second time since the mills had been established:

the river Clyde, above the celebrated Fall of Corra, deserted its usual course, leaving its bed below, for four hours, almost entirely dry ... the cause has not been ascertained. It is, however, supposed that the waters have found a subterraneous passage between the Bonnyton and the Corra Linn (*Telegraph*, 1797).

²⁰³ Receipt for rent paid by New Lanark Co to Miss Edmondston for Dam Dyke, 1813. Records of Gourrock Ropeworks Co Ltd, New Lanark Mills material. University of Glasgow Archives & Special Collections. GB 248 UGD 042/7/13.

A similar occurrence took place on the 19th and 20th December 1855, when the Cora Linn waterfall was ‘asleep, no foam nor fury, but all gracefully hanging ice-bound to the ledges of the rock’, resulting in New Lanark Mills being forced to halt production entirely for two days, barely managing to return even to half-time on the following two days, ‘a fact quite unprecedented in their history’ (*Glasgow Herald*, 1856). As these examples show, even a location with a substantial head of water on one of Scotland’s ‘ample streams’²⁰⁴ (as Arkwright described them) such as the Clyde was subject to occasional unpredictability – a situation that was increasingly problematic as the demands of capitalist production in the factory style mill called for greater power and productivity.

A proposed scheme by Gorbals Gravitational Water Company in early-1844 to take water directly from the Clyde at Hyndford Bridge (*Glasgow Herald*, 1853a) could have seriously impacted New Lanark by making water shortages a more frequent occurrence because the mills were located only a short distance (approximately 7 km) downstream of the location from where it was proposed to abstract water. This possibility was offered as an alternative to Glasgow Water Works Company’s Loch Lubnaig and Katrine scheme that, as we will see, affected Deanston. In a report delivered to the Lord Provost, Magistrates, and Town Council of Glasgow, by John Frederick Bateman,²⁰⁵ reproduced in the *Glasgow Herald* (1853b) it was stated that New Lanark Mills suffered from a shortage of water for months during each year and that, due to their reliance on the river, only provision of water, not money, could provide suitable compensation if such a scheme were to go ahead. Luckily for New Lanark, the Hyndford Bridge option was not selected after it was discovered that the proposed location of the Clyde for compensation reservoirs was not clean enough, being full of moss during summer floods (Burnet, 1869: 21). Based on comments recorded a few decades earlier in a notebook belonging to Owen,²⁰⁶ the concerns over water supply were no exaggeration. Much of the notebook was dedicated to recording changes to working patterns and the speed at which the machines were operating. In January 1814, for example, notes were taken for 20 working days, of which only one day records ‘full speed’. Following a temporary stoppage at 9 am on 4th January due to a shortage of water, the machinery ran at between two-thirds to

²⁰⁴ Richard Arkwright quoted in *OSA*, Lanark, Lanark, Vol. 15, 1795: 46.

²⁰⁵ John Frederick La Trobe Bateman (1810-1889) was a civil engineer based in Manchester and son-in-law of the Scottish engineer William Fairbairn. Bateman was asked to advise the Town Council of Glasgow on the proposed water supply schemes for the city of Glasgow (Grace’s Guide, 2025).

²⁰⁶ Robert Owen’s Diary, 1813-1822. Records of Gourock Ropeworks Co Ltd, New Lanark Mills material. University of Glasgow Archives & Special Collections. GB 248 UGD 042/7/24.

seven-eighths of their potential until full speed was finally achieved again on the 27th of the month. Neither Dale and his managers, nor Owen, opted to solve the water issues with an alternative prime mover – coal. We know both that Dale corresponded with James Watt, the Scottish inventor and co-partner of steam engine manufacturing firm Boulton & Watt (McLaren, 2015), and that Owen had supervised Piccadilly Mill in Manchester, which used an eight hp Boulton & Watt rotary beam engine to directly power its cotton machinery (Nevell, 2005). Curiously, despite key figures certainly being aware of the of the successful application of steam power in mills elsewhere, water persisted at New Lanark.

The profitability of New Lanark during its first 50 years of existence in particular likely owed a lot to the management and techniques of control that were implemented at the mills and village. As previously stated, New Lanark was just one of many enterprises owned by Dale who lived primarily at his residence in Glasgow. Under Dale's ownership, the day-to-day running of the mill was left to managers William Kelly (co-partner of Robert Thom at Rothesay) and James Dale (David Dale's half-brother). Dale also gave his nephew (also called David Dale) a role in the running of New Lanark prior to helping him establish himself in business in Glasgow (McLaren, 2015). Regardless of whether this was a case of nepotism, evidence suggests they formed a good management team. The mills had been entrusted by Dale to capable hands.

Owen was highly critical of the state of the mills and the previous management style when he took over, but he too was absent for prolonged periods of time. Owen spent the entire month of September 1821 away from New Lanark visiting Leeds, Manchester, Liverpool, Darlington, and Newcastle, promoting his benevolent ideas around the country, leaving the village in the hands of others (*Royal Cornwall Gazette*, 1821). Contrary to Owen's opinions, William Kelly was a hardworking and inventive manager of New Lanark. Kelly was a clockmaker by trade, a highly skilled profession that would have enabled him to understand the complex machinery used in cotton processing. He made improvements to the self-acting spinning jennies used in mill no. 3, and worked with Dale to create a novel heating and ventilation system for the mill buildings (HES, 2023b). Dale himself possessed a wealth of knowledge regarding cotton, even if he did not make the site of the mills his primary residence. In his letters, Dale would discuss technical issues and the state of business for his Scottish rivals and the cotton industry across Britain (McLaren, 2015). The legacy of innovative managers and proprietors continued under the Walkers. In 1857 both Charles

Walker and his manager John Miller applied for patents; for ‘improvements in atmospheric railways’ and ‘improvements in oil-cans or apparatus for lubricating machinery’ respectively (*Glasgow Herald*, 1857).

As already indicated, the population of the parish of Lanark was not large enough to supply workers for such a large manufactory. Labour supplies fluctuated, however, and in 1788 New Lanark was in a position to spare some of its workforce, sending an unknown number of men and children of both sexes, but no adult women, to Claud Alexander at Catrine, to be discussed below.²⁰⁷ Whether this was because New Lanark had a surplus of hands or because Dale was keen to prevent his other business from struggling is unknown. Dale famously hired people from the Scottish Highlands, mention having already been made of Highlanders in the mill workforce. New Lanark was founded at a time when many regions of Scotland had been subjected to years of poor harvests and poverty, motivating the move south to find work in factories or to emigrate outside of Britain.

Dale, like some other mill owners, including his business partner Dempster, was concerned with the issue of emigration. Dale’s solution was to contribute to a ‘Society for Preventing Emigrations to Foreign Parts’ and actively both to recruit would-be-migrants through advertisements and reach out directly to ministers in affected parishes (Nicolson and Donnachie, 2003). Among the many Highlanders employed at New Lanark, there were three distinct groups, as identified by Nicolson and Donnachie (2003). The first group came from Caithness and Sutherland. The dominance of workers from this region up until the mid-nineteenth century led indeed to the naming of one of the village streets as Caithness Row. A further group originated from Argyllshire and the Western Isles, relocating in response to an advertisement from Dale in the early-1790s offering work and houses for as many as two hundred families (Davidson, 1828). The third cohort were passengers from the aborted transatlantic journey on the ship the ‘Fortune’. This strong Highlander presence continued after Dale passed on the mills to Owen. Advertisements seeking specifically Scottish families (from the Highlands or Lowlands) of good character with three or more children aged over ten would appear periodically in the both the *Caledonian Mercury* and *Aberdeen Journal* from 1805 to 1808. These families were promised ‘constant employment, with every comfort

²⁰⁷ Labour indenture between Claud Alexander & Co and young people under 21 years of age, 1791-1792, 1825. Records of James Finlay & Co, Catrine, Deanston, production records. University of Glasgow Archives & Special Collections. GB 248 UGD 091/1/5/3/7/1.

that work people can desire' (*Aberdeen Journal*, 1807). It was reported that some Highland migrants were unhappy with the conditions of factory life or found it difficult to integrate, given the cultural and language differences encountered, and hence did not stay at New Lanark very long:

[T]he manners of the Highlander, accustomed to wander at ease on his native mountains, in the full enjoyment of personal freedom, ill-fitted him for the confinement of a room; and his ignorance of the lowland dialect, operated as a bar to his improvement. (Davidson, 1828: 165)

To overcome the frequent coming and going of workers, Dale apprenticed pauper or orphaned boys and girls from parishes in Glasgow and Edinburgh (Davidson, 1828).²⁰⁸ More than 250 children were hired in this way in exchange for the provision of food, accommodation, and schooling at the mills (Siméon, 2017). New Lanark, as elsewhere, used the indenture system whereby workers were tied with a legally binding contract to their employer for a set number of years. This system was in use for both adults and children, and under its terms they received a set wage for the entire period of their contract. But it also meant that they were protected under the pre-existing terms if there was a change of ownership, as when Owen took over from Dale (McLaren, 2015). The standard offer at New Lanark was a four-year contract or, for children from workhouses, guaranteed employment until the age of 15 (Ferguson, 1948). The indentures did still allow workers to leave voluntarily, however, or to be dismissed by the employer if their behaviour was unsatisfactory.

Working conditions were generous for the time but still incredibly strict, and under Owen an experimental programme of 'moral control' was trialled. This included public appraisals of work quality on the factory floor with the 'silent monitor', extending into the village to the domination of leisure time. Even the village facilities, for example, were strategically placed to alter the behaviours of workers. More will be said on this matter in Chapter 6. Owen claimed that the workers at New Lanark were prejudiced against him because he was a stranger to them coming from outside of Scotland (Owen, 1813), but perhaps their distrust was a natural response to his radical views on society and religion rather than a reflection on his origins. In practice, the two most likely went hand-in-hand.

²⁰⁸ Use of indentured orphans for mill labour was common around Britain including at the Quarry Bank Mill in Cheshire (Murray, 1958; Hughes, 2005).

The village’s population certainly declined significantly through the nineteenth and twentieth centuries, excepting a temporary increase in the 1850s (Table 5.3). Much of the drop was due to the substitution of human labour costs for fixed capital costs at the mills, or ‘variable’ and ‘constant’ costs under Marxist logic (Okishio, 1990). In other words, technology changed and machinery could run with fewer operatives (Donnachie and Hewitt, 2015). The bias towards female spinners (who were paid lower wages compared to males) created problems of male unemployment in the parish for family members. Although it did not fully solve the issue, some of the brothers, husbands, and fathers, were hired as supervisors, mechanics, or labourers at the mills and engineering shop, and others could work in the shops in the village. Thus, the development of the company village encouraged greater stability and self-sufficiency in terms of workers as well as goods (Fleming, 1839).

Table 5. 3. Population of New Lanark (Donnachie and Hewitt, 2015; Minnery, 2019).

Year	Population
1819	2,285
1831	1,901
1841	1,644
1851	1,807
1861	1,397
1871	973
1881	706
1891	672
1951	550

By the mid-nineteenth century New Lanark had earned itself the reputation of ‘The happy valley’ (Fleming, 1839: 11). Contemporary accounts do suggest a state of relative happiness and wellbeing for residents, especially in comparison to other industrial sites of the time.²⁰⁹ One visitor claimed that some workers had been known to leave for work in other manufacturing regions only to find the grass was not greener and so,

²⁰⁹ Due to Lanarkshire’s popularity as a tourist destination for both the natural and humanmade wonders of Cora Linn falls and the neighbouring mills, numerous contemporary accounts of conditions in the village and of the inhabitants themselves were written in the nineteenth century. While these accounts need to be read with the knowledge that the mill owners, Owen in particular, had a specific agenda to push, offering tours and staged performances from the children for visitors, they still offer valuable descriptions of New Lanark and outside perspectives on the village.

... like Noah's dove, "no rest for the soles of their feet," and sickened with the misery and evils, prevalent in these heartless and selfish moral solitudes, they gladly wend their way back again to the duties and enjoyment of a tranquil life, exempt from the vicissitudes of elevation and depression, which exert such an injurious and demoralising effect upon the being and character of those constantly exposed to them. (Fleming, 1839: 11)

Despite some mild resistance to proposed changes at various times (the suggested communal dining, removal of religious teaching), the workers of New Lanark appear to have been comparatively content. New Lanark's only strike took place in the 1940s in response to the proposed introduction of time clocks suggested by the Gourrock Ropework Co. (Donnachie & Hewitt, 2015). This was an impressive track record for a site operating for 183 years.

5.4 Deanston

5.4.1 Location and water supply

Founded the same year as New Lanark (1785) were the Deanston Mills. Located in the parish of Kilmadock in western Perthshire. Deanston was situated on the southern bank of the River Teith, eight miles north of Stirling and one mile west from Doune (see Figure 5.11), which was the nearest town and the location of the parish church (Govscot, 2015).²¹⁰ The parish had an abundant supply of water for both domestic and commercial use from springs of soft water, lochs, and the River Teith.²¹¹ The Teith, which was 59 km in length with a catchment area of 579 km³, formed at Callander, Stirlingshire, from the confluence of two rivers, Garbh Uisge and Eas Gobhain (Forth Rivers Trust, 2022). As well as passing through numerous lochs such as Loch Katrine, Loch Venacher, Loch Achray, Loch Voil, and Loch Lubnaig, many smaller lakes and streams added to the Teith along its course, providing excellent regularity of flow according to contemporary sources.²¹² The mills were located to make use of the Teith for waterpower, with additional water supplied from Loch Katrine and Loch Lubnaig when required. The previously mentioned upstream lakes placed the mill at Deanston at a lower risk than was true for other mills elsewhere of disrupted flow due to

²¹⁰ *OSA Kilmadock, Perth, Vol. 20, 1798.*

²¹¹ *OSA Kilmadock, Perth, Vol. 20, 1798.*

²¹² *Inverness Courier* reproduced in *NSA, Kilmadock, Perth, Vol. 10, 1845.*

summer droughts and winter frosts (Turner, 1982a). However, in periods of heavy rainfall the fast flowing river was known to cause repeated damage to dam heads.²¹³

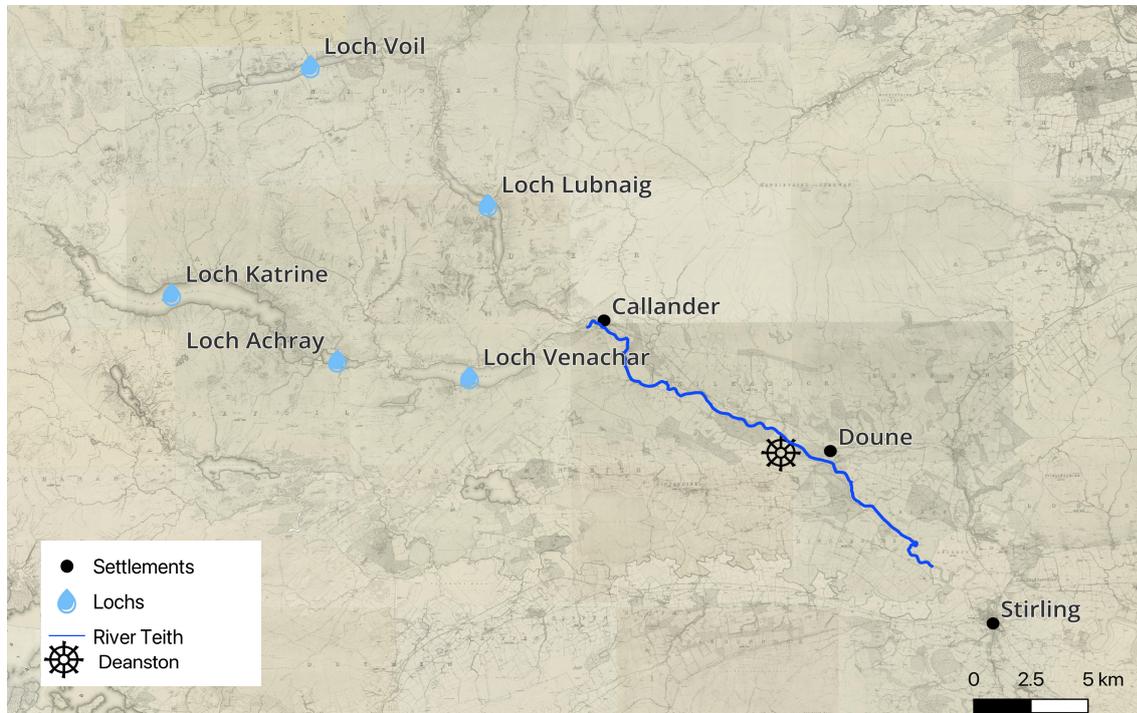


Figure 5. 11. Location of Deanston relative to Doune, Callander, Stirling, and nearby lochs.²¹⁴

The numerous small rivers joining the Teith from the north were ideal for water-powered machinery (Figure 5.12).²¹⁵ In the late-eighteenth century there were seven grain mills in Kilmadock, at Doune, Cambus, Candy, Lanerick, Cessintuly, Auchleshie, and Argaty, with a disused corn mill at Callichat.²¹⁶ Although Deanston was the largest industry of its kind in the area, there were some small to medium sized wool mills nearby (Turner, 1982a). One of these was Springbank Mill (dates of operation 1790–1980), a two-storey woollen carding and spinning mill, located southeast of Kilmadock in the parish of Dunblane and Lecropt. Springbank Mill was powered by both water and steam and employed as many as 800 workers in 1800 (HES, 2022).²¹⁷

²¹³ *OSA Kilmadock*, Perth, Vol. 20, 1798.

²¹⁴ Background layer: OS Six-Inch 1st edition, 1843-1882.

²¹⁵ *OSA*, Kilmadock, Perth, Vol. 20, 1798.

²¹⁶ *OSA*, Kilmadock, Perth, Vol. 20, 1798.

²¹⁷ OS Name Books - Perth county - Volume 25 - Parish of Dunblane - 1859-1862, OS1/25/25.

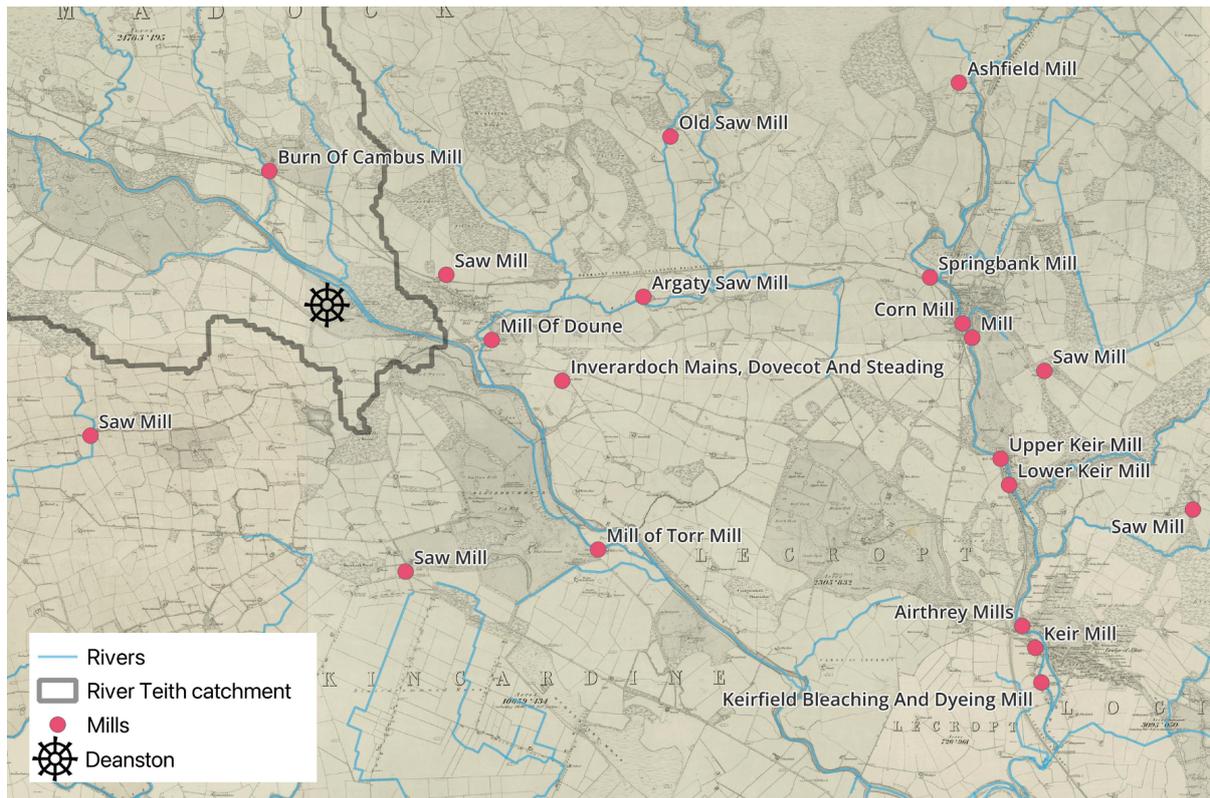


Figure 5. 12. Location of mills in proximity to Deanston.²¹⁸

5.4.2 Local economy and population demographics

When Roy's military map of Scotland was surveyed in the mid-eighteenth century there was no settlement at Deanston beyond a single enclosed building (Figure 5.13). However, the parish as a whole had a population of over 2,700 and after the erection of the mills the population further increased significantly, particularly after the census of 1821 when Deanston's owners expanded the buildings and the number of machines within the mills (Table 5.4). The local population were described as honest people if 'careless of modern refinement', who were only beginning to discover sciences and agricultural improvements.²¹⁹ The language spoken locally in the 1790s was a mixture of English and Gaelic, the latter being most popular in the region of the parish near to Callander, creating the potential for communication issues between workers and overseers if employees were recruited locally. By the 1840s however, English had become the dominant language, although some families still used Gaelic.²²⁰

²¹⁸ Background layer: OS 25 Inch 2nd edition, 1892-1905.

²¹⁹ *OSA*, Kilmadock, Perth, Vol. 20, 1798: 53-54.

²²⁰ *OSA*, Kilmadock, Perth, Vol. 20, 1798; *NSA*, Kilmadock, Perth, Vol. 10, 1845.



Figure 5. 13. Deanston (Deinstane) and Doune (Down) depicted on the Roy Military Survey of Scotland (1747–55).²²¹

Table 5. 4. Population of the parish of Kilmadock.²²²

Year	Population
1755	2,730
1792	3,209
1821	3,250
1831	3,752
1841	4,050

As in the other parishes discussed in this chapter, the greater portion of heritors were non-resident and this contributed to the poverty of the area as around 85% of rents were leaving the parish. This is likely part of the reason road access to the parish was still poor in the 1790s, particularly during periods of bad weather and flooding. There was just one bridge over the River Teith below Callander and two main roads capable of use during adverse weather conditions, one from Edinburgh to Fort-William, and another from Glasgow to Perth that crossed each other in Doune.²²³ By the 1840s turnpike roads were still very limited in extent though a stagecoach ran twice weekly in winter and Monday to Friday in summer

²²¹ Roy Military Survey of Scotland, 1747-55, British Library Maps CC.5.a.441, 16/2d. Courtesy of the British Library. View online: <https://maps.nls.uk/view/217499614>.

²²² *NSA*, Kilmadock, Perth, Vol. 10, 1845.

²²³ *OSA*, Kilmadock, Perth, Vol. 20, 1798.

between Callander and Stirling and a twice daily coach connected Doune with the Edinburgh and the Glasgow railway lines.²²⁴ James Finlay & Co., the owners of Deanston at the time, were involved in a joint stock company in the mid-1830s aiming to build a canal that would have terminated in Stirling (*Caledonian Mercury*, 1837). Had this been successful it would have allowed cheaper transit of raw materials and finished manufacturing goods to and from the main markets in Edinburgh and Glasgow, but the canal was never built. A railway line connecting Dunblane to Callander via Doune was opened in 1858, greatly increasing the ease of transportation and remaining in use until 1965 when it was removed during a programme of widespread railway closures across Britain (Loft, 2001; Doune & Deanston, 2022).

The parish had no major industry apart from the Deanston Mills but slaters from the village of Doune had an excellent reputation and would find plentiful work outside of the parish during the summer months. Previously, the manufacture of Highland purses was carried out in Doune but by the late-1700s the only traditional trade remaining was Highland pistol making and this too was dying out due to the decline in the use of pistols as a part of Highland dress. The average wages that could be expected by a male farmhand in 1798 were £10 12s while a female servant earned £3 to £5 with bed and board. Alexander MacGibbon, author of Kilmadock's entry for the *OSA*, felt these to be good wages and noted that, along with other occupations in the parish, wages had already increased as a result of operations at Deanston.²²⁵ By the 1840s the local area was becoming far better equipped with amenities, enabled by the population attracted to the mill. A savings bank had been set up in Doune with a second bank at Deanston for exclusive use of the cotton workers. The parish could also boast of fourteen public houses (or sixteen including the two additional ones at Deanston that did not sell spirits).²²⁶

5.4.3 Ownership and Management

Very little is known about the first 20 years of Deanston's existence. John Buchanan and Archibald Buchanan were both named as founders of the mill in 1785 (Clarke, 1897).

Whether or not their other siblings were involved is unclear, the *OSA* for example listing John Buchanan 'and his brothers'.²²⁷ The family relationship was reflected in the mill's original

²²⁴ *NSA*, Kilmadock, Perth, Vol. 10, 1845.

²²⁵ *OSA*, Kilmadock, Perth, Vol. 20, 1798.

²²⁶ *NSA*, Kilmadock, Perth, Vol. 10, 1845.

²²⁷ *OSA*, Kilmadock, Perth, Vol. 20, 1798: 87.

name, Adelphi Cotton Works, ‘*adelphi*’ deriving from the word for brothers in Greek (Ward and Hodge, 2020). As with many other firms in the final decade of the eighteenth century, the Buchanans suffered a lack of liquidity (Chapman, 1979) and so, bankrupt, they put the mill up for sale in 1793.²²⁸ One of the brothers, Archibald, joined James Finlay & Co., initially as a manager at their Ballindalloch Mill in Stirlingshire and later taking on the role of partner and manager of the Catrine Mills. The stories of both of these other mills, and of Archibald Buchanan will follow.

The second owner of the mill, from 1793 to 1804, was an English company headed by Benjamin Flounders.²²⁹ Flounders (1786–1846) (Figure 5.14) was born in Yorkshire, growing up within a family of Quakers and industrialists (*Grace’s Guide*, 2014). His father owned shops in Darlington and bleach fields in Crathorne (Heritage Stockton, 2022) and his uncle, Gideon Bickerdike, was head of a company of merchants and cotton manufacturers in Manchester (Maw, 2021). Flounders was said to have owned a second linen mill in Egham, Surrey, and a business importing timber for shipbuilding (*Grace’s Guide*, 2014). Beyond his interests in textiles, Flounders was involved in numerous transportation projects including being a founding Director for the Stockton and Darlington Railway, a trustee of the Thirsk to Yarm turnpike road, and also a Governor of the Scientific Agricultural Association (Flounders Folly Trust, 2022). Late in his life, Flounders bequeathed his wealth to Quaker founded schools across northeast England (*Grace’s Guide*, 2014). The mill at Deanston appears to have been his only Scottish investment and it is not clear what led him to purchase or later sell the mills, but Chapman (1979; 1993) suggests that his uncle Bickerdike formed a business partnership with the Buchanan brothers in the late-1780s and so perhaps it was this family connection that drew this Yorkshire gentleman to Perthshire. In terms of Flounders’ personality, MacGibbon described him as ‘a gentleman of exemplary character, and much esteemed’ within the mills.²³⁰

Whatever the reason may have been, Flounders disposed of the mill in 1804 and there followed a period of uncertainty regarding the mill’s ownership and functioning. Robertson (1965) states that the mill was sold to and briefly operated by a Mr Glen in 1805, although there are no additional sources to corroborate this claim. Deanston was said to have then been

²²⁸ NRHE ID: 128863 (Deanston, Deanston Mills, Spinning Mill).

²²⁹ *OSA*, Kilmadock, Perth, Vol. 20, 1798.

²³⁰ *OSA*, Kilmadock, Perth, Vol. 20, 1798: 87.

disused for a period of two years before it was once again advertised for sale in the regional newspapers in June 1806 (*Manchester Mercury*, 1806) and returned partially to the Buchanan family. This time it was owned and operated by the company James Finlay and Co., with one of the mill's founders, Archibald Buchanan, a partner. It is likely that this is when the name changed from Adelphi to Deanston²³¹. While they owned the three mills at Deanston, Catrine, and Ballindalloch, James Finlay and Co. was likely Scotland's largest cotton manufacturer (Devine, 1978).

Archibald Buchanan did not resume a direct running of the mills, occupied as he was at Catrine. However, his nephew, James Smith (1789–1850) (Figure 5.14) was appointed as manager. Due to the passing of his father, a Glasgow merchant, at an early age, Smith grew up in the care of his uncle on his mother's side (Archibald Buchanan), moving to Catrine to live with him after attending university (ICE, 1851). Smith entered into employment at Catrine Mills, gaining practical knowledge of cotton spinning machinery, the business, and trade (*The Gentleman's Magazine*, 1850). At the age of eighteen Smith was appointed as manager of Deanston by his uncle. Smith was a keen improver and inventor who earned great respect from his peers within the spheres of agriculture and commerce (*Aberdeen Journal*, 1836). Smith's talents extended far beyond textiles. In 1836 he gained membership of the Institution of Civil Engineers (*Caledonian Mercury*, 1843) and in October 1839 he was granted two patents, one for 'a self-acting temple, applicable to looms for working fabrics, whether moved by hand or power' and a second for 'improvements applicable to canal navigation' (*Preston Chronicle*, 1839), and he also developed a strong interest in agricultural improvements that distracted him from cotton (Cheape, 2004). James Smith's partnership with James Finlay & Co. was dissolved in April of 1842 (*Era*, 1842), his benevolent management style apparently having received criticism (Cheape, 2004). After retirement from the mills, Smith was listed as living in London as a civil engineer, devoting his time to agriculture and inventions both locally and as an advisor to others conducting improvements to land (*Caledonian Mercury*, 1843; *The Celtic Magazine* 1882).

Following Smith's departure, Thomas Norton took over the role of manager of the Cotton Mills with engineer and millwright Robert Crawford overseeing the associated Machine

²³¹ The mills are referred to as Adelphi Cotton Works in the *OSA* in 1798 and as Deanston in the company records of James Finlay & Co.

Works. An attempt by James Finlay & Co. to dispose of all three cotton mills in 1844 was unsuccessful (*Glasgow Herald*, 1844b), Ballindalloch being the only site to find a buyer. Deanston therefore remained in the hands of James Finlay & Co. A Calcutta branch of the company was formed in 1870, acting predominantly as agents for trading in cotton and later the import of other products too (Jeffery, 1982). In the face of the decline in the cotton trade in the 1880s James Finlay & Co. diversified their interests, making investments in tea and steamer companies. The movement into tea was their first investment outside of Britain. The company extended its tea production branch of the business into Africa in the 1920s (Brogan, 1951: 108). Now known simply as Finlays, and owned by the Swire Group, the company still operates as a business to business tea and coffee supplier (Finlays, 2022).



Figure 5. 14. Left: Benjamin Flounders (Flounders Folly Trust, 2022). Right: Portrait of James Smith of Deanston, 1842, by Alexander Craig (ArtUK, 2022).

5.4.4 Buildings and facilities

Initially when the Buchanans bought the land adjacent to the Teith, it included an old lint mill which they used for their carding and roving machines (Govscot, 2015).²³² A situation similar to that of Rothesay, discussed earlier in the chapter, where an old lint mill was also used in the early years of production prior to the construction of a specialised building. A new spinning mill (Figures 5.15 and 5.16) was built in 1828–1829 and, although it is doubtful that

²³² *NSA*, Kilmadock, Perth, Vol. 10, 1845.

the mill was actually designed by Arkwright, as some sources claim, the mill was certainly based upon the principles of his mill in England. The mill building was constructed with five storeys plus an attic made of red sandstone and Scots slate roof (Govscot, 2015). A weaving shed was also added, containing a high vaulted ceiling to assist with keeping the space a constant cool temperature throughout the year (Figure 5.17). Motive power was generated by water diverted from the Teith to waterwheels via a lade 1,500 yards in length.

While in the possession of James Finlay & Co., the mills expanded significantly and a redevelopment of the waterpower resources was necessary. In 1822, an additional fall of 20 feet was procured through ‘arrangements with the neighbouring proprietors’, increasing the fall of water available to Deanston to 33 feet.²³³ It was proposed for eight waterwheels capable of a combined 800 hp to be installed, to be enclosed in a 90 ft sq. building. In the end, only five wheels were constructed. Two wheels were built by Messrs Fairbairn & Lillie,²³⁴ and the other two by the company’s engineer at Deanston, William Smith (Shaw, 1984). The installation of the wheels took place during what was to be the last period of large scale waterpower construction in Scotland (Hume, 1976). The wheels were different sizes, the largest, nicknamed ‘Hercules’, was a breastshot wheel measuring 36 ft in diameter, making it the largest wheel in Europe and second largest in the world at the time (Happer and Steward, 2015) (Figure 5.18). The remaining wheels and the square mill designed to surround the wheelhouse were never built, although a fifth wheel is thought to have been constructed and was on the Deanston premises but was not erected, while the foundations for six wheels were in place.²³⁵

²³³ It is not specified what these arrangements entailed. *NSA*, Kilmadock, Perth, Vol. 10, 1845: 1234–1235.

²³⁴ The partnership (1817–1832) between Manchester based engineers Sir William Fairbairn and James Lillie constructed some of the most powerful waterwheels used during the Industrial Revolution in Britain (Byroms, 2015: 72).

²³⁵ 1855 Correspondence and papers concerning Glasgow Water Co and legal cases, 1825-1853. Records of James Finlay & Co, Catrine, Deanston, production records. University of Glasgow Archives & Special Collections. GB 248 UGD 091/1/5/3/6/1.

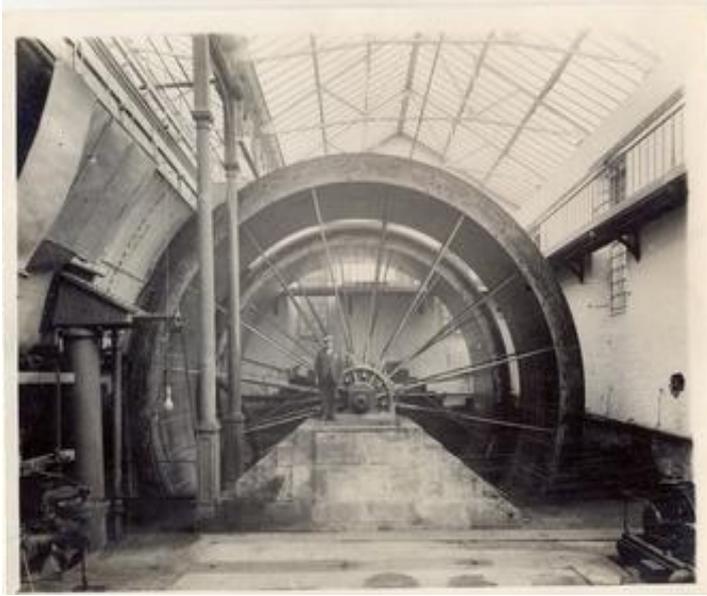


Figure 5. 18. Waterwheel at Deanston c. 1930. A person stands in the centre of the photograph for scale (S, 2022).

A valuation of both fixed and loose plant at Deanston in September of 1904 came to a total of £27,003 13s, equivalent to over £2.2 million today.²³⁷ The waterwheels and wheel house alone were valued at almost £5,000 (see Table 5.5). At this point in time, the major investments and alterations to the mill complex had already taken place and the buildings, included the spinning mill, consisting of a ground floor packing room, three flats for spinning, two flats for carding and roving, a winding flat in the attic, and a reeling flat. Then there was the weaving shed, dressing and heddling room, warping rooms, machine house and plant, an engineer's shop, joiner's shop, smithy, foundry, and gas works.

Prior to 1904 water turbines were already in use at the site for the gas works. Power supply for the cotton mill itself was eventually modernised in 1947 when hydro-turbine engines and a steam electricity generating plant were installed (SLHS, 2022). The weir from the previous waterpower system continued to be used for the hydroelectric power, providing another example of that late reversion to waterpower, noted previously for New Lanark.

²³⁷ Inventory and valuation of Deanston and Catrine Mills belonging to James Finlay & Co, 1904. Records of James Finlay & Co, Catrine, Deanston, production records. University of Glasgow Archives & Special Collections. GB 248 UGD 091/1/5/2/7/1/1.

Table 5. 5. Extract from inventory and valuation of fixed and loose plant at Deanston Spinning and Weaving Mills for 1904.²³⁸

Description	Valuation	Location
4 High breast water wheels about 36'4" diam. X 11'0" wide with cast iron shrouding and malleable iron soling and buckets. Driving internal and external toothed gear to intermediate shafts, fitted with two spur pinions. Two 18'0" spur wheels and driving pinion on main shaft with pulley blocks, sole plates, one malleable iron water trough 80'0" long with cast iron plates on top fitted with water sluices for water wheels supported sixteen cast iron columns	£3,400	WHEEL HOUSE
Stone foundations for water wheels and tall water course to inside of wheel house	£600	WHEEL HOUSE
1 main driving shaft of cast iron driven off intermediate shafts from water wheels 52'0" long x 13 1/2" diam., driving weaving mill. Upright shaft with two couplings, one spur pinion 5'6" diam. x 15" broad, one mitre wheel 7'0" diam. x 18" broad, one bevel wheel at upright shaft 5'6 1/2" diameter x 11" broad. One main cross driving cast iron shaft from main water wheel shaft driving spinning mill 140'0" long x 13 1/2" diam. With six couplings, eight pulley blocks and sole plates, one 7'0" mitre wheel 18" broad on face and one 5'10 1/2" bevel wheel 11" broad	£900	WHEEL HOUSE
2 turbine water wheels 17" and 12 1/2" with 30'0" fall Cast iron water supply pipes 16" and 20" diam. Fitted with sluice valves.	£140	ASBESTOS FIXED PLANT
1 Turbine water wheel 9" diameter with inlet pipe 40'0" long x 4'0" diam., one centrifugal pump, high lift, four chambers, suction pipe, 30 yards long x 4" flanged pipe, discharge pipe, Two cast iron beams etc.	£285	GAS WORK

Aside from the industrial buildings, an adjoining planned village to the west of the mill (Figure 5.19) was founded by the company, in a similar fashion to New Lanark. Houses for workers were uniform, two-storeys with attics, with a small garden attached and arranged in rows on a street that ran parallel to the river (Govscot, 2015).²³⁹ When occupied fully, their housing brought in £700 in rent to the company (*Glasgow Herald*, 1844b). To meet demand for accommodation, deteriorating houses in nearby Doune were rebuilt and new streets added to that village too to house workers. In March of 1830 there were 469 employees of Deanston: 93 of these workers lived in Deanston village itself, 220 in Doune, and the rest

²³⁸ Inventory and valuation of Deanston and Catrine Mills belonging to James Finlay & Co, 1904. Records of James Finlay & Co, Catrine, Deanston, production records. University of Glasgow Archives & Special Collections. GB 248 UGD 091/1/5/2/7/1/1.

²³⁹ *OSA*, Kilmadock, Perth, Vol. 20, 1798.

resided elsewhere in the local area.²⁴⁰ For the managers of the mill, a mansion set within landscaped parkland, Deanston House, was built. James Smith was the first occupant (Govscot, 2015). At the eastern side of Deanston village a school room with capacity for 200 children was established and supported by the company (Ferguson, 1948).²⁴¹ Here, the child employees of the mills could have an education far beyond the basics of reading and mathematics that they might receive elsewhere.

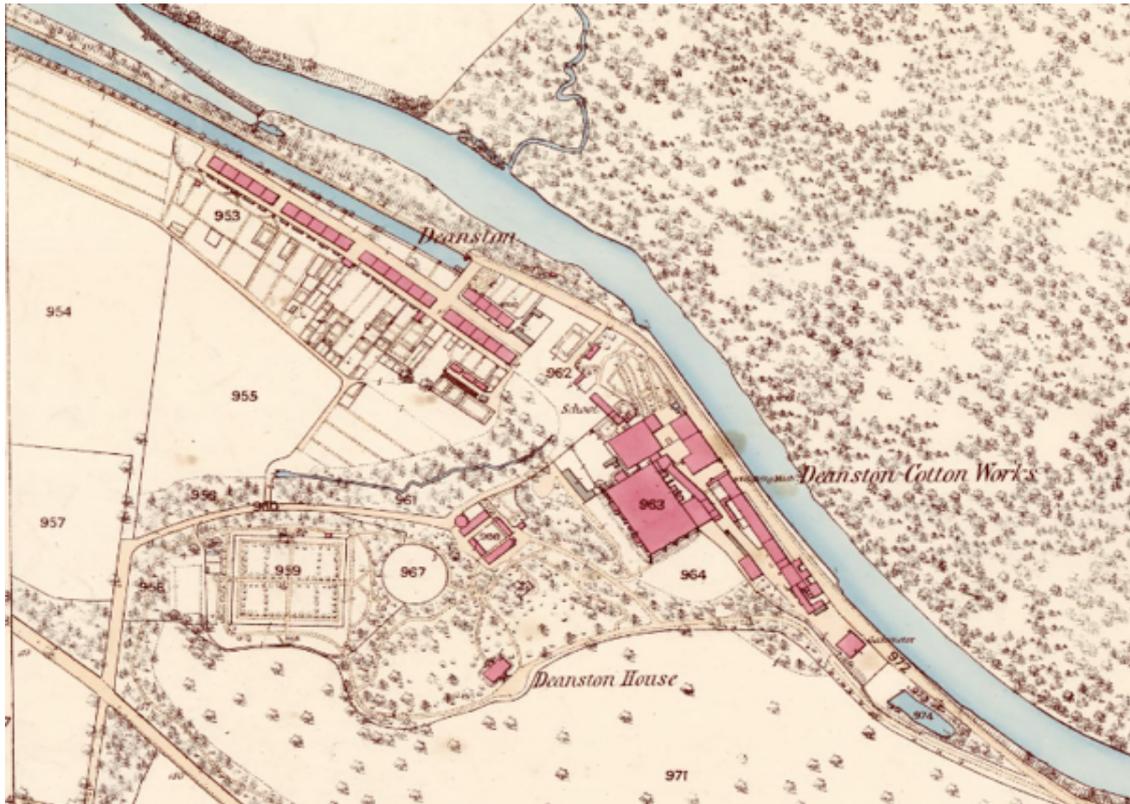


Figure 5. 19. Map of Deanston in 1862 displaying from left to right: the lade, workers housing, school, manager's Deanston House, cotton works with gasometer (gas lighting was installed from 1813).²⁴²

²⁴⁰ Loose leaves: weaving room orders, jotting of number of workers at Doune, Deanston, etc, 1825-1855. Records of James Finlay & Co, Catrine, Deanston, production records. University of Glasgow Archives & Special Collections. GB 248 UGD 091/1/5/3/15/1.

²⁴¹ OS Name Books - Perthshire - Volume 37 - Parish of Kilmadock - 1859-1862, OS1/25/37.

²⁴² Ordnance Survey, 25 Inch to the mile, Perth and Clackmannanshire CXXV.13 (Kilmadock) (Surveyed: 1862, Published: 1864). View online: <https://maps.nls.uk/view/74960863>. Courtesy of the National Library of Scotland.

5.4.5 Successes and failures

Contemporary commentators noted the use of successful employment practices at the mills under Flounders. For instance, wages were generally paid by the piece, dependent on the quality and quantity of the work, and were distributed on Thursday mornings to coincide with market day. Paying according to piece work rather than set weekly wages was said to have caused workers to ‘become extremely dexterous’ and, although they were not indentured and therefore having the option to leave at any moment, they generally stayed for a longer length of service than could be expected in other mills.²⁴³ That said, reports suggested that initially, living and working conditions were poor and workers unhappy due to overcrowding both in the houses and the workrooms (Ferguson, 1948). The construction of the new mill building by James Finlay & Co. in the 1820s was a turning point for conditions. The new building featured improved ventilation, better safety (guarding belts and shafting), fewer health risks (wooden flooring over the stone base provided some protection to the joints of the workers who often laboured barefooted), and there were also improvements to the housing stock (Ferguson, 1948).

The River Teith was an enormous advantage to Deanston. The *Preston Chronicle* (1833) estimated that the costs incurred transporting goods to and from Deanston were entirely offset by the savings gained from not using steam power, enabling Deanston to easily compete with the mills of Glasgow and Dundee: The Deanston power, inclusive of the carriage, does not amount to half the expense of steam-power in Glasgow. It is fully £10 per horse-power in Glasgow; that is, not a fourth of the cost of steam-power in Dundee’. The waterpower from the Teith over and above the burden of the feu duty was valued at £4,500 in 1904 but the full potential of the waterpower was not available during the whole year.

Deanston may have been ideally situated for harnessing waterpower, but, akin to New Lanark, it suffered from a lack of available local labour due to its relatively remote location, a problem compounded by a local reluctance to work in factories (Lockhart, 1986).²⁴⁴ The residents of Kilmadock were said to look upon improvements in the parish with jealousy and distrust. They were suspicious of the Deanston Mills, just as they had been of the

²⁴³ *OSA*, Kilmadock, Perth, Vol. 20, 1798: 87.

²⁴⁴ One might speculate that this was possibly why there was some maintenance of an older ‘craft’ ethos of piecework and putting-out, in a resistance of sorts to the full-blown arrival of wage-slavery capitalism.

construction of the bridge of Teith before it.²⁴⁵ Early on, in the 1790s, a fire at Deanston resulted in 20 families leaving the mills and the village of Doune entirely, but attracting and retaining workers was indeed a more general problem faced by other mills located outside of the major towns or cities.²⁴⁶ To overcome the issue, like at New Lanark for a while, Deanston employed poor and orphaned children. The Guardians of St. Martin's Parish in London, England offered 20 children to Deanston in 1834. When the Guardians next enquired if Deanston was able to accommodate more of their children, Smith informed them that the village's population was growing sufficiently that they had no need for additional orphaned workers (Ferguson, 1948). Unfortunately, this self-sustainability did not last and in 1860 there were unoccupied houses in the village,²⁴⁷ a problem that persisted and eventually contributed to the lack of profitability of the mills. In a minute of agreement between Archibald Buchanan Jr and John Muir (both partners of James Finlay & Co.) in 1881 it was stated that:

The cotton works at Catrine and Deanston are at present unremunerative, and the future prospects of the cotton trade discouraging. This is intensified at Deanston on account of the want of adequate labour to keep all the machinery going ...²⁴⁸

The company partners of James Finlay & Co. therefore felt it necessary to focus their capital into other industries including branching out into steam boats in conjunction with another textile producing firm, Coats of Ferguslie.²⁴⁹ This was not their first attempt to diversify. The mills had previously hosted a highly successful mechanical department that constructed machinery for other mills across Britain and beyond, their commissions ranging from a 70 ft (22 m) diameter wheel for Scott and Sinclair's cotton mill in Greenock all the way to an iron waterwheel for use in Jamaica. Around 1845 the department was nonetheless broken up and many of the tools sold off by auction (*Glasgow Herald*, 1845).²⁵⁰ These attempts at diversifying investments to other activities through the likes of Deanston's mechanical department manufacturing machinery for use elsewhere, can be seen as attempts to handle fluctuating profitability of a mill. Where such alternative or complementary activities

²⁴⁵ *NSA*, Kilmadock, Perth, Vol. 10, 1845.

²⁴⁶ *OSA*, Kilmadock, Perth, Vol. 20, 1798.

²⁴⁷ Deanston annual statements, 1859-1871, 1860. Records of James Finlay & Co, Catrine, Deanston, production records. University of Glasgow Archives & Special Collections. GB 248 UGD 091/1/5/3/13/5

²⁴⁸ Minute of agreement between Archibald Buchanan and John Muir, 1881. Records of James Finlay & Co, Catrine, Deanston, production records. University of Glasgow Archives & Special Collections. GB 248 UGD 091/1/5/2/7/2/2.

²⁴⁹ J. & P. Coats was a cotton thread manufacturing firm in Paisley, Renfrewshire.

²⁵⁰ Deanston letterbook, Jan 1840-Jul 1844. Records of James Finlay & Co, Catrine, Deanston, production records. University of Glasgow Archives & Special Collections. GB 248 UGD 091/1/5/3/6/7; *NSA*, Greenock, Renfrew, Vol. 7. 1845.

continued on the same site, sharing some of the same buildings as was the case here (and also the cotton mill with associated bleaching works at Catrine in the next case study), this was arguably another version of dynamic inertia: staying in place physically but still trying to innovate and move the business forward.

Both the financial and technical records kept during the period of ownership by James Finlay & Co. were incredibly detailed, providing evidence that the managers of the mill had acute knowledge of business and engineering practices. A notebook kept between 1826 and 1937 for example, recorded the specifications of the mill equipment and machinery. Among the entries in this notebook, records of the waterwheels are given, detailing the number and size of buckets on each wheel, the volume of water held, and the maximum speed of revolutions.²⁵¹ It is clear that maintaining a sufficient supply of water was of the utmost importance to the mills. Calculations were made and updated regarding the depth of water in Loch Katrine and Loch Lubnaig and a river gauge kept regularly from August of 1831 informing Deanston's managers precisely what depth of water was needed to power the machinery.²⁵² These records were highly valuable to the mills, and they would be needed in a subsequent dispute over water rights, though they failed to fully insulate the mills against alterations to their water supply.

The water works that had been designed for the city of Glasgow by James Watt and Scottish civil engineer Thomas Telford at the start of the nineteenth century rapidly became insufficient for the city's water demands in terms of both quality and quantity. Alternative schemes had been proposed, including a report by Robert Thom, owner of the Rothesay Cotton Mills who we have already encountered, on the possibility of drawing water from North Calder, while Deanston's James Smith had earlier suggested that water might be drawn from Loch Lomond for supplying Glasgow (*Glasgow Herald*, 1853a). None of the alternatives were deemed practicable so the Glasgow Water Works Company obtained parliamentary Acts that allowed them initially to use the water of Loch Lubnaig (1846) and later from Loch Katrine too in 1855 (Taylor, 1896) (Figure 5.20). It was argued that Loch Katrine was the only natural water source that could meet Glasgow's needs (Paxton, 2009).

²⁵¹ Observations on rainfall, progress of construction at Deanston, machinery, etc. Notebook, J. [] Finlay, 1826-1937. Records of James Finlay & Co, Catrine, Deanston, production records. University of Glasgow Archives & Special Collections. GB 248 UGD 091/1/5/3/13/1.

²⁵² A page from the record book was shown in Figure 3.16.

The proposed Acts received opposition from landowners, millowners, and proprietors of fisheries along the Rivers Teith, Leny, and the Forth who feared that the Glasgow scheme would reduce water supply for industry, agriculture, and impact fish populations.²⁵³ The shared risk to their businesses encouraged collaboration to fight the act. Before construction of any water works could be undertaken following the 1846 act, compensation in the form of guaranteed water levels had to be calculated by arbitrators.²⁵⁴ When examined for a House of Commons Committee, the manager of the Glasgow Water Works Company admitted that the result calculated was impossible to meet: they could not guarantee the required water supply levels (*Glasgow Herald*, 1853a). The dispute that ensued from the proposed schemes would be one of the greatest challenges that Deanston Mills faced.

In 1852, even before the Glasgow Water Works Company had taken any water from the Lochs, Deanston experienced stoppages due to insufficient water during the summer months.²⁵⁵ When the water level in the New Dam fell below 5 to 5 ¼ inches, the machinery could not reach the correct speed. Over the preceding 28 years, the water level was recorded as under 5 inches on average 32 days per year; 1826 and 1852 were especially dry years, with 96 and 99 days respectively measuring below five inches, resulting in ‘calamity’ for the works. Previously, stoppages that occurred during the working day due to water shortages, breakages *etc.* could be compensated by imposing extra working time in the early morning or night. However, the restrictions on the number of hours their workers could perform per day imposed by the Factory Acts (introduced in 1819 but made stricter and enforceable from 1833) rendered it impossible to make up for lost time. The 1847 amendment known as the Ten Hours Bill, further restricted women and adolescents to a maximum of ten hours work a day over five days a week (Oliver, 1914), in effect also limiting the hours the mill could be operational and water flow capitalised upon.²⁵⁶ The managers of Deanston were of the

²⁵³ Correspondence and papers concerning Glasgow Water Co and legal cases. Records of James Finlay & Co, Catrine, Deanston, production records. University of Glasgow Archives & Special Collections. GB 248 UGD 091/1/5/3/6/1.

²⁵⁴ The idea of compensation water was that water levels could be regulated for river users further downstream from the point of extraction by a municipal water company. Water was diverted and stored in reservoirs with systems of artificial dams, pipes, and sluices, and released into the river in a controlled manner by the water company who would also maintain the infrastructure.

²⁵⁵ Observations on rainfall, progress of construction at Deanston, machinery, etc. Notebook, J. [] Finlay, 1826-1937. Records of James Finlay & Co, Catrine, Deanston, production records. University of Glasgow Archives & Special Collections. GB 248 UGD 091/1/5/3/13/1.

²⁵⁶ Some mills trialled night work with a second set of workers employed through the night (Brown and Hume, 1980). This never gained widespread popularity and would not have been possible for the rural mills where it was already challenging at times to hire sufficient workers for a day shift.

opinion that half of the water that reached the mills from the River Teith originated from Loch Lubnaig and they estimated that, even when combined with all other sources available to them, the proposed volume of compensation water would drive only half of their current machinery. The use of a steam engine was ‘impossible’ due to the costs of coal, so the management of James Finlay & Co firmly held the position, in the early-1850s, that they would ‘rather remain as we are than accept the proposed compensation’ as ‘the measure would be seriously injurious to our interests’.²⁵⁷

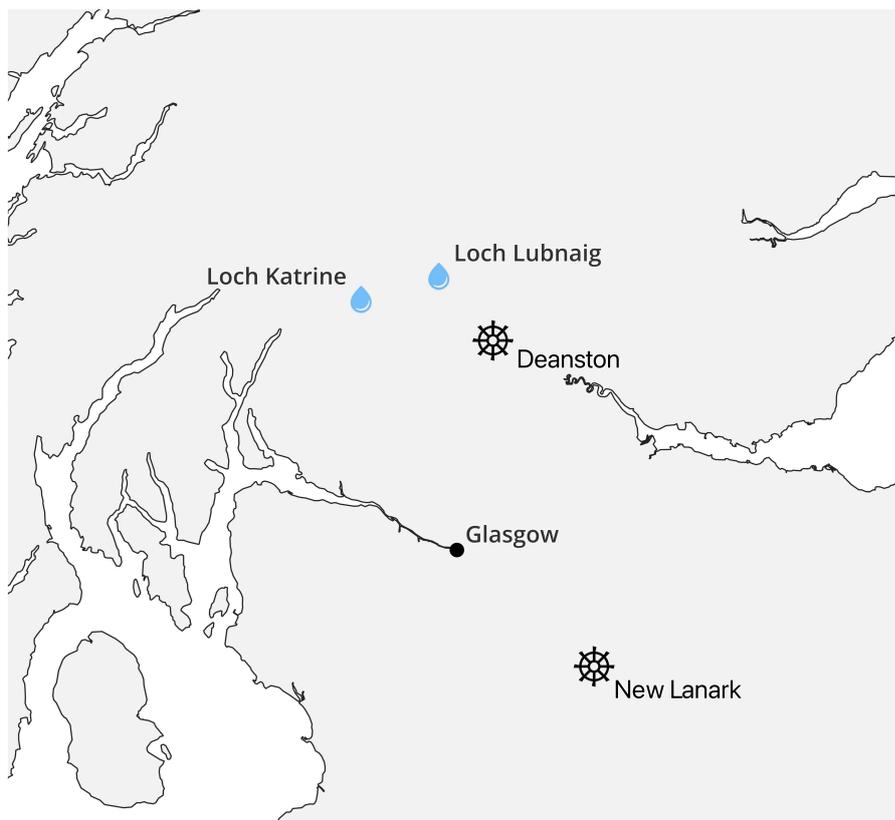


Figure 5. 20. Locations of Deanston, Loch Lubnaig, Loch Katrine, Glasgow. The location of New Lanark is also marked – a scheme at nearby Hyndford Bridge was proposed as an alternative to Loch Katrine (previously mentioned under New Lanark in section 5.3.5).²⁵⁸

Perhaps it was this business with the Water Works that prevented the desired expansion and building and installation of all the planned wheels at Deanston. An anonymous letter dated

²⁵⁷ These statements appear on page 18 of a notebook containing observations about production and the running of Deanston. The author of this, and other notes within the book is unknown but presumed be a partner of James Finlay and Co. considering the detailed recordings, high level statements on business operations, and notes of contact details for solicitors. Observations on rainfall, progress of construction at Deanston, machinery, etc. Notebook, J. [] Finlay, 1826-1937. Records of James Finlay & Co, Catrine, Deanston, production records. University of Glasgow Archives & Special Collections. GB 248 UGD 091/1/5/3/13/1.

²⁵⁸ Background layer: OS Six-Inch 1st edition, 1843-1882.

1855 suggests that, when originally planning for the expansion of the works and its power system in the 1820s, the company had acknowledged that an increased supply of water would be needed before all eight wheels – six of which were finally envisaged – could be worked during the summer, but that no potential problems on this front had then been envisioned:

The extra water that would be required for the eight wheels would be easily obtained from Loch Katrine at a very trifling expense - having such a prospect in view you were induced to lay out your capital expecting whenever the said wheels were put down you could get the necessary supply of water for the whole without much difficulty.²⁵⁹

The new Water Works for Glasgow were completed in 1860. In the end the water levels of Loch Vennacher and Drunkie were also raised to provide compensation water to proprietors along the Teith, and it was agreed that 6,480,000 gallons would be released daily from Loch Vennachar at a rate of 3000 cubic feet per minute from 1 pm to 1 am and at double that rate from 1 am to 1 pm (The Glasgow Corporation Waterworks Act, 1855). Nonetheless, the waterpower at Deanston was never further increased. Instead, a steam engine was eventually purchased and installed prior to the start of the twentieth century as an auxiliary power source for use during periods of drought and frost.²⁶⁰

Briefly bringing the story into the twentieth century, the Works were eventually refitted as a weaving factory in 1948, its operations integrated with those of the mills at Catrine. Deanston then closed for a final time in 1965 and its buildings were purchased shortly after by Brodie Hepburn, who refitted the mill over the following year for the distilling of Scotch whisky. Whisky production began in 1966 for the Deanston Distillery Co. Ltd which online sources (e.g. Whisky Antique, 2020) claim was created as a subsidiary of James Finlay & Co., keeping a connection to its history, though corroborating evidence for this was not found.

²⁵⁹ 1855 Correspondence and papers concerning Glasgow Water Co and legal cases, 1825-1853. Records of James Finlay & Co, Catrine, Deanston, production records. University of Glasgow Archives & Special Collections. GB 248 UGD 091/1/5/3/6/1.

²⁶⁰ The inventory and insurance reports suggest that traditional waterwheels continued to be used for the spinning mill. Meanwhile, the engineer's shop was fitted with 1 horizontal engine (8" cylinder) and 1 low breast waterwheel (16' diameter x 14' wide) and the gas work was powered by 1 turbine waterwheel (9" diameter). Inventory and valuation of Deanston and Catrine Mills belonging to James Finlay & Co, 1904. Records of James Finlay & Co, Catrine, Deanston, production records. University of Glasgow Archives & Special Collections. GB 248 UGD 091/1/5/2/7/1/1.

5.5 Catrine

5.5.1 Location and water supply

Catrine Mills,²⁶¹ another of the mills purchased by James Finlay & Co., was located in the village of Catrine, in the parish of Sorn, in Southwest Scotland (Figure 5.21). The nearest town to Catrine is Mauchline, approximately 5 km northwest of Sorn. The village also lies 97 km west of Edinburgh, 48 km southwest of Glasgow, and 22 km east of the seaport town of Ayr. The overall climate in this region since the eighteenth century has been damp and windy, although with less rainfall than is typical in much of the West of Scotland (Steven, 1912).²⁶² Ayrshire's cool summers and mild winters result from the prevailing westerly winds from the Atlantic. The village of Catrine itself is on the north side of the River Ayr where sloping hills and woods on either side of the river offer some protection from the harsh winds that can be experienced in the region (East Ayrshire Council, 2005).

The River Ayr runs through the parish of Sorn from east to west, with a catchment area of 166.3 km². Its present day median flow rate is 5.289 m³/s (Figure 5.21) (NRFA, 2022). A description of the Ayr in the *OSA* for Sorn parish stated there was 'water sufficient for any machinery, and abundance of fall every quarter of a mile'.²⁶³ This claim was not entirely accurate, and since the parish of Sorn had no natural lakes, it was deemed necessary for artificial reservoirs to be built for the cotton mill and bleaching works.

²⁶¹ Mills plural is used here to refer to the entire complex of the Catrine Cotton Mills and Bleaching Works. Some primary and secondary sources refer to the Catrine Works rather than Mills.

²⁶² *OSA*, Mauchline, Ayrshire, Vol. 2, 1792.

²⁶³ *OSA*, Sorn, Ayrshire, Vol. 20, 1798: 156.

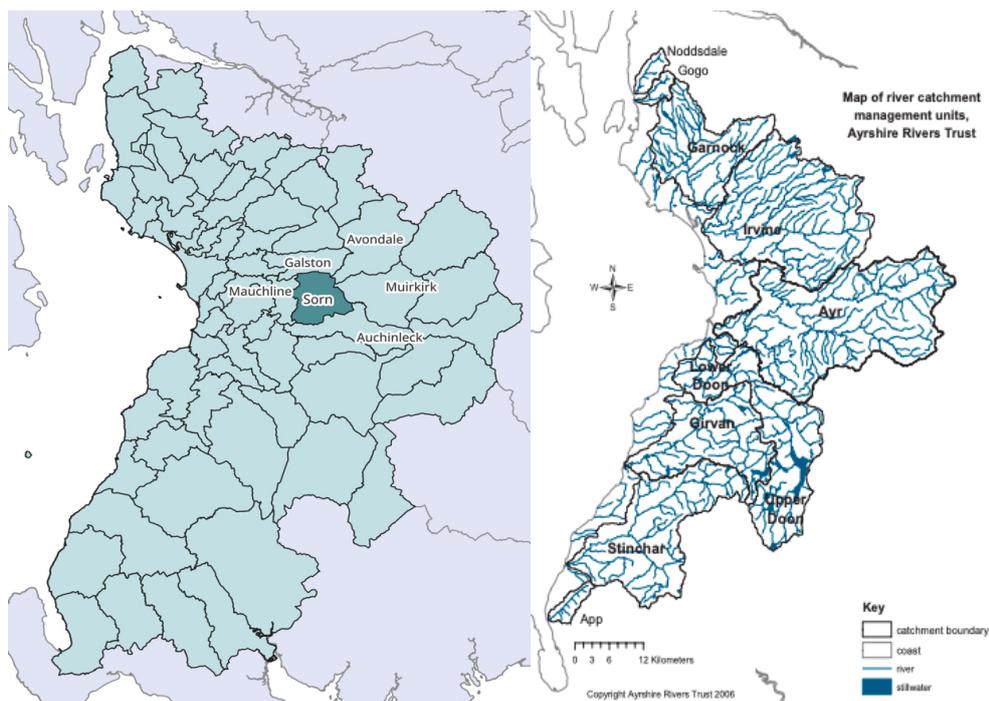


Figure 5. 21. Left: Location of Sorn and immediately surrounding parishes within Ayrshire. Right: Catchment boundary of the River Ayr (Ayrshire Rivers Trust, 2006).

A number of other mills were located within Sorn parish and neighbouring Mauchline parish that were operational at same time as Catrine, including two other textile mills (Figure 5.22). To the East, in Sorn village was Dalgain Mill, a water-powered grain mill (pre-1850s–1920s) and New Mill (c.1850–1901), a worsted mill, also water-powered (Hume, 1976; *Ayrshire History*, 2022a). There would also have been several farms with threshing mills on their properties, but these were primarily horse-driven.²⁶⁴ To the west at Haugh village was a woollen mill (mentioned in Chapter 4, Section 4.4 for its shared lade). The final mill in the region worth noting was slightly further west, Barskimming Mill: for this substantial water-powered grain and sawmill, water was taken off the Ayr shortly after its confluence with Lugar Water.

²⁶⁴ *NSA*, Sorn, Ayrshire, Vol. 5, 1845.

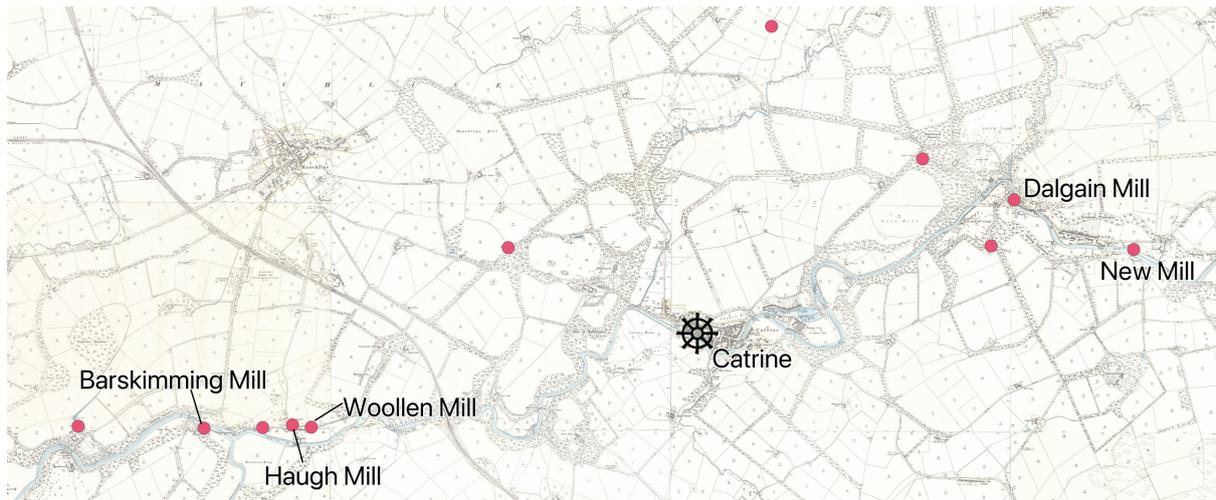


Figure 5. 22. Mills in close proximity to Catrine (represented by pink circles).²⁶⁵

5.5.2 Local economy and population demographics

Prior to the establishment of its mills, Catrine was an insignificant site, with two thatched houses that were home to a miller and a blacksmith. By the 1840s the parish of Sorn could boast of two villages, Catrine and Sorn, although the population of the former massively outweighed the latter, with 2,700 and 300 persons respectively. Since Catrine was a planned industrial village, employment was dominated by the Catrine Mills, whereas Sorn was primarily occupied by agricultural workers, colliers, and quarriers, with a smaller number of hand-sewers and hand-loom weavers as well.²⁶⁶ The population of the county as a whole doubled over the first half of the nineteenth century in response to the development of industries that included the large carpet and cotton manufactories of Killburnie, Dalry, Catrine, Stewarton, and Kilmarnock, and 34 tile drain manufactories across the county (*The Standard*, 1845). The region was abundant in natural resources available for industrial exploitation. Sorn possessed peat, coal, limestone, ironstone, and red free-stone, while the Ayr supported trout and salmon.²⁶⁷ Some coal had been wrought in the parish since the year 1497, but most of the coal that existed either was not being extracted and utilised, or was expensive. The coal seam between Sorn and Dalgain, for instance, required a steam engine to remove water and others were limited by a lack of roads for access. Where a landowner did take advantage of this resource, its value was very much recognised and coal prices rose

²⁶⁵ Background layer: OS 25 Inch 2nd edition, 1892–1905.

²⁶⁶ *NSA*, Sorn, Ayrshire, Vol. 5, 1845.

²⁶⁷ *OSA*, Sorn, Ayrshire, Vol. 20, 1798.

substantially in the last decade of the eighteenth century.²⁶⁸ In the early years of the Industrial Revolution, therefore, steam was not an obvious choice of motive power for the mills in this locality.

Until around 1790, poverty was high in the parish. The Reverend George Gordon attributed this impoverishment in part to low wages, but also accused the population of spending an excessive proportion of their wages in drinking establishments, a moralising judgement typical of the times. However, a rise in wages for labour, the introduction of industry in the parish, the increased cost of spirits, and rural improvements, all resulted, in Gordon's opinion, in a considerable enhancement of the character of the people. At the time he submitted his contribution to the *OSA*, Gordon believed the residents of Sorn to be on the whole 'a peaceable, sober, and industrious people, contented with their lot, tolerably regular in their attendance upon public worship, and attached to the principles of the British Constitution, by which they find their lives and properties so well secured'.²⁶⁹

In terms of communications, there were a small number of private roads and three public roads passing through the parish, one from Glasgow to Dumfries, and another two from Edinburgh to Ayr. In the 1840s, a carrier departed from Catrine to Ayr every Tuesday and Friday, one from Catrine to Kilmarnock on the same days, and from Sorn and Catrine to/from Glasgow on Mondays and Thursdays. Additionally, the Catrine Company sent its own carts with goods to Glasgow daily using a relay of horses so that products could depart in the evening and arrive in the city by the following afternoon.²⁷⁰ Catrine was temporarily connected to the rail network, beginning in September 1904, with four trains a day travelling between Catrine and Mauchline. This link provided faster access to the ports on the west coast of Scotland, aiding the international expansion of James Finlay & Co. (Dalziel *et al.*, 1987), a company – with its multiple interests and overseas connections – that has of course already featured heavily in this chapter. James Finlay & Co. had been integral in the campaigning for this route, with a Mr E. B. Ramsay giving evidence in Parliament in support of the line on behalf of the firm's partners (*Glasgow Herald*, 1895c). The route closed to passengers from 1943, continuing to run a service for goods only until July 1964 when the entire line was closed permanently (Thomson, 2016). Prior to the opening of Catrine's station

²⁶⁸ *OSA*, Sorn, Ayrshire, Vol. 20, 1798.

²⁶⁹ *OSA*, Sorn, Ayrshire, Vol. 20, 1798: 166.

²⁷⁰ *NSA*, Sorn, Ayrshire, Vol. 5, 1845.

the nearest rail connection was 3 km away at Mauchline and this service also ceased in the 1960s (Railscot, 2022).

5.5.3 Ownership and management

The Catrine Mills were created through a partnership between Claud Alexander, a former servant of the East India Company, and the merchant and philanthropist, David Dale, whose name has recurred throughout the chapter already. Dale, who had opened the New Lanark Mills the previous year, worked his way up from a weaving apprenticeship to textile business owner, whereas Alexander was an example of the landed interest's involvement in industrialisation in Scotland (Robertson, 1965; Butt, 2006)

Claud Alexander (1752–1809) made his money with the East India Company between 1772–1785, including taking on the role of Military Paymaster-General in Calcutta (McGilvary, 1990). As a young, unmarried, and educated man, Alexander was assisted in his entry and progression within the East India Company by the wealth and influence of his aunt and uncle (Coltman, 2019: 107). The role brought him fortune of his own, some of which was remitted back to Scotland when he made the decision to obtain land and set up a mill (McGilvary, 1990). Alexander purchased the Ballochmyle estate in Ayrshire from the Whiteford family who had suffered bankruptcy following the failure of the Douglas & Heron Bank in Ayr (Purdie, 2004). This estate included the hamlet of Catrine. Alexander had considered purchasing alternative estates, including one in Renfrewshire that had previously belonged to his family, but settled upon Ballochmyle in 1782 for the sum of £27,000 (Coltman, 2019: 119). The occasion of this purchase was commemorated in a painting commissioned by Alexander prior to leaving India (Figure 5.23). On his return to Britain, Alexander was appointed a member of the Society for the Encouragement of Arts, Manufactures and Commerce in London within a year (McLaren, 2015). As far as is known, he was the only industrialist in the family, his immediate relatives mostly serving as merchants or in the British Army. Catrine was his first manufacturing endeavour. However, Alexander had gained experience in the import and export side of business, engaging in private trading of goods while residing in India under the East India Company (Coltman, 2019: 114–115). Rather than encouraging his children to join the business of the mills, Alexander used part of his wealth to assist his sons, Boyd Alexander and William Maxwell Alexander, in establishing themselves as West Indian merchants (Jeppesen, 2013). The symbiotic

connection between colonialism and the establishment and running of mills, even in the remoter rural parts of Scotland, cannot be plainer than in this example. In Figure 5.23 we find the state of affairs poignantly captured by the presence of the 'Indian servant' as Alexander uses his profits from Empire to purchase land to build a mill, the proceeds from the mill later used to help his sons embark on their own imperial goals.

It is not clear when or how Alexander and Dale met, nor how their business partnership developed, but by 1787 the pair had founded a mill at Catrine. Dale took on a similar role at Catrine to the one that he assumed at New Lanark, wherein he focused on the financial side of the business and offered advice while the day-to-day running of his mills was primarily left to someone else, here Alexander (McLaren, 2015). This arrangement was seemingly successful and continued for fourteen years until Dale aged and his health deteriorated. Dale relocated to the country at Rosebank near Cambuslang and began the process of severing himself from his businesses. Alexander was younger than his business partner, although his correspondence with his brother indicated that he also needed to reduce his workload and that the mills were a concern which he would not miss greatly (McLaren, 2015). In 1801 the mill was purchased by the Glasgow-based firm, James Finlay & Co., being the second mill in Scotland to be purchased by the company.

The first manager under James Finlay & Co. was Archibald Buchanan (1769–1841) (Figure 5.23), encountered already in the description of Deanston. Buchanan was born in Carston, Stirlingshire, the youngest of ten children (Smith, 1896). When Richard Arkwright, the proprietor of Cromford Mill in England, travelled through Scotland in 1783 – as discussed previously in the case of New Lanark – he visited Buchanan's home and, after meeting him, invited the sixteen-year old Buchanan to train as an apprentice at Cromford. Afterwards, he was appointed as Arkwright's first cotton twist sales agent in Glasgow (Brogan, 1951). Shortly after returning to Scotland, as was previously mentioned, Buchanan and his brother set up Deanston. He would have been familiar with Kirkman Finlay, head of James Finlay & Co. at the time, since their families were, according to the biography of the company, related. So when the Buchanan brothers put Deanston up for sale in the 1790s, Buchanan moved into a managerial position for James Finlay & Co. at their Ballindalloch Cotton Mill in Balfour, the next case study below. Almost immediately after the company purchased Catrine Mills, Buchanan transferred to Catrine as the on-site manager, by which point he was also a partner in the company (Brogan, 1951). Buchanan purchased the lands of Daldorch around the year

1810 on which he built Catrine Bank mansion, where he resided presumably until his death (Paterson, 1847–1852: 247). Further members of the Buchanan family went on to join the firm of James Finlay & Co. too, including Archibald's son, also Archibald, and nephew, James Smith, further details of whom can be found under Deanston. The junior Archibald remained a partner until his retirement in 1883, although he never took on the role of mill manager like his father.

Archibald Buchanan Sr was both an early adopter of new technologies and an inventor of them himself. He arranged for the installation of gas lighting at Catrine in 1814 ahead of its use in urban areas such as Glasgow and contracted the engineer William Fairbairn to make and install an enormous pair of waterwheels (Dalziel *et al.*, 1987). Buchanan also made his own improvements to the workings of the mill. In 1823 he obtained a patent for 'an improvement in the construction of Weaving Looms impelled by machinery whereby a greater quantity of cloth may be woven in a given time without injury to the fabric than by any application of power for that purpose heretofore employed'. The following year his patent was transferred to all the partners of James Finlay & Co. without requesting payment, allowing his innovation to be shared within the firm.²⁷¹ Based on his interactions with Buchanan, Fairbairn described him as 'a true citizen of the world; noted for simplicity, benevolence ... well educated, a great reader, and possessed of an extraordinary budget of miscellaneous and useful information' (Fairbairn & Pole, 1877: 123). Buchanan's nephew, James Smith, also proved himself an inventive manager, earning patents and awards for inventions of both textiles and agricultural machinery (Cheape, 2004).

²⁷¹ Transference of patents from Archibald Buchanan Esq to Kirkman Finlay Esq, 1824. Records of James Finlay & Co, Catrine, Deanston, production records. University of Glasgow Archives & Special Collections. GB 248 UGD 091/1/5/2/7/2/10.

THIS IMAGE HAS BEEN
REMOVED BY THE AUTHOR OF
THIS THESIS FOR COPYRIGHT
REASONS



Figure 5. 23. Portrait of Claud Alexander (1752–1809), with his brother Boyd, attended by an Indian Servant by Johann Zoffany R.A (Sotheby's, 2025); Portrait of Archibald Buchanan (1769–1841) by Henry Raeburn (ArtUK, 2023).

Unlike the partners in the firm, many of whom resided elsewhere, the managers of the Catrine Mills lived locally. A record kept by James Finlay & Co. from 1801 onwards (Table 5.6), reveals that, for unknown reasons, the turnover of management was generally more frequent in the Cotton Works compared to the associated Bleaching Works. For the most part the two management roles were kept separate, although there were periods when one person oversaw the entire enterprise at Catrine. The first manager of the Bleaching Works was James Barclay, brother of John, and uncle of Robert Barclay, managers of the Cotton Works. Outside of the business James Barclay had an interest in education and was a supporter of the Catrine Public School (*Glasgow Herald*, 1869). H.W. Pollock, manager from 1895-1908, was also heavily involved in the local community, having grown up in Catrine and so having a direct connection and interest in the village beyond business (Dalziel *et al.*, 1987).

Table 5. 6. Managers of the Catrine Cotton Works and Bleaching Works under James Finaly & Co. 1801-1951 (from Brogan, 1951).

Name	Dates
Managers of Catrine Cotton Works	
Archibald Buchanan	1801–1813
John Barclay	1813–1847
Robert Barclay (Son of John Barclay)	1847–1868
William Stevenson	1868–1873
James Morton	1873–1888
Hugh Morton (Brother of James Morton)	1888–1893
Andrew Faulds	1893–1895
H. W. Pollock	1895–1908
J. B. B. Morton	1908–1928
James Taylor & Fred. Grundy	1928–1951 onwards
Managers of Catrine Bleaching Works	
James Barclay	1823–1869
Hugh Morton	1869–1893
J. B. B. Morton	1893–1928
John Hogg	1928–1951 onwards

5.5.4 Buildings and facilities

Catrine developed as a factory village around the site of the first mill building. The village was oblong with a 28 m² square at the centre where the cotton twist mill was located (Figure 5.24). The twist mill was built with five storeys plus attic and in the 1790s could accommodate 5,240 spindles.²⁷² Carding, roving, and spinning took place in this building, conducted by 301 men, women, and children. Initially, there were just eleven other buildings in the village, including a smithy and a corn mill. A mule or jeanie mill was added in 1790, employing a further 200 persons on 76 jeanies.²⁷³ As well as the work undertaken in the mills' buildings, cotton-picking was undertaken by female employees in their own homes,²⁷⁴ another version of a gender division of labour (and space) in these early-industrial concerns. This second mill was located so that it could use the tail-water of the twist-mill to power its waterwheel, removing the need for a separate lade. The first twist mill had four waterwheels in locations spread across the building, all installed by Thomas Lowe of Nottingham, an English millwright recommended to Dale and Alexander by Arkwright (McLaren, 2015).

²⁷² *OSA*, Sorn, Ayrshire, Vol. 20, 1798.

²⁷³ Alternate spelling for spinning jenny. See glossary for description.

²⁷⁴ *OSA*, Sorn, Ayrshire, Vol. 20, 1798.

When the Cotton Works were bought by James Finlay & Co., they were enlarged and improved. An artificial reservoir named Glenbuck Loch with two dams was created in 1802 to store water. This was located 24 km west of the mills and covered an area of 121 acres.²⁷⁵ The annual rent for the land occupied by the reservoir was £156, a cost that was shared between James Finlay & Co. for Catrine Mills and the Muirkirk Iron Company, whose works were south of present day Muirkirk. Although the Iron Company benefitted from the water, the Catrine Mills had full control over the discharge of the water (*Glasgow Herald*, 1844a). It would take twelve hours for the water to travel from the reservoir to the mills at Catrine, so workmen would open the sluices at six o'clock in the evening to allow water to reach the Catrine Mills by the following morning when work started for the day. Water was delivered from the river via a weir and a stone aqueduct and stored locally in a system of artificial reservoirs known as Voes (Figure 5.25).²⁷⁶ The weir raised the water so it was deep enough for the sluices to operate and control the water flow. Each of the Voes had a function: the first and largest Voe trapped silt and debris and the other Voes powered the various waterwheels (East Ayrshire Council, 2005).



Figure 5. 24. Twentieth century view of the Catrine Mills complex from the north and view of entrance block from the north-west.²⁷⁷

²⁷⁵ NSA, Mauchline, Ayrshire, Vol. 5, 1845.

²⁷⁶ In Orkney and Shetland the word voe, from the Old Norse *vagr* refers to a small bay or narrow creek (Collins, 2023).

²⁷⁷ Trove.scot image reference: SC 344633 (View of mill complex from North); Trove.scot image reference: SC 1124181 (View of Catrine Mill entrance block from north west). Reproduced courtesy of Historic Environment Scotland.

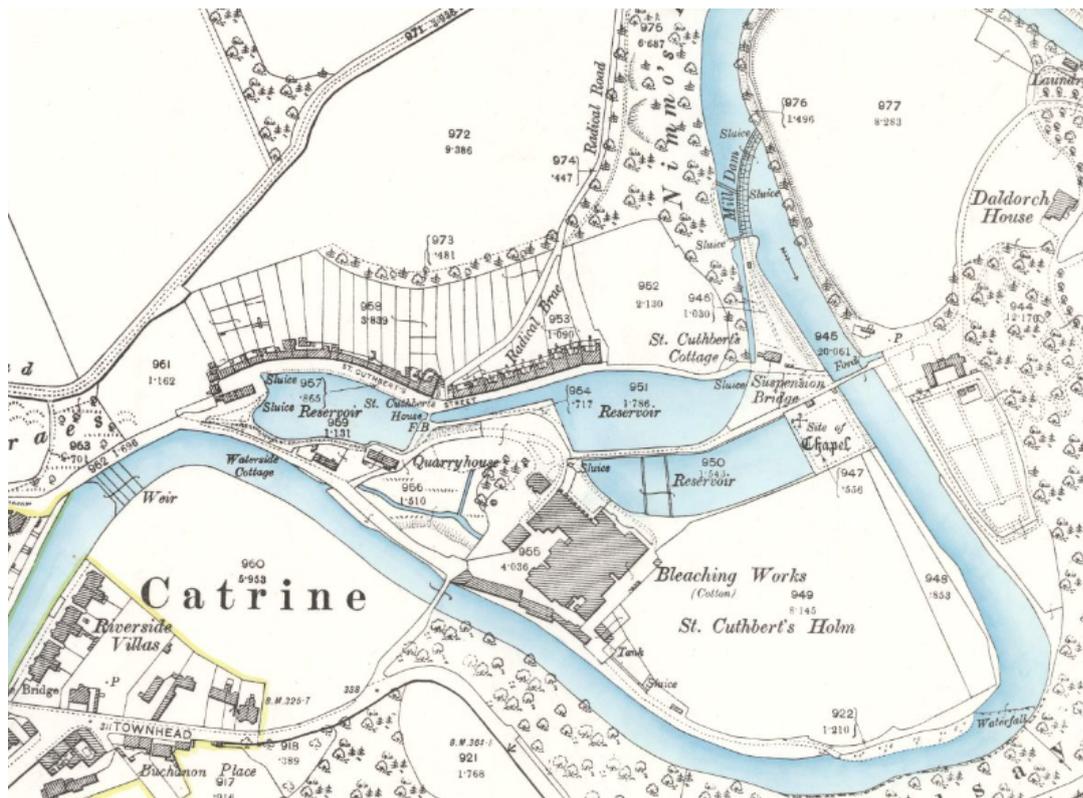


Figure 5. 25. Map depicting the Catrine Voes reservoir system.²⁷⁸

Ancillary buildings to assist with the operation of the mills were added around the 1810s, such as iron and brass foundries and a mechanics shop, but the most significant change came with the addition of the large Bleaching Works in 1824. Subsequently, the lade was extended along with the construction of a new aqueduct and a complete redesign of the waterwheels and gearing system. By 1848 the size of the weir had been doubled to a height that was 4 ft 8 inches greater than the natural water level of the Ayr (East Ayrshire Council, 2005). These alterations were required because the existing waterpower system was insufficient for the growing mills and the increased power requirements, another instance of purposeful adaptations allowing a water-powered mill to continue operating in its original and preferred location. The new 50 ft (15 m) waterwheels for the twist and mule mills were the largest and most powerful wheels in Scotland at the time of installation. So impressive were they that they received the nickname ‘Lions of Catrine’ and were featured on postcards (Figure 5.26).

An inventory taken in 1904 after the major expansion and improvements of the nineteenth century show the mills’ key assets to have been substantial in terms of both buildings and

²⁷⁸ Ordnance Survey, 25 Inch to the mile, Ayrshire XXIX.10 (Revised: 1895, Published: 1896). View online: <https://maps.nls.uk/view/82867815>. Reproduced courtesy of the National Library of Scotland.

machinery (Table 5.7). According to the inventory there were two steam engines at the spinning mill and one at the bleaching works. Details of the installation date of the engines for the spinning machinery or the regularity of their use are unknown, but their potential power output did not come close to matching that of the waterwheels.

Table 5. 7. Extract from inventory of Catrine Mills 1904.²⁷⁹

Building	Key assets
Spinning Mill	10,152 Thorstle Spindles, 16,200 self acting mule spindles, 458 Power Looms Two water wheels, conjoined, 50 ft diameter, 10 ft wide, combined hp of almost 200 Two steam engines, conjoined, 45 hp each
Machine Shops	Turning Lathes, powered by a 15 hp water wheel
Bleaching Works	Wash Wheels, Mangles, Calenders, Beetling Machiners, Hydraulic Presses, One 50 hp water wheel One 25 hp steam engine
Other	Foundry, Drying Stove, 2 Cupolas

Production records show that the total motive power for the mills had increased from around 365 hp to 400 hp the following year (1905).²⁸⁰ This slight rise in power was presumably due to further increased steam power, since the wheels are not thought to have been altered or replaced until they were dismantled in 1945 after 120 years of service, and a hydroelectric station installed, yet another example of a final reversion to waterpower. The final scrapping of the waterwheels coincided with the laying of the foundation stone of the ‘New Mill’ building which was completed, ready for production of cotton and spun rayon goods from 1950, a final fixed capital expenditure on modernisation of the mills (Brogan, 1951: 120–121).

As the works expanded, so did the village that was formed around it. Workers initially lived in small cottages on the 30 plots of land that had been feud by Alexander (East Ayrshire Council, 2005; McLaren, 2015). According to the village register of 1863, the majority of workers resided on the four main streets of St Cuthbert Street (215 residents), Wood Street

²⁷⁹ Inventory and valuation of Deanston and Catrine Mills belonging to James Finlay & Co, 1904. Records of James Finlay & Co, Catrine, Deanston, production records. University of Glasgow Archives & Special Collections. GB 248 UGD 091/1/5/2/7/1/1.

²⁸⁰ General Register - certificates of fitness of young persons and children for employment after the 1901 Factory and Workshop Act, including accidents and steam boiler maintenance, 1905. Records of James Finlay & Co, Catrine, Deanston, production records. University of Glasgow Archives & Special Collections. GB 248 UGD 091/1/5/2/6/2/8.

(387), Ayr Place (86), and Townhead Street (86).²⁸¹ The managers of the mills lived in Ayrbank House on Ballochmyle Street, a typical class-based organisation of space and property in these early industrial communities. To provide for the residents, a school room was built to fit up to 250 pupils during the era of Alexander and Dale, with a schoolmaster hired to instruct child employees for two hours in the evening. Between 1810 and 1845, four libraries were instituted in the village: the Public Library, New Public Library, Philosophical Library (1825), and a fourth library for the Catrine Mills' Sabbath school.²⁸² Only one of these was directly connected to and financed by the mills, the first three being publicly accessible via subscription, but their formation would have been directly in response to the growth of the village as a result of industry. The Public Library would later be housed within the A. M. Brown Institute building. Alexander Marshal Brown, a partner in James Finlay & Co., donated £2000 for the founding of the Institute as a gift to the village in celebration of Queen Victoria's Diamond Jubilee. The building was to provide employees of the mills and other residents of Catrine facilities for self-improvement in the form of recreational activities such as reading and billiards (*Glasgow Herald*, 1898),²⁸³ another, diluted variant on the 'moral' community-building ideal experimented with at New Lanark that was itself a key feature within the locational decision-making around the rural watermills.

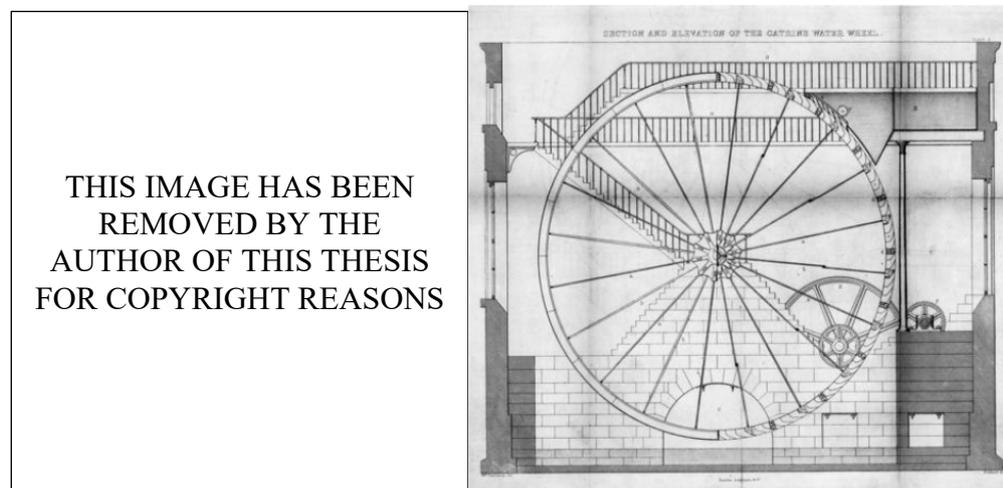


Figure 5. 26. Photograph of Fairbairn's Catrine wheels (unknown date) and technical drawing of one of the wheels (1860) (Ayrshire History, 2022b).²⁸⁴

²⁸¹ Catrine village register, 1863. Records of James Finlay & Co, Catrine, Deanston, production records. University of Glasgow Archives & Special Collections. GB 248 UGD 091/1/5/2/8/1.

²⁸² *NSA*, Sorn, Ayrshire, Vol. 5, 1845

²⁸³ Letter book, 1897. Records of James Finlay & Co, Catrine, Deanston, production records. University of Glasgow Archives & Special Collections. GB 248 UGD 091/1/5/2/10/2.

²⁸⁴ Trove.scot image reference: SC 976636 (Scanned image of photographic copy of technical drawing of water wheel). Reproduced courtesy of Historic Environment Scotland.

5.5.5 Successes and failures

One measure of the success of the mills was the growth of the local population. As already signalled, from a hamlet of two houses, Catrine expanded into a thriving village of 1,601 people in 1793 through to a peak that was nearing 3,000 in 1837. There was a slight loss of population in the final years of the eighteenth century, with only 1,350 residents in 1797, a decline reported to have been common among many manufacturing settlements (McLaren, 2005). Firms were experiencing issues with trading during this period due to the war with France, one of the consequences of which was a blockade against the import of goods from Britain and India into continental Europe (Crouzet, 1964; McLaren, 2015). Dale did not desire to discharge workers from the mills, but the weekly wages of those at Catrine as well as New Lanark were causing a financial strain during a period of difficulty.

While locating in Ayrshire provided a scenic location, good water supply, and an estate large enough for expansion and locating the cotton production and bleaching processes together, there were downsides. For one, raw materials and finished goods had to be transported to and from the main market at Glasgow at an expense. In 1845 the cost of cartage was between 5*d* and 6*d* per ton per mile. Given that the mills produced 61,958 pounds of goods that year, the cost of cartage would have been substantial (*The Standard*, 1845). By 1895 the cartage from Catrine to Mauchline alone was costing James Finlay & Co. between £1,100 and £1,200 yearly (*Glasgow Herald*, 1895c). The creation of a Bleaching Works helped to lower costs of transportation as cloth could be bleached on site (previously it had to be sent elsewhere for bleaching and then returned for finishing). Goods from all three of James Finlay & Co.'s mills came to be bleached here, making it a good financial investment for the company. According to Catrine's Local History Group, the issue of high transport costs persisted into the twentieth century. Combined with a lack of public financial support for the textiles industry that was needed but not received, the 'New Mill' was forced to close in 1968, just 18 years after it had opened (Dalziel *et al.*, 1987). The properties that were once natural advantages for the site became irrelevant compared to technological advances of the late-nineteenth and early-twentieth centuries.

The location of the mills also impacted the ability to hire workers. As already noted, following the passing of the 1833 Factory Act, children under the age of nine were not permitted to work in factories and those between nine and 13 were limited to working eight hours per day, rising to a maximum of twelve hours for those 13 to 18 (UK Parliament,

2022). This legislation created a complication for mill owners as it was inconvenient to employ different workers for different time periods. It resulted in a reduction in the number of children under 13 employed in many mills across Britain (Nardinelli, 1980: 743), but it was reported that in rural manufacturing villages such as Catrine there was less change in workforce demographics because they were more reliant on the local population already employed in their factories, being less capable, compared to urban mills, of quickly recruiting new employees (*Leeds Mercury*, 1837). The task of attracting and retaining sufficient skilled workers being an issue encountered in the two previous case studies of New Lanark and Deanston as well.

Despite these challenges, Catrine Mills successfully gained a reputation both in Britain and abroad not only for the high quality of the goods produced, but also for the management style and treatment of workers. Reverend George Gordon held Alexander in high esteem, describing him as a ‘spirited and truly patriotic gentleman’ who strove to ‘give every encouragement to the sober and industrious’ while discharging those that did not meet the company’s expected standards.²⁸⁵ Forty years later, Catrine was spoken of on a par with New Lanark in terms of the benevolence of the proprietors and the promotion of welfare for employees. The prominent member of the cooperative and communitarian movement in Liverpool, John Finch, wrote in a correspondence for the *North Star* (1838) that he had ‘no hesitation in declaring that the work people of Catrine, New Lanark, and similar establishments, form some of the healthiest, happiest, and most moral communities in the World’. Unfortunately, a healthy workforce could not guarantee financial success, especially during national downturns in trade. Correspondence between two of the company partners states that neither Catrine nor Deanston were producing profit by 1881, although problems were seemingly less severe at Catrine than at Deanston. At the latter mill, as recorded above, the managers were struggling to appoint sufficient hands to keep the machinery in continuous operation, a difficulty not mentioned as an issue at Catrine at the time.²⁸⁶

The managers and owners made a considerable investment of time and finances into improving the mills. As noted, Buchanan travelled to Manchester in 1824 to meet with the

²⁸⁵ *OSA*, Sorn, Ayrshire, Vol. 20, 1798: 180.

²⁸⁶ Minute of agreement between Archibald Buchanan and John Muir, 1881. Records of James Finlay & Co, Catrine, Deanston, production records. University of Glasgow Archives & Special Collections. GB 248 UGD 091/1/5/2/7/2/2.

leading engineer of the time, Fairbairn (Fairbairn and Pole, 1877). This initial consultation was followed by several conversations before Fairbairn was even invited to Catrine, where he then spent two weeks surveying the existing motive power at the mills and devising improvements. Buchanan accepted not only Fairbairn's proposals for the waterwheels, but also his suggestions regarding alterations to the water courses so that further wheels could potentially be added in future. In taking these suggestions, he, and the rest of the management within the firm, were evidently considering the longevity of the mills, investing in the future to allow for potential increases in machinery and greater power requirements. Thus, the mills should never have needed to rely on steam for power, since plans were laid – even if they ultimately failed – to enable continuing operation of a water-powered works in the location occupied since the later eighteenth century. Fairbairn described his time working on the Catrine wheels and with Buchanan as 'one of the most interesting and most gratifying circumstances I ever experienced in the whole of my professional career' (Fairbairn and Pole, 1877: 123).

With water being the primary source of motive power it would have been important to monitor water levels and weather. The detailed meteorological registers maintained at Catrine suggest that this task is something that the managers took seriously, noting down air temperature, atmospheric pressure, wind direction, and a description of the general conditions.²⁸⁷ An additional column for remarks preserved a record of significant events nationally or at the mills, such as the funeral of a manager or a flood and whether it resulted in a pause to the operation of the mills. There is evidence of these meteorological registers being kept from at least the 1830s, but it is not certain if records were maintained throughout Catrine Mills' entire history.²⁸⁸

Fairbairn had indeed believed that his wheels would remove the need for a steam engine, but a sales advertisement of 1844 said there were two 45 hp steam engines that needed to be used for up to four months of the year to compensate for loss of waterpower during dry seasons. In 1845, moreover, the works were consuming 4,000 tons of coal annually (*The Standard*, 1845). Further to this, the accounts of 1825 list that a steam engine had been purchased for

²⁸⁷ See Chapter 3, Figure 3.14 for an image of the meteorological register.

²⁸⁸ Detailed record books from 1898 to 1939 are held at University of Glasgow Archives & Special Collections (GB 248 UGD 091/1/5/2/8/3) and a reproduction from the 1830s appears in the new statistical accounts for Scotland. For Deanston, record books survive for waterflow, temperature, and air pressure from 1831.

£1,382 4s 1d for the Catrine Bleachworks.²⁸⁹ Water was evidently considered suitable for cotton machinery at that time, while the management apparently felt steam was needed for the bleaching processes. By the mid-twentieth century, the second of the two artificial reservoirs was no longer in use, although Glenbuck Loch continued to store water for power generation in Catrine village (Hume, 1969).

Most of the mills' buildings experienced closure and demolition in the 1960s through to 1980s. The old mill, which had closed in 1960, burnt down in May 1963, the same year that the twist mill was demolished (Abbey, 2010). The only major industrial building that remains now is that of the former Bleaching Works. Ayr County Council, who were interested in purchasing the works, valued them at £15,600.²⁹⁰ Many of the properties in the village had already been transferred to the County Council by this time. Since 1974 the former Bleaching Works has acted as the Glen Catrine Bonded Warehouse where bottling and blending of spirits for the Loch Lomond Distillers takes place (Scotch Whisky, 2022).

5.6 Ballindalloch

5.6.1 Location and water supply

The third Scottish mill associated with James Finlay and Co. was Ballindalloch Mill. Ballindalloch took its name from the estate on which it was located, the Ballindalloch estate situated next to the historic village of Balfron at the southern tip of Loch Lomond. Prior to its life as an industrial location, Balfron was an ecclesiastical site with a church and clachan from the medieval period (Stirling Council, 2014). Its name is believed to mean either the Town on the Burns, after the town's original location at the confluence of two streams, or the Town of Mourning, in reference to a story of local children being attacked by wolves.²⁹¹ The name Balfron also applied to the parish bordered by the parishes of Killearn, Drymen, and Kippen, approximately 24 km from Glasgow, Dumbarton, and Stirling (Figure 5.27). Reverend Alexander Niven described Balfron's location as 'commanding, and extremely

²⁸⁹ Balance book, Catrine Bleaching Works, 1823-1867. Records of James Finlay & Co, Catrine, Deanston, production records. University of Glasgow Archives & Special Collections. GB 248 UGD 091/1/5/2/1/2/1.

²⁹⁰ Sale of property, 1968-1971. Records of James Finlay & Co, Catrine, Deanston, production records. University of Glasgow Archives & Special Collections. GB 248 UGD 091/1/5/2/7/2/9.

²⁹¹ Ordnance Survey, 25 Inch to the mile, Ayrshire XXIX.10 (Revised: 1895, Published: 1896). View online: <https://maps.nls.uk/view/82867815>. Reproduced courtesy of the National Library of Scotland.

beautiful’ due to its surroundings in the River Endrick valley with the mountains of the Grampians and Cowal in the distance.²⁹²



Figure 5. 27. Parishes of the county of Stirlingshire.

The Endrick Water, an upland rural catchment with an area of 219.9 km² (UKCEH, 2022a), its source in the parish of St Ninians, and emptying into Loch Lomond, was – indeed, still is – the only substantial water source in the parish. The climate in the late-eighteenth century was described as ‘wet but not unhealthy’ and the region continues to receive high levels of rainfall in the present day (Figure 5.28).²⁹³ Ballindalloch Mill was constructed on the banks of the Endrick and water was directed to the wheel via a lade. Due to seasonal inconsistency in the water levels, a reservoir of 33 Scotch acres (0.17 km²) was created around 1810 in Dundaff Moor.²⁹⁴ Details of the construction or funding are unknown and the original reservoir no longer exists due to the reconstruction of the area for the Carron Valley Reservoir in the 1930s (Stirling Archives, 2016). However, it is known to have been located near to the ruins of Sir John De Graham’s castle (Figure 5.28).

²⁹² *NSA*, Balfiron, County of Stirling, Vol. 8, 1845: 289.

²⁹³ *OSA*, Balfiron, County of Stirling, Vol. 17, 1796: 530.

²⁹⁴ *NSA*, Balfiron, County of Stirling, Vol. V8, 1845: 293.

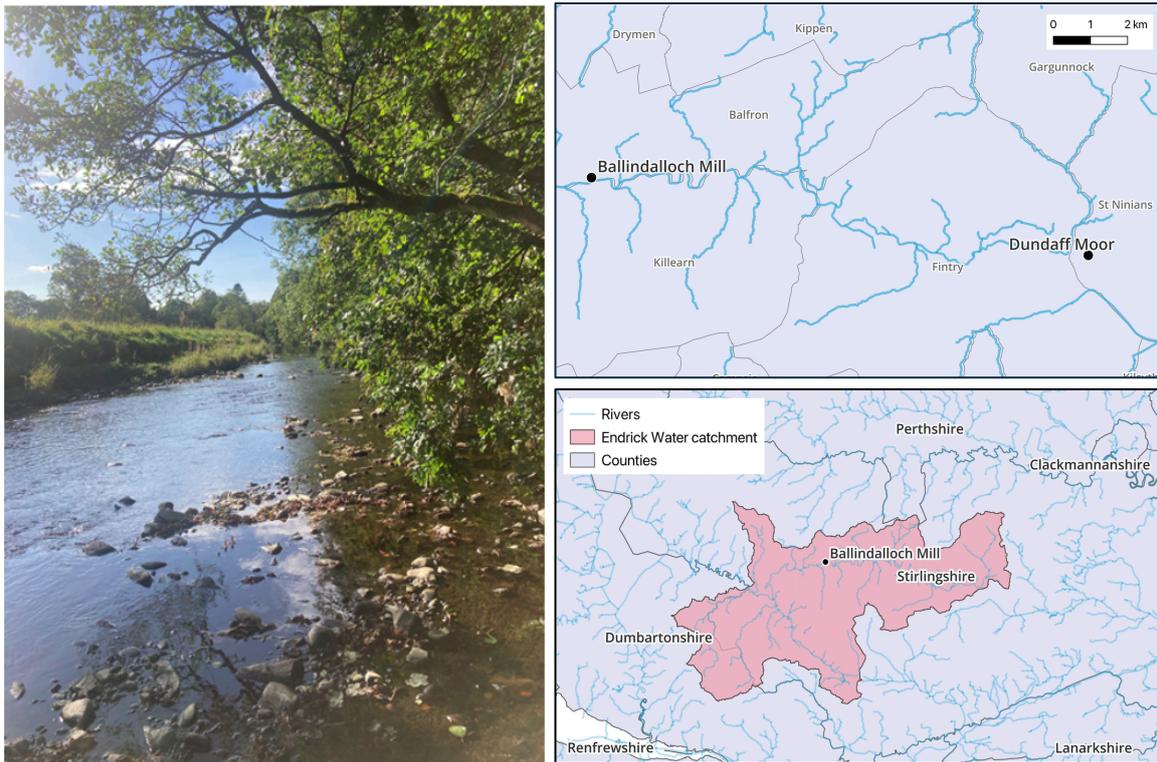


Figure 5. 28. Endrick Water at Ballindalloch (left); approximate location of the Dundaff Moor reservoir (top right) and catchment boundary of the Endrick Water (bottom right)

5.6.2 Local economy and population demographics

Until the late-eighteenth century, roads in the parish were incredibly poor and verging on unpassable in the winter.²⁹⁵ It was not until the 1790s, after the mill's construction, that improvements were made to infrastructure in the village. The market held in Balfroun attracted people from the surrounding parishes, giving farmers the opportunity to trade.²⁹⁶ Peat and turf were plentiful in Balfroun and hence were the principal fuels used by residents when roads were poor and nothing else could be obtained. After road improvements, coal could be transported from Campsie and Baldernock, none having been successfully found in the parish itself.

Prior to the establishment of the mill, the first industry of note was cotton weaving. In 1780 Robert Dunmore, who would later set up the Ballindalloch Mill, established calico manufacturing and funded and arranged the building of houses near the parish church for

²⁹⁵ OSA, Balfroun, County of Stirling, Vol. 17, 1796.

²⁹⁶ OSA, Killearn, County of Stirling, Vol. 16, 1795.

cotton weavers.²⁹⁷ The number of domestic looms in the village of Balfroon was in the range of 300 to 400 by the mid-nineteenth century, producing light jaconets and lawns and harnesses, and, although the parish minister described the weavers as hard-working, it was, as with elsewhere in the country, not a profitable employment.²⁹⁸ Before this, residents were engaged purely in farming work using practices described as rudimentary. The state of agriculture was blamed on the poverty of the farmers, the small size of their holdings, and the aforementioned poor quality of roads. In the view of the local minister, the size of farms along with absent proprietors continued to hold back advances in agricultural techniques here until into the nineteenth century.²⁹⁹ The introduction of manufactures resulted in a substantial growth in the local population. In 1755 the population of Balfroon parish was just 755 people.³⁰⁰ This number was said to fluctuate over the following 40 years before increasing greatly after Ballindalloch Mill was built, at which point there were 1,381 residents, 930 of whom were new settlers to the region.³⁰¹ By the year 1841 the village of Ballindalloch was home to 1,793 souls, whereas there had been just six or seven families prior to Dunmore's actions.³⁰²

Despite its rural location, Ballindalloch was not the only mill on this stretch of the Endrick nor the only textile mill (Figure 5.29). Two miles east of Ballindalloch was Cowden Mill on the southern bank of the Endrick. The date of construction is not known, but it was listed as a lint mill in 1772 and was used for breaking and scotching flax before later being repurposed as a grain mill.³⁰³ In the mid-nineteenth century, a purpose built water-powered sawmill was constructed next to the old disused Cowden Mill building.³⁰⁴ Balfroon's neighbouring parish of Killearn possessed two woollen mills on the Endrick, one near to the Pots of Gartness fall and another in the northern part of the parish (Smith, 1896). Fintry, five miles to the west and again on the Endrick Water, boasted a six-storey, five-bay, cotton spinning and weaving mill called Culcreuch Mill, with a 60 hp waterwheel and 60 hp auxiliary steam engine (Figure 5.30).³⁰⁵ Culcreuch Mill operated until the 1860s (Fintry Museum, 2021).

²⁹⁷ *OSA*, Balfroon, County of Stirling, Vol. 17, 1796; *NSA*, Balfroon, County of Stirling, Vol. V8, 1845.

²⁹⁸ *NSA*, Balfroon, County of Stirling, Vol. V8, 1845.

²⁹⁹ *NSA*, Balfroon, County of Stirling, Vol. V8, 1845.

³⁰⁰ *OSA*, Balfroon, County of Stirling, Vol. 17, 1796.

³⁰¹ *OSA*, Balfroon, County of Stirling, Vol. 17, 1796.

³⁰² *OSA*, Killearn, County of Stirling, Vol. 16, 1795; *NSA*, Balfroon, County of Stirling, Vol. V8, 1845.

³⁰³ NRHE ID: 128358 (Cowden Saw).

³⁰⁴ NRHE ID: 128357 (Cowden Saw Mill).

³⁰⁵ NRHE ID: 159738 (Fintry, Culcreuch Mill); OS Name Books - Stirling county - Volume 13 - Parish of Fintry - 1858-1861, OS1/32/13/7.



Figure 5. 29. Mills near to Balfour.³⁰⁶



Figure 5. 30. Culcreuch Mill in 1862 with mill lade taking water to/from the Endrick Water.³⁰⁷

5.6.3 Ownership and management

Ballindalloch was owned and operated under multiple companies during its lifespan (Table 5.8). As stated, the mill was founded by Robert Dunmore of Kelvinside (Figure 5.31).³⁰⁸

³⁰⁶ Background layer: OS Six-Inch 1st edition, 1843–1882.

³⁰⁷ Ordnance Survey, 25 Inch to the mile, Stirlingshire XXI.4 (Fintry) (Surveyed: 1861, Published 1862). View online: <https://maps.nls.uk/view/74983326>. Reproduced courtesy of the National Library of Scotland.

³⁰⁸ The *NSA* of Balfour claims that Dunmore ‘formed a connection with the Buchananas of Carstone... and with these gentlemen...he built the cotton-mill’ (*NSA*, Balfour, County of Stirling, Vol. V8, 1845: 293). This statement by the Rev. Alexander Niven, differs from that of the minister, Mr James Jeffrey, in the *OSA*. Jeffrey’s account was written while Dunmore was still in possession of the Mill and no other contemporary or secondary sources were found to corroborate Niven’s statement so in this thesis it is assumed to be correct that Dunmore founded the mill alone. The connection with the Buchananas arose when Archibald Buchanan joined Ballindalloch as manager under James Finlay & Co., as was mentioned in the Deanston case study.

Born in 1744 in Glasgow, Dunmore was the youngest of seven children (Stephen, 2009). His father, Thomas Dunmore, made his riches in the Virginia tobacco trade and used part of this money to build their Kelvinside Mansion. Like his father, Robert was a wealthy businessman with investments in the tobacco and sugar industries. His business ventures connected him directly to plantations and slavery across the Atlantic, and the multiple funds to which he subscribed included a fund by Planters and Merchants concerned in the Island of Jamaica to raise a Regiment for the island (*General Evening Post*, 1779; *Legacies of British Slavery*, 2025a). Dunmore Jr was also a partner in the cotton mills in Spinningdale, the final case study in this chapter, and at Duntocher, as well as being a shareholder in numerous corporations – many also with imperial and colonial trading connections – including: Robert Dunmore and Co., West India merchants; Dunmore, Blackburn and Co., tobacco merchants; Richard Marshall and Co., West India merchants; Ropework Manufactory of Glasgow; Port Glasgow Sugar House; Glasgow Bottlework Co.; Dalnottar Iron Co.; Muirkirk Iron Co.; Pollockshaws Printfield Co.; and Inkle Manufactory (Devine, 1978; Shaw, 1984). Dunmore also partnered with a Mr John Monteith to establish the Endrick Printworks opposite the Cotton Mill.

Table 5. 8. Ownership of Ballindalloch Cotton Mill.

Owner	Approximate Dates
Robert Dunmore	1790–1798
James Finlay & Co.	1798–1844
Robert Jeffrey & Sons	1844–1880
J. M. Dawson	1880–1894
Unknown	1894–1898



Figure 5. 31. Robert Dunmore of Kelvinside, 1744 –1799. Merchant in Glasgow (National Galleries Scotland, 2022).

As the available archival records for the mill only cover the period of ownership by James Finlay & Co., with nothing from earlier years, we can only infer the reasons behind its existence. It is possible that Dunmore’s desire to promote textiles in the village and build a mill was inspired by his father’s business ventures and experience with the manufacturing and processing of fabrics. The location was clearly well suited for a textiles mill, meeting numerous predicted criteria of classic industrial location theories. Land was plentiful as Dunmore had purchased the Ballindalloch estate and also gained the adjacent estate of Ballikinrain through his marriage to Janet Napier (Stephen, 2009). Although rural, the site was not prohibitively far from the market and port of Glasgow and there was a river passing through the estates, complete with generous water rights described in the title deeds to the mill in c.1808:

the said Robert Dunmore hereby gives grants and dispones to the said vassals and their foresaids all benefit and privilege of the water and water courses leading to Ballindalloch Cotton work and Mill and liberty to take off all or any part of the water of Endrick by the present Dam and lade (In the said Robert Dunmore’s power to give) and to make such improvements and repairs on the dam water gate and mill lade, by widening, or otherwise as to the said vassals or their foresaid.³⁰⁹

³⁰⁹ Title deeds, Ballindalloch, c1808. Records of James Finlay & Co, Catrine, Deanston, production records. University of Glasgow Archives & Special Collections. GB 248 UGD 091/1/5/2/7/2/1.

Dunmore's actions and character received a positive reception from the parish reverend and he seemingly gained a favourable local reputation.³¹⁰ Two years after founding Ballindalloch, Dunmore was recorded as a shareholder in the Balnoe Company's Spinningdale Mill, a highly risky financial venture in part to provide employment for displaced communities from the Highlands, as will be covered in this chapter's final case study.

Ownership of the mill was transferred to James Finlay & Co. in 1798 (Brogan, 1951). Kirkman Finlay (1772–1842), son of the company's founder James Finlay (1727-1790), was in charge at this point in time and Ballindalloch was to be the first of the company's three Scottish cottons mills (all three of which feature in this chapter).³¹¹ The motivation behind the purchase of the mill by James Finlay & Co. was evidently part of a strategy of expansion for the firm. The firm had already been exporting cotton goods to continental Europe since the 1750s and decided to extend the business by producing their own goods as well (Brogan, 1951). Subsequently, James Finlay & Co.'s three mills were placed up for sale following Kirkman's death in 1844, but only Ballindalloch found a buyer, Catrine and Deanston remaining with the company until their final closures in the 1960s.

Ballindalloch was purchased by Robert Jeffrey & Sons (also referred to as W. and A. Jeffrey).³¹² The Jeffrey family's connection with textiles began two generations earlier with James Jeffrey, a linen manufacturer in Fife. James' son, Robert, went into cotton manufacturing in Lawnmarket, Edinburgh, and his sons continued the manufacturing tradition. William and Andrew Jeffrey took on the Ballindalloch Mill, while Robert Jr married the daughter of the founder of Govan Dyeworks, and John Jeffrey, the other son, ran a linen works in Kirkcaldy (Ludin Links, 2015; Glasgow Museums Art Donors, 2021). William and Andrew Jeffrey were in charge of the Ballindalloch Works. Andrew lived on Buchanan Street in Balfron so would most likely have overseen the running of the mill on behalf of the family firm (Glasgow Museums Art Donors, 2021). The mill was advertised for sale again in 1880 and Robert Jeffrey & Sons cotton spinners, were no longer listed in the Glasgow Post Office Directories from 1881. Little is known of the mill's final 18 years other

³¹⁰ *OSA*, Killearn, Stirling, Vol. 16, 1795: 116.

³¹¹ James Finlay & Co. is discussed in greater detail in the descriptions of Catrine and Deanston.

³¹² OS Name Books – Stirlingshire - Volume 04 - Parish of Balfron, 1858-1861, OS1/32/4: 44.

than that it was in the possession of J. M. Dawson of Balfron in 1894 who had used it as a 'Making up Factory' (*Glasgow Herald*, 1894b).³¹³

5.6.4 Buildings and facilities

The mill building varied from one to six storeys in height and ten bays across (Figure 5.32).³¹⁴ This building was able to house 10,752 mule spindles. The machinery was initially powered by a 28 feet (8.5 m) diameter waterwheel, providing approximately 30–35 hp. A steam engine was installed as a back-up power source for use during drier seasons, reflecting the concurrent use of power sources that enabled mills to remain operational in their original riverine locations, but it was far less powerful than the wheel at only 16 hp (*Glasgow Herald*, 1844c). This engine was not mentioned in the Stirlingshire OSNB, suggesting that it may have been removed prior to the survey taking place.³¹⁵

Ballindalloch can be considered a planned village because of the facilities that were provided alongside the introduction of industry. Workers at the mill had the opportunity to rent a house with garden. These were sizable properties, some of them three storeys, and with up to ¼ of an acre of land, while 105 new houses were constructed in the village as a direct result of the mill.³¹⁶ In addition to housing, improvements were made to the village's infrastructure in the 1790s. A bridge over the Endrick was placed at Ballindalloch, and two turnpike roads were constructed offering connections to Glasgow.³¹⁷ There was also a two-storey school building with a teacher provided by the mill to educate the child workers.³¹⁸

³¹³ Leiper (1995: 124) suggests the mill was purchased by Sir Archibald Orr-Ewing of Ballikinrain in 1893 but it has not been possible to find the source of this or other corroborating sources.

³¹⁴ OS Name Books - Stirlingshire - Volume 04 - Parish of Balfron - 1858-1861, OS1/32/4: 44.

³¹⁵ OS Name Books - Stirlingshire - Volume 04 - Parish of Balfron - 1858-1861, OS1/32/4: 44.

³¹⁶ *OSA*, Balfron, County of Stirling, Vol. 17, 1796.

³¹⁷ *OSA*, Balfron, County of Stirling, Vol. 17, 1796.

³¹⁸ OS Name Books - Stirlingshire - Volume 04 - Parish of Balfron - 1858-1861, OS1/32/4: 44.

THIS IMAGE HAS BEEN REMOVED BY THE AUTHOR OF THIS THESIS
FOR COPYRIGHT REASONS

Figure 5. 32. Photograph of Ballindalloch Mill (Balfron Community, 2025).

Opposite the cotton mill, a print field and bleachfield were established on the southern bank of the Endrick in 1792 (Figure 5.33). Although technically located in the adjoining parish of Killearn, most of the workers lived in Balfron, many of them on Printers' Row. A significant investment was put into the furnishing and protection of these works including the construction of a levee to protect the 15 acre bleachfield from flooding by the river. Dunmore was involved in this venture too but a separate company, Messrs Monteith, Warren, and Company of Glasgow,³¹⁹ operated the business. The Endrick Print Field had 250 employees, more than double the workers at the cotton mill at that time.³²⁰ Printing and bleaching started in June of 1793 using 16 printing presses and 72 tables for block-printing, all the equipment being new and state of the art. The *NSA* states that by September of that same year, however, trade was so poor that the works were stagnant, a problem compounded by the unmanageable distance from coal according to Alexander Niven, minister for Balfron parish.³²¹

³¹⁹ Also referred to as Messrs John Monteith and Company.

³²⁰ *OSA*, Killearn, County of Stirling, Vol. 16, 1795.

³²¹ *NSA*, Balfron, County of Stirling, Vol. V8, 1845: 288-302.

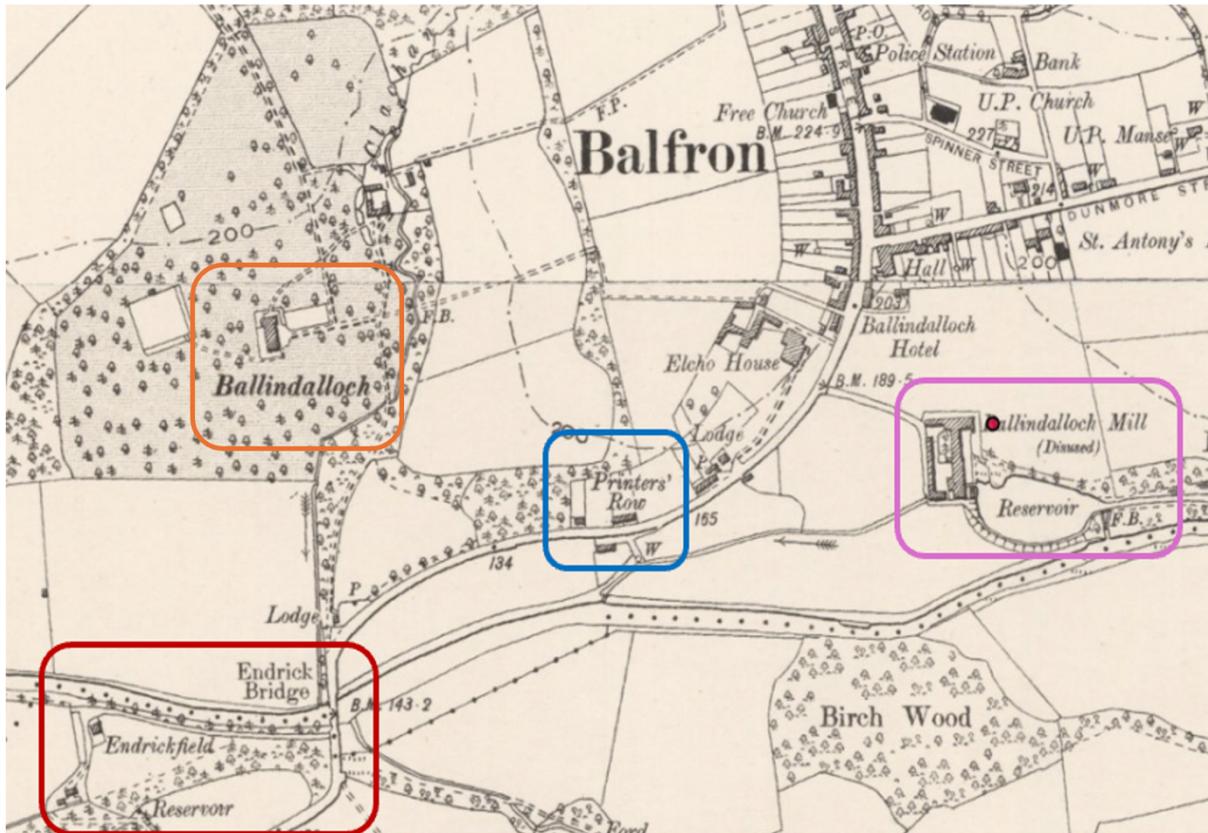


Figure 5. 33. The village of Balfroun depicted on the 2nd edition OS map showing the locations of the former print field (red), Ballindalloch house (orange), Printers' Row (blue), and the disused Ballindalloch Mill (purple).³²²

5.6.5 Successes and failures

Ballindalloch had the initial advantage of having a heritor of the land that was not only the proprietor of the mill but also resident in the parish. Therefore, Dunmore had an interest and motivation to improve the communications and agriculture of the parish. A key success was Dunmore's ability to view the construction of neighbouring mills not as a threat but as an opportunity to collaborate to achieve his goals regarding improvements. Dunmore hence joined with Peter Spiers, owner of Culcruech Mill, to upgrade the toll road between Fintry and Lennoxton, allowing faster transportation of goods from both mills to Glasgow (Fintry Museum, 2021). Dunmore unfortunately suffered bankruptcy in 1793, only three years after founding Ballindalloch Mill (Stephen, 2009), coinciding with a period of economic difficulty nationally, in part a consequence of the French Revolution. Dunmore's assets, which totalled in excess of £60,000, were sequestered and the majority of his properties sold (Devine,

³²² Background layer: OS Six-Inch 2nd edition, 1882-1913. Reproduced courtesy of the National Library of Scotland.

1978). The printing and bleaching works suffered too during this period, but it was the distance from a supply of coal that is said to have ultimately resulted in the closure.³²³ Despite purchasing the site of the Endrick Print Works along with the cotton mill, James Finlay & Co. did not make use of the land.

Kirkman Finlay was an astute businessman and politician, taking up, among others, the roles of Lord Provost, MP for Glasgow burghs, and founder of the Glasgow East India Association (Clough, 2004). The mill should have been in good hands under Kirkman's watch. It is unclear, however, how much direct involvement Kirkman actually had in the day-to-day running of his mills. For example, Symes (1997) poses the question of whether or not Kirkman was responsible for the issuing or the withdrawal of the 'Ballindalloch notes'. These Ballindalloch notes were issued to workers for their wages between 1826 and 1830 when there was a scarcity of coin money in Scotland. Yet Kirkman is quoted in 1826 telling the House of Commons Committee on Promissory notes that he had heard of such a system but felt it to be 'very unsound', so it is possible that he was unaware that such currency was in use in his own mills (Symes, 1997). This seeming lack of awareness implies that the company's director might indeed have held a minimal interest in Ballindalloch (Hodge, 2020).

Fortunately, though, James Finlay & Co. appointed knowledgeable and inventive staff to manage the mill. Under the management of Archibald Buchanan – previously founding partner of Deanston and afterwards manager at Catrine, as already explained – cost-cutting measures were successfully adopted at Ballindalloch. Buchanan refitted the mill with new mule jennies that were lighter and could be operated solely by young women. Women received lower wages than men and were also claimed to adapt better to the discipline of a mill in terms of tidiness and following direction. When Buchanan moved on to manage Catrine Mills in Ayrshire, he implemented the same system there.³²⁴

It is unclear whether or not there were issues with water supply at the site. The installation of a steam engine indicates that water was unreliable during drier periods of the year, and in the wetter seasons the mill could also have been at risk from the same flooding that threatened

³²³ *NSA*, Balfour, County of Stirling, Vol. V8, 1845.

³²⁴ *NSA*, County of Lanark, Vol. 6, 1845.

the bleach field, although the former was seemingly not an issue for nearby Culcreuch Mill, which also relied on the Endrick Water, where the steam engine was seldom required. Peter Speirs, the owner of Culcreuch, informed a surveyor from the Ordnance Survey that his mill had been forced to stop production due to lack of water for merely ten hours in the twelve months prior to their visit.³²⁵ Ballindalloch nonetheless persisted as a site of water-powered industry for approximately a century, albeit with partial assistance from steam in the first half of the nineteenth century. However, the mill became less desirable as time passed, reflected by the diminishing sale and rent values that it attracted. In 1880 Robert Jeffrey & Sons put the mill up for sale with an asking price of £7,000, and the mill was likely sold to a J. M. Dawson because the next mention in the press appears in March 1894, once again for sale, as part of Dawson's sequestered estate. The price had been reduced significantly from the previous sale to just £800 for the mill and the fixed machinery within the building 'to induce competition' (*Glasgow Herald*, 1894a). The following month a new auction date had been set (*Glasgow Herald*, 1894b). This time, only £250 was asked for the mill buildings, cottages, and land. A year later in August 1895 the mill was advertised as to let, still remaining unoccupied by October of that year (*Glasgow Herald*, 1895a). The 'powerful water wheel, extensive water rights, and liberty to draw of all or any part of water from river Endrick; ground 4 ½ acres' were insufficient to entice a tenant to give Ballindalloch a final lease of life (*Glasgow Herald*, 1895b). In 1898 the mill building was demolished entirely and within a decade a sewage works had been placed on the site, which has remained the land use here ever since.

5.7 Spinningdale

5.7.1 Location and water supply

The final cotton mill explored in this chapter left a far smaller trace on the industry. By this point in the chapter, many of the actors will be familiar names. Spinningdale Mill, built in 1792, was located on the north side of the Dornoch Firth, in the county of Sutherland on the northeast coast of Scotland (Figure 5.34).³²⁶ The mill here was located within the large

³²⁵ OS Name Books - Stirling county - Volume 13 - Parish of Fintry - 1858-61, OS1/32/13/7.

³²⁶ The modern spelling of Spinningdale is a coincidence rather than a result of the industry established there. The settlement was called *Spanigidill* in 1464, a name with elements of Norse influence (Fraser, 1986: 30).

administrative parish of Creich,³²⁷ near to the border of neighbouring parish Dornoch. The first reference to settlement in Dornoch dates from the early-twelfth century and by the thirteenth century the site held enough importance for a cathedral to be established there (Coleman *et al.*, 2008). The area held significance in the early-Middle Ages, the River Kyle being three miles wide at this point, acting as a natural boundary between Ross and Sutherland, and also between Norse and Celts in northern Scotland (Fraser, 1986; Coleman *et al.*, 2008).



Figure 5. 34. Parishes of the county of Sutherland

The local climate here in the late-eighteenth century was described as temperate, dry, and good, but the weather was still regularly damp enough to be well suited to textile production (McCullough, 2016).³²⁸ This was an important climatic condition because brittle cotton threads were best processed at high levels of humidity to reduce the risk of them breaking. Spinningdale Mill was sited within the Dornoch Coastal catchment area, which includes 15 natural water bodies (SEPA, 2010). One of these is Loch Migdale, a lake with an area of 1.01 km² and 6,572,283 m³ volume (UKCEH, 2022b). From the eastern end of Loch Migdale

³²⁷ Spelt Crieich in eighteenth and nineteenth century in sources such as the Ordnance Survey and *Statistical Account*.

³²⁸ *OSA*, Crieich, Sutherland, Vol. 8, 1973.

flows what became known as the Spinningdale Burn. The burn travels 2.7 km, initially in an eastern and then a southern direction, before reaching Spinningdale and its confluence with the Dornoch Firth.³²⁹ It was water from this burn that was harnessed as the motive power for the cotton mill.

5.7.2 Local economy and population demographics

The *OSA* for Creich and Dornoch stated that in the 1790s roads in the region were poor though passable.³³⁰ The Reverend George Rainy placed the blame for the lack of investment in transportation routes on the fact that so few of the heritors actually lived within the county (in contrast to the previous case study where Dunmore resided near Ballindalloch and invested heavily in the parish). One later commentator would describe the situation as ‘simply deplorable’ (Stewart, 1881: 76), but the area did possess redeeming features. Although the location was far more remote than that occupied by any of the other larger, successful, cotton mills, discussed in this chapter, its proximity to the coast would have offered good access to ports. The Firth was navigable for up to 39 kilometres by small vessels and vessels of up to 50 tons burden could have reached Spinningdale via the harbour in the Dornoch Firth to deliver raw materials and transport finished goods. The Meikle Ferry also provided for communication and trade across the Dornoch Firth, linking the eastern portion of Ross and Cromarty with Sutherland (Mackintosh, 2022).

The nearest market town to Spinningdale, Dornoch, was in the neighbouring parish of Dornoch. Prior to the completion of Spinningdale Mill, the only form of manufacturing in Creich was the spinning of flax yarn. This was undertaken through a putting-out system and women could earn up to *5d* daily, although usually the amount was much less. Dornoch possessed two whisky distilleries and there was also some flax spinning. Similarly, in the parish of Creich, the flax business was conducted on a small scale and spun by women in the home. Wages for labourers were comparatively low here in relation to the Lowlands. A male day labourer was estimated to earn *6d* to *8d* per day and during harvest women took home *5d* a day. For fuel, good quality coal was hard to come by locally, the best available coals having to be shipped from Newcastle and sold at Dornoch for *1s 10d* to *2s* per barrel in the 1840s.³³¹ Less than a third of the land was cultivated in the early-1790s. Soils in the parish allowed for

³²⁹ OS Name Books - Sutherland county - Volume 6 - Parish of Criech - 1871-1875, OS1/33/6/1: 115.

³³⁰ *OSA*, Criech, Sutherland, Vol. 8, 1973; *OSA*, Dornoch, Sutherland, Vol. 8, 1793.

³³¹ *NSA*, Dornoch, Sutherland, Vol. 15, 1845.

the growing of wheat, barley, oats, and peas towards the banks of the Kyle.³³² The hills and their valleys may have held potential for further cultivation but had not yet been exploited.

Gaelic was the main language spoken by the population, although many people spoke English too because of the introduction of schools and outsiders entering the region. A lack of economic opportunities locally resulted in regular temporary migration out of the area. Young women relocated south to enter into domestic service and many young men would migrate south in spring and summer to work as agricultural labourers, returning in the winter and relying on their friends and relations until the next harvest season. It has been suggested that it was easier for people in the south-west areas of the Highlands, who were closer to the Lowland areas of developing industry, to permanently relocate than it was for those displaced in Sutherland to move and find stable employment (Bangor-Jones, 2002). Further north, it was more challenging for the population to adjust to changing agricultural policies. In the 1790s, out of a total population of 2230 for the parishes of Dornoch and Creich there were approximately 150 paupers. No relief fund was available to those in need, supposedly leading to the regular occurrence of petty crime.³³³ It was perhaps these paupers that George Dempster described as having a ‘wretched appearance’.³³⁴ Speaking of the character of the people, Reverend John Bethune felt that he could not call them industrious due to the lack of work in the region, but he still thought that they were quiet, tenacious, frugal, and, ‘under proper direction and encouragement, might be employed in manufactures with advantage to themselves and to the country’.³³⁵

The remoteness of the location gave the advantage of there being very few other mills in the surrounding area to compete for water resources. This also removed any need for collaboration and cooperation between mill owners. At the time that Sutherland was surveyed by the Ordnance Survey in 1874 there were only three mills in the entire parish of Creich (Figure 5.35). Migdale Mill, sited north of the Migdale Loch, operated as a corn mill from the early-nineteenth century until the 1950s with a 3 m diameter waterwheel (Hume, 1976; Farrell, 2002). A second corn mill was recorded 0.3 km east from Loch Migdale, measuring 7 m by 4 m, was one story in height, and was powered by a small vertical wheel.³³⁶ A

³³² *OSA*, Criech, Sutherland, Vol. 8, 1973.

³³³ *OSA*, Criech, Sutherland, Vol. 8, 1973.

³³⁴ *OSA*, Criech, Sutherland, Vol. 8, 1973: 376.

³³⁵ Bethune quoted in *OSA*, Dornoch, Sutherland, Vol. 8, 1793: 16.

³³⁶ NRHE ID: 91385 (Spinningdale Burn).

threshing mill was also depicted on the maps, appearing to be in use and fed by a lade that diverted water from the Spinningdale Burn (Figure 5.36). The age of these last two mills is not known.³³⁷ Given their size, though, it is unlikely that they would have caused problems for Spinningdale Mill, even if they had been in operation at the same time.

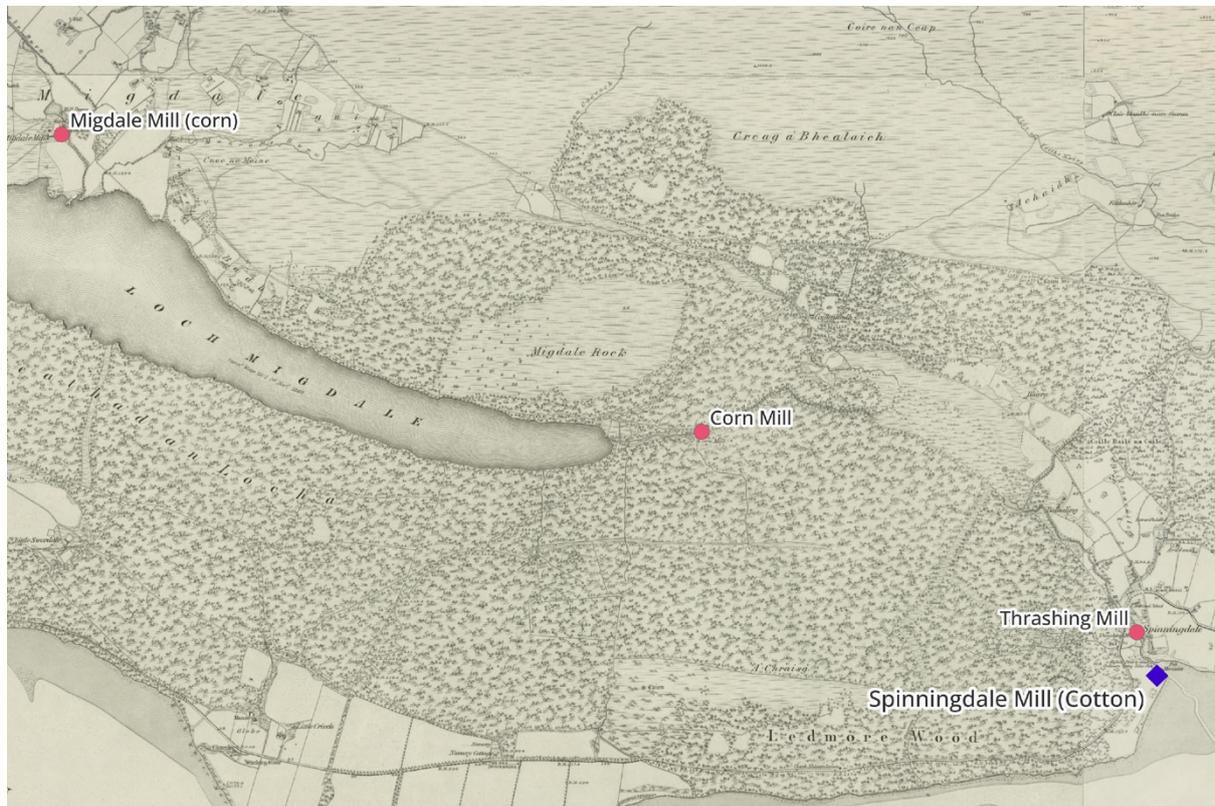


Figure 5. 35. Spinningdale Cotton Mill (blue diamond) and other pre-nineteenth century mills (pink circles).³³⁸

³³⁷ Unfortunately, earlier mapping is not helpful in determining the timeline of features such as these in Sutherland as the Roy map does not name settlements and other pre OS maps are of too small a scale (Higgins and Johnston, 2010).

³³⁸ Displayed on the OS Six-Inch 1st edition, surveyed 1868-73.

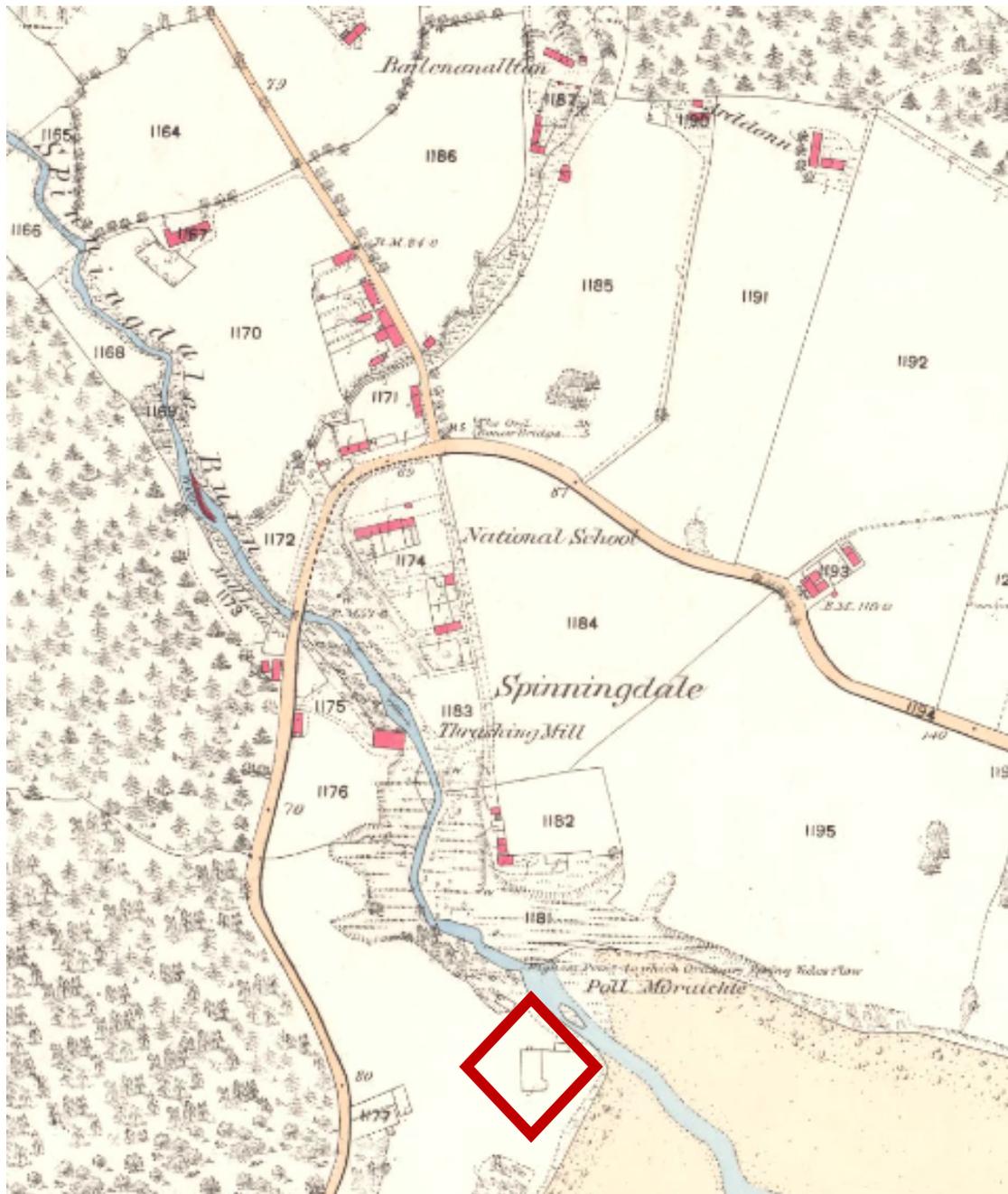


Figure 5. 36. Spinningdale Burn passing through Spinning village in 1874. A red diamond marks the site of the ruins of Spinningdale Cotton Mill.³³⁹

5.7.3 Ownership and management

The idea to construct a water-powered cotton mill at Spinningdale was the idea of one of New Lanark's original investors, already introduced, Sir George Dempster of Dunnichen

³³⁹ Ordnance Survey, 25 Inch to the mile, Sutherland CXI.4 (Criech) (Surveyed: 1874, Published: 1874). View online: <https://maps.nls.uk/view/75115524>. Reproduced courtesy of the National Library of Scotland.

(1732–1818). The son of a wealthy merchant from Dundee, Dempster was studying for the bar at Edinburgh University when, at the age of 23, he inherited his family's estates of around 6,000 acres (24 km²), worth approximately £769 per year (Lang, 1998; Evans, 2005). Although the death of his father cut short Dempster's studies as he had to fulfil familial responsibilities, his years at university and acquaintances made there were formative in his later goals of improvement. Dempster's imagination was said to have been ignited during a Grand Tour in Europe with fellow law student and, later on, renowned philosopher of the Scottish Enlightenment, Adam Fergusson (Evans, 2005). Afterwards, Dempster had the chance to be regularly exposed to the latest debates within the Enlightenment movement at the Poker Club of Scotland where he met with fellow members and intellectual giants of their age Adam Smith and David Hume. Dempster also corresponded with Sir John Sinclair, the first president of the Board of Agriculture and creator of the *Statistical Accounts of Scotland*.³⁴⁰ A further significant encounter occurred between Dempster and Richard Arkwright, who has surfaced throughout this chapter, in Matlock, Derbyshire, during a visit to the region in 1783. The pair met again soon after in London where Arkwright offered his support to Dempster in establishing and training the staff for a cotton mill in Scotland (Lang, 1998), which would manifest in 1785 as the New Lanark Mills (discussed earlier) and a second cotton mill in Perthshire, Stanley Mills (Turner, 1957b: 124)

After his retirement from parliament in 1790, Dempster dedicated himself to putting his beliefs into action, particularly at his estates of Dunnichen (Forfarshire) and Skibo (Sutherland). For many landlords and the factors advising them, sheep farming was looked upon negatively as it was a risky enterprise compared to cattle farming or other sources of income (Banjor-Jones, 2002), whereas surveys conducted by both the Board of Commissioners for the Annexed Estates and the Board of Trustees for Manufactures, Fisheries and Improvements suggested untapped potential for manufactures in the Highlands, leading to increased interest in investment in the area. Meanwhile, The Highland Society of Edinburgh was founded in 1784, the same year that John Knox's *A View of the British Empire* was published. In this report Knox recommended the building of fishing villages, suggesting that investment in the Scottish Highlands would provide greater returns than investing money in the American colonies (Lang, 1998).

³⁴⁰ The Poker Club of Scotland was a social club for the literati of Edinburgh formed in 1762. In contrast to Scotland's more formal societies, the Poker Club was a space for drinking as well as for political discussion (Cheape, 2001; Carr, 2008).

Although Dempster agreed that change in the Highlands was unavoidable, he was troubled by the forced movement of people under the so-called ‘Clearances’, in favour of the more profitable sheep farming (Cooke, 1995: 89). Dempster considered it possible to stop emigration through the development of agricultural practices and industry, as well as by the building of villages.³⁴¹ He also believed that the people of the Highlands should play an active role in the management of their own land, something he trialled by giving his tenants the security of lifelong leases and the formation of a Feuars’ Committee for Letham village (Lang, 1998).

Along with his half-brother, Captain John Hamilton Dempster, George aimed to bring industry to their jointly owned estates in Sutherland. He had purchased the Skibo estate in July 1786 via auction, at a cost of £11,500. Three years later he added the adjoining estate, Pulrossie, followed by Over-Skibo in 1796 (Lang, 1998), giving an overall estate of approximately 18,000 acres (73 km²) with which to enact his schemes. The Dempster brothers possessed insufficient capital to erect a mill by themselves, so required investors to turn the vision into reality. Dempster invited George Macintosh (a colleague of David Dale in Glasgow) to visit the land along the Dornoch Firth where the mill was planned (Evans, 2005).³⁴² Macintosh, originally from the Highlands himself, would make an ideal partner in the venture given his 30 years of experience in the textile industry, including management of a Gaelic-speaking workforce at his cudbear Dye Works in Glasgow (Withers, 1998).

In order to finance the mill, the Balnoe Company was created, with 30 shares available, valued at £100 each. The Company successfully attracted investments from 19 individuals, four of whom held two shares, leaving seven shares vacant (Table 5.9), and in 1792 the inaugural meeting of the Balnoe Company was held.³⁴³ The majority of the shareholders acted as silent partners in business, having very little or no involvement with the day-to-day running of the mill. The Balnoe Company joined together landed gentlemen with merchants, and their combined finances, political influence, and knowledge of textile production and markets offered great potential for success.

³⁴¹ *OSA*, Criech, Sutherland, Vol. 8, 1973.

³⁴² See Appendix 1 for biographies.

³⁴³ *OSA*, Criech, Sutherland, Vol. 8, 1973: 383.

Table 5. 9. Opening shareholders in the Balnoe Company.

Partner	Shares	Profile
Mr David Dale of Glasgow	2 x £100	Merchant and cotton master involved with mills at New Lanark, Catrine, Blantyre, Kilmore, Newton Stewart, Stanley, Rothesay. Established Britain's first turkey-red dyeworks with George Macintosh (Butt, 2006).
Mr George Macintosh of Glasgow	2 x £100	Glasgow dyer, partner in George Macintosh and Co, Glasgow's first chemical works. The son of a tenant farmer in Ross-shire (Cooke, 1995; Grace's Guide, 2012). Also spelt McIntosh.
Mr William Robertson of Glasgow	£100	Related to James and Andrew Robertson. Glaswegian merchants who owned estates in the West Indies, managed the Smithfield Iron Co. and the Glasgow Arms Bank (Quinton, 2020).
Mr James Robertson of Glasgow	£100	Related to Andrew and William Robertson.
Mr Andrew Robertson of Glasgow	£100	Related to William and James Robertson.
Mr Robert Dunmore of Glasgow	£100	A tobacco lord. Owner of Ballindalloch Mill, Duntocher Mill, and a print field in Pollockshaws in Glasgow.
Mr Robert Bogle of Baldowie, of Glasgow	£100	Robert Bogle junior, of Daldowie, son of merchant Robert Bogle. Bogle was a partner in a London mercantile firm that failed in 1772, then a partner in a cotton estate in Grenada (Legacies of British Slavery database, 2025b).
Mr Robert Mackie of Glasgow	£100	A West Indies merchant (Evans, 2005).
Mr William Gillespie of Glasgow	£100	Further details unknown
Mr John Mackenzie of London	£100	This may have been John Mackenzie, Esq. of the Temple, honorary Secretary of the Highland Society of London (Fairney, 2018).
Mr Dugald Gilchrist of Hospidale	£100	Owner of 150 acres of land in Hospidale to the west of Skibo (Henderson, 1815).
Mr William Monro of Achanny	£100	Adjoining landowner to Dempster's estate (Evans, 2005).
Mr John Fraser, factor to Lord Gower	£100	Dempster's factor at Skibo.
Mr Benjamin Ross of Tain.	£100	Lived in Tain, south of the Dornoch Firth. Merchant and first agent for the British Linen Company Bank's Tain branch (Mackenzie, 2015).
Mr Scott of Dunninauld, M.P.	£100	Merchant and director of the East India Company (1788) and MP for Dunninauld, Forfarshire from 1790 (Cooke, 1995).
Captain James Rattray of Arthurstone	£100	A captain of East Indiamen ships. Rattray sold his last ship in 1787 and used the money to retire. On his return to Scotland James bought Arthurstone estate near Meigle in Strathmore (Filor, 2013).
Mr John Ramsay, acting manager	£100	Worked as a cotton spinner prior to his appointment as manager (Evans, 2005).
Captain J.H. Dempster of Polrossie.	2 x £100	George Dempster's half-brother.
George Dempster of Dunnichen	2 x £100	M.P. for Perth, director of the East India Company, and owner of the Skibo estate (Lang, 2022).

To the enthusiastic Dempster, the remoteness of Sutherland was not a barrier. Speaking of his nearby Skibo estate, he wrote:

... it is actually the only habitable spot in Scotland I ever was possessed of. The sea, an arm of the sea, fine sailing, fishing, river and sea, dry and warm rides - climate near the level of the sea better than any I have as yet [known] - the distance I think nothing of, the roads being good. (November 1786, quoted in Dempster *et al.*, 1934: 157)

Dempster's passion for his project is evidenced by his correspondence with his friends and in his lengthy contribution to the *OSA* of a 'plan for improving the estates of Skibo and Pulrossie' that comes close to equalling that of the main entry from the Reverend. In this account Dempster reveals his aim to replicate manufacturing structures seen in Renfrew, Perth, Angus, and Aberdeen, where weaving took place in the homes of tenants as well as in the mills themselves. For Dempster, Spinningdale was just one part of a larger plan: 'By these means, constant employment will be found for people of all ages and sexes, and a considerable market opened for the productions of the country'.³⁴⁴

His motivations may not, however, have been solely philanthropic in nature. From the 1770s a great concern for many British politicians, including Dempster, was stopping emigration to North America for fear that it would weaken the economy of Great Britain and diminish its military power by depleting resources available to the British army (Lang, 1998). There was also an air of conceit in Dempster's aims. In 1803 he wrote to Macintosh claiming that they two were the only men capable of improving the Highlands (quoted in Evans, 2005).

5.7.4 Buildings and facilities

Local carpenter and builder, James Boag of Dornoch, known also for designing churches in Sutherland, was contracted to design and build the mill (Dictionary of Scottish Architects, 2016). The mill was around half the size of its lowland counterparts, standing at four storeys in height with only six bays (Figure 5.37). The southern end had a stair bay with Palladian windows and the north featured a semi-circular heating tower.³⁴⁵ Even this remote mill of a smaller scale than the earlier case studies was a site of technological experimentation:

Dempster trialled a novel heating system at his home in Dunnichen and then at the mill, whereby the upper floors would be heated from a stove located in the base of this tower, with

³⁴⁴ Dempster quoted in *OSA*, Criech, Sutherland, Vol. 8, 1973: 377.

³⁴⁵ NRHE ID: 13845 (Spinningdale, Cotton Mill).

the air diffused through iron pipes to the rest of the building (Lang, 1998). A concrete lined lade was constructed to draw the water from the Spinningdale Burn to the wheel pit at the mill.³⁴⁶ A survey conducted in 1966 identified an engine house for a steam engine (Figure 5.37), but other accounts do not corroborate this finding and the use of a combination of hand-operated jennies (Shaw, 1984) and water-powered machinery seems more likely as the motive power for the facility.

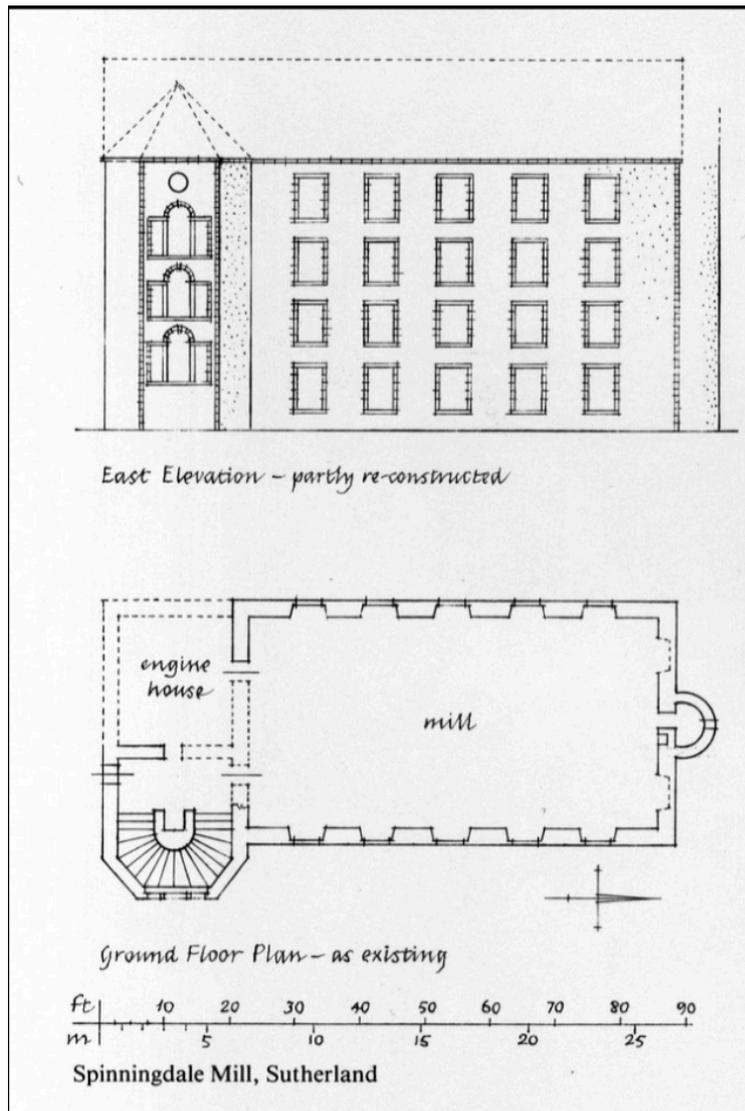


Figure 5. 37. Plan of mill building based on a survey of 1966.³⁴⁷

³⁴⁶ NRHE ID: 13845 (Spinningdale, Cotton Mill).

³⁴⁷ Trove.scot image ref: SC 346194 (East Elevation-partly re-constructed; Ground Floor Plan-as existing Drawn 1984 on basis of survey 1966. Insc. 'GDH'). Reproduced courtesy of Historic Environment Scotland.

Alongside the mill building itself, Boag oversaw the construction of two slate-roofed weaving sheds, a barrack, and ten entirely new houses for workers (Evans, 2005). The intention was for the mill to initially weave yarn transported from Glasgow on handlooms and then move onto the production of cotton weft on the spinning jennies (Cooke, 1995: 91). By 1795 the mill machinery constituted around 30 looms producing cotton handkerchiefs and 13 jennies for spinning cotton yarn. Although the quality being produced could rival that of Glasgow, the quantity simply could not do so as this equipment comprised barely half of the originally intended machinery (Evans, 2005). For the workforce, the plan was to hire trained recruits from Glasgow to work and teach local people, with 28 local apprentices initially (Evans, 2005).³⁴⁸

At its peak, Spinningdale was said to have begun a transformation into a prosperous village and the mill employed 100 hands (Anderson, 1850), but a difference between Spinningdale and the other mills founded by some of the same investors is that few resources were provided beyond the mill building itself. The planned village in this case consisted only of company built houses. A schoolhouse was not erected until 1809, three years after all manufacturing had ceased,³⁴⁹ and roads were not constructed to improve communications either. In a statement relayed in the *OSA* for Creich, Dempster acknowledged the importance of roads but stated that they were something that he thought should fall to the government to provide. There is no evidence of the mill supporting wider employment whereas the registers of the residents of Deanston, for example, records hat-makers, domestic workers, and surgeons, all living and working in the industrial village. This situation gives the impression that the partners did not make the same level of investment into Spinningdale as they did at other mills.

5.7.5 Successes and failures

Early on, prospects for Spinningdale were positive. Writing to his friend, Sir Adam Ferguson, from Skibo in September of 1792, Dempster reported that:

Our cotton mill goes on charmingly. The banks of the Kyle appear to me a paradise already highly improved and ornamented. Tradesmen's houses not yet built bestud the sides of hills and forests not yet planted are supplying in my imagination the Navy with timber and their owners with gold. (Quoted in Dempster *et al.*, 1934: 223)

³⁴⁸ *OSA*, Criech, Sutherland, Vol. 8, 1973.

³⁴⁹ OS Name Books, Sutherland county - Volume 6 - Parish of Criech - 1871-1875, OS1/33/6/1: 116.

The mill was not completed until 1794 and at a cost of £974 2s 8 ½ *d.* In total, over £3,000 was spent on buildings and machinery, exceeding the capital raised from shares. A £700 advance was sought from the Bank of Scotland's Tain branch and the business began its operations already in debt (Lang, 1998). The company accounts in March 1795 raised questions about the viability of the endeavour (Evans, 2005). As referenced earlier, the cotton trade was experiencing a dull period due to disruptions from the Napoleonic Wars (Broadberry and Gupta, 2009), the mill still only had half the machinery for which it had been designed, and the slow pace of construction meant very few goods had been produced. There was a divide between the local partners and the Glasgow investors in terms of whom they blamed. In the eyes of the distant Glasgow investors, the problem was the idleness of the local population. They were seen as ill-prepared and unwilling to learn the trade or to embrace modern industry (Evans, 2005), whereas the partners located in Sutherland believed that the mill could not succeed without more capital. These differing opinions did not endear either group to the other. There were questions over whether the business should continue, but it was decided that a sub-committee of Dale, Macintosh, and William Gillespie (who replaced Andrew Robertson after his death) should be appointed to procure a loan of £2,500 (Evans, 2005).

By 1803 Spinningdale was in deep financial trouble. The partners were unable to obtain a grant or share offer and were left with only the option of selling the mill. For some of the partners, the loss of Spinningdale coincided with a process of selling off multiple assets. Dale, for example, had recently removed himself of his mills at New Lanark and Catrine. In late-1805 Spinningdale Mill and its machinery was sold to a Mr McFarlane for a price of £2,000 to be paid over ten years (Evans, 2005). McFarlane already operated a cotton mill in Glasgow and had plans to make alterations to the work conducted at Spinningdale. His plans included hiring hands from Lanarkshire to complement the local workforce (Henderson, 1815), but only a year later a fire gutted the mill building, after which it was abandoned. A final opportunity for Spinningdale almost came to fruition in 1815 when Robert Mackid offered £2,000 for the feu of the land to start a tannery (Cooke, 1995). This endeavour did not go ahead, but suggests that industrialists continued to see a business opportunity at the site of the former cotton mill despite its previous failures.

What was the cause of the failure of Spinningdale? Unlike many other mills, there are no records of power supply being an issue. Weaving was in fact moved from nearby Balnoe to Spinningdale in 1796 because of insufficient waterpower at the first village (Lang, 1998). It might be inferred from this shift that waterpower at Spinningdale was functioning well and that the site held the potential for increased capacity. Despite Dempster's faith, Macintosh blamed the workers for the mill's misfortune. The partners had sent instructors from Glasgow to Spinningdale to train the workforce so that they might rival any other mill in skills and quality (Stewart, 1881: 80), but they struggled to recruit apprentices because the local labouring population was 'by no means industrious or fond of work' (Macintosh, quoted in Cooke, 1995: 92). The attitudes of the partners did not help the endeavour either. This extract from the *OSA* gives the impression that the mill was never expected to be a profitable undertaking:

The reader will observe, that public spirit is the motive by which most of the partners have been induced to embark their property in an undertaking which may prove highly advantageous to the Highlanders, and particularly so to the proprietors of the above and other contiguous estates; but never, probably, will prove so profitable to the other partners, as undertakings of this kind, situated more immediately under their own eye.³⁵⁰

Even the passionate Dempster and his brother had minimal interaction with the day-to-day running of the mill, leaving that mostly to their manager, Ramsay. For example, in 1803, Dempster made just two visits to Spinningdale (Evans, 2005). He may have retired from political life, but he still had his mill at Stanley, his family and home at Dunnichen, and the planned village at Lethan to juggle alongside Spinningdale. Dempster was troubled by the financial difficulties at Stanley Mills, which were worsened by a fire gutting the newly built flax processing mill in 1799. Despite his initial enthusiasm, it was Dale, and especially Macintosh that stayed committed to Spinningdale Mill the longest, but they too had other investments demanding their attention.

After the closure of the mill, the population of the village either relocated elsewhere or remained in the region as subsistence farmers (Lockhart, 2012: 22). The venture could therefore be considered a failure as both a business and a social project. Although data on migration from the region is limited, there is no evidence to suggest that the introduction of this industry or other forms of improvement projects had any significant impact on the

³⁵⁰ *OSA*, Criech, Sutherland, Vol. 8, 1973: 382.

movement of people in and out of southeast Sutherland (Houston, 1986). By the time of the OS map, surveyed in 1871–1881, the township of Spinningdale still existed but over a fifth of the 27 buildings were depicted unroofed, abandoned.³⁵¹ A small settlement still exists today and the remains of the mill itself, pictured in Figure 5.38, were assigned the status of a Scheduled Monument in 1999,³⁵² described in its Statement of National Importance as ‘an attractive landmark on the South Sutherland Coast’ (HES, 2015). The topic of the ‘afterlives’ of mill sites will be returned to at the end of Chapter 6.



Figure 5. 38. Ruins of Spinningdale Mill c.2001 (Littlewood, 2013).

5.8 Conclusion

This chapter has presented in-depth micro-histories of six cotton spinning mills that opened in Scotland during the late-eighteenth century. Through examining the physical surroundings of the mills and the existing economic and demographic situations of the local areas, the

³⁵¹ NRHE ID: 91129 (Spinningdale).

³⁵² Scheduling of a monument or archaeological site provides statutory protection as per the Ancient Monuments and Archaeological Areas Act 1979. A site may be scheduled if deemed to be of national importance. Consent is required to carry out works to scheduled monuments thus offering some protection to the site.

chapter has shown that mills often did not meet the criterion of expected production factors for industrial location. All were set up in rural areas, bar Rothesay, which was not a particularly large urban centre either, and, although the countryside did often have some form of complementary pre-existing ‘proto-industry’, the local population was rarely sufficient to sustain the required workforce. These mills placed themselves at a relative disadvantage compared to the commercial centres such as Glasgow in terms of their access to transportation for materials and goods, including coal for both possible conversion to steam power and also other purposes. The driving force of the mill industrialists and financiers has also emerged as an important commonality in this chapter, the same names appear repeatedly across the six examples, with further connections at the other mills they owned across the country. What is indicated by these micro-histories is that even though mills might be remote from the centres of economic activity and wider civic progress, these entrepreneurial figures were clearly intelligent, learned, and well-networked. They were individuals, and firms making industrial location decisions with respect to their mills – and sometimes an adjacent planned villages – in a highly informed manner, even if those decisions may appear flawed retrospectively. I argue that this means that the historical geography of Scotland’s watermills *did* have a logic, one that often manifested in mills staying in their original location rather than moving: a dynamic inertia.

What we can perhaps principally infer from these cases, moreover, is that the overriding locational logic was motive power in the shape of (usually) fast-flowing water. Where a new site was selected, there were impressive waterfalls or the ability to lease generous water rights, along with the land and ample room for future horizontal expansion, although this was not the case for Rothesay where a town already existed. What Rothesay boasted instead was a proven history of available and effective waterpower in the form of the King’s Mill and the old lint mill. Even when the anticipated water supply proved insufficient in later years, however, these mills persisted in their often quite remote rural or island locations. Having already sunk capital costs into buildings and machinery, invested in engineering the landscape (often in collaboration with others), created skilled local labour, and vertically integrated production with the addition of machine-making and finishing works, there was a strong pull to stay in place. Further conclusions will follow in the next chapter, amplifying the brief conclusions offered here, wherein a synthesis is provided of key themes emerging from this and the earlier chapters of this thesis.

6. I am loath to change my mill: Trajectories of Scottish watermills

6.1 Introduction

This chapter builds upon the preceding literature review and two empirical chapters, drawing upon and elaborating themes that have emerged along the way. The chapter's content is divided into four main sections. The first two of these correspond with the theories of industrial location and aspects of diffusion that were introduced in Chapter 2. Specifically, I question the manner in which mills have shaped the development of transportation infrastructure or whether the advent of private roads, canals, and railways reformed the locational geography of mills. A second dimension of the land component of industrial location is discussed: energy. A brief analysis of the availability and practicalities of water and steam power use in the late-eighteenth to early-twentieth century is given with a discussion of what the purported energy transition in this period looked like and whether a transition was ever fully completed.

The remainder of the chapter explores themes closer to the factors of production of capital and labour. Focussing primarily on the 61 actors encountered in Chapter 5, but also drawing on the literature introduced earlier in the thesis, the characteristics of the 'mill industrialist' or 'entrepreneur' are discussed in section 6.3. The economic and social origins of these people are categorised: it is seen whether the cotton mill entrepreneurs had a background in textiles or whether this was an industry that others could enter with enough social and financial capital. The volatility and regular changeover of partnerships is explored and visualised, and I further examine and visualise the connections between this network of mills that were touched upon in Chapter 5. Section 6.4 considers mills as places of collaboration, contestation, experimentation, and control, drawing primarily on the case studies in the previous chapter. Examples of disputes between mill owners and other parties (rival mill owners or otherwise) are given in 6.4.1, in relation to water rights and other conflicts, and the legal/institutional framework governing the mills, questioning whether such conflicts and the need to cooperate with others was reason enough for mills to stay, relocate, shut down, or substantially alter their operations. Section 6.4.2 explores the various mechanisms for moral and social order in the mill community and whether geographical location facilitated paternalistic discipline and control. In the final section (6.5), I explore the 'afterlives' of mills

and their place in present-day Scotland, outlining current watermill numbers and the different institutional protections afforded to post-industrial sites. The different fates that have befallen the case studies from Chapter 5 are discussed, ranging from restoration or commodification for tourism to ruination, as are the ways that custodians of mills are addressing the challenging sides of their history as places situated within the global networks of the British Empire.

6.2 Industrial location

6.2.1 Transport

Despite the natural benefits found in rural locations, including water and plentiful space to construct a mill and its associated artificial landscapes, the spatial isolation of these places was an economic disadvantage. When the owners of Deanston Cotton Mills stated that coal was too expensive, it was implicitly a comment on the cost of carriage due to location. The best physical sites for water-powered mills also tended to be far from the markets for raw materials and finished goods. To reiterate what has been shown in the previous two chapters, mills were placed almost everywhere in Scotland. Grain mills especially were found in all inhabited regions and even industries such as cotton, reliant on importing raw materials and exporting finished goods, often opted to locate inland, far from the ports. Ballindalloch Cotton Mill in Balfour was comparatively close to commercial centres at just 29 km from both Glasgow and Stirling, versus 40 km for Lanark to Glasgow, or the 68 km separating Spinningdale from Inverness. Yet distance was still thought to have brought an end to the various manufactures in Balfour and the Endrick valley region due to the great expense of moving goods. When such costs were too high, from a purely financial perspective, it eventually offset the value of a renewable ‘free’ power source and may therefore have prompted the closure of mills and possibly even relocation of the enterprise (possibly encouraging locations nearer to urban centres and adoption of steam rather than waterpower).

It might therefore be expected that transport would have a controlling influence on mill location, but this was not entirely true of the Scottish mill. Interestingly, as noted in Chapter 4, isolation likely delayed the modernisation and therefore encouraged the survival of horizontal grain mills on Scotland’s northern islands, while poor road infrastructure may in

fact have been what kept them going (Collie, 2009). These small simple mills were still used by some of the country's most remote populations into the twentieth century, when improved road transportation permitted easier access to a larger, centralised mill, a clear instance of industrial and locational inertia – these mills survived largely because of customs and traditions and a lack of a perceived need to alter the existing situation. This was a fairly unique case, however, and outside of grain milling, or for any mill with a wider target market, geographical isolation was a threat to the viability of a mill and hence required purposeful, strategically considered decisions to close, move, or stay put.

According to theories of industrial location outlined in Chapter 2, the provision of transport is expected to influence the growth and distribution of economic activities, although causality between transport and location of industry can be debated upon examination of specific historic examples. Here I will consider how transport developed in Scotland and whether industry really did follow. The creation of better quality roads in Scotland was in the first instance a response to changes to agricultural systems rather than industry. As the population gradually moved away from subsistence crop farming, agricultural goods needed to be taken to markets for cash. This encouraged the construction of turnpike roads. These turnpikes, for which a fee was charged in exchange for passage, gained popularity in Scotland more slowly than in England. When a Parliamentary Act for a turnpike road for the County of Edinburgh was passed in 1713, turnpikes trusts had already been adopted south of the border in small numbers for half a century (Day, 2003). Despite requiring Parliamentary approval, turnpike roads were private, unsystematic endeavours. Existing roads were improved and new routes created according to the priority of the landowner providing the finance or the judge approving the Turnpike Act (Silver, 1987). Routes through estates that possessed high-value mineral deposits or roads that the judge would use themselves were more likely to go ahead, while physical legacies of past economic policy, in the form of enclosure walls, made certain routes impossible to construct (Silver, 1987: 142). Consequently, in the earlier years of the eighteenth century roads near urban or industrialising areas remained unimproved if they were far from the estates of the 'improving' landowners (Silver, 1987: 148). The importance of connectivity for Scotland's economic growth was nonetheless eventually recognised and some large civic improvement schemes were introduced in the second half of the eighteenth century. Investment was predominantly directed to the central region of the country, however, associated with projects such as the construction of the New Town of Edinburgh in the 1760s, deepening of the River Clyde to make it navigable up to the city of Glasgow, and

the construction of canals (Hamilton, 1963). Thus, much of the country remained poorly served into the nineteenth century.

The canal system in England was central to the take-off of steam but did not have as strong an effect in Scotland. Canals certainly had an influence on industry but not to the same extent as in England simply because the size of the networks in terms of distance covered and towns served were so vastly different. At the peak period of ‘canal mania’, Britain’s inland waterway network reached over 8,000 km (~5,000 miles), carrying up to 30 million tonnes of goods annually (Canal & River Trust, 2023) and almost every major city and town in England had a canal (Kaaristo, 2024). However, very little of this network was constructed in Scotland and, unlike in England, the canals did not develop into an interlinking network (Figure 6.1).³⁵³ In 1907 there were merely four stretches of canal and two stretches of navigable river in Scotland capable of transporting goods, totalling 290 km (180 miles) (H.M.S.O, 1907). Similar to canals, Scotland’s rail network was also far less substantial in comparison to England. The figure of 1,591 km (989 miles) of railway available in Scotland in 1851 can be compared to the approximately 8,607 km (5,348 miles) of railway for England and Wales combined in 1851 (Shaw-Taylor and You, 2018: 20).³⁵⁴ Considering that Scotland accounted for around a third of the landmass of Great Britain, it was clearly under-represented in the rail network. Consequently, many Scottish mills long remained reliant on costly horse and cart transport.

It was hoped that canals would alleviate some of the issues facing industry in towns. Edinburgh was one such place expected to benefit from the water supply and reduced costs of transporting goods. Contemporaries had previously been surprised by the lack of industry in Scotland’s capital. As one commentator remarked in the *Caledonian Mercury* in 1824 (the year that the Union Canal was completed):

It has long been matter of surprise that almost the whole of the manufactories of this country, especially such as are considered its staples, should have hitherto been carried on at a distance from the capital. For it is manifest that a very great proportion of the home consumpt of every article of manufacture must be by the metropolis ... the only obstacles which have hitherto been thought to attach to the local situation of Edinburgh, as suited for the purpose of manufactures of this kind, are the scarcity of water and expense of fuel. Very little however of the former is required in the

³⁵³ This was due partly to Scotland’s physical geography that made canal construction more challenging and its dispersed population (McKean and Lennon, 2018: 193).

³⁵⁴ Canal and rail lengths for Scotland calculated in QGIS using the datasets listed in Chapter 3.

manufacture of cotton yarn, and the supply is now ample by means of the new Water Company, Canal, &c. and will be rendered superabundant by the projected operations on the Water of Leith.

These remarks helpfully clarify the hopes felt for waterpower for economic activity such as cotton manufacture in industrialising Scotland, as well as the consequences of different costs (and locations of) power sources. More specifically in this context, the Union Canal was anticipated to be an important link between the capital and the industrial hubs of the west of Scotland. Although the canal company's revenue was not as high as expected due to competition from railways (Cossar, 1912), there was some resultant economic growth within the engineering sector and the rubber industry (Robertson, 1958).

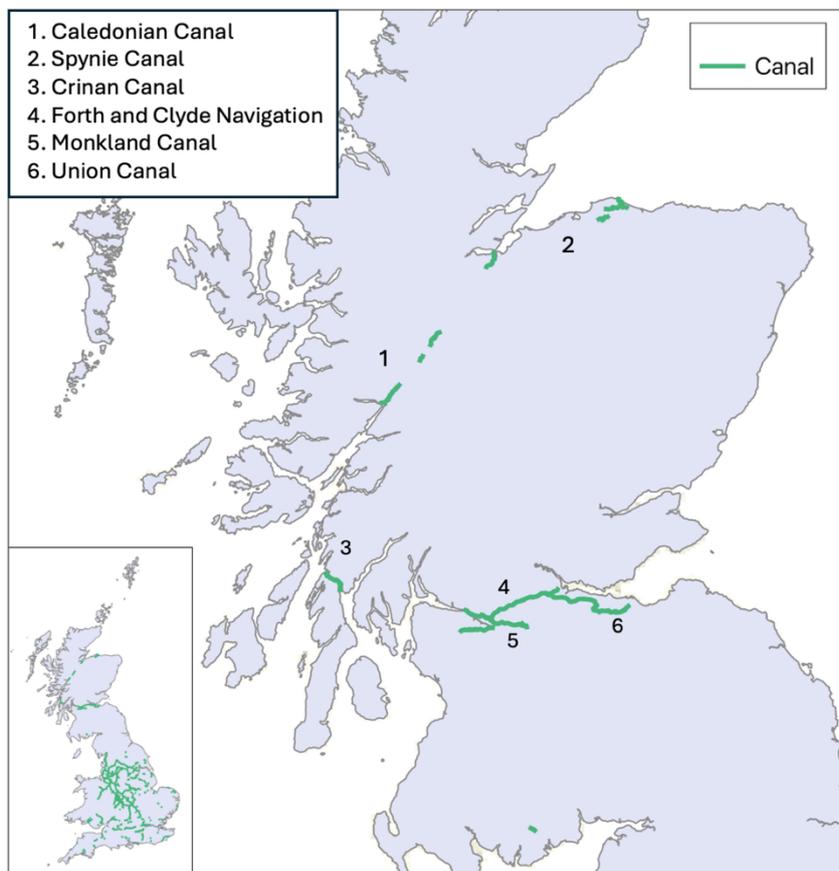


Figure 6. 1. Location of canals constructed in Scotland for the purposes of transport, industry, and drainage. Inset: canal network across Britain. The most important Scottish sections were Union Canal from Falkirk to Edinburgh, Crinan Canal linking the Sound of Jura to the Clyde Estuary, Caledonia Canal bridging Fort William and Inverness, and the Forth and Clyde and Monkland Canals that connected Glasgow with Coatbridge, Clydebank, and Grangemouth.

Elsewhere in Scotland the results were also slow and uneven. Further west of the capital at Bonnybridge in Falkirk, there was some early take up by mills of sites along the Forth and Clyde Canal, with a flour and corn mill on one side and a dyeworks on the other, both

replaced by the 1900s with foundries and chemical and gas works. More constructions appeared in close proximity to the waterway but did not directly use its water. A sawmill (previously a grain mill) just north of the canal was powered by water from the river, while a paper mill that took over the location of the previous Broomhill distillery, 250 m from the canal, sourced its water from a reservoir instead.³⁵⁵ Despite not using the canal's water for power or processing, the paper mill was ideally placed on Broomhill Road to make use of both the canal and railway for transportation, the Bonnybridge railway station being opened two years before the mill was purchased and refitted for paper, most likely an important selling point.

Other stretches of canal remained entirely devoid of mills (Figure 6.2). Along the Highland Caledonia Canal the only mills placed adjacent to the canal were on the eastern portion at Muirtown Basin, now part of Inverness, with none on the Fort William end. At some point between 1869 and 1903 (the OS survey dates), an industrial complex developed at the south eastern side of the basin comprising the Caledonian Sawing and Bobbin Mills, Glen-Albyn Distillery, Muirtown Mills (Tweed), a buoy factory, Glenmhor Distillery, and a series of goods sheds along the neighbouring stretch of canal. A separate smaller sawmill was built near the railway siding. Both the canal and railway were present in 1869 but had not yet stimulated industrial development. Crinan Canal likewise did not industrialise other than the Glengilp (or Glenfyne) distillery north of Ardrishaig, built 1831, nested between a waterfall on the Kilduskland Burn to the north and the canal to the east. However, in these cases it was never the primary intention to make the canals into hubs of manufacturing. The Caledonian Canal was designed to offer an alternative to the treacherous Pentland Firth shipping route between the Orkney Islands and Caithness (Cadell, 1923). Similarly, the Crinan Canal was constructed primarily to render journeys from the Clyde to ports in the Highlands at Oban or the Hebrides both faster and safer, offering a shortcut that reduced the distance by around two thirds and simultaneously avoided open sea. However, the 'public-spirited' landlords investing in the waterways did supposedly have an interest in developing industries in the west coast area as well as fisheries and trade (Cadell, 1923: 79).

³⁵⁵ Ordnance Survey, 25 Inch to the mile, Stirlingshire XXX.1 (Falkirk) (Surveyed: 1860, Published: 1862). View online: <https://maps.nls.uk/view/74972532>; Ordnance Survey, 25 Inch to the mile, Stirlingshire XXX.1 (Revised: 1896, Published: 1898). View online: <https://maps.nls.uk/view/82906170>. Reproduced courtesy of the National Library of Scotland.

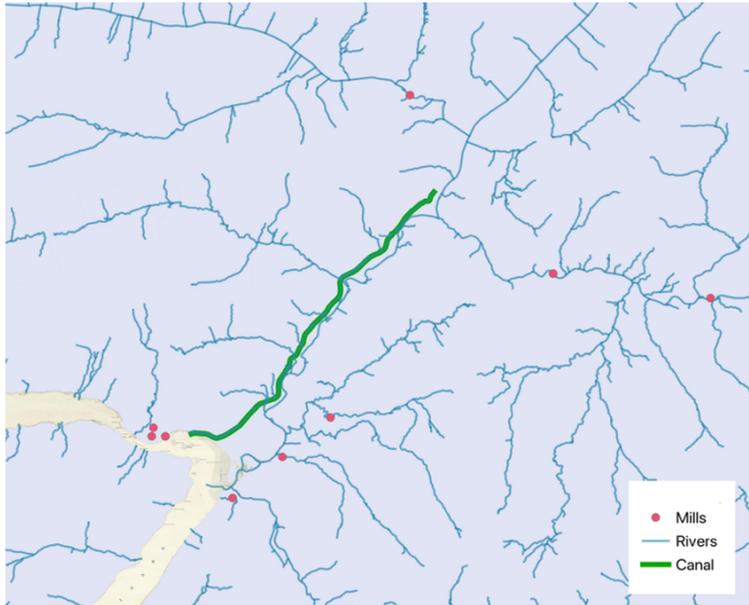


Figure 6. 2. Western portion of the Caledonian Canal from Glen Albyn to Loch Lochy.

It was predominantly the transport networks through areas with predeveloped settled regional industry that developed into hubs of concentrated activity, especially where they could be linked to onward transportation networks like ports for receiving and shipping goods. For this reason, a different outcome entirely took place on the Glasgow Branch of the Forth and Clyde Canal. Development along the Forth and Clyde and Monkton Canals was also not immediate, as documented by maps of early-nineteenth century Glasgow, such as Fleming's map surveyed c.1808 (Figure 6.3a) depicting Port Dundas surrounded by empty tree-enclosed fields. But by the 1900s an entirely different landscape had materialised and nearly every parcel of land from Temple through to St Rollox had works and associated commercial units spread across it, resulting in one of the most heavily industrialised areas of the city. This can be seen on the OS maps where more than 60 separate industries were labelled along this stretch of canal on the 1st and 2nd editions (displayed on Figure 6.3b). They tended however to be chemical and heavy industries, with chemical works, iron foundries, glass works and similar industries making up the bulk. Port Dundas became a centre for warehousing and storage of barges while the St Rollox region of the city hosted a vast chemical works (MacKenzie, 1987: 92). Placing timber basins at Port Dundas, Rockvilla, and Firhill, which was fairly easy to do by widening a sharp bend on the canal, enticed sawmills to the area by providing valuable storage space for logs (usually imported from Scandinavia) until they were processed in the mill. Furthermore, transport of logs was far easier and cheaper by water than road since the logs could be tied to form a raft and towed to mills further inland. It is no wonder that sawmills would congregate around a transportation link designed with the

carriage of goods in mind after problems were encountered elsewhere. In response to damage sustained along the River Dee in Aberdeenshire, an ‘act to prevent Damage to certain Bridges in Scotland from the floating of Timber’ (Bridges (Scotland) Act 1813, 53 Geo.3, 117) was passed in Parliament in 1813 that necessitated the use of horse and ox carts to move timber by road instead (Jenkins, 1985).

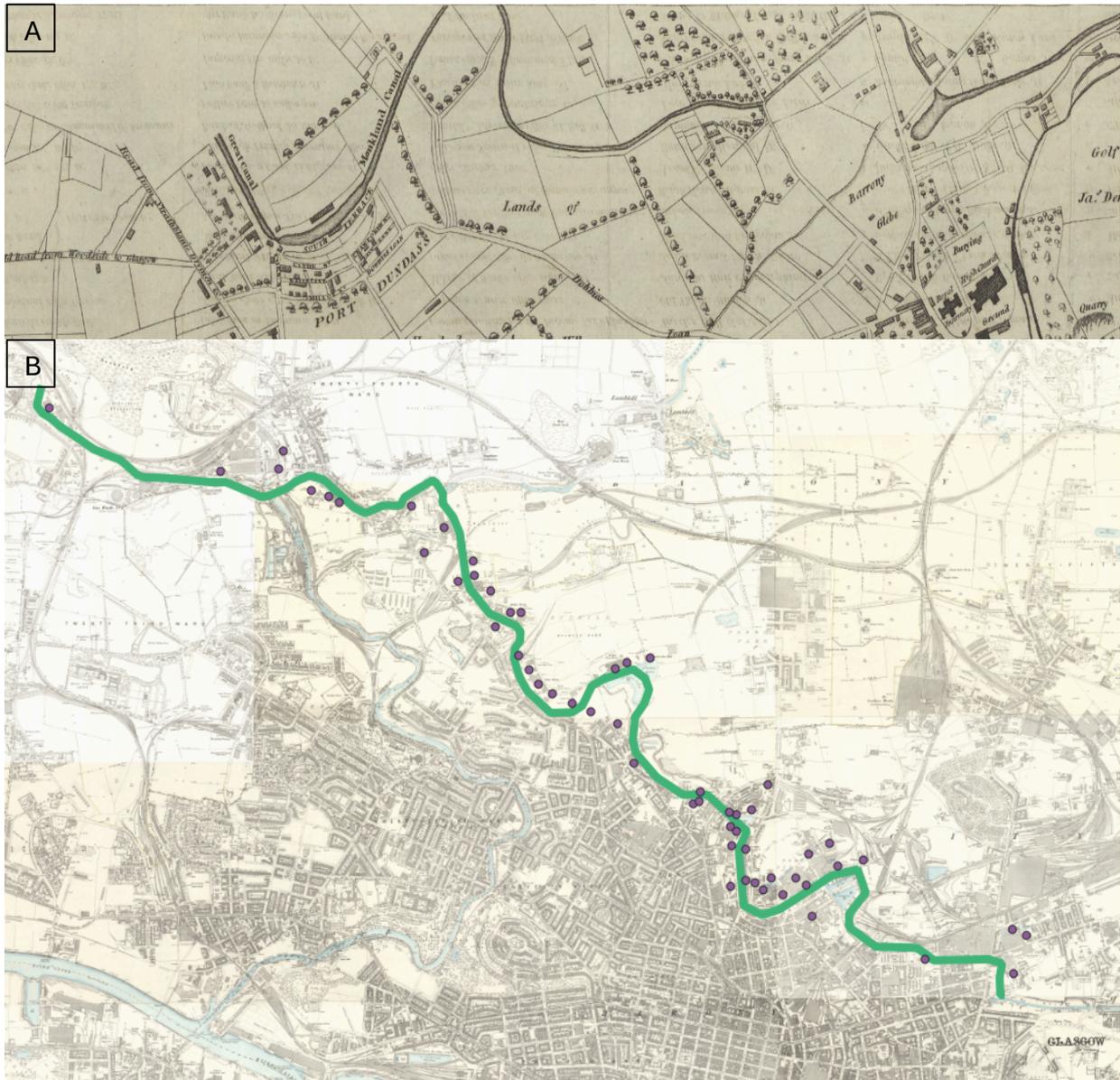


Figure 6. 3. (a: above) Map of the Port Dundas area of Glasgow c.1808 prior to industrialisation in the area and (b: below) Map of the Forth & Clyde Canal from Temple in the west to the St Rollox chemicals complex in the east. All mills and other industrial sites from c.1850 to c.1900 are marked as purple dots and the canal is represented in green.³⁵⁶

³⁵⁶ (a): Excerpt from Map of the City of Glasgow and Suburbs. Reduced from the same in six sheets from actual survey / by P. Fleming. EMS.b.1.72. View online: <https://maps.nls.uk/view/216443187>. Reproduced courtesy of the National Library of Scotland. (b): Background layer: OS 25 Inch 2nd edition, 1892-1905.

This observed underutilisation of the new transportation networks, particularly by certain sectors, may be interpreted as evidence supporting the concept of inertia in the locational geography of mills – a slowness in colonising sites adjacent to transport links; a tendency to stay put in originally occupied, even if remote, locations – and of the influential power of mills on the wider economy. A similar situation took place in the Lancashire cotton regions in England where cotton was said to have ‘dominated transport rather than being dominated by it’ (Ogden, 1927: 1576). The Lancashire cotton industry was stable, having settled to take advantage of preferable geological and climatic conditions and could not be persuaded to move to a port location, so transportation networks and a new port developed around the industry instead (Ogden, 1927). In Scotland too, rather than move to better connected localities, the cotton mill owners gave political and financial backing to transportation infrastructure schemes improving transport to their sites rather than moving to benefit from extant transport links elsewhere. Representatives from mills were hence recorded putting forward the interests of their companies in debates and petitions for transportation. For instance, Robert Somerville was actively involved in a petition to place New Lanark on the main rail line (*Glasgow Herald*, 1882). New Lanark was not the only industrial village struggling with connectivity. Indeed, Catrine’s manager, Mr Barclay, provided a detailed account of the Cotton Mills’ situation to support the cause for a Dumfries line (*The Standard*, 1845) and half a century later Barclay’s successor, Mr Ramsay, along with Mr Morton of the Bleach Works, was still trying to persuade the Glasgow and South Western Company to provide a rail line, promising that the line would have the custom and financial support of James Finlay & Co.

Scotland’s deficit of transport was insufficient to persuade owners to give up an otherwise favourable site. A larger company especially could overcome lack of transport services in the region by arranging for their own carts to carry raw materials and finished goods between the mill and urban transport nodes. The large rural cotton mills had the resources to keep their own horses and carts to regularly send goods to Glasgow among other locations. At the far end of the spectrum these resources stretched to arranging international cargo. Kirkman Finlay, as a dual merchant-manufacturer, went so far as freighting ships to India and the 600 tonne Earl of Buckinghamshire was the first ship sailing directly from the Clyde to a port in the East Indies (Renwick *et al.*, 1921). Another anecdote involving the Finlays tells of a drastic fall in cotton prices just days after the company had ordered their agent in India to make a large purchase of raw cotton. The story goes that the company despatched an

overland express to retract the order, ‘the first (and I believe the only) overland express despatched from Glasgow to India, by a private party on commercial purposes’ (*Glasgow Herald*, 1850). While these tales might imply that regional, national, or even international transportation services were not necessary, it must be remembered that James Finlay & Co. was among the elite of the time, with far greater assets at their disposal than the average Scottish enterprise.

What these examples convey is that transport was certainly important, but its locational impact was perhaps more limited in Scotland compared to elsewhere in Britain at least. The canal system was always small and some canal corporations were driven to early closure due to competition from railways (Vamplew, 1972).³⁵⁷ The combination of improved roads, railways, and canals should have encouraged industry to flourish, as in the example of Bonnybridge, but in reality the advent of railways, instead of opening up new parts of the country, in some cases led to competition, in turn forcing existing transport links – notably canals – to be closed and some turnpike roads to have their revenues threatened (Vamplew, 1972). The mills data from Chapter 4, displayed against transportation lines (as in Figures 6.2 and 6.3) and the examples from Chapter 5 of cotton mills establishing in remote areas, and crucially, remaining in those locations, suggests that transport was not the primary influence on the location of certain industries such as textiles. On the other hand, there appears to have been a greater draw of heavy industries, such as steelworks and shipbuilding to the new transportation networks. Taking into consideration the locations of roads, canals, and railways, as well as who was funding them, we see that transportation was being brought to established industry as much as transport was encouraging new growth. The spatial distribution of mills predates the availability of good transport and, although industrialists lobbied for improvements, the lack of a modern transport network was for many mills not the main deciding factor in their locations.

³⁵⁷ Competition was so fierce that the opening of the railway between Glasgow and Edinburgh forced the Forth and Clyde and the Union canal companies to reduce their charges for the transportation of goods by around 85%. Eventually the canal came under ownership of the railway, possibly to ‘end the ruinous competition’ (Vamplew, 1972: 139).

6.2.2 Energy

6.2.2.1 Water

The study by Jonell *et al.* (2024) claims that there was no shortage of available waterpower across Scotland during the Industrial Revolution, even in basins with larger clusters of mills. However, some contemporary manufacturers had the impression that the situation was otherwise. Despite the clear evidence of systematic monitoring of hydrological conditions and mathematical calculations of river flow, the mill entrepreneur of the Industrial Revolution simply did not have the same knowledge or ability to model that is possessed by the modern researcher.³⁵⁸ Some decisions made by tribunals in response to water disputes highlight the misunderstandings of experts and parliamentary members around hydrological processes (Sheail, 1988: 228–9). Data and scientific knowledge in the mid-nineteenth century remained insufficient to accurately calculate catchment yields and suitable compensation (Sheail, 1988: 228). The perception of shortage (what a mill owner thought to be true even if based on imperfect knowledge) was thus more important than reality in many cases, potentially leading to decisions – to close or relocate mills – that may not have been strictly necessary. According to modern calculations, water utilisation reached 2–17% of its potential in Dundee and Fifeshire (Jonell *et al.*, 2024: 5) but contemporary entrepreneurs were concerned about water supply. One concerned party was Richard Neilson who wrote to James Watt in 1788 (reproduced in Boulton *et al.*, 1981: 301–2), recognising that Scotland as a whole did not suffer a want of water but that suitable sources appeared nowhere near enough for towns with existing clusters of manufacturing like Dundee:

running past our door, is the firth of River Tay, with a pretty high ebb & flow – several Methods have been talked of to make it useful in driving the machinery necessary to our manufactures M, one of which is tide Mills, another raising water from the River by pumps into Reservoirs.

At this early date in the Industrial Revolution, Neilson was discussing steam without anticipating that it would provide an overall solution to what he perceived, possibly incorrectly at that time, as insufficient water supply. Within the same correspondence, Neilson went on to ask Watt if he could recommend any literature on constructing water-powered mills and for calculating the size of fall and quantity of water.

³⁵⁸ The behavioural approach to industrial location theory introduced in 2.3.3 compares actual knowledge and capacity to process that information against a matrix of, hypothetical, optimal knowledge/capacity, to explain why actual location decisions differ from predictions according to classic theories.

Water as a resource was cheap in Scotland. In 1832 it was estimated that the average annual cost of waterpower for a mill on the Shaws Water Works at Greenock was just £3 and a similar cost of £2 10s per hp for rent of a waterfall between Dalernie Mill and the Devils Bridge.³⁵⁹ The value of waterpower lay in its reliability or, rather, the assumed capacity to render its volume and flow reliable through the provision and consistent maintenance of infrastructure in the form of reservoirs, dams, aqueducts, and sluices. However, water was important for industrial location decisions in more ways than just as a motive power. This importance is reflected in the proximity of mills to water even after the introduction of steam engines.³⁶⁰ Water would always be essential for industry, even if now it was being heated in a steam engine rather than itself being the motive force, but the different quantities and qualities required, and perceptions thereof, still dictated if it was a controlling factor of industrial location. Water for industrial processes was incredibly important too, particularly so for industries such as paper making as described in Chapter 4, for which the water needed to be clean, but if the water was being used in the boiler of a steam engine it did not need to be as pure, although there were complaints that the quality of Dundee water could be ‘hurtful’ to a steam engine’s boiler (Brown and Hume, 1980: 8). More importantly, water for use in steam power generation did not need to be flowing, therefore steam mills potentially had greater locational flexibility compared to water-powered mills. However, steam mills were not entirely free from the locational tie of needing water sources. The Forth and Clyde Canal did end up being used for water for steam engines, initiated by Messrs. Tennant, Knox and Company’s request in the early-1800s to use water from the Junction Canal (Cruickshank, 1965: 251). This was a welcome opportunity to generate further revenue by selling water rights to mill owners: the institutional control of rights over water resources maintained importance albeit for a different purpose than solely as a prime mover. A third need for water on top of motive power – whether itself or in steam generation – and as process water, was disposal of waste. The earliest legislation in Britain related to discharge of refuse into rivers dates to 1388, but even in the Victorian era environmental protection laws were limited and those that did exist were poorly enforced (Wohl, 1983: 234–251). Manufacturers insisted that disposing of waste in rivers was the only option available and that, if it were restricted, it would cause economic decline. They were so adamant that an objector to legislation told the

³⁵⁹ Anon. 1834, On the waterfall between Dalernie Mill and the Devils Bridge. Robert Thom collection, Bute Museum.

³⁶⁰ In Chapter 4.3.1.1. it was stated that 88% of the mills from the OS/Canmore dataset were located within 200 m of a watercourse.

1867 Rivers Pollution Commission that forbidding the disposal of waste from tanners in rivers would destroy the industry and render thousands unemployed (Wohl, 1983: 227).

6.2.2.2 Steam

The cliometrics study by Nuvolari *et al.* (2011) introduced in Chapter 2 confirmed that the local price of coal was a critical factor in the diffusion of steam between 1700 and 1800. Evidence presented in the Rothesay and Deanston case studies suggests that price continued to influence uptake of steam engines (and the viability of keeping a steam mill open) for manufacturing into the following century too. In weighing up the viability of utilising steam, both the price of coal at the colliery and potential further costs had to be calculated. Since land transport was most costly, the further a mill was from a source of coal, or a port at which to receive it, the greater the costs that could be expected. Costs varied wildly throughout the country. In 1832 steam power in Glasgow was said to cost £20 per hp per year³⁶¹ and the cost of operating a steam engine in a mill in Dundee was four times higher than in Glasgow (*Preston Chronicle*, 1833). The Isle of Bute obtained coal from Glasgow, priced in 1791 at 3s 6d a cart, reaching double that price by the time river dues and tonnage duty for Rothesay were factored in.³⁶²

The Dundee mills still ended up embracing steam power despite their distance from the coal mines. East Mill, a flax-spinning mill in Dundee, spent on average, £7 3s on coal in the years 1818–1819 which equated to 10 1/3 tons priced at 13s 10d per ton. East Mill purchased its coal from Alloa, 61 km distant as the crow flies but a journey of 75 km based on the modern transport networks and bridge over the Tay, a journey that would have been even further in the early-nineteenth century before the advent of the railway. A delivery of coal tended to last 39 working days in this mill which operated for 12 ½ hours per day (Brown and Hume, 1980). Nonetheless, the manager seemed happy with the situation, stating that ‘coals can at all times be easily had’, recommending to a Messrs B&B of Dundee that they also use Alloa Chews coal for their spinning mill (Brown and Hume, 1980: 73). Quality also had to be considered alongside proximity to the colliery, certain types of coal being more suitable for certain uses compared to others, as well as different prices available and the ability to meet the quantity of an order required. Some manufactures in the towns of Dundee and Aberdeen

³⁶¹ Anon. 1834, On the waterfall between Dalernie Mill and the Devils Bridge. Robert Thom collection, Bute Museum.

³⁶² *OSA* Rothesay, Bute, Vol. 1791: 305.

were said to use Wigan coals for gas (Cotterill, 1980: 22). Deanston Mills also used collieries in Alloa, although they were purchasing coals for gas only rather than other purposes.³⁶³ This was a much shorter distance (compared to Dundee to Wigan) of 22 km, so should have incurred lower charges for carriage, had they wished to buy coal for a steam engine too. But in 1838 the manager felt that the overall cost was ‘excessively dear’ for use as a motive power despite their best efforts to find cheaper sources than Alloa, or even to haggle the price.³⁶⁴ The managers of the Machine Works at Deanston made enquiries in 1838 with collieries near Dunfermline, Stirling, and those of the Marquis of Lothian, with the latter informing McLaren of Deanston that their offered price was simply too low.³⁶⁵

An engine in the early era of steam came with many additional costs. In the early years of Boulton & Watt, customers were charged an annual premium in addition to the cost of the engine. Once manufactured, the engine was erected by mechanics hired by Boulton & Watt but paid in cash by the customer (Boulton *et al.*, 1981: 215). The insufficient number of mechanics resulted in delays in both commencing and completing the installation and made arranging repairs for any faults extremely frustrating too. No doubt this is part of the reason why Glasgow manufacturers preferred to buy their engines from more local manufacturers and why Boulton & Watt struggled to enter the market there (Boulton *et al.*, 1981: 275–310). Lag times between placing and receiving orders were typically longer for an engine than a wheel, and delays of 18 months to receive engine parts were recorded in the eighteenth century (Tann, 1978: 363). An increase in the number of specialised works producing engines did not ameliorate the delays since demand was growing so fast from mills, steam boats, and collieries. The *Glasgow Courier* (reproduced in *Berrows Worcester Journal*, 1824) reported that:

[a] gentleman from Lancashire, not being able to get a steam engine made in England for some time, on account of the full employment of the manufactories, came here

³⁶³ Different types of coal were available and depending on the quality some combusted better than others, achieving greater fuel efficiency. There were specific coals used for producing gas. The Deanston Mills were a pioneer of using gas street lighting (*NSA*, Kilmadock, Perth, Vol. 10, 1845: 1235).

³⁶⁴ Bundle of business letters to Alex. McLaren at Deanston from Robt. Croll and James Fintry, 1838-1839. Records of James Finlay & Co, Catrine, Deanston, production records. University of Glasgow Archives & Special Collections. GB 248 UGD 091/1/5/3/6/3; Correspondence and papers concerning Glasgow Water Co and legal cases, 1825-1853. Records of James Finlay & Co, Catrine, Deanston, production records. University of Glasgow Archives & Special Collections. GB 248 UGD 091/1/5/3/6/1.

³⁶⁵ McLaren is referred to as ‘Cashier Deanston’: Incoming correspondence to Robt. Crawford, Manager at Deanston, James Smith and Ebenezer Walker at Deanston Works, 1831-1839. Records of James Finlay & Co, Catrine, Deanston, production records. University of Glasgow Archives & Special Collections. GB 248 UGD 091/1/5/3/6/4.

thinking to get one immediately constructed. The engineer he applied to told him he could not engage to commence it for eight months to come.

To borrow terminology from the diffusion literature introduced in Chapter 2, steam engines were a technology with high complexity. Waterwheels needed the technical knowledge of millwrights but there was likely already someone knowledgeable employed directly by the larger mills or providing their services in the region. The impression is that a waterwheel was generally a lot more durable, with the expectation that once installed it would remain in place for decades unless the proprietor had a reason to upgrade it (to increase power in response to the installation of more machinery for example), whereas engine parts broke and the entire machine had to be removed and replaced far more frequently. The latter perhaps worked in steam's favour in some respects, however, since a market existed for the selling and purchasing of pre-used engines, reducing the cost barrier somewhat. Like coal, the engine itself had greater mobility than waterpower and the waterwheel. Further, to understand and summarise the considerations that mill owners and managers may have had to take into account, the respective innovation attributes of waterwheels and steam engines are summarised below (Table 6.1).

Table 6. 1. Innovation attributes (based on Rogers, 2003) and an example of each attribute type in relation to the steam engine

Attribute description	Application to steam and water
<p>Relative advantage: The extent to which an innovation is perceived to be superior to what it is intended to replace. Measurements of relative advantage include economic terms, social prestige, and convenience. Whether the perceived advantages are subjective or not is not important. A greater perceived relative advantage results in faster adoption.</p>	<p>A steam engine allowing longer working hours compared to a waterwheel. Fewer modifications were required to the existing structures of a pre-existing mill for the installation of a new wheel compared to installing an engine. Purchasing a steam engine gave greater flexibility in mill location.</p>
<p>Compatibility: Whether the innovation matches with the existing values, needs, and desires of the potential adopter. An incompatible innovation may require the adoption of a new value system first.</p>	<p>A steam engine does not fit with company ethos and image of selling traditionally produced goods. For instance, Allinson’s Natural Food Company produced its wholemeal flour at Castleford so the continued use of stone-grinding and the waterwheel may have been integral to the company’s products and ethos (Rollinson, 2016).</p>
<p>Complexity: An innovation that requires the adopter to develop new skills or knowledge will be diffused slower than one which is simple to understand.</p>	<p>A steam engine which requires a specialist engineer to maintain would have high complexity. The existing skillset and knowledge of staff was tailored to the use and maintenance of waterwheels. A water-powered mill might have access to its own millwright or experienced local wrights.</p>
<p>Trialability: The ability to experiment with the innovation before fully committing to it can make an innovation more attractive.</p>	<p>A steam engine is installed but a functioning waterwheel is maintained for separate use or in conjunction with the engine.</p>
<p>Observability: Individuals in a social system are more likely to adopt if they can see the results of others using the innovation. Triggers discussion about the innovation as friends and neighbours can provide information and opinions on the innovation.</p>	<p>A mill manager visits another mill and sees the steam engine that has been erected. An entrepreneur in a remote location with limited social networks may not be able to see a working steam engine.</p>

6.2.2.3 Energy transitions

The age of waterpower was *not* over by the 1830s or even the 1900s. The presence of more than 3,000 watermills on the 1st edition OS maps and 2,451 watermills on the 2nd edition presents a strong argument that waterpower continued to hold importance in Scotland throughout and even long after the heyday of the Industrial Revolution. In certain industries, particularly traditional ones such as grain milling, new mills were still being constructed with water in mind as the prime mover. This was especially true for those situated outside the major towns. Certainly a transition was taking place: steam did indeed penetrate all manner of industrial endeavours, but the process was messy and far from clear cut. It is tempting to become fixated on trying to quantify the shift, such as defining the significance of water

based on its percentage share of total hp or contributions to gross domestic product (Malm, 2016: 77). But instead, I suggest that we consider the importance of water for those that chose to persist with it as a source of motive power, an importance arguably missed by solely trying to quantify differentials in sources of energy generation. The immense sums of money invested into waterpower and the fights put up against any threats to water supply are testament to water's continued value.

As noted in earlier chapters, quantifying steam mill numbers is challenging for both the early and later periods of steam's use. The use of multiple power sources, mills capable of drawing on water and steam power, in tandem or at different times, as well as the use of engines not for directly moving machinery complicates the situation further. Engines for returning water to wheels at mills, particularly the Savery type, were commonplace from the 1780s onwards, but Kanefsky and Robey (1980) note that records did not always distinguish these from the standard engines directly powering machinery. Depending on the circumstances of a particular mill, any periods of stoppage could be devastating financially. If a mill owner had a large workforce they had the choice of either paying salaries despite no work being done or stopping payments or even letting workers go, losing the good will of the workforce and having to find replacements if they moved on. The mill might also be in a chain of payments, loans, and duties that had to be paid whether or not milling took place. As the proprietor of Aitchesons & Brown wrote to James Watt, they had duties to pay on their stills regardless of whether the distillery was in operation or not (reproduced in Boulton *et al.*, 1981: 190).³⁶⁶ Perhaps it was then a savvy business move to have several power options, which may be why we see so many mills utilising both water and steam: retaining the 'free' and renewable power source, water, but with a backup plan for when nature could not be predicted or controlled, or having water still available as a motive force if the steam engine needed repairs.

The point that the transition was non-linear and that water retained importance even when the two overlapped is further illustrated by looking at examples of power outputs from mills that applied both technologies simultaneously, opting for partial use (a characteristic noted in the

³⁶⁶ To give an idea of costs, Robert Owen paid £7,000 in wages to the employees of New Lanark a four month period of stoppage in 1806 (Robertson, 1971: 147) although this particular stoppage was due to the 'cotton famine' that resulted from the American embargo on export of cotton to Britain (Cole, 1925: 105) rather than a problem with power supply. According to Owen the mills made £60,000 total profit between 1799–1809 so £7,000 was a substantial sum of money for the company (Robertson, 1971).

early diffusion studies of Ryan and Gross (1943) discussed in Chapter 2). Balgonie Flax and Tow mill (previously featured in Figure 3.6), installed a steam engine of 35 hp but the wheel at the same mill was capable of 60 to 70 hp. Culcreuch cotton spinning mill, mentioned in the previous chapter in relation to Ballindalloch Mill, invested in a backup engine that was of equal power to the primary waterwheel (60 hp and 60 hp). Returning to Harris (1967) and Bottomley's (2024) arguments from Chapter 2 (section 2.6), steam had to break a bottleneck to justify its use. Steam did not do this for many of Scotland's mills and so, a transition away from water often was not a necessity. Stockbridge flour mills in Edinburgh had a 55 hp engine powering nine pairs of mill stones.³⁶⁷ Many local mills would struggle to achieve a fall generating 55 hp, but outside of the larger towns the miller was unlikely to have sufficient custom to need nine pairs of stones. For reference, one of the smaller falls of Robert Thom's Greenock scheme, where the landscape was engineered specifically for use by water-powered mills, was 21 hp. The goal here is not to resist the argument that the steam engine had diffused both geographically – given that it had reached as far as the Orkney islands by the 1870s – and across sectors – being utilised in most types of manufactures – over the course of the nineteenth century, but I want to stress that water remained important in both the factory-style mill and the small-to- medium traditional or 'artisan' scale mill.

As an aside, although this thesis has primarily focused on inanimate power, animate power had not been fully displaced at the start of the Industrial Revolution. Although no mill sites of this kind were identified during this research, in parts of Britain, textile factories existed that utilised horses to power carding machines and continued to be advocated for by some millwrights into at least the early-1800s (Chapman, 1970: 238). It is no surprise that this type of mill did not survive the growth of the industry. While only a small amount of capital input was required – not more than £1,000 – potential output was also limited, with a mill of this size unlikely to employ more than ten people or so (Chapman, 1970: 238). Previous research indicates that these horse-powered carding machines were more common in the north of England, such as in Oldham and Bolton, than in Scotland, but examples were constructed in Paisley at a similar time to the large Arkwright style mills. Founded in the 1780s, Paisley's Underwood Mill went through four iterations of motive power in under 20 years (Nisbet, 2003: 178): first using hand power by around 100 operatives; then by horse gins; later

³⁶⁷ OS Name Books - Midlothian county - Volume 94 - Parish of St Cuthberts - 1852-1853, OS1/11/94: 28.

switching to inanimate power in the form of a waterwheel with a Savery steam engine for returning water; and lastly ordering a Boulton & Watt engine to power the mules directly.

Complicating the story of energy transition still further, it is evident that steam never fully dominated before it too was replaced. For example, at Carluke High Mill (originally a windmill) the mid-nineteenth-century steam engine was replaced by a Tangye gas suction engine in the 1920s.³⁶⁸ A concurrent transition to hydroelectric power and then other forms of electricity happened as steam was still just becoming established in some places and sectors. The previously mentioned Broomhill Paper Works at Bonnybridge removed the waterwheel used by the previous proprietor for the distillery and installed new turbines in 1873. This was 66 years after steam had been demonstrated to be used successfully for a paper mill,³⁶⁹ and this case was by no means unique, Broomhill being just one of the mill sites that embraced technological progress without opting for steam. The Straven Town Mill (grain) installed a hydroelectric turbine in 1935. The iconic water-powered rural cotton mills held on to their wheels for longer than most. Deanston's 'Samson' and 'Hercules' wheels were so integral to the mill's identity that Deanston named its wheels after figures from the Bible and Roman mythology and celebrated their inauguration with a procession accompanied by a band (Brogan, 1951). The introduction of electricity was almost simultaneous with steam at New Lanark, with steam power only being utilised at New Lanark from 1873. The first engine, capable of 200 hp, came from William Hunter & Company of Glasgow at a cost of £800, or £1,170 including the boiler and engineering for installation. It was deliberately used in conjunction with 800 hp of traditional waterpower, being replaced by a new engine eight years later (Donnachie and Hewitt, 2015), a much faster replacement for the engine than for the waterwheels. A little over a decade after the first steam engine, a water turbine was installed at New Lanark in 1884 and another in 1898 for electric lighting and to power some (but not all) of the machinery. A further turbine was installed in 1931 in the basement of mill no.3 for hydroelectricity.

Furthermore, the transition process was non-linear. Mills that were designed to use water could go back and forth between power sources to suit their needs at a particular time.

Rothesay was built with only a waterwheel, but the owners brought in two engines during the

³⁶⁸ NRHE ID: 46702 (Carluke, Chapel Street, High Mill).

³⁶⁹ Springfield Mill in Kent, opened in 1807, was the first paper mill in Britain to utilise a steam engine to power a Hollander machine for breaking rags up into pulp for paper making (Historic England, 2015).

1800s; Robert Thom then removed the engines and returned to a reliance on just water, whereas the final owners opted to purchase a 30 hp engine to assist the wheel from time to time. Thom had retired by the time the latter engine was purchased, so that we can only wonder if the same would have happened had Thom or a similarly mechanically-minded manager remained in charge. To summarise the various claims made here, it was in part because of these fluctuating, concurrent, or consecutive uses of different power sources within the same mills that the overall distribution of mills across Scotland did not change materially during this time period. These locationally-static changes reflect what I am calling dynamic inertia – not just a holding on to old ways and old mill sites, but something carefully orchestrated through adopting multiple sources of motive power.

6.3 The mill industrialist

A complicated, intertwined network of social links developed between the owners, investors, and managers of the mills that facilitated entry into a particular industry or helped to maintain the business as a viable concern. As a sample of only six mills from a single industry were researched in depth in Chapter 5, one has to be cautious at applying the following observations to all mills, but certain commonalities indeed become apparent from these case studies, from the evidence presented in Chapter 4, and from the work of others on the subject.

6.3.1 Pathways to industry

Looking back to when Scotland was a pre-industrialised society or in the early stages of industrialisation, mill building was driven by landowners, ‘a highly active group in Britain’s imperial expansion and industrialising economy, often leading from the front in terms of investment in innovation’ (Tindley and Wodehouse, 2014: 217). Lint mills are one type of mill mostly associated with this earlier period when landowner priorities shaped the distribution of industry. It was discussed in Chapter 4.4.4 that landowners built mills or gave their patronage to others to build them on their land so as to take advantage of financial aid from the Board of Trustees for Fisheries, Manufactures and Improvements. Landowner-driven mills continued into later periods. Dempster’s Spinningdale is a good example of a landowner directly conceiving and financing a textile mill, while Lord Bute, via his factors, took on an active role recruiting industrialists to the island and later a back-seat position of leasing the land and permitting adaptations to the landscape.

In reference to seventeenth-century river management schemes Sheail (1988: 222) refers to ‘the adventurers’ and ‘the undertakers’. To borrow Sheail’s terms, the landowners putting forth the capital can be thought of as ‘the adventurers’ and ‘the undertakers’ were the engineers designing and implementing the works. Examples from the Scottish cotton industry demonstrate how these two groups sometimes worked together or were overlapping. Robert Thom was by no means a wealthy landowner though he acquired, through unknown methods, sufficient capital to purchase the mills alongside his co-partner, William Kelly, who had equally notable practical skills. The pair had both the vision to conceive of the scheme and the know-how to enact it, and they were fortunate that supporting industry fitted into the ideals of an improving landowner, with Lord Bute (initially) responsive to their plan. In the cotton industry more generally, though, the ‘undertaker’ or engineer-driven scheme was uncommon. By the late-eighteenth century onwards, it was increasingly another, new category of mill owner that emerged and operated alongside the landowners. The more usual situation was a middle ground involving the *nouveau riche*, *i.e.* a merchant that had acquired wealth by working up through the ranks of industry, often assisted by family, and making wise (or perhaps simply fortunate) investment choices permitting them to become leading industrialists.

Six common routes into the cotton industry (Table 6.2) are identifiable on examination of the owners and managers of the six cotton mills covered in Chapter 5 based on available biographical information (supplemented by the additional biographies in Appendix 1). The first category comprises the landed gentry or those comfortably supported by the wealth of their families. Then there are those who made their money trading and investing in the colonies. The third group hailed from mercantile families, most likely supported by access to money and contacts of their relatives. Many of the known investors in New Lanark and Spinningdale fit into these first three categories, and some of the figures involved here received a formal academic education, such as Dempster who studied law, and James Smith with a college education covering mathematics, mechanics, and chemistry (valuable subjects for his later engagement with technological and agricultural improvements). The next three groups are those originating from humbler social backgrounds, such as farming, although, as was noted in Chapter 2.7.2, they were above the ranks of peasants (Chapman, 1992). Catrine, Ballindalloch, Deanston, New Lanark, Rothesay, and Spinningdale were all at one time under the ownership or management of people (or their firms) who ascended the social order via

apprenticeships and junior positions within the textiles trade or by developing a high level of mechanical skills.

Table 6. 2. Pathways taken by mill owners and notable investors or managers. Initials in brackets indicate the mills they were associated with: B (Ballindalloch), C (Catrine), D (Deanston), N (New Lanark), S (Spinningdale), R (Rothesay). * Indicates that the individual took on an active managerial role. † Landowner without financial involvement.

<p style="text-align: center;">Landed gentry or familial wealth</p> <p>George Dempster (NL, S) John Hamilton Dempster (S) Dugald Gilchrist (S) William Monro (S) James Rattray of Arthustone (S) Claud Alexander (C) Alexander Campbell (NL) Colin Campbell (NL) Jeremy Bentham (NL) Lord Bute, (R†)</p>	<p style="text-align: center;">Colonial trade: East / West Indies / plantations</p> <p>John Hamilton Dempster (S) Andrew Robertson (S) William Robertson (S) James Robertson (S) Robert Bogle (S) Robert Mackie (S) Scott of Dunninauld, M.P. (S) James Rattray of Arthustone (S) Robert Dunmore (S,B) Claud Alexander (C) Robert Dennistoun (NL) Alexander Campbell of Hallyards (NL) Colin Campbell (NL)</p>
<p style="text-align: center;">Mercantile family</p> <p>George Dempster (S) John Hamilton Dempster (S) Robert Bogle (S) Robert Dunmore (S, B) William Jeffrey (B) Andrew Jeffrey (B) James Smith (D) Benjamin Flounders (D) William Allen (NL) Charles Walker (NL) Henry Walker (NL) Henry Birkmyre (NL) Robert Galbraith Somerville (NL) James Birkmyre (NL) John Jr Birkmyre (NL)</p>	<p style="text-align: center;">Agricultural background</p> <p>George Macintosh (S) Robert Thom (R) David Dale (NL, C, S)</p>
<p style="text-align: center;">Entered industry via apprenticeship or junior positions</p> <p>David Dale (NL, C, S) George Macintosh (S) John Ramsay (S*) Archibald Buchanan (C*, D) Robert Owen (NL) James Finlay (B, C, D)</p>	<p style="text-align: center;">Practical / mechanical trades</p> <p>James Kenyon (R) Robertson Buchanan (R*) William Kelly (NL*, R) Robert Thom (R)</p>

It is also possible to group the mill industrialists according to their involvement in politics, religion, philanthropy, or social reform (Table 6.3), in common with previous studies that concentrated on the significance of membership of religious non-conformist groups for entrepreneurs (Musson, 1972; Payne, 1988). Quakers were well represented in this sample, with members of four separate Quaker families investing in these mills and the Walker family in particular having success, operating the New Lanark Mills for 56 years with the business passing through successive generations of the family. Many of the other key figures involved with the case study mills can be characterised by their prominence in the public sphere, firstly by holding positions in local and national government. There is then a split between those active in politics prior to their interest in cotton manufacturing (Dempster, Dunninauld, Gibbs, Bute) and others who embarked on political careers once they had made a name for themselves in industry (Kirkman and James Finlay). Such positions afforded the mill owners power within local and national institutions that they could use for lobbying the interests of their businesses.

Table 6. 3. Shared characteristics of mill owners and investors. Initials indicate associated mills. † Landowner without financial involvement.

Philanthropists	Quakers	Politics	Social reformers
Joseph Fox (NL) William Allen (NL) George Dempster (S, NL) David Dale (NL, C, S) Benjamin Flounders (D)	Benjamin Flounders (D) William Allen (NL) Joseph Foster (NL) John Walker (NL) Charles Walker (NL) Henry Walker (NL) Charles Walker Jr (NL)	George Dempster (S, NL) Scott of Dunninauld, M.P. (S) Michael Gibbs (NL) Henry Birkmyre (NL) John Birkmyre (NL) Lord Bute (R†) Kirkman Finlay (C, D, B) James Finlay (C, D, B)	Jeremy Bentham (NL) David Dale (NL, C, S) Robert Owen (NL) George Dempster (S, NL)

Seven entrepreneurs are classified here as philanthropists and/or social reformers, a designation based on how they portrayed themselves, the opinions of their peers, and their involvement in benevolent organisations. Whether or not these men truly were philanthropic and genuinely liked by their workers, or were ultimately just out for profit is hard to say for certain. Kirkman Finlay thought Robert Owen was a philanthropist, yet the schemes that Owen came up with for industry and society were judged ‘visionary’ but ‘impracticable’ (Kirkman, 1833: 3). Never gaining a reputation for kindness himself, Kirkman’s statements about the conditions of workers imply that he felt mills were doing the people a service:

many large Factories in England and Scotland, where the whole of the workers, children and adults, enjoy better health, are better educated, have more comforts and better food, are as sober and well conducted as any other class of persons in the same parish. (Finlay, 1833: 5)

Another obvious common characteristic reflects the unavoidable fact that this thesis has been a story of British entrepreneurs, all of them male. There were many barriers hindering women from entering business in the 1700 and 1800s. Women in this period generally held a lower social standing than men, being formally excluded from holding positions in politics or church governance (Houston, 1989: 137) and not permitted to study at Scottish universities until 1892 (Myers, 2000). References to female mill proprietors do appear in the records, but very rarely. The OSNB references the Hon. [Honourable] Mrs. Leslie Cunningham as proprietor of the Barbieston Corn Mill and Skeldon Woollen Mill, in Dalrymple parish, Ayrshire. Her mills were both fairly small enterprises, described as being propelled by waterwheels of just 9 hp and 10 hp respectively from the River Doon, and presumably were tenanted, although this is not stated.³⁷⁰ Mrs Cunningham was likely in the minority, of course, although not alone.³⁷¹ Barker and Harvey (2003) uncover evidence of women running businesses in Manchester under the name of their husband or taking over a family business in widowhood. The range of business opportunities open to women was expanding in this period, and a woman could be an entrepreneur in her own right, although their achievements might go unrecorded or hidden behind those of men (Houston, 1989).

6.3.2 Size and longevity of partnership

Those embarking on a large-scale mill alone appear to have been in the minority. Robert Dunmore was one such industrialist who, as far as is known, embarked upon the construction and running of Ballindalloch without partners. While he may have been the sole proprietor in his cotton mill business, he certainly had a strong network around him, including family connections to mercantile trade and numerous other investments that were set up as co-partnerships. He collaborated with Glasgow-based merchants William Cunningham, Thomas

³⁷⁰ The surveyors do not comment on Mrs Cunningham's ability as a mill proprietor other than describing the mills as in 'middling repair' (Barbieston) and 'good repair' (Dalrymple) unlike the disparaging comment on another of her properties, Skeldon House, which had 'a great want of that care and neatness, which is generally displayed about Gentlemen's Seats'. OS Name Books - Ayr county - Volume 22 - Parish of Dalrymple - 1855-1857, OS1/3/22: 32, 35, 36.

³⁷¹ Occasional examples were encountered of female proprietors elsewhere in Britain. One of the cotton mills that experienced a boiler explosion was Mrs Chadwick's mill on Currier Lane in the Ashton area of Manchester. Chadwick owned the mill but rented it to three separate tenants (*Manchester Times*, 1831).

Crawford, and Adam Lightbody in the firm of Robert Dunmore and Company to obtain the Hermon Hill estate in Jamaica (Legacies of British Slavery database, 2025a). Of all the textile industries, cotton required the most substantial up-front investment of capital. An Arkwright-style cotton mill had an insurance value of £3,000 – £5,000 typically (Chapman 1970: 239), which was certainly not an endeavour that could be embarked on fresh out of an apprenticeship and rarely without the financial backing of others, meaning that the norm was indeed for a partnership to be formed. The benefits of collaboration over finance and control of a mill were recognised in other industries too, including the grain industry. The Corporation of Bakers, a Joint Stock Company, owned several Edinburgh mills and granaries in the 1700 and 1800s to provide wheat for the city, including Bell’s Mill, Water of Leith Mill, Stockbridge Mill, and West Mills.³⁷²

Within the six-year period of 1800 to 1805 all six of my case study mills underwent complete changes in ownership (Figure 6.4). This period was just before the 1807 Embargo Act was imposed on United States ports, prohibiting foreign trade, these ports only being reopened to Great British shipping in April 1809 with the Erskine treaty (Daniels, 1916: 277–8). The period corresponds to a particularly volatile cycle within the trends of industrial production in Britain in the nineteenth century (Crafts *et al.*, 1989). Robert Owen at New Lanark and Robert Thom at Rothesay both took charge of their respective mills for a period of around 24 years each and both went through three iterations of ownership, with periods of sole ownership in the middle of joint partnerships. Other periods of ownership change – albeit possibility coincidentally rather than implying that anything more general or ‘cyclic’ was occurring – were in 1881–1882, which saw the sale of Ballindalloch and New Lanark, and 1965–1968, when the last three mills, New Lanark, Catrine, and Deanston, all ceased operations.

Amongst my case-study examples, it was very rare for a mill owner to invest in one mill and focus all their resources, financial, time, or social capital, into that one site. While Owen was managing New Lanark he was frequently absent, promoting his writings, had his sights set on a new industrial colony abroad, and was unofficially involved with Stanley Mills in Perthshire. But while it may seem like these were people throwing their money at the latest

³⁷² OS Name Books - Midlothian county - Volume 94 - Parish of St Cuthberts - 1852-1853, OS1/11/94: 28; Henry Band v James Clerk, Sheriff-depute, and William Scott, Procurator-fiscal of the County of Edinburgh. [1797] Mor 7670 (31 May 1797).

economic trend at the time, the evidence presented in Chapter 5 does back up that they were astute businessmen. They were knowledgeable in the trade, able to carefully oversee finances, and hire trustworthy, knowledgeable managers. They also attempted to understand and monitor weather and river conditions, to the best of their ability. Cooke (1979b: 107) interprets Robert Owen's letter books of 1802–1811 as the writings of a 'practical businessman'.

Some of the changeover in ownership and partners was certainly a result of financial pressures and economic trends, but there were other causes too. Perhaps in desperation for capital inputs, owners went into partnerships with people with incompatible views. Anecdotal evidence of personality clashes between hot-headed mill partners or managers are scattered through the histories – the story of Richard Arkwright severing ties with New Lanark over something as trivial as the placement of a tower being just one instance. This was not the first time David Dale had experienced people unable to work together. Pierre Jacques Papillon, the French dyer who introduced a process for Turkey Red to George Macintosh and Dale, was forced out of the Dyehouse because the latter 'could not manage his [Papillon's] unhappy temper' (Macintosh, quoted in Peel, 1952: 497). Two decades later, Robert Owen put the entire New Lanark enterprise at risk by conducting his controversial social experiments in the Mills and village. New Lanark was a huge undertaking that Owen could not handle alone for long, while his other interests – with experiments in New Harmony and his travels promoting his writings – also presumably posed a severe burden on Owen's finances as well as on his time. A range of reasons are assumed for the end of other partnerships referenced in Chapter 5. Dale was in his 60s at the time that he sold off all his mills, including Stanley and Blantyre, hoping to spend an increasing amount of time at his country home, Rosebank, near Cambuslang, after at least 40 years as a successful business owner in the textile trade. Confusingly, Dale did provide capital investment for Stanley Mills when Dempster sold it to James Craig in 1801, but this was merely an offer of financial assistance and not an official partnership (Cooke, 1979b). Dale arguably thereby moved from active entrepreneur to silent financial backer.

The rise in the limited, multinational company brought capital to the cotton industry on a new scale. Large enterprises with multiple locations benefitted from many internal 'sources of expertise from the contacts of its managers operating in different institutional and geographic milieus' (Kelley and Helper, 1999: 100). Gourock Ropeworks provided New Lanark a final

lease of life in manufacturing, keeping the mills running in the same physical location while taking them on a new pathway, diversifying production to include a new range of finished goods and introducing modern synthetic materials to complement cotton. James Finlay & Co., the other large company featured in this thesis, were able to keep Catrine and Deanston running when they failed to sell in the 1840s. James Finlay & Co. were probably able to keep them operating without going bankrupt as the business received income from elsewhere. The company was also able to survive periods of political instability and institutional restrictions, for instance, finding a way around the blockades of the Napoleonic Wars by establishing houses on Heligoland and Malta to supply north and southern mainland Europe (Brogan, 1951). According to a biography of James Finlay & Co. (Brogan, 1951: 113), the mills were kept on in the second half of the twentieth century out of a moral and social responsibility more than a business perspective. Whether the decision was really as philanthropic as the company suggested or just to maintain a good public reputation, they continued manufacturing in locations that no longer made financial sense, held in place by forces of inertia (perhaps in a more a static version than the dynamic term deployed elsewhere in the thesis).

6.3.3 Mobility and networks

Geographical mobility was a characteristic across social classes in Scotland in the eighteenth century. Unskilled workers in the Highlands regularly made both temporary (usually seasonal) and long-term economic migrations, as did the country's merchant and landed classes. In the case of mills, Gauldie (1981: 188–191) recounts the story of the migrant grain miller who travelled around the country in search of a mill to settle at, learning practical milling skills along the way. In the case of grain millers, their mobility made them outsiders each time they joined a new neighbourhood. The country miller faced distrust from the local population, just as Owen claimed his workers were suspicious of him at New Lanark.

Similarly, in the textiles industry moving from place to place was part of the lifestyle for mill workers and owners. Those working their way up through the practical trades route would take on apprenticeships far from their hometown to learn the skills that they would need in the industry. When one position ended they sought another elsewhere, aiming to move up the social order, leaning on familial contacts or the recommendations of their past employers to do so. When an opportunity arose, they were not afraid to enter new geographical territory. In the examples of cotton spinning mills discussed in Chapter 5, most investors had no prior links to the areas in which they established themselves. Robert Dunmore, Claud Alexander, and George Dempster all purchased land away from their home 'turf' for the purpose of investing in industry. Highlanders founded mills in the Central Belt, Glasgow-based investors sent money to the Highlands, and the English placed their industries in Scotland (Table 6.4), facilitating an 'English invasion of the Scottish cotton industry', as Cooke (1979a: 197) described it. Some functioned as silent partners, influencing decisions from a distance, while others moved to live adjacent to the mill. Not only were these mill entrepreneurs commonly moving to areas unfamiliar to them, they were sometimes picking regions that were not established textile areas, unlike when Richard Arkwright moved to Nottingham to build his machinery, venturing into an area of England already known for textiles including the location of works owned by James Hargreaves. Some of the Spinningdale investors were local landowners, probably jumping on the opportunity for agrarian improvement. New Lanark and Rothesay both had input from the major textile regions in the north of England, and New Lanark gained numerous London-based investors, for which Owen's regular social visits were to thank. For the selected examples in this thesis, London appears as a far more substantial node in the social networks of the mill industrialists than the Scottish capital. For

instance, the aforementioned collaboration between two Scots, Dale and Macintosh, and the French chemist, Papillon, was an idea born out of a meeting between the parties in London (Wertz, 2014).

While the geographical distance between partners and mills was oftentimes great, there was still a close-knit community of people and capital spun around the mills. The case studies in Chapter 5 illustrate the intricate linkages between many of the actors in the cotton spinning industry, supporting similar conclusions made by Chapman (1992) for the Leicestershire textile magnates. Visualised in a network diagram (Figure 6.5) the overlapping web of connections is striking, even when only the direct links of investment between entrepreneurs and the case study mills are shown. For instance, George Macintosh worked in Robert Bogle’s tannery near Glasgow, Macintosh later went into business with David Dale, and all three purchased shares in Dale’s former partner’s new experimental venture at Spinningdale. Family run companies were also common. The biographer of James Finaley & Co. suggests that the Buchanans who built Deanston Mills were cousins of the Finlays (Brogan, 1951). Even though other sources have not been found that support this claim, it is certainly plausible and does explain how a family who have left few footprints in the archives came to be visited by Arkwright, one of Britain’s most prominent industrialists.

Table 6. 4. County of origin of mill investors.³⁷³

Country	County	No. of people
Scotland	Lanarkshire	13
	Ayrshire	6
	Perthshire	1
	Sutherland	2
	Ross-shire	2
	Edinburgh	3
	Angus	3
	Renfrewshire	2
England	Yorkshire	3
	Middlesex	9
	Lancashire	2
Wales	Montgomeryshire	1

³⁷³ Place of birth if known or primary residence at the time of investing in one of the featured mills.

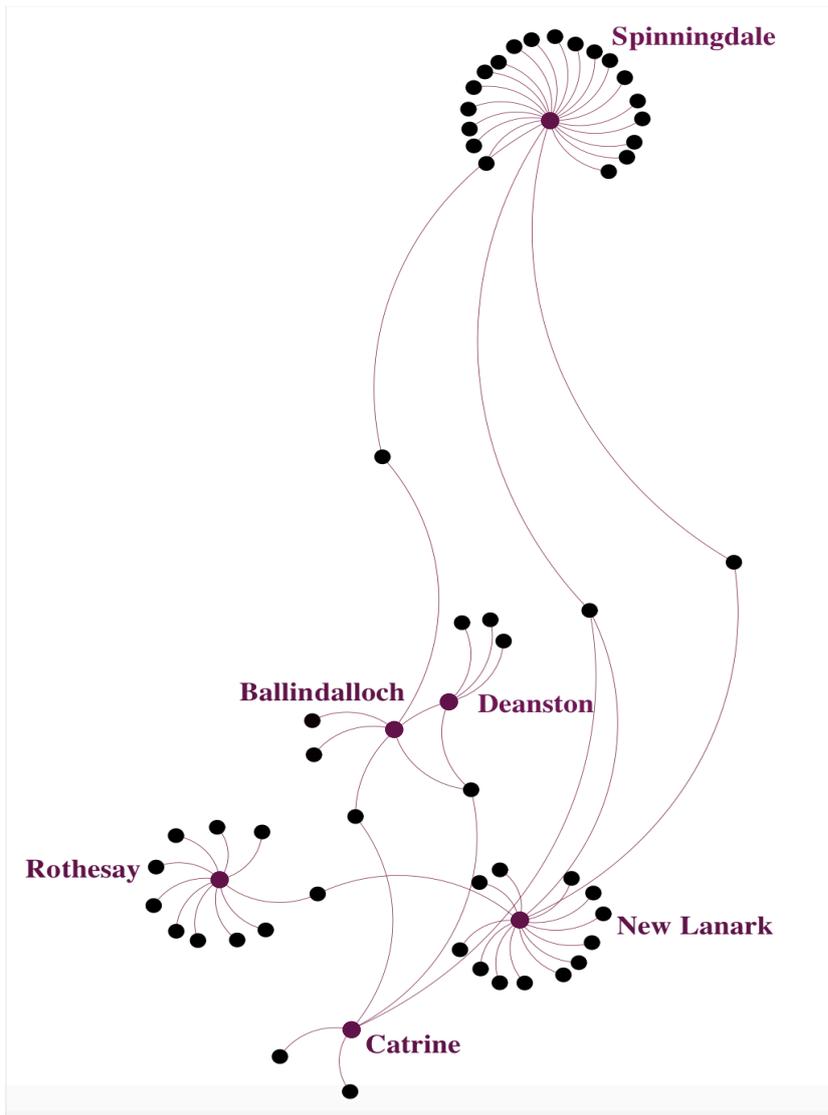


Figure 6. 5. Network of mills and ownership. Only connections between actors and the six case study mills are displayed. Further connections have not been mapped but are described in the text such as other businesses between partners, engineers consulted for multiple mills, or the workers who were sent between mills for the purpose of skill sharing or to fill temporary shortages (Diagram created in Gephi 0.10)

Compared to the other mills in this chapter, Spinningdale stands as somewhat of an enigma. Spinningdale had the potential to take advantage of the knowledge and links of the many investors that held a share in the company established to back the mill's development, some of whom had prior success in textiles manufacturing and others of whom had influence through political links and colonial trade. Yet Spinningdale Mill only survived 14 years, a mere fraction of the time that the other case study mills were open. Far less is known about this example, but what the data shows is how much the mill relied on the enthusiasm and

social capital of Dempster. A person without the latter's networks and standings would have been unlikely to convince so many people to invest in a venture that was never likely to bring in significant profit, since there is nothing to suggest that it was *ever* intended to reach the scale of the other five mills examined. Many industrialists were evidently held in great esteem by others of the bourgeois and upper social orders, a respect that was earned in different ways. Upon his return from colonial trading, Claud Alexander did not embroil himself in politics, choosing instead to reside in his estate close to the mill and as was described in the previous chapter, his character was praised by the local reverend. That is not to say that he was isolated. Indeed, he was a member of the Society for the Encouragement of Arts, Manufactures and Commerce in London, although it is unfortunate that more is not known about his involvement or what support he perhaps took from the society and its members. Alexander's sons made use of their father's wealth and good standing to embark on their professions of choice, just as Alexander had relied on family at the start of his own career.

Mills were nodes in the global history of textiles (Morris, 2018). It has been demonstrated that the wealth derived from slavery contributed to economic growth and accumulation of capital in Britain (Williams, 1944, Hudson, 2015, Hebllich *et al.*, 2022). The infrastructure and institutions that mills utilised for importing and exporting were financed through profits derived from other colonial trades (Berg and Hudson, 2023: 226–228). In some cases these connections were obvious and explicit: for instance, direct investments in plantations, acting as servants of West or East Indies companies, or inherited money earned by family members engaged in colonial trade. Even those who were less obviously directly connected became complicit in the entanglement as soon as they engaged in the manufacture of goods. Linen and cotton textile industries used raw materials picked by enslaved people and then re-exported the finished goods back to the colonies (Mullen, 2022a: 4). At the time it was deemed perfectly reasonable to be in favour of slavery abroad while in favour of improved living and working conditions for those employed in Scotland. Dunmore gained a positive local reputation while residing at his Balfron estates, and David Ure, Killearn's reverend at the time, suggested an altruistic motivation behind Dunmore's investments – describing him as a 'public-spirited gentleman, inspired with an ambition of doing good to mankind by employing them in useful industry'³⁷⁴ – and yet at the same time his firm, Robert Dunmore &

³⁷⁴ OSA, Killearn, Stirling, Vol. 16, 1795: 116.

Co., owned estates and enslaved people in Jamaica and made money from supplying goods to other Scottish enslavers (Mullen, 2022c: 95). Dunmore was not alone among the mill industrialists in seeming perfectly capable of holding conflicting views on the subject. Morris (2018: 118) points out that Dale's active position within the Abolitionist Society, with aims to stop the trading of enslaved people rather than banning slavery altogether, would have risked alienating him from the business community in Glasgow. Yet Dale profited from enslaved labour his entire career, and, even after selling his mills, he still provided financial support to the owner of Stanley Mills, thus remaining complicit in a process that he purportedly wished to reform.

6.4 The mill as place

6.4.1 Places of collaboration or contestation

Mills obviously did not function in isolation. They were the product of physical, economic, and social processes surrounding them and, to be a success, mill owners needed to navigate relationships with other people, companies, institutions, and legislation. In consequence, owners often found themselves in conflict with others when their respective priorities did not align. Laws are instrumental in shaping the interactions between humans and between them and their environment (Legg and Prior, 2023: 235). Examples of disputes between millers and other parties over water resources began to appear in legal documents in increasing numbers from the eighteenth century. Gauldie (1981: 106–107) believes that this appearance is not merely a reflection on the growing total number of mills, but rather indicates a response to landscape changes and an increase in tenants receiving written contracts that more clearly defined their rights instead of less defensible verbal agreements. Rivers present problems of law and governance given their non-static geographies. What is dry land and what is under water is subject to variation across a range of time scales, from geological periods to daily changes. Rivers traverse the boundaries of landownership and extend beyond jurisdictions when they pass from one town to another, into new counties, and across multiple countries, creating problems of enforcement. An institution or body may have the right to prescribe and enforce a role or to do one but not the other, and they will only be able to enforce law over a certain, delimited geographical space (Matthews, 1984). The question arises too whether water is considered a public or common good. The Scottish law of common interest

developed gradually, partly in response to cases in the courts involving mills (Robbie, 2015: 119). In the eighteenth century there were still four bases for water rights in the courts: prior appropriation; common right of possession to all riparian owners; rights granted by immemorial existence; and factually presumed granting of use in excess of common rights (Getzler, 2006: 193). By the nineteenth century, the rights prescribed to private water sources stated that downstream owners of property had a right to receive water ‘undiminished in quantity, unpolluted in quality, and unaffected in force and natural direction and current, except in so far as the primary use of it may legitimately operate upon it within the lands of the upper heritor’ (quoted in Robbie, 2017:1). Therefore, anything that materially affected flow needed permission of all owners, otherwise one or multiple parties had the right to make objections (Robbie, 2017: 2).

Oftentimes, issues emerged not because of water shortages but because of issues with neighbouring landowners. We have already heard the case of the Edmondstone sisters against the owners of New Lanark in Chapter 5 (Section 5.3.5). The sisters were not actually making use of the water concerned but used the legal rights assigned to them to achieve their desired outcome to keep their new neighbours, the mill workers, away from their land. The New Lanark weir, meanwhile, offers one illustration of how different personalities responded to challenges. Dale, living up to his benevolent reputation, was willing to compromise the design of the dyke to find a civil solution to the challenge while Owen, seemingly not a fan of interference in his plans, rebuilt the dyke, eventually taking on the legal repercussions of hefty financial compensation to the Edmondstones. Another very different story involving a dam dyke exemplifies that lengthy, costly complications could arise from what should have been a simple action due to the need for collaboration from multiple landowners. While acting as managing partner of the Deanston Mills, James Smith was involved in ongoing correspondence relating to a dyke that had burst on the Earls Burn reservoir, resulting in damage to surrounding properties. All but one of the injured parties had given their approval for repairs to begin in April of 1840, but in August the work had still not begun due to a Mr Dick’s objections to the assessment of the damages incurred. Smith believed the objections to be due to a misunderstanding on Dick’s part but, after five months of delay without resolution, Smith feared that legal steps might soon need be taken to resolve the matter.³⁷⁵

³⁷⁵ Deanston letterbook, Jan 1840-Jul 1844. Records of James Finlay & Co, Catrine, Deanston, production records. University of Glasgow Archives & Special Collections. GB 248 UGD 091/1/5/3/6/7.

Challenging cases like these two lend support to Malm's theory that the footloose steam engine freed those unwilling to collaborate from the restrictions that water placed on them, an indirect reason why an energy transition from water to steam might have occurred (Malm, 2014, 73).

While Thom's scheme on Bute for the Rothesay Cotton Mills was unique and adventurous, methods of altering drainage patterns and flow had been implemented much earlier in Scotland. The seventeenth century in particular was a period of capital expenditure from landowners who enlisted leading engineers from home and the European continent to undertake drainage of land in the name of improvement (Sheail, 1988: 222). Lands that were previously waterlogged, boggy peat moss due to Scotland's high rainfall were drained and reclaimed for arable use, with several consequences. The availability of more land for growing crops increased the demand for work from the miller but reduced the flow of water reaching the miller's wheels. The natural flow of some rivers was reduced due to the effects of draining a pond or loch miles away (Gauldie, 1981: 105–7). Records of legal cases from the period show that the creation of artificial water bodies in landscaped gardens and pleasure grounds around stately homes also interfered with flow to mills (Robbie, 2015: 147). In the towns, conflicts arose from the implementation of large scale infrastructure schemes, an early example being the diversion of water from the Townhead Reservoir to feed the Forth and Clyde Canal in 1768 (Hume, 2017).

Legal cases became more complicated, involving a wider range of different actors than in earlier centuries. Take for instance the disputes, mentioned in Chapter 5, over the proposed schemes to increase Glasgow's domestic water supply. Such schemes were strongly opposed by James Finlay & Co. as they feared damage to their Deanston Mills in the form of reduced water supply. Multiple iterations of the Parliamentary Bill for the principal scheme were presented before it was finally granted permission. An iteration of the bill to supply Glasgow with water from Loch Lubnaig was passed into law in 1845, but shortly afterwards this proposal was deemed impracticable on account of the compensation water required to be released into the River Teith for mill owners and other claimants. Further meetings were held by the Committee of the House of Commons to discuss proposals such as the hearing of 20th March 1854, involving a 'formidable array of counsel, agents, and parties' (Burnet, 1869: 77). Among those in attendance to argue for and against the scheme were counsel for the promoters of the bill, for the Gorbals Gravitation Water Company, agents for the Town

Council of Rutherglen, the town of Stirling, the Commissioners of the Forth Navigation, for ‘the working classes and ratepayers of Gorbals’, agents for individuals including the Duke of Argyle, and representatives of James Finlay & Co. (Burnet, 1869: 77–8). Over the following months proceedings were paused to allow sampling to test for lead in the water, but in the end it was an issue raised by the Lords Commissioners of the Admiralty, ‘instigated, no doubt, by the Commissioners of the Forth Navigation’ (Burnet, 1869: 83) regarding the removal of water from the Teith and therefore the Forth that proved critical. Proceedings were halted once more, having already cost the public £11,094 10s 10d. Letters preserved in the Company’s archives confirm that staff at Deanston were communicating and collaborating with other concerned mill owners,³⁷⁶ but in the account of the case by Burnet (1869) just given, the mills barely feature, riding instead off the power of bigger forces such as the Admiralty. Although such instances were undoubtedly extremely worrying for mill owners, those governing the cases tended to act in favour of the mills – with Parliament recognising the necessity for clean municipal water but setting the precedence of normally insisting on compensation for mills in the form of water rather than money (Sheail, 1988: 229). These were some of the more highly publicised cases, since they involved public corporations versus numerous private needs and they required an Act of Parliament to go forward. The main takeaway from these examples is that some mills, with the best-connected and well-resourced owners, might have the power to pursue favourable water access decisions, whereas a smaller mill might not have had the economic and social capital to stick with their operations. Possibly, some mills might have found it easier to switch to steam or even to shut down entirely, presenting another avenue of influence on decisions about mills staying in place, relocating, or closing.

Although legal restrictions influenced the choice or the longevity of certain sites, secure access to water was not enough to guarantee those sites’ survival. Ballindalloch Mill, which seemingly had no troubles with water rights or other legal questions, proved to have one of the shorter operating lives out of the mills examined in Chapter 5. The land on which this mill was built had been purchased along with water rights, a fact stressed in future sales adverts. Dunmore was blessed with cooperative neighbouring industrialists, willing to collaborate on

³⁷⁶ Remarks J H Callander, esq of Craigforth, on the proposed schemes of the Glasgow water company, and their heads of agreement with Deanston company: Correspondence and papers concerning Glasgow Water Co and legal cases, 1825-1853. Records of James Finlay & Co, Catrine, Deanston, production records. University of Glasgow Archives & Special Collections. GB 248 UGD 091/1/5/3/6/1.

water engineering schemes and yet Dunmore went bankrupt and James Finlay & Co. could not make a success of the mill either. As much as there was talk of potential ruin for mills due to the municipal water schemes, the reality is that disputes over water were a risk that mill owners took when opening or buying a mill, one that, with persistence and co-operation with other threatened parties, the larger concerns certainly appeared able to weather.

6.4.2 Experimentation and control in the mill community

That mills were sites of technological innovation has been evidenced both in this and the previous chapter in the descriptions of inventions and patents that managers across Scotland obtained throughout their careers. In contrast to the thesis of British entrepreneurial failure in the late-nineteenth century (*e.g.* Aldcroft, 1964; Landes, 1969), cotton manufactures were ready to embrace change when they foresaw the benefits. Mill owners ‘pushed boundaries’ by commissioning waterwheels larger than any others in Europe. Robert Thom took an enormous risk when altering the drainage of Bute with previously untried mechanisms so as to control the natural hydrological system. Mills were at the forefront of harnessing and regulating nature through experimentation, and this desire to transform and govern the natural world extended to attitudes of social order imposed upon the working classes. Robert Owen’s efforts to produce a model community were only the most obvious and remembered ‘moral’ experiments for creating disciplined and hopefully loyal mill labour forces.

The rural mill communities had to be financed entirely by the manufacturer without the assistance of public funds (Malm, 2016: 103). This situation could be seen as a partial explanation for why some opted to turn their back on water in favour of an urban, steam-powered, location. But in contrast, it is argued here that a rural location afforded mill owners unrivalled opportunities to design and operate as they wished, with less outside interference, aligning with the *laissez-faire* ideologies that many merchants such as Kirkman Finlay so clearly held, especially when the proprietor owned, or leased, the surrounding land as well as the mill buildings. Once any difficulties in recruiting workers had been overcome – and some of the cases presented in Chapter 5 did involve recruitment problems that had to be solved if a mill was to survive in its chosen location – the proprietor gained a degree of control over almost every element of the worker’s lives. This extended from designing the housing, deciding what leisure activities to make available, the type of shops permitted leases, which religious domination to offer patronage, through even to control over what food was

consumed. Planned mill villages tended to set up schools years before the Factory Acts made the provision of education compulsory. As financial backer, the mill owner selected the teacher and designed the curriculum provided. The aim of education in Scotland and across Europe at the time, was to give ‘an *appropriate* training’ in the eye of the owners ‘and thereby to promote social stability’ (Houston, 1989: 56). The advertisement placed in the *Glasgow Herald* (1846) requested that Deanston’s school teacher have knowledge of a breadth of subjects that would educate them far beyond the needs of a cotton mill worker but, crucially, in the eyes of the bourgeoisie would enhance the moral character of its pupils through classes such as Psalmody:

WANTED, A TEACHER for the DEANSTON WORKS SCHOOL. He will require to teach English Reading and Grammar, Writing, Arithmetic, Geography, the Elements of Latin and of Mathematics; and it will be a recommendation if he can give lessons in Mechanical Drawing and in Singing, particularly Psalmody. The Emoluments are – a Salary of £30 per annum for teaching the workers in an Evening Class, and superintending the Sabbath School, with the Fees from pupils attending the Day School; but the young children in the Cotton Works are paid for at a fixed weekly rate by the Company.

Precise methods of exerting control depended on the proprietor. John Fergus, Whig MP for Kirkcaldy, who erected the Redford Flax Factory on his estates, supposedly to provide employment for the poor, imposed his ideals outside of the mill by offering financial incentives, awarding a premium each year to the resident that kept the neatest house and garden on his estate.³⁷⁷ Proprietors were at liberty to dictate what holidays the workers received and for what they could take ‘time off’, lending importance to external and internal events that fitted with the company ethos. Banquets and festivals could be held to celebrate the owner’s successes as they were at New Lanark (Siméon, 2017: 123). Production would halt for the funerals of company partners and on site managers of the mills of James Finlay & Co., for workers to pay their respects to their benevolent masters.³⁷⁸

Others trialled more subtle techniques of surveillance and visibility, designing their communities so there might always be the gaze of the employer on the workers, the display of workers for outsiders, and of the village residents upon each other. Within the Deanston Mills the 300 power-looms and the 150 workers operating them were assembled under one

³⁷⁷ Previously featured in Figure 4.33. OS Name Books - Fife and Kinross county - Volume 12, Parishes of Abbotshall, Auchterderran, Dysart and Wemyss - 1853-1855, OS1/13/12: 16.

³⁷⁸ Weather reports for Catrine Area Vol.2, Nov 1911-Sep 1939. Records of James Finlay & Co, Catrine, Deanston, production records. University of Glasgow Archives & Special Collections. GB 248 UGD 091/1/5/2/8/4.

roof, 'so arranged as to permit perfect supervision of the whole, from one point.' (ICE, 1851: 93). The larger Scottish textile mills of the late-eighteenth century onwards thus displayed relations of power termed by Michael Foucault 'disciplinary power'. As interpreted by Dianna Taylor (2014: 28), disciplinary power is defined by:

its endeavour to meticulously, exhaustively and continuously control the activities of bodies so as to constitute them as bearers of a highly particular relationship between utility and docility, whereby increases in utility correspond to increases in docility and vice versa.

This form of discipline was of course possible in both urban and rural settings. Emma Wainwright (2005), for example, presents a reading of Dundee's jute mills as spaces where architecture and ordering of internal spaces was used to ensure visibility and regulation of the workforce. Furthermore, urban residents were said to already be predisposed to discipline, a 'trained population ready for such factories.'³⁷⁹ However, the rural, water-powered mill provided the opportunity to push these kinds of disciplinary regimes to their extreme. In the planned industrial community, spatially separate from urban population centres, discipline of the individual could extend beyond the factory walls. Indeed, in the industrial colony, the entire village could be designed to emphasise the dominance of the mill, standing physically and metaphorically at the centre of the lives of the workers. The mill in such circumstances loomed over its workers as a constant presence, reminding everyone of the expectations placed on them to be civil and docile. Catrine village was even designed so that all three principal streets, Mill Street, Bridge Street, and St Germain Street, radiated from a central Mill Square at perpendicular angles, ensuring a view of the mill from the housing (Figure 6.6).

³⁷⁹ Anon. 1834, On the waterfall between Dalernie Mill and the Devils Bridge. Robert Thom collection, Bute Museum. Emphasis as in original manuscript.

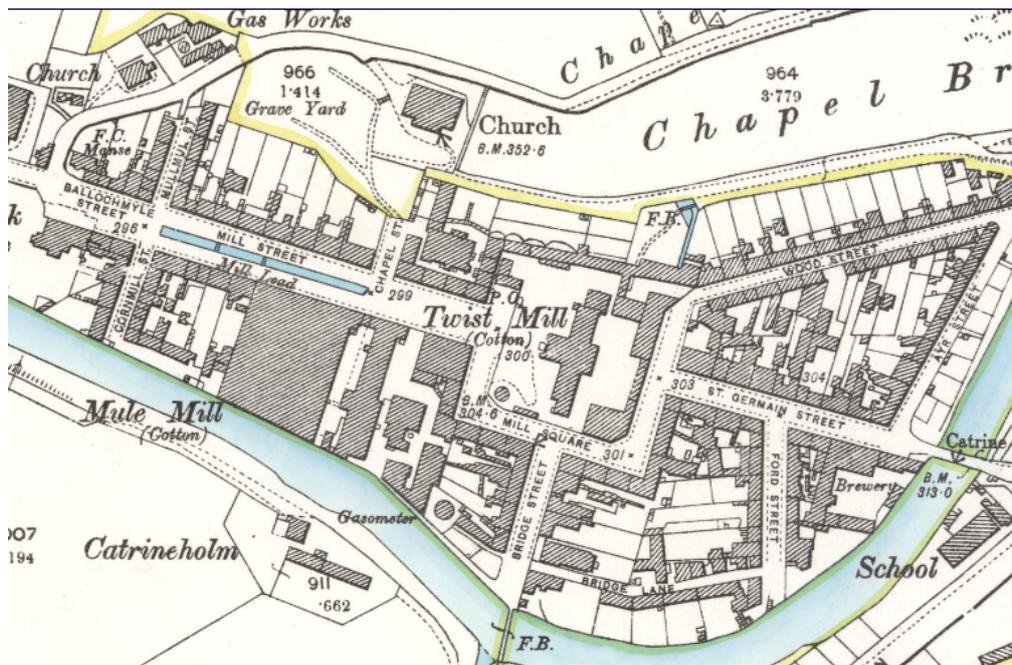


Figure 6. 6. Catrine village in 1895. The main roads of the village diverge outwards from the Twist Mill at the centre.³⁸⁰

Robert Owen chose not to forbid the consumption of alcohol amongst the workforce, encouraging sobriety instead by directing the gaze of their peers upon those partaking in drinking. Owen permitted a store selling alcohol but only if placed in a prominent central street to shame those seen entering. By discouraging the habits that the bourgeoisie considered less desirable in favour of more suitable pastimes, the obedient worker was of more use to the mill. This was just one of Owen's techniques of behavioural manipulation, and he also endeavoured to boost labour productivity and quality with a contraption known as the 'silent monitor', a four-sided block of wood with a different colour on each side (Donkin, 2010). A monitor was hung beside every employee, visible to all, and it was the job of the mill's superintendents to turn the block to the colour that reflected the worker's performance for that day: black for 'bad', blue for 'neutral', yellow for 'moderately good', and white for 'excellent'. The assessment was more a reflection on the worker's moral conduct that day than on the quality of work (Donkin, 2010). Jeremy Bentham, who, alongside his brother Samuel, is credited for the conception of the panoptical principle, was an investor in New Lanark alongside Owen. How much communication Bentham had with Owen regarding their views on social reform or whether Bentham had any input in the Mills at all beyond a

³⁸⁰ Ordnance Survey, 25 Inch to the mile, Ayrshire XXIX.10 (Revised: 1895, Published: 1896). View online: <https://maps.nls.uk/view/82867815>. Reproduced courtesy of the National Library of Scotland.

financial backing is unclear, although Donnachie (2000: 119) suggests that Owen's essay in support of a national education system could have been influenced by his partner.³⁸¹

The perceived effectiveness of using the rural community for imposing moral improvement was openly discussed in the printed press in the nineteenth century. As a commentator on the temperance movement reflected, Owen's plans for the reform of his workers 'would not be possible in large communities, where individual freedom is not to be controlled by the will of one man or one body of men' (*Leicester Chronicle*, 1876). The targeted recruitment of vulnerable populations in the form of displaced Highland families was, in this connection, arguably less an act of benevolence and more another tactic in the moulding of a pliable workforce. Likewise, indentured orphan labour was maybe enacted less as a matter of necessity to fill employment gaps and more as the selection of malleable young minds. Whatever the intentions, some manufacturers such as the Spinningdale partners complained that these marginalised people were the least amenable to conditioning for the factory system. Moreover, Morris (2018: 117) identifies a shared ideology of 'gradual improvement' taking place at home and in the colonies whereby Scottish mill workers and enslaved persons were morally civilised and improved through systems of education and discipline implemented from above. The discussion here has ostensibly strayed from the core matter of mill locations, but there is an argument to be made that there was an overlap between sites that were abundant in waterpower (river valleys with steep falls) and relatively remote sites amenable to being set apart from the disordered and uncontrollable industrial urban people and places. In these isolated mill communities, the proprietors could trial a 'rural panopticon' of intimate surveillance and self-discipline (Philo *et al.*, 2017: 230). Such an angle implies that locational decision making was much more complicated than the cost-based conventions of classic industrial location theory, but there is warrant for proposing that the social-experimental side and the planned mill village, was another factor drawing and holding mills to certain types of location against pressures to close or relocate. Here, another, different perspective, is proposed on what I am terming the dynamic inertia within the historical geography of Scotland's water-powered mill landscape.

³⁸¹ Owen provided updates to his partners on his regular trips to London but the nature of the meetings is unknown. The only direct communication to Bentham referenced in Donnachie's (2000) biography of Owen is a letter of a practical manner, informing him of the fire in no. 3 Mill.

6.5 Afterlives

What happened to Scotland's mills after their machinery stopped turning? Some concluding thoughts and questions will be raised here on the place of mills within Scotland's present. The number of watermills with functional machinery has shrunk today from the thousands presented in Chapter 4 to only a handful, estimated at fewer than 20 in Scotland in 2018, and likely even lower at present (Ainslie, 2018). One of the only remaining commercial mills is Barony Mill on the Orkney mainland, which produces beremeal,³⁸² claiming to be the only mill in the world to do so. Since the grinding is conducted over the winter, the owners supplement their income by opening the mill to the public during the summer. A handful of other watermills have been restored to full or near working condition, occasionally operating as displays for tourists but without producing grain (or anything else) for consumption. HES currently manages Stanley Mills, New Abbey Corn Mill, Dounby, and Tormiston Mill, while the National Trust for Scotland has a further five watermills in its portfolio.

The most visible industrial heritage is that which is preserved, and literature has been produced debating the value of, and potential for, sustainably managing heritage sites (Hay, 2011; Oevermann, 2011, Cossons, 2016; Oevermann and Jones, 2022; Jin and Jin, 2024), many contributions to which include a focus on New Lanark (Rodwell, 2002; Leslie, 2005). At New Lanark, the bid to protect the heritage of the mill and village commenced in the 1970s. New Lanark Trust was formed in 1974 to restore the site, while also transforming it into a functioning community, with Jim Arnold, a former teacher, appointed Village Manager (Davidson and Arnold, 2011). A compulsory purchase order was granted in 1980 and a grant from National Heritage Memorial Fund used to cover compensation costs to the mill owner (Metal Extractions Limited), bringing the site into public ownership (Minnery, 2019). The village of New Lanark itself was inscribed by UNESCO as a World Heritage Site in 2001 due to the site's 'Outstanding Universal Value' based on its meeting three out of the ten criteria for World Heritage status, outlined in the table below (Table 6.5) (UNESCO, 2022). New Lanark Trust, HES, and South Lanarkshire Council now work together on the management of the site to maintain UNESCO's requirements of a World Heritage Site, continuing to show that the site has international significance (UNESCO, 2019).

³⁸² Bere is an ancient barley that has been cultivated on Orkney since the Neolithic Period (Barony Mill, 2025).

Table 6. 5. New Lanark’s criteria for Inscription as a World Heritage Site (based on UNESCO, 2019).

Criterion number and description	Application to New Lanark
CRITERION (II) - Exhibit an important interchange of human values, over a span of time or within a cultural area of the world, on developments in architecture or technology, monumental arts, town planning or landscape design.	The development of a model community for the industrial factory system that was replicated globally.
CRITERION (IV) - Be an outstanding example of a type of building or architectural or technological ensemble or landscape which illustrates (a) significant stage(s) in human history.	The design and construction of workers’ housing, public building, and outside spaces that took consideration of practical as well as social and physical needs.
CRITERION (VI) - Be directly or tangibly associated with events or living traditions, with ideas, or with beliefs, with artistic and literary works of outstanding universal significance.	The connection between Robert Owen and New Lanark. Owen’s philosophy, writings, and practices, influenced social developments in Scotland and internationally and transcended the nineteenth century context in which they began.

While UNESCO could be said to be the pinnacle of protected statuses, other protections have been afforded to sites in Scotland. Firstly, there is the listing process for which HES is responsible under the Planning Listed Buildings and Conservation Areas (Scotland) Act 1997. Listing provides legal protection for buildings that are of ‘special architectural or historic interest’, affecting how changes to the building can be approached by the planning system (HES, 2019). These often focus on natural landscapes of the mill assemblage as much as on the human-made structures. What remains of Dunmore’s planned village on the Endrick has been incorporated into the Balfron South Conservation Area, a designation assigned to protect the character and appearance of places with historic value, and the area that originally contained the mill workers’ houses remains predominantly residential (Stirling Council, 2014). The Catrine Voes (the water storage system) was designated a Local Nature Reserve and Scheduled Ancient Monument in 2006, providing a habitat for water voles, otters, kingfishers, and heron. Glenbuck Loch is also now a wildlife reserve and Site of Special Scientific Interest (East Ayrshire Leisure, 2022). At New Lanark, as well as the UNESCO designation, an area of 67.44 ha surrounding the village has been designated the Falls of Clyde Nature Reserve and is managed by the Scottish Wildlife Trust. The existence of these different protections, with inconsistent spatial boundaries, has the potential for a confusion of disparate priorities where multiple organisations are responsible for a site (or only for part of a site). One challenge for post-industrial sites is the ‘fuzzy geographies’ (Rhodes II *et al.*, 2025: 3) of these spaces that combine tangible and intangible heritage within a border defined by an institution, a protection agency, or legal instrument, external to the area.

The majority of Scotland's thousands of mills were fated for destruction but their traces remain within wider and everyday society. Phrases related to milling of grain in particular have entered the English language lexicon, becoming *run of the mill* in everyday speech, and the relicts of industry shape the collective memory of present-day places. Despite Ballindalloch no longer physically existing, the mill building features on the logo of Balfon Primary School and street names retain connotations to the cotton industry, emphasising the legacy of the mill on the village. Similar examples abound on unassuming street corners across the country (Figure 6.7). Milling features in leisure spaces such as trails and walks, often with interpretative signs and millstones incorporated into artwork, offering visitors the chance to engage with the cultural landscape.



Figure 6. 7. Top row: Lade Park in Rothesay, featuring circular stone structures to represent the wheels of mills past; logo of Balfon Primary school (Balfon Primary, 2022); mosaics representing mill stones and wheels on the water of Leith walk. Bottom row: Place names associated with historic mills in Edinburgh and Leith.

But it is not a given that mills or other forms of industrial heritage will be incorporated into the collective local identity or protected. The logic behind which sites are saved is not set in stone; the outcomes can be reliant as much on the initiative and drive of local people and individuals (Goodall, 1993: 97) or a reflection of changing trends within the priorities of heritage organisations. The latter was witnessed with New Lanark in 1986 when a previous attempt to gain World Heritage status was unsuccessful. The initial failure but eventual

success in this case may reflect shifting attitudes towards industrial heritage in the United Kingdom, where traditionally it has been easier to preserve castles and stately homes than industrial sites telling the stories of the working classes (Davidson and Arnold, 2011; Minnery, 2019). Notions of ‘authenticity’ also come into play. To make the village as faithful as possible to what it would have been like in the nineteenth century, some later twentieth-century structures have been removed from the site. Such conceptions of ‘authenticity’ are highly debatable, imposed sometimes to the detriment of those who continue to inhabit a place. Should more recent buildings have been removed from New Lanark or did they too present a chapter in the history and heritage of the village but of a different era? Of course this question leads to further ones about what sites should be protected: what types of heritage have value and to whom, and which stakeholders should be prioritised? As with any form of conservation, what baseline should be worked towards? ‘Trapped by fear of change and innovation’ (Ronchini, 2018: 179), what can be deemed cultural inertia is often considered the solution in the heritage sector, wherein avoiding loss through maintaining the status quo is thought preferable to taking risks for potential gains (Holtorf, 2015).

In this regard, it is instructive to ask what has become of Spinningdale, the geographical outlier of the cotton mills examined in Chapter 5. Despite having more physical remains than some of the other mills also examined, Spinningdale Mill has left the smallest heritage legacy. A small settlement at Spinningdale still exists today and, considering its location on the North Coast 500 touring route, one might expect the mill ruins to be proudly publicised as an attraction in promotional materials, but this is not the case. Does its remote location, in a remote part of eastern Highland Scotland, hold back its heritage potential as much as it hindered its viability as a working mill? A sudden fire caused ‘fast’ ruination and the mill was left afterwards to face a ‘slow’ decay (DeSilvey and Edensor, 2013: 466–7). Remaining in a state of limbo, the fragile, grade 2 listed structure is neither removed nor deemed worthy of strengthening against further collapse, standing as a symbol of both a failed local capitalist endeavour and, it might be added, a failed heritage intervention. The reality is that abandonment and ruination has been the fate for many of the country’s mills, a process occurring in some instances for centuries. The site may be left untouched as in the case of Spinningdale, or a new building placed over or next to the ruins.

Simply having protected status of one form or another does not guarantee the survival of a mill environment. It can protect a building from encroachment from developers or help to

attract funding and tourism. But it can bring restrictions too, such as requirements to maintain the character of a site, meaning changes and repairs may be highly specialised and costly to carry out. The skills and knowledge required to maintain or operate traditional machinery is becoming rare, with very few people now being trained as millwrights. In the face of these challenges, the mill space is commodified and diversified through various forms of adaptive reuse. Private housing, offices, hotels, museums, and community centres are among the common outcomes (Table 6.6). In the UK, preference is often given to adaptive reuse once historic assets such as machinery have already been removed, whereas in Germany best practice advocates for the safeguarding and exhibition of associated assets even if it limits the potential use of the building (Oevermann and Jones, 2022). Meanwhile, there are groups attempting to challenge traditional heritage models such as Konvent at the former Casa Rosal factory, Catalonia. The not-for-profit artist collective of Konvent practice geocreativity to bring a renewed sense of place that bridges the past, the present, and the community within a post-industrial space (Cerarols and Luna, 2020).

The New Lanark site now includes a Visitor Centre, a hotel and hostel, and spaces for the production of ice cream and woollen yarn (New Lanark Trust, 2022). To solidify New Lanark's status as a cultural venue and to bring in revenue, mill no. 3 contains an exhibition gallery that hosts both permanent and temporary exhibitions. Thus, New Lanark comes full circle as a site drawing in tourists from all over the world. But at what cost? Tourism attractions are often built via consultation with community members and former industrial workers, with the resulting interpretation allowing communities to tell their stories and preserve artefacts of significance (Rhodes II *et al.*, 2020: 13). But this process also results in commodification and spectacle in the deindustrialised landscape. Community memory and identity is 'harnessed to support a view of industry that contributes to heritage tourism' (Summerby-Murray, 2007: 58), manifested in watching an ex-worker in a live display of machinery dressed up as a Victorian millworker, or at New Lanark motorised 'pods' reminiscent of fairground rides taking visitors through the story of Annie McLeod, who, as a ghost, tells her story of life in the mill and village in 1820. This is arguably a problematic form of objectification for the benefit of the tourist gaze that Kennedy and Kingcome (1998: 46) compare to dressing up as characters at Disneyland. That said, in contrast to the accusation that colonial networks are often ignored in post-industrial landscapes (Rhodes II *et al.*, 2020: 11), work is being done to address the more difficult histories behind Scotland's industrial heritage and museum exhibits, including in mill spaces. The use of multidirectional

memory between enslaved labourers and mill workers in heritage sites holds interesting potential but is not without its own challenges (Campbell, 2024). A recent public talk held at Dundee's Verdant Works invited attendees to address the less celebrated, uncomfortable pasts of the working conditions and colonial connections of the mill and the city (Dundee Heritage Trust, 2025b).

The potential for hydroelectric power production is being explored at many historic watermill sites, going full circle to bring water back as a prime mover. The water storage and lade systems at Catrine, New Lanark, and Deanston are all presently in use for electricity generation using turbines. The Deanston Distillery continues to use the original mill lade to bring water to the distillery for use in the whisky production process and to power the turbines of a hydroelectric plant. Commissioned in 2020, the plant has been fitted with a Kaplan Turbine capable of producing 355kW output at 4.2m³/s flow (Gugler, 2022).³⁸³ Any excess electricity not used by the distillery and visitor centre is sold to the national grid (Deanston Distillery, 2022). Smaller sites are also being identified as candidates for sustainable energy generation as their potential for contributing towards local Net Zero strategies is recognised, such as the former Pollock Park Sawmill in Glasgow (Glasgow City Council, 2025). To quote Shaw (1984: 544), 'water power may yet find its place again' even if movement towards it is slow. This potential strengthens the importance of identifying and maintaining a record of Scotland's milling history.

³⁸³ Kaplan Turbines consist of a propeller with adjustable blades, favoured for rivers with smaller heads or variable flow rates (Polák, 2021).

Table 6. 6. Adaptive reuse of mill sites in Scotland.

Mill name and heritage status	Description of historic mill	Modern use
Tormiston Mill (Orkney) 1884–1965 Category B	1884–1885 set up as a mill for preparation of animal feed by Colonel Balfour of Shapinsay for use by tenants and farmers on the surrounding and neighbouring estates.	The conversion of the mill into a restaurant and shop in 1972 was awarded a European Architectural Heritage Award in 1975. In 1989 HES acquired and re-fitted the site as a visitor centre for neighbouring attraction Maeshowe but at present only the carpark is used and visitors are unable to enter the mill building (HES, 2025).
Verdant Works (Dundee) 1833–1889 Category A	Steam powered mill that began as a flax mill but switched to processing of jute in the 1840s. In 1864 the mill had three steam engines, 70 power looms, and 500 workers.	The first re-use of the mill site in the 1900s was as a site for recycling jute waste, curing rabbit skins, and dealing scrap metal. The site opened as a museum in the 1990s following five years of renovation by Dundee Heritage Trust. Visitors are invited to learn about the city's 'Juteopolis' era whilst discovering its 'global connections'. Ex-workers from the mill offer displays of the machinery (Dundee Heritage Trust, 2025a).
Mill on the Fleet (Gatehouse of Fleet, Castle Douglas) 1788–1930s Category B	Originated as a cotton mill. The complex consisted of an upper and lower mill. The upper mill was converted to making bobbins and the lower mill used as a store and bark mill for processing oak in conjunction with the local leather tanning industry.	The lower mill was restored by Dumfries and Galloway Council in the 1980s and made into a visitor and exhibition centre that now houses a bookshop and sells regional crafts. The mill was reconstructed using materials from other mills including two waterwheels that were installed as a decorative rather than functional feature.
Mill of Glenbuchat 1829–1927 Category B	Water-powered oatmeal mill on the Water of Buchat, a tributary of the Don. A sawmill was added later due to the need for wood to rebuild cottages on the landowner's estate.	The mill was purchased from the estate in 2017 with a vision of creating a Heritage Trust, restoring the mill to a fully working condition, and making it an education and tourism centre, bringing jobs and upskilling to the local population (The Mill of Glenbuchat, 2022).
Baldernock mill cottage and former sawmill Category C	The site has had a watermill since 1532. Most recently, a two storey rubble-built nineteenth century water-powered saw mill by the Craigmaddie Burn that operated into the 1930s at least.	The mill building has been converted and extended to be a residential dwelling. The 20 ft pitch-back waterwheel has been restored and remains in-situ.
Dounby Click Mill, 1820s–1880s Scheduled Monument, Status: Designated	Water-powered horizontal grain mill.	The mill has been reconstructed and is managed by HES but is left to be explored by the visitor by themselves, the key to the door remaining at the site. There is an information board giving a brief history of the mill.

Pollock Park Stables and Sawmill Category A	Water-powered saw mill on the River Cart in the south of Glasgow.	Proposals and funding have been received to create a ‘living heritage centre’ that ‘will explore the history of power, from the mighty Clydesdale Horse to the harnessing of the white cart river to create sustainable electricity (Page\Park, 2025, n.p.). The project will reintroduce hydropower and provide a community space and education centre.
Rosefield Mills 1886–1939 Category B	Woollen textiles mill (worsted, serge, blankets), water-powered.	Dumfries Historic Buildings Trust has acquired some of the former mill buildings although these remain derelict and on the at risk register. The Trust envision restoration of the mill as part of a wider plan for urban regeneration in the local area (Dumfries Historic Buildings Trust, 2022).
John O’Groats Mill 1901–2001 Category B	Used until the death of the last miller in 2001. Oats and bere were milled. The current building dates from 1901 but the site has been used for centuries – since 1750 generations of the same family operated the mill.	Now owned by a local charity run by volunteers who hope to open the site as a heritage attraction and community venue. The mill, which still contains its original machinery, is thought to be the last waterwheel driven grain mill built in Scotland (John O’Groats Mill Trust, 2022).
Dalgarven Mill 1203–1975 Category B	There has been a mill on or near the site since 1203 (a waulk mill associated with Kilwinning Abbey and later a meal mill). The most recent mill was used until 1975, grinding grains for cattle food. 1203 there was a waulk mill 2 miles south of the site that was associated with Kilwinnig Abbey.	Currently the Dalgarven Mill Museum of Ayrshire Country Life & Costume. In the 1980s restoration began on the mill and a trust was set up. The site is currently a museum containing the grain mill, a collection of agricultural artefacts from the eighteenth and nineteenth centuries, and a textile and costume collection. The mill contains machinery ‘rescued’ from another mill and the wheel is still capable of turning (The Dalgarven Mill Trust, 2025).
City Mills Perth Category A	Water-powered mill complex that included the Upper Mills (wheat flour mills and granary) and the Lower Mills (grinding of corn and barley). The site has had a mill since the twelfth century although the current buildings date from the eighteenth and nineteenth centuries.	The Upper Mills are currently used as the Mercure Perth Hotel. Original features from the mill are retained and guests are now invited to ‘enjoy a drink in the comfort of the Bar and watch the mill run flowing under your feet’ (Mercure Perth Hotel, 2020, n.p.). The Lower Mills were restored by Perth and Kinross District Council in the 1980s and opened to the public as a working mill tourist attraction. At present the building is vacant but Perth and Kinross Heritage Trust hope to raise funds and develop a Conservation Management Plan (PKHT, 2025).
North Woodside Flint Mill Scheduled Monument, Status: Designated	Water-powered flint mill on the River Kelvin in Glasgow.	The dam, lade, and foundations of the mill and kiln remain in-situ within the Kelvin Walkway. An interpretive board details the history of the mill for passers-by.

6.6 Conclusion

This chapter has demonstrated how transport infrastructure in the form of canals, railways, and improved roads, was developed in Scotland after the traditional industries had already established themselves and formed their geographical distributions. New industries flocked to canal- and railway-adjacent sites in areas that had complementary activities or convenient onward links, such as a railway siding that could connect a mill to a port facilitating the import and export of goods, or an urban centre where there was a market for a finished product. However, investment was made unevenly across the country and the existence of canals and railways did not stop rural industries from continuing or indeed new ones establishing themselves away from their routes. If a mill was established and settled it often remained in place, the owners preferring to bear the costs of carriage of goods or attempting to use their political and social influence to improve transportation. This was exemplified in the example of James Finlay & Co. who lobbied for infrastructure investment in the locality of their mills but were able to finance private transportation options when civic schemes did not materialise.

In regard to the discussion of energy, this thesis makes no claims to add a theory to the debates over why energy transitions happened. Instead, it has provided evidence furthering our knowledge of when and in what manner it took place. An almost concurrent transition to electricity and hydroelectric power happened alongside coal and by the time that steam engines were reliable and accessible enough to mill owners, they already had competition from other energy sources. This is not to claim that steam made no significant inroads as a motive power source in Scotland, nor that certain areas did not struggle for water. Even the most famous and long-lasting water-powered cotton mills such as New Lanark, Deanston, and Catrine, suffered from periods of water shortage and employed back-up power sources to ensure consistent production was possible. The shift to coal was arguably often unnecessary, even so, but it is important not to see this as an either/or scenario. In many cases, a site might have been able to survive using only water or by steam alone, but it was frequently a combination of the two that best suited the individual situation. The transition was non-linear – some mills adopted and persisted with steam, others opted for partial use, trialling the technology, but reverted to water when coal was not economically viable, or embraced a hybrid system of power with more than one source at once. The transition was also characterised by non-use of steam, with mills across the spectrum of industrial scale, from

local grain mills to ‘factory’ style cotton mills persisting with water. Some never moved away from using water (towards steam or any of the alternatives) fully or at all.

In the chapter’s discussion of how entrepreneurs in the Scottish cotton spinning industry were immersed in social systems that spanned from local social and business circles to global networks of empire, a key theme coming to light is that of the conscientious, philanthropic gentleman proprietor. Common desires to instigate societal change brought together otherwise geographically and societally disparate individuals – the English dentist (Fox) and Welsh shopkeeper’s son (Owen) or the Highland politician (Dempster) and Lowland merchant (Dale), for instance. Sometimes the partnerships worked well, other times they did not, especially when the partners held vastly different visions for an industrialised society, resulting in conflict that interfered in the continuity of the mills’ operations. Milling in Scotland has for centuries been connected with the mobility of workers and later the mobility of industrialists. Mills and their owners were also intricately tied up into global systems of finance, trade, and social connections, often suggesting ‘dark’ connections between mills in remoter parts of Scotland and the likes of cotton production, plantations and slavery far beyond Scotland. Mills were further connected, sometimes against their choice, in networks constituted by legal and institutional frameworks that governed aspects of their operation. The discussion in this chapter, and examples from the preceding case study chapters have provided evidence to support that mill owners were capable of working together. However, utilisation of water placed a mill at greater mercy of its neighbours, and the need to collaborate, or conversely, to push back against other riparian users was at times costly and burdensome, the case of municipal water schemes being one of the most obvious.

A further characteristic of mills was paternalistic employers engaging in surveillance and discipline of their workers, which was easier to achieve in the rural planned mill village than in the midst of a sprawling and congested industrialising city. Decisions not to relocate a mill or to adopt alternative motive power sources in the face of difficulties with waterpower, recruitment or transportation could be interpreted as the behaviour of ‘laggards’. But what appeared as a reluctance to change – an inertia holding the mills in a set state – often disguised dynamic decision-making based on scientific, entrepreneurial, and even cultural-moral principles.

Lastly, this chapter has shown that in the current day, historic mills maintain a presence in our everyday lives, whether we are aware of them or not. There is no set pathway for a disused mill. Much as the vigour of the mill owner and societal expectations could determine the geographies of the mill when it was functional, the vision of the landowner, community, and current paradigms in heritage conservation, dictate what shape a mill's future will take. Institutions play a central role too in the implementation of planning regulations and the designation of funds to heritage organisations based on national priorities. Whether mills, including both those that are functional and those in an adapted use, now stay in a given location, is hence open to a not entirely dissimilar play of complex and sometimes contradictory forces as those that shaped their locational geography during the Industrial Revolution.

7. All is grist for the mill: Conclusions

This thesis has charted the historical geography of mills in Scotland, with a primary focus on water-powered mills during the period of industrialisation from the late-eighteenth century through to the early-twentieth century. It has contributed to knowledge of mill locations, their histories, and industrial archaeology by combining two methods, starting with a broad-level discussion of the distribution of the various types of mill found in Scotland, followed by micro-level examples from the cotton industry. With the advent of new transportation routes and energy sources, certain mill sites were no longer advantaged by their original natural endowments and yet many remained in place, arguably against the logic of theories of (optimal) industrial location. Mill owners innovated and adapted to keep their mills operating on their existing sites, thus exhibiting a positive, and what I suggest be termed a ‘dynamic’ form of inertia. In other words, there was less an ‘inert’ inertia – passively sticking to former methods, habits, and places – but rather an active staying put enabled by conscious appraisal and then innovation technologically (in design and operation of mills and machinery), logistically (in terms of business practices), and even socially (intervening in and experimenting with housing provision and workforce composition).

The first overarching aim (1) of this thesis was to document the changing geographies of milling at a national scale as recorded on the OS maps and in the Canmore database, in striving to (1a) quantify mill numbers, types, and locations from the 1850s to the early-1900s. Within this aim I also, (1b) set out to evaluate the completeness of the resulting dataset and appraise the suitability of historic maps for accurately identifying and cataloguing features of the built environment such as mills. This thesis has furthered our knowledge of Scotland’s historical geography of mills by producing a record of 5,837 mill sites, evidencing the presence of 3,698 mills on the 1st edition OS map series and 3,630 on the 2nd edition. As underlined in Chapter 4, the dataset shows that the overall distribution of mills did not change substantially from earlier periods, suggesting that once patterns of industrial location were formed they largely held their place. There was however, clearly ongoing turnover in the ownership of mills in terms of the people and firms financing and controlling the mills. This volatility appears to be characteristic of the period from the late-1700s onwards, a state of affairs that was evidenced through the mapwork in Chapter 4 and the micro-histories of Chapter 5, both of which drew attention, if in different ways, to mills that remained on the same site but changed their function either under the same or new ownership.

Reflecting on and evaluating the process of producing the mills dataset, historic maps hold great potential for identifying industrial archaeological features, including mills. Producing data at a national scale nonetheless presents a formidable task that in this instance would not have been possible without access to crowd-sourced data (GB1900). Starting with a georeferenced gazetteer of place names allowed the targeting of locations highly likely to be mills, significantly increasing the speed at which the entire country could be covered. Although, as discussed in Section 3.2 of the Methods and Sources chapter, this approach may have resulted in the exclusion of mills that would otherwise have been identified by a systematic approach working with physical map sheets. Additionally, maps present the same challenges of interpretation as any other form of historical source. The uncertainties surrounding the remit of the OS surveyors and conventions with regard to their mapping of mills is a challenge and some level of lack of accuracy is unavoidable. The dataset underlying Chapter 4 of this thesis was created based on sites that have specifically been called ‘mills’ by others. The lack of a consistent definition of mills across contemporary sources and mill studies is certainly a challenge and something that requires greater clarity. To some extent this issue created challenges at all stages of the thesis, from data collection to the analysis and comparisons with figures derived by other researchers. This thesis hence shows how much is still unknown about historic mill sites and perhaps we will never be able fully to record every mill. Given the sheer number of mills, many of them leaving no trace in the archives, it is not realistic to expect to ever have a complete representative picture. It is less likely that all mill functions can be recorded given the repeated turnover of owners, companies, and buildings that has been evident at many mill sites. For those in search of definite numbers, the margins of error for mill data derived from maps may be significant. The level of accuracy does, however, vary between mill subcategories. For horizontal mills, papermills, and windmills, the OS maps combined with Canmore produced similar cumulative mill numbers to the estimations of other sources, whereas comparisons with prior studies on grain and textile mills suggest an underestimation of cumulative mill numbers. Many steam-powered mills were likely present on the 1st and 2nd edition maps but recorded as powered by ‘unknown’ means. However, if we accept that I have developed defensible estimations or approximations, which I would maintain is the case, then this method can produce overall patterns of distribution and categorisation that correlate with the findings of others and the data is likely to be representative.

Combining HGIS with data from documentary sources, multiple illustrative examples have been presented that give support to the conclusions of prior work on Scottish mill locations, such as that by Bishop and Muñoz-Salinas (2013). Having acknowledged the limitations inherent in the dataset, the data compiled for this PhD has the potential for supporting further investigations of a more quantitative nature to reconstruct the parameters of mill locations. The existence now of a digitised and georeferenced dataset of mill locations can allow future quantitative analysis into co-location of mills and geomorphological features such as knickpoints, ‘overcrowding’ of waterpower sites, and proximity to urban centres, for example. Work in this direction is currently being carried out by Jonell *et al.* as part of the ‘*Away from the water*’ project. A future direction would also be to connect mills with their wider landscape both in terms of associated buildings and features of the mill ‘envirotechnical system’ (Pritchard, 2011: 1). Only mill buildings were included in the dataset for this thesis, however, the methodology would be suitable for collating mill related features in the landscape such as mill ponds and lades, either by extraction of the GB1900 text or by inference from mill locations. These would have their own heritage, conservation, and ecological consequences for identifying potential detrimental fluvial impacts from mill dams (Downard and Skinner, 2005) or for locating old industrial mill ponds with potential as resources for biodiversity (Wood and Barker, 2000). Additionally, Historic England (2014: 4) have stated that sites with ‘historic significance’ such as former mill buildings, including those where only remnants of the original mill infrastructure remain, are often ‘well-suited’ to hydroelectric power generation. A database of mill locations therefore has potential value in identifying suitable sites for the future installation of renewable energy systems.

As explained in the methodology, it was not practical to refer to the OSNB or additional documentary sources for every mill, although it was during those occasions when the maps were combined with other archival documents, and records of archaeological surveys from Canmore, that the greatest understanding of the mill and its landscape was achieved. To fully understand these or other features of the built environment, the best approach proved to be the combination of methods and sources. By combining traditional and less traditional methods of historical geographical inquiry, we can gain further insights into the processes of industrialisation. It was found that 3,747 of the mill sites recorded from the OS maps did not have a corresponding record in Canmore. Allowing for discrepancies where sites were potentially not matched correctly during the initial processing of the data (Section 3.2.1) and other human error, this implies that over 60% of Scotland’s mill sites from the mid-

eighteenth to early-nineteenth century may have no formal record. It was beyond the scope of this thesis to engage deeply with discourse on preservation, conservation, and heritage of the built environment and it is not possible to comment on the availability of resources of heritage organisations such as HES or how they should be used. The gap in the records should be acknowledged nonetheless, as it will have consequences for mill heritagisation: sites cannot be conserved and valued without a record of their existence. Research documenting mill sites has, and continues to be conducted within academia (*e.g.* Shaw, 1984, Jonell, 2024) and by local historians (*e.g.* Robertson and Robertson, no date), but the findings from these studies are not consistently translated into official records of the built environment. My interpretation is that greater communication, collaboration, and research sharing is required between researchers and heritage partners, which projects such as AHRC's CDP scheme are working to enhance.

My second overarching aim (2) was to examine the geography of mills through their physical, social-political, and economic contexts. Within this aim I firstly (2a) questioned what was the relationship between transportation routes (canals, rivers, roads) and the location of mills? Transport infrastructure was developed in Scotland after the traditional industries had already established themselves and water-powered mills had already acquired a distinctive geographical distribution. Investment in transport infrastructure was made unevenly across the country and while canals, railways, and ports in particular did attract clusters of heavy industry, their existence did not stop rural industries from continuing or indeed new rural mills from being established. Transportation links were important to mills, evidenced by the involvement of mill owners in the lobbying for investment local to their mills. However, a lack of good quality roads or a connection to a railway or canal did not prevent the establishment and continuation of a mill in a location that was otherwise desirable.

My next question asked (2b) how, and to what extent, did natural endowments in the form of rivers, coal, and geomorphological features shape mill geographies? The distribution maps and the discussion in Chapter 4 showed a clear correlation between physical characteristics of landscape and land use and mill location, most obviously in the paucity of mills at elevations higher than cultivation, proximity to watercourses, and sawmills in woodland. In addition, a *reliable* supply of water was an essential consideration, most obviously as power for watermills, but also for other industrial uses. The lengths mill owners went to in monitoring

meteorological conditions and protecting their water rights bears witness to the cruciality of this natural resource. However, human engineering was also capable of amplifying natural features to allow the use of a site that was, without human intervention, incapable of meeting required power needs. Proximity to, and by implication, the price of coal, influenced the founding and distribution of mills utilising steam in the eighteenth century (Nuvolari *et al.*, 2011) and continued to control mill geographies into the nineteenth century, the price of coal being cited as the failure of the first iteration of the Rothesay Cotton Mills, for example.

I then asked (2c) how significant was an energy transition from water to steam for the development and shaping of mill numbers and geographies? Can conclusions drawn in other worldly contexts regarding (limited) availability of water and a desire to switch from waterpower to steam-power, so as to be free from geomorphology and hydrology, be applied to Scotland? The data presented in this thesis supports the argument that, while the ‘Age of Waterpower’ (Shaw, 1984) did indeed diminish over the nineteenth century, watermills had by no means been entirely replaced. Rather, the work was being shared by other motive powers, some new and others that had co-existed with water for centuries. It was demonstrated in Chapter 4 that mills in the c.1850s to 1900s were powered by vertical waterwheels and steam engines, but also that they were powered by horizontal waterwheels, wind pumps, electricity, hydroelectric water turbines, and Scotland’s one remaining tide mill. If we move beyond routine assumptions and only focussing on the most visible presences, for instance of ‘dark Satanic mills’ driven by steam power in the growing urban-industrial conurbations, we really see the rich diversity of mills across Scotland. For instance, the horizontal mill maintained importance in remote regions, and continued not for lack of knowledge or ability, but because there was no need to change until society and the local economy transformed.

By the nineteenth century, certain stretches of river were undoubtedly crowded but general statements regarding water being in short supply or that all suitable sites were occupied would be incorrect. The potential waterpower of Scotland as a whole remained underutilised and some of the largest, most power-hungry mills had the potential for expansion with the help of engineering. For traditional industries such as grain milling in particular, waterpower continued to be utilised into the second half of the twentieth century, albeit in much diminished numbers (Gauldie, 1981: 232). The loss of millwrighting skills and miller knowledge combined with loss of demand for products in particular places was as much a

cause of the final demise of the water-powered mill than rivalry from an alternative motive power. The conclusions here therefore fit into the gradualist views of the industrial revolution that see the era as one of incremental changes and technological micro-improvements (Mokyr, 1990; Crafts and Harley, 1992). The transition from water to steam was characterised by periods of testing, adopting, rejecting, and returning to prior technologies and power sources.

The thesis that steam was preferable as a motive power due to its mobility needs to be called into question as there is indeed evidence of mill industrialists displaying ingenuity in switching their motive power *in-situ* rather than moving to benefit from steam. Installation of hybrid power systems capable of using both steam and water, or alternating between the two seasonally, allowed mills to adapt dynamically to changing needs without requiring a locational change. From Malm's (2016: 96–7) perspective, a move to steam was also in part a shying away from complicated cooperative schemes with others such as creating reservoirs – schemes requiring advanced scientific knowledge, since Malm interprets steam as ‘the ruder option, more easily understood and manipulated, less of an art: it offered opportunities for ‘managerial deskilling’’. In this sense, the engine won over the wheel because it was the less advanced productive force. But I would want to argue a slightly different interpretation. In the early decades of the application of steam power to industrial uses the steam engine was not a simple machine: it was not cheap, skilled mechanics were required who were in high demand and short supply, while breakages could incur large financial losses or, in the case of boiler explosions, sometimes deaths (incidents of which were reported in newspapers such as *The Standard*, 1827; *Bristol Mercury*, 1829). The implication is that steam was far from the simpler, ‘ruder option’ and hence not necessarily the sensible or obvious direction for mill entrepreneurs. Within the case studies and additional supporting evidence presented here there are numerous examples of mill managers and company partners engaging in practices of scientific monitoring, but this amateur science tended to stick with what was known and better understood, namely water. Water was a ‘reliable’ phenomenon and technology in the sense that it had been used for centuries and there was good knowledge and mathematical calculations regarding quantities of water needed for mill activities, and mill owners and managers could record hydrological conditions and deduce these themselves. Whether they thought to do so beforehand is unclear, but once established, their own familiarities with water – even as nascent hydrologists – evidently shaped their working practices and how they assessed the need for alteration or expansion of power systems. Therefore, when choosing to

open a mill, to decide upon a site, or indeed to remain at a certain location, proclivity towards water often – if far from always – prevailed. This was a form of inertia in action, but it was considered and calculated, technologically, economically, and even culturally.

My argument here has begun to address the issue (2d) of whether common features can be identified amongst the people who owned Scotland's mills. Using the partners of the companies in charge of my case study mills as a focus I have observed their social and economic origins and educational backgrounds. Many were well educated and highly active in Britain's learned societies and political systems. Landowners and those with connections to colonial trading or mercantile families were the most represented in this sample, but there were also opportunities for those from lower socio-economic standings to become entrepreneurs, and to form partnerships with other investors based on shared moral principles as well as a desire for economic gain.

In addressing the issue of (2e) regarding the social, economic, and cultural role played by mills, and their hinterlands, in people's lives, I have shown how mill owners used their mills to push forward their own beliefs on social order. Further to this, in recognising that mills and their owners were entwined in far reaching networks of people, goods, and institutions, I observed the influence of socially constituted laws and norms on locational decisions. The very existence of a mill in a particular place was often the result of institutional pulls as much as the attractiveness of natural knickpoints and reservoirs. Previously bound to grinding their grain at the landowner's mill, industrialisation tied the people of Scotland to the new mills in a different way. Separated from the means of production, displaced rural workers and growing urban populations became dependent on the mill for paid work, while the mill owners developed into their paternalistic masters, and all classes were connected by consumption of the mill's produce and often unwittingly embroiled in Scotland's legacy of slavery. Both the 'idyllic' and the 'dark' traces of milling industrial heritage remain in Scotland's present. Sometimes discreetly as a 'run of the mill' part of our culture in placenames, idioms, and disused buildings in the landscape; elsewhere as a proud marker of local socio-cultural identity (Dragan *et al.*, 2024), carefully restored to protect their 'Outstanding Universal Value' (UNESCO, 2022).

My final overarching aim (3) was to consider the ways that locational decisions were governed by processes of inertia. I have proposed the use of *dynamic* inertia to describe the

processes taking place because what was very clear from the data was a conflict of sorts: the same companies and people sticking with mill locations based on locational factors that were no longer as crucial as they once were (*e.g.* water), or were in fact a hinderance (rural sites with limited human resources), were simultaneously highly innovative and well versed in current scientific principles and business acumen. In everyday use, inertia is defined as ‘the state of being inert; disinclination to move or act’ (Collins English Dictionary, 2025). But this is not quite what we see happening in the case of mills. External forces did regulate mills, in the form of laws, rival water users, the unpredictability of weather for instance, and in many instances their owners *fought* to stay in a pre-existing state. This thesis has presented evidence – cartographically and through patient archival encounter – to argue that such forces of inertia acted upon Scottish mills throughout their existence over the centuries. The inertia was dynamic, manifesting in different ways according to not only the physical geography but also cultural norms, economic and technological developments, and perhaps of equal importance was the driving force of a network of mill industrialists and their personal preferences and motivations. Inertia may have often been the result, but it was not stifling, static, or an inability to move forward. It was instead a more dynamic inertia, motivated by empirically based knowledge and experiment, profit-seeking, paternalistic moralising, and more.

References

Contemporary sources

University of Glasgow Archives & Special Collections

A cotton tale 200 years of Catrine and Sorn Parish, 1987. Records of James Finlay & Co, Catrine, Deanston, production records. University of Glasgow Archives & Special Collections. GB 248 UGD 091/1/5/2/8/5.

Agreement regarding river Aye, 1908. Records of James Finlay & Co, Catrine, Deanston, production records. University of Glasgow Archives & Special Collections. GB 248 UGD 091/1/5/2/7/2/4.

Balance book, Catrine Bleaching Works, 1823-1867. Records of James Finlay & Co, Catrine, Deanston, production records. University of Glasgow Archives & Special Collections. GB 248 UGD 091/1/5/2/1/2/1.

Catrine village register, 1863. Records of James Finlay & Co, Catrine, Deanston, production records. University of Glasgow Archives & Special Collections. GB 248 UGD 091/1/5/2/8/1.

Correspondence and papers concerning Glasgow Water Co and legal cases, 1825-1853. Records of James Finlay & Co, Catrine, Deanston, production records. University of Glasgow Archives & Special Collections. GB 248 UGD 091/1/5/3/6/1.

Deanston annual statements, 1859-1871. Records of James Finlay & Co, Catrine, Deanston, production records. University of Glasgow Archives & Special Collections. GB 248 UGD 091/1/5/3/13/5.

Deanston Grounds plans October 1845 Records of James Finlay & Co, Catrine, Deanston, production records. University of Glasgow Archives & Special Collections. GB 248 UGD 091/1/5/3/12/5/1.

Deanston letterbook, Jan 1840-Jul 1844. Records of James Finlay & Co, Catrine, Deanston, production records. University of Glasgow Archives & Special Collections. GB 248 UGD 091/1/5/3/6/7.

Deanston river gauge, 1831-1870. Records of James Finlay & Co, Catrine, Deanston, production records. University of Glasgow Archives & Special Collections . GB 248 UGD 091/1/5/3/13/2.

General Register - certificates of fitness of young persons and children for employment after the 1901 Factory and Workshop Act, including accidents and steam boiler maintenance, 1905. Records of James Finlay & Co, Catrine, Deanston, production records. University of Glasgow Archives & Special Collections. GB 248 UGD 091/1/5/2/6/2/8.

Incoming correspondence to Robt. Crawford, Manager at Deanston, James Smith and Ebenezer Walker at Deanston Works, 1831-1839. Records of James Finlay & Co, Catrine, Deanston, production records. University of Glasgow Archives & Special Collections. GB 248 UGD 091/1/5/3/6/4.

- Inventory and valuation of Deanston and Catrine Mills belonging to James Finlay & Co, 1904. Records of James Finlay & Co, Catrine, Deanston, production records. University of Glasgow Archives & Special Collections. GB 248 UGD 091/1/5/2/7/1/1.
- Labour indenture between Claud Alexander & Co and young people under 21 years of age, 1791-1792, 1825. Records of James Finlay & Co, Catrine, Deanston, production records. University of Glasgow Archives & Special Collections. GB 248 UGD 091/1/5/3/7/1.
- Letter book, 1897. Records of James Finlay & Co, Catrine, Deanston, production records. University of Glasgow Archives & Special Collections. GB 248 UGD 091/1/5/2/10/2.
- Loose leaves: weaving room orders, jotting of number of workers at Doune, Deanston, etc, 1825-1855. Records of James Finlay & Co, Catrine, Deanston, production records. University of Glasgow Archives & Special Collections. GB 248 UGD 091/1/5/3/15/1.
- Minute of agreement between Archibald Buchanan and John Muir, 1881. Records of James Finlay & Co, Catrine, Deanston, production records. University of Glasgow Archives & Special Collections. GB 248 UGD 091/1/5/2/7/2/2.
- Monthly account of yarn and castings bought by Deanston Mill from Ballindalloch Mill. John Thomson to James Smith, 1809. Records of James Finlay & Co, Catrine, Deanston, production records. University of Glasgow Archives & Special Collections. GB 248 UGD 091/1/5/1/1.
- Observations on rainfall, progress of construction at Deanston, machinery, etc. Notebook, J. [] Finlay, 1826-1937. Records of James Finlay & Co, Catrine, Deanston, production records. University of Glasgow Archives & Special Collections. GB 248 UGD 091/1/5/3/13/1.
- Receipt for rent paid by New Lanark Co to Miss Edmondston for Dam Dyke, 1813. Records of Gourock Ropeworks Co Ltd, New Lanark Mills material. University of Glasgow Archives & Special Collections. GB 248 UGD 042/7/13.
- Robert Owen's Diary, 1813-1822. Records of Gourock Ropeworks Co Ltd, New Lanark Mills material. University of Glasgow Archives & Special Collections. GB 248 UGD 042/7/24.
- Sale of property, 1968-1971. Records of James Finlay & Co, Catrine, Deanston, production records. University of Glasgow Archives & Special Collections GB 248 UGD 091/1/5/2/7/2/9.
- Title deeds, Ballindalloch, c1808. Records of James Finlay & Co, Catrine, Deanston, production records. University of Glasgow Archives & Special Collections. GB 248 UGD 091/1/5/2/7/2/1.
- Titled Letter book No. 1, 1881. Records of Gourock Ropeworks Co Ltd, rope makers and textile manufacturers, Port Glasgow, Inverclyde, Scotland. University of Glasgow Archives & Special Collections. GB 248 UGD 042/7/9/2.
- Transference of patents from Archibald Buchanan Esq to Kirkman Finlay Esq, 1824. Records of James Finlay & Co, Catrine, Deanston, production records. University of Glasgow Archives & Special Collections. GB 248 UGD 091/1/5/2/7/2/10.

Visitor's books, 1795-1962. Records of Gourock Ropeworks Co Ltd, rope makers and textile manufacturers, Port Glasgow, Inverclyde, Scotland. University of Glasgow Archives & Special Collections. GB 248 UGD 042/7/1.

Weather reports for Catrine Area Vol.1, Nov 1898-Oct 1911. Records of James Finlay & Co, Catrine, Deanston, production records. University of Glasgow Archives & Special Collections. GB 248 UGD 091/1/5/2/8/3.

Bute Museum and Archives

Anon (1834) On the waterfall between Dalernie Mill and the Devils Bridge. Robert Thom collection, Bute Museum Archives.

Anon. (1829) Account of a new system of water power, invented by Robert Thom, esq., Rothesay Cotton Mills (Communicated by a Friend of the Inventor). *Mechanics Magazine*, 307, 306–317, Bute Museum Archives.

Bute Museum Archives (1995) Correspondence between researcher and Bute Museum Archives.

Moncrieff, James, W. (1829) Memorandum for the Rothesay Spinning Company. 23 February 1829 Bute Museum Archives.

Rothesay Spinning Company (1828–1847) Book of rainfall from 1828-1847. Bute Museum Archives.

Rothesay Spinning Company (1848–1875) Book of rainfall from 1848-1875. Bute Museum Archives.

Rothesay Spinning Company (1839–1875) Water book 1839 to 1875. Bute Museum Archives
Rothesay Spinning Company, (1800–1845) Tabulated record of local rainfall 1800-1845. Bute Museum Archives.

Thom, R. (1829) Brief Account of the Shaws Water Scheme and Present State of the works, Columbian Press, Greenock, 1829. Bute Museum Archives.

Thom, R. (1843) Copy of minutes of evidence as corrected by Mr Thom. Ascog Oct 15 184. Health of Towns Commission 1843. Bute Museum Archives

Thom, R. (c1846) Description of the Rothesay Scheme by Robert Thom for Ian MacCagan. Unpublished manuscript, Bute Museum Archives.

Thom, R. (c1847) Extract from Robert Thom's essay on the collection and storage of water. Final draft probably dating C1847 [from Upper Clyde Water Board]. Bute Museum Archives.

Thom, R. (no date) On Collecting and Storing Water for moving power & for supplying towns, including detailed descriptions of works executed and a variety of Reports on Water operations generally. Unpublished manuscript, Bute Museum Archives.

Other repositories

National Records Scotland:

NRS GB 234, RHP4205 Plan of the Common between Migdale and Lochs Buidhe and Laro in process of division. 1825.

National Museums Scotland:

Oliver and Boyd of Edinburgh and Robert Weir of Glasgow, 1832, National Museums Scotland, Paper mills list / letter, T.1973.10.

Digitised newspapers

- Aberdeen Journal* (1807) Advertisements & Notices. 29 April, British Library Newspapers.
- Aberdeen Journal* (1827) Mr. Thom's hydraulic improvements at Rothesay and Greenock. 14 March, British Library Newspapers.
- Aberdeen Journal* (1836) 3 August, British Library Newspapers.
- Belfast News-Letter* (1837) Supply of water for Belfast. 24 October, British Library Newspapers.
- Berrows Worcester Journal* (1824) Sunday's Post Concluded. 20 May, issue 6333, British Library Newspapers.
- Bristol Mercury* (1829) 'Thursday and Friday's Posts' Dec. 29, 1829, Issue: 2072, British Library Newspapers.
- Caledonian Mercury* (1800a) Advertisements & Notices. 1 May, issue 12264, British Library Newspapers.
- Caledonian Mercury* (1800b) Advertisements & Notices. 17 May, issue 12271, British Library Newspapers.
- Caledonian Mercury* (1800c) Advertisements & Notices. 3 April, issue, 12252, British Library Newspapers.
- Caledonian Mercury* (1814) Advertisements & Notices. 8 January, British Library Newspapers.
- Caledonian Mercury* (1824) Prospectus of a Joint Stock Company, to be named Edinburgh Cotton Mill Spinning Company. Thursday, 11 November, Issue: 16107, British Library Newspapers.
- Caledonian Mercury* (1837) Advertisements & Notices. 10 April, British Library Newspapers.
- Caledonian Mercury* (1843) Hot Blast Case. 22 May, British Library Newspapers.
- Caledonian Mercury* (1855) The Scottish Factories. 22 February, British Library Newspapers.
- Era* (1842) London Gazettes. 10 April, British Library Newspapers.
- Financial Times* (1938) City Men and Matters. 23 December, 4, Financial Times Historical Archive.
- General Evening Post* (1779) Advertisements and Notices. 20 November – 23 November, Seventeenth and Eighteenth Century Burney Newspapers Collection.
- Glasgow Herald* (1844a) Advertisements & Notices. 25 March, British Library Newspapers.
- Glasgow Herald* (1844b) Advertisements & Notices. 11 March, British Library Newspapers.
- Glasgow Herald* (1844c) Advertisements & Notices. 18 March, British Library Newspapers
- Glasgow Herald* (1845) Advertisements & Notices. 14 April, British Library Newspapers
- Glasgow Herald* (1846) Advertisements & Notices. 29 May, British Library Newspapers.
- Glasgow Herald* (1850) Glasgow in olden time. 11 November, issue 4986, British Library Newspapers.
- Glasgow Herald*, (1852) 'GLASGOW, FEBRUARY 6'. 06 February, British Library Newspapers.
- Glasgow Herald* (1853a) Glasgow water company's bill. 04 July, British Library Newspapers.
- Glasgow Herald* (1853b) Glasgow water works. 5 September, British Library Newspapers.
- Glasgow Herald* (1856) Glasgow. 11 January, British Library Newspapers.
- Glasgow Herald* (1857) Advertisements & Notice. 2 November, British Library Newspapers.
- Glasgow Herald* (1866a) Advertisements & Notice. 17 October, British Library Newspapers.
- Glasgow Herald* (1866b) Advertisements & Notices. 11 May, British Library Newspapers.

Glasgow Herald (1869) 'Police Board', 14 September, British Library Newspapers.

Glasgow Herald (1880) Advertisements & Notices 14 May, British Library Newspapers

Glasgow Herald (1881) Advertisements & Notice. 21 January, British Library Newspapers.

Glasgow Herald (1882) LANARK – IMPROVED RAILWAY ACCOMMODATION. 19 December, Issue 302, British Library Newspapers.

Glasgow Herald (1892) Advertisements & Notice. 15 February, British Library Newspapers.

Glasgow Herald (1894a) Advertisements & Notices. 9 March, British Library Newspapers.

Glasgow Herald (1894b) Advertisements & Notices. 9 April, British Library Newspapers.

Glasgow Herald (1895a) Advertisements & Notices. 19 August, British Library Newspapers.

Glasgow Herald (1895b) Advertisements & Notices. 11 October, British Library Newspapers

Glasgow Herald (1895c) Scotch Private Bills in Parliament'. 10 May, British Library Newspapers.

Glasgow Herald (1898) Monday, 16 May, British Library Newspapers

Glasgow Herald (1900) Port-Glasgow. – Death of Mr Henry Birkmyre. 5 May, British Library Newspapers.

Leeds Mercury (1837) The Mercury. 15 April, British Library Newspapers

Leicester Chronicle (1876) Free trade in drink. 3 June, p. 12, British Library Newspapers.

Manchester Mercury (1806) Advertisement and Notices. 3 June, British Library Newspapers.

Manchester Times (1831) Steam Engine Accident. 17 September, issue 150, British Library Newspapers.

Manchester Times (1852) Advertisements & Notice. 24 January, British Library Newspapers.

Morning Chronicle (1832) The Marquess of Bute and the Reformers of Rothesay. 2 Feb. 1832, Issue, 19480, British Library Newspapers.

Preston Chronicle (1833) Table Talk. 13 July, British Library Newspapers.

Preston Chronicle (1839) New patents for October. 16 November, British Library Newspapers.

Royal Cornwall Gazette (1821) London, &c. 6 October, British Library Newspapers.

Senex (1860) Loose jottings regarding Glasgow about the Year 1775. *Glasgow Herald*, 4 February, British Library Newspapers

Telegraph (1797) News. 26 January, Seventeenth and Eighteenth Century Burney Newspapers Collection.

The Celtic magazine (1882) History of The Mathesons. The Editor. 1 September, 7, 83; ProQuest pg. [489]

The Gentleman's Magazine: and historical review (1850) James Smith, Esq. of Deanston. July 1856-May 1868; Sep 1850, p.333, ProQuest.

The Standard (1827) 'DREADFUL ACCIDENT AT TYLDESLEY' July 13, 1827, Issue 47. British Library Newspapers.

The Standard (1845) 'Multiple News Items'. 22 May, Issue 6495, British Library Newspapers

The World (1792) 'Advertisements and Notices'. 21 July, 1792, London, England. Seventeenth and Eighteenth Century Burney Newspapers Collection.

The Statistical Accounts of Scotland

All extracts from the Statistical Accounts were accessed and viewed via University of Edinburgh, University of Glasgow (1999) *The Statistical Accounts of Scotland online service*: <https://stataccscot.ed.ac.uk>.

- The New Statistical Account of Scotland*, Gordon, J. ed. *NSA*, County of Lanark, Vol. V6, 1845.
- The New Statistical Account of Scotland*, Gordon, J. ed. *NSA*, Balfron, County of Stirling, Vol. V8, 1845.
- The New Statistical Account of Scotland*, Gordon, J. ed. *NSA*, County of Fife, Vol. 9, 1845.
- The New Statistical Account of Scotland*, Gordon, J. ed. *NSA*, Dornoch, Sutherland, Vol. 15, 1845.
- The New Statistical Account of Scotland*, Gordon, J. ed. *NSA*, Kilmadock, Perth, Vol. 10, 1845.
- The New Statistical Account of Scotland*, Gordon, J. ed. *NSA*, Lanark, Lanark, Vol. 6, 1845.
- The New Statistical Account of Scotland*, Gordon, J. ed. *NSA*, Lochs, Ross and Cromarty, Vol. 14, 1845.
- The New Statistical Account of Scotland*, Gordon, J. ed. *NSA*, Mauchline, Ayrshire, Vol. 5, 1845.
- The New Statistical Account of Scotland*, Gordon, J. ed. *NSA*, Penicuik, County of Edinburgh, Vol. I, 1845.
- The New Statistical Account of Scotland*, Gordon, J. ed. *NSA*, Rothesay, Bute, Vol. 5, 1845.
- The New Statistical Account of Scotland*, Gordon, J. ed. *NSA*, Sorn, Ayrshire, Vol. 5, 1845.
- The Statistical Account of Scotland*, Sinclair, Sir John ed. *OSA*, Balfron, County of Stirling, Vol. 17, 1796.
- The Statistical Account of Scotland*, Sinclair, Sir John ed. *OSA*, Criech, Sutherland, Vol. 8, 1793.
- The Statistical Account of Scotland*, Sinclair, Sir John ed. *OSA*, Dornoch, Sutherland, Vol. 8, 1793.
- The Statistical Account of Scotland*, Sinclair, Sir John ed. *OSA*, Killearn, Stirling, Vol. 16, 1795.
- The Statistical Account of Scotland*, Sinclair, Sir John ed. *OSA*, Kilmadock, Perth, Vol. 20, 1798.
- The Statistical Account of Scotland*, Sinclair, Sir John ed. *OSA*, Lanark, Lanark, Vol. 15, 1795.
- The Statistical Account of Scotland*, Sinclair, Sir John ed. *OSA*, Mauchline, Ayrshire, Vol. 2, 1792.
- The Statistical Account of Scotland*, Sinclair, Sir John ed. *OSA*, Rothesay, Bute, Vol. 1, 1791.
- The Statistical Account of Scotland*, Sinclair, Sir John ed. *OSA*, Sorn, Ayrshire, Vol. 20, 1798.
- The Statistical Account of Scotland*, Sinclair, Sir John ed. *OSA*, Stonykirck, Wigton, Vol. 2, 1792.

Ordnance Survey Name Books

The reference beginning 'OS1' corresponds to the physical item in National Record of Scotland and can also be used to locate the digitised volumes.

- OS Name Books - Aberdeen county - Volume 1 - City of Aberdeen, 1865-1871, OS1/1/1.
- OS Name Books - Aberdeen county - Volume 4 - Parish of Aboyne and Glentannar, OS1/1/4.
- OS Name Books - Aberdeen county - Volume 66 - Parish of Newhills, OS1/1/66.
- OS Name Books - Ayr county - Volume 22 - Parish of Dalrymple, 1855-1857, OS1/3/22.
- OS Name Books - Ayr county - Volume 37 - Parish of Kirkmichael, OS1/3/37.

OS Name Books - Berwickshire - Volume 15 - 1856-1858, OS1/5/15.
 OS Name Books - Bute county - Volume 7 - Parish of Rothesay - 1855-1864, OS1/6/7.
 OS Name Books - Fife and Kinross county - Volume 12 - Parishes of Abbotshall, Auchterderran, Dysart and Wemyss - 1853-1855, OS1/13/12.
 OS Name Books - Fife and Kinross county - Volume 60 - Parish of St Andrews and St Leonards - 1853-1855, OS1/13/60.
 OS Name Books - Fife and Kinross-shire - Parishes of Markinch and Wemyss - 1853-1855, OS1/13/95.
 OS Name Books - Fife and Kinross-shire - Volume 98 - Parishes of Scoonie, Markinch and Wemyss - 1853-1855, OS1/13/98.
 OS Name Books - Forfar (Angus) county - Volume 67 - Parish of Mains and Starthmartine, OS1/14/67.
 OS Name Books - Lanark county - Volume 24 - Parish of Dunsyre, 1858-1861, OS1/21/24.
 OS Name Books - Lanark county - Volume 44 - Parish of Lesmahagow, 1858-1861, OS1/21/44.
 OS Name Books - Lanarkshire OS Name Books - Volume 55 - 1858-1861, OS1/21/55.
 OS Name Books - Midlothian county - Volume 94 - Parish of St Cuthberts - 1852-1853, OS1/11/94.
 OS Name Books - Morayshire - Volume 13 - Parish of Forres, 1868-1871, OS1/12/13/1.
 OS Name Books - Orkney - Volume 12 - Parish of Kirkwall and St Ola - 1879-1880, OS1/23/12.
 OS Name Books - Perth county - Volume 25 - Parish of Dunblane, OS1/25/25.
 OS Name Books - Perthshire - Volume 37 - Parish of Kilmadock - 1859-1862, OS1/25/37.
 OS Name Books - Perth county - Volume 42 - Parishes of Kinloch, Lethendy, Clunie and Caputh, OS1/25/42.
 OS Name Books - Perth county - Volume 71 - Parish of Redgorton, OS1/25/71, 10.
 OS Name Books - Renfrew county - Volume 19 - Town of Paisley - 1856-1857, OS1/26/19.
 OS Name Books - Stirlingshire - Volume 04 - Parish of Balfron - 1858-1861, OS1/32/4.
 OS Name Books - Stirling county - Volume 11 - Parish of Falkirk, OS1/32/11.
 OS Name Books - Stirling county - Volume 13 - Parish of Fintry - 1858-1861, OS1/32/13.
 OS Name Books - Stirling county - Volume 15 - Parish of Killearn - 1858-1861, OS1/32/15.
 OS Name Books - Sutherland county - Volume 6 - Parish of Criech - 1871-1875, OS1/33/6/1.
 OS Name Books - Wigtown county - Volume 35 - Parishes of Leswalt, Portpatrick, Stranraer and Inch - 1845-1849, OS1/35/35.

Maps and Plans

Ordnance Survey

Ordnance Survey, 25 Inch to the mile Argyllshire and Buteshire - Buteshire CCIV.6 (Rothesay) (Surveyed: 1863, Published: 1864) View online: <https://maps.nls.uk/view/75119689>.

Ordnance Survey, 25 Inch to the mile, Aberdeenshire, LXXXII.12 (Combined) (Surveyed: 1865, Published: 1868) View online: <https://maps.nls.uk/view/74477974>.

Ordnance Survey, 25 Inch to the mile, Ayrshire XXIX.10 (Revised: 1895, Published: 1896). View online: <https://maps.nls.uk/view/82867815>.

Ordnance Survey, 25 Inch to the mile, Kinross-shire XVIII.9 (Revised: 1895, Published: 1896) View online: <https://maps.nls.uk/view/82888470>.

Ordnance Survey, 25 Inch to the mile, Lanarkshire VI.5 (Govan) (Surveyed: 1857 to 1858, Published: 1860) View online: <https://maps.nls.uk/view/74955247>.

Ordnance Survey, 25 Inch to the mile, Lanarkshire VI.6 (Govan) (Surveyed: 1857 to 1858, Published: 1860) View online: <https://maps.nls.uk/view/74955250>.

Ordnance Survey, 25 Inch to the mile, Lanarkshire XLIX.3 (Crawford), (Surveyed: 1858, Published 1861). View online: <https://maps.nls.uk/view/74953901>.

Ordnance Survey, 25 Inch to the mile, Lanarkshire XLIX.3, (Revised: 1896, Published: 1897). View online: <https://maps.nls.uk/view/82895037>.

Ordnance Survey, 25 Inch to the mile, Lanarkshire XVI.15 (Revised: 1895, Published: 1897) View online: <https://maps.nls.uk/view/82892919>.

Ordnance Survey, 25 Inch to the mile, Orkney CVIII.3 (Kirkwall & St Ola) (Surveyed: 1880, Published: 1881). View online: <https://maps.nls.uk/view/75136044>.

Ordnance Survey, 25 Inch to the mile, Orkney XCV.6 (Birsay) (Surveyed: 1880, Published: 1881). View online: <https://maps.nls.uk/view/75135585>.

Ordnance Survey, 25 Inch to the mile, Perth and Clackmannanshire CXXV.15 (Revised: 1899, Published: 1900). View online: <https://maps.nls.uk/view/82899909>.

Ordnance Survey, 25 Inch to the mile, Perth and Clackmannanshire LIII.6 (Revised: 1898, Published: 1900). View online: <https://maps.nls.uk/view/82898334>

Ordnance Survey, 25 Inch to the mile, Perth and Clackmannanshire LXXX.2 (Revised: 1898 to 1899, Published: 1900). View online: <https://maps.nls.uk/view/82898766>;

Ordnance Survey, 25 Inch to the mile, Perth and Clackmannanshire CXXV.13 (Kilmadock) (Surveyed: 1862, Published: 1864). View online: <https://maps.nls.uk/view/74960863>.

Ordnance Survey, 25 Inch to the mile, Renfrewshire XII.2 (Abbey, Middle Church, High Church and Low Church) (Surveyed: 1858, Published: 1860). View online: <https://maps.nls.uk/view/74964128>.

Ordnance Survey, 25 Inch to the mile, Renfrewshire, VI.8 (Kilmacolm) (Surveyed: 1857, Published: 1858). View online: <https://maps.nls.uk/view/199436371>.

Ordnance Survey, 25 Inch to the mile, Stirlingshire XXI.4 (Fintry) (Surveyed: 1861, Published: 1862). View online: <https://maps.nls.uk/view/74983326>.

Ordnance Survey, 25 Inch to the mile, Stirlingshire XXX.1 (Falkirk) (Surveyed: 1860, Published: 1862). View online: <https://maps.nls.uk/view/74972532>.

Ordnance Survey, 25 Inch to the mile, Stirlingshire XXX.1 (Revised: 1896, Published: 1898). View online: <https://maps.nls.uk/view/82906170>.

Ordnance Survey, 25 Inch to the mile, Sutherland CXI.4 (Criech) (Surveyed: 1874, Published: 1874). View online: <https://maps.nls.uk/view/75115524>.

Ordnance Survey, 25 Inch to the mile, Wigtownshire XI.15 (Revised: 1893, Published: 1895). View online: <https://maps.nls.uk/view/82907940>.

Ordnance Survey, 25 Inch to the mile, Ayrshire XXVIII.12 (Revised: 1895, Published: 1896). View online: <https://maps.nls.uk/view/82867731>.

Ordnance Survey, Six-Inch to the mile, Ayrshire Sheet XI.NE (Revised: 1895, Published: 1897). View online: <https://maps.nls.uk/view/75494193>.

Ordnance Survey, Six-Inch to the mile, Berwickshire, Sheet XVI (Surveyed: 1857, Published: 1862). View online: <https://maps.nls.uk/view/228776932>.

Ordnance Survey, Six-Inch to the mile, Lanarkshire Sheet XXXII.NW (Revised: 1909, Date Published: 1912). View online: <https://maps.nls.uk/view/75651417>.

Ordnance Survey, Six-Inch to the mile, Perth and Clackmannan Sheet LIII.NW
(Revised: 1898, Published: 1901). View online: <https://maps.nls.uk/view/75655171>.

Other

Drawing - Plan at Greenland Mills - Edinburgh, Leith, Water of - surveyed by John Steedman., 1927. MS.5848 (97) National Library of Scotland. Plans chiefly made by Messrs Stevenson, the Edinburgh civil engineers. (MSS.5843-5896).

Gordon Jenkins, George (1876) Stoneywood - Plan and sections of intake mill-lade at Paper Works. MS.5862, No.126. National Library of Scotland Plans chiefly made by Messrs Stevenson, the Edinburgh civil engineers. View online: <https://maps.nls.uk/view/218518580>.

H.M.S.O. (Her Majesty's Stationery Office) (1907) Map of the canal systems and navigable rivers of Scotland. London : H.M.S.O., 1907. Available from: <https://maps.nls.uk/view/223169088>

Roy Military Survey of Scotland, 1747-55, British Library Maps CC.5.a.441, 16/2d. View online: <https://maps.nls.uk/view/217499614>.

National Record of the Historic Environment (previously Canmore)

NRHE ID: 2269 (Dounby, Click Mill)

NRHE ID: 103570 (Fort William, Corpach, Scottish Pulp And Paper Mills)

NRHE ID: 128357 (Cowden Saw Mill)

NRHE ID: 128358 (Cowden Saw)

NRHE ID: 128863 (Deanston, Deanston Mills, Spinning Mill)

NRHE ID: 13845 (Spinningdale, Cotton Mill).

NRHE ID: 150929 (Glasgow, Bunhouse Road, Regent Flour Mills)

NRHE ID: 159738 (Fintry, Culcreuch Mill)

NRHE ID: 159738 (Fintry, Culcreuch Mill)

NRHE ID: 17242 (Craig Castle, Dovecot And Mill)

NRHE ID: 21089 (Savoch Tower Pumping Mill)

NRHE ID: 211523 (Arniston, Joseph's Mill)

NRHE ID: 273001 (Braemar, Balloch)

NRHE ID: 291353 (Muck, Rubh' A' Chroisein)

NRHE ID: 295838 (Haugh, Woollen Mill)

NRHE ID: 29596 (Gleann Beag)

NRHE ID: 29611(Gleann Beag, Cro Na H-Airighe)

NRHE ID: 351496 (Greenock, Gourock Rope Work)

NRHE ID: 355053 (Port Glasgow, Ardgowan Street, Glen Mills)

NRHE ID: 3672 (North Ronaldsay, Peckhole Windmill)

NRHE ID: 44016 (Glasgow, 125 Garriochmill Road, North Woodside Flint Mill)

NRHE ID: 556411 (Fort William, Corpach, Scottish Pulp And Paper Mills)

NRHE ID: 60425 (Cairnside)

NRHE ID: 60593 (Stoneykirk, Windmill)
NRHE ID: 7927 (Achscrabster Quarries, Windmill)
NRHE ID: 91129 (Spinningdale)
NRHE ID: 91385 (Spinningdale Burn)
Trove.scot image reference: SC 1124181 (View of Catrine Mill entrance block from north west)
Trove.scot image reference: SC 344633 (View of mill complex from North)
Trove.scot image reference: SC 346194 (East Elevation-partly re-constructed; Ground Floor Plan-as existing Drawn 1984 on basis of survey 1966. Insc. 'GDH')
Trove.scot image reference: SC 755078 (New Lanark: interior. View from S within engine house showing steam engine)
Trove.scot image reference: SC 976636 (Scanned image of photographic copy of technical drawing of water wheel)

Other

Birt (1844) *The Lord Mayor of London*, Birt, printer, 39, Great St. Andrew Street, Seven Dials. Available from: <https://digital.nls.uk/english-ballads/archive/74894668?mode=transcription>.

Bremner, D. (1869) *The industries of Scotland: their rise, progress, and present condition*. Edinburgh: A. and C. Black.

Buchanan, R. (1823) *Practical essays on mill work and other machinery / by Robertson Buchanan : v.2. Vol. 2*. England: Printed for J. Taylor, 1823.

Burnet, J. (1869) *History of the water supply to Glasgow, from the commencement of the present century ... and an appendix, containing tables of capital ... and chemical and medical reports on the quality of water supplied in various localities*. Bell & Bain, 1869.

Cooke, J. (1795) Description of a Steam-Engine. In: *The Repertory of Arts and Manufactures*, Vol. III, London: G. and T. Wilkie 401–404

Davidson, W. (1828) *History of Lanark, and guide to the scenery; with list of roads to the principal towns*.

Fairbairn, W., Sir, and Pole, W. (1877) *The life of Sir William Fairbairn, Bart., F.R.S., LL.D., D.C.L.* Longmans, Green.

Finlay, K. (1833) *Letter to the Right. Hon. Lord As ey, on the cotton factory system, and the Ten Hours' factory Bill*. Glasgow, printed for John Smith & son.

Fleming, G. A. (1839) *A day at New Lanark : and a sketch of its present condition*. F.B.S. Flindell, 1839

Fowler, G. (1836–1837) *Fowler's Commercial Directory of the Lower Ward of Renfrewshire ... 4th ed.* Paisley.

Groome, F. H. (1885) *Ordnance Gazetteer of Scotland: A survey of Scottish topography, statistical, biographical, and historical*. Edited by Francis H. Groome. Edinburgh: Thomas C. Jack, 1884-85.

Henderson, J. (1815) *General view of the agriculture of the county of Sutherland; with observations on the means of its improvement*. London: Sherwood, Neely & Jones.

- Hewison, J. K. (1893) *The Isle of Bute in the Olden Time*. Vol. II. William Blackwood and Sons. Edinburgh.
- Hodder, E. (1890) *Sir George Burns, Bart: His times and friends*. Hodder and Stoughton.
- Holyoake, G. (1859) *Life and last days of Robert Owen, of New Lanark. [Discourse delivered in the Public Hall, Rochdale, January 1859]* Source: JSTOR Primary Sources , 01-01-1859.
- ICE (1848) Obituary. Robert Thom, Born 1774. *Minutes of the Proceedings of the Institution of Civil Engineers* 7(1848): 7–9.
- ICE (1851) Obituary. James Smith (Deanston), 1789-1850. *Minutes of the Proceedings of the Institution of Civil Engineers Annual Report*, 10(1851), 91–94.
- Local Government (Scotland) Act 1889, 1889 c. 50 (Regnal. 52_and_53_Vict) Available from: <https://www.legislation.gov.uk/ukpga/Vict/52-53/50/enacted>.
- Local Government (Scotland) Act 1894, 1894 c. 58 (Regnal. 57_and_58_Vict) Available from: <https://www.legislation.gov.uk/ukpga/Vict/57-58/58>.
- Murray, J. and Pullar, L. (1910) *Bathymetrical Survey of the Fresh-Water Lochs of Scotland, 1897-1909. Volume II, Part II*. Edinburgh Challenger Office. 1910.
- Owen, R. (1813) *A new view of society; or, essays on the principle of the formation of the human character*. London.
- Paterson, J. (1847–1852) *History of the County of Ayr : with a genealogical account of the families of Ayrshire*. Edinburgh: T.G. Stevenson. Edinburgh [Online] Available from: <https://archive.org/details/historyofcountyo02pateuoft/page/n5/mode/2up> [Accessed 25/01/2025].
- Paton, J. (1890) *Scottish national memorials: A record of the historical and archaeological collection in the bishop's castle, Glasgow, 1888*. James MacLehose and Sons.
- Pering, R., Duckworth, J. T., Wise, W. F., Henderson, R., Holditch, G., Allen, T., Leaford, J., Goodwin, C., Wardrop, J., Gordon, H., Watson, J., Thom, R., Busby, C. A., Hutton, C., Gregory, O., Troughton, E., Kelly, P., Bramah, T., Bramah, F., ... Mayfield, T. (1822) Papers In Mechanics. *Transactions of the Society, Instituted at London, for the Encouragement of Arts, Manufactures, and Commerce*, 40, 54–177.
- Porteous, A. (1912) *History of Crieff*. Edinburgh, 1912.
- Reid, J. (1864) *History of the county of Bute, and families connected therewith*. Glasg. &c.
- Simmonds, P. L. (1870) 8th meeting: - On new paper-making materials, and the progress of the paper manufacture. *Journal of the Society of Arts*, 19, 171.
- Smith, J. (1896) *Strathendrick, and its inhabitants from early times : An account of the parishes of Fintry, Balfron, Killearn, Drymen, Buchanan, and Kilmarnock*. Glasgow: James Maclehorse.
- Sommerville, A. F. (1845) Paper mills in Scotland, makers' names, where situated, and description of papers made at each. A.F. Sommerville, 1845. *The Making of the Modern World*, link.gale.com/apps/doc/U0106472936/MOME?u=oxford&sid=bookmark-MOME&pg=1. [Accessed 12/12/2023].
- Stewart, G. (1881) *Curiosities of Glasgow citizenship, as exhibited chiefly in the business career of its old commercial aristocracy*. J. Maclehorse.
- The Glasgow Corporation Waterworks Act 1855. 1855 c. cxviii (Regnal. 18_and_19_Vict Available from: <https://www.legislation.gov.uk/ukla/Vict/18-19/118/contents/enacted>.
- Thirlage Act 1799, 1799 c. 55 (Regnal. 39_Geo_3), Available from: <https://www.legislation.gov.uk/apgb/Geo3/39/55>.
- Thomson, J. (1800) General view of the agriculture of the county of Fife: with observations on the means of its improvement: drawn up for the consideration of the Board of

- Agriculture & Internal Improvement. By John Thomson, D. D. Minister Of Markinch. (1800). Printed by J. Moir.
- Tredgold, T. (1841) Life of Buchanan. In: Buchanan, Robertson. (1850). *Practical essays on mill work and other machinery. By Robertson Buchanan, engineer. With notes and additional articles, containing new researches on various mechanical subjects, by Thomas Tredgold.* England: J. Weale, 1841. Pages xlv -xlvii.
- Weber, H. (1899) An Address. *The Lancet*. May 20 1899. No. 3951, 1343-1346.
- William B. Reid & Co. (1903) *Guide and Directory to Mauchline, Catrine, Sorn, and Surrounding Districts, comprising Historical and Topographical Notes.* William B. Reid & Co.: Mauchline. Reproduction available from:
https://www.ayrshirehistory.com/pdf/guide_to_mauchline_catrine_&_sorn.pdf.

Secondary sources

- Abbey, C. (2010) *Catrine Cotton Mills* [Online] Available from:
<https://yesterdayrules.wordpress.com/2010/09/23/catrine-cotton-mills/> [Accessed 31/08/2022].
- Abbott, E. A. and Yarbrough, J. P. (1999) *Re-Thinking the Role of Information in Diffusion Theory: An Historical Analysis with an Empirical Test.* Paper Submitted to Communication Theory and Methodology Division, Association for Education in Journalism and Mass Communication, for its annual convention, New Orleans, LA, 1999. Access date: June 2006. Available from:
http://www.infoamerica.org/documentos_pdf/difusion_teoría.pdf.
- Acemoglu, D. (2009) *Introduction to modern economic growth*, Princeton University Press, Princeton.
- Adams, I. H. and Whyte, I. D. (1978) The Agricultural Revolution in Scotland: Contributions to the Debate. *Area*, 10(3), 198-205.
- Ainslie, D. (2018) *Five Things You Didn't Know About...Maintaining a Mill* [Online] Available from: <https://blog.historicenvironment.scot/2018/05/maintaining-a-mill/> [Accessed 23/04/2025].
- Aldcroft, D. H. (1964) The entrepreneur and the British economy, 1870-1914. *The Economic History Review*, 17(1), 113-134.
- Allen, R. C. (2009) *The British industrial revolution in global perspective.* Cambridge, UK: Cambridge University Press.
- Allen, R. C. (2011) Why the industrial revolution was British: Commerce, induced invention, and the scientific revolution. *The Economic History Review*, 64 (2), 357–384
- Allen, R. C. (2015) The high wage economy and the industrial revolution: a restatement. *The Economic History Review*, 68: 1–22.
- Alonso del Rosario, J. J., Vidal Pérez, J. M., Pérez Serrano, J., and Mendoza Sánchez, J. C. (2006) Exploitation of tidal power in the Bay of Cadiz: ancient tidal mills. *Scientia Marina*, 70(1), 21–30.

- Alvarez-Palau, E. J., Bogart, D., Satchel, M. and Shaw-Taylor, L. (2024) Transport and urban growth in the First Industrial Revolution. *The Economic Journal*, 135(668), 1191–1228.
- Anderson, G. (1850) *Guide to the Highlands and Western Islands of Scotland, Including Orkney and Zetland*. Edinburgh: A. and C. Black.
- Anderson, R. D. (1983). Education and the State in Nineteenth-Century Scotland. *The Economic History Review*, 36(4): 518-534.
- Angus, S., Hansom, J.D., and Rennie. A.F. (2011) Habitat change on Scotland's coasts. In: S.J. Marrs, S. Foster, C. Hendrie, E. C. Mackey, D. B. A. Thompson, eds. *The Changing Nature of Scotland*, Edinburgh: The Stationery Office, 183–198.
- Anton, A. E. (1958) Handfasting' in Scotland. *The Scottish Historical Review*, 37(124): 89-102.
- Archer, J. E., Thomas, H. and Turley, R. M. (2017) The millers' tales: sustainability, the arts and the watermill. In: A. Johns-Putra, J. Parham and L. Squire, eds. *Literature and sustainability*, Manchester: Manchester University Press, 13–32.
- Archives Hub (2025) *Frequently Asked Questions* [Online] Available from: <https://archiveshub.jisc.ac.uk/faq/> [Accessed 08/07/2025].
- Argyll & Bute Council (n.d) Rothesay Conservation Area. Town Centre Character Area Appraisal [Online] Available from: <https://www.argyll-bute.gov.uk/moderngov/documents/s50134/> [Accessed 09/02/2025].
- ArtUK (2022) *James Smith of Deanston* [Online] Available from: <https://artuk.org/discover/artworks/james-smith-of-deanston-127033> [Accessed 20/11/2022].
- ArtUK (2023) *Archibald Buchanan (1769–1841) by Henry Raeburn (1756–1823)* [Online] Available from: <https://artuk.org/discover/artworks/archibald-buchanan-17691841-179916> [Accessed 05/03/2023].
- Ashton, T. S. (1934) III. The industrial revolution. *The Economic History Review*, a5(1): 104–119.
- Ashton, T. S. (1948) *The industrial revolution, 1760-1830*. Oxford University Press.
- Ashworth, W. (2008) The Ghost of Rostow: Science, Culture and the British Industrial Revolution. *History of Science*, 46(3), 249–274.
- Atack, J., Bateman, F. and Margo, R. A. (2008) Steam power, establishment size, and labor productivity growth in nineteenth century American manufacturing. *Explorations in Economic History*, 45(2): 185–198.
- Atack, J., Bateman, F. and Weiss, T. (1980) The Regional Diffusion and Adoption of the Steam Engine in American Manufacturing. *The Journal of Economic History*, 40(2): 281-308.
- Ayres, R. U. (1998) Eco-thermodynamics: economics and the second law. *Ecological Economics*, 26(2): 189–209.
- Ayrshire History (2022a) *Dalgain Mill / Sorn Mill* [Online] Available from: <https://www.ayrshirehistory.com/> [Accessed 22/10/2022].

- Ayrshire History (2022b) *Catrine Mill Wheels* [Online] Available from: https://www.ayrshirehistory.com/catrine_mill_big_wheels.html [Accessed 02/11/2022].
- Ayrshire Rivers Trust (2006) 3. *Catchment description* [Online] Available from: <http://www.ayrshireriverstrust.org/wp-content/uploads/3%20Catchment%20description.pdf> [Accessed 01/11/2022].
- Babb, C. C., Covert, C. C. and Bolster, R. H. (1912) *Surface Water Supply of the United States 1910. Part I. North Atlantic Coast*. Washington: Department of the Interior United States Geological Survey, Water-Supply Paper 281.
- Balfron Community (2025) *Our History* [Online] Available from: <https://www.balfron.org.uk/history> [Accessed 09/02/2025].
- Balfron Primary (2022) *Balfron Primary School* [Online] Available from: <https://blogs.glowscotland.org.uk/st/balfronprimary/> [Accessed 04/09/2022].
- Bangor-Jones, M. (2002) Sheep farming in Sutherland in the eighteenth century. *Agricultural History Review*, 50(2), 181–202.
- Barão, M., Valente, T. and Reimão Costa, M. (2014) Watermills and traditional landscape in the hills of the Algarve, Portugal. In: M. Correia, GD Carlos, S. Rocha, eds. *Vernacular Heritage and Earthen Architecture: Contributions for Sustainable Development*. London: Taylor & Francis Group, 283–288.
- Barker, H. and Harvey, K. (2003) Women Entrepreneurs and Urban Expansion: Manchester 1760–1820. In: R. Sweet and P. Lane, eds. *Women and Urban Life in Eighteenth-Century England*, Routledge, 111–129.
- Bârliba, L. L., Bârliba, C., Vasile, P. and Ivu, L. (2024) Performing a cartographic work to update the tourist maps with the route of the water mills in the natural reservation "Cheile Rudăriei". *Research Journal of Agricultural Science*, 56(2), 23–30.
- Barony Mill (2025) *The Only Place on Earth for Stoneground Bere* [Online] Available from: <https://baronymill.com/> [Accessed 12/07/2025].
- Barraud, R. (2017) Removing mill weirs in France: The structure and dynamics of an environmental controversy. *Water alternatives*, 10(3), 796–818.
- Bartlett, J. N. (1980) Alexander Pirie & Sons of Aberdeen and the expansion of the British paper industry, c. 1860–1914. *Business History*, 22(1), 18–34.
- BatchGeo (2024) *BatchGeo* [Online] Available from: <https://www.batchgeo.com/> [Accessed 18/11/2024].
- Beckles, N. I. (1968) Textiles and port growth in Dundee. *Scottish Geographical Magazine* 84(2): 90–98.
- Bennett, R. and Elton, J. (1898) *History of Corn Milling* (Vol. 2). Simpkin, Marshall, Limited.
- Berg, M. (1993) Small Producer Capitalism in Eighteenth-Century England. *Business history*, 35 (1), 17–39.
- Berg, M. (1994) *The age of manufactures, 1700-1820: industry, innovation, and work in Britain*. 2nd ed. London: Routledge.
- Berg, M. (2013) Useful knowledge, ‘industrial enlightenment’, and the place of India. *Journal of Global History*, 8(1), 117–141.

- Berg, M. and Hudson, P. (1992) Rehabilitating the industrial revolution. *The Economic History Review*, 45(1), 24-50.
- Berg, M. and Hudson, P. (2023) *Slavery, capitalism and the Industrial Revolution*. London: Polity.
- Bignell (2013) *Mapping the windmill: the Ordnance Survey in England*. London: The Charles Close Society.
- Bishop, P. (2011a) The water mills of Baldernock parish. *History Scotland*, 39–43.
- Bishop, P. (2011b) Whin millstones in Baldernock, western Central Belt. *Vernacular Building*, 34, 43–54.
- Bishop, P. (2019) A rural water mill in Baldernock, East Dunbartonshire. *Vernacular Building*, 42, 77–96.
- Bishop, P. (2021) OS mapping of water mills. *Sheetlines*, 120:11–35.
- Bishop, P. (2022) OS 25-inch mapping of threshing mills in Scotland, *Sheetlines*, 123, 7–25
- Bishop, P. and Jansen, J. D. (2005) The geomorphological setting of some of Scotland's east coast freshwater mills: a comment on Downward and Skinner (2005) 'Working rivers: the geomorphological legacy...'. *Area*, 37(4), 443-445.
- Bishop, P. and Muñoz-Salinas, E. (2013) Tectonics, geomorphology and water mill location in Scotland, and the potential impacts of mill dam failure. *Applied Geography*, 42, 195–205.
- Bishop, P., Cuenca-Garcia, C., Jones, R. and Cook, D. (2017) Lime Burning in Clamp Kilns in Scotland's Western Central Belt: Primitive Industry or Simple but Perfectly Adequate Technology? *Industrial Archaeology Review*, 39(1), 38–58.
- Bishop, P., Hoey, T. B., Jansen, J. D., and Artza, I. L. (2005) Knickpoint recession rate and catchment area: the case of uplifted rivers in Eastern Scotland. *Earth surface processes and landforms*. 30(6), 767–778.
- Bishop, P., Muñoz-Salinas, E., MacKenzie, A. B., Pulford, I. and McKibbin, J. (2010) The character, volume and implications of sediment impounded in mill dams in Scotland: the case of the Baldernock Mill dam in East Dunbartonshire. *Earth and Environmental Science Transactions of the Royal Society of Edinburgh*, 101(2): 97–110.
- Blaikie, P. (1978) The Theory of the Spatial Diffusion of Innovations: A Spacious Cul-De-Sac. *Progress in Human Geography*, 2(2), 268–295.
- Blake, W (1810) Preface to Milton a Poem.
- Blomley, N. K. and Clark, G. L. (1990) Law, Theory, and Geography. *Urban geography* 11(5): 433–446.
- Blomley, N. K., Delaney, D., and Ford, R. T. (2001) *The legal geographies reader: law, power, and space*. Oxford: Blackwell Publishers.
- Bogart, D., L. Shaw-Taylor and X. You (2018) "The development of the railway network in Britain 1825–1911." *Transport, Urbanization and Economic Development in England and Wales C: 1670-1911*.
- Bond, E. (2023) An Introduction to Scotland's Transnational Heritage: Sites, Things and Time(s). In: E. Bond and M. Morris, eds. *Scotland's Transnational Heritage: Legacies of Empire and Slavery*. Edinburgh: Edinburgh University Press, 1–20.

- Bottomley, S. (2024) Stationary steam power in the United Kingdom, 1800–70: An empirical reassessment, *Economic History Review*, 1–24.
- Boulton, M., Watt, J. and Tann, J. (1981) *The selected papers of Boulton & Watt*. Diploma Press.
- Bowley, A. L. (1900) The Statistics of Wages in the United Kingdom During the Last Hundred Years. (Part VII.) Wages in the Building Trades--Contd. Scotland and Ireland. *Journal of the Royal Statistical Society*, 63(3), 485–497.
- Brake, L. (2012) Half Full and Half Empty, *Journal of Victorian Culture*, 17(2), 222–229.
- Britannica (2025a) *textile* [Online] Available from: <https://www.britannica.com/topic/textile> [Accessed 29/07/2025].
- Britannica (2025b) *steam engine* [Online] Available from: <https://www.britannica.com/technology/steam-engine> [Accessed 27/07/2025].
- Broadberry, S. and Gupta, B. (2009) Lancashire, India, and shifting competitive advantage in cotton textiles, 1700–1850: The neglected role of factor prices. *The Economic History Review*, 62(2), 279–305.
- Brogan, C. (1951) *James Finlay & Company Limited : manufacturers and East India merchants, 1750-1950*. Jackson, for James Finlay and Company.
- Brunel University of London (2019) *William Allen* [Online] Available from: <https://www.brunel.ac.uk/life/library/ArchivesAndSpecialCollections/News-and-events/News/William-Allen> [Accessed 06/03/2025].
- Brykała, D. and Podgórski Z. (2020) Evolution of landscapes influenced by watermills, based on examples from Northern Poland. *Landscape and urban planning*, 198, 103798.
- Buchty-Lemke, M., and Lehmkuhl, F. (2018) Impact of abandoned water mills on Central European foothills to lowland rivers: a reach scale example from the Wurm River, Germany. *Geografiska Annaler: Series A, Physical Geography*, 100(3), 221–239.
- Burnett, J., Mercer, K., and Quye, A. (2003) The Practice of Dyeing Wool in Scotland c. 1790—c. 1840. *Folk Life*, 42(1), 7–31.
- Burnley, J. and Brown, R. (2008) Fairbairn, Sir William, first baronet (1789–1874), engineer. *Oxford Dictionary of National Biography* [Online] Available from: <https://doi.org/10.1093/ref:odnb/9067> [Accessed 11/07/2025].
- Bute Museum (2025) *Rothesay cotton mills* [Online] Available from: <https://www.butemuseum.org.uk/rothesay-cotton-mills/> [Accessed 09/02/2025].
- Butt, J. (1966) The industrial archaeology of Gatehouse-of-Fleet. *Industrial Archaeology*, 3(2), 127-37.
- Butt, J. (2006) Dale, David (1739–1806), merchant and cottonmaster. *Oxford Dictionary of National Biography* [Online] Available from: <https://doi.org/10.1093/ref:odnb/7014> [Accessed: 14/10/2022].
- Butt, J. (2015) cotton industry. In: R. Crowcroft and J. Cannon, eds. *The Oxford companion to British history*. Second edition. Oxford University Press, 2019.
- Byroms, R. (2015) *William Fairbairn - experimental engineer and mill-builder*. Doctoral thesis, University of Huddersfield.
- Cadell, H. M. (1923) Scottish canals and waterways. *Scottish geographical magazine*, 39(2), 73–99.

- Cain, P. J. and Hopkins, A. G. (1987) Gentlemanly capitalism and British expansion overseas II: new imperialism, 1850-1945. *The Economic History Review* 40(1), 1–26.
- Caird, J. B. (1964) The making of the Scottish rural landscape. *Scottish Geographical Magazine*, 80(2), 72–80.
- Calcluth, H. (2017) *Henry Birkmyre and his Descendants* [Online] Available from: <https://rlhf.info/henry-birkmyre-and-his-descendants/> [Accessed 30/01/2023].
- Campbell, S. (2024) Examining interwoven narratives: multidirectional memory between enslaved labourers and mill workers in Northern England heritage sites. *International Journal of Heritage Studies*, 30(5), 573–585.
- Canal & River Trust (2023) *Canals Over Time* [Online] Available from: <https://storymaps.arcgis.com/stories/f0d6d5d96a964a358ee914d915e95edc> [Accessed: 01/05/2025].
- Capecchi, D. (2013) Over and undershot waterwheels in the 18th century. Science-technology controversy. *Advances in Historical Studies*, 2(03), 131–139.
- Cardwell, D. (2003) *The Development of Science and Technology in Nineteenth-Century Britain: The importance of Manchester*. In: R. L. Hills, ed. *The Development of Science and Technology in Nineteenth-Century Britain*. Hampshire, Ashgate, 2003.
- Carlson, H. L. (1992) Care and education of young children of pauper and working classes: New Lanark, Scotland, 1790–1825. *Paedagogica historica*, 28 (1), 8–34.
- Carlyle, W. J. (1979) The changing distribution of breeds of sheep in Scotland, 1795–1965. *The Agricultural History Review*, 27(1), 19–29.
- Carr, R. (2008) The gentleman and the soldier: patriotic masculinities in eighteenth-century Scotland. *Journal of Scottish Historical Studies*, 28(2), 102–121.
- Carvajal Castro, Á. and Escalona, J. (2024) Mills and the politics of water management in the NW of the Iberian Peninsula, 900-1050. In: I. Martín-Viso, ed. (2024) *Political landscapes in Late Antiquity and Early Middle Ages: the Iberian Northwest in the Context of Southern Europe*, Firenze University Press, 225–228.
- Cerarols, R., and Luna, A. (2020) 7 Geocreativity. In: M.A. Rhodes II, W.R. Price, and A. Walker, eds. *Geographies of Post-Industrial Place, Memory, and Heritage*, Routledge, 103–122.
- Chaloner, W. H. (1953) Sir Thomas Lombe (1685-1739) and the British silk industry, *History Today*, 3(11), 778.
- Chaloner, W. H. (1954) Robert Owen, Peter Drinkwater and the early factory system in Manchester, 1788-1800. *Bulletin of the John Rylands Library*, 37(1), 78–102.
- Chapman, S. D. (1965) The Transition to the Factory System in the Midlands Cotton-Spinning Industry. *The Economic History Review*, 18(3), 526–543.
- Chapman, S. D. (1969) The Peels in the Early English Cotton Industry. *Business History* 11(2), 61–89.
- Chapman, S. D. (1970) Fixed Capital Formation in the British Cotton Industry, 1770-1815. *The Economic History Review*, 23(2), 235–266.
- Chapman, S. D. (1971) Fixed Capital Formation in the British Cotton Manufacturing Industry. In: J. P. P. Higgins, S. Pollard, and J. E. Ginarlis (1971) *Aspects of capital*

investment in Great Britain, 1750-1850: A preliminary survey, Report of a conference held at the University of Sheffield 5-7 January 1969. Routledge, 57–107.

- Chapman, S. D. (1979) Financial restraints on the growth of firms in the cotton industry, 1790-1850. *The Economic History Review*, 32(1), 50–69.
- Chapman, S. D. (1992) *The early factory masters: the transition to the factory system in the Midlands textile industry.* Gregg Revivals.
- Chapman, S. D. (1993) XI The foundation of the English Rothschilds: N.M. Rothschild as a Textile Merchant 1799–1811, *South African Journal of Economic History*, 8:1, 221–241.
- Charlier, R. H. and Menanteau, L. (1997) The saga of tide mills. *Renewable & sustainable energy reviews*. [Online] 1 (3), 171–207.
- Charlier, R. H, Ménanteau, L., Chaineux, M. C. (2004) The Rise and fall of the tide mill. In *Ocean sciences bridging the millennia: a spectrum of historical accounts*, Paris: UNESCO, 314-338.
- Cheape, H. (1984) *Kirtomy mill & kiln.* Edinburgh: Scottish Vernacular Buildings Working Group.
- Cheape, H. (2001). For the betterment of mankind: Scotland, the enlightenment and the agricultural revolution. *Folk Life*, 40(1), 7-24.
- Cheape, H. (2004) *Smith, James, of Deanston* [Online] Available from: <https://www.oxforddnb.com/> [Accessed 02/11/2022].
- Ciliberto, F. (2010) Were British cotton entrepreneurs technologically backward? Firm-level evidence on the adoption of ring spinning. *Explorations in Economic History*, 47(4), 487–504.
- Clapham, J. H. (1939) *An economic history of modern Britain.* 2nd ed., reprinted with corrections, Cambridge: University Press.
- Clark, S. (1976) 5. The Shaws Water Falls in Greenock. *Renfrewshire Local History Forum*, 14, 26.
- Clarke, E. (1897) "Smith, James (1789–1850)." *Oxford Dictionary of National Biography* [Online] Available from: <https://www.oxforddnb.com/view/10.1093/odnb/9780192683120.001.0001/odnb-9780192683120-e-25822> [Accessed 03/01/2023].
- Claus, R. J. and Claus, K. E. (1971) Behavioural location theory: A review and discussion of pred's dynamic location model. *Australian geographer*, 11(5), 522–530.
- Cliff, A. (1981) *Spatial diffusion: An historical geography of epidemics in an island community* (Cambridge geographical studies; 14). Cambridge: Cambridge University Press.
- Cliff, A., Pred, A., and Hägerstrand, T. (1992) Classics in human geography revisited: Hägerstrand, T. 1967: Innovation diffusion as a spatial process. Chicago: University of Chicago Press. Translation and postscript by Allan Pred. *Progress in Human Geography*, 16(4), 541–544.
- Clough, M. (2004) *Finlay, Kirkman* [Online] Available from: <https://doi.org/10.1093/ref:odnb/9467> [Accessed: 18/09/2022].

- Clow, A. (1945) The chemical revolution: a contribution to social technology. *Annexe Thesis Digitisation Project 2018 Block 18*.
- Clow, A. and Clow, N. L. (1945) Vitriol in the Industrial Revolution. *The Economic History Review*, 15(1/2), 44–55.
- Clyde River Foundation (2023) *The Clyde catchment* [Online] Available from: <https://www.clyderiverfoundation.org/clyde-catchment/> [Accessed 02/02/2023].
- Cohen, R. (2008) Fox, Joseph (1775–1816), dental surgeon and philanthropist. *Oxford Dictionary of National Biography*. [Online] Available from: <https://doi.org/10.1093/ref:odnb/38625> [Accessed 01/05/2024].
- Cole, G. D. H. (1925) *New Lanark, 1800–1813*, Routledge.
- Coleman, D. C. (1957) The Early British Paper Industry and the Huguenots. *The Huguenot Society Journal*, 19(5), 210–225.
- Coleman, D. C. (1983) Proto-Industrialization: A Concept Too Many. *The Economic History Review*, 36, 435–448.
- Coleman, D.C. (1992) *Myth, history, and the Industrial Revolution*, London: Hambledon Press.
- Coleman, R. *et al.* (2008) Early Medieval Settlement and Ironworking in Dornoch, Sutherland. *Scottish Archaeological Internet Reports*, 28 (January), 1–22.
- Collins English Dictionary (2025) *inertia* [Online] Available from: <https://www.collinsdictionary.com/dictionary/english/inertia> [Accessed 06/07/2025].
- Collie, G. (2009) A comparison of the horizontal water mill at Dounby, Orkney with those found in Shetland. *Vernacular Building* 32, pp31-40.
- Collins (2023) *Definition of 'voe'* [Online] Available from: <https://www.collinsdictionary.com/> [Accessed 24/04/2023].
- Collinson, E. and Baxter I. (2022). Liminality and contemporary engagement: Knockando Wool Mill - a cultural heritage case study. *Journal of heritage tourism* 17(1): 107-123.
- Coltman, V. (2019) Scots in Empire: ‘Good Fishing in Muddy Waters’: Claud Alexander in Calcutta and Catrine. In *Art and Identity in Scotland: A Cultural History from the Jacobite Rising of 1745 to Walter Scott*, V. Coltman, ed. Cambridge: Cambridge University Press, 104-136.
- Companies House (2023) *ARJOWIGGINS Group Limited* [Online] Available from: <https://find-and-update.company-information.service.gov.uk/company/SC634103/filing-history> [Accessed 22/12/2023].
- Connah, G. (1994) "Bagot's Mill: Genesis and revelation in an archaeological research project." *Australasian historical archaeology : Journal of the Australasian Society for Historical Archaeology* 12: 3-55.
- Cooke, A. (1979a) Richard Arkwright and the Scottish Cotton Industry, *Textile History*, 10:1, 196-202.
- Cooke, A. J. (1979b) Robert Owen and the Stanley Mills, 1802–1811. *Business History*, 21(1), 107–111.
- Cooke, A. J. (1995) Cotton and the Scottish Highland Clearances – the development of Spinningdale 1791-1806, *Textile History*, 26, 89-95.

- Cooke, A. J. (2009) The Scottish Cotton Masters, 1780–1914, *Textile History*, 40:1, 29-50.
- Cooke, A. J. (2012) An Elite Revisited: Glasgow West India Merchants, 1783–1877. *Journal of Scottish historical studies* 32(2): 127-165.
- Cookson, G. (2014) Quaker families and business networks in nineteenth-century Darlington. *Quaker Studies*, 8(2).
- Cooney, E. W. (1991) Eighteenth Century Britain's Missing Sawmills: A Blessing in Disguise? *Construction History*, 7, 29–46.
- Cossar, J. (1912) Notes on the geography of the Edinburgh district, *Scottish Geographical Magazine*, 28:1, 10-30,
- Cosson, F. (2017) The small politics of everyday life: local history society archives and the production of public histories. *Archives and records* (Abingdon, England) 38(1): 45-60.
- Cossons, N. (2016) Why preserve the industrial heritage?. In *Industrial heritage re-tooled* (pp. 6-16). Routledge.
- Cotterill, M. S. (1980) The Development of Scottish Gas Technology 1817–1914: Inspiration and Motivation, *Industrial Archaeology Review*, 5(1), 19–40.
- Couclelis, H. (1999) Space, time, geography. *Geographical information systems*, 1, 29-38.
- Coull, J. R. (1963) The historical geography of Aberdeen. *Scottish Geographical Magazine*, 79(2), 80-94.
- Crafts, N. and Mulatu A. (2005) What explains the location of industry in Britain, 1871–1931? *Journal of Economic Geography* 5(4): 499-518.
- Crafts, N. F. R. (1983) British economic growth, 1700-1831: a review of the evidence. *The Economic history review*, 36(2), 177–199.
- Crafts, N. (2004) Steam as a general purpose technology: a growth accounting perspective. *The Economic Journal*, 114(495), 338-351.
- Crafts, N. F. R. and Harley, C. K. (2004) “Precocious British industrialisation: a general-equilibrium perspective,” in de la Escosura, L. P. (ed.) *Exceptionalism and Industrialisation: Britain and its European Rivals, 1688–1815*. Cambridge: Cambridge University Press, pp. 86–108.
- Crafts, N. F. R., and Harley, C. K. (1992) Output Growth and the British Industrial Revolution: A Restatement of the Crafts-Harley View. *The Economic History Review*, 45(4), 703–730.
- Crafts, N. F. R., Leybourne, S. J., and Mills, T. C. (1989) Trends and Cycles in British Industrial Production, 1700-1913. *Journal of the Royal Statistical Society. Series A, Statistics in Society*, 152(1), 43–60.
- Crafts, N., and Wolf, N. (2014) The location of the UK cotton textiles industry in 1838: a quantitative analysis. *The Journal of Economic History*, 74(4), 1103-1139.
- Crane, B. (2001) Evaluating Archaeological Mill Districts: Using GIS to Identify Key Measurements for Assessing Integrity. Poster presented at *The 80th Transportation Research Board Annual Meeting. Jan 7-11, 2001. Washington, D.C.*

- Crouzet, F. (1964) Wars, Blockade, and Economic Change in Europe, 1792–1815, *The Journal of Economic History*, 24(4), 567–588.
- Crouzet, F. (1985) The Industrialist: A New Man. In: R. Crouzet, ed. *The First Industrialists: The Problem of Origins*. Cambridge: Cambridge University Press, 1–19.
- Crowe, P. R. (1927) The population of the Scottish lowlands. *Scottish Geographical Magazine*, 43(3), 147–167.
- Cruden, S. H. (1948) The Horizontal Water-Mill at Dounby, on the Mainland of Orkney. *Proceedings of the Society of Antiquaries of Scotland* 81. Vol 81, pp. 43-47.
- Cruikshank, A. B. (1965). Water-resource development in the Campsies of Scotland. *Geographical review*, 55(2), 241–264
- Crutzen, P. J. and Steffen, W. (2003) How Long Have We Been in the Anthropocene Era? In: S. Benner, G. Lax, P. J. Crutzen, U. Pöschl, J. Lelieveld, and H. G. Brauch eds. *Paul J. Crutzen and the Anthropocene: A New Epoch in Earth's History. The Anthropocene: Politik—Economics—Society—Science*, vol 1. Springer, Cham., 2021, 39–45.
- Crutzen, P. J. and Stoermer, E. F. (2021) The ‘Anthropocene’ (2000). In: Benner, S., Lax, G., Crutzen, P.J., Pöschl, U., Lelieveld, J., Brauch, H.G. (eds) *Paul J. Crutzen and the Anthropocene: A New Epoch in Earth's History. The Anthropocene: Politik—Economics—Society—Science*, vol 1. Springer, Cham, 2021, 219–221.
- Dalziel, R., Harrison, T., Catrine, Sorn & District Local History Group (1987) 200 years of Catrine and Sorn Parish: A Cotton Tail. Chorley: Countryside Publications.
- Daniels, G. W. (1916) American Cotton Trade with Liverpool Under the Embargo and Non-Intercourse Acts. *The American Historical Review* 21(2): 276–287.
- Davidson, D. and Arnold, J. (2011) The Great Experiment: New Lanark from Robert Owen to World Heritage Site. In Chris Williams, and Noel Thompson (eds.) *Robert Owen and his Legacy*, University of Wales Press, 2011.
- Davidson, J. L. (1987) The collection of antiquarian information for the early Ordnance Survey maps of Scotland. *Proceedings of the Society of Antiquaries of Scotland*, 116, 11–16.
- Day, T. (2003) The Construction of Aberdeenshire's First Turnpike Roads. *Journal of Transport History*, 24(2), 154–176.
- Deanston Distillery (2022) *About Us* [Online] Available from: <https://deanstonmalt.com/pages/about-deanston> [Last accessed 12/12/2022].
- Decker, S. (2013) The silence of the archives: business history, post- colonialism and archival ethnography, *Management & Organizational History*, 8:2, 155–173.
- Dempster, G., Fergusson, A., Sir and Fergusson, J., Sir. (1934) *Letters of george dempster to sir adam fergusson, 1756-1813: With some account of his life*. Macmillan.
- Darby, H. C. (1977) *Domesday England*. Cambridge: Cambridge University Press (Domesday Geography of England).
- DeSilvey, C. and Edensor, T. (2013) Reckoning with ruins. *Progress in human geography*, 37(4), 465-485.
- Devine, T. M. (1975) The tobacco lords: a study of the tobacco merchants of Glasgow and their trading activities, c.1740-90. Edinburgh, Donald.

- Devine, T. M. (1978) An Eighteenth-Century Business élite: Glasgow-West India Merchants, c. 1750-1815. *The Scottish Historical Review*, 57(163), 40–67.
- Devine, T. M. (1989) *Improvement and enlightenment : proceedings of the Scottish Historical Studies Seminar, University of Strathclyde, 1987-88*.
- Devine, T. M. (2011) Did slavery make scotia great? *Britain and the World*, 4(1), 40-64.
- Di Stefano, F., Sanità, M., Malinverni, E. S. and Doti, G. (2023). Geomatic technologies to valorize historical watermills. *The International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences*, 48, 511-518.
- DiCenzo, M. (2015) Remediating the past: Doing “Periodical studies” in the digital era. *English Studies in Canada*, 41(1), 19-39.
- Dictionary of Scottish Architects (2016) *James Boog or Boag*. [Online] Available from: <http://www.scottisharchitects.org.uk/> [Accessed 05/06/2022].
- Djellal, F. and Gallouj, F. (2014) *The laws of imitation and invention: Gabriel Tarde and the evolutionary economics of innovation*. Working Paper, halshs-00960607, HAL.
- DSL, Dictionaries of the Scots Language (2025a) *FACTOR, n., v. Sc. usages* [Online] Available from: <https://dsl.ac.uk/entry/snd/factor> [Accessed 29/07/2025].
- DSL, Dictionaries of the Scots Language (2025b) *FEUAR* [Online] Available from: <https://dsl.ac.uk/entry/snd/feuar> [Accessed 29/07/2025].
- DSL, Dictionaries of the Scots Language (2025c) (*Journay-,*) *Jurnayman* [Online] Available from: <https://dsl.ac.uk/entry/dost/jurnayman> [Accessed 29/07/2025].
- DSL, Dictionaries of the Scots Language (2025d) *SUCKEN* [Online] Available from: https://dsl.ac.uk/entry/snd/sucken_n1_adj_v [Accessed 29/07/2025].
- DSL, Dictionaries of the Scots Language (2025e) *"Ton n."* [Online] Available from: <http://www.dsl.ac.uk/entry/snd/ton> [Accessed 26 Jan 2025].
- Diogo, M. P. and Simões, A. (2016) “All History is Relevant, but the History of Technology is the Most Relevant”: An informal tribute to Kranzberg’s Laws. *Icon*, 22, 1–7.
- Dobson, P. and Jackson, P. (2017) Using critical realism and reflexivity to explain broadband non-adoption in rural Australia. *Australasian Journal of Information Systems*, 21.
- Donkin, R. (2010) *The Silent Monitor*. In: *The History of Work*. Palgrave Macmillan, London.
- Donnachie, I. L. (2000) *Robert owen: Owen of new lanark and new harmony*. Tuckwell Press.
- Donnachie, I. L. and Hewitt, G. (2015) *Historic New Lanark: The Dale and Owen industrial community since 1785* (Classic ed.). Edinburgh University Press.
- Donnachie, I. L. and Stewart, N. K. (1967) Scottish windmills: an outline and inventory. *Proceedings of the Society of Antiquaries of Scotland*, 98, 276-299.
- Donovan, M., Miller, A. and Baker, M. (2016) "Reassessing the role of milldams in Piedmont floodplain development and remobilization." *Geomorphology* (Amsterdam, Netherlands) 268: 133-145.
- Doudney, S. (n.d.) *The Lesson of the Water Mill, Sarah Doudney, 1841-1926* [Online] Available from: https://englishverse.com/poems/the_lesson_of_the_water_mill [Accessed 03/06/2025].
- Douglas, G. and Oglethorpe, M. (1984) A Survey of Scottish Windpumps. *Industrial Archaeology Review*, 7(1), 74–84.

- Douglas, G. and Oglethorpe, M. (1986) Scottish Windpumps & Windmills: New Information. *Industrial Archaeology Review*, 9(1), 82–86.
- Downard, S. and Skinner, K. (2005) Working rivers: the geomorphological legacy of English freshwater mills. *Area*, 37(2), 138-147.
- Dragan, A., Cretan, R., Terian, M. I. (2024) Landscapes of Watermills: A Rural Cultural Heritage Perspective in an East-Central European Context. *Heritage*, 7, 4790–4813.
- Dryen, R. G. (1969) Accountancy records as archival sources. *Archives & Manuscripts*, 3-9.
- Dumfries Historic Buildings Trust (2022) *Rosefield Mills* [Online] Available from: https://heritagetrustnetwork.org.uk/wp-content/uploads/2025/01/Mill-Posters_FINAL-copies.pdf [Accessed 03/06/2025].
- Duncan, W. M. (1979) *Newtyle: a planned manufacturing village*. Forfar, Tayside: Forfar Historical Society.
- Dundee Heritage Trust (2025a) *A Brief History of Verdant Works* [Online] Available from: <https://www.dundeeheritagetrust.co.uk/story/history-of-verdant-works/> [Accessed 30/03/2025].
- Dundee Heritage Trust (2025b) *Online Learning* [Online] Available from: <https://www.dundeeheritagetrust.co.uk/visit/learning/online-learning/> [Accessed 30/03/2025].
- Dunhill, N. (1964) A Pioneer New Town: New Lanark. *Ekistics*, 18(108), 364–366.
- Dunlop, J. (1982) Pulteneytown and the Planned Villages of Caithness. In: J. R. Baldwin and Scottish Society for Northern Studies, eds. *Caithness a Cultural Crossroads*. Edinburgh: Scottish Society for Northern Studies, 131–159.
- Earls, A. (1945) Robert Thom and his work on water power for the Rothesay cotton mills, *Trans Buteshire Natur Hist Soc*, 13, 129.
- East Ayrshire Council (2005) *Catrine Conservation Area Appraisal* [Online] Available from: <https://www.east-ayrshire.gov.uk/Resources/PDF/C/CatrineCAA.pdf> [Accessed 31/08/2022].
- East Ayrshire Leisure (2022) *Nature reserves & wildlife sites* [Online] Available from: <https://eastayrshireleisure.com/countryside-outdoor/nature-reserves-wildlife-sites/> [Accessed 26/09/2022].
- EDINA (2022) Integrated Hydrological Digital Terrain Model (IHDTM) [ASC geospatial data], Scale 1:50000, Tiles: GB, Updated: 14 January 2016, CEH, Using: EDINA Environment Digimap Service. Available from: <https://digimap.edina.ac.uk> [Accessed: 04/11/2022].
- Edlin, H. L. (1969) The forestry commission in Scotland: 1919-1969. *Scottish Geographical Magazine*, 85(2), 84–95.
- Eley, G. (1984) The social history of industrialization: “proto-industry” and the origins of capitalism’, *Economy and Society*, 13(4), 519–539.
- Eling Tide Mill Experience (2018) *How it works* [Online] Available from: <https://www.elingexperience.co.uk/how-it-works> [Accessed 28/01/2025].
- Elwood, S. and Cope, M. (2009) Introduction: qualitative GIS: forging mixed methods through representations, analytical innovations, and conceptual engagements. In: M. Cope, and S. Elwood, eds. *Qualitative GIS : A Mixed Methods Approach* SAGE Publications, Limited, 2009. ProQuest Ebook Central, 15–29.

- Engels, F. (1892) *The condition of the working-class in England in 1844: With preface written in 1892*. Swan Sonnenschein & Co.
- Engerman, S. L. (2004) Institutional change and British supremacy, 1650–1850: some reflections. In: L. Prados de la Escosura, ed. *Exceptionalism and industrialisation: Britain and its European rivals, 1688-1815*. Cambridge University Press, 261–282.
- English Heritage (2025) *ARKWRIGHT, Sir Richard (1732–1792)* [Online] Available from: <https://www.english-heritage.org.uk/visit/blue-plaques/richard-arkwright/> [Accessed 13/07/2025].
- Escott, M. (2011) Robert Owen as a British Politician and Parliamentarian. In: C. Williams, and N. Thompson, eds. *Robert Owen and his Legacy*, University of Wales Press.
- Evans, J. (2005) *The gentleman Usher : The life and times of George Dempster (1732-1818): Member of parliament and Laird of Dunnichen and Skibo*. Barnsley: Pen & Sword Military.
- Fagan, J. (2023) Paisley’s Empire: Representation, Collection and Display. In: E. Bond and M. Morris, eds. *Scotland’s Transnational Heritage: Legacies of Empire and Slavery*. Edinburgh University Press, 120–135.
- Fairney, J. (2018) The Cultivation and Preservation of the Martial Music of the Highlands by the Highland Society of London. *Scottish Studies*, 38, 54–70.
- Fajer, M. (2018) Changes in river channel pattern as a result of the construction, operation and decommissioning of watermills – the case of the middle reach of the River Liswarta near Krzepice, Poland. *Environmental & socio-economic studies*, 6(1), 25–37.
- Farnie, D. A. (1979) *The English Cotton Industry and the World Market, 1815-1896*. Oxford: Clarendon Press.
- Farrell, S. (2002) *Migdale Mill* [Online] Available from: <https://canmore.org.uk/site/14049/migdale-mill> [Accessed 04/06/2022].
- Ferguson, R. (2005). *The life and times of the Dalgarnen Mills 1200-2005*. Kilwinning: Dalgarnen Mill Trust.
- Ferguson, T. (1948) Early Scottish Essays In Industrial Health. *Brit J Industr Med*, 1948, 5, 180–184
- Ferrier, J. (1966) Robert Thom's water-cuts. *Trans Glasgow Archaeol Soc, New*, 15(3), 129–138.
- Filor, E. (2013) *WILLIAM RATTRAY OF DOWNIE PARK* [Online] Available from: <https://blogs.ucl.ac.uk/eicah/> [Accessed 04/06/2022].
- Finlays (2022) *Overview* [Online] Available from: <https://www.finlays.net/about-us/overview/> [Accessed 22/12/2022].
- Fintry Museum (2021) *Fintry Cotton Mill* [Online] Available from: <https://fintrymuseum.org.uk/fintry-cotton-mill/> [Accessed 18/09/2022].
- Fishman, A. and Rob, R. (2003) Consumer inertia, firm growth and industry dynamics. *Journal of Economic theory*, 109(1), 24–38.
- Fleming, P. D. and Probert, S. D. (1984) The evolution of wind-turbines: An historical review. *Applied energy*, 18(3), 163–177.
- Flounders Folly Trust (2022) *Benjamin Flounders* [Online] Available from: <https://www.floundersfolly.org.uk/benjamin-flounders/> [Accessed 25/11/2022].

- Forth Rivers Trust (2022) *River Teith* [Online] Available from: <https://forthriverstrust.org/rivers-wildlife/explore/river-teith/> [Accessed 18/12/2022].
- Fouquet, R. (2016) Path dependence in energy systems and economic development. *Nature Energy*, 1(8), 16098.
- Frajer, J. and Geletič, J. (2011) Research of historical landscape by using old maps with focus to its positional accuracy. *Dela (Univerza v Ljubljani. Oddelek Za Geografijo)*, 36(36), 49–67.
- Franck, R., O. Galor and i. b. Centre for Economic Policy Research (2017). *Industrial development and long-run prosperity*. London: Centre for Economic Policy Research.
- Fraser, I. A. (1986) Norse and Celtic place-names around the Dornoch Firth. *Scottish Society for Northern Studies*, 23–32
- Frenken, K. and Nuvolari, A. (2004) The early development of the steam engine: an evolutionary interpretation using complexity theory. *ICC* 13(2), 419-450.
- Garretsen, H., and Martin, R. (2010) Rethinking (New) Economic Geography Models: Taking Geography and History More Seriously. *Spatial Economic Analysis*, 5(2), 127–160.
- Gauldie, E. (1981) *The Scottish country miller 1700-1900: a history of water-powered meal milling in Scotland*. Edinburgh: John Donald Publishers Ltd.
- Geddes, G. F. (2012) ‘An enormous expense enclosing and dividing’. Agricultural Improvement in eighteenth-century Bute. In: A. Ritchie and Scottish Society for Northern Studies. Conference Bute, Scotland. (2012) *Historic bute: Land and people*. Scottish Society for Northern Studies, 129–150.
- Getzler, J. (2006) *A History of Water Rights at Common Law*, Oxford Studies in Modern Legal History. Oxford: Oxford Academic.
- Gibb, A. (1983) *Glasgow: The making of a city*. Croom Helm.
- Gibson, A. J. and Smout, T. C. (1995) Regional prices and market regions: the evolution of the early modern Scottish grain market 1. *The Economic History Review*, 48(2), 258-282.
- Gilliatt, J. (2018) *Bobbin mills in the north of Scotland*. Independent Publishing Network
- Giordano, A. and Cole, T. (2020) Places of the Holocaust: Towards a model of GIS of place. *Transactions in GIS*, 24(4), 842–857.
- Gittins, L. (1979) Innovations In Textile Bleaching In Britain In The Eighteenth Century. *Business History Review*, 53(2), 194.
- Glasgow City Council (2025) *Pollok Country Park - Stables and Sawmill Project* [Online] Available from: <https://www.glasgow.gov.uk/article/10318/Pollok-Country-Park-Stables-and-Sawmill-Project> [Accessed 12/07/205].
- Glasgow Museums Art Donors (2021) *CLOTH MANUFACTURER Robert Jeffrey (1827 – 1902)* [Online] Available from: <https://glasgowmuseumsartdonors.co.uk/2021/03/15/robert-jeffrey-1827-1902/> [Accessed 06/09/2022].
- Glückler, J. (2007) Economic geography and the evolution of networks. *Journal of Economic Geography*, 7(5): 619–634.

- Goff, L. (2019) “Something pretty out of very little” Graniteville Mill Village, 1848. *Journal of the Society of Architectural Historians*. 78 (1), 49–67.
- Goodall, B. (1993) Industrial heritage and tourism. *Built environment*, 19(2), 93.
- Google Earth (2025) Partick Glasgow 30/05/2023 55°52'07"N 4°17'52"W [Online] Available from: <https://earth.google.com/web/> [Accessed 18/01/2025].
- Gorb, P. (1951) Robert Owen as A businessman. *Bulletin of the Business Historical Society*, 25(3), 127–148.
- Gordon, J. E. (2012) Rediscovering a sense of wonder: Geoheritage, geotourism and cultural landscape experiences. *Geoheritage*, 4(1-2), 65–77.
- Goudie, G. (1886) On the Horizontal Water Mills of Shetland. *Proceedings of the Society of Antiquaries of Scotland*, 20, 257–297.
- Govscot (2015) *Deanston Conservation Area Appraisal* [Online] Available from: https://www.gov.scot/binaries/content/documents/govscot/publications/factsheet/2018/06/stirling-council-planning-authority-core-documents/documents/sg07-conservation-area-character-appraisals-statements---deanston-sep-2014/sg07-conservation-area-character-appraisals-statements---deanston-sep-2014/govscot%3Adocument/SG07%2B-%2BConservation%2BArea%2BCharacter%2BAppraisals_Statements%2B-%2BDeanston.pdf [Accessed 28/11/2022].
- Grace’s Guide (2012) *George Macintosh and Co* [Online] Available from: https://www.gracesguide.co.uk/George_Macintosh_and_Co [Accessed 05/06/2022].
- Grace’s Guide (2014) *Benjamin Flounders* [Online] Available from: https://www.gracesguide.co.uk/Benjamin_Flounders [Accessed 01/12/2022].
- Grace’s Guide (2025) *John Frederick La Trobe Bateman* [Online] Available from: https://www.gracesguide.co.uk/John_Frederick_La_Trobe_Bateman [Accessed 27/01/2025].
- Grano, M. C. and Bishop, P. (2017) Barceló’s ‘Missing Water Mills’ and Scottish and southern Italian horizontal mills. *Vernacular Building*, 40, 109–122.
- Grano, M. C., Del Monte, M., Lazzari, M. and Bishop, P. (2016) Fluvial dynamics and water mills location in Basilicata (Southern Italy). *Geografia fisica e Dinamica quaternaria*, 39(2), 149-160.
- Great Britain Historical GIS Project (2003-2023a) *A vision of Britain Through Time: Data Access* [Online] Available from: <https://www.visionofbritain.org.uk/data/> [Accessed 02/07/2025].
- Great Britain Historical GIS Project (2003-2023b) *Census Reports* [Online] Available from: <https://www.visionofbritain.org.uk/census/> [Accessed 02/07/2025].
- Great Britain Historical GIS Project (2003-2023c) *1911 Census of Scotland, Population, Ages and Conjugal Condition, Occupations, Birthplaces, Housing, Gaelic-speaking, Table 20 : " Burghs in Order of Population"*. Available from: https://www.visionofbritain.org.uk/census/table/S1911POP_Int_A20 [Accessed 02/07/2025].

- Gregory, I. N. (2002) The accuracy of areal interpolation techniques: standardising 19th and 20th century census data to allow long-term comparisons. *Computers, Environment and Urban Systems*, 26(4), 293–314.
- Gregory, I. N. and Ell, P. S. (2007) *Historical GIS: technologies, methodologies, and scholarship*. Cambridge: Cambridge University Press.
- Gregory, I. N., Bennett, C., Gilham, V. L. and Southall, H. R. (2002) The Great Britain Historical GIS Project: From Maps to Changing Human Geography. *The Cartographic Journal*, 39(1), 37–49.
- Gregory, I., and Southall, H. (2000) Spatial frameworks for historical censuses: the Great Britain Historical GIS. In: R. M. P. Hall, & G. Thorvaldsen, eds. *Handbook of Historical Microdata for Population Research*, Minnesota Population Center, 319–333.
- Gugler (2022) *Deanston Hydropower Plant commissioned* [Online] Available from: <https://www.gugler.com/news/deanston-hydropower-plant-commissioned/> [Accessed 31/08/2022].
- Hägerstrand, T. (1966) Aspects of the spatial structure of social communication and the diffusion of information. *Papers in regional science*. 16(1), 27–42.
- Hägerstrand, T. (1967) *Innovation diffusion as a spatial process*. Chicago: University of Chicago Press.
- Hall, P., Hesse, M. and Jean-Paul, M (2006) Reexploring the Interface between Economic and Transport Geography. *Environment and planning. A* 38(8), 1401–1408.
- Hamilton, H. (1963) *An economic history of scotland in the eighteenth century*. Clarendon Press.
- Hammer, C. I. (2008) "A Suitable Place for Putting up a Mill.: Water Power Landscapes and Structures in Carolingian Bavaria", *Vierteljahrschrift für Sozial- und Wirtschaftsgeschichte*, 95(3): 319-334.
- Hanlon, R. T. (2020) *Block by Block: The Historical and Theoretical Foundations of Thermodynamics*. Oxford: Oxford University Press.
- Hannah, A. (2012) Bute from Norse times to the Improvement. Some notes of landholdings and rural settlement patterns. In: Ritchie, A., & Scottish Society for Northern Studies. Conference Bute, Scotland. (2012). *Historic Bute: Land and people*. Scottish Society for Northern Studies, 129–150.
- Happer, R. and Steward, M. (2015) *River Forth: from source to sea*. Stroud: Amberley.
- Harley, C. K. (1982) British Industrialization Before 1841: Evidence of Slower Growth During the Industrial Revolution. *The Journal of Economic History*, 42(2), 267–289.
- Harley, J. B. (1964) *The historian's guide to Ordnance Survey maps*. London: National Council of Social Service.
- Harley, J. B. (1989) Historical geography and the cartographic illusion. *Journal of Historical Geography*, 15(1): 80-91.
- Harris, C. (2001) Archival Fieldwork. *The Geographical Review*, 91, no. 1/2 (1-2), 328–334.
- Harris, J. (2025) Visualising and mapping historical networks of international diplomatic training. *Area (London 1969)*, 57(1).
- Harris, J. R. (1967) The employment of steam power in the eighteenth century. *History (London)*, 52(175): 133–148.

- Hassink, R. and Gong, H. (2019) New Economic Geography. In: A. Orum, ed. *The Wiley Blackwell Encyclopedia of Urban and Regional Studies*. Chichester, UK: John Wiley & Sons, Ltd, 1–6.
- Hay, D. (2011) Preserving industrial heritage: challenges, options, and priorities. *Forum Journal: Preserving America's Industrial Heritage*, 25 (3), 11–24.
- Heblich S., Redding, S. J. and Voth, H. (2022) "Slavery and the British Industrial Revolution," NBER Working Papers 30451, National Bureau of Economic Research, Inc.
- Heller, H. (2011) The industrial revolution: marxist perspectives. In *The Birth of Capitalism: A 21st Century Perspective*. London: Pluto Press, 176–214.
- Hendrickson, W. B. and Owen, D. D. (1944) David Dale Owen and the Chippewa Land District Survey. *The Wisconsin Magazine of History*, 28(2), 210–224.
- Henning, M. (2019) Time should tell (more): evolutionary economic geography and the challenge of history. *Regional Studies*, 53(4), 602–613.
- Heritage Stockton (2022) *Benjamin Flounders* [Online] Available from: <https://heritage.stockton.gov.uk/articles/people/benjamin-flounders/> [Accessed 24/11/2022].
- Herod, A. (2010) Labour Geography Where Have We Been? Where Should We Go? In: Bergene, A. C., Endresen, S. B. and Knutsen, H. M. eds. *Missing Links in Labour Geography*. 1st edition [Online]. Routledge, 15–28.
- HES (2015) *Spinningdale Cotton Mill, remains of SM8028* [Online] Available from: <https://portal.historicenvironment.scot/apex/f?p=1505:300:::VIEWTYPE,VIEWREF:designation,SM8028> [Accessed 04/05/2025].
- HES (2019) *Scotland's Listed Buildings* [Online] Available from: <https://app-hes-pubs-prod-neu-01.azurewebsites.net/api/file/3b8ba322-1cd5-4f6a-bcce-aca900999a72> [Accessed 06/04/2025].
- HES (2022) *SPRINGBANK GARDENS, 1-12 (INCLUSIVE), 14-30 (INCLUSIVE) SPRINGBANK MILL INCLUDING FORMER SCHOOL HOUSE* [Online] Available from: <https://portal.historicenvironment.scot/designation/LB26426> [Accessed 11/12/2022].
- HES (2023a) *1-5 (INCLUSIVE NOS) JOHN STREET* [Online] Available from: <http://portal.historicenvironment.scot/designation/LB44855> [Accessed 01/04/2023].
- HES (2023b) *NEW LANARK, MILL NO 3* [Online] Available from: <https://portal.historicenvironment.scot/designation/LB37053> [Accessed 22/02/2023].
- HES (2024) *Scotland on the page* [Online] Available from: <https://www.historicenvironment.scot/archives-and-research/online-exhibitions/sir-walter-scott/scotland-on-the-page/> [Accessed 23/01/2025].
- HES (2025) Our vision, mission and values [Online] Available from: <https://www.historicenvironment.scot/about-us/who-we-are/our-vision-mission-and-values/> [Accessed 29/07/2025].
- Higgins, P. and Johnston, A. (2010) *194 Migdale Archaeological Watching Brief* [Online] Available from: <https://her.highland.gov.uk/api/LibraryLink5WebServiceProxy/FetchResourceFromSt>

- ub/1-1-8-6-8-6_83d8f7244a459fb-118686_cfb2fb5384e2e75.pdf [Accessed 09/02/2025].
- Hill, I. A. N. (2017) The Origins of the New Statistical Account of Scotland. *The Scottish Historical Review* 96(2 (243)), 161–186.
- Hills, R. L. (1988) *Papermaking in Britain 1488-1988: a short history*. London: Bloomsbury Academic.
- Hills, R. L. (1989) *Power from Steam: A History of the Stationary Steam Engine*. Cambridge: Cambridge University Press.
- Hills, R. L. (1994) *Power from wind : a history of windmill technology*. Cambridge : Cambridge University Press.
- Historic England (2014) *Micro-Hydroelectric Power and the Historic Environment* [Online] Available from: <https://historicengland.org.uk/images-books/publications/micro-hydroelectric-power-and-historic-environment/> [Accessed 29/07/2015].
- Historic England (2015) *Former Rag Room at Springfield Mill* [Online] Available from: <https://historicengland.org.uk/listing/the-list/list-entry/1086282?section=official-list-entry> [Accessed 17/03/2025].
- Historic England (2024) *Textile Mills. Introduction to Heritage Assets*, Swindon: Historic England.
- Hodder, J. (2017) On absence and abundance: Biography as method in archival research. *Area*, 49(4), 452–459.
- Hodder, J. and Beckingham, D. (2022) Digital archives and recombinant historical geographies. *Progress in human geography*, 46(6), 1298–1310.
- Hodge, E. C. (2009) 'Their palms were crossed with silver': The Payment of Workers in Early Textile Factories 1780–1830, *Textile History*, 40(2), 229–237.
- Hodge, E. C. (2020) *Ballindalloch works checks revisited. Further Contemporary Documentation Discovered* [Online] Available from: <https://britnumsoc.files.wordpress.com/2020/02/60-eric-hodge-article.pdf> [Accessed: 26/06/2022].
- Hodgen, M. T. (1939) Domesday Water Mills. *Antiquity*, 13(51), 261–279.
- Hoeksema, R. J. (2007) Three stages in the history of land reclamation in the Netherlands. *Irrigation and Drainage*, 56(S1), S113–S126.
- Hognogi, G. G., Marian-Potra, A. C., Pop, A. M., and Mălăescu, S. (2021) Importance of watermills for the Romanian local community. *Journal of Rural Studies*, 86, 198–207.
- Holt, R. A. (1988) *The mills of medieval England*, Oxford.
- Holtorf, C. (2015) Averting loss aversion in cultural heritage. *International Journal of Heritage Studies*, 21(4), 405–421.
- Hosseini, K., McDonough, K., van Strien, D., Vane, O. and Wilson, D. C. S. (2021) Maps of a Nation? The Digitized Ordnance Survey for New Historical Research. *Journal of Victorian Culture: JVC*, 26(2): 284-299.
- Houston, J. M. (1948) 'Village planning in Scotland, 1745–1845', *Advancement of Science* 5(1948–49), 129–132.
- Houston, R. (1986) The Clearances in South-East Sutherland. In: ed. Baldwin, J. (1986) *Firthlands of Ross and Sutherland*. Edinburgh: Scottish Society for Northern Studies, 168–181.

- Houston, R. A. (1989) Women in the economy and society of Scotland, 1500–1800. In: Robert Allen Houston and I. D. Whyte, eds. *Scottish Society, 1500–1800*. Cambridge: Cambridge University Press, 118–147.
- Houston, R. and Snell, K. D. M. (1984) Proto-Industrialization? Cottage Industry, Social Change, and Industrial Revolution, *The Historical Journal*, 27(2), 473–492.
- Howard, R. A. (1983) A Primer on Waterwheels. *Bulletin of the Association for Preservation Technology*, 15(3), 27–33.
- Hudson, J. C. (1969) Diffusion in a central place system. *Geographical Analysis*, 1, 45–58.
- Hudson, P. (1992) *The industrial revolution*. London: Arnold.
- Hudson, P. (2015) Slavery, the slave trade and economic growth: a contribution to the debate. In: C. Hall, N. Draper and K. McClelland, eds. *Emancipation and the Remaking of the British Imperial World*. Manchester University Press, 36–59.
- Hughes, S. (2005) Institutional Buildings in Worker Settlements. *Industrial archaeology review*, 27(1), 153–161.
- Hume, J. R. (2017) The River Kelvin: route and resource from pre-history to the 20th century. In *The Proceedings from the Kelvin Conference. The Glasgow Naturalist*, 26(4).
- Hume, J. R. (1969) The Mills of the River Ayr. *A.A.N.H.S. Ayrshire Collections*, Vol. 8 (Second Series) 1969.
- Hume, J. R. (1971) The Industrial Archaeology of New Lanark. In: J. Butt, ed. (1971). *Robert Owen, prince of cotton spinners: A symposium*. David & Charles, 215–253.
- Hume, J. R. (1987) *Isle of Bute*. Edinburgh: H.M.S.O.
- Hume, J. R. (1976) *The industrial archaeology of Scotland*. London: Batsford.
- Humphries, J. (2010) *Childhood and child labour in the British Industrial Revolution*. Cambridge: Cambridge University Press.
- Humphries, J. (2013) The lure of aggregates and the pitfalls of the patriarchal perspective: a critique of the high wage economy interpretation of the British industrial revolution. *The Economic History Review*, 66(3), 693–714.
- Humphries, J. and Schneider, B. (2019) Spinning the industrial revolution. *The Economic History Review*, 72(1), 126–155.
- ICE (2025) John Smeaton [Online] Available from: <https://www.ice.org.uk/what-is-civil-engineering/meet-the-engineers/john-smeaton> [Accessed 21/05/2025].
- ICOMOS (2001) *WHC Nomination Documentation* [Online] Available from: <https://whc.unesco.org/uploads/nominations/429rev.pdf> [Accessed 03/03/2025].
- Irwin, D. A. and Chepeliev, M. G. (2021) The Economic Consequences of Sir Robert Peel: A Quantitative Assessment of the Repeal of the Corn Laws. *The Economic Journal (London)*, 131(640), 3322–3337.
- Jeffery, R. (1982) Merchant Capital and the End of Empire: James Finlay, Merchant Adventurers. *Economic and Political Weekly*, 17(7), 241–248.
- Jenkins, D (1985) *The biology and management of the River Dee*. Abbots Ripton, Institute of Terrestrial Ecology.

- Jenkins, D. T. and Ponting, K.G. (1982) *The British wool textile industry, 1770-1914*, London: Heinemann Educational Books.
- Jeppesen, C. (2013) *East Meets West: Exploring the Connections Between the East India Company and the Caribbean* [Online] Available from: <https://lbsatucl.wordpress.com/2013/05/31/east-meets-west-exploring-the-connections-between-the-east-india-company-and-the-caribbean/> [Accessed 10/10/2022].
- Jespersen, A. (1966) Watermills on the River Eden. In *Proceedings of the Society of Antiquaries of Scotland*, 97, 237–244.
- Jin, W. and Jin, J. (2024) Assessing Industrial Heritage Through Collaborative Counter-Mapping: A Case Study of Salts Mill, UK. *Urban Planning*, 9, Article 7976.
- Jonell, T. (2024) *Mills of Britain* [Online] Available from: <https://maps.nls.uk/projects/mills-of-britain/> [Accessed 01/10/2024].
- Jonell, T. N., Jones, P., Lucas, A., and Naylor, S. (2024) Limited waterpower contributed to rise of steam power in British “Cottonopolis.” *PNAS Nexus*, 3(7), pgae251-.
- Jonell, T. N., Nave Calton, I., Jones, P., Lucas, A. R., and Naylor, S. (2023) Shaping landscapes and industry: linking historic watermill locations to bedrock river knickpoints. *Scottish Geographical Journal*, 139(3-4), 328–345.
- Jones, P. (2008) *Industrial enlightenment: science, technology and culture in Birmingham and the West Midlands, 1760-1820*. Manchester: Manchester University Press.
- Jones, P., Jonell, T. N., Hurst, M. D., Lucas, A. R. and Naylor, S. (2023) *Location, location, location: reassessing W.H.K. Turner’s legacy for industrial geography in Scotland and beyond*. Routledge.
- Jovanovic, M. N. (2003) Spatial location of firms and industries: an overview of theory. *Economia Internazionale*, 56(1), 23–82.
- Kaaristo, M. (2024) Pacemaking and placemaking on the UK canals. *The Geographical Journal*, 190(2), e12525.
- Kahma, N. and Matschoss, K. (2017) The rejection of innovations? Rethinking technology diffusion and the non-use of smart energy services in Finland. *Energy Research & Social Science*, 34, 27–36.
- Kammen, C. (2003) *On doing local history*. 2nd ed. AltaMira Press.
- Kandler, A. and Steele, J. (2009) Innovation diffusion in time and space: Effects of Social Information and of Income Inequality. *diffusion-fundamentals.org* 11 (2009) 3, 1–17.
- Kanefsky, J. (1979a) *The Diffusion of Power Technology in British Industry, 1760-1870* (University of Exeter, PhD Thesis).
- Kanefsky, J. (1979b) Motive Power in British Industry and the Accuracy of the 1870 Factory Return. *The Economic history review*, 32(3), 360–375.
- Kanefsky, J. (2024) *The Early Engine Database* [Online] Available from: <https://coalpitheath.org.uk/engines/> [Last accessed: 29/12/2024].
- Kanefsky, J. and Robey, J. (1980) Steam Engines in 18th-Century Britain: A Quantitative Assessment. *Technology and culture*, 21(2), 161–186.
- Karunarathna, H. (2011) Modelling the long-term morphological evolution of the Clyde Estuary, Scotland, UK. *J. Coast Conserv.*, 15, 499–507.

- Kauffman, R. J. and Techatassanasoontorn, A. A. (2009) Understanding early diffusion of digital wireless phones. *Telecommunications Policy*, 33(8), 432–450.
- Kavanagh, D. and Brigham, M. (2018) The Quakers: forgotten pioneers. In: T. Peltonen, H. Gaggiotti, and P. Case, eds. *Origins of Organizing*. Edward Elgar Publishing, 147–168.
- Kelley, M. R. and Helper, S. (1999) Firm Size And Capabilities, Regional Agglomeration, And The Adoption Of New Technology. *Economics of Innovation and New Technology*, 8(1–2), 79–103.
- Kennedy, N. and Kingcome, N. (1998) Disneyfication of Cornwall—developing a poldark heritage complex. *International Journal of Heritage Studies*, 4(1), 45–59.
- King, A. (2016) Gabriel Tarde and Contemporary Social Theory. *Sociological Theory*, 34(1), 45–61.
- King, A., Easley, A. and Morton, J. (2016) *The Routledge handbook to nineteenth-century British periodicals and newspapers*. Abingdon, Oxon: Routledge.
- Kinnunen, J. (1996) Gabriel Tarde as a founding father of innovation diffusion research. *Acta sociologica*, 39(4), 431–442.
- Kirkbright, M. (2018) *Blackburn's Future* [Online] Available from: <https://coins.westlothian.gov.uk/coins/viewSelectedDocument.asp?c=e%97%9Dg%92iy%8F> [Accessed 16/03/2023].
- Kitsikopoulos, H. (2013) From hero to Newcomen: The critical scientific and technological developments that led to the invention of the steam engine. *Proceedings of the American Philosophical Society*, 157(3), 304–344.
- Kitsikopoulos, H. (2016) Innovation and Technological Diffusion: An Economic History of Early Steam Engines. *Routledge Explorations in Economic History*, vol. 74. London and New York: Taylor and Francis, Routledge.
- Kitsikopoulos, H. (2023) *An Economic History of British Steam Engines, 1774-1870: A Study on Technological Diffusion*. Springer Nature Switzerland.
- Knowles, A. K. (2005) Emerging trends in historical GIS. *Historical Geography*, 33, 7–13.
- Knowles, A. K., Cole, T. and Giordano, A. (2014) *Geographies of the Holocaust*. Indiana University Press.
- Knox, W. (1999) *Industrial nation: work, culture and society in Scotland, 1800-present*. Edinburgh: Edinburgh University Press.
- Kogler, D. F. (2015) Evolutionary economic geography—theoretical and empirical progress. *Regional Studies*, 49(5), 705–711.
- Kriedte, P., Medick, H. and Schlumbohm, J. (1977) *Industrialisierung vor der Industrialisierung: Gewerbliche Warenproduktion auf dem Land in der Formationsperiode des Kapitalismus*. Göttingen: Vandenhoeck and Ruprecht.
- Krugman, P. (1991) Increasing Returns and Economic Geography. *Journal of Political Economy*, 99, 483–99.
- Krugman, P. (1999) The Role of Geography in Development. *International regional science review*, 22 (2), 142–161.

- Kumagai, Y. (2010) Kirkman Finlay and John Crawford: Two Scots in the Campaign of the Glasgow East India Association for the Opening of the China Trade, 1829–1833. *Journal of Scottish historical studies*, 30(2), 175–199.
- Kumekawa, I. (2024) Historical network analysis: two problems of scale. In: J. McLevey, J. Scott, and P. J. Carrington, eds. *Historical network analysis: two problems of scale*, 2nd ed., Vol. 0, Sage Publications Ltd.
- Landes, D. S. (1969) *The unbound Prometheus: technological change and industrial development in Western Europe from 1750 to the present*. Cambridge, U.K.: Cambridge University Press.
- Lang, A. (1998) *A life of George Dempster, Scottish M.P. of Dunnichen (1732-1818)*. Lewiston, NY: Edwin Mellen Press, Lampeter.
- Lang, A. (2022) Dempster, George, of Dunnichen (1732–1818), agriculturist and politician. *Oxford Dictionary of National Biography* [Online] Available from: <https://www.oxforddnb.com/view/10.1093/ref:odnb/9780198614128.001.0001/odnb-9780198614128-e-7472> [Accessed 09/05/2022].
- Langdon, J. (1991) Water-mills and windmills in the west midlands, 1086-1500¹. *The Economic History Review*, 44, 424–444.
- Langdon, J. (2004) *Mills in the medieval economy: England 1300-1540*. Oxford: OUP.
- Latour, B. (2012) Gabriel Tarde and the End of the Social. In: P. Joyce, ed. *The social in question. New Bearings in History and the Social Sciences*. London: Routledge, 117–132.
- Lazerson, M. and Lorenzoni, G. (1999) Resisting organizational inertia: The evolution of industrial districts. *Journal of management and governance*, 3(4), 361–377.
- Le Chapelain, C. and R. A. Wilke (2025) Spatial patterns of steam technology diffusion in nineteenth-century France. *Cliometrica*.
- Lee, D. (2018) Experimental mapping in archaeology: Process, practice and archaeologies of the moment. In: M. Gillings, P. Hacıgüzeller, G. Lock, eds. *Re-Mapping Archaeology*. Routledge, 143–176.
- Legacies of British Slavery (2025a) 'Robert Dunmore of Ballindalloch' [Online] Available from: <http://www.depts-live.ucl.ac.uk/lbs/person/view/2146649299> [Accessed 03/07/2025].
- Legacies of British Slavery database (2025b) 'Robert Bogle junior, of Daldowie' [Online] Available from: <http://www.depts-live.ucl.ac.uk/lbs/person/view/2146642497> [Accessed 03/07/2025].
- Legacies of British Slavery database (2025c) *Colin Campbell of Colgrain* [Online] Available from: <https://www.ucl.ac.uk/lbs/person/view/6745> [Accessed 03/07/2025].
- Legg, R. and Prior, J. (2023) Toxic torts as compensation: Legal geographies of environmental contamination litigation. *Geographical Research*, 61(2), 234–247.
- Leiper, J. (1995) Early Textile Industry and Planned Villages in the Endrick Valley. *Forth Naturalist & Historian Journal*, 18, 117–125.
- Leitham, S., McQuaid, R. W., and Nelson, J. D. (2000) The influence of transport on industrial location choice: a stated preference experiment. *Transportation Research Part A: Policy and Practice*, 34(7), 515–535.

- Lenman, B. and Donaldson, K. (1971) Partners' Incomes, Investment & Diversification in the Scottish Linen Area 1850-1921. *Business history*, 13(1), 1–18.
- Lenman, B. (2009) *Enlightenment and Change: Scotland 1746-1832*. Second Edition. The New History of Scotland Series. Edinburgh: Edinburgh University Press.
- Leslie, D. (2005) Effective community involvement in the development and sustainability of cultural tourism: An exploration in the case of New Lanark. In: D. Leslie and M. Sigala, eds, *International Cultural Tourism*, London: Routledge, 2005, 122–136.
- Leunig, T. (2001) New answers to old questions: Explaining the slow adoption of ring spinning in Lancashire, 1880-1913. *The Journal of Economic History* 61(2): 439–466.
- Lewis, B. J., Cimbala, J. M. and Wouden, A. M. (2014) "Major historical developments in the design of water wheels and Francis hydroturbines." *IOP conference series. Earth and environmental science*, 22(1), 12020–12030.
- Lindsay, J. M. (1977) Forestry and Agriculture in the Scottish Highlands 1700–1850: A Problem in Estate Management. *The Agricultural History Review*, 25(1), 23–36.
- Lindsay, N. (2006) *Ospisdale Woodlands Near Dornoch, Sutherland. A Report on an Archaeological Walk-Over Survey Prepared for Scottish Woodlands Ltd* [Online] Available from:
https://her.highland.gov.uk/api/LibraryLink5WebServiceProxy/FetchResourceFromStub/1-0-0-1-9-1_4ebf148160dfc4b-100191_96e880a1f97e546.pdf [Accessed 05/07/2025].
- Littlefield, A. and Reynolds, L. T. (1990) The putting-out system: Transitional form or recurrent feature of capitalist production? *The Social Science Journal*, 27(4), 359–372.
- Littlewood, T. (2013) *NH6789 : Ruins of Spinningdale Mill* [Online] Available from:
<https://www.geograph.org.uk/photo/3484307> [Accessed 13/07/2025].
- Lloyd, C. D., Gregory, I. N., Shuttleworth, I. G., & Lilley, K. D. (2012) Exploring change in urban areas using GIS: data sources, linkages and problems. *Annals of GIS*, 18(1), 71–80.
- Lockhart, D. G. (1978) The planned villages of Aberdeenshire: The evidence from newspaper advertisements. *Scottish Geographical Magazine*, 94(2): 95–102.
- Lockhart, D. G. (1982) Patterns of migration and movement of labour to the planned villages of North East Scotland. *Scottish Geographical Magazine*, 98(1): 35–48.
- Lockhart, D. G. (1986) Migration to planned villages in Scotland between 1725 and 1850, *Scottish Geographical Magazine*, 102(3), 165–180.
- Lockhart, D. G. (2012) *Scottish planned villages*. Edinburgh: Printed for the Scottish History Society.
- Lockhart, D. G. (2001) Lotted Lands and Planned Villages in North-East Scotland. *Agricultural history review* 49(1): 17-40.
- Loft, C. (2001) Reappraisal and Reshaping: Government and the Railway Problem 1951-64. *Contemporary British History*, 15(4), 71–92.
- Lorimer, H. (2009) Caught in the nick of time: archives and fieldwork. In: D. DeLyser, S. Aitken, M. A. Crang, S. Herbert and L. McDowell, eds. *The SAGE Handbook of Qualitative Research in Human Geography*. SAGE Publications, 2009, 248–273.

- Lösch, A., Woglom, W. H. and Stolper, W. F. (1954) *The economics of location*. Yale University Press.
- Lucas, A. (2005) Industrial Milling in the Ancient and Medieval Worlds: A Survey of the Evidence for an Industrial Revolution in Medieval Europe. *Technology and Culture*, 46(1), 1–30.
- Lucas, A. (2006) *Wind, water, work : ancient and medieval milling technology*. Leiden: Brill.
- Lucas, A. T. (1953) The Horizontal Mill in Ireland. *The Journal of the Royal Society of Antiquaries of Ireland*, 83(1), 1–36.
- Ludin Links (2015) *John Jeffrey* [Online] Available from: <https://ludinlinks.weebly.com/blog/john-jeffrey> [Accessed 05/09/2022].
- Maaß, A. L. and Schüttrumpf, H. (2019). Elevated floodplains and net channel incision as a result of the construction and removal of water mills. *Geografiska annaler. Series A, Physical geography*, 101(2), 157–176.
- MacEachen, E., MacBain, A. and Whyte, J. (1922) *Faclair Gaidhlic is Beurla*. Inverness: The Northern Counties Newspaper and Printing and Publishing Company.
- Mackenzie, H. J. (2015) *BANK OF SCOTLAND AND ABBIAN HOUSE, TAIN (FORMERLY BRITISH LINEN BANK)* [Online] Available from: <https://i.rcahms.gov.uk/canmore-pdf/WP00004173.pdf> [Accessed 05/06/2022].
- MacKenzie, J. (1987) *The highland community in Glasgow in the nineteenth century: a study of non-assimilation*. Thesis. University of Stirling.
- Mackintosh, D. (2022) *Meikle Ferry (South)* [Online] Available from: <http://ports.org.uk/port.asp?id=598> [Accessed 29/05/2022].
- MacLagan, I. (1996) Robert Thom's Cuts on the Island of Bute. *Transactions of the Buteshire Natural History Society*, 24, 3–19.
- MacVaugh, J. and Schiavone, F. (2010) Limits to the diffusion of innovation: A literature review and integrative model. *European journal of innovation management*, 13(2), 197–221.
- Magee, G. B. (1997) Technological divergence in a continuous flow production industry: American and British paper making in the late Victorian and Edwardian era. *Business History*, 39(1), 21–46.
- Malm, A. (2012a) China as Chimney of the World: The Fossil Capital Hypothesis. *Organization & Environment*, 25(2), 146–77.
- Malm, A. (2012b) Steam: Nineteenth-century mechanization and the power of capital. In: A.Malm, A. Hornborg, K. Hermele and B. Clark, eds. *Ecology and Power*. Routledge, 108–123.
- Malm, A. (2014) Fleeing the flowing commons: Robert thom, water reservoir schemes, and the shift to steam power in early nineteenth-century britain. *Environmental History*, 19(1), 55–77.
- Malm, A. (2016) *Fossil Capital: The Rise of Steam Power and the Roots of Global Warming*. London: Verso.
- Manley, G. (1938) "Memorandum on the Geographical Factors Relevant to the Location of Industry." *The Geographical Journal*, 92(6), 499–526.
- Mantoux, P. (2006) *The Industrial Revolution in the Eighteenth Century: An outline of the beginnings of the modern factory system in England* (1st ed.). Routledge.

- Marfany, J. (2010) Is it still helpful to talk about proto-industrialization? Some suggestions from a Catalan case study. *The Economic History Review*, 63(4), 942–973.
- Marglin, S. A. (1974) What Do Bosses Do?: The Origins and Functions of Hierarchy in Capitalist Production. *Review of Radical Political Economics*, 6(2), 60–112.
- Marine.gov.scot (2018) *Mean Spring Tidal Range (m)* [Online] Available from: <https://marine.gov.scot/information/mean-spring-tidal-range-m> [Accessed 21/07/2025].
- Marsden, P. (2000) Forefathers of Memetics: Gabriel Tarde and the Laws of Imitation. *Journal of Memetics - Evolutionary Models of Information Transmission*, 4(1), 1176–1180.
- Martin, D., Dorling, D. and Mitchell, R. (2002) Linking censuses through time: problems and solutions. *Area (London 1969)*, 34(1), 82–91.
- Martin, R., and Sunley, P. (2010) The Place of Path Dependence in an Evolutionary Perspective on the Economic Landscape. In: R. Boschma, and R. Martin, eds. *The Handbook of Evolutionary Economic Geography*. Cheltenham, UK: Edward Elgar Publishing, 62–92.
- Martínez, E. and Polo, Y. (1996) Adopter categories in the acceptance process for consumer durables. *Journal of Product & Brand Management*, 5(3), 34–47.
- Mason, J. (2004) Arkwright, Sir Richard (1732–1792), inventor of cotton-spinning machinery and cotton manufacturer. *Oxford Dictionary of National Biography* [Online] Available from: <https://doi.org/10.1093/ref:odnb/645> [Accessed 06/07/2025].
- Matthews, O. P. (1984) *Water resources, geography and law*. Association of American Geographers.
- Maudlin, D. (2007) Robert Mylne, Thomas Telford and the architecture of improvement: the planned villages of the British Fisheries Society, 1786–1817. *Urban history*, 34(3), 453–480.
- Maw, P. (2021) Provincial Merchants in Eighteenth-Century England: The ‘Great Oaks’ of Manchester, *The English Historical Review*, 136(580), 568–618.
- Maw, P., Wyke, T., and Kidd, A. (2012) Canals, rivers, and the industrial city: Manchester’s industrial waterfront, 1790–1850. *The Economic History Review*, 65(4), 1495–1523.
- McCloskey, D. N. (1981) *Enterprise and trade in Victorian Britain: essays in historical economics*. London: Allen & Unwin.
- McCullough, K. L. (2016) ‘Honest’ George Dempster and the Spinningdale Experiment. [Online] Available from: <https://historylinksdornoch.wordpress.com/2016/09/02/honest-george-dempster-and-the-spinningdale-experiment/> [Accessed 06/08/2020].
- McEwen, L. J. and Werritty, A. (1997) Falls of Clyde. In: Gregory, K. J. ed. *Fluvial geomorphology of Great Britain*. Chapman & Hall, 1997, 551–552.
- McGeachan, C., Forsyth, I. and Hasty, W. (2012) Certain Subjects? Working with Biography and Life-Writing in Historical Geography. *Historical Geography*, 40, 169–185.
- McGilvary, G. K. (1990) *East India patronage and the political management of Scotland 1720–1774*. Thesis (PhD). The Open University.
- McKean, A. and Lennon, J. (2018) Tourism and Scotland’s canals: A twenty-first century transformation. In: F. Vallerani and F. Visentin, eds. *Waterways and the Cultural Landscape*. 1st ed. [Online]. London: Routledge, 192–202.
- McLaren, D. J. (2015) *David Dale: A life*. Stenlake Publishing Ltd.

- McLaren, T. (1946) Old Windmills in Scotland, with Special Reference to the Windmill Tower at Dunbarney, Perthshire. *Proceedings of the Society of Antiquaries of Scotland*, 79, 6–14.
- McLean, I. and Bustani, C. (1999) Irish Potatoes and British Politics: Interests, Ideology, Heresthetic and the Repeal of the Corn Laws. *Political Studies*, 47(5), 817–836.
- McMaster, P. (1991) The Ordnance Survey: 200 years of mapping and on. *RSA Journal*, 139(5421), 581–593.
- Meisenzahl, R. and Mokyr, J. (2012) The Rate and Direction of Invention in the British Industrial Revolution: Incentives and Institutions. In: J. Lerner and S. Stern, eds. *The Rate and Direction of Inventive Activity Revisited*. Chicago, IL: Chicago Scholarship Online, 443–482.
- Mendels, F. (1972) Proto-industrialization: The first phase of the industrialization process. *The Journal of Economic History*, 32(1), 241–261.
- Menzies, I. E., and Chapman, D. (2003) The Jute Industry. In: H. A. Silverman, ed. *Studies in Industrial Organization*. London: Routledge, 235–263.
- Merritts, D., Walter, R., Rahnis, M., Hartranft, J., Cox, S., Gellis, A., Potter, N., Hilgartner, W., Langland, M., Manion, L., Lippincott, C., Siddiqui, S., Rehman, Z., Scheid, C., Kratz, L., Shilling, A., Jenschke, M., Datin, K., Cranmer, E., ... Becker, S. (2011). Anthropocene streams and base-level controls from historic dams in the unglaciated mid-Atlantic region, USA. *Philosophical Transactions of the Royal Society of London. Series A: Mathematical, Physical, and Engineering Sciences*, 369(1938), 976–1009.
- Met Office (2023) *What is the Gulf Stream?* [Online] Available from: <https://www.metoffice.gov.uk/weather/learn-about/weather/oceans/what-is-the-gulf-stream> [Accessed 21/02/2023].
- Met Office (2025) *Where are the windiest parts of the UK?* [Online] Available from: <https://weather.metoffice.gov.uk/learn-about/weather/types-of-weather/wind/windiest-place-in-uk> [Accessed 27/07/2025].
- Mills Archive Trust (2025a) *A-Z glossary* [Online] Available from: <https://new.millsarchive.org/glossary/a-z-glossary> [Accessed 29/07/2025].
- Mills Archive Trust (2025b) *Pitchback Wheel* [Online] Available from: <https://new.millsarchive.org/glossary/a-z-glossary/?action=show&which=3676> [Accessed 08/07/2025].
- Minchinton, W. E. (1979) Early Tide Mills: Some Problems. *Technology and Culture*, 20(4), 777–786.
- Minnery, J. (2019) New Lanark: Sustaining Robert Owen’s Legacy in Scotland. In: *Iconic planned communities and the challenge of change*. M. Corbin Sies, I. Gournay, and R. Freestone, eds. Philadelphia: University of Pennsylvania Press, 2019, 21–39.
- Miskell, L. and Kenefick, W. (2000) 'A Flourishing Seaport': Dundee Harbour and the Making of the Industrial Town, c. 1815-1850. *Scottish Economic and Social History*, 20(2), 176-198.
- Miskell, L., and Whatley, C. A. (1999) Juteopolis in the Making: Linen and the Industrial Transformation of Dundee, c.1820-1850. *Textile History*, 30(2), 176–198.

- Mitchell, D. (2020) *'That important branch of rural science': historical geographies of lime burning in Scotland*. Thesis (PhD), University of Glasgow.
- Mitchison, R. (2015) Sinclair, Sir John, first baronet (1754–1835), agricultural improver, politician, and codifier of 'useful knowledge'. *Oxford Dictionary of National Biography*. Available from: <https://www.oxforddnb.com/view/10.1093/ref:odnb/9780198614128.001.0001/odnb-9780198614128-e-25627>.
- Mokyr, J. (1990) *The Lever of Riches*. New York: Oxford University Press.
- Mokyr, J. (2002) *The gifts of Athena : historical origins of the knowledge economy*. Princeton, N.J.; Princeton University Press.
- Mokyr, J. (2005) The intellectual origins of modern economic growth. *The Journal of Economic History*, 65(2), 285–351.
- Mokyr, J. (2009) *The enlightened economy: an economic history of Britain, 1700-1850*. Yale University Press.
- Mokyr, J. (2018) The past and the future of innovation: Some lessons from economic history. *Explorations in Economic History*, 69, 13–26.
- Mokyr, J., Sarid, A., and Van Der Beek, K. (2022) The wheels of change: Technology adoption, millwrights and the persistence in Britain's industrialisation. *The Economic Journal*, 132(645), 1894–1926.
- Moodie, D. W. (1971) Content Analysis: A Method for Historical Geography. *Area*, 3(3), 146–149.
- Moodie, D. W. and Lehr, J. C. (1976) Fact And Theory In Historical Geography, *The Professional Geographer*, 28(2), 132–135.
- Moore, F. P. L. (2010) Tales from the archive: methodological and ethical issues in historical geography research. *Area*, 42(3), 262–270.
- Morgan, K. (1999) *The birth of industrial Britain: economic change 1750-1850*. London; New York: Longman.
- Morgan, V. (1971) Agricultural wage rates in late eighteenth-century Scotland. *The economic history review*, 24(2), 181–201.
- Morris, M. (2018) The Problem of Slavery in the Age of Improvement, David Dale, Robert Owen and New Lanark Cotton. In: A. Benchimol, and G. L. McKeever, eds. *Cultures of Improvement in Scottish Romanticism, 1707-1840*. New York: Routledge, 111–131.
- Mullen, S. (2022a) Centring transatlantic slavery in Scottish historiography. *History Compass*, 20(1), e12707.
- Mullen, S. (2022b) *The Glasgow sugar aristocracy: Scotland and Caribbean slavery, 1775-1838*. University of London Press.
- Mullen, S. (2022c) Glasgow, slavery and Atlantic commerce: An audit of historic connections and modern legacies. *Project Report, Glasgow City Council*, 27.
- Müller, G. and Kauppert, K. (2002) Old watermills—Britain's new source of energy? *Proceedings of the Institution of Civil Engineers - Civil Engineering*, 150(4), 178–186.
- Müller, G. and Kauppert, K. (2004) Performance characteristics of water wheels. *Journal of Hydraulic Research*, 42(5), 451–460.
- Munro, I. S. (1973) *The island of Bute*. Newton Abbot: David and Charles.

- Murray, R. (1958) Quarry Bank Mill: 1. The Story of the Mill. *British journal of industrial medicine*. 15(4), 293–298.
- Murray, N. (1978) *The Scottish hand loom weavers, 1790-1850: a social history*. Edinburgh: John Donald Publishers.
- Mussell, J. (2008) Ownership, institutions, and methodology. *Journal of Victorian Culture – JVC*, 13(1), 94–100.
- Musson, A. E. (1972) *Science, technology, and economic growth in the eighteenth century*. London: Methuen.
- Musson, A. E. (1976) Industrial motive power in the United Kingdom, 1800-70. *The Economic History Review*, 29(3), 415–439.
- Myers, C. D. (2000) The Glasgow Association for the Higher Education of Women, 1878 to 1883. *The Historian*, 63(2), 357–371.
- Nardinelli, C. (1980) Child Labor and the Factory Acts. *The Journal of Economic History*, 40(4), 739–755.
- Nash, C. (2005) Local Histories in Northern Ireland. *History workshop journal*, 60(1), 45–68.
- National Galleries Scotland (2022) *Robert Dunmore of Kelvinside, 1744 - 1799. Merchant in Glasgow* [Online] Available from: <https://www.nationalgalleries.org/art-and-artists/2337/robert-dunmore-kelvinside-1744-1799-merchant-glasgow> [Accessed 05/09/2022].
- National Portrait Gallery (2023) *Robert Owen Portrait Print* [Online] Available from: <https://npgshop.org.uk/products/robert-owen-npg-4521-print> [Accessed 20/02/2023].
- National Records of Scotland (2024) *Settlements and Localities Digital Boundaries* [Online] Available from: <https://www.nrscotland.gov.uk/statistics-and-data/geography/our-products/settlements-and-localities-dataset/settlements-and-localities-digital-boundaries> [Accessed 18/11/2024].
- National Trust (2025) *The history of Wellbrook Beetling Mill* [Online] Available from: <https://www.nationaltrust.org.uk/visit/northern-ireland/wellbrook-beetling-mill/history-of-wellbrook-beetling-mill> [Accessed 29/07/2025].
- NatureScot (2025) *Ancient Woodland Inventory* [Online] Available from: <https://opendata.nature.scot/datasets/ancient-woodland-inventory/explore> [Accessed 22/07/2025].
- NatWest Group (2022) *£5 note, 1966* [Online] Available from: <https://www.natwestgroup.com/heritage/history-100/objects-by-theme/our-public-face/five-pound-note-1966.html#:~:text=The%20portrait%20on%20this%20note,for%20more%20than%2020%20years> [Accessed 09/09/2022]
- Nave Calton, I. and Fleet, C. (2021) *Scottish Water Mills Website* [Online] Available from: <https://maps.nls.uk/projects/mills/about.html> [Accessed 20/01/2023].
- Naylor, S. (2008) Historical geography: geographies and historiographies. *Progress in Human Geography*, 32(2), 265–274.
- Neill, S. P., Vögler, A., Goward-Brown, A. J., Baston, S., Lewis, M. J., Gillibrand, P. A., Waldman, S., and Woolf, D. K. (2017) The wave and tidal resource of Scotland. *Renewable Energy*, 114, 3–17.

- Nevell, M. (2005) The Social Archaeology of Industrialisation. In: E.C. Casella, J. Symonds, eds. *Industrial Archaeology. Contributions to Global Historical Archaeology*. Boston, MA: Springer, 177–204.
- Nicolson, M. and Donnachie, I. (2003) The New Lanark Highlanders: Migration, Community, And Language 1785-C. 1850. *Family & Community History*, 6(1), 19–32.
- Nightingale, P. (2009) Scott, David (1746–1805), merchant and director of the East India Company. *Oxford Dictionary of National Biography*. Available from: <https://www.oxforddnb.com/view/10.1093/ref:odnb/9780198614128.001.0001/odnb-9780198614128-e-63537>.
- Nisbet, S. M. (1994) Renfrewshire Snuff Mills. *RLHF Journal*, 6, 8–12.
- Nisbet, S. M. (2003) *The rise of the cotton factory in eighteenth century Renfrewshire*. Thesis (PhD), University of Paisley.
- Nisbet, S. M. (2004) Early cotton spinning in the west of Scotland (1778- 1799): Rothesay Cotton Mill. *Trans. Buteshire Natural History Society*, 26, 39–47.
- Nisbet, S. M. (2009) The making of Scotland's first industrial region: the early cotton industry in Renfrewshire. *Journal of Scottish Historical Studies*, 29(1), 1–28.
- Nisbet, S. M. (2019) The Water Mills of the Lower Kelvin: Nine Dams, Thirty Mills. *Scottish Local History*, 102.
- NLS (2024) *Scottish Counties and Parishes: their history and boundaries on maps* [Online] Available from: <https://maps.nls.uk/geo/boundaries/history.html#histcounty> [Accessed 22/11/2025].
- NLS (2025a) *Boundaries viewer* [Online] Available from: <https://maps.nls.uk/geo/boundaries/> [Accessed 18/07/2025].
- NLS (2025b) *Viewing our Georeferenced Maps Guide* [Online] Available from: <https://maps.nls.uk/guides/georeferencing> [Accessed 18/07/2025].
- NLS (2025c) *Ordnance Survey Characteristic Sheets* [Online] Available from: <https://maps.nls.uk/os/characteristic-sheets/> [Accessed 08/07/2025].
- NLS (2025d) *Survey and revision dates for County Series mapping, 1843-1943 – Scotland* [Online] Available from: <https://maps.nls.uk/os/county-series/dates.html> [Accessed 23/07/2025].
- NLT: New Lanark Trust (2022) *Welcome to New Lanark* [Online] Available from: <https://www.newlanark.org/> [Accessed 20/12/2022].
- Noori, H. (1987) Benefits arising from new technology adoption: small vs. large firms, *Journal of Small Business & Entrepreneurship*, 5(1), 8–16.
- NRFA (2022) *National River Flow Archive Catchment Boundary Download* [Online] Available from: https://nrfa.ceh.ac.uk/data/station/spatial_download/83003 [Accessed 10/10/2022].
- NRFA (2025) *National River Flow Archive* [Online] Available from: <https://nrfa.ceh.ac.uk/> [Accessed 13/07/2025].
- Nuvolari, A. (2004) Collective invention during the British industrial revolution: The case of the Cornish pumping engine. *Camb. J. Econ*, 28(3), 347–363.
- Nuvolari, A., Verspagen, B., and von Tunzelmann, N. (2011) The early diffusion of the steam engine in Britain, 1700–1800: a reappraisal. *Cliometrica*, 5(3), 291–321.

- O'Brien, P. K. (1988) The costs and benefits of British imperialism 1846–1914, *Past & Present*, 120(1), 163–200.
- O'Brien, P. K. (2000) The Reconstruction, Rehabilitation and Reconfiguration of the British Industrial Revolution as a Conjuncture in Global History. *Itinerario*, 24(3–4), 117–134.
- O'Reilly, J. P. (1902) Some Further Notes on Ancient Horizontal Water-Mills, Native and Foreign. *Proceedings of the Royal Irish Academy. Section C: Archaeology, Celtic Studies, History, Linguistics, Literature*, 24, 55–84.
- Oevermann, H. (2021) *Urban textile mills: Conservation and conversion*. BeBra Wissenschaft.
- Oevermann, H. and Jones, P. (2022). Experience and engagement: Good practice in heritage conservation and adaptive reuse of textile mills in UK and Germany. *The Historic Environment: Policy & Practice*, 13(1), 91–120.
- Ogborn, M. (2003) Knowledge Is Power: Using Archival Research to Interpret State Formations. In: A. Blunt, P. Gruffudd, J. May, M. Ogborn and D. Pinder, eds. *Cultural Geography in Practice*. London; New York: Routledge, 2014, 9–20.
- Ogborn, M. (2011) Archive. In: J. Agnew and D. N. Livingstone, eds. *The sage handbook of geographical knowledge*. SAGE Publications, 88–98.
- Ogden, H. W. (1927) The geographical basis of the Lancashire cotton industry. *Journal of the Textile Institute Transactions*, 18(11), T573–T594.
- Ohta, H., Asami, Y. and Kohlhase, J.E. (1990) Land, Labour and Product Markets under Spatial Monopoly and Spatial Competition. In: M. Chatterji, M. and R.E. Kuenne, eds. *New Frontiers in Regional Science*. London : Palgrave Macmillan, 95–111.
- Okishio, N. (1990) Constant and Variable Capital. In: J. Eatwell, M. Milgate, P. Newman, eds. *Marxian Economics*. London: The New Palgrave, Palgrave Macmillan, 91–103.
- Oliver, R. (2013) *Ordnance Survey maps: a concise guide for historians*. London: The Charles Close Society.
- Oliver, T. (1914) The rise and progress of factory legislation. *The Journal of State Medicine (1912-1937)*, 22(8), 472–483.
- Ordnance Survey (2023) *OS Open Rivers* [Online] Available from: <https://osdatahub.os.uk/downloads/open/OpenRivers> [Accessed 18/11/2024].
- Ordnance Survey (2024) *OpenData Downloads*. Available from: <https://osdatahub.os.uk/downloads/open> [Accessed 02/10/2023].
- Oxford English Dictionary (2025a) *Mill, N. (1), Sense III.5.a*. [Online] Available from: <https://doi.org/10.1093/OED/4307291117> [Accessed: 17/05/2025].
- Oxford English Dictionary (2025b) *Mill, N. (1), Sense III.5.b*. [Online] Available from: <https://doi.org/10.1093/OED/4914013954> [Accessed: 17/05/2025].
- Oxford English Dictionary (2025c) *Factory, N., Sense 4.a*. [Online] Available from: <https://doi.org/10.1093/OED/7698811162> [Accessed: 17/05/2025].
- Pacione, M. (2011) Introduction. In: M. Pacione, ed. *Historical Geography: Progress and Prospect*. Oxford: Taylor & Francis Group, 1–15.
- Pacina, J. and Havlicek, J. (2015) Identifying, modelling and visualizing a vanished settlement in the Czech – German borderland. *International Journal of Interdisciplinarity in Theory and Practice*, 8(2344–2409), 117–123.

- Page\Park (2025) Pollok Park Stables and Sawmill [Online] Available from: <https://pagepark.co.uk/project/pollok-park-stables-and-sawmill/> [Accessed 11/06/2025].
- Palmer, M. and Neaverson, P. (1998) *Industrial Archaeology: Principles and Practice*, Taylor & Francis Group.
- Park, B. A. (1984) *The woollen mill buildings in the Hillfoots area*. Forth naturalist and historian.
- Parrinello, G. (2018) Systems of power: a spatial envirotechnical approach to water power and industrialization in the po valley of Italy, ca. 1880–1970. *Technology and Culture*, 59(3), 652–688.
- Pastor, M. B., Vieira, E. and Sanchiz, J. M. C. (2021) Labour and Technology Migrations in the Iberian Peninsula — The Case of the Spanish Millano Family’s Woollen Mills in Portugal (Late 19th–Early 20th Century). *Industrial Archaeology Review*, 43(2), 80–94.
- Paton, T. A. L., and Brown, J. G. (1960) *Power from water*. L. Hill.
- Pavlovskaya M (2006) Theorizing with GIS: a tool for critical geographies? *Environment and Planning A: Economy and Space*, 38(11), 2003–2020.
- Paxton, R. (2009) Loch Katrine Water Supply to Glasgow, Scotland, 1855–1903. *Great Rivers History: Proceedings and Invited Papers for the EWRI Congress and History Symposium*. American Society of Civil Engineers, 2009.
- Payne, P. L. (1980) *The early Scottish limited companies, 1856-1895: an historical and analytical survey*. Scottish Academic Press.
- Payne, P. L. (1988) *British Entrepreneurship in the nineteenth Century*. Second Edition. Hampshire: Macmillan Education Ltd.
- Pearson, W. (1996) Water Power in a Dry Continent: The Transfer of Watermill Technology from Britain to Australia in the Nineteenth Century. *Australasian Historical Archaeology*, 14, 46–62.
- Pedersen, P. O. (1970) Innovation Diffusion within and between National Urban Systems. *Geographical analysis*, 2(3), 203–254.
- Peel, R. A. (1952) Turkey red dyeing in Scotland its heyday and decline. *Journal of the Society of Dyers and Colourists*, 68(12), 496–505.
- Philip, L. J. (2003) The creation of settlements in rural Scotland: Planned villages in Dumfries and Galloway, 1730–1850. *Scottish Geographical Journal*, 119(2), 77–102.
- Philip, L. J. (2005) Planned Villages in South-West Scotland, 1730-1855: Analysing Functional Characteristics. *Landscapes (Bollington, England)*, 6(1), 83–107.
- Philip, L. J. (2006) Planned villages in Dumfriesshire and Galloway: Location, Form and Function. *Transactions of the Dumfries and Galloway Natural History Society*, 80, 105–121.
- Philip, L., Macleod, M. and Stockdale, A. (2013) Retirement transition, migration and remote rural communities: Evidence from the Isle of Bute. *Scottish Geographical Journal*, 129(2), 122–136.
- Philo, C. (1998) A ‘lyffe in pyttes and caves’: Exclusionary geographies of the west country tanners. *Geoforum*. 29 (2), 159–172.

- Philo, C., Parr, H. and Burns, N. (2017) The rural panopticon. *Journal of Rural Studies*, 51, 230239.
- Pinder, D. (2003) Mapping Worlds. In: A. Blunt, P. Gruffudd, J. May, M. Ogborn and D. Pinder, eds. *Cultural Geography in Practice*. London; New York: Routledge, 2014, 172–187.
- Pizzuto, J. and O’Neal, M. (2009) Increased mid-twentieth century riverbank erosion rates related to the demise of mill dams, South River, Virginia. *Geology*, 37, 19–22.
- PKHT (2025) *Lower City Mills* [Online] Available from: <https://www.pkht.org.uk/lowercitymills/> [Accessed 03/06/2025].
- Plackett, R. L. (1986) The Old Statistical Account. *Journal of the Royal Statistical Society. Series A (General)*, 149(3), 247–251.
- Podgórski, Z., and Szatten, D. (2020) Changes in the Dynamics and Nature of Sedimentation in Mill Ponds as an Indicator of Environmental Changes in a Selected Lake Catchment (Chełmińskie Lake District, Poland). *Water*, 12(1), 268.
- Polák, M. (2021) A Brief History of the Kaplan Turbine Invention. *Energies*, 14(19), 6211.
- Pollard, S. (1964) The factory village in the industrial revolution. *English historical review*, 79(312), 513–531.
- Pollard, S. (1990) *Typology of Industrialization Processes in the Nineteenth Century*. London: Routledge.
- Pomeranz, K. (2000) *The great divergence: China, Europe, and the making of the modern world economy*, Princeton University Press, Princeton, N.J.
- Pouso-Iglesias, P. X., Arcones-Pascual, G., Bellido-Blanco, S. and Valentín-Gamazo, D. V. (2023) Abandoned rural pre-industrial heritage: study of the Riamonte mil complex (Galicia, Spain). *Virtual archaeology review*, 14(28), 95–109.
- Pratt, D. H. (1980) Empirical education and quaker prowess in chemically oriented businesses during the industrial revolution. *Journal of educational administration and history*, 12(2), 7–18.
- Pratt, E. A. (1922) *Scottish canals and water-ways, comprising state canals, railway-owned canals and present-day ship canal schemes*. London: Selwyn and Blount, ltd.
- Pred, A. (1969) *Behavior and location. Foundations for a geographic and dynamic location theory*. Royal University of Lund, Department of Geography: C.W.K. Gleerup.
- Pred, A. R. (1975) Diffusion, Organizational Spatial Structure, and City-System Development. *Economic geography*, 51(3), 252–268.
- Price, J. M. (1954) The Rise of Glasgow in the Chesapeake Tobacco Trade, 1707-1775. *The William and Mary Quarterly*, 11(2), 179–199.
- Prior, A. and Kirby, M. (1998) The Society of Friends and business culture, 1700–1830. In: D. J. Jeremy, ed. *Religion, business, and wealth in modern Britain*. 1st ed. London: Routledge, 115–136.
- Pritchard, S. B. (2011) *Confluence: the nature of technology and the remaking of the Rhône*. Cambridge, Mass: Harvard University Press.
- Proudfoot, E. and Hannah, A. (2000) 'Deserted Settlements on Bute'. *Transactions of the Buteshire Natural History Society*, XXV. Rothesay, Bute.
- Puffert, D. J. (2023) Path dependence. In: C. Diebolt and M. Hauptert, eds. *Handbook of cliometrics*. Berlin, Heidelberg: Springer, 2491–2517.

- Pujol, T. and Montoro, L. (2010) High hydraulic performance in horizontal waterwheels. *Renewable Energy* 35(11): 2543–2551.
- Pujol, T., Solà, J., Montoro, L. and Pelegrí, M. (2010) Hydraulic performance of an ancient Spanish watermill. *Renewable energy* 35(2): 387–396.
- Purdie, D. W. (2004) "Never Met-and Never Parted": The Curious Case of Burns and Boswell, *Studies in Scottish Literature*. 33(1), 169–176.
- Quaranta, E. and Wolter, C. (2021) Sustainability assessment of hydropower water wheels with downstream migrating fish and blade strike modelling. *Sustainable energy technologies and assessments*. 43, 100943.
- Quinton, R. (2020) *John Robertson: Cash for a Cashier* [Online] Available from: <https://glasgowmuseumsslavery.co.uk/> [Accessed 02/06/2022].
- Railscot (2022) *Mauchline* [Online] Available from: <https://www.railscot.co.uk/locations/M/Mauchline/> [Accessed 04/06/2022].
- Rawson, K. and Muñoz, T. (2019) Against Cleaning. In M. K. Gold & L. F. Klein (Eds.), *Debates in the Digital Humanities 2019* (pp. 279–292). University of Minnesota Press.
- Redding, S., and Turner, M. A. (2014) *Transportation costs and the spatial organization of economic activity*. London School of Economics and Political Science. Centre for Economic Performance.
- Reilly, V. (2009) Coats and Clark. The Binding Thread of Paisley's History. *RLHF Journal*, 15, 1–12.
- Reiner, B. I. (2011) Optimizing Technology Development and Adoption in Medical Imaging Using the Principles of Innovation Diffusion, Part I: Theoretical, Historical, and Contemporary Considerations. *J Digit Imaging*, 24, 750–753.
- Renwick, R., Lindsay, J., Sir and Eyre-Todd, G. (1921) *History of Glasgow*. MacLehose, Jackson and Co.
- Reynolds, T. S. (1979) Scientific influences on technology: The case of the overshot waterwheel, 1752-1754. *Technology and Culture*, 20(2), 270–295.
- Reynolds, T. S. (1983) *Stronger than a hundred men: a history of the vertical water wheel*. Johns Hopkins University Press.
- Reynolds, T.S. and Cutcliffe, S.H. (1997) *Technology & the West: a historical anthology from Technology and culture*. Chicago; London: University of Chicago Press.
- Rhodes II, M. A., Hannum, K. L., and Ketola, Z. (2025) Managing the Imagined Spatialities of Protected Sites: (Un)Bounding Industrial World Heritage via Mental Maps. *Annals of the American Association of Geographers*, 1–16.
- Riello, G. (2022) Cotton Textiles and the Industrial Revolution in a Global Context. *Past & present*. 255(1), 87–139.
- Ritchie, A. and HES (Historic Environment Scotland) (2003) *Industrial Scotland*. Edinburgh: Historic Scotland.
- Riverola, C., Dedehayir, O. and Miralles, F. (2016) Who are the early adopters in the diffusion of innovations? A literature review. In *ANZAM Conference (Australian & New Zealand Academy of Management)*.

- Rivington, M., Akoumianaki, I., and Coull, M. (2020) *Private Water Supplies and Climate Change: The likely impacts of climate change (amount, frequency and distribution of precipitation), and the resilience of private water supplies*. Scotland's Centre of Expertise for Waters CREW.
- Robbie, J. (2015) *Private water rights*. Edinburgh Legal Education Trust.
- Robbie, J. (2017) *Policy Brief. Reform of Scottish Water Rights*. Documentation. University of Glasgow.
- Robert Owen Museum (2023) Robert Owen's Institute at New Lanark: engraving by G. Hunt, 1825 [Online] Available from: <https://www.peoplescollection.wales/items/10460#?xywh=-17%2C-21%2C783%2C584> [Accessed 20/02/2023].
- Robertson, A. J. (1965) *Growth of the cotton industry and Scottish economic development, 1780-1835* (T). University of British Columbia.
- Robertson, A. J. (1971) Robert Owen, Cotton Spinner: New Lanark, 1800-25. In: S. Pollard and J. Salt, eds. *Robert Owen, prophet of the poor : essays in honour of the two hundredth anniversary of his birth*. London: Macmillan, 145–165.
- Robertson, C. J. (1958) Locational and structural aspects of industry in Edinburgh. *Scottish Geographical Magazine*, 74(2), 65–77.
- Robertson, T. and Roberson, A. (n.d.) Historical Journeys along Rivers of Scotland: The Aberdeenshire River Don [Online] Available from: <https://drtombooks.com/wp-content/uploads/2023/02/the-aberdeenshire-river-don-b.pdf> [Accessed 02/07/2025].
- Rodgers, A. (1952) Industrial inertia. A major factor in the location of the steel industry in the United States. *Geographical Review*, 42(1), 56–66.
- Rodrigue, J. P., Comtois, C. and Slack, B. (2013) *The geography of transport systems*. Third edition. London: Routledge.
- Rodwell, D. (2002) The World Heritage Convention and the Exemplary Management of Complex Heritage Sites. *Journal of Architectural Conservation*, 8(3), 40–60.
- Rogers, E. M. (2003) *Diffusion of innovations* (Fifth edition.). Free Press.
- Ronchini, C. (2018) Cultural Paradigm Inertia and Urban Tourism. In: E. Fayos Solá and C. Cooper, eds. *The future of tourism : innovation and sustainability*. Springer. 179 – 194.
- Roper, C. (2003) Historical Mapping is Still Under-valued and Under-used, *The Cartographic Journal*, 40(2), 131–134.
- Rose, M. B. (2000) *Firms, networks, and business values: the British and American cotton industries since 1750*. Cambridge: Cambridge University Press.
- Rosen, F. (2014) Bentham, Jeremy (1748–1832), philosopher, jurist, and reformer. *Oxford Dictionary of National Biography* [Online] Available from: <https://doi.org/10.1093/ref:odnb/2153> [Accessed 06/07/2025].
- Rosenberg N, Trajtenberg M. (2004) A general-purpose technology at work: the Corliss steam engine in the late-nineteenth-century United States. *J Econ Hist.* 64(1), 61–99.
- Rossi, C., Russo, F. and Savino. S. (2017) Windmills: Ancestors of the wind power generation. *Frontiers of Mechanical Engineering*, 12(3), 389–396.
- Royle, S. A. (1982) Tide Mills: An Example from Brittany. *Industrial Archaeology Review*, 6(3), 241–244.

- Ryan, B., and Gross, N. C. (1943) The Diffusion of Hybrid Seed Corn in Two Iowa Communities. *Rural Sociology* 8(1), 15–24.
- Rynne, C. (2009) Water-power as a factor of industrial location in early medieval Ireland: the environment of the early Irish water mill. *Industrial Archaeology Review*, 31(2), 85–95.
- Satchell, C., and Dourish, P. (2009) Beyond the user: use and non-use in HCI, Proceedings of the 21st Annual Conference of the Australian Computer-Human Interaction Special Interest Group, Design: Open 24/7, ACM, Melbourne, 2009, 9–16.
- Satchell, M. and Wrigley, E.A., Shaw-Taylor, L.M.W, You, X., and Henneberg, J. (2023) *1851 England, Wales and Scotland Rail Lines*. [Data Collection]. Colchester, Essex: UK Data Archive. 10.5255/UKDA-SN-852991 [Accessed 18/11/2024].
- Sauer, C. O. (1956) The education of a geographer. *Annals of the Association of American Geographers*, 46(3), 287–299.
- Sawang, S. and Unsworth, K. L. (2011) Why adopt now? Multiple case studies and survey studies comparing small, medium and large firms. *Technovation*, 31(10), 554–559.
- Schweizer, K. (2009) Stuart, John, third earl of Bute (1713–1792), prime minister. *Oxford Dictionary of National Biography*. Retrieved 8 Mar. 2025, from <https://www.oxforddnb.com/view/10.1093/ref:odnb/9780198614128.001.0001/odnb-9780198614128-e-26716>.
- Science Museum Group (2025a) *Collycroft worsted textile mill, 1790. Maker: Phillip Veale. 1977-542 Science Museum Group Collection* [Online] Available from: <https://collection.sciencemuseumgroup.org.uk/objects/co68076/collycroft-worsted-textile-mill-1790> [Accessed 29/01/2025].
- Science Museum Group (2025b) *"Progress of Cotton" by J R Barfoot Science Museum Group Collection* [Online] Available from: <https://collection.sciencemuseumgroup.org.uk/documents/aa110016602/early-prints-of-cotton-mills-and-cotton-processes> [Accessed 29/01/2025].
- Scotch Whisky (2022) Glen Catrine Bonded Warehouse [Online] Available from: <https://scotchwhisky.com/whiskypedia/13340/glen-catrine-bonded-warehouse/> [Accessed 12/10/2022].
- Scott, A. J. (2022) The changing fortunes and future prospects of a traditional industrial cluster: Woollen textile production in the Scottish Borders. *Local Economy*, 37(3), 125–141.
- Scott, B.R. (2011) *Capitalism: its origins and evolution as a system of governance*, Springer, New York.
- Scott, W. R. (1930) Economic Resiliency. *The Economic History Review*, 2(2), 291–299.
- Scottish Geographical Magazine (1913) Scottish place names: Revision of ordnance survey maps, *Scottish Geographical Magazine*, 29(6), 322–323.
- SEPA (2010) *North Highland Area Management Plan Catchment Summaries* [Online] Available from: <https://www.sepa.org.uk/media/75583/doc-22-nh-catchment-summaries-moray-firth-dornoch-to-inverness.pdf> [Accessed 02/06/2022].
- Sharp, R. (1908) The Cotton Industry in Rothesay. *Buteshire natural history society*, 2, 12–22.

- Shaw-Taylor, L. and You, X. (2018) The Development of the Railway Network in Britain 1825-1911. In Bogart, D. Cambridge: Transport, Urbanization and Economic Development in England and Wales C, 1670–1911.
- Shaw, J. (1980) *Utilisation of water power in Scotland 1550-1870*. Thesis (PhD). The University of Edinburgh.
- Shaw, J. (1984) *Water power in Scotland: 1550-1870*. Edinburgh: John Donald Publishers Ltd.
- Sheail J. (1988) River regulation in the United Kingdom: an historical perspective. *Regul Rivers: Res Manage*, 2, 221–232.
- Shennan, J. H. (1892) *Boundaries of counties and parishes in Scotland* (Edinburgh, 1892)
- Scherer, F.M. (1965) Invention and innovation in the Watt-Boulton steam-engine venture. *Technology and Culture*, 6(2), 165–187.
- Silver, O. (1987) The roads of Scotland: From statute labour to tolls the first phase, 1700 to 1775. *Scottish Geographical Magazine*, 103(3), 141–149.
- Siméon, O. (2017) *Robert Owen's experiment at New Lanark: From paternalism to socialism*. Springer International Publishing.
- Simonton, D. (2013) 'Negotiating the Economy of the Eighteenth-Century Scottish Town: Female Entrepreneurs Claim their Place'. In: K. Barclay and D. Simonton, eds, *Women in Eighteenth-century Scotland* (Aldershot: Ashgate, 211–32.
- Slaven, A. and Checkland, S. G. (1986) *Dictionary of Scottish business biography 1860-1960: The staple industries*. Aberdeen University Press.
- SLHS (2022) *Archives Document of the Month for June 2013* [Online] Available from: <https://www.stirling-lhs.org/sca-deanston-mill-c1930.html> [Accessed 26/12/2022].
- Smedley, P.L. Bearcock, J.M. Fordyce, F.M. Everett, P.A. Chenery, S. and Ellen, R. (2017) *Stream-water geochemical atlas of the Clyde Basin*. Nottingham, UK: British Geological Survey.
- Smith, A. (1776) *An Inquiry into the Nature and Causes of the Wealth of Nations*. London: Printed for W. Strahan and T. Cadell.
- Smith, D. (1989) The representation of non-extractive industry on large-scale county maps of England and Wales 1700-c.1840: *The Cartographic Journal*, 26, 134-147.
- Smith, D. (1990) The Representation of Industry on Large-Scale County Maps of England and Wales 1700-c. 1840. *Industrial Archaeology Review*, 12(2), 153–177.
- Smith, D. M. (1966) A theoretical framework for geographical studies of industrial location. *Economic Geography*, 42(2), 95-113.
- Smith, D. M. (1971) *Industrial location : an economic geographical analysis*. New York: Wiley.
- Smith, N. (1989) Uneven development and location theory: towards a synthesis. In: R. Peet, and N. Thrift, eds. *New Models in Geography - Vol 1: The Political-Economy Perspective* (1st ed.). Routledge, 152–175.
- Smith, P. (2015) Labour under the law: a new law of combination, and master and servant, in 21st-century Britain? *Industrial Relations Journal*, 46, 345–364.

- Smout, T. C. (1970) The Landowner and the Planned Village in Scotland 1730-1830. In: N. T. Phillipson, and R. Mitchison, eds. *Scotland in the Age of Improvement: Essays in Scottish History in the Eighteenth Century*. Edinburgh University Press, 1996, 73-106.
- Smout, T. C. and Fenton, A. (1965) Scottish Agriculture before the Improvers—an Exploration. *The Agricultural History Review*, 13(2), 73–93.
- Solomon, J. F. and Thomson, I. (2009) Satanic mills?: an illustration of Victorian external environmental accounting [Paper in special issue: Financial Accounting: Past, Present and Future. Jones, Michael John and Oldroyd, David (eds.)]. *Accounting forum*, 33(1), 74–87.
- Sorenson, O. (2005) Social Networks, Informational Complexity and Industrial Geography*. In: D. Fornahl, C. Zellner, and D. B. Audretsch, eds. *The Role of Labour Mobility and Informal Networks for Knowledge Transfer. International Studies in Entrepreneurship*, vol 6. Boston, MA: Springer, 79-96.
- Sorenson, O. (2018) Social networks and the geography of entrepreneurship. *Small Business Economics*, 51(3), 527-537.
- Sotheby's (2025) *Johann Zoffany R.A.* [Online] Available from: <https://www.sothebys.com/en/auctions/ecatalogue/2010/old-master-british-paintings-evening-sale-110036/lot.42.html> [Accessed 09/02/2025].
- Southall, H., Aucott, P., Fleet, C., Pert, T. and Stoner, M. (2017) GB1900: Engaging the public in very large scale gazetteer construction from the ordnance survey “County series” 1: 10,560 mapping of Great Britain. *Journal of Map & Geography Libraries*, 13(1), 7-28.
- Spear, B. (2008) James Watt: The steam engine and the commercialization of patents. *World Patent Information* 30(1), 53-58.
- Stansfield, C. (2018) New Lanark And Haverbreaks. *Contrebis. The journal of Lancaster Archaeological and Historical Society*, 36, 67-69.
- Stearns, P. (2015) *Debating the industrial revolution*. London: Bloomsbury Academic.
- Stephen, A. (2009) *The lost history of Ballindalloch, Balfroun*. Balfroun: A M M and S M O Stephen.
- Stein, J. (1995) Time, space and social discipline: factory life in Cornwall, Ontario, 1867-1893. *Journal of Historical Geography*, 21(3), 278–299.
- Steinmueller, W. E. (2013) The pre-industrial energy crisis and resource scarcity as a source of transition. *Research Policy*, 42(10), 1739–1748.
- Stern, D.I. (2011) The role of energy in economic growth, *Annals of the New York Academy of Sciences*, 1219 (1), 26-51.
- Stern, D.I., and Kander, A. (2012) The Role of Energy in the Industrial Revolution and Modern Economic Growth, *The Energy Journal*, 33 (3), 125-152.
- Stirling Archives (2016) *Creating the Carron Valley Reservoir, 1935-1939* [Online] Available from: <http://www.stirlingarchives.scot/2016/12/01/creating-carron-valley-reservoir-1939/> [Accessed 01/11/2024].
- Stirling Council (2014) *Balfroun Conservation Area Appraisal - June 2014* [Online] Available from: <https://www.dpea.scotland.gov.uk/LibraryDocument.aspx?id=616> [Accessed 05/09/2022].

- Storper, M. and Walker, R. (1983) The theory of labour and the theory of location. *International Journal of Urban and Regional Research*, 7(1), 1-43.
- Summerby-Murray, R. (2007) Interpreting personalized industrial heritage in the mining towns of Cumberland County, Nova Scotia: Landscape examples from Springhill and River Hebert. *Urban history review*, 35(2): 51-59.
- Symes, P. (1997) The Ballindalloch Note Issues of 1830. *International Bank Note Society Journal*. 36(4), 43.
- Tann J. (1965) Some problems of water power: a study of mill siting in Gloucestershire. *Trans Bristol Gloucestershire Archaeol Soc*.
- Tann, J. (1970) "1. Archaeology and the factory." *Local historian* (London. 1968), 9(4), 183.
- Tann, J. (1974) The textile millwright in the early industrial revolution. *Textile History*, 5(1), 80-89
- Tann, J. (1978) Marketing Methods in the International Steam Engine Market: The Case of Boulton and Watt. *The Journal of Economic History*, 38(2), 363–391.
- Tanner, S., Munoz, T., and Hemy Ros, P. (2009) Measuring Mass Text Digitization Quality and Usefulness: Lessons Learned from Assessing the OCR Accuracy of the British Library's 19th Century Online Newspaper Archive. *Dlib Magazine*, 15(78).
- Tarde, G. (1890) *Les lois de l'imitation : étude sociologique / par G. Tarde*. F. Alcan (Paris).
- Taylor, B. (1896) Chambers's journal of popular literature, science and arts, Jan. 1854- Nov. 1897; London Vol. 13, Iss. 662, (Sep 5, 1896): 563-566.
- Taylor, D. (2014) *Michel Foucault: Key Concepts*. Taylor & Francis Group.
- Taylor, M. J. (1975) Organizational growth, spatial interaction and location decision-making. *Regional studies*, 9(4), 313-323.
- Teixeira, A. (2003) "Does Inertia Pay Off? Empirical assessment of an evolutionary-ecological model of human capital decisions at firm level." FEP Working Paper no. 124, March 2002.
- Temin, P. (1966) Steam and Waterpower in the Early Nineteenth Century. *The Journal of Economic History*, 26(2), 187–205.
- Temin, P. (1997) Two Views of the British Industrial Revolution. *The Journal of Economic History*, 57(1), 63–82.
- Ter Wal, A. L., and Boschma, R. A. (2009) Applying social network analysis in economic geography: framing some key analytic issues. *The annals of regional science*, 43, 739-756.
- The Alan Turing Institute (2022) *How can machine learning help us unlock historical maps* [Online] Available from: <https://www.turing.ac.uk/blog/how-can-machine-learning-help-us-unlock-historical-maps> [Accessed 02/07/2025].
- The Alan Turing Institute (2024) *Machines reading maps* [Online] Available from: <https://www.turing.ac.uk/research/research-projects/machines-reading-maps> [Accessed 06/11/2024].
- The Dalgarnen Mill Trust (2025) *History* [Online] Available from: <https://www.dalgarvenmill.org.uk/history/> [Accessed 03/06/2025].
- The Insolvency Service (2011) *History of Companies in the British Isles* [Online] Available from:

- <https://www.insolvencydirect.bis.gov.uk/freedomofinformationtechnical/technicalmanual/ch73-84/chapter%2075/Part%202/Part%202.htm> [Accessed 02/06/2025].
- The Mill of Glenbuchat (2022) *Mill of Glenbuchat* [Poster] Milling Matters – Scottish Heritage Mills Conference, Perth Lower City Mills 07/05/2022.
- Thomson, A. G. (1974) *The paper industry in Scotland 1590-1861*. Scottish Academic Press.
- Thomson, G. (2016) *Railways of Ayrshire*. The Crowood Press.
- Tide Mill Institute (2025) *Tide Mill Database* [Online] Available from: <https://www.tidemillinstitute.org/tmi-database/> [Accessed 08/07/2025].
- Tiller, K. (2020) *English Local History*. United Kingdom: Boydell & Brewer, 5–32.
- Timmins, G. (2021) *The built environment transformed : textile Lancashire during the Industrial Revolution*. Swindon: Historic England.
- Tindley, A. and Wodehouse, A. (2014) The Role of Social Networks in Agricultural Innovation: The Sutherland Reclamations and the Fowler Steam Plough, c.1855-c.1885. *Rural History*, 25(2): 203-222.
- Todd, D. (1983) Industrial inertia versus relocation: A shipbuilding illustration. *Professional Geographer*, 35(3), 286–298.
- Tosti, G. (1897) The sociological theories of Gabriel Tarde. *Political Science Quarterly*, 12(3), 490-511.
- Trepal, D., Lafreniere, D. and Stone, T. (2021) Mapping Historical Archaeology and Industrial Heritage: The Historical Spatial Data Infrastructure. *Journal of Computer Applications in Archaeology*, 4(1), 202-203.
- Trifan, R. (2023) *Morile Banatului. Patrimoniul mulinologic al județelor Timiș și Caraș-Severin*. Acasa in Banat Association in Timisoara
- Trinder, B. S. (2013) *Britain's industrial revolution : the making of a manufacturing people, 1700 - 1870*. Carnegie Publishing Ltd.
- Tuckett, S. and Whatley, C. A. (2023) Textiles in Transition: Linen, Jute and the Dundee Region's Transnational Networks, c.1740—1880. In: E. Bond and M. Morris, eds. *Scotland's Transnational Heritage: Legacies of Empire and Slavery*. Edinburgh: Edinburgh University Press, 38–54.
- Turnbull, R. (2014) *Quaker capitalism: lessons for today*. Centre for Enterprise, Markets and Ethics.
- Turner, W. H. K. (1952) "The Evolution of the Pattern of the Textile Industry within Dundee." *Transactions and Papers (Institute of British Geographers)*, 18, 107–119.
- Turner, W. H. K. (1953) Some eighteenth-century developments in the textile region of east central Scotland. *Scottish geographical magazine*, 69(1), 10–22.
- Turner, W. H. K. (1957a) The textile industries of Dunfermline and Kirkcaldy 1700–1900. *Scottish Geographical Magazine*, 73(3), 129–145.
- Turner, W. H. K. (1957b) The textile industry of Perth and district. *Transactions and Papers (Institute of British Geographers)*, 23, 123–140.
- Turner, W. H. K. (1958) The significance of water power in industrial location: Some Perthshire examples. *Scottish Geographical Magazine*, 74(2), 98–115.

- Turner, W. H. K. (1964) Wool Textile Manufacture In Scotland. *Scottish geographical magazine*, 80(2), 81.
- Turner, W. H. K. (1966) The concentration of jute and heavy linen manufactures in east central Scotland. *Scottish Geographical Magazine*, 82(1), 29–45.
- Turner, W. H. K. (1972) Flax cultivation in Scotland: An historical geography. *Transactions of the Institute of British Geographers*, 55(55), 127–143.
- Turner, W. H. K. (1982a) The Localisation of early spinning mills in the historic linen region of Scotland, *Scottish Geographical Magazine*, 98(2), 77–86.
- Turner, W. H. K. (1982b) The development of flax-spinning mills in Scotland 1787-1840. *Scottish geographical magazine*, 98(1), 4–15.
- Turnock, D. (1975) Small farms in north Scotland: An exploration in historical geography, *Scottish Geographical Magazine*, 91:3, 164-181.
- Turnock, D. (1982) *The historical geography of Scotland since 1707: Geographical aspects of modernisation*. Cambridge University Press.
- UK Grid Reference Finder (2011) *Batch Convert Tool* [Online] Available from: <https://gridreferencefinder.com/batchConvert/batchConvert.php> [Accessed 18/11/2024].
- UK Parliament (2022) *The 1833 Factory Act* [Online] Available from: <https://www.parliament.uk/about/living-heritage/transformingsociety/livinglearning/19thcentury/overview/factoryact/> [Accessed 01/11/2022].
- UKCEH (2022a) 85002 – *Endrick Water at Gaidrew* [Online] Available from: <https://nrfa.ceh.ac.uk/data/station/spatial/85002> [Accessed 14/09/2022].
- UKCEH (2022b) *UK Lakes Portal*. [Online] Available from: <https://eip.ceh.ac.uk/apps/lakes/> [Accessed 27/05/2022]
- UKRI (2025) *Collaborative Doctoral Partnerships (CDP)* [Online] Available from: <https://www.ukri.org/what-we-do/developing-people-and-skills/ahrc/training-and-support-before-the-future-doctoral-provision-programme/collaborative-doctoral-partnerships-cdp/> [Accessed 28/07/2025].
- UNESCO (2019) *New Lanark World Heritage Site Management Plan 2019-2023* [Online] Available from: <https://whc.unesco.org/en/list/429/documents/> [Accessed 21/12/2022].
- UNESCO (2022) *New Lanark* [Online] Available from: <https://whc.unesco.org/en/list/429> [Accessed 21/12/2022].
- University of Edinburgh Library (2024a) *The Statistical Accounts of Scotland 1791-1845* [Online] Available from: <https://stataccscot.ed.ac.uk/static/statacc/dist/home> [Accessed 23/01/2024].
- University of Edinburgh Library (2024b) *The Old Statistical Account* [Online] Available from: <https://stataccscot.ed.ac.uk/static/statacc/dist/exhibition/osa> [Accessed 27/01/2024].
- Valente, T. W. and Rogers, E. M. (1995) The Origins and Development of the Diffusion of Innovations Paradigm as an Example of Scientific Growth. *Science Communication*, 16(3), 242–273.

- Vamplew, W. (1972) Railways and the Scottish Transport System in the Nineteenth Century. *Journal of Transport History*, ss-1(3), 133–145.
- van Dijk, J., and Pellenbarg, P. H. (2000) Firm relocation decisions in The Netherlands: An ordered logit approach. *Papers in Regional Science*, 79(2), 191–219.
- Van Lieshout, C. and Newman, B. (2023) *Historical geographies. Concise Encyclopedia of Human Geography*, Edward Elgar Publishing, 185–189.
- Venturini, T., Jacomy, M., and Jensen, P. (2021) What do we see when we look at networks: Visual network analysis, relational ambiguity, and force-directed layouts. *Big Data & Society*, 8(1).
- Vint, Allan Scott (2018) *Statistics, planning and the mission of the Church of Scotland: a critical examination of quantitative data as a resource for national, regional and local engagement*. Thesis (PhD). University of Glasgow.
- von Tunzelmann, G. N. (1978) *Steam power and British industrialization to 1860*. Oxford: Clarendon Press.
- von Tunzelmann, N. (1986) Coal and steam power. In: J. Langton and R. J. Morris, eds. *Atlas of industrializing Britain 1780-1914*. Methuen, 72–80
- Wainwright, E. M. (2005) Dundee's jute mills and factories: Spaces of production, surveillance and discipline. *Scottish Geographical Journal*, 121(2), 121–140.
- Walker, B., Ritchie, J. N. G. and Royal Commission on the Ancient and Historical Monuments of Scotland. (1987) *Fife and Tayside*. H.M.S.O.
- Walter, R. C., and Merritts, D. J. (2008) Natural streams and the legacy of water-powered mills. *Science*, 319(5861), 299–304.
- Wang, Y. and Hu, W. (2024) Cultural geography meets architectural typology: A mixed-methods study of traditional Bayu dwellings in southwestern China. *Journal of Asian Architecture and Building Engineering*, 1–25.
- Ward, T. and Hodge, E. C. (2020) *Correction of an Ownership Misconception* [Online] Available from: <https://britnumsoc.files.wordpress.com/2020/04/72-eric-hodge-twigg-article.pdf> [Accessed 29/05/2023].
- Watson, M. (1990) *Jute and flax mills in Dundee*. Tayport: Hutton Press.
- Watson, M. (1992) Matthew Murray and Broadford Works, Aberdeen: Evidence for the Earliest Iron-Framed Flax Mills. *Textile History*, 23(2), 225–242.
- Watson, M. (2004) Using the Third Statistical Account of Scotland to Expose a Major Gap in Scottish Historiography. *Contemporary British History*, 18(1), 100–122.
- Weber, A. (1929) *Alfred Weber's theory of the location of industries*. The University of Chicago Press, 1929.
- Weir, A., and Ayrshire Archaeological and Natural History Society, issuing body. (2020) *Watermills of Arran*. Ayrshire Archaeological and Natural History Society.
- Wertz, J. (2014) Turkey red textile dyeing in Glasgow: a cross-disciplinary investigation into Scotland's bygone industry. *Scottish Business and Industrial History*, 29, 74–97.
- Wheeler, P. T. (1963) The Development of Shipping Services to the East Coast of Sutherland. *The Journal of Transport History*, 2, 110–117.
- Whisky Antique (2020) *Deanston* [Online] Available from: <https://www.whiskyantique.com/en/deanston> [Accessed 09/07/2025]

- Whyte, I. D. (1989) "Proto-industrialisation in Scotland," In: P. Hudson, ed. *Regions and Industries: A Perspective on the Industrial Revolution in Britain*. Cambridge: Cambridge University Press, 228–251.
- Wideman, T. J. (2023) Archives and care: Caring archival research practices in geography. *The Canadian geographer*, 67(3), 394–406.
- Williams, E. E. (1944) *Capitalism & slavery*. Chapel Hill: University of North Carolina Press.
- Williams, R. (1999) Management Accounting Practice And Price Calculation At Boulton And Watt's Soho Foundry: A Late 18th Century Example. *The Accounting Historians Journal*, 26(2), 65–88.
- Williamson, E. (2015) "'Hence the name': Berwickshire parishes along the Anglo-Scottish Border as described in the Ordnance Survey Name Books" , *Journal of Scottish Name Studies*, 9, 83–96.
- Williamson, E. (2021). The Ordnance Survey Name Books: a 'treasure-trove' for toponymists. *Scottish Archives*, 25, 42–55.
- Wilson, C. (1891) Methods and processes of the Ordnance survey. *Journal of the Society of Arts*; Nov 14, 1890; 39, ProQuest, 258–263.
- Wilson, C. (1957) The entrepreneur in the industrial revolution in Britain. *History (London)*, 42(145), 101–117.
- Withers, C. W. J. (1998) *Urban Highlanders: Highland-Lowland migration and urban Gaelic culture, 1700-1900*. East Linton: Tuckwell Press.
- Withers, C. W. J. (2002) Constructing 'The Geographical Archive'. *Area*, 34(3), 303–311.
- Witkowski, K. (2022) The Development of the Use of Water Energy in the Mountain Catchment from a Sociohydrological Perspective. *Energies*, 15, 7770.
- Wohl, A. S. (1983) *Endangered lives: public health in Victorian Britain*. London: Dent.
- Wolverton, C. and Cenfetelli, R. (2019) An Exploration of the Drivers of Non-Adoption Behavior: A Discriminant Analysis Approach. *ACM SIGMIS Database: The DATABASE for Advances in Information Systems*, 50(3), 38–65.
- Wood, P. J. and S. Barker (2000) Old industrial mill ponds: a neglected ecological resource. *Applied Geography*, 20(1), 65–81.
- Wooldridge, S. W. and Kirkaldy, J. F. (1936) River Profiles and Denudation-Chronology in Southern England. *Geological Magazine*, 73(1), 1–16.
- Wrigley, E. A. (2010) *Energy and the English Industrial Revolution*, Cambridge University Press.
- Wrigley, E. A. (2013) Energy and the English Industrial Revolution. *Phil Trans R Soc A*, 28(371), 20110568.
- Yeager, C. D. and T. Steiger (2013) Applied geography in a digital age: The case for mixed methods. *Applied Geography*, 39, 1–4.

Appendices

Appendix 1. Biographies of mill owners, managers, investors, and facilitators described in the text.

Locations refer to notable places they lived or travelled to. N/A indicates information was not available.

Name	Mill	Locations	Pathway & Characteristics	Biography
Alexander Campbell of Hallyards (1768–1817)	New Lanark	Glasgow	Colonial trade: East / West Indies / plantations Landed gentry	Glasgow based West India merchant, a member of the ‘sugar aristocracy’ during Glasgow’s ‘golden age’ of sugar. Brother in law of Colin Campbell and son in law of Campbell of Jura.
Alexander Struthers Finlay (1807–1886)	Rothesay (?)	Glasgow	Merchant family Local politics	Son of Kirkman Finlay. Alexander Struthers Finlay established the house of Finlay, Campbell & Co. in Liverpool with his brothers in law in 1852 – they were Alexander and George, the sons of Colin Campbell of Colgrain. A Mr Struthers is listed as a partner at Rothesay in the 1830s but there is no evidence to confirm if it was the same person.
Andrew Jeffrey	Ballindalloch	Edinburgh, Balforn	Textile manufacturing family / mercantile family	Third generation textile manufacturers. In charge of the Ballindalloch Works with brother William. Andrew Jeffrey lived on Buchanan Street in Balforn so would most likely have overseen the running of the mill on behalf of the family firm (Glasgow Museums Art Donors, 2021)
Andrew Robertson	Spinningdale	Glasgow	Colonial trade: East / West Indies / plantations	Related to James and William Robertson, Glaswegian merchants who owned estates in the West Indies. Managed the Smithfield Iron Co. and the Glasgow Arms Bank (Quinton, 2020).
Archibald Buchanan	Catrine; Deanston	Carston; Cromford	Entered via apprenticeship / junior positions; merchant family	Born in Carston, Stirlingshire, the youngest of ten children. Trained as an apprentice at Cromford then set up Deanston Mill alongside his brother, John. He would have been familiar with Kirkman Finlay, head of James Finlay & Co. at the time, since their families were related. When the Buchanan brothers put Deanston mill up for sale in the 1790s, Buchanan moved into a managerial position for James Finlay & Co. at their Ballindalloch cotton mill in Balforn. Almost immediately after the company also purchased Catrine Mill, Buchanan transferred to Catrine as the on-site manager, by which point he was also a partner in the company (Smith, 1896; Brogan, 1951).
Benjamin Flounders (1786–1846)	Deanston	Yorkshire	Mercantile family Quaker Philanthropist	Born in Yorkshire. Flounders grew up within a family of Quakers and industrialists. His father owned shops in Darlington and bleach fields in Crathorne and his uncle, Gideon Bickerdike, was head of a company of merchants and cotton manufacturers in Manchester. Flounders was said to have owned a second linen mill in Egham, Surrey, and a business importing timber for shipbuilding. He was involved in transportation

				projects: Director for the Stockton and Darlington Railway, trustee of the Thirsk to Yarm turnpike road. Flounders was Governor of the Scientific Agricultural Association and bequeathed his wealth to Quaker schools (Grace's Guide, 2014; Maw, 2021; Flounders, Folly Trust, 2022; Heritage Stockton, 2022).
Benjamin Ross of Tain.	Spinningdale	Tain		Lived in Tain, south of the Dornoch Firth. Merchant and first agent for the British Linen Company Bank's Tain branch (Mackenzie, 2015).
Captain James Rattray	Spinningdale	Arthurstone, Blairgowrie	Colonial trade: East / West Indies / plantations; landed gentry	A captain of East Indiamen ships. Purchased land with profits from East Indies trade. It is unknown if he owned land before. Rattray sold his last ship in 1787 and used the money to retire. On his return to Scotland James bought Arthurstone estate near Meigle in Strathmore (Filor, 2013).
Captain John Hamilton Dempster	Spinningdale	Dunnichen	Colonial trade: East / West Indies / plantations; mercantile family	Brother of George Dempster.
Charles Walker; Henry Walker	New Lanark	Scotland, London (?)	Mercantile family Quakers	Charles and Henry Walker, sons of John Walker, under the name of Walker & Co. At some point during the 1840s, the Walker family gained full control of New Lanark as Robert Owen & Company, William Allen, and Michael Gibbs all eventually removed themselves from the business. The Walkers were Quakers and, in accordance with their beliefs, tried to keep the mills running under humanitarian conditions. Charles moved to England in 1881 so it is possible the family had connections there (Donnachie and Hewitt, 2015; Stansfield, 2018).
Claud Alexander (1752–1809)	Catrine	Scotland, London	East India Merchant Mercantile and military family	A servant of the East India Company from 1772 to 1785, assisted in his entry and progression within the East India Company by the wealth and influence of his aunt and uncle. On his return to Britain, Alexander was appointed a member of the Society for the Encouragement of Arts, Manufactures and Commerce in London within a year. As far as is known, he was the only industrialist in the family (McLaren, 2015, Coltman, 2019).
Colin Campbell of Colgrain (1782–1863)	New Lanark	Glasgow	Mercantile family; West India merchant; landed gentry	Brother in law of Alexander Campbell of Hallyards and sons in law of Campbell of Jura. West India planter and merchant based in Glasgow (Legacies of British Slavery database, 2025c).
David Dale	New Lanark, Catrine, Spinningdale	Ayrshire, Glasgow, Blantyre, Kilmore, Newton Stewart, Stanley, Rothesay	Apprenticeship Philanthropist, social reformer, abolitionist	Merchant and cotton master involved with mills at New Lanark, Catrine, Blantyre, Kilmore, Newton Stewart, Stanley. Established Britain's first turkey-red dyeworks with George Macintosh (Butt, 2006).
David Scott of Dunninauld, M.P.	Spinningdale	Dunninauld, Forfar; London	East Indies merchant University educated Politics	Merchant and director of East India Company; born Dunninauld House, Craig, Forfarshire; attended St Andrews for school and university; a ship's officer in India and then in Bombay a partner in Scott, Tate and Adamson; London – 1786 moved and directed the English side of the business from there; Became friends with Henry Dundas, head of the India Board of Control; 1788 became a director of the India Board

				of Control with help from Dundas; MP of Forfarshire 1790 to 1796 (Nightingale, 2009; Rory, 2024).
Dugald Gilchrist	Spinningdale	Hospidale	Landed gentry	Owner of 150 acres of land in Hospidale to the west of Skibo. Gilchrist shared ownership of common land with Dempster of Skibo and Mr Houston of Creech. Appears to have been resident in the area, moving to Sutherland in 1737 to become factor of the Sutherland estate. He let the Ospidale estate to William Munro (Monro) of Achany. An improving landowner reported to have ‘planted considerably’ (Lindsay, 2006; NRS GB 234, RHP4205).
Duncan Salmond	Rothesay	N/A	N/A	Last known owner of the Rothesay Cotton Mills.
George Dempster of Dunnichen (1732–1818)	New Lanark, Spinningdale	Dunnichen, Angus; Edinburgh; Skibo (Sutherland); Stanley	Landed gentry; university educated; mercantile family Politics, improvement of estates, philanthropist	The son of a wealthy merchant from Dundee. Member of parliament until 1790, Owned estates of Dunnichen (Forfarshire) and Skibo (Sutherland). In 1763 he founded the first bank in Dundee and established a second in 1792; promoted founding of lighthouses in 1787 and 1789; established the Northern Lighthouse Board; 1783 met Arkwright; 1785-6 owned New Lanark; 1785–1799 owned Stanley mills; campaigned for turnpike roads for Forfarshire 1780s–90s; 1760s conducted improvements on his estates; 1788 founded a model village at Letham; 1786 bought Skibo estate – the plan was for his brother John Hamilton Dempster (captain in the East India Company) to run it when he retired and was intended to be inherited by George’s nephew later. He tried to establish villages on the Dunnichen estate - at one he introduced linen-weaving, at another was Spinningdale mill (Lang, 1998; Evans, 2005; Lang, 2022).
George Macintosh (1739–1807)	Spinningdale	Roskeen (Ross and Cromarty)	Agricultural background Entered via apprenticeship / junior positions	The son of a tenant farmer in Roskeen, Ross-shire. Moved to Glasgow to work as a clerk of a tannery on the Molindar burn owned by Mr Bogle of Daldowie. He became head of another tannery before opening a cudbear works in 1777 in Dennistoun, Glasgow. Macintosh partnered with David Dale and French dyer Pierre Jacques Papillon to start a Turkey Red business in Glasgow. He was a partner in Spinningdale. Outside of manufacturing, Macintosh was Director of the Chamber of Commerce from 1783 to 1807 then continued as chairman and a member of the Gaelic Club and the Highland Society. Also spelt McIntosh or Mackintosh (Stewart, 1881; Cooke, 1995; Grace’s Guide, 2012; Wertz, 2014).
H.W. Pollock	Catrine	Catrine	Local resident	Grew up in the village of Catrine. Manager of the Catrine Works from 1895–1908. Elected as Member for Parish on the County Council and president of Catrine Historical Portrait Gallery Association (William B. Reid & Co. 1903).
Henry Birkmyre	New Lanark	Renfrewshire	Manufacturing and mercantile family Local government	Grandson of a Renfrewshire weaver and sailcloth manufacturer. He purchased and managed the New Lanark mills through a partnership with his brother in law, Robert Galbraith Somerville.
J. M. Dawson	Ballindalloch	Scotland	N/A	N/A
James Finlay (1727–1790)	Ballindalloch, Catrine, Deanston	Glasgow	Family links to West Indies trade	Born 1727 in Killearn village in Stirlingshire; James Finlay (1727) likely began as a pedlar though this is not certain. His brother John was a West India merchant who imported rum and sugar. He gathered enough money to set up in business as a

			Weaver to merchant to manufacturer Politics	merchant and manufacturer. By 1769 he was a Burgess and was listed in the first Glasgow Directory of 1783 having premises in Bell's Wynd. James Finlay met with Richard Arkwright on his visit to Glasgow in 1783 (Brogan, 1951: 4).
James Kenyon	Rothesay	Sheffield	Practical / mechanical trades	Watchmaker from Sheffield. Received financial backing from Glasgow including from banker Robin Carrick.
James Robertson	Spinningdale	Glasgow	Colonial trade: East / West Indies / plantations	Related to William and Andrew Robertson, Glaswegian merchants who owned estates in the West Indies, managed the Smithfield Iron Co. and the Glasgow Arms Bank (Quinton, 2020).
James Smith (1789–1850)	Catrine (employee), Deanston (managing partner)	Glasgow, Catrine, Deanston, London, Carston	Mercantile family, university education Inventor, agricultural improver	After the death of his father, a merchant in Glasgow, Smith grew up in the care of his uncle on his mother's side, Archibald Buchanan, moving to Catrine to live with him after attending university. Smith entered into employment at Catrine Works, until, aged eighteen, Smith was appointed as manager of Deanston. In 1836 Smith gained membership of the Institution of Civil Engineers (<i>Preston Chronicle</i> , 1839; ICE, 1851).
James, and John Jr Birkmyre	New Lanark, Renfrewshire	Lanarkshire	Mercantile/ manufacturing family	Partners in the Port Glasgow timber firm, Somerville and Co. Sons of Henry Birkmyre.
Jeremy Bentham	New Lanark	London	Wealthy family, university education; landed gentry Social reformer, philosopher	Partner in New Lanark. Bentham's father was an attorney in London with substantial capital investments in property. Following an education at Oxford University, Bentham was admitted to the bar. He wrote numerous manuscripts on morals, legislation, crime, punishment, and later chemistry. In the early-1800s he took an interest in education of children and believed religion should play less of a role, which could explain Bentham meeting Owen and the investment in New Lanark (Rosen, 2014).
John Atkinson	New Lanark	London, Manchester	N/A	Partner based in London with investments in Manchester mills too.
John Barton	New Lanark	Manchester	N/A	Partner in New Lanark, a Manchester based merchant.
John Buchanan	Deanston	Carston	N/A	Brother of Archibald, founder Deanston.
John Fraser	Spinningdale	Scotland		Mr John Fraser, factor to Lord Gower and also Dempster's factor at Skibo (Spinningdale); Factor of Sutherland Estate 1791–1802.
John Mackenzie	Spinningdale	N/A	N/A	This may have been John Mackenzie, Esq. of the Temple, honorary Secretary of the Highland Society of London (Fairney, 2018).
John Monteith	Ballindalloch (indirectly)	Balfron	N/A	A partner of the Ballindalloch Printworks. Collaborated with Dunmore on water supplies.
John Ramsay	Spinningdale	Scotland	Practical skills; entered via apprenticeship/junior positions	Worked as a cotton spinner prior to his appointment as manager at Spinningdale (Evans, 2005).
John Stuart, third earl of Bute (1713–1792)	Rothesay	Edinburgh, London, Mount Stuart (Isle of Bute)	Landed gentry Politics	The first Scottish British prime minister. Lord Bute was not an investor but he encouraged/allowed industry on his land (Rothesay Cotton Mills). Educated at Eton College in England and University of Leiden, Bute returned to Scotland and lived at

				Mount Stuart for four years, during which time he was concerned with the improvement of his estates on the island. Bute had a strong interest in the sciences and is noted for providing patronage to several Scottish universities and to notable individuals in the natural sciences (Schweizer, 2009).
John Walker	New Lanark	London	Quaker	Quaker, probably initially London based.
Joseph Foster	New Lanark	London	Quaker	Quaker, probably London based.
Joseph Fox (1775–1816)	New Lanark	London	Philanthropist Baptist	London based dentist (his father was also a dentist), member of the Askesian Society, a Baptist (Cohen, 2008).
Kirkman Finlay (1772–1842)	Ballindalloch, Catrine, Deanston	Glasgow	Mercantile family Philanthropist	Son of James Finlay. Born Gallowgate, attended Glasgow university. Began his business career in the Stockwell Street Office of his cousin, James Buchanan. During his life he held numerous public offices: 1812 lord provost; 1812 Member of Parliament for the Glasgow District of Burghs; Governor of the Forth and Clyde Navigation Trust; President of the Chamber of Commerce repeatedly; Dean of guild; Rector of University of Glasgow; Dean of the Faculty of the University. He lost popularity while on the Committee for the Corn Bill and was not re-elected for Glasgow after 1818. He was a member of the Hodge-Podge Club in 1808 which was a small dining club and the Gaelic Club. After acquiring the Auchwillan estate he built Castle Toward. While a partner of James Finlay & Co. in the 1800s he opened branches in Charleston, New Orleans, New York, then in 1806 a branch of James Finlay & Co. opened in New Providence, Bahamas for supply of South America.
Michael Gibbs	New Lanark	London	Local politics	Lord Mayor of the City of London in 1844. Member of the Fishmongers' Company (Birt, 1844).
Mr McFarlane	Spinningdale	Glasgow	N/A	Owner of Spinningdale. McFarlane already operated a cotton mill in Glasgow and had plans to make alterations to the work conducted at Spinningdale.
Mr Prentice	Rothesay	N/A	N/A	N/A
Mr Struthers	Rothesay	N/A	N/A	Partnered with Robert Thom at Rothesay, later forming a new partnership with Salmond.
Peter Fisher	Rothesay	N/A	N/A	Second owner of the Rothesay Mills from 1785 alongside managing partner Robertson Buchanan.
Richard Arkwright (1732–1792)	New Lanark	Preston, Bolton, Stanley Mills (Perthshire), Derbyshire	Tradesman Inventor	Born in Preston. One of seven children, his elder brother was a tailor. Worked in Bolton first as a peruke (wig) maker. Upon inventing a machine for cotton spinning, the <i>waterframe</i> , Arkwright moved to Nottingham and set up first a horse-powered mill. He then built a mill in Cromford, deriving waterpower from the Bosnall Brook and Cromford Sough. The Cromford mill became a model design for hundreds of other mills across Britain as did the development of an industrial village with workers housing by the mill. Social connections included Erasmus Darwin and James Watt.

				Arkwright held connections to the Sierra Leone Company. He provided training to Archibald Buchanan, knew the Finalys, and had direct involvement in Stanley Mills (Mason, 2004).
Robert Bogle	Spinningdale	Glasgow; Baldowie; London	West Indies merchant; mercantile family	Robert Bogle junior, of Daldowie, son of merchant Robert Bogle. Bogle was a partner in a London mercantile firm that failed in 1772, then a partner in a cotton estate in Grenada. A partner in the Bell's tannery where George MacIntosh worked as a clerk (Legacies of British Slavery database, 2025b).
Robert Dennistoun	New Lanark	Glasgow	Colonial trade: East / West Indies / plantations	Glasgow-based merchant.
Robert Dunmore	Ballindalloch, Spinningdale	Glasgow (Kelvinside) Balfron Dontocher	Transatlantic merchant family; colonial trade; mercantile family	Born in 1744 in Glasgow, Dunmore was the youngest of seven children. He had family connections with the tobacco trade. Dunmore partnered with a Mr John Monteith to establish the Endrick Printworks opposite the cotton mill. Owner/mortgagee of eight estates in Jamaica and a shareholder in numerous corporations. Dunmore partnered with a Mr John Monteith to establish the Endrick Printworks opposite the cotton mill (Stephen, 2009; Legacies of British Slavery, 2025a).
Robert Galbraith Somerville	New Lanark	Scotland	Mercantile family	Brother in law of Henry Birkmyre. Partner and then possibly still a manager later. A partner in the Port Glasgow timber firm, Somerville and Co.
Robert Mackie	Spinningdale	Glasgow	West Indies merchant	A West Indies merchant (Evans, 2005).
Robert Oliphant or 'Rossie'	Rothesay	Ross-shire	N/A	Factor to Lord Bute, Postmaster General, and a Commissioner for the Board of Trustees for Manufacture (Nisbet, 2004).
Robert Owen (1771–1858).	New Lanark	Newtown, New Harmony, London, Lincolnshire, Manchester	Apprenticeship to merchant to manufacturer Social philosopher / reformer; hostile to religion	Born in Newtown, Wales, the son of a shopkeeper. With the assistance of familial connections, moved to London with a sibling to undertake an apprenticeship with a drapers. Moved to Manchester aged 17 and transitioned from merchant to manufacturer. With financial support from his brother, Owen and a colleague created a machine making business. Owen moved on to manage both steam- and water-powered mills. Owen held strong ideas for the social reformation of society which he experimented with at New Lanark and a 'utopian' community in New Harmony, USA.
Robert Thom	Rothesay	Tarbolton (Ayrshire)	Agricultural background, practical / mechanical trades, university educated	Robert Thom assisted on his father's farm in Ayrshire before training as a wright. Studied at the Andersonian Institute (now Strathclyde University) prior to purchasing the Rothesay Cotton mills.
Robertson Buchanan (1770–1816)	Rothesay	Glasgow, London	Apprenticeship, practical or mechanical trades, mechanical engineer, inventor	Began his career as an apprentice to a house-carpenter, later training and working as a millwright in London and Glasgow. Managing partner at Rothesay with Mr Fisher (Buchanan, 1823).
William Allen (1770–1843)	New Lanark	London	Manufacturing family Scientist, philanthropist and abolitionist, quaker	Committee member and treasurer of the British and Foreign School Society (BFSS) from 1808 until his death in 1843. The son of a Quaker silk manufacturer of Spitalfields, London. Member of the Askesian Society, a Fellow of the Linnean Society and of the Royal Society (Brunel University of London, 2019).
William Gillespie	Spinningdale	Glasgow	N/A	Lived in Glasgow.

William Jeffrey	Ballindalloch	Edinburgh	Mercantile family	Third generation textile manufacturers. In charge of the Ballindalloch Works with brother William. Andrew Jeffrey lived on Buchanan Street in Balfour so would most likely have overseen the running of the mill on behalf of the family firm (Glasgow Museums Art Donors, 2021).
William Kelly	New Lanark, Rothesay	Scotland (?)	Practical / mechanical trades	Clockmaker. Manager at New Lanark and a managing partner at Rothesay. While at New Lanark he invented technical developments to heating and ventilation systems for the mill and a self-acting mule (ICOMOS, 2001).
William Monro	Spinningdale	Achanny, Sutherland	Landed gentry, local	Adjoining landowner to Dempster's estate. Rented Ospidale from Dugald Gilchrist (Evans, 2005).
William Robertson of Glasgow	Spinningdale	Glasgow	Colonial trade: East / West Indies / plantations	Related to James and Andrew Robertson, Glaswegian merchants who owned estates in the West Indies. Managed the Smithfield Iron Co. and the Glasgow Arms Bank (Quinton, 2020).

Appendix 2. Heritage terms

Mill Heritage Terms list received from Peter McKeague, 20th October 2020. Extract from *Monument Type Thesaurus (Scotland)*: Monument types relating to the archaeological and built heritage of Scotland.

The list can be found online at the Heritage Data – *Linked Data Vocabularies for Cultural Heritage* project under the Historic Environment Scotland Scheme ‘Monument Type Thesaurus (Scotland)’. Available from: <https://heritagedata.org/live/schemes/1.html>.

Term	Description
Aluminium Rolling Mill	A factory where aluminium is thinned by rolling to produce aluminium foil, sheet or plate.
Bark Mill	A mill used for stripping the bark from cut tree trunks.
Bobbin Mill	A factory producing bobbins for use in the textile industry.
Bone Mill	A mill for grinding or crushing bones, in the process of making bone china, for example.
Boring Mill	A building containing a machine tool for boring out large cylindrical holes in items such as steam engine cylinders, pump barrels, etc.
Calico Mill	A textile mill producing calico, coarse cotton.
Carding Mill	A workshop where hand-operated carding engines and hand jennies are used to spin yarn for handloom weavers.
Carpet Mill	A factory where carpets are manufactured.
Click Mill	A water mill in which the mill wheel is set horizontally within the water channel, and turns a mill stone directly without the use of gears.
Cold Rolled Steel Mill	A site where cold strip steel is rolled into coils.
Corn Mill	A mill where grain is ground to produce flour.
Cotton Mill	Usually a cotton spinning factory, although some mills have weaving sheds attached, in which case the end product is completed cloth, not yarn only.
Cruck Framed Mill	A mill in which pairs of curved timbers form a bowed A-frame to support the roof independently of the walls.
Crushing Mill	A building containing mechanically powered crushers or rollers.
Donkey Mill	A treadwheel using a donkey as motive power. Usually found in association with wells.
Embroidery Mill	A building or complex of buildings where textiles and textile products are embroidered.
Farina Mill	A mill where farina is produced for human consumption.
Feed Mill	A building or site for the manufacture of animal feed.
Flax Mill	A mill where flax is processed to make linen, thread and yarn.
Flint Mill	A mill for crushing flint. Crushed flint was used as a source of silica for the manufacture of pottery glazes.
Flour Mill	A factory where flour is produced for use in food products.
Fulling Mill	A mill for beating and cleaning cloth, using soap or fullers' earth.
Gas Mill	An industrial unit, usually situated in a city or town, concerned with the manufacture of gas from sources including coal, oil and calcium carbide (acetylene), for use as fuel by industrial or domestic consumers.
Grain Mill	A mill where grain is ground to produce flour.

Grist Mill	A grain mill used to grind portions of grain brought in by individual customers.
Gunpowder Mill	A site used for the manufacture of gunpowder.
Handloom Weaving Mill	A mill where textiles are woven using a handloom.
Hemp Mill	A factory where hemp, the woody stalk of the hemp plant, used for the making of coarse cloth and cordage, was processed.
Horizontal Mill	A water mill in which the mill wheel is set horizontally within the water channel, and turns a mill stone directly without the use of gears.
Hosiery Mill	A factory or works housing machinery used to produce stockings and socks, using mechanized knitting processes.
Jute Mill	A factory where jute (plant fibres), was used to make products such as hessian, sacking, cordage and backing materials for carpet and linoleum.
Lace Mill	A factory where lace is manufactured.
Leather Mill	A factory for the manufacture of leather goods, such as shoes, saddles, etc. Use TANNERY for the manufacture of leather.
Linen Mill	A mill where flax fibres were woven into linen cloth.
Lint Mill	A mill where flax fibres were woven into linen cloth.
Meal Mill	A mill where grain is ground to produce flour.
Mill	A factory used for processing raw materials. Use more specific term where known.
Mill Dam	A dam constructed across a stream to raise its water-level and make it available to power a mill wheel.
Mill House	The residence of a miller, often attached to a mill, brewery or distillery.
Mill Pond	The area of water retained behind a mill dam for driving a mill.
Millers House	The residence of a miller, often attached to a mill, brewery or distillery.
Millstone Quarry	A site where millstones have been quarried. Circular depressions may be visible, along with unfinished or broken millstones.
Millwrights Shop	A workshop where industrial machinery and equipment is repaired and maintained.
Millwrights Workshop	A workshop where industrial machinery and equipment is repaired and maintained.
Oil Mill	A factory where fruit and seed oil is produced by an oil press.
Paint Mill	A building or buildings used for the production of paints, varnishes, colours and distemper. Use also for the manufacture of ink.
Paper Mill	A factory where paper is made.
Plash Mill	A mill for beating and cleaning cloth, using soap or fullers' earth.
Post Mill	A type of windmill mounted on a post so that it can rotate into the wind.
Potato Mill	A mill where potatoes are turned into flour for human consumption.
Provender Mill	A building or site for the manufacture of animal feed.
Pumping Windmill	A windmill used to drive a pump.
Rice Mill	A factory where rice is processed.
Rubber Mill	A factory for processing rubber or manufacturing rubber goods, such as tyres, expansion joints, seals etc.
Saw Mill	A factory in which logs are converted to timber by running them through a series of saws.
Sawmill	A factory in which logs are converted to timber by running them through a series of saws.

Slitting Mill	A mill with machinery used to cut slabs of metal into rods, or thin sections, for use in nail making or wire drawing.
Snuff Mill	A factory where tobacco is ground to form snuff.
Spinning Mill	A factory in which raw fibres are spun into yarn or thread. Many separate processes are required to achieve this.
Stamping Mill	Building or structure housing a form of ore crushing device associated with tin mines.
Starch Mill	A mill used for the extraction and processing of starch.
Steam Mill	A steam-powered factory.
Textile Mill	Any factory used for the manufacture of textiles.
Thread Mill	A factory where thread is spun from cotton, silk and other materials.
Threshing Mill	A mill which contains machinery for separating grain from chaff.
Tidal Mill	A type of WATERMILL, powered by retaining seawater at high tide and releasing it at low tide via a water wheel.
Tide Mill	A type of WATERMILL, powered by retaining seawater at high tide and releasing it at low tide via a water wheel.
Timber Mill	A mill used to process raw timber.
Tin Mill	A mill used for the processing of tin ore by razing, stamping or smelting.
Tower Mill	A windmill with a rotating cap containing the windshaft, and a stationary body in the form of a tower.
Treadmill	A structure for producing power through a rotary motion achieved by the weight of people or animals treading on a succession of moving steps or a belt that forms a kind of continuous path.
Tweed Mill	A factory where tweed, a twilled woollen fabric, is manufactured.
Watermill	A mill in which the machinery is driven by waterpower.
Waulk Mill	A mill for beating and cleaning cloth, using soap or fullers' earth.
Weaving Mill	A factory, incorporating power driven machinery from the late 18th century, where cloth was manufactured from threads interlaced at right angles to each other in a loom.
Whin Mill	A mill used to crush whins (gorse) for animal fodder.
Windmill	A tower-like structure of wood or brick with a wooden cap and sails which are driven around by the wind producing power to work the internal machinery. Use with product type where known.
Windmill Tower	A windmill with a rotating cap containing the windshaft, and a stationary body in the form of a tower.
Wire Mill	A factory where metal wire is manufactured.
Woollen Mill	A factory where short wool was spun into woollen yarn to produce cloth.
Worsted Mill	A factory where worsted, a well-twisted woollen yarn made from long staple wool and used in the manufacture of suits and other garments, is produced.
Worsted Spinning Mill	A factory where worsted, a well-twisted woollen yarn made from long staple wool and used in the manufacture of suits and other garments, is produced.

Appendix 3. Survey dates of the Ordnance Survey County Series mapping 1st and 2nd editions (Adapted from NLS, 2025d)

Historic County	Survey Dates	
	1 st Edition	2 nd Edition
Aberdeenshire	1864-71	1899-1901
Argyllshire	1862-77	1897-98
Ayrshire	1854-59	1893-96
Banffshire	1865-70	1900-01
Berwickshire	1855-57	1896-98
Buteshire	1855-64	1895-96
Caithness-shire	1870-72	1904-05
Clackmannanshire	1859-63	1895-99
Dumfriesshire	1854-58	1898-99
Dumbartonshire - main	1858-61	1894-98
Edinburghshire (Midlothian)	1850-52	1893-94
Elginshire	1866-71	1902-04
Fifeshire	1852-55	1893-95
Forfarshire	1857-62	1898-1902
Haddingtonshire (East Lothian)	1852-54	1892-93
Inverness-shire	1866-77	1898-1903
Kincardineshire	1863-65	1899-1902
Kinross-shire	1853-54	1893-95
Kirkcudbrightshire	1845-50	1893-94
Lanarkshire	1856-59	1892-97
Linlithgowshire (West Lothian)	1854-56	1894-96
Nairnshire	1866-69	1903-04
Orkney	1877-78	1900
Peeblesshire	1855-58	1897-98
Perthshire	1859-64	1894-1900
Renfrewshire	1856-58	1892-96
Ross & Cromarty	1848-75	1895-1905
Roxburghshire	1856-59	1896-98
Selkirkshire	1856-59	1897
Stirlingshire	1858-63	1895-96
Sutherland	1868-73	1903-05
Wigtonshire	1843-47	1892-95
Zetland	1877-78	1900

Appendix 4. Newspaper searches

Table a. Search terms used in the online Burney Newspapers Collection and number of results

Filter	Theme	Search Terms	Results
Publications country: Scotland	Steam engines	Steam Engine	0 0
None	Steam engines	“Steam engine”	361
None	Mills	Mills Mill Factory Watermill “Water mill”	112,227 112,180 1,752 30 1,206
Publications country: Scotland	Mills	Mill Mills Factory “Water mill”	6 6 1 0
Publication country: Scotland	Textiles	Cotton thread	1 0
Publication country: Scotland	Watermill	Water-wheel waterwheel water wheel water	0 0 0 12
None	Catrine	Catrine	23
None	Deanston	Deanston	1
None	Ballindalloch	Ballindalloch	7
None	New Lanark	“New Lanark”	15
None	Rothesay	Rothesay cotton Rothesay mill	1 0
None	Spinningdale	Spinningdale	0

Table b. Search terms used and number of results in the online 19th Century British Library Newspapers collection

Theme	Search Terms	Results
New Lanark	“Walker new Lanark” “New Lanark spinning company” “New Lanark”	38 2 1,009
Ballindalloch	“Ballindalloch works” “Ballindalloch mill” “Ballindalloch” and “works” “Ballindalloch cotton” Ballindalloch cotton “Ballindalloch spinning” “Ballindalloch bleach” Ballindalloch spinning Ballindalloch mill	5 5 1,569 0 8 0 0 1 16
James Finlay & Co	“Finlay and Company” “James Finaly” “James Finlay Co”	18 4,941 487
Spinningdale	“Spinningdale” “Spinning-dale” Creich [and] mill Creich [and] cotton Sutherland [and] spinning Balnoe Balnoe spinning Balnoe cotton	31 4 264 109 5,713 2 149 0
Catrine	Catrine cotton Catrine Catrine mill “Catrine mill” Catrine works “Catrine works”	149 3,230 39 1 61 16
Deanston	Deanston Deanston mill “Deanston mill” Deanston works “Deanston works”	4,461 51 10 244 166
Rothesay	Rothesay Cotton “Robert Thom” “William Kelly” “Rothesay mill” “Rothesay works”	53 561 9,577 3 0

Appendix 5. Mill distribution maps

A set of three maps are provided for each of the key mill categories described in Chapter 4. On the left is the distribution of mills on the 1st edition OS maps (c.1850s), centre is the distribution on the 2nd edition OS maps (c.1900s), and to the right a cumulative distribution map (1st edition and 2nd edition OS maps and additional Canmore data that either pre- or post-date the maps). The categories are presented in the same order as in Chapter 4.

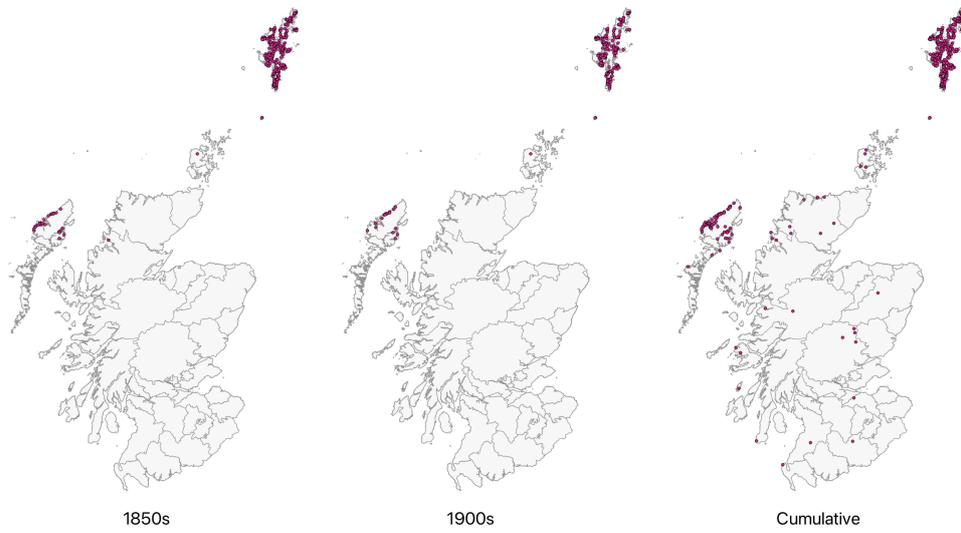
(a) Mills (all categories)



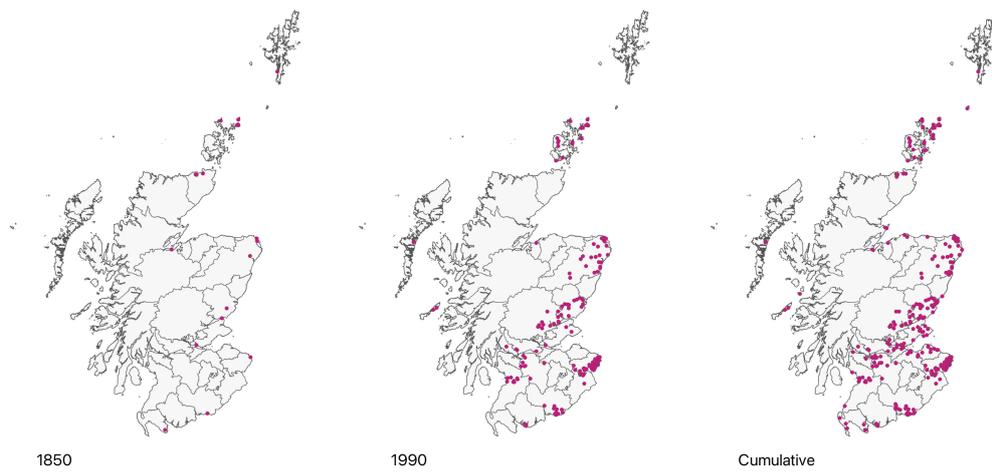
(b) Watermills - vertical



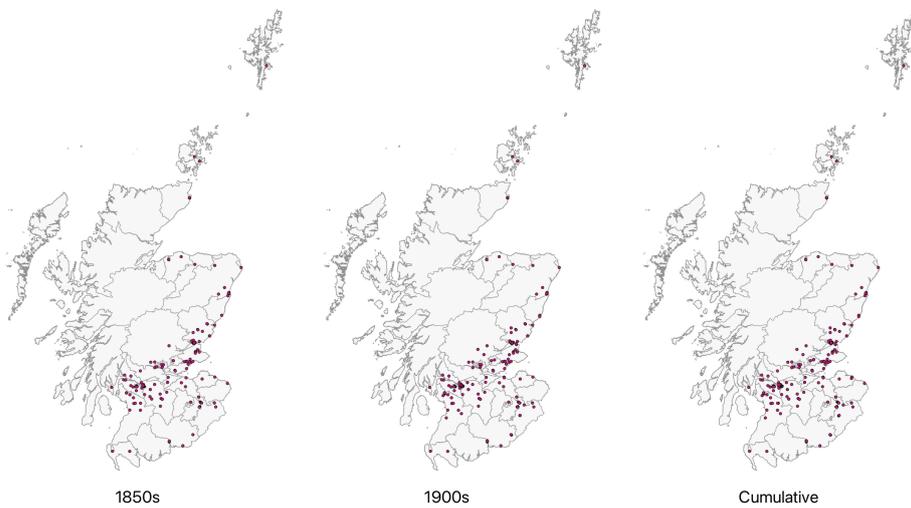
(c) Watermills – horizontal



(d) Windmills



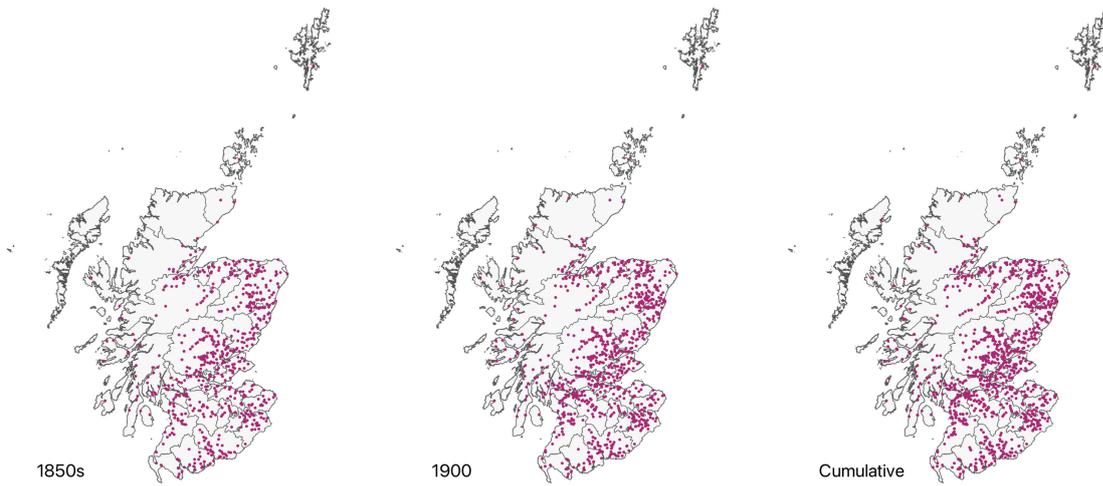
(e) Steam mills



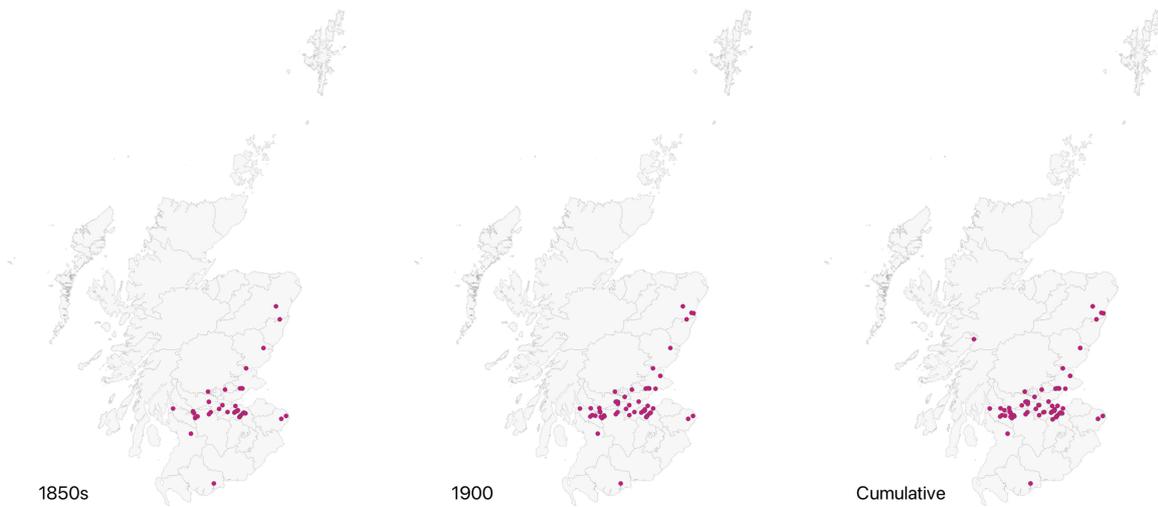
(f) Grain mills



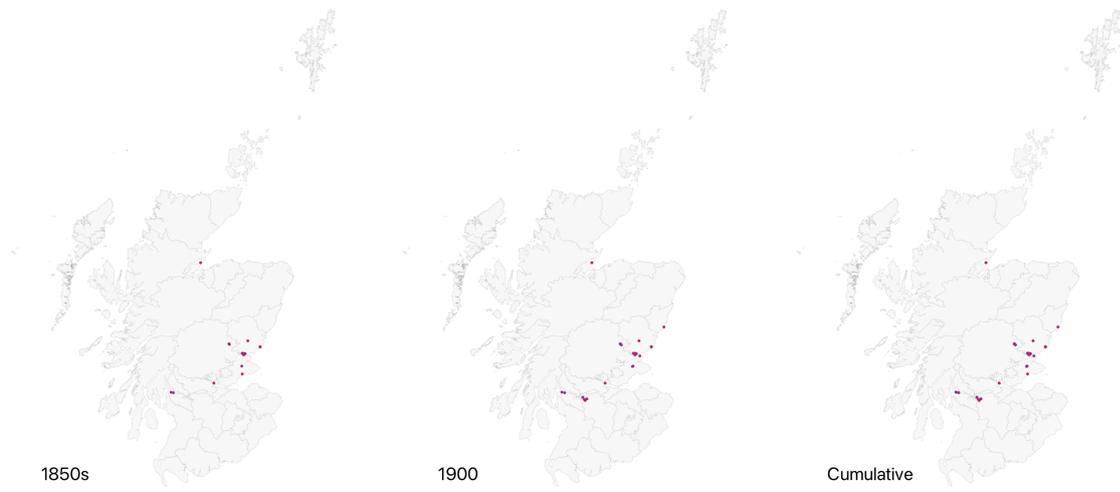
(g) Sawmills



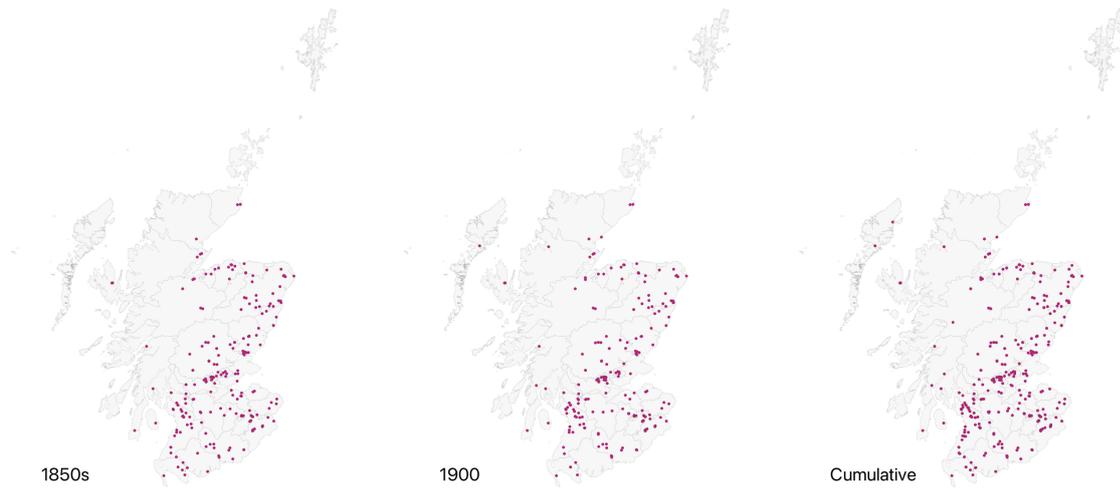
(h) Papermills



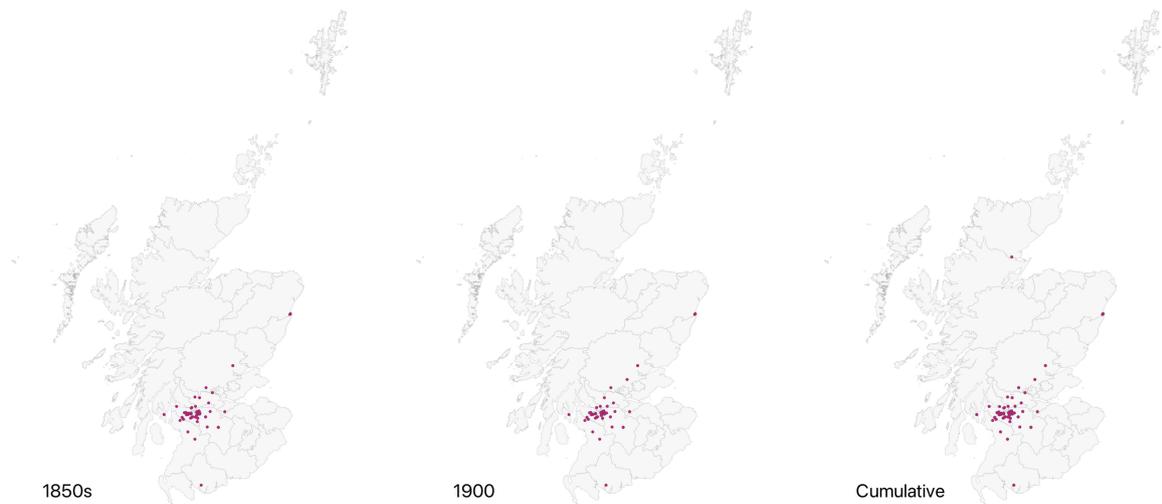
(i) Coarse fabric mills



(j) Woollen mills



(k) Cotton mills



Appendix 6. Mill data according to historic county.

This table displays mill numbers, population (Great Britain Historical GIS Project, 2003-2023b), and area (km²) data for Scotland's historic counties. The first group of columns (left) show the area and total number of mills for the cumulative dataset. The rest of the table shows number of mills and population density for the 1850s (centre) and 1900 (right). Ranks are from 1 for the county with the greatest number of mills/area/population to 33 for the lowest.

County	Overall						1850s							1900								
	Area (km ²)	Area (rank)	Total no. of mills	Rank	Mills per km ²	Mills per km ² rank	No. of mills	Mills rank	Population density	Population density (rank)	Population	Population rank	Mills density	Mill density rank	No. of mills	Mills rank	Population density	Population density (rank)	Population	Population rank	Mills density	Mill density rank
BUTE	569.47	29	25	33	0.044	27	15	33	29.61	20	16860	29	0.026	27	11	33	32.32	16	18408	30	0.019	28
KINROSS	201.91	32	29	32	0.144	10	18	32	38.14	12	7702	33	0.089	9	16	32	31.15	17	6289	33	0.079	13
NAIRN	500.28	30	35	31	0.070	22	22	31	20.33	25	10172	32	0.044	22	25	30	20.03	24	10019	32	0.050	21
CLACKMANNAN	123.62	33	41	30	0.332	3	24	30	189.73	4	23455	28	0.194	3	33	28	230.00	4	28433	27	0.267	1
LINLITHGOW	315.01	31	55	29	0.175	5	35	27	121.72	6	38342	21	0.111	6	35	26	167.58	5	52789	17	0.111	5
PEEBLES	925.83	25	59	28	0.064	23	38	25	13.04	29	12070	31	0.041	23	39	25	15.94	29	14760	31	0.042	24
DUMBARTON	678.21	26	60	27	0.088	17	41	24	85.26	8	57826	15	0.060	15	42	24	139.35	7	94511	10	0.062	18
SELKIRK	663.35	27	61	26	0.092	16	32	28	22.54	22	14955	30	0.048	21	48	22	41.23	12	27349	28	0.072	14
SUTHERLAND	5451.58	5	71	25	0.013	33	27	29	4.50	33	24513	27	0.005	33	24	31	4.02	33	21940	29	0.004	33
CAITHNESS	1807.94	13	72	24	0.040	28	43	23	21.95	23	39690	20	0.024	28	44	23	20.55	23	37161	21	0.024	27
WIGTOWN	1274.56	18	72	23	0.056	26	46	22	31.94	16	40706	19	0.036	26	35	27	28.28	20	36048	22	0.027	26
HADDINGTON	2285.83	11	77	22	0.034	29	37	26	16.43	28	37563	22	0.016	29	30	29	16.40	28	37491	20	0.013	30
ELGIN	1257.35	19	94	21	0.075	20	70	21	33.60	15	42252	18	0.056	18	70	21	34.56	15	43448	18	0.056	19
KINCARDINE	994.51	23	110	20	0.111	13	85	18	34.73	14	34543	24	0.085	11	83	19	35.84	14	35647	23	0.083	12
BANFF	1669.69	15	140	19	0.084	19	92	17	35.66	13	59537	14	0.055	19	91	16	38.43	13	64167	15	0.055	20
BERWICK	1199.50	20	140	18	0.117	12	77	19	30.17	19	36192	23	0.064	14	101	13	27.01	21	32398	24	0.084	11
ORKNEY	1013.42	22	142	17	0.140	11	72	20	31.37	17	31795	25	0.071	12	95	15	30.03	19	30438	25	0.094	9
KIRKCUDBRIGHT	2354.21	9	150	16	0.064	25	94	16	18.00	27	42382	17	0.040	24	84	18	16.98	27	39979	19	0.036	25
ROXBURGH	1740.78	14	154	15	0.088	18	100	13	30.61	18	53290	16	0.057	17	112	12	30.86	18	53726	16	0.064	17
ARGYLL	8485.76	2	161	14	0.019	31	97	14	9.50	31	80592	12	0.011	31	83	20	8.95	31	75945	13	0.010	31
EDINBURGH	949.28	24	164	13	0.173	6	96	15	329.36	1	312654	2	0.101	7	85	17	467.78	1	444055	2	0.090	10
DUMFRIES	2777.49	8	173	12	0.062	25	108	12	27.45	21	76230	13	0.039	25	136	9	26.75	22	74308	14	0.049	22
INVERNESS	11011.74	1	174	11	0.016	32	108	10	8.21	32	90457	10	0.010	32	96	14	8.02	32	88362	11	0.009	32
STIRLING	1196.87	21	175	10	0.146	9	108	11	81.21	9	97195	9	0.090	8	114	11	104.94	9	125604	9	0.095	8
RENFREW	645.88	28	226	9	0.350	2	146	8	316.77	2	204600	5	0.226	2	156	8	450.22	3	290790	3	0.242	2
ROSS AND CROMARTY	8251.60	3	259	8	0.031	30	129	9	9.80	30	80859	11	0.016	30	128	10	9.42	30	77751	12	0.016	29
FIFE	1285.85	17	303	7	0.236	4	180	6	124.50	5	160093	7	0.140	4	156	7	145.68	6	187320	7	0.121	4
AYR	2951.60	7	310	6	0.105	14	176	7	68.36	10	201767	6	0.060	16	197	6	75.97	10	224222	6	0.067	16
LANARK	2300.61	10	355	5	0.154	8	203	5	307.68	3	707853	1	0.088	10	238	5	454.57	2	1045787	1	0.103	7
FORFAR	2285.83	12	361	4	0.158	7	270	4	98.38	7	224883	4	0.118	5	241	4	121.53	8	277788	5	0.105	6
PERTH	6703.73	4	472	3	0.070	21	325	3	19.72	26	132224	8	0.048	20	286	3	18.81	26	126128	8	0.043	23
ABERDEEN	5133.99	6	505	2	0.098	15	349	2	46.06	11	236496	3	0.068	13	366	1	54.80	11	281331	4	0.071	15
SHETLAND	1471.60	16	633	1	0.430	1	435	1	21.08	24	31018	26	0.296	1	330	2	19.51	25	28711	26	0.224	3

Appendix 7. Mill categories

The table below lists the categories used to group mills for Chapter 4.

Category name	Mills included
MINERAL PRODUCT SITE	Brick & Tile Works, Cement Manufacturing Site, Glassmaking Site, Pottery Manufacturing Site, Terracotta Works, Barytes Mill, Blacking Factory. Includes Both Mineral Production And Mineral Processing, Fuller's Earth
EXPLOSIVES	Gunpowder
CHEMICAL PRODUCTION SITE	Lime Works, Paint Factory, Acid Works, Bleach Works, Paraffin Works, Salt Works, Alum Works, Fertilizer Works, Pharmaceutical Works, Starch
GRAIN MILL	Corn Mill, Meal Mill, Flour Mill, Barley Mill, Farina, Granary Mill
TEXTILE MILL	Waterproofing, Canvas Works, Flax Mill, Lace Factory, Sailcloth Factory, Weaving Mill, Fulling Mill, Linen Mill, Sailmaking Works, Carding Mill, Cotton Mill, Flax Dressing Shop, Handloom Weaving Mill, Jute Works, Madras Factory, Silk Factory, Spinning Factory/Spinning Mill, Tweed Mill, Woollen Mill, Worsted Mill, Hemp Mill, Rope, Clipping. Includes Leather And Clothing (Gloves, Shoes); Includes Madder
PAPER MILL	Paper Mill, Alum Works, Cardboard Factory
WOOD PRODUCT SITE	Cabinet Works, Bark Mill, Timber Mill, Saw Mill, Saw Pit, Bobbin Mill/Pirn Mill, Barrel Manufactory
ANIMAL PRODUCT MILL	Bone Mill, Glue, Soap
METAL PRODUCTION SITE	Aluminium Rolling Mill, Crushing, Metal Smelting, Smithy, Forge, Lead Ore, Lead Ore Washing
FUEL	Charcoal, Electricity, Gas
STONE	Stone, Curlingstone
FOOD/DRINK	Sugar, Brewery, Distillery, Oil
HEAVY ENGINEERING	Coach Works, Machine Tool, Turbine Works, Engineering Works, Agricultural Engineering Works, Boiler Works, Engine Works
THRESHING	Threshing Mills
PUMPING	Pumping Windmills
SNUFF	Snuff Mills