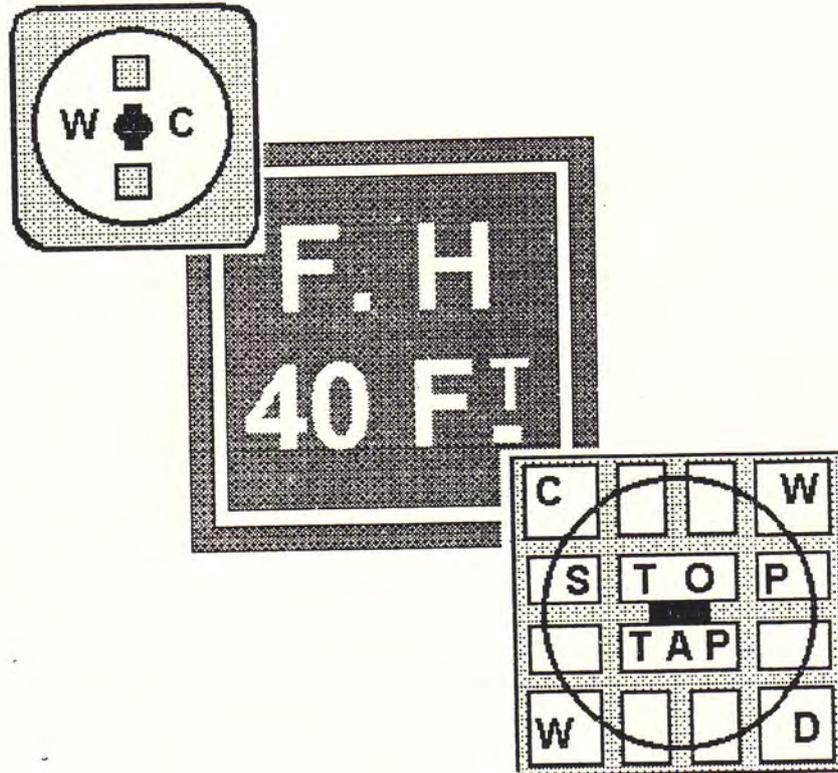


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THE WARWICK IMPROVEMENT WORKS

The Story of Warwick's Water Supply and Drainage
1848 to 1877



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PREFACE

In the early 19C most towns were very insanitary. Muck and filth vied with poor housing, vermin and impure water to spread disease. The arrival of Cholera provided the impetus for the sanitary reforms that culminated in the first Public Health Act in 1848. By this act parliament encouraged towns to improve their sanitary conditions by setting up Local Boards of Health to provide, amongst other things, pure water and drainage.

The works necessary to bring good water and sanitation to a town were called 'improvement works'. Warwick's improvement works were carried out in three phases:-

- a) The works of water supply and mains drainage completed in 1858.
- b) The works to purify the towns sewage completed in 1868 and
- c) The works to provide the town with water from Haseley (Hazeley) completed in 1877.

This sequence is reflected in the text. However, for completeness, the story starts in 1693 and some reference is made to later developments. The main work is supplemented by appendices with more detailed information and comment.

In researching this subject I have made best use of the surviving records which, although voluminous, are not complete. Thus there is a considerable record of proposals with very much less information on completed works. Similarly a great deal of ill informed, and often politically motivated, comment is recorded often without an adequate response.

In the text I have sought not to confuse opinion with fact and where circumstances have necessitated the use of suspect sources I have sought to make this clear.

Finally it must be confessed that not all of the available records have been consulted. It would have been useful to consult the medical officers reports, particularly their comments on the quality of Warwick's water and sanitation, but these, and the minutes of The General Board, are not easily accessible. It must also be confessed that the local press has only been selectively read.

Front Cover. No evidence of the original improvement works can now be seen about the town. However several 'Stop Cock' cover plates and two white on blue 'Fire Hydrant' indicator plates survive from the days when Warwick had its own water supply.

LOCAL GOVERNMENT

and

PUBLIC HEALTH

Before entering into a chronological report of the slow advancement of sanitary improvements in Warwick it is necessary to introduce the several public bodies involved.

Within the Borough of Warwick, formed in 1835, the parishes of St. Mary and St. Nicholas continued as independent bodies. The parish vestries set rates for their own purposes, principally for the maintenance of the church, for highway maintenance and for the maintenance of their poor through the poor law union..

The town council was directly elected. The major beneficial activities of the council were in respect of the watching of the town (policing), fire fighting, regulation of the markets and the provision of street lighting - however in its early years the council was also much distracted by long legal disputes with officials. Although levying a small rate much of the towns income was derived from charities - this being sufficient to defray the whole cost of street lighting and part of the cost of watching the town. There is little evidence that the council took much interest in the sanitary condition of the town before 1847 - the exceptions being the maintenance of public pumps and an occasion in 1843 when a committee set up to enquire into improving the water supply quickly concluded that "irrespective of the cost" nothing could be done [2 14 Jne. 1843]. In fact during these early years the town had few, if any, powers to abate nuisances. This changed with the passing of the 'Nuisances Removal and Diseases Prevention Act of 1847' which the town early took advantage of by appointing as its own the 'Officer of Nuisances' previously employed by the Board of Gardians [2 10 Jan. 1848, 17]. The immediate improvements to the town were such as to be favourably reported on by Mr Clark in his report of February 1849 [18 Paras 5&27].

The third arm of local government was The Poor Law Union. This provided not only work and relief for the poor but also medical services. It was the union, and not the town, who had been most active in seeking to improve the sanitary conditions and it was the vic chairman, and later chairman, of the board of guardians (Mr. G. Lloyd) who spoke and had pamphlets published on town improvements[18 Para 3].

Finally, from September 1849, Warwick had its own Local Board of Health. Charged with the sanitary improvement of the town it possessed certain powers of compulsion e.g. the power to oblige property owners to connect their properties to mains water and drainage, the power to raise revenue and the power to borrow money.

BEFORE THE IMPROVEMENT WORKS

The sanitary condition of Warwick was not unlike many other contemporary towns. By the early Victorian years much of the town was filthy overcrowded and squalid - the town had an abundance of cesspools and much of the water, in the town, was contaminated. The various watercourses about the town were little more than open sewers and the water of the River Avon less than pure.

The town got most of its water from wells and watercourses but much use was also made of rainwater collected in butt's or cisterns. From about 1644 [17] the castle had its water pumped from The Avon by machinery in the castle mill. Few details of the first castle water supply are known but papers from 1872/3 [25] refer to a three inch rising main. In 1872, following the disastrous fire of the previous year, the Earl of Warwick obtained a quotation [25] for the installation of much more powerful pumps sufficient to provide water not only for domestic purposes but also for fire fighting - these pumps would have provided a supply of not less than 80 gallons per minute through a five inch rising main to screwed hydrants about the castle. However it appears that this was not proceeded with for in 1876/7 a 5 inch water main was run from the High Street to the castle with hydrants installed in the carriage drive and along the back lane [35].

About 80 houses in the town, the goal and some public buildings, also benefited from having a piped water supply. This water was provided by a private undertaking that pumped water up to the town from priory pools (*See appendix 3*). From c1693 this supplied water to a stone cistern located at the North end of Sheep St. from where it was distributed to the houses by underground pipework. Later water was distributed about the town in wooden water pipes from a lead tank close by the Punch Bowl Public House. (*A short piece of this wooden pipework can be seen in St. John's Museum.*) By 1849 houses were paying up to 18/- a year for a very poor supply which was both impure and rationed. With only one third of the town supplied with water on any day the water was, at best, on for only two days of each week but the supply is known to have failed completely for three months of one year and for two months the next. Households stored water in cisterns for the days when the water was off and they no doubt also made much use of wells and rainwater.

The town had many wells and these provided the main source of water for much of the town. Many of these wells were fitted with pumps and were typically 70 or 80 ft. deep. Most of these wells, or pumps, were private but a few, one near to the Lord Leicester Hospital and another in The Saltisford, were publicly maintained by the town council. By 1849 contamination of well water by sewage and other filth was a serious problem - some had already been abandoned and others were at constant risk.

Well water was very hard and that taken from the watercourses about the town was little better. Thus for

laundry work rainwater was much preferred. Nevertheless a great quantity of Soda was used in the town to soften laundry water [18 *Para 112*, 21 *P87*].

Thus not only was there a great shortage of easily accessible water in the town but very much of that was impure when received and likely to become more so when stored in open barrels and cisterns.

As for sanitation by 1849 Warwick had upwards of 1500 cesspools into which was thrown the filth of houses, privy's, pigsties and slaughter houses. Most of these were open exposing an estimated 37,000 sq. ft. of faecal matter to the sun. These cesspools were reportedly emptied by scavengers one or twice a year with the muck then sold on to local farmers as fertiliser realising a sum estimated to be not less than £780 per year.

Most of the streets had a culvert, or drain, 1ft. 6ins. or 2ft. in dia to carry away the surface water to the nearest water course. Into these many house drains also conveyed sink water. The drains thus accumulated much matter and much foul air was emitted particularly in the lower parts of the town.[21 *P85*] But offence was not confined to the poorer parts of the town - e.g. "In the market place, on visiting one most respectable shop, the kitchen underground was found to be on a level with the sewer (*storm drain*), into which a damp and dark recess in the wall was cut and employed as a privy. The smell was very offensive, and the inmates of the house and shop complained bitterly of it." No surprise then that "fitted with enormous gutter grates (*without traps?*) they are much complained of for the foul effluvia which they give out" [18 *Para's 32 to 42*].

The passage of the 1846 Act 'To Encourage the Establishment of Public Baths and Wash Houses' apparently went without comment or consideration in the town.

THE FORMATION OF THE WARWICK LOCAL BOARD OF HEALTH AND THE FIRST IMPROVEMENT WORKS (1848 - 1858)

The Public Health Act of 1848 established the General Board of Health and encouraged towns, or other places with populations exceeding 2000 persons, to form Local Boards of Health. Although the General Board had reserve powers to establish Local Boards, without consent, in towns with high mortality, the usual procedure was for the town to petition for a Local Board to be established. On receipt of such a petition the General Board would appoint an inspector to hold an inquiry into the condition of the town and to make appropriate recommendations. If appropriate a Local Board would then be set up. Two parliamentary procedures were used for this purpose. If there was a suitable existing local elected body e.g. town council, the procedure was to reform that body into the Local Board of Health by means of a Command Order - new elections were not required. Otherwise the formation of the Local Board

would be authorised by naming the town in the annual Public Health Act with its members being directly elected.

Petitions required the signature of at least 10% of those eligible to pay the poor rate - the Warwick petition thus required not less than 235 signatures. The subsequent enquires were brief but comprehensive - the inspector had to establish that there was good reason to set up a Local Board, the extent of its remit, its geographical extent, that it was not desirable to combine with any adjacent town and finally that sound improvement works were not only practical but would not cost more than the town could afford.

Warwick had viewed the passage of The Public Health Act through parliament as a threat to its independence. Thus, in May 1848, the borough petitioned The Commons and The Lords objecting to the centralisation of power in a general board which diminished the authority of municipal and corporate bodies [29 May 1848]. This petition clearly failed for very soon the General Board of Health was established but the sentiment of 'the diminution of local authority' was one to be often repeated.

By the end of October 1848 a petition for the formation of a Local Board of Health was lying, for signature, in the courthouse. This quickly gathered the requisite number of signatures and was despatched to The General Board who by mid November had appointed a Mr. George Thomas Clark as superintending inspector. The public enquiry started on the 21st. Dec. against the wishes of many in the town who objected to the expense of employing an outside inspector [32 Nov 1848]. The Preliminary Report to The General Board, dated 20 February 1849, was received on the 7th. June [3].

The report [18] confirmed that the town was in need of improvement that these could be provided by a Local Board of Health and that those improvements could be obtained at a cost that the town could afford. The major recommendations were in respect of Water Supply and Drainage; other recommendations covered scavenging, burial grounds and paving.

In respect of the towns water supply the inspector found that this was variously impure, hard and "utterly insufficient, in both quantity and quality for the needs of the town." In recommending that the town should have a new water supply he was aware that there was no immediately available source of good, that is pure and soft, water to be found. He therefore recommended that the first actions of the Local Board should be to undertake a more extensive survey of possible sources particularly recommending an investigation of the upper parts of the Chesterton Valley where he thought some of the tributaries might provide a suitable source of pure and soft water for the town. However for the purposes of estimating the cost of providing water to the town he assumed that this would be drawn from the River Avon where :-

"It would, be necessary to draw the supply from a point near Emscote, above the mouth of the Leam River. From hence it would be led by a clay main conduit to a filtering reservoir by the Avon side near Cotton-end, where a pumping-engine would force it up to a service tank, constructed upon the summit level of the town, whence it would be distributed by street mains. The capacity of the Avon is much to great, even in dry seasons, to be materially affected by the quantity thus abstracted, added to which the reservoir, containing about a 30 days supply would not draw its water when the stream was low, and consequently less pure than usual" [Para 84].

In respect of drainage he was concerned to ensure that there should be no discharge into the river above the town. This presented a problem for much of the town drained naturally into the river between St. John's and the Castle Mill. However he concluded that by laying a deep sewer all the town drainage could be induced to flow Westward to a single outfall at Fishers Brook between the Stratford Rd. and the River [Para's 90 - 93].

The improvements were described thus :-

"There will be a constant supply of water, unlimited in quantity, of good quality, distributed to every house, on the ground-floor; and for those who wish it, the pressure will command the upper floors also. For the poorest houses there will be two taps, one in the kitchen or principal room, and one over the water-closet in the yard. For this accommodation, this class of houses will be charged a penny a week" [Para 105].

"Every house will be in reach of a fire-plug and hose. The streets will be cleansed and, in dusty weather, watered, by more moderate jets; and water for public baths will be supplied at a cost that will place them within reach of all" [Para 106].

"By the drainage arrangements there will be provided for the poorest houses, a sink and drain from beneath the water tap, a sink and drain from the yard, and a drain from the privy, converted into a water closet. All cesspools will be filled up, and each landlord will be called upon to provide a proper dustbin for the dry refuse of the houses. The general sewerage rate to meet all this will be, for the poorest houses, one half-penny per week, besides the private improvement rate which will vary according to the condition of each property" [Para 107].

Mr. Clark concluded that the improvement works could be funded, within the statutory powers of a Local Board, by means of a mortgage to be repaid over 30 years at an interest of 5% per annum. Unfortunately his estimates have not been found. From such details as are given it appears that his estimate of the total cost of the improvement works, including the cost of Private Works¹, was about £20,000

¹ Note. Some explanation is necessary of the difference between Public and Private Works. The public works laid water mains and sewers through the

and that he envisaged a water rate of about 1/- in the pound - this cost to be offset by the sale of the sewage as liquid manure which should cover 43% of the outlay [Para's 108, 109, 114.7].

Absent from Mr. Clark's report is any estimate of the water requirements of the town. In respect of the drainage flow he suggests that each house would produce some 3 cubic feet of sewage per day which he then totals for 2,000 houses to be 6,000 cubic feet per day [Para's 98 to 102]. This is a very meagre quantity for a closeted² town, being less than 20 gallons per day for each house, with the total apparently not including any allowance for surface water flow.

The report, although recommending that The Guardians of the Poor should be represented [Para 83], made no recommendation as to how the Local Board should be formed. In the event the General Board decided that the Local Board should be formed from the town council without any formal representation from the Guardians. By so doing no new elections were necessary and the Local Board could be established by order of the Privy Council. This came into effect on the 5th. September 1849. At first the town was uncertain as to how to proceed and sought clarification from The General Board [3 Sept. 1849] but by the end of September the town council had formed itself into the Warwick Local Board of Health. *Henceforth, unless necessary to make a distinction, both the 'Town Council' and 'The Local Board of Health' will be referred to as 'the town.'*

Almost immediately the town found itself having to deal with an outbreak of Cholera in Saltisford. They took action to have the streets cleaned and the cesspools emptied daily - they also sought to have the cesspools covered with two or three inches of earth, moss or peat charcoal after being cleaned [3 Oct. 1849]. They had fires lit in the streets which were also dressed with lime but it was an engineer, working on the new railway line to Birmingham, who drew the towns attention to the state of Saltisford Brook which, despite being little more than an open sewer, had been impounded into a series of stagnant pools [3 Oct. 1849]. He also advised the remedy - to draw the hatches and flush the brook with water from the canal. These actions, no doubt assisted by the onset of winter, brought the outbreak under control.

In respect of the towns water and drainage, and despite the long gestation period between the inspectors report and the establishment of the Local Board, the town had not prepared itself for action and indeed was uncertain as to

town. The private works were within the property and connecting it to the mains. These were the responsibility of the householder but in his report Mr. Clark assumed that they would be undertaken by the Local Board who would then recover their cost by an additional annual charge on the property. This was, apparently, a new idea.

² Not all towns with a good water supply used water closets. Those without, e.g. Manchester, were 'Uncloseted'.

how to proceed. However by October they had decided to hold an open competition for the towns improvement works [3 15 Oct. 1849] and placed the following advertisements in the local and national press :

TO CIVIL ENGINEERS AND OTHERS

A premium of £50 will be awarded by the Local Board of Health for the best plans and specifications for the entire drainage and supply of water for the town of Warwick with an estimate of the probable cost of same ----- delivered on or before 14th. December.

Concurrently with this the Local Board received a letter from a Mr. Pery W. Hewgill who had, at his own initiative re-surveyed parts of the town. He doubted the inspectors conclusion that the towns best interest would be served by laying the deep drain necessary to carry all of the drainage below the town. He thought this much too expensive and recommended two outfalls - one above and one below the town [34 2 Oct. 1849]. The towns opinions are not recorded.

Warwick received eight entries in response to the advertisement. Unfortunately the town decided that no details would be released to the public and maintained that secrecy over the next several months. Such records as are available reveal that they found it necessary to appoint a "thoroughly qualified engineer to examine the plans" [3 27 Dec. 1849]. This was to be a Mr. Dixon of Leamington. The outcome was that a Mr. W.W.B. Moffatt, of London, was judged to have submitted the best entry with the premium being awarded in January of 1850. Even after this the Local Board refused to release any details to the press or public. A copy was however forwarded to the Earl's agent [34 2 Feb.. 1850].

Mr. Dixon was then engaged to prepare detailed plans of this scheme for submission to The Commissioners. For this he was paid £195 - 6s - 11 3/4d. with the plans forwarded in March 1850 [3].

Nothing of these plans, or the estimated cost, has been found in the town records, however a set of water and drainage drawings, dated 1850, amongst the Castle records [19] are likely to be those produced by Mr. Dixon. These plans are well drawn and to a scale of about 25 inches to the mile.

The water supply is shown to be taken from the Avon above Portobello Bridge from where it is carried in an 18 inch earthenware culvert across the meadows to an engine house close by St. John's. From the engine house a 9 inch rising main carries the water to a reservoir in the town near the junction of Priory and Cape Rd. No details of the engine house, reservoir or inlet are given and nothing is shown as to how water was to be distributed about the town.

As for drainage the details were complex. The town was to have not only two outfalls, one above and one below the

castle, but the drainage from the higher parts of the town was to be separate from that serving the lower. The Eastern outfall was to be at Pickard Rd. where two filtering tanks, one each for the high and low level drains, were to be built just above the river flood level. Then although a drains is shown flowing West along the Stratford Rd. no details of that outfall are shown. Elsewhere the drainage of the lower part of Mill St. presented a particular problem as it was below the level of the town drains. This was overcome by lifting the sewerage, from a low level drain, into the higher town drains part way along Mill St. However no details of the necessary pump, or bucket, are given.

Throughout the town no levels are shown and the depth and fall of the drains can only be inferred from sections. A note to the effect that drains were to be laid 9ft. deep was presumably intended to ensure that the drains would be below the basements of houses.

These plans together with an estimate of the cost of the works, and such other details as the Local Board thought necessary, were forwarded to the Commissioners in March 1850. By July they had the Commissioners reply [3]. This criticised almost every aspect of the proposals before them. In particular they found :-

The drawings and details inadequate.

The sizing of the drains and pipework unsupported by any calculations.

The proposed use of separate high and low level drains unsatisfactory.

The proposal to keep the existing drains for surface waters unsatisfactory and,

That the water supply should be filtered.

This was not well received precipitating vociferous calls for the town to withdraw from the Act [34 17 Aug. 1850]. Such calls were to be often repeated in Warwick and were also to be made in other towns e.g. Stratford on Avon [27]. However those making such calls faced a serious impediment in that their wishes could only be fulfilled by the passing of a new Parliamentary Act. For better or worse the Local Boards were there to stay.

By September the Local Board had before them both a report from Mr. Dixon and a new, very long, letter from the commissioners [34 14 Sept. 1850]. In his report Mr. Dixon sought to minimise the problems identified by the Commissioners which he thought could be overcome with little difficulty. The commissioners however continued to insist on the necessity of having accurate large scale plans of the town, with levels, in order to avoid the problems that had arisen elsewhere where the use of local plans had led to the laying of drains that did not carry away the sewage and drains laid too shallow to drain the basements of the houses.

By October Mr. Dixon had checked the accuracy of the existing large scale plans of the town [34 26 Oct. 1850]. Drawn to the large scale of 3 chains to the inch, he had

found errors of up to 1 chain in the lengths of some of the streets. Clearly a new survey was necessary and he obtained a quotation for 'perfectly detailed' plans in the sum of £400 which he recommended to the Board despite the commissioners clear preference for plans to be drawn by the Ordnance Survey³. In the event, and only after much acrimonious debate, the Ordnance Survey was asked to survey the town.

The survey was undertaken early in the new year (1851) under the direction of a Captain Beaty. The first task was to establish suitable triangulation points about the town and a request was made for the use of Guy's Tower for this purpose. Lord Warwick was not well pleased with having a 'Crow's Nest' erected on his castle and at first refused permission [3 Feb. 1851]. By the time that he had been persuaded otherwise the 'survey' had made other arrangements.

The plans were received in November - 3 at two feet to the mile and 17 at 10 feet. [3 5 Nov. 1851]. The town was well pleased with these and was soon receiving requests to take copies which were made by tracing over the originals. This was hardly satisfactory and the town asked for lithographic copies but was advised that this was not possible [34 13 Dec. 1851] - the 'survey' recommended that they engrave the plans onto printing plates at an estimated cost of £10 for a 2 ft. sheet or £20 for 10 ft. - a cost that the town was not prepared to entertain.

With the town now fully surveyed there appeared no impediment to appointing an engineer but it was not until February 1852 that the town wrote to the commissioners asking 'that they send down a competent engineer to advise the board as to the necessity and best mode of carrying out the requirements of the Public Health Act' [34 28 Feb. 1852]. In their reply [3 21 Feb. 1852] the commissioners pointed out that it was not their policy to recommend engineers for that purpose but indicated that those appointed as inspectors would be suitable. They did however continue by drawing the boards attention to the improvement works recently completed in Rugby, by a Mr. Rammell, in glowing terms⁴. The town took the hint and after inspecting the works at Rugby decided to engage Mr. Rammell as engineer to the Warwick Local Board of Health in March 1852 [34 27 March 1852].

Mr. Rammell very quickly appraised himself of the state of the town and by June had advised the Mayor that, in his opinion, the town should get its water from a spring recently laid bare in the railway cutting at Hatton - however his full report was not received until that August. [34 14 Aug. 1852]

³ Locally drawn plans would only be accepted if first checked for accuracy by the Ordnance Survey.

⁴ First brought into use in 1852 Rugby's water supply was failing by 1854 - the catchment area was said to be too small [26].

THE DRAINAGE WORK

In his report Mr. Rammell drew the Local Boards attention to the fact that much of the town was very low and that the fall of the river from East of the town to below the castle was less than two feet in the mile - a gradient quite insufficient for the unaided discharge of the sewerage matter.

He made two suggestions. Firstly that the sewage should be collected somewhere to the South of the town from whence it would be pumped to its final outfall or secondly that a main drain should be laid across the meadows from a point about 1/2 mile below the Emscote Bridge and then continue Westwards through the gardens below Mill St., and through the castle pleasure grounds to an outfall at the junction of Fishers Brook and the River Avon - the flow to be assisted by the admission of water from The Avon i.e. that the main should be continuously flushed with river water. In this scheme Bridge End, on the South bank, was to be joined to the main drain by a pipe crossing the river above the weirs. The drains were to be in glazed stoneware pipes varying from between 7 and 15 inches in diameter for the street and branch drains with the main drain 18 inches diameter. The river crossing from Bridge End to be in 18 inch cast iron pipe.

This second option, estimated to cost £8,250, was immediately the preferred option as it avoided the necessity for pumping whilst permitting the later utilisation of the sewage manure should this be profitable. Lord Warwick was however not pleased to have his pleasure grounds dug up for the drainage works [34 18 Sept. 1852] and also being keen to make use of the sewage manure on his land suggested that the main drain should run through the castle park. If the town would then build a sewage collection tank on his land he would undertake to keep this clean and pay a fair price for the manure. This plan was not unreasonable for there was already the intention of connecting Bridge End to the town by means of a river crossing - to run the main drain South of the river it was only necessary to reverse the flow in this drain. However it would still be necessary to retain the outfall into Fishers Brook to serve the needs of that part of the town, West and North of the town centre, that naturally drained below the Castle.

It was this modified scheme that was built between 1856 and 1858 concurrently with the water works that are described in the following section. The drains were laid at a sufficient depth to allow the connection of closets installed in the basements of the houses⁵ but were not intended to drain the basements or take any other waters [34 17 Jan. 1857] despite the inspectors recommendation that some of the street drains should be so connected [18 Para 95]. Nevertheless surface waters were being diverted into the drains, at Emscote, very soon after the work was complete

⁵ The basement of one house in West Street, occupied by a Mr. Brown, was below the drain [34 17 Jan. 1857].

[34 11 Sept. 1858]. The works apparently [34 17 Dec. 1853] included some 11 miles of glazed earthenware pipework. The river crossing was in cast iron laid on saddles of cast iron fixed to elm piles. We later learn that it was necessary to draw a brush through the river crossing to keep the pipe clear [3 13 Oct. 1868].

WATER SUPPLY

As noted Mr. Rammell moved swiftly in the summer of 1852 to conclude that the preferred source of water for the town was the spring recently exposed in the new railway cutting at Hatton [14 Part of serial 36]. However further enquires found the railway unwilling to let the town have their water - they required it for their own purposes. Mr. Rammell's second preference was to get water from the Inchford Brook at Haseley - firstly as the sole source of water for the town [14 Part of serial 36] but later to supplement the water that he believed would be surplus the railways requirement from the spring in Hatton Cutting [14 Serial 39]. He was also asked to consider the use of springs at Shrewly - which he found small and feeding the Inchford Brook above Haseley Mill [3 3 Nov. 1852]- and Pinley - the waters of which he found hard and expensive to exploit due to the distance from the town and the necessity for both a deep cutting, to take water to the town, and a large storage reservoir, of 20 million gallons capacity, to store water for use in dry weather when the flow was low [14 Serial 45].

The Haseley Scheme was for a time the towns preferred option and Mr. Rammell lost no time in having drawings, specifications and draft advertisements drawn up despite having no agreed site for the necessary reservoir. However this scheme eventually foundered on the towns failure to agree compensation with those who had rights to the water below Haseley Mill.⁶

Mr. Rammell did not abandon his hope to persuade the railway company to allow the town the use of its surplus water until June 1853 but then presented the town with some very different proposals. These were to obtain water from the red sandstone rock below the town by means of a deep borehole [14 Serial 45]. This water was then to be pumped into a water tower, in the town centre, which would have a sufficient capacity to maintain the supply when the pumping engines were shut down at night. He estimated the cost of these works at £18,000 with annual costs of £350. This brought Mr. Rammell's estimate of the whole works (water and drainage) to £26,250 which the council believed it could fund at 4% p.a. over 30 years with a water rate of 1/6d in the pound. In the event the town sought approval to borrow £29,000 - a sum no doubt intended to cover not only the cost of the works but also the

⁶ Under the 1848 act Local Boards had compulsory powers only within their districts. If water was to be brought from Haseley they would require either the voluntary agreement of all the landowners and all those with water rights below the mill - extending certainly as far as Kenilworth and perhaps, in the light of events some 20 years later, down the Avon as far as Saxon Mill - or new parliamentary powers.

engineers fees and other necessary expenses - which was granted on the 25 th. August [3, 34 3 *Sept. 1853*]. Meanwhile the towns attention had been engaged in the selection of sites for the pumping station and the water tower whilst Mr. Rammell had been asked to advise on the advantage of joining with L'Spa on improvement works. On this Mr. Rammell thought the 'savings slight' and that 'it would not be possible to accommodate the wash houses [34 13 *Aug. 1853*].' Unfortunately no further details are given but the reference is noteworthy being the only indication that the provision of heated public wash houses was ever considered by the town.

Mr. Rammell's preferred site for the pump house was close under the town along Old Park Lane (now Cape Rd.) with the water tower at the corner of Priory Park nearest to the town centre [3 13 *Jne. 1853*, 14 *Serial 32 & 45*]. For unknown reasons these were found unsuitable. Two other sites for the pump house were then considered - the first on charity land between Coventry Rd. and Packmore Lane and then, after objections from residents not wishing to see 'a smoking chimney',⁷ to a 1 1/2 acre site adjoining the canal in the ownership of the Earl of Warwick [3 11 *Oct. 1853*].

By the end of September the town was able to advertise for tenders for the water supply and drainage works which, with but one exception, were placed in the first quarter of 1854.

The well, which was to be 12 in. dia. and up to 400 ft. deep, was to be sunk by a Mr. Robert Paten (*see appendix 6*). Unfortunately although water was found it was of indifferent quality and in quantity much less than the town required [34 17 *March 1855*]. Mr. Rammell was keen to go deeper in search of good water, but the town was reluctant to enter into new contracts without some greater assurance of water being found. To this end they sought to obtain the advice of an 'eminent geologist or mining engineer' [3 28 *May 1855*]. They obtained the services of a Mr. Ramsay who had recently completed a geological survey of Warwickshire. His report was not favourable. Warwick, lying about 1/2 mile East of a fault, he thought that although going deeper might find more water this was unlikely to be of better quality than that found so far. The town also had a report from the town's surveyor [34 2 *June. 1855*] suggesting that the Red Sandstone might not be found 'under a distance of 1,100 feet'. With this advice the town was reluctant to proceed with the bore being finally abandoned in July 1855 [3]. The towns last option was to take water from the Avon but with the costs already incurred the towns financial position was becoming critical.

By statute local boards were able to borrow up to the total rack rent (rateable value) of their district with the loan to be repaid in not more than 30 years. In the case of Warwick the total rack rent was a little over £30,000. In principal

⁷ Warwick residents had already prevailed upon the railway company to erect wooden screens along the new railway line to B'ham.

funds could be raised privately, from insurance companies, or on less favourable terms from the Loan Commissioners,⁸ Seeking first to raise finance privately the town had, by April 1854, unsuccessfully approached sixteen leading insurance companies [34 15 *April 1854*] with a view to borrowing £29,000. They found two problems - firstly that they had no assets to mortgage and secondly that the insurance companies took the revenue base to be not that of the whole district but only that part of it which would benefit from the proposed works. This was the so called 'special district' with a value of only £27,626. By necessity the town turned to the loan commissioners and obtained a loan of £29,000 repayable over 20 years at an interest rate of 5% [34 13 *May 1854*]. Even then the town was finding the value of the tenders received to high and was instructing Mr. Rammell to reduce costs to not more than £26,000 excluding land, engineers and inspectors fees, and land charges. [34 13 *May 1854*]. However, by August, the General Board had come to recognise that their loan approval exceeded the value of the special district and reduced their approval accordingly [34 12 *Aug. 1854*]. The town had no option but to make further savings and instructed Mr. Rammell to further reduce the value of the works which were not to exceed £24,000. This he agreed to do 'without in any way impairing the efficiency' [5 10 *Aug. 1854*, 34 12 *Aug. 1854*].

How the savings were achieved is not recorded but the necessity for economy very likely contributed to the subsequent engineering problems.

When the works were complete the town lost no time in re-mortgaging their debts at 4 1/4% interest over 27 years (30 years from the date of the original loan) with the Economic Life Assurance Society [34 24 *Dec 1858*].

Almost simultaneously with the abandonment of the bore the town found that the partnership between Messrs Rammell and Lister was to be dissolved. From the ensuing debate it is clear that the town had not, up to then, entered into any formal agreement with the engineers as regards to their fees. Mr. Lister offered his services to complete the works, which by then were at a complete standstill, on the following terms. £1,000 to be paid in settlement of all past engineering fees with a further £800, inclusive of all expenses but exclusive of the costs of employing a clerk of works, to be paid on completion [34 18 *Aug. 1855*, 5 6 *Aug. 1855*]. This was agreed.

It was then necessary to obtain a suitable site for the waterworks which would draw water from the river and pump to the water tower in the town. The site selected was at Emscote, above Portobello Bridge (GR 301658) some

⁸ An alternate way of providing water and drainage to a district was to have these provided by a private company, or companies, who would complete the works at no cost to the local board - indeed many private undertakings predate the passing of the public health legislation. Such arrangements freed the local boards from seeking the commissioners approval and were a means by which works with a greater cost than permitted by the statutory constraints could be undertaken.

1 1/2 miles East of the town. By late November trial borings had shown the site to be suitable for the proposed works and negotiations were entered into with the Earl of Warwick not only to obtain the land but also the right to abstract up to 200,000 gallons of water a day from the river [5 26 Nov. 1855]. The Earl's right to grant, or to impose conditions, on the abstraction of water from the river was apparently not questioned and the agreement entered into included for a penalty of 2/6d. to be paid for each 1,000 gallons by which the abstraction exceeded 200,000 gallons per day⁹[16]. In this matter the Earl's concern was that reducing the river flow would cause a nuisance by exposing the river bed opposite the castle. In the end agreement was reached only after the Earl had been assured that not only was the proposed rate of abstraction 'not one fiftieth part of the flow past the castle' but that with the towns drainage to be discharged downstream the river water quality would improve and not deteriorate.

1856 finally saw the improvement works started. By May the commissioners to the general board had sanctioned the revised works and the loan commissioners had agreed to advance the necessary funds - the town had also agreed terms with the Earl of Warwick over the waterworks site and the abstraction of water although the documents would not be signed for some time.

The town lost no time in resurrecting the suspended contracts for the supply of materials and in appointing James Marriot for the civil engineering works. To supervise the works they appointed a Chief, and Deputy, Superintendent of Works at, respectively, salaries of 12 and 8 gns per month [33 7 Jne. 1856].

By October the works were well under way with the reservoir and two filter beds at Emscote nearing completion and the water tower started [33 18 Oct 1856] but the town had still not finished with meddling with the works then in hand. Firstly members were distressed to discover that the water pressure would be insufficient to fight fires in the upper floors of the highest houses in the town [3 9 Dec 1856, 33 17 Jan. 1857]. Mr. Lister advised that to fight such fires it would be necessary to raise the height of the tower some 50 feet which he estimated would cost an additional £1,400 but that it could be raised some 20 feet for about £250 [33 14 Feb. 1857] - even this the town could not afford. Then others discovering that they would not be allowed to drain their basements sought to have the design changed but without success [33 17 Jan. 1857].

The most prominent of the new improvement works in the town was the water tower (GR 281650) The engineers

⁹ When the agreement to abstract water from the River Avon was renegotiated in 1867 the Earl sought to include a clause to the effect that abstraction of water over 200,000 gallons per day would be entirely at his discretion i.e. he would very likely refuse such permission when the river was low. However due to some confusion this was not included in the final agreement which apparently allowed the town to abstract any quantity of water without the Earl's permission and with the penalty for exceeding 200,000 gallons per day reduced to 1/-d. for every 1,000 gallons.[34 18 May 1867]

had intended to have this in some architecturally pleasing design but the town found this to be too ornate for its tastes and instructed that it should be in plain brickwork [3 11 April 1854]. The result was the monolithic monstrosity that survived into the 20C [20]. By August 1857 the Warwick Advertiser was reporting the progress of the works as follows:-

"The tower was complete - so far as the brickwork was concerned - some weeks ago, and the iron tank upon its summit is now in course of construction. The height of the tower is fifty feet three and one half inches; and the tank was capacious enough to hold nearly 60,000 gallons of steam compelled Avon.

We fear the structure may be a water tower in the additional sense of drawing water from the eyes of the rate paying beholders."

The public improvement works were substantially complete by the end of 1857. The pumps were first run in January 1858 when the water tower was filled in two hours [33 9 Jan. 1858]. Only then [33 16 Jan.] did the town seek tenders for the private improvement works which would bring water and drainage into the houses - work expected to be finished in 30 months but which was still incomplete 15 years later [33 16 July 1870 & 13 Sept. 1873].

The formal completion of the improvement works took place in July 1858 when, without fanfare or public ceremony, the town took over the pumping engines from the contractor.

PROBLEMS

At first the town was well pleased with its new water supply and drainage but this was soon to change. The first problem was the poor quality of the water. This was unavoidable given the state of the river and the very simple filtration used at the water works¹⁰ however this was at first masked by the exploitation of a small spring discovered during construction of the works [33 17 July 1858]. By using this spring water it was, at first, unnecessary to use any river water but as the demand increased more and more river water was used with consequent deterioration in the quality of the supply.

Then it was found that the taps ran dry soon after the pumps stopped in the evening - the water tower did not hold sufficient water to meet the overnight demand. This problem arose from several very different, but often interrelated problems. Firstly the town stopped the engines at 9 pm. after only 15 hours pumping. Thus the water in the tower was expected to supply the towns needs for 9 hours, including the hour of high demand between 9 and 10 pm., rather than the 8 night hours that had been the engineers intention. Then the demand for water was very much

¹⁰ The inspector had recommended that a reservoir, holding 30 days water, be provided to avoid taking in river water when it was badly polluted. This was not built.

higher than expected. Intended to provide the town with a constant supply of water the demand was not expected to exceed 250,000gpd. but by 1863, with the water on for only 15 hours each day, about 263,000gpd. was being supplied with the overnight demand, when experimentally kept on, not falling below 4,000gph.[3]. This was partly due to leakage, some wooden water pipes had been retained, and partly to deliberate waste although the failure to make any allowance for industrial demand, street or garden watering contributed to the problem.

The primary source of deliberate waste was the practice of continuously flushing water closets. This had its origins in a drainage problem. For whatever reason the engineers intention to ventilate the drains through '122 Cast Iron Gratings over Vertical Pipes' [14] was not carried out. This resulted in the drains becoming pressurised - sometimes sufficiently to blow gasses through the closet water traps [33 14 March 1874]. The response of householders so affected was to continuously flush their closets. This was easily done for most of the town had the very cheapest type of closet the 'Hopper Closet'. This type had a plain truncated bowl that was flushed by a opening a manual stool cock connected directly to the mains. The stool cock would automatically close when the hand was removed but it was very easy to prop it open with a brick, or to tie it up with a string.

The waste of water was of course considerable and the town sought to identify and prosecute those it discovered wasting water. However it was another 20 years before the town undertook to ventilate the sewers and remove stool cocks.

The shortage of water at night was not only an inconvenience to the people of Warwick but it also left the town without water for fire fighting. Thus it became the practice to turn the water off at 9p.m. in order to keep a reserve for this purpose [6 20 Dec. 1860].¹¹

Then the winter of 1859/60 found much of the town, including all of the Saltisford, New Road, Water Cart Lane, Priory Rd. and The Cape, without water when the mains froze. The problem was repeated the following winter when many houses were without water for several weeks. This led to a ratepayers revolt and the town found it necessary to arrange for men to carry water, in buckets, about the town [33 12 Jan. 1861].

The problem was caused by much of the pipework being laid at to shallow a depth - some had only 10" or 12" of cover. As the specification had called for all water pipework to be laid 21" below the surface¹² legal notices were served against the contractors - James Marmot - and the engineer -

Mr. Lister [4 Jan. and Feb. 1860, 10 Jan. 1860]. It is not known how this matter was resolved but there are no reports of freezing pipes after the winter of 1860/61. Curiously no blame seems to have been directed against either The Chief Superintendent of Works or his Deputy for their failure to ensure that the works were carried out in accordance with the specification.

In January 1861 the town found itself without water, for 1 day, when the water works were inundated by flood water [3 5 Jan 1861]. This was to be only the first of many similar occurrences. Then in March the pipework serving the water tower failed and for several days the water was only to be on between the hours of 7 to 10 am and 3 to 6 p.m. [33 9 March 1861].

In 1869, following difficulties with keeping the drain under the canal at Emscote clear, it was decided to install a new brick, egg shaped, sewer. Unfortunately, on the 16 May, the works caused the canal embankment to fail carrying boats and fish into the meadows where, to the great enjoyment of many, the fish were gathered up by hand. This is all very humorously reported in the Warwick Advertiser of 22 May 1869.

The canal was closed from the 16 May until the 1st. June. The town accepted full responsibility for all losses which appear to have eventually exceeded £1,200. Of this total £800 was paid to the canal company [3 11 May 1869, 24] with smaller sums to boat owners and others. Why no responsibility lay with the contractor is not explained.

Similar problems of repeated blockage were also experienced along the other main drain running west from the town. In 1872 the surveyor reported finding up to 13 inches of deposits in the 18 inch drain - deposits which included many large stones that he thought likely to have been left in the pipe by the original contractors [33 25 May 1872]. To clean this drain recourse was made to the newly acquired steam fire engine. The drain was opened every 60 yards or so and after pulling a rope through the main was flushed clear by a water jet from the fire hose.

Not having a constant supply of water was a great inconvenience to the town. Early risers would leave for work before the water was on and many would be about long after the water was off for the night. Thus several times the hours of supply were varied in attempts to minimise the inconvenience at least cost but always the hours of supply were to revert to 6 am. and 9pm. By the 1870's the town was pumping as much water as it could, some 350,000g during the day, and still there was very little water in the tank when the pumps stopped [33 5 April 1873].

¹¹ It was much later pointed out [34 16 Dec. 1871] that the quantity of water required to recharge the mains was so large that very little, if any, was available for fire fighting until the pumps started.

¹² Modern practice requires water pipework to be laid at a depth of 3 ft. (900 mm) for protection against frost.

THE SEWERAGE IMPROVEMENT WORKS

With few exceptions the sanitary improvement works of the mid 19C discharged raw, or only partially treated sewage into rivers or other watercourses. The consequent gross pollution of many inland waterways was apparently not of any initial concern to the sanitary reformers who although promoting the utilisation of the solid matter as manure did so for its economic benefit in defraying the cost of the works not in order to reduce river pollution. Inevitably those downstream of the sewage outfalls were not best pleased with the new arrangements and put much pressure on the towns to clean up their act. Whilst Warwick sought to reduce pollution from Coventry, Kenilworth and Leamington Spa it was itself being pressurised by the residents of Barford.¹³

By 1865 things were coming to a head and Warwick joined others to petition parliament for the early passage of an act for facilitating the more useful application of sewage maintaining that nothing could be done without additional powers [3 2 March 1865]. Although this act was passed in the summer of 1865 it appears not to have given any greater powers to Local Boards - to the contrary it provided new opportunities for complainants to prosecute over discharges. Be that as it may many in the town were strongly against the expense¹⁴ of cleaning the discharges and it was only the determination of a Miss Ryland to have the nuisance abated that forced the town to act [33 14 April 1866].

The technology of the day provided few options for the abatement of sewage pollution. Those that could discharged their sewage into the sea, or at least (e.g. London) into a large estuary, whilst some inland towns, e.g. Birmingham after the Great Stink of 1871 [32], sought to exclude sewage from the drains by the twin track approach of encouraging the use of earth closets whilst penalising the users of water closets. Otherwise arrangements would be made to separate solids from the liquor - the solids to be composted with street sweepings and the liquor used to irrigate the land. Within these general principals several variations were to be found. Some recommended deep flooding of the land followed by cultivation, others intermittent shallow irrigation or furrowing the land with crops grown on the crests above the irrigation level [29]. The manure would be collected by simple settlement and/or filtration sometimes assisted by chemical precipitation in so called deodorising tanks. In some towns, e.g. Coventry, the liquid manure would be mechanically compressed into a cake for easier transport.

Warwick, apparently, never considered excluding sewage from the drains but determined to provide itself with a Sewage Irrigation Farm. A committee of the Local Board then enquired into the practices of other towns and visited works at Rugby, Stroud and Croydon. They were not favourably impressed with the works that used chemical precipitation and recommended that the town adopt a system similar to the recently completed works at Croydon where up to 5,000,000 gallons of sewage effluent were treated each day first by a clay filter bed and then by land irrigation with the liquor flowing to the land in open trenches regulated by float and stop gates. They reported that ice was no problem in winter as the temperature of the inlet was between 50 and 56°F, with the outlet never falling below 33°F. The new works had apparently cost about £5000 and the sale of manure, at 1/- per cartload, produced a revenue of £300 to £400 per annum. They also reported that previous attempts at chemical precipitation had proven unsuccessful costing between £300 and £400 per annum [3 13 Feb. 1866, 33 17 Feb. 1866, 11].

The engineer for the Croydon works that had so impressed the committee was a Mr. Latham and it is therefore no surprise to find that it was he who was appointed to be engineer for the Warwick Sewage Improvements. He worked very quickly, too quickly, to complete his first report on the 15 May 1866 [11, 33 10 Sept. 1866]. In this he reported that there was not sufficient fall in the land away from Warwick to operate a sewage farm entirely by gravity flow - pumping would be necessary. For this purpose he favoured water power and proposed taking over the Castle Mill for this purpose. The two main drains would be brought together in a covered reservoir/filter close to the mill from which the manure would be taken away by road. For the pumping engine he recommended the use of a Wrought Iron Poncelet Water Wheel¹⁵ working a number of pumps according to the demand. As he was expecting only to run the pumps during the day he thought that power would be available at night to run a corn mill. The report continued to recommend the installation of an auxiliary steam pump for use during excessive flood or drought or to supplement the power of the wheel for raising storm water.

He further recommended that the town should obtain between 100 and 110^a of land for the sewage farm either on the Banbury Road or on The Common and concluded with costing several alternate schemes the least expensive of which was £5917 and the most expensive £6817 excluding compensation for the land, property to be taken and all running costs. In both cases the cost would be offset by the revenue from the expected sales of 650 tons of hay which at £3 per ton would produce a revenue of £1,950 p.a.

¹³ The original drainage works in Warwick included two filtering tanks on Lord Warwick's land. From these he took as much manure as he required letting all surplus, and all of the liquor, pass through to the river outfall.

¹⁴ The statutory constraints on borrowing that would have made it impossible to contemplate any additional capitol works a few years earlier had been eased by the Local Government Act of 1858 which allowed increased borrowings if approved by a 'provisional order'.

¹⁵ A Poncelet Water Wheel was a new form of breast shot water wheel that by employing shaped buckets greatly improved the efficiency.

These were unrealistic proposals for the Earl of Warwick was unlikely to accept the construction of a sewage tank under the Castle wall.

Mr. Latham was therefore asked to come up with new and less expensive proposals [3 12 *Jne. 1866*].

Meantime the town sought about 100^a of land for a sewage farm somewhere to the West of the town and found Lord Dormer willing to lease land on Gog Bridge Farm (GR SP2663) between the Hampton on the Hill and Stratford Roads. A suitable site for a pumping station was found on the West bank of Fishers Brook where it joined the River Avon (GR SP277630). The existing drains would then be extended from their present outfalls to the new pumping station. This was all agreeable to Lord Warwick, who used the manure from the present tanks, so long as he retained the right to fill these 12 times a year [3 12 *Jne. 1866*].

In his first assessment of the towns needs Mr. Latham had assumed that the sewage flow would be 500,000 gallons per day (gpd) but gauging's in early September found the flow to average 950,000gpd. Whatever the reason for the higher flow the effect was to cause Mr. Latham to double the size of the pumping engines from 15 HP to 30 HP and to recommend that the town find 200^a of land for the farm [11 2nd. *Report*]. This advice wasn't very well received and following new gauging's in the second week of October that showed a reduced average flow of 743,000gpd. Mr. Latham reluctantly conceded that 100^a would probably do. Subsequently the design flow (dry weather flow) was taken to be 700,000 gpd. and the storm flow to be 'as much as the existing sewers will convey'.

In his third, and final, report, of October 1866 [11], the pumping station was to have duplicate separation and cleaning (tanks) to keep back the crudest portions from the pumps and from being applied to the land. The Stratford Road outfall was to be extended to the pumping station by a new 18" earthenware pipe whilst the Castle Park outfall would be brought across the river in a 24" Cast Iron pipe laid beneath the bed of the river.¹⁶ Two 25 HP. condensing beam engines would pump the liquor through a 16" rising main to the farm. A single engine would pump the dry weather flow in the normal working hours of an engine driver (12 hours) whilst two engines would raise all the sewer water that could be conveyed by the existing sewers. The pumping head was calculated to be 80 ft.

Mr. Latham separately confirmed that the engines would be of a simple design - the town had enough of the complicated gearing at the water works. The town was also showing an interest in the 'new apparatus for the consumption of smoke' [14 *Serial 31, 33 16 May 1868*].

The estimated value of the works was £9,000 with annual expenses of £1,550. The sale of crops was expected to bring in about £1,950 p.a.

Application was promptly made to the Secretary of State for approval to borrow £8912-11-7d for this work. This was granted in January of 1867 on receipt of which the town sought to fund the new works by a combination of new borrowing and the re-mortgaging of the outstanding debt in the sum of £30,000 to be repaid over 50 years [3 12 *Feb. 1867*]. This was unsuccessful and it was not until April 1867 that a new mortgage, for less than £9,000, was apparently arranged with Messers Ryland and Mashincan [3 9 *April 1867*] although it was later said to be with a Mr. Dixon.

Due for completion on the 1st. February 1868 the works were not finished until late July. Although the full reasons for the delay are not known it seems that the excavations at the pumping station had to be deeper than originally intended with consequent delays and escalation of the cost. By August the original loan had been exhausted with the contractors still owed some £3,000. Not all of this deficit was additional construction costs for the delay in irrigating the land had lost much of that summers crop and the value of what had been produced had been greatly depressed by the 'prejudice against sewage crops' [3 13 *Aug. 1868, 11Report on Completion Sept. 1869*].

The fields, which were drained by ditches, were to be irrigated by sewage liquor in rotation - 1/10th. of the land to be under irrigation at any time - with the liquor passing over two fields before draining away from the sewage farm. The main crop was to be grass which was to be cut and sold as fodder. Milan Rye Grass was particularly recommended for this purpose as the foliage was not burnt by contact with sewage liquor. One third of the land was to be broken up each year and intercropped with vegetables chosen on the basis of matching the chemical composition, of the mature crop, with the minerals found in the soil and liquor on a proportionate basis [11 *Report on Completion Sept. 1869*]. These fields, presumably, not being able to receive sewage until the crop was well grown and the tender parts clear of the ground.

The town had expected to be able to lease the sewage farm as a going concern and indeed advertised for tenders on the 23rd. May 1868 [33, 15] with the operation of the farm described thus :-

"The tenant shall at all times pass the sewage over not less than two plots of land in succession, or more if found necessary in order to complete the purification -- "

"The sewage to be delivered on the land daily free of expense to the tenant."

"The tenant shall at his own option, break up the land and cultivate with sewage any crop he chooses provided that such portion of land broken up shall not, at any time, exceed one fourth of the whole area."

¹⁶ It will be recalled that the original river crossing, above the weir, was 18" dia. and carried on piles below the surface.

Nothing was to come of this and in August they appointed a Mr. Clifford, of Westgate Lodge, as superintendent of the farm. Mr. Clifford, with much experience of irrigation in India and elsewhere [3 11 Aug. 1868] held differing views to Mr. Latham on how the farm should be run. Apparently he wished to irrigate the land by flooding with liquor. Unfortunately it is not known which view prevailed.

The town, given to expect a profit from the farm, soon found the opposite to be the case. This was partly due to the land being overloaded - Mr. Latham's advice to obtain 200^a being eventually shown to be about right - and partly to some of the land being very heavy and not free draining - a problem exacerbated by the apparent failure to install sub surface drainage. To overcome these problems it was necessary to have more land and in 1871 the sewage farm was extended to cover 135^a [7 14 March & 11 April 1871] and subsequently 3 and 4 inch field drains were laid [2 13 Oct. 1874].

In 1875 an offer was received from the Warwick Irrigation and Dairy Co. Ltd. to lease 180^a of irrigated land at £3 per acre they to pay all tithes, rates etc. provided that the town agreed to pump the sewage at their own expense. The town then paying only £2 - 19 - 0d. for the land and the revenue from the sale of produce often not covering the expenses¹⁷ this offer was well received. However the town held only 135^a of land. In the months that followed the town negotiated a new lease, on 180^a of land, with Lord Dormer and by February 1876 [2] was ready to complete the deal. The course of subsequent events is not clear - if The Warwick Irrigation and Dairy Co. Ltd. ever took over the running of the sewage farm the enterprise did not last long for by 1880 [7] the farm was under their direct control.

The farm continued to be unprofitable and after much procrastination the town finally decided to adopt another of Mr. Latham's recommendations - to stock the farm with cattle and pigs. The funding for this was approved, by Whitehall, on 14 Dec. 1880 [9] in a complicated agreement with items for buildings, stocking etc. each with a different repayment period e.g. that part of the loan approved for the purchase of stock was to be repaid in two years when the animals were sold.

The pumping station was on a triangular piece of land about 9 x 5 chains, North and West of the confluence of the River Avon and Fishers Brook (GR 277630). Facilities included an Engine House, cottages for the foreman and engineer and two settling beds divided by a large perforated wooden screen to separate the solid from the liquid matter.[33 8 Aug. 1868] A well was also sunk for the use of the two cottages but this was reported to be a failure[33 16 May 1868]. Later an 18 ft. deep receiving well is referred to with the sewer entering 10 ft. below the surface [33 18 Nov.

1871]. We do not have the capacity of the receiving well but, no doubt, Mr. Latham intended that this should be sufficient to hold the overnight arisings below the inlet. However the inlet was regularly covered overnight with the sewers backing up for a great distance towards the town. This was clearly both bad practice and a public health risk to the extent that the Privy Councils Medical Officer not only commented adversely upon this but also sought to have this remedied by either increasing the capacity of the well or by longer hours of pumping [33 18 Nov. 1871 & 14 March 1874 (Quoting Dr. Buchanon's 1870 report)]. The town would have non of this and when, how or whether this problem was ever overcome is not known.

It is not known how the settling tanks were emptied but the settlings were apparently composted with street sweepings before use as manure.¹⁸

When negotiating the lease of the land for the pumping station Lord Warwick had asked that the tanks be covered. This was unacceptable to the town who believed that no offence would arise. However the final agreement apparently included a clause to the effect that the tanks would be covered if this was found to be necessary. In September 1867 Lord Warwick did complain of the nuisance and asked that the filters be covered. This backfired for the town was able to point out that the tanks only held stagnant water at that time and that the nuisance complained of probably came from the brook [33 14 Sept. 1867].

Concurrently with these works the town took the first steps towards improving the drains when ventilators were fitted every 100 yds. along the drain from West St. [33 8 Aug. 1868]. Little, or no, further progress was made until 1874 when under pressure from Dr. Wilson, the Medical Officer, and the Local Government Board [33 14 Jne. 1873, 14 March & 18 April 1874] the town had before them a report on the work required [2 12 May 1874]. The proposals were to provide a 3 ft. square brick manhole, covered with a Cast Iron Open Grating, at every junction and a 9 in. air shaft at every dead end. In all a total of 44 manholes and 47 air shafts being required at an estimated cost of £364. It was also recommended that soil pipes, at the water closets, should have an open ended continuation above the connection to the pan. The principal recommendations were adopted with the necessary contracts being let in July [8]. The work apparently also included arrangements for flushing the sewers [33 18 July 1874] but it is not known whether the proposed changes to the water closets were proceeded with.

In order to minimise nuisance, the vents being at street level, the first gratings were fitted with charcoal 'stench

¹⁷ From March 1867 to September 1872 the sewage farm had shown a total profit of £36 - 6 - 5d. from an expenditure of £5054 - 10 - 6d. [34 12 Oct. 1872].

¹⁸ This is inferred from the practice at Croydon, reported at the Leamington Sewerage Conference Oct. 1866, a report in the Warwick Advertiser of 8 Aug. 1868 that 'space (was) reserved to deposit settlings and street sweepings' and another of 27 April 1872 to the effect that the refuse was left, on the border of the beds, for six months.

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Meantime the town sought about 100^a of land for a sewage farm somewhere to the West of the town and found Lord Dormer willing to lease land on Gog Bridge Farm (GR SP2663) between the Hampton on the Hill and Stratford Roads. A suitable site for a pumping station was found on the West bank of Fishers Brook where it joined the River Avon (GR SP277630). The existing drains would then be extended from their present outfalls to the new pumping station. This was all agreeable to Lord Warwick, who used the manure from the present tanks, so long as he retained the right to fill these 12 times a year [3 12 Jne. 1866].

In his first assessment of the towns needs Mr. Latham had assumed that the sewage flow would be 500,000 gallons per day (gpd) but gauging's in early September found the flow to average 950,000gpd. Whatever the reason for the higher flow the effect was to cause Mr. Latham to double the size of the pumping engines from 15 HP to 30 HP and to recommend that the town find 200^a of land for the farm [11 2nd. Report]. This advice wasn't very well received and following new gauging's in the second week of October that showed a reduced average flow of 743,000gpd. Mr. Latham reluctantly conceded that 100^a would probably do. Subsequently the design flow (dry weather flow) was taken to be 700,000 gpd. and the storm flow to be 'as much as the existing sewers will convey'.

In his third, and final, report, of October 1866 [11], the pumping station was to have duplicate separation and cleaning (tanks) to keep back the crudest portions from the pumps and from being applied to the land. The Stratford Road outfall was to be extended to the pumping station by a new 18" earthenware pipe whilst the Castle Park outfall would be brought across the river in a 24" Cast Iron pipe laid beneath the bed of the river.¹⁶ Two 25 HP. condensing beam engines would pump the liquor through a 16" rising main to the farm. A single engine would pump the dry weather flow in the normal working hours of an engine driver (12 hours) whilst two engines would raise all the sewer water that could be conveyed by the existing sewers. The pumping head was calculated to be 80 ft.

Mr. Latham separately confirmed that the engines would be of a simple design - the town had enough of the complicated gearing at the water works. The town was also showing an interest in the 'new apparatus for the consumption of smoke' [14 Serial 31, 33 16 May 1868].

The estimated value of the works was £9,000 with annual expenses of £1,550. The sale of crops was expected to bring in about £1,950 p.a.

Application was promptly made to the Secretary of State for approval to borrow £8912-11-7d for this work. This was granted in January of 1867 on receipt of which the town sought to fund the new works by a combination of new borrowing and the re-mortgaging of the outstanding debt in the sum of £30,000 to be repaid over 50 years [3 12 Feb. 1867]. This was unsuccessful and it was not until April 1867 that a new mortgage, for less than £9,000, was apparently arranged with Messers Ryland and Mashincan [3 9 April 1867] although it was later said to be with a Mr. Dixon.

Due for completion on the 1st. February 1868 the works were not finished until late July. Although the full reasons for the delay are not known it seems that the excavations at the pumping station had to be deeper than originally intended with consequent delays and escalation of the cost. By August the original loan had been exhausted with the contractors still owed some £3,000. Not all of this deficit was additional construction costs for the delay in irrigating the land had lost much of that summers crop and the value of what had been produced had been greatly depressed by the 'prejudice against sewage crops' [3 13 Aug. 1868, 11 Report on Completion Sept. 1869].

The fields, which were drained by ditches, were to be irrigated by sewage liquor in rotation - 1/10th. of the land to be under irrigation at any time - with the liquor passing over two fields before draining away from the sewage farm. The main crop was to be grass which was to be cut and sold as fodder. Milan Rye Grass was particularly recommended for this purpose as the foliage was not burnt by contact with sewage liquor. One third of the land was to be broken up each year and intercropped with vegetables chosen on the basis of matching the chemical composition, of the mature crop, with the minerals found in the soil and liquor on a proportionate basis [11 Report on Completion Sept. 1869]. These fields, presumably, not being able to receive sewage until the crop was well grown and the tender parts clear of the ground.

The town had expected to be able to lease the sewage farm as a going concern and indeed advertised for tenders on the 23rd. May 1868 [33, 15] with the operation of the farm described thus :-

"The tenant shall at all times pass the sewage over not less than two plots of land in succession, or more if found necessary in order to complete the purification -- "

"The sewage to be delivered on the land daily free of expense to the tenant."

"The tenant shall at his own option, break up the land and cultivate with sewage any crop he chooses provided that such portion of land broken up shall not, at any time, exceed one fourth of the whole area."

¹⁶ It will be recalled that the original river crossing, above the weir, was 18" dia. and carried on piles below the surface.

traps' [33 8 Aug. 1868]. These were later considered unnecessary and omitted from the 1874 improvements. In his annual report of March 1875 [9] Dr. Wilson was able to report the omission was causing little nuisance but the L'Spa Courier of 2 Sept. 1876 described similar vents in that town as 'Stink Holes'.

THE DEMISE OF THE EMSCOTE WATER WORKS

Warwick's waterworks took water from the river Avon above Portobello Bridge. This had never been considered satisfactory for the water was both hard and contaminated by sewage - it was only the 'least objectionable supply' [3 27 Jly. 1850]. The engineers had no effective way of purifying a such water for although they could remove the solids by filtration or in a settling reservoir, and also understood the value of having a storage reservoir that could be drawn upon when river water was particularly foul [18 Para 84] they had no means of sterilising water.

Warwick's waterworks had gravity sand filters but no storage. This might just have been acceptable if the river had remained lightly contaminated but other towns were undertaking sanitary improvement works concurrently with those in Warwick. The consequence was that the river became grossly polluted with town sewage from Coventry and Kenilworth soon after the opening of the Warwick waterworks. Several times ineffective efforts were made to improve the filters and on one occasion it was even suggested that it would be better not to stand the manure where the liquor, and rain washings, would drain back into the filters [33 27 April 1872] but all this was to very little beneficial effect. The construction of settling tanks were also several times recommended but not built.

The colour of the water from the taps was not the only problem - the smaller pipes were often blocked by vegetation [33 13 Sept. 1873] and, no doubt silt accumulated in the larger mains contributing to the 'throbbing'¹⁹ found in houses near to the waterworks[33 14 Nov. 1874]. The town was also without water at night and the attempt to retain sufficient water in the tower for fire fighting proved ineffective for not only was the tank not full when the pumps stopped [33 5 April 1873, 28] but even if full the capacity was barely sufficient to re charge the mains [33 16 Dec. 1871].

By 1866 Warwick's water was very bad and letters started to appear in the local press e.g. "So bad has been the state of the towns water this week that no one, unless driven by sheer necessity, would use it for domestic purposes" and about a tumbler of water left standing for 30 hours "It is

¹⁹ If the mains were clean there should have been very little frictional resistance between the waterworks and the town and thus very little change in pressure as the pumps worked. That throbbing was reported after 1866, when the air vessel was enlarged 'by adding more feet (9 ft.) to its length' [34 17 March & 16 Jne. 1866], is very strong evidence that the main had become partially blocked with sediment.

yellow, muddy and so opaque that I can not see one object in the room through it, nor can I define the outline of a strong gas light." It was also about this time that the town came to the attention of the Privy Council for its high, and not declining, death rate. As a result of these concerns a Dr. Buchanon was sent to report on the health of the town. On the subject of water he reported this to have been " all along in an unsatisfactory state with organic matter in considerable quantity and some brown particles of organic matter in suspension" [30]. The towns response is lost but it appears that the town again considered obtaining water from Haseley going so far as to have new plans drawn up. In the event this proposal was deferred in preference to the sewage works.[33 27 Sept. 1873]

By 1868 the town was looking for other ways to improve both the quality and quantity of the town water. The surveyor in addition to proposing new reservoirs suggested 'The use of prison labour to obtain water from the wells of the new goal to be connected to the present pipes.' [28] ²⁰ Again nothing was done - the town pinning its hopes on improving the river water quality by pressing for improvements to the discharges of Kenilworth and Coventry to little immediate effect

Dr. Buchanon paid Warwick a second visit in 1870. His report of this visit was as damning as the first noting:

"Its present condition is scandalously filthy -- throughout the town it is regarded only suitable for water closets and watering gardens." "Being softer than any other water it is also used for washing but is so often muddy that white things can not be washed in it." "Wherever possible it is not used for drinking -- where so used let it stand till it gets clear or tie a piece of muslin over the tap to catch the creeping things that are sometimes 3/4 inch long." "While water from some pumps was perfectly transparent; that from others contained fibres and floccule; whilst from a few it was so thick and foul that even the towns water was drunk by preference." [28]

The implications of this second report, and the continued interest of Whitehall on the sanitary state of the town, were not lost - if they did not sort it out for themselves the Privy Council would appoint engineers to do so and recover the cost from the town. [33 26 April 1873].

Almost concurrently with Dr. Buchanon's second visit the town appointed Mr. Edward Pritchard as surveyor. The town was to benefit greatly from the employment of this energetic and ambitious engineer who well understood the value of publicity. Mr. Pritchard was to remain the towns surveyor for only three years but was retained as an adviser for many years. The circumstances of his leaving are very unusual - he persuaded the town that it would be necessary to appoint an engineer for the Haseley Water Scheme and sought to obtain this position for himself. But as he could

²⁰ It was about this time that a William Hayes invented a machine for just this purpose [22].

not be both engineer and surveyor he entered into an arrangement, in September of 1873, that allowed him to be engaged as the engineer to the Haseley Scheme, whilst retaining the security of having his old job held open for him [7 11 Sept. 1873]. The arrangement was that, for a fixed fee of £600, he would act as engineer whilst appointing, and paying for, a deputy to cover his other duties. In the event he did not return to the town as surveyor resigning on completion of the works in 1877.

Within the month following his appointment he was advising the town to further modify the filter beds so as to increase the capacity of the medium by one third - to build a new covered reservoir at Emscote - to increase the quantity of water stored in the town - to fit water waste prevention cisterns - to meter the water supplied to large consumers - for the town to use dustbins - and to ventilate the sewers [3 13 Jly. 1870]. However although the town had a new surveyor they did not have a new council. They agreed only to increase the capacity of the filter bed whilst redoubling their efforts to get Coventry to purify its discharges [3 13 July and 11 Oct. 1870, 33 16 July and 15 Oct. 1870].

Mr. Pritchard also found the waterworks to be in poor condition and lost no time in appointing a new engine driver who reported thus on the state of the engines and pumps in March 1871 [12 13 March 1871]:-

That one safety valve, on each boiler, was loaded with pieces of grate bars.

That the steam receiver had its clothing pulled off.

That there was no provision for condensate to return to the boiler.

That the steam domes and pipework were without covering.

That there were bad joints and leaking cocks.

That the beam was in poor condition.

That the wooden teeth on the gear wheel were in poor condition as light had been allowed to fall on them.

That the pump crankshafts were at right angles so that they passed water at the same time (He recommended turning another 90° so that they would oppose each other).

That the gauge did not indicate the height of the water in the air vessel.

That he had been able to increase the vacuum from 5 to 12 lbs. by tightening up.

Towards the end of 1870 Mr. Pritchard was recommending that the town take out fire and boiler insurance for the two pumping stations. Unfortunately the pumping stations were found to be uninsurable without costly improvements. These the town found 'too great' and the proposed premium of £1 per £100 of insured value 'too high' [33 17 Dec. 1870 and 18 Feb. 1871].

By the following year Mr. Pritchard was looking for a new source of clean water in the high lands around the town and which would not require pumping. Looking South he found the existing mill reservoir at Chesterton capable of

enlargement but to be 27 ft. below the summit of the town [33 16 Sept. 1871]. Looking North he found no such problem and by September 1871 he was recommending that the town should exploit the Inchford Brook below Haseley Mill apparently unaware that this had been proposed by others [30 P7]. This recommendation was favourably received by the town who then referred it to Messers Crawley and Newton for a second opinion. Their report was generally favourable. They recommended that 20,000,000g. of water should be stored in a large reservoir with an additional 1 days storage to be held in a holding reservoir on the crest of the hill South of Brownley Green. The cost was expected to be between £8,000 and £9,000 excluding compensation [33 11 Sept. 1871].

As the proposed works were partly outside the 'District' new parliamentary powers were required for the work to proceed - this was put into motion before the end of 1871. In the meantime the surveyor monitored rainfall and flow in the brook.

The publication of Warwick's proposals brought forward many concerns. Many of these were on cost, others on the necessity, some were sceptical that there was sufficient water in the brook for the towns needs or that the reservoir was large enough but 1872 started with concern that it was not healthy to store water in reservoirs. To address this problem the mayor made enquires of several towns - the replies were all favourable with the advice also being given that vegetable growth was not a problem in reservoirs 10 or 15ft deep [33 17 Feb. 1872].

Then the concerns of those along the course of the Inchford Brook below the point of abstraction had to be addressed.²¹ To this end Mr. Pritchard found himself addressing a public meeting in Kenilworth [33 16 March 1872]. He was well prepared to assuage their concerns even suggesting, at one point that Kenilworth could take a water supply from the same source. He started with a few details :

In dry seasons the flow in the brook at Haseley was expected to fall to 150,000 gpd. with all of this being taken for use in Warwick. Below Haseley Mill the Inchford Brook was joined by 8 tributaries before reaching Kenilworth. On the 7th. Dec. last he found these tributaries to be flowing at a rate of 1,000,000 gpd. when the flow at Haseley was only 235,980 gpd. Additionally he had found hidden underground springs greatly contributing to the total flow - with only 700,000 gpd. flowing at Haseley he had found 3,000,000 gpd. only one mile downstream.

Then asked about compensation water he stated that this was usually between 1/3 and 1/2 of the flow.

Lastly, noting that it would be possible to run a 6 or 7 inch main to Kenilworth from the proposed works, he stated that Warwick would be agreeable to joining with

²¹ It will be recalled that it was objections from these persons that caused the town to withdraw from the first Haseley Scheme in 1852.

Kenilworth in this if they would agree to diverting their sewage from the Avon.

In the event Kenilworth was not interested in obtaining water from Haseley and the bill passed through parliament with little delay receiving the Royal Assent in the summer of 1872. The Warwick Local Board Waterworks Act empowered the town to take lands and construct the necessary works for obtaining a supply of water from Haseley. The cost was not to exceed £20,000, the water main was to pass over the canal ²² and they were not to be permitted to abstract all of the flow - 10,000 gpd.²³ of compensation water was to be allowed past the works. However by then the town had decided to defer any further action having received advice, in February, that the cost had risen to £15,000 ²⁴ which sum if borrowed at 4 1/2% interest would cost £800 pa. to be partly offset by a £500 pa. saving in the present working expenses.

By March 1873 the water committee was able to give the town a detailed report on the options.[33 29 March 1873] Commencing with a review of the river pollution it noted that Coventry, 15 miles above Warwick and having a population of some 40,000, discharged about 1,500,000 galls. of nominally purified effluent daily into the river and that further contamination came from Kenilworth. The committee had spent some time looking at other ways of improving the towns water. If the existing waterworks were to be retained not only must the size of the filters be increased but two new settling reservoirs must be built above Rock Mills 'in which matter in suspension in the water may, as far as is possible, be deposited.' Each reservoir was to hold 13 days supply. It was also recommended that carbide of iron, or some other approved material ²⁵, be used in the filter beds. It would also be necessary to fully overhaul the machinery and that 'at no distant date' a new boiler would be required.

They further recommended that a new rising main would be required to take water directly to the water tower with the original main becoming a distribution pipe fed, by gravity, from the tower. By this means the pressure in the lower parts of the town would be much reduced so avoiding the 'enormous waste' of water blamed on the needlessly high pressure. The throbbing of the pumps would also be eliminated.

²² The reader will recall the breach at Emscote in 1869.

²³ It would be interesting to discover how this quantity was determined for it is little more than a trickle.

²⁴ The new estimate apparently included several new elements - legal and engineers fees, the cost of land and compensation to land and mill owners. However the estimated cost of the works had also risen due to the increase in the cost of cast iron pipe and to the influence of the 9 hour day.

²⁵ Carbide of Iron was a product promoted by a Mr. Spencer. The medium was supplied as a direct replacement for the sand and gravel used in regular filters but there was little understanding as to how it worked or the continuing cost of using it. Firstly although an effective filter there is no reason to suppose that it was a better than sand. Its special action was to soften hard water by precipitating calcium in a manner very similar to lime treatment processes. The benefit, if any, of the iron content is unknown. When tried at Rugby, in 1865, it was found to taint the water and to block the filters with precipitates [26].

The estimated cost of improving the Emscote works was:-

For the land	£1,600
For the reservoirs	£5,200
For pipes between the reservoirs and filter beds	£600
For the enlargement of the filter beds	£800
For the new rising main	£1,100
For a new boiler	£500
Sundries	<u>£200</u>
Total	£10,000

The costs of the two schemes were then compared, in the belief that they could be financed at 3 1/2% interest over 50 years, as follows:-

For the improvements to the Emscote water works:-

	£	s	d
Present annual cost	500	0	0
Addition of 1/3rd. for the extra cost of fuel and labour [For a constant supply ?]	166	13	4
Finance charge	<u>426</u>	<u>6</u>	<u>9</u>
Total annual charge	£1093	0	0

For the Haseley Scheme - and assuming that the sale of the existing works would be sufficient to meet the claims for compensation.

	£	s	d
Annual attendance/repairs etc.	130	0	0
Finance charge	<u>669</u>	<u>10</u>	<u>1</u>
Total annual charge	£799	10	1d.

On this comparison the case for adopting the Haseley Scheme was very strong but both technically and financially the comparison was flawed. Firstly it is doubtful that the proposed improvements to the Emscote Water Works would have provided the town with good water - Haseley water was much cleaner. Secondly the carbide of iron to be used in the filter bed was not only expensive - £500 having been quoted in 1865 [3 8 Aug. 1865] - but required regular replacement as it became chemically exhausted. This never seems to have been recognised by the town for with the increased volume required for larger filter beds the recurring renewal cost would have been considerable perhaps adding close to £1,000 pa. to the expenses. Then the proposal to run a new rising main to the water tower appears to have been given insufficient thought. It would not only reverse the flow in much of the pipework about the town but would require that all of the towns water pass through the water tower and not the much smaller quantity that was presently the case with much of the town being supplied directly from the rising main. That this particular recommendation is included, almost as an afterthought, suggests that it was intended principally to inflate the cost

of retaining the existing works and by so doing improve the prospects of proceeding with the Haseley scheme.

Again although not directly stated in the report, but implicit in the costings, was the extra cost of pumping a sufficient quantity of water from the existing works to give the town a continuous supply. No doubt intended to make the two alternatives comparable, both to be continuous, this was not obtained for on the one hand the pumps were to run in order to meet the known demand for water in the town whilst the Haseley Scheme assumed that the demand would be much reduced.

Then not only were the not inconsiderable fees for engineering and legal services omitted but the financing costs were incomplete. Firstly no provision was made for the interest payable on loans during the course of construction and secondly it was not recognised that the value, of the Emscote works, could not be immediately realised. Thus the full cost of the Haseley Scheme had been understated.

Not unexpectedly the town continued to favour the Haseley Scheme but before proceeding again consulted Messers Crawley and Newton. Only then was Mr. Pritchard instructed to prepare detailed drawings. These were complete by May 1874 and went forward for approval with a revised estimate of £17,500 the price of iron pipes said to have risen 30%, earthenware pipes 70% and labour 15% in two years [33 30 Aug. 1873].

Not everyone in the town agreed with proceeding with the Haseley, or any other scheme, for improving the towns water - some were implacably opposed with several candidates standing for election on the basis of their opposition. Although comprehensively defeated, only their leader Mr. Clifford appears to have been returned, his opposition was unrelenting. Before the end of 1873 he had produced a very substantial booklet entitled 'Report of the Executive Committee of the Warwick Ratepayers Association'. Apparently a tirade of unfocussed opposition it criticised the towns decision making, its use of committees etc., but failed to include any constructive proposals for improving the towns water [33 13 Dec. 1873]. It, apparently, received little support and had no effect. The following year Mr. Clifford was claiming that Mr. Pritchards gauging's of the flow in the Inchford Brook were wrong - that there was less water than Mr. Pritchard had reported. This caused Mr. Pritchard to arrange for independent gauging's to be taken the reports of which are of some interest [33 27 Jne. 1874]. The flow over the cill was determined using 'Box's' lessor formulae and the height of the water over the cill. It was the method used to determine the height of the water that produced the discrepancy. The correct method was to gauge the height in still and not running water. For this purpose a post was driven into the water, about 2 ft. upstream, until the top was level with the cill - a spirit level being used for this purpose. The height of the water was then found using a 2ft. rule. By this method the flow was measured in June 1874 with results as follows:-

Mr. Purnell of Coventry	151,781gpd.
Mr. Davidson - surveyor of Leamington	151,735 gpd.
Mr. Pritchard	151,758 gpd.

whilst Mr. Clifford, the objector, and using his own methods, found only 120,000 gpd.

This, at least temporarily, put Mr. Clifford in his place but shows the professionals to have had an unreasonable expectation as to the accuracy of their measurements with no attempt being made to assess the magnitude of errors and uncertainties.

The Sanitary Improvement Act of 1874 reformed The Warwick Local Board of Health into an Urban Sanitary Authority. As such they had sufficient powers to undertake the proposed Haseley Works without the need for additional parliamentary powers - the Warwick Water Act was no longer needed and approval was to be sought through the Local Government Board. However it would have been unwise to lightly set aside, or depart from, the 1872 act. Thus in seeking the approval of The Local Government Board they felt constrained to keep within the limits of that act despite the surveyors belief that a better, and less expensive, supply could be obtained from a newly discovered reservoir below the Inchford Brook.

The town first applied for an inspector to be sent down to enquire into the Haseley Scheme in June of 1874 and followed this with the dispatch of detailed plans in September. The enquiry, in November [33 14 Nov. 1874], was to look into the technical merit of the work but the town also sought to establish its credit worthiness - a necessary endeavour as it transpired that the town had not always repaid its loans on time. From this part of the enquiry we learn that the Local Board had, up to that time, secured six loans to a total value of £38,000. Of this £26,421 was outstanding at an interest of 5% p.a. To some sceptical amusement the town explained that they were intending to consolidate these loans, with the new borrowings for the Haseley Works, into a 50 year loan at 3 1/2% interest from the Public Works Loan Commissioners. This would affect a reduction in the annual repayments from £2,312 to £1,902. In effect the town was seeking not only to borrow at a lower rate of interest but to also extend the original loan to 70 years. In the event not only were the Loan Commissioners unwilling to grant loan extensions unless they had reason to believe that the works would have a longer life than had originally been expected²⁶ but that they were additionally unwilling to advance money, at a very low rate of interest, for the purpose of paying off debts [33 12 Jne. 1875].

²⁶ That part of the assets securing the existing loans, the waterworks, were to be abandoned as soon as the Haseley Scheme was commissioned had been ignored by the town.

So far as the technical presentation was concerned this was largely without interest however Mr. Pritchard spent some time explaining why he expected the demand to fall with the introduction of a constant supply (*see Appendix 5*) - surprisingly not only was this accepted by the inspector but he suggested that the supply might be further reduced from 25 to 20 gallons per day per person. However at no time was there any mention of the substantial additional water requirements of the new Budbrook Barracks which the town had agreed to supply with water that summer [7 9 *Jly. 1874*].

Otherwise Mr. Pritchard found the inspector amenable to his suggestion that the reservoirs and filter beds could be dispensed with in favour of using the underground water and thus when the scheme was sanctioned, in December [33 26 *Dec. 1874*], the approval was reduced to £12,000 although they indicated their readiness to reconsider this should it prove necessary.

The town wasted no time in getting on with the work despite not having reached agreement with the loan commissioners over the new loan. Until agreement on the new loan was concluded in the summer of 1875 the town made use of a temporary facility from S.C.Smith which reached £2000 in June of that year [33 12 *Jne. 1875*].

The contractual arrangements for the work were very similar to those used previously - the town purchased the pipes and fittings which it then supplied to the civil engineering contractors of whom there were two, Mr. G.F. Smith, of Milverton, undertaking the works at Haseley and Mr. Charles Hart, of Leamington, who was to lay 10 and 12 inch water pipes from the town with a branch to Budbrook. This second contract quickly ran into difficulties with the contractor finally abandoning the work on the 24 Nov. 1875 [1]. The immediate cause of this was the unexpected necessity of trenching through marl after the work left the turnpike at Hatton but the contract had soured long before this (*see appendix 6 Part IV*). The town quickly entered into an arrangement with Mr. Smith to complete the pipelaying work but this was not to be as originally contracted for [31]. Shortly after recommencing work on the unfinished main between Hatton and Haseley the works encountered a deep bed of running sand that made progress slow and expensive. Eventually it became apparent that to continue the excavations at depths up to 48 ft. was impractical. The solution was to divert the line of the main and to raise the level of the pipe some 9 or 10 ft. to form a syphon about one mile long. Although the highest part of the syphon was above the then water table at Haseley it would become a true syphon as the water table was drawn down. It was therefore necessary to arrange some mechanical means of drawing air out of the pipework. This was achieved by means of a water powered vacuum pump located above the pure water tank at Haseley and connected to the highest part of the syphon by a 4 inch cast iron pipe. The water to power the water wheel was taken from Inchford Brook but it is not known where the water was discharged - it would have been very easy to discharge this into the pure water

well but to do so would have contaminated an otherwise very pure supply. Novel, if not unique, this arrangement served the town for many years.

Although much work remained to be finished the town received its first water from Haseley in September of 1876 and there was a grand official opening at Saltisford on Tuesday 26th. of that month [23 30 *Sept. 1876*] when the mayor, by turning a tap, caused two fire hoses to send jets of water 50 or 60 ft. into the air. The water was at first supplied 24 hours each day but the demand was so great, at one time being about 700,000 gallons in 24 hours, that almost immediately it had to be rationed by being turned off at night [23 14 *Oct. 1876*]. The blame for this state of affairs was immediately placed upon the residents for wasting water although as early as October Mr. Prichard was conceding that much water passed away through the mains. To assist in bringing the waste under control the town appointed two inspectors to assist the surveyor and engineer [23 3 *Feb. 1877*, 7 30 *Nov. 1876*]. The principal means of identifying those houses leaving taps, or stool cocks, running was by inspection of premises in the day and sounding the stop cocks for running water at night - any flow heard at night being considered waste. However many of the houses in Warwick did not have outside stop cocks but kept them in cellars, or other inaccessible places. Thus by February 1877 Mr. Pritchard was recommending that all houses should be provided with outside stop cocks at a cost that he estimated to be 10/- per house. This was not favoured by the town and by May the intensive efforts to stem the waste had ended [7 7 *May 1877*]. To what extent the demand had been controlled is not known but in February the demand remained 310,000 gpd. when the water was on for 15 hours and 470,000 gpd. when on constantly [23 *Feb. 1877*].

About this time Dr. Wilson, who had long campaigned against water pipes discharging directly into W C pans, presented the town with a report that included details of work recently completed in Rugby to have these removed [33 17 *March 1877*]. In Rugby the pans were now either flushed with pails of water or by cisterns. In addition to removing the risk of contaminating the water supply from the closets a great saving in the demand for water had been achieved amounting to about 10 gallons per person per day. It was not suggested that similar savings could be achieved in Warwick for by that date the sewers were ventilated and the need to continuously flush the pans removed. However no doubt the hope that some water would be saved by these measures contributed to the prompt acceptance of this report [2 13 *March 1877*].

In December, when the surveyor was unable to say how much of this work had been completed, the average daily demand in both July and December 1877 was reported to be less than 250,000g. and when the supply was experimentally laid on constantly for 8 days in November this increased to only 362,285g. [33 15 *Dec. 1877*].

Needless to say the out turn costs were much higher than expected. By September 1876 the estimated final value of

the works, including all contingencies, had very nearly doubled to be £23,818 [2 17 Sept. 1876]. Much of this increase arose from the difficulty of the works at Haseley and the termination of Mr. Harts contract but other factors included:-

The transfer of prior expenditure from the general to the Haseley account [2 8 Jne. 1876] viz.

For the cost of the Water Act.	£674 - 14 - 4d
The costs of water analysis	£43 - 10 - 8d
Messers Cawley and Newton	£110 - 16 - 9d
Other Previous Expenses	£240 - 16 - 9d

The additional cost of laying a supply to Budbrook Barracks for which the War Office was to contribute £600 but which was yet to be received [23 14 Oct. 1876].

The unexpected necessity of purchasing an additional 10^a 3^r 36^y of land at Haseley on apparently very unfavourable terms - the town paying £2,500 for land most of which the town subsequently sought to lease out at only £3 per acre.²⁷

The cost of new pipework and wash out valves, to avoid dead ending, in the town [23 16 Sept. 1876].

Installing a water meter at Saltisford [23 30 Sept. 1876].

Reinstatement of the land, fencing and seeding of land at Haseley [2 8 May 1877].

The cost, including that of employing two inspectors, of attempting to reduce the demand for water.

The town sought to obtain a further loan from the Loan Commissioners but, perhaps not unexpectedly, this was not easily forthcoming. In order to meet its most pressing needs temporary borrowings were again necessary [2 9 Jan. 1877]. However, when received, even the new loan proved insufficient for a further loan was required to meet Mr. Hart's award (see appendix 6).

The final cost not known but the sale of the old waterworks site, which was expected to cover the cost of compensation to the mill owners, was long delayed.²⁸

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- [3] Local Board of Health Minute Books. WRO CR1618/W33.
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- [5] File of Letters from Rammell & Lister. WRO CR1618/W33.8.
- [6] Local Board of Health Reports of Committees. WRO CR1618/W34.3
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- [11] Local Board of Health Sewage Farm: Loose Papers WRO CR/1618/WA6/102.
- [12] Local Board of Health: Waterworks. WRO CR1618/WA6/103.
- [13] Local Board of Health Waterworks. WRO CR/1618/WA6/104

²⁷ Although the town possessed powers of compulsory purchase they were unwilling to proceed with the legal process owing to the delay and the expense that this would incur[2 9 March 1875].

²⁸ The site was apparently still in the possession of the town in the 20C.

- (Serials 55 and 65).
- [14] Local Board of Health Waterworks. WRO CR1618/WA6 105.
 - [15] Local Board of Health Sewerage Farm. WRO CR1618/WA6/106 22.
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Note. WRO = Warwick Record Office.

Appendix 1

PUBLIC HEALTH MAPPING

The General Board of Health required all Local Boards to have accurate, levelled, large scale maps of their towns before they would approve sanitary improvement works. Only with such maps was it possible to accurately describe the extent, and cost, of improvement works and ensure that the drains would carry away the sewerage

As the General Board had a very poor opinion of private surveys they sought to have all Public Health Mapping done by the Ordnance Survey. This view had some substance for not only was the accuracy of historical mapping notoriously poor but of those maps recently drawn up under the Parochial Assessment and Tithe Commutation Acts of 1836 only 1/6th. of the former and 1/2 of the latter were sealed as first class maps. Not that everything done by the Ordnance Survey was perfect for although the accuracy of the main triangulation was, apparently, not questioned much of the detailed work was unsatisfactory and had to be repeated.

Needless to say private surveyors objected strongly to loosing work to the Ordnance Survey and took every

opportunity to denigrate their work as both slow and expensive.

It was not however this dispute that delayed production of the first Public Health Maps but the uncertainty as to what was required for although a Sample Public Health Map of Preston had been produced in 1845 neither the scale or extent of detailing had been agreed when the first Local Boards of Health were established. The Preston map was to a scale of 5ft. to the mile and the Ordnance Survey long recommended this scale to all who made enquires. The General Board of Health however believed this scale to be too small and promoted the use of a scale of 10ft. to the mile. Not until July 1850 were the scale and other details agreed - the scale was to be 10ft., levels were to be shown at the centre of the roadway, at the angle of every street and public place and at every change of inclination of the surface. The level of all cellars, or underground floors were also to be shown.

This agreement came too late for some towns where public health mapping was either complete or in hand. Coventry was one such town and found it necessary to commission new 10ft. 'Detailed Plans' having already obtained 'Block Plans' of the town. Then, the receipt of the Detailed Plans being long delayed, the town found it expedient to have levels added to tracings of the Block Plans already in their possession. Another town that had embarked on Public Health Mapping before guidance had been issued was Liverpool. These were drawn at the enormous scale of 20ft. to the mile 'a scale [later to be said by the Ordnance Survey] so large that from the inequalities in the contraction and expansion in different directions of the paper on which it is laid down, it is almost impossible to execute it correctly as a general detailed map of the town'.

The agreement on scales did not stop efforts to reduce costs. Principally the pressure was to permit private surveyors to do the work but it was also directed to reducing unnecessary detail and to have the treasury meet part of the cost. The first point was soon conceded - from at first being unwilling to accept the work of private surveyors unless certified by the Ordnance Survey as accurate this became an examination of the plans which were to be submitted with the surveyors notebooks. On the second, in July 1851, it was agreed that 'That the amount of ornamental work, in fields and gardens, was to be curtailed' - no longer was every tree and shrub to be shown. And lastly, and only after a long contrition, the treasury conceded that they should make a very substantial contribution towards the cost of producing public health maps.

Warwick first sought approval to undertake sanitary improvement works in March 1850. These were quickly rejected the General Board finding many technical shortcomings including the failure to have the town properly surveyed. This rejection was not well received but after tempers cooled the town sought to re submit their plans with the minimum of additional work. They sought to

avoid the cost of a new survey by using a plan drawn up by John Wood in 1837 which was to a scale of 3 chains to the inch (or about 2ft. to the mile). This was however hardly likely to satisfy the General Board for not only was the scale small it gave no heights or basement levels and when checked for accuracy was found to have errors of up to 1 chain in the length of some streets. Finding that a new survey was unavoidable the town was advised to have this undertaken by a Mr. Hurst who was prepared to supply Block Plans of the town, with a limited series of levels, for £285 or Perfectly Detailed Plans, with a perfect series of levels including every house, for £400. However under continued pressure from the General Board the Ordnance Survey was asked to do this work. The survey was undertaken in 1851 with the town receiving 17 plans at the 10ft. scale, 3 at the 2ft and an index sheet in December of that year.

Initially expected to cost about £600 the full cost of the survey was given as £723 - 9 - 0d. in November of 1852. The account was however not settled until 1856 by which time the treasury had agreed to reduce the charge to £397 - 13 - 9d.

It is interesting to compare the cost of the Warwick plans with those produced privately for Leamington Priors the following year. The Leamington survey was carried out by a John Lyon Alexander of London for which he quoted £584 - 10s. For this the town received 24 Detailed Sheets and a small scale index sheet. Although these appear suitable for their purpose there are clear differences from those of Warwick. Warwick got Block Plans, Leamington did not. Warwick was tied into the national triangulation and was levelled with respect to the sea, Leamington was levelled with respect to the River Avon at Emscote. Warwick got many very useful bench marks, Leamington had none. But only in Leamington was existing underground pipework shown on the plans.

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Appendix 2

WAYS AND MEANS

Local Boards of Health, and later Sanitary Authorities, were never given a free hand to do as they sought fit for although they were encouraged and cajoled into sanitary, and other improvements, very little could be done without the approval of Whitehall. The mechanisms of control were statutory and financial. Firstly the maximum water and sewage rate that could be charged on properties

compulsorily required to take mains services was limited by statute - 2d. per week under the 1848 Act - and secondly not only were there statutory limits on their total borrowing but each borrowing had to be individually approved.

The constraints under the 1848 Act. were not only very restrictive, borrowings to be not more than the total rack rent and to be repayable in not more than 30 years, but were interpreted in a way which was even more so. Thus the total rack rent came to be interpreted as the total rack rent of only those properties that could benefit from whatever works were envisaged. Thus as the outlying parts of the Borough of Warwick were not to benefit from the 1st. sanitary improvement works their rack rent was excluded from the total in determining the board's borrowing powers - a loss of about 10% in value.

As Warwick spent up to its limit completing the 1st. improvements it was many years before any other significant works could be undertaken. There were however other mechanisms for providing sanitary improvements avoiding this difficulty. Firstly you could encourage private investment, by individuals or companies, and secondly you could seek to obtain additional powers by means of a private bill. Both appear to have been widely used but the problem of raising sufficient monies at low interest over long periods remained. No doubt many solutions to this problem were floated but Warwick's only venture into alternative markets was to join what appears to have been a national campaign, in 1867 [1], to obtain powers for the issue of transferable bonds.

The various acts also limited the period for repayment of loans. In the first instance to 30 years but relaxed in the 1858 Act which empowered the secretary of state to increase this to 50 years in appropriate cases. This was further relaxed in 1872 when the maximum period for repayment was extended to 60 years with the borrowing limit raised to twice the annual rateable value of the district.

Having obtained Loan Sanction Approval Local Boards had two principal means of raising funds - commercially, usually by means of a mortgage from an insurance company, or from The Treasury via The Loan Commissioners. Although commercial sources offered loans at lower rates of interest loans were only available if secured by some asset. If the local board had none, and Warwick had very little, no loan was forthcoming. On the other hand although The Loan Commissioners would make unsecured loans they sought to ensure that these would be repaid within the economic life of the works. In general loans were to be repaid within 20 years but in some cases they entered into shorter, and occasionally complex arrangements e.g. When Warwick obtained a loan to stock the sewage farm that part of the loan to purchase the stock was to be repaid in two years whilst that part for the construction of farm buildings was to be repaid in 10 [2].

Having completed the improvement works local boards were apparently free to re mortgage their debt in the commercial market and Warwick certainly lost no time in re mortgaging theirs with the Economic Life Assurance Society at an interest rate of 4 1/4% to be repaid in 26 years (the original approval for a 30 year loan having already run 4 years) which was a considerable saving on the original loan which was at an interest rate of 5% with the loan to be repaid in 20 years.

By the 1870's circumstances had changed for now the Loan Commissioners offered loans at lower rates of interest than were available commercially. This money was, however, not available for the re financing of existing debts except in the most exceptional circumstances [3]. Thus the new Sanitary Authorities only had need of the commercial market to cover short term requirements.

- [1] WRO CR1618/WA6/99 1 Jne. 1867.
[2] WRO CR1618/WA6/32 14 Dec. 1880.
[3] Warwick Advertiser 12 June 1875.

Appendix 3

THE WARWICK WATERHOUSES

In 1693 a John Hopkins, of Birmingham, started an enterprise for supplying the inhabitants of Warwick with water from the Priory Pools just to the North and East of the town. He converted an old mill to pump water to a 'waterhouse' which he had built on a plot of land measuring not more than 20 yards by 16 yards at the North end of Sheep St. (now Northgate) close by the modern traffic island. The 'waterhouse' included a tank, or cisterns, that were filled from the pools with the houses being connected to the cistern by underground pipework. The works were, at least, substantially complete by the following year as water taps are recorded amongst the losses suffered in The Great Fire of Warwick. Whether the new water supply was then used for fire fighting is not known but subsequently the 'Aldermen' of the town acquired the right to break into the pipes in case of fire. The street plan of Warwick dated 1711 shows the 'waterhouse' to be a substantial, probably stone, building but no other details have been found. Clearly the 'tank' or 'cistern' must have been raised above ground level if water was to reach the better houses in the highest parts of the town.

Finding that the 'engines' did not supply sufficient water the original mills were demolished and new buildings and machinery installed about 1703. In the later half of the 18th century the undertaking was in the hands of the Valentine Cooks who had a new 'waterhouse' built about 100 meters to the East of the original on a site which is now part of the car park of 'The Punch Bowl' public house. This second site is lower than the first and so the cistern must have been raised well above ground level to serve the highest parts of the town - truly a water tower but one of which we have no details.

For the first 100,000g. pa.	1/- per 1,000g.
For the next 100,000g. pa.	10 1/2d per 1,000g.
All used over 200,000g. pa.	9d. per 1,000g.

As for the private works these were initially charged at net. cost to the owner as follows :-

"The Local Board will lay down all pipes for water and drainage from the mains to the outer wall of the premises charging the owners or occupiers with the net cost thereof ; and will also, if requested, supply and fix all the requisite pipes and other works for the house services at the net cost of the person desiring them to carry out such works -----" [4]

Later the town was to charge a small premium (2 1/2%) for the private works that it carried out [5].

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 [4] Warwick Advertiser. 27 March 1858.
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Appendix 5

DETAILS OF THE HASELEY WATER SCHEME

Warwick needed a source of clean water to replace that drawn from the River Avon at Emscote. The water of the Inchford Brook at Haseley Mill was found to be comparatively clean (cleaner in the brook than water supplied to Birmingham after filtration) and was at a sufficient height to supply the town without pumping. The problems were of insufficient flow in dry weather and of finding a way to cross the higher ground between Haseley Mill and the town. The solution to the first was large storage reservoirs and the second necessitated a deep cutting through the hill.

Mr. Pritchards first proposals to exploit the water at Haseley, made at the end of 1871, were to be several times changed before the work was finished in 1876.

As first envisaged the water was to be extracted from the Inchford Brook just below Haseley Mill at an elevation some 100 ft. above the highest surface of the town. Eleven acres of land were to be acquired upon which the reservoirs, filters and other facilities were to be provided. These proposals were intended to provide the town with a continuous supply of clean water at a rate of 25 gallons per head of population per day - no extra allowance was given for industrial usage or for watering the streets - a total of 245,000 gallons per day. How the capacity of the reservoirs was determined is not known (but see below) but the minimum flow in the brook was assumed to be 150,000 gallons per day. On reaching the town the new supply was

to connect into the existing mains and the water tower was to be abandoned.

As the Haseley works, and part of the supply main, lay outside the jurisdiction of the Warwick Local Board it was necessary to obtain new parliamentary powers before work could start. This was easily obtained but during the passage of the bill a clause was added to the effect that at least 10,000 gpd., of compensation water, must be allowed to flow in the Inchford Brook below the point at which Warwick was to abstract its water.

By the time of The First Enquiry into the Haseley Scheme, Nov. 1874, not only had changes been made but detailed engineering drawings were available. It was also by then known that a considerable quantity of water lay beneath the surface of the land.

The detailed plans provided for an increased supply of 300,000 gallons per day and made up for the loss of compensation water - 10,000 gpd. - by providing two short 12 inch earthenware adits into the underlying water reservoir. Two reservoirs were to be provided. To the West of the road leading to the mill a depository reservoir 10 ft. deep and with a capacity of 2,116,000 gallons. To the East a storage reservoir 16 ft. deep to contain 19,519,487 gallons. The water would be decanted from the depository reservoir to the storage reservoir and then to filter beds. There were to be three filter beds, one of which would always be at rest, complete with self acting apparatus for washing the foul sand. Each filter bed had a superficial area of 350 square yards. The beds were of washed sand and gravel 5 1/2 ft. deep and had the capacity to wash 245,000 gpd. From the filters water passed to a small fresh water tank, or well, then through an oval brick conduit 3ft 6 ins. x 2 ft. 6 ins and 1661 yds. long to join 736 yds. of cast iron pipe laid along the Beausale Rd to Hatton. From Hatton the water was to be conveyed to the town in 4284 yds. of 10 inch main laid along the Warwick and B'ham Road. On reaching the town the water was to be taken to the water tower which was now to be retained in order to reduce the pressure in the pipes.

The reasons for employing a mixture of brick conduit and two sizes of cast iron pipe to carry the water from Haseley to the town is not explained. The most likely reason for proposing a brick conduit under the hill was to reduce the gradient and therefore the depth of the cutting although it was also credited with keeping the water cool and acting as a service reservoir. Why then two different sizes of cast iron pipes should be used to complete the connection to the town is lost - the hydraulic pressure loss in the 10 inch pipe was stated as 20 inches per mile and in the 12 inch to be negligible.

Details of the main reservoir show that the embankment was clay filled and earth covered, that it was up to 18 ft. high, 90 ft. thick at the bottom and 8 ft. at the top. The embankments sloped 3:1 internally and 2:1 on the outside. The design was said to include due provision for subsidence

of the clay and resistance to percolation. Again it is not known how the size of the reservoirs had been determined but the capacity was reported to be equal to 270 days supply for a population of 11,000 after allowance for evaporation.

By the time of the enquiry Mr. Pritchard had concluded that a sufficient quantity of very pure water could be obtained from the underlying water reservoir to obviate the need for surface reservoirs or filters. The inspector agreed with this assessment and reported "There is impounded within a natural reservoir an immense volume of very pure water which, if properly managed, will require no filtration, and in my opinion will yield an abundant supply for the town of Warwick". The report did however suggest that the design flow be reduced to 260,000 gpd. (20 gallons per head per day with a population of 12 or 13,000). The revised works, without reservoirs, were subsequently approved at the reduced cost of £12,000.

The works taken in hand not only excluded the reservoirs and filter beds but also but also discarded the brick conduit in favour of a 12 inch cast iron main to run from Haseley to the Birmingham Rd. Laid at a gradient of about 1:280 [*The gradient is quoted as both 1: 283 and 1:278*], and at depths of up to 48 ft., this was said to have a capacity of 1,238,400 gpd. The capacity of the 10 inch main was given as 950,400 gpd. at ground level in the market square or 518,400 gpd. to the tower. The work was to include two adits at Haseley - one of 400 yds and average depth of 21 ft. the other of 218 yds. and 15 ft. 6 ins. average depth. The adits were to be of 15 in. cast iron pipe perforated on the upper side. Each pipe was 2 ft. long and, where conditions allowed, laid upon a platform of elm. In quicksand two 5x4 in. runners were laid along the adit joined by 3 ft. x 6 in. x 1 1/2 in. crosspieces secured to the runners by 4 in. iron nails. Finally the pipes were to be supported on two 1 ft. 9 in. x 6 in. x 3in. saddles 'properly cut to receive the pipes'. The trenches were then to be backfilled with:-

Washed gravel the size of hens eggs to a depth of	2 ft. 3 ins.
Washed gravel the size of walnuts to a depth of	9 ins.
Washed gravel the size of horse beans to a depth of	6 ins.
Washed sand to a depth of	1 ft.
all laid to a width of 4 ft.	

In the event ground conditions were so bad that very great difficulty was experienced laying the adits and supply main. For example to reach a depth of 22ft. it was found necessary to excavate a cutting 49ft. wide. Costs escalated and something had to be done.

This was achieved by re-aligning the supply main which was also raised between 9 and 10ft. to form a syphon. Some means then had to be made to release air from the syphon and as the pressure was not expected to remain positive recourse was made to having a water powered vacuum pump draw the air out. Supplied by Messrs Glenfield of Kilmarnock this had two double acting pumps of brass and gunmetal driven by a 3ft. diameter waterwheel with brass

buckets. The machinery was installed over the pure water tank and was connected to the syphon by a 4 inch cast iron pipe. Water to power the wheel was drawn from the brook but it is not clear whether the discharge entered the well, where it would not have improved the quality of the water, or ran away elsewhere. The vacuum pumps were run only as required - this being determined by reference to a vacuum gauge. By these means savings of £3,000 were said to have been made.

Secondly the adits not being complete when water was first supplied to the town and yet found to provide a greater quantity of water than intended, (the 385 yds. of adits completed providing 500,000 gpd.) the town was minded to not to complete these to their full length. Mr. Pritchard did not disagree with this but took pains to ensure that he could not be held responsible for any future difficulties should the adits not be completed to his design. The outcome is not known.

Other changes were made as the work proceeded. Firstly it was agreed to supply water to the new Budbrook Barracks by means of a branch from the supply main North of the town. Although this was likely to result in a considerable increase in the total demand for water it appears not to have had any effect on the design of the work in hand. Then, as the work neared completion, it was decided to install a 6 in. Kennedy Patent Position Water Meter, to register flows of up to 70,000 gph., in the main at Saltisford, to install wash out valves on the dead ends of the existing water mains in Warwick, to fence the manholes at Haseley and finally to re-seed the disturbed land.

As a final note in the course of the works at Haseley and on the greater part of the 12 in. main to the Birmingham Rd., the contractor is said to have employed plant to the value of £2,500 and to have supplied 41,500 ft., or nearly 8 miles, of timber for piles and barrow runs.

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Appendix 6

THE CONTRACTS

Part I - AN OVERVIEW

Superficially the contracts for the Warwick Improvement Works are very similar to those in modern use - they include firm price contracts based upon technical specifications, contracts based on a specification with bills of approximate quantities and a series of contracts based on

a schedule of rates - but a closer examination reveals not only many detailed differences but also a wealth of interesting technical information. This overview describes the contract procedures and documentation used by the Warwick Local Board of Health, and later Sanitary Authority, for the town improvement works. Details of individual contracts are given later.

All the improvement works were carried out by contractors directly appointed, and managed, by the town - there were no 'Main Contractors' and 'Sub Contractors' were not recognised. Pipework, and some other items, were purchased by the town and issued 'free of charge' to the contractor.

All tender documentation was produced by 'The Engineer'. This took the form of a printed 'Specification' and 'Form of Tender', supported, as necessary, by drawings and schedules. The schedules, and the Form of Tender were to be completed by the tenderer and returned.

In addition to the necessary technical information the Specification would include clauses necessary for the management of the tendering process and contract. e.g.

That the works should be in conformity with the specification and drawings.

That the engineers might reject inferior work.

The liability for defects.

The contractor to guarantee the Board against damages arising from neglect or carelessness.

Payment details.

The date for Completion of the Works (not a contract period but a specific date).

Requirement for Sureties to guarantee the work.

Penalties.

The tendering process was open - that is the town did not select who would be asked to tender, it was open to all. The process would start by the placing of a suitable advertisement in the local and technical press advising that specifications could be obtained by application to the town clerk and that drawings could be seen at the council offices and at the offices of the engineer - prospective tenderers were not supplied with drawings but could, apparently, take tracings.

Tenders were to be returned to the town clerk by a certain date after which no further tenders were accepted. After a cursory examination the tenders would be passed to the engineer for detailed examination and recommendation as to which tender should be accepted. The acceptance process was, however, very different from current practice. Firstly none, or very few, of the printed documents produced by the engineer, the tender or any correspondence, was used in the contact. The lawyers brought them all together in a long, legalistic, hand drafted 'Indenture' that additionally included many clauses not previously seen by those tendering for the work. It was this 'Indenture', in

conjunction with a bond to guarantee satisfactory completion of the works, that formed the contract.

Part II - THE FIRST IMPROVEMENT WORKS

For these works the town let a series of eight contracts between 1854 and 1856 as detailed below:-

Contract No. 1 (See WRO CR1618/WA6/104/1)

For the supply of Cast Iron Straight Pieces, Taper Pieces, Curved Pieces, Quarter Pieces, Caps, etc.

Awarded to The Horseley Co. of Tipton Staffs in the sum of £4,600. January 1854

This contract was for a total of some 9,500 tons (12 miles) of both pressure and non pressure socketed pipework. The pressure pipework, between 2 inches and 12 inches diameter and of 1/4 to 5/8 inch thickness, was to be pressure tested at 400 ft. head. The non pressure pipework was 18 inch diameter and 1/2 inch thick. All pipes were to be cast vertically with the metal, in all cases, being equally distributed. The approximate requirements were scheduled and priced on weight ranging from 7/3d. per cwt. for straight pipe between 6 and 18 inches in diameter to 10/- per cwt. in the case of small castings. All pieces, as soon as they had been cast and cleaned and before any rust shall have been produced upon them, were to be submitted to Dr. Angus Smith's patent process (*For the Exterior Coating of Pipework Against Corrosion with a mixture of gas tar, pitch, linseed oil and resin. 1848*).

Half of the pipes were to be delivered by the 14th. of March 1854 and the deliveries were to be complete by 14th. May. Interim payments were to be 75% of the value of the items delivered two weeks after the given contract dates with the remainder held for three months.

Contract No. 2 (See WRO CR1618/WA6/104/23)

For the supply of Stoneware Pipes.

Awarded to Henry, John and Frederick Dalton in the sum of £5306-16-0d. January 1854

This contract was for the supply of non pressure pipes of diameters between 3 and 18 inches and with thickness' up to 1 1/2 inches.

Contract No.3 (See WRO CR1618/WA6/104/47)

For the supply, installation, setting to work and running, for up to twelve months, of duplicate steam engines, boilers and pumps.

Awarded to J Hodgson Jones of Westminster in the sum of £2,400 plus the costs of employing an enginman and labourer as required. Apparently March 1854.

The specification called for each pump to deliver 250,000 gallons of water in 16 hours from a well 30 ft. deep. Delivery was to be through a 12 in. pipe about 1,900 yds.

long and rising 180 ft. above the water level. The fuel consumption was not to exceed 3 1/2 lbs. of Newcastle coal per horse power per hour and the boiler pressure was not to exceed 45 lb. per square inch of surface. The engines and pumping apparatus were required to work either in conjunction or separately and the boilers were to be smoke consuming.

Payments were to be 50% of the contract sum when all of the parts and pieces shall have been brought upon the ground where they were to be erected - a further 25% when fixed and in working order - and the remainder three months later.

The works were to be completed, and in working order, by 1st. July 1854.

In fact Mr. Jones offered double cylinder, and compounded, Woolf condensing engines from the Hyde Park Foundry Glasgow. These he guaranteed to have a fuel consumption not exceeding 2 3/4 lb. per horse power per hour. The cylinders were of 19 1/2 in. and 10 1/2 in. dia. respectively, of 3 ft. stroke and were to run at 40 strokes per minute. The pumps were of 2 ft. 9 ins. stroke and 14 in. dia. - they made 15 strokes per minute. *(Not made clear in the offer they actually got two pumps and two engines all connected together by gearing - indeed the pumps shared a common outlet valve box so that neither pumps nor engines could work independently.)* He also offered horizontal Cornish Boilers each 20 ft. long by 4 ft. 6 ins. dia. with 2 ft. fire tubes.

The work was not to be completed without several crises. Firstly the site of the waterworks was changed from North of the town to Emscote. The consequent delays led to the engines etc. having to be taken into store. Such an event was not provided for in the contract and the town at first refused to make any additional payment for the delay. They relented only after being advised that not to do so would lead to legal action. It was then found necessary to modify the machinery so that it would fit into the pump house.

Contract No.4 (See WRO CR1618/WA6/104/32)

For the supply of 220 Street Hydrants with Boxes and including two sets of keys.

Awarded to W Simpson and Co. of Pimlico
in the sum of £253-7-0d. January 1854

Contract No.5 (See WRO CR1618/WA6/104/36)

For the supply of Sluice Valves from 3 to 12 in. dia. with keys.

Awarded to James Burton and Sons
in the sum of £180-18-0d. February 1854.

A letter from the Court of Bankruptcy reveals the demise of this company after the valves had been delivered.

Contract No.6 (See WRO CR1618/104/46)

For the supply of Small Iron Castings.

Awarded to Edward Blackmore of Wednesbury
in the sum of £156-12-0d. January 1854.

Contract No.7 (See WRO CR1618/WA6/104/64 &65 also
the Warwick Advertiser 17 March and 9 May 1855)

To Sink a Borehole at the North East end of Packmore Lane and adjoining the Warwick and Napton Canal.

Awarded to Robert Paten - Well Sinker
and Engineer of Watford. March 1854.

The specification called for the sinking of a well of 12 ins. dia. and up to 400 ft. deep with the final depth, and other details, to be agreed as the work proceeded. Work was to commence within 7 days of the order being given and was to reach a depth of 100 ft. in 35 days and to then proceed at not less than 3 ft. per day. The specification provided for the bore to be lined with from 20 to 30 ft. of cast iron pipe 12 1/2 in. in dia. and 3/4 in. thick. Elsewhere wrought iron tube of 11 in. dia., galvanised and perforated if necessary, was to be fixed as required.

The intended method of working was, apparently, to install the lining only after water had been found. However the unlined bore kept falling in. If the bore was to continue at its full diameter it would have been necessary to line the bore as the work proceeded. This would not only slow progress but would prove to be very expensive if they failed to find water. In the event instructions were given firstly to reduce the bore from 13 to 12 inches and then to 7 1/2 inches. By December 1854 the bore had reached 320 ft. without finding good water. In February 1855 the bore had reached 374 ft. and water was reported to be flowing out of a pipe 9 inches above the ground - shortly thereafter the bore reached its final depth of 404 feet of which 108 feet was lined with tube of 12 inch internal diameter, 192 feet was 12 inch unlined bore and 104 feet was of 7 1/2 inch diameter. However the flow was found to be only about 1/4 of the towns requirements and of indifferent quality. The contractors subsequent attempts to 'force the springs' were not successful.

The bore still not having reached the Red Sandstone Rock that Mr. Rammell was expecting to yield a 'most ample quantity of good water' he sought to have the bore deepened. However Mr. Paten having reached the full depth that he had contracted for, and not having suitable equipment on site to go deeper, Mr. Rammell was obliged to seek new tenders for this work whilst simultaneously instructing Mr. Paten to fully open, and line the existing bore. This did not meet with the towns favour and instructions were given to abandon the bore but not before Mr. Paten had obtained the tube necessary to line the bore. By the terms of his contract Mr. Paten was due no payment for incomplete work and his claim for compensation in respect of the unused tube was again met only after the threat of legal action.

The work was to be valued on a schedule of prices as follows :-

For the first 50 ft.	£45
For the next 50 ft.	£57
For the next 50 ft.	£68
For the next 50 ft.	£80
For the next 50 ft.	£92-10-0d
For the next 50 ft.	£105
For the next 50 ft.	£117- 5-0d.
For the next 50 ft.	£129- 2-6d.
To supply and fix Wrought Iron tube 1/4" thick	
£1-2-6d. per ft. lineal.	

The schedule does not give rates for the cast iron tube, for the perforated tube or for the shoe all of which were called for in the specification. With additional work e.g. testing the water, measuring the flow, and trying to 'force the springs' it is no surprise that the final cost of the aborted well was £1,066-10-0d.

Contract No.8 (See WRO CR1618/WA6/105/51)
For Drainage and Waterworks.
Awarded to James Marriot & Co. of Coventry
in the sun of £9948-3-6d. July 1856.

This is the civil engineering contract for the construction of the Emscote Water Works, the Water Tower in the town and the laying of all pipes and sewers. It is the only contract not to have been let in 1854. The specification makes reference to 11 drawings dated the 28th. April 1856 and includes the following clauses :-

The sides of the trenches were to be well supported.
The excavations were to be kept clear of water.
All soil, filth and much --- was to be removed and carted away.
Drain pipes were to be laid on a bed of concrete half around the pipe --- with the inclination of the pipes being accurately determined by means of wooden templates, each 10 ft. in length, to be constructed in the manner to be directed by the engineer.
Vertical pipes were to be fixed at the extremities and junctions of all sewers --- and covered with iron caps.
No water pipe was to be laid within 2 ft. of any gas pipe.
A strainer of 3/8 in. thickness -- punched with 1/2 in. holes and afterwards galvanised --- was to be provided (at the waterworks ?).
The drain pipes across the River Avon --- are to be of cast iron jointed with lead --- and supported by piles in the manner shown on drawing No.5. --- The piles are to be of Elm 10 inches square with proper cast iron shoes.
Water pipes are to be laid [at a depth] 1 ft. 9 ins. to the top of the pipe.
Joints were to be made with Hempen Spun Yarn and Soft Blue Lead --- the depth of jointing in sockets to average 2 inches.
The [boiler] flues were to be lined to 20 ft. above the base with fire brick.

The contractor was to supply inlet, delivery and overflow pipes [to the water tower] of 12 in. I/Dia and 5/8 in. thick. The contractor was not to assign, or make over, any part of the works to others.

All antique remains and other articles of value or curiosity which might be discovered --- were to be immediately delivered to the engineer.

The contractor was to be responsible for any accidents or damage.

Temporary works were to be properly lighted and watched at night.

The contractor was to commence work within 6 days of the order being received and the several works were to be completed within the space of 12 months. The penalty for delay was £10 per day.

Monthly payments were to be made at 80% of the valuation of the work finished - the remainder to be paid 3 months later but the engineer was empowered to release up to half the retention.

The final value of this contract was £10,188-15-11d.

Private Works. (See WRO CR1618/WA6/99)

The first reference to a Private Works Contract is in March 1858 when it was apparently in the hands of a Mr. Clark and Son but there are no further details. By November 1863 the contractor was a Mr. Thomas Cashmore. This was a 'Schedule of Rates' contract based upon a priced schedule of work that included stoneware pipes from 2 to 12 ins. dia., cast iron 'D' traps, closets (*unfortunately not described*), pipework etc. The specification called for the drain pipes to be laid in puddle clay to 1/2 the depth of the pipes and for water pipes to be galvanised.

Rates included:-

Supply and fix cast iron 'D' traps

9"x9" 2/8d.

6"x6" 1/9d.

4"x4" 1/6d.

Stoneware Closet Pans and Traps of approved description to be fixed complete including all materials 8/6d.

Part III - THE SEWERAGE IMPROVEMENT WORKS (See WRO CR1618/WA6/106/26)

Few details of the contracts for the sewerage improvement works have been found but there appears to have been the intention to place 5 separate contracts.

Contract No.1

For the supply of 240 tons of 12",16" and 24" Cast Iron Socketed Pipes.

This contract was awarded to Messers Roberts of West Bromwich in April 1867.

Contract No.2

For the Construction and Setting to Work of Two Condensing Beam Pumping Engines and Cornish Boilers. This contract was awarded to a Mr. Josiah Gimson and Co. of Leicester in April 1867.

Two 25HP pumping engines were said to pump up about 45 ft. and one mile to Gog Bridge Farm [*Warwick Advertiser 8 Aug. 1868*]. The flywheels were some 16 ft. in diameter and weighing 4 tons 15 cwt. each. The work was apparently not satisfactory for an extensive list of defects was prepared in April of 1869 [*WRO CR1618/WA6/102*] which noted:-

- That the boiler tube was only 3/8 in. thick and not 1/2 in.
- That the lagging was not complete.
- That no allowance had been made for the expansion of the flue or the expansion of the steam pipes.
- That the safety valves were only 4 3/4 in. and not 6 ins. in dia. and blew off at 30 lb. 3 ozs. and not 40 lb.
- That no starting gear or blow through valves, had been provided.

Contract No.3

For the Levelling, Laying Down and Sowing of 104^a of land for sewage irrigation.

Contract No.4

For the Construction of Outfall Sewers, Store, Reservoir and Filters.

Awarded to a Mr. J H Clark in the sum of £2,453. April 1867.

Contract No.5

For the construction of an Engine House, Boiler House, Chimney Shaft, Pair of Cottages and Boundary Fence.

Awarded to Mr. J H Clark in the sum of £2,353 in September 1867.

Part IV - THE HASELEY WATER SCHEME

Again details of these contracts are incomplete.

Contract No.1 (See WRO CR1618/WA6/92 & WRO CR1618/W22/5 of 3 Feb. 1875)

For the Manufacture, Delivery and Off Loading of Cast Iron Socket Pipes to the Canal Wharf, Saltisford. This was awarded to a Messers Roberts with scheduled prices varying from £7-2-6d. per ton for 10,12and 16 in. straight pipe to £10 per ton for special castings.

The pipes were to be cast vertically and given Dr. Angus Smiths [*coal tar*] Coating.

Diameters were internal.

The sockets were to be 4" deep with 1/4" of free space for packing with lead on yarn.

The hydraulic test pressure was to be held for 3 minutes "whilst the pipe is sufficiently, and repeatedly, struck in

every part with a hammer of suitable weight." The test pressures were to be:-

For the 16" pipe	200 ft.
For the 12"and 4" pipe	400 ft.
For the 10" pipe	600 ft.
For the 8"and 6" pipe	200 ft.

All pipes were to be 9 ft. long, excluding the socket, and were detailed as follows:-

SIZE	LENGTH	WEIGHT		
16"	38yds.	9cwt.	0qtr.	0lbs. +/- 19lbs.
12"	726yds.	5cwt.	2qtr.	10lbs. +/- 10lbs.
10"	4295yds.	4cwt.	1qtr.	22lbs. +/- 9lbs.
8"	101yds.	3cwt.	0qtr.	24lbs. +/- 7lbs.
6"	43yds.	2cwt.	1qtr.	6lbs. +/- 5lbs.
4"	1236yds.	1cwt.	1qtr.	14lbs. +/- 3lbs.

The contract provided for :-

Powers of Inspection.

The engineer to resolve any discrepancy between the plans and specification without appeal to the courts.

The employers powers in event of non performance of the contractor.

Variations in the work.

The manufacturer was to be held responsible for any failure due to neglect found within 12 months of the completion of the works.

The cost of testing was to be borne by the town but the contractor was to provide, free of expense, the hydraulic test apparatus which was to be delivered to the wharf.

The contractor was to provide two sureties, each 1/6 of the contract value, to guarantee the work.

Payment was to be 90% of the value of work delivered in 1 month - the final payment was to be made 6 months after the deliveries were complete.

All pipes were to be delivered within 3 months of the order being given or £10 [per day] was to be forfeited.

The contractor was to pay the cost of printing.

Second Contract.

This was for the construction of adits and other work at Haseley. No details have been found.

Third Contract. (See WRO CR1618/W14/18)

On the 10 January 1876 a contract was let to a Mr. Charles Hart to lay 10 and 12 inch pipes from the town to Haseley with a branch to the new Budbrook Barracks. The contract quickly turned sour with the contractor finally abandoning the work in November. The immediate cause of this was the unexpected necessity of trenching in marl after leaving the turnpike at Hatton and the determination of the engineer not to concede any additional payment outwith the contracted rates.

The town arranged to have the work completed by others and believed that it would be able to recoup the extra costs of so doing from Mr. Hart. But Mr. Hart was to prove to have very well protected his own interests and it was he who lodged a claim against the town which was heard at

the Warwickshire Lent Assize of 1877. The case was subsequently referred to arbitration under a Mr. George Berkly.

Many of the claims related to the supply of pipes to the contractor. These were purchased by the town and stored by them until required. There were problems with the delivery of the pipes from the factory not keeping up with the progress of the work in hand exacerbated by the engineers determination to minimise the number of unlaied pipes left on site at the end of the days work. Thus although the town never appears to have run out of pipes they were often in short supply and sometimes not available in the size requested by the contractor. Mr. Hart was thus finding it very difficult to plan his work and more than once withdrew his labour citing shortage of pipes, always first ensuring that his problems had been well recorded. The engineer, who maintained that work was always available somewhere, apparently failed to refute any of these allegations in writing. As to the contract with the manufacturer this required only that the pipes should be delivered within three months of the order being placed without specifying in what order the different sizes of pipes would be required. Indeed the extant correspondence shows that there was never an agreed programme of deliveries with Mr. Pritchard making vague requests for, for example, more 12 inch pipes.

A second problem was that many of the pipe sockets were found to be oversize and thus requiring more lead, and time, to complete the joint. Mr. Prithchard did ask the manufacturer to correct this problem and always maintained that he made additional payments to Mr. Hart to compensate for the extra lead. However this was never made clear - he didn't confirm the additional payment in writing and his valuations were not itemised - all the contractor got was an occasional cheque.

Then, despite having been inspected and pressure tested prior to issue, some of the pipes failed. When Mr. Hart sought redress from the town he got very short shift - so far as Mr. Pritchard was concerned this was nothing to do with the town but a matter between Mr. Hart and the manufacturer. A manifestly untenable attitude.

The final contentious issue relating to the pipes was the location of the store where the pipes were held - the contract clearly stated that this was to be the canal wharf but in fact it was the railway sidings and Mr. Hart sought to claim the extra haulage costs. This was rejected on the grounds that Mr. Pritchard believed that the railway had come to some arrangement with the hauliers to meet the additional costs. However he had nothing in writing and maintained that he was not party to these matters.

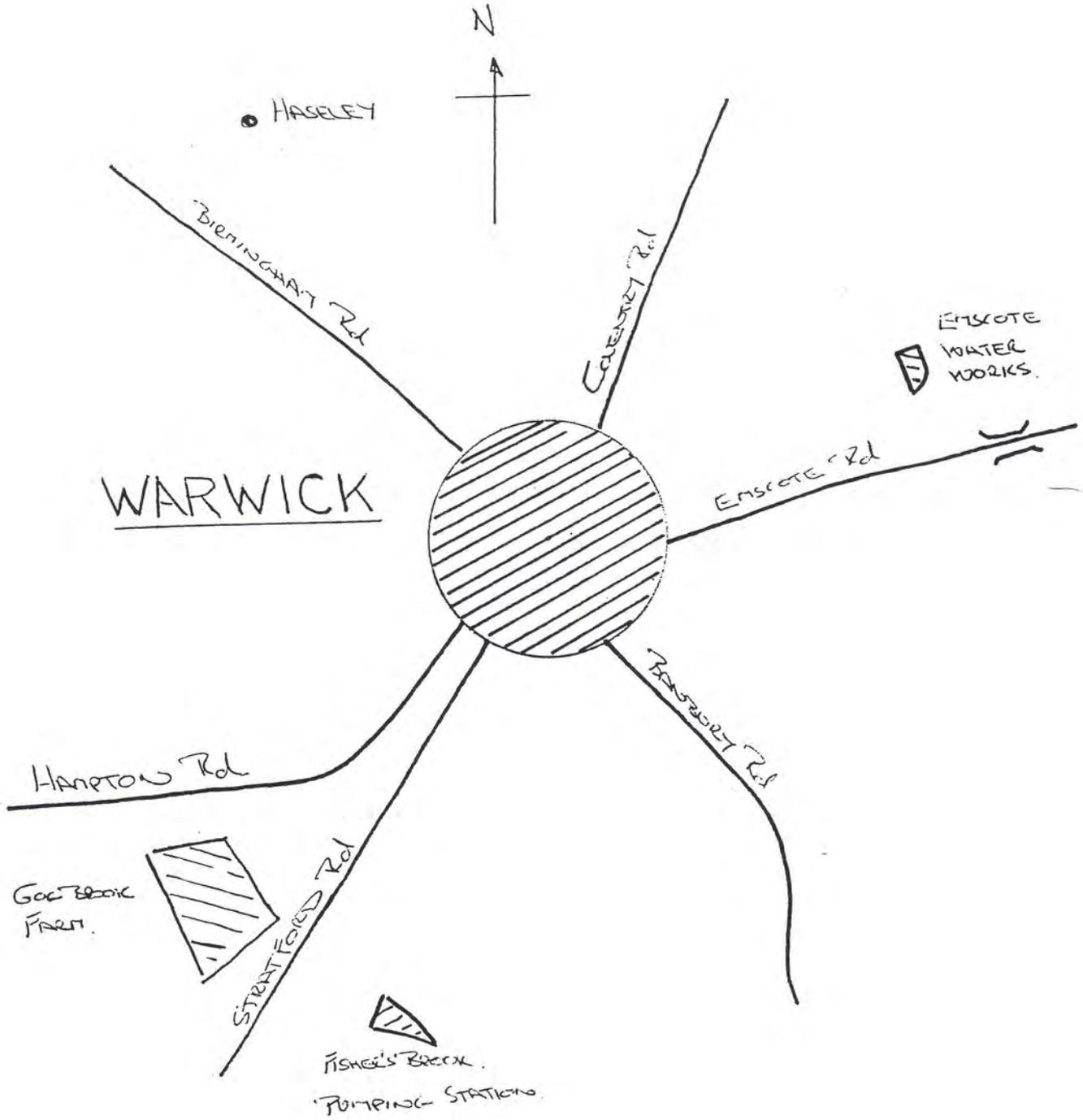
That the excavations for laying the 12 inch pipe to Haseley would be partly in Marl had not been anticipated. The Bill for this part of the works included only for excavations in clay and loam. Clearly an additional payment would have to be made and Mr. Pritchard sought

to apply the contracted rate for similar work in the town. Mr. Hart clearly found this to be uneconomic and claimed it to be inappropriate. He sought to negotiate but Mr. Pritchard would have nothing to do with it. Then he met with the water committee asking plainly what they would pay for this work. They also would enter into no commitment - valuations were the responsibility of Mr. Pritchard and he saw no reason to make any commitment or to put anything in writing. At arbitration the town was to maintain that this was standard practice and not peculiar to Warwick.

Mr. Hart's claim then continued with a number of other items. Firstly that as the work had been delayed, through no fault of his, he was entitled to additional payments for winter working and for the additional cost of winter haulage the original haulage contract having expired in the autumn. Then that the engineer had failed to properly peg and level the line of the 12 inch pipe, that he should be compensated for the monies due to him being paid late and finally that he should be paid for the temporary fencing and shoring that he had left on site.

The towns counter claim was for the additional cost of having the work completed by another contractor. Unfortunately this claim was very difficult to establish. Not only was there disagreement as to whether it was proper to use the rates for excavations in the town to work between Haseley and Hatton but it transpired that much of this was to be in sand which again had not been provided for in the contract. And finally not only had the design of this work been changed but the contractor had been instructed to hasten the work by opening two faces.

After a long arbitration the town lost and was instructed to pay Mr. Hart £560 10s plus costs.



LOCATION PLAN

DRAWING NO. 111

WARWICK WATER SUPPLY

SECTION OF SUPPLY MAIN & SYPHON

E. PRITCHARD C. E.
WARRENVILLE & BIRMINGHAM

FIG. 1

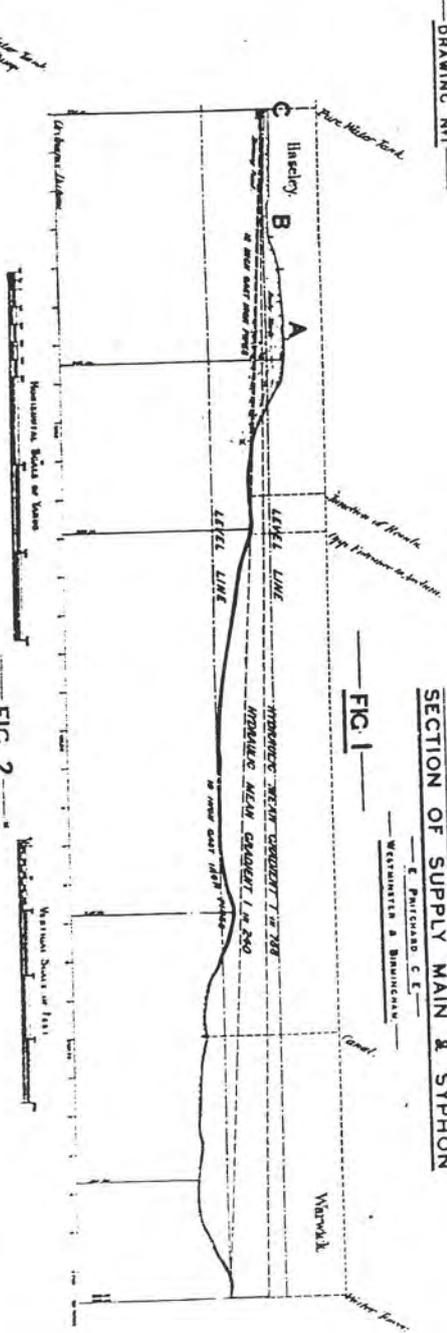
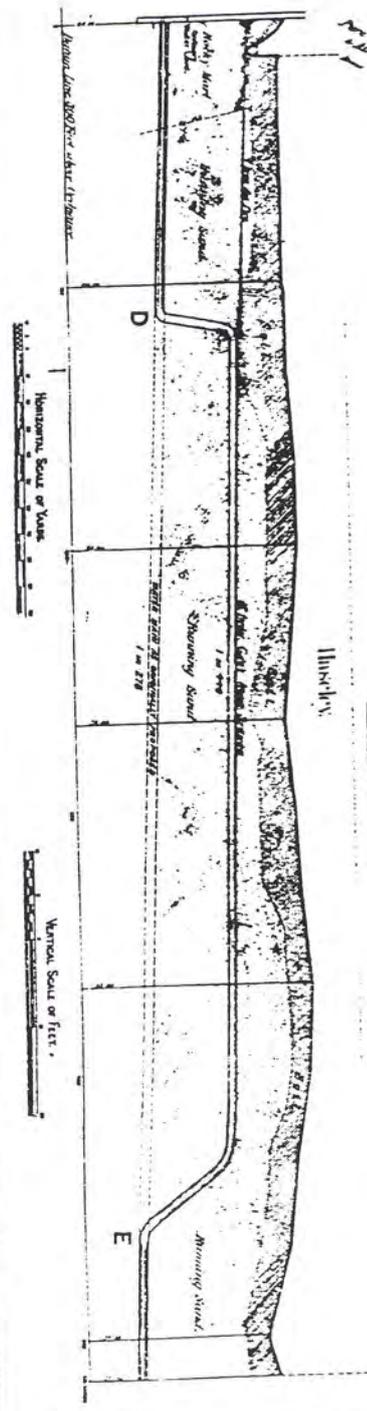


FIG. 2

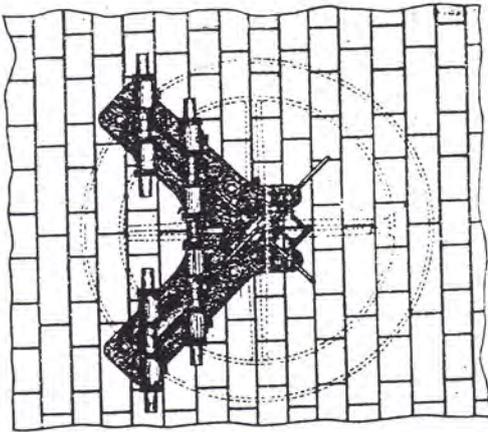


BIRMINGHAM
 GEORGE W. ...
 1912

DRAWING NO. 2

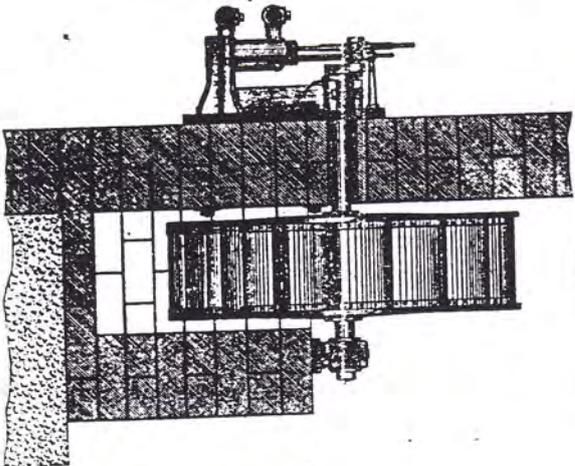
WARWICK WATER SUPPLY DETAILS OF AIR PUMPS & PURE WATER TANK

E. PRITCHARD C. E.
DESIGNED BY A. BARNICKER



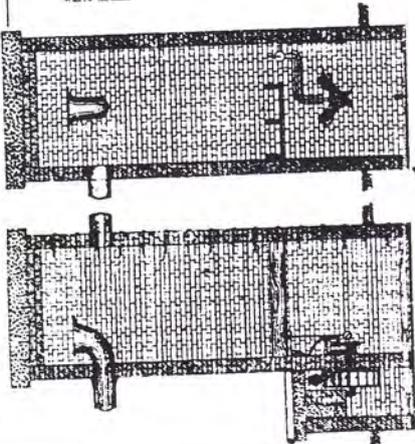
ELEVATION

FIG. 3



SECTIONAL ELEVATION

FIG. 4



SECTION ON LINE SECTION ON LINE

A. A. FIG. 5

B. B. FIG. 6

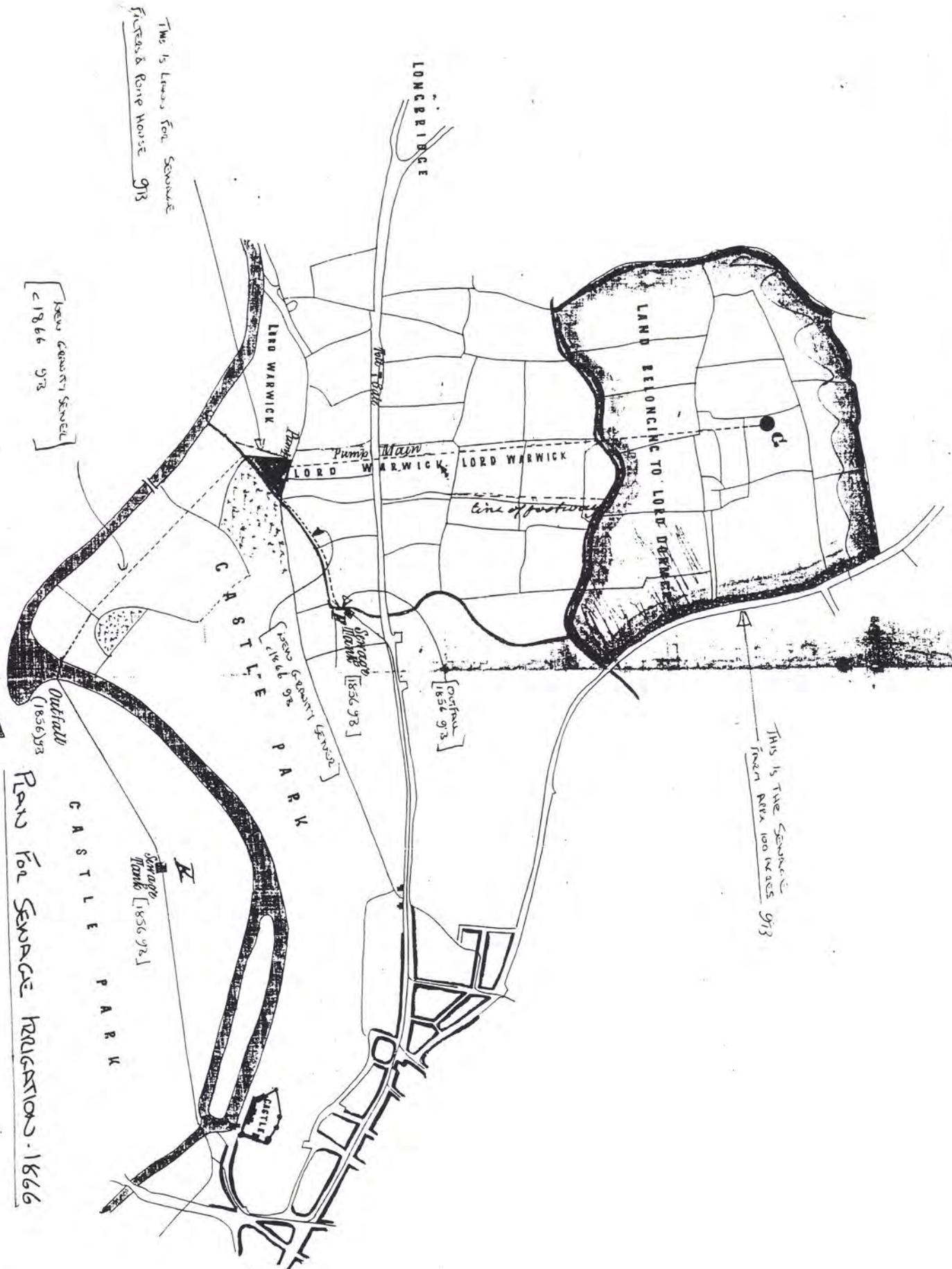


PURE WATER TANK

PLAN

REPRODUCED FROM THE ORIGINAL DRAWING BY THE ARCHITECTURAL RECORD CO. NEW YORK, N. Y.

HAMPTON ON THE HILL



This is Line for Sewerage
Facing to River House 913

[New County Sewer]
1866 93

This is the Sewerage
from River 100 Wages 913

Plan for Sewerage Irrigation - 1866