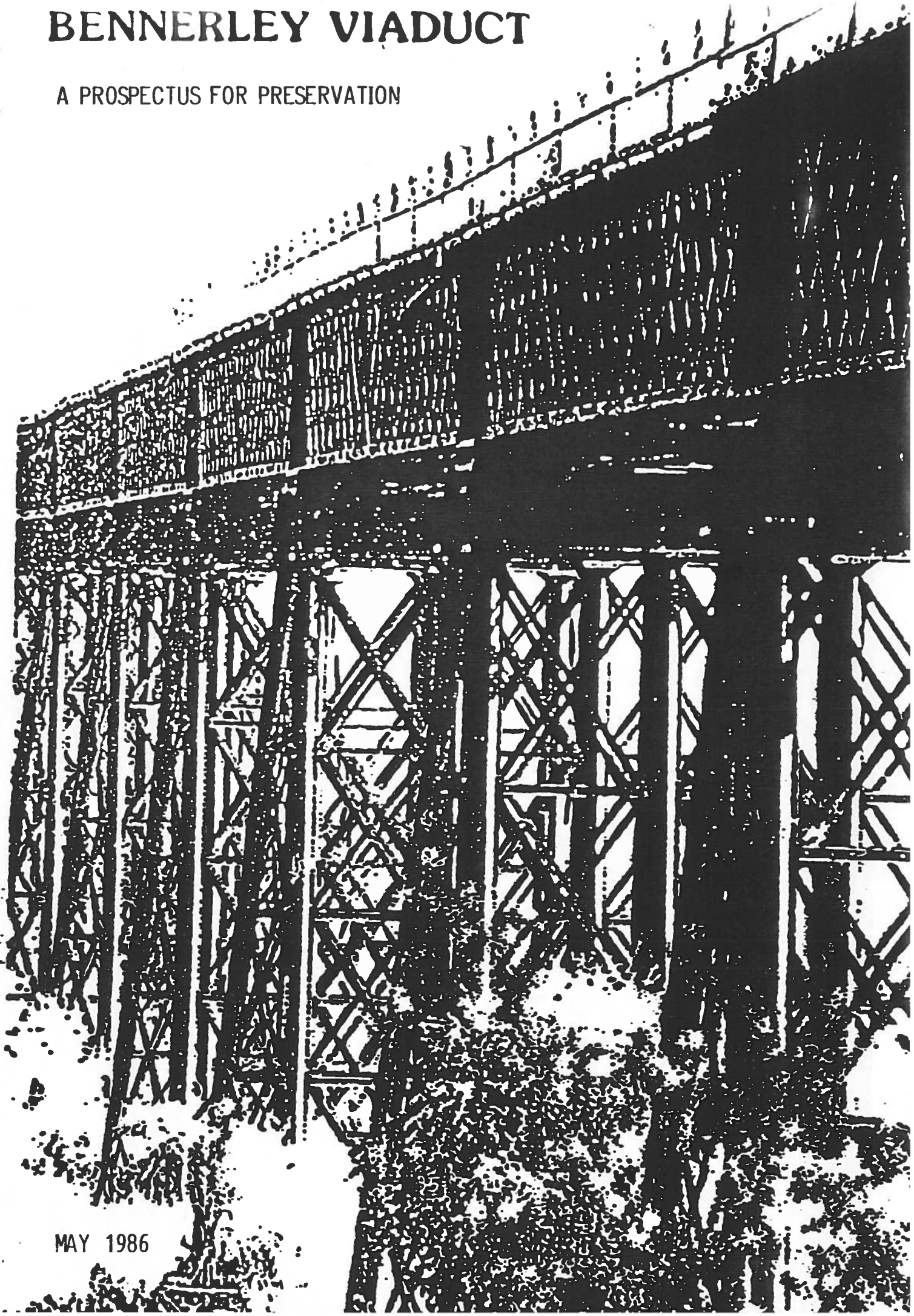
BENNERLEY VIADUCT

A PROSPECTUS FOR PRESERVATION



MAY 1986

CONTENTS

Published by the Bennerley Viaduct Preservation Trust Working Party. May 1986

Further copies of this document can be obtained from The Arkwright Society, c/o Tawney House, The Green, Matlock. DE4 3BT

1. INTRODUCTION

Bennerley Viaduct is an interesting and skillfully engineered railway viaduct built in wrought iron some 440 metres long crossing the valley of the river Erewash from Awsworth in Nottinghamshire to Cotmanhay in Derbyshire. The viaduct was built in 1877 as part of the Great Northern Railway extension from Nottingham to Derby. It is however now disused and the railway track has been removed. It is a grade 11* Listed Building.

In 1980 a public inquiry was held consequent upon the refusal of consent to demolish the Viaduct. At the inquiry it became apparent that there were a number of groups and individuals who would be prepared to act to enable the Viaduct to be preserved. The Secretary of State for the Environment has postponed giving a decision on the appeal pending the outcome of efforts to establish a trust prepared to undertake its preservation. Such a trust is now in the process of its formal creation and this document sets out aims and intentions. The present owners of the Viaduct are British Rail Property Board. They have indicated a willingness in principle to sell the Viaduct to the proposed trust for a nominal sum and negotiations regarding the terms of the sale are in progress.

2. HISTORICAL ENGINEERING IMPORTANCE OF THE VIADUCT

1) The Engineering Context

The viaduct did not play a significant role in British railway history and no important people or events were associated with it. It is however representative of a very significant phase of railway bridge construction techniques and is now virtually unique in illustrating a family of structures which have otherwise vanished. Because of its location and the fact that it no longer has to bear considerable weights it presents an opportunity to save and interpret the art of the Victorian wrought iron bridge engineer to future generations.

The viaduct is largely built of wrought iron, in itself a feature of considerable interest. The use of the material for railway bridges began in the 1840's. By the time the viaduct was built it was still in common use although it was beginning to be challenged by steel. Had it been built in steel, which is more prone to corrosion, it would probably not have lasted as long. Wrought iron is no longer manufactured and bridges built in it are becoming rare.

The structural form of the viaduct derived from the fact that it needed to be built cheaply and quickly across a valley prone to mining subsidence and upon poor soils which could lead to differential settlement. The techniques used are the most interesting features of the structure, especially since coming at the end of a period of development of bridges of its kind, it demonstrates them in their ultimate and most sophisticated form.

The techniques can be listed as follows:-

a. Trestle piers formed of columns linked together by pin jointed bracing. This technique permitted very tall iron bridges to be built. The Crumlin viaduct of 1856 was the first of this type. Early bridges had cast iron columns. Later ones substituted wrought iron, only five viaducts (including Bennerley) ever had this feature. Because wrought iron was only available in short lengths ingenuity had to be used to make the column fabrications strong enough. The cross section of the columns reduces near the top to reduce their weight.

b. Lattice girder spans. These are a common Victorian bridge building technique dating from 1842. The famous French engineer Eiffel also combined truss trestle piers and lattice girder spans when be built his first high girder bridge at Busseau in the Creuse Valley in 1864. In that case a wish to minimize the effects of high winds in the valley were the cause of the choice of method. Lattice girders support the decking efficiently and save weight.

c. Segmented Columns. The form of construction is very interesting, the four segments bolt together to form a section which is very efficient in bending. The method, know as "Hughes Patent Piling" was also found on seaside piers.

d. Extensive use of prefabricated sections. The use of repetitive components, fabricated off-site, had developed in the years following 1850. Crumlin was the first viaduct built in this way and the technique is the basis of modern methods. At Bennerley the technique permitted rapid construction.

e. Decking resting on the main girders instead of being suspended between them. This reduced the lateral span saving weight and is only possible where height is available. It is thus more common on viaducts that bridges.

f. Through decking. This is a particularly important feature of Bennerley Viaduct. Ballast is used to pack the track in the conventional way but the amount required is less that on a normal trackbed due to the shape of the corrugations. It would have been even lighter to have built the viaduct with special decking and track construction but this would have been inconvenient and expensive to correct had subsidence occurred.

The context of these features represented at Bennerley can be understood better by considering the complete family of viaducts.

Viaduct	Built	Length ft	Height ft	Spans	Piers	Deck	Demolished	Note
Crumlin	1856				CI	Timber	1965	
Solway	1869	5800			CI	Timber	1930's	
Sharpness	1868				CI	Timber	1960	
Oaks	1869				CI	Timber	1968	
Tay	1878	11000	77	85	CI	Timber	1879	(1)(2)
Deepdale	1859		150		WI		1963	(1)
Beulah	1859	1040	200		WI		1963	(1)
Meldon	1874/9		120		WI	Steel	Extant	(3)
Bennerley	1877	1452	60	16	WI	WI	Extant	
Dowery Dell	1878		110	10	WI		1960's	

Notes

1. Designed by Thomas Bouch.
2. The most famous. Its collapse in a gale was the cause of a reaction against this method of bridge construction.
3. Consists of two interlaced single viaducts it is used as a road. Scheduled as a Listed Building. Steel decking replaced timber in 1935.

The importance of Bennerley is that it is only one of two surviving viaducts of this famous family. It has been claimed that Meldon is more representative of the wrought iron examples. This is perhaps true in terms of height but dimensions are less important that engineering features. Meldon has been altered, is not representative in design because of its interlaced construction, and its current use and inaccessibility to the general public limits its interpretive value.

2) The Viaduct's History

The Midland Railway enjoyed a virtual monopoly of the Derbyshire/Nottinghamshire coalfield until the 1860's but the Great Northern Railway has access in return for running rights into Kings Cross. The opening of the independent line to London St. Pancras permitted the Midland to cease this arrangement ant the two great companies became rivals.

In the late nineteenth century "wasteful" duplication of rival rail lines became common but where this happened the newcomer was of course obliged to follow second-best routes demanding ingenuity in construction.

The Great Northern Railway promoted its Derbyshire and Staffordshire Extension, a bold attack crossing the centre of Midland Railway territory from Nottingham to Derby and onto a junction with the North Staffordshire Railway, a friendly concern, permitting through running to Burton-on-Trent and Stafford.

The engineer of the Great Northern Railway, Richard Johnson, was nominally engineer of the line but his assistant Samuel Abbott was resident engineer and designed Bennerley Viaduct. It was one of three unusual bridges on the line. At Derby the Derwent was spanned in a single arch of wrought iron, and Georgian Friergate by a master-piece of cast iron decoration. These two bridges were built by the Derby firm of Handyside. Bennerley was the largest of the three; spanning the River Erewash, and the Midland Erewash valley line plus a tract of extensively mined valley floor. Abbott successfully drew on the techniques of Bouch and his predecessors to achieve a structure that worked and survived.

Concrete foundations were laid in May 1876, these being faced in Staffordshire blue bricks. The foundations were comparatively shallow. The pier erection began in July and work was completed in November 1877. The iron work was supplied by the Derby firm of Eastwood, Swingler & Co. Ltd. This company derived from the merger of the two firms in 1864, both had premises in Osmaston Road. Eastwood had 14 puddling furnaces and Swingler 25. The company made wrought ironwork for railways and general engineering purposes. The viaduct appears of have carried the first commercial traffic in January 1878 and was officially 'opened' on 1st April 1878.

The viaduct was the subject of a feature in "The Engineer" of 19th October 1877 which is reproduced as Appendix A. "Engineering" of April 11th 1879 pointed out that the design of the viaduct was such that the viaduct floor, cross girders and stays were all combined as one structural unit to achieve minimum weight. The total weight of the structure on the foundations was only 12 cwt per square foot.

Originally the viaduct had handrails but for safety reasons, apparently, these were replaced at an early date by a more substantial lattice parapet. This is the only alteration which has occurred. Inspection walkways and drainage gutters have suffered damage due to neglect but these are not an integral part of the historic structure. During its lifetime as a railway viaduct the bridge formed part of a very popular route from Derby to Skegness, the development of the resort having been very much the result of Great Northern Railway promotions. It was also a popular route from Derby to Nottingham due to the better location of the GNR stations, and of course heavily used by Ilkeston's inhabitants as the best way of reaching either town. It and the adjoining Bennerley Ironworks were the subject of a Zeppelin air raid on 31st January 1916 but its history seems otherwise to have been uneventful. As a duplicate route however it was doomed and finally closed to regular passenger traffic in 1964 and to freight in 1968. The last significant event in the viaduct's history was it repainting, 50 years ago!

3) Historical Context

The viaduct does not survive in isolation. The two other historic bridges which have already been conserved on the same route have been mentioned. The area is one of great significance in industrial archeology notably in the fields of coal and iron mining, ironworking, iron and steel pipe making, early railway and canal development. A large iron foundry once stood to the north of the viaduct.

The Erewash Canal, a popular cruiseway passes the western end of the viaduct and the remains of the Nottingham Canal the eastern end. Important literary associations also exist in the works of D. H. Lawrence, which refer to the viaduct, the railway line and the valley. Extensive scope therefore exists for focussing interpretation on these associated topics in the area of the viaduct.

Within recent years the area round the viaduct has been subject to open cast coal mining. At present a large coal handling plant serving open cast mining operation in the Ilkeston and Eastwood areas stands immediately to the north of the viaduct. This plant will, it is understood, be dismantled in the medium term following which the Erewash Valley will have undergone a full cycle of heavily industrialised development and subsequent restoration to a rural condition.

3. FUTURE USES OF THE STRUCTURE

It would be the wish of those seeking preservation of the viaduct that its continued existence be a source of practical amenity to the community, and that the viaduct should not merely be an object of historical interest preserved in an inaccessible vacuum. Access to the bridge is desirable both to allow it to be examined and appreciated for its intrinsic interest, and to enable it to become of practical physical benefit.

Fortunately the viaduct is so situated as to provide a vital link in the network of existing and proposed paths and cycleways. This can best be appreciated by examining maps of the area. Figure 1 shows the Erewash valley around the viaduct. The communities of Cotmanhay and Awsworth are linked by the road, Newtons Lane. This is a narrow twisting and heavily trafficked road, without separate footways over part of its length. It offers a poor standard of amenity to cyclists and a measure of danger to pedestrians. Communication by footpath is indirect and the paths are unsuited to safe or convenient use by cyclists.

It is the policy of Broxtowe Borough Council to provide a footpath and cycleway along the line of the abandoned railway across their administrative area from Nuthall t the east of Awsworth terminating at the western end of the viaduct. To the east of Nuthall this route is continued towards the centre of Nottingham and has already been developed by Nottingham City Council. To the west the Borough Plan currently being prepared by Erewash Borough Council envisages extension of the route from close to the western end of the viaduct through Ilkeston towards Derby. In the long term it seems quite likely that the whole of the former railway line will form a link for cycle and foot traffic between Nottingham and Derby. Bennerley Viaduct forms a vital link in this route. Without utilisation of the viaduct to cross the Erewash Valley the alternatives are so indirect and inherently unsatisfactory in nature as to be seriously damaging to the concept of coherent and attractive through route.

Not only, however, is the viaduct important to the concept of a viable link between Nottingham and Derby, it also lies at a point of strategic importance to the more general scheme of leisure and secondary communication routes. The disused Nottingham Canal, which is in local authority ownership and whose tow path forms a public footpath, terminates close to the eastern end of the viaduct. Close to the west end of the viaduct lies the Erewash Canal which is maintained by British Waterways and is well utilised for leisure cruising purposes. The towpath of the canal is part of a long distance north-south footpath up the Erewash Valley which is already in heavy use. Figure 1 demonstrates the importance of the viaduct as the focal point of these routes. The creation of a link across the viaduct is not of value to purely local traffic, but is essential to the coherence of a system of longer distance routes.

The recent history of opencast mining in the locality has left the area around the bridge with only limited mature vegetation. The proposed trust has a significant role to play in the creation of a pleasing visual appearance in the section of the Erewash Valley which is potentially an area of freely accessible open countryside for the adjoining towns and settlements. The preservation of the viaduct can act as a catalyst for the promotion of existing planning policies stressing the recreational value of the area and its status as Green Belt.

4. REPAIR AND PRESERVATION OF THE VIADUCT STRUCTURE

The viaduct structure consists of 15 sets of wrought iron trestle legs supporting 16 clear spans. At the west end of the viaduct, and physically separate from, although integral in purpose with the viaduct, is a three span bridge structure of conventional type for its period, spanning British Rails main line. This bridge is supported on brick abutments.

From the east the viaduct was approached by an earth embankment terminating the brick east abutment. This embankment is now largely removed as a result of opencast mining operations, only a short length immediately adjoining the viaduct remaining in position. From the west the viaduct is approached by an earth embankment, some 50 metres long, and terminating at the tow path of the Erewash Canal, the former bridge structure over the canal having now been removed.

The information upon which this proposed specification is compiled has been obtained through the interest and close involvement over a number of those interested in the formation of a trust to preserve the viaduct. Investigations have been thorough and this document draws upon previous reports circulated to the Department of the Environment and other interested bodies. In order to be sure that unrealistic assumptions regarding the condition of the bridge would be avoided extensive survey work was carried out in January 1983 involving full inspections of the structure from both above and below the bridge deck. The full length of the underside of the deck and supporting trusses and trestles have been subject to close visual examination. Ballast has been removed from the bridge deck to examine the ends of the deck troughing at 100 positions. This represents a 9.46% sample of the total number of trough ends, these being the positions at which it can be seen the weakening effects of corrosion have been most severe.

Preservation of the Viaduct Structure

It is convenient to discuss the preservation of the viaduct structure by reference to its various component parts. In these discussions it

is assumed that costings are made on a normal commercial basis, and at costs compiled on a mid 1986 basis.

a) Foundations

The foundations of the trestles supporting the viaduct are of brickwork, with some concrete. They have apparently never needed major repair since the viaduct was built in 1877 and it is likely that even routine maintenance has been neglected for the last 40 years. The brickwork is weathered, bricks are loose in places and repointing and some haunching of upper surfaces in concrete is appropriate. This work is not immediately necessary. There has, as yet, been no significant or material structural weakening. There is a need for maintenance to prevent long term decay, and whilst it would be desirable to carry out work in the near future if funds are available, it could probably be delayed for, say, 5-8 years without there being any major deterioration in condition or great increase in the real cost of the work. The work required will be of a piecemeal nature and is not readily amenable to quantitative measurement. However it is assessed that for all repair work to be carried out in 1986 expenditure of £4,500 will be needed.

b) Abutments

There is a need for minor repairs to main brickwork abutments. There is some cracking, apparently of great age and not endangering the safety of the structure, which needs filling and repointing. This probably has its origins in foundation problems encountered early in the life of the structure, and the effects of deep mining subsidence. It is to be noted that the site is not likely to be subject to the effects of deep mine workings in future. Observation of the abutments over the past few years has yielded not evidence of rapid deterioration. Abutment parapets hare missing and new copings need to be provided to prevent continuing deterioration. Various minor repairs are needed. Whilst some of this work is not immediately necessary, and might be postponed for sometime, other parts should desirably be carried out in the near future. It is therefore suggested that the whole of the work might sensibly be carried out at once.

It is assessed that the cost of necessary patch repairs, including scaffolding, is £2,000. This does not include for reinstatement of old parapets, new demolished, nor for extensive repointing. It is recognised that existing pointing is weathered and that comprehensive repointing will be needed in 10-15 years time.

c) Repairs to Trestle Piers

There are places where rivets and wedges are missing and ties are broken around the bottom of pier legs. It can be demonstrated that the degree of redundancy in the trestle legs is such that this probably has little or no effect on the ultimate capacity of the legs and the current factors of safety are so large that these defects are of negligible practical consequence. The defects are apparently, in part, mechanical damage of recent occurrence and may therefore reasonably be assumed to have been caused by NCB traffic during opencasting operations. They are of such a nature that they can only have been caused by heavy impact.

It is not considered necessary that repairs be carried out expect as a matter of principle in the inters of historical accuracy and aesthetic appearance. It is though that the cost of repairs would be about £650.

d) Expansion Joints and Manhole Covers

It is necessary to renew the cover plates at expansion joints at the ends of the viaduct, which are substantially decayed, and to provide lockable manhole covers to the four access points. Allowing £350 per expansion joint and £250 for each lockable manhole cover this amounts to a cost of £1,700.

e) Main Trusses

The condition of the main trusses has been examined at close quarters. At the west end there is substantial corrosion of the top flange of the main trusses for a distance of some 8 metres in from the end of the viaduct. At worst there has been perhaps a 35% reduction in the strength of these trusses. However it will be appreciated that the trusses were originally designed conservatively and with relatively low working stresses, and that they will not be required to carry more that pedestrian loading in future. Even with the corrosion which has taken place there is probably a higher, and very ample, factor of safety with the bridge taking pedestrian traffic only that there was when it was new and taking rail traffic.

It is desirable that the corrosion be carefully removed and it may prove appropriate to carry out minor strengthening work on joints. However it is not thought that it will be necessary to carry out more that £1,000 of work in this area.

Over the rest of the viaduct the extent of corrosion in main trusses is of negligible extent. In some places leakage of water through the discontinuity in deck troughing at trestle support positions has caused localised minor corrosion. The extent of this is not such as to have led to weakening of any significance and it can be removed in the ordinary course of repainting work. The waterproofing of the deck needs locally to be repaired at each of these positions.

The reason for the localised corrosion at the east end of the viaduct is very probably that this end was closest to the main railway line below. It would have been exposed to smoke and fumes in the days of steam traction and this is no doubt the explanation of the increased extend of corrosion at the west end. There are, of course, no longer any severe corrosion inducing conditions affecting the bridge.

The position is, therefore, that significant corrosion of main trusses is localised over a short area at the west end of the viaduct. However it does not necessitate major strengthening, and can be simply and cheaply repaired. Elsewhere there has been minimal deterioration in condition of main trusses in the hundred and eight years of their life. Overall the extent of deterioration in condition is such as to

indicate that the future life expectancy of trusses is at worst, very long, and with proper maintenance may be indefinite.

f) Deck Troughing

It can be seen by inspection from below that corrosion in the deck troughing is largely confined to the end 150mm of the troughing. The trough ends cantilever out by about 375 mm from the top flange of the outer supporting truss and the water falling on the deck originally flowed through holes in the end of the trough into half round cast iron gutters. This is indicated on the attached sketch figure 2. The gutters discharged through spouts which were intended to throw the water clear of the structure. It seems likely that these gutters and spouts have not been maintained for many years. They are now either missing or defective over the whole length of the viaduct and it might well be considered that they never served a properly effective or useful purpose. The trough ends have corroded around the holes, typically for a distance of 50-75mm back from the hole position. However water is still shed clear of the main beams below. It is thought that the replacement of gutters and spouts is inessential. Of the 100 troughs inspected only two had corrosion in the bottom plate at the trough end such that it would be appropriate to repair it within the next 5 - 10 years. Of the (2x100) = 200 trough side plates inspected eleven were so corroded that repair in the next few years would be appropriate. Of the eleven side plates 9 were in the two most westerly spans of the bridge and only 2 in the other 14 spans. Both badly corroded bottom plates were in the most westerly span. It will thus again be noticed that corrosion is most severe in the portions at the west end of the viaduct close the main railway line. It is also noted that corrosion is generally slightly more advanced in the northern side of the viaduct. There was formerly an iron works just to the north of the site and industrial fumes are probably the cause of this.

None of the corrosion seen in trough ends affects the overall strength of the viaduct, nor the strength of any part affecting its safety or serviceability. It has not progressed so far as to present any kind of danger to viaduct users and, even without remedial measure, it would be many years before it were to do so. A small number of troughs have been uncovered over their full length for inspection, and these inspections have revealed no corrosion beyond their extreme ends.

In the long term of, say, 30-50 years it will probably be necessary to carry out repairs on side and bottom plates of all trough ends. However the pitch coating of the upper surfaces of the troughs, which is about 12mm thick on the trough bottom but much thinner on trough sides and tops, appears to be in sound condition throughout the structure. With the exception of trough ends, which do not contribute to the strength of the structure, significant corrosion of the deck structure will not foreseeably occur in the short to medium term. There is unlikely to be a need for widespread major repair, except at trough ends, within the next 50 or so years and, with a fairly basic standard of normal care and maintenance an indefinite life may be achieved.

At present it would be desirable but not essential to carry out repair by plating rough ends as part of an initial programme of maintenance and repair. Such work would involve removal of ballast from either end of each of the 528 troughs and plating wherever necessary. On the basis of our recent investigations it may be regarded as a conservative assumption that 160 strengthening plates would need to be provided. It will probably also be necessary to renew a small number (not more that 20) of the ballast boards which retain the deck ballast. On the basis of experience gained in excavation work it is though that the cost of this work is likely to be about £3,250.

A sum of £1,500 should be allowed for localised repair to deck waterproofing over trestles.

It is likely that repair and the replacement of trough ends would be a permanent feature of the future maintenance of the bridge. There would need to be a thorough examination and repair of trough ends at 10-15 year intervals and the cost of this work would be likely to be, on average, about £900 per year as a permanent and continuing maintenance charge.

g) Maintenance Access

There seems to be no reason to expect that access cannot be provided for minor maintenance and inspection purposes by conventional modern

means of hydraulic inspection platforms. The cycle route which is hoped will eventually cross the bridge, will offer opportunity for access to the bridge deck for lorry mounted inspection units. The embankment up which cycles will travel at the east end of the viaduct will allow access to construction traffic of all kinds. To the north of the viaduct is a strip of land owned by the Coal Board over which a right of access exists and which will not be cultivated and which will offer vehicle access at ground level. Access at ground level may be difficult in the winter when the ground is wet but during the summer there should be no problem.

The viaduct has planked walkways at either side running the full length of the structure at deck support truss level. The end parts of these walkways have been removed to prevent access by unauthorised persons. However the great majority of the walkways remain in place and in serviceable condition. It is estimated that restoration of missing parts of the walkway and minor repairs necessary to existing parts would cost £2850. This figure allows only for refurbishment to the original standard, not for the provision of handrails which might be a feature of such access walkways in a modern structure. Because modern access equipment makes it inessential to have walkways for access purposes and because the presence of walkways may be attractive to trespassers and vandals, it may be preferable to remove the walkway decking rather than to restore it. The cost of this is estimated at £750.

h) Removal of Loose Items

It will be necessary to carry out work in removing loose sections of guttering and generally tidying the structure. The figure which it is suggested appropriate to allow for this is £1500.

i) Painting

Advice on the current condition of the bridge paintwork and on its maintenance has been taken from Mr. J. E. Smith who was formerly responsible for paint and protective coatings in the Quality Control Division of British Rail and from Mr. S. E. Wise C. Eng., FIMechE, MIN former Deputy Director of Research (Mechanical) for British Rail.

The condition of the paint film on the ironwork of the viaduct is highly variable. Over considerable areas a sound satisfactory paint covering exists even though the bitumen top coat is frequently crazed, due to having been applied on a slow drying primer. On other areas the paint film is damaged or indeed non-existant. There is little indication of serious corrosion even on members totally denuded of paint unless the members are also subject to water leakage from the deck.

If the bridge is to have an extended future life it will be necessary for it to be repainted but there is no immediate need for this to be done except in certain areas vulnerable because of existing corrosion. There are two possible approaches to the painting problem:-

1. Patch painting of those areas already damaged by or which are already susceptible to corrosion and which are already bare or where the present paint is obviously disappearing.
2. A programme of complete repainting.

The first alternative is considered less satisfactory because of problems of definition of areas to be patch painted and for aesthetic reasons. The second approach is therefore preferred. Repainting would be carried out using a good quality zinc chromate primer and a bituminous top coat. Surface preparation is envisaged as being principally by hand since shot blasting, although theoretically ideal, is considered to be impracticable in the circumstances. Total costs at 1986 prices are estimated at £70,000.

Once repainting has taken place a serviceable life for the paint film in the region of 40 - 60 years can be expected.

The Railway Crossing

The railway is crossed by a three span plate girder bridge which is probably contemporary with the main viaduct which it abuts. The railway crossing is of limited intrinsic interest although its appearance visually complements that of the viaduct. It has never been fully apparent to those interested in the preservation of the viaduct whether the railway crossing has 'listed' status although any alteration to it would probably require listed building consent as works affecting the setting of a listed building.

The main plate girders and deck troughing of this bridge are much more heavily corroded than the structure of the viaduct, this no doubt being due to the conditions generated by steam traffic. It is now however weakened structurally so as to currently have inadequate factors of safety under its proposed use as a cycleway. The extent of corrosion, whilst marked, is not catastrophic.

There are two alternative courses of action available. Firstly the deck of the rail crossing bridge, which has holes at trough ends in many places, can be repaired and other essential repairs can be carried out. This we estimate would cost about £3750. Thereafter the bridge would be allowed to continue to deteriorate in condition with only limited future maintenance. Within 15-25 years the bridge would have to be replaced which, we suggest, might be done with a conventional tubular steel footbridge. The cost of such work would, at current costs, be in the region of £14,000-£16,000. For obvious aesthetic and practical reasons it is preferable that the existing bridge be retained for as long as possible, although it is not thought that if it were to be ultimately removed and replaced the arguments in favour of retention of the viaduct would be significantly weakened.

Alternatively the bridge could be subject to major painting and strengthening work, including repairs to the deck which might give a life expectancy of 30 - 50 years. The cost of such work might be in the region of £50,000 but because there might be difficulties in effectively waterproofing parts of the deck it cannot be said that it will be given an indefinite rather than extended life. To maintain the bridge in service for as long as possible might be rather more expensive that to accept the need for renewal but would afford a higher level of amenity. Because the appearance of the railway crossing complements that of the viaduct it would be strongly preferable to retain it while ever possible.

The total costs of remedial structural work are summarised in Table 1. overleaf.

TABLE 1

Total Costs of Remedial Work

Item	Cost (£)
Foundation repair	4,500
Abutments	2,000
Trestle piers	650
Expansion joints and manhole cover	1,700
Main trusses - joint cover plates	1,000
Deck troughing - repairs to ends	3,250
Deck - repairs to waterproofing	1,500
Walkway - assume removal	750
Renewal of loose items, gullies, etc.	1,500
Renewal of painting	70,000
Rail Crossing	3,750
Total	90,600
Add V.A.T. @ 15%	13,590
	104,190

5. WORKS TO ALLOW ACCESS TO THE VIADUCT AND PROVIDE OTHER FACILITIES

As it currently stands access to the viaduct deck might be made easily and fully available without any works taking place beyond what might be necessary in the strict interests of safety. The embankment may be climbed from the tow path to the east of the viaduct, with a little effort. However it is clearly desirable to improve standards of access and if the viaduct is to form a proper part of a system of foot and cycleways improvement is essential.

There are several aspect of access to and across the viaduct, the treatment of the viaduct deck, the eastern and western approaches and access to the land beneath the structure.

a) <u>The Viaduct Deck</u>

The parapets of the viaduct are in a generally sound physical condition and stand about 1100 mm high above the surface of the ballast. This, in general terms, may be regarded as offering adequate standards of security to persons using the viaduct. Is is foreseen that British Rail will lay down some requirements restricting access to the existing parapets above the running liens of the railway. For a distance of some 50 metres, therefore it is expected that access will be confined to a 3 metre wide pathway down the centre of the bridge between fences of sufficient height to deter casual trespassers.

Certain works are necessary in renewing manhole access covers repairing deck through ends and replacing parapets on abutments before access might safely be made available to the general public. However these works have been covered within the previous section of this document.

The layer of ballast covering the bridge deck forms an unsuitable surface for wheeled traffic. It is proposed that a strip 2.25 m wide be paved with fine crushed stone, rolled and vibrated into the ballast. This will then form a sufficiently smooth and durable surface for wheeled traffic.

b) The Eastern Approach

In the long term it will be necessary to form a shallow sloping ramp up to the deck of the viaduct. Considerable quantities of material will be needed for this purpose, but it is envisaged that such material will be made available as a result of land reclamation, landscaping and path grading along the section of the former railway line between the A6096 in Awsworth and the Nottingham Canal. Indeed it seems that there will be positive advantage in being able to dispose of waste material in this way, within a short haul distance, rather than by having to dispose of it elsewhere.

In the short term the Trust would wish to see a through footway between the east end of the viaduct and Awsworth opened as soon as possible. The Trust will wish to negotiate on this matter with the owners of the land who may, by the appropriate time, be Broxtowe B.C. Although, at present, the descent from the eastern end of the viaduct down to the open land beyond is somewhat precipitous there will be surplus material available from alterations to the Western Approach. This can be used to form a ramp as indicated on figure 3 which will be readily negotiable by able bodied pedestrians and allow access along the toe of the embankment to the land beneath the viaduct. In the long term this ramp will become part of the fabric of a longer shallower approach.

c) The Eastern Approach

At present the Western approach terminates in the abutment of the former canal crossing. It is necessary to make provision for easy access from the Erewash Canal tow path. In the long term the provision of a new canal bridge, giving direct through access to the cycleway following the old rail track to the west is envisaged. It is proposed that the existing embankment be regraded as shown on figure 4. There will be a footway rising at about 1 in 6, from the tow path to the bridge. Unfortunately a shallower angle of ascent than this is not possible within the constraints of the area of land which will be owned by the Trust and the need to maintain a future cycleway. Running parallel to this footway, but at a higher level and with a fall of 1 in 14 will be a strip of unsurfaced land left in readiness for conversion to form a cycleway continuing across the

canal. The material removed from the existing embankment will be transported to the eastern end of the bridge where it will form an access ramp.

d) Land Beneath the Viaduct

The Trust would wish there to be access to the land beneath the viaduct. At present a public footpath follows a north-south route alongside the railway from Newtons Lane, under the first span of the viaduct to a footbridge over the railway 100 m further on. The footpath then crosses a field to join the tow path of the Erewash Canal.

With the removal of a section of fence on the eastern boundary of the footpath and its replacement by a gate, access would be gained to the Trust's land and three spans of the viaduct.

However the River Erewash provides a barrier to access to the land beneath the rest of the structure unless a detour is made via the public footpath to the canal so as to gain access to the deck of the viaduct and enable a descent to be made at the eastern end.

This could be overcome by the provision of a route across an existing bridge to reach the other bank and thus regain the Trust's land. It would necessitate the provision of a suitable surface for a path for a distance of 30 m and cost about £1200. An agreement with the N.C.B. would also be needed.

e) Other Works

i) Landscaping

As has been stated in section 3 the locality is in need of environmental enhancement and the Trust would undertake landscaping work to the land beneath the viaduct and as appropriate to the western and eastern approaches. This would consist of tree and shrub planting of species indigenous to railway locations with the aim of providing both visual

enhancement for the area and hopefully a suitable habitat for wildlife.

ii) Provision for Visitors

There is a need to make provision for visitors to the Viaduct. Such provision may be viewed as part of the longer term aims of the Trust and may have to await the raising of funds. By utilising the existing vehicular track from Newtons Lane to the viaduct, parking for up to 30 cars may be provided in the area beneath the first and second spans of the bridge. This would be a matter to be negotiated with the National Coal Board who own the land over which cars would make access.

It would be hoped to provide notice boards and other display material describing and interpreting the viaduct, its method of construction, and its place within the local geographical and historical context.

The Trust would wish to think in terms of eventually having a small range of permanent buildings on the site providing toilets, refreshment facilities and a small office and materials store. It is considered that there is potential for the development of cycle hire to the public to enable non-cycle owners or visitors travelling by car to explore the cycleway which will eventually be created. Clearly this development would have to await completion of the cycleway system.

The cost of access works and other allied developments is given in Table 2. overleaf.

TABLE 2

Costs of Works for Access and Amenity Purposes

Immediate Works	Cost (£)
Regrading of embankments as shown on figures 2 & 3	15,000
Provision of rolled crushed stone paved 2 m wide path (approx. 500 m long)	4,000
Fencing for security and safety purposes (to British Rail requirements)	2,000
Access beneath viaduct	1,200
General landscaping and planting	2,000
	£24,200
Further Proposals	
Car Parking	3,000
Interpretative Displays	3,000
Permanent Buildings	25,000
	£31,000

6. FORMATION OF A TRUST

The solicitors acting for the Trust, Messrs. Broomheads of Sheffield, are actively engaged upon discussions with the Charity Commissioners with regard to approval of the memorandum of agreement of the Trust and its registration as a charity. It is proposed that the Trust will be a company limited by guarantee.

The aims of the Trust currently under discussion with the Charity Commissioners are:-

a) to acquire, preserve, exploit and interpret the Bennerley Viaduct in the Parishes of Awsworth and Ilkeston in the Counties of Nottinghamshire and Derbyshire for the benefit of the public generally and particularly to provide for its maintenance, repair and upkeep and to provide access to the Viaduct and generally to enhance the surrounding environment and to preserve and exploit the amenities afforded by the Viaduct as a National and local monument;

b) to do all such other lawful acts or things that are incidental to the attainment of the above primary object and particularly the establishment and running of any museum or museums or similar institutions for the interpretation of the Viaduct and the local history connected therewith; to encourage tourism in connection with the Viaduct by all such means and in particular preserving and exploiting the footpath thereto and thereover by the use of pedestrians and bicycles (particularly by way of hire by the Company to members of the public) and to do all such acts or things consistent therewith whether in collaboration with any other person,s bodies, institutions, authorities or otherwise.

The following bodies have taken action in their support for the Trust and would be invited to participate on its governing Council or otherwise assist in its aims:-

The Arkwright Society
Association for Industrial Archaeology
Derby Cycling Group
Derbyshire Archaeological Society
Friends of Erewash Museum
Ilkeston Civic Society
Ilkeston & District Local History Society
Institution of Civil Engineers Panel for Historical Engineering Works
D H Lawrence Society
The Newcomen Society
Nottinghamshire Building Preservation Trust
Pedals
Railway & Canal Historical Society
Victorian Society

In addition British Rail and the county, borough and parish authorities within whose boundaries the viaduct lies are to be invited to participate on the Council. Places on the Council will be available to individual elected persons. Participation on the Council will not, of course require and direct financial involvement or commitment by participating bodies. The Trust will take out adequate public liability insurance to cover it against any claims arising from accident or mishap. In the improbable event of the Trust failing to succeed in its aims the community will not be left with the liability of abandoned and decaying dangerous structure. The value of scrap recoverable from the bridge structure may be expected to be able to meet the costs of its removal and subsequent tidying of the site.

The Trust may expect to have the continuing active support of those on Working Party which has been instrumental in its formation. Amongst those on the working party are people with wide experience in the direction and management of preservation trusts. The Trusts advising consulting engineers, Messrs. Eastwood and Partners, have indicated their willingness to continue active long term involvement in its affairs. Mr. K W Parson, F.R.I.C.S. has been assisting the Trust in its negotiations to acquire the viaduct from British Rail. The Working Party are grateful to these parties for their interest and expert guidance.

7. ORGANISATION OF REPAIR WORKS

It is anticipated that the Trust's consulting engineers, Messrs. Eastwood and Partners, will provide full working drawings and specifications for repair and access works and will carry out all necessary technical and engineering negotiations on the Trust's behalf. They will also offer such assistance as may be necessary in the planning and supervision of contracts.

The Trust working party is actively exploring the possibility of carrying out the works through an agency aided by Manpower Services Commission grant. The works are considered to be an ideal vehicle for such an agency in that they are of direct public benefit, interesting and varied in nature and give the opportunity for the acquisition of experience of various types of work. There remain, of course, some aspects of the work for which it will be necessary to obtain skilled labour. An agency working with M.S.C. grant aid will be able to provide experienced and competent management of the works.

As an alternative the Trust would be prepared to raise funds to pay for the works to be carried out on a purely commercial basis by established contractors. It may be that this would result in the postponement of certain non-urgent items of remedial works, but the Trust are confident that if necessary the viaduct can be restored and opened to the public on this basis and without incurring unsatisfactory delay.

8. FUNDING OF THE WORKS

The Trust working party have been active in seeking financial support. English Heritage have been approached and in a letter of 18th January 1985 have offered grant aid of £20,000. Further offers of £10,000 from British Rail and, in general principle of £10,000 from the Railway Heritage Trust have been received. By a letter of 20th April 1982 The Countryside Commission confirmed their willingness

in principle to offer grant aid to those parts of the works associated with access and public amenity.

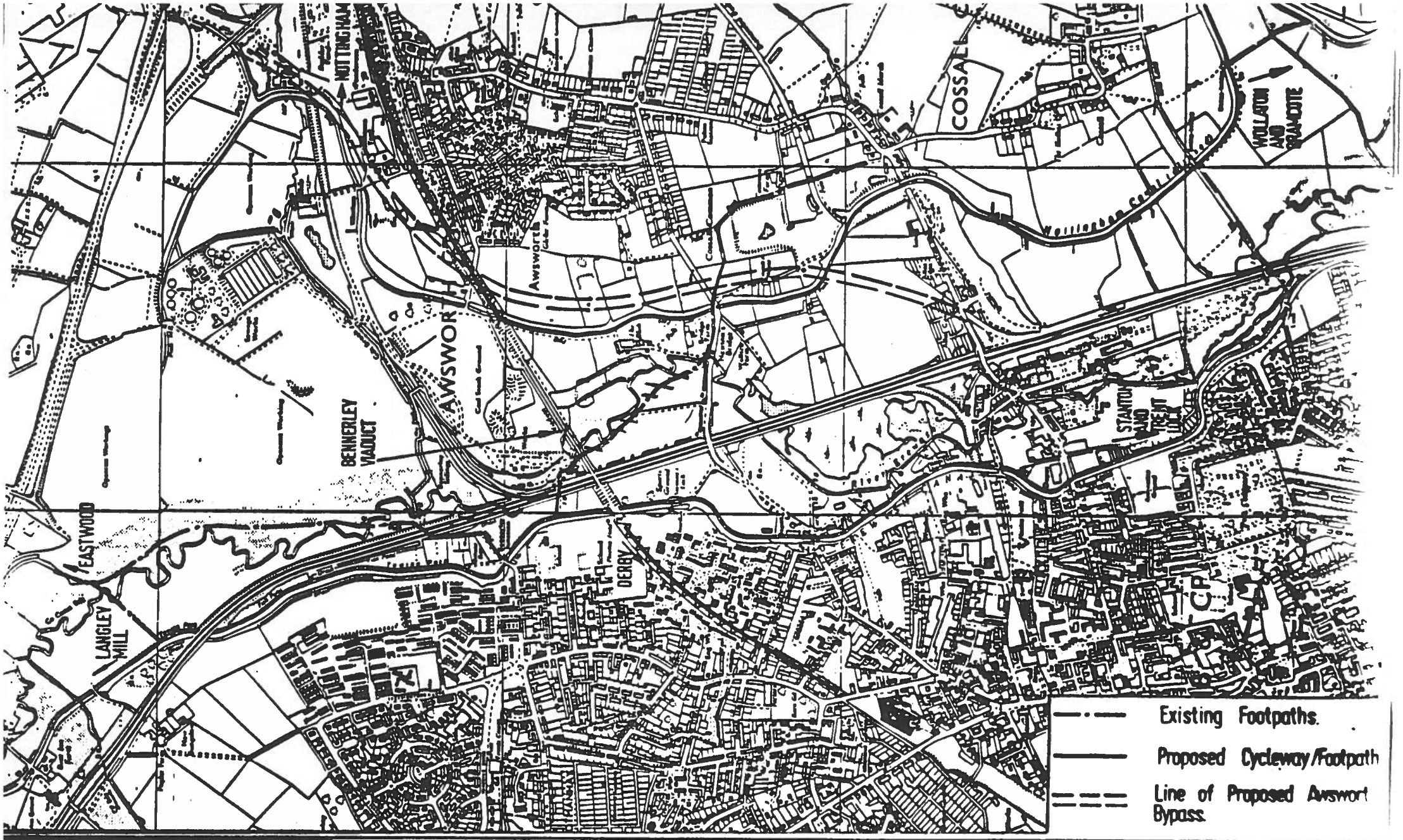
The Trust has not yet approached other sources of grant aid. Clearly, as an important listed building the viaduct may hope to be the recipient of grant aid from local authorities although it is recognised that the sums of money available for such purposes are limited, and that it may be unrealistic to see the local authorities as major sources of funds. The Trusts charitable aims give it a standing from which to approach suppliers of goods and materials for preferential treatment.

If any agency operating a Manpower Services Commission Scheme is able to take on the project of preservation and access works then there is effectively a major source of funding to be obtained by way of aid in the costs of labour and materials. Subject to the satisfactory negotiation of such an arrangement and receipt of the grant aid already promised the Trust would now be in a position to commence work in the near future.

9. SUMMARY OF CURRENT POSITION

The Working Party examining the preservation of the Viaduct has been in existence for six years. During that time it has attracted an increasing measure of support for its aims. At the beginning there were many legal, financial and engineering problems to be faced. These have all now either been overdone or are in the process of being surmounted.

The Working Party now feel that the Trust may be formally launched in the sure expectation of achieving its aims, with general benefit to the community at large and with the production of particular benefit to the local population through improvement of the environment and the provision of a practical amenity.

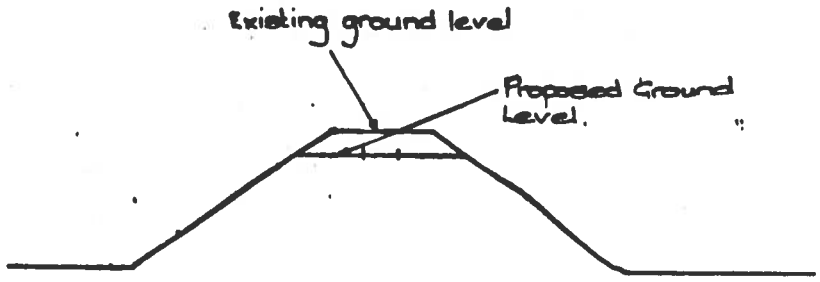


EASTWOOD & PARTNERS

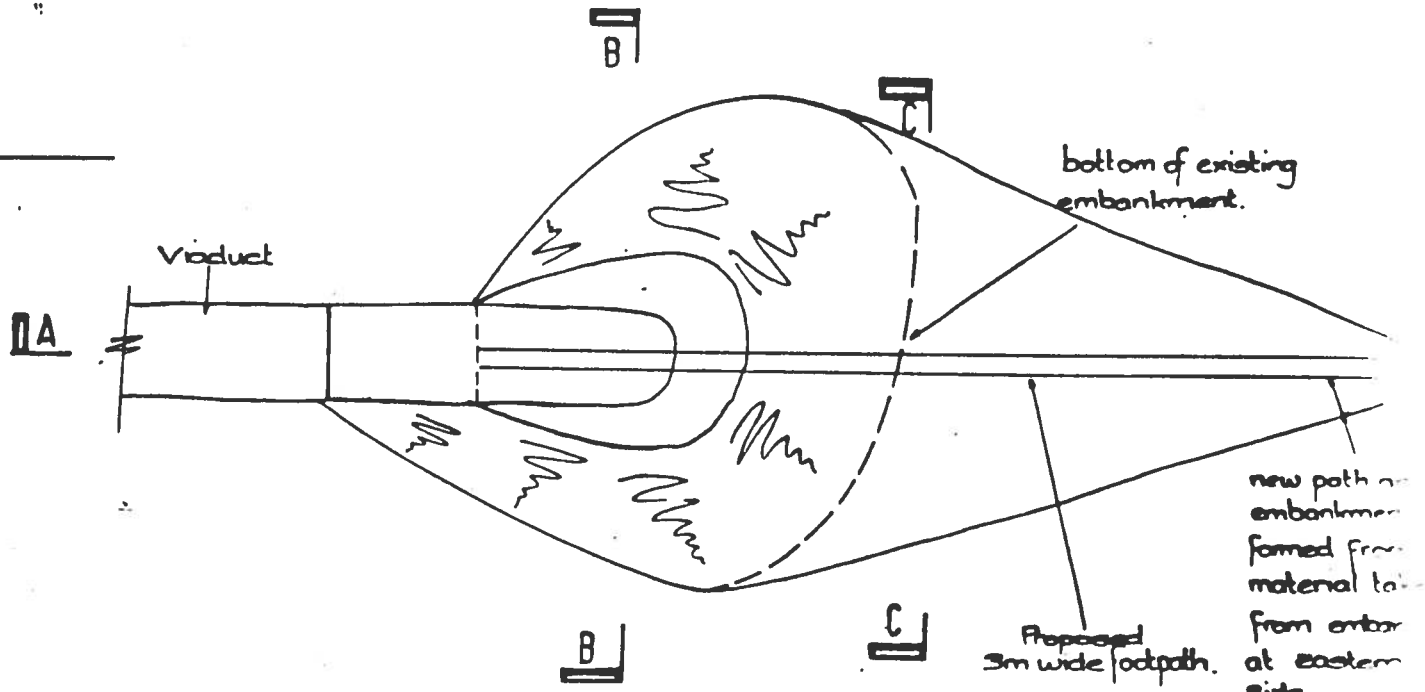
Consulting Engineers
St. Andrews House
23 Kingfield Road
Sheffield S11 9AS Tel. (0742) 685871

BENNERLEY VIADUCT PRESERVATION TRUST
MAJOR LONG DISTANCE FOOT AND CYCLEWAYS IN THE EREWASH VALLEY.

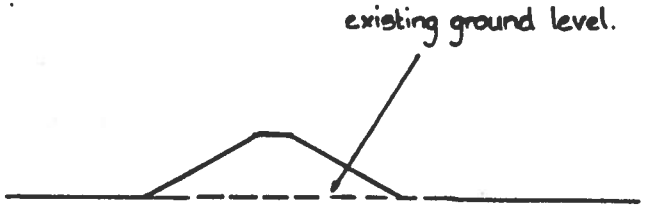
DRAWN		SCALE
CHECKED		
APPROVED		DRAWING No FIG 1.
DATE		



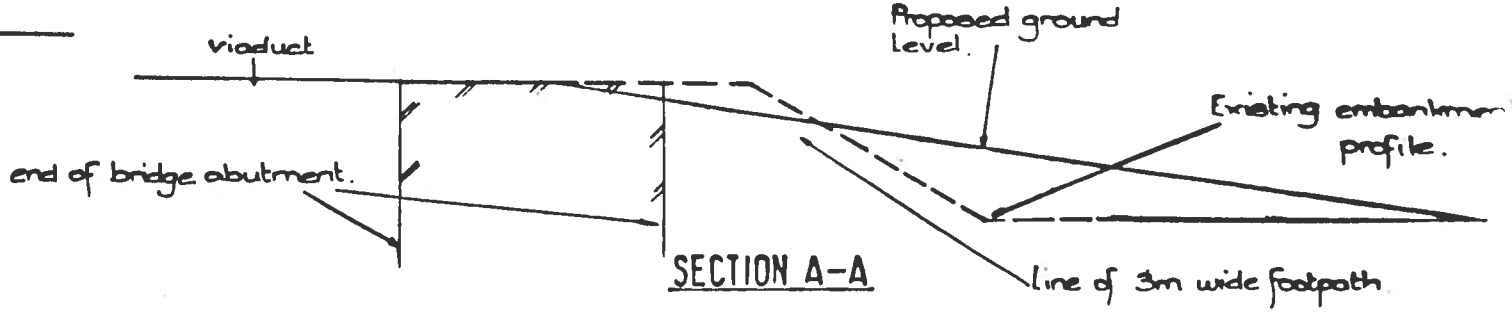
SECTION B–B



PLAN OF EMBANKMENT



SECTION C–C

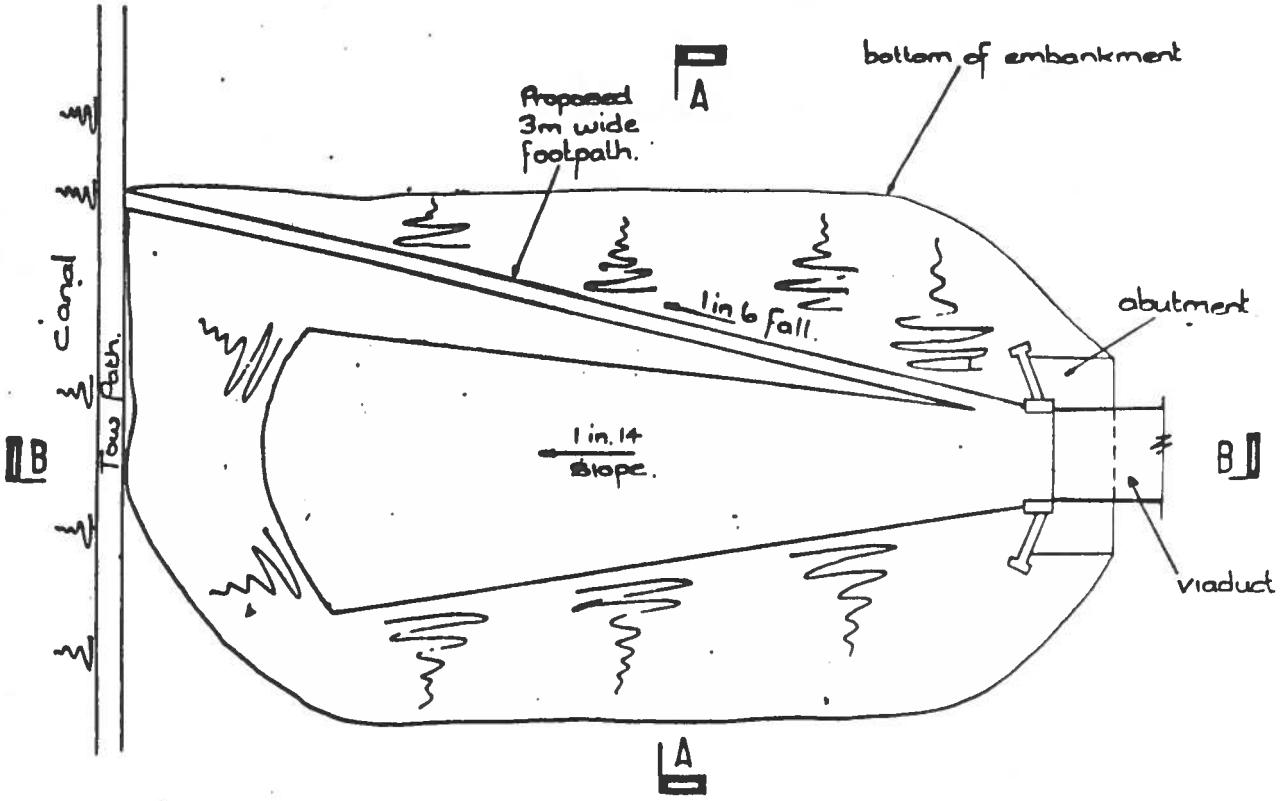


SECTION A–A

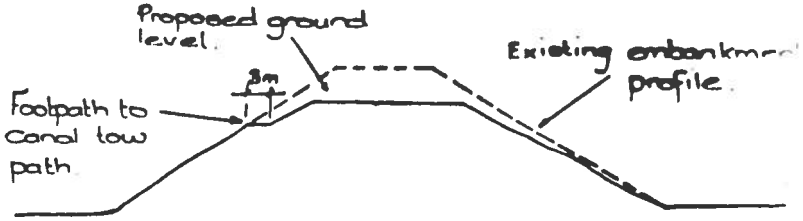
EASTWOOD & PARTNERS
Consulting Engineers
St. Andrews House
23 Kingfield Road
Sheffield S11 9AS
Tel. (0742) 58597

BENNERLEY VIADUCT.
PROPOSED ALTERATIONS TO EMBANKMENT AT EASTERN END OF VIADUCT.

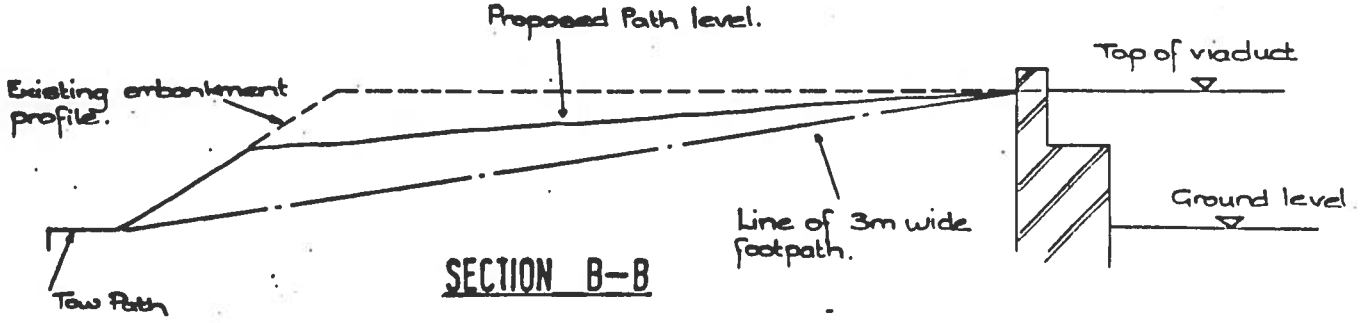
DRAWN	SF	SCALE 1:500
CHECKED		
APPROVED		DRAWING No. FIGURE 2



PLAN OF EMBANKMENT



SECTION A-A



SECTION B-B

EASTWOOD & PARTNERS Consulting Engineers St. Andrews House 23 Kingfield Road Sheffield S11 9AS Tel. (0742) 660071	BENNERLEY VIADUCT PROPOSED ALTERATIONS TO EMBANKMENT AT WESTERN END OF VIADUCT.	DRAWN SF. CHECKED APPROVED DATE 23.1.86
		SCALE 1:500
		DRAWING No. FIGURE 4

APPENDIX A

EXTRACT FROM 'THE ENGINEER' 19 OCTOBER 1877

THE ENGINEER. OCT. 19, 1877.

ILKESTON VIADUCT.

THE new line of railway now nearly completed, and which in its course crosses the Erewash Valley, forms one of the several connecting links of the Great Northern Company's Derbyshire extension work, the object of which is to connect the town of Derby and the Derbyshire coal-field with the Great Northern system. Commencing at Colwick Junction on the north side of Nottingham, and on the Nottingham and Grantham line, the new railway runs through several villages to Kimberley.

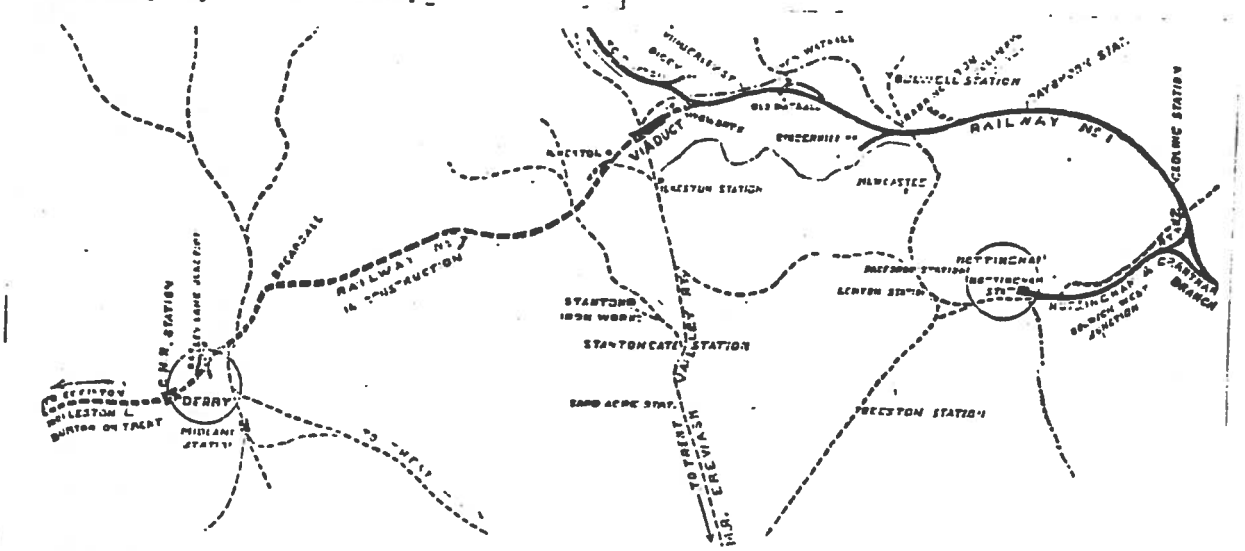
About a mile to the west of Kimberley, at Awsworth, a branch line runs up to Pinxton, thus bringing the Great Northern Railway in communication with the centre of the Midland or Derbyshire coal-field. From Awsworth the line crosses the Erewash Valley by means of the viaduct which also carries it over the Midland Railway, near Ilkeston, and which we illustrate this week. From Ilkeston the line runs through West Hallam, Locko, Breadsall, and Stanley districts, on to Derby. Near Derby the line runs for some distance upon embankment, but after leaving West Hallam the line is lost in a deep cutting through sandstone and compacted gravel, known on the works as conglomerate. Thin veins of coal may be seen in several places in this cutting, but they are lost near a tunnel through the new red sandstone at Morley. Leaving this, the line runs on the hill side, along which several severe slips and settlements have been encountered. From Derby the line runs on to Egginton Junction and Rolleston Junction, and at these places it runs on to the North Staffordshire line, over which connection is obtained with Burton-upon-Trent, the total length of the line, exclusive of the branch to Pinxton, being thirty-two and three-quarter miles. We are, however, only here concerned with that portion of the new line which crosses the Erewash Valley by means of the viaduct, to the illustrations of which we must now refer. The direction of the line and position of the viaduct will be seen on the map given below, the light lines on which show the Midland Railway. One of the principal conditions influencing the choice of the design to be adopted was the necessity for lightness in the structure imposed by the inability of the honeycombed formations below the position of the foundations to carry any great weight, old discarded coal and ironstone workings running in various directions under the line of the new railway, records of some of which have either not been preserved or are inaccessible. A masonry structure, or even masonry piers, were therefore inadmissible, and a light wrought iron structure was that most obviously suited to the conditions—not only on account of the necessity for lightness, but in order to secure a structure which would withstand considerable distortion in case of very probable settlement in the foundations. The wisdom of the choice has already been proved by the settlement of the foundation of the end of the embankment supported by the masonry which forms the abutment at the western end of the viaduct, and which has by the settlement been considerably broken, rendering partial reconstruction necessary. The viaduct consists of sixteen spans 77ft. in length between the centres of the piers, the elevation of the girders and some of piers being seen in elevation on page 276, and an enlarged section of the girders is given on page 277, which also illustrates the general construction of the piers with some of the details. Other enlarged details and sections are given on page 276, and these, with the particulars accompanying them, make minute description unnecessary.

The piers consist mainly of wrought iron hollow columns rivetted together in four sections, as shown on page 277, these columns being supported, as against buckling or bending strains, by cross braces and ties of the forms and dimensions given in the figures referred to. The ends of the columns are fastened into the foundation and cap-castings, as shown on page 277, the joint being made good in the annular step by means of iron cement. The floor of the viaduct consists, as will be seen by the figures on page 276, of a series of ridges and furrows of plate iron rivetted together at the angles and the end, each ridge fastened to the main girders. This construction thus forms at once the cross girders, stays and flooring. The furrows are filled in with ballast and the sleepers dropped therein, packing being very easily performed when necessary. This floor would not recommend itself in all cases of girder bridge construction, but it is considered by the engineers of the viaduct that it gives greater strength per unit of weight of the floor than could be obtained by other suitable constructions. Its main advantage, however, is that it gives a loose road; but it can only be adopted with economy where three girders are used, or upon single-line bridges. The weight of the flooring in this case is about 734 lb. per foot run. The foundation castings are carried upon brick masonry, supported upon a concrete bed of such area that the weight of the structure imposes a weight of but 12 cwt. per square foot on the foundations.

Mr. Richard Johnson, M.I.C.E., chief engineer of the Great Northern Railway, is the engineer, and Mr. S. Abbot, Assoc. I.C.E., is the resident engineer of the whole line under construction and the designer of the viaduct.

The contractors for the line are Messrs. Benton and Woodiwiss of Derby, the ironwork, including the viaduct, being in the hands of Messrs. Eastwood, Swingler, and Co., also of Derby. The same contractors have in hand the part of the line which runs through Derby, and Messrs. Handyside and Co. have in construction the ironwork, which includes a fine single span cast iron bridge to cross Friar Gate, close to which will be the Derby station, and a wrought iron arched bridge of one span over the Derwent.

It is expected that the line will be ready for goods traffic at the end of the year and for passengers shortly after.

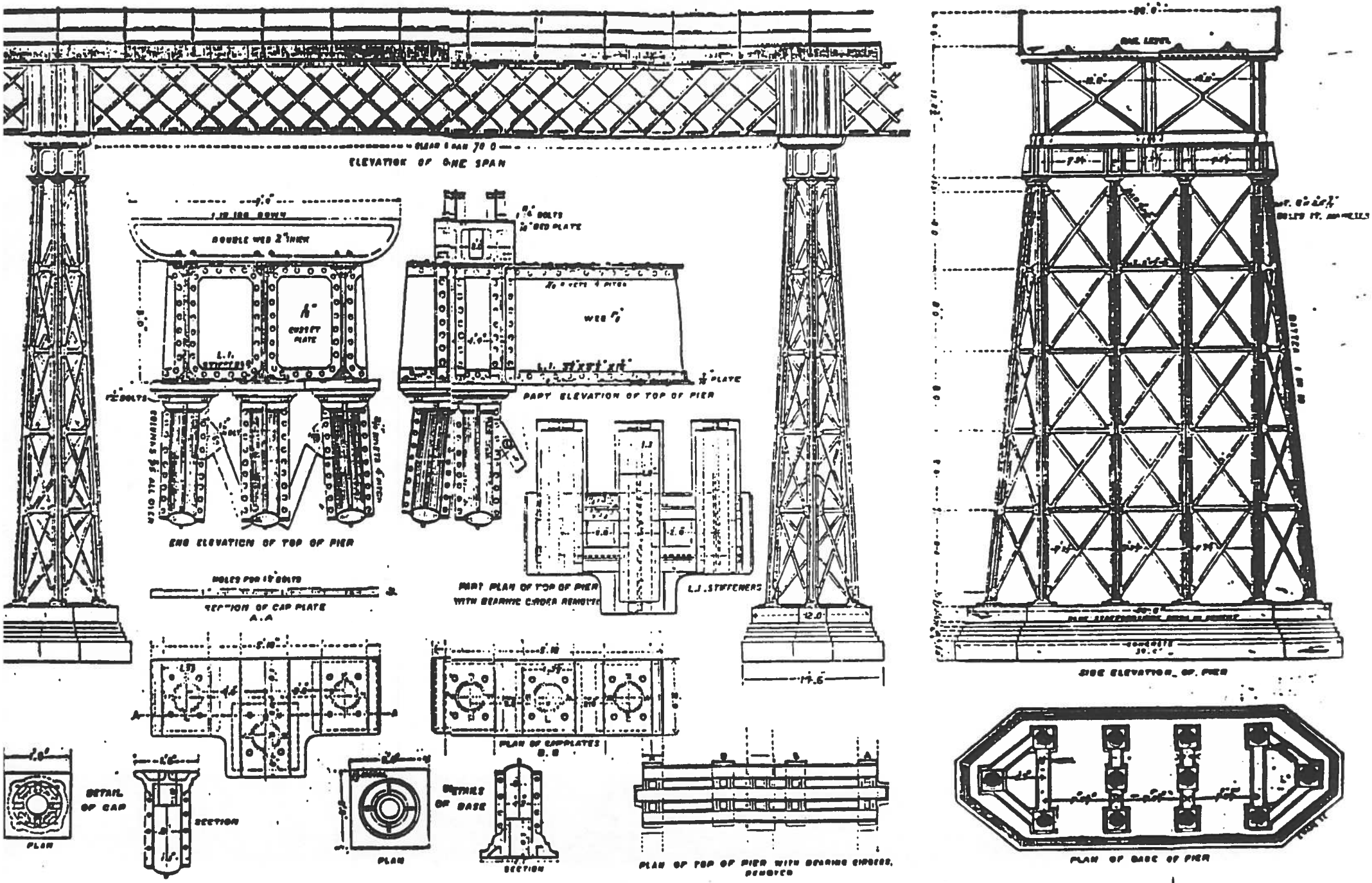


DERBYSHIRE EXTENSION, GREAT NORTHERN RAILWAY.

ILKESTON VIADUCT, DERBYSHIRE EXTENSION, GREAT NORTHERN RAILWAY.

MR. R. JOHNSON, M.I.C.E., ENGINEER.

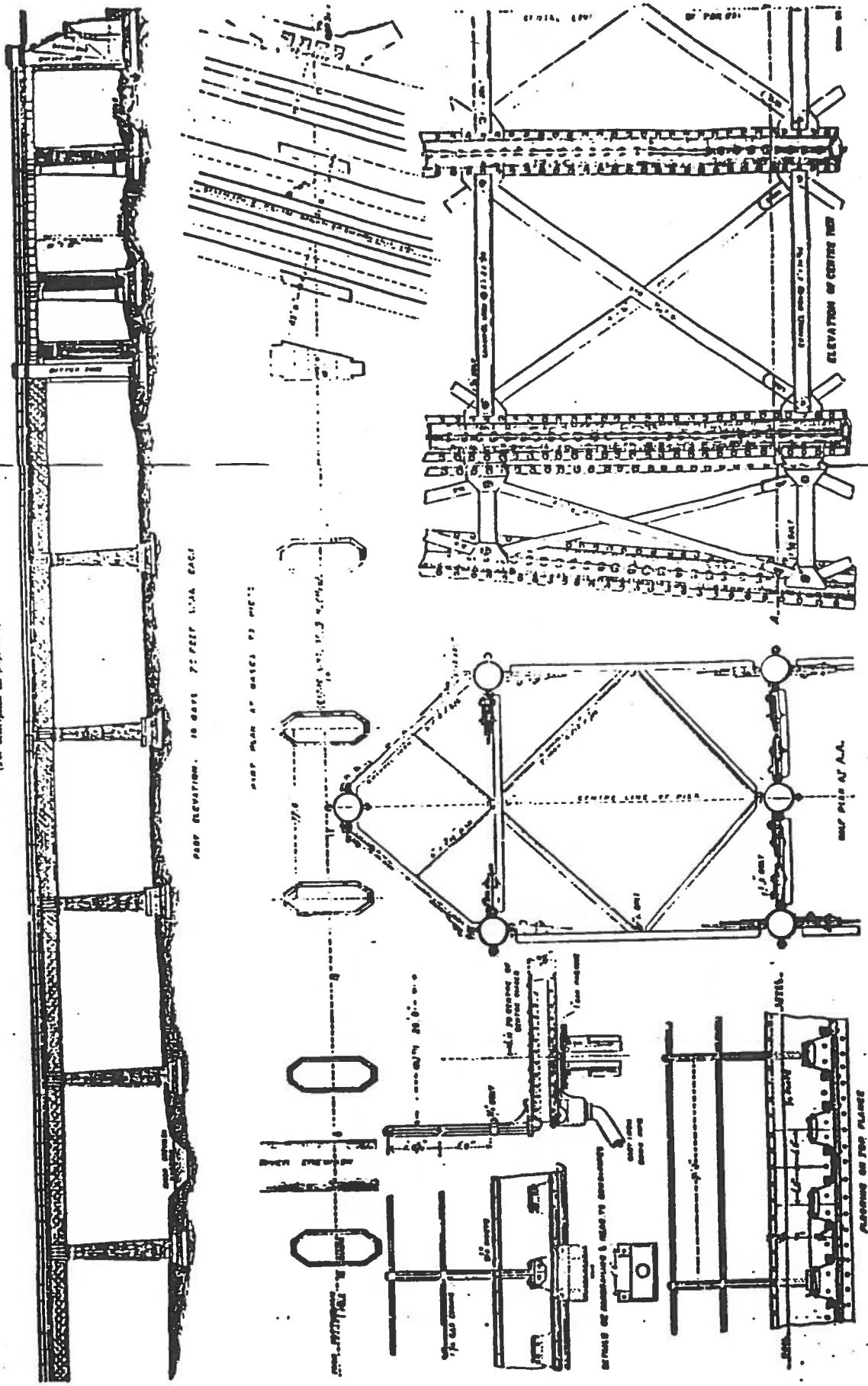
(For description see page 374.)

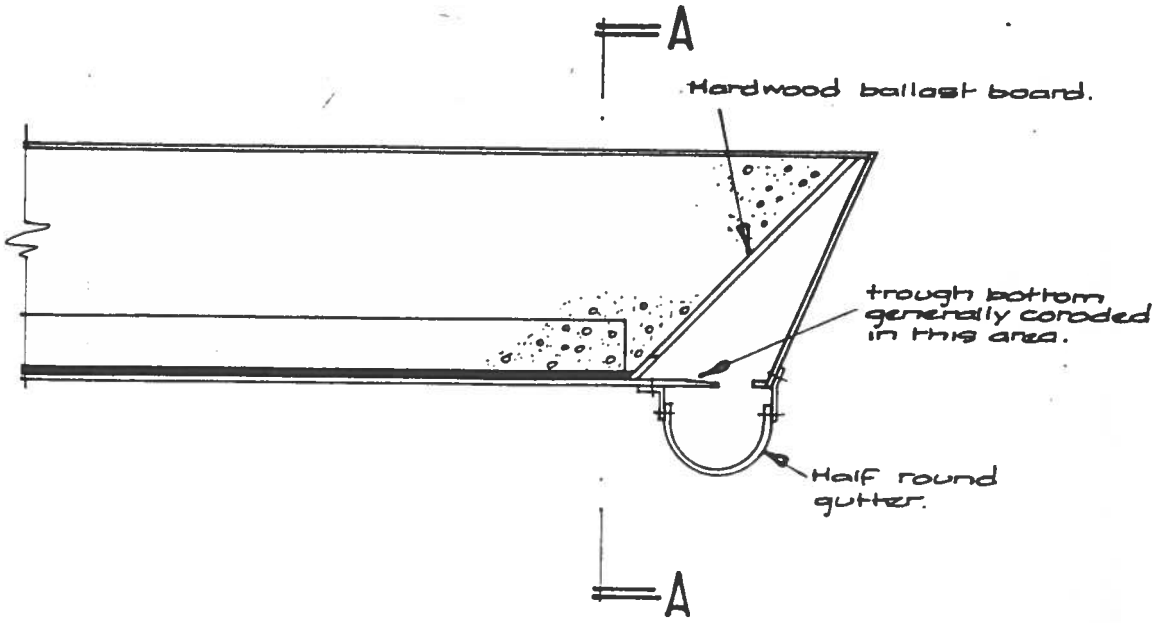


ILKESTON VIADUCT, DERBYSHIRE EXTENSION, GREAT NORTHERN RAILWAY.

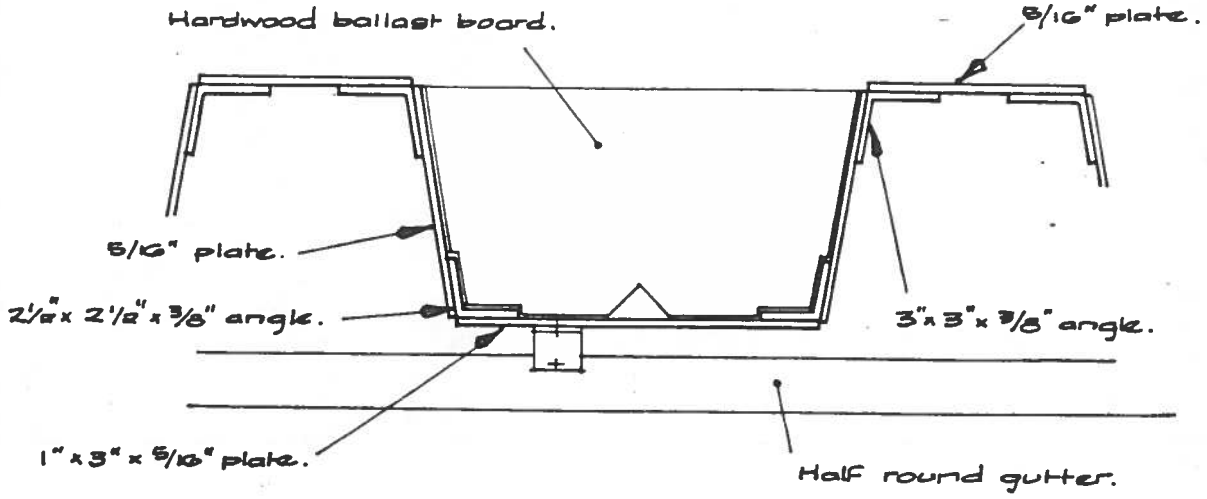
MR. R. JOHNSON, M.I.C.E., ENGINEER.

(For description see page 271.)





SECTION THROUGH TROUGH



SECTION A — A

Fig 2 BENNERLY VIADUCT
DECK TROUGH END DETAIL