EXARC JOURNAL 2025/2
13 Articles | Open Access

Reviewed Article:

Rediscovering and Rebuilding the Tranent-Cockenzie Waggonway: archaeology and experimental archaeology of Scotland's First Railway

Persistent Identifier: https://exarc.net/ark:/88735/10805

EXARC Journal Issue 2025/2 | **Publication Date:** 2025-08-06

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This paper discussed the history, archaeology and experimental reconstruction of the Tranent-Cockenzie Waggonway. First it outlines the known chronology of the railway; secondly is describes the archaeology of the wooden phases of the waggonway (1722-1815) and finally the recent (2024) experimental archaeological project which attempted to reconstruct a 6m long section of the waggonway based on archaeological evidence found in 2019 and 2021. It concludes that wooden

railways used old technology to solve a new problem, and required very little skill to construct or maintain, with a team of approximately 20 relatively unskilled individuals being able to build 1km of track in a month.

> The wearing of semi-authentic period costume as part of the public experimental archaeology not only drove engagement with members of the public who were drawn by the sense of spectacle, but also in terms of questions asked about what we were doing and wearing. Equally, and more important in terms of embodiment, it helped create a sense of immersion: nothing used in reconstructing the waggonway was 'modern'.

History

The Wollaton Waggonway, constructed in 1604, was probably the first railway in England, and there is a suggestion that the technology use reached Scotland two years later (New, 2014, pp.1-11; Lewis, 1970, p.103; Robertson, 1983, pp.5-6). The Tranent-Cockenzie waggonway is the earliest recorded railway in Scotland. It was constructed in 1722 to transport coal from pits around Tranent to Salt Pans at Cockenzie. The railway was built as a result of the sequestration of the lands of the Earl of Winton because of his support for the Jacobite Rebellion of 1715. The Winton estate was forfeit and in 1719 was sold to Robert Hackett and John Wicker for £50,300, being transferred to the York Buildings Company [YBC] of London in 1720, and they would retain ownership until the 1770s when it was sold to the Cadell family. The YBC leased the barony of Tranent from November 1721 and its coal works from May 1722 (Robertson, 1983, p.6; Bethune, et al., 2022, pp.xvi-xviii). In order to manage the estate tenants were brought in during 1728 William Adam (1689-1748) the noted Scottish architect and industrialist, with a new series of leases including Adams' brother-in-law from 1736 (Bethune *et al*. 2022, p.xviii; Bethune, et al., 2023, pp.140-142). The estate was sold in 1779 to the Cadell family, and under their ownership in 1815 the wooden waggonway was replaced by one using cast-iron fish-belly rails laid on stone sleeper blocks (Bethune, et al., 2023, pp.142-144), a section of which was excavated at Cockenzie Harbour in September 2023 (See Figure 1).

Construction

The waggonway linking coal mines at Tranent to salt pans and the harbour at Cockenzie was made entirely out of wood: the rails and sleepers which formed the track, and the waggons which ran upon it were wooden. The track, and very likely the waggons, were constructed from 1722 by the wright William Dickson of Cockenzie, as recorded in two of his surviving notebooks. Dickson's journals indicate three periods of activity on the waggonway, either repairs or construction: 1722-25, 1728-30 and 1743-44. The first recorded construction of rails is on 17 May 1722, and all three phases included typical jobs expected for the building and maintenance of a waggonway including specific entries relating to 'maken at the realle' and 'sawen wagen wheels' to more general 'worken at the wagenway.' The first phase of activity is the longest (three years), with numerous entries for 'mendin the wagenway.' This work does not seem to have been methodical, and as Bethune et al. (2022) note, this earliest phase may have been carried out by an individual or individuals who were not familiar with the technology and scheduling of such a novel piece of engineering. However, the subsequent phases, are more ordered, shorter and therefore efficient, taking eighteen to twenty-four months (Bethune et al., 2022, pp.xxi - xxii).

Analysis of Dickson's journal demonstrates that work on the waggonway was seasonal, which perhaps coincided with 'down time' at the Salt Pans as they underwent their annual winter maintenance, and periods of lower salt production. Table 1 shows concentration of work on the railway by Dickson over an 8-year period. It should also be noted that Dickson was one of three wrights working in Cockenzie 1716-1719 (and probably later) who could also have been employed on the waggonway, which means that whilst his Journals are an invaluable resource, they may not give a full picture of the labour required to build and maintain a wooden waggonway. It is evident most work on the waggonway in terms of infrastructure took place October, November and December, the work sometimes extending into January and February.

Year	Month	Days Worked (Waggonway)	Days worked (Waggons)	Days worked (Infrastructure)	Task
1722	May	10			Finishing the latrine & making rails
1723	April			1	Dickson and Apprentice: working on the Trunk at the Coalfould.
	July	9			Dickson and man: finishing the waggonway/mending the waggonway.
	July			9	Dickson and man; Putting up framing at the Coalfould; working on the Trunk; hanging gates.
	November			10	Dickson and man: Working on the trunk in the Coalfould. Dickson 9 days; 'man' 10 days.
1724	March		6		Sawing timber for waggons/sawing waggon wheels at Milton.
1725	July		1		Cutting beams for the use of the waggons.
	July	2,5			Dickson and man: sawing rails and mending the waggonway.
	August	5			Mending the waggonway
	August		1,5		Dickson and man: Sawing planks for the waggons.
	September	17			Self and man: working on the waggonway
	September		1		Sawing planks for the waggons
	October	16			Dickson and man: working at the waggonway

	November		5		Dickson and man: sawing planks for waggons.
	November	10			Dickson and man: working at the waggonway.
	December	17			Dickson and man: working at the waggonway.
	December		1		Sawing planks for the waggons
1726	January	4			With Adam Grant : working at the waggonway.
	February	5			My man working on the waggonway.
	February		2		Putting the iron work on the wagon doors.
	February			3	Altering a partition in the Barn (coal store?) at the Coalfould.
1727	November	4			Sawing rails in the Coalfould.
1728	August			2	Altering the gates at the Coalfould
	November		5		Dickson and man: cutting waggon wheels in the workshop
	December		17		Cutting waggon wheels
	December		6		Sawing waggon wheels and working on the waggonway
1729	January	20			Working on the waggonway
	February	11			Working on the waggonway and sawing waggon wheels.
	April		4		Going to Pencaitland for waggon wheels and cutting them.
	May		8		Going to Clerkington to cut waggon wheels (5 days); at home (3 days)"
	December		4		Cutting waggon wheels.
1743	October	5			Sawing rails and working on the waggonway
	November	24			Sawing rails and working on the waggonway
	December	12			Sawing rails and working at the waggonway
	December		1		Cutting waggon wheels and sawing in the workshop
1744	February		6		Going to Aberdour for waggon wheels and making them.
	March		24		Working at at Aberdour on wagon wheels.

	April		4		Working on wagon wheels.
	August		12		Sawing waggon wheels in the shop
1744	October	11			Sawing rails for the waggonway/working on the waggonway
	November		3		John Stevens: sawing planks for waggons.
	November	11			'Sawing the oak timber'. Potentially waggonway? Comes directly after previous entries in October for sawing rails.
TOTALS		193.5 days worked	111.5 days worked	25 days worked	

TABLE 1. WILLIAM DICKSON DAYS WORKED ON THE WAGGONWAY AND INFRASTRUCTURE.

It is also clear that Dickson was working on the waggonway either alone or with his apprentice or 'man.' He does not refer to any ditch digging, suggesting he was not responsible for that task; but the small amount of labour is surprising. Work on the waggons themselves was also seasonal, often corresponding with periods of activity on the track.

Timber used to construct the waggonway is specified by Dickson to have been oak. Scotland had limited supplies of oak which meant it had to be imported largely from the Baltic via the Hanseatic League. Dickson refers to importing timber from Denmark, and he is clearly purchasing whole trees as unprocessed timber. It is unlikely Dickson was importing timber specifically for building the waggonway, rather using the timber he had in stock. Going by the lengths of the timber he had 'at the harbour' in 1728 (Bethune, et al., 2022, p.160), these were whole trees varying in circumference from 37 to 60 inches (93.9cm to 152cm), and from 14 feet 6 inches to 17 feet (4.4m to 5.1m) in length. They would probably weigh several tons and from their length were ideal for making keels for wooden ships as well as planks, rather than masts (Bethune, et al., 2022, p.160). He was also felling timber locally, and archaeological evidence from excavations carried out in 2021 demonstrate that whilst the rails were made from squared off, dressed timbers, the sleepers were effectively made from branches, in the round and with their bark left on. The only processing of these sleepers being the preparation of either end to form half lap joints where they fastened to the rails (Bethune, et al., 2022, p.xxxiii). The use of imported timber at Cockenzie by Dickson is not unusual: at Alloa in the 1760s 'foreign fir' was used, together with imported 'best Memel or Prussian fir' in the 1780s (Dott, 1947, pp.26,28). Memel, today Klaipèda in Lithuania was in the eighteenth century in East Prussia, and together with Danzig - then in Prussia but today Gdansk in Poland - was a major port for shipping timber. Memel timber was thought to be inferior to that from Danzig but as Åström has demonstrated, from the 1760s Memel became a major exporter of 'fir timber' to Britain, the rise in imported timber from Memel particularly from the 1770s onwards being due to a boom in house building and canal building (Åström, 1970, pp.20 - 22).

Preference for oak for the rails is demonstrated by Lewis (1970, pp.170,175), so too the use of beach for the upper or running rails, a practice also adopted in Scotland (Dott, 1947, p.28; Lewis, 1970, p.170). Oak and Ash were also used for sleepers in England whilst in Scotland pine was used (Dott 1947, p. 28). Unlike the rails, the finish of the sleepers was not important. This is confirmed by John Buddle writing in March 1807 (Buddle, 1807, p.201). Buddle also provides a sketch plan and section of a wooden railway, demonstrating the rough nature of the sleepers and that they were burried (Buddle, 1807, p.202). Clearly, given that the sleepers were buried, their shape and finish was not important. What was important was their ability to hold the rails to gauge with the minimal amount of finishing to create a level surface onto which the rails were pegged. The use of different materials for the rails is confirmed by Buddle who writes:

> "*The best wood for constructing the Ways is Oak for the Sleepers and Bottom Rails and Beech for the Top Rails. Norway Fir Timber is most commonly used for the bottom rails... The sleepers are made generally of small oak trees unsquared are from 5 to 7in diameter. The bottom rails 4 ½ in by 5in, and the top rails 4in by 5in laid the flat way... The sleepers are 20in asunder middle to middle. The bottom Rail is fastened to the Sleepers by Oak Trenails, as is also the Top Rail to the Bottom Rail. It is advisable to have the Bottom Rails in long lengths and the Top Rails so placed so as to cross the joinings of the Bottom Rails*" (Buddle, 1807, pp.201-202).

The pegs or trenails were slightly conical in shape 'properly rounded and of equal thickness from the point to within ¼ of their length from the head' where they were to swell somewhat. Driving in such a trenail would bring both elements tightly together. They would be tightened or 'caulked' using a trenail iron by making a single stroke 'crosswise, which swells out the head of the trenail.' Larger trenails were caulked using three strokes. It was also important that all the drills and augers were of the same size (Bell, 2018, pp.154-155).

Dickson must have had a timber yard somewhere at Cockenzie: the skills he demonstrates through his journal include cleaving timber, i.e. splitting with wedges, as well as sawing which implies the presence of a sawpit. He was also employing 'wrights' and 'a carpnter' (sic., carpenter) on some of his jobs, suggesting he was not working alone but employing a skilled team of artisans, some of whom are named. He also worked with other local tradesmen, including James Paterson the blacksmith who made nails for Dickson (Bethune, et al., 2022, xl). From entries in his journals, he was also capable of making wheels and axles - suggesting the presence of some form of lathe to turn the axle stubs - and was making both deals and planks. He was clearly skilled in working with large pieces of timber as he records 'finisen the keell' (sic, finishing the keel) of a boat as well as handling 'waplleats' (sic wall plates) and 'treases' (sic, roof trusses). (Bethune, et al., 2022). Dickson therefore possessed the skills and was able to call on the knowledge of others in his local community to build and maintain the waggonway. One question remains, however, is to where Dickson gained his knowledge of railways. Whether the waggonway constructed 1722-25 was a 'home brew' without access to wider knowledge of wooden railways being built in the North of England at that period, or whether the idea was a technological import to Scotland, remains unknown.

The second phase of the waggonway, using double rails has so many parallels south of the border to suggest that this was indeed imported technology. The lack of familiarity and coordination implied through the documentary record for the primary phase of the waggonway does suggest either a 'home brew' element or lack of familiarity with the technology. However, a skilled wright such as Dickson would have been familiar with a ladder which, in essence, is what a wooden railway is, a wooden ladder laid on the ground, but it is unlikely he had any experience of building something on such a scale. This likely accounts for him getting into difficulty with planning and coordinating its construction and the time taken on repairs for what may have been a poorly constructed structure, or one because of its experimental nature was perhaps not up to the task.

Archaeology

Previous work

Around 40 wooden railways have been excavated in northeast England, mostly around Tyneside between the 1990s and early 2020s (Bell, 2018, pp.17-26; Turnbull, 2023, pp.148-149). However, not all of them have produced evidence demonstrating how these structures were made. The most important of these have been Lambton D Pit (1995) and Willington (2013). Prior to the work at Lambton, only three other such railways had been explored archaeologically (Turnbull, 2023, p.119). Over 150 metres of wooden railway were excavated, including several sets of points, probably dating to 1812-1817. It may have been in operation as late as 1830 utilising a route and formation from the 1790s. There was evidence of wood working on site, and it was thought that the more irregular rails and sleepers were evidence of running repairs a 'pragmatic 'make do and mend' approach involving continual re-use and replacement of timber' (Turnbull, 2023, p.120). At Willington, a 33m long stretch of wooden railway was located and fully excavated. This consisted of a 'double way' main-way and a 'single way' by-way leading to a wash pond. The archaeology demonstrated that the upper or running rails had been turned over for re-use once worn (Bell, 2018, pp.50-52; Turnbull, 2023, p.95 ff). There was also a set of truncated points, but the archaeology did not reveal how they functioned.

Table 2 summarises the finding of these excavations where evidence of how these waggonways were constructed were located archaeologically including rails and sleepers surviving as wet wood; as mineralised wood; or as stains or voids. From this it is demonstrable that sleepers were earth-fast, as described by Buddle in 1807. This means that they did not transfer the load of the rails to the ground via ballast, rather that they served merely to keep the rails to gauge. The lack of a ballast cushion beneath the sleepers also meant that they could not absorb any shock from the waggon passing over them. Likewise, the load from the rails was transferred by the rail itself, to the ground through a thin spread of ballast - if present - beneath the rail or directly to the ground underneath. Such a railway would not be elastic and able to absorb dynamic loads, and it would also be very susceptible to changes in weather (temperature and humidity).

Waggonway	Archaeology	Type	Ballast	Rail material	Rail section	Rail length	Sleeper material	Sleeper shape and length	Sleeper spacing
Lambton D (1998)	Wet wood	Single way	Small coal,	Primarily oak, but	0.12m -	1.25m - 3.3m	Oak	Irregular; mostly	Eratic; between

			ashes	also elm, ash, fir.	0.13m square			straight. 1.7 - 2.0m long	0.40m and 0.85m
Rainton Colliery (2003)	Wet wood, sleeper impressions and voids.	Single way? Four tracks, two main-ways and two by-ways	Small coal, ashes				Oak	Irregular: roughly trimmed branches. Average 1.80m x 0.18m x 0.10m.	Irregular: Main way 0.30m - 0.38m, by-way 0.40m - 0.59m
Harraton (2009)	Wet wood; voids fill with small coal	Double track	Small coal, ashes				Not recorded.	Irregular; trimmed branches. Maximum 1.280m x 0.13m x 0.12m.	Not reported
Hawks Iron Works (2011)	Voids filled with small coal, ashes etc		Small coal, ashes		0.15m square	Two surviving: 3.13m and 2.8m	Not reported	Not reported	Regular; closely spaced
Redburn Row (2018)	Wet wood; stains and impressions		Small coal, ashes				Oak	Irregular; trimmed branches. Largest example 1.94m x 0.22m. Others 1.162m x 0.90m diameter and 1.165m x 0.13m diameter.	Irregular: 0.30m - 1.10m

Willington (2018)	Wet wood	Double Way with wash pond siding	Small coal, ashes	Primarily oak with some beech for top rail; oak and pine for bottom rail.	0.12m x 0.16m	0.50m - 4.92m	Primarily oak, but some beech, elm, and pine	Irregular; some re-used ship timber; tree boughs.	Irregular: 0.50m - 0.68m on main way and 0.55 - 1.08m on by-way
Coaley Lane (2019)	Impressions in clay; timber voids filled with small coal.		Small coal, ashes		0.22m x 0.12m	Not reported	Not reported	Maximum 1.98m x 0.35m x 0.20m	Irregular but close spacing; 0.08m - 0.45m
Cockenzie (2021)	Wet wood and mineralised wood	Double way?	Small coal, ashes		0.20m x 0.20m	No evidence		Maximum 0.20m x 0.20m	Irregular, but perhaps not all excavated. Varies from 0.40m to 2.0m.

TABLE 2. KEY FEATURES OF EXCAVATED WOODEN WAGGONWAYS

Thus, sleeper shape was irregular, being simply tree boughs with minimal processing, confirming observations in the period by Buddle (1807) and by Lewis (1970). They averaged 1.8m long, and as Lewis (1970, p.165) notes were rarely more than one and a half times the gauge. They measured between 0.13m and 0.35m wide and 0.10m and 0.20m thick. As a result of their irregular shape, it also meant that spacing was irregular, but that spacing on the main-way which was expected to see more traffic was closer than on the by-way. Rails by their nature had to be properly dressed which involved more processing. Whilst length varied, from the forgoing their dimensions were never less than 0.12m square, and never more than 0.16m square.

The material packing the space between the rails should not be described as ballast. Ballast has the following key properties to perform:

- It provides levelled bed or support for the railway sleepers.
- It transfers the load from sleepers to subgrade and distributes the load uniformly on subgrade.
- It holds the sleepers in a firm position while the trains pass by.
- It prevents the longitudinal and lateral movement of sleepers.
- It offers good drainage to the track.

The material which forms the horse track performs none of these functions, and due to being hygroscopic in nature impedes drainage and by retaining moisture would cause the rails and sleepers to rot.

Field Work

In 2019 the 1722 Waggonway Heritage Group (WHG) carried out a trial trench on part of the route of the waggonway which crosses the Prestonpans Battlefield. This is now a public footpath and right of way. It located a small coal surface, which could be interpreted as a sleeper impression as it ran parallel to the rail impressions found in 2021, and the end of a sleeper surviving in the ground as wet wood. In September 2021 a 10m stretch of waggonway was excavated by members of the WHG located close to an earlier sondage dug in 2019. The 2019 sondage included a full section of the ditch on the east side of the waggonway route which demonstrated spoil was heaped outside the ditch. The 2021 trench was orientated north south, on the eastern side of the track bed abutting the later, stone built boundary wall. Preservation of the archaeology was excellent with wooden rails and sleepers surviving *in situ* as both wet wood and as mineralised wood. Two, potentially three phases of wooden railway were located, surviving as wet and mineralised wood.

The first phase of activity on the site was laying a corduroy of round or half-round timbers directly onto the natural, all top and sub soil having been removed. There was no evidence for any redeposited material from ditch digging being used to level the site or create an embankment. This corduroy created a 'raft' on which the waggonway was built, being used to spread its weight as it was 'floated' across an area of soft and boggy ground. These round or half-round timbers show minimal evidence for processing; they were still in the round and with bark left on. Archaeological work on other wooden railways suggest that this was an unusual construction technique as shallow trenches were dug into which sleepers were set on top of a shallow bed of small coal and ashes (Bell, 2018, pp.17-26). The method of construction employed on the Tranent-Cockenzie waggonway was clearly dictated by geographical concerns and crossing an area of wet ground (See Figure 2).

As part of this corduroy 'extra-long' sleepers were laid which were initially thought to act as 'stabilisers' to support the waggonway as it crossed the soft ground. Post excavation work, however, demonstrated that these sleepers extended for approximately one metre wider than the track and rather than being 'stabilisers' may have been used to maintain a parallel passing loop or siding to gauge. Equally putative evidence of a slot on the west side of the waggonway could be interpreted as evidence for a rail suggesting that the waggonway was double track at this point, and that it was the location of a passing loop. Whether the archaeology represented was the 'main way' or the 'by way' is not clear.

Immediately above the corduroy was a layer of large, irregular, beach cobbles and stones packed with dark earth containing small coal, and industrial waste forming the 'sub-base' in road-building terms. Above this was the 'base' layer of smaller cobbles and broken stone, mixed with industrial waste including glass slag. The use of such material as ballast appears to be 'typical'; Broken stone as used nowadays does not appear to have been utilised for wooden railways (Lewis, 1970, p.164), with small coal and ashes being the preferred material.

The site was very clean and almost devoid of finds other than glass slag from Port Seton glassworks which was incorporated within the make up of the horse track and a small assemblage of ceramics: a glaze piece of clay pipe steam; a ceramic button and a single piece of glazed slip-decorated barleycorn pottery made by Cadell & Roebuck at Prestonpans (Bethune, 2021a, pp.1-4; Bethune, 2021b, pp.1-4). The Port Seton glassworks were in operation from c.1728-1736 (Turnbull, 2021, pp.238-265) but the glass slag cannot be used diagnostically to provide dating evidence since the material occurs frequently throughout eighteenth-century archaeological contexts in and around Port Seton and Cockenzie (Bethune, 2021b, pp.1-4). The ceramics all came from the top of the working/walking surface of the horse track, dating that period of activity. The Cadell & Roebuck barleycorn pattern ceramic dates to c1750 and can be used to date activity on the waggonway, either construction or a period of repair (Bethune, 2021a, pp.1-2). It is tempting to see a correlation between the artefactual date of c.1750 and a known phase of rebuilding of the waggonway 1743-1744 by William Dickson, or with a change in ownership in 1759.

The final layer, forming the horse track, was made from small coal, ashes and industrial waste. This was very compact and uniform in colour (almost black), consistency and grain size. Numerous tipping and tamping events, combined with the trample of horse's hooves compacted this material into a uniform mass. Likewise, it was observable from the experimental work (below) that wetting this mixture of small coal, ashes and slag helped the material to 'run' into all the spaces around the cobbles, as well to congeal the material together, which once dried, took on a hard, dry, almost crusty texture which like its archaeological equivalent, was able to shed water.

This ballast material was contained by the voids of timber rails and sleepers, set at 4 feet 8 inches (1.42m) gauge. The use of 4ft 8in gauge, together with the terminology 'waggonway' would suggest links with waggonway building tradition around Newcastle upon Tyne where a gauge of 4ft to 5ft was preferred, suggesting a cross-border link and transfer of technology (Lewis, 1970, pp.134-136, 164-165). The rails were a maximum 20cm x 20cm in section, equating toward the upper end of rail size quoted by Lewis for Newcastle waggonways; he suggests a general size of 4.5in x 5in (8.8cm x 12.7cm), but never lager than 6in square (15.2cm) (Lewis, 1970, p.165). Rails at Lambton were 12cm - 13cm square and varied in length from 1.25 - 3.3m in length. Those at Willington were generally 12cm x 16cm and ranged in length from 0.5m to 4.92m (Bell, 2018, pp.17,35) (See Figure 3).

Within both the horse track surface and the second layer of cobbles and broken stones were both voids and mineralised timber showing where sleepers had been positioned. These sleepers were within this material and had not been cut into it, suggesting that they had been in situ when the material was dumped as ballast or to form the horse track around them. The sleepers were irregular in shape, 20cm x 20cm maximum diameter, often still in the round and with their bark left on, with only the ends of the sleepers being processed and dressed where joints were formed. It is likely windfall or regular felling timber was used for the sleepers, and that a minimal amount of processing was used, and only where it was needed. The sleepers, where excavated varied from 0.4m centres to 2.0m centres although not all sleepers may have been excavated; the close spacing suggesting this was the 'main way'. The use of irregular sleepers with a minimal amount of processing of dressing is observable from other sites. At Lambton D pit (1998) the sleepers were erratically spaced from 0.4m to 0.85m and at Willington from 0.5 - 0.68m on the 'main way' and 0.55

- 1.08m on the 'byeway' suggesting the less intensely used 'bye ways' only required fewer, and thus more broadly spaced sleepers than the 'mainway' which would naturally have seen more use. (Bell, 2018, pp.17-18,36). This is an observation shared by Lewis who records that sleeper spacing was generally 1ft 6in or 2ft (0.45m - 0.60m) for the 'mainway' and as much as 3ft (0.91m) for the 'by-way' or 'sideings' but never more (Lewis, 1970, p.165).

At the northeastern end of the trench preservation through mineralisation was sufficiently good for a single lap or half-lap joint to be identified between a rail and sleeper. The sleepers within the second phase of ballast were more apparently paired and more closely spaced than those within the horse-track. These were excavated at a higher level than those associated with the corduroy, which initially suggested a multi-phase structure of at least three phases, an interpretation which seemingly fits the documentary evidence from the journal of William Dickson (above) which provides evidence for three major phases of work on the waggonway from 1722 to 1744. Phase 1 being the timber corduroy with extra-long 'stabiliser' sleepers with rails pegged on top to an unknown gauge. However, whilst the presence of a tentative small cross-section rail on the west side of the waggonway, against which the later, much larger rail butted, was confirmed its partner on the east side could not and its presence was supposed. The potential earlier rail on the west side may not have in fact been a rail, due to it butting up against the later rail and could have been some form of check rail or brace (See Figure 4).

The Second phase was built to 4ft 8in gauge using larger, better dressed rails and sleepers and phase three (also 4ft 8in gauge) which was 'double way' sitting directly on top of the timbers from phase 2. These phases being dated to 1728-1730 and 1743-44. The short lifespan of phase 1 demonstrating the roughness of its construction. Likewise, the ten year or so gap between phases 2 and 3 is supported by Buddle writing in 1807, who notes that these structures had a life-span from 2 to 10 years before needing major work or total replacement (NEIMME/bud/15/201/). A pattern observable on the north side of the Forth on the Alloa waggonway (Lewis, 1970, pp.166-167,216-225; Dott, 1947, p.28).

This interpretation is, however, open to debate, with two rival theories. The 'double way' waggonway being carried across the boggy ground on a corduroy. Typologically ('double way') and artefactually (pottery) may confirm a single build date. The alternate suggestion is two phase structure: the first phase being a simple waggonway laid on the timber corduroy, which was then replaced by a 'double way' waggonway.

In the light of the experimental work outlined below the archaeology could be re-interpreted to suggest that the waggonway as excavated in 2021 one phase, with two distinct phases of work. A corduroy of round or half-round timbers was laid to carry the railway over the soft ground. This was also used to transport workers and materials to the work site. On top of the corduroy a 'double rail' waggonway was then constructed, placing two 'frames' on top of each other, the frames having been prepared off-site at a timber yard where they were dry fitted together, dismantled and transported to site via the waggonway. Although Lewis (1970) does not indicate the use of sleepers to tie together the 'upper' rail of a 'double way', without the quarried material being banked up either side of it to form the foot way for the horse attendant, there would be nothing to prevent the upper rails from spreading and moving wide to gauge causing derailments. This became immediately obvious as part of the experimental work and additional somewhat rough sleepers were inserted by processing relatively straight wind-fall timber to act as crossties in the upper rail to pull the structure together.

What is clear, however, is more archaeological work is needed on a larger area to investigate the construction and dating of the waggonway. Furthermore, a test-pitting or trial trenching strategy along the route of the waggonway on the Battlefield section to assess preservation of wood.

Experimental Archaeology

The reconstruction led by the WHG is probably the first time an attempt has been made in the UK to build a section of wooden waggonway using authentic tools and techniques, but it is not the first such reproduction. During 1983 coincident with conservation work carried out on the Causey Arch, Durham County Council built a section of single-rail wooden waggonway representing the type of waggonway which would originally have run over the bridge. It is thought that they referred to Dr Lewis' book *Early Wooden Railways,* but the actual construction methods were very likely modern. None of the process was recorded but photographs, including those of a replica wooden waggon which was posed with a horse on the track were taken. The waggon is currently on static display, and in poor condition, close to the Causey Arch (Smith, 2024, pers. comm.).

A 200 yard long wooden waggonway, based on the Lambton D pit waggonway was built under the auspices of Paul Jarman at Beamish Museum in the early 2000s. This was built using a combination of techniques and has been described as 'too substantial for a waggonway.' For ballast, a sub-base of broken brick was utilised, which was then ballasted. Reclaimed mainline Jara sleepers were re-purposed, accompanied by oak rails as was therefore probably far more robust than the eighteenth-century originals which were quite rough and ephemeral. It was built by a trained carpenter who made some changes to the construction, such as drilling holes for the trenails at an angle so that the rails would not lift from the sleeper. Ballast was spread by machine using a 'JCB' type excavator. No ditches were dug but it was securely fenced off to respect neighbouring landowners wishes. Experiments with running an iron-wheeled waggon with coned wheel treads were carried out on the replica waggonway. It is likely that wooden wheels had parallel wheel treads rather than tapered or coned like modern wheel treads, but that iron wheels had coned wheels. A wheel with parallel treads would have more 'grip' on the wooden rail but would need a substantial flange to help keep it on the rail which would add to the rolling resistance between wheel and rail. A coned wheel, whilst helping to centre the wheel on the rail, would not distribute the waggon's weight evenly across the rail and tend to crush the gauge or flange side of the rail. Lewis notes that from the 1770s onwards the upper rail was often planed to create a convex shape. This probably came with the introduction of iron wheels, the shape of the rail mirroring that of the coned wheels tread (Lewis, 1970, pp.165-166) (See Figures 5 and 6).

It was found that due to a poor wheel: rail interface between coned iron wheels and square wooden rails that check rails, to help keep the wheels on the rails, were required. Likewise, 'if the horse took a racing-line, it helped the waggon transition along quite well' (Jarman, 2024, pers. comm.) and kept the wheels on the rails. Equally, some speed could be developed in a straight line with the horse sticking directly to the centre line of the rails. But this was probably not typical behaviour or operation. Using the fixed points presented challenges, however, with the waggon invariably de-railing as it had to be man handled over them. Performance of iron wheels on the oak rails was recorded, noting that the iron flange tended to tear up the inner - i.e. gauge - face of the rail quite severely, suggesting the 'armour plating' provided by mid-18th century strap rails was perhaps in the wrong place (Jarman, 2024, pers. comm.). A convex rail profile, however, would have helped prevent damage and keep the wheel properly centred. (See Figures 7 and 8).

During the weekend of 31 August to 1 September 2024 members of the Waggonway Heritage Group constructed a 6m length of wooden railway, primarily based on evidence from the 2021 excavation, supported by the writing of Dr Lewis and the Willington excavation report. A large, flat area of grassy waste ground at Cockenzie Harbour, close to the site of the 2023 Salt Pan excavation was chosen.

Two styles of waggonway were constructed to assess: the skill needed to build them; the time taken and man-power requirement; their durability. One section of single-rail waggonway 3m long was built, which was joined to a double-rail section of equal length. Due to time and manpower constraints, only sections of the bank and ditch were dug rather than full length.

The team consisted of one trained joiner (Richard Garside); a marine archaeologist (Ben Saunders); two archaeologists (Alan Braby and Anthony Dawson); a historian (Edmund Bethune) and railway enthusiast (Dan Lohrenz). Each process was recorded photographically, including waste produced, with observations of practitioners being recorded orally and through interviews. The process was recorded photographically and with video updates posted on social media.

Single Rail

Marking Out

The first task required to build the waggonway would have been to survey the route and mark out where the waggonway and its attendant ditches were to go. The site chosen for the replica waggonway was surveyed using traditional methods using a theodolite, alidade and plain table. Measurements were made using a Gunter's chain from a fixed datum point. The centre line of the waggonway was thus pegged out from which off-sets were used to peg out the line of the rails, footway, ditches and banks.

Earth-moving and digging would have been major items. After marking out, the second task would be to dig the drainage ditches, and de-turf and level the area. A group of four individuals with mattocks, Cornish shovels, and barrows were able to de-turf and level an area measuring 6m x 1m in one hour.

One individual with mattock, barrow and shovel was able to dig a section of V-profile ditch 1.5m x 1.0m x 0.6m in one hour, the spoil being heaped outside the ditch to form a bank, suggesting 0.9m3 of spoil was generated an hour. Shirley (2001) argues that a fit and strong individual can move

1.5m3 of topsoil an hour and 1.25m3 of subsoil in the same period; Victorian estimates were that a Navvy could dig 1 cubic yard (0.76m3) of earth an hour suggesting this figure is about typical for an 'average' male (Shirley, 2001, pp.41-42). A team of experienced ditch diggers would have been required to excavate the 8km of ditches flanking the waggonway; a team of ten diggers working at one metre per hour each would equate to ten metres of ditch per hour, thus requiring 800 hours to construct the ditches or about 80 10-hour working days. The ditch digging alone would be a major undertaking in terms of manpower. It is, however, worth noting that due to the indentured nature of salt making, and the nature of the work itself, that there was always a ready pool of workers who had 'downtime' whilst the pans were out of operation for maintenance. Likewise, ditch digging could possibly have been done outside the major fishing seasons. Furthermore, as Whatley notes the salt works were 'a major focus for skilled and unskilled 'industrial' workers' as well as for traditional craftsmen including masons, smiths and wrights who would all have possessed skills suited to building a waggonway (Whatley, 1984, pp.46-48).

Because of the built-up nature of the ground where the reconstruction was to be made, it was not possible to strip back to natural, instead the turf was removed and the area levelled, to a depth of approximately 15 cm.

Demonstrable archaeologically, the first phase of construction of the Tranent-Cockenzie waggonway had been to de-turf and remove any topsoil down to natural, in this case an orange clay. There was no evidence of a buried soil or old ground surface beneath the waggonway, nor was there any evidence of redeposited material from ditch digging that would been used to create an embankment or piled up either side of the waggonway. Whilst no bank was recorded archaeologically, its presence it demonstrated through lenses of material being washed into the ditch fill from a supposed bank on the outside of the ditch. However, the archaeology here can be challenged from the documentary record. Archibald Robertson's 'deed of tack' from 1736 mentions that:

> "*He be obliged to keep and leave not only the timber of the waggon way but also the breadth of the earthen road on both sides of the way which supports the timber sleepers and raills and at the narrowest place to keep and leave them two foot of well rammed earth on each side of the raills of the said waggon road.*" (Bethune, et al., 2022, p.231)

In other words, the spoil was used to create the foot way and was packed around the timber structure, exactly as described by Lewis (1970, p.164) who suggests spoil from the ditches was piled against the timber structure to support it and create the foot way either side. It is therefore likely that the digging of ditches and construction of the railway were contemporaneous events, the ditches being dug as the waggonway extended in length, providing a quarry for material to build the horse track and the 'well beaten earth' foot way on either side. Digging ditches prior to laying the railway would have had the advantage of demarcating the route in the landscape and draining the site, ready to receive sleepers and rails. But this would have a major disadvantage because the work site would be very narrow and constricted, but if such an option were taken it further suggests material was brought up the waggonway and assembled on site from a kit of parts.

The Tranent-Cockenzie waggonway was potentially built directly on the natural, with no evidence thus far of any upcast material from ditch digging being re-deposited as ballast on either side. This was used to provide evidence during the experimental work that upcast material may have been used to form banks outside the ditches as well as quarry material for ballast. The likelihood of upcast material being used to create banks has been questioned, as the material forming the banks had to be entirely used as horse track material and create the foot way. It is likely that there were at least three teams at work: one digging the ditches and levelling; the second erecting the timber railway; the third ballasting.

Rough Wood Sleepers

Timber for the sleepers was selected from felled material collected at Prestongrange Museum. The material was probably twelve months old and still quite wet. The ends of each of these round branches was processed to create a level recess onto which the rails would sit. The processes followed were:

1. Marking horizontal datum. This was achieved by marking out a horizontal line the length of each branch using a traditional chalk line. This acted as a datum point to work to. The sleepers were cut to a length of one and a half times the gauge, which is short compared to modern railway sleepers.
2. Cutting the shoulder. The first physical process was to use a saw to mark the 'shoulder' of the worked area, with the sleeper being supported by a sawhorse.
3. Cutting the rebate. The sleeper was laid on the ground and an adze was used to cleave the level rebate at each end.
4. Finishing. The sleeper was returned to the sawhorse, and was finished with a side axe and a box plane to create a finished surface. It took a single individual working alone for one hour to make a single sleeper using this process.

In total four sleepers were produced using this methodology (See Figures 9 - 12).

Laying Rails

Rails were 3m long pieces of kiln-dried pine sourced from a local timber yard. Although the rail lengths are not known, Lewis (1970, p.165) indicates a length of 6ft to 8ft (1.8m to 2.4m), with '6ft ... being the norm', although at Willington one rail was considerably longer. Therefore, the use of 3m rails, whilst making logistical sense in terms of availability of material, may not necessarily be accurate. Whilst Buddle suggests bottom rails were longer than top rails, in this practice the top and bottom rails were the same length. Replica rails had a cross section of 10cm x 10cm, which whilst smaller than those excavated (above), they do correspond with known dimensions given by Lewis, who says they were never less than 4in x 3in (10.16cm x 7.62cm) (Lewis, 1970, p.165). Buddle notes in 1807 bottom rails measured 4½in x 5in (11.43 x 12.7cm) with the top rails 4in x 5in (10.16cm x 12.7cm) 'laid the flat way' so wider than they were thick (Buddle, 1807, p.201). Although the length of rails is unknown archaeologically, given the length of trees Dickson had (see above), a rail length of 7ft to 8ft (2.13m to 2.44m) is likely from halving their lengths.

Irrespective of whether rails and sleepers were made at the work site or, as this paper argues, in a timber yard at Cockenzie, it is unlikely that processing of trees took place at the work site. The material would already have been processed into deals and planks by Dickson in Cockenzie. Whole trees would have been too difficult to transport to the work site and materials either as prepared rails and sleepers or as planks would have been transported along the waggonway from their primary processing site in Cockenzie to the work site. Evidence of in-situ woodworking has yet to be found archaeologically, although all the wood working waste and debris was photographed and recorded as indicative of the type of material which might be found archaeologically (See Figures 13 and 14).

One rail was placed *in situ* which would act as the datum from which the gauge could be measured. Rails were marked where the trenail would need to be drilled. The rail was drilled on site using an antique carpenter's brace with a 19mm drill bit. The rails were drilled through the rail and the sleeper so the holes would correspond exactly. It took one individual approximately 1 minute to drill the hole through the rail and, based on the suggestion from Lewis, halfway through the sleeper. The 16 peg holes took one individual 15 minutes to bore.

The rails were then pegged into place using trenails. These trenails were produced by hand using a drawknife and replica draw-horse. They were made as round as possible, broadening toward the head. However, examining archaeological examples suggests that four or six sided were more common, having a larger head than the body. At first the trenails were made over size and without any lubricant. They were found to jam whilst being driven home and did not pass all the way through the rail and into the sleeper. These had to be drilled out and trenails produced of a smaller diameter. They were also lubricated with candle wax as tallow was unavailable which made them easy to drive home with a wooden mallet while still retaining sufficient 'grip.' The stump of the trenail was then cut off using a saw and an adze. The saw left a very small nub, slightly proud of the running rail and gave the neatest finish. An adze did not leave a neat finish and left more of a stub of trenail, which was more ragged. The stubs of the trenails could then be hammered flush and were were then caulked with a single blunt chisel stroke as best representing a trenail iron (See Figures 15 - 17).

It rapidly became apparent that drilling only halfway through the sleeper, despite the assertion from Lewis that this was so, was not correct (Lewis, 1970, p.166). The rail was not held securely to the sleeper and could be easily broken off. Therefore, the decision was made to drill out the trenails, drill the holes the full depth of the sleeper and re-peg the entire structure. This made for a more solid, reliable joint. Rails pegged to sleepers with a simple butt-joint without a half lap or shoulder to sit against was found to be very weak in comparison. The shoulder provided considerable support to the rail to prevent it from moving laterally.

It became evident to the participants than there was very little skill required to build a railway in such a manner. The half lap joint is one of the basic joints and one of the earliest joints taught to trainee carpenters. Rails and sleepers would have likely been prepared in advance, in a timber yard - especially the sleepers. Trenails may have been made on the work site, but it was more usual for shipbuilding (in which Dickson was experience) to purchase them ready made. Certainly, rails would have been prepared off-site to split them from the round, dressed with adzes and finishing axes. Sleepers could have been prepared either in a timber yard or on site, but to ease the speed of construction it is likely they were prepared off site and all the materials required transported to the work site using the waggonway as it progressed. Materials had been processed and prepared off-site and the waggonway constructed from components rather like 'flat pack' furniture as a modern railway is.

Because of the problems with trenails, it took four individuals two hours to drill and lay the rails, a process which would have been considerably quicker with correctly sized and lubricated trenails, and had the holes been bored through the full thickness of the sleeper.

Ballasting

Based on what was observable, the ballast was made up from layers of rammed beach cobbles and broken stone, packed into each of the compartments formed between the rails and sleepers. There were two tipping events: large cobbles forming a base layer, with smaller cobbles as well as pieces of broken stone on top. Whilst this was interpreted as two phases of archaeology, evidence from the reconstruction work suggests this was perhaps a single event, so that the size of ballast material reduced from larger to smaller in size to create a compact finished surface. Equally, the smaller size material would work its way around the larger and help to lock it together.

It was found that each compartment required two modern wheelbarrow loads of cobbles to fill it - approximately 180 litres of material based on one barrow holding 90 litres of heaped material. Eighteenth century barrows were much smaller and therefore would have required more barrow trips. Barrowing cobbles and broken stone to the worksite the 100m or so from the Waggonway Heritage Centre where materials had been delivered also created a delay which perhaps the original waggonway builders would not have experienced due to such materials having been brought to site as needed along the waggonway as it was constructed (See Figure 18).

Above the layers of rammed cobbles and broken stone, a variety of industrial waste was used to create the horse track on which the horse walked. Archaeologically, the small coal ballast proved to be a hard, compact mass with a texture akin to modern tarmac which required archaeologists to use a pickaxe to break up.

Material for the reconstructed horse path was spoil quarried from the ditches, combined with broken up coal, coal briquettes, ashes together with clinker and slag. This material was processed on site, which slowed down the construction process as such material would have been freely available from the various industries in Cockenzie and Port Seton and transported to the work site as needed as the waggonway extended. Two 4.5kg bags of coal briquettes were purchased to create the horse track material but this proved to be insufficient, and two 10kg bags of house coal were broken up to create small coal ballast. Acquiring and then breaking up suitable material for the horse track created a considerable delay to completing the first track panel: at least 90 minutes were lost to this.

Coal briquettes, which are essentially formed from coal dust with a binding agent, broke up easily and after sieving created a material which was close in grain size and texture to the small coal ballast observable archaeologically. Broken up coal, even after sieving, produced a much coarser grain size than the briquettes or the excavated material.

Horse track material was bucketed onto the work site and tamped by foot and using large round timbers to compress the material. Wetting the horse track material helped it to 'run' into the spaces around the cobbles and broken stone beneath, and helped create a more uniform matrix of material (See Figure 19).

The quantity of material needed to create the horse track took the team by surprise, requiring upwards of 60kg of material (including quarry material) for the 6m stretch of reconstructed waggonway, which would equate to around 10 tons of material per kilometre. Given ditch digging could produce between 1.0m3 and 0.90m3 or about 1 ton of spoil per metre, upcast material alone was insufficient for the ballasting. Therefore, ballast material such as small coal, industrial waste etc would have been freely available or at minimal cost from the industries served by the waggonway in Cockenzie and Port Seton and which was of no further use either in industry or for domestic use. It was also available in large quantities, and it is likely would have been carried up the waggonway to the work site as it extended from Cockenzie to Tranent. As with the use of beach cobbles and broken waste stone, it suggested to the archaeologists that the only major cost would have been the oak timber for rails and labour.

Double Rails

Production of rails and sleepers for the double rail waggonway required more skill to cut the half-lap joints to fasten the rails and sleepers together as found archaeologically in 2021. However, the wooden railways excavated hitherto show no evidence of such complicated joinery, the rails simply being butt-jointed to the sleeper. The same timber as used for the single rail reconstruction was used for the rails, together with salvaged kiln dried 76mm x 100mm timber for the sleepers 1.50m long. All joints were cut by hand using traditional tools. A single individual - a trained joiner - was able to cut four half-lap joints in each 3m rail in two hours. They were cut with a tenon saw and chisels, with a marking gauge being used to set the depth of the joint. Each joint took approximately 30 minutes depending on the wood and the presence of any knots. Therefore, one man working alone, could cut the joints for the four rails required in eight hours. This time is rather longer than that suggested by Shirley who argues an experienced wood worker could produce such a joint in twenty minutes suggesting that the process may have been quicker historically. (Shirley, 2001, pp.71 - 72) (See Figure 20).

Cutting the corresponding half-lap joint on the sleepers took an equal amount of time, approximately twenty minutes per joint, giving a total time of 40 minutes per sleeper. Cutting half lap joints, however, is one of the most basic joints taught to any carpenter or joiner, making it a relatively slow-skill job. The trained joiner who was part of the team was able to demonstrate and teach the skill needed to produce such a joint to unskilled practitioners who were able to produce useable, if rough, joints speeding up the process. Thus, it is likely rails would have been prepared off site, at a timber yard, quite rapidly by carpenters possessing the most basic wood-working skills (See Figure 21).

Putting it all together

The rails and sleepers were rough fitted together *in situ* before for fine-tuning before final assembly. The resulting wooden frame was easily man-handled into its final position, and packing and jacking of the track, as with 'modern' railway which uses prefabricated track panels, was much easier as the whole frame could be packed and jacked to deal with any twist faults rather than trying to pack individual sleepers and rails as with the previous method of construction. It would therefore be a less labour-intensive and more precise method of railway construction.

Peg holes were drilled through the full thickness of the rail and sleeper by hand, the process taking one individual approximately 1 minute. Trenails lubricated with candle wax or lard (as best representing tallow) were driven home with a wooden mallet and pinned the frame to the ground where they passed through the sleeper. This led one of the reconstruction team to suggest that the ends may have been dipped in tar to prevent the trenails from 'wicking' moisture from the ground due to the capillary action from the orientation of the grain in the wood used to make them.

The trenails were cut off with a tenon saw, and caulked with a blunt chisel, as best representing a trenail iron. A wooden mallet was used to drive the trenails fully home so that the stump did not stand proud of the upper surface. This also flattened out the end of the trenail, improving the caulking (See Figure 22).

The frame was packed and levelled with cobbles filling each 'compartment' and was then ready to receive the upper or running rail. This was marked to take holes for the trenails which joined the upper rail to the lower. It was observed that whilst the lower level was tied together with sleepers to provide lateral strength, to stop the rails from spreading under the load of wagons running over then, and from the outward pressure of the ballast, that the upper rails would need similar cross ties to support the structure. Without sleepers the whole structure was somewhat flimsy, with nothing to constrain the upper rails and stop them spreading. Lewis demonstrates that material was often piled up against the sides of the structure or indeed it was partially buried which would help prevent the structure from spreading laterally and thus keep the rails to gauge (Lewis, 1970, p.167). However, this was not observable archaeology. Therefore, it was proposed that a second row of sleepers was needed for the upper rail, jointed and pegged in place using tree branches with joints cut on either end as suggested in the archaeology (See Figures 23 and 24).

The reconstruction team felt it most likely that all the timber components were prepared off-site. All the joints were cut and dry-fitted at a timber yard and the completed components transported in kit form to the work site where they would be needed along the waggonway as it grew in length. Furthermore, the presence of the ditches either side would have restricted the worksite, meaning there was no room to process the timber. Nor would there be the opportunity to process timber in the fields alongside the waggonway, or at least it would be more difficult due to having to carry it across the ditch. Equally, material for ballast, was transported from Salt Pans and the Glassworks at Cockenzie and Port Seton to where they were needed. Each 'frame' as each track panel came to be termed was assembled as a kit on site. Whilst perhaps awkward to carry, it could be assembled and then placed in its final position. This meant it was easier to pack and level each track panel rather than trying to pack and level individual sleepers and rails. With the 'bottom rails' of the 'double way' thus packed and levelled, it was easy to lay the 'upper rails' above as a finished panel which could be drilled and pegged to the 'bottom rails.' Thus, the likelihood is that materials were processed off-site and the waggonway constructed as a kit of parts on site, the waggonway being used to carry its own materials as it grew. Due to the need for beach cobbles, small coal and industrial waste, the likelihood is that work on the waggonway began at Cockenzie rather than Tranent so that all this material - including Dickson's timber yard and the harbour as a source of timber - were all at hand and did not have to be transported cross-country uphill to Tranent. It is likely that the first cargo carried on the waggonway were the men and materials used to build it.

Man-power requirements

In total, six individuals were able to build two 3m lengths of wooden waggonway, to two different styles, in two six-hour working days suggesting a team so sized would be able to build one kilometre of track in 28 days with a total build-period of 112 days for the four-kilometre waggonway. This was based on the workers building the waggonway from scratch rather than using components off-site; they were also working to a 6-hour day (10am to 4pm) rather than from dawn until dusk. Furthermore, it does not take into consideration Sundays where any work on the waggonway would be forbidden. Therefore, this estimation may not be accurate due to short length of working day; inexperience and lack of embodied knowledge of the reconstruction team; lack of available material for the horse track and not including full length ditches. Furthermore, the rate of construction sped up considerably thanks to 'hands on' gaining of embedded knowledge by day two. However, the inexperience of the reconstruction team, and delays due to lack of materials for creating the horse track, could account for the time required to dig the ditches.

The labour requirements to build the waggonway were not high: a team of around twenty relatively unskilled individuals divided equally between track laying and ditch digging would be able to construct 1km of wooden waggonway and its accompanying ditches in approximately one month.

Clothing and Costume

Those taking part in the reconstruction were dressed in eighteenth-century style clothing. These garments were by and large made to commercially available patterns for a 1770s date. They were machine made but one member of the team (Dawson) sewed their frock coat and cap by hand. Frock coats were worn by three members of the team, accompanied by breeches and stockings worn with either buckled shoes, shoes and gaiters, or long boots. Other members wore shirts, waistcoats, loose-fitting 'slop' trousers, and appropriate footwear. Clothing was protected by wearing linen aprons. Experiences were recorded orally and in writing at the end of each day. It became readily apparent that frock coats, stockings and shoes were not practical for manual work: the coat skirts were too long; stones and soil easily got into shoes so that gaiters were required. Likewise, although tightly fitted breeches looked smart and elegant, they were not practical for manual work, as they restricted movement, especially any involving bending and kneeling so that knee-straps and buttons were unfastened. Nor did stockings provide much protection for the legs so that gaiters, especially leather or wool with leather tops, were preferred to cover the lower leg and shoe. Long boots provided the most protection, especially when handling manual tools such as mattocks and picks but it is unlikely manual labourers in Cockenzie would have been able to afford such luxuries. It was concluded a short jacket or sleeved waistcoat, accompanied by an apron and 'slop' trousers were the most practical form of dress for manual work. Where trousers were not available, loose-fitting breeches and gaiters with leather tops were likely worn.

Tricorn hats were equally impractical and instead either broad brimmed felt hats or a linen workmen's cap were favourable in keeping the sun off the head and face, as well as keeping the head cool - the linen cap being especially successful in keeping the head cool.

The wearing of semi-authentic period costume as part of the public experimental archaeology not only drove engagement with members of the public who were drawn by the sense of spectacle, but also in terms of questions asked about what we were doing and wearing. Equally, and more important in terms of embodiment, it helped create a sense of immersion: nothing used in reconstructing the waggonway was 'modern'. All the tools - other than modern wheelbarrows and buckets - were antique dating from the nineteenth century, or like the draw-horse and saw-horse were replicas. Three of the practitioners (Dawson, Garside, Lohrenz) also ate period 'rations' included salted porridge; rye bread; cheese; salted meat and fish; and small beer the latter represented by 0.5% German Weiss-bier. The focus on traditional tools, traditional skills, and dress drove the immersive experience and the embodied experience. It helped the practitioners think in an eighteenth-century way, especially when faced with problems such as jammed trenails. It would have been easy to have used power tools to drill them out, but instead the period-appropriate means of laboriously drilling them out by hand was preferred.

Waggonway Revisited

After nine months of weathering, Dawson and Braby examined the reconstruction in May 2025. It was observed that much of horse track material had 'run' into the voids between the broken stone and cobbles making up the base of the horse track suggesting that it would have required constant tipping to maintain the surface, due to natural weathering let alone damage from horses' hoofs. Likewise the surface of the horse track was found to have been baked to a hard, tarmac-like consistency through weathering alone. There was no evidence of rot in the timbers, but one of the joints had 'blown' due to one of the rails having warped.

Summing up

This project demonstrated the value of experimental archaeology in understanding and interpreting archaeology visible in the ground. It is also the second attempt to reconstruct a wooden waggonway since the replica of Lambton D pit was built at Beamish in the 1990s. The reconstruction demonstrates that components were likely made off site and transported where they were needed. It also shows the relative lack of skill required, even by the carpenters as construction used the simplest of joints. There was nothing novel about the technology, skills or tools required to build the waggonway: any competent carpenter or wright would have the skills to build such a wooden frame, which was no different from a house frame, ship bulkhead or ladder. Constructional methods on the Tranent-Cockenzie Waggonway appear to differ from those excavated in the Northeast of England, notably the use of a corduroy of timbers to 'float' it upon and the use of sleepers to connect the 'upper rails' but both of these could be innovations due to geological situation. More archaeological work is clearly needed on the Tranent-Cockenzie waggonway and on early wooden railways in Scotland to establish a chronology and typology for these structures in Scotland.

Keywords transport
experiment

Country United Kingdom

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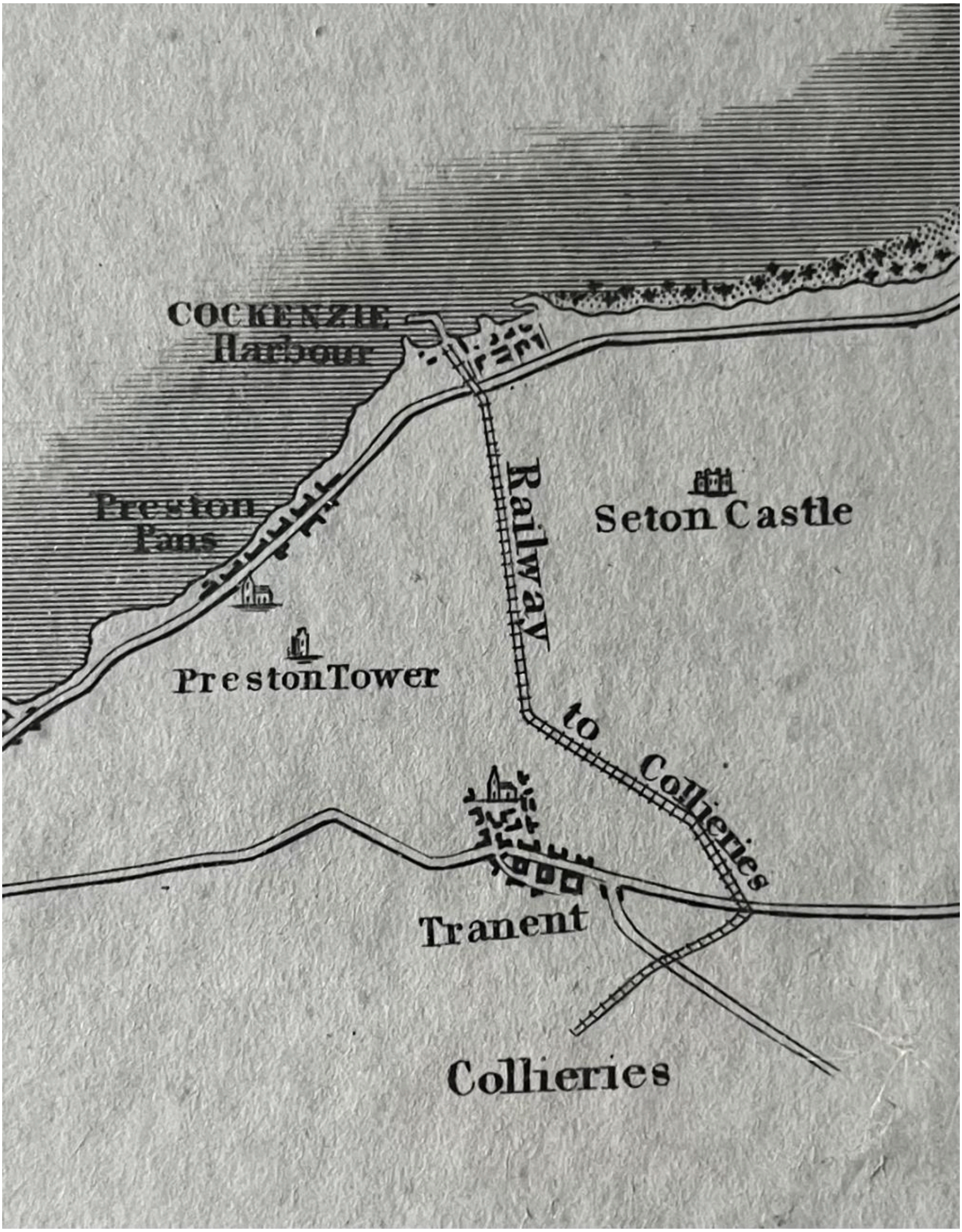

FIG 1. MAP OF THE TRANENT- COCKENZIE WAGGONWAY AS SHOWN IN A MAP OF C.1840. THE WAGGONWAY WAS BUILT ON A FALLING GRADIENT FROM PITS AT TRANENT TO SALT PANS AT COCKENZIE AND SERVED AT VARIOUS TIMES THE HARBOURS AT PORT SETON AND COCKENZIE (WIKIMEDIA COMMONS).

FIG 2. OVERVIEW OF THE 2021 EXCAVATION AT PRESTONPANS BATTLEFIELD, LOOKING NORTH. EVIDENT ARE VOIDS FROM RAILS AND SLEEPERS; THE THICKNESS OF THE SMALL COAL HORSE TRACK AS WELL AS THE LARGE ROUNDED BEACH COBBLES WHICH OVERLAY A TIMBER CORDUROY, WHICH SURVIVED AS WET AND MINERALISED WOOD. PHOTO BY ANTHONY DAWSON.

FIG 3. VIEW OF THE 2021 LOOKING SOUTH. VISIBLE AT THE NORTH END OF THE TRENCH ARE MINERALISED WOOD RAILS AND SLEEPERS SET WITHIN THE COBBLE AND BROKEN STONE BALLAST OF THE HORSE TRACK. ON THE E SIDE PRESERVATION INCLUDED A HALF-LAP JOIN BETWEEN SLEEPER AND RAIL. PHOTO BY ANTHONY DAWSON.

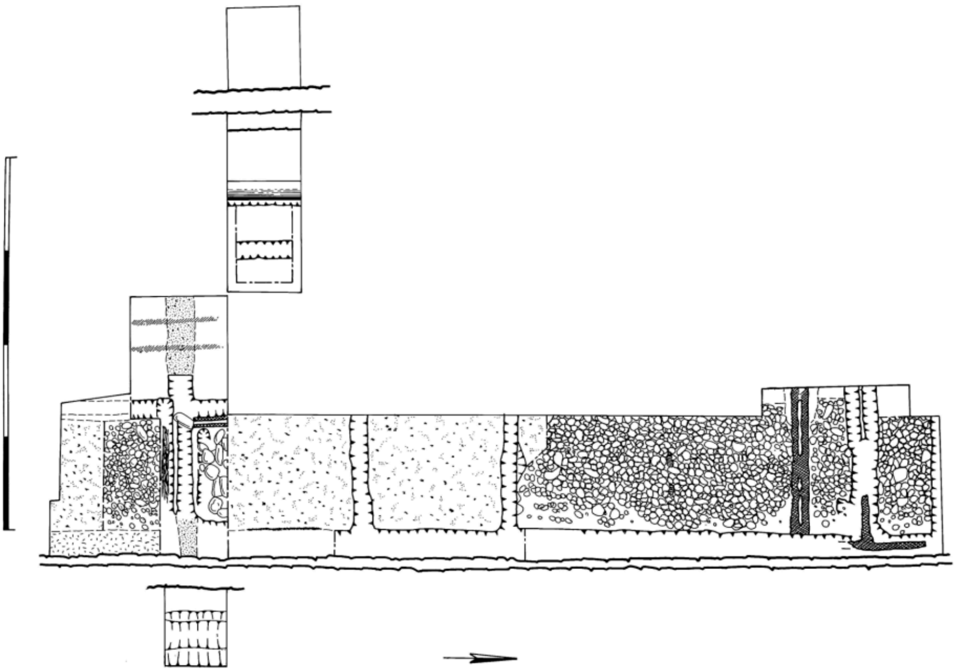

FIG 4. COMPOSITE PLAN OF THE 2017 AND 2021 EXCAVATIONS. THE FULL WIDTH OF THE TRACK WAS RECOVERED, TOGETHER WITH A TENTATIVE SECOND PAIR OR RAILS RUNNING PARALLEL TO THE WEST, SUGGESTING THE POSSIBILITY OF A PASSING LOOP. PHOTO BY ALAN BRABY.

FIG 5. CONSTRUCTION OF THE REPLICA WOODEN WAGGONWAY AT BEAMISH WHICH USED A MIXTURE OF MODERN MATERIALS (SUCH AS SLEEPERS AND PRE-SAWN OAK TIMBER) BUT ALSO TRADITIONAL METHODS SUCH AS DRILLING TRENAIL HOLES BY HAND. PHOTO BY PAUL JARMAN, BEAMISH MUSEUM.

FIG 6. THE BEAMISH REPLICA WAS BALLASTED BY MACHINE. IN ORDER TO RESPECT THE LANDOWNERS WISHES NO DITCHES WERE DUG BUT IT WAS SECURELY FENCED OFF. PHOTO BY PAUL JARMAN, BEAMISH MUSEUM.

FIG 7. THE RELATIVELY POOR INTERFACE BETWEEN A CONED, CAST-IRON WHEEL ON THE REPLICA ‘CHALDRON’ TYPE WAGGON AND THE WOODEN RAIL. THE WHEEL IS TRYING TO CRUSH THE WOOD TO MIRROR THE SHAPE OF ITS TREAD. PHOTO BY PAUL JARMAN, BEAMISH MUSEUM.

FIG 8. THE WHEEL AND IN PARTICULARLY THE FLANGE OF THE IRON WHEELS DAMAGED THE INSIDE FACE OF THE RAILS. THE RAILS WERE CRUSHED BY THE WEIGHT AND SHAPE OF THE WHEELS, AND THE FLANGE RUBBING AGAINST THE INSIDE FACE OF THE RAIL CAUSE CONSIDERABLE DAMAGE. THIS SUGGESTS LATER 18TH CENTURY WROUGHT-IRON STRIPS ON TOP OF THE RAIL WERE PERHAPS EITHER IN THE WRONG PLACE, OR REINFORCED THE EDGE, RAISING THE WHEEL SUFFICIENTLY SO THAT THE CONED TREAD RAN MORE HAPPILY ON THE STRIP OF IRON AND ALSO RAISED THE FLANGE SO THAT IT DIDN’T DAMAGE THE INSIDE OF THE RAIL. PHOTO BY PAUL JARMAN, BEAMISH MUSEUM.

FIG 9. CUTTING ROUND WIND-FALL SLEEPERS TO LENGTH. SLEEPERS WERE CUT TO ONE AND A HALF TIMES THE GAUGE. PHOTO BY ANTHONY DAWSON.

FIG 10. SLEEPER CUT TO LENGTH, BEFORE FURTHER PROCESSING TO CREATE A SHOULDER AND REBATE TO TAKE THE RAIL. PHOTO BY ANTHONY DAWSON.

FIG 11. CUTTING SHOULDERS AND REBATES ON THE SLEEPER WAS BY SAW TO MARK OUT THE SHOULDER, AND THEN USING HAND AXES AND A BOX PLAIN TO CREATE A LEVEL SURFACE ONTO WHICH THE RAIL WOULD SIT. PHOTO BY ANTHONY DAWSON.

FIG 12. COMPLETED SLEEPER, DEMONSTRATING THE MINIMUM AMOUNT OF PROCESSING REQUIRED TO PREPARE ONE. IN TOTAL ONE INDIVIDUAL TOOK 60 MINUTES TO PRODUCE A SINGLE SLEEPER. PHOTO BY ANTHONY DAWSON.

FIG 13. ROUND TIMBER SLEEPER HALF BURIED AND LEVELLED IN THE EARTH WITH FOUR MACHINE-FINISHED SLEEPERS ROUGHLY IN SITU. PHOTO BY ANTHONY DAWSON.

FIG 14. SLEEPERS AND RAILS IN SITU, PRIOR TO DRILLING OF HOLES FOR TRENAILS AND BALLASTING. BUILDING SUCH A RAILWAY REQUIRED THE MINIMAL AMOUNT OF TOOLS OR SKILLS. PHOTO BY ANTHONY DAWSON.

FIG 15. DRILLING HOLES FOR TRENAILS BY HAND THROUGH THE RAIL AND THE FULL THICKNESS OF THE SLEEPER. THIS PROCESS TOOK APPROXIMATELY 1MINUTE USING A CARPENTER'S BRACE. PHOTO BY ANTHONY DAWSON.

FIG 16. TRENAILS WERE TRIMMED USING A SAW (HERE) AND ADZE. THE SAW LEFT THE NEATEST RESULT AND CREATED THE LEAST AMOUNT OF WASTE. IT ALSO LEFT A TELL-TALE SAW MARK AS A RESULT OF THE SAWING PROCESS. PHOTO BY ANTHONY DAWSON.

FIG 17. THE SECOND METHOD TO TRIM THE TRENAILS WAS USING AN ADZE. THIS LEFT MORE OF A STUMP; WAS LESS NEAT THAN A SAW; AND CREATED MORE WASTE MATERIAL. PHOTO BY ANTHONY DAWSON.

FIG 18. EACH 'COMPARTMENT' FORMED BY THE RAIL AND SLEEPER REQUIRED TWO MODERN BARROW LOADS OR APPROXIMATELY 180LITRES OF COBBLES AND BROKEN STONE TO FILL IT. THIS WAS THEN RAMMED AND PACKED WITH SPOIL TO CREATE A SOLID FOUNDATION. PHOTO BY ANTHONY DAWSON.

FIG 19. SMALL COAL, ASHES, CLINKER AND SPOIL FROM THE DITCHES WAS USED TO CREATE THE WALKING SURFACE OF THE HORSE TRACK. THIS WAS TRAMPLED UNDER FOOT AND RAMMED USING TIMBER POSTS TO MAKE THE FINAL SURFACE. PHOTO BY ANTHONY DAWSON.

FIG 20. CUTTING HALF LAP JOINTS IN THE RAILS BY HAND. EACH JOINT TOOK ONE INDIVIDUAL 30 MINUTES TO CUT, A MORE EXPERIENCED JOINER MAY HAVE TAKEN LESS TIME. IT IS LIKELY RAILS WERE PREPARED OFF-SITE. PHOTO BY ANTHONY DAWSON.

FIG 21. CUTTING JOINTS IN THE SLEEPERS. IT TOOK ONE INDIVIDUAL 40 MINUTES TO PRODUCE ONE SLEEPER WORKING ON THEIR OWN USING HAND TOOLS. AS WITH RAILS, IT IS LIKELY THEY WERE PREPARED OFF-SITE. PHOTO BY ANTHONY DAWSON.

FIG 22. THE LOWER SET OF RAILS SECURED IN POSITION WITH TRENAILS. THE MORE ROBUST CONSTRUCTION COMPARED TO THE SINGLE-PHASE WHERE RAILS WERE SIMPLY MATED ONTO ROUGHLY PREPARED SLEEPERS IS EVIDENT. AGAIN, HOWEVER, THE SKILL REQUIRED TO PRODUCE SUCH A WAGGONWAY WAS RELATIVELY LOW. PHOTO BY ANTHONY DAWSON.

FIG 23. THE UPPER OR RUNNING RAILS SECURED IN POSITION, AND BALLASTED WITH BROKEN STONE AND COBBLES. ALSO EVIDENT ARE THE INTERMEDIATE SLEEPERS SUGGESTED BY THE ARCHAEOLOGY. PHOTO BY ANTHONY DAWSON.

FIG 24. THE COMPLETED RECONSTRUCTION SHOWING THE TIMBER RAILS STANDING PROUD OF THE RAMMED EARTH FOOT WAY EITHER SIDE, AND THE SMALL COAL HORSE TRACK. THE PERHAPS EPHEMERAL NATURE OF THE STRUCTURE SHOULD BE NOTED COMPARED TO THE EARTH WORK FEATURES OF THE DITCH. PHOTO BY ANTHONY DAWSON.

FIG 25. MEMBERS OF THE RECONSTRUCTION TEAM WITH A REPLICA WAGGON PLACED ON THE TRACK. THE WAGGON WAS RUN BACKWARDS AND FORWARDS SEVERAL TIMES AND PERFORMED WELL: THE WHEELS HAVING FLAT TREADS HAD AN IMPROVED RELATIONSHIP WITH THE WOODEN RAIL THAN THE IRON WHEELS AT BEAMISH. PHOTO BY ANTHONY DAWSON.