[Extracted from a mss book of unknown origin but contemporary to the period, purchased at an auction in Carlisle in 2002; this copy made by Russell Wear, September 2004; minor revisions October 2004. The book contains other items relating mainly to Scotland and has a label on the cover of Anderson & Co (successors to Cameron & Co), stationers, 2 Bank St, Edinburgh. The paper is watermarked 1825. Original spelling, abbreviations and layout retained as far as possible. Where two fractions occur together the second one is a fraction of a farthing. The name M Stewart, 17 Keir St, Laurieston, a district of Glasgow, has at some time been written in the front of the book]

Observations on Railways with the most Eligible Motive Power for Carriages travelling thereon humbly addressed to the Committee for enquiring as to a better communication between Newcastle and Carlisle by their most obediently Humble Servant George Dodds. [Dated] Hetton Colliery, Decr 1824

Gentlemen

Having had the charge of the Hetton Colliery Railway for the last two years, and during that time made several observations, and experiments on the advantages and disadvantages in the construction of that Railway, with the cost of leading the coals by various kinds of Machinery etc shall in the following pages give a general outline of that concern with remarks on other Railways which have been used in the Coal trade upon the Rivers Tyne and Wear since 1819 intended with a view to obtain a more accurate knowledge of the outfit and expences of the intended Railway between Newcastle and Carlisle.

Line of Railway from the Hetton Pits to the Staiths near Sunderland

Stations		No of yards	Descent p yard	Ascent p yard	Whole Descent	Whole Ascent
1	From the Pits to Rough Dean	2541	1/6 of an inch	-	35ft 4in	-
2	From Rough Dean to Byre Engine	882½	-	2 1/8 in	-	151ft 0in
3	From Byre Engine to Meetings	775½	-	7/16 in	-	30ft 0in
4	Mill Engine Bank	775½	-	2 1/8 in	-	115ft 0in
5	1st Incline Plane	1302	1 3/16 inch	-	130ft 4in	-
6	2nd Ditto Do	1224	1 ¼ inch	-	129ft 6in	-
7	3rd Do Do	716	0 15/16 inch	-	54ft 7in	-
8	4th Do Do	902	1 inch	-	76ft 5in	-
9	From 4th incline to top of 5 incline	4350	5/16 inch	-	63ft 5in	-
10	5 Incline to Staith	325	2½ inch	-	67ft 9in	-
Total		13793½	-	-	557ft 4in	296ft 0in

Explanation of the preceeding table

Station 1st – When it is said the distance from the Pit to Rough Dean is 2541 yards, at 1/6 of an inch descent to the yard; it is not intended to be understood that the whole distance is one continued plane, but that the average descent is 1/6 of an inch to the yard and whole descent 35 feet 4 inches.

Station 2nd - From Rough Dean to Byre Engine 882½ yards at 2 1/8 inches ascent p yard. It is intended to be understood that allowance for the Bank head etc is included in the distance, but not in the ascent p yard, the whole ascent being 151 feet.

Station 3rd – From Byre Engine to Meetings 775½ yards at an ascent of 7/16 of an inch to the yard. The waggons are taken up this ascent by means of a tail rope attached to the wagons ascending the Mill Engine Bank, allowance for Bank head etc is included in the distance but not in the ascent p yard.

Station 4th - Mill Engine Bank 775½ yards at an ascent of 2 1/8 inches p yard, allowance for Bank head etc is included in this distance but not in the ascent p yard. Station third and fourth being equal distances, the Mill engine brings a train of wagons up the lesser ascent in the same time that another train is ascending the Mill Engine Bank. Both Bank head & foot are included in this distance all the rest of the way ascends @ 2 1/8 inches p yard whole ascent 115 feet, and the whole ascent at 7/16 inches p yard 30 feet.

Station 5th – First inclined plane self acting 1302 yards long. Decent 1 3/16 inches p yard. The Bank head & foot are included in the distance but not in the descent p yard and the whole descent being 130 feet 4 inches.

Station 6th – Second inclined plane self acting 1224 yards long, descent 1¼ inches p yard, Bank head & foot included in the distance but not in the descent, the whole descent being 129 feet 6 inches.

Station 7th – Third inclined plane self acting 716 yards long descent 15/16 of an inch to the yard, Bank head & foot included in the distance but not in the descent p yard, the whole descent being 54 feet 7 inches.

Station 8th - Fourth inclined plane self acting 902 yards long descent one inch p yard, Bank head etc included in the distance but not in the descent p yard, the whole descent being 76 feet 5 inches.

Note – Self acting planes can only be used where the preponderancy of weight is always in the same direction, and with such declivities, as will nearly equalize the resistance of the empty & loaded waggons, but in Railways where no material difference of weight of carriage is to be expected either way, they could not be used with any advantage.

Station 9th – From 4th inclined foot to the top of 5 incline 4350, the whole descent which is 63 feet 5 inches is contained in 2602 yards, the other 1748 being nearly level.

Station 10th – Fifth Inclined Plane; this is a Horizontal Wheel 14 feet diameter with a grove [sic] for the rope to run in, and a Brake wheel attached to it, the distance is 325 yards, and descends 2½ inches p yard. Bank head and foot included in the distance but not in the descent p yard – the whole descent being 67 feet 9 inches.

The whole length of the way then is 13793½ yards or a little more than 7¾ miles with a rise and fall of 853 feet 4 inches viz from Rough Dean to Mill Engine an ascent of 296 feet and from Mill Engine to Staith 557 feet 4 inches descent.

Weight and Price of one Rope for each Plane viz two Engines and five Inclined Planes – tail rope etc

	Length of rope (fath)	Size of ditto (in)	Weight of ditto Cwt qrs lbs	Price p p cwt	£ s d
Byre Engine	500	7¼	62-0-0	@ 50/-	155 0 0
Mill Engine	450	7¼	56-0-0	@ 50/-	140 0 0
Tail Rope	400	5	26-0-0	@ 50/-	65 0 0
1st Incline	650	5	42-0-0	@ 50/-	105 0 0
2nd ditto	650	5	42-0-0	@ 50/-	105 0 0
3rd ditto	400	4	15-0-0	@ 50/-	37 10 0
4th do	500	5	32-2-0	@ 50/-	81 5 0
5th ditto	190	7¼	24-0-0	@ 50/-	60 0 0
					748 15 0

Note – Oweing to the great weight of 8 loaded waggons coming up the Bank at one time, where the fixed engines are placed the thickness of the rope and smallness of the drums (7 feet diameter) the rope having to traverse 4 times over itself is greatly injured.

An account of the Wear of Ropes on each Plane with the cost p Chaldron from 18 Novr 1822 to 26 Septr 1824

Byre Engine Plane	Length of Time Weeks Days		Quantity Chaldrons	Cost p chaldron d
First rope laid on Byre Engine bank Novr 18th 1822 and taken off 12 April 1823	20	5	11,702	@3¼ nearly
Second rope taken off 19 Janry 1824	39	0	44,242	@ 1d nearly
Third rope taken of 4 June 1824	20	6	22,047	@ 1¾ nearly
Fourth rope taken of 26 Sept 1824	16	2	25,247	@ 1½ nearly
	96	6	103,238	

These four ropes in ninety six weeks & six days took up the Bank one hundred & three thousand two hundred & thirty eight chaldrons & cost £622 which on an average is 1¼ 4/5 p chaldron nearly for ropes.

Mill Engine Tail Ropes to Meetings	Length of Time Weeks Days		Remarks
Byre Engine First tail rope on Novr 18th [1822] & taken of 27 Decr 1823	57	4	This rope 400 fathoms 5 inch rope cost £65
The second taken of 28 Septr 1824	39	3	This rope 875 fathoms 5 inch rope cost £145
The first tail rope at Mill Engine was laid on 18 Nov 1822 and taken of 25 July 1823	35	4	This rope 875 fathoms 5 inch rope cost £145

These three ropes cost £355 and led 98,475 chaldrons 775½ yards up an ascent of 7/16 inch to the yard, there being 1160 left at a land sale near Byre Engine, 873 for the use of the engine and 1853 chaldrons of small etc laid on the way near Byre Engine, making 4763 to be deducted from the quantity led by the Byre Engine Rope, cost ¾ 5/9 p chaldron nearly for ropes.

Mill Engine Bank Rope	Length of Time Weeks Days		Quantity of Chaldrons	Price of chalds d
First rope laid on 18 Nov 1822 & taken of 26 April 1823	22	5	11,020	@ 3 p ch a little more
The second rope taken of 24 April 1824	51	6	52,741	½ ½ nearly one half penny ½ farthing
The third rope taken of 25 Sept 1824	22	1	34,714	1 penny a little less nearly

These three ropes led 98,475 chaldrons 775½ yards up an ascent of 2 1/8 inches p yard and cost £420, which is a little above one penny p chaldron for ropes.

1st Incline Rope	Length of Time Weeks Days		Quantity of Chaldrons	Cost p chaldron d
The first laid on 18 Nov[1822] and taken of 24 July 1823	35	3	24,205	1d p chaldron nearly
Second rope taken of 21 June 1824	47	5	56,824	¼ 4/5 p ch nearly
Third rope to 26 Sept may be considered as one third worn being on as yet	13	5	16,573	½ p chal nearly

These three ropes have led 97,602 chaldrons 1302 yards, and cost £245 which is nearly ½ 1/3 p chaldron. The other 873 chaldrons were used by the Mill Engine etc. Note – One third the value of the rope £35.

2nd Incline Rope	Length of Time Weeks Days	Quantity Chaldrons	Cost p chaldron d

First rope laid 18 Nov 1822 & taken of 10 Jany 1824	59	4	52,190	½ p chald a little less
Sept 26 The 2nd rope nearly worn out	37	2	44,912	½ p chald a little less

These two ropes have run 97,102 chaldrons 1224 yards and cost £190 which is considerably below one halfpenny p chaldron, but being so often repaired with pieces of new rope may fairly be reckoned one halfpenny p chaldron allowing £85 for the second rope. 500 chaldrons of small coals were put upon the battery of the 1st incline consequently were not run by this rope. The length of this incline 1224 yards.

3rd Incline Rope	Length of Time Weeks Days	Quantity of Chaldrons	Cost p chald d
First rope laid on 18 Novr 1822 and taken of 9 Octr 1824	96 6	96,652	7/9 of a farthing nearly

Owing to this rope being repeatedly repaired with pieces of new rope, and 350 fathoms of it twice laid the whole cost was very near £80 for 96652 chaldrons which is considerable below on[e] farthing p chaldron for this rope. The length of the plane 716 yards. 450 chaldrons were put upon the 2nd Incline Battery and were not run by this rope.

Each of these three Inclined Planes have a very strong turn in them, which is a great disadvantage.

4th Incline Rope	Length of Time Weeks Days	Quantity of Chaldrons	Cost p chaldron d
First rope laid on 22 Novr 1822 & taken of 29 July 1824	88 3	87,390	7/8 of a farthing nearly
Second rope may be said to be one tenth worn out	8 3	8,938	¼ nearly a little less

These two ropes have run 96328 chaldrons and cost £90, which is 7/8 of a farthing p chaldron. 324 chaldrons were put upon the Battery of the 3rd incline, consequently were not run by this rope. The length of the plane 902 yards. The one tenth of the rope valued at nine pounds nearly.

This plane being remarkably straight has cost considerably less trouble and expence in various ways than any of the others. 161 chaldrons were put into the way on this incline.

Between this incline foot and the staith there were 3000 chaldrons of small put upon different Batteries & into the way.

5th Incline Rope	Length of Time Weeks Days	Quantity of Chaldrons	Cost p chald d
First rope laid on 18 Nov 1822 &	38 5	26,702	½ 1/6 nearly

taken of 16 Augt 1823				
Second rope taken of 27 March 1824	32	0	29,726	rather less than ½
Third rope taken of 7 July 1824	14	4	20,789	½ 4/5 nearly
Fourth rope may be said to be one half worn haveing been on	11	4	14,944	½ nearly

These 4 ropes have run 92,161 chaldrons and cost £210, which is ½ 1/4 p chaldron nearly.

This incline (5th) has a brake wheel & having a turn to pass round which is nearly a semicircle is very much abused. If the inclines were straight and a rider on each set of waggons the ropes would wear more than twice the time. The other 1167 [chaldrons] went to two land sales, staiths & were not run by this rope.

Cost p chaldron on each station for labourage, keep of engines etc from 18 Novr 1822 to 26 Septr 1824

1st station from Pits to Rough Dean	£ s d
One Locomotive Engine 54 weeks at £5 7 p week	288 18 -
Two ditto " 43 " £10 14 "	460 2 -
	£749 - -

during which time they have led 109,279 chaldrons at the rate of one penny three farthing & 4/5 of a farthing nearly p chaldron, the distance being 2541 yards at a descent of 1/6 of an inch p yard which is nearly ¼ 1/5 p ton p mile including the weight of the waggon – the empty waggon being 3472 pounds, the loaden waggon 9408 pounds allowing 53 cwt for coals.

From an average of 6 months ending 30 June 1823 each Locomotion Engine cost p week as follows viz

	£ s d
One engineman p week	1 1 6
One fireman "	13 -
Wheels "	17 6
Grates & Repairs "	7 6
Grease, oil, tallow , spun yarn etc	7 6
Coals for fire 2 chaldrons second best @ 20/-	2 - -
	£5 7 0

2nd station from Rough Dean to Byre Engine	£ s d
From the same average of 6 months the Byre engine cost as follows viz	
2 enginemen at 21/- p week	2 2 -
1 boy @ 7/6 "	7 6
Grease, oil, tallow, hemp, spun yarn etc	1 8 6
9 chaldrons of nutt coals @ 10/- p chaldron	4 10 -
Repairs, fire barrs etc	1 5 -
	9 13 -
One rider going up and down with the waggons 18/- p week	18 -

One man Bank top @14/- "	14	-
A Boy at meetings to ring the Bell owing to a great turn in the bank	5	-
Grease for Rollers	5	-
A man at the Bank foot	12	-
Cost p week	**£12 7**	**-**

97 weeks at £12-7 p week   1197 19

Cost for Ropes   622 -

£1819 19 –

103,238 chaldrons were led up this bank 882½ yards at an ascent of 2 1/8 inches p yard for the above sum which is 4d ¼ p chaldron nearly or 2d p ton p mile.

There was laid on the way from the Pits to the Staith during this time 12,202 chaldrons of small coal – 6041 of these chaldrons went to raise the Rough Dean Battery 4 feet and the rest of the Way towards the Pit in order to equalize the Way for the Locomotive Engines, consequently were not drawn by the Byre Engine rope.

3rd station from Byre to Mill Engine including both banks	£ s d		
From the same average of 6 months the Mill engine cost as follows viz			
2 enginemen at 21/- p week	2	2	-
a boy @ 7/6 "		7	6
Grease, oil, tallow, hemp, spun yarn etc	2	4	-
10 chaldrons of nutt coals @ 10/- p chaldron	5	-	-
Repairs etc, fire bar's	1	5	-
	10	**18**	**6**
2 riders @ 18/- p week	1	16	-
2 labourers at Bank top & meetings @ 14/-	1	8	-
A Boy 7/6		7	6
Another boy greasing rollers & grease		10	-
Cost p week	**£15**	**-**	**-**

& 97 weeks at £15 p week   1455 - -

Cost for ropes during the above time   775 - -

£2230 - -

The Mill Engine has taken 98,475 chaldrons 1551 yards, the one half of which is an ascent of 7/16 of an inch to the yard, the other half an ascent of 2 1/8 inches p yard and cost the above sum which is rather above 5¼ p chaldron or 1¼ 2/5 p ton p mile – The weight of both waggons and coals are included. Note – There being no permanent springs it has been found exceedingly expensive to keep these two engines with a sufficient supply of water through the Summers and what with leading water, making Reservoirs, open cast drifts etc have cost upwards of two thousand pounds the last two years, and indeed wherever Engines are fixed on the tops of hills there will be considerable difficulty and expence in procuring a permanent supply of water for the engine. Even an engine of the high pressure kind will use more water than a Condensing Engine were it not for the waste of slab water etc. In a Condensing Engine the steam is converted to water again in the condenser, while the high

pressure engine by exhausting into the chimney or open air [the steam] is entirely lost.

1st Incline Plane to second Station 4th	£ s d
2 riders, one with the loaden the other with the empty waggons @ 18/- p week each	1 16 -
A boy at the Bank top	7 6
Cost p week	£2 3 6

& 97 weeks at £2.3.6 p week   210 19 6
97602 chaldrons cost the above ropes   245 - -
     £455 19 6

This inclined plane has run the above quantity for the above sum 1302 yards down an ascent of 1 3/16 inches p yard and cost about 1¼ 2/5 p chaldron or ¼ 2/5 p ton   p mile.

2nd Inclined Plane to third Station 5th	£ s d
2 riders same as the other each 18/- p week	1 16 -
A boy at Meetings owing to a turn in the way	6 -
Cost p week	£2 2 -

& 97 weeks at £2.2.- p week   203 14 -
Ropes during the above time   190 - -
     £393 14 -

This inclined plane has run 97,102 chaldrons and cost £393 14/- for 1224 yards at a descent of 1¼ inches p yard which is about ¾ 8/9 p chaldron or about ¼ 1/3 p ton p mile.

3rd Incline Plane to fourth Station 6th	£ s d
2 riders same as the other each 18/- p week	1 16 -
A boy to grease rollers etc with grease	10 -
Cost p week	£2 6 -

& 97 weeks at £2.6.- p week   223 2 -
Ropes during the above time   80 - -
     £303 2 -

This inclined plane has run 96,652 chaldrons 716 yards at a descent of 15/16 of an inch to the yard and cost £303 2/- which is about ¾ p chaldron or about ½ p ton p mile.

4th Incline Plane to the Locomotive Engines Station 7th	£ s d
2 riders same as before each @ 18/- p week	1 16 -

& 97 weeks at £1.16.- p week	179	12	-
Ropes during the above time	90	-	-
	£269	12	-

This inclined plane has run 96,328 chaldrons and cost £269 12/- the length of the plane 902 yards at a descent of 1 inch to the yard and cost about ½ 2/3 p chaldron or nearly ¼ ¼ p ton p mile.

From 4th Incline foot to top of 5th Incline Station 8th	£ s d
Two Locomotive Engines 54 weeks @ £5 7 each	577 16 -
Three Engines do 43 " @ do	690 3 -
One man pumping & warming water for the engines 60 weeks @ 12/- p week	36 -
Whole cost	£1303 19 -

These engines have led 96,328 chaldrons 4350 yards and cost the above sum which is about 3¼ p chaldron or nearly ¼ ¼ p ton p mile. 3000 of these were small laid on the Batteries and on the way and would have been less trouble had the[y] gone the whole distance. The whole descent in the above distance being 63 feet 5 inches.

5th Incline to the Staith Station 9th	£ s d
Two men at the Bank head each 18/- p week	1 16 -
Another @ 12/- p week	12 -
	£2 8 -

& 97 weeks at £2.8.- p week	232	16	-
Cost of ropes during the above time	210	-	-
	£442	16	-

This inclined plane has run 92,161 chaldrons 325 yards at a descent of 2½ inches p yard and cost £442 16/- which is considerably above 2 1/3 p ton p mile.

The distance the coals are conveyed by Machinery with ropes on the Hetton Colliery Waggonway is 6902 yards or nearly four miles and has cost in 97 weeks £2212 – for ropes alone £1185 16 – p annum.

Ropes lying on railways are exposed to be cut by malicious or mischievous persons, we have had several instances of this kind on the Hetton Railway and several accidents by ropes breaking with a train of loaded waggons on the ascending planes which causes great breakage of wheels & rails which are very expensive and it is more than probable some of these accidents happened from the same quarter as ropes may be very seriously injured by malcious persons without being detected in such a manner as to bring them to justice.

Expence of keeping Waggonway

The whole length of Waggonway from the Pits to Staith, including branches at Pits, different sidings, Bank tops, third rails for Inclines, Land Sales, and different branches at Staiths is 13 miles nearly of single way.

On this way there are 6 men at 20/- p week each   £312 – p annum
One Superintendant @ 25/-   65   "
Breakage of rails p annum not including accidents   120   "
                                                  £497   "

which is nearly £38 p mile p annum for single way.

Had the whole line of way been on such levels that Locomotive Engines might have gone whole distance 4 men without any Superintendant would have kept the way, which would have been a saving of £13 p mile p annum and on such a railway as between Newcastle and Carlisle £832 p annum. Were horses employed on the whole line it would take at least double the expence in creasing [?] and ballast to keep the same way.

Expence p mile for laying Railways sufficient to bear Locomotive Engines

The Rail and Chair on the Hetton Colliery Railway as cast by Losh & Co weighs 73libs @ 9/6 p cwt and lays three feet nine inches in length. There will then be in one mile of single way 2816 rails and chairs which at the above price cost
                                                      £871.16.6

2816 blocks of wood or stone for the way to rest upon at 6d each   70 8. -

Laying the way, filling up covering, including gates, styles, fences, quicks
etc at 1/- p yard   88 - -
                                                  £1030.4.6

There is at present a very great advance on iron of all descriptions, the above was the price of the Hetton rails & if I am not mistaken the[y] had to be kept good for three years.

Outfit expence of different kinds of Machinery on the Way

5 Locomotive Engines Each £500 complete	£2500
2 Sixty Horse Engines Reciprocating or fixed engines at £3000 each	6000
5 inclined planes, including walls, arches, framing, wheels, pullies etc	1000
Ropes, one for each engine & incline	748
Sheaves, rollers etc on the engine & incline Banks	813
	£11061

Were the whole intended line of Railway between Newcastle and Carlisle varied from the dead level to a rise or fall of one fourth of an inch to the yard, according to the different situations of the ground through which it might pass, 16 Locomotive

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Engines would be able to lead 500 tons p day the whole distance if required and the outfit expence of Machinery for 64½ miles would be the small sum of £8000. A sum £3061 less than the Hetton Railway which is only 7¾ miles.

If the precise line were determined upon and the levels taken and the expence found to be such as not to warrant the whole line to be brought to a rise or fall not exceeding 5/16 of an inch, cog rails might be laid on greater ascents where absolutely necessary with very little more expence, and the Locomotive Engines have a cog wheel so placed as to suit these rails, and need only be used on such ascents.

One great reason why the Locomotive Engines, and the cog rail were laid aside at Coxlodge Colliery, they were not so well understood as at present, and owing to some explosions which took place about that time either by neglect or want of judgement particularly one at Newbottle Colliery on the Wear where several persons lost their lives & several more badly wounded a general panic pervaded the public mind which has hardly yet subsided although the dangerous effects from the bursting of their boilers is much lessened by being at present generally made of the best malleable iron plates, and sufficiently strong to bear at least 5 times the pressure the are loaded at, and experience has proved that they have gone several years at Killingworth Colliery on the Tyne and led the coals without any interruption and the[y] have likewise led all the coals at Hetton Colliery on the Wear for 2 years, a distance of 4 miles without the loss of a single day, and this proves that by proper management there is little fear of explosions.

The only disadvantage to Locomotive Engines is the density of the materials of which are composed, and having to convey the cause of motion itself as well as the carriages on which they have to operate.

Fifty strokes p minute being a sufficient speed for the engine pistons to travel, by increasing the size of the wheels from three to four feet would increase their speed upon the way from upwards of five to upwards of seven miles p hour without the speed of the engines pistons being altered by it, which undoubtedly would be one great improvement - at the same time it is certain that other improvements might be made which would increase the power of the engines far beyond the power lost by increasing the size of the wheels as there will be the same friction for five miles by the three feet wheel that their is for seven miles by the four feet wheel, the rubbing surfaces being the same in both cases.

Dimensions and Powers of some other Engine Planes, which have been at use on Railways since 1819 or are now at use in the Coal Trade on the Rivers Tyne & Wear

Three Tons Engine Plane, 30 horse power cost erecting £1500, length 364 yards, ascent 65 feet 6 inches 2 15/100 inches p yard, drew 4 full chaldron waggons and 4 empty running immediately down at the same time, at the rate of 125 feet p minute or about 1½ miles p hour.

Black Fell Engine Plane, 36 horse power, length 1111 yards ascent 216 feet 6 inches 2 34/100 inches p yard drawing 15 full waggons at the rate of 230 feet p minute or a little above 2½ miles p hour. [Black Fell Engine on Ouston Waggonway]

Ayton Bank Engine Plane, 25 horse power, length 323 yards and ascent 113 feet 6 inches = 4 21/100 inches p yard, drawing 4 full waggons at the rate of 184 feet p minute, a little above 2 miles p hour. [Ayton Bank Engine on Ouston Waggonway]

Kenton New Engine Plane, 26 horse power, length 403 yards, ascent 141 feet 4 inches = 4 2/5 inches p yard and draws 4 full chaldron waggons at the rate of about 5 miles p hour.

All engines of this kind are pretty much the same in point of work and attendance on the Planes, including engineman, keep of the engine, such as coals, grease, oil, hemp, ropes etc and every other particular are generally above one penny p ton p mile, without reckoning interest for outfit expence in the engine, rollers, sheaves etc upon the way. From an account which I have of one of the above planes it cost 1¼d p ton p mile.

On the Powers of Horses as applicable to Carriages on Railways

The Hetton Chaldron Waggon when empty weighs 3472 pounds & from experiments made takes 134 pounds to move her forward on the dead level.

The loaded chaldron waggon weighs 9408 pounds & takes 55.2 pounds to move her forward on the dead level.

A table, showing the power required to move an empty waggon forward on a cast iron railway on the dead level and up different acclivities from a quarter on an inch rise in the yard to 2¼ inches. And likewise a table showing the power required to move a loaded chaldron waggon along a cast iron railway on the dead level, and up different acclivities from a quarter of an inch to the yard to 2¼ inches p yard.

Empty chaldron waggon weighing 3472 lbs

Rise in the yard	level	Inch ¼	Inch ½	Inch ¾	Inch 1	Inch 1¼	Inch 1½	Inch 1¾	Inch 2	Inch 2¼
Power required in lbs	13.4	33.4	53.7	73.8	94.3	114.1	134.2	154.4	174.5	194.6

Loaded chaldron waggon weighing 9408 lbs

Rise in the yard	level	Inch ¼	Inch ½	Inch ¾	Inch 1	Inch 1¼	Inch 1½	Inch 1¾	Inch 2	Inch 2¼

Power required in lbs	55.2	121.4	187.6	253.9	320.1	386.3	452.6	518.8	585.4	651.3

According to Boulton & Watts method of calculating the horse power, 187½ lbs upon a shaft over a pulley at the rate of 2 miles p hour is equal to one horse power.

By assuming these as a data we find them at accord pretty near with experience.

One horse will draw 4 full chaldron waggons 53cwt each of coals on a level and will stand to it at 24 miles a day viz twelve miles with full waggons & twelve miles with empty.

One horse will also draw 6 full waggons down a descent of 1/8 on an inch to the yard * bring back the empty ones.

One horse will draw three full waggons up an ascent of 1/16 on an inch to the yard, two waggons up 3/16 of an inch and one waggon at ½ inch to the yard.

From 18 Novr 1822 to 30 Novr 1823 there was led from the Pits to Rough Dean 53,823 chaldrons of coal a distance of 1½ miles nearly.

From 18 Novr 1822 to 30 Novr 1823 is 54 weeks at six working days each week is 324 days. Then 5 horses 8 gait [journeys] each day with 4 full chaldron waggons each gait and bring back the empty ones is 24 miles each day for 324 days, steady work.

The keep of these 5 horses @ 20/- p week	£5 - -
5 drivers at 15/- p week	3 15 -
Shoeing, gears etc for each horse at 1/- p week	5 -
	£9 - -

54 weeks at £9 p week, £486 for 51,840 chaldrons. One Locomotive led 53,823 chaldrons in the above 54 weeks & cost £5.7 - p week £288.18. – Leaving a profit of £197 2. – in 54 weeks besides leading near 2000 chaldrons more.

Every impartial reader will perceive that every [dis?]advantage is thrown to the side of the horses, they are reckoned full work every day 6 days in each week for 54 weeks together, while the Engine had to take the coal as she could get them sometimes be[?] of two or three days together at one time - one instance among many that might be brot forward:

On Friday 27 June 1823 this engine led 388 chaldrons the above distance, and travelled the ground 23 times backward & forward which was upwards of 66 miles in 16 hours – it would have taken 12 horses to do the work.

The same day two of the Locomotive Engines on the lower part of the way took 336 chaldrons a distance of 4350 yards taking 16 waggons at a time each way the ascent

for the empty waggons being about 5/16 of an inch to the yard upwards a mile of the way – each engine travelled 47¼ miles in 16 hours.

From the preceeding accounts one of the Engines travelled in 54 weeks during all kinds of weather 9713½ miles with a load never less than 24¾ tons and on an average 46. The ascent with the empty waggons being 1/6 of an inch p yard and during that time cost £288.18/- including every item of charge for labour, keep of engine, repairs etc which is about 5/6 of a farthing p ton p mile including the weight of both waggons & coals.

From these views of the subject in various situations, and under various circumstances, the three different modes of conveyance of carriages on Railways viz Locomotive Engines, Fixed and Reciprocating Engines, and Horses may be fairly reckoned at the following prices p ton p mile, not including the outfit expences of any of three different modes:

Locomotive Engines	5/6 of a farthing p ton p mile		
Horses	¼ ½d	do	on the same ground
Self acting planes	¼ ¼ d	do	on suitable ground
Fixed Engine reciprocating	1½ d p ton p mile up an ascent of 2 1/8 inches p yard		

and varied in proportion to the different ascents p yard on which they may be placed.

It is then evident that whatever mode of power be applied to Carriages on a long line of Railway such as that intended between Newcastle & Carlisle, the nearer the whole line approaches to a level, the cheaper will be the conveyance of goods etc p ton p mile and that the Locomotive Engines will be least on[e] fourth cheaper than any other kind of power and less expence at the outfit.

These things being ascertained by matter of fact and experience, it now remains to be shewn whether the small outfit expence of Locomotive Engines, with the advantages gained by this leading on nearly level ways (or varied from the dead level to a rise or fall one fourth of an inch to the yard according to the variation of the ground through which it might pass) would compensate for making such a line of way, but as this cannot be ascertained til the line be surveyed and levels taken, the following remarks may throw some light on the subject.

According to Mr Chapman's report there must necessarily be 6 or 7 or perhaps more inclined planes, & where the weight of articles conveyed is not decidedly the greatest on the downward line, a steam Engine must be placed on the summit beyond which it will answer for one end of a reciprocating line. Mr Chapman it seems has studied his subject & from his perfect knowledge of the line of way is well informed on a variety of particulars relative thereto.

Seven engines then with two ropes to each engine, and sheaves, rollers etc for two Banks cannot be reckoned at less than £14,000 for these inclines alone at the outfit whatever length they may be we shall say 14½ miles, then 50 miles is still to be

provided for, either by Locomotive Engines or horses which we shall call £6000, making the whole outfit expence for the conveyance of goods etc £20000, which is £12000 more than the outfit of 16 Locomotive Engines which would be fully adequate to the work in all weathers even on their present construction and doubtless they are capable of great improvements, whether Mr Samuel Brown's gas engine should realize the effects expected from it or not.

Should the tonnage come near to what Mr Chapman thinks it may viz 500 tons p day for 300 days in the year the whole of distance 64½ miles, and the way made that Locomotive Engines might go through from Newcastle to Carlisle or from Carlisle to Newcastle the Public Company who may execute it must necessarily become carriers at a given rate which by locomotives would be one farthing p ton p mile, less expence than any other mode of conveyance which on 500 tons for 300 days over 64½ miles would be £10,078 p annum which added to £12,000 less outfit expence makes £22078 a sum which at 5d p square yard would remove upwards of one million yards of metal.

This is a most important consideration at the outset of a long line of railway.

Where engines are fixed on railways the ascent is generally from 1 to 4 or 5 inches p yard so that whenever any thing happens to the engine (which will be the case sometimes) horses are of comparatively little use owing to the rollers being set on the middle of the way and the ascent so steep that hardly any number can do much business and in these cases the whole line would be stopt until the engine was repaired, which in some instances might be a day or two as it might be a great distance from any foundry or factory where materials might be had for such repairs.

And on a Public Railway when passengers would almost constantly be going backward and forward should a rope break several lives might be lost, and considerable damage done to the baggage.

Should anything happen to a Locomotive Engine, horses might be applied immediately without loss of time as there would be no sheaves or rollers to hinder them, or the next engine that came might pull her to the nearest sideing where she might stand till repaired, and if such engine happens not be heavy loaden might take her carriages to their place of destination along with her own without employing any horses at all.

If two single railways were laid the whole distance 64½ miles, parallel to each other & six feet asunder which would give sufficient room for carriages of all descriptions to pass each other on any place of the line, these sixteen Locomotive Engines might then leave Newcastle, one every three hours night & day for Carlisle, and one leave Carlisle every three hours night & day for Newcastle, those going from Newcastle to Carlisle might take one way & those from Carlisle to Newcastle the other. There then would be no stoppage at all, but for coals & water which might be every eight or ten miles at the most convenient places, where coals & water might be had, eight of such

places on the whole line would be sufficient & not cost more than £200. The stoppage at such places need not be above 2 minutes at each place – proper sideways might be taken of where any considerable quantity of tonnage was wanted either to or from the Railway.

Where engines are placed on the summit of hills there is generally no permanent spring to supply water, in these cases large reservoirs are to be made, that besides the expence of the Engines there may be some hundreds if not thousands of pounds expended in providing a constant supply of water for 7 engines.

The changes from one kind of machinery to another, & from one machine to another is also attended with considerable expence, danger and loss of time; there would necessarily have to be men at the Bank head, Bank foot etc besides the Engineman otherwise there would very often accidents happen.

On the Hetton Railway there is 9 changes, from Locomotive Engines, to Fixed Engines, from one Fixed Engine to another, four changes from one incline to another & from inclines to Locomotives again, & from Locomotives to inclines again; through these changes it takes nearly two hours to take a train of waggons from the Pits to the Staith, and owing to these changes we have had several accidents which have cost a considerable sum of money to repair them again – had the way been for a Locomotive to have gone between Pit & Staith she would frequently have done it in half the time without such accidents happening, but this was not practicable, the fall being one half inch to the yard the whole distance. Whereas the rise and fall between Newcastle & Carlisle in 64½ miles is less than the rise and fall on Hetton Colliery Railway of 7¾ miles. Now if we suppose the 64½ miles divided into two planes, the one to have the ascent from Newcastle 1/11 of an inch to the yard, the other to descend to Carlisle at the same rate, this would be more rise & fall than there is [sic] actually is in the whole distance and this might be varied to one quarter or 5/16 of an inch according as the cutting or other circumstances might require; the cost for labour would only be about one third were the Locomotive Engines to go the whole distance.

The following is the expence for labour on the 4 miles led by Locomotive Engines on the Hetton Colliery Railway:

13 men & boys weekly wages	£11. 4.6
32 men & boys weekly wages on the other 3¾ miles	25. 3.9
	£36. 8.3
Or to shew it more clearly there is	
5 Travelling Engine men @ 21/6	£5. 7.6
5 Firemen 13/-	3 . 5.-
2 Waggonway wrights 20/-	2. - -
1 Man pumping water etc 12/-	12 -
3 houses & fireing p week 3/-	9 -
	£11.13.6
On the other 3¾ miles	
10 Incline men on the 5 inclines @ 18/-	£9 - -
6 men & boys at the fixed engines	4. 19. -

16

4 waggonway wrights @ 20/-	4	-	-
12 men & boys at Bank heads, bank foots, greasing rollers etc	7	4	9
16 houses and fireings @ 3/- p week	2	8	-
	£27	11	9

The distance being at 16 to 15 makes a difference of £4.8.9 p week p mile in favor of Locomotive Engines from the keep of the way alone.

Enough has already been said to prove to every dispassionate mind the superiority of a Locomotive power in preference to any other than can possibly be adopted on such a line of Railway as that intended between Newcastle and Carlisle.

First – in the quickness of the mode of conveyance which may safely be reckoned at 6 miles p hour while that by horses or Reciprocating Engines must necessarily fall short of 3 miles p hour.

Second – The cost to the undertaking will be one farthing p ton p mile less

Thirdly – the outfit expence for sufficient power to travel the whole length of the line more than one half less.

Fourthly – The labourage and keep of the way more than one half less.

Fifthly – Ropes, Rollers, Sheaves, Reservoirs for water, Engine Houses, Dwelling Houses, except at each end of the way, accidents by breakage of ropes, destruction of carriages and baggage, breakage of wheels and rails and the probable loss of lives by such accidents are taken out of the way and envious and malicious persons prevented from doing mischief on such like property.

Estimate of a Railway between Newcastle and Carlisle such as described the preceding pages, suitable for Locomotive Engines drawings trains of loaden carriages

64½ miles at £1030.4.6 p mile	66449	10	-
64½ " Double way ditto	66449	10	-
Land inclusive of fences (Embankments and cuts) average width 45 feet on 64½ miles equal to 352 acres at £60 p acre	21120	-	-
Cuts & Batteries (Excavations & Embankments) under the variations sufficiently level for Locomotive Engines or horses, assumed at an average of £1000 p mile)	64500	-	-
Short tunnell at Lemington, wooden bridge to Ryton Haughs, over the North Tyne, the Eden etc according to Mr Chapman's report	20000	-	-
	238,519		
Temporary damage to land, Superintendence, incidents etc at 15 p cent	35777	15	-
	274,296	15	-
16 Locomotive Engines	8000		
8 Watering places	200	-	
	282,496	15	-

The above sum includes the outfit, expence of sufficient machinery to lead 500 tons p day for 300 days p annum which at one penny p ton p mile on the whole distance is

	40312,10 -
The actual expence for conveyance one farthing p ton p mile	10078. 2. -
	30234.8. -
For Agency, keep of the way, broken rails, incidents etc	4000. - -
	26234.8. –

Clear annual revenue or 9 p cent p annum on the capital employed.

There is nothing in the preceeding accounts which is theoretical, but one item of charge viz £1000 p mile for making the line of way suitable for Locomotive Engines to travel the whole distance, and in the present uncertain state of information as to the whole localities of the way nothing can be ascertained without an accurate survey, and all the particular levels taken. (So far as my own knowledge goes and I have travelled the whole distance twice over and great part of it some hundred of times being born at Bells Fell near Bradley in the Parish of Ryton and not far from Stanley Burn.) £1000 p mile will be more than sufficient. All this part of the Country abounds with coal at an easy depth, the greatest part of which is unwrought, the Royalties of Bradley Moor, Stanley Burn & Hedly Fell where there are three or four different seams of coal from 3 to 12 feet thick. One of my uncles, still living on a small farm near Bradly Hall wrought in a Pit somewhere on Bradly Fell where the coal was upwards of 12 feet thick. There were collierys at Hedly Fell & Stanley burn between 40 & 50 years ago, and so far as I know they were discontinued on account of disagreement among the Proprietors of the different Royalties. A long lead of 6 or 7 miles to Stella where the coals were put into keels, & from thence taken to Sheilds, which was very costly owing to the bad navigation of the River Tyne to Lemington which in the winter time was frequently frozen for weeks together, added to which the powers of Steam Engines of any kind were very imperfectly understood. It is more than probable that if a line of Railway were to go right through this part of the Country and coals would be led for one farthing p ton p mile, and the mines completely drained at a very trifling expence, being of an easy depth and for the most part using little timber being generally what is called Post Roof, these collieries would immediately be wrought and owing to the quality of the coal would be able to compete in the London Market with the best collieries on the Tyne or Wear.- there would in all probability be 1000 tons p day for 8 or 10 miles, where they might be put either into keels or ships somewhere about the high end of the Close at Newcastle or at any place higher up between there and Lemington.

It is then pretty evident that Locomotive Engines will be the most eligible motive power that can be applied, and will form the cheapest and most expeditious mode of conveyance, and that it is highly probable that the whole line may be made to suit such conveyance for a sum less than that proposed.

And as observed by Mr Chapman in his report "The design is also worthy the aid of Goverment, as it will afford certain easy and rapid means of conveyance for troops and military stores, across that part of the Island & that exclusive of an increased carriage of minerals, from the line of Railway passing in front of every opening into the mineral country, the parties who may subscribe to carry the work into effect will meet with an ample remuneration for any expenditure requisite for its execution.