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SOME PHYSICAL AND ECONOMIC ASPECTS
OF WATER USE IN THE WEAR BASIN

being a thesis submitted
for the degree of Doctor of Philosophy
of the University of Durham

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Some Physical and Economic Aspects of Water Use in the Wear Basin

Abstract of a thesis submitted for the
degree of Doctor of Philosophy by
D. A. Kirby B.A.

The thesis analyses the changing pattern of water utilization within the Wear catchment over the historic period.

First the evolution and present characteristics of the surface water system are examined. River discharge over the period May 1965-September 1967 was measured by the erection of a gauging station at the Abbey Weir, Durham, and rainfall records, kept over the same period were applied to the computed results.

Secondly the use of these water resources is considered. Before 1830 water power was widespread and used as a prime mover in many aspects of a productive economy. Water supply was organised on a local and family basis, and although the drainage functions of watercourses were ubiquitous, the low density of population had little effect on the quality of river water.

After 1830 water power declined and water supply began to be organised on a community basis, with abstraction from one ^{or} plant on a local stream and the distribution of water by pipe within the community, subsequently extended until the unit of supply became a statutory area and contained many communities. The drainage

function of watercourses became more important with the development of urban communities, and the extension of shaft mining for coal and lead.

Since 1945 water power has almost disappeared. Water supply is being thought of in regional terms, and the role of the Wear has been reduced. The drainage function of watercourses remains important, although effluents must now maintain a high degree of purity consequent on the increasing use of watercourses as an amenity. This has always been of some importance, with angling remembered since the days of the 'Larhton Worm' and pleasure boating since the late seventeenth century.

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FOREWORD

'The dominant idea in all geographical progress', wrote Vidal de la Blanche in 1918 'is that of terrestrial unity', and this holistic concept is not out of place fifty years later when Chorley and Haggett quote Ackerman's reminder that the philosophical goal of geography 'is nothing less than the understanding of the vast interacting system comprising all humanity and its natural environment on the face of the earth'ⁱ. It could thus be said that no geographical study is satisfactory which did not take into account every aspect of this interacting system, but the fact that innumerable agents are at work does not mean that the role of the individual agent or the place of the individual aspect should not be studied, and this is witnessed by the work of all the specialised scientists.

Whilst no scientist would suggest that he was studying any particular aspect or agent without any reference to its context in the world system, it is the special responsibility of the geographer qua geographer to place the focus of his study very firmly in the context of this 'vast interacting system', and thus in this study of a river system and the use man has made of its waters the physical and human environments have been strongly

i. Chorley, R.J. & Haggett, P., Models in Geography, Methuen, 1967, 35.

invoked as the essential framework within which the particular aspect ought to be studied.

Accordingly, therefore, the following pages contain an examination of the river Wear and its tributaries above the tidal estuary. The thesis ... falls into two parts, first a description of the river system, with an analysis of its origins and present characteristics, followed by a study of the functional inter-relationship of the river and man, set in the context of a changing technological environment.

PART I

THE RIVER SYSTEM

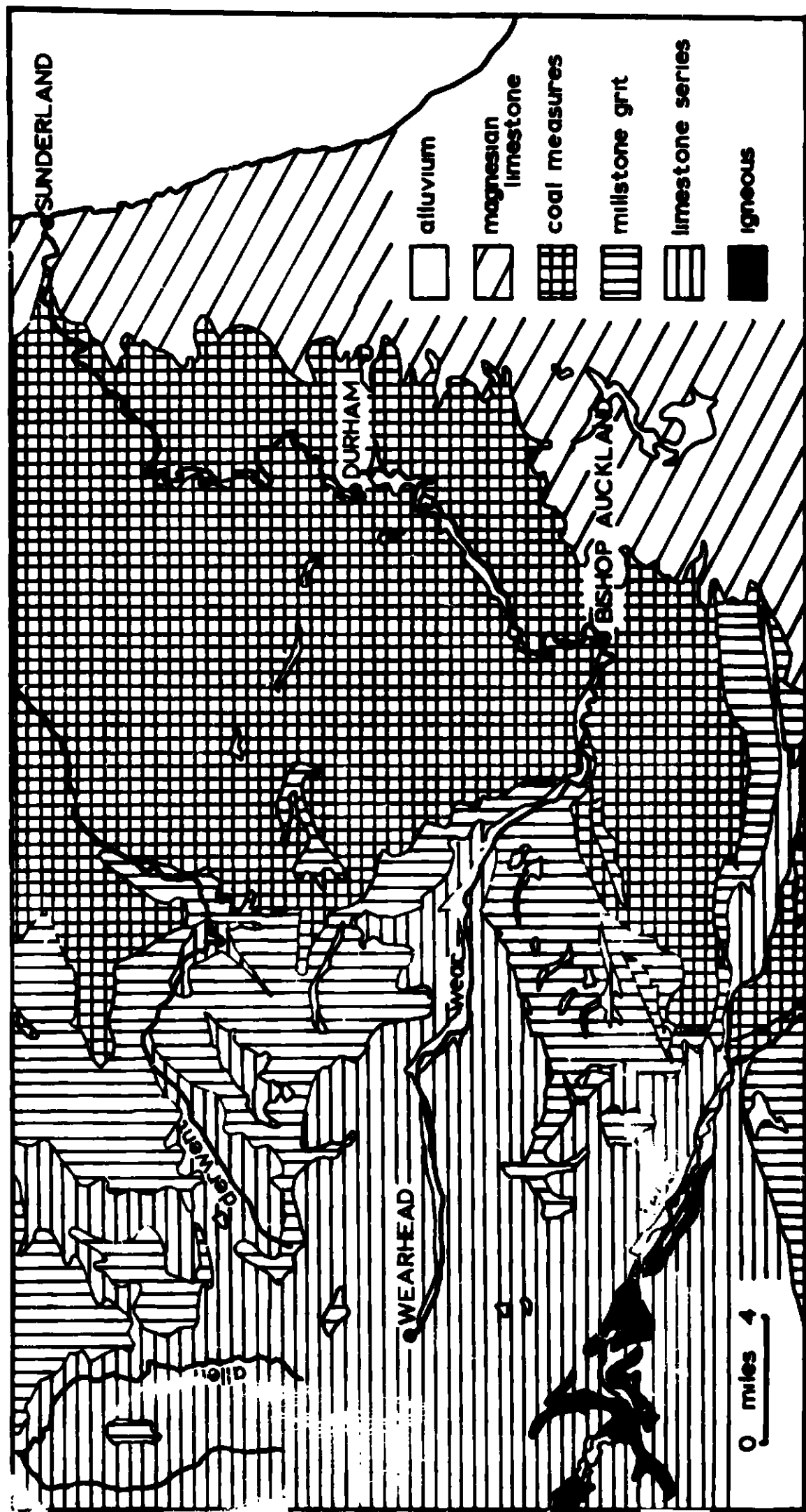


FIG.1 GEOLOGY ABOUT THE WEAR BASIN

The River and its Basin

Before any consideration is given to the present character of the river Wear, it would be appropriate to suggest the main features of its genesis and its evolution into the present river system.

Genesis

County Durham lies upon the eastern flanks of the Pennines, hills which here take on the form of a low dome and reach their maximum structural and topographical elevation around the Alston Block in the far west of the county. The county is built almost entirely of Carboniferous rocks, with the exception of the intruded lavas of the Whin Sill, and the Permian cuesta that extends from the coast near the mouth of the river Wear, to the fox-hunting country between Bishop Auckland and Darlington (Fig. I). The pre-Carboniferous floor is exposed only in Teesdale: at Crook, half way along the course of the Wear, it lies 2,176' below sea level,ⁱ and at sea level in Rookhope. In Carboniferous times, Durham was an area of comparative stability, and it was not until the latter half of the lower Carboniferous that the stable block of the north

i. Maling, D.H., The Geomorphology of the Wear Valley, Unpublished Ph.D. Thesis, University of Durham, 1955.

Pennines was submerged, when the coal measures were deposited which were to enrich the County and colour, both actually and metaphorically, the economy of the North East^{region} and the use it made of its riverine resources.

During the Hercynian orogeny, fault block movements resulted in a relative depression of the Alston Massif, and in consequence deposition took place in Permian times. Subsequent marine invasions deposited a series of strata which culminated in the extensive cover of Cretaceous times. Writers seem to agree that the present topography was largely initiated by the post-Cretaceous uplift that occurred during the Alpine orogeny, and upon this uplifted chalk cover, a series of consequent streams flowed eastwards. The earlier writers agree that the upper course of the Wear formed part of one of these consequents, although Wright_i would prefer to think that the Wear was already in existence before the activating of the Tertiary dome.

During the early Tertiary, the chalk cover, was removed, and a broad peneplain effected. This latter was subsequently dissected during Miocene and Pliocene times, and a second sub-aerial platform was formed, now standing at about 1,000' O.D. From this mid-Tertiary plateau, Maling_{ii} sees a series of streams radiating from

i. Wright, R.L., An Investigation into the Denudation Chronology of Parts of Teesdale and Weardale, Unpublished M.Sc. Thesis, University of Sheffield, 1955.

ii. op cit

two centres, one near Pontop Pike, and the other near Tow Law. Where streams from both these sources met they formed the Browney, the Deerness drained exclusively from the Tow Law centre, while the Cong and Twizell burns drained east from the node at Pontop Pike. Trotter_i would ascribe much of the drainage of the eastern flanks of the Pennines to superimposition from the Cretaceous dome. He suggested that the upper Derwent drained into the Twizell, which found its way to the eastern sea by way of the present course of the lower Wear; that the upper courses of the Rookhope, Stanhope and Waskerley burns joined those of the upper Browney and flowed on to meet the Cong burn and so flowed to the sea; and that the Deerness was a continuation of the upper course of the Wear. Wright, however, along with Maling, would not wish to propound a system with so many consequent streams.

At some time in the pre-glacial period, however, the Team, a powerful right bank tributary of the Tyne, cut back along the softer strata of the Magnesian limestone and captured all those east-flowing streams until it reached the Wear at Witton le Wear. From colliery borings it would seem that this pre-glacial Wear-Team stream followed a graded course from a height of about 200' O.D. at Witton Park to -60' at Cocken, and then fell abruptly to -140' O.D.

i. Trotter, F.M., 'The Tertiary Uplift and Resultant Drainage of the Alston Block and Adjacent Areas'. Proc. Yks. Geol. Soc. Vol. XXI. 1931.

at Dunston on the Tyne. Subsequent streams developed upon the eastern bank of the river, and Maling notes that it is believed that every re-entrant of the Permian scarp contains a buried valley. It would seem probable, therefore, that there were pre-glacial equivalents of the Herrington-Lumley Park Burn, and most of the streams which at present make up the Old Durham Beck system, although these latter would probably join the Wear nearer Shincliffe than Durham, perhaps along the line of its mid-seventeenth century course_i. This course is still discernible, reaching the Wear at the site of the present Shincliffe Bridge. In essence, then, most of the present river system would seem to ^{have been} already in existence before the onset of glaciation.

During the period of glaciation, the area was affected first by ice from Scotland and Scandinavia and then by local glaciers. At the period of maximum glaciation, Dwerryhouse_{ii} showed that the valleys of the Wear and its tributaries were occupied by ice of local origin, which joined with that of the Tees below Witton le Wear. The southern margin of the South Tyne glacier passed into the Browney Valley, and thence joined up with ice from the Wear, and that from the north. A series of ice-dammed lakes was produced along the

-
- i. Dean and Chapter Muniments, Post-Dissolution loose papers Box 4 (provisional Number) Magdalene Leazes.
 - ii. Dwerryhouse, A.R., 'The Glaciation of Teesdale, Weardale, the Tyne Valley and their Tributary Valleys.' Quart. Jnl. Geol. Soc. Vol. 58. 1902.

southern margin of this South Tyne glacier, which ultimately overflowed along the Browney by a series of overflow channels opened as the ice retreated_i. Raistrick observed that the first streams to respond to warmer conditions were those of the smaller Pennine valleys such as the Wear_{ii}. The retreat of the Wear glacier left a considerable lake in the mid-Wear lowland, contained by the ice sheets, confluent to the east and the south. The shrinking of the Scottish ice did not immediately affect this lake, for the Permian scarp continued to confine the water which was obliged to overflow to the south and the east, notably at Ferryhill, where the present large spillway is eloquent testimony to the volume of water using the gap. The continued retreat of northern ice, however, allowed the waters of lake Wear to find a low col, (or possibly Trotter's post-Cretaceous Twizell) and flowing over it, reversed the drainage from south to north, and forming the Hylton gorge, initiated the present route of the Wear.

The intrusion of the ice, however, considerably altered the morphology of the middle portion of the Wear valley. The old course of the river from Witton le Wear to the Tyne was obliterated, and its valley filled with glacial debris. At Durham,

-
- i. Herdman, G., 'Glacial Phenomena of the Vale of Derwent' Proc. Univ. Durh. Phil. Soc. Vol. 3. 1909
 - ii. Raistrick, A., 'Glaciation' in 'Contributions to the Geology of Northumberland and Durham' Proc. Geol. Ass. Vol.42. 1931.

the Browney was forced to the south, and taking into its system the Deerness, joined the river two miles south of its pre-glacial confluence. No longer contained within its pre-glacial valley, the Wear meandered across the old bed of lake Wear, cutting through the soft drift underneath. Occasionally its course flowed outside the pre-glacial valley and with fluctuations in base level, it cut through the old valley sides to give the spectacular gorges between Durham and Chester le Street. Similarly tributaries along this stretch ^{of the river} are obliged to cut down through the old rock sides, sometimes giving fine sites for water mills. Maling noted that the whole of the Wear north of Bishop Auckland shows the same degree of incision, but where the river has kept within the limits of its pre-glacial valley and the associated thick drift, the instability of the resultant slopes has tended to cause considerable land slips, and produce the gentler landscapes of Butterby or Harberhouse.

Thus it appears that the Wear system has had three major stages of development. First came the east-flowing alignment consequent to the Pennine dome, either before or during the post-Cretaceous uplift. Later the vigorous back cutting of the Team captured those consequent streams between the Tyne and the Wear. Lastly, the blockage of the Team by ice forced the Wear to the east, where it inaugurated its present estuary to the eastern sea through the Hylton Gorge.

Physiography

Each of the major phases in the development of the drainage pattern are today represented by a topographic zone. These are Weardale, representing the original consequent stream, mid-Durham - a remnant of the north-flowing tributary of the Tyne, and the Hylton Gorge, latest exit of the river to the eastern sea.

i. Weardale A typical north Pennine dale, the Wear drains a deep trough of varying width. The amplitude of relief throughout the major part of the dale is about 1200', the river falling from 1,050' O.D. at Wearhead, where the dale splits into three tributary valleys, to about 400' O.D. at Harperley, generally considered the entrance to the dale. Carboniferous Limestone series, and then a large grained sandstone predominate in the dale, although extensive tracts of grey limestone, so much a feature of the dales of the Swale or upper Wharfe are not apparent. Here the predominant sandstones and mudstones of Wensleydale colour the landscape, although the limestones themselves do occur at intervals of 100' or so, some reaching thicknesses of 50'-100'. As repositories of lead ore they had a considerable economic importance. The authors of the Hydrological Survey₁ point out that each of these sandstones and limestones is a potential aquifer, and boreholes could make

i. Wear and Tees Rivers: Hydrological Survey: M.H.L.G.
London 1961.

them yield considerable supplies of water. Being the highest part of the basin, rainfall is plentiful (Fig.4) and surface water abundant. For instance, the Burnhope Burn with a catchment of about $7\frac{1}{2}$ square miles has within it 43 first order streams, 9 second order and 3 third order. In comparison it can be noted that the Lumley Park Burn in the east of the basin has a catchment of approximately $9\frac{1}{2}$ square miles, but has only 3 first order and 1 second order streams, the total length of which are a little under one third the length of the watercourses in the Burnhope catchment_i.

Above the limestone series is exposed a fringe of gritty sandstones separated by mudstones and shales, called Millstone Grit but not strictly comparable with the millstone grits of Lancashire and Yorkshire. From a quarry above Stanhope, however, millstones have actually been quarried from the series, so perhaps their name is justified. Reaching to a depth of 300' the sandstones can be regarded as a single aquifer, and occupying high ground, with a rainfall above 35" p.a. they yield a good supply of soft water which is impounded on the north side of the valley in a series of reservoirs.

i. after Horton et.al. see also Gray, D.M., 'Interrelationship of Watershed Characteristics' Jnl. Geophys. Res. Vol.66 No.4. 1961.

Work on the soils of upper Weardale is at present being undertaken by K. Atkinson of this Department, and it is not intended here to note at length the superficial deposits in the dale. It will be sufficient here to say that on the uplands drift is generally thin or absent, although Maling notes that occasional patches of drift as high as 1,000' have proved to be 30' deep. An almost continuous cover of boulder clay runs along the southern edge of the valley, suggested by Maling to be the site of the pre-glacial Wear, which has subsequently developed on the northern edge of the drift cover. In all the tributary valleys considerable quantities of drift are to be found, nearly always on the western side of the valleys. Generally speaking, the solifluction deposits and congeliffracted regoliths found on the interfluves have given rise to podzols and peaty gleys, while the bare rock outcrops and solifluction deposits of the valley sides have produced gleys, acid brown earths and rendzinas and limestone soils, while on the valley bottom, moraines, terraces and alluvia give alluvial soils, ground water gleys and acid brown earths. Water holding capacity, therefore is high over the whole of the dale.

ii. Mid-Durham Topographically, mid-Durham comprises the eastern flanks of the Pennines, dissected by consequent streams now tributary to the Wear, and the platforms that are found north of Bishop Auckland

in the east of the basin. Coal Measures underlie the whole of the area, and when they are fully developed reach thicknesses of 2,000'. They consist of repeated alternations of mudstones and sandstones inter-bedded with many coal seams. In many cases these were pumped by colliery workings, but now that coal mining has virtually ceased to the west of the river Wear, it can be expected that aquifers there will fill up again, along with the deserted mine workings, although it is thought that some continued pumping might be necessary to prevent flooding in collieries further east. When streams have exposed the bed rock, rapids are produced, an effect which is especially marked in the Wear gorge itself, between Kepier and Woodwell House.

The land surface, then, falls down from the 1,000' plateau at Tow Law and Pontop, to the Wear lowlands some nine or ten miles away to the east, which are as low as 25' O.D. at Lambton. The Browney forms the principal stream, subsequently joined by the Deerness. Both flow over drift-covered pre-glacial valleys, and at Bearpark, the Browney is some 236' above its pre-glacial course. Both of these streams were diverted by a ridge of fluvio-glacial sands which run north from Sunderland Bridge on the Wear, and the contrasts along the lower course of the Browney are marked. At Bearpark, the broad valley with unstable sides and a marshy floor

epitomises the post-glacial stream flowing over its drift-filled pre-glacial valley. At Moorsley Banks, the river cuts through the rock side of its pre-glacial valley, giving sites for two water mills, and emerges into the drift-filled valley of the pre-glacial Deerness at Stonebridge, where it meets that stream and flows again out of the pre-glacial valley, through a rocky gorge at Burn Hall to meet the Wear at Sunderland Bridge. The aspect of most of this western area, however, is one of incised streams flowing through often narrow valleys. Structural influences often produce steep easterly walls to the valleys, especially in the south west, and the general effect produced is one of broad interfluves with occasional precipitous slopes.

In the remainder of the area two extensive platforms can be recognised. At 320' stands a fluvio-glacial surface lying between the Permian scarp to the east and the flanks of the Pennines to the west. Along these hilly margins the surface is composed largely of boulder clay, but in the centre of the surface running north from Sunderland Bridge to Ravensworth on the Team is a line of sands and gravels now forming low sandy hills. These sands were associated with outwash fans into lake Wear and are recognisable, though not so extensive as far upstream as Witton le Wear. This 320' surface has been subsequently dissected by the river which has

incised into it an equally distinct platform standing at 190' O.D., which would seem to be the remnant of a meander-trimmed floor, graded to some level slightly below 190'. Across this surface the river passes in broad meanders, further dissecting it, making broad flood plains as it passes over the drift filled pre-glacial valley, and narrow gorges as it flows beyond the confines of this pre-glacial valley. Until the eighteenth century much of this 190' surface was moor, and even today the area immediately to the north of Durham presents a forlorn appearance.

This eastern part of mid-Durham, therefore, is characterised by extensive areas of low relief across which little surface water drains. The heavy boulder clay retains moisture, and wells sunk into it give very small yields.

iii. The Hylton Gorge This narrow corridor lies outside the area chosen for discussion and it is sufficient to note that in its course to the sea, the Wear continues to flow over the Coal Measures at the foot of the Permian escarpment until it reaches Hylton. Here a broad gorge has been cut, and the river becomes tidal. This gorge narrows until it becomes the narrow cleft at Sunderland, over which the Wear Bridge was flung with such élan in the eighteenth century.

River Gauging

Any scientific description of the surface water within the Wear basin must necessarily involve some measurement of its discharge character. No long term records of discharge are available, and the first gauging station was established by the Wear and Tees River Board on the Browney at Burn Hall in November 1954.

Another station on the Wear at Sunderland Bridge was established soon afterwards. It was therefore decided to set up a gauging station below the confluence of these two streams, which would more readily record discharge from the whole catchment.

Selection of a Gauging Site

To set up a river gauging station three things are necessary. There must be a control point which remains constant, a gauge to measure the stage of the river, and a straight stretch of the river at least five times as long as the river is wide where current metering can be performed_i.

The optimum site for the whole catchment would have been to create an artificial control point in the form of a weir above the tidal head of the river at Lambton Bend, but this was obviously

i. Wisler and Brater, Hydrology, J. Wiley and Sons, 1959



PLATE I

The Gauging Station at the Abbey Weir

beyond the scope of the project. The next highest control point was on rocky rapids some three miles upstream, a little below Finchale Abbey, where the Wear flows directly over the Coal Measures. This was unsuitable for several reasons. The site was difficult of access, a suitable metering point was not at hand, and the site was above the confluence of the Wear with the Lambton Park and Chester burn systems. As there was not a suitable site below Chester le Street, this last factor had to be accepted anyway. Accordingly, it was decided to come as far upstream as Durham itself, where two dams control the water. The lower of these two dams still serves an economic function in providing water to drive cooling apparatus at the neighbouring Ice Rink, and as water is drawn off at irregular intervals it was decided to use the second dam, the Abbey Weir (Plate I). In 1945 after a period of prolonged snow cover the subsequent melting of the snow, along with a rainstorm made the river particularly strong, and the stakes were swept away and the dam broken. This had a very considerable effect on the river for two miles upstream_i, and so this was obviously a good control point. Apart from land and street drainage, no significant contribution is made to the river for a mile and a half upstream where the Old Durham Beck drains about 30 square miles into

i. Durham County Advertiser, January 1945.

the Wear. Between this point and the Abbey Weir several straight stretches made metering possible.

However, difficulties were apparent. This stretch of the river is used extensively for pleasure, both in amateur rowing for the University and the City, and also for pleasure boating. A motor launch also operates during the summer. The banks themselves are public promenades and thronged with visitors on fine days in Spring and Summer, some of whom, unfortunately, have malicious intent. The gauging station, therefore, would have to be strongly constructed and prevented from damage from both the banks and the river. Moreover, to construct a permanent or even semi-permanent gauging station, with a stilling pool for the float, and completely separate from public access was beyond the scope of the project, and fraught with difficulties, not the least of which would have been the obtaining of planning permission.

It was therefore decided to make use of the University's own property at the Old Fulling Mill on the right bank of the Abbey Weir. The water-level recorder_i was housed in a strong steel cabinet, mounted on the wall which used to support the sluice gate for the mill. The float mechanism was suspended in a strong steel mesh cage which extended from the base of the cabinet to a level well

i. Munro Portable Water Level Recorder, Vertical Multi-Range type, 1H 103

below the crest of the weir. A stilling pool was found to be unnecessary. As the gauge was so close to the weir there was no danger of any disturbance from pleasure boaters or any other sort of craft, and by land the site was locked away within protective fencing and within the garden of the Fulling Mill cottage. A measuring rod was attached to the cage for manual readings, and the site was carefully levelled. Unfortunately, however, because the Abbey Weir crosses the river diagonally, the river is not so sensitive at this point as it could be, but this did not prove to be a great disadvantage and did allow the use of a small water level recorder.

Current Metering

Originally it was hoped to meter at a stretch of water approximately 700 yards above the gauging station at a point immediately below St. Oswald's Well, where the river conformed to the necessary pre-requisites. However, the depth of the river precluded wading and consequently a boat would have had to have been used. This would have engendered many difficulties, and it was decided to move the metering section a further 800 yards upstream to Baths Bridge. This single span structure provided convenient access to the river at a point where the river flows along a straight course.

Accordingly a section was taken across the river to determine the shape and nature of the bed. Although a considerable amount of rubble was deposited at this site during the construction of the bridge in 1961-1962, it was shown that the river was now free from any serious obstruction, although the bed was composed of soft materials liable to be stirred up at times of high water and strong current.

Using a Watts Mark IV Current Meter, an attempt was thus made to measure discharge at this point, to be subsequently correlated with stage at the Abbey Weir. A portable hoist was constructed, designed to hang on the parapet of the bridge and lower the weighted current meter into the water. The meter was re-calibrated by Saunders Roe in May 1965, and from the equations provided by them, a rating table was computed, which converted cup revolutions into cubic feet of discharge per second. After several small teething troubles with the extension cable to the meter had been overcome, metering was accomplished at periods of low water, giving results that agreed with the subsequent stage-discharge table produced of the Abbey Weir by another method. The procedure adopted was as follows.

1. The time was noted that metering commenced.
2. The distance from the bank was noted.

3. The meter was lowered to the river, until the weight underneath the meter touched the surface. This depth was noted on the measured cable.
4. The meter was allowed to sink through the water until the weight touched the bottom of the bed. Ensuring that this was the true bed, and keeping the cable taut, this depth was noted, and the depth of the river at that point calculated.
5. From a pre-computed table, the meter was then drawn upwards until the meter, not the weight, stood at exactly 0.6 of the depth.
6. The cup revolutions were then recorded, and repeated three times to ensure that a correct value was reached.
7. By the use of the pre-computed rating table, the discharge was noted.
8. The operation 2-7 was repeated across the river at 6' intervals, giving a total of 17 operations.
9. On completing the operation the time was noted, so that this discharge could be calibrated with a stage at the Abbey Weir.

In calculating the total discharge during these periods of metering, the generally accepted "Mean Velocity Method" was used_i.

i. Horton et al, see Carter J.H., 'Stream Discharge Measurements by Current Meter and the Establishing of a Rating Curve', Soc. Eng. Jnl. Vol. LV pt.3. 1964.

The calculation, summarised in Tables 2 and 4_i is as follows.

1. The cross section of the river was divided into a series of vertical sections. The undivided depth measurements were used as the limits of these sections, giving a total of 18 values $d_1 \dots d_{18}$
2. The area of each section $a_1 \dots a_{18}$ was determined.
3. The mean velocity (i.e. that recorded at 0.6 depth) was noted, for each vertical.
4. From each two successive vertical means, in each case, Velocity 1 and 2 in the tables, a mean velocity for each section was obtained ($q_1 \dots q_{18}$).
5. By the formula $Q = q_1 + q_2 \dots q_{18}$ the total discharge (Q) was obtained.

The two sets of readings successfully accomplished are given in Tables 1 and 3. It should be emphasised at this point that these two sets of readings were essentially in the nature of test runs, and should this technique have been adopted, then discharge readings would have been taken at 0.2 and 0.8 of the depth, as well as that at 0.6.

Metering was next attempted at a period of moderate high water, when the river had risen 12" at the Abbey Weir. Unfortunately, the apparatus proved to be inadequate for even this degree of increased

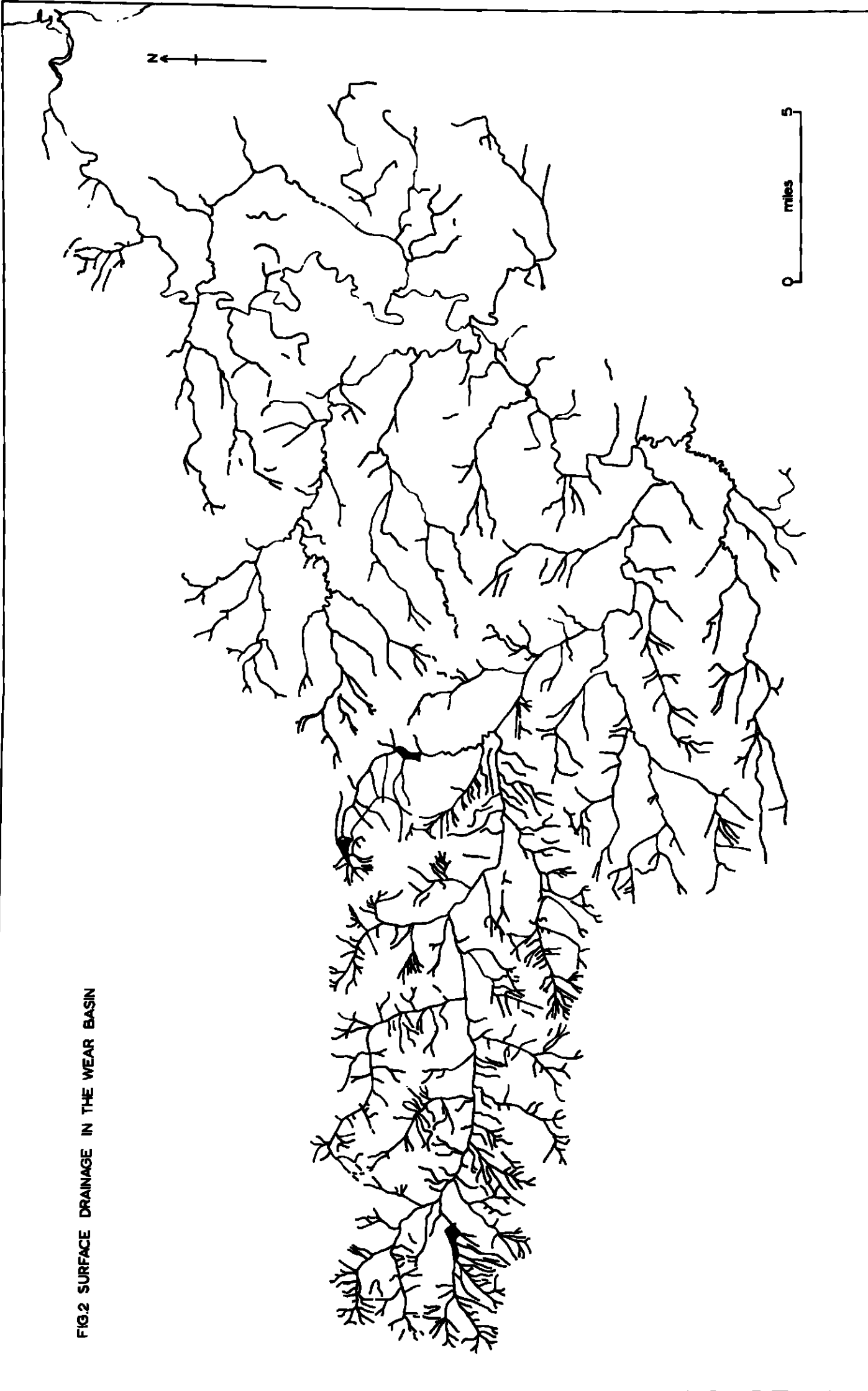


FIG 2 SURFACE DRAINAGE IN THE WEAR BASIN

flow. As the meter hung like a pendulum in the water, suspended at the end of a 20' cable, then the increased current was able to carry the meter under the bridge, and lift it out of the vertical, making metering impossible. While it might have been possible to meter such currents while the meter was attached to a fixed rod, it was impracticable using a cable and a 25lb or even a 60lb weight. As that level of the river was still considerably less than the average reached by a winter flood, then it was plainly obvious that it would have been impossible, using that apparatus to meter the higher two thirds of the stage-discharge curve, and that to continue with the present operation was outside the scope of the immediate investigation.

The Correlation of Stage with Discharge at the Abbey Weir

Because of the difficulties mentioned above it was decided to invoke the help of the Northumbrian River Authority. River gauging is carried out by them on the Wear at Sunderland Bridge, Croxdale, some five miles upstream from Durham, and above the confluence of the Browney with the Wear. The Browney is gauged by them about a mile above the confluence of that river with the Wear. Two other streams also enter the river Wear below Sunderland Bridge, the Croxdale Beck system entering the river above Butterby, and the Old Durham Beck system joining the river a little below Old Durham. (Fig.2)

Thus to gain any indication of the discharge of the river at Durham all these streams had to be taken into account.

The method adopted was to correlate hydrographs at the Abbey Weir, with hydrographs at Sunderland Bridge and Burn Hall. By adding together the discharges at Burn Hall and Sunderland Bridge, the major part of the water was accounted for, but it was still necessary to make some allowance for the water draining from the 40 square miles between Sunderland Bridge, Burn Hall and the Abbey Weir. Two problems were immediately apparent. The first was how to allow a suitable compensation for this latter area, and the second was the correlation of the relatively minor Burn Hall catchment, with the more important Sunderland Bridge values.

Unfortunately there is little information concerning the two eastern catchments of the Old Durham Beck and Croxdale Beck. No discharge readings have ever been taken on the streams, which are both quite small. No rain gauges are established within the catchments, a deficiency the River Authority intend to remedy, and so there are no point rainfall records between Durham City and the eastern flanks of the Permian escarpment. There is little similarity between the topography of the two areas to the east and west of the Wear. The land drained by the Browney is characterised by broad interfluves rising to 1,000' O.D. in the

west, while the Croxdale and Old Durham becks drain an area of low amplitude of relief which only rises to 526' O.D. at the Permian escarpment. These two streams flow over gently undulating post-glacial surfaces before falling down through the pre-glacial valley sides to the Wear.

However, the two eastern catchments and the Browney basin do have certain aspects in common. They are, after all, immediately adjacent, and share the Wear as a common boundary. From point rainfall records all around the eastern catchments it would seem in fact that rainfall differences between them and the Browney are slight. It therefore proved not unreasonable to suppose that they and the Browney had appreciably similar discharges per unit area, and accordingly allowance for these areas was based upon this assumption. Even should this have proved a grossly erroneous assumption, the proportion of the two catchments to the entire Wear basin is small, and the absolute degree of error would be minimal.

The second problem, alluded to earlier, was the actual correlation of discharge records at Sunderland Bridge and Burn Hall, to allow a stage-discharge relationship to be established at the Abbey Weir. The optimum conditions for this correlation would be

i. Hydrological Memoranda No.8 G.12271, Meteorological Office, 1963.

long periods of constant discharge at the three stations, when the calculation of discharge at Durham would have been very easy. However, such conditions are not found in the Wear, except for periods of very low water, and so it was necessary to select a stage at Durham which would be recognisable at Sunderland Bridge and Burn Hall. As the regime of the river is characterised by sudden floods, it was an obvious matter to take sharp peaks at Durham, and isolate the same flood peak on hydrographs from Sunderland Bridge and Burn Hall.

As the peaks at Durham were very largely the result of water passing down the Wear and through the Sunderland Bridge station, the isolation of peaks there was an easy matter. The Browney, however, did not always have a correspondingly high flow, and so in order to achieve a correct corresponding discharge, it was decided to use a distance-time method to determine at what time it was necessary to read the hydrograph at Burn Hall. Thus by noting the length of time that elapsed between the record of a peak at Sunderland Bridge, and at Durham, and making allowance for the fact that the Browney and Wear are confluent for the greater part of the distance between the three gauges, in order to find the time at which the hydrograph should be read at Burn Hall, the formula contained in Equation 1 was used.

Equation 1

$$t = \frac{b}{c} \left(T - \frac{a}{c} T \right) + \frac{a}{a+c} T$$

Where:

- a = distance from Abbey Weir to the confluence of Wear and Browney
 b = distance from Burn Hall to the confluence of Wear and Browney
 c = distance from Sunderland Bridge to Wear-Browney confluence
 T = time taken for peak to travel from Sunderland Bridge to Durham

As a = 10,000 yards, b = 2,500 yards and c = 1,000 yards, the formula became

$$t = 1.1261 T$$

This was calculated for all the values above 0.60' at the Abbey Weir, and a discharge calculated (Table 5). For values below 0.6 it was difficult to find a peak, and so long periods of constant water level were selected. These were then correlated accordingly.

It is readily admitted that this method is not perfect. Reference should ideally be made to the fall of the rivers below Sunderland Bridge and Burn Hall to the confluence of the two streams, and from there to the Abbey Weir. Reference should also be made to the width and nature of their beds, and the load they carry, as these will all effect the velocity of the streams. In practice, however, the method used proved satisfactory, and the procedure for drawing up a stage-discharge curve for the Abbey Weir was as follows.

1. Hydrographs from the Abbey Weir were examined, and from them, suitable sharp peaks were selected, for as many stages as possible.
2. These hydrographs were then compared with the equivalent charts from the Burn Hall and Sunderland Bridge Gauging Stations.
3. The same peak which was registered at the Abbey Weir was noted on the Sunderland Bridge chart, with the time taken for it to reach the Abbey Weir.
4. This time was then multiplied by 1.1261, as above, in order to find out what time to take stage at Burn Hall. This value was noted.
5. This value was then multiplied by 0.588 to give an allowance for the remaining unmeasured section of the Abbey Weir catchment.
6. These three values were summed to give discharge at Durham.
7. In order to give some degree of toleration, an hour's difference each way was allowed at Burn Hall, and thus on the Croxdale and Old Durham systems.

Maximum and minimum values were established, and these were plotted on linear graph paper. It became obvious, that the original values best fitted the curve contained in Equation 2.

Equation 2

$$\text{Log } D = p \text{Log } s + \text{Log } a \quad \text{or} \quad (D = as^p)$$

Where:

D = Discharge at the Abbey Weir

s = Stage at Abbey Weir

a and p are constant

It will be noted that this is similar to the curve for a straight line ($y = mx + c$). Therefore if log s is plotted against log D a straight line should result of slope p and intercept log a. This was done and it was found that the best p value, or constant, was equivalent to $\frac{3}{2}$, giving Equation 3.

Equation 3

$$\text{Log } D = \frac{3}{2} s + \text{Log } a \quad \text{or} \quad (D = as^{\frac{3}{2}})$$

To find the most correct value of a, the constant, each value of stage and discharge was submitted to the above formula, as in Table 6. The average of these 22 values was then taken giving an answer of 1024, and it was therefore assumed that the formula to change stage height into discharge at the Abbey Weir was

$$D = 1024 s$$

Theory shows that $D = 3.065$ for an ideal weir_i, where D is discharge for unit length. The obtained value for the coefficient, then corresponds to a weir length of $334' \left(\frac{1024}{3.06} \right)$ which agrees well with

i. Francis, J.R.D., Textbook of Fluid Mechanics, Arnold, 1959.

an actual weir length of 332'. As it can be expected that this is not a perfect weir, this formula is satisfactory. In order to attempt to introduce a better fit to the graph, a further constant was introduced, and various other curves were drawn. From these it became obvious that the best fit was to be obtained from the original formula.

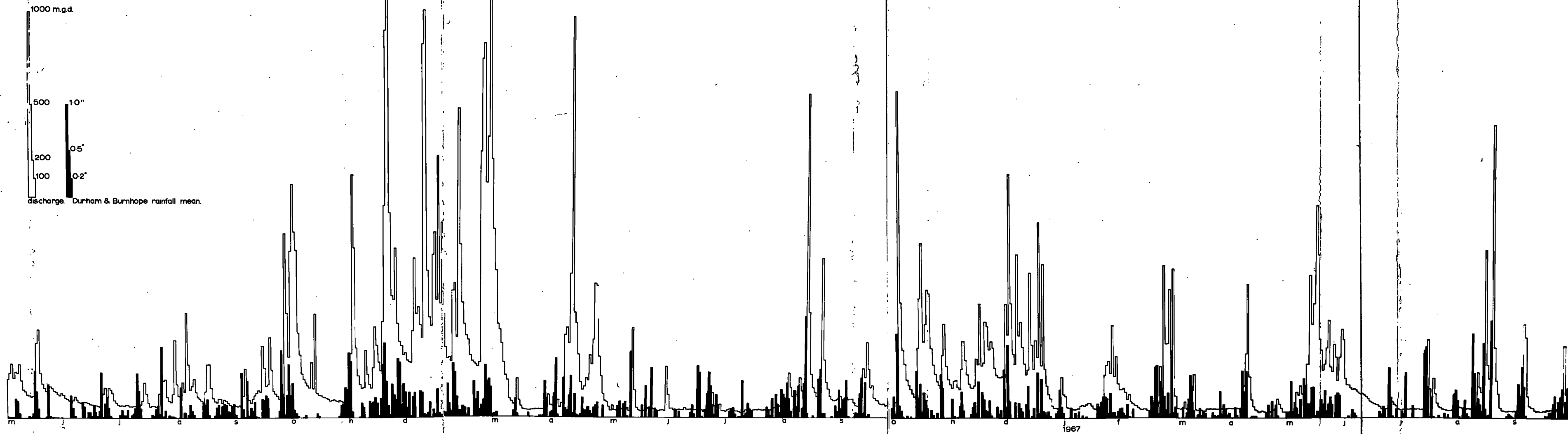
On inspecting the hydrographs from the continuous recorder at the Abbey Weir it was apparent that a reading taken off every two hours would provide a sufficiently accurate account of the river's behaviour. As all other volumetric records used in this present work were in millions of gallons per day, in order to give a comparable print-out, in the subsequent computer calculation the formula used was

$$D = 1024 \times \left(\frac{7,200 \times 6.229}{1,000,000} \right) \text{ s}$$

or

$$D = 45.92\text{s}$$

FIG. 3 DAILY DISCHARGE AT THE ABBEY WEIR
MAY 1965 - SEPT. 1967



The Readings and Results

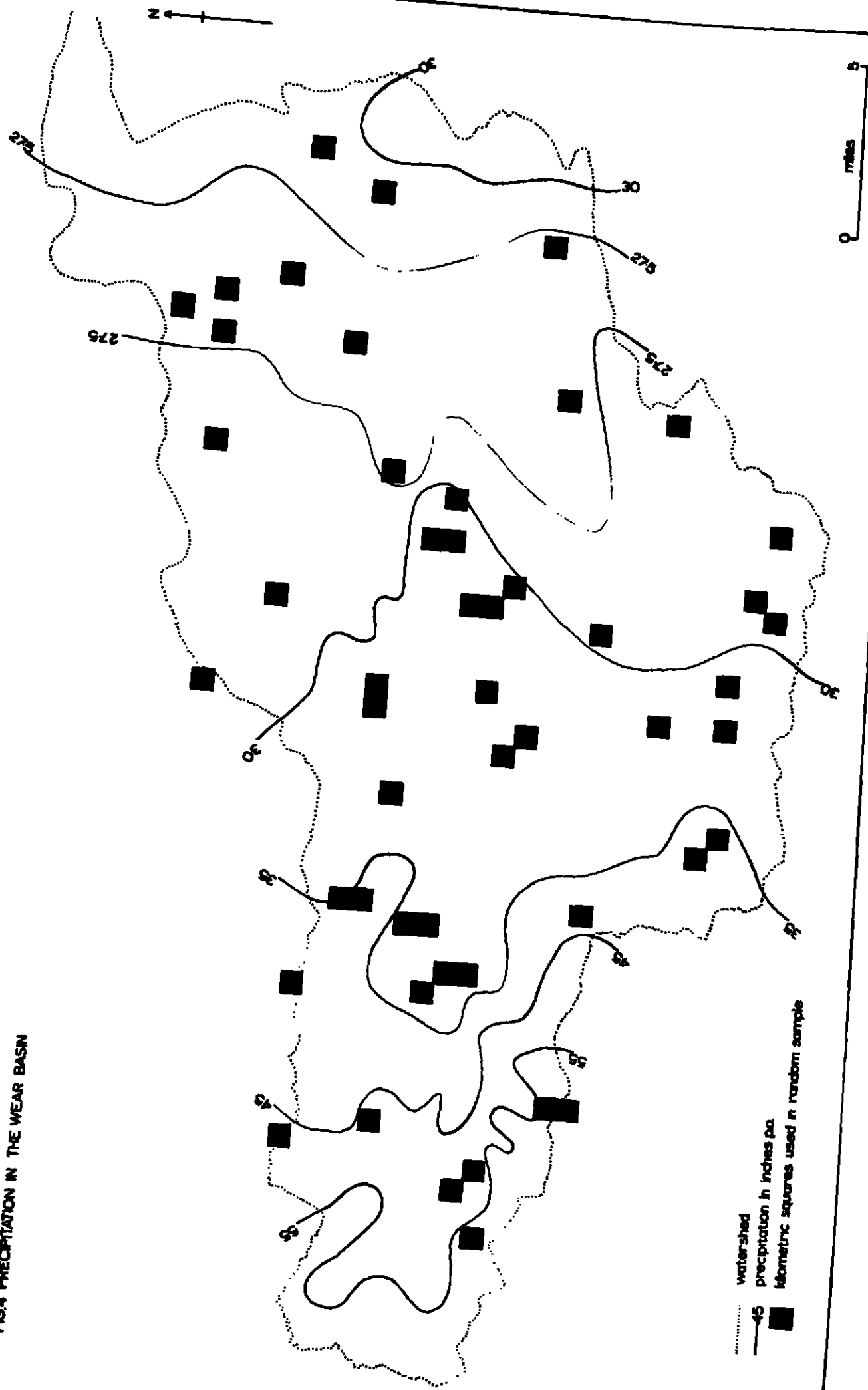
The results obtained from the two-hourly readings are contained in Appendix A, and in Figure 3. It is regretted that it is not possible to present a continuous discharge record over the entire period, May 1965 - September 1967, that the gauging station was in operation, because of a mechanical fault that occurred in the water level recorder at the Abbey Weir at 10.00am. on February 14th 1966. Unfortunately the weekly inspection of the gauge had taken place one hour before, and so the failure was not discovered until a week later. Apparently, continued wear of the steel tape at the point it passed over the tape wheel had caused it to break. According to the manufacturers, this was not a common fault, and was probably caused by a defect in the steel tape itself, but the consequent delay in obtaining a replacement tape, float and counter weight meant that three weeks readings were lost. It is particularly unfortunate that this should have happened at this time, when the river passed through a very 'flashy' period with considerable, and often-fluctuating amounts of water passing over the weir on the melting of snow, and occasional rainstorms. Manual readings, therefore, were not practical. Further, the absence of records

for this period means that only one complete water year can be presented, 1966-7, and that no entire calendar year is complete. However, in an attempt to present a close approximation to the discharge conditions prevailing at this time, daily values were obtained from the Northumbrian River Authority for their Burn Hall and Sunderland Bridge stations, and submitted to the simple modification to make some allowance for the unmetered areas between Durham and the two stations. A subsequent test showed that these values were probably a close approximation to the discharge at Durham, but it must be remembered that any calculations which include this period are subject to error, especially as the volumes of water included snow melt, which did not necessarily come from all parts of the basin over the same period.

In view of the nature of the problem it would not be pertinent here to present a necessarily extensive account of the complex association of rainfall, runoff and evaporation. Other workers have considered the subtle relationships involved on local Pennine streams in greater detailⁱ, and in view of the fact that it has subsequently appeared that the volumes of water available have never been of great importance in determining the character of water use,

i. e.g. Shaw, E.M., Rainfall and Runoff: Hydrological Studies in Weardale, Unpublished M.Sc. Thesis, University of Durham, 1957. Smith, K., Some Aspects of the Hydrology and Water Use of the Nidd Valley, Yorkshire, Unpublished Ph.D. Thesis, University of Hull, 1964.

FIG.4 PRECIPITATION IN THE WEAR BASIN



it will be sufficient here to note the general characteristics of surface water flow, and in anticipation of future demands, on the Wear, remember the amounts of surface water that are available.

In considering Figure 3 it will be apparent that there are three major characteristics of the surface water discharge; the extreme 'flashiness' of the river, with sudden high discharges occurring at any time of the year, the seasonal increase of discharge during the first months of the water year, and the relatively constant discharges that characterise the spring and early summer.

Sudden Floods

The flashy nature of runoff can be attributed to the fact that drainage is at once more efficient in those areas where rainfall is highest, and so intense rainstorms can be transmitted to watercourses with great speed. In order to depict this, the Wear basin was submitted to a random sample survey, based upon the kilometric division of the Ordnance Survey. For reasons of speed a 4% sample was used, which with 1,244 kilometric squares over the whole basin gave a convenient sample population of 50. The squares selected by means of a table of random numbers are presented in Figure 4. By determining the drainage density of each of the sample squares (length of watercourses per unit area) and classifying these by the mean isohyetal zone within which each square falls (according to 1916-50 standard period) Figure 5 was produced. Unfortunately

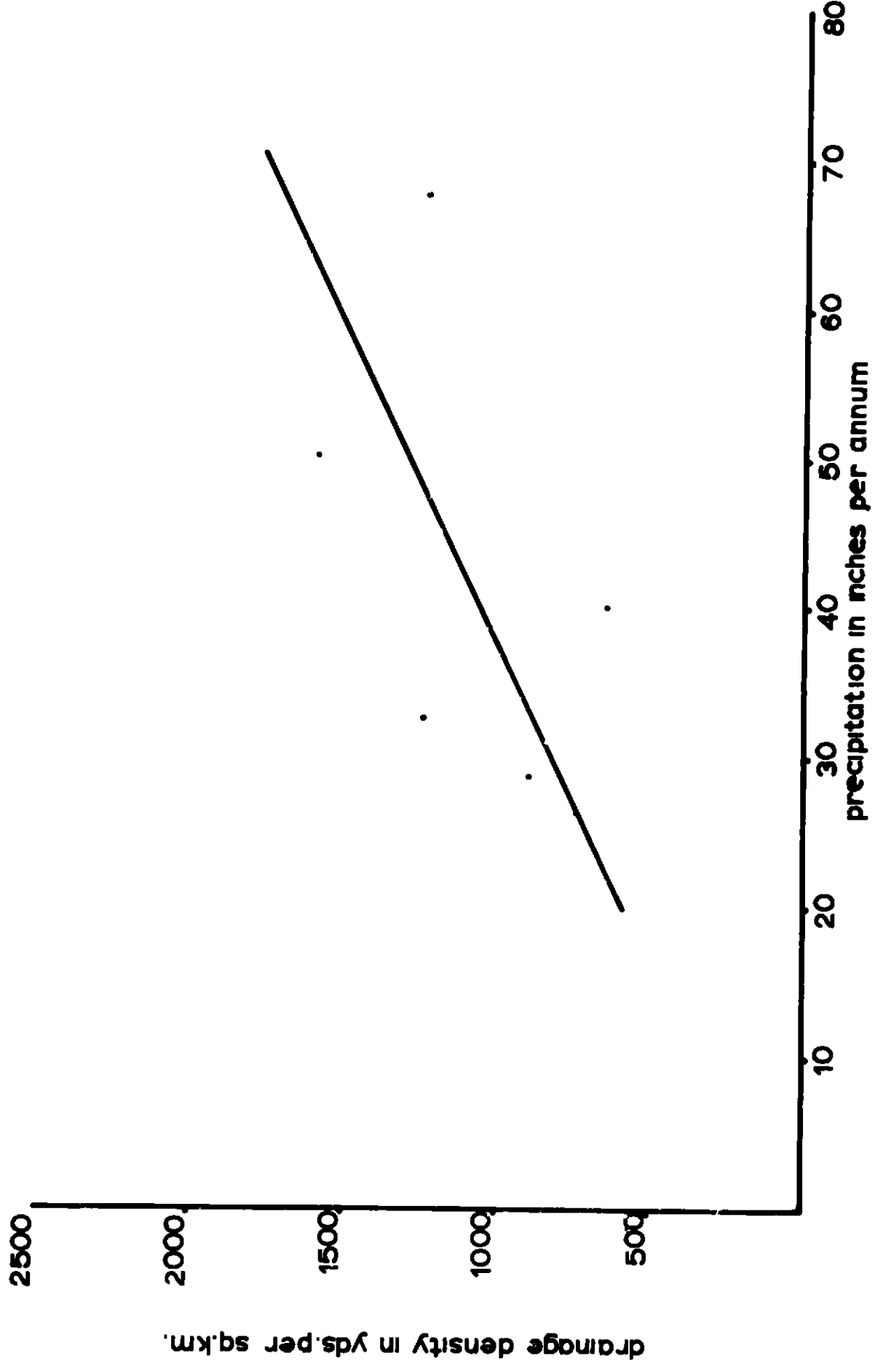


FIG.5 PRECIPITATION AND DRAINAGE DENSITY

only two sample squares fell in the zone of the highest rainfall (55"-70") and with such a small class population, the resultant value must be regarded with more caution than the other figures.

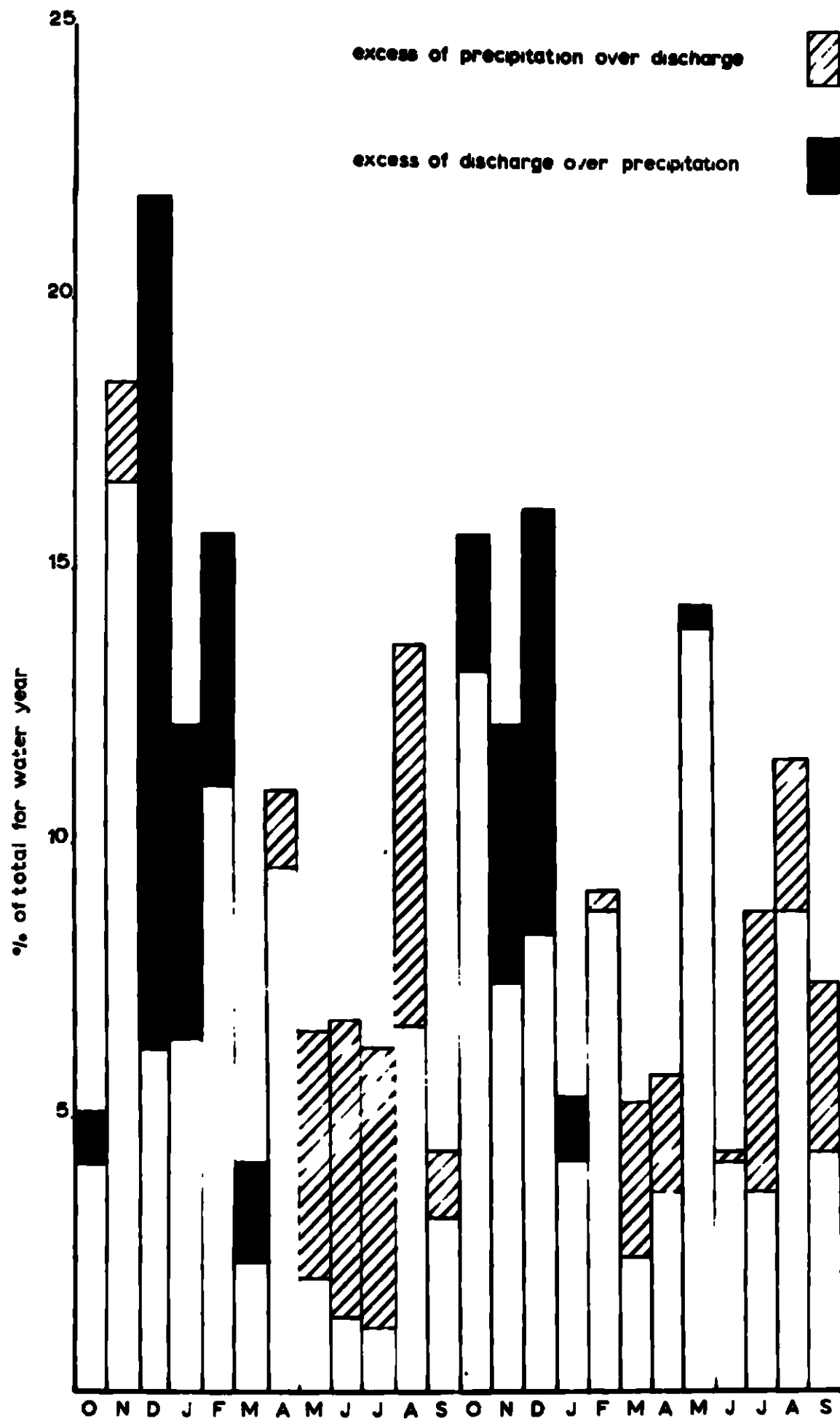
Although the two water years presented exhibit different characteristics, it will be noted that considerable floods can occur at any time of the year. While the very high discharges noted in November and December 1965, and February and April 1966 are the result of the melting of an extensive snow cover, the considerable peaks in August and September 1966, and August 1967, represent runoff from heavy rainstorms. Thus, for instance, August 1966 was a generally rainy month, with a very severe rainstorm occurring after several days of occasional rain and on the 13th 1.58" of rain was recorded at Burnhope Reservoir at the head of Weardale, 1.25" at Satley at the head of the Browney catchment, and 0.98" at Willington in the middle reaches of the Wear. This gave the heavy flood of the following day, with 1,771 m.g.d. passing the Abbey Weir. The more severe storm on the 3rd October, however, produced a slightly less spectacular flood at Durham. Rainfall was 1.7" at Burnhope, 1.45" at Satley and 1.09" at Willington. It will be noted, however, that the river was already flowing at twice its usual summer volume at the time of the earlier flood, suggesting that runoff from a rainstorm would be speeded up, while the river had returned to its lower level by the time of the October flood,

suggesting that a greater proportion of rainfall would be absorbed by the drier ground.

Far more common, however, are those rises in daily discharge giving values of between 400-900 m.g.d. If those freshes such as occurred on the 22nd and 25th June are included, and which frequently flush the river after periods of low precipitation, it will be seen that the median value for floods is 380 m.g.d. with an inter-quartile deviation of 610 m.g.d., but if these freshes are not included, then the median value of floods is 528 m.g.d., with an inter-quartile deviation of 162 m.g.d., which gives a much clearer idea of the general nature of the floods than the arithmetic mean of 758.2 m.g.d. +/- 635.6, where the occasional very large floods considerably distort the picture.

Seasonal Increases of Discharge

The most striking feature of the two water years presented is the seasonal increase of discharge over the autumn and winter period. In the water year 1965-6, it will be seen that apart from a short period of eight days in the last half of October, discharges are continuously greater than 100 m.g.d. for the period 9th September - 7th March, and for the period after the 31st October, minimum discharges are double this value for all but 11 days. In the following year, however, these latter values are not so consistently attained, and indeed, values over 100 m.g.d. are only continuously



**FIG.6 DISCHARGE AND PRECIPITATION REGIMES
1965 - 67**

maintained for the period 3rd October - 24th December, while over the following five months discharges of less than 50 m.g.d. are typical, with only occasional increases of discharge. In the period 1st January - 1st May, only 27 days have discharges greater than 100 m.g.d.

Although it is not proposed here to enter upon a detailed hydrological investigation into the relationship between rainfall and runoff it is hardly feasible to examine fluctuations in surface water discharge without reference to the rainfall regime over the period under discussion. Thus, in Figure 6 the monthly proportions of annual rainfall for ten stations throughout the catchment are shown with the monthly proportions of the annual discharge of the Abbey Weir for the two water years 1965-1967. It will be noted that the regime of rainfall over the two years is slightly different, and that although the customarily wetter season of July-January is slightly wetter in 1966-7 (61.3% annual rainfall) than in 1965-6 (60.0% annual rainfall), 1965-6 was distinctly less equable in rainfall terms than the subsequent year, with the three wettest months (November, August, and February) having a mean proportion of 15.1% while in the following year, October, May and August were the three wettest months, with a mean value of 12.9%. The three driest months in 1965-6 (March, October and September) have a value of 3.6% compared with 4.6% for the three driest months in 1966-7 (January, March and June). It will be noted that in each case only

one month is common in each group, March in the driest months, and August in the wettest months, while October in 1966-7 was the second wettest month, but in the following year was the second driest month. In both years, however, more than 4% of the annual rainfall fell in each month, excepting March 1967, when only 2.4% fell.

As might be expected, therefore, the runoff characteristics of the two years are slightly different. If the difference between the monthly proportion of runoff and the monthly proportion of rainfall are tabulated, then it will be seen that the more equable year of 1966-7 shows a much closer association of the monthly proportion of rainfall and runoff than the preceding year. The mean difference between the two is 4.38% in 1965-6, and 2.83% in 1966-7, (Table 7). For both periods, however, the winter season sees a greater proportion of runoff occurring than precipitation, with excesses between December and March in 1965-6 and October - January in 1966-7. This excess must be regarded as either the contribution of water from other sources, or the lack of a water demand either as evapotranspiration or as a contribution to aquifers. It is probable that both factors are at work. Over the subsequent period (April- September 1966, after February 1967) runoff is less than the proportion of precipitation would suggest, which would seem to represent a loss of water, probably to the atmosphere through increased evapotranspiration consequent upon the growing season,

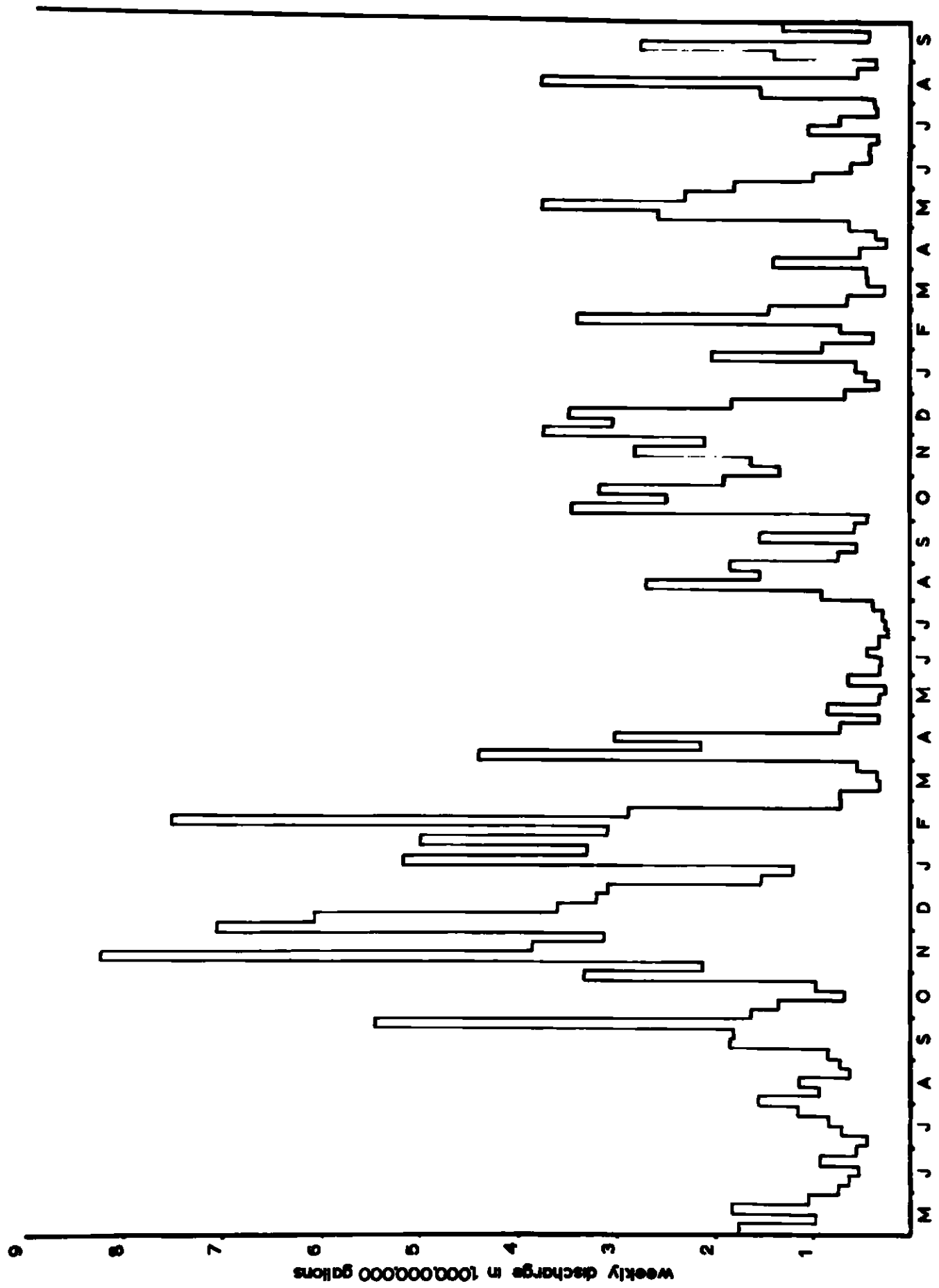


FIG.7 DISCHARGE AT ABBEY WEIR BY WEEKS, 1965-67.

but also to the replenishment of those subterranean sources which may help to maintain the high flows of the winter season. The evaluation of the role of these two agents, evapotranspiration and the contribution of subterranean sources deserves more attention than can be given here, but it would certainly seem that the hydrological balance is not necessarily annual, as is shown in the data for 1966-7.

Constant Discharges

In considering Figure 3 it is apparent that there are a number of daily discharges around the single value of c 45 m.g.d. As these discharges are not the immediate result of precipitation, it is obvious that they must be derived from ground water flow with daily fluctuations reflecting changing meteorological conditions that affect evaporation etc. If these daily values are smoothed out by presenting the discharges in weekly form (Figure 7) then by comparing the two histograms, it is easier to pick out these mainly ground water days as periods of low weekly flow, lying in the troughs between periods of high discharge. If the mean value for these weeks is found, it will be seen that for the water year 1965-6 a weekly value of 306.5 m.g.w. +/- 27.5 m.g.w. (c 43.8 +/- 3.46 m.g.d.) is obtained, and for the following year, 333.9 +/- 45.9 m.g.w. (47.7 +/- 5.19 m.g.d.)

Discussion

Throughout the preceding paragraphs the mention of the accepted

hydrological terms of surface runoff, interflow, and ground water discharge, or base flow, have been for the most part avoided, but it would seem to be appropriate to introduce them at this point. Using the definition given by Ineson and Downingⁱ, surface runoff represents that part of precipitation which flows directly over the surface into the stream and river channels, and is that part of precipitation which has not passed underneath the surface of a basin. Interflow may be considered to be that part of infiltration which moves rapidly in horizontal directions usually in the soil zone, or immediately below it, but which does not penetrate to the underlying zone of saturation. Base flow originates from that part of the infiltrated water which moves downward under gravity to reach the zone of saturation under the water table, and then percolates laterally along the aquifers according to the hydraulic gradient, and subsequently discharges into watercourses either as effluent discharges, seepages, or springs rising contiguous to the river channel.

Hydrologists have given considerable attention to the separation of these three components, and when all three occur together, during periods of peak discharge, then their distinction must be open to speculation. However, it is suggested that this triple division,

i. Ineson, J. & Downing, R.A., 'The Ground Water Component of River Discharge and its Relationship to Hydrogeology' Jnl. Instn. Wat. Eng. Vol.18. No.7. 1964.

based essentially on the depth to which water penetrates into the ground, may on a broader scale be applied to the three characteristics of the Wear noted above. The flashy increases in discharge consequent upon sudden rainstorms, or long periods of precipitation represent water that cannot be immediately retained in the ground, although it may pass into streams direct as surface runoff or indirectly as interflow. The fact that sudden rainstorms do not necessarily imply sudden increases in discharge, emphasises that such discharges can only occur when the ground is already saturated, or when the rainstorm is of such intensity that precipitation cannot be absorbed at the rate at which it is falling.

The seasonal increases in discharges represent the seasonal raising of the water table consequent upon increases of precipitation and decreases in the demand of vegetation after the growing season, and a lower rate of evaporation in the cooler months of the year, and thus represents water that has penetrated into the ground, but has not passed into the deeper aquifers. Base flow, or the contribution of the deeper aquifers, lying below the summer water table is represented by the long periods of constant level experienced during the growing season. Even this, of course, will vary from year to year, but these variations will be slight.

It will be apparent therefore, that the amount of water available for use shows a seasonal rhythm, which varies according to

meteorological conditions, and in particular, according to the incidence of precipitation. The rainfall conditions prevailing over the period when discharge records were kept have already been mentioned. The daily mean values for two rainfall stations, one at Burnhope at the head of the catchment, and the other at Durham at the lower end, are presented graphically in Figure 3, but in order to put these figures into perspective, it is necessary to consider, briefly, the longer term nature of precipitation over the Wear basin.

Rainfall over the Standard Period 1916-50

The Wear and Tees catchments were the first to be considered by the Meteorological Office in the preparation of annual and monthly mean rainfall values for the standard period 1916-50, and the mean isohyetal picture of the Wear catchment is set out in Figure 4_i. As the highest relief in the Wear basin lies in the west, it is not surprising that most precipitation falls there, with rainfalls as high as 65"-70" likely on the highest parts of the extreme west of the basin. At Grassmeres recording station (1850'O.D.) in the Burnhope catchment, 93.20" was recorded in 1903, but Shaw_{ii} considers this and the other monthly gauges in this reservoir catchment to be unreliable, and considers that the Grassmeres mean of 59.71" and the Lodgegill mean of 63.47" for the period 1903-52 both too high.

i. Hydrological Memoranda, op cit
ii. op cit

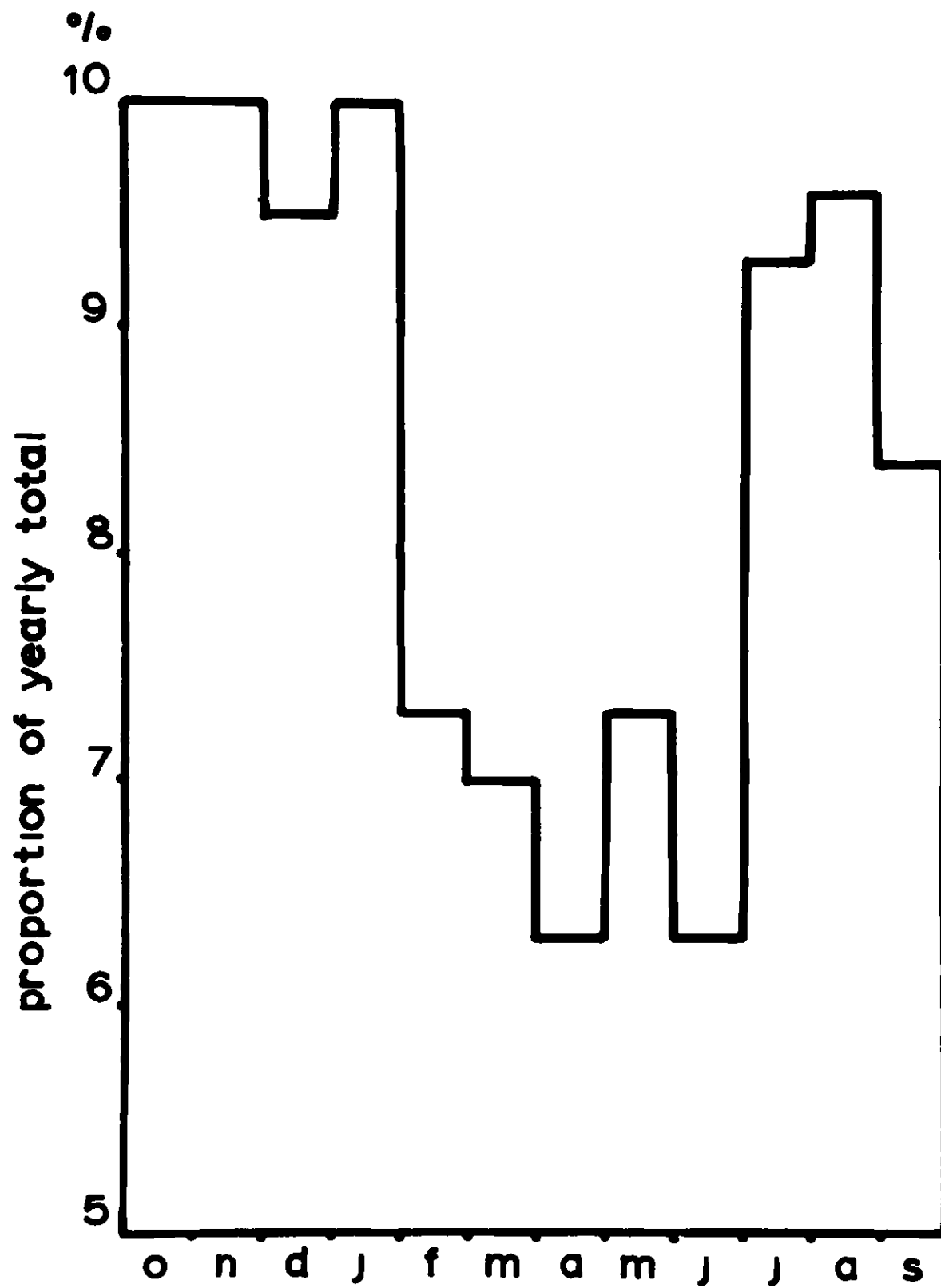


FIG 8 RAINFALL REGIME FOR ABBEY WEIR OVER STANDARD PERIOD 1916-50

Rainfall decreases rapidly eastwards as elevation falls, to 35" in the valley a little to the west of Stanhope, but thereafter the gradient is less steep, until parts of the Wear valley around Chester le Street have less than 27.5" p.a. Increases of height along the Permian escarpment, however, result in increases of precipitation with a mean for this area of a little over 30" p.a.

The monthly means for this standard period are presented in Table 8, for the catchment of the Wear above Stanhope, the Wear above Sunderland Bridge, and the entire Wear catchment, and also for the Gaunless and Browney tributaries. By means of the Browney and Sunderland Bridge catchments the estimated mean monthly rainfall figures for the catchment above the Abbey Weir has also been inserted. Figure 8 dramatically reveals the presence of a drier season from February to June, during which time for the catchment as a whole only 32.8% of the precipitation falls in 41.6% of the year. It will be noted from Table 8 that the other divisions of the catchment fall close to that value. As might be expected the western areas of the catchment above Stanhope are consistently wetter than the other areas, but it will be seen from Table 9 that the wetter season is slightly more pronounced than for the rest of the basin. The similarity of the rainfall and regimes of the Gaunless and the Browney catchments betokens their broadly similar position on the flanks of the Pennines, although the

Browney tends to be wetter than the Gaunless in the last five months of the water year. The proportion of rainfall in these two areas during the drier season, however, at 34.4% (Gaunless) and 34.2% (Browney) agree well. Within the wetter season, the period from October to January will be seen to be rather wetter than the first three months of the season (July - September), although there are significant differences throughout the season, with, for the basin as a whole 8.6% of the annual rain falling in the two months of July and September, but 10.2% in August. In terms of regime the whole basin follows a similar pattern during the wetter season, although the Gaunless proves eccentric during November, its monthly proportion of rain rising above the October figure, when all the other areas remain the same, except for the highest region which actually falls.

To sum up, then, more than 6% of the annual precipitation falls in each month of the year, while a wetter season lasting from July to January inclusive has an average of almost 7.2% of the annual rainfall each month. This regime is followed throughout the basin, but is more pronounced in the wetter parts of the catchment, which is relatively more significant in terms of runoff than its area would suggest.

PART II

WATER USE

Water Corn MillsA Note on Water Power in the Wear Basin

The use of water power in the Wear basin has in the past been both extensive and important. Before the introduction of steam power in the eighteenth century, water provided the most important motive force for the many extractive and productive industries that were conducted in the area. Accordingly, considerable attention has been given to the use and development of water power in the basin, and in this and the following chapter an analysis is made of the 95 mills not immediately connected with the lead mining industry, which has been given separate treatment in Chapter VI. As mills could have been established at almost any point on the many watercourses within the basin, the position of the mill was often determined more by questions of land ownership rather than physical necessity, although some very fine mill sites were undoubtedly utilised. The interest of the sites, therefore, lies largely in the way water power has been developed at these particular places, and the consequent arrangement of mill and watercourses. Accordingly, in Appendix B a plan is presented of each known mill site, based upon the first edition of the 25" Plans of the Ordnance

Survey. The County is fortunate in that it was the first to be surveyed at this large scale, and the plans were mostly complete by 1857. At this time, most of the mills, even if some were abandoned, were still in existence, and with the use of field work, the last landscape effects of the mills can be accurately plotted. It can be assumed that the sites of mills have for the most part remained constant, although the arrangements of leets and the buildings themselves have changed from time to time. Where possible, this question of site has been checked, and although, unfortunately, the sample was small, the result has almost always been to confirm this assumption. Thus, the mill at Hett, established by 1168 was shown by a sketch map of c.1430 to be in the same position as a much enlarged mill of 1857, although at Shincliffe, the mill was shown to have moved to its last site sometime after the mid seventeenth century, when the course of the Old Durham beck was changed.

Corn Milling

In the third century A.D., an undershot water wheel was fitted to the right bank bridge abutment of the Roman bridge over the North Tyne at Chesters in Northumberland. This is the earliest water mill ever recorded in the North East, and one of the earliest in the country. The first reliable allusion to a post-Roman corn

mill in England occurs in 762_i, but by 1086 5,624 mills were active in 3,000 or so communities south of the Trent and the Severn. Although Northumbria was laid extensively waste by William I it seems not unlikely that the larger Saxon communities which erected the stone churches such as have survived at Escomb, Wearmouth and Pitlington would have had a water mill, if only of the more primitive Norse type. It is not, however, until the twelfth century that there is definite proof of a water corn mill in the Wear basin.

The First Mills

The first reference to a mill occurs in 1118 when the mill in the new faubourg of Framwellgate, at Durham, was given to the brethren of the Hospital of St. Giles, in their original foundation charter_{ii}. It would seem probable that this is very near the time of the erection of the mill, for the inhabitants of Palace Green who were moved in 1112 were probably settled across the river by Bishop Flambard, who subsequently built Framwellgate Bridge in 1120. As this mill was at work by this time, it seems hard to imagine that the mills worked off the Abbey Weir, known to be in existence by 1172_{iii}, were not already established, and similarly that the Bishop's Mill on the right bank of the river below St. Nicholas Church was not already serving the needs of the walled town. It

i. Oxford History of Technology, Vol.II.
 ii. S.S. XCV 37
 iii.S.S. I 252

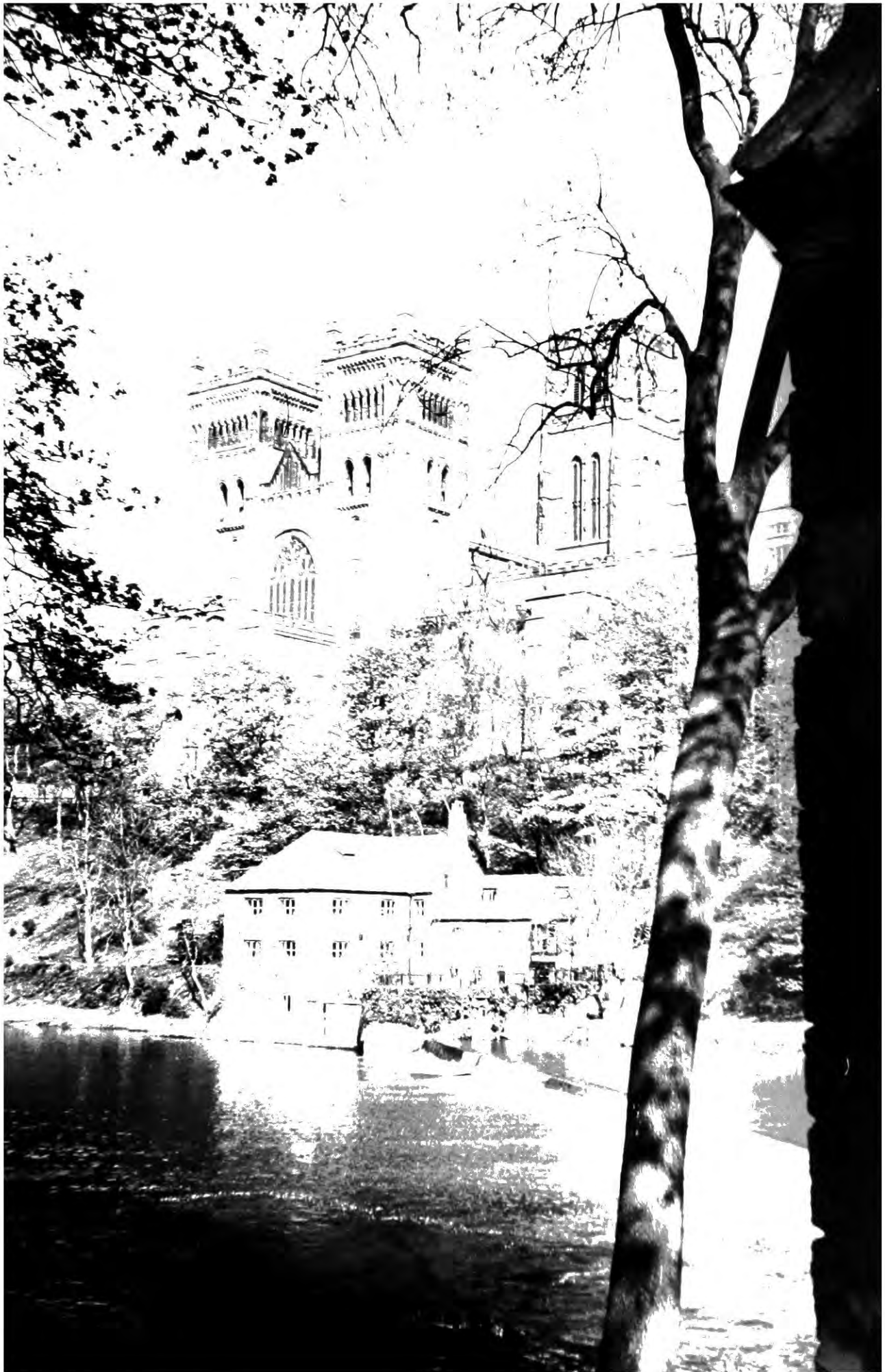


PLATE II

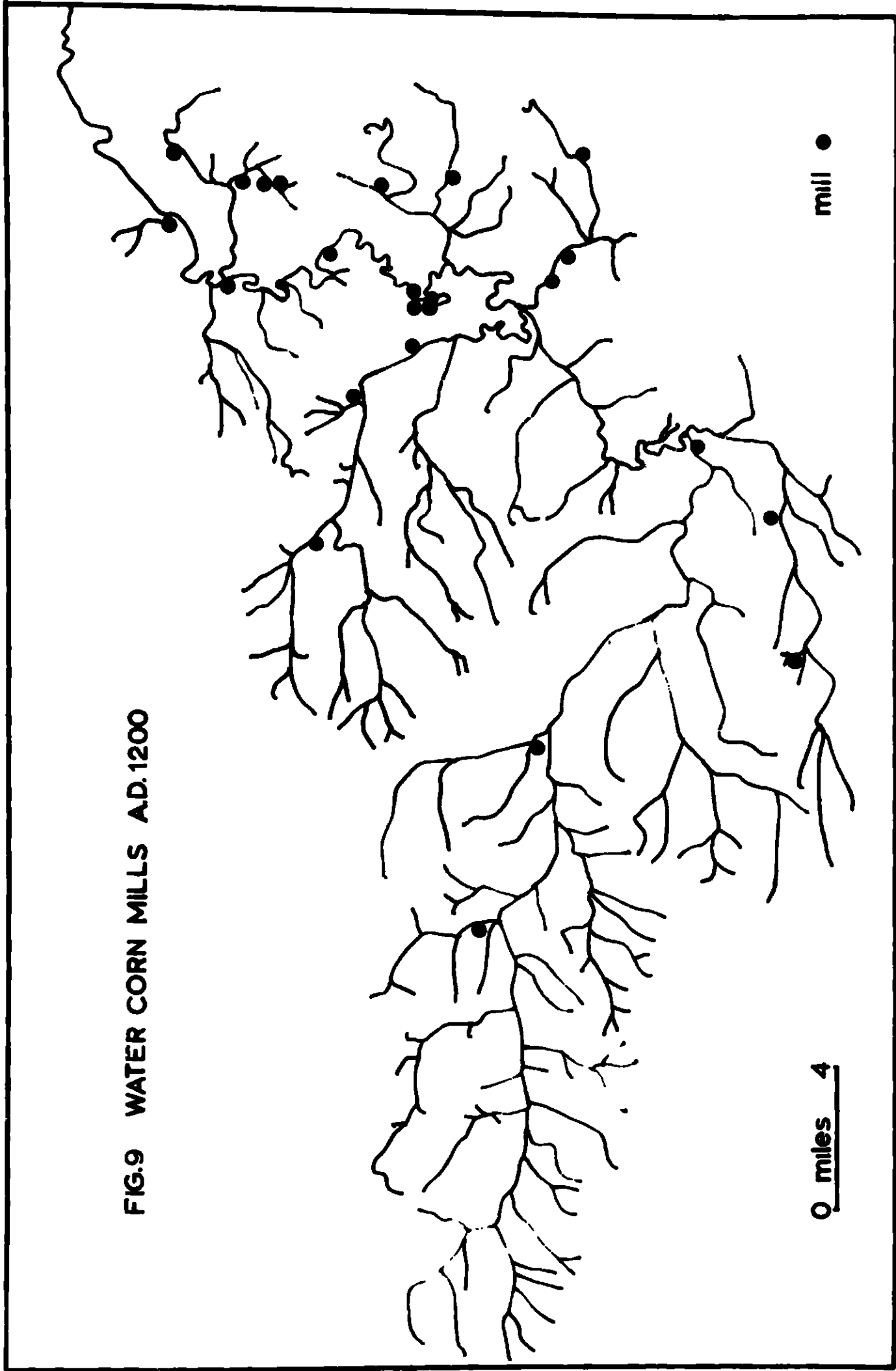
The Jesus Mill, Durham

will be appropriate at this point to note the precise functions of the several mills at Durham. The Abbey Weir was maintained at the common cost of the Convent and the Bishop. The Bishop had a corn mill at the eastern end, subsequently known as the Jesus Mill (Plate II) which supplied flour for the Castle and the fortified peninsula. By the fifteenth century a second corn mill was established here. On the western side the Convent had a mill, the Abbey Mill, to supply flour to the large conventual household and its retainers in Crossgate, assuming the role of manor mill to the Prior's vill of Crossgate (Plate III). In the fifteenth century a fulling mill was established by the side of the corn mill. In Framwellgate the mill established by Flambard was manor mill to his vill of Framwellgate, and at the other side of the river the walled City was served by the Bishop's Mill (Plate IV). The mill at Framwellgate subsequently passed to the Convent and went under the name of Clock Mill.

Other mills at work during this period can be summarised as follows. At the Prior's vill of Pitlington, a mill was being used before 1154_i, and at his vill of Hett a mill was established by 1168_{ii}. According to Boldon Book_{iii} mills were also established in the episcopal vills of Chester le Street, Newbottle, Biddick, Turisdale, Stanhope, Wolsingham, Lanchester, Witton Gilbert, and in Aucklandshire, and Quarringtonshire.

i. S.S. LXXXII 129
 ii. S.S. LVIII 130
 iii. S.S. XXV

FIG.9 WATER CORN MILLS AD.1200

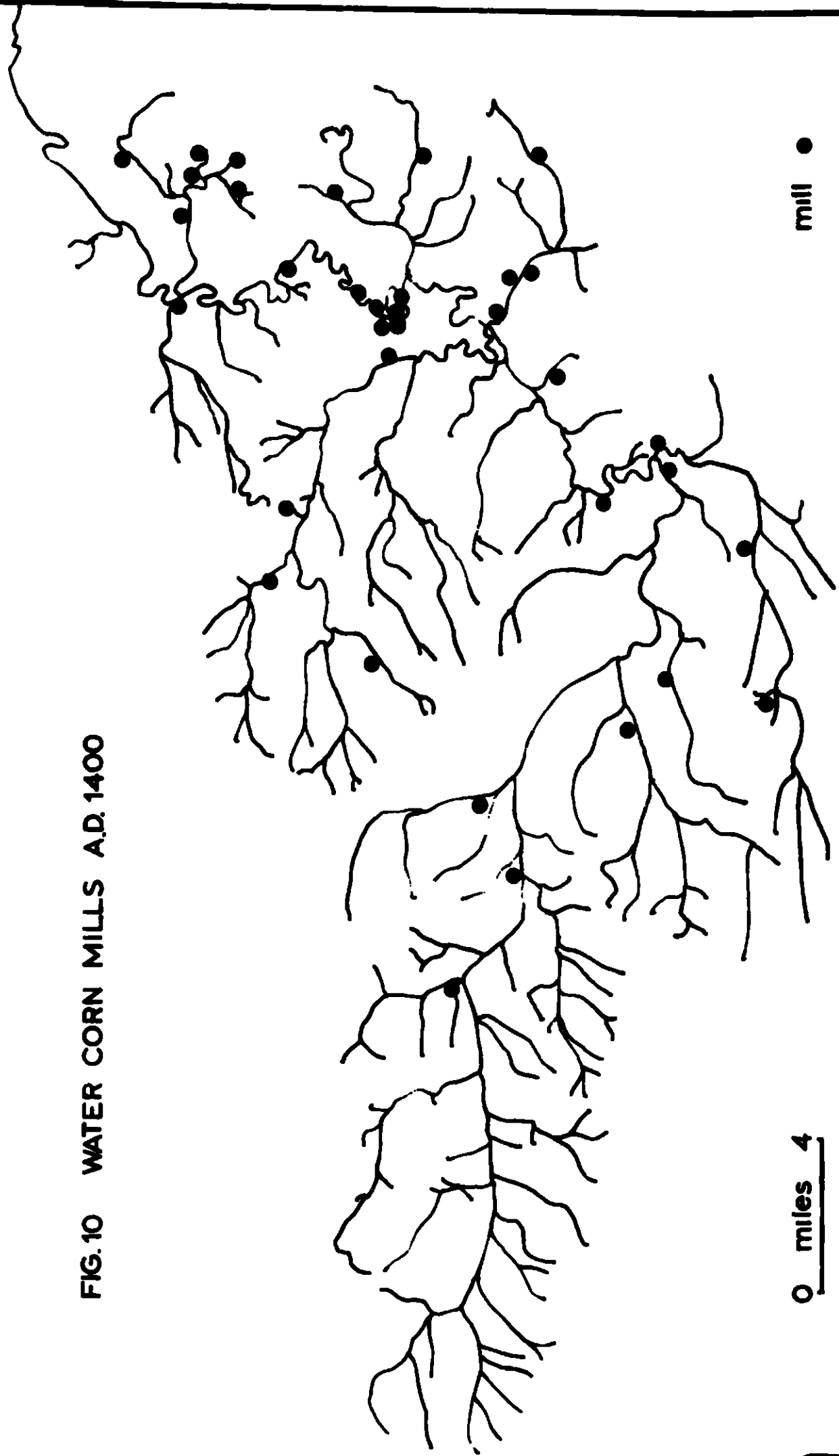


If an examination is made of the distribution of mills found at this time (Figure 9) it will be seen that their erection reflects certain physical conditions, and the ownership of lands. Thus in the upland area to the west of Dere Street there were few mills. Those at work are in the chief vills of the episcopal manors of Auckland, Lanchester and Wolsingham, supplemented by mills at Stanhope and West Auckland. These areas lie within an area which has been visualised as having less than 100 acres of arable land per square mile, and can be represented as lying within small oases of settlement and improved agriculture set in an extensive forest and waste_i.

To the east of this upland area, in the gentler fertile vale and post-glacial platforms of the middle Wear valley, mills are distributed much more frequently. While the chief vill of the episcopal manors each have a mill, Durham, Chester le Street, Cornforth, Houghton le Spring, several vills have a mill to themselves, as at Witton Gilbert, Sherburn, and Tursdale (Trillesden in ancient charters). A whole line of mills can be seen stretching along the foot of the Permian escarpment, from Penshaw in the north to Cornforth and Tursdale in the south. All these mills lie within an area of 100-200 acres of arable per square mile_{ii} and reflect a larger amount of land given over to arable farming, and a larger population.

i. Dickinson, P., The Historical Geography of County Durham in the Middle Ages, Unpublished Ph.D. Thesis, University of Durham, 1957.
 ii. Dickinson, op cit

FIG.10 WATER CORN MILLS A.D.1400



Mills at the Beginning of the Fifteenth Century

From 1200 to 1400 another 15 mills make their appearance known, most, if not all of which, it is suggested would be established before the outbreak of the Black Death in the County in 1349-50. The distribution of these mills portrayed in Figure 10 would seem to suggest the further opening up of the wastelands of the upland west, and the growing prosperity of the more fertile middle Wear valley. It is probable that a mill was established at Frosterley by 1210_i and the Hatfield Survey of c.1380_{ii} records expansion particularly in the south west of the basin, along the Bedburn, Linburn and Gaunless valleys. Mills were established by this time at Witton(Fychewak later Fitches), Lynsak, and Evenwood and at Bedburn. To the north on the head waters of the Browney, the mill at Satley was at work by 1324_{iii}.

The number of dams placed on the Wear at this time is doubled. At some time after 1244 the brethren of Kepier Hospital established their new mill by the side of the hospital_{iv}. From the Bursar's Roll at the Convent_v it would seem that the conventual mill at Skaltok, manor mill of Elvet, had been established some time before 1300. At Hunwick, north of Bishop Auckland, the Hatfield Survey

i. S.S. XCV 198
 ii. S.S. XXXII
 iii. Surtees II 345
 iv. S.S. XCV 203
 v. S.S. CIII 503

notes that 'Johannes Burdon ... ten placeam pro stano molendini'_i, and the mills at Tudhoe (1279) and Shincliffe (1355) further suggest the growing prosperity of the lands immediately about the river over this period. The mill at Tudhoe was deemed to be old in 1279_{ii} and it may be that this mill ought more properly to be included in the list of early mills. To the east, however, mills continued to be established, with mills mentioned at Herrington in 1328_{iii}, at Coxhoe by 1250_{iv} and at Hetton by the Hatfield Survey.

The Black Death is generally taken to be the turning point for feudal England, after which labour became scarce, and ancient services were commuted in favour of money payments. It would be appropriate therefore to examine the place of the mill in feudal Durham. The services performed at a lord's mill by his servile tenants are familiar enough, and Durham is no exception. The whole range of services is aptly summed up in the Feodarium Prioratus Dunelmensis_v with regard to the mill at Hett. The tenants were to 'operantur ad stagnum molendini et dant stramen pro cooptertura molendini et cariant lapides molares et meremium pro reparacione molendini quociens necesse fuerit'. Services were not necessarily restricted to the local mill of the vill, of course,

i. S.S. XXXII 50
 ii. Surtees III, 297
 iii. Surtees I, 188
 iv. S.S. VI 103
 v. S.S. LVIII 70



PLATE III

The Abbey Mill, Durham

and the men of Urpeth in 1181_i and Sheruton in 1380_{ii} had to carry millstones to the episcopal mills at Durham. Similarly half of the mill dam at Lanchester was repaired by Nicholas Rugheved in 1340, who held half of the vill of Greencroft_{iii} while the dreng tenants of Greencroft were liable for the repair of one twelfth of the Lanchester dam.

Most important of all the services, of course, was the tenants' obligation to grind at the lord's mill, paying a certain amount in multure. Bradshaw_{iv} notes that some free tenants might get exemption from multure, others ground, but only paid perhaps one twentyfourth of the produce. This was by no means universal as the free tenants of the Prior at Rainton had to pay one thirteenth part multure_v. The bondager, notes Bradshaw, generally paid one thirteenth part, but again this was not uniform for the Prior's tenants at Pittington and Moorsley paid only one fourteenth_{vi}. The mills, as Dickonson noted, were usually put out to farm at a fluctuating rent. To take as an example the mill at Coxhoe, farmed out by Finchale Priory. Between 1360-90 the annual rent varied from 43s.4d. to 66s.8d., remained at 60s. until 1456 when it was increased to 66s.8d. until 1476 when it was again increased to 80s.

i. S.S. XXV 71
 ii. S.S. XXXII 152
 iii. Surtees II 321
 iv. Victoria County History of Durham II 189
 v. S.S. LVIII 19
 vi. S.S. LXXXII 106

The mill at Finchale, however, steadily declined in rent from 58s.4d. 1361 to 20s. in 1388, and for the following century remained at around two marks, except for some violent fluctuations between 1460-90.

If the revenue of the mills is examined, the expected pattern emerges. In, for instance, the *Magnum Rotulum Receptorum Dunelmensis* of 1308_i there are five episcopal mills west of Bishop Auckland, which together yield £16.7.0., while the six mills to the east of Bishop Auckland, including Auckland, but not Durham, where the mills were not at farm, yielded £30.6.8. It must be further remembered that there were 19 other mills in this eastern area, but only 3 more in the west. Thus it is easily apparent that not only were there fewer mills in the upland west, but that they were smaller, and yielded less revenue. It is to be noted that this reflects the economic condition of the two areas rather than the water power potential.

Mills from the Fifteenth to the Seventeenth Century

From 1400 to 1647 eleven more mills come to light, of which it is probable that six were much earlier foundations. The mills at Barnwell, mentioned in 1426_{ii}, Harberhouse and Lumley on the Wear, Croxdale mentioned in 1575_{iii} and Crook Hall, first mentioned in 1636_{iv} were all upon secular estates of considerable antiquity.

i. S.S. XXV

ii. Surtees II 120

iii. D/S L77-83

iv. Surtees IV 46

All are within the relatively prosperous middle Wear valley, and it would not be unlikely that these estates possessed a water corn mill at an earlier date than their first documentary evidence, would suggest. Similarly, the mill on the Gaunless at Bishop Auckland, first mentioned in 1647_i which existed primarily for the 'grinding of the corn of the servants and officers of the Bishop at his house'_{ii} was probably at work if not from the origins of the palace at Auckland in the early fourteenth century, then at least soon afterwards. It is not known when the second mill established on the east side of the Abbey Weir at Durham was erected, but there were certainly two mills there when they were bought by Prior Castell at the close of the fifteenth century.

In the west, it is significant of the further opening of Weardale that two mills should have been erected upon freehold land by 1595, at Unthank across the river from Stanhope, and Eastgate_{iii} while the decay of the bishop's mill at Stanhope by 1647 was said to be offset by the erection of a new mill at Westgate_{iv}. It will have been noted that concomitant with the development of Weardale has run the opening of the Gaunless valley, and continuing this trend a further mill in this valley becomes noted in 1622 in the chapelry of St. Helens Auckland. This is probably Broom Mill_v.

i. C.C. R/S 23375
 ii. C.C. /B.E.S. 382/185036
 iii. C.C. /R.S. 277863
 iv. C.C. /R.S. 23387
 v. C.C. /B.E.S. 393/185247

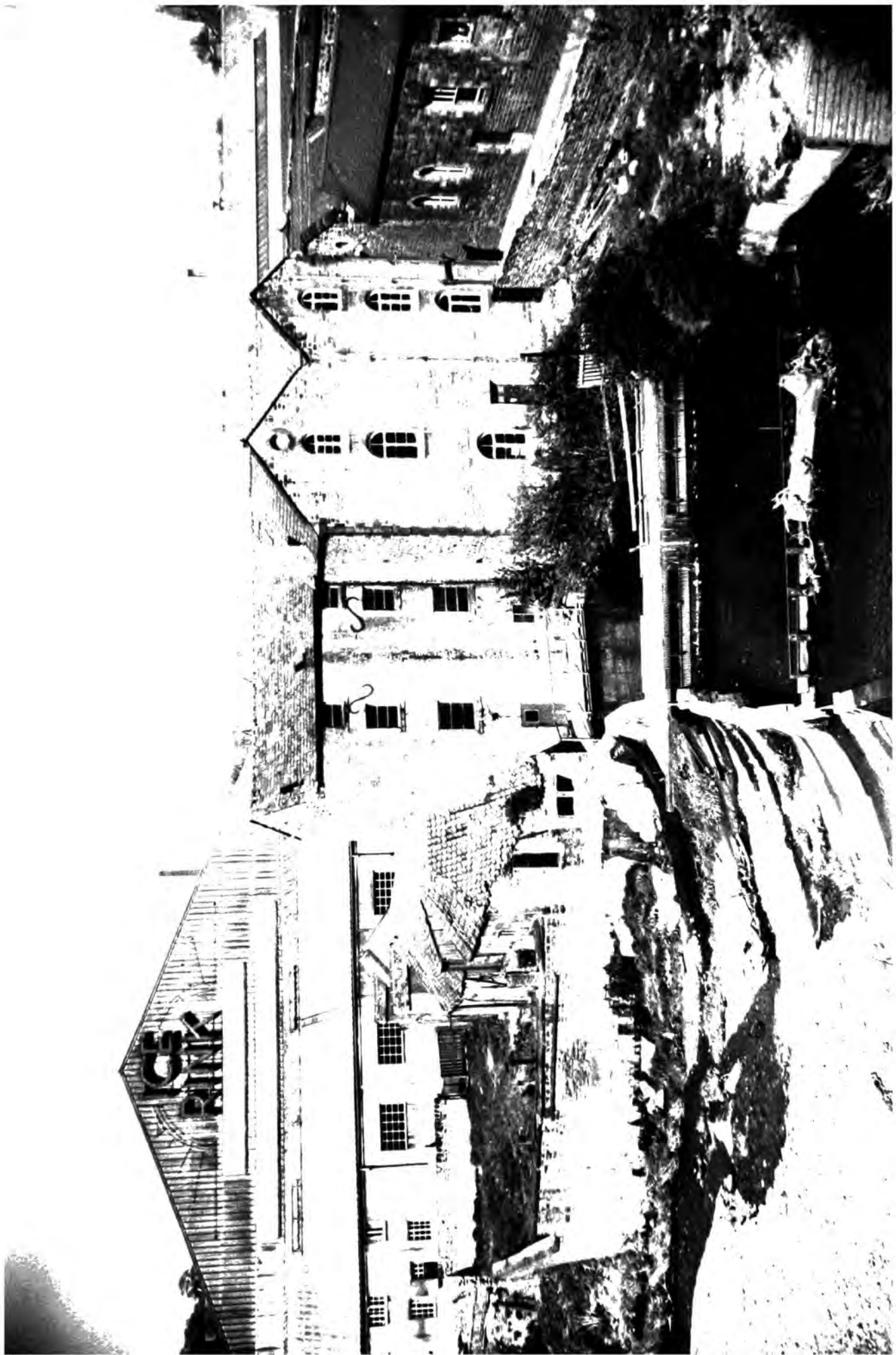


PLATE IV

The Bishops' Mill, Durham

The breakdown of feudal services, alluded to above, meant the growing necessity for the hiring of men and skilled labour, and the consequent extension of book-keeping and accounts. Thus, from the fifteenth century onwards, a much clearer picture of the construction and use of corn mills can be assembled from the various account rolls that are available today. The account rolls of the convent officers at Durham, of course, are of great interest, but another survival of note is a roll relating exclusively to the repair and reconstruction of some of the episcopal mills in 1421_i. In this one year at Chester le Street, the dam was cleaned out, a new roof was put on the mill, the miller's house repaired, the water wheel lifted up and fitted on a new axle tree, and the leet made water-proof. Because there had been an 'obstupacione aquo de Were a la fleme molendinorum granniticorum' at Bishop Auckland, 10s.6d. had to be expended on building up and scouring out the leet. At Durham, a new road was built to the Jesus Mills, 'Et sol Johne Turbott de Dunelm pro portacione culpacione at exaspacione de 401 piles adquosit pro reparacione et emendacione viarum ex australe parte molendinorum austrorum de Dunelm pro singulo 12d. cum 14d. Solu eidem pro portacione 14 plaustr oobosti pro emendacione eorum viarum'. At Cornforth the water wheel was repaired, new woodwork

was introduced at Stanhope Mill, and the rynd spindle on the stones was renewed at Lanchester.

It is evident that specialist workmen were about. Johni Rychemond de Auckland supplied pitch for works on water wheels at both Bishop Auckland and Stanhope, and Johni Hobson de Derlyngton was also at work on both mills. Thomas, the smith of Shincliffe, seems to have had a thriving trade as a millwright working at both Chester le Street and Durham. Materials, if at all possible were brought from the episcopal estates. Thus timber from the park at Frankland was used at both Chester le Street and Durham, and both stone and timber were used in the construction of the mills. Extensive use was made of pitch for waterproofing launders and water channels, while local iron was utilised in the many smaller implements, 'pykkes, wymbles, axes, fetylokkes, chisels et alia instrumenta consimilia'ⁱ. Sometimes the skilled workmen recruited local labour, occasionally he used his own family. Thus at Stanhope, John Colson, a mason erecting new walls was paid '10 dies $\frac{1}{2}$ ad 5d. cum 3s.6d. solut pro famulo so ibidem operant per eidem as 4d., summa 7s.10 $\frac{1}{2}$ d.' Thus it will be seen that the use of watermills implied not only an appreciation of the application of water power, but also a whole range of skills developed by specialist workmen whose services could be hired.

i. S.S. CLXIX 807

The mill dam, of course, was vital to the whole operation, it being necessary to regulate the amount of water passing onto the wheel, and as a certain amount of information is available on the large dams that were set on the Wear itself, it would be appropriate to note the construction of this important factor. The mediaeval dam was essentially a heap of wood, stones and moss arranged in varying degrees of sophistication according to the temper of the times and the care of the miller. Two methods were used, often in conjunction, but occasionally separately. Sometimes the base of the dam was composed of a trapezoidal pile of stones upon which were placed branches to form the 'ryssdam'. Thus, 'Et Thomae Cokfeld, Johanni Person et aliis pro factura le ryssdam super stagnum molendini de Fynkall'ⁱ. At other times the base of the dam was formed by hurdles weighted down with stones upon which was then placed the ryssdam of branches, the whole being made waterproof by the application of moss to the interstices. Where the dam joined the river bank at the mill, strengthening was needed, and a masonry wall was usually constructed. At Finchale in 1375 £4.2.4. was expended upon 'facta columpnia petrina contra defenciozem aquae pro molis'ⁱⁱ. Each year the dams had to be repaired with the application of moss. Thus at Durham in 1473 'diversis mulieribus

i. S.S. VI ccclv

ii. S.S. VI xci

pro portacione de le mosse ad stagnum molendini Abb'ie hoc anno 8s.Od.ⁱ and in 1523 'Reparaciones ,... operantibus super ampnem molendini Abbathie per 14 dies 21s. pro aquisiicione et carriagio le mossez ad predictum ampnem 14s.5d.' At other times hurdles had to be laid down, and thus in 1355 is the entry 'Et in 36 flakkes factis in parco de Beaurep et Houghall pro stagno Molendini Dunelm et Skaltok.'

As might be expected on such a flashy river as the Wear, these primitive dams were often swept away or severely damaged. A flood in 1402 swept away the dam at Finchale and Skaltok, and the Clock Mill at Durham, but if these dams were easily lost they were easily rebuilt. It was not until the eighteenth century that masonry dams became the norm, and even as late as 1860 the dam at Kepier was constructed in the ancient manner.

1640-1840

In the mid-seventeenth century the sequestration of the Bishop's lands and property, and their subsequent evaluation allows an examination to be made of the value and condition of the watermills at this turning point in the historical development of the area. Unfortunately, the surviving surveys do not cover the many mills in the centre of the basin, and information on lands in the middle Wear valley, relatively rich in mediaeval times is not available,

save that the mill at Cornforth was worth £15.6.8. p.a. to its tenant_i, that at Chester le Street £12.8.0._{ii} and that at Newbottle £12.3.4._{iii}. It is unfortunate for this present purpose that the surveys taken of the Dean and Chapter lands also sequestrated at this time, have not survived. It is possible, however, to gain some information on mills in the south and west of the basin. It is significant that the manors of Wolsingham, Evenwood and Auckland, which had one, or perhaps two mills each at the time of the Hatfield Survey now contain many more. The manor of Evenwood had five mills within its bounds in 1647, worth upon average £11.11.0. to their tenants. The new mill at Westgate built to supplement the one at Stanhope was worth £12 p.a., but the mills at the two most important centres of Wolsingham and Bishop Auckland were worth much more. At Wolsingham the mill was worth £23 p.a. and at Bishop Auckland the two mills were worth £26 and £24 p.a. It is worth noting the difference in value between the country mill and that serving the more important manor centre. It may be significant for the other mills in the east of the middle Wear lowland, that the mill at Cornforth, one of three in the manor of Bishop Middleham was worth £15 p.a.

Remnants of feudal service still existed at this time. All

i. C.C. /R.S. 23374
 ii. C.C. /R.S. 23376
 iii. C.C. /R.S. 23383

the tenants of the manors of Evenwood and Bishop Middleham were still required to grind at the episcopal mills, but at Chester le Street they had no such obligation, this, perhaps, explaining the relatively low value of this mill situated at a manor centre.

At Houghton le Spring none of the tenants had to grind at the lord's mill except the unfortunate tenants of Newbottle and East and Middle Herrington, on whom the full feudal service was enjoined, 'ye Tennants of Newbotil and of East and Middle Herringtons are bound by their tenancy to carry and lead stones and timber to the said milne and to find thatch for the repairs thereof and to scower the mill dam or water race of the said Mill'ⁱ. Tenants at Bishop Auckland were also obliged to grind at the lord's mills but 'regrators ... at thyre expense may grind at other mills if they please'ⁱⁱ. It would seem that this was due to a decree of Chancery at Durham on a case brought in 1623 by George Walton farmer of the Bishop's Mills at Durham against the miller of Croxdale. It would appear that for over fifty years previously the tenants of the country mills round about Durham had brought their carts to the City and taken away grain bought by retailers at Durham market, ground it in their mills at a cheaper rate than the Durham retailers would have enjoyed at their lord's mill, 'so they grind little corn

i. C.C. /R.S. 23383

ii. C.C. /R.S. 23375

at the Bishop's Mills to yr Orator's loss and damage of £80_i'.

Not only did the millers of Shincliffe, Kepier, Hett and Croxdale mills come to the City, but also those just outside the City limits, from the mills on the Abbey Weir, those at Crook Hall, and the Clock Mill on the Millburn. Over the next century, most claims to feudal service had been abandoned. When in 1726 John Tempest claimed that all the inhabitants of his manor of Gilesgate were obliged to grind at his mill at Kepier, the local vestry were quick to organise opposition to him_{ii}. Twenty years later, the miller of the Bishop's Mills again complained that tenants were withdrawing their suit and service, and were 'using stool mills or hand mills ... and procuring other householders to grind their malt in their own houses_{iii}' but his complaint went unheeded and there are no fines in the manor court books of the time for not grinding at the manor mill. It will thus be apparent that by the eighteenth century, virtually all vestiges of the mediaeval system had vanished.

Expansion in water corn milling, however, continued into the early nineteenth century with a rapid rise occurring in the number of mills in Weardale and the Gaunless valley. By 1818 a mill was established at Cowhill at the head of Weardale, and another mill set up at Westgate. Broadwood mill was at work on the Bollihope

i. D/S L77-83

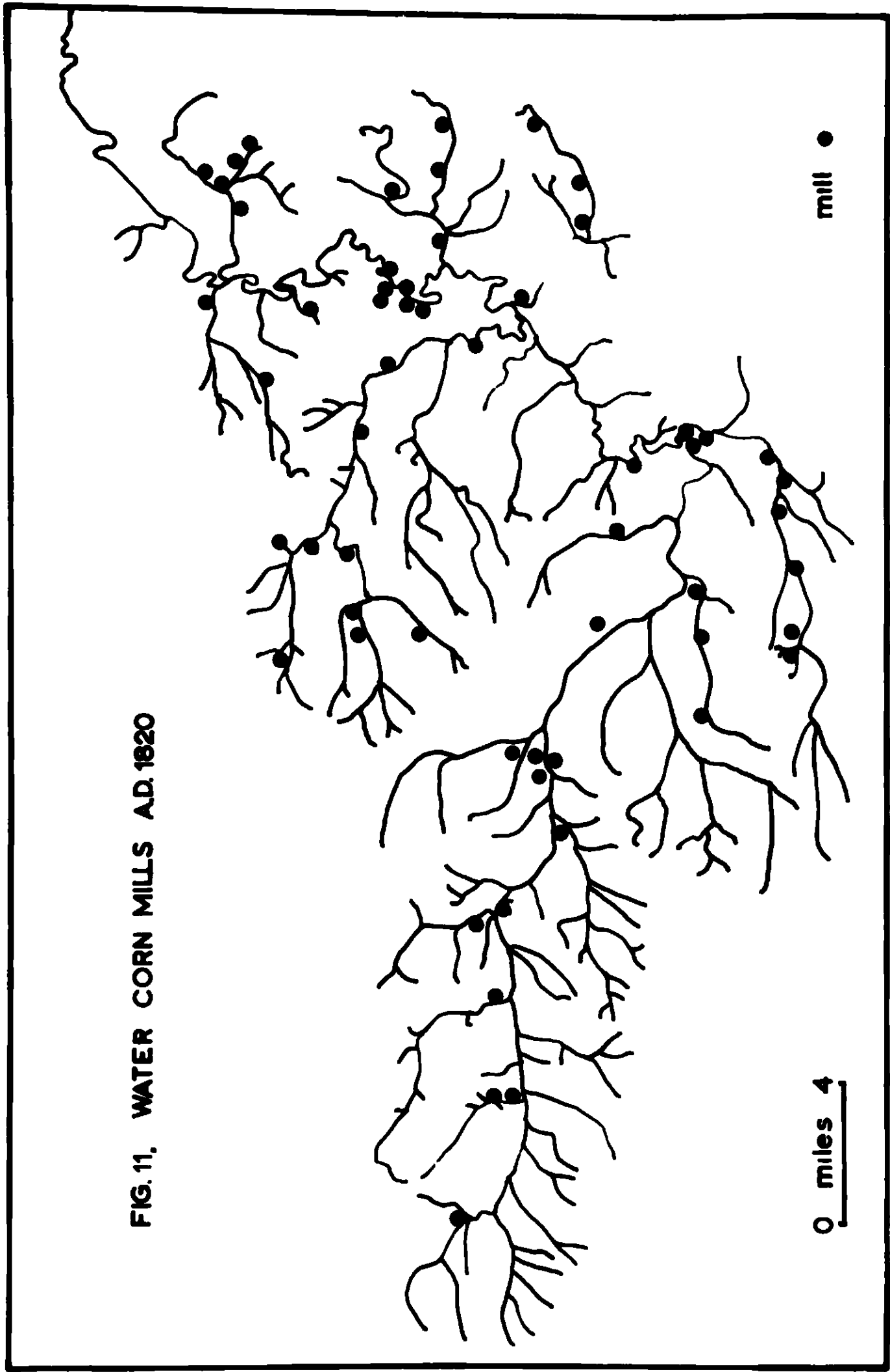
ii. S.S. XCV 110

iii. D.C. Box 54

Burn immediately south of Frosterley, and three corn mills had been established on a new leet and dam thrown across the Wear at Wolsingham. The mill on the freehold of Holebeck was established by 1773_i. On the Bedburn, a mill was established at Harthope by 1847, and on the Linburn, mills were at work at Podge Hole and Beckside, below the village of Hamsterley. The mill at Low Lands on the Gaunless belongs to this time as does one, if not both of the mills at Slack. Although the grain shortage of the Napoleonic period did much to encourage the cultivation of wheat in areas which had previously grown little wheat, this very great increase in milling was probably more closely related to the large increases in population which took place at this time in Weardale and the Gaunless valley consequent on the development of lead mining and coal mining. The population of the parish of Stanhope, for instance, rose from 5,155 in 1801 to 10,330 in 1871, with a large increase taking place in the first twenty years of this period. At Wolsingham the story is repeated, although the increase was at once more sudden, more dramatic, and later, the population increasing from 2,086 in 1841 to 7,778 in 1871. At Evenwood, the population doubled between 1821 and 1841, rising to 1,729, with a similar expansion taking place at neighbouring Cockfield. Thus it will be apparent that there was a great increase in the demand for

i. Newcastle Courant

FIG. 11. WATER CORN MILLS AD. 1820



grains of all kinds not only for human consumption, but also for the many horses, 'galloways' to use the local term, which were employed not only in coal mining, but also in lead mining.

The greatest number of mills active in the basin would seem to be the 62 which were at work about 1820 (Figure 11). Not only in the west of the basin, but also in the rest of the area, especially around Durham and Houghton le Spring, milling was particularly active. It will be noticed that there is a fairly even distribution over the whole basin, with the two exceptions above. In 1820 there were no less than six mills active within a radius of half a mile of Durham City. A report on the Bishop's Mill at Durham in 1816, states that it was 'contiguous to and most advantageously situated for the grinding of corn consumed by the most popular parts of Durham as well as for the manufacture of flours for the Sunderland market which is carried on to a great extent by the occupiers_i'. To the north, around Houghton le Spring, the neighbourhood was said to be 'very populous among the collieries, and there is ample demand for the flour_{ii}'.

Rapid Decline, 1840-1920

The decline in water corn milling after its zenith in 1820 was rapid. A pattern that had taken 700 years to establish was almost

i. Letter in possession of Mr. J. Smith, Bishops Mill

ii. L. EMS/40

entirely removed in the following century. In 1850 there were only two mills active in place of the six around Durham. Only the Bishop's Mill and Kepier Mill were still at work, although this latter was 'old, insignificant, and expensive to repair ... its functions could more efficiently be done by a steam flour mill'.ⁱ By 1880 only two of the six mills on the Lumley Park Burn system were active, and there were only 31 mills active in the whole basin. Mills in the upper part of Weardale continued to trade, but the decline of lead mining after the 1870's quickly removed the stimulation of a local market, and the four mills at Stanhope and Westgate had ceased work by the end of the century. Mills closed down in the rest of the basin at a steady rate and in no apparent pattern. Only 14 mills were active in 1914, but by 1918 only the mills at Cowhill, Holme, and Gaunless Mill Bishop Auckland remained. Cowhill ceased soon afterwards, and Holme in 1940.

The decline in local corn milling and the virtual abandonment of water power in the basin can be simply ascribed to the nature of the trade which was carried on, and its position on the coalfield. Although the occupiers of the Bishop's Mill at Durham may have been supplying the growing Sunderland market with flours in the early

i. H.C. (1863) XXVIII 77

part of the nineteenth century, the majority of mills were part of a local trade, supplying a local market with flours and meals from largely locally grown grains. The sudden growth of very large industrial markets in highly concentrated nuclei, rather than a sub-uniform scatter across a rural countryside meant the rise of a trade organised upon more intensive lines, using larger units of production. In parts of southern England this meant the erection of very large water mills. On the coalfield of Durham it meant the introduction of steam mills. Millers at West Auckland, Wallnook, and Bishop Auckland introduced steam engines to their water mills, but new steam mills were established at Chester le Street, Shiney Row, Durham and Spennymoor. Thus the new concentrations of population were more easily served by the new mills.

These mills themselves, however, were also a response to a re-organisation of the supply of raw material. The repeal of the corn laws in 1848, the development of railway and steamer communications and the opening up of the wheatlands of North America, meant the development of a world-wide corn trade, and the speeding up of a process of regional specialisation which had already started in Britain. County Durham had largely ceased to be a wheat producing county by 1861, and on the larger scale, the changing picture of wheat supplied can be seen when it is noted that while the population of England and Wales doubled between 1831 and 1861, the quantity of

grain imported, increased no less than thirteen-fold. The subsequent fall in food prices over the last thirty years of the nineteenth century did nothing to encourage the continuance of a local trade of any kind, but typically, the local mills that remained attacked the lower parts of the market and concentrated on the production of animal foodstuffs and coarse meals of all kinds, for the supply of a local market. The miller at Cowhill, for instance, in the 1920's supplied the upper parts of Weardale and Nenthead with cattle fodder. Even this, however, was soon denied to the small millers, and with the closure of Ferens Mill, Bishop Auckland, in 1958 the water corn mill became a piece of industrial archaeology.

CHAPTER VOther Water MillsFulling Mills

By the fourteenth century there were seven fulling mills established within the Wear basin, and at some time or another 15 mills have been used for fulling. A list of their names, with the first documentary evidence of their existence is set out below.

1308 Bishop Auckland 'et de 10/- incremento molend fulon'
(S.S. XXV 69)

1334 Relly lease of a fulling mill at Relly from the Almoner to Thomas and James, fullers.
(Durham Treasurer's Accounts Loc 6/5)

1357 Moorsley Banks (Bacstanford or Aldingrange) The mill is mentioned annually in the Finchale Account Rolls.
(S.S. VI)

1360 Finchale Abbey mentioned annually in the Finchale Account Rolls
(ibid)

1380 Bedburn 'Johannes Walker ,... ten j placeam pro situ molendini fuller'

1380 Evenwood 'Johannes Walker ten molendinum fullonicum red p.a. 3s.4d.

1380 Wolsingham 'Willielmo de Mertey pro molo aqatico et fullonico ibid'

All these three mills receive their first mention in the Hatfield Survey

(S.S. XXXII)

1427 Durham 10s. received for the fulling mill next to the Abbey Water Mill

(Bursar's Roll, S.S. CXI 620)

1595 Unthank (Stanhope) 'likewise the walk mill there is builded within the said wall'

(C.C. /R.S. 277863)

1658 Croxdale Fine levy on Gerard Salvin '... Croxdale ... with a fulling mill there.'

(D/S E 28)

- 1688 Witton 'uno molo fulloniro uno mollo fferrarg'
(D/C D 55)
- 1717 Colepike 'One fulling mill now in possession of Robert Fulthorpe'
(S.S. CLXXIII 117)
- 1729 Woodwell House 'That a fullers mill ... with all convenient
speed be erected'
(D/L D 55)
- 1793 Butterby Bargain, sale or lease of Butterby ... including all
that fulling mill.
(D/S D 207/214.13)
- 1827 Sleetburn (Primrose Side) Wm. Thompson, Fuller.
(White and Parsons, 1827)

It will be apparent from the quotations that most of the mills were used as fulling mills some time before they received these documentary entries. The fact that all the fourteenth century mills were under ecclesiastical patronage, and all the later ones in secular hands is not necessarily significant. In common with other parts of the country there are more survivals of mediaeval ecclesiastical documents than secular papers, and it is not impossible that some of the later mills were in existence long before the date given above would suggest.

It is necessary to note here that landscape evidence for these mills is, with one exception, entirely lacking. At Moorsley Banks, a large quantity of fullers earth was discovered on the digging of foundations for a garage in 1966. At Finchale the mill was washed away by an 'aquam magnam' in the winter of 1402-3 and was never rebuilt.ⁱ Similarly, at Witton le Wear, the great flood of 1771

i. S.S. VI cxxv

washed away the mills, and as the river abandoned its course they were never rebuilt. This flood also probably destroyed the mill at Woodwell House, if it was still standing by 1771. The mill at Wolsingham was turned into a smelt mill by 1647ⁱ, while there is no mention of a fulling mill at Durham after the Dissolution. No subsequent reference to a fulling mill at Unthank has been found after the one quoted, and no trace of this mill can be seen there. At Colepike and Sleetburn, the nearby presence of the place name 'Bleach Green' suggests the presence of a fulling mill, but no further traces are to be found. At Relly, Bishop Auckland and Butterby although the sites are still recognisable, extensive rebuilding and alterations in the nineteenth century, and subsequent demolition in the last fifty years disguise the sites considerably. At these sites, however, and at Moorsley Banks, Colepike and Croxdale, continuity of record allows the sites to be fixed with certainty, and the plans of the last buildings on them are to be found in Appendix B. At Durham, Finchale, Wolsingham, Unthank, Witton and Woodwell House, contemporary documentary evidence only admits of the general position of the mill, while nothing is known of the mill at Evenwood, although it is probable that it stood near the corn mill. The mill at Wolsingham stood 'in Wolsingham town'ⁱⁱ

i. C.C. /R.S. 23387

ii. C.C. /R.S. 23387

so it is possible that it used the waters of the Waskerley Burn like the corn mill previously established. At Finchale the mill shared the fishery dam with the corn mill, but it could have stood either on the right bank, or on the left near the corn mill. At Unthank, it is known that the mill stood within the same wall as the corn mill, but there is no indication as to the arrangement of the buildings. The remaining traces of the leet show that it was relatively long, and it is possible that the fulling mill stood on this leet, at a lower point than the corn mill. At Witton le Wear, the old course of the river was a little to the north of its present course, and it would seem likely that the fulling mill stood near the place now known as Low Barns_i. According to Shirley's Map of 1731 (Plate V.), the mill at Woodwell House stood in the meadow at the end of Kepier Gorge on the right bank of the Wear, but no traces are to be found today.

From an examination of the sites of those mills that are known it is readily apparent that no particular kind of topographical site was preferred, the mills being established in secluded sites, and in more open positions, on small streams, and large rivers, near to settlements, and remote from habitation, and indeed, it must be admitted that the necessary physical requirements for a fulling mill - a plentiful and regular supply of soft water with sufficient

i. G.R. NZ 160314

head to drive machinery, could be found on almost any watercourse in the basin. If an examination is made of the broader situation of the mills, however, certain patterns do emerge.

In the fourteenth century, it is apparent that the mills fall conveniently into two groups, the episcopal mills in the west, and the conventual mills in the east. The presence of a fulling mill at the chief vill of each of the western episcopal manors of Wolsingham, Evenwood and Auckland, with the site for a fourth at Bedburn, within the extensive manor of Wolsingham, would suggest that the extensive moors of the Pennines, then, as now, were used for sheep rearing, and that the fulling mills were situated close to the source of supply of wool, at a point which was easily reached from most parts of the manor. The mills at Wolsingham, Evenwood, and the site at Bedburn, are all at the focus of the Wear, Gaunless, and Bedburn valleys, respectively, while Bishop Auckland could easily receive wool not only from the open waste lands to the north of the town, but also from the pastures of the Permian escarpment.

Around Durham lay the three conventual mills of Relly, Moorsley Banks and Finchale, with Durham itself in the early fifteenth century. Midway between the pastures of the Permian escarpment at Pitlington, and the grassy flanks of the Pennines at Esh, Aldingrange and Bearpark, the waters of the Wear and the Browney provided ideal sites for the establishment of fulling mills. Sufficiently near

the Convent for supervision, yet secluded enough to prevent disturbance, the noisy fulling mills were first established on the Browney where the rapid fall of the river as it passes over the pre-glacial interfluvium between the Browney and the Deerness valleys provided excellent sites for dams and the erection of mills. The Convent certainly had large numbers of sheep. In the Abbey account rolls it can be seen that there were 1,028 sheep on the pastures around Pitlington in 1338, 791 in 1414 and 771 in 1441_i, but the business of fulling always seems to have had some closer connection with the cell at Finchale than with the mother house. The fulling mill at Finchale was established sixty years before the mill at Durham, while the mill at Moorsley Banks stands on a site where Bishop Pudsey gave the monks of Finchale the right to establish a mill in the twelfth century. It is curious to note that the cell at Finchale had a regular remittance from the mill at Rely of 2s.0d. p.a. It may be that this was part of some agreement concerning the Moorsley Banks dam, and the passing of sufficient water down to Rely, but this is just speculation.

It is not pertinent here to examine the values of the mills at length, but it can perhaps be noted that they were not a source of great revenue to their owners, or thus presumably, to their farmers. The mill at Moorsley only returned a rent of 10s. p.a. until after

the destruction of the mill at Finchale in 1402. Reference has already been made to the rents of water corn mills at this period, and it will be at once apparent that this rent was lower than that to be gained from a modest corn mill. The Finchale mill at Moorsley was not an exception, for the mill at Durham returned a rent of only 10s. in 1427. In the seventeenth century the mills were not of great moment. From 1613 until 1680 the mill at Bishop Auckland was leased at a yearly rent of £2.ⁱ but in the survey of 1647 was said to be 'much in decay' and only worth £6 p.a. to its tenantsⁱⁱ. From 1680 until 1810, however, it was let at £4 p.a., but by this time this had become a customary rent and bore little relation to the real value of the property.

Although it was reported in 1605 that the county 'had no great trades such as clothing and suchlike'ⁱⁱⁱ it would seem that there was a consistent demand for local homespun cloths such as to support the erection of fulling mills at Stanhope and Croxdale. Although nothing is heard of the Durham Mill after the Dissolution, the mills at Rely and Moorsley Banks continued in use until the later eighteenth century. At the beginning of the seventeenth century the fulling mill at Bishop Auckland was replaced by a new one, although the two continued to run together for a while. A little

i. C.C. /B.E.S. 382/185036
 ii. C.C. /R.S. 23375
 iii.V.C.H. II 314

higher up the valley the mill on the Chaytor estate at Witton was functioning in 1688. The existence of a textile trade of some vigour is attested to by the establishment of companies of weavers, and fullers and feltmakers at Durham, the former in the mid-fifteenth century, the latter in the mid-sixteenth century. It would seem that all kinds of low-quality cloths were woven, from plain linens to the heavier shalloons. The fullers held considerable powers over the trade of the country mills, having the right to inspect the cloths that were brought to market at Durham_i.

Decline seems to have set in in the west at a time when new mills were still being introduced in the middle Wear lowlands. Nothing is heard of the western mills of Stanhope and Evenwood after their first mention. The mill at Wolsingham had gone by 1647, so that by the third quarter of the seventeenth century, fulling had retreated from the remote dales of the west. Of the mills in the middle Wear valley, however, only the mill at Bishop Auckland survived into the following century, and even that was ultimately converted into a corn mill. The flood of 1771 took away the mill at Witton, and probably Woodwell House, while the growth of the paper industry seduced the owners of Relly, Moorsley Banks, Butterby and Croxdale mills into that trade by the beginnings of the nineteenth century.

i. Surtees IV 24

Thus it will be seen that the streams of the Wear basin were well suited to the erection of fulling mills, which could serve the needs of a local and domestic woollen and linen textile trade. With the rise in the textile trades of Lancashire and Yorkshire, and improvements in communications, the manufacture of cloth became less profitable, and either natural disaster, or the more lucrative opportunities of the paper trade meant the eclipse of the ancient craft of fulling in the Wear basin.

Paper Mills

During the later decades of the eighteenth century there were three clusters of paper mills in County Durham_i. In the north of the county a string of mills lay along the lower courses of the Derwent, while another group of four were established along the Team, both these streams being tributaries of the Tyne. To the south and west of Durham City, however, a series of paper mills developed along the lower courses of the Browney and the Croxdale Beck, this latter stream driving the first paper mill to be established in the North East, which was at work by 1678. The others, however, did not follow until the later eighteenth century. Generally speaking, those mills in the north were established in the third quarter of the century, and those around Durham, Croxdale excepted, during the last quarter.

i. Shorter, A.H., Paper Mills and Paper Makers in England, 1495-1800, Paper Publications Society, Hilversum, 1957.

It is not difficult to suggest reasons for the development of paper manufacture around the growing industrial district of Tyneside. Principally there was a growing market in the immediate vicinity with the development of weekly and daily newspapers, while the rising business concerns connected with the coal, lead, iron and shipping industries obviously needed a supply of paper. With an expanding population, raw materials in the form of rags were available, while the shipping, and to a lesser extent the mining trades produced a quantity of hempen ropes which could be used in the manufacture of brown paper. Labour, too was available, and, if not skilled, could be taught the necessary arts. And, of prime importance, the Derwent and the Team would provide a steady and dependable source of soft water, necessary for the washing of the rags, whilst their fall was such as to provide the essential power to drive the grinding and washing apparatus used in the process.

In the centre of the county, however, the advantages of a thickly populated local market were absent. Durham City was a small town, although it did possess a relatively large literate population of clerics and County gentry. It would be wrong, however, to think of this group of people calling into existence no less than ten paper mills, which produced, in any case, coarse brown paper rather than higher quality writing paper. In order to realise the origins of the paper making industry around Durham at this time it is

necessary to look a little more closely at both the period and the place. From this it will be seen that certain political factors stimulated the demand for paper, and thus presented an opportunity for paper making, whilst a large number of local factors allowed the taking up of this opportunity here rather than in other places in the North East.

During the Napoleonic Wars, trade with France was interrupted, while at the same time, the quickening of the economic scene in England resulted in a growing demand for paper of all qualities. With the spread of the Hollander which made the process of manufacture more efficient, and the increasing skill of established manufacturers, older firms began to produce the higher grades of paper, formerly supplied from the Continent. This allowed the rise of newer firms, with perhaps less expertise, and in situations not so immediately favourable, to take up with vigour the production of heavy duty, coarser papers, and it is with this trade, that all the eight mills known to have come into existence after the start of the French wars, were connected.

In the more local situation, five major factors are implied in the manufacture of paper of whatever quality. The first of these is the presence of a plentiful and constant supply of water both for processing and washing the raw materials and for driving the necessary machinery. The better the quality of paper produced,

the more necessary it was for the water to be clear, and soft water was better for washing rags than hard calcareous water, while if white paper was being produced, it was important that the water should not contain a peaty hue, at least before the introduction of bleaching agents in the nineteenth century. There had to be suitable sites for the erection of mills, or in the cases under consideration, where low capital investment was the keynote, it was necessary for mills to be available which could be converted from their original function. Again, the higher the quality of paper intended to be produced, the higher was the cost of machinery and the employment of the most skilled craftsmen.

Access to materials and a market was, of course, of great importance. If these were not immediately available, it was necessary that there should be good communications between the source of materials, the mill and the market. This is made particularly important in the case of low quality paper where both the raw material and the finished product have a low weight-value ratio. Particularly important in the early stages of the industry is the presence of a nucleus of skilled master-workers who could teach the skills necessary in the manufacture of paper, before the extensive mechanisation of the process in the later nineteenth century.

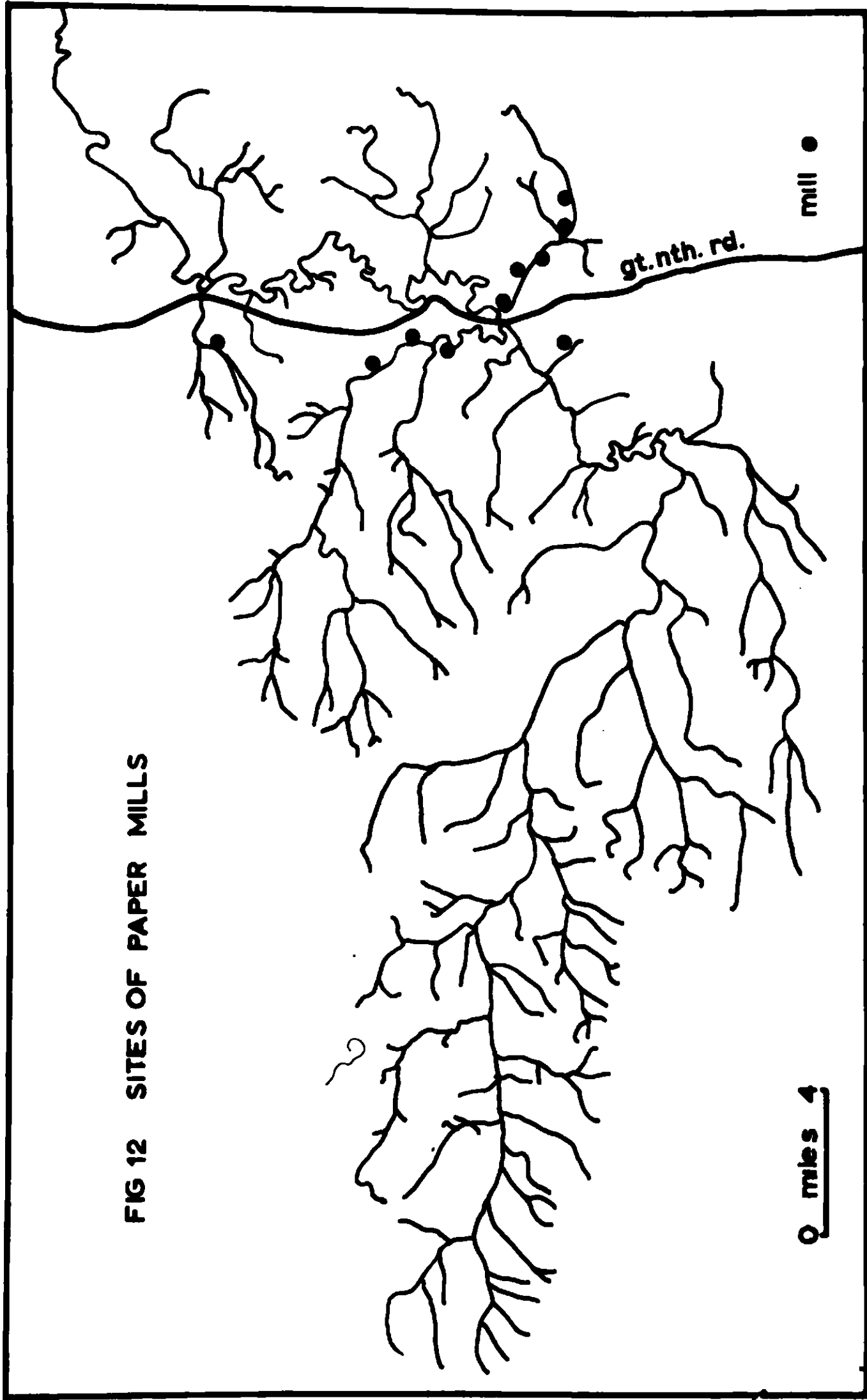
While a steady and reliable water supply could be maintained by almost any of the major tributaries of the Wear, as is witnessed by

the many mills already at work in the basin, those streams in the upper parts of the basin would not be acceptable to paper manufacturers. Discoloured by their peaty origins, polluted by the washings and hushes of the lead mining industry, and liable to severe fluctuations in discharge, virtually all the streams and the river itself, above Bishop Auckland, were immediately eliminated as sites for paper mills. Below this point there are few streams which would have sufficient water for the establishment of paper mills. They comprise, briefly, the Stockley Burn, flowing through lordly Brancepeth, the Valley Burn, the Croxdale system, the Shincliffe system, and then the Chester and Lumley Park burn systems. While all the paper mills except two were ultimately situated on the Browney or on the Croxdale system, any of these streams would have been suitable for the erection of a paper mill in the last decade of the eighteenth century.

Although all of these streams flowed over coal measures, these were not worked until well into the nineteenth century, and it was not until the middle of the nineteenth century that streams in the district became heavily polluted with coal washings, when small coal was used for the manufacture of coke.

The principal market for all forms of paper in the North East at this time, of course, was sub-metropolitan Newcastle, and access to Tyneside must have been of great importance. The nodal position of Durham City must also be noticed, but as the seat of manufacture

FIG 12 SITES OF PAPER MILLS



and population, Newcastle was at once the largest market and the largest single supplier of the necessary cellulose materials in the form of rags and rope, and much later, esparto grass. It is significant, therefore, that all the paper mills are established on streams within two miles of the Great North Road (Figure 12).

Even outside the Wear basin the Great North Road seems to have had some importance, with twelve of the eighteen paper mills recorded in the County being within two miles of it. Of the remaining six, one was actually on the shores of the Tyne, while the other five were on the Derwent and close to another coach road to Newcastle. However, it must not be thought that the presence of a mill site close to the Great North Road necessarily implied the development of that site as a paper mill. All the paper mills lay within a five mile corridor running north south through the basin. Within this corridor were eleven corn mills and eleven paper mills. As the chance of a mill site being developed as a paper mill was by this reckoning no more than fifty-fifty, then it is clear that other factors must have operated to secure the location of the paper mills in the positions they subsequently occupied.

Of the eleven sites identified in the basin, it would seem that only two, or possibly three, were virgin sites, developed specifically as paper mills. All the other mills occupied premises formerly used for fulling or corn milling. If an examination is made of

the eight mills that were ancient sites, then it appears that four were fulling and four were corn mills. The significance of the fulling mills is realised when it is seen that these were the sole fulling mills then being worked in the basin. That this represents a decline in the local textile industry is obvious, but it must be remembered, that before the introduction of the Hollander, which had a rotary action, fulling more closely approximated to paper making than corn milling. However, it is likely that only Croxdale Mill was worked by the old system of macerating hammers, being at work by 1678, and that all the other conversions involved the use of the Hollander. Thus the contribution of the fulling mill must be attributed to a decline in the fulling trade, rather than a particular suitability of the existing fulling machinery to conversion to paper making. The decline of the fulling mill was not necessarily sudden, for if the first mention of each of the paper mills is arranged chronologically, then old fulling mills appear first, fourth, sixth and ninth, although it must be remembered that these dates do not necessarily represent the first conversion of the mills.

There still remains, however, the problem of the four corn mills that were converted, and the eleven that were not. Proximity to Newcastle does not seem to have operated to any great extent, for the four corn mills that were converted were all in the southern part of the basin, at Tudhoe on the Valley Burn, and Hett, Thinford and Cornforth Mills on the Croxdale Beck. It has been noted that

this period was a time of grain shortage, and that in other parts of the basin new corn mills were being erected at a considerable rate. It seems curious, therefore, that mills in such a relatively favoured situation as these, in the middle Wear valley, should find paper making more profitable than corn milling. Although all these mills continued a little corn milling, it would seem likely that there was a relative decline in local milling in this small area. Population increases were taking place in the west of the basin and at the mouth of the Wear, rather than to the south of Durham City. The conversion of the Jesus Mill to a spinning factory in 1792, and the fact that the Bishop's Mill at Durham was working largely for the Sunderland trade, in 1816, would suggest that the local demand for flour was not such as to prohibit millers in this part of the county from turning to more profitable trades. It may well be that the growing efficiency of corn milling at this time meant that fewer mills could perform the same function as a larger number of old mills, and that only in those places with a considerably increased demand, were the numbers of mills actually increasing. Thus, as late as 1845, when steam milling was already introduced into the area, the demand for flour around Floaters Mill, between Chester le Street and Houghton le Spring, was said to be strong.

However, the development of the industry was impossible without the abilities of skilled master-craftsmen. Ten surnames crop up

with great regularity as owners or tenants of paper mills. The Ords, for instance, already paper makers at Lamesley, south of Gateshead, were evident in the area from 1777 to 1860. The Ayers were associated with Croxdale Mill in 1738, relinquished it in 1772 and subsequently re-furbished Hett Mill as a paper mill and were found there until 1803. The Egglestones, first noted at Langley Mill in 1773 became associated with Cornforth Mill in 1827 and held it until its disuse, within living memory. Likewise, the Smiths, who had a paper warehouse in Newcastle, were associated with Relly Mill from its conversion from a fulling mill in 1790, until its abandonment in the early part of this century. They also acquired Langley Grove Mill from Eggleston when he moved to Cornforth, and held this until its disuse, about the same time as Relly. Other names include Lonsdale, Lumley, Teasdale and Cooke. A regular pattern is to be seen as a master established one mill, and then moves on to convert another. Thus an Ord moves from Croxdale to Tudhoe, where he buys the mill, and then a subsequent move is made to Moorsley Banks. It will be noted that the links with Tyneside are strong. The Ords originated from Lamesley, while the Smiths' connection with Newcastle has already been noted.

While it is not pertinent here to enquire too closely into the origin of the capital which promoted the trade, it is interesting to note two or three examples. As far as the ecclesiastical mills were concerned, it was a matter of an entrepreneur to lease the mill,

and then take on a master worker. Thus at Moorsley Banks, the Quaker bankers, Johnathon and James Backhouse financed the operation from 1827 to 1860, when the mill was purchased by two Durham businessmen, and during which time the mill was actually run by two Ords. Similarly, although Johnathon Ord, senior, converted, worked and subsequently bought Tudhoe Mill in the last decade of the eighteenth century, he was financed by several persons variously described as miller, farmer, yeoman and gentleman, all of whom subscribed a hundred or so pounds. At Croxdale and Butterby, where the mills stood within a secular estate, it was the custom for the landlord to build, repair and equip the mill with the necessary machinery, and then to take on a master paper worker such as an Ord. It will thus be seen that this was not a very heavily capitalised industry, but was supported by several sorts of individuals with varying amounts of money to invest. Because of this, the quality of the paper produced was very necessarily limited.

Before concluding it would be appropriate to make a short note of the first paper mill to be established within the area, long before the rapid development of the late eighteenth century. Croxdale Mill, anciently a fulling mill was converted into a paper mill sometime between 1658 and 1678. At this time there was no paper mill further north than that at Thornton le Dale near Pickering. Although the mill was established on the well-documented Salvin estate,

there is no suggestion as to its origin. As recusants, the Salvin family were familiar with France, and it may well be that the vigorous paper trade of that country inspired a Salvin to establish a paper mill on his own estates. It would have been necessary for a master-worker to be introduced to the area, as there was no tradition of paper-making in the North East, but the parish records of St. Oswald do not suggest the non-local origins of the first paper worker who died connected with the mill, neither do they suggest that he was sympathetic to the old religion. It seems that for the moment, at least, the reasons for the planting of a paper mill in the area and at this time must remain unknown.

In conclusion, therefore, it will have been seen that the growing demand for paper in the late eighteenth century stimulated the already established mills to move into the production of better quality papers, and allow room for expansion in the lower parts of the trade.

Lying between the fouled streams of the west of the county, and the vigorous flour trade to be had in the east and north of the county, mid-Durham could offer clean and reliable water and a number of mills that were available for conversion to paper making. Stimulated by the active industry in the north of the county, and using skilled workmen originating from there, paper making developed especially during the Napoleonic Wars on those streams that were close to the North Road, and were within easy reach of the major local centres of population, which were both the markets and the source of raw

material for this curiously localised trade.

Forge Mills

With deposits of iron present in both the Carboniferous Limestone and the Coal Measures series, it is not surprising that the mining and reducing of iron ore has been practised in the basin since Roman times. The use of water power to drive furnace bellows, however, dates only from the fifteenth century, and even after this date it is probable that aeolian bloomeries continued to be used. In 1899, Lapsley revealed the existence of an account roll of the iron master employed by Bishop Langley at 'Byrkenott juxta Bedbourne' in 1408_i. Probably stimulated by the forges he had seen at Rotherham, near the episcopal manor of Wheel Hall, in Yorkshire, Langley had a furnace built to smelt the iron ore of the Bedburn valley, using timber from his own woods and the waters of the Bedburn to drive a pair of bellows. A team of specialist workmen were employed, and it is suggested by Lapsley that about two tons of inferior iron were produced each week. Unfortunately, it is not known how long this furnace was at work, and there is no further reference to iron smelting until the sixteenth century.

In 1597, Sir William Bowes was reported to have erected an 'Iron or Lead Mill' at Burtreeford 'wherein there hath been sundry trials made of the Ore gotten within the Iron Mine'_{ii}. Nothing is

i. Lapsley, G., 'An Account of a Fifteenth Century Iron Master', Eng. Hist. Rev. XIV, 1899.

ii. C.C. /R.S. 277863

subsequently heard of this forge, and the next reference to an iron forge is in 1688, when the forge mill standing upon the Wear at Witton le Wear is mentioned in a deed to the Witton Castle estate_i. Another forge established at West Auckland by 1768 was said to have been in existence 'since the granting of the lease'. Standing next to the corn mill there, and using the same leet, it was said to be worth £10 p.a., and to have a thriving trade with the many neighbouring collieries_{ii}.

With the development of the lead mining industry in the eighteenth and nineteenth century, and a consequent demand for picks and spades, not only for the mines, but also for the smallholding miners, it is not surprising that an edge tool industry should develop at Wolsingham and Bedburn. By 1827 there were two forges on the common leet off the Wear at Wolsingham, with a third added in 1859, and at Bedburn, a forge had been established a little before 1813_{iii}.

In the north of the basin, on the Cong burn, the first blast furnace in the north east was established by the new owner of the Whitehill estate, Mr. I. Cookson. Using local coal, a blast was provided by bellows worked from a water wheel on the burn. At first local black band iron ore was used from above the High Main coal on Waldrige Fell, but these ores were soon supplemented by

i. D/C D III

ii. C.C. /H.C.M. 10/123

iii. Bailey, J., 'A General View of the Agriculture of County Durham', London, 1810

imports from Robin Hoods Bay, where Liassic ores were picked off the beach, and sent by boat to Picktree Quay near Chester le Street.

'The Iron was used for colliery castings and latterly government ordnance. Frequent interruptions for want of water to drive the wheel led to the furnace being 'gobbed' and ultimately abandoned about the close of the last century'.ⁱ

At the other side of the Wear valley a forge mill was established on the Lumley Park Burn before 1783. In that year, William Hawkes, who already owned several forges around Gateshead, offered Lord Scarbrough the outrageously high rent of £200 p.a. for the forge mill and the fishery on the Wear which was of no great significance. It was his aim to establish rolling and slitting mills on the river, using not only imported ores, but the scrap metal brought by the colliers as ballast.ⁱⁱ With the initial objective of supplying anchors and chains for the growing Wearside and Tyneside shipping trade, the onset of the Napoleonic Wars led Hawkes to produce good quality metal for army and navy ordnance. Unfortunately, his proposed slitting mills proved impracticable on the Lumley Park burn, and Lord Scarbrough would not have the prospect of the Castle from the river, and vice versa, ruined by ugly mills near the Fishery Dam, so Hawkes was obliged to abandon his ideas and

i. Armstrong, W.G., The Industrial Resources of the Tyne, Wear and Tees, Newcastle, 1864.
 ii. L.EMC/1-6, EMS/40

move to the Team valley, where he established the Team Iron Foundry in 1829. He sublet the forge to Lord Durham, who allowed the buildings to become dilapidated, and by 1845 they were described as being in a state of great decayⁱ.

Thus it is apparent that although the watercourses of the Wear basin could support the smaller ventures associated with local iron foundries, the larger developments of the blast furnace and the rolling mill were not practicable on the relatively small streams that predominate in the area.

Epilogue - Electricity Generation in the Twentieth Century

The eclipse of water mills was not the end of the use of water for power, although its subsequent application was very limited. Direct current for domestic electricity was provided by water wheels in at least two places until recent times. At High Allers on the Killhopeburn, a four foot undershot wheel, taken from old lead workings, generated electricity for the farmhouse, until the introduction of mains electricity, and at Holme Mill on the Gaunless, the 20' overshot wheel could be applied to a dynamo to generate electricity for the mill house and its once extensive market garden, until 1947. Turbines were installed at Bradley Low Farm on the Bradley Burn to drive a thresher in the 1890's, and at the West Mills

i. ibid

Supply Works at Bishop Auckland in 1890, to lift water from the river to the town's reservoir 200' above. At Durham, the Bishop's Mills were bought by an ice manufacturer in 1929, who installed a turbine to drive cooling machinery at his premises at the other side of the river. In 1946 he erected an Ice Rink on the old Mill Isle below the mill, and installed a further turbine to provide electricity for the cooling apparatus there. The Ice Rink is still in existence, and the Bishop's Mill is the last remaining power site in the basin.

On a larger scale, it was proposed in 1942 to erect an electricity generating station on the river at Kepier Haugh near Durham. In the late 1930's the Northern Electricity Supply Company (NESCO) realised that County Durham would suffer a 60,000 kwt. deficiency in 1942-3 unless extra generating capacity was created. As the company already had stations on the Tees at Darlington and the Tyne at Dunstan, it was decided to establish a station in mid-Durham. Water at the rate of $3\frac{1}{2}$ m.g.d. was essential for cooling, and so a site was sought along the Wear. The co-incidence of the river, a level site with firm foundations, the Gilesgate railway line for the delivery of coal, and existing easements for power lines, made Kepier an apparently ideal site, but when the proposal was announced in 1944, it caused widespread controversy. Without wishing to elaborate too much on this admittedly peripheral matter, it is useful to remember Mainig's conclusions that 'one must reconstruct

as carefully as possible the geographical context of each decision, that constellation of situations, objectives and possibilities with which the decision makers were faced ... if we are to understand the results we must understand their geographical visions'ⁱ.

A public enquiry was held in December 1944, before an inspector of the newly formed Ministry of Town and Country Planning, when each side pressed their case with vigour. During the considerable economic difficulties of the North East, electricity was regarded as something of a saviour, and it had at this time a certain mystique in the minds of many local people, who imagined light industries springing up, like mushrooms in a fairy ring, around the new power station. Consequently, district and county authorities, and the local trades councils vigorously supported the scheme as the herald of better things to come. On the other hand, the University, the Bishop and the Dean and Chapter, along with local and national architectural and preservation societies, and the City of Durham's own planning consultant, viewed the scheme with undisguised horror. Although NESCO had appointed Sir Giles Gilbert Scott, architect of the recently completed Battersea Power Station, to design the station, it was clear that the four cooling towers, and a large chimney would dominate the City, and be visible even from Palace

i. Meinig, D.W., A comparative historical geography of two railnets: Columbia basin and South Australia. Ann. Ass. Am. Geogr. 52, 1962.

Green, the heart of the university and ecclesiastical precinct.

In the event, planning permission was refused by the Ministry after the issue had already been decided by the Electricity Commissioners. The Minister, in fact, procrastinated so much before announcing his decision that the electricity company decided they could wait no longer before effecting their improvements, and enlarged their existing stations on the Tyne and Tees, and abandoned the Kepier project.

In order to explain this curious position it is necessary to invoke the wider issue of national conditions. Reference has already been made to the local demand for employment opportunities, but at the same time a new concept of 'planning for a Brighter Britain' had emerged at Westminster. This ideal was largely entrusted to the newly-formed Ministry of Town and Country Planning, and the Kepier project was in fact the first major case that came before that ministry.

The decision-making process is here a misty thing, which is not a matter of public archives and press reports. It is necessary to rely on the observations of persons concerned, supplemented by a certain amount of supposition, but it would seem that while both the Ministry and the electricity company were unsure of the exact powers available under the Town and Country Planning Act, neither were prepared for a direct confrontation. It seemed likely that

the new ministry would play an important role in the development of post-war Britain, so the electricity company did not wish to make itself persona non grata, while at the same time the Ministry was not willing to undertake a major test case.

It is not certain, therefore, how much these 'political' considerations affected the final decision. It seems that the Ministry had come down against the project, but it is open to speculation whether that would have been the final decision had the Electricity Commissioners pressed for a re-examination of the evidence. Nevertheless the result of the case was that no major power station was ever erected on the non-tidal Wear.

The Lead Mining Industry

Mining operations have characterised County Durham since the earliest recorded times, and of the coal, iron and lead that have been wrought from the area, lead mining alone deserves special study here because of the intensive use it made of water.

Water was an essential component of all the stages of lead ore winning, preparation and refining. In the actual mining operations, hydraulic action was used from the earliest times to expose a vein of ore, while water played a necessary part in the dressing and preparation of the crude ore, providing a solvent in the washing and sorting processes, and power for the crushing mills of the nineteenth century. Similarly, water power was necessary for the eighteenth century ore-hearth smelting mills, although subsequent developments superseded the use of water-driven bellows.

Hush Mining

Used by the 'groovers and miners' of the sixteenth and seventeenth century surveys of the parish of Stanhope, hush mining was the use of a sudden torrent of water to strip a shallow overburden, often of peri-glacial material, and expose the veins of lead in the strata beneath. Turf dams were built at the head of a slope, sometimes across a watercourse, and then broken to allow the water

to burst down the hillside. Westgarth Forster left a vivid description of the process:

'A slope of considerable declivity is absolutely necessary ... the dam must be so situated that you can make collateral diagonal cuts across the slope, on both sides, to lead ... the water from small rivulets or higher springs ... into the reservoir. If a little dingle, settle, flat or hollow place can be had for the site of the place then so much the better as the head can in that case be made with less expence to hold so much water; but where such a convenient spot cannot be had they are often made upon the declining slope of the declivity in the form of a crescent. A large dam is always better than a small one, if it can be had; and where the sloping ground to be hushed is of any considerable length from the hush dam to the bottom of the slope, the reservoir must contain a quantity of water otherwise its force will be spent too soon ...

... From this hush dam you draw a line right down the hill ... then cut off the sod or upper surface of the ground ... about two or three feet wide and about one or one and a half feet deep, all the length to make room for it to contain a small run of water; and when the gutter is so prepared, let out a small proportion to the capacity of the gutter and when the water is let out the two or three first times, the men must be divided at proper distances from each other with their tools in their hands, to help loosen the earth

for the water to carry away. The steeper the declivity and the longer the gutter is, the greater the force it hasⁱ.

Because hush mining was necessarily restricted to those places with a thin drift cover, and where the veins were near the surface, the remains of hushes are to be seen in the higher parts of Weardale, around Ireshopeburn, Burtreeford, and Killhopeburn. They extend up to an elevation of 1800' and are generally not more than 200 yards long, with a fall of 100'. Cowhorse Hush, some three-quarters of a mile above Lanehead is something of an exception, extending half a mile up the hillside, with a total fall of 280'.

Shaft Mining

The only way to reach the deeper veins was by shaft mining. Although adit mining was practised in the fifteenth century, problems of drainage and ventilation precluded the following of a vein for any considerable distance underground, and although these problems were encountered in shaft mining they were more easily overcome. Sooner or later, shafts reached the water table, and to allow mining to continue it was necessary to allow the water to leave the working area at a rate equivalent to its seepage. In June, 1834, the Rookhope agent of the Beaumont mines wrote in his quarterly report, 'We have sunk 7 fathoms below Waggonlevel at the Pump Sump, Boltsburn and met with a very good ore ... but we have made such a

i. Forster, W., A Treatise on a Section of the Strata from Newcastle upon Tyne to Cross Fell, 1st Edition, 1809, 139.

great quantity of water, as makes it expensive to work - if this working were free from water it would work at 15/- per bing, where we are now giving 30/- to 12 men, 6 of whom it requires to pump the water'ⁱ. The benefit and the cost of draining was often carefully considered, and in 1808, Agent Dickinson wrote for instructions on one of the Beaumont mines at Breckonsike, '... whether or not it would be right to give up that part until the low level take the water off you are best to decide, as knowing the price of lead, and what situation you are in with the Bishop'ⁱⁱ.

Although mechanical means of shaft drainage were known in classical antiquity, the technique of a watergate was most widely used in Weardale wherever it was practicable. This involved the driving of an adit from the lowest part of the mine out into the nearest valley. Obviously this can only work in heavily dissected topography, and for those shafts sunk from a considerable height on the hillside. Raistrick says that this technique was not generally adopted until the seventeenth and eighteenth centuriesⁱⁱⁱ, but there is a reference to a watergate to a mine in Weardale in 1426, 'pro 24 lodeo minere plumbi hoc anno per eodem lugacione apud le Blakden in le Watergate ibidem'^{iv} which would seem to suggest that the technique

i. A.B. Vol. 55.

ii. A.B. Vol. 53.

iii. Raistrick, A. & Jennings, B., A History of Lead Mining in the Pennines, London, 1965.

iv. C.C. /L.M.A. 190016

was known in the area at an early date. An entry in the Bursar's account roll at Durham in 1375_i suggests that the technique was used on the coalfield at an even earlier date. If the technique was known at Rainton, it is likely that it was also known in Weardale fifty years later.

By the eighteenth century all the shaft mines in Weardale which went below the water table would be likely to have these watergates, but many mines went deeper still, and the water had then to be raised from the lowest part of the mine to the level of the watergate. It was reported in 1806 that 'The Burtree Pasture vein is now Rich in the forehead, but the Ore workings is under level and of course the water is to draw off by hand to the water level'_{ii}. This was a laborious and expensive business. In 1809, two men were being paid £26 a quarter for pumping the water out of the mine at Burtree Pasture_{iii}, and two years previously, it had been noted at the mine that 'the expence of raising the water will increase every quarter and will soon be as much expence drawing the water as would pay the expence of an engine'_{iv}. These engines were pumps, generally driven by water wheels, although horses were often used at gin wheels, and it is probable that they were in use in the Beaumont mines in Weardale by the 1730's. In a fine example from

i. S.S. CIII, 583.

ii. A.B. Vol. 53.

iii. *ibid*

iv. *ibid*

a manuscript in his own collection, Raistrick_i shows how two water-wheels mounted on the water level at Burtree Pasture mine were driven by 'day water' allowed down the shaft, and pumped the water out of the lower reaches of the mine passing it out along the water-gate with their own tail race. Certainly by the 1750's an engine was installed in Stoup Slitt Mine, when a bargain was made '... to make the Level Carrant, draw water races and make all conveniences, to open a shaft and sump so as to bring the day water on to the engine wheel, and to sink three yards in the engine sump at £30.'_{ii}.

Although water was everywhere plentiful, it was not always in the exact place it was needed. Thus, while at Boltsburn in 1834 it was suggested that an engine should be transferred from Crawlaw mine '... the only expense would be labour and building a new wheel case, sinking the shaft, etc. We have always a sufficient supply of water and at trifling expense', at the troublesome Burtree Pasture mines there was not sufficient water percolating into the sump to 'drive a small engine (which) would relieve the vein for several years until a more durable way be found out ... We sent the Engineer to that at Coalcleugh ... and he is of the opinion that one of the same construction will be most suitable'_{iii}. Nine months later it was reported that there was 'now enough water to drive a small engine'_{iv}.

i. op cit

ii. Neasham, G., North Country Sketches, Durham, 1893

iii. A.B. Vol. 55.

iv. ibid

Not all the mines had such difficult drainage problems, or such ingenious solutions, and of the 36 mines in Weardale enumerated by Westgath Forster only five had 'water wheel engines' in 1809. The wheels were by no means always placed inside the mine as at Burtree Pasture, and many shafts were distinguished by the presence of a pump and water wheel. At Rookhope, for instance, the large cast iron water wheel was to be seen adjacent to the shaft until recently. A more extravagant example is provided by the Presser shaft at Hunstanworth. A pump at the head of the shaft was driven by a water wheel over a mile away on the Boltsburn by means of a series of coupling rods.

Dressing and Preparation of the Ore

When the bouse was brought to the surface, the pure ore had to be separated from the 'dead' stones. This was effected by a series of washing and sieving processes. The high specific gravity of lead allowed a separation to be made if the bouse or crude material brought from the mine was reduced to particles of the same size, and then suspended in water.

From the mid-sixteenth century the process consisted of three operations. Obvious ore and stones were immediately separated, the ore being broken down by hand to a suitable size. If the bouse was thoroughly mixed, separation was achieved by the use of the simple buddle. This was a wooden trough or a sloping stone floor down which ran a current of water. The bouse was raked across the

buddle so that the water at once cleaned the bouse, and made ore and stone more distinguishable, and also carried the lighter stone and impurer ore to the bottom of the slope, leaving the pure ore at the head of the buddle. Lastly, the finer material washed from the buddles, and also that brought direct from the mine was sieved by hand in a tub of water, the lighter stones being flicked off the sieve by the action of the operator. These cold, unwelcome jobs were performed by women and children, while the boys of 14-16 years were employed to break the ore into a suitable size. An illustration from the Blakett Partnership Book of 1753 will illustrate the point.

'Brecon-sike, July 23, 1753.

Lett to Margaret Milburn to wash up the cuttings at the Level Head shaft from the knockstone downwards at 12/- per bing

Lett to Tomas Ridley and Tomas Brown to wash up the wastes in the burn at Level Mouth at 14/- per bing and to go no further than 20 fathoms below ye Dike Nook

Lett to Jane Smith, Jane Stephenson, Jane Hobson and three lads to wash the cuttings above Stephen Dawson's buddle at Ra. Featherstone's shaft at 12/- bing'. Around 1800, there were several changes of technique which led to the introduction of the crushing mill and the substitution of the Grate or Kiln for the simple buddle, all requiring the more extensive use of water.

After the obvious ores and deads had been picked out of the

newly-mined bouse by the washer boys, the remainder would be taken to the kiln, described by Westgarth Forster.

'A pretty strong Current of Water is allowed to fall onto the Grate, on which a quantity of the bouse to be washed is located. It is then raked and stirred backwards and forwards so as to make the small ore and cuttings pass through the Grate, down the inclined plain into a Pit below made ready for its reception. What remains upon the grate consists of Stones, Rider, Spar, etc., and Ore mixed, and intimately blended with these matrixes, as also pure pieces of Ore from the size of a large walnut to the size of a persons fists. These pure lumps are broken down into a proper size for smelting'. (This was at first done by hand, but by the 1880's this operation was performed by Blake's Crushers which reduced the size of these large pieces of bouse to a size suitable for introduction into the crushing mill.) 'The pieces of Bouse that are mixed with Stone, Rider, Spar, etc., are taken to the Grinder or Crushing Machine, where they are reduced to a coarse powder'ⁱ.

The water-powered crushing mill was a significant addition to the washing floor, as it allowed poorer mines to be worked, and old spoil heaps to be re-worked. In March, 1828, Agent Dickinson at Killhope wrote in his Quarterly Account 'Killhope Mines are very poor and the produce less than last quarter or Quarter before ...

i. Forster, W., op cit, 2nd Edition, 1821, 338.

From the bouse being so particularly hard and expensive to work, I would recommend a small Crushing Mill to be built on a convenient site and the bouse led to it by carts, a Water Wheel of 16' or 20' in diameter with 2 pair Rolls would be sufficient for the purpose, which might be built for about £150. There is a great quantity of old waste-heaps at the Bank which will produce a quantity of Ore with the use of a Mill but cannot be worked at advantage without it'. A year later the agent wrote that 'The workings are poor but the produce will be increased from that of last year in consequence of more men raising Ore, a part of which have taken to Workings for the purpose of drawing old deads and working them, which the use of the Crushing mill has enabled them to do, and previous to the mill being built, such places would not work at the highest prices given. The bargains are 54 men @ 35/- per bing'. In the previous year there had been four men working at 32/-, four at 35/- and twenty at 40/-. Thus the erection of the crushing mill had allowed the employment of a further twenty men.

Invented in Cornwall in 1796, the Crushing Mill was introduced into Weardale by the London Lead Company, and the Beaumonts soon after. A mill had been built at Sedling at some time before the erection of the one at Killhope, and was probably very similar to the mills at Allenheads and Coalcleugh, of which a description survives in the Allendale MSS.

Sept. 16th. 1807

Description of a Crushing Mill at Allenheads

'Water wheel 36' in diameter and 3' wide in the Clear will require 14 pair of arms and 98 buckets.

The Shrouds, of Cast Iron, 10" wide or deep in the clear and $\frac{1}{2}$ " thick with Flanges to hold the Buckets, and the Shrouds to extend $\frac{1}{2}$ " or $\frac{3}{4}$ " beyond the Buckets.

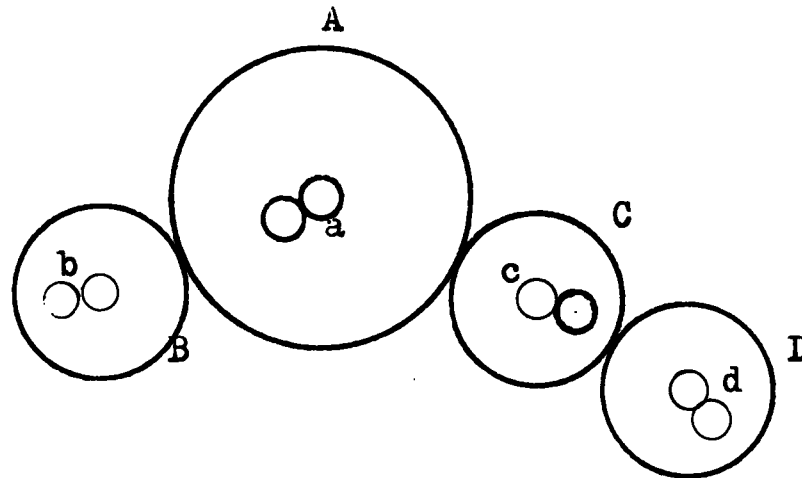
The arms of Oak	Width at the Shroud	8"
	do at the Centre	11"
	thickness	3"

The flat part of the Arms may be tapered $\frac{1}{4}$ "

The arms at the Centre 3" further apart on each side than at the Shrouds and spring to the shroud.

The Axle Tree, say $2\frac{1}{2}$ ' in diameter

Rolls, 4 pairs (One pair fluted, three pairs plain. One of these pairs to crush chatts instead of stamps) The diameter of the Four pairs Rolls 13"



a The Fluted Rolls

b and c the 2 plain rolls

d the Chat Rolls

A the large wheel upon the water wheel shaft $6\frac{1}{4}$ ' in diam.

B and C the 2 wheels giving motion to the Chat Rolls, diameter of b, c, and d, 3' with 39 teeth in each. A has 80 teeth.

Provision to be made for a Flay Wheel to be erected if thought needful, the wheel when finished to be well-painted with tar and fine charcoal dust mixed to a proper consistency () or quite hot.'

Another mill was to be built at Coalcleugh, the same as at Allenheads, 'Rolls also the same as at Allenheads except the three pair for crushing the chatts not here to be used - but instead to have a set of 3 Stampers here thought necessary from the excessive hardness of the materials.

At both places the outer end of the wheel shaft to have a () to receive a coupling box, for purposes that may be needfull at any time.

Wm. Morrison to direct where the Castings shall be made.

The Diam of the Gudgeons to be 6"

The Diam of the Wheel to give motion to the Fly 10"

The diam of the lesser Wheel upon the shaft of the Flay 1' 6"

The diam of the Fly wheel 18'

This whole to cost £137 at Allenheads without casing the water wheel or a () waggonways or water troughs to be made by day work.

The only Crushing Mill of which there are any extensive remains today, is in fact at Killhope, although it seems likely that this is the remains of a re-construction of the one first built in 1828, (vide Appendix B). In 1821, Forster mentions only two crushing mills in Weardale, at Brecon sike owned by the Beaumonts, and at Middlehope New Vein owned by the London Lead Company. By 1857, however, there were two on the Middlehope burn, one at Rookhope, another at Stanhope, a fifth at Newlandside on a tributary of the Horsleyburn, and others at Killhope, Sedling, Blackdene, and Bollihope and at Pinfoldhouse on the Daddryshields burn.

After being crushed the bouse was passed into juggers or mechanical sieves where the ore and dead material were separated. In the first 60 years of the nineteenth century, however, the Break Sieve was still used extensively. This was a large manual sieve, worked in water, which separated the bouse into four grades. At the top of the sieve material known as 'Cuttings' collected, worthless matter that was thrown away. Underneath this lay 'chats' or a layer of particles neither clean ore nor cuttings. These were taken to the Stampers, mechanical crushing hammers, often worked off the same wheel as crushing rollers, where the chats were broken down to a smaller grade and re-graded. Resting on the sieve itself was the pure ore, know as 'round' or 'sieve' ore.

In the tub of water, however, a quantity of small ore and bouse collected, known as 'smiddum'. More often than not, this was mixed with a fine sand and had to be subjected to further washing and sorting processes, being passed through the running and trunk buddles, from each of which a proportion of ore was extracted by means of a current of water. Finally the 'smiddum tails' were allowed to collect in a 'slime pit'. When this was filled, the slime was dug out and placed in a 'dolly' or circular buddle in which a vortex was created by means of a rotating paddle. The lighter materials were swept to the side, while the heavier ores remained at the centre. Thus by these means all but the finest particles were saved. Pollution of watercourses, however, was high. The considerable amount of solids in suspension darkened the water, inhibited plant growth and reduced the animal life of the streams in the basin so that the quality of both commercial and private fishing in the Wear declined considerably.

Lead Smelting Mills

Prior to the sixteenth century, lead smelting was carried out at hill-top bloomeries such as existed at Stanhope and Wolsingham, 'les bolehillis' of mediaeval account rolls. The introduction of the ore-hearth furnace, however, necessitated the maintenance of a steady draught which could obviously not be maintained by the capricious wind, but which could be provided by a pair of bellows

worked by a water wheel. The earliest lead-smelting mill in the area was that opened by Sir William Bowes at Burtreeford in the late sixteenth century, 'wherein here hath been sundry trials made of both the Ore gotten within the saide Iron mine the which hath been converted into iron and likewise Lead Ore gotten in Teesdale which hath been made into lead at the same mill'ⁱ. The position of this mill at Burtreeford is not known. The place name Mellen Eale has been associated with this mill, but there is no proof that there is any connection between the two. At a time when the principle of the overshot water wheel was well known, it seems curious, if Mellen Eale is the site, that a place where only an undershot wheel could be used was chosen, when there were more apparently better sites to be had nearer Sedling burn and the iron mine.

The 1647 survey of the manor of Wolsingham contains the entry, 'memorandum. There is a Lead or Smelt Mil in Wolsingham Towne, formerly granted to one John Parsons Gent, at ye yearly rent of £10.8.0. But now is in the possession of one Mr. Wharton (the Moor Master) ... worth by rent £6.13.4., and worth upon improvement above the rent £6.13.4. p.a.'ⁱⁱ. As the mill was in its second tenancy, and was converted from a fulling mill during the former tenancy, it would seem probable that it dates from the early seventeenth century. It is significant that the mill should be in

i. C.C. /R.S. 277863
 ii. C.C. /R.S. 31611

the hand of the moor master who also allotted mining rights in the Forest of Weardale.

There is no subsequent reference to either of these two early mills, and there is no proof of any other smelt mill being established in the basin until the early eighteenth century. Raistrick notes that the mill at Rookhope 'was apparently getting old and inadequate as it was closed before 1740 for reconstruction'ⁱ, which suggests a date of construction at least at the beginning of the century, and it is known that the Beaumonts had established a mill at Burtreeford around 1743. Smelting mills were subsequently erected at Copley (vide Appendix B), Stanhope and Bollihope, but on the introduction of the reverberatory furnace, or cupola, a water-powered blast was not needed, and ore hearths were used less extensively. Only 3 of the 9 hearths at Copley needed a water-driven bellows, although at Rookhope ore hearths were used until the abandonment of the works in 1916 (vide Appendix B). Because of the arrangement of the orefield and the mining concessions, most smelting, in fact, was done outside Weardale. The London Lead Company's major rights were in Teesdale, and after a boundary dispute with the Bishop in 1846, the Stanhope mill was abandoned and the Egglestone mill in Teesdale, received a considerable proportion of the Weardale ore. Similarly, the Beaumont mills at Allenheads, Nenthead and Dukesfield received

i. Raistrick, A., 'Lead Smelting in the North Pennines during the 17th and 18th Centuries' Proc. Univ. Dur. Phil. Soc. Vol. 9, 1935.

almost all the ore mined in upper Weardale, and only the Beaumont ore mined from Rookhope, and the London Lead Company ore mined from Bollihope was refined within the dale. Weardale did not, therefore, possess large water-powered smelt mills such as existed at Nenthead and Allenhead.

As railways, and consequently cheap coal were not introduced into Weardale until the 1840's, and as the industry virtually collapsed in 1873, it will be apparent that steam power, applied vigorously in the neighbouring coalfield since the eighteenth century, was limited in application to those more prosperous mines in the lower parts of Weardale. It will be readily seen, therefore, that water and water power were the essential life blood of the lead mining industry through most of its history. Their application have been shown above to depend upon advances in technology, facilitated by the presence of the extensive surface waters of Weardale, which were impounded, diverted and channeled to serve this important aspect of the economic development of the North East, and the 'zussammenhang' of the Wear basin.

The Wear Navigation

In the late sixteenth and early seventeenth century the owners and tenants of land around the head of the tidal Wear realised that they had as much coal, as easily to be won, and as near the sea as the lately-incorporated Company of Hostmen at Newcastle; and that by using the same methods of sending the coal down the river in keel boats they could compete with the Tyne in sending coals to London. By the beginning of the seventeenth century, the coal pits of Lumley were famed as among the best in the North, and at the township of Sunderland such rapid expansion took place that in 1634, the Bishop of Durham, within whose manorial lands that township lay, incorporated it as a municipality, so that its trade might be encouraged. The mayoralty, however, much to the dislike of the inhabitants, remained within the Bishop's nomination. Partly because of this, and partly because of the influx of many Scots into the township during the first four decades of the seventeenth century, the township, alone within the Bishopric, supported the Parliamentary cause throughout the Civil War. Parliamentary reward came in 1643 when free and open trade was declared in the port of Sunderland and the jurisdiction of the Bishop was abolished, an advantage consolidated over the next year when the Tyne was

*A Survey of the River Wear
 from W. M. Mearns' Mouth to
 the City of Durham*
 1731

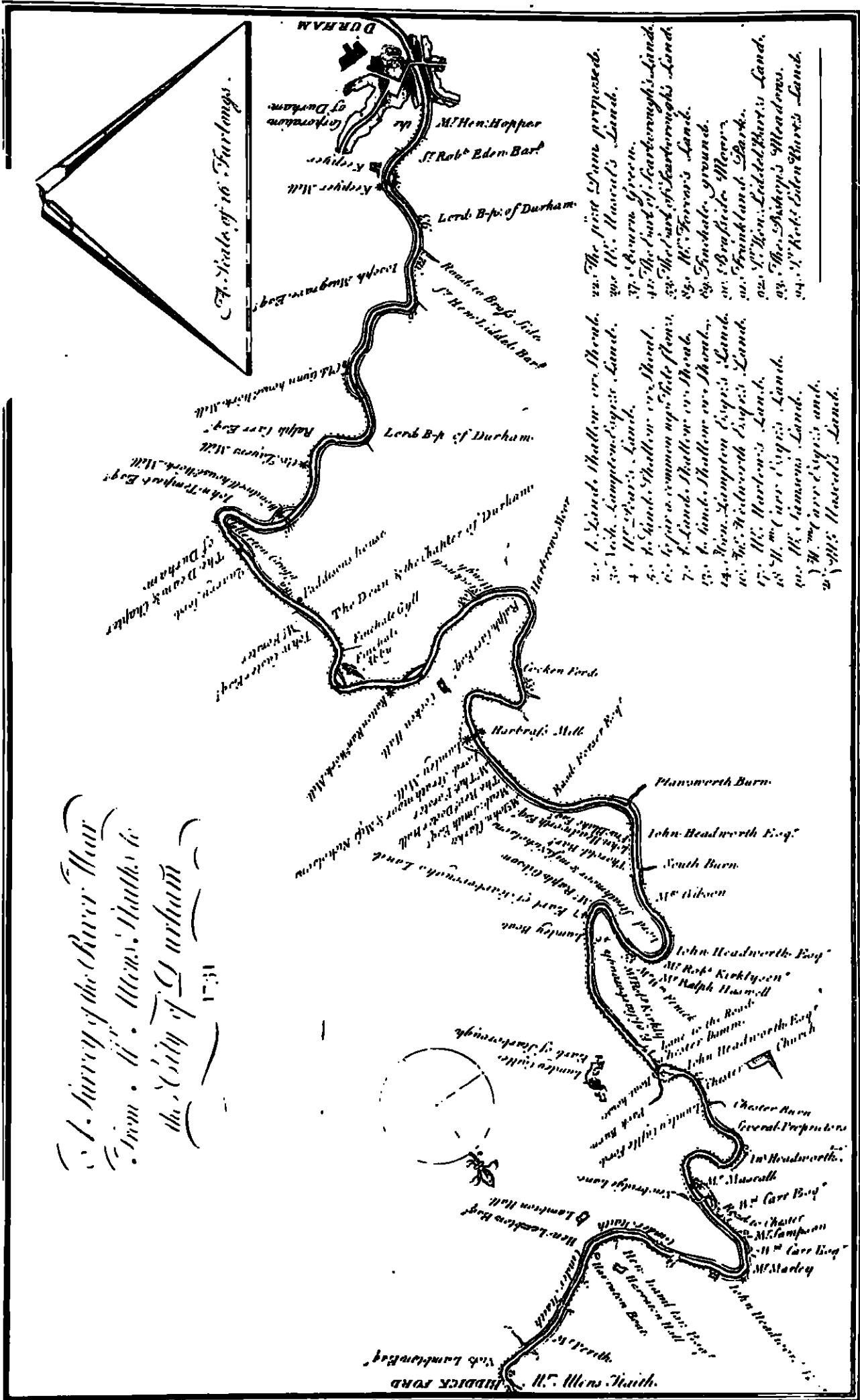


PLATE V

John Shirley's Map of the River Wear 1724

blockaded, and Sunderland alone supplied London with coals. Sunderland, says Bradshaw,ⁱ 'forged ahead with almost incredible rapidity'. The increase in the coal trade stimulated keel-building, and especially in the latter half of the century, ship-building became firmly established at the mouth of the Wear. The harbour, however, was far from satisfactory, being 'very much gorged up, stopped up and checked by the many sholes, sand beds and much rubbish, daily increasing ... almost rendering the river un-navigable'ⁱⁱ, and in 1669, the King granted to Edward Andrew the right to build a pier, erect a light house and to cleanse the harbour. How much was accomplished by Andrew is not known, but it is certain that over the next forty years the coal trade of the Wear grew to such an extent that by the turn of the century it was producing almost half as much coal for export as was the Tyne.

The Coal Trade

At this time the coal industry of the Tyne had reached a critical state. The thin seams near the surface of Gateshead Fell, Whickham and Dunston Hill, upon which the great advance in the Tyne coal trade in the seventeenth century had been largely based, were for the most part exhausted. It had become necessary, therefore, to work either the deeper seams, which required extensive and expensive

i. V.C.H. II

ii. Quoted by Surtees op cit II, 259.

pumping operations, or to go further afield in search of shallow seams, which involved costly waggonways and the expensive purchase of easements often across the land of a rival coal owner. On the whole the latter was preferred, for horse ginns and windmills could not deal with the amount of water which it was necessary to pump out of deep mines, and the improved Newcomen steam pump was not widely available until the 1720's. Thus the industry increasingly devolved upon men of capital and the influence of the Company of Hostmen declined as they gradually became simple carriers. Thus at a time when the coal trade of the Tyne was undergoing physical and economic re-organisation, the trade on the Wear was being undertaken within physical terms equivalent, perhaps, to the position of the Tyne a century before, but organised on the basis the Tyne magnates were only just consolidating. Thus, Lord Harley noted in the spring of 1724, that the inhabitants of Newcastle 'seem at present a little jealous of Sunderland which has of late showed pretty considerably in this (coal) trade and as I am told is likely to gain more and more upon it every day'¹. The ratio of coals exported from Sunderland to coals from Newcastle was 1:4 in the mid-seventeenth century, but by the mid-eighteenth century had risen to 1:2. In 1750 Newcastle exported 288,000 chaldrons, and Sunderland 162,000.

i. H.M.C., Portland MSS VI. 106.

The Condition of the Wear

Notwithstanding these advantages the Wearmen had to suffer considerable inconvenience in the transport of their coal from the mines above Hylton Gorge to the coasters waiting at Sunderland. The principle involved was that the coal would be loaded onto keels, which, John Smeaton observed, 'draw less water than ever I saw'ⁱ, and would be taken by them to the coasters at the mouth of the river. Here the Wearmen paid their price for not suffering the regulation of their traffic. From the mouth of the river to the highest point from which keels plied, geomorphological and artificial hazards obstructed navigation.

The harbour mouth in 1717 was 'much obstructed and prejudiced by sands thrown up by the Sea, and very much ill'd stopped up and choaked in its channels and the depth of water thereof exceedingly lessened by the great banks of sand and quantities of stone and other gross matters washed and brought down by land floods and other Accidents, but more especially by throwing ballast, coal ashes and Rubbish within the said port and river'ⁱⁱ. On their return from London the coasters were obliged to carry ballast which they tipped out on reaching Sunderland. The resulting haphazard mounds of ballast, which could have been used for the building of keys and

i. C.J. 28.1759

ii. Preamble to Wear Navigation Act, 1717.

wharfs were allowed to obstruct the harbour entrance and produce yet more difficult currents for both coaster and keel boats to navigate. Moreover, the fickle river in times of heavy land flood or strong tide, occasionally changed its course through the undredged sands of the harbour mouth. In 1752, it was noted that an 'extreme flood happened which made surprising changes in the mouth of the Harbour and so choaked it up yt there was no proper channel left'_i.

Similarly, upstream, shoals of sand were a grave hindrance to navigation. At Forsters Sands, the river was only 9" deep at periods of low water in dry weather, and neap tides only swelled the depth to 1'8". Although the sands were cleared in the 1730's, for want of sufficient attention they were as bad as ever by 1747, with keels sometimes having to wait five or six days for sufficient water. At Biddick Ford, the water was only 1'9" deep at low water, although between these two points there was usually ample draught. From this it will be obvious that the tide was crucial to the passage of keels. While it was necessary to wait for periods of high water, high tide did not last long, especially in the upper reaches of the river, where it was most essential, and its ebb was particularly capricious. The keel men often found themselves in danger of running aground or being trapped in an unmanoeverable

channel, unable to use their sail.

These physical hazards moreover were exaggerated by the attitudes of the riparian owners. When the keelmen were unable to use their sail they were obliged to walk along the bank towing their boat behind them, and several landowners objected strongly to the trespass of the rude sailors, and even used violence when, at periods of low water, the keelmen moored their boats and went in search of refreshment. Thefts of coals and even keels were a commonplace at such times, but even more distressing to the keelmen was the ford at Biddick. In 1711, a case was submitted for Counsel's opinion: 'And there being a King's Streete lyeing over ye River the owners of the grounds thro' which yt way lies tho they have noo manor nor charter to enable them have set up a ferry boate for carrying over passengers and have placed and hung a rope across over the water which is to the gt prejudice of the keels passing and re-passing upon yt River'ⁱ.

The First Petitions

During the first decade of the eighteenth century, then, some 300 craft were using the river, which at periods of the highest tides was navigable as far as Newbridge, the lowest bridge over the river which was located at Lambton. It had become obvious, however,

i. W.C. MSS.

that some regulation of both the river and the traffic was necessary for the well-being of the coal trade. In January, 1705, therefore, the Mayor and Aldermen of Durham, the Dean and Chapter of Durham, and the Township and Borough of Sunderland petitioned Parliament for leave to bring into the Commons a bill 'to erect one or more piers at the mouth of the R. Wear into the Sea; and that the Port of Sunderland thereto adjoining be kept clean and unimpaired as it might be, and that the said River be made navigable up to the said City; whereby a great revenue would yearly arise to her Majesty, and a settled Nursery for seamen erected and Trade in general increased'. This was the first that was heard of the aspirations of the Chapter and the City of Durham, to make Durham an inland port. Quick to realise Durham's nodal position at the heart of the County, the City Corporation had visions of coal and lead, lime and building stone, wool and corn being brought by road to Durham for shipment down the Wear to the sea. The Chapter had more realistic aims. Owning extensive tracts of land between Chester le Street, Houghton le Spring and Durham, they saw a navigable Wear opening up the undoubtedly rich coal seams underlying their property, which could at that time only be worked at relatively great expense. An indication of the value of the land can be gained from the fact that John Tempest was obliged to pay a fine of £17,000 for the Grand Lease of the Rainton Mines in 1777₁. The petition was referred

i. Dean and Chapter post-dissolution muniments, loose papers, Box 28.

to a committee and leave was eventually given to bring in a bill, but nothing more was heard of the subject, and it may be that the Tyne magnates had assured the bill a rousing defeat in the House.

The making of the river navigable all the way to Durham, however, would have meant the surmounting of several obstacles, at a considerable expense. It was subsequently estimatedⁱ that the river could be made passable for keels of 20 tons or so between Biddick Ford and Cocken Ford for £7,000, but between Cocken and Durham the cost would be at least £20,000. The essential trouble was caused by the river flowing out of its drift-filled pre-glacial valley. Where the post-glacial river had cut its new eastward course to the sea, it had left the Wash and cut through its pre-glacial valley side to give a series of rocky shallows between Lambton Hall and Harraton Hall. Similarly, between Harberhouse and Kepier the river had cut itself a narrow rock-floored gorge, and to surmount these obstacles would mean either the construction of locks and dams, or the difficult excavation of the rocky floor. Between Picktree and Harberhouse, however, the river flowed across relatively soft boulder clay which would have presented no real problem to an engineer.

In 1716, another petition was presented to Parliament, sponsored by the 'Wearmen' as they were known in Newcastle: the Earl of Scarborough, of Lumley, Hedworth, secular Dean of Chester le Street,

i. C.J. 28, 1759.

the Lambton brothers and Thomas Allen of Fatfield. They wished to make the river navigable only as far as Newbridge, but even this was sufficient to dismay the Tynemen, led by the doughty Cotesworth of Gateshead. A counter petition was quickly drafted that the scheme would mean '... oppression to most of those of least acclaim and be only beneficial to a few Great Coal Owners who notwithstanding their Zeal to promote the said Bill and thereby as they (who) pretend to open and Enlarge the trade of the Said river, have for severall years past by farming and purchasing lands and contracting with the owners of adjacent grounds for Stopping all Coal Carriages from other Collieries to the River Wear very near engrossed the coal trade to themselves alone and in a short time have the prices and quantities of coales to be tended in their power'ⁱ. This allegation was certainly partly true. Thomas Bewick petitioned the Lords in May 1717 'That he is possessed of a very great colliery situate near the R.Wear ... and that by unjust contracts made by some who prosecute the Bill for preserving and improving the river and Port of Sunderland he will be debarred from bringing his coals to the river ...'ⁱⁱ. This practice, however, was not confined to the Wearmen, for the great magnates of the Tyne had pursued just such a policy against each other for many years, which was only to be curtailed by the Grand Alliance of 1726. The allegation, however, was soundly based,

i. Carr-Ellison MSS, B2/1/60.

ii. L.J.

and a petition from the County gentry, well aware of the crafty schemes of the great owners along the tidal stretch of the river suggested an amendment 'That the Bill ... may extend to the City of Durham and that the receipt of Duties for perfecting the said work may be lodged with the Co. Treasurer ... and not in the hands of any of the coal owners upon the Wear'. The Bishop of Durham, also, although rather a dark horse throughout the long history of the scheme was also anxious that his ancient prerogatives as Conservator of the Wear should not be taken away from him without, at least, his permission.¹ The entry of the Bill onto the statute book in June 1717, however, was undoubtedly a victory for the great owners at the estuary. Whilst ultimately the river was to be made navigable up to Durham, work was to start at the mouth of the river. Although the Bishop and the Dean of Durham were appointed Commissioners for carrying out the scheme, the majority of the Commissioners were "in the pocket" of the great magnates. Duties raised from traffic above Newbridge were to be applied to the making of the river navigable from Newbridge to Durham, but as no traffic could use the river above Newbridge, no duties could be raised. The "inland" party, therefore, were defeated.

The Wear Commissioners

The Commissioners, however, set to work with something like vigour.

i. Hughes, E., North Country Life in the 18th Century, 293.

A Survey was entered upon, and, according to the Act, work was begun at the harbour mouth. Plans were drawn up to erect a pair of stone piers at either side of the mouth of the river, and work was set in hand. By February 1726, the southern pier had been carried 270 yards into the sea, although no start had been made on the northern pier. To their dismay, however, the Commissioners found that the duties being raised upon the river were not sufficient to pay back the capital and the interest on the money they had borrowed. Over the ten years since the passing of the Act they had raised £15222.10.8. in duties, which they had applied to the erection of the pier, but this was not sufficient and they had borrowed a further £3,500 on their own security, and even then found that 'they shall want a considerable sum of money more to complete and secure the sd. works; which they should do if they were impowered to borrow a sum of money upon the Credit of the sd. Act'ⁱ.

There was no alternative but to petition Parliament for an extension of the powers of the 1717 Act. It was noted in Committee that a further £6,000 would be needed for the harbour works to be successful, and with no opposition a bill was passed through all its stages within three weeks to allow the Commissioners to borrow a further £6,000 upon the credit of the Act of 3 Geo I. The royal assent was given on the 24th March 1726. The Commissioners were

i. C.J. 20, 1727.

already on the slippery road towards the non-fulfillment of their statutory duties.

The money was accordingly raised. In 1732, it was noted in the Commissioners' Treasurer's Book that £6,862 had been borrowed since the 1726 Act, of which all but £1,400 had been paid back by 1730. The work on the harbour continued, watched with growing dismay on the part of the City of Durham, the Dean and Chapter and the inland party.

It was apparent that in proceeding according to the Act of 1717 and gradually improving the river upstream, the Commissioners would never reach Newbridge, let alone Durham before the time limit of 21 years placed upon the Act expired. The Dean and Chapter, impotent against the great coal owners around the estuary, resolved to prepare their case for a petition to Parliament to prevent the present scheme of things being continued. In 1731 their agent noted '... It appearing plainly that it was against the Interest of much the major part of the then Acting Commissioners that the river should be made navigable higher, for that they and their friends and Confederators were possessed of or interested in the present working Coalyerys upon the said River and if the sd river shld be made navigable higher, other considerable collyerys would be wrought and perhaps at an easier rate than their own, and the coals brought down to the river which would interfere with them in

point of trade and reduce the price of coals'ⁱ. The Chapter were plainly here thinking of their own collieries at Finchale and especially Rainton, where rich deposits of coal were to be mined over the next forty years. Meanwhile, John Shirley was employed by the City of Durham to make a survey of the river from Biddick Ford to the City (Plate V). He reports that it would cost at least £20,000 to make the river navigable up to Durham, so in the February of 1731, the City petitioned the Commons that 'Navigation is not yet completed ... and the money arising from duties below Newbridge will not be sufficient to complete the navigation of the said River and that for the defraying of expenses amounting to £20,000 or so for making the sd River navigable from Mr. Allen's staithes up to the City of Durham, it will be necessary to lay a further duty ...'. Further than this, they urged that they should be allowed to bring in a bill to complete the navigation themselves, upstream from Biddick.

The Wearmen were not to be dismayed by such tactics, and quickly filed a counter petition to the effect that the proposals put forward by the Durham party, would prejudice the rights given to the Commissioners by the 1717 Act. They intimated to the Durham party that they might be willing to allow the Corporation to take over that part of the river above Newbridge, but insisted that they must

i. Dean and Chapter, post-dissolution muniments, loose papers, Box 29.

be allowed to keep the river between Biddick Ford and Newbridge, as they had already mortgaged the duties arising from that part of the river_i. This cogent argument was accepted by the Durham party, whose petition was defeated in Committee.

In the following Session, the City of Durham again petitioned Parliament that they wished to bring in a bill to render the river navigable from Newbridge to the City, but that they must insist that the Commissioners must make the stretch of water between Biddick and Newbridge navigable 'as an obstruction in any pt below, between Mr. Allen's Staithes and Newbridge would have totally stopp'd up ye navigation from ye see'_{ii}. All was not well with the Commissioners, however, for the duties they levied were not being paid, 'by reason that the power given to the Commissioners to direct their warrants only to the Constable of the Place where the offence is committed ... the Distress upon Goods for Offences committed is frequently evaded by the offenders removing their goods into such different parts ... where the Constable cannot exercise the same'_{iii}. At Christmas, 1734, for example, nine of the greatest coal owners owed between them £1,408,1.11½. in duties for the previous year_{iv}. By such means were the greater owners reducing the risk of competition from further upstream. Having

i. Dean and Chapter, *ibid*
 ii. Dean and Chapter, *op cit*
 iii. C.J. 22, 1736
 iv. W.C. MSS.

secured sufficient improvements below their staithes, notably the the removal of Forsters Sands and the erection of the southern pier, they withheld their dues to delay improvements further upstream. The duplicity of these men is revealed when it is seen that they were all, to a man, Commissioners.

Again, then, the Durham petition failed in Committee, for besides their complaint of not receiving their just duties, the Commissioners were quick to point out that they really ought to complete the northern pier at the harbour before completing improvements further up the river.

In 1736, however, the powers vested in the Commissioners under the Act of 1717 were on the point of becoming extinct. It was realised at Durham that the present Commissioners would petition Parliament for a renewal of their powers, and it was suggested to them that were they to give an undertaking that they would make the river navigable as far as Durham, then the Dean and Chapter and the Mayor and Corporation would be ready to support them, on the understanding that these bodies should be incorporated as Commissioners under the new Act, and that a strict time limit should be placed upon the Commissioners to make the river navigable as far as Newbridge_i. The Wear Commissioners, however, would have none of this, and the Durham party, their compromise rejected, resolved on more radical demands. Knowing that the capital raised against

i. Dean and Chapter, op cit

the duties levied between Newbridge and Biddick had been paid off, they returned to their previous demand that the Commissioners should surrender the river above Biddick, and allow them to make the river navigable to Durham. This time, however, they had a powerful ally in the Earl of Scarborough, who was originally one of the Wearmen. The building of the pier and the erection of keys along both sides of the river, surveyed so well by Burleigh and Thompson in 1734, had reduced the size of the estuary so that tides could no longer penetrate the river with such effect as they used. It was claimed that since the construction of the Southwick and Pallion keys, the river had lost 2 feet at Newbridgeⁱ. The shipment of coals therefore above Biddick had decreased considerably, and it was put out that duties arising there did not amount to more than £10 p.a. At this time, duties on the whole river, if collected, would have produced £1,200 p.a.ⁱⁱ. Thus Lord Scarbrough was obliged to favour the Durham party and a general navigation of the river. The Chapter's correspondent wrote on the last day of the proceedings that 'that noble lord hath acted with great justice and honour to the County having declared himself several times for a General Bill of Navigation, whereby all proprietors on the River might receive Benefit for their several Collieries in due time'ⁱⁱⁱ.

i. W.C. MSS.

ii. C.J. 22, 1737

iii. Dean and Chapter, op cit

However, the Committee stage became so protracted that there was no time for a Bill to be brought in during that Session, and it is with a sigh of relief, almost, that the Chapter's agent in London writes to them that 'I can now tell the Chapter with assurance that the Bill cannot possibly be brought in this Session'ⁱ. It was, perhaps, relief misplaced, for although the Commissioners had not secured the extension of their powers, they no longer had any powers. Three months later, on the 24th June, 1738, the Act setting up the Commissioners became extinct, and the river, a little improved, began to fall back to its old condition.

Interregnum

At this point it would be pertinent to note the amount of coal being sent down the river. 1734 is unique in this earlier period in having a list of 'Coal Owners Arrears'ⁱⁱ from which the production of individual owners can be determined. A list is set out below:

	<u>Chaldrons</u>
Jn. Hylton & Ptners	13,144 ³ / ₄
Hy. Lambton	12,280
Jn. Hedworth	11,522 ¹ / ₂
Jn. Tempest	13,013 ³ / ₄
Nic. Lambton	15,969 ¹ / ₄
Thos. Allen	12,831 ¹ / ₄
Meabom Smith	10,954 ³ / ₄
M. Davison	9,918 ³ / ₄
Wm. Dennison	9,173
	<hr/>
Total	108,808
	<hr/>

i. Dean and Chapter, op cit

ii. W.C. MSS.

Without the superintendence of the Commissioners, the condition of the river rapidly declined, and the mouth of the river became 'very much choaked up with sand'ⁱ, and 'ships could not go out with safety, as they could not take in the necessary ballast to get over the Sands at the harbour mouth'ⁱⁱ. The regulations over the river had lapsed, and keys were built too low so that 'the sea in high and raging tides washed great quantities of Ballast from the same into the sd River'ⁱⁱⁱ. It was therefore determined that the old Commission should be set up again and a petition was presented to Parliament for that end by the 'Owners of Lands and Grounds adjoining or lyeing nr the R.Wear and Other Gentlemen'. Needless to say the Durhan lobby immediately re-formed and resumed its former agitation. The Corporation of the City, well aware of the Chapter's contacts in London joined common cause with the Prebendaries, although the latter had no illusions of the Corporation's alliance, knowing that 'if the River can only be made navigable in part ... they will be no longer concerned for our Interests ... as they are now when they happen to co-incide with our own'^{iv}. The Chapter were now of the opinion that it might not be possible to bring the navigation all the way to Durham, and rather than prejudice the whole scheme they would be satisfied if the navigation was

i. C.J. 25, 1746

ii. C.J. 28, 1759

iii. W.C. Order Book, 1746

iv. Dean and Chapter, op cit

brought as high as possible. Certainly it would serve the Chapter's collieries at Rainton sufficiently well if the river could be made navigable only to Cocken or Kepier, although they were not averse to the canal being brought to Durham and near their property at Shincliffe. The Mayor and Corporation, however, wanted the navigation brought all the way to Durham or not at all, for it would obviously not serve the City's interest should the canal be brought past Chester le Street, but not to Durham.

The petition for leave to bring in a bill was referred to a committee, who heard in evidence that in the 21 years of the Commissioners' existence they had raised £33,341 in duties, all of which, saving £300 or so, had been expended on works along the lower courses of the river, and at the harbour mouth. They urged that it was necessary to erect a pier on the northern side of the harbour, and asked for powers to re-open the river as far as Blacksford, between Biddick and Newbridge. The committee allowed a bill to go forward and on March 4th, 1746 it was read for the second time, immediately followed by petitions. The rest of the County were dismayed at the Wearmen's lack of interest in opening the river above Newbridge. James Lumley, of Lumley, sought to have the river made navigable to 200 yards above Newbridge 'because other coal owners will thereby have an Opportunity of bringing their coals to the river ... and it will not cost more than £400'. To secure a convenient and efficient despatch for his coals, he

was even willing to pay the cost of it himself, but alive to the procrastinations of the Commissioners in previous years, he urged that 'a certain time be named or that in default their Power be transferred to new Commissioners'. At Durham, the Chapter and the Corporation disputed the wording of a petition they should send to Westminster, but tired of the Chapter's vacillations, the Corporation took the exercise into their own hands and urged Parliament that 'men of great skill and experience judged that the River might be made navigable from Newbridge to Durham by the expense of a sum for which the Duties of Tunnage proposed to be laid on coals and other Commodities conveyed upon that part of the river would raise an interest sufficiently high to encourage undertakers', and that there should be no doubt, as there had been none in previous Acts that the ultimate aim of the Wear Commissioners was to make the river navigable as far as the City itself, it being 'well placed for an extensive and profitable commerce' despite what may be said by 'Adversaries so rich and so powerful'ⁱ. Unfortunately, the City were defeated in Committee, but Lumley's amendment was allowed. The Commissioners were to make the river navigable as far as Newbridge not later than 24th June, 1759. Disgruntled, but not entirely dismayed, the City retired, determined to watch closely the Commissioners' activities over the following thirteen years.

i. C.J. 25, 1746

The Commissioners Restored

For twelve years the Commissioners procrastinated as before, and no attempt was made to open up the river any further than it was navigable in 1736. 'In Spring tides, keels may get to Mr. Lampton's staithes a little above the Ford but no further, and the Tides do no so much as swell the river up to Newbridge'ⁱ. At the mouth of the river, however, the Commissioners had of necessity been busy. In 1752, two abnormal floods in the February, and later in the August 'made surprising changes in the mouth of the Harbour, and so choaked it up yt there was no proper channel left The removing of whch and making a Channel was largely expensive. That during the erection of the Above the Pier end gave way and was likely to tumble down into the best of the Channel so yt was of absolute Necessity to take it down And as the direction of the end of the pier was thought proper to be altered and lengthened the doing it when the other was taking down was the propperest time and would save a vast expense ... So much time was taken up in treating for leave to build a No pier and in procuring a proper Engineer yt the Succeeding time has not been sufficient to complete the afore-mentioned works'ⁱⁱ. By June, 1758, there was only one year to go before the expiry of the Commissioners' powers above Biddick under the Act of 1746. It was necessary, therefore, for

i. C.J. 28, 1759
ii. W.C. MSS. 1758

the Commissioners to have at least some semblance of intentions regarding that part of the river, if they were going to be allowed to receive an extension to the Act. Consequently they set their own engineer to work in that month to prepare plans for improving the navigation on that stretch of water. He subsequently submitted to them a memorandum. There were, he noted, four ways of making a river navigable. The bed could be narrowed, or more water added to the stream, both of which were not practicable in this case, or the bed could be deepened, or locks and dams could be constructed. The Commissioners feared that the latter would reduce the amount of water available in the river during periods of low tide, so they asked for an estimate for lowering the whole bed from Biddick to Newbridge. A century later during the construction of railways, the scheme would have been a commonplace, but at this time, before the Duke of Bridgwater's canal, the idea was audacious, and expensive. It is worth noting what would have been involved. Between Biddick Ford and Harraton Hall, 27,592 square yards of gravel would have to be taken up to lower the bed 2 feet, in a channel 50 feet wide. The next 6,838 feet would have to be excavated through the coal measures to a depth of 3 feet, at over nine times the cost of the first stretch. The remainder of the distance to Newbridge was through boulder clay excavated to a depth of $4\frac{1}{2}$ feet. In short, over 90,000 square yards of material would

have^{had} to be excavated at a cost of a little over £19,000. With an average income of between £1,200 and £1,400 p.a., and all their other commitments, it was plainly impossible for the Commissioners to undertake the scheme. Accordingly they appointed John Smith of Sheffield to draw up an alternative scheme. In November 1758, he laid his report before them. He suggested following the scheme suggested by Robson, their own engineer, by deepening the bed as far as Harraton, but to erect a dam there, with a lock, to give 7 feet of water above the shallows immediately above the dam, and to give $3\frac{1}{2}$ feet of water at Newbridge. He estimated that the scheme would cost only £6,694_i.

The following month, December 1758, the Commissioners were visited by the Durham lobby who told the Wearmen of their intentions to submit a petition to Parliament for leave to bring in a bill to continue the navigation to the City. For the first time, the Commissioners offered no objection, but when they heard two months later that the Durham lobby wished to take over the river from above Biddick, the Commissioners were moved to make their position quite plain. In their Order Book_{ii} lies the entry: 'The Cmrs ... will oppose the Gentlemen of the City of Durham in fixing the limits of the Bill ... but that the said Cmrs have no objection to the Gents of the City of Durham taking upon them the

i. W.C. MSS.
ii. W:C. MSS.

Navigation of the river from the first Shallow or Shoal above the high staithes belonging to Hy. Lambton up the Cy of Durham and that they the said Cmrs will make or cause to be made and Maintain the sd river navigable up to the sd Shallow or shoal for vessels of burthen of 22 tuns'. The Commissioners had numerous meetings with the Durham lobby, but did not persuade them to alter their petition which was submitted in its original form on the 26th January 1759. The House learned that 'there are several Coal Mines and Collieries on each side of the sd R. Wear between South Biddick and the City of Durham, which by reason of procuring and maintaining Way leaves to the same cannot be wrought but to great disadvantage, and on that Account either remain unopened or not wrought'. The petition was accepted by the Commons and referred to a committee. Five days later the Commissioners presented their petition, asking that they should be given power to erect locks and dams on the river so that what might otherwise be undertaken for £19,000, 'might be affected by a lock and a dam at the Expense of £6,000 or so'¹. This was also referred to committee. Meanwhile the municipal grapevine had been carefully tended, and petitions in support of the Durham cause came rolling in from the coastal and inland ports which received coals from the Wear. London, Gainsborough, Boston, Norwich, Exeter and Plymouth

i. C.J. 28, 1759.

all supported the general navigation in the fond hope that the price of coal might be reduced.

After lying on the table the subject came up for discussion in Committee. Mr. Smurfitt exaggerated a little, perhaps, when he said 'Several of the collieries now in use are 4 miles from the present navigation - but if the navigation was extended to the City of Durham, then the most distant collieries would not be more than 2 miles away'. Perhaps he was referring to those collieries producing mostly sea coals. More professional evidence was given by John Smeaton, the celebrated engineer. He viewed the river and saw that 'It is practical to make the sd River navigable for Keels of c 20 tons and $\frac{1}{4}$ burden, that these keels draw less water than ever I saw, and that there is water enough to carry any number of them - 48 may pass a lock in 12 hours. From Biddick to Cocking (sic) Ford would cost £8,000, but beyond this point it would be necessary to cut through the rock and the cost was uncertain, perhaps £20,000 would be appropriate'ⁱ. John Shirley who drew up the plan for the Durham lobby in 1731 agreed with Smeaton, but added that the 'Rocks might be of advantage by furnishing large blocks of stone for the locks'ⁱⁱ. For the Commissioners, both Robson's and Smiths plans were laid before the Committee, but in the end it was decided that there should be two separate bills, setting up two

i. C.J. op cit
ii. C.J. op cit

separate authorities. The present Commission, or their newly-elected successors should have kept of the river between Biddick and the sea, while a new body should maintain the river from Biddick to the City of Durham. The Mayor and Corporation had at last achieved their corporate hearts' desire. Although Henry Lambton was not to pay any tolls, as this would interfere with a right he already claimed, tolls were to be levied on all other traffic upon the river. Towing paths, cuts, locks and dams were to be erected, while riparian owners could erect warehouses or weighbeams, cranes, keys, landing places or wharfs, and levy rates themselves for the use of their facilities. It would seem that the golden age had arrived. For their services, the Bishop, the Earl of Scarborough and George Bowes were rewarded by being made Freemen of the City, and were appointed, among others, Commissioners of the new navigation.

In May, 1761, John Smeaton was again induced to inspect the river, but his report filled the citizens with dismay. The first lock was to be at the point suggested by Smith in his report to the Commissioners, three years previously. Immediately adjacent stood Henry Lambton's Harraton Colliery. Should the river be dammed and a cut made his workings would be flooded. 'From this circumstance and the opposition then made, the Act was not further proceeded with'ⁱ.

The scheme was twice raised again, but was never taken up. In 1796, it was proposed to cut a canal along the Team valley to join up

i. Durham City Dep. Box 54/11.

with the Wear above Harraton, at Picktree_i, but the scheme attracted little support. In 1825, noting that the Harraton workings were abandoned, the Corporation again inquired into the scheme, and took Counsel's opinion^m as to whether it would be possible to revive the scheme under the old Act. They were assured it was not advisable, and so the scheme was finally abandoned.

For a mere £20,000 it seems strange that the scheme was not prosecuted with more vigour in the earlier years of the century. Shirley's map shows the Wear gorge to be a hive of activity, which ought to have encouraged men of substance to invest their capital, although, it must be admitted, Shirley might have been trying to paint a rosy picture. The real power of the Wear magnates must be questioned. It would not seem improbable that the Bishop of Durham, although so often a political pawn in the hands of higher statesmen could have cultivated more influence than the Wearmen, and yet he hardly appears upon the scene. Hughes_{ii} quotes Bishop Trevor's contempt for the scheme in 1728, which is supported by Bishop Chandler's opinion in 1747 ('A chimerical, impracticable scheme to make ye River navigable to ye City and carrying their goods by water at a dearer rate than they could have had them by land from Chester'_{iii}.) If this sums up Chandler's attitude

i. Sykes, Local Records, I, Newcastle, 1833

ii. Hughes, North Country Life in the 18th Century, op cit

iii. ibid

accurately it would seem that he had badly missed the point of the scheme, which was, essentially, to promote the cheap and efficient despatch of coals to the metropolitan market. Were the other prelates as short-sighted as Chandler? It is true that Crewe, Bishop until 1722, was not especially interested in the good-husbanding of his temporal possessions, but other things could be expected from the energetic Talbot, his successor, who, by his approach to the question of mineral leasehold showed that he had a very firm idea where the wealth of the bishopric lay. While it was the self-interest of the Wearmen which stimulated them to oppose the further opening up of the river, it would seem that it was the lack of vested interest of the bishops which inhibited them from opposing the Wearmen's schemes. The principal landowner on the exposed coal measures within striking distance of the river between Lumley and Durham was the Dean and Chapter. While the bishops held the mineral rights under the moors that fringed Durham to the north and east, the coal there was buried beneath a hundred feet or so of glacial sands and gravels, and was largely unproved and unworkable, and at a time when relations between the See and the Chapter were cool, then the one would hardly help the other to riches. It can be expected, then, that for the most part the Bishops were prepared to stand aside and allow the principal contenders to prosecute their cause as they would.

In this study much has been made of little. It is highly probable that the extraordinarily high flood of November, 1771, would have severely damaged, if not entirely destroyed any locks or dams that might have been erected along the Wear gorge between Keping and Harberhouse, which, along with the wider use of waggonways later in the century, would have inhibited the rebuilding and continued use of the New Navigation. But in any case the schemes for the navigation of the Wear came to nothing. No impression was ever made upon the landscape, and yet, it makes an interesting study for the geographer by virtue of the emphasis that is placed upon persons and vested interests. What might at first sight be regarded as the province of the historian alone can be seen to have especial relevance for the geographer, who too little takes account of the fact that decisions taken by man in the context of his physical and economic environment are so often taken against a background of personal cupidity and self interest. In this particular instance the river was the focus of attention, but the historical accident could light upon any aspect of the landscape. While it would be undesirable to raise here a question of personal morality, it would be useful to note that vested interest, whatever its character is a force to be met with in many aspects of man's role in changing the face of the world.

Water Supplies in the pre-Industrial Period

A most sophisticated piece of water supply engineering is to be found at the Roman Fort at Lanchester (Longovicium). First noted in 1822ⁱ, the site was more thoroughly investigated by Steers in 1936ⁱⁱ. Although Longovicium was not a large station, it contained the basic Roman amenities of bath house and latrines, both of which facilities needed a reliable supply of running water. To achieve this the higher ground to the west of the fort was tapped as a gathering ground, and two channels, named by Steers the north and south aqueducts brought water from these gathering grounds to a large reservoir at the fort. On the north aqueduct two streams were dammed by a 110 yard embankment 17' 9" wide and 20' high. The dam was a trapezoidal mass of clay faced on both sides with rough masonry. From this dam pipes led 1½ miles over a shoulder of the hillside, siphoning the water into an open channel from which it could flow by gravity to the fort below. The southern aqueduct was fed with water from a spring to the south east of the fort, and a simple channel carried along an embankment conducted the water to the station.

i. Archaeologia Aeliana, I, 1822.

ii. Steers, K., Archaeology of Roman Durham, unpublished Ph.D. Thesis, Durham, 1938.

As with the Roman water mill at Cilurnum, such sophisticated water engineering is not to be found in the area for another thousand years. The occupation at Longovicium lasted from the third to the end of the fourth century, but it is not until 1300 that the Convent at Durham had an extra-peninsular water supply carried by pipes from springs at Elvet Hill over the river at the Abbey Weir and up to the Cloisters and the Deanery Garden. It is not known when this supply was first instituted, but it was certainly of great importance in the early fourteenth century. In dispute with the monks, Bishop Bek cut off their water supply by breaking the pipe, in 1300, and on such occasions when the pipe was frozen or had to be repaired, the monks had to go to considerable trouble to carry water up to the Convent. There are many entries in the account rolls concerning this, and an entry in the Bursar's Roll of 1338 is particularly enlightening. 'Exp. nec. Et Mulieribus portantibus aquam de Were usque Abbathiam pro pistrina. Bracina et Coquina per diversis vices quando pipa gelidata fuit 8s.Od. Mulieribus portantibus aquam pro bracina et pistrina et coquina in Septuaria post festum Purificacionis eo quod pipa fuit gelidate, 6s.Od. In aqua wyndanda de fonte tracticio in claustra as idem, et pro opere circa pipem 6s.'¹. The water pipe consisted of hollowed-out logs joined together with cloth and pitch, 'Item in 7

i. S.S. CIII 536

duodem et 5 uln panni linei empt. pro ligatura aqueductus, 13s.2d.ⁱ,
 and across the river lead was used. Thus in 1366 is the entry
 'W. Plumer operanti circa emendacione aqueductus infra aquam de Were
 una cum 12 lib dell towe empt 5s.10d.'ⁱⁱ.

By the mid-seventeenth century the old wooden pipes had begun to rot and the delivery of the water was not satisfactory. The prebendaries, with their wives and families, newly established in the College felt that a more efficient water supply was desirable. A letter preserved in the Dean and Chapter post-dissolution loose papers was written by the prebendaries to Bishop Merton and appeals that 'May it please your L^D, Wee have brought the water from the Head allmost to the Bridge in new Pipes of Lead and the charge of the whole worke will come to about £200 which is a vast summe considering our great want of Money at this time.... Ant though the Bishops your Predecessors did in thes Publicke Workes bear halfe the charge and wee the other halfe, yet if you L^D will be pleased to give Order to your Steward to pay our Treasurer the third part Wee shall willingly undergoe the burden of the other two: And wee humbly desire your L^D to signify your pleasure to your steward with convenient speed because wee are forced to borrow Money to finish this Worke'. In actual fact the works were interrupted by the

i. Account Rolls, op cit, 611.

ii. ibid, 91.

Commonwealth, and it was not until after the Restoration, and Cosin had been appointed to the See that the works were completed. The water was subsequently conducted over Palace Green to the Castle, and the Norman Well in the courtyard abandoned. A bill of the work undertaken at this time survives in the Mickleton MSS.

'A note of the charges for bringing the water from Elvet Moore to the Collidge'

Imp. for 9 fother, 242 stones of lead	£153.12. 0.
Plumber work	98. 9. 0.
Labourers for digging the trench	18.16. 0.
Soulder	42.19. 0.
23 brass cocks and souldering ym into pipes	9.15. 0.
For work abt the fountain	10. 0. 0.
Coales, candles and cloth	2. 5. 0.
	<hr/>
Total	<u>£335.16. 0.</u>

A note of charges for bringing the water from the conduit to the Bishop's Castle.

Imp. 267 stones of lead	£23. 0. 0.
Plumber work	21.15. 0.
4 brass cocks	1.16. 0.
Soulder	8. 0. 0.
Labourers	4.16. 0.
Coales, candles and cloth	1.15. 0.
	<hr/>
Total	<u>£61. 2. 0.</u>

By the fifteenth century a municipal water supply was inaugurated for the City of Durham. In 1450, Thomas Billingham granted to the civic-minded Corpus Christi Guild in Durham the right to cover a



PLATE VI

The Pant Head, Framwellgate, Durham

well in his Manor of Sidgate, and to conduct the water by a pipe across his land and over Framwellgate Bridge to the Market Place. For all his public benefaction he reserved the right to a piped supply to his own house in the Market Place, but nevertheless this laudable act ensured the provision of a clean water supply for the walled town, besides their wells. Unfortunately, his descendant, Cuthbert Billingham was not so generous, and on the pretext that the citizens had trampled his crops down around the Pant Head (Plate VI) he diverted the water. A suit against him in the Durham Chancery in 1636 made it clear that the City was dependant upon this extra-municipal supply. A calculation made in 1847 suggests that the pant at this time supplied approximately 200 gallons per hour or sufficient for 2 cu.ft. a day for 300 citizens₁. The growing population of the City in the eighteenth century led to the necessity for improving the water supply. A larger pipe was introduced from the well to the Market Place by a grateful Charles Talbot in 1726 on his re-election to Parliament as a member for the City, while the statue of Neptune added to the Pant in 1729 emphasised the civic pride in this still primitive amenity. For all this the supply was unsatisfactory. While not enough water was available at times of peak demand, water ran to waste at other times and during the night. In 1784 a larger reservoir was constructed at the pant in

i. Ainsley's Durham Almanack, 1871.

place of the shallow ponds which formerly held the water in an attempt to conserve more of the night water. It must be realised that this was the principal source of fresh water for a large proportion of the inhabitants of not only the City, but also Gilesgate, who descended to the Market Place for water for 'particular uses' even in the early nineteenth centuryⁱ.

These three examples of water engineering were, however, the exceptions in an eotechnic age. By far the greatest numbers of people obtained their water supplies from springs and wells, a method which had obtained since the earliest times.

It is interesting to note that attempts were made to keep public wells free from pollution as early as the fourteenth century. In 1378-9 two injunctions in the Prior's Halmote urge all the tenants at East Rainton 'non ponant ferra carucarum infra communem fontem nec alinquam out maculam faciunt in eodem' and again at West Rainton 'nullas eorem lavent pannos, nec alinqua utensilia ad fontem communem, sub peona 4Od.'ⁱⁱ Such large fines were quite out of reach of the ordinary tenant, but it is significant that such a large penalty should be put upon the offence. Wells were not always frequent, and water from them was usually reserved for 'particular uses'. Water for general use, was on the whole freely abundant in the basin. By the sixteenth century there were two

i. Londonderry MSS E/548.1.
ii. S.S. LXXXII, 1889, 161.

pants or water troughs at Gilesgate, fed by springs coming off the moorⁱ, and one of these was to be seen at the beginning of this century. Similarly, at Durham, river water could be used for general purposes, and it is apparent that the ancient vennels of the City allowed access to the river. A decree of September 1698 notes that there is '... a Vennel from Silver Streete down to the River of Weare for the use of the Inhabitants there to fetch water in case of Fire in the Neighbourhood or any other public occasion. And whereas by reason of the ways lying open some of the inhabitants of the said Streete have of late perverted the ends of the sd Vennel was designed for, and with Ashes and Dirt soe filled up the same that it is become noysome and unwhollsome'. 6s.8d. was to be paid to the vestry of St. Nicholas for 'keeping the said Vennel constantly clean and passable as formerly it used to be. To inclose and keep shutt the said Vennel against all persons and except when any ffire shal happen or other extraordinary publick occassion shall fall out'. This vennel is still to be seen with a handsome wrought iron gate, although rusty, still at its entry. That it was in use in the early nineteenth century is apparent from old prints of the City, which show washerwomen at the foot of its steps by the river, although this may have been artistic license.

Often, however, streams were used for drinking purposes, and

i. S.S. XCV 10-16.

occasionally strenuous attempts had to be made to ensure that the community at large were aware of the dangers of contamination, and alive to the necessity of keeping the stream clean. A series of entries in the Brancepeth Manor Court Books are more enlightening, not only for the efforts towards a clean water policy, but also the use to which a running stream was put in a rural community at the end of the seventeenth century.

'October 21. 1697 ... 'Whereas some of the Inhabitants in the township of Brancepeth had been known to Wash dirty Vessels and Cloaths, Intrals of Cattle from the Butchers and severall other unclean things in the running stream that descends down the said town, which makes the water unwholesome and dangerous for the use of all sch as take it up below; To prevent all abuse in the said water for the future wee do order that no persons shall wash any foul vessel or Vessels, foul cloathes, foul or bloody meat or any unclene thing whatever within the said stream or Running water so that no excrement filth or that which is unwholesome may run in the same nor that no cloth shall be bleached so near as that the dirty water can or may run from the Webbs into the Streame nor the said water shall not be stopt for any particular use so as to hinder the Current of running for the advantage of the Castle and whole town, nor no Geese nor Swine suffered to wash wallow or defile the said water upon paine of 3s.4d. for everye persons offending therein.

... We do amerce Elizebeth Hackworth for Rinsing and Washing her Washing Tub and Chamber Pott in the Running Stream and defiling the water to the prejudice of the Castle and of the whole Towne'ⁱ.

It will be apparent that even in this period it was realised that all water users had to consider each other, and that water resources were a collective responsibility.

i. Brancepeth MSS.

Water Supply & Drainage 1847-19201. Water Supply

Industrial expansion in the nineteenth century stimulated the growth of relatively large centres of population in the form of colliery villages and small towns based upon the iron and steel or railway trades, and this in turn necessitated the development of a less haphazard system of water supply, based not upon natural springs and wells, but on the organised abstraction of water from watercourses and mine shafts, and its distribution, in varying degrees of sophistication, by pipe, to neighbourhoods, streets, and eventually to individual houses. Characteristically, the first schemes in the basin were local, municipal, and based upon the abstraction of river water, with organised water distributions in the towns of Durham in 1847, and Bishop Auckland in 1856.

In the following decade the needs of the railway workshops at Shildon in the Tees catchment, and the iron and steel works at Consett, partly in the Tyne catchment stimulated the formation of public companies aimed principally at the supplying of these industrial concerns, and of secondary consequence, the provision of a piped water supply at first to the local population, and later to many more people in wider, statutorily defined areas. In both

these industries, lime-free moorland water was at a premium, and while the situation at Consett was relatively simple, involving the impounding of tributaries of the nearby Derwent, the position at Shildon was complicated by the fact that the town stood upon the Magnesian Limestone of the Permian escarpment. Thus in order to provide the workshops, the railway boilers, and the township with a satisfactory water supply, the nearest lime-free water, flowing off the peaty moors on the Millstone Grit into the Waskerley Burn was utilised.

Other significant water suppliers at this period, however, were the colliery proprietors of East Durham. On the low-lying drifts of the middle Wear valley, and the Magnesian Limestone of the Permian escarpment, surface water was infrequent, and wells were either very deep on the limestone, or low-yielding and liable to pollution on the drift. Thus colliery proprietors were obliged to supply their newly-erected villages with water pumped from the mine shaft, and these intensely local, often primitive water supply systems were to be found throughout the coalfield east of the Wear.

Thus it will be apparent that there were three types of water undertaking in the nineteenth century, the municipal, in the case of Durham a public company, in the case of Bishop Auckland a Local Board enterprise, the private systems of the colliery villages, and the larger public companies which were to eventually take over the two previous groups, and which were to ultimately become a local authority undertaking.

The Municipal Suppliers

i. Durham City.

Between 1801 and 1841 the population of the City of Durham very nearly doubled, from 7,824 to 13,927, and although this increase largely took place in the suburbs of Gilesgate, Framwellgate and Crossgate, the population of the tiny parish of St. Nicholas increased by 1,000 to 2,757 over the same period. It has been shown how the inhabitants of Gilesgate in the 1820's were obliged to descend to the City for drinking water from time to time, and it will be readily apparent that the problem of water supply was severe, despite the fact that the supply of water to the pant at the Market Place was trebled with the laying of new pipes in 1846. Nevertheless, a supply of 600 g.p.d. to the parish of St. Nicholas alone was barely one-fifth of a gallon per head per day, and the many other springs in the City would be similarly overburdened. To improve the situation, a public company was launched in 1847 with capital of £14,000 to supply the City and suburbs with water from the river Wear. Gravel filtering beds were constructed on the left bank of the Wear immediately above Shincliffe Bridge, and water was lifted out of the river and pumped, by a 40 h.p. steam engine, to a service reservoir 220' above on a remnant of the 320' surface of Mountjoy Hill. The reservoir was constructed to hold two days supply for the inhabitants, who were calculated to need not more than two gallons each per day. In point of fact the whole City

and suburbs were never supplied. Elvet was the first to be served, but it was not until the 1860's that pipes reached the peninsula and the western suburbs. The villages of Shincliffe and Houghall Colliery, however, were among the first to be supplied.

Although the condition of the Wear was satisfactory in 1847, its condition rapidly deteriorated over the following thirty years. In that time 107 collieries were established above Shincliffe, to give in 1878 a total of 161 collieries and their attendant population of 100,000 draining into the Wear or its tributaries. With imperfect filtration, it is not surprising that zymotic diseases in particular were a growing danger in the City. Increases in small coal washing and hush mining daily coloured the river, the appearance of which horrified the inhabitants, who took to using the piped river water only for washing and obtained their drinking water from the old wells and springs. The situation, in fact was similar to that obtaining before the introduction of a piped water supply to the City. In 1878, the condition of the river stimulated the inhabitants, led by the Dean and Chapter to oppose a bill laid before Parliament by the Durham Water Company to increase their charges and extend their area of supply, and after a controversial Lords committee, it was announced that the Weardale and Shildon Water Company would take over the Durham Water Company and eventually supply the City with moorland water.

i. Durham County Advertiser, May-November 1878.

ii. Bishop Auckland

In 1851 the population of the town was 5,324, dependent upon wells and natural springs for its water supply and 'a pipe conveying the surplus water from a cistern in the castle yard to a pant in the Market Place. The Newgate spring never altogether fails; but its supply is sometimes very small, and discoloured after heavy rains. The supply at the pant depends very much on the quantity of water used at the Castle ... Most of the better class houses have their own private wells, which are not generally more than 15' deep. They yield a hard water, and generally fail in their supplies. It is, therefore, a very general practice to catch the roof water in tanks for purposes of washing. In times of Droughts, water is brought from the Wear in carts'ⁱ. Not surprisingly, one of the first minutes of the newly-formed Local Board of Health, was to inquire 'upon the feasibility of bringing water from Waskerley to Bishop Auckland, or alternatively the cost of supplying the town from the Wear and the best site on the river for any works'ⁱⁱ. It took eighteen months for a decision to be reached, although the situation in the town was grave, and two of the existing wells had to be opened out, and pumps installed at others. The idea of bringing water from the Waskerley was turned down but the Local Board did

i. Fordyce, W., The History and Antiquities of the County Palatine of Durham, Newcastle, 1857, 560.

ii. Bishop Auckland, Local Board Minutes, December 1854.

consider bringing water into the town from a spring at Whiteoaks. The Bishop, whose spring it was, offered no objection, as long as a steam engine was not used, but the General Board of Health refused to sanction a loan for the scheme as the water was twice as hard as that which could be obtained from the Wear. As with the Mountjoy works at Durham, it was necessary to lift the water from the Wear onto the remnant of the 320' surface on which most of the town was built, and a steam engine at Newton Cap Bank, or the existing waterwheel at West Hill was considered. Again, the G.B.H. proved decisive and a steam engine was installed in 1857. The Local Board proudly erected hydrants in the Market Place and at street corners in the town, and for those who wished to pay a special water rate, pipes could be laid on to private houses.

The efficiency of the system was not, however, high. At times of low water difficulty was encountered in abstracting sufficient water from the river, and bank storage had to be tapped by adits driven into the banks. The steam pump itself was not always equal to its task. When the West Mills site became vacant in August 1890, therefore, the Urban Sanitary Authority, successor to the Local Board, decided to buy the mills, install a turbine and pump the water up from there. With the benefits of a dam and a leet the actual abstraction of the water was easier, and after widening the leet to accommodate the 70 cusecs needed to supply the turbine the supply works were inaugurated in 1893. Even this site was not

without disadvantages, for at times of high water the sand filters, near the level of the river were put out of action, and the loss of a differential head on the dam meant that the turbine could not work and accordingly unfiltered water had to be pumped up to the town from the old steam engine at Newton Cap. 'The filtration of Wear water' records the County Council Health Committee in 1893 'efficient in normal times, is dangerously disrupted in times of flood. Enteric fever has been associated with the drinking of this water at both Bishop Auckland and South Church'. 'Loans of nearly £20,000 have been granted by the Local Government Board for the purpose of constructing and then extending the waterworks since 1854. While the death rate of enteric fever has decreased in England and Wales, it has increased at Bishop Auckland to twice that of County Durham, and four times the national average. Above the waterworks the river takes the raw sewage of 10,000 persons, about a third of which enters the river within three miles of West Mills ... the prevention of pollution of the Wear is infinitely more difficult than the obtaining of an alternative supply of water for Bishop Auckland'¹. Continued pressure from the County Council resulted in improvements being made to the filtration of the water, pressure filters were introduced in 1923, and the water was chlorinated and a diesel turbine installed for use when the river was high, but the works continued in use until 1966.

i. D.C.C. Health Committee Minutes, 1894.

A comparison with Durham is illuminating. Although the condition of the river was undoubtedly worse at Durham than at Bishop Auckland, the attitude of the consumers towards the river water, was the major reason why the Wear water continued to be used at Bishop Auckland when the citizens of Durham had recoiled in horror from such a practice. At Durham, the local water company were supplying the water at rates compatible with those of the Weardale and Shildon water company. At Bishop Auckland, the local authority ran the works, financed largely out of the rates. In 1905, the District Council proudly announced that at 3d. per 1,000 gallons, Bishop Auckland water was cheaper than that of any other populous town in the country, excepting Liverpool_i. Evidently, the risk of illness, enteric fever, zymotic diseases of all kinds and possible death was palatable at a price. Another factor in this may well be the lack of a relatively large professional and upper class, unlike Durham which was not only the County town and a cathedral and university city, but also the centre for the fashionable society of both Northumberland and Durham_{ii}. After the first decade of the present century, however, Wear water became indispensable, and although the Durham County Water Board took over the Supply Works in 1952, there was simply not sufficient water in the D.C.W.B. distribution system for this supply of 500,000 g.p.d. not to be utilised.

i. Bishop Auckland D.C. Health Committee Minutes, Vol.19.

ii. c.f. The Recollections of a Northumberland Lady, Charlton, L.E.O., London, 1949.

Unfortunately very few records of water consumption for the area supplied from West Mills survive. D.C. Health Committee Minutes, do, however, record a little information over the period 1902-11. In 1902 the total daily consumption of water in the town was 24 gallons per head, rising to 25 g.p.d. in the following year, in which it was calculated that there were 1,265 w-c's and 634 baths. The mean inter-censal population 1901-11 of the urban district was 12,598. Thus, although many families would share a w-c, it is clear that the demand for water was below what it could have been during the period. The consumption of baths and w-c's was rated at 30,000 g.p.d. By 1911 the total water consumption of the district had risen to 400,000 g.p.d., but the per capita consumption for all purposes had actually fallen. With a rise in population of 11.5% over the previous ten years, it can only be assumed that non-domestic demand in the town had fallen. A breakdown of the Bishop Auckland water supply budget is given below.

Yearly supply of water to Bishop Auckland Urban District, 1911.

Domestic	88,839,000 gallons
Special Charges	10,400,000
Meters	28,767,000
New Buildings	5,572,000
Public Lavatories	207,000
Troughs	110,000
Flushing of Sewers	3,672,000
Street Watering	1,328,000
Road Making	250,000
Overflow	1,500,000
Fire Brigade	10,000
General waste	1,620,000
	<hr/>
	145,696,000 gallons
	<hr/>

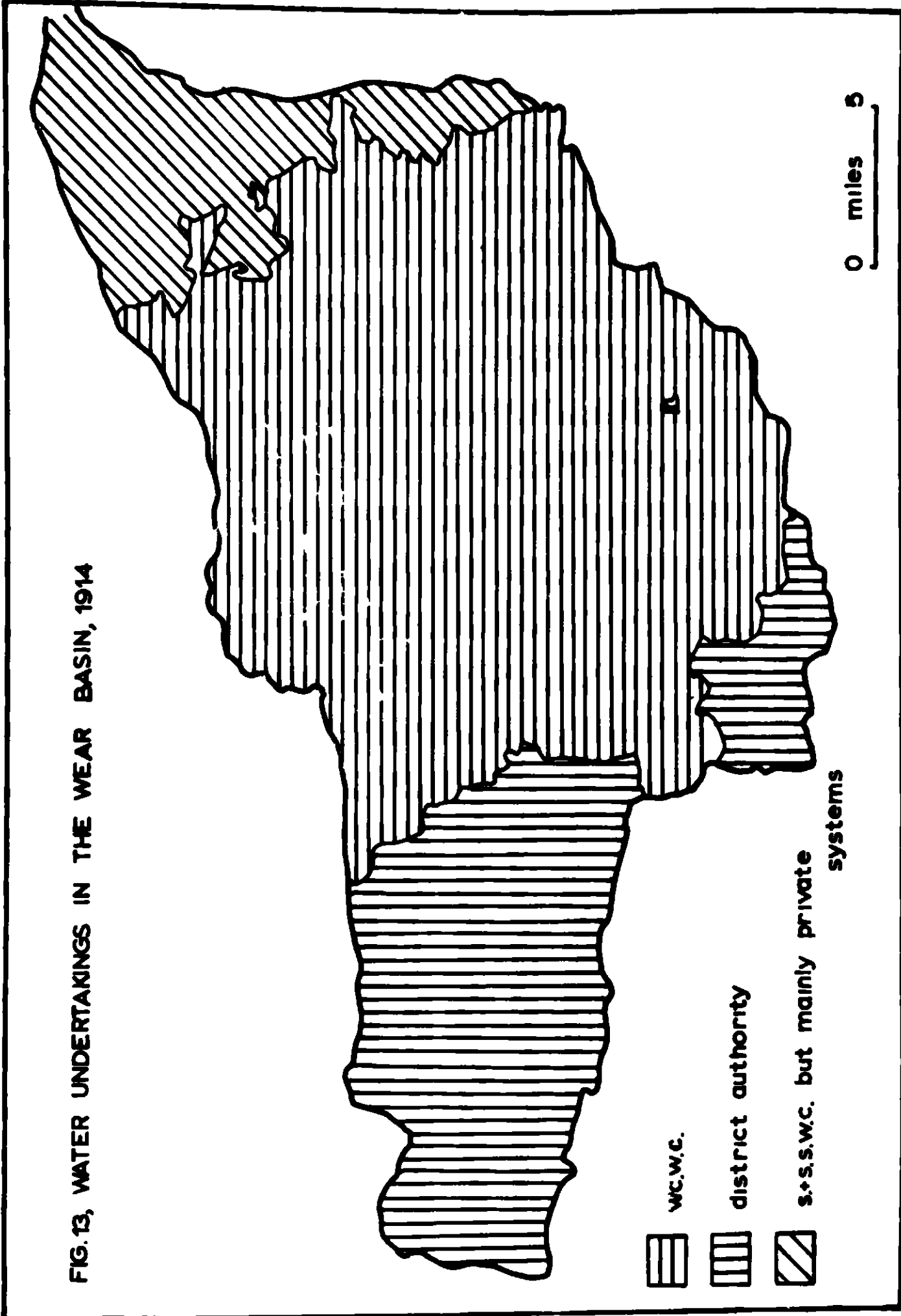
Daily Domestic Supply 18.8 g.p.h.

The Private Systems

With the development of large-scale shaft mining along the foot of the Permian escarpment in the 1820's and 1830's, considerable villages were established in a line from Newbottle to Coxhoe. The parish of Hetton le Hole, for instance, increased in population from 919 in 1821 to 4,158 in 1841, and to the south the parish of Coxhoe similarly increased from 132 to 3,904. The springs and wells which had previously supplied the small villages within these parishes could obviously not support such increases and the colliery proprietors were obliged to provide water pumped from the mines. This was not philanthropy, for the mines had to be pumped anyway, and the water supply to the colliery tenants was always of secondary consequence. The distribution of the water varied in its efficiency. At Ludworth, the villagers had to collect their water from the pit shaft. The pumping machinery was not adequate and would often break down, when the local population had to be supplied by tubs brought up the shaft. At neighbouring East Hetton, the water was distributed by stand pipes to the ends of the colliery rows, but again the pumps were not efficient and even as late as 1910 the village was occasionally without its customary water supplies for two days on end₁. No filtration or purification of the pit water took place at any of the collieries. At Hetton le Hole a small

i. D.C.C. Health Committee Minutes, November 1910.

FIG. 13, WATER UNDERTAKINGS IN THE WEAR BASIN, 1914



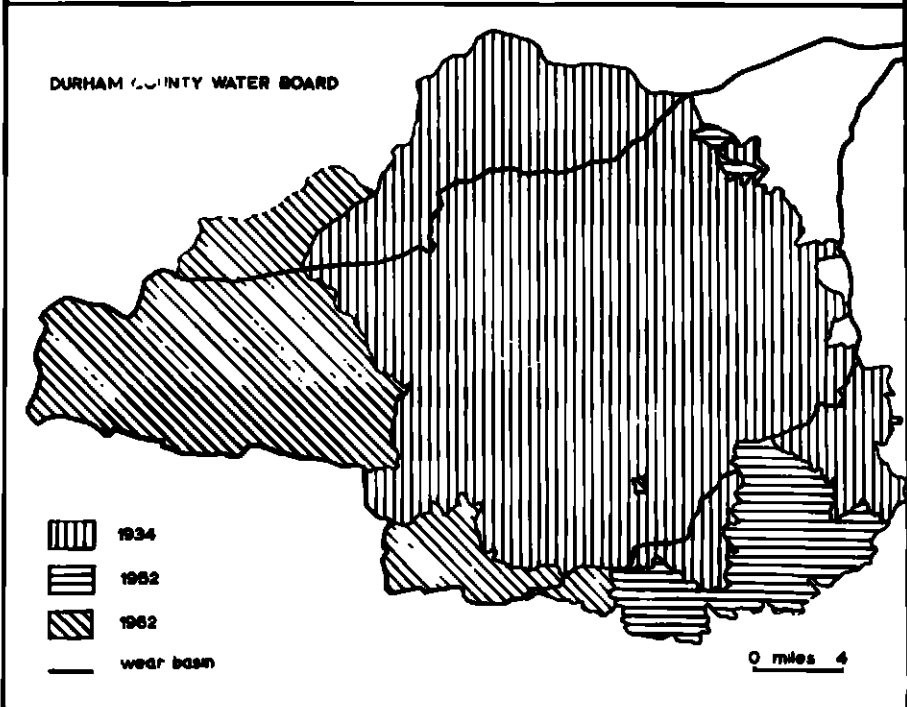
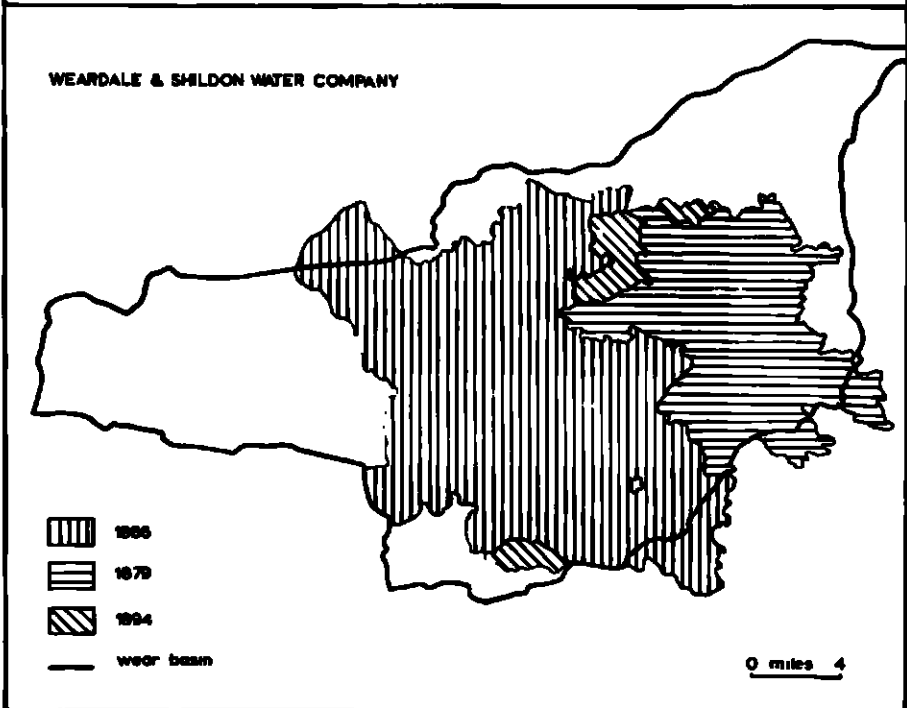
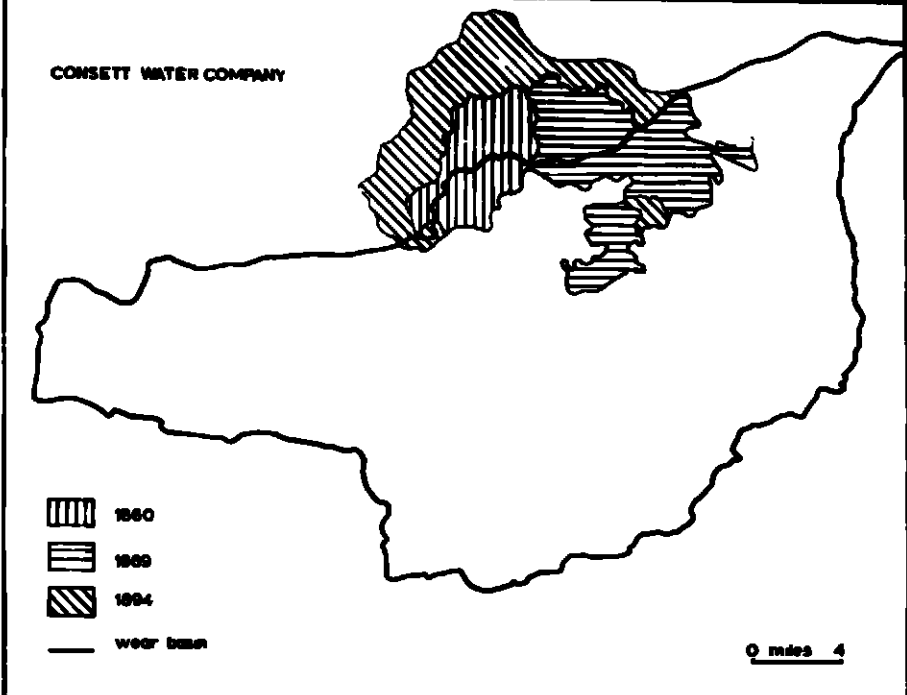
private company was formed to take over the supply of water to the town from the colliery proprietor but the inconvenience of the water supply being dependent upon pumping operations at the mines remained. From time to time, the engine normally used for pumping water to the reservoirs had to be used for hoisting coals, and consequently pumping operations promptly ceased. Distribution was carried out to individual houses but was very faulty, not being laid down by competent engineers, and in any case the water was so hard, that the pitmen preferred to collect rainwater for their daily baths. The private company went out of business in 1931, and the district council took over the supply works to save the town's water supply, but the situation remained just as precarious until the town was absorbed within the Sunderland and South Shields Water Company area in 1952.

Returns of private water suppliers in 1914, are set out in Table 10 and in Figure 13.

The Public Companies

The two public companies which came to be the major water suppliers in the basin were both originally formed to secure the interests of industrial concerns outside the basin. In 1860 a few directors of the three iron works established around Consett (subsequently merged to form the Consett Iron Company) promoted the formation of the Consett Waterworks Company, to supply those iron works with water, and to serve approximately 22,000 persons in the

FIG.14. EVOLUTION OF D.C.W.B.



Consett district who lived within the parishes of Lanchester and Ebchester. The supply was unfiltered for both purposes and was brought to the district by earthenware pipes from catchwaters on streams on the Muggleswick moors. This primitive system was obviously unsatisfactory, and in 1869 the company secured a second Act of Parliamentⁱ for increasing the share capital of the company from £25,000 to £150,000 so that reservoirs could be built, and the statutory area of supply extended to the parish of Chester le Street as far east as the Wear (Fig. 14). The Smiddy Shaw reservoir was subsequently built on open moorland four miles south west of the iron works. It would be appropriate to note here that the establishment of a statutory area of supply, meant nothing more than the fact that no other water company might be established to supply water within the prescribed area. In actual fact the installation of a piped water supply within the various statutory areas established in the basin was very tightly governed by the amount of capital the company had available, the co-operation of the local authorities concerned, and the willingness of householders and property owners to pay a water rate. This last condition was often the crucial condition as far as the colliery proprietors were concerned.

The Weardale and Shildon Waterworks Company was similarly formed

i. Consett Waterworks Act 1869.

on the instigation of an industrial concern, the Stockton and Darlington Railway Company, whose works at Shildon were in need of a reliable water supply. The company was incorporated in 1866 by the Weardale and Shildon Waterworks Act with the power to raise capital of £150,000 in order to build two reservoirs on the Waskerley Burn and supply the western parts of the parish of Lanchester, the township of Wolsingham and the area covered by Auckland Local Board, with water (Fig. 14). As a result of this Act the reservoir at Waskerley (1872) and Tunstall (1879) were constructed, with a combined capacity of 770,000,000 gallons. Large increases in the population of the original statutory areas were echoed by similarly large increases in the valleys of the Browney and Deerness, where the population of Brandon and Byshottles district rose from 1,486 in 1861 to 10,853 in 1881, consequent on the extension of mining operations, and in 1875 the statutory area was extended to include part of the lower Deerness valley and the colliery villages along the foot of the Permian escarpment. In 1879 a further enabling act allowed the company to take over the Durham Water Company and consolidate its area, taking in Brandon and Byshottles, the rest of the Browney valley and the Durham Rural Sanitary Area (Fig. 14). In order to supply these areas permission was given to initiate further reservoirs on the Bedburn Beck at Bedburn and Redford, on the Linburn Beck below Hamsterley, on the Houseslop Beck below Tow Law, and a third reservoir on the Waskerley at Bishop Oak.

The Weardale and Consett Water Company

In the north of the basin, the Consett Water Company was facing severe difficulties in meeting the demand for water by both domestic and industrial consumers. A further enabling act was granted to the company in 1894 so that it could extend its water supply and construct new reservoirs. The headwaters of the Derwent Burnhope Burn were to be impounded in a series of dams, echoing the meltwater lakes of glacial times, each draining successively into the lower, and ultimately into a new reservoir to be constructed on the headwaters of the Hisehope Burn. The Hisehope reservoir was completed in 1896, but public confidence in the company was not such as to encourage investment, and the scheme progressed no further. In 1901 owing to the exceptional dry spring and summer, domestic users had their water turned off for all but an hour a day, and even then the supply was 'extremely dirty and discoloured and not fit for drinking'ⁱ. The company's principal customer, the Consett Ironworks, could not be without its very large daily quantities of water (c 540,000 g.p.d.) and with its very special connection with the water company laid first claim on the water, while the very low price it paid gave an insufficient return on the capital invested in supply works. The water company was therefore on the horns of a dilemma. Obligated to supply its least profitable customer, it

i. D.C.C. Health Committee Minutes, 1901.

could only supply its most profitable customer with the dregs that were left.

It became necessary, therefore, for the Consett company to be included in a larger unit, where the special demands of the ironworks could be absorbed in an altogether wider market. In 1902, therefore, the Weardale Water Act empowered the Weardale and Shildon company to take over the Consett undertaking, and as a new company, the Weardale and Consett Water Company, to extend its water supplies and construct new reservoirs, all the powers previously granted to the two companies being extinguished. To increase supplies in the northern part of the new area, the headwaters of the Beldon Burn were to be impounded, and to increase supplies in the south of the area it was proposed to construct new reservoirs at Bishop Oak on the Waskerley Burn, also fed by a catchwater from the Thornhope Beck, and on the Burnhope Burn (Wear).

The marriage of the two companies was not the success it was hoped. If the Consett company was in an unhealthy condition then the Weardale and Shildon company was not especially virile. Procrastination on behalf of the company, hesitance on behalf of many landlords to install a domestic piped water supply to their tenants, the high costs involved in laying and repairing mains constantly being fractured by mining subsidence, and lack of sufficient capital meant that nothing was done to implement the powers given to them by the 1879 Act. The powers of the 1902 Act remained similarly unused by

the new company. In the northern area the stratigraphy was found to be unsuitable for the erection of an impounding dam at Beldon. The establishment of a pump at the Presser lead mining shaft above Hunstanworth, as a short term measure, along with the tapping of Syke Head springs by a catchwater, satisfied the most insistent of the Company's critics in North West Durham, and the idea of further impounding works on the Wear-Derwent interfluvium was abandoned. The Bishop Oak and Burnhope schemes for the southern area were also abandoned because it was thought that there would be a decline rather than an increase in demand over the immediate future, 'to construct a further reservoir ... should make provision for water which in all human probability would never be needed in the area which the company provides'ⁱ.

This assumption, startling by modern eyes, can perhaps be ascribed to the fact that both the old companies were originally formed to supply water to industry, and they tended to assume that industry would always be their largest consumer. From consumption figures it was apparent that over the four years 1904-8 industrial demand had remained steady, while over the previous eight years it had increased by 37%; over the following four, 1908-12, industrial demand actually fell 2%. It did seem, therefore, that industrial consumption was on the decrease, despite the fact that over the

i. Weardale and Consett Water Company, Chairman's Report, 1914.

whole period, 1884-1912, industrial consumption had risen 50% from 1,953,600 g.p.d. over the period 1884-8 to 2,980,000 g.p.d. over the period 1909-13. The opinion of Consett Ironworks that they would not want any increased supplies over the next few years seemed to set the seal on the water company's opinions.

Domestic consumption, however, had risen 84% over the same period and had increased at twice the rate of industrial consumption over the period 1903-13. What then, made the water company think that this demand would not continue to rise? It appeared to the water company that 'as a very large part of the west Durham coalfield was fully developed and if the pits were stopped there, there would be a decrease in the water required both for industrial and manufacturing purposes which would meet the increase in other parts of the district'¹. It is not appropriate here to castigate the directors and officials of a defunct water company for decisions made almost sixty years ago, but in view of the fact that it must have been plainly obvious that domestic consumption alone must of necessity rise a very considerable amount when the majority of the area served by the company, still served by earth closets, transferred to a water carriage system, their attitude towards their responsibility for providing a public utility seems to be remarkably ill-informed.

Curiously enough, it was the company's attitude to industry that

i. Weardale & Consett Water Company, Chairman's Report, op cit.

provoked its downfall. In the winter of 1913-14, the Consett Ironworks increased their demand for water by an extra million gallons per day. Following a drier than average summer, in a drier than average winter, the Hisehope and Smiddy Shaw reservoirs were not allowed to increase their reserves. A drought the following summer was disastrous. The whole of the northern area of supply suffered a blanket reduction of 25% in the amount of water available. The company were thus obliged to seek a further enabling act, the powers of the 1902 Act being expired. The Weardale and Consett Water Act of 1915 revived the powers of the 1902 Act to allow the company to take water out of the Weardale Burnhope Burn, but to increase the speed at which this water could be introduced into the company's distribution system, a simple catchwater was to be used rather than a reservoir. Unfortunately, because of war time restrictions, the Treasury refused leave to raise the necessary capital. Local authorities had already been circularised that they should not continue with any scheme for the adoption of a water carriage sewerage system, so although supplies could not be increased, demand also would be kept at roughly its present level. After the war, however, it was still necessary to increase the reserves of the company, but the rise in costs had made the financial provisions of the 1915 Act completely irrelevant to the necessary works. It therefore was determined to approach Parliament for a further enabling act. The drought of 1914 left a bitter memory in the north west

of the County, and the district councils there had agreed amongst themselves that in order to achieve a satisfactory water supply it would be necessary to take over the water company. After sounding out the district councils in the southern area of supply it was decided that should the water company apply for any further powers, then the County Council should ask for a suspensory clause to be inserted in the bill to allow the water company to be taken over and run as a local authority joint water board. Accordingly, when the Weardale and Consett Water Company made known its intentions, the Labour-controlled County Council decided that the time was now ripe for the people to take over control of this important public utility, and it was decided to sponsor a bill to allow the formation of a Durham County Water Board. Ironically enough, the County Council had to join forces with a public company, the Sunderland and South Shields Water Company, and agree to undertake joint works in the basin to achieve its ends, but in September 1920, the shareholders of the Weardale and Consett Water Company were bought out and the Durham County Water Board constituted.

2. Drainage

It would be unwise to attempt to separate the distribution of a piped water supply from the effect that relatively large centres of population using considerable supplies of water had upon the

watercourses to which they drained. While the general framework within which piped water distribution developed has been outlined above, several local conditions influenced the actual development of water systems, and it is now necessary to descend from the County to the District level.

Methods of Sewage Disposal

It must be remembered that before the adoption of the water carriage system, sewage effluent consisted only of sink waste and slops. This did not mean that it was not a severe pollutant of watercourses. T.Eustace Hill, the celebrated County Medical Officer of Health, noted in 1901 'My experience of slop sewage in colliery districts is that it is more offensive than ordinary domestic sewage. The pitmen use a lot of soap, and there is a lot of urine, and it is one of the most offensive sewages I know of in many cases'ⁱ.

Since the Royal Commission on Sewage of 1865, the approved method of disposal was by the application of the sewage to an area of land, one acre for every 1,000 people using the system, in the hope that the organic content of the sewage would be absorbed into the ground. Great expectations were held of the manurial value of the sewage, and at several places in the basin where the scheme was adopted, crops were grown at the new sewage farms. Although there was never anything so extensive as the celebrated fishponds at

i. H.C., 1901, XXXIV, Minute 5095.

Munich, the case of Hetton le Hole is typical of the larger works. The farm was begun in the 1880's, and in 1894 there were a little over nine acres of land. In 1897 £36 was raised by the District Council from the sale of three acres of mangol wurzel, three acres of cabbages, carrots, beet, celery and leeks, two and a half acres of swedes and half an acre of potatoes. At this time the works were dealing with an average dry weather flow of 203,394 g.p.d. The system was not, however, successful. More often than not questions of farming were more important than questions of sewage purification, and it was generally found that the crops thrived better when the sewage was diverted directly into the watercourses. At Chester le Street in the 1890's this was the exact situation, and the works were, moreover, in the hands of a local councillor.

In the smaller villages, land irrigation was not generally practised, and at the most settling tanks were constructed in the hope that the more offensive solids might be precipitated before the effluent was discharged into the water course, but again, inefficient management of the system generally meant that the tanks became silted up and themselves acted as a severe pollutant. The construction of proper bacterial contact beds was not undertaken until after the final report of the Royal Commission on Sewage Disposal in 1916. In point of fact little was done towards the adoption of this system within the basin until well after the Great War, when it was intimately connected with the wider adoption of the water carriage system.

The Larger Towns

The earliest report made upon any settlement within the basin was made by an inspector of the General Board of Health on Durham in 1849ⁱ. The mortality of the City at 32.2 per thousand was the highest for the County, an appropriate index of the City's sanitary condition. Of the 10,392 yards of streets, 6,979 yards were undrained and only 1,322 yards had satisfactory sewers, of which only those in Church Street and tiny Paradise Lane were low enough to drain the cellars of the houses. The incised topography of the City rather than helping the drainage, often aggravated the situation. Drainage naturally flowed down to the river, but this inevitably meant that house drainage fell from one property into that at a lower level, while those houses along the principal streets simply emptied their slop refuse into the highway where it drained away of its own accord, or was swept away by the town scavenger. After the formation of the Local Board in 1846 the main streets were sewered, although the sewer simply conducted the effluent to the river. The Chapter's agent wrote to the Local Board in 1891, complaining of the 'disgraceful state of the main sewer from the South Bailey, which is open and entirely uncovered in the banks near the College Bridge'ⁱⁱ. But at least after the formation of the water company in 1847 the sewers could be flushed out from time to time 'within range of the Company's pipes at 7s. 6d. each time'ⁱⁱⁱ.

i. Clark, G.T., A Preliminary Inquiry into the Sewerage Drainage and Supply of Water to the City of Durham, London, 1849.

ii. Durham City MSS Box 43

iii. *ibid*

The situation was similar at Bishop Auckland. The Bondgate and Market Place areas of the old town, stood on a peninsular remnant of the 300' surface between the Gaunless and the Wear which allowed free drainage down the steep banks, but the evils of Durham were repeated. The extension of the town along the line of the old Roman road away from this free draining area led to severe problems of drainage and in 1854 the Local Board minuted that 'Mr. Storey be appointed Engineer to superintend the construction of sewerage works'ⁱ. Storey accomplished little. Sewers were put down, but had no outlet. In no place were they placed low enough to drain the cellars of the houses which had to be pumped dry from time to time, and they were constructed of inferior segmented tiles which tended to disintegrate. In 1856 it was suggested by the General Board of Health that the sewers should be made to focus on the Batts at the confluence of the Wear and Gaunless, but no disposal works were ever constructed, and all that was accomplished was the thorough pollution of the Wear as it left the town.

The Condition of the Villages

When Auckland Rural Sanitary Authority was formed in 1873 it found that 'a scanty or impure water supply, imperfect drainage, insufficient privy accommodation and want of systematical arrangements for the frequent removal and safer disposal of excrement are

i. Bishop Auckland, Local Board Minutes, Volume I.

unwholesome conditions not infrequent throughout the whole districtⁱ. Water supply was generally by pump, well and spring, and in no place was there a provision of a filtered water supply. The Sanitary Authority did their best within their limited means. New pumps were erected over the wells at Toft Hill and Witton le Wear in the winter of 1873, and at Coundon in 1875. A water tank was constructed at Escombe in 1873 and in 1876 the well there was sunk deeper and lined with brick in the hope of reducing pollution. It must be remembered that the permeable nature of the glacial drift upon which many villages stood increased the risks of pollution spreading from drains and cess pools. Even as late as 1885 both of the two public wells at Evenwood were contaminated, and only one of the four private ones was not in a foul condition.

In the December of 1875 the Weardale and Shildon Water Company (W.S.W.C.) were in the position to extend their pipes to West Auckland, and the Sanitary Authority urged all landlords to install a piped water supply to each of their properties. Witton le Wear was connected in 1876 and in 1879 supplies were offered to Coundon village, but the inhabitants objected to paying a water rate. In 1884 the water supply situation at Toft Hill was so severe that the water company, although their mains were not capable of lifting water up to the village, agreed to supply the village by water cart

i. Auckland R.S.A. Minutes, Vol.I.

for an additional charge to the Sanitary Authority and 420 g.p.d. were carried to the village. In the same year the villages of Coundon, Westerton and Merrington appealed to the Sanitary Authority for help in securing water, although when the W.S.W.C. succeeded in laying pipes to these villages on the edge of the Permian escarpment only half the inhabitants would accept the pipes, and the accompanying water rate into their houses. To their dismay, the water company found that many of the inhabitants of these villages were stealing the company's water by using their neighbours taps. In the lower village of Coundon, only 121 of the 962 houses were supplied with piped water in 1892, while none of the 462 houses owned by Bolckow and Vaughan, the colliery and ironworks proprietors, had been connected to the mains, and they were all compelled to rely on well water. Thus it will be readily seen that it was no easy task to ensure the distribution of a pure water supply to villages where only a minority of the inhabitants was prepared to pay for it, and only a few landlords readily paid the cost of installing water into their tenant's houses.

The provision of a piped water supply made an adequate system of drainage a vital necessity, although some of the villages of Auckland already possessed some rudimentary form of drainage in the late 1870's. Improvements and completion of drainage works in the villages would seem to have depended largely upon the ability of a community's representative on the Sanitary Authority, and

considerations of necessity were not always given priority. It should be further noted that the ratepayers of these small communities of low quality housing did not usually want the expense of providing sewers and some means of sewage purification. The Hunwick and Helmington Row parish council, for instance, petitioned the District Council in 1894 not to be placed under a Rivers Pollution Order as 'the sewage farm method of disposal is both costly and unsatisfactory'.¹ Coundon alone, in Auckland rural district, with a population in 1881 of 3,510, had a sewage disposal system for 100 houses, perhaps one sixth of the population. Most of the villages, like the rest of the district drained its effluent direct to the nearest watercourse. The parish of Escomb contained the two villages of Witton Park and Escomb. On hearing of a £6,000 scheme to provide proper sewerage for Witton Park, the inhabitants of Escomb petitioned the District Council not to go ahead with the scheme because part of the burden of paying for it would descend upon them. The situation was given a further twist when the District Council heard that Bishop Auckland had just received £10,000 loan for improvements to the water supply works there. The sewerage scheme was promptly abandoned on the understanding that it did not now matter whether the river was contaminated or not. The County Medical Officer of Health, however, insisted that the scheme

i. Auckland Rural District Council, Health Committee Minutes, 1894.

be carried through, but it was not until 1908 that disposal works were constructed for this village of 2,000 inhabitants.

Questions of public health ensured that most of the villages of the district were given some satisfactory sort of drainage over the last decade of the nineteenth century, but questions of river pollution were always of a secondary nature. Thus when Witton le Wear was sewered in 1893, the only concession to river pollution was the carrying of the main outfall into the centre of the river, so that the effluent would stand the best chance of being diluted by the river before the river received its next major source of pollution at Crook Beck. At Newfield, Binchester, Byers Green and the villages along the Gaunless valley, no attempt was made at sewage purification when these villages were sewered in the last three years of the nineteenth century, with the result that although the settlements were adequately cleared of sewage, it was simply conveyed to the watercourses more efficiently.

The situation in Auckland Rural District was similar to that which existed in other areas, but again local conditions inhibited the way in which water systems developed. The attitude of the District Council was important and often inhibited the provision of adequate water arrangements. In 1878, Spennymoor with a population of 8,000 was without a single water closet. Until 1875, the town was supplied by the Local Board with colliery water, but after that date the W.S.W.C. took over the distribution system.

Inferior drains were laid first by an uninterested local board and then the urban sanitary authority, to convey slop sewage to the Valley Burn, which became known locally as 'Stinking Ditch'ⁱ. As late as 1903 the sewerage system of the town was 'laid without plan, imperfectly ventilated, defective in construction and in danger of silting up'ⁱⁱ. No attempt had been made by the District Council at sewage purification until 1897 when the Tudhoe Mill site was bought, although satisfactory disposal works were not constructed until 1901. The Ferryhill and Tudhoe areas were added to the district in 1894, but the Spennymoor authority 'systematically neglected, and has declined when pressed to take adequate steps to drain and purify the sewage'ⁱⁱⁱ. In 1906 a scheme was prepared for the sewerage of Tudhoe Colliery and Village, but this so upset the ratepayers of Spennymoor that they petitioned the County Council to be laid under a special rate so that they would not have to pay for facilities they would not use. This was refused, but the District Council so procrastinated that with the onset of the Great War, it was not until 1923 that these works were carried out.

The dispersed character of settlements in the Weardale district naturally inhibited the development of both a piped water supply and drainage systems. In its unique position, immediately below

i. Durham County Advertiser, 12. April, 1878.

ii. D.C.C. M.O.H. Quarterly Report, Dec. 1903.

iii. *ibid.*

the W.S.W.C. reservoirs on the Waskerley Burn, Wolsingham town was one of the first places to be supplied with company water, and by 1903, all but 33 of the houses in the town were on the company's mains. Of these 21 had pumps or wells, and the remainder used open watercourses for their supply. Wolsingham, however, was not typical, and although Stanhope urban district had the use of a reservoir formerly built by the London Lead Mining company, only 33%^{of the inhabitants} in the wider Stanhope parish had a piped water supply by 1913₁. In response to its favoured water supply position, Wolsingham was the first town in the district to construct disposal works, and some form of land filtration was completed in 1883. There were a few water closets in Stanhope Urban District in 1903, but the majority of households had the use of ash privies, and no sewerage existed in the town until 1905. It was not until 1910, that three acres of land were purchased for land filtration. In all the other major nucleations there were neither sewerage nor disposal works, although sewerage was undertaken at Westgate in 1900 and Frosterley and St. John's Chapel in 1902. The effect of these small communities on the watercourses of the district was minimal. The many people who lived on remote farms had no alternative, of course, but to use watercourses as drains, but the quantity of water was such as to sufficiently dilute the foul effluent. In

i. H.C. LXXIX (1914) 395.

any case, the main stream was often foully polluted by washings from the lead mines. In 1896 the District Council 'had had under consideration the pollution of the river by washings from lead mines, but that there will be great difficulty in dealing with it on consequence to the interference with the main industry of the district which would probably be the result of any action taken'ⁱ.

In contrast to the dilatoriness of most district councils, it is surprising to note that Lanchester District Council in 1896 had 'caused every populous district to be provided with a pure and plentiful supply of water'ⁱⁱ, but this attractive action was not followed by the unglamorous provision of adequate drainage and disposal facilities. By 1900 there were disposal works at only Malton Colliery, and this was the direct result of enlightened colliery ownership. Most of the villages were provided with sewerage systems by this time, but neither the District Council nor its officials were willing to face up to the responsibilities of pollution prevention. In 1899 the County Medical Officer of Health noted that the reports of the District and County Inspectors conflicted in every case. Reports of slight amounts of pollution by the District Inspector were invariably gross cases, and the reported absence of pollution always meant that the stream was in a dirty condition.ⁱⁱⁱ

i. D.C.C., Health Committee Minutes, 1896.
ii. D.C.C. M.O.H. Quarterly Report, December, 1896.
iii. D.C.C. Health Committee Minutes 1899.

Water supply in the Chester Rural Sanitary Authority area was undertaken by a number of concerns. In the east of the district, colliery companies provided their own villages with a water supply, with distribution first by standpipe, and later to individual houses. In Chester le Street itself a small undertaking, the Chester le Street Water Company, supplied the lower parts of the town with water taken from the Cong Burn. In existence by 1860, when the Cong Burn was not badly polluted, its continuance into the 1890's was a source of disease to those households connected to its mains. By this time the Cong Burn was heavily polluted by the sewage effluents of Stanley, Annfield Plain, Craghead and Edmondsley. The water was passed through sand that had been taken from the already polluted Wear, and not surprisingly cases of enteric fever had been associated with the drinking of the water. 'Most of the better class houses and the workhouse obtain their water from the Consett Company'ⁱ and it was a real improvement when the works were abandoned in 1899, and the rest of the town could be connected to the Consett mains. Generally speaking, those villages which were supplied with water by the Consett Company were better drained than those villages relying on colliery supplies, and it does seem that in this latter case, the sanitary authority allowed their responsibility to lapse in the hope that the colliery owners would promote any necessary improvements.

i. D.C.C., M.O.H. Quarterly Report, December 1893.

There were exceptions, however, in both cases. At Chester Moor, Nettlesworth and Sacriston drainage was by open channels in 1894, while at Bournmoor and Lambton deep sewers adequately drained the villages. Only at Edmondsley, Chester le Street and Lumley, however, were there any disposal works by the end of the century, although at Nettlesworth, sewage discharged into old pit workings was effectively disposed of. The sanitary authority, however, were determined not to construct extensive land filtration systems that were not efficient and signified its resolved intention to wait for the deliberations of the Royal Commission on Sewage disposal before spending public money.

The water supply position was also responsible for the relatively unsanitary condition of part of Durham Rural District well into the present century. Although the district lay within the statutory area of supply of the W.C.W.C., the more remote villages of the eastern part of the district were not supplied with moorland water until 1945. Although colliery water was laid on to those villages not connected to moorland mains, the supply was indifferent, and in these villages, drainage was poor. Ludworth was described as the most insanitary village in the County in 1912₁ and the village was not provided with a system of drainage until 1913. At East Hetton, the District Council were obliged to allow houses to be built without

i. D.C.C., M.O.H. Quarterly Report, July, 1912.

water closets, as late as 1908, because the colliery company who supplied the village with water could not pump sufficient water to allow any concessions to a water carriage system. In those areas in the west of the district, however, where moorland water was introduced by the 1890's, sewerage was introduced after 1895, although it was 1915 before some villages were adequately sewered, and even then there was little purification of the sewage before it was discharged to watercourses.

Throughout this period there was only one imaginative scheme in the whole basin. The massive increase in population along the Crook Beck between 1841 and 1881, due to the development of Pease & Co's collieries, naturally made a very great difference to the condition of the beck. Crook was one of the very first townships to be supplied with moorland water by the W.S.W.C., and in 1878, 90% of the houses there were connected to the Company's mains. One of the reasons why sanitary authorities were unwilling to undertake sewage disposal works was that the condition of local streams was often determined by conditions outside the sanitary authority's area. It was a vicious argument. At Crook, however, a real step forward was made in the 1890's. Schemes for the drainage of Crook were put forward in 1884, but it was apparent that to improve the condition of the Crook Beck would mean the co-operation of all those other villages round about which drained into the watercourses, and

in 1887 it was suggested that a special drainage district be formed. Each of the parishes in the catchment were to contribute funds in proportion to the number of their houses within the Crook catchment. It does seem that the Local Government Board were taken aback by such an avant-garde suggestion, for it was almost two years before they agreed to sanction the necessary loan. In 1890 work was started on the scheme and the whole valley drained to one disposal works at the confluence of the Crook Beck and the Wear.

At Willington, however, the situation was very different. Like Crook, moorland water was brought to the town immediately after the construction of the reservoirs, and the town was sewered in the 1880's. The District Council deliberately procrastinated for eight years after being served with a statutory notice under the River Prevention Pollution Act, and it was not until 1903 that crude land filtration was introduced, previous to which the raw sewage was discharged into the Wear.

It will be apparent, therefore, that although district councils and sanitary authorities encouraged the provision of a piped water supply, they were not prepared to fulfill the larger responsibilities which a piped water supply implied. Basic dangers to public health were removed with the provision of rudimentary systems of sewerage, but sewage purification not such an attractive electoral issue, and a real expense to the ratepayers was avoided. Cost apart, however

it was plainly obvious that land filtration was an unsatisfactory method of sewage disposal, yet it was the only one approved by the Local Government Board. The County Medical Officer of Health summed up the situation at the turn of the century - 'In nearly all our villages which are mainly pit villages, the sewage goes into the nearest watercourse, and although we are doing our utmost to prevent this pollution, and are insisting on all existing works being kept in as good a condition as possible, I am sorry to say that my County Council has given way to the general clamour that further action regarding pollutions should be suspended pending the report of your commission. It is no use, my County Council will not press the matter further, and the result is that as far as regards the further prevention of pollution we are at a standstill'ⁱ.

The Condition of the Watercourses

The refusal to purify sewage was not, however, simply a matter of unwillingness because the approved methods were both expensive and inefficient, but also because it was plainly obvious that most watercourses in the basin were already severely polluted with industrial effluents. In 1846 the 'R.Wear was a comparatively pure river. Neither the Deerness nor the Browney was polluted, and the river itself was perfectly clear and was a splendid river at all times of the year except in times of flood'ⁱⁱ, but the rapid rise

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- i. Royal Commission on Treatment and Disposal of Sewage, Minute of Evidence 9059, H.C. 1901, XXXIV.
 - ii. Durham County Advertiser, November 6th, 1878.

in coal mining and ancillary industries, just as much as increases in population, along the Deerness valley, Willington, Crook and Spennymoor considerably changed the situation. Twenty years later the river was reported to be 'dreadfully polluted by "slush" from the lead mines, black water from coal mines, ashes from collieries, ironworks and cinder ovens, waste lag etc., from paper works, refuse from gas works and chemical works, by sewerage and by every abomination that a thickly populated district can get rid of by putting into the river'ⁱ.

One of the worst offences was produced by innovations in coke making which allowed the use of small coal which 'used to be burnt at the pit mouth or left there until it took fire, but it is now washed and made into coke. The water carries off much impurity and deposits it on the bed of the river receiving it'ⁱⁱ. Protestations from local boards of health, and prosecutions by the Wear Fishery Association encouraged the general introduction of a catch pit system within a couple of years, and the severest pollutions from this small coal washing were avoided for the most part, but the condition of the river continued to decline. Significant amounts of coal washings continued to infest the river, with the result that plant life in the murky waters was discouraged and fish life declined. Even without coal washings, discharges from collieries could be a

i. H.C. 1867, XVIII 196.

ii. H.C. 1865, XXIX 194.

very severe pollutant. The Croxdale Beck was 'as red as any mining river in Great Britain depositing an orange coloured mud which heightens the bright red water passing over it ... The only injury afforded by it, on account of which there is any serious complaint appears to be the increased labour which both cottagers and farmers now incur in fetching clean water for domestic purposes'ⁱ.

Pollution was not, however, restricted to those streams on the coal field. Pollution from lead mining at the head of the basin was severe, despite the elaborate precautions taken by the lead miners to preserve as much of the ore as possible. In the earlier decades of the century, when hush mining was commonly practised, the river was severely fouled as far downstream as Durham, on the occasion of a hush being letⁱⁱ, but this source of pollution decreased towards the latter half of the century. The worst and continuing pollution came from the washing and sorting processes. The pollution was said to be particularly bad at Burtree Pasture Minesⁱⁱⁱ and a sample taken at Cornish Hush Mine in 1872 showed that no less than 6.8% of the waste matter being discharged into the stream was pure lead ore, while water issuing from the slime pits there had a suspended solids content of 41 ppm, compared with 'a few' in an uncontaminated part of the river^{iv}.

i. H.C. 1874, XXXIII, 17.

ii. c.f. Henderson, W., Notes and Reminiscences of my Life as an Angler 1876.

iii. H.C. XIX 1868, 301.

iv. H.C. XXXIII, 1874, 17.

By 1878, however, the most serious single form of pollution was coming from sewage effluents. By de-oxygenising a stream, sewage pollution had a very serious effect upon its plant and animal life. The situation was aggravated by the introduction of a drainage system which efficiently carried effluent to the nearest water course, but did nothing to purify it. At least in the early days of the growing mining communities, waste waters did not reach watercourses quite so readily. In 1896 sewage effluent from 13,115 persons drained unfiltered into the Browney system. 'It is in several places stagnant and very dirty, and like all streams in the County, contains the carcasses of dead animals. The stagnation in places is caused by the bed of the stream being dished out or silted up from various causes, but chiefly by the presence on its course of several mill dams (some of which are old and disused and might with advantage be removed) which hold the water back in most cases for several hundred yards, thereby increasing its depth and making a harbour for all kinds of filth and refuse'ⁱ. Although not all watercourses were so badly afflicted, the picture of foul, de-oxygenated, turbid and poisoned waters with high nitrogen contents, their channels obstructed by colliery and domestic refuse held good for most of the streams of the middle Wear, and of the river itself, for the latter half of the nineteenth century and the first decades of the present century.

i. D.C.C. Report of County Health Inspector on the condition of the Browney, September, 1896.

3. A Quantitative Assessment

Water Supply

The earliest source of water supply data is the return made to Parliament by urban sanitary authorities, and published in 1878ⁱ. Only those towns on limited systems of distribution not supplied by the major water companies submitted consumption figures, which are given in Table 11. It will be noticed that there is a considerable increase in per capita consumption with an increase in the population of the town. The very large value at Durham, however, ought to be reduced, as the railway company used 100,000 g.p.d.ⁱⁱ, which would reduce the per capita consumption at Durham to a more modest 27.6 g.p.d. As the limits of supply at Bishop Auckland, Houghton le Spring and Stanhope did not extend to the railway there was no equivalent contribution at those places. Although it is to be expected that at the relatively more sophisticated urban centres such as Durham and Bishop Auckland 'water consciousness' would be higher, and per capita consumption would increase, it must be remembered that at Bishop Auckland in 1911, when per capita consumption was 28.8 g.p.d., actual domestic demand was only 18.8 g.p.d., and it will be shown that in 1891 average domestic demand in those areas with a piped water supply within the basin was 16.3 g.p.d., and therefore the published consumption figures include, for Durham and Bishop Auckland at least, considerable volumes of water used

i. H.C. 1878, LXI, 108.

ii. Durham County Advertiser, November 6th, 1878.

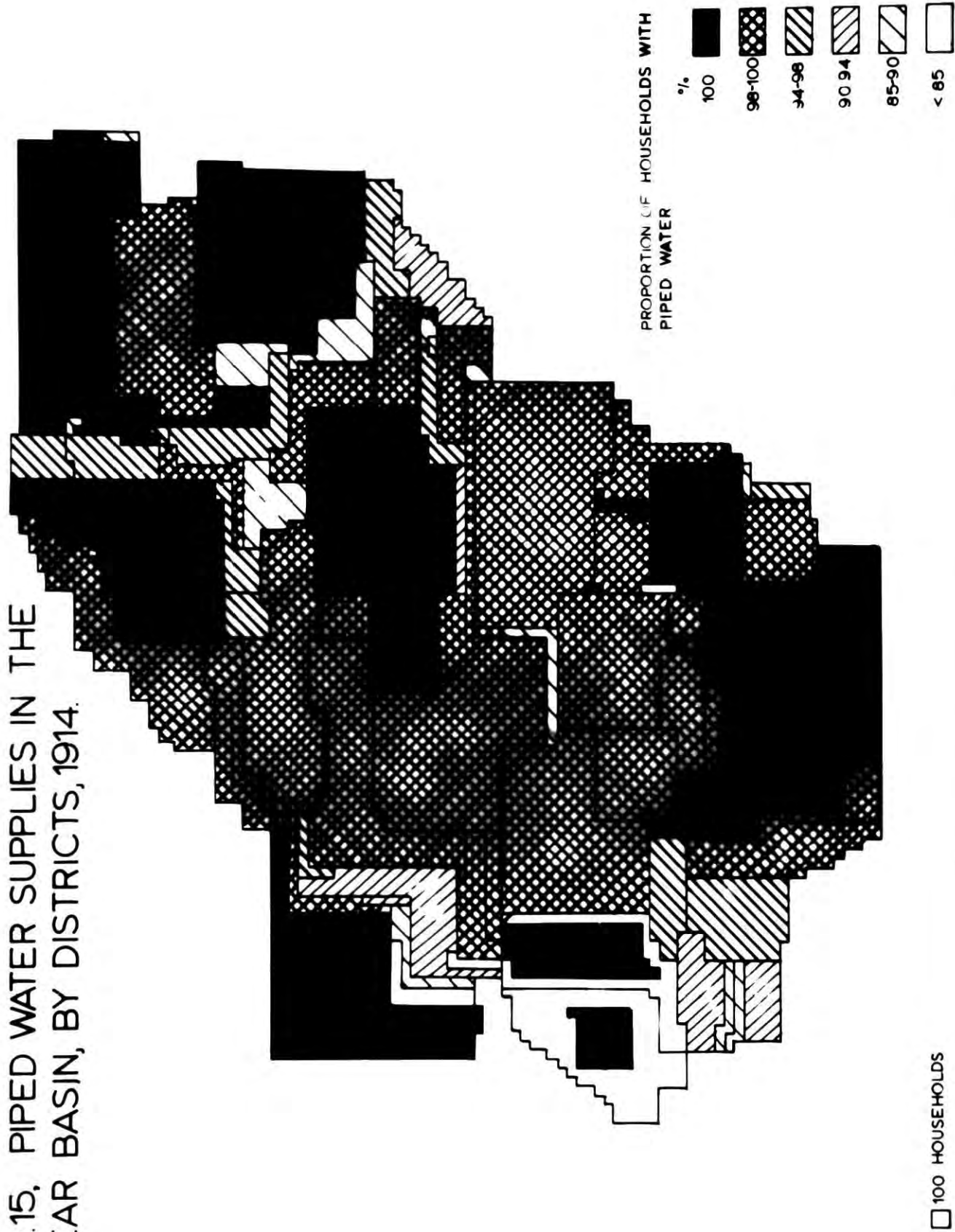
for trade purposes. It ought to be also borne in mind that at this time a large proportion of the population of Durham City was using local springs and wells for drinking water, and so not all the water consumption was included within the published figures. This factor further increases the gap between the two larger towns and the smaller districts of Houghton le Spring and Stanhope. It will be remembered that the miners of Hetton le Hole disliked the hard water supplied from the local collieries and instead used rainwater for their daily baths. It is probable that the miners of Houghton le Spring did the same, and that the true domestic water consumption is not represented in the published figures. As virtually all the water supplied by the Stanhope authority would be used for domestic consumption, there being few trade customers in the town at that time, and as springs and wells were still used, it is probable that the average domestic consumption was not far short of the average for the basin

Unfortunately there is little indication of the water demand from reservoirs for the period before the amalgamation of the W.S.W.C. and the C.W.C. in 1902. If figures survived that amalgamation they do not appear to have survived the transfer to the D.C.W.B. in 1920, and there are no assessments of the numbers of houses with a piped water supply until 1914. It is possible, however, to arrive at some estimate of the character and quantity of the demand for water

in this early period. Table 13 is abstracted from the chairman's report of the W.C.W.C. in February 1920, and shows the average daily consumption of domestic and industrial water over the period 1900-1919. The chairman's report of 1914 included Table 14 which shows relative industrial and domestic demands for five-yearly periods, 1884-1913. By comparing these tables, therefore, it is possible to note the average daily domestic and industrial demands for water for these quinquennia from 1884 to 1913, which are given in Table 15. It will be realised that these figures include areas which are outside the Wear basin, both in the Shildon district in the south and those mining villages on the Derwent and Team catchments in north-west Durham. Although these were relatively small areas in relation to the Wear basin, they include the two largest industrial consumers in the Consett Ironworks and the Shildon railway works, who undoubtedly took a large majority of the metered supply.

At this time, however, population figures of the statutory areas are an uncertain guide to domestic consumption, as it is not known what proportion of the population of the various districts were connected to the company mains. If the population of the parishes within the statutory areas known to have a piped water supply is calculated, and allowance made for the number of households which are known not to have a piped water supply in 1891 then a total population of 159,409 is reached. As the censal year falls conveniently in the middle of the quinquennium, 1889-93 in Table 15,

FIG.15, PIPED WATER SUPPLIES IN THE WEAR BASIN, BY DISTRICTS, 1914.



then it can be assumed, for these present purposes, that the per capita domestic consumption is 16.3 g.p.d., a figure which would seem to be of the right order for this time. Applying this figure, therefore, to population figures for those parishes known to have a water supply in 1881, a daily average domestic demand of 1,660,425 gallons is produced. Taking those areas within the Wear basin, therefore, it would seem that c.308,417 g.p.d. of piped moorland water was distributed in the basin in 1881, and c.2,288,000 g.p.d. in 1891. It will have been noticed that the estimated rise in domestic consumption over the period has been entirely attributed to increases in the numbers of consumers attached to the companies' mains. It is certain that some households introduced water closets into their houses, and that a few installed baths, but the numbers of such conversions is not known, and is probably small.

By 1914 by far the greater majority of households within the basin had a piped water supply (Table 12 and Figure 15). Because the first consideration here is one of the numbers of households with a piped water supply, and not a matter of area, urban districts and constituent rural parishes have been depicted by the numbers of households within their area, rather than by their areal extent. Contiguity of areas has been maintained in all cases, and it is hoped that the true importance of the larger urban centres is clearly apparent. To a great extent the figure speaks for itself. It will

be immediately apparent that the large urban authorities fall into the first or second categories, and they all laid claim to at least a 99% connection to Company mains. This is certainly an optimistic view. As might be expected the lowest values are recorded for the remote areas of the upland west, with the whole of Weardale Rural District falling into the lowest category, and the western parts of Auckland and Lanchester rural districts also scoring low values. The anomalous position of Durham Rural District is to be noted. Here within a small area all categories are to be found, reflecting at once the very mixed nature of water supply within the district. A few compact colliery villages such as Coxhoe or Morton Grange have a high level of water supply, but predominantly rural parishes such as Hett have at best a supply of only the major settlement in the parish, while the scattered farmsteads have to rely upon wells.

The essential characteristic at this time, however, is amply brought out by the figure. The greatest densities of population are easier to supply with piped water than the dispersed population of rural areas, and it is in the largest settlements that the degree of piped water supplies is highest.

Drainage

Any quantitative assessment of drainage works is even more difficult to make. The only yardstick which can be used is in the rate of public expenditure by the various local sanitary authorities. Accordingly, tables of local taxation returns and loan expenditure

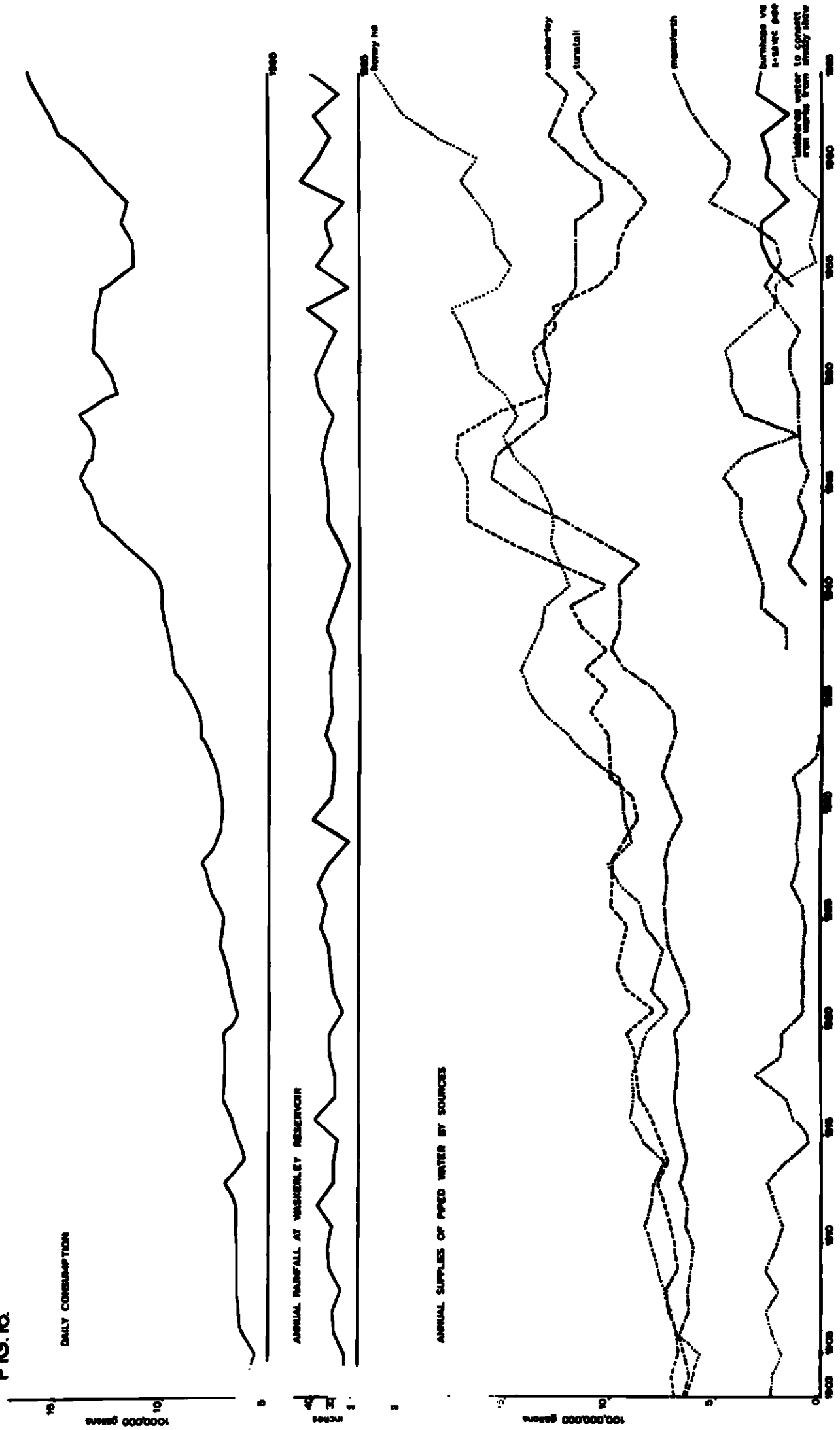
have been examined for the period 1876-1911, 1876 being the first year local taxation returns showed amounts spent upon sewerage and water supplies, 1911 being the last censal year during which the returns were made in this manner. There are many difficulties apparent in using these figures. All the districts involved have different populations in different conditions of dispersal and density. Similarly different topographical conditions inhibit the effect a particular sum of money had upon the problem, and allowance ought to be made for the authority like Brandon and Byshottles which lies in a free draining river basin, in comparison with Durham City, where the incised topography and the meanderings of the river made the satisfactory sewerage of the City a particularly expensive problem. It must also be borne in mind that private improvements were also taking place at this time, which have no record in official statistics. It would thus be unwise to draw conclusions solely from the material presented in these tables, but it is possible to detect the trends evident in the basin at this time, and the pattern of public spending does corroborate the evidence presented in detail above.

It will be apparent from Table 16 that although urban areas generally spent more money per capita on the problems of drainage and sewerage in the earlier years of the period, this relatively higher level of spending was not maintained. The stimulus for improvement was obviously more apparent in urban areas, and the

figures may be taken to suggest that the essential improvements completed, urban authorities tended to rest, while the rural authorities, less vigorous in the first two decades assume the principal position in the last. As might be expected, Weardale, most rural of all the rural authorities has the lowest per capita expenditure on sewerage during the first decade, and never rises to the highest places, but the towns of Durham and Bishop Auckland stand out as consistently low spending authorities. The presence of an articulate body of ratepayers at these towns inhibited the expenditure of large sums of public money on works made more expensive by the particular topographical conditions of the towns, which were consequently slow to make improvements to their condition. The influence of the introduction of a piped water supply is clearly demonstrated in the Table, not only by the simple fact that those authorities extensively served by a water company have little or no expenditure on water supplies, but also by the considerable increases in expenditure on drainage and sewerage. Thus the consistently low expenditure by Houghton Rural Sanitary Authority contrasts markedly with the Lanchester Rural Sanitary Authority over the period 1880-1900, but thereafter the position is reversed when a more extensive sewerage programme was instituted by the Houghton authority on the increase of piped water distributed from colliery sources.

The ^{initiative} of the district, however, had much to do with the

FIG. 16.



pattern of expenditure. In cases where severe problems existed, or where a piped water supply was established at an early date, both conditions which would suggest the adoption of an efficient system, sometimes nothing was done by the authority. The cases of Durham and Bishop Auckland have already been cited, and it is worth recalling the comparison between the neighbouring townships of Crook and Willington. Where sanitary authorities were slow to realise the problems before them, the formation of the County Council Health Committee, after the erection of County Councils in 1888, was particularly important. The increases in expenditure on both water supply and sewerage of the rural authorities in the period after 1890 is closely related to this event, and the paternal, occasionally outraged County Council Health Committee, with its officers, did much to stimulate authorities, including towns like Durham, unwilling to embark upon costly schemes, to complete the necessary works.

Thus it will be apparent that although local taxation returns provide only a tenuous index to the extension of piped water supplies and the consequent development of sewerage systems, they do provide a useful piece of corroborative evidence.

The Inter-War Period

Although the population of the W.C.W.C. statutory area fell by 4.2% over the period 1921-31, the domestic consumption increased 16.2% (Fig. 16). Increases in consumption until the outbreak of the Great War in 1914 were caused largely by increases in the numbers

of people connected to water company mains. Indeed, the increases in domestic consumers was such that per capita consumption actually decreased until by 1921 it was under 12 g.p.d. Increases in consumption after the Great War, however, are entirely due to the conversion of ash privies and earth closets to a water carriage system, and to the installation of fixed baths in both private and district authority development. Unfortunately an exact picture of the rate of privy conversions and the situation obtaining at about the beginning of the Great War cannot be given. District authorities made no regular returns to either County or National health authorities, and have kept no record themselves. The D.C.W.B. have preserved records of new water closets and baths connected to their mains over the period 1921-36 (Table 17) but made no compensation for amenities taken off the system as old property was demolished, or houses became empty, so no absolute rate of increase can be calculated. The figures also, of course, relate to the whole of the D.C.W.B. area and not solely to the Wear basin. They can, however, be taken to illustrate the general trend in the basin, but during these years of economic crisis it cannot be assumed that all districts shared the same rates of increase. As might be expected, the proportion of houses with water closets increases rather faster than those with a bath. While it was a general rule that new houses were provided with both a bath and a water closet, the many conversions that were made to old property in the area involved in most

cases only the construction of a water closet.

The impression gained from the data suggests that the area remained backward in matters of water amenities for longer than might be expected from an area which was predominantly urban in population character. In 1935 a spokesman for the Ministry of Health noted that the 'average consumption for domestic purposes lies between 20-30 gallons per head in urban areas, and 15-20 in rural areas with piped supplies'¹. For that very year in the D.C.W.B. area the per capita consumption of water for domestic purposes was 16.6 gallons. Even by the standards of rural areas this was not high. Although the population of the basin was not nucleated in a large centre, most people lived in colliery villages of considerable size, which were for the most part, adequately drained by 1914, even if disposal works were not usually provided.

The lack of what could be considered proper water amenities can be attributed to three major factors. The first was a lack of sufficient water supplies to support a general adoption of a water carriage system throughout the basin. The second is a refusal on the part of colliery landlords to undertake the expense of providing adequate sanitary facilities for their men. Although the severe economic climate of the late twenties precluded considerable expense of such a nature, these amenities could have been provided in an

i. Joint Commission on Water Resources and Supplies, H.C. 1935-6, VI, 983.

earlier period. The third reason was the reluctance of district authorities to press the matter with the property owners, partly because some sewerage systems were not up to the demands that would be placed on them with the adoption of a water carriage, and there was just not enough money to pay loan interest rates for any necessary capital expenditure, and partly because they did not wish to increase the rate burden of property owners, generally colliery proprietors, who might then find that the entire business of mining coal was unprofitable. Since the Public Health (Amendment) Act 1907, district authorities had the power to serve notices for improvements on landlords, and charge them with the costs, but the Act was never invoked in the area. Because of the character of settlement within the basin, of course, sewerage costs were high. The rateable value of the colliery villages was low, and many of them were contained within extensive rural districts, whose responsibilities were consequently strained in comparison with the highly rated and compact towns such as Durham or Bishop Auckland. Even urban authorities occasionally contained several nuclei, Brandon and Byshttles for instance containing five distinct villages. It is obviously cheaper to provide adequate sewerage facilities for one large and compact town, than for five sizeable, but scattered villages.

The sudden rise in the numbers of conversions undertaken after 1923 was entirely due to the operation of first the Unemployed

Grants Committee (U.G.C.), and after 1932, the Commission for Special Areas, (C.S.A.). Under these schemes half of the costs of capital works schemes of this kind were met by the Government. Needless to say, all district councils took advantage of the situation and drew up schemes of improvements to include privy conversion, sewerage and the construction of disposal works. By 1939, 2,972 conversions out of a total scheme of 3,294 had been completed in Chester Rural District. Over the same period 4,000 conversions were carried through in the Hetton Urban and Houghton Rural districts, and to the south 1,795 were completed in Durham Rural district. Thus in this eastern part of the basin, approximately 45,000 persons were provided with a water closet. Similar developments were taking place in the Browney valley, with improvements to both colliery and agricultural villages in Lanchester Rural district, in which only 5½% of the houses were provided with a water closet in 1932. The outbreak of war in 1939, however, brought an abrupt end to further schemes of this kind, although schemes already approved were carried through. At Bishop Auckland, though, a scheme for 300 houses in the centre of the town had to be delayed until peace time and in 1939 the town of Spennymoor was still not converted to the water carriage system.

Thus during the inter-war period, although the area was in a very poor economic condition, considerable strides were made in

the provision of the water amenities which are today considered basic to human dignity, but this increase in water demand implied a drastic re-organisation of water supply, and very often, a complete overhaul of sewerage and disposal systems.

Water Supply and Drainage 1920-19671. Water Supply

The transfer of the Weardale and Consett Water Company to the newly formed Durham County Water Board was something of a fierce controversy. The Labour party-controlled County Council was actively disliked by the coal owners, and the landed establishment of County Durham, who perhaps longer than in areas south of the Tees had held an influence in County affairs not rivalled by their feudal ancestorsⁱ. With the revolution in Russia still a fresh memory it was perhaps natural for the property-owning employers to regard the County Council with suspicion, although that body was eager to allay their suspicion, protesting their interest in the welfare of all the people in the County. 'The Labour Party' wrote Peter Lee 'were quite willing to trust some who had held high places under the old order'ⁱⁱ, and again on the completion of new works in Weardale 'Large numbers of men living in the Weardale have been found work ... when most of the works in the valley were idle ... This has been a blessing for these honest workers, even though they chose Monkhouse before Lee, Moderates before Labour'ⁱⁱⁱ. Nevertheless, it is worth noting that the character of the ownership of

i. c.f. Eden, Sir Timothy, Portrait of County Durham, Robert Hale, London, 1952.

ii. Lee, P., Review of the Durham County Water Board, 1922.

iii. *ibid.*

such an important public utility as water supplies was largely determined by certain political attitudes engendered in an economic system fostered by geographical conditions.

The steady increase in domestic demand necessitated the prompt construction of new supply works, and the Durham County Water Act 1922 authorised the Board, in conjunction with the S. & S.S.W.C. to undertake the construction of a new impounding reservoir on the Burnhope Burn. There was, however, an immediate need for increased water supplies and as a temporary measure the scheme proposed by the W.C.W.C. of erecting a catchwater on the Burnhope and feeding unfiltered water into the Waskerley Reservoir by means of a pipe was adopted by the new Board. By 1924 the catchwater and pipe were constructed, being led under Stanhope Moor by a tunnel to emerge into Waskerley Reservoir some 50' lower than the intake on the Burnhope Burn. From Waskerley a second tunnel was constructed under Muggleswick Moor to carry water into Smiddy Shaw reservoir for distribution to the northern area of supply. This was completed by 1926. The immediate effect of the construction of the pipe was that a further $2\frac{1}{4}$ m.g.d. were available for distribution. The pumping of water from the Presser Lead mine at Hunstanworth begun in 1902 was discontinued and other supplies from springs at Sykehead Spring were obtained, yielding a supply of 0.2 m.g.d., and the expensive task of pumping water over the hill from Waskerley to Smiddy Shaw begun in 1921 could then be halted. The County Water

Board, however, soon found that they had not solved the problems of the old water company simply by taking it over. Over the first year of operation the Board made a loss of £43,280, and over the following years it was to prove impossible to raise a loan for the construction of the works authorised by the 1922 Act, as interest rates could not be met.

The formation of the Unemployment Grants Committee, however, made the proposed new reservoir a feasible project. Unemployed labour was cheap, and the necessary loan was authorised at interest free rates until 1935, after which the remaining loans would be subject to half the normal rates of interest for a period of fifteen years. The works made a considerable contribution towards the relief of unemployment in the area during the early thirties, with a maximum payroll of 700 workers, who were housed in a small village created for the purpose. With social facilities, a special electricity supply brought fifteen miles up the dale, and a temporary reservoir, the works caused a considerable, if temporary addition to the cultural landscape of Weardale. The reservoir was completed in 1936 and an extra $4\frac{3}{4}$ m.g.d. were added to the Board's supply through the pipe to Waskerley. The whole process had cost over £1,340,000, which represented an enormous public investment in the area at this time.

It will be noted that the construction of the Burnhope reservoir

greatly added to the movement of water from one catchment to another, and that although some of the Burnhope water remained in the Wear basin, a proportion of it was distributed in the Derwent catchment of the Tyne basin, and after the construction of the S. & S.S.W.C. pipe in 1947, 5 m.g.d. were lifted onto the Permian escarpment and distributed in east Durham, draining through several small consequent streams directly to the North Sea.

The whole project was regarded as something of a vindication of the ability of the 'workers' to promote the improvement of society without the help of capitalism. To understand the curious sociological position at this time, it is necessary to remember that the Durham County Water Board was not akin to the great civic water undertakings of Manchester or Liverpool, who had promoted far more ambitious schemes. These bodies had all the weight and interest of great provincial cities behind them, whereas the area covered by the D.C.W.B. was essentially a federation of small mining communities, whose members were often hostile to the coal owners. The men who constituted the Board were the miners' leaders, from the same origins and with the same attitudes as the miners themselves. It is also worth noting that the project passed into folk memory, with Peter Lee, the moving spirit behind the miners, the County Council, and the Water Board, enshrined, with the Burnhope Reservoir on the obverse, on a miners' union lodge banner, along with Aged Miners Homes, Convalescent Hospitals and other examples of pitman's philanthropy to pitman.

Over the following thirty years the water demand in the area soared, due largely to the long delayed conversion of sewerage systems to water carriage, the installation of baths, the substitution of old property for district authority housing and a subsequent development of water consciousness. Figure 16 shows the average daily consumption and source supplies over the period 1902-1965. Figure 16 affords a comparison with the rainfall of the period, over the gathering ground, and it will be seen how periods of low rainfall drastically affected the water supply situation, and how tightly supply and demand were related. 1905, 1914 and 1921 stand out particularly in the earlier period, while it will be seen that the dry years of 1955 and 1959 had a very real effect upon the supplies available in the Tunstall and Waskerley distribution systems. The very considerable increase in consumption over the period 1949-50 was largely due to munition works at Aycliffe, on the Tunstall distribution system, and at Spennymoor on the Waskerley system.

The Burnhope reservoir never satisfactorily met increased demands. The reservoir was completed in 1936, and the D.C.W.B. were negotiating for increased supplies from a colliery company within three years, and over the following thirty years, the considerable increases in demand meant that new sources of water had to be tapped, existing filtration and distribution systems became

overloaded, which necessitated either overhauling or rebuilding plants, while the absorption of the many other miscellaneous suppliers ranging from the colliery company to the district authority into either the D.C.W.B. or the S. & S.S.W.C. meant a considerable increase in the numbers of people and business concerns to be supplied.

In considering new sources of supply, the possibility of using underground water, which was already pumped from the coal measures by the various collieries excited considerable interest. The idea of unlimited supplies of water being available, just for the pumping, appealed to local politicians and newspaper editors alike, and the public imagination was caught much as it had been by the Burnhope scheme before. Unfortunately both the character of the water and nature of its supply prohibited the development of the scheme. By its very nature, water pumped from the coal measures has a high mineral content with both sodium and iron salts being present in very large proportions necessitating the extensive use of softening and iron reducing processes to give a barely satisfactory water. Moreover to use water pumped from working collieries would make the system dependent upon the collieries, a situation which had been proved to be unsatisfactory at places such as Hetton le Hole. Further, the quality and quantity of water available would vary with the season, depending upon the ground water condition of the aquifers, so that besides fluctuations in supply, variations in the

chemical content of the water would make the installation of treatment works an expensive and complicated operation. Nevertheless, the situation was such that three colliery sources were tapped as an interim measure. In 1939 Dorman Long agreed to the installation of a treatment plant to soften 1.6 m.g.d. at Mainsforth Colliery on the fringe of the basin at Ferryhill. The water was to augment the moorland water from the Tunstall reservoir, and would be mainly passed to the Shildon Service reservoir for distribution to the Aycliffe Ordnance site, and eventually, to the new town, although some would pass into the Ferryhill and Trimdon service areas. The initial agreement was optimistic, and although 0.4 m.g.d. were subsequently passed into the distribution system the water contained a high proportion of suspended solids and it was not until 1945 when a more effective water treatment plant was completed that large quantities of water were able to be used. Water was also taken from Page Bank Colliery in 1945. The water was only abstracted when the supply position in the Waskerely distribution zone was critical, but it was an unpopular water. Highly ochrous, it proved unsuitable for some industrial consumers, and for instance, a soft drinks manufacturer in Durham City was unable to continue manufacture when Page Bank water was introduced. A similar source of water was taken from New Brancepeth Colliery by the Sunderland company in 1961. 0.5 m.g.d. were abstracted

and introduced into the Burnhope pipe, where it formed a less than 10% constituent of the water delivered to the Sunderland system at Stony Gate. At this time this was a valuable contribution. In addition, the Presser pumping station, abandoned in 1926 was re-opened in 1955 with a new pump installed - the old one had been tipped down the shaft by hapless D.C.W.B. officials-and 0.5 m.g.d. were passed into the Honey Hill filters and the northern area of supply. It is now considered a useful emergency supply in the event of nuclear war, although the small quantity available might limit its usefulness.

Increases in the supply of water inevitably meant that all three filtering plants, at Honey Hill, Waskerley and Tunstall, became overloaded by 1940. The first pressure filters in the United Kingdom were installed at Honey Hill in 1902, but this forward-looking gesture was not followed up by other works, until 1936 when eight were installed at Honey Hill to supplement the work of the slow sand filters. These latter were abandoned in 1953 and a new set of 24 pressure filters introduced at Waskerley but even these were overloaded, and a very dark water was delivered to the Waskerley distribution system until 1967.

If filtration plants were overloaded, then so too was the distribution system. On the outbreak of war in 1939, extensive new trunk mains and the increasing of local water supplies became

imperative for A.R.P. purposes. Service reservoirs at Ferryhill, Wheatley Hill, Horsegate, Findon and Loud were duplicated, and this was undoubtedly a shot in the arm to the distribution system. The essential problem, however, was that the distribution system was not laid down according to any satisfactory plan. As areas required a new water supply, then a connection was made to the nearest water main, regardless of what might happen to pressure in other areas. Because colliery proprietors built their villages, particularly in the north west of the supply zone, on the tops of hills at the pit head, then it was necessary to install booster pumping stations to maintain sufficient pressure, while the frequent subsidence of land above coal workings meant large numbers of fractures. On the whole, away from the upland areas of the west, distribution mains existed in sufficient density, but they were not of large enough diameter, and the Spens Report of 1946¹ specifically pointed out the need for the duplication of trunk mains distribution in the area. This, however, proved difficult, for the steel shortage in the early 1950's meant that extensions could not be completed, because the asbestos cement pipes which were also used by water engineers could not be used in this area because of their extreme fragility in cases of land subsidence.

The worst problems of distribution existed in those areas which

i. Ministry of Health, N.E. Development Area Water Survey, DS 52134/1.

the D.C.W.B. took over in the period 1952-62 (Fig. 14). The rationalisation of water undertakings in the area did little to alleviate the problems of those parts of the basin previously supplied by small undertakings with little expertise in water engineering. The shortage and distribution of water from the old Weardale Steel, Coal and Coke Co., Ltd., to parts of Durham Rural district was crude, and the water supplies barely adequate. Little immediate help could be given by the D.C.W.B. In Weardale and that part of Barnard Castle R.D. which lies within the Wear catchment, water was generally obtained from springs which were unreliable, and while the continuing abandonment of the higher, more marginal farms has made the distribution of water to the remaining population easier, the area remains a difficult problem, which might best be met by the construction of a new distribution system from the Burnhope reservoir.

The Spens Report urged the necessity of constructing a new reservoir on the river Derwent to have a capacity of 5,000 m.g., and a yield of 16 m.g.d. By this means it was suggested that the northern zone of supply could be watered from the Derwent, supplemented by the existing Smiddy Shaw and Hisehope Reservoirs, while the Waskerley and Tunstall reservoirs would then be able to deal exclusively with demand in the south of the statutory area, supplemented by water from Burnhope. After preliminary research

for a suitable site the Derwent Water Order of 1957 gave powers to the D.C.W.B. and the S. & S.S.W.C. to build a reservoir of 11,000 m.g. capacity in order to deal with the three new towns in the two statutory areas. The reservoir was completed in 1966, and water was introduced into the distribution systems in early 1967. Two 36" mains carry the water from the reservoir to the Sunderland mains at Washington, and the Durham mains at Castleside. The continued rise in demand for water all over the D.C.W.B. area, coupled with the unsuitability of the highly mineralised Mainsforth water for the light industries of Newton Aycliffe, has meant that the Derwent water will eventually permeate the whole system, in varying mixtures with the Burnhope and Waskerley water. The colliery sources at Page Bank, New Brancepeth and Mainsforth can now be abandoned, along with the West Mills supply from the Wear at Bishop Auckland. Areas in the extreme north of the basin, supplied by the Sunderland company after the absorption of the old Lambton, Hetton and Joycey Colliery distribution system, are similarly now provided with soft moorland water.

2. Sewerage and Purification Systems

If most authorities had some system of sewerage by the end of the Great War, the sewers were in many cases not capable of dealing with the increased effluents of a water carriage system, nor were they sufficiently water_tight. Many sewers in the area were composed

of segmented tiles and had fallen apart or decayed, and in some places, notably Bishop Auckland and Spennymoor, their exact whereabouts had been lost. Thus the growing adoption of a water carriage system meant that sewerage works were necessary to a greater or lesser extent in all districts. After the report of the Royal Commission on Sewage Disposal in 1916 there was a general adoption of the bacterial contact bed treatment. In this process, after the removal of the larger solids by screening and sedimentation, the sewage is passed through a porous filter in which the finer solid particles and colloidal matter are removed, and organic substances oxidised by the bacteria which build up in the filter. After a further stage for the sedimentation of solid matter, the effluent is discharged to a watercourse. If the system is properly worked, effluents are purified to perhaps a tenth of their previous strength. A great many schemes were undertaken under the Unemployment Grants Committee, and the Commission for Special Areas, but as sewerage was carried out before the erection of disposal works, the result was that watercourses received considerable volumes of untreated sewage, and the condition of watercourses throughout the basin grew steadily worse. In 1932 the County Medical Officer of Health reported that 'The progress of privy conversion schemes in all parts of the County is adding considerably to the volume and strength of domestic sewage to be dealt with'ⁱ. However, the

i. D.C.C., M.O.H., Quarterly Report, March 1932.

eventual construction of disposal works, the closer supervision of river use by the Wear and Tees River Board, erected after the River Boards Act, 1948, and the subsequent Northumbrian River Authority, along with the closure of most of the coal washeries and by-product works of the basin meant that the quality of the watercourses rose over the following fifteen years.

Chester le Street Rural District had hesitated more than most districts before erecting disposal works and laying down efficient sewerage systems, with the result that after the Great War the district was in a generally backward and insanitary condition. Little was accomplished over the succeeding decade, but the preparation of a council housing scheme for the village of Great Lumley in 1930 stimulated the completion of a £6,000 scheme for the sewerage of the whole village, and the installation of settling tanks to replace those installed before 1890, but it was the U.G.C., and the C.S.A. which really produced improvements in the area. Under the U.G.C. schemes of sewerage and disposal works were constructed for the 245 households at Plawsworth and Nettlesworth, on the Black Dene Burn, where previously, raw sewage had been discharged into the burn. At Edmondsley a scheme for disposal works to serve 2,500 persons ran into difficulties with the closure of the U.G.C. scheme, but C.S.A. rescued it, and the works were completed in 1937. Similarly new disposal works costing £24,535 were completed at

Sacrison in 1936, and improvements were carried out at Craghead, although a comprehensive scheme for the village was delayed until 1946.

The neighbouring rural district of Lanchester was in a similar condition to Chester le Street, although improvements were carried out at Knitsley Station and Delves in 1925. As at Chester le Street, though, the main improvements came with the U.G.C. and C.S.A. schemes. Disposal works were constructed for Lanchester in 1931, Hedley Hill in 1936 and Burnhope and Quebec in 1937, with sewerage at Lanchester, Esh and Cornsay villages. Lower down the Browney at Littleburn and Browney Colliery, Brandon and Byshottles U.D.C. completed sewerage and disposal works in 1932. At Hetton a scheme was completed in 1936 under the C.S.A. for the reconstruction of the town's main sewage works at Glebe Farm. Mining subsidence had continually damaged these works, and the sewerage system of the town for many years. On the District Council's initiative in 1928, unemployed labour was used to repair the works, but a joint scheme put forward with Houghton le Spring in 1928 was postponed. 'In view of the serious financial difficulties' goes the Council minute 'the committee consider it advisable to have the scheme postponed for as long a period as possible'¹. A further scheme for the re-sewering of the town was postponed until after the war, but at Crook, the

i. Hetton U.D.C., Health Committee Minutes, 1928.

town was in such a bad state that a re-sewering was begun in 1940. The town had suffered from its precocious development of a sewerage system in the 1890's, but which was totally inadequate to cope with the demands of a water carriage system. Works were similarly undertaken in Durham Rural District with sewerage completed at Shadforth, Brasside and Sherburn, and disposal works constructed at Sherburn and Pittington on the Old Durham Beck system, at Pity Me on a minor tributary of the Wear, and at Hett on the Croxdale Beck. In Weardale, sewerage systems were laid down, but no attempt at constructing disposal works was undertaken for the major villages until 1953.

The lead given by the Auckland Rural Sanitary Authority in 1889 was not taken up by other Authorities who could well have benefitted from a catchment scheme such as that for the Crook Beck. The Crook Beck, however, is a short stream, only six miles or so in length, and it did lie entirely within the Auckland Sanitary Authority area, while other streams on the basin were at once longer, and drained several districts. In 1933, however, Brandon and Byshottles U.D.C. and Lanchester R.D.C. came together to construct a joint disposal works at Esh Winning to deal with sewage from the Hedleyhope and Deerness valleys around Esh Winning. After an enlargement in 1935, the disposal works at Cornsay Colliery were abandoned, and sewage brought to the joint works at Esh Winning. The works catered for

7,861 persons of whom 2,538 were in the Lanchester district.

In 1938 the two districts agreed that it would be more efficient to deal with the entire sewage of the Deerness valley at two sewage works instead of the fifteen then used, and to drain the entire valley of its sewage to two works, an enlarged joint works at Esh Winning, and a new works at Browney Colliery on the Browney.

Because of the outbreak of war, however, the scheme was not pursued, and afterwards had to be entirely re-costed. It was not until

1953, therefore, that the scheme was submitted to the Ministry.

The basin was broken down into three areas, and three schemes of treatment were suggested:

1. Hedley Hill, Waterhouses, Esh Winning, Lymington Tce., Hamsteels, Cornsay Colliery and adjacent areas scheduled for housing development. In this area the only modern disposal works were at Esh Joint, and these were overloaded.
2. Ushaw College, Ushaw Moor, New Brancepeth, Alum Waters and Broom Park and adjacent areas scheduled for housing. There were six disposal works all of which were obsolete and in a deplorable condition.
3. Langley Moor, Littleburn, Meadowfield, Brandon Colliery, Browney Colliery and adjacent areas which drain to the Browney works. In this group there was also the St. Oswald's area of Durham which was scheduled for University extension. Drainage from Neville's Cross went to Stonebridge. These works were overloaded and the effluent could go direct to Browney.

a. Treatment at two centres:

- i. Areas in group 1 to an extended Esh Winning
- ii. Areas 2 and 3 and Neville's Cross to an extended Browney

This scheme would be less efficient and proportionately more expensive in maintenance than b. Further the existing works at Esh Winning were much too small for what would ultimately be required and it would mean the uneconomic extension of works which should be replaced.

b. Treatment at the Browney alone:

The works would be large enough to justify the appointment of a full-time qualified sewage works manager. The site was strategically placed for developments anywhere in the whole region, and in spite of its higher capital cost than scheme a, would in the long run cost no more than the alternatives.

c. Treatment at three centres:

- i. Group 1 to an extended Esh Winning
- ii. Group 2 to a new disposal works at Ushaw Moor
- iii. Group 3 and Neville's Cross to Browney

This scheme suffered from the same disadvantages as 1, only more. The Wear and Tees river board supported scheme 2.

A public enquiry was held in January 1956, with the result that the Minister offered to support the first of the proposed schemes, but refused to sanction the Esh Winning part of the works, as he did not

consider it urgent enough in view of the current restrictions on public spending. The two district councils were outraged, the Esh scheme being 'vital to public health and the furtherance of the Councils' Slum Clearance programme and the conversion of earth closets to w-c's'¹. Nevertheless, work proceeded on the Browney scheme which was completed in 1963, and the Esh scheme, given Ministerial approval in June of the same year was completed in 1965. Both these new works use the 'activated sludge' process. Rather than presenting large open filters to the landscape, these works exhibit closed concrete cylinders in which the sewage is aerated, and an activated sludge is produced which performs the same process as the film in a percolating filter.

Another rationalisation scheme deserves attention at this time. With the dismemberment of Auckland Rural District in 1937, the lower part of the Gaunless valley, below West Auckland, was absorbed into Bishop Auckland Urban District. At this time, Bishop Auckland had just been re-sewered to cope with an intended general adoption of the water carriage system, and a scheme was put forward in 1938 for the drainage of the whole urban district to an enlarged works at Binchester. The question of sewerage and sewage disposal had been a vexed one at Bishop Auckland ever since the inception of the Local Board in 1854. The parsimonious ratepayers and the incised topography of the town which was built above working collieries had

i. Lanchester R.D.C., Health Committee Minutes, Letter to the Minister 17th March, 1956.

together delayed the sanitary drainage of the town until 1913.

Because the Local Government Board insisted upon land filtration as the only efficient method of sewage disposal, it was necessary to find a 13 acre level site below the general elevation of the town, which proved to be over a mile away at Binchester. The local rate-payers strongly resisted the pressures of the Local Government Board 'to force upon the town a sewerage scheme the cost of which is out of all proportion to our financial resources',¹ but were eventually obliged to give way. Perhaps it was because of this continued trouble that the comprehensive scheme was taken up by the enlarged district authority as a way to deal once and for all with the entire area. However, because of the war the scheme was deferred, but was given first priority afterwards, and was completed in 1952, bringing the capacity of the Vinovium works at Binchester up to 40,000 persons.

Mention should here be given to the considerable works undertaken by Durham Rural District Council since the last war. The importance of the vigour of officers of local authorities should be remembered, and in this case, a district engineer, particularly interested in problems of sewerage and sewage disposal was largely responsible for a complete overhaul of Durham Rural District's sewerage systems, including the rationalising of schemes in the

i. Bishop Auckland Sanitary Authority, Minutes, December 1905.

south east of the district at the head of the Croxdale Beck system, where the disposal works at Coxhoe, Coxhoe Bridge and Cornforth Lane were abandoned, and sewage treatment concentrated at an enlarged Bowburn disposal works. It is worth noting that the far-seeing R.D.C. erected sewerage works at Belmont, outside the City of Durham, which enabled extensive housing development to be constructed there in preference to another site at Framwellgate Moor, within the City boundaries and originally chosen for development, but because of the lack of disposal facilities at the City's sewage works unable to be constructed.

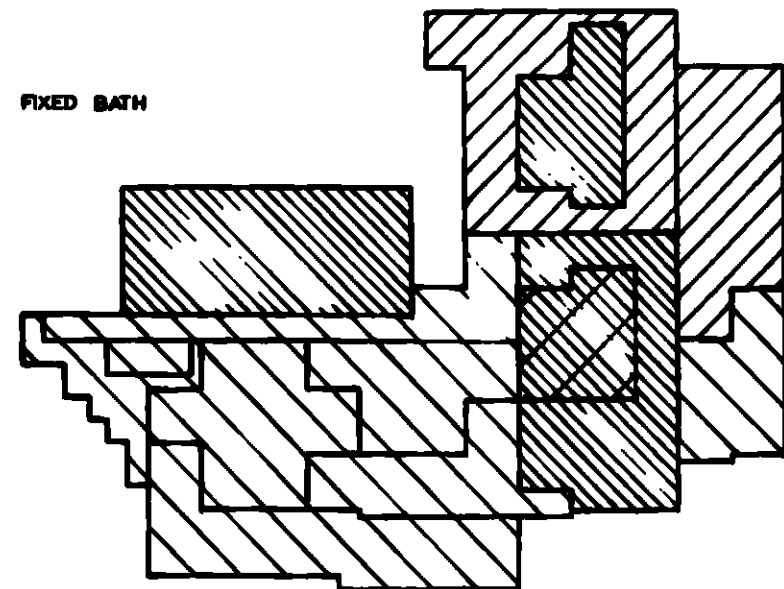
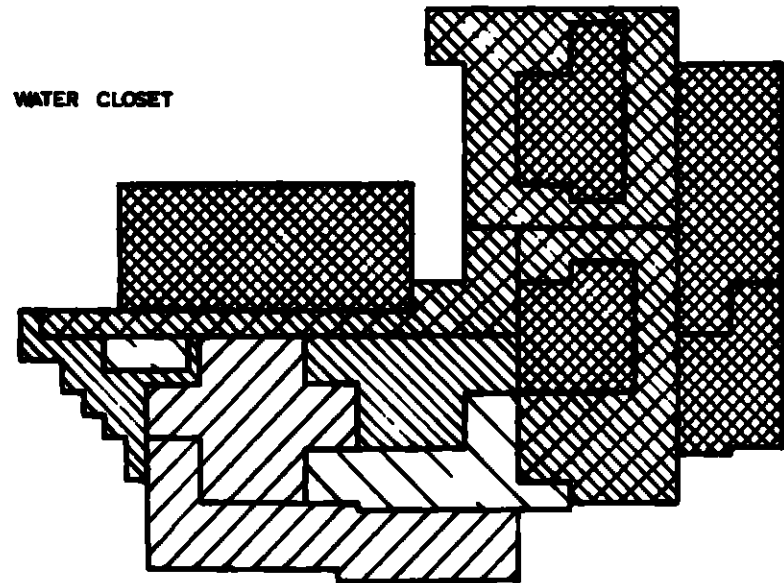
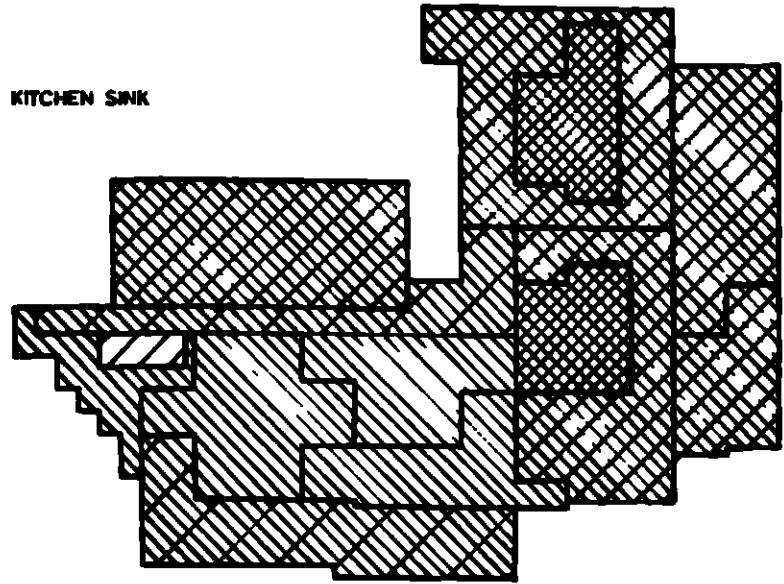
In the post-war period, and particularly over the last decade, extensive modernisation schemes have been prevalent over the whole basin. As the period after the first war saw the painfully slow provision of the basic sewerage and disposal amenities for those areas which had few before, and the bringing up to date of those schemes first constructed in the 1880's and 90's then so the post war period saw the modernisation of the works begun in the first four decades of this century. If land filtration characterised the first period of public sanitation, and bacterial filters the second, then the latest period must be characterised by the activated sludge process of sewage disposal, operated as part of a supra-local scheme of drainage, and typified by the new works established at Chester le Street, Durham City and Browney

for the Deerness Main Drainage system. Although there will always be a place for the small disposal plant serving a remote rural population, in areas such as the middle Wear basin, with a close network of strongly nucleated settlements, the type of sewerage scheme typified by the Browney works is obviously the most appropriate for these present times.

3. Some Quantitative Assessments

The 1951, 1961 and 1966 Sample Censuses allow a quantitative assessment to be made of water amenities within district authority areas. While this is not an entirely satisfactory arrangement, as the Wear basin does not exactly coincide with district boundaries, nine of the fourteen authorities are entirely within the basin, three have only small proportions of their population outside the basin, of which one drains entirely to the Wear, and only two, Consett and Chester le Street Rural District have a significant proportion of their population outside the basin. Statistics relating to domestic arrangements were extracted from the census tables, and the figures used were 'the provision of a piped water supply', 'a water closet', and 'a fixed bath'. In 1961, 'piped water supply' was not used, and 'cold tap' substituted. For the present purposes, these two terms were regarded as synonymous. In each category, a small proportion of households shared facilities. In Tow Law, for example, 967 households in 1951 had a piped water supply

FIG 17 WATER AMENITIES 1951



□ 1000 households

□ 30-49 □ 50-59 □ 60-69 □ 70-79 □ 80-89 □ 90-99%

see figure 19 for key to districts

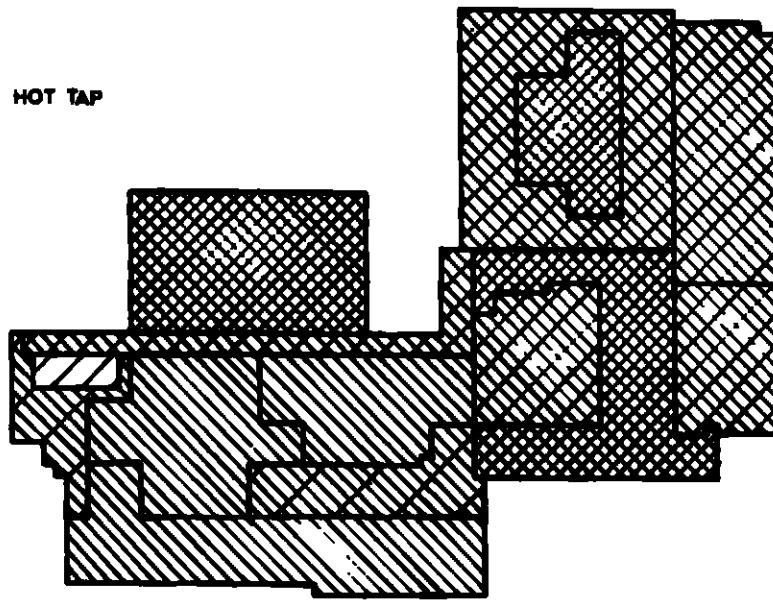
but 40 (c 4%) shared this facility with their neighbour(s). As sharing a facility generally means a reduction in the amount of water consumed, care should be taken in interpreting the following figures. Because the actual reduction in consumption due to such small amounts of shared facilities would be small, however, the total number of households having access to a facility has been used throughout the exercise, thus including households which shared a facility.

Districts have been depicted in figures 17-19 by the numbers of households within their area, using the same method as in figure 15. Contiguity of area has been maintained in all cases, and apparent changes in shape of the districts are due to changes in the numbers of households within them over the censal periods. The data is set out in Table 18 and 19.

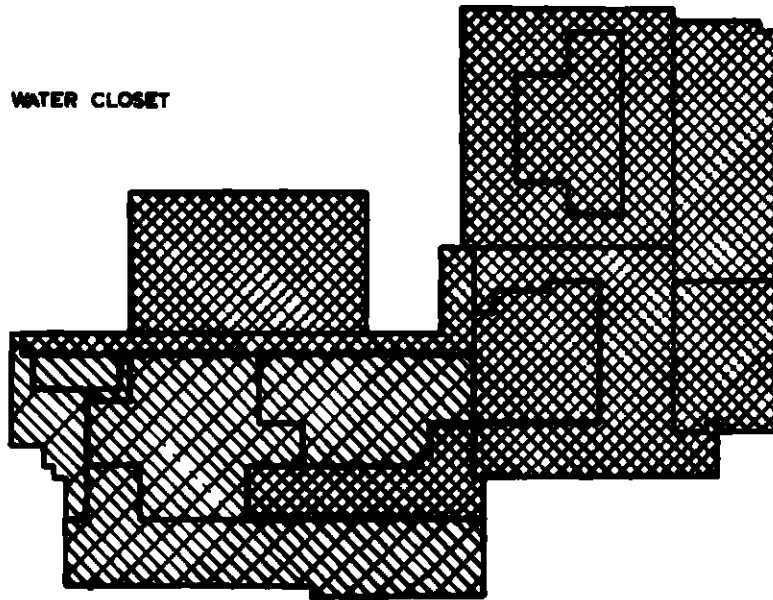
Rural authorities as such were not necessarily deprived of a piped water supply (Fig. 17a). Although in 1951 the mean proportion of households in rural districts with a piped water supply was 92.3% and in urban districts 96.9%, Lanchester Rural District, with a value of 98.2% was better endowed than many urban districts, such as Houghton le Spring, Hetton and Bishop Auckland. Indeed, Houghton le Spring had the largest number of households not supplied with water in the whole basin. This reflects the difficult water supply situation of those eastern districts which lie on the boundary

FIG 18 WATER AMENITIES 1961

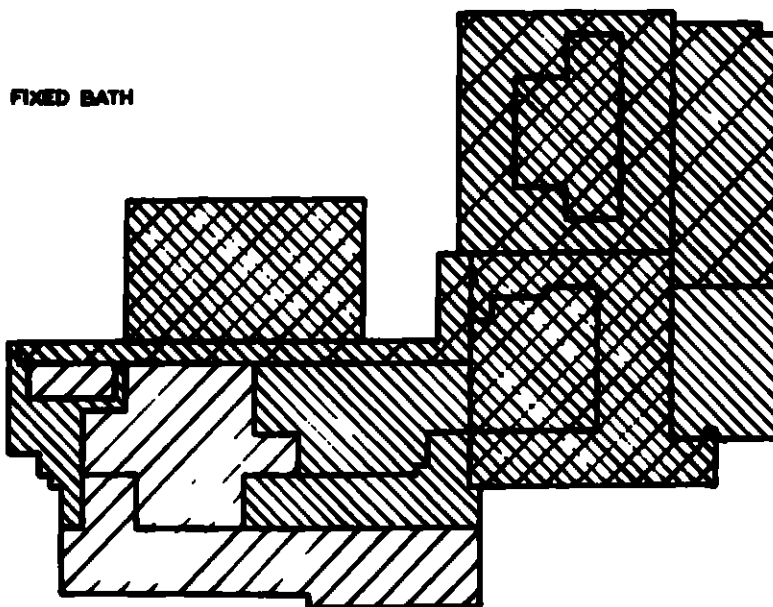
HOT TAP



WATER CLOSET



FIXED BATH



1000 households

50-59 60-69 70-79 80-89 90-99%

see figure 19 for key

of the two major water undertakings and described more fully above. Although Weardale, most rural of the rural authorities had only 74.2% of its households supplied with piped water in 1951, this figure should not be given undue weight, as the total numbers involved are only very small, and Bishop Auckland Urban District, with a value of 96.9% actually had more houses without a water supply than the Weardale area. Two other districts stand out for special mention. The only authority in both 1951 and 1961 (Fig. 18a) to have all its households supplied with piped water was Tow Law. This is a small authority in both population and the area of its district and of course a degree of compactness is a very great help in constructing a water supply system. This high value, however, is due to its special position in relation to Waskerley reservoir and supply system. The first settlement, on one of the earliest water mains to be constructed, its water supply was installed in the earliest days of the W.S.W.C. It seems curious, on the other hand, that Durham City, with a water supply company since 1847 should have 138 households without a piped water supply in 1951, almost twice the number of the far larger rural district. This can perhaps be attributed to the large amount of very old property in the City, and the few isolated dwellings such as the cluster at Old Durham which were not connected to mains water until recently. By 1961, this relatively large number had been reduced to 26.

By the 1961 census, many of these areal differences in the proportion of piped household supplies had been made statistically insignificant, with most authorities having a 99% household supply of piped water, and only Weardale falling markedly below this value with a figure of 92.1%.

In both 1951 and 1961 it will be seen that water closets are essentially for the relief of urban areas in the north and east of the basin (Figs. 17 and 18). While the average proportion of households with access to a water closet is 75% for the basin as a whole in 1951, the rural districts have a value of 80% while the urban districts have an average of 73%. The apparently anomalous situation is resolved if the relative positions of the various districts are compared. In the north and east of the basin the urban districts of Consett, Chester le Street, and Durham, with Hetton and Houghton le Spring lead the way, each with over 90% of households having a water closet. The rural district of the mid-Wear valley, Chester le Street, Durham and Lanchester are close behind with a mean value of 85%. In the south and west of the basin, however, values swiftly tumble. To the west, Brandon and Byshottles U.D. has a value of 66.6%, Bishop Auckland 59%, Crook and Willington 56%, Spennymoor 48.6% and Tow Law a mere 39.2%. This would seem to reflect the trends apparent in the discussion above, to be an index of the old and unimproved property in these areas of declining

economy. A rapidly decreasing population precluded the extensive council house development which had taken place in other districts with the corollary, that sub-standard houses had not been replaced by convenient dwellings.

By 1961, the total average proportion of households with access to a water closet had risen by 18.6%, but this time, rural districts had not shared in the improvement. Whilst the urban districts had increased the proportion of households with access to a water closet by 21%, the rural districts had increased by only 12.4%. This large figure for the urban districts is largely the result of significant increases at Spennymoor (45%), Bishop Auckland (26%), Tow Law (24%) and Crook and Willington (31%), which brought these previously deprived areas closer to the basin average of 88%, with the general adoption of water carriage systems.

Nevertheless, the division between the north eastern areas and those to the south and west which could be recognised in 1951, was still present in 1961, although Spennymoor had joined its eastern neighbours with a value of 93%. However, it is significant that this figure is still less than Lanchester Rural District with a value of 94.4%. Extensive local authority building, and the growing improvement of old cottages, along with the start of what has come to be extensive private development in this pleasant rural area close to Durham and Tyneside are the essential reasons for this high value.

The proportion of households enjoying the amenity of a fixed bath shows a similar situation, with northern and eastern districts enjoying the higher values (Figs. 17 and 18). Durham M.B. well known as a 'middle class island' leads in both 1951 (70.6%) and 1961 (86.3%). Three distinct areas stand out. The compact urban areas of Durham City, Chester le Street, and Consett, with Durham and Chester rural districts, and Houghton urban district have the highest values in 1951 (52%-70%). The eastern and western fringes of this area, Lanchester rural and Hetton urban stand together at 47%, while the south western districts are all closely grouped at around 36%. In 1951, these latter areas show a marked deterioration of their amenities to the south and west. In 1961 the relative situation was much the same. Durham M.B. and R.D. with Chester le Street and Consett urban district all have values above 80%. To the north east Houghton le Spring had a value of 74.5%, Lanchester, between Durham and Consett, 76.9%. Again, to the south west values fell. None of the remaining districts, except Spennymoor with 66.4%, had values larger than 65%, and the average value for these districts is 60%.

To examine the total facilities for each area, the districts were ranked using two sets of data. The first method used was to obtain the mean value of the three facilities for each area. The second method was to construct a hierarchy for each facility, and

award one point to each district for each position in the table, the first to have 14 points, the last to have 1. Of these two methods the first proved most useful. With the second method, equal weight was given to each facility, with the result that the very slight differences in the availability of a piped water supply masked the greater differences in the availability of the other two facilities. The first method, however, revealed a much clearer picture.

In 1951, the three major urban centres of Durham, Chester le Street and Consett head the table in that order. These three are close together. The neighbouring rural districts of Durham, Chester le Street and Lanchester, with the urban areas of Hetton and Houghton all have values above 77%. Of these, Durham stands out as having the largest value of 83%, and reflects a very large amount of district authority building. Below these lies Brandon and Byshottles U.D. in a position in the table not unlike Durham R.D., between two classes. This reflects its intermediary position between the fringes of the well-provided core of mid-Durham, and the deprived western authorities. With many sub-standard miners' cottages, Brandon and Byshottles also possessed a significant minority of district housing. Bishop Auckland (64.1%), Crook and Willington (63.6%) and Spennymoor (62.3%) occupy another distinct class, and were the very heart of depressed West Durham. With a very large proportion of sub-standard housing, a declining economy

and decreasing population these areas fell behind the richer authorities to the east where coal mining was relatively prosperous, and districts were not losing considerable amounts of revenue. To the west of these areas lies the extensive rural districts of Weardale and the tiny urban district of Tow Law. Although numerically small, accounting for only 4% of households within the basin, these two authorities with values of 58.3% and 56.6% respectively, were really deprived of basic household amenities. In Weardale, a barely subsistence economy in many parts, a rapidly declining population, and scattered settlement, made the relative costs of providing these expensive amenities high, and the district authority, at this time also the water undertaking, relied heavily on individual farmers providing and supplying their own water arrangements, whilst the major villages relied upon sources provided at the turn of the century, and often now inadequate. With a small demand for district authority housing, and the absence of house improvement grants, most households had to be content with only basic sanitary arrangements.

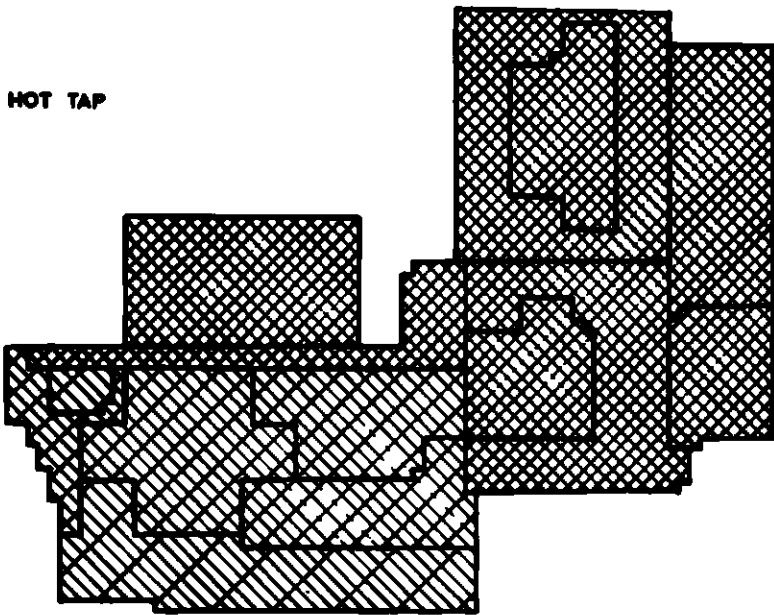
By 1961, however, the position had changed slightly. Throughout the whole range of districts, classes stand out much less readily, but certain districts can with confidence be grouped together.

Durham City and Durham R.D. had emerged as the best-provided for areas. Chester le Street and Consett U.D's had values almost

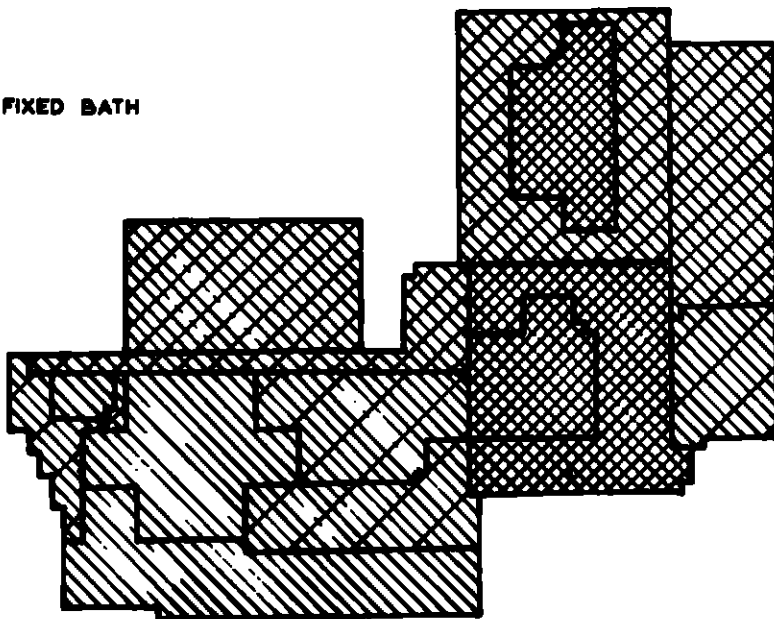
as high, all with values between 92.7% and 94.5%. The emergence of Durham R.D. to this prime position is significant. Large new council estates had been built over the last decade, and the expansion of private housing estates on the fringe of Durham City were taking place. A little below this class two authorities with equal values can be seen. Significantly these lie to the immediate north east and north west of Durham, with Lanchester and Houghton districts having a value of 90.3%. These two areas are different in character and represent two different trends. Houghton le Spring U.D. is a relatively compact authority comprising several mining settlements as well as the main nucleus of Houghton itself. Improvement here is largely the result of the demolition of sub-standard miner's houses, and their replacement by council houses. Lanchester R.D., however, has shared in the increase of private development of its neighbour Durham. Although some slum property has been replaced by council houses, many other rural houses have been improved as commuter cottages, and the district has witnessed a considerable influx of middle class people working in Durham and on Tyneside. Around the fringes of this prosperous nucleus the Hetton and Spennymoor urban and the Chester rural districts have a mean value of 86.9%, and while not exhibiting the high standards of the former authorities have shared in the general improvements of the middle Wear valley.

FIG 19 WATER AMENITIES 1966

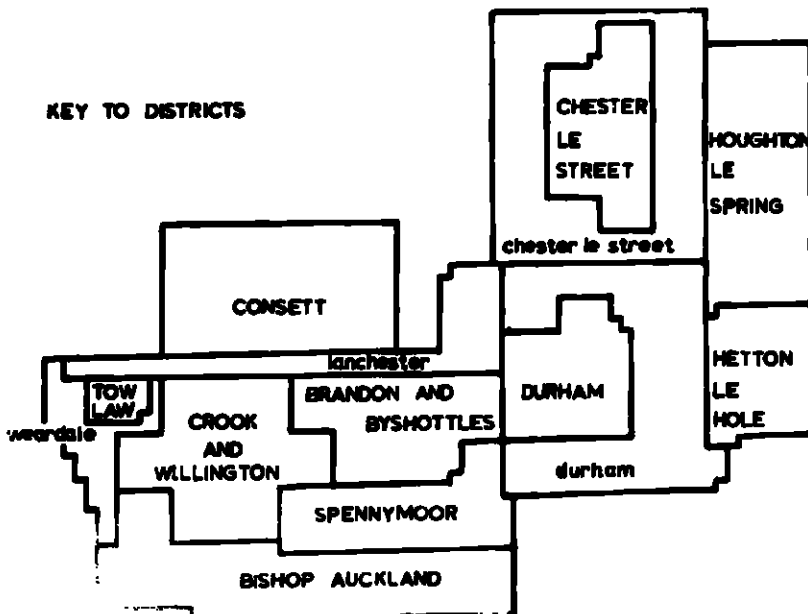
HOT TAP



FIXED BATH



KEY TO DISTRICTS



60-69
 70-79
 80-89
 90-99%

Crook and Willington and Brandon and Byshottles districts stretch out westwards from Durham, and with values of 82.4% and 82.8% can be considered one class. Like Hetton and Houghton le Spring, much old property has been replaced but this is still an area of decreasing population. The district authorities lack much of the impetus and revenue of their eastern neighbour, and although improvement had been carried on at a relatively quick rate in Crook and Willington there was much to catch up on and fewer resources from which to build. Bishop Auckland stands near to the values of these authorities with a value of 80.1%, but like its northern neighbour, Spennymoor, stands a little separate. Neither of these districts had many water amenities in 1951, but have improvements of 39.8% and 44.9% respectively over the inter-censal period. Spennymoor enjoys a closer proximity to the mid-Durham corridor in which a degree of economic expansion has been maintained throughout the period, and its superior position to Bishop Auckland, along with the inferior position in the hierarchy of the two most westerly districts, Tow Law and Weardale, further suggests the rapidly increasing water demand of mid-Durham, as compared with the remoter districts of the west.

Within the limits of a 10% sample, the 1966 Census provides a useful check on the trends evident in the full surveys of 1951 and 1961. As the census did not enquire if there was a piped water

supply or cold tap in the house, it is not possible to detect whether there are still significant numbers of households within the basin without a domestic water supply. It is probable, in fact, that there are very few such households within the basin. It is apparent, moreover, that considerable strides have been made to extend water systems to include a hot supply, and this inevitably means an increase in domestic consumption. The mean number of households within the basin possessing a hot tap increased from 78.9% to an estimated 89.3% over the period 1961-1966. If the proportion of households with a hot tap in 1961 is compared with those estimated in 1966 it will be seen (Table 20) that in seven out of the fourteen cases, the relative increase in hot water systems were exactly the same as the relative position of the district in 1961. Thus Tow Law, the district with the lowest value in 1961 made the largest increase of all fourteen districts, Chester le Street U.D., the second district in 1961 made the second least proportion of improvement by 1966. This result is only to be expected. As a greater proportion of houses have a hot water system, then there are fewer improvements to be made. The spread of values in the 1961 census was 33.1%, but by 1966 it was only 19.8%, and thus there is a general levelling up throughout the basin. The relative differences between the authorities, however, remains basically the same. The most adequately provided districts remain in the middle

Wear valley, with Chester le Street urban and rural districts, Hetton and Houghton urban districts and Durham City and rural district all having more than 92% of their households with hot water systems, while the depressed areas to the west, Brandon and Byshottles, Crook and Willington, Bishop Auckland, Tow Law and Weardale all having less than 85%.

As with hot water systems, the period 1961-66 saw a general levelling up of the numbers of baths within the basin. The spread of values in 1966 was only 25.2% compared with 34.1% in 1966, while the mean proportion of houses within the basin which possessed a fixed bath had risen from 70.8% to 80.9% over the same period. As this is a rise only slightly less than the rise in the same period of the number of hot water systems, it might be thought that there was a close connection between the installation of a fixed bath and a hot water system, but when the figures are broken down into districts, this close tally does not necessarily apply. Thus, although 70 new baths were fixed in Tow Law over the period 1961-66, no less than 206 hot water systems were installed in the same period, while in Durham City, 2.5% more baths were installed than hot water systems, and in Houghton le Spring 6.3%. As it is unlikely that a new bath would be installed without a hot water system, this suggests at once the fact that there were a larger number of house improvements undertaken in Houghton le Spring than Durham, where most of the new baths and hot water systems are represented by new housing, while the low number of baths installed at Tow Law compared with the large

number of hot water systems emphasises the unfavourable position of the town, not only in its inadequate provision of water amenities, but also in the inadequate rate at which it is having these amenities extended. The figures for 1966, therefore, fall into the by now predictable pattern of the middle Wear valley having the largest values, and the less prosperous old mining communities of the west the lowest values, while those areas fringing the relatively prosperous mid-Durham corridor have middle values.

By 1966, only a very small proportion of households were not provided with a water closet, and as the census was only a 10% sample, the small numbers involved were not sufficiently significant to be regarded as reliable. No real indication, therefore, can be given of the small areal differences existing at this time. It will be sufficient to say, therefore, that the remote areas of the upland west had fewer water closets per household than the more prosperous areas of mid-Durham.

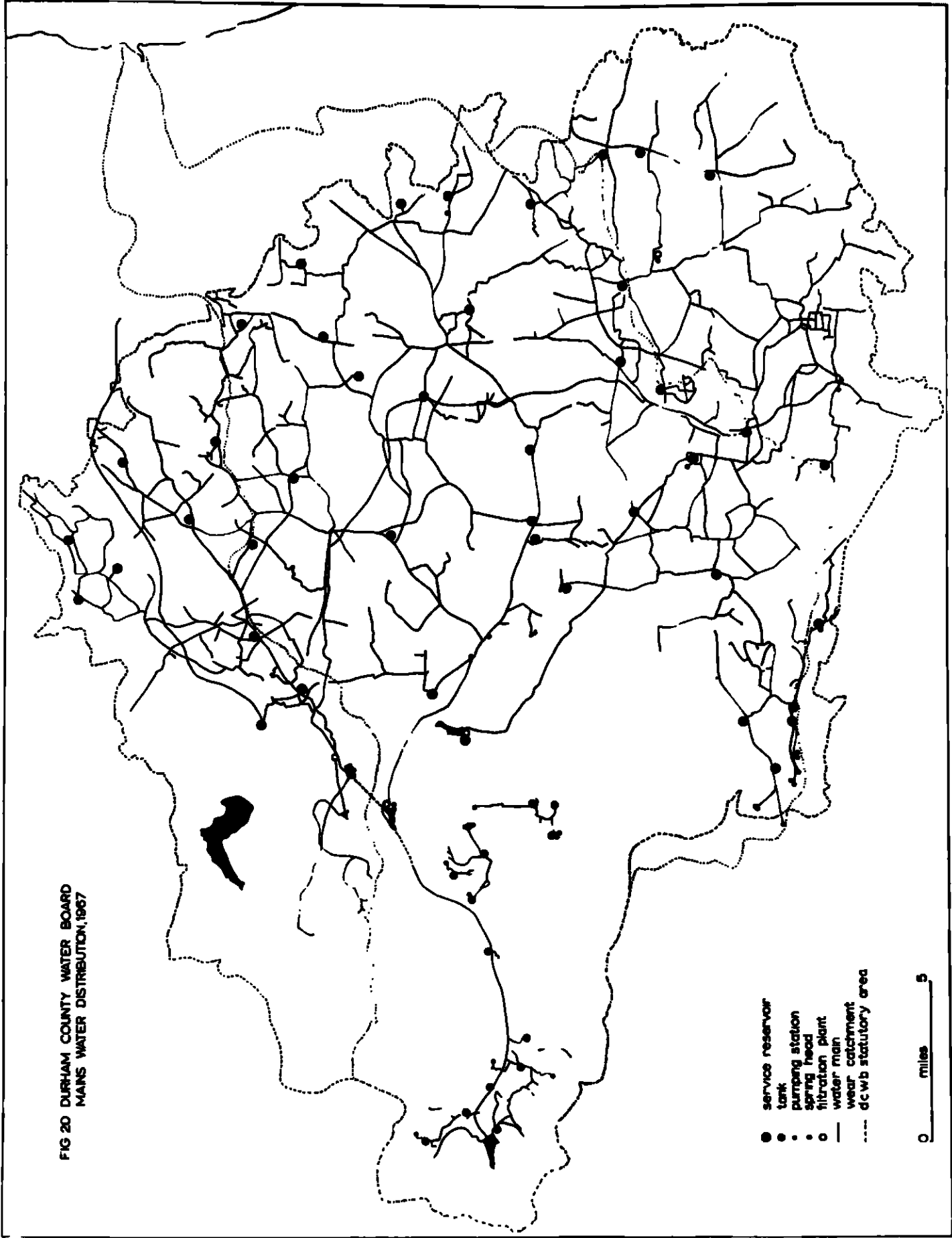
It will be apparent that while in the earlier phases of the water supply industry the provision of water amenities was intimately related to the ability of the water undertaking to provide water, once water supplies were distributed to the whole basin, the extension and development of water facilities is essentially connected with the standard of living and the general prosperity of an area. It was unfortunate that the greatest increase in water demand

should come from that area which lies on the fringes of the D.C.W.B. and the S. & S.S.W.C. statutory areas, and where supply was most difficult. The construction of the Derwent reservoir, however, a facility shared by both undertakings, has solved the immediate problems of the two undertakings, but because the area of economic expansion within the basin lies neither near the pluvius uplands of the west nor the permeable aquifers of the east, then the major water supplies have had to be imported from a neighbouring catchment.

Water Movements

What, then, are the physical implications of the water supply system which has grown up within the basin? Reservoir abstraction and supply figures are available for the period after 1902 (Fig. 16) but because of the evolution of the distribution system, calculations regarding water supply within the Wear basin alone, is particularly difficult. In the period before the introduction of water from Derwent reservoir, only water from the Waskerley reservoir was both raised and distributed within the basin. Water from the Tunstall reservoir was fed into the southern part of the basin and over the watershed into the Tees basin, while water from the Derwent passed through Honey Hill filters was introduced into the northern area of supply, formerly undertaken by the C.W.C. After the construction of the Burnhope pipeline in 1924, water was brought from the Wear basin and pumped into the northern area although water was

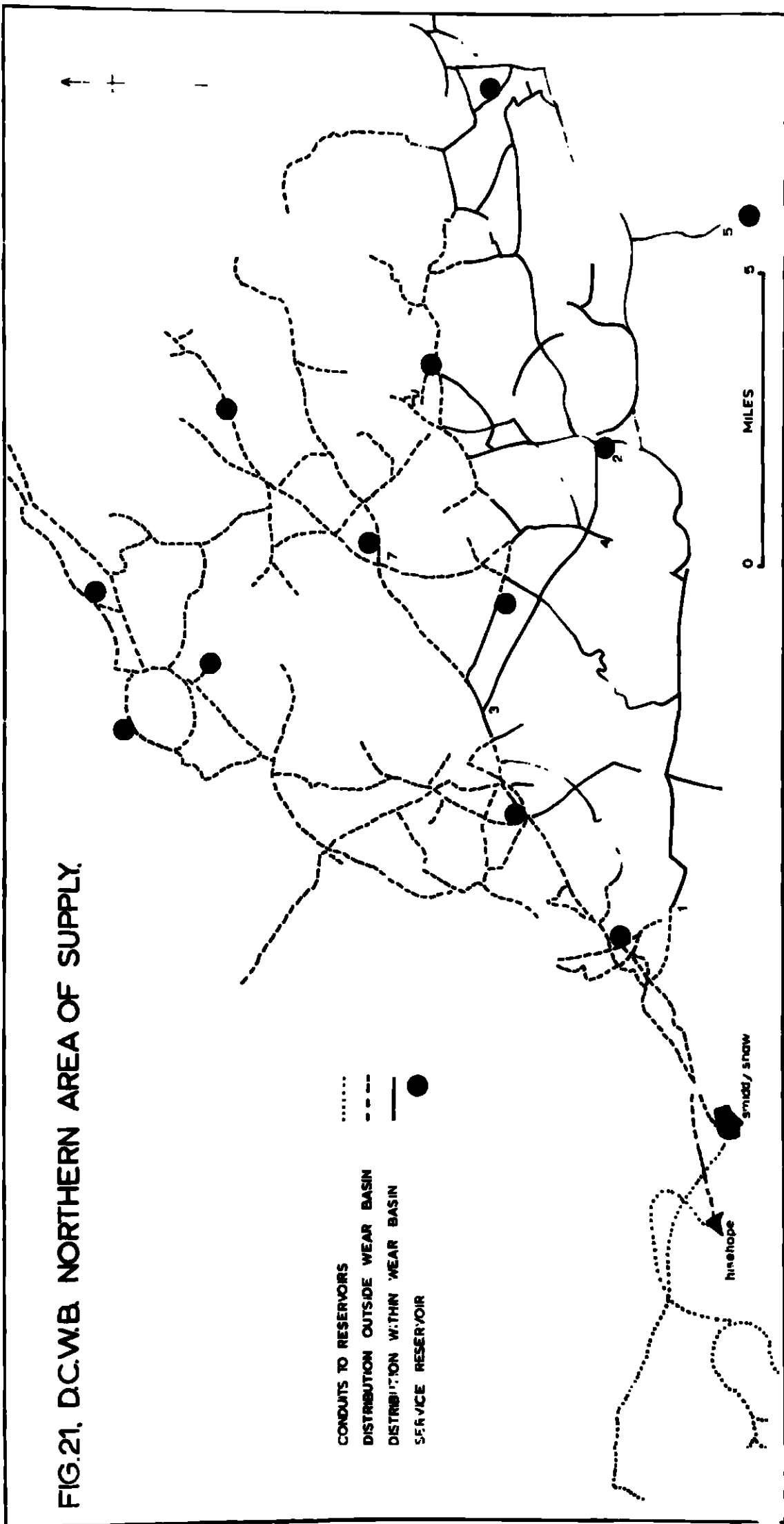
FIG 20 DURHAM COUNTY WATER BOARD
MAINS WATER DISTRIBUTION, 1967



occasionally pumped from Waskerley to Smiddy Shaw as the need arose from 1889. With the introduction of the Mainsforth supply works in 1941, water from the Tees basin was introduced into the south eastern part of the basin, supplementing the water from the Waskerley burn in the Shildon-Newton Aycliffe area. On the completion of the Derwent reservoir, water from the Tyne basin has been introduced into the three distribution systems. This present is a time of daily flux and change. The Derwent reservoir could supply the whole of the present D.C.W.B. area, and its exact role over the immediate future is not yet decided. Thus little can be said about the present position.

Because the old companies, and to a lesser extent the D.C.W.B. adopted no policy of metering their distribution mains in any systematic manner, very few meters have been installed, none have long runs, and a considerable proportion of them record flow both ways through the same pipe according to pressure conditions. Thus it is difficult to estimate water movements within and about the basin, and to estimate its role in supplying itself and other areas. In 1965, however, the existing series of meters began to be supplemented by a number of new ones, and for the period immediately before the introduction of Derwent water in 1967 it is possible to give an indication of the movements of water within the basin, but it should be realised that the figures used are only estimates and reveal significant gaps in the knowledge of how the water is actually distributed.

FIG.21. D.C.W.B. NORTHERN AREA OF SUPPLY.

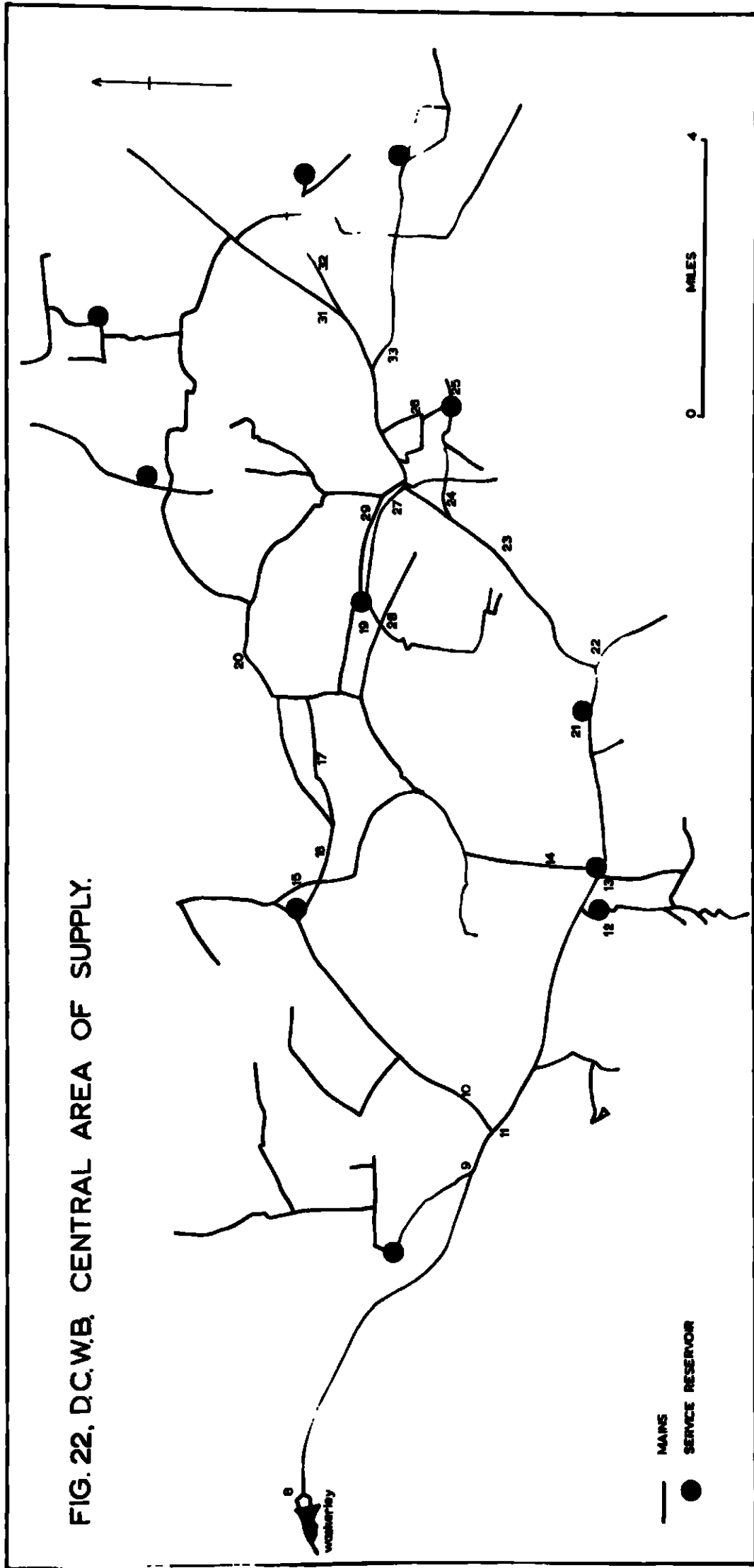


The distribution systems operated within the basin and the D.C.W.B. statutory area are shown in Figure 20.

Northern Zone (Figure 21)

This is at once the most complicated distribution system, and the least satisfactorily metered. Although only part of this zone lies within the basin, it is difficult to isolate any section of the system, as water can flow in many ways through the system, depending upon pressure conditions. Only two meters can be used which record water, the majority of which stays within the Wear basin, at Whitehill and Leadgate. In 1966, an average of 1,383,000 g.p.d. was passed down the Browney valley from Whitehill (1) to the Lanchester and Burnhope areas, and ultimately to South Moor Service Reservoir (S.R.) (2). At the same time, 493,000 g.p.d. passed through Leadgate (3), losing 110,000 g.p.d. to Lanchester and the Browney via Maiden Law (4), and the remainder feeding into the South Moor S.R. (2), feeding part of the southern half of the Twizell catchment, then passing on to the Sacristan S.R. (5) and Chester le Street, drained directly to the Wear. However, water also flowed into the area via the Flint Hill S.R. (7) and the Loud S.R. on which there are no meters, and which also feed part of the Team valley. Thus for this northern zone it is only possible to say that a minimum of 1,876,000 g.p.d. was passed from the Derwent basin into the Wear basin, and note that the inadequate system of metering precludes any satisfactory examination of the distribution of water.

FIG. 22. D.C.W.B. CENTRAL AREA OF SUPPLY.



Central Zone (Figure 22)

This zone lies entirely within the Wear basin. In 1966 the Waskerley filters passed an average of approximately 3,577,000 g.p.d. (8). High Stoop (9) pumping station lifted 15,000 g.p.d. into Saltersgate S.R. for distribution along the Butsfield and Plantation mains, drained ultimately to the Browney, along with most of the 30,000 g.p.d. passed along the Sotley main (10), although some of this water passed to the scattered farmsteads at the head of the Hedleyhope Burn, and so drained to the Deerness. At Tow Law (11), 55,000 g.p.d. was distributed to the urban district (at 22.5 g.p.d. reflecting the general lack of water amenities of this remote township) which drained away to the Wear by way of the Houseslop beck. The Crook valley was fed by two pipes, Crook and Billy Row S.R. with 200,000 g.p.d. (12) and Helmington Row taking a further 20,000 g.p.d. (13) from Mount Pleasant S.R., all of this 220,000 g.p.d. draining to the Wear through Wadsworth disposal works.

At Mount Pleasant S.R. a 12" high pressure main (14) delivered approximately 1,250,000 g.p.d. to the scattered mining communities between Esh Winning and Kimblesworth, with any surplus passing to Lumley and the Raintons, supplementing water distributed through the Stockley Fell S.R. and Durham. From Mount Pleasant 20,000 g.p.d. was delivered to Wilks Hill S.R. (15) for distribution to the southern part of Lanchester village, and draining to the Browney by the

Lanchester S.D.W., 720,000 g.p.d. was passed through Quebec (16), leaving 520,000 g.p.d. taken by Esh Winning and Waterhouses, draining into the Deerness by the Esh Winning Joint S.D.W. Of the 720,000 g.p.d. passed through Quebec 10,000 g.p.d. were used by Esh (17) and Quebec villages, Quebec draining to the Esh Joint Works and the Deerness, and Esh into the Browney Main system. A further 90,000 g.p.d. was distributed in Langley Park (18) and draining through the same source to the Browney and 350,000 g.p.d. passed on to Auton Stile S.R. (19). The remaining 250,000 g.p.d. was passed (20) out to Witton Gilbert, draining into the Browney, and then Sacristan and Kimblesworth, draining to the Wear by the South and Black Dene Burns.

Approximately 2,000,000 g.p.d. passed through Stockley Fell S.R. (21), and 20,000 g.p.d. was delivered to Oakenshaw and the Jobs Hill districts of Willington, draining to the Wear (22). A further 120,000 g.p.d. (23) was distributed en route by a main along the A690 from Brancepeth to Langley Moor, the Brancepeth supplies draining into the Stockley Beck and the remainder to the Browney Main drainage scheme. 450,000 g.p.d. was delivered to the Mountjoy S.R. (24) for distribution to Shincliffe village (25) draining to the Wear and the southern part of Durham City (26) south and east of the meander, including some of the colleges of the University. (The presence of large numbers of undergraduates during

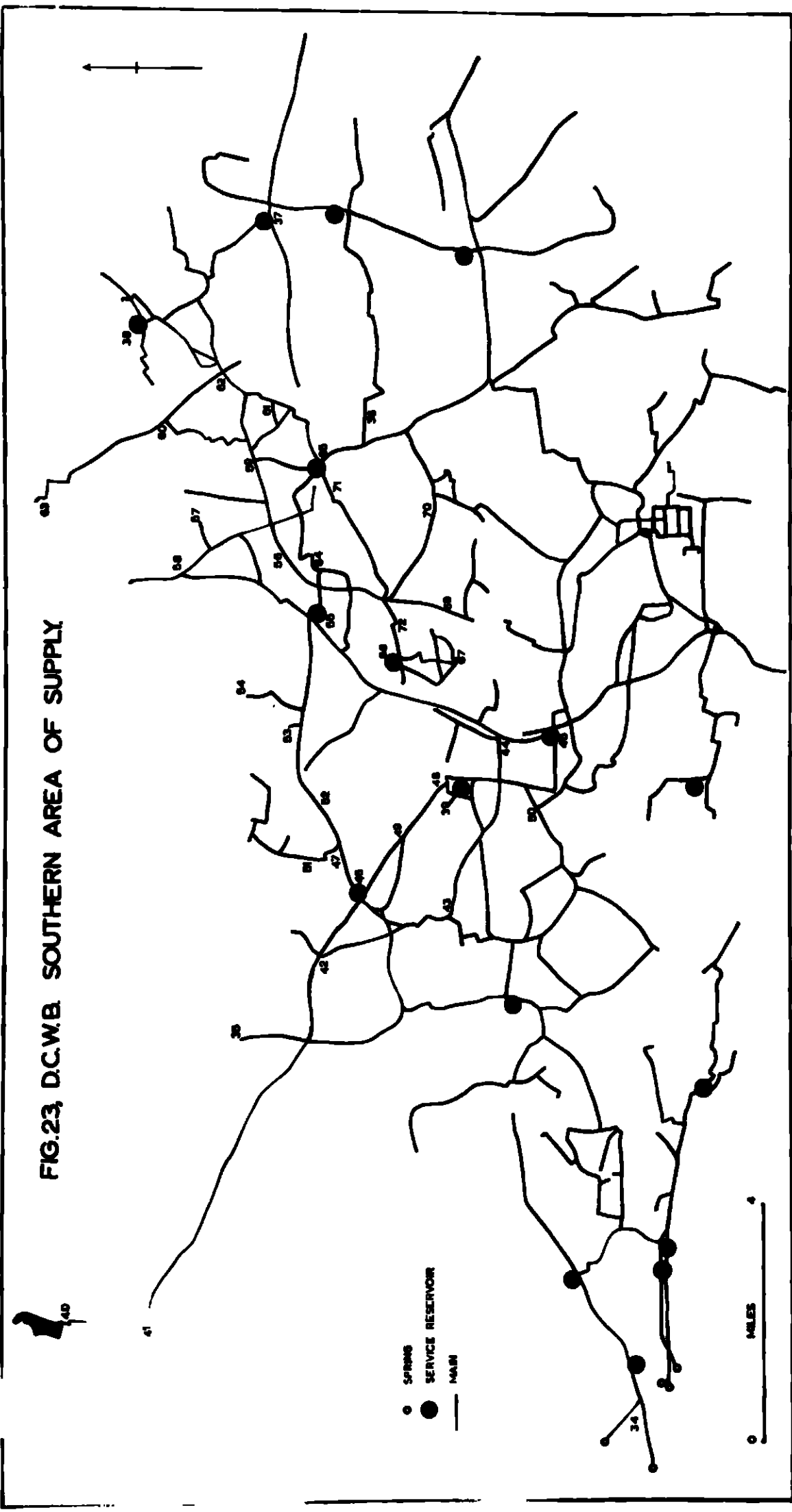


FIG.23, D.C.W.B. SOUTHERN AREA OF SUPPLY



term time increases the demand on Mountjoy S.R. by up to 100,000 g.p.d.). The remaining part of Durham City was served from the Auton Stile S.R. which received 700,000 g.p.d. from the Stockley Fell pipe (27), which gave it a total daily intake of 1,050,000 g.p.d. Of this 160,000 g.p.d. was distributed to Broom, Ushaw Moor and the higher parts of Brandon (28), all draining to the Browney by the Browney Main scheme, the remaining 890,000 g.p.d. (29) being distributed to Bearpark, also on the Browney Main, and the City of Durham, draining to the Wear through the Barkers Haugh S.D.W. The remaining 600,000 g.p.d. was distributed to the east of Durham (30), along the Rainton (31), Pitlington (32) and Sherburn (33) systems, draining to the Wear by way of the Old Durham Beck.

Southern Zone (Figure 23)

This complicated zone was supplied from no less than five sources in 1966, Tunstall filters, passing water from the Waskerley Burn, Mainsforth Supply Works pumping colliery water into the south east of the system, springs and wells supplying the south west of the region at the head of the Gaunless valley, an additional Weardale supply from the S. & S.S.W.C. main from Burnhope to Stony Gate, and the West Mills Supply Works which lifted water from the Wear to Bishop Auckland.

The supply from springs at the head of the Gaunless (34) provides an estimated 60,000 g.p.d. ⁱ for the scattered farmsteads and

i. Hydrological Survey, 1965.

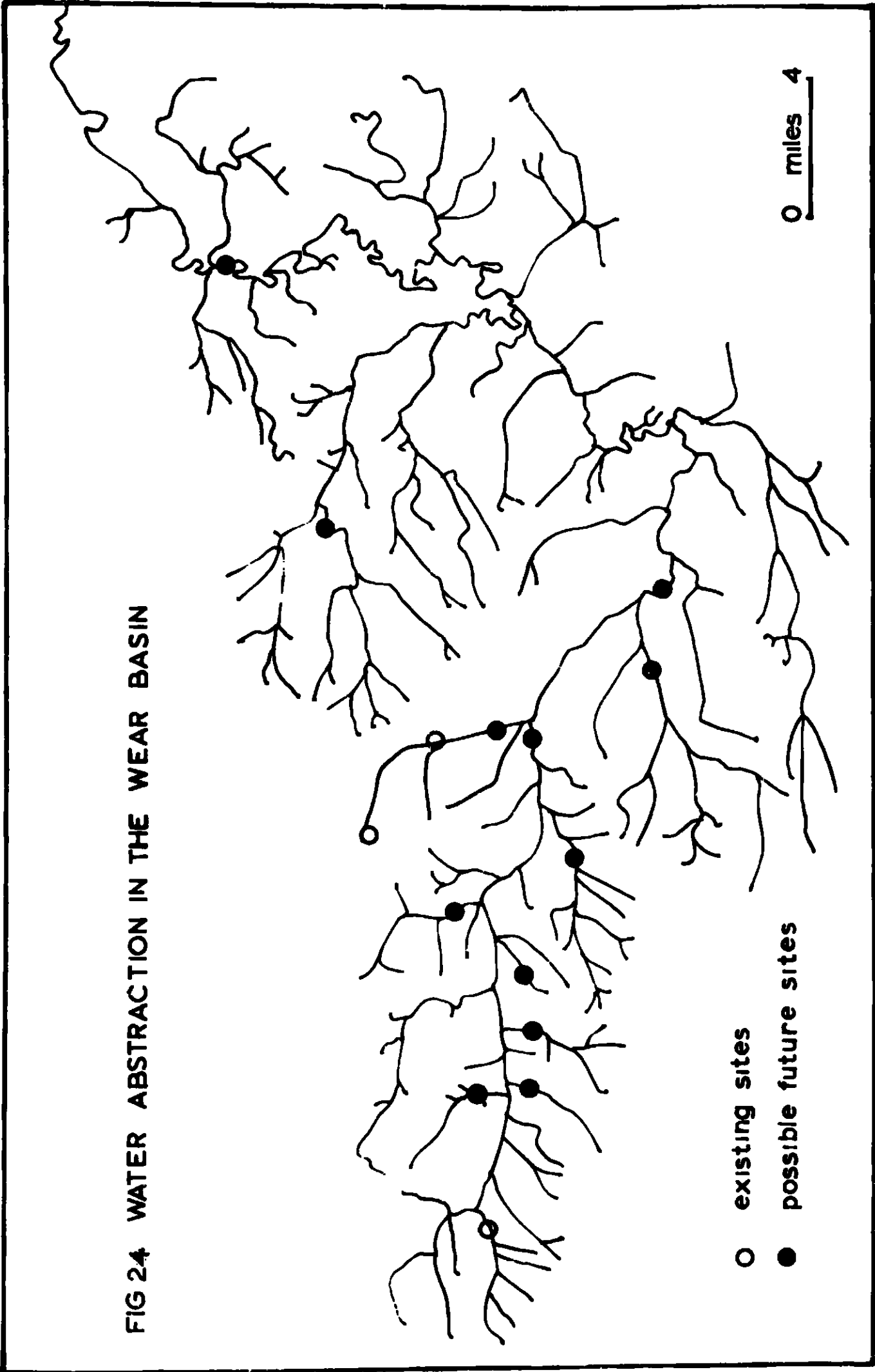
villages of Barnard Castle R.D., and remains within the Gaunless catchment. The supply from the Burnhope (35) pipe varied according to demand, but c 750,000 g.p.d. was passed into the general distribution system at Toft Hill (36). Some of this water would find its way into the Shildon area and the Tees. Only under exceptional circumstances did Mainsforth (36) water penetrate the Wear basin, when a small amount would be passed by way of Trimdon (37) and Quarrington S.R. (38) into the Croxdale Beck system. 500,000 g.p.d. were abstracted at West Mills (39) supply works, and returned to the river through Vinovium disposal works a mile or so downstream.

In 1966, approximately 2,900,000 g.p.d. was passed through Tunstall (40) filters. Of this 60,000 g.p.d. was supplied to Wolsingham town (41) and passed into the Wear half a mile below the confluence of the Wear and Waskerley burn. At Howden le Wear (47) 950,000 g.p.d. were passed over the river to Witton Park (43), South Church (44) and Shildon (45). It is not known what quantity of water was used by any of these places. Another main carried water from Howden le Wear to Beechburn S.R. (46). 1,600,000 g.p.d. was taken by the Hunwick (47) pipe leaving approximately 250,000 g.p.d. for distribution around Bishop Auckland (48), Toronto (49) and Fielden Bridge (50). This supply was not metered. Of the 1,600,000 g.p.d. taken from Beechburn by the Hunwick main, 190,000 g.p.d. was passed along the Sunnybrow and Willington branch (51) to drain into the Wear

at Sunnybrow and Willington S.D.W. It is not known how much was consumed at Newfield (57), but at Byers Green (53), 17,000 g.p.d. was abstracted to drain directly into the Wear by a small tributary, and a further 3,000 g.p.d. was delivered to Page Bank (54).

Unfortunately, it is not known how much water was consumed by Spennymoor (56), and drained to the Wear by Tudhoe Mill disposal works and the Valley Burn, but as 445,000 g.p.d. was unaccounted for between Beechburn and the main pipes out of the town, it is probable that the large majority of this water was delivered to Spennymoor, only Hunwick and Newfields, quite small villages, being en route. Distribution to the north east of Spennymoor is uncertain, the only meter at Garden House (56) recording 325,000 g.p.d. passed along the Great North Road to Hett (57) and Croxdale (58), and along the B629 to Thinford (59), Bowburn (60) and the Cornforth (61) and Coxhoe (62) districts, draining into the Croxdale Beck system, and a little passing to Shincliffe Colliery (63) and Bank Top, draining to the Old Durham Beck. From Garden House, a second pipe delivered 195,000 g.p.d. to the Spennymoor trading estates (64), draining to the Tudhoe Mill S.D.W. and the Valley Burn, and a further 180,000 g.p.d. to the Ferryhill S.R. (65) a few hundred yards from the watershed with the Tees. Virtually all of this water is lost to the Wear basin, draining down the Permian escarpment ultimately to the Tees. A further 350,000 g.p.d. was carried from Merrington Lane (66) to the Coundon (67), Westerton (68), Leasingthorne (69), West Chilton (70) and the Dean Bank (71) areas. It is not known how much of this was

FIG 24 WATER ABSTRACTION IN THE WEAR BASIN



distributed to each of these villages, but as Leasingthorne and Middlestone (72), although out of the Wear basin are drained into the Vinovium S.D.W., and both Coundon and Westerton are within the Vinovium drainage system, only that water distributed to Dean Bank, Kirk Merrington and West Chilton was lost to the Wear basin.

Epilogue

Although the construction of the Derwent reservoir has meant that the immediate water demand in the Wear basin is more than adequately met, on a wider scale it is estimated that Tyneside and County Durham, excluding Teeside will suffer a deficit of 29 m.g.d. by 1981, while Teeside will have a massive deficit of 50.4 m.g.d. The area served by the D.C.W.B., however, will still have a modest surplus_i. It is plain, therefore, that extra water supplies will have to be found in the immediate future. It is already proposed that 10 m.g.d. should be taken out of the Wear a little above Chester le Street by the S. & S.S.W.C., but this is a small amount compared with the potential that is available in the Wear catchment. In 1961 it was estimated that a series of 11 conventional reservoirs could be placed within the Wear catchment (Fig. 24) which would yield a total of 76.1 m.g.d. Alternatively, a regulating reservoir could be established at Middlehope, for the abstraction of water from the Wear at Bishop Auckland, which would yield 37 m.g.d.

i. Interim Report on Water Resources in the North, H.M.S.O., 1967.

All this, of course, would be achieved at a price, and it seems probable that a more appropriate way of providing the extra supplies needed in the future would be by way of an aqueduct from the Solway or Lake District to Tyneside, with a further aqueduct along the line of the present A.1. to Teeside. This would still leave the Wear catchment considerably under-employed, and it is likely that additional storage capacity will be established in the near future on a major tributary of the Wear.

Recreational Use of the RiverFishing

By far the most extensive recreational use of the Wear is for angling, and although the quality of plant and animal life in the river declined considerably in the period 1850-1950, angling remained a popular sport with miners glad to escape from the close confines of the pit to the solitary pleasures of a rural stream. In 1860, William Henderson reported that 'The wealthier classes subscribe to the (Wear Fishery) Association, but we leave the management to the hands of the working men, because they could more effectively carry out operations against poachers'ⁱ. Although the gentlemanly fishery associations were disbanded during the 1870's angling continued in unpolluted waters.

Fishing for both pleasure and profit has been practised in the Wear from the earliest recorded times. The place name Kepier would seem to denote a fish lock or fishery dam, and although it does not occur until the thirteenth century, it is known that fisheries were established on the river at various points in the twelfth century. The presence of two monastic houses on the river stimulated the demand for fish of all kinds for days and seasons of abstinence, and of course fish was a common food of lay folk at this time. Fisheries were established at Finchale (c 1120), Lumley (1183),

i. H.C. XXIII. 1861, 465.

Cocken (c 1260) and at Kepier and Durham. With so many dams across the river it seems surprising that migratory fish ascended the river in sufficient numbers to maintain the Wear as a migratory river, but despite the dams the fish ascended the river at times of flood and both brown trout, and migratory trout and salmon were caught. There is no doubt that private fishing was also carried out, and Surtees_i suggests that the celebrated folk legend of the 'Lambton Worm' is essentially a warning against the evils attendant on fishing on the Sabbath.

A considerable body of material is to be found in the account rolls of both monastic houses on the river regarding their fisheries, but it is sufficient here to quote Greenwell's abstraction from the Finchale rolls. 'A monastic community lived to a very great extent upon fish. Therefore what they sold is over and above what they used themselves. In 1348 they sold salmon to the value of £9.12.8. (In that day a bull and three cows were purchased for £1.12.0.) In 1358 from their fishery they received £11.2.1. and three years afterwards £12.5.4. In 1437 they sold £5's worth of salmon, in 1438 £16, and in 1439 £39.6.8.'s worth. In 1532, 550 fresh salmon were brought from the various fisheries by the Convent. They seem to have bought fresh salmon every month except January'_{ii}. It is worth noting that although salmon were caught in the Wear by all the

i. Surtees, II, 171.

ii. H.C. XXXII, 1861, 477.

fisheries, both houses expended considerable sums of money in buying salmon and bringing them from the Tyne, the Yorkshire Ouse and Derwent and the sea at Shields. It would seem possible that the Wear never supported a considerable salmon population perhaps by virtue of the many dams on the river, and the netting that was carried out at Wearmouth, but certainly when conditions in the river began to deteriorate in the early nineteenth century, the true salmon was the first fish to disappear. In 1845, fish caught at Lumley were said to be 'exceedingly fine in both size and quality ... Salmon from 20-30 lbs each have been caught here which at their first coming are sold as high as 3/= per lb., but during the season about 1/- a lb. is the usual price. The trout fetch 4d. to 1/- a lb. and they are all sold about home excepting a few which go to Newcastle when they reach the former price'ⁱ. By 1854, however, the last fisherman at Lumley reported 'We did not get a very large quantity of salmon ... they were very scarce towards the end (1854): we might kill 30 or 40 trout to one salmon ... We used to get a great many more bull trout than salmon trout, the average of our salmon trout ran about 2½ lbs. and were better than the bull trout, and I did not sell them at all. I used to salt them down until I got a quantity to send away to the towns in the neighbourhood'ⁱⁱ. By

i. L./EMS/40.

ii. H.C. XXIII, 1861, 476.

1862 it was reported that 'there is no salmon proper now in the Wear'ⁱ.

After the dissolution of the monastic communities, only the fishery at Lumley was kept up, and was worked until 1854, although in its later days it was valued more for its scenic function than for its fish. Held by the Bishop, it was leased to the Lumleys of Lumley Castle in 1553ⁱⁱ in whose family it remained until its abandonment. Situated on the Wear immediately below the castle, the fishery consisted of a dam across the river, first made of brushwood, and later of stone, 'its original construction so very bold and as I esteem it unsafe, that it surprises me how it has stood for so long'ⁱⁱⁱ, which except in times of flood prevented the fish passing upstream so that they could be caught with drag nets and boats, or driven up the Lumley Park Burn and caught in its soon constricted channel. Although the fishery survived well into the period of systematic book keeping, its value is difficult to assess as until 1808 it was always let with the tenancy of Lumley Forge. Fines paid on the renewal of the lease from the Bishop provide a rough index of the prosperity of the concern, with £10 being paid in 1775^{iv}, £25 in 1789^v and £54 in 1803^{vi}. A valuation made in 1817 notes that 'The fishing has for some years not been productive,

i. H.C. XIX, 1862, 341.
 ii. Surtees, II, 137.
 iii. John Smeaton in L./EMC/40/6b.
 iv. C.C./B.E.S. 186061.
 v. *ibid* 55401.
 vi. *ibid* 55403.

and Lord Scarbrough and his tenants has been at great expense in repairing the dam. The Fishery worth £73.5.0.ⁱ. In 1826, however, £80 p.a. paid for the fishery 'made good profit'ⁱⁱ, but by 1832 another episcopal survey places the value of the fishery at £30 p.a.ⁱⁱⁱ and by 1845 it had fallen to £25 p.a. ^{iv}. The fluctuations in the value of the property can be attributed to two factors, the general rise in prices that occurred from 1750-1810, and the gradual decline in the numbers of fish caught. As food prices rose then the value of the fish obviously increased, but after the turn of the century it is likely that large numbers of migratory fish were driven out of their spawning ground by lead mining, which along with the decline in food prices after the end of the Napoleonic wars resulted in the diminishing value of the Fishery.

By the 1830's the population along the banks of the river was rapidly increasing and fishing was much in demand. Unfortunately, due to the increased efficiency of fishing at Lurley, consequent on the declining numbers of fish in the river, few migratory fish were finding their way upstream. It was noted in 1861 that 'with the exception of the winter of 1820 when the highest portion of the dam was washed away by a great flood, there is no distinct record of any salmon in the Wear; whilst the dam was down, the river

i. C.C./H.C.M. 11/41
 ii. H.C. XXIII, 1861, 468
 iii. C.C./H.C.M. 10/165
 iv. L./EMS/40

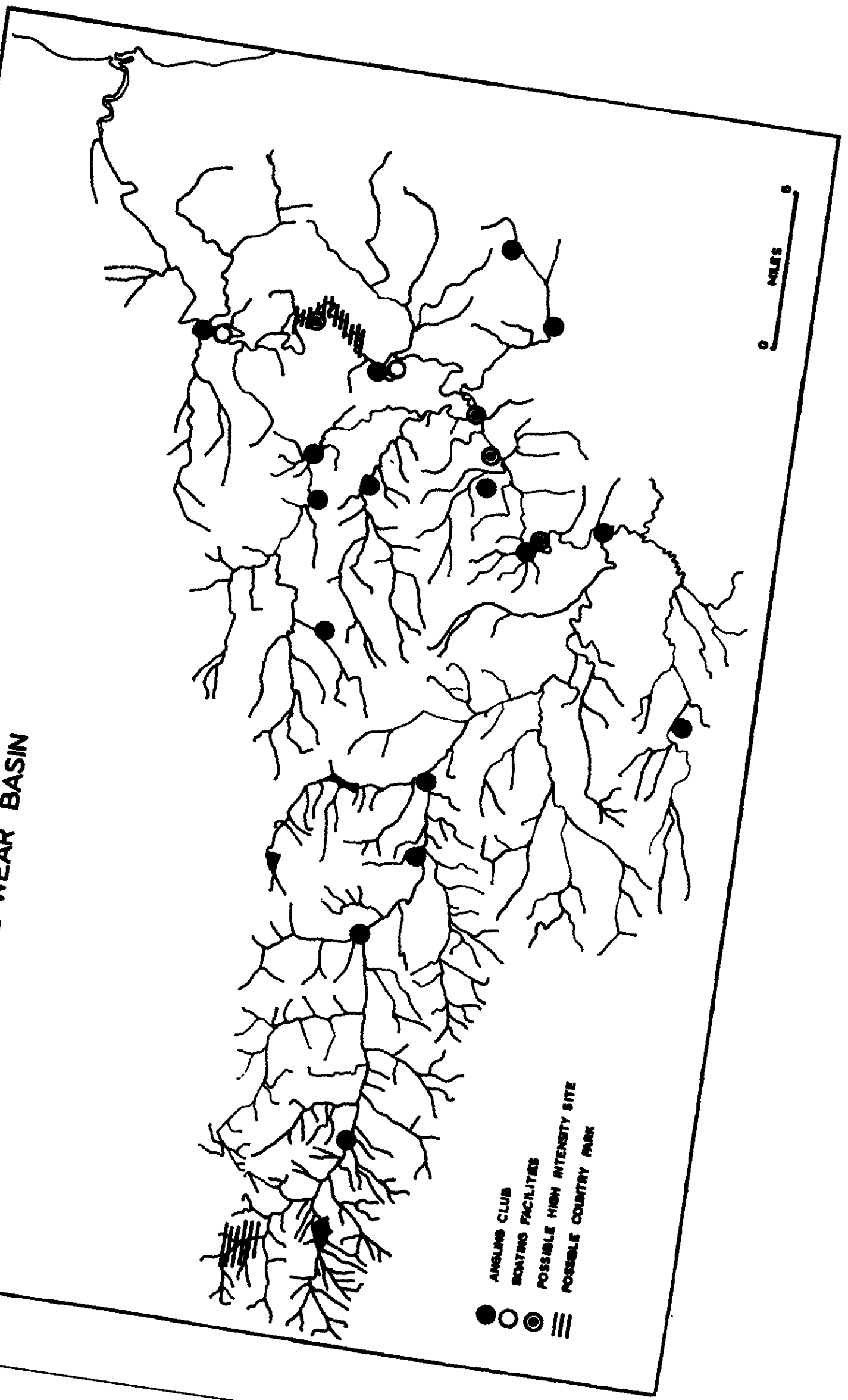
was filled with salmon of a large size'ⁱ. The new coal owners took up the cause of free angling, 'the public being deprived of the delightful and innocent recreation of the Cast for Salmon as well as a great loss from a pecuniary point of view to all classes by being deprived of Salmon from the Wear as a substitute for other food'ⁱⁱ. A fishery association was formed in 1848, and as a result of much agitation Bishop Maltby was persuaded not to renew Lord Scarbrough's lease, and the Lumley Fishery was abandoned in 1854.

Over the following fifteen years, however, the quality of the river declined, and for the following seventy years the Wear ceased to be a fishing river of any significance. Although migratory trout never left the river, their numbers were drastically reduced, and the dominant fish in the river were the few brown trout that remained in unpolluted stretches of a few watercourses. Angling, however, although for meagre game, remained popular, and especially during the years of economic depression, the angling societies did much to alleviate the boredom of years of unemployment, and a number of local societies owe their existence to the inter-war depression.

After 1945, however, the condition of watercourses began to improve, and fish life increased. Sewage disposal systems were

i. H.C. XXIII, 1861, 465.
ii. C.C./B.E.S./57332.

**FIG 25
RECREATION AND THE WEAR BASIN**



made more efficient, many collieries were closed and by-product plants abandoned, and on the constitution of a river board for the Wear and Tees in 1952 a closer watch was kept on the condition of watercourses in the basin. As fish life increased, then angling became more enjoyable, and its popularity soared. In 1952-3 a total of 4,416 annual licenses were issued for the Wear and Tees area. This had doubled by 1959, and by 1965 had reached a total of 14,058, of which 5,301 were youngsters under the age of sixteen. Many angling societies were formed, especially in the mining districts of the middle Wear valley (Fig. 25), and indeed, on the eleven mile stretch of river between Escomb and Croxdale, over 1,000 rods were played in 1967.

The local societies vary in size from about 40 to as many as 450 members, and usually have some residence qualification attached to their membership. They fish local waters but a few, such as Durham City Angling Club have coarse fishing on brickyard ponds to supplement the fine fishing they have on the river itself. Other clubs have occasional outings to the Tees for coarse fishing, while the Ramshaw and Everwood club have rights on the Greta for small wild trout, and venture as far as Scotland for game fishing. Many of the clubs have annual re-stocking programmes, and have made no small contribution to the improvement in the quality of watercourses by their continued representations to local authorities and the National Coal Board on repeated severe pollutions. Due to the clubs'

re-stocking and that of the Wear and Tees River Board, and their successors the Northumbrian River Authority, not only brown trout, but also migratory trout are increasing rapidly in the river. In 1956, 30,000 salmon eyed ova were planted in the Bollihope Burn by the Wear and Tees River Board as the start of a planting programme in an attempt to re-establish a salmon run in the river. Occasional salmon have been seen in the river over the last two seasons, but the fruits of the planting programme have not been so plentiful as, perhaps, it was hoped. Nevertheless, with continued improvements in the quality of the water, there is little doubt that the Wear is going to become a fishing river of some note, and will in the future be able to make a significant contribution to the enrichment of the quality of life available in the North East as a whole.

Boating

Pleasure boating has a relatively long history on the river at Durham, where the Abbey Weir maintains a depth of water sufficient for small boats for almost two miles. Nathaniel Crewe, Bishop of Durham 1647-1725, maintained a gondola on the river for pleasure outings, and annual celebrations to mark the victory at Waterloo included a procession of boats as the highlight of the festivities. Annual rowing regattas were inaugurated in 1834 as part of the Waterloo celebrations, with races between the University, whose undergraduates had just completed their first session, and a crew raised by the Sheriff of the county. The annual regatta, the

presence of the university and a boys' public school fostered the development of competitive rowing at Durham, until it is estimated that 350 oarsmen (and women) using some 50 or so boats regularly use the Wear for competitive rowing. The annual regatta, first in the country, and still held near the original Waterloo day (18th June) now attracts crews from throughout northern England and Scotland, and is a major two-day holiday for the town, although this is not now so much observed as in former years.

Pleasure boating is also practised on the river at Durham. Some 86 boats, including punts, patronised mainly by members of the university, skiffs and rowing boats are hired from a boathouse at Elvet Bridge, and a motor launch also plies during the season which lasts from Easter until mid-October. The boathouse was established in 1884, when there was already a small boat-repair workshop on the site, and the owner now employs a full time staff of three men, who are mainly concerned with the repair of racing boats for the area served by Durham Regatta, and a part time staff of five, who work on the hiring of boats during the summer months.

It ought to be mentioned here that 30 boats are hired at Chester le Street, where there is also a racing club and a small regatta. Canoeing has also developed as a popular sport over the past ten years, and clubs are established at Chester le Street and Durham.

Other Recreational Uses

The attraction of water bodies in general, and rivers in particular as a focus for recreation is well known. Not only active pursuits such as rowing and fishing, but also the pleasure of walking or sitting by a river is amply demonstrated at Durham on any sunny weekend. Here, the banks are flanked by public promenades, and are justifiably popular. As virtually the whole length of the river passes through relatively unspoiled countryside, some of which, such as that between Croxdale and Lumley is of a high order, yet within very easy distance of the large centres of population on Tyneside, Wearside and east Durham, the recreational potential of the river is plainly enormous. Because of the glacial and post-glacial history of the river, it flows either in the Wash where there was little incentive to mining except between Witton Park and Page Bank, or in the constricted gorge to the north of Durham City. Thus the river forms a meandering corridor of rural seclusion, of varying widths, but almost always of attractive charm. Thus, although the flood plain is up to a mile wide at High Houghall, it presents a broad pastoral vale bounded by tree-covered bluffs, while the narrow gorge between Kepier and Finchale is perhaps only 400 yards wide, but 200' deep, an incision which makes it apparently far-removed from the hapless nineteenth century colliery villages and twentieth century suburbs which flank it above. Thus, not a thousand yards

from the colliery village of Rainton, lie National Trust woodlands and a riparian scene of modest beauty. However, not all the pleasant stretches of the river lie within the coalfields, and the thirty miles stretch of water above Witton Park, penetrates to the heart of the Pennine uplands, and offers the potential for extensive recreational activity, with the possibility of more intensive pursuits at a few selected points.

However, to open the river to recreational use demands the creation of public rights. For instance, a series of footpaths along the right bank of the river provide a fine walk through some of the remotest stretches of the river, but sections of the path are not public rights of way. It is in circumstances such as these that the Country Parks, proposed to be set up by County Councils in the Countryside Bill at this moment before Parliament, will be most useful. In anticipation of the proposed Act, the Durham County Council have already undertaken certain studies towards the creation of a country park at Killhope on the highest tributary of the Wear, where the disused and restored crushing mill at Park Level is to form the focus of an open area in the midst of forestry commission development. On a more extensive scale, the Planning Authority are at present considering the formation of a country park corridor along the Wear from Bishop Auckland to the tideway. Certain sites would be developed as intensive recreational areas, leaving the remaining stretches for more solitary pursuits. The

presence of the picturesque ruins of Finchale Abbey in a particularly attractive setting by the river has already promoted the establishment of a caravan site, although planning permission has been refused to extend this popular site from 100 to 350 caravans. Other intensive recreational points under consideration are at Sunderland Bridge, at Page Bank, where it is suggested that flooded gravel pits would afford opportunities for the observation of wild life, and at Willington, where 35 acres of derelict gravel and mine workings offer an opportunity for a variety of pursuits from sailing to angling (Fig. 25). A nature trail has already been promoted at a similar site at Witton le Wear.

Thus, along with improvements in the quality of river water, and the careful supervision of a vigorous planning authority, it is apparent that the major role of the Wear in the immediate future is in the provision of a recreational amenity to a population which has for too long had to be content with the more limited opportunities of the football pitch, the dog-racing stadium and third rate angling for open air activity.

It will have been seen that there are four major aspects of water use, none of which have ever been extinguished, but all of which have experienced a period of special importance. These are water for power, water for consumption, water as a drainage agent, and water as an amenity.

In an eotechnic age, again to borrow Mumford's terminology, water power was widespread, and used in all aspects of a productive economy, in corn mills, fulling mills, forge mills, and as prime mover in many other ways in the mining industries of the area. Water supply in this period was organised on an intensely local basis, with the family being ultimately responsible for the provision of its own water supply, although communal wells were sometimes available. The drainage functions of watercourses were ubiquitous, but because of the low density of population, this did not make any considerable difference to the quality of the water.

In a paleotechnic age, in this instance after about 1830, water power declined, and water wheels were in a few cases replaced by turbines, but in most cases abandoned. Water supply began to be organised on a community basis, with the abstraction of water from one point on a local stream, and distributed by pipe within the community. Subsequently, this was extended until the unit of supply was the statutory area, containing several communities;

and the transfer of water from one watershed to another became the norm. The drainage function of watercourses became more important, with the development of large clusters of population in urban communities, and deep shaft mining for coal, lead and iron demanded extensive draining operations.

In a neotechnic age, again, in this local instance, after 1945, water power has been almost entirely displaced. Water supply is being thought of in terms of multi-catchment regional terms, and the role of the Wear itself has been considerably reduced on the introduction of extra-basin supplies. The drainage function of watercourses remains important, although shaft drainage is considerably reduced. The quality of river water, however, has become of considerable import, and effluents must maintain a high degree of purity. In this period the use of watercourses as an amenity comes to the foreground, as the amount of time available for leisure increases. This has always been of some importance, however, for angling as a sport is remembered in the basin since the days of the 'Lambton Worm', and boating for pleasure since at least the late seventeenth century.

In a more general vein, it will be apparent that the material used in the preparation of this thesis has varied considerably from the synthetic data of the river ~~discharge~~ records, to the eighteenth century correspondence that formed the basis of the account of the canalisation scheme. All the major manuscript sources available

and relating to the area have been consulted for evidence of past water uses, and it is, perhaps, appropriate at this point to bring together the range of literary sources that have been consulted.

The point has already been made that the earliest records are those connected with the episcopal and conventual possessions, and for the facility by which many of these are made available the writer, along with many other workers on the north of England cannot fail but be grateful for the industry of the editors of the Surtees Society, who have produced printed editions of many local documents. Even then, however, there are still many religious MSS not yet transcribed, and on several occasions it has been necessary to resort to the original pre-dissolution material. Fortunately the legibility of most of those fifteenth century account rolls consulted made this a not extravagantly difficult task.

Mediaeval evidence can be grouped under one of three broad headings: surveys and account rolls; court books and episcopal registers; and contemporary writers. Of these the last is least important as there were, of course, very few contemporary writers, and of them Reginald of Durham is the most usefulⁱ. Nevertheless such early references to water mills on the Wear provide a valuable record. The only extant court books of this period are those of the Prior of Durham, but fines associated with the lord's mill or

i. S.S. I 1834, and IX 1837.

communal water supplies, abstracted from their many proceedings provide a useful index of the character of water use in at least part of the area. Accounts and surveys were undoubtedly the most useful series of material, and provided the core of the information concerning water mills at this time. Again these are of ecclesiastical lands, but as church land was so widespread in the basin, their survival is of paramount importance. Although the land surveys undertaken during the episcopates of Pudsey and Hatfield, supplemented by the surveys of Priory lands contained within the Feodarium and Inventarium Prioratus Dunelmensis¹, were useful in that they provided evidence for the early existence of water mills, much more valuable were the account rolls of the bishop's clerk of works, and the corresponding rolls of the Convent and the daughter house of Finchale, as these provided a more particular account of the character of water use in the pre-dissolution period.

For the present purpose the most important series of MSS relating to the seventeenth century were the surveys of episcopal lands ordered by Parliament in 1647. Although the surveys of lands in Lanchester and around Durham City are missing, the evidence relating to the remaining manors is particularly enlightening, not only for the specific mention of the condition of water mills and their values but in the surveys' exposition of tenurial obligations to the lord's mill, at this time.

i. S.S. LVIII, 1852.

Over this whole period it is tempting to assume that like conditions as existed within ecclesiastical lands prevailed over the whole area, but this was not necessarily so, and the lack of comparable evidence relating to secular lands prevents the acceptance of this assumption. Nevertheless ecclesiastical lands occupied the greater part of the area and the character of water use within them must at the very least be regarded as having considerable significance.

However, by the early seventeenth century secular documents become at once more common and of greater use. Although a few deeds of the fourteenth century have survived in such collections as the Salvin MSS these are on the whole too general as to be of any use for these present purposes, and it is not until the seventeenth century that deeds enumerate the more detailed appurtenances of a manor, revealing, for instance, the presence of a water mill. From this period moreover dates the occasional secular rent roll or summary of legal proceedings, and in the case of the Chancery proceedings against the miller of Croxdale in 1625 these latter proved to be of some value.

Throughout the pre-industrial period the basic manuscript sources of estate surveys, rent and account rolls and accounts of legal proceedings at various levels became more numerous, and towards the early eighteenth century these sources are supplemented by the

survival of correspondence. This has generally taken the form of letters from agents to their masters and so tends to concern the larger estates where owners were absent for at least part of the year, such as the Lumley estates of the Earls of Scarborough, or where legal or Parliamentary business required the work of an agent in London.

This latter provided a great deal of the evidence concerning the proposed Wear navigation, and the reports sent almost daily by the Chapter's agent at Westminster on the progress of their business, and in answer to their frequent questions are of considerable value. Unfortunately the agent's letters form only half the correspondence as no record was kept of the Chapter's letters to their agent. There is little doubt that the survival of the Chapter's letters would have added to our present appreciation of the Chapter's 'geographical vision'¹. Again, the Chapter was only one party in a situation that involved many, and it is difficult to evaluate a close record of the attitudes and intentions of the other parties from half the correspondence of one. However, a little information concerning the other parties is available, especially in the surviving records of the Wear Commissioners who possess Order Books and accounts covering parts of this early period of their existence.

i. Meinig. op cit.

At the opening of the industrial period literary sources of all kinds become more readily available. In the Allendale MSS was found useful information concerning the erection of water-powered crushing mills in the regular reports of the mining agent in the early nineteenth century, while further information on mining techniques is provided by the publication at this time of trade descriptions_i. Trade directories provide useful information on the ownership and character of water mills, business correspondence, rent rolls and surveys of the larger estates become more explicit in character and more frequent in survival, while the publication of various local topographical histories_{ii} helped to portray the general matrix of environment and society with their references to the contemporary scene.

During the nineteenth century the quickening of a social conscience at Westminster, the ensuing interest in the sanitary conditions of towns and populous places, and in the growing pollution of watercourses in industrial districts resulted in a series of inquiries local and national, occasional and regular. These, for the most part published in the form of Blue Books provide a wealth of information on local

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- i. Forster, Westgarth, op cit.
 Fordyce, W., A History of Coal, Coke ... Iron, etc., London 1860.
 Sopwith, T., An Account of the Mining Districts of Alston Moor, Alnwick, 1833.
- ii. e.g. Fordyce, W., The History and Antiquities of the County Palatine of Durham, Newcastle, 1857.

water-use conditions. This flurry of Parliamentary activity culminated in the erection of first local boards of health, and then the sanitary authorities which subsequently became county districts, and much of the material concerning the period from the later nineteenth century until about 1950 was taken from the reports of the medical officers of health of these new authorities. This leads directly to the present time and the assistance given by those many persons to whom acknowledgement has already been given.

Accordingly, therefore, a range of techniques has had to be used, to fit the material available. Wherever possible quantitative methods have been used to underpin the argument, but because of the nature of the evidence, these have necessarily been of limited application. It will have been apparent that although quantitative technique is able to demonstrate the existence of trends, it does not necessarily provide an explanation of them, and to be used properly should be seen as only the framework, around which our perception of more qualitative values can be built.

In attempting to relate man's use of the Wear to the broader 'zussammenhang' the greatest difficulty that has been encountered, has been to decide how far to follow particular aspects of water use back into the zussammenhang. The line has to be drawn somewhere, and it is almost inevitably an arbitrary one. It is very evident that each of the aspects studied in Chapter IV - XI could form the basis of a more intensive study, and there is indeed a considerable

attraction in taking a specialist view of a particular aspect, and this is the pattern of modern science. Just as the 'uomo universale' of renaissance times subsequently split into his components of artist, theologian, natural scientist and philosopher, so this fissiparous tendency has continued into our own day. There is nothing sacred about the present conventional academic disciplines, and the multiplying of fields of study, as a cell dividing and subdividing, would seem to be closer to the natural order of things, than any static conception of scientific inquiry. At the same time it is clear that the advances in scientific thought which are characterised by the further compartmentalising of knowledge, are achieved only at the cost of our understanding. As scientific investigation widens our awareness of the infinite complexity of nature, then our comprehension of the whole becomes dimmer. If the geographers of Vidal's day saw the whole, but darkly, the specialists of our own time see but the tiniest part clearly. It is a matter of opinion which group is nearer the truth.

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The Priory of Finchale	VI	1836
Histericae Dunelmensis Scriptorum Tres	IX	1837
The Durham Household Book	XVIII	1844
Boldon Book	XXV	1852
Bishop Hatfield's Survey	XXXII	1857
Feodarium Prioratus Dunelmensis	LVIII	1872
Halmota Prioratus Dunelmensis	LXXXII	1889
Memorials of St. Giles ... and Kepier etc.	XCV	1896
Extracts from the Account Rolls of the Abbey of Durham I	XCIX	1898
II	C	1899
III	CIII	1901
Six North Country Diaries I	CXVIII	1910
II	CXXIV	1915
Durham Civic Memorials	CLX	1952
Records of Antony Bek	CLXII	1953
Register of Thomas Langley I	CLXIV	1956
II	CLXIX	1957
III	CLXIX	1959
Durham Recusants' Estates 1717-78 I	CLXXIII	1962
1717-78 II	CLXXV	1965

Contemporary records published by the Historical Manuscripts
Commission:
Portland MSS

Commons Journals Vols. 20-28 (1727-57)

British Sessional Papers (Blue Books)
H.C. 1861 XXIII
XXXIII

H.C. 1862 XIV
1865 XXIX
1867 XVIII
1868 XIX
1874 XXXIII
1878 LXI
1901 XXXIV
1914 LXXIX
1935-6 VI

In addition the following manuscript records have been consulted:

a. In the custody of Durham County Council, at the County Record Office, County Hall, Durham:

Brancepeth MSS
Chaytor MSS (D/C)
Londonderry MSS (D/L)
Salvin MSS (D/S)
Minutes: Bishop Auckland Local Board of Health 1854-1950
Bishop Auckland Rural Sanitary Authority 1872-1937
Creek & Willington Rural Sanitary Authority 1899-1929
Crook Joint Sewage Works Committee 1898-1921
Hetton Water Supply Committee 1930-1947
Hetton Main Sewage Committee 1896-1954
Houghton Rural Sanitary Authority 1872-1888
1903-1926
Lanchester Rural Sanitary Authority 1872-1894
Spennymoor Local Board of Health 1864-1894
Tow Law Local Board of Health 1863-1894
Weardale Rural Sanitary Authority 1873-1894

at the Library of the Medical Officer of Health:

Health Committee Minutes 1893-1958
Quarterly Reports of the Medical Officer of Health 1893-1958

b. In the custody of Gateshead County Borough at Gateshead Public Library:

Coatesworth MSS

c. In the custody of the River Wear Commissioners, St. Thomas Street, Sunderland:

Wear Commissioners' MSS

d. In the custody of the Rt. Hon. the Earl of Scarborough at Sandbeck Park, Rotherham, Yorkshire:

Lumley MSS (L)

e. In the custody of the University of Durham, Department of
Paleography and Diplomatic, at the Prior's Kitchen, Durham:

Dean and Chapter Muniments

at South Road, Durham:

Church Commission, Halmote Court Deposit (C.C./H.C.)

Church Commission Deposit including Rentals and Surveys (C.C./R.S.)

Bishopric Estates Schedule

(C.C./B.E.S.)

Lead Mine Accounts (C.C./L.M.)

Durham City Deposit

Weardale Chest

f. In the custody of the University of Newcastle upon Tyne at the
University Library:

Allendale MSS., Beaumont Collection (A/B)

APPENDIX A

PART I

Results of two-hourly readings
of stage at Abbey Weir

Week Beginning	Daily Discharges in Millions of Gallons										Weekly Discharge	
<u>1965</u>												
3 May	210.1	246.5	294.5	214.7	251.8	241.9	292.8	1752.0				
10 May	201.7	154.5	144.0	129.3	122.3	115.9	117.9	985.6				
17 May	192.1	410.7	483.7	241.3	186.9	160.8	140.5	1816.0				
24 May	168.5	170.8	160.9	148.2	143.8	129.3	121.2	1042.0				
31 May	134.0	124.7	108.3	101.8	95.0	81.9	97.1	742.8				
7 June	119.3	99.5	86.0	80.5	78.6	88.7	85.1	637.6				
14 June	81.9	75.5	74.2	72.1	70.6	68.2	63.0	505.5				
21 June	68.4	133.2	169.6	110.9	168.5	153.1	136.9	940.5				
28 June	98.9	84.9	72.8	69.1	69.6	67.1	71.7	534.1				
5 July	70.2	64.0	62.5	65.4	66.6	57.2	64.9	450.8				
12 July	71.6	94.1	196.5	132.7	83.6	65.4	65.7	709.7				
19 July	67.5	62.7	65.8	136.3	92.9	205.6	212.5	843.3				
26 July	117.5	95.8	88.3	131.1	421.7	184.3	121.6	1160.0				
2 Aug	103.2	199.3	147.5	575.8	296.8	158.6	177.5	1659.0				
9 Aug	215.9	146.1	117.4	108.0	99.7	88.1	149.0	924.1				
16 Aug	297.3	298.3	166.1	110.5	95.1	88.3	109.5	1165.0				
23 Aug	105.7	84.3	102.5	95.8	85.6	72.4	69.5	615.8				
30 Aug	72.6	70.2	67.1	73.0	67.1	124.6	272.7	747.3				
6 Sept	134.0	100.6	84.7	108.2	128.0	139.0	153.4	847.9				
13 Sept	145.3	397.8	272.0	178.0	184.6	444.9	260.5	1883.0				
20 Sept	154.9	132.4	120.8	103.6	102.0	98.8	1097.0	1810.0				
27 Sept	576.5	338.1	911.9	1275.0	1015.0	919.6	468.2	5504.0				
4 Oct	347.5	242.9	212.2	191.2	177.7	165.0	306.6	1643.0				

11 Oct	161.3	570.4	-	137.9	128.8	127.2	119.1	114.9	1360.0
18 Oct	113.4	102.1		97.3	98.5	100.1	94.5	92.6	698.7
25 Oct	98.4	93.8		89.6	92.7	109.1	152.1	355.3	991.0
1 Nov	1324.0	930.7		383.4	231.3	184.5	163.1	168.9	3386.0
8 Nov	371.1	240.3		185.5	165.9	271.4	496.3	395.9	2126.0
15 Nov	303.4	257.8		529.3	1156.0	2104.0	2742.0	1218.0	8311.0
22 Nov	667.8	647.6		923.2	513.0	418.9	394.3	346.1	3911.0
29 Nov	354.5	313.4		306.5	302.0	475.9	872.7	567.9	3193.0
6 Dec	607.1	506.7		439.5	2030.0	2211.0	805.9	550.2	7150.0
13 Dec	501.2	890.3		1012.0	642.1	1428.0	622.3	1064.0	6159.0
20 Dec	453.7	836.7		356.4	576.7	447.0	559.8	397.6	3628.0
27 Dec	293.2	238.1		207.0	364.2	436.0	548.7	1190.0	3277.0

1966

3 Jan	666.2	386.7	330.8	627.0	446.7	351.6	311.7	3121.0
10 Jan	255.5	235.2	221.3	212.5	209.6	200.6	201.1	1536.0
17 Jan	195.1	183.9	160.6	137.5	162.2	157.6	213.4	1210.0
24 Jan	806.5	469.8	919.6	933.9	982.0	867.0	736.4	5215.0
31 Jan	564.5	381.8	321.5	330.5	303.6	692.7	734.5	3329.0
7 Feb	438.6	1681.0	941.1	627.6	508.1	449.0	421.3	5066.0

Break Down of Guage

* 14 Feb	332.0	307.0	298.5	289.2	258.6	299.8	1343.0	3125.0
* 21 Feb	1847.0	1930.0	1273.0	1526.0	2678.0	1404.0	1021.0	11679.0
* 28 Feb	800.2	509.3	479.5	407.8	302.3	232.7	208.8	2940.6
7 Mar	100.0	89.3	74.0	69.8	214.3	96.2	61.2	704.8
14 Mar	46.4	45.7	43.9	42.4	42.1	42.5	43.1	306.2
21 Mar	46.3	46.3	46.3	46.3	46.3	46.3	56.7	334.4
28 Mar	123.9	68.2	69.8	69.8	74.8	98.3	55.7	560.8
4 Apr	81.6	69.9	456.4	496.1	409.9	787.9	2183.0	4485.0
11 Apr	574.3	519.1	347.1	193.6	152.7	170.6	216.4	2174.0
18 Apr	204.7	345.4	291.7	429.6	735.4	724.9	334.2	3066.0
25 Apr	227.0	130.5	92.2	85.5	60.7	37.2	68.9	701.9
2 May	41.9	40.8	49.1	44.5	48.2	44.8	43.9	313.1
9 May	52.9	38.8	39.0	492.3	150.8	54.2	42.0	870.0
16 May	37.5	43.6	38.8	44.5	52.7	44.8	44.5	306.3
23 May	46.9	47.5	40.0	39.8	41.5	41.9	37.7	295.4
30 May	282.5	124.0	49.7	49.1	43.4	46.3	46.0	641.0
6 June	45.8	43.7	43.7	54.2	44.0	41.9	46.3	310.4
13 June	41.3	40.7	41.6	46.1	55.4	42.3	37.3	304.6
20 June	43.9	46.3	43.1	88.1	137.5	63.3	45.2	467.4
27 June	47.0	71.7	34.1	37.0	32.5	40.4	45.4	308.1
4 July	35.8	41.2	37.0	36.6	32.8	29.3	32.2	245.0
11 July	32.2	43.4	35.6	47.2	38.4	41.2	46.1	284.1
18 July	42.7	45.7	43.6	40.7	41.4	42.4	42.1	298.6
25 July	41.9	42.2	56.6	58.5	66.8	64.7	41.9	372.6

* Approximate values computed from Sunderland Bridge and Burn Hall discharges during period of mechanical fault at Abbey Weir.

1 Aug	111.8	100.3	98.6	246.0	166.6	111.7	87.3	922.4
8 Aug	130.8	118.7	222.2	146.1	101.7	261.4	1771.0	2752.0
15 Aug	574.9	239.8	166.8	140.6	115.1	101.6	225.6	1564.0
22 Aug	872.6	316.9	197.8	159.2	116.4	100.0	91.7	1855.0
29 Aug	96.1	100.8	111.0	117.7	98.5	96.7	111.6	732.3
5 Sept	96.1	102.0	102.4	81.1	69.9	64.3	57.7	573.3
12 Sept	79.6	270.0	220.6	413.8	266.9	162.8	176.3	1590.0
19 Sept	108.5	98.6	96.4	75.0	71.7	73.2	66.8	570.1
26 Sept	68.2	64.0	62.4	60.9	57.2	65.5	89.5	467.7
3 Oct	119.5	1682.0	636.4	375.2	297.2	210.9	181.1	3502.0
10 Oct	160.0	135.7	119.5	113.3	388.1	657.6	959.7	2534.0
17 Oct	419.3	517.7	702.8	683.6	383.2	292.9	243.9	3243.0
24 Oct	202.2	180.5	168.2	346.6	518.7	283.9	212.8	1913.0
31 Oct	184.0	165.9	203.8	208.5	169.7	155.3	270.7	1358.0
7 Nov	424.8	319.6	240.4	186.4	167.3	165.0	179.5	1683.0
14 Nov	324.4	292.7	628.5	288.3	300.8	528.0	501.1	2864.0
21 Nov	376.4	420.7	383.1	271.4	232.2	224.4	221.8	2130.0
28 Nov	227.4	201.2	622.7	457.0	1334.0	628.0	350.2	3820.0
5 Dec	294.5	895.1	451.9	525.8	388.8	297.2	239.5	3093.0
12 Dec	264.8	795.7	399.6	267.1	424.7	332.2	1069.0	3553.0
19 Dec	286.4	840.9	269.0	173.6	127.5	102.1	60.2	1860.0
26 Dec	53.2	53.2	50.3	74.8	220.6	124.7	116.7	693.4

1967

2 Jan	56.2	53.8	53.4	46.4	44.6	48.4	50.0	352.7
9 Jan	62.4	68.5	62.4	69.4	73.4	73.4	62.2	471.7
16 Jan	48.8	46.3	72.5	44.2	48.2	79.8	233.5	573.2

23 Jan	285.3	309.2	243.6	505.6	224.2	332.9	184.5	2085.0
30 Jan	151.2	151.9	160.5	138.4	98.3	124.7	85.3	910.3
6 Feb	73.4	69.2	64.3	56.7	46.0	43.6	46.6	399.7
13 Feb	46.6	39.0	39.2	44.8	34.9	40.8	48.3	728.7
20 Feb	808.6	281.9	155.7	836.1	405.2	406.6	703.8	3598.0
27 Feb	356.3	813.2	116.7	49.4	46.3	46.6	50.0	1478.0
6 Mar	84.3	48.1	47.5	44.8	152.1	238.3	40.9	656.1
13 Mar	39.8	38.3	41.5	37.7	37.8	49.7	48.4	293.2
20 Mar	49.7	47.5	50.0	47.2	46.6	49.1	50.0	340.0
27 Mar	50.0	48.7	50.0	50.0	50.0	50.0	50.0	348.6
3 Apr	51.8	49.4	34.3	23.2	177.2	351.7	735.2	1423.0
10 Apr	224.6	100.3	61.9	45.2	39.3	29.8	34.7	535.9
17 Apr	39.7	32.3	29.6	33.6	38.1	32.5	45.2	250.8
24 Apr	52.2	102.3	77.0	52.7	35.6	33.6	32.5	385.7
1 May	31.7	37.5	37.2	50.2	140.5	126.8	176.0	605.9
8 May	129.8	149.0	122.2	297.8	787.1	513.0	629.3	2628.0
15 May	1168.0	896.3	432.5	372.0	260.6	295.8	387.6	3813.0
22 May	538.7	286.0	252.2	406.6	335.4	205.3	332.9	2357.0
29 May	489.4	434.0	219.0	180.5	180.5	167.7	159.4	1830.0
5 June	161.7	154.9	157.2	141.3	137.8	133.0	126.6	1013.0
12 June	118.2	105.9	90.7	85.0	81.0	75.5	72.0	628.2
19 June	62.4	50.0	50.0	50.0	50.0	50.0	98.7	411.0
26 June	89.3	76.7	67.6	50.9	47.2	45.7	49.4	426.7

3 July	51.9	50.0	50.0	51.9	48.4	49.9	50.0	352.1
10 July	50.0	43.4	47.2	42.1	294.7	432.5	160.4	1072.0
17 July	114.0	221.7	134.2	81.6	62.3	58.7	50.6	723.2
24 July	50.0	48.7	45.7	44.5	47.2	47.5	62.4	346.0
31 July	67.8	61.0	60.0	54.2	46.0	54.6	56.2	399.7
7 Aug	53.8	48.1	415.5	495.4	256.8	170.3	142.7	1583.0
14 Aug	197.4	922.5	295.8	219.1	235.1	1614.0	389.5	3874.0
21 Aug	208.5	133.3	58.4	44.6	42.4	41.2	39.8	568.0
28 Aug	41.2	41.2	40.6	41.5	40.3	40.9	40.0	285.8
4 Sept	123.1	521.8	447.7	122.5	67.6	60.6	59.4	1403.0
11 Sept	44.8	37.5	40.9	39.2	39.2	40.9	39.8	282.2
18 Sept	50.0	46.9	48.2	44.4	44.4	56.2	38.3	328.4
25 Sept	76.2	71.3	402.8	134.1	111.2	351.0	343.3	1481.9

PART II

Tables

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Table 1

Current Metering 21, December, 1965. 1000-1200 hrs.

Stage at Abbey Weir 0.6 Feet

Distance from Bank (feet)	Depth (Feet)	0.6 Depth	Cup Revolutions	Time in Seconds	Velocity in feet per second
6	1.0	0.60	2	22	0.277
12	4.5	2.76	4	16	0.610
18	7.5	4.50	9	30	0.720
24	7.0	4.20	8	28	0.695
30	8.0	4.80	9	29	0.720
36	7.0	4.20	10	30	0.792
42	7.2	4.32	14	30	0.805
48	7.4	4.44	14	30	0.805
54	7.5	4.50	15	30	1.15
60	6.7	4.02	16	30	1.25
66	7.4	4.44	12	29	0.890
72	6.0	3.60	12	28	1.00
78	6.0	3.60	12	30	0.760
84	5.5	3.30	12	31	0.938
90	7.0	4.20	12	38	0.915
96	5.4	3.24	12	40	0.753
102	4.0	2.40	8	30	0.718
108	1.0	0.60	2	27	0.244

Table 2

Conversion Table for Table 1

Velocity 1 in feet per sec	Velocity 2 in feet per sec	Mean Velocity in feet per sec	Area in sq. feet	Discharge in cubic feet per sec
Bank	0.277	0.1675	3.0	0.5025
0.277	0.610	0.4435	16.8	7.4500
0.610	0.720	0.6650	36.3	24.1300
0.720	0.695	0.7075	43.5	30.7700
0.695	0.720	0.7075	45.0	31.8400
0.720	0.792	0.7560	45.0	34.0100
0.792	0.805	0.7985	42.6	34.0200
0.805	0.805	0.8050	43.8	35.2600
0.805	1.150	0.9775	44.7	43.6900
1.150	1.250	1.2000	42.6	51.1200
1.250	0.890	1.0700	42.3	45.2600
0.890	1.000	0.9450	40.2	37.9900
1.000	0.760	0.8800	36.0	31.6800
0.760	0.938	0.8490	34.5	29.2900
0.938	0.915	0.9265	37.5	34.7300
0.915	0.753	0.8340	37.2	31.0200
0.753	0.718	0.7355	28.2	20.7400
0.718	0.244	0.4810	12.0	5.7200
0.244	Bank	0.1710	5.0	0.8548

Total Discharge 530.0773 cusecs

Table 3

Current Metering 20, January, 1966. 1100-1230 hrs.

Stage at Abbey Weir 0.4 Feet

Distance from Bank	Depth in Feet	0.6 Depth	Cup Revolutions	Time in Seconds	Velocity in feet per second
6	1.25	0.75	..Current too slow to register..		
12	4.00	2.40	2	36	0.176
18	6.10	3.60	3	27	0.319
24	6.60	3.92	3	18	0.433
30	6.50	3.90	3	16	0.478
36	6.40	3.84	3	15	0.503
42	6.90	4.14	3	13	0.572
48	7.00	4.20	3	14	0.533
54	7.00	4.20	3	14	0.533
60	6.20	3.72	3	17	0.456
66	7.00	4.70	3	15	0.503
72	6.70	4.02	4	20	0.503
78	6.00	3.60	4	20	0.503
84	6.60	3.96	3	25	0.336
90	6.20	3.72	4	40	0.295
96	4.40	2.64	4	31	0.364
102	3.00	1.80	2	37	0.180
108	1.00	0.60	..Current too slow to register..		

Table 4

Conversion Table for Table 3

Velocity 1 in feet per sec	Velocity 2 in feet per sec	Mean Velocity in feet per sec	Area in sq. feet	Discharge in cubic feet per sec
Bank	0.176	0.880	19.5	1.716
0.176	0.319	0.2475	30.3	7.499
0.319	0.433	0.3760	38.1	14.326
0.433	0.478	0.4555	36.3	16.535
0.478	0.503	0.4905	38.7	18.982
0.503	0.572	0.5325	39.9	21.247
0.572	0.533	0.5525	41.7	23.040
0.533	0.533	0.5330	42.0	22.390
0.533	0.456	0.4945	39.6	19.582
0.456	0.503	0.4945	39.6	19.582
0.503	0.503	0.5030	41.1	20.673
0.503	0.503	0.5030	38.1	19.164
0.503	0.336	0.4195	37.8	15.860
0.336	0.295	0.3255	38.4	12.499
0.295	0.364	0.3295	31.8	10.480
0.364	0.180	0.2730	22.2	6.040
0.180	Bank	0.0900	12.0	1.080

Total Discharge 250.695 cusecs

Table 5

Calculation of Discharge at Abbey Weir

<u>Sunderland Bridge</u>				<u>Burn Hall</u>				<u>Abbey Weir</u>				
Time in OO-hrs	Stage in feet	D'chge in cusecs	Time in OO-hrs	Stage in feet	D'chge in cusecs	Compen- sated D'chge	Time in OO-hrs	Stage in feet	D'chge in cusecs	Time in OO-hrs	Stage in feet	D'chge in cusecs
2000	6.60	5650	1940	3.25	724.0	425.7	2200	3.50	6799.7			
0600	6.09	4906	0543	4.15	1173.0	689.7	0745	3.44	6786.7			
1800	5.36	3909	1743	4.73	1510.0	887.9	2015	3.30	6296.9			
1330	4.67	3041	1305	3.75	963.0	566.2	1600	2.80	4570.2			
1000	5.60	4230	0935	2.03	256.0	150.5	1230	2.60	4636.5			
1700	5.24	3753	1653	1.23	76.0	44.7	1815	2.45	3873.7			
0100	4.33	2638	0045	2.00	246.0	144.6	0235	2.25	3028.6			
0600	2.65	1006	0530	1.65	156.0	91.7	0900	1.20	1253.7			
0045	3.85	2110	0035	2.28	340.0	199.9	0145	1.28	2650.9			
0400	3.75	2038	0342	1.89	215.0	126.4	0550	1.70	2381.4			
0530	2.88	1197	0525	2.53	430.0	252.8	0600	1.50	1864.8			
1800	3.50	1750	1750	2.04	259.0	152.9	1900	1.37	2161.9			
0130	2.75	1088	0120	1.62	149.0	87.6	0230	1.17	1314.6			
1115	2.40	812.3	1102	2.05	262.0	154.0	1300	1.07	1228.0			
0730	2.42	827.8	0720	1.00	54.5	32.0	0830	0.95	914.0			
2220	1.25	78.8	2200	2.61	246.4	144.8	0000	0.75	471.2			
1930	1.80	421.4	1905	0.82	40.5	23.8	2200	0.62	485.8			
0500	1.51	282.6	0500	0.90	46.5	27.3	0500	0.50	346.3			
*	1.26	197.5	*	0.90	46.5	28.3	2400	0.40	271.3			
*	1.10	151.9	*	0.74	34.7	20.4	0900	0.35	217.0			
*	0.98	121.9	*	0.69	31.0	18.2	0100	0.30	171.1			
*	0.97	119.6	*	0.52	20.4	13.9	1800	0.26	153.9			

* = periods of constant level

Table 6

Calculation of the formula $\log a = \log D - \frac{3}{2} \log s$

s	D	log s	$\frac{3}{2} \log s$	log D	log a	a
3.50	6799.7	0.544	0.816	3.832	3.016	1038
3.44	6786.7	0.536	0.804	3.831	3.027	1064
3.30	6296.9	0.518	0.777	3.799	3.022	1052
2.80	4570.2	0.447	0.670	3.660	2.990	977
2.60	4636.5	0.414	0.621	3.666	3.045	1109
2.45	3873.7	0.389	0.583	3.588	3.005	1009
2.25	3028.6	0.352	0.528	3.481	2.953	895
1.20	1253.7	0.079	0.118	3.097	2.979	952
1.82	2650.9	0.260	0.390	3.423	3.033	1078
1.70	2381.4	0.230	0.345	3.377	3.032	1076
1.50	1864.8	0.176	0.264	3.270	3.006	1013
1.37	2161.9	0.137	0.206	3.335	3.129	1345
1.17	1414.6	0.168	0.252	3.119	2.867	736
1.07	1228.0	0.029	0.044	3.089	3.045	1109
0.95	914.0	1.978	-0.033	2.961	2.994	986
0.75	471.2	1.875	-0.188	2.673	2.981	957
0.62	485.8	1.792	-0.312	2.687	2.999	998
0.50	346.3	1.698	-0.453	2.539	2.992	981
0.40	271.3	1.602	-0.398	2.433	2.831	921
0.35	217.0	1.544	-0.684	2.336	3.020	1047
0.30	171.1	1.477	-0.785	2.233	3.018	1042
0.26	153.9	1.415	-0.877	2.187	3.064	1158

Average value of a = 1024

Table 7

Monthly Proportions of Precipitation and Discharge (%)

	<u>Oct</u>	<u>Nov</u>	<u>Dec</u>	<u>Jan</u>	<u>Feb</u>	<u>Mar</u>	<u>Apr</u>	<u>May</u>	<u>Jun</u>	<u>Jul</u>	<u>Aug</u>	<u>Sep</u>
<u>1965-6</u>												
Discharge	5.1	16.1	21.9	12.2	15.7	4.2	9.6	2.1	1.4	1.2	6.7	3.2
Precipitation	4.2	18.5	6.3	6.5	13.2	2.4	11.0	6.6	6.8	6.3	13.7	4.4
Difference	0.9	2.4	15.6	5.7	2.5	1.8	1.4	4.5	5.4	5.1	7.0	1.2
<u>1966-7</u>												
Discharge	15.7	12.2	16.2	5.4	8.8	2.5	3.7	14.4	4.2	3.7	8.8	4.4
Precipitation	13.2	7.5	8.4	4.3	9.2	5.3	5.8	14.0	4.4	8.8	11.6	7.5
Difference	2.5	4.7	8.8	1.1	0.4	2.8	2.1	0.4	0.2	5.1	2.8	3.1

Table 8

Mean Monthly Rainfall in Inches over Standard Period 1916-1950

<u>Catchment</u>	<u>Oct</u>	<u>Nov</u>	<u>Dec</u>	<u>Jan</u>	<u>Feb</u>	<u>Mar</u>	<u>Apr</u>	<u>May</u>	<u>Jun</u>	<u>Jul</u>	<u>Aug</u>	<u>Sep</u>
Wear above Stanhope	5.4	5.2	4.8	5.4	3.8	3.3	3.3	3.5	3.0	4.5	5.0	4.7
Gaunless	2.8	2.9	2.7	2.9	2.2	1.9	2.0	2.2	1.9	2.7	2.9	2.5
Browney	2.9	2.9	2.6	2.8	2.2	1.9	2.0	2.3	2.0	3.0	3.1	2.6
Wear above Croxdale	3.7	3.7	3.3	3.7	2.8	2.4	2.4	2.7	2.3	3.4	3.5	3.2
Wear above Durham	3.4	3.4	3.1	3.4	2.6	2.5	2.2	2.6	2.2	3.3	3.4	3.0
Wear	3.3	3.3	2.9	3.2	2.4	2.1	2.2	2.4	2.1	3.2	3.4	2.9
Burnhope	5.5	5.5	5.5	6.1	4.8	4.3	3.6	3.0	2.7	3.4	4.3	3.9

Source: Surface Water Year Book

Table 9

Monthly Proportion of Mean Annual Rainfall 1916-1950 (%)

<u>Catchment</u>	<u>Oct</u>	<u>Nov</u>	<u>Dec</u>	<u>Jan</u>	<u>Feb</u>	<u>Mar</u>	<u>Apr</u>	<u>May</u>	<u>Jun</u>	<u>Jul</u>	<u>Aug</u>	<u>Sep</u>
Wear above Stanhope	10.5	10.1	9.2	10.5	7.3	6.4	6.3	6.6	5.7	8.7	9.7	9.0
Gaunless	9.4	9.9	9.2	9.8	7.4	6.4	6.8	7.4	6.4	9.2	9.8	8.4
Brownney	9.6	9.6	8.5	9.3	7.2	6.3	6.5	7.5	6.3	9.7	10.0	8.5
Wear above Croxdale	9.9	9.9	8.9	9.9	7.5	6.5	6.5	7.3	6.3	9.2	9.5	8.6
Wear above Durham	9.6	9.6	8.6	9.6	7.3	7.0	6.3	7.3	6.3	9.3	9.6	8.5
Wear	9.9	9.9	8.6	9.6	7.2	6.3	6.6	7.2	6.3	8.6	10.2	8.6

Table 10

Private Water Undertakings in 1914

<u>Company</u>	<u>Source of Water</u>	<u>Quantity</u>	<u>Filtration</u>	<u>Reservoirs</u>	<u>Capacity</u>	<u>Water Quality</u>
Lambton & Hetton Collieries Ltd.	Shaft at E. Herrington Shaft at Houghton	301,000 gpd 170,000 gpd	None None	Herrington Hill Houghton Hill Houghton Hill Houghton Hill	300,000 228,000 114,000 114,000	Inferior Good Good Good
N. Hetton Coal Co., Ltd.	25' boring at Moorsley	20,160 gpd	None	Lower Moorsley Higher Moorsley	23,930 8,974	Good Good
Walter Scott Ltd.	Well at Trimdon Shaft at Trimdon Colliery	245,800 gpd 218,000 gpd	None None	Trimdon Grange Trimdon Grange Trimdon Grange Quarrington Hill Quarrington Hill Quarrington Hill Deaf Hill	10,000 10,000 5,000 6,750 6,750 6,750 5,000	Hard Hard Hard Hard Hard Hard Hard
Sherburn Hospital	Springs at Old Cassop	3,600 gpd	None	Cassop (in 8 tanks)	36,788	Wholesome
Steatley Lime Co.	Springs at Quarrington	6,120 gpd	None	Quarrington Hill W. House Farm Joint Stock Farm Prescott hall Farm	3,500 2,500 2,500 1,200	Satisfactory Satisfactory Satisfactory Satisfactory
Weardale Coal & Coke Co. Ltd.	Wells at Ludworth Colliery	35,000 gpd	None	Ludworth	incomplete return	

Hetton le Hole & Easington Lane W.C.	Well at Eppleton Colliery	170,000 gpd	None	Eppleton Easington Lane	460,000 270,000	Hard Hard
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Source: H.C. LXXIX (1914) 395

Table 11

Returns of District Authority Water Undertaking

<u>Authority</u>	<u>Population</u>	<u>Water Consumption</u>	<u>per capita</u>
Bishop Auckland	11,000	250,000 gpd	22.7
Stanhope	1,700	c20,000 gpd	11.8
Durham City	14,450	c500,000 gpd	34.6
Houghton le Spring	5,276	65,000 gpd	12.3

Source: H.C. (1878) LXI, 108.

Table 12

Return as to Water Undertakings in England and Wales

Area	Acres	Pop ⁿ 1911	No. of Houses		Undertakers	With Piped Service		
			Total	Supplied		Source	Nature & Sufficiency	
<u>Urban Districts</u>								
Bishop Auckland	691	13834	2906	2906	B.A. U.D.C. & W & C.W. Co. (bulk)	-	-	-
Brandon & Byshottles	6669	17667	3374	3359	W & C.W.C.	Springs	Satisfactory	-
Chester le Street	2511	14712	2861	2861	W & C.W.C.	-	-	-
Consett	1005	11207	2169	2169	W & C.W.C.	-	-	-
Crook	4056	12308	2476	2462	W & C.W.C.	Wells	Good	-
Durham M.B.	1006	17550	2722	2722	W & C.W.C.	-	-	-
Hetton le Hole	1617	15678	3083	3083	Hetton le Hole & Easington	-	-	-
Houghton le Spring	1551	9953	1858	1844	Lane W.C. Ltd. S & S.S.W.C. (bulk)	Springs	Doubtful	-
Spennymoor	3388	17909	3556	3544	Lambton & Hetton Coll's. W & C.W.C.	Springs	Fair & Adequate	-
Stanhope	216	2010	438	438	Stanhope U.D.C.	-	-	-
Tow Law	477	4324	928	928	W & C.W.C.	-	-	-
Willington	3793	8731	1715	1705	W & C.W.C.	Springs	Satisfactory	-

Rural Districts

1. Auckland

Auckland St. Andrew	1275	5605	1233	1233	1233	B.A. U.D.C. & W & C.W.C.	-	-	Good & Generally Adequate
Auckland St. Helen	1510	1622	345	341	341	B.A. U.D.C. & W & C.W.C.	-	Wells & Springs	Good & Generally Adequate
Binchester	596	50	10	8	8	W & C.W.C.	-	Springs	Good & Generally Adequate
Bolam	1013	124	27	-	-	-	-	Wells & Springs	Good & Generally Adequate
Byers Green	935	2349	490	489	489	W & C.W.C.	-	Springs	Good & Generally Adequate
Coundon Eldon	794 1421	6912 1657	1430 313	1430 297	1430 297	W & C.W.C. W & C.W.C.	-	Springs	Good & Generally Adequate
Coundon Grange	669	3627	781	780	780	W & C.W.C.	-	Springs	Good & Generally Adequate
Escomb Evenwood & Barony	1029 5437	2783 4987	706 1000	706 960	706 960	W & C.W.C. W & C.W.C. (part in bulk)	-	Wells & Springs	Good & Generally Adequate
Hamsteley	2985	425	106	0	0	-	-	Wells & Springs	-

Helmington Row	1303	4841	948	935	W & C.W.C.	Springs	Good & Generally Adequate
Hunwick & Helmington	1977	2464	580	573	W & C.W.C.	Springs & River Wear	Good & Generally Adequate
Lynsack & Softley	3742	2706	587	547	B.C. R.D.C. (bulk)	Springs & Wells	Good & Generally Adequate
Merrington	1646	882	190	187	W & C.W.C. W & C.W.C.	Wells	Good & Generally Adequate
Middlestone	893	1984	392	385	B.C. R.D.C. (bulk)	Springs & Surface Water	Good & Generally Adequate
Middridge	1132	452	122	116	W & C.W.C. B.C. R.D.C. (Bulk)	Springs & Wells	Good & Generally Adequate
Middridge Grange	977	79	14	11	W & C.W.C. B.C. R.D.C. (bulk)	Springs	Good & Generally Adequate
Newfield	341	1340	249	247	W & C.W.C. B.C. R.D.C. (bulk)	Springs	Good & Generally Adequate
Newton Cap	1304	1192	237	230	W & C.W.C. B.C. R.D.C. (bulk)	Springs	Good & Generally Adequate
N. Bedburn	2843	2542	516	498	W & C.W.C. W & C.W.C.	Springs & Wells	Good & Generally Adequate

Old Park	414	835	154	149	W & C.W.C.	Springs	-
Pollards Lands	1896	1123	215	215	-	-	-
S. Bedburn	10039	226	56	-	-	Wells & Springs	-
W. Auckland	3407	4471	940	936	W & C.W.C.	Wells & Springs	Good & Generally Adequate
Westerton	699	521	94	94	W & C.W.C.	Wells & Springs	Good & Generally Adequate
Whitworth Without	583	77	16	16	W & C.W.C.	-	-
Windlestone	1188	188	39	10	W & C.W.C.	Springs & Wells	Good & Generally Adequate
Witton le Wear	3192	2271	458	439	W & C.W.C.	Springs & Wells	Good & Generally Adequate

2. Chester le Street

Barmston	919	492	102	94	S & S.S.W.C. (bulk)	Wells	Fair
Birtley	1429	8409	1662	1655	N & G.W.C.	Wells	Fair
Bournmoor	513	1320	258	258	Lambton & Hetton Coll's Ltd.	-	-
Cocken	464	190	34	32	W & C.W.C. (part in bulk)	Wells	Fair
Edmondsley	2104	2222	456	449	W & C.W.C. (bulk)	Wells	Fair

Great Lumley	1642	2177	448	425	W & C.W.C. (bulk)	Wells	Fair (some doubtful)
Harraton	3002	3399	664	648	W & C.W.C. Lambton & Hetton Coll's Ltd. N & G.W.C. S & S.S.W.C. (bulk)	Wells	Fair
Lambton	691	130	30	27	N & G.W.C.	Wells	Fair (some insufficient)
Lamesley	7177	6369	1325	1264	W & C.W.C. (part bulk) N & G.W.C. John Bowes & Partners	Wells	Fair (but some insufficient)
Little Lumley	867	1239	325	318	W & C.W.C. (bulk)	Wells	Fair (but some insufficient)
Ouston	641	942	165	157	W & C.W.C. (bulk)	Wells	Fair
Pelton	1078	8118	1785	1783	W & C.W.C. (bulk)	Wells	Fair
Plawsworth	1320	1333	291	286	W & C.W.C. (bulk)	Wells	Fair
S. Biddick	352	57	20	17	N & G.W.C.	Wells	Fair
Urpeth	1860	3320	713	672	W & C.W.C.	Wells	Fair
Usworth	2134	7986	1552	1540	N & G.W.C. (bulk)	Wells	Fair
Waldrige	680	1256	283	274	W & C.W.C.	Wells	Fair

Washington	1973	7821	1549	1491	S & S.S.W.C. N & G.W.C.	Wells	Fair (but some insufficient) Fair
Witton Gilbert	3255	7098	1562	1555	W & C.W.C.	Wells	Fair
<u>3. Durham</u>							
Bearpark	1137	1758	304	302	W & C.W.C.	Wells	Good & Adequate
Belmont	1604	3246	680	677	W & C.W.C.	Wells	Good & Adequate
Brancepeth	3752	384	73	50	W & C.W.C.	Wells	Good & Adequate
Broom	1086	3260	694	694	W & C.W.C.	-	-
Cassop cum Quarrington	3257	2967	565	525	Walter Scott Ltd. (part in bulk)	Wells	Good & Adequate
Coxhoe	1058	3833	726	724	Walter Scott Ltd. (part in bulk)	Wells	Good & Adequate
Framwellgate Moor	3745	2552	503	450	Steetley Lime Co. W & C.W.C. W & C.W.C.	Wells	Good & Adequate
Hett	1279	369	80	65	W & C.W.C.	Wells	Good & Adequate
Kimblesworth	626	1221	244	238	W & C.W.C.	Wells	Good & Adequate
Neville's Cross	305	962	220	220	W & C.W.C.	-	-
Pittington	2371	2130	459	431	W & C.W.C. Hetton le Hole & Easington Lane W.C.	Wells	Good & Adequate

St. Oswalds	2227	631	141	130	W & C.W.C.	Wells	Good & Adequate
Shadforth	2904	1744	416	396	W & C.W.C. (bulk) through Lambton & Hetton Coll's Ltd. Weardale Steel, Coal & Coke Co.Ltd. W & C.W.C. through Lambton & Hetton Coll's Ltd.	Wells	Good & Adequate
Sherburn	1310	2918	635	626	W & C.W.C. through Lambton & Hetton Coll's Ltd.	Wells	Good & Adequate
Sherburn House	740	217	37	33	W & C.W.C. (bulk) Master & Governors of Sherburn Hospital	Wells	Good & Adequate
Shincliffe	1378	1015	275	260	W & C.W.C. (bulk) Master & Governors of Sherburn Hospital	Wells	Good & Adequate
Sunderland Bridge	1438	1431	282	277	W & C.W.C.	Wells	Good & Adequate
Whitwell House	643	152	31	66	Master & Governors of Sherburn Hospital	Wells	Good & Adequate
<u>A. Houghton le Spring</u>							
E & Mid. Herrington	998	248	56	48	S & S.S.W.C. (bulk)	Springs	Satisfactory

E. Rainton	1091	1503	318	280	W & C.W.C.	Springs	Fair Satisfactory
Great Eppleton	706	73	13	9	Hetton le Hole & Easington Lane W.C.	Springs	Satisfactory
Little Eppleton	337	30	7	7	Hetton le Hole & Easington Lane W.C.	-	-
Moor House	282	71	18	18	W & C.W.C.	-	-
Moorsley	603	1038	227	227	N. Hetton Coal Co.	-	-
Morton Grange	462	1190	240	240	Lambton & Hetton Coll's Ltd.	-	-
Newbottle	1454	7191	1402	1402	S & S.S.W.C. Lambton & Hetton Coll's Ltd.	-	-
Offerton	926	318	61	56	Earl of Durham	Springs & Wells	Some Satisfactory
Painshaw	1087	6431	1360	1360	Lambton & Hetton Coll's Ltd. (bulk)	-	-
Silksworth	1993	1161	250	240	S & S.S.W.C.	Springs	Fair Satisfactory
Warden Law	499	91	17	10	Hetton le Hole & Easington Lane W.C.	Springs & Wells	Satisfactory
W. Herrington	979	3828	720	720	Lambton & Hetton Coll's Ltd.	-	-

W. Rainton	1775	2354	513	500	W & C.W.C.	Springs	Satisfactory
<u>5. Lanchester</u>							
Cornsay	3039	2069	407	401	W & C.W.C.	Wells & Springs	Good & Generally Adequate
Craghead	1242	3896	706	700	W & C.W.C.	Wells & Springs	Good & Generally Adequate
Ebchester	599	510	146	134	W & C.W.C.	Wells & Springs	Good & Generally Adequate
Esh	3148	10175	1995	1974	W & C.W.C.	Wells & Springs	Good & Generally Adequate
Greencroft	1676	381	75	68	W & C.W.C.	Wells & Springs	Good & Generally Adequate
Healeyfield	2168	904	204	154	W & C.W.C.	Wells & Springs	Good & Generally Adequate
Hedleyhope	1607	808	241	237	W & C.W.C.	Wells & Springs	Good & Generally Adequate
Knitsley	2201	881	187	165	W & C.W.C.	Wells & Springs	Good & Generally Adequate

Lanchester	13483	5208	929	849	W & C.W.C.	Wells & Springs	Good & Generally Adequate
Langley	2404	513	118	112	W & C.W.C.	Wells & Springs	Good & Generally Adequate
Medamsley	3769	6221	1267	1153	W & C.W.C.	Wells & Springs	Good & Generally Adequate
Muggleswick	12465	367	83	3	W & C.W.C.	Wells & Springs	Good & Generally Adequate
Satley	3350	302	69	-	-	Wells	Good & Generally Adequate
<u>6. Weardale</u>							
Edmonbyers	5103	221	61	20	W.R.D.C.	Springs	Good
Hunstanworth	8039	247	67	-	-	Springs	Good
Stanhope	60620	5769	144	478	W.R.D.C.	Springs	Good
Wolsingham	21909	3414	686	553	W.R.D.C.	Springs	Good

Source: H.C. 1914 (395) LXXIX

Table 13

Weardale & Consett Water Company: Average Daily Consumption

Year	Domestic			Trade			Total
	Weardale	Consett	Total	Weardale	Consett	Total	
1900	1,925,000	1,084,000	3,009,000	1,718,000	1,357,000	3,075,000	6,084,000
1901	1,907,000	1,018,000*	2,925,000	1,752,000	1,186,000*	2,938,000	5,863,000
1902	1,920,000	1,030,000	2,950,000	1,789,000	1,189,000	2,978,000	5,928,000
1903	2,021,000	1,106,000	3,127,000	1,712,000	1,305,000	3,017,000	6,144,000
1904	2,062,000	1,089,000	3,151,000	1,615,000	1,391,000	3,006,000	6,157,000
1905	2,058,000	1,005,000	3,063,000	1,581,000	1,126,000*	2,707,000	5,770,000
1906	2,217,000	1,089,000	3,306,000	1,574,000	1,467,000	3,041,000	6,347,000
1907	2,160,000	1,056,000	3,216,000	1,635,000	1,660,000	3,295,000	6,511,000
1908	2,152,000	1,084,000	3,236,000	1,647,000	1,538,000	3,185,000	6,421,000
1909	2,132,000	1,331,000	3,463,000	1,488,000	1,550,000	3,038,000	6,501,000
1910	2,109,000	1,302,000	3,411,000	1,469,000	1,538,000	3,007,000	6,418,000
1911	2,216,000	1,416,000	3,632,000	1,523,000	1,395,000	2,918,000	6,550,000
1912	2,339,000	1,548,000	3,887,000	1,482,000	1,291,000	2,773,000	6,660,000
1913	2,354,000	1,580,000	3,934,000	1,665,000	1,502,000	3,167,000	7,101,000
1914	2,354,000	1,640,000*	3,994,000	1,430,000*	923,000*	2,352,000*	6,346,000
1915	2,523,741	1,696,513	4,220,254	1,420,474	807,817	2,228,291	6,448,545
1916	2,646,326	1,848,747	4,495,073	1,490,470	1,040,834	2,531,304	7,026,377
1917	2,790,224	1,911,525	4,701,749	1,523,574	1,038,117	2,561,691	7,263,440
1918	2,860,000	1,920,000	4,780,000	1,505,000	1,000,000	2,505,000	7,285,000
1919	2,849,342	1,880,719	4,730,061	1,504,159	1,022,382	2,526,541	7,256,602

* Supplies greatly restricted owing to shortness of water

Table 14

Relative Quinquennial Demands for Water 1889-1913

<u>1. Manufacturing Supply</u>	%
1889-93 as compared with 1884-8 an increase of	18
1894-98	12
1899-03	18
1904-08	no alteration
1909-13	1904-08 a decrease of 2

<u>2. Domestic Supply</u>	%
1889-93 as compared with 1884-8 an increase of	16
1894-98	12
1899-03	8
1904-08	6
1909-13	15

Table 15

Average Daily Consumption in Gallons

	<u>Industrial</u>	<u>Domestic</u>
1884-8	1,953,600	2,167,600
1889-93	2,305,200	2,591,200
1894-98	2,502,000	2,790,500
1899-03	3,046,800	3,013,200
1904-08	3,046,800	3,194,400
1909-13	2,980,200	3,665,400

Table 16

Per Capita Expenditure for Mean Inter-Censal Populations in Pounds

U.S.A's	1873-1881		1881-1891		1891-1901		1901-1911	
Place	Pop ⁿ	Sewers Water	Pop ⁿ	Sewers Water	Pop ⁿ	Sewers Water	Pop ⁿ	Sewers Water
Bishop Auckland	9416	.253	10312	.059	11248	.245	12901	.270
Spennymoor	5272	.135	7979	.057	12355	.423	17287	.178
Stanhope	1770	.441	1852	.144	1914	.203	1987	.587
Tow Law	9973	.056	4779	.063	4423	.136	4347	.519
Consett	6712	.189	7669	.303	8935	.849	10450	1.266
Durham	14669	.002	14898	.084	15507	.100	16506	.209
Houghton le Spring	5658	.209	6259	.038	7167	.469	8806	.542
Brandon & Byshttles	7561	.022	12569	.097	14927	.269	16620	.833
Willington			7521	.018	7846	.132	8309	.526
Hetton le Hole							14676	.122
Chester le Street							13133	
Crook							11889	.168
<u>R.S.A's</u>								
Bishop Auckland	53756	.048	60874	.091	57189	.231	54922	.527
Weardale	11762	.001	10363	.090	49687	.010	9680	.411
Lanchester	33416	.021	37014	.209	33385	.622	29958	.423
Durham	35576	.095	31937	.225	29814	.196	28889	.765
Houghton le Spring	49643	.011	29775	.037	32217	.232	22422	.848
Chester le Street	13908	.043	47193	.042	49697	.265	56339	1.143

N.B. Previous to 1901 Hetton U.S.A. included in Houghton R.S.A.
 Chester le Street U.S.A. included in Chester le Street R.S.A.
 Crook U.S.A. included in Willington U.S.A.

Table 16

Sources: Local Taxation Returns: H.C.

1878	LXIV
1878-9	LX
1880	LXI
1881	LXXVIII
1882	LVII
1883	LVIII
1884	LXVII
1885	LXVI
1886	LV
1887	LXIX
1888	LXXXV
1889	LXIV
1890	LXII
1890-1	LXVII
1892	LXVII
1893-4	LXXVI
1894	LXXII
1895	LXXXIII
1896	LXXI
1897	LXXV
1898	LXXVI
1899	LXXXII
1900	LXXII
1901	LXIII
1902	LXXXVII
1903	LVIII
1904	LXXXI
1905	LXVI
1906	CI
1907	LXXI
1908	XCII
1909	LXXIV
1910	LXXVII
1911	LXVII
1912-13	LXXII
1913	LIV

Table 17

New Supplies Laid on by D.C.W.B. 1921-36

	<u>1921</u>	<u>1922</u>	<u>1923</u>	<u>1924</u>	<u>1925</u>	<u>1926</u>	<u>1927</u>	<u>1928</u>	<u>1929</u>	<u>1930</u>	<u>1931</u>	<u>1932</u>	<u>1933</u>	<u>1934</u>	<u>1935</u>	<u>1936</u>
Houses	417	2671	275	906	948	2158	1145	1073	228	314	493	777	765	1364	1199	2254
Baths	513	2645	100	930	1155	1971	1219	1162	327	363	688	947	779	1408	1286	2057
W-C's	862	2937	127	1273	1838	2566	1640	1466	586	638	1896	3307	2591	2917	2120	3224

Table 18

Proportion of Households with Access to Water Amenities 1951 & 1961

<u>a.</u>	<u>1951</u>	<u>Piped Water</u>	<u>W/C</u>	<u>Bath</u>	<u>Sink</u>
<u>Urban District</u>					
Bishop Auckland		.969	.592	.362	.733
Brandon & Byshtotles		.990	.666	.385	.660
Chester le Street		.994	.922	.676	.946
Consett		.995	.949	.648	.879
Crook & Willington		.993	.564	.352	.696
Durham		.974	.934	.706	.934
Hetton le Hole		.977	.924	.471	.701
Houghton le Spring		.901	.919	.520	.801
Spennymoor		.996	.486	.386	.640
Tow Law		1.0	.392	.358	.547
<u>Rural District</u>					
Chester le Street		.986	.889	.530	.885
Durham		.992	.859	.641	.872
Lanchester		.982	.860	.479	.757
Weardale		.742	.605	.351	.680

<u>b.</u>	<u>1961</u>	<u>Cold Tap</u>	<u>W/C</u>	<u>Bath</u>	<u>Hot Tap</u>
	<u>Urban District</u>				
	Bishop Auckland	.987	.854	.562	.662
	Brandon & Byshottles	.996	.863	.624	.693
	Chester le Street	.999	.978	.848	.906
	Consett	.998	.977	.834	.901
	Crook & Willington	.998	.877	.597	.672
	Durham M.B.	.995	.976	.863	.885
	Hetton le Hole	.996	.974	.675	.823
	Houghton le Spring	.989	.974	.745	.867
	Spennymoor	.998	.936	.664	.784
	Tow Law	1.0	.629	.522	.582
	<u>Rural District</u>				
	Chester le Street	.992	.950	.720	.827
	Durham	.996	.966	.850	.913
	Lanchester	.994	.944	.769	.845
	Wesrdale	.921	.795	.643	.718

Source: 1951 and 1961 Census: County Report - Durham

Table 12

Proportion of Households with Access to Water Amenities
According to the 1966 10% Sample Census

	<u>Hot Tap</u>	<u>Fixed Bath</u>
<u>U.D.'s.</u>		
Bishop Auckland	78.6	66.7
Brandon & Byshttles	84.8	76.8
Chester le Street	96.8	93.2
Consett	94.6	87.5
Crook & Willington	80.4	67.8
Durham	94.4	90.6
Hetton le Hole	93.5	78.4
Houghton le Spring	94.2	82.9
Spennymoor	89.9	78.5
Tow Law	74.7	65.9
<u>R.D.'s.</u>		
Chester le Street	92.0	83.6
Durham	95.4	89.6
Lanchester	91.2	82.6
Weardale	84.2	76.3

Table 20

Relative Positions of Districts in Hot Tap Hierarchy
1961 and Improvement Hierarchy 1961-1966

<u>U.D.'s</u>	<u>1961</u>	<u>Improvement</u>	<u>1961-1966</u>
Bishop Auckland	13		11
Brandon & Byshttles	11		13
Chester le Street	2		2
Consett	3		1
Crook & Willington	12		12
Durham	4		4
Hetton le Hole	8		8
Houghton le Spring	5		6
Spennymoor	9		9
Tow Law	14		14
<u>R.D.'s</u>			
Chester le Street	7		7
Durham	1		3
Lanchester	6		5
Weardale	10		10

APPENDIX B

Gazetteer of Water Mills

Apart from the following plans of known mill sites, there remain a significant group of mills for which the exact site is lost, or of which little is known.

Mills on the Wear

It would seem that there were at least a forge and a fulling mill on the Wear at Witton le Wear, as part of the Witton Castle estate in 1688_i. The great flood of November 1771 altered the course of the river_{ii} and the mills were abandoned, their presence today attested to by the presence of two field names, containing the word 'Dam'. At Binchester a farmer is recorded at Binchester Mill in 1827_{iii} but occasional references to a mill at Binchester in other sources do not allow the distinction of whether this was a water or a wind mill.

A little upstream from Durham stood the conventual mill of Skaltok. Although the site was abandoned in the late sixteenth century, an undated early seventeenth century plan locates the site satisfactorily_{iv} as occupying the inside of a downstream loop of a meander which once occupied the Hollow Drift below Maiden Castle. The site is now lost under a railway embankment. The mill was first mentioned in 1300 in the Bursar's Roll, and is frequently

i. D/C D 111

ii. D/C D 117

iii. White and Parsons

iv. D & C Post-Dissolution Monuments, Misc. Chtr. 7100.

mentioned over the next two centuries. The mill was said to be much decayed in 1580ⁱ, although there were 'two mills under one roof' in 1551ⁱⁱ. It would seem that the river abandoned this meander at some time towards the end of the sixteenth century.

A whole series of mills, now lost, were located on the Wear between Durham and Chester le Street. A dam across the river at Harberhouse worked a mill at either side of the Wear. It is not known when this dam was erected, but it was swept away during the great flood of November 1771. The mill on the Harberhouse bank was destroyed, and that on the Lumley bank severely damaged. Curiously, the Lumley mill is not mentioned in any of the surviving Lumley muniments, nor the Harberhouse mill in any of the surviving Forcer records. At Woodwell House, a little further upstream a fulling mill was erected in 1729. It was built of stone and was supplied with water from the Wear by means of a masonry damⁱⁱⁱ. Although it was marked on Shirley's map of 1731 (Plate V) there is no subsequent reference to it to be found in the Londonderry muniments. The most interesting feature along this stretch of river, however, was the series of so-called 'work mills' revealed in Shirley's map. It seems probable that all of these mills were connected with pumping operations at colliery shafts sunk into the side of the Wear gorge. In 1686, the Bishop leased to Christopher Musgrave, owner of the

i. S.S. LXXXII

ii. Durham Treas. Loc. 29/13

iii. D/L D 55

Kepier estate a piece of ground at the bishop's side of the river 'for the erecting of a damm for the drawing of water in order to the working of a certeyne Colliery ... in Kepier'ⁱ. All the sites marked on Shirley's map are in remote parts of the Wear gorge, and it is almost certain that the mills would be swept away by the great flood of 1771.

Mills on Tributaries

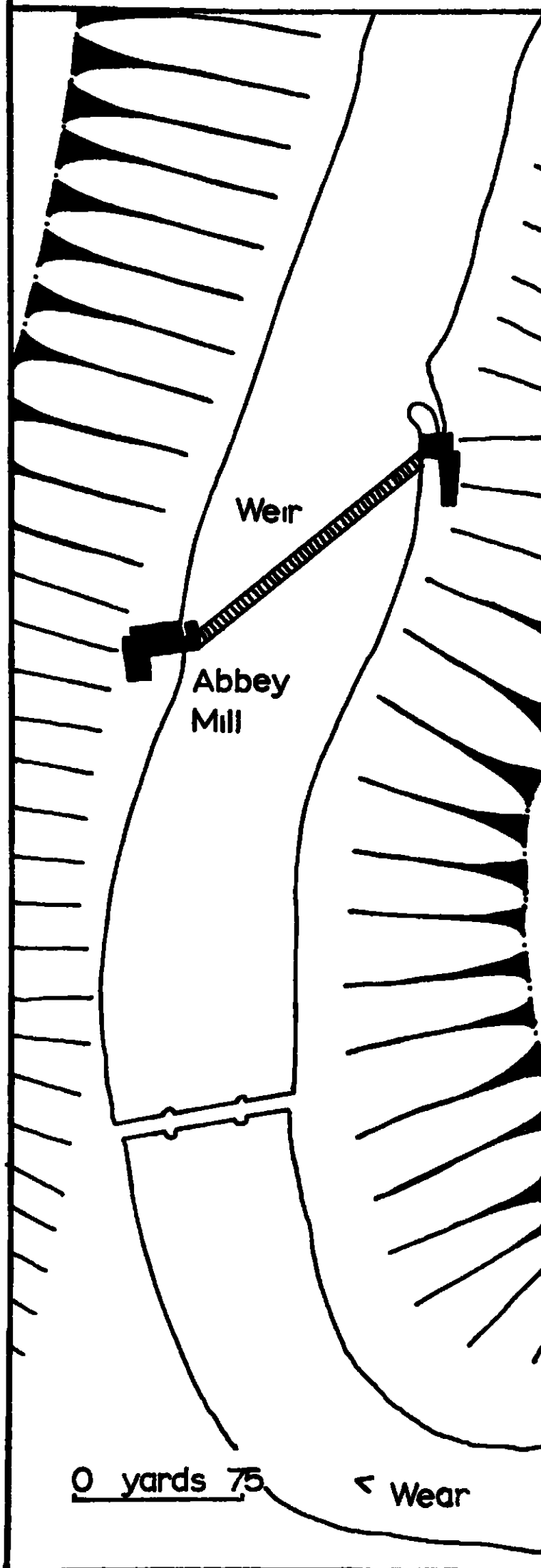
Remote country mills, with perhaps only one pair of stones were to be found throughout the eighteenth and nineteenth centuries. Podgehole at the head of the Linburn valley was a good example. The mill is now absorbed within two cottages with little to suggest its former occupation. In Weardale, Pinfoldhouse Mill at Daddryshields was a similar structure and is now used as a barn, while at Hedleyhope Hall on the Deerness, the site of the mill is lost under a spoil heap. At Low Lands, on the Gaunless near Evenwood, a small corn mill has similarly disappeared.

Saw mills were to be found in various parts of the basin close to forest cover. During the nineteenth century, mills were established at Shull on the Dryderdale estate near the present Hamsterley Forest, while in the Wear valley a sawmill was established at Slutburn, near the Wear valley railway junction. To the north, Sawmill Wood on the Woodlands estate to the west of Lanchester marked the site of another saw mill which was standing recently.

On the Browney three sites are unlocated. In his history, Surtees speaks fondly of Langley Hall, and the stream running down through a fine fringe of oakwood and turning the old mill wheel before entering the Browney_i. It is possible that the mill dated from the earliest days of the ancient hall, but it seems the mill did not survive far into the nineteenth century, for it was never mentioned in directories. The presence of the place name Bleach Green at a group of nineteenth century cottages near the stream on which the mill must have stood may be significant, but there is no trace of a mill to be found near that site. At Witton Gilbert further down the Browney mention is made of a mill in the twelfth century_{ii}, but no reference to it has been found after 1181. A little lower down the Browney, and even more puzzling, a mill 'to the north of Bearpark upon the water of Browney'_{iii} is recorded in leases from 1608 until 1845, but there is no mention of this mill in contemporary trade directories, and no indication on the first edition of the Ordnance Survey, thirteen years later. Two other mills remain, those fifteenth century mills mentioned by Surtees as being on the Ellyngburn at Barnwell in 1426_{iv} and at Morton, to the west of Houghton le Spring_v.

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- i. Surtees, II, 332-3
 - ii. Surtees, II, 369
 - iii. C.C./B.E.S.
 - iv. Surtees, I, 196
 - v. Surtees, I, 202

ABBHEY MILL



G.R. NZ272422

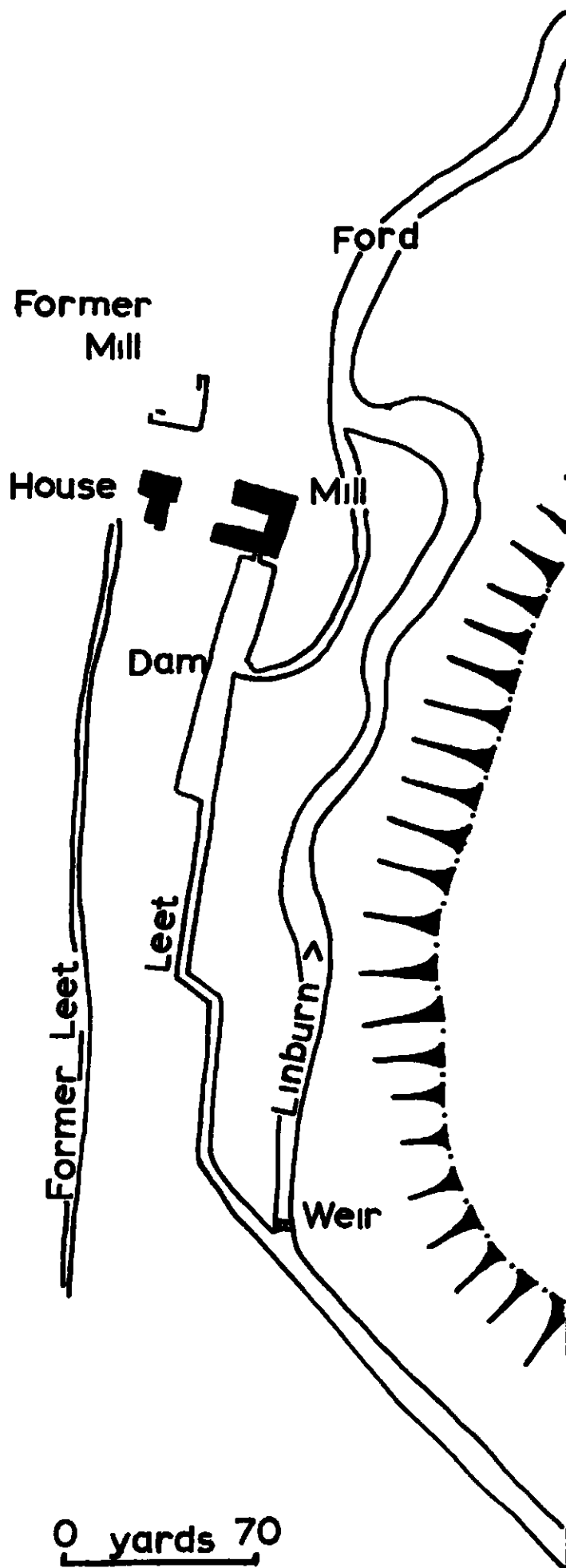
This is the survivor of a pair of mills that anciently stood on this site in the constricted gorge of the Wear at Durham. This mill was built out on a man-made terrace 10' above the level of the river, which is here spanned by a diagonal weir. The present weir, a copy of an earlier structure, would allow a dry weather fall of 3.5'. The mill was served by an exterior wheel 16' in diameter and 5' broad, shot at low breast, and enclosed by a broad arm of masonry. The mill and mill house are of late 18th century stone construction with stone roofs. The mill has three floors, but the interior has been gutted and so there is little indication of the interior organization of the mill. The house is now used as a private residence, and the top two floors of the mill as a garage for the house. The ground floor, reached only from the downstream side of the mill, is used as a store for Durham Canoe Club.

This very ancient site was first recorded in the last quarter of the 12th century (1), and it is probable that the monks ground their corn by a water mill here from the earliest days of the Abbey. The site was part of the Borough of Crossgate and belonged to the Convent, and certainly from the early 15th century there was both a corn and a fulling mill here (2). After the dissolution there is no mention of the fulling mill, and the mills lose their title to those at the other side of the weir, and are subsequently known as Miles Whyte's Milnes (3), Banks Mill (4) and South Street Mill. The mill was completely washed away during the great flood of November 1771, but rebuilt and used as a corn mill at least until 1827, but it fell into disuse soon afterwards.

1. References will be found at the end of the Gazetteer.

BECKSIDE MILL

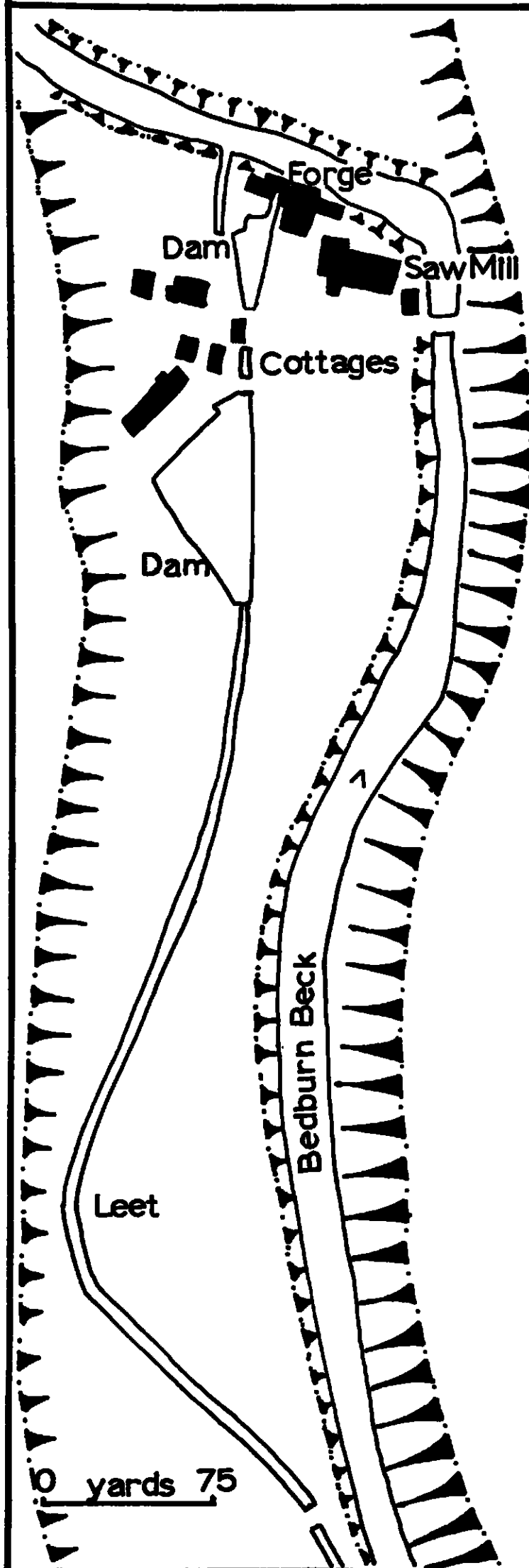
G.R. NZ119301



This mill stands in an open position in the broad valley of the Linburn Beck, on a terrace 2' - 3' above the present level of the beck. The mill was fed by field drainage and water from the Linburn Beck taken off by a leet 240 yards upstream, and maintained in a large shallow dam. The present buildings are constructed of brick with a stone roof, and seem to date from the early nineteenth century. They show little sign of ever having been used as a corn mill and have been considerably altered, although they maintain the plan recorded in 1857. Pieces of French Stone are used as coping for a garden wall, but this is the only reminder of the building's past function, except for the water courses which are still apparent. The present tenant has known the building for over 30 years but can remember no part of the mill, which was last recorded in a trade directory in 1827.

A second watercourse can be traced above and behind the present farm, feeding into the remains of another dam. Hummocky ground nearby indicates the probable site of an earlier mill, of which no mention has been found.

BEDBURN MILLS



G.R. NZ103317

The mills, shown here in 1857, stand in a narrow valley upon a level terrace at this point 12'-15' above the level of the Bedburn Beck as it falls down from the level of this terrace, 500 yards upstream, to the Wear, two miles downstream. A leet led 500 yards from a diagonal weir across the beck to serve two dams which supplied water for a wheel in each of the mills. It is probable that at this time both mills used overshot wheels.

Only the saw mill and the cottages belonging to and grouped around the mills remain. The saw mill is a fine stone building of four floors, with a pantile roof. It has an outside stair turret, with a bell cote upon which is an illegible date stone, which could read 1800. The whole group of buildings is surrounded by a 6' stone wall.

Mills were first mentioned on this site at the Hatfield Survey when there was a site for a fulling mill and another water mill (1). In 1408-9 Bishop Langley tried the experiment of running his own iron forge at Byrkenott juxta Bedbourne (2), but there is no conclusive evidence that this was on this site. Bailey remarks in 1813 (3) that iron works have been recently established at Bedburn but in 1827 White and Parsons report that until 1820 there was an extensive bleachery at Bedburn where linen cloths and yarns were whitened by chemical process, but since that year the mill had been employed in the manufacture of edge tools and knives (4). It would seem that the spade mill continued until at least 1865, and that a saw mill was established by 1857 (5), which continued as such until the 1914 war.

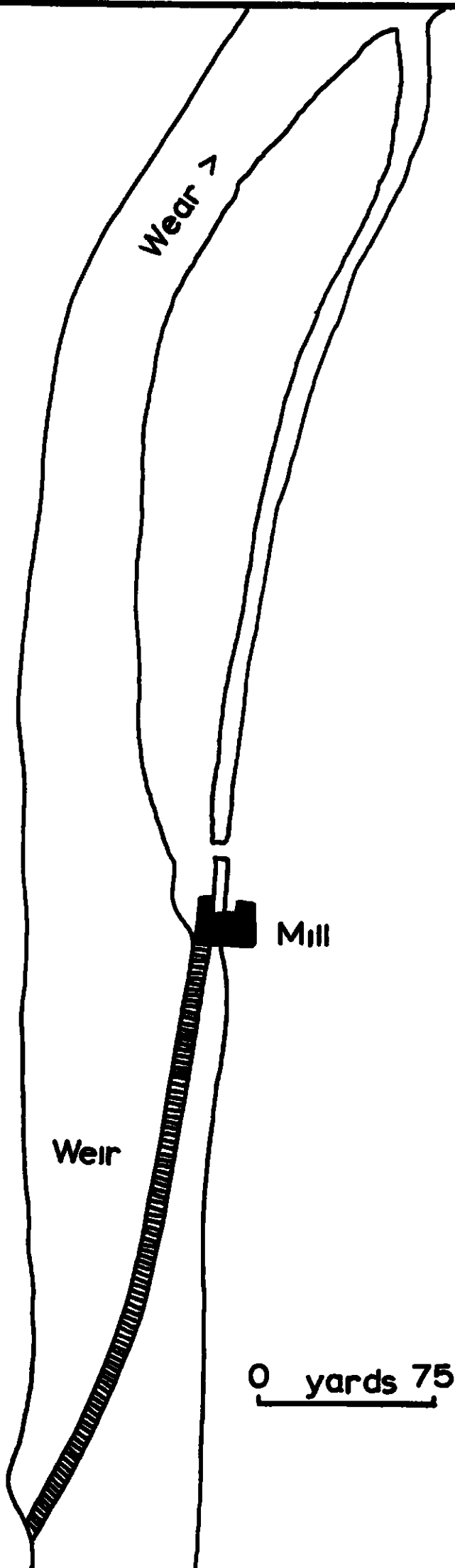
BISHOPS MILL

G.R. NZ274427

This site is one of two sites still functioning in the basin, although the mill itself is no longer used. The mill stands on a terrace 10' above the present level of the Wear outside the walled City of Durham. It is fed directly from a diagonal weir which now stands 8' above the bed of the river, but which, when the water used to drive the mill stood a little less than 6'.

The present building is of nineteenth century construction, of stone, with a slate roof, and has three floors. At the time of its disuse there were two breast-shot wheels, driving no less than eight pairs of stones, a quite remarkable number. Water left the mill by way of a long tail, of 350 yards, in an attempt to minimise the loss of a differential head in times of flood.

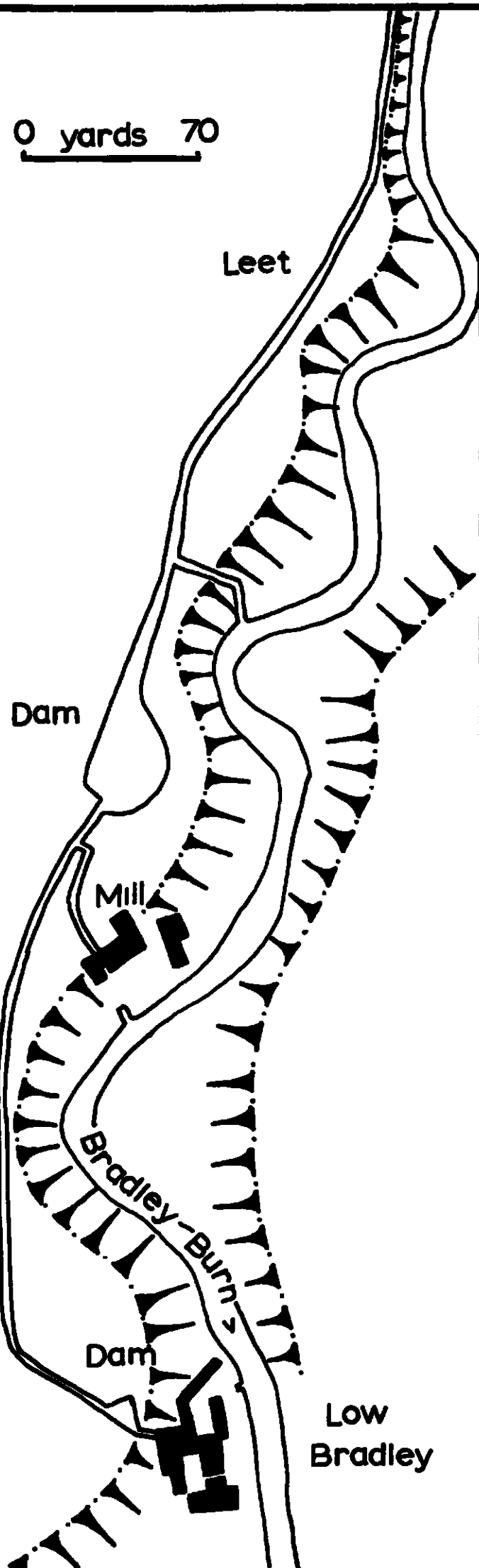
This was the manor mill for the Borough of Durham and as such is probably as old a site as any in the basin. Because the mill was usually leased with the Tolls of the City there are few separate references to the mill, but it was certainly in existence by the first decade of the thirteenth century (1). In the 15th century there were two mills on the site, but in the 16th only one which was swept away in 1544. This was rebuilt and by the early 17th century (2) there were three mills worked off the dam, although there is no subsequent reference to so many (3). The mill was used until the 1914 war, and in 1929 was sold to an Ice Manufacturer who installed turbines to provide electricity to drive cooling machinery at his factory at the other side of the river.



BRADLEY MILL

G.R. NZ106365

0 yards 70



Bradley Mill stands on a small terrace 4' above the present level of the Bradley Burn, being built into the side of a terrace wall at this point 12' high. The mill is fed by a 400 yard leet making use of this terrace, bringing the water to a dam on the open hillside behind the mill from which it was anciently carried by a launder to a backshot wheel 3'-4' by 18', enclosed within the mill, and from thence direct to the burn.

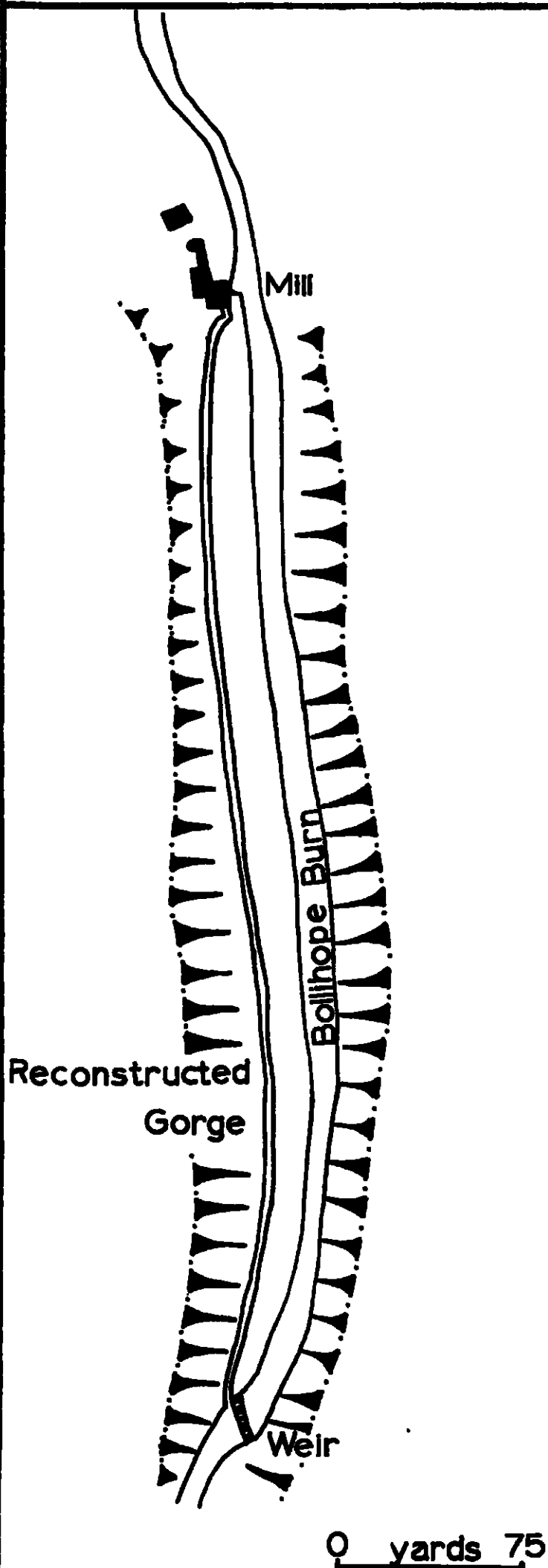
The mill and miller's house are contiguous and now compose the house of Bradley Burn Farm. The buildings are of 18th century style of local stone with a stone roof. The mill has low walls with a high gable permitting the erection of a fine wooden loft in the 19th century.

The mill was first recorded in the early 19th century, although there is little doubt that this is an ancient mill site for Bradley Hall. The mill was abandoned in 1898, but the water was diverted to Bradley Low Farm, where it continued to drive a turbine for a threshing machine until the last war.

BROADWOOD MILL

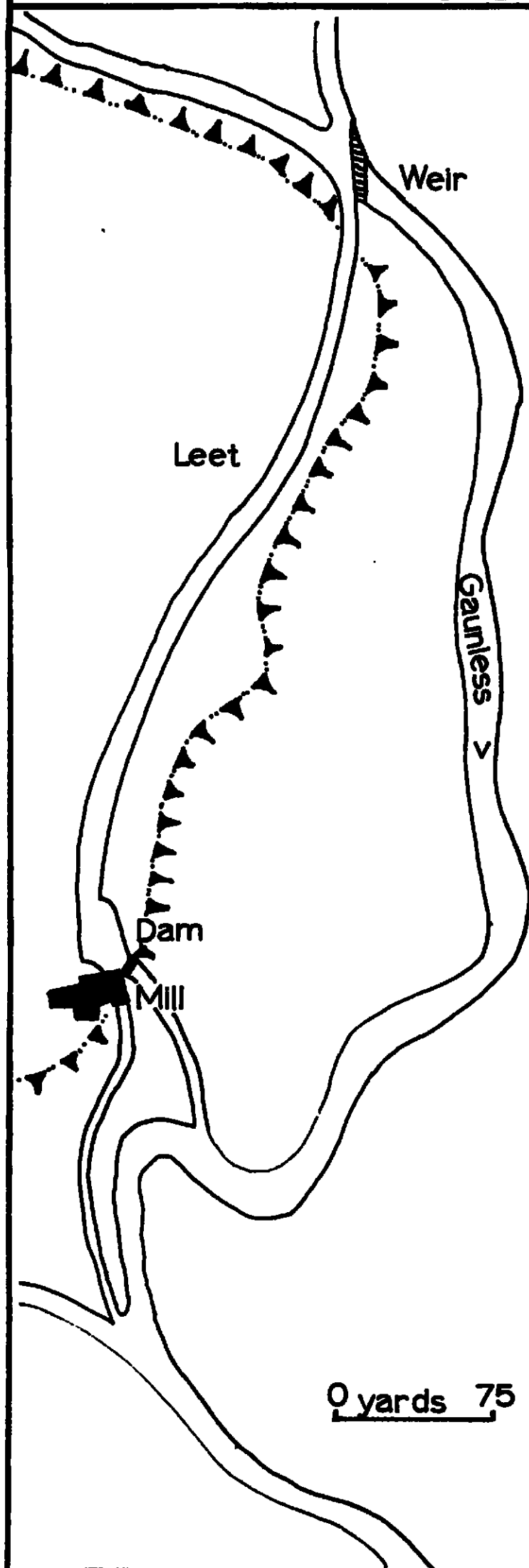
G.R. NZ028366

The site of this mill is now entirely lost in the quarry working the limestone and dolerite to the south of Frosterley. The mill is recorded in trade directories from 1827 until 1902, and was probably erected in response to the growing population of the lead mining districts in the 18th and 19th centuries.



BROOM MILL

G.R. NZ193262



This isolated mill stands on the flood plain of the wide valley of the Gaunless to the west of Bishop Auckland. The mill is built into a 4' terrace wall, and is fed by a 370 yard leet across this terrace which conducted water to a small dam. Two sets of three foot stones were powered by a 16' low breast or undershot wheel outside the mill.

The mill and house are contiguous and are of stone construction with a pantile roof, and would seem to date from the late 18th or early 19th centuries. Although the house has two floors the mill itself is a low structure 18' by 15', the roof almost reaching the level of the 4' terrace at the back. A small door in this roof allowed access to a small loft from which the grain could be fed onto the stones.

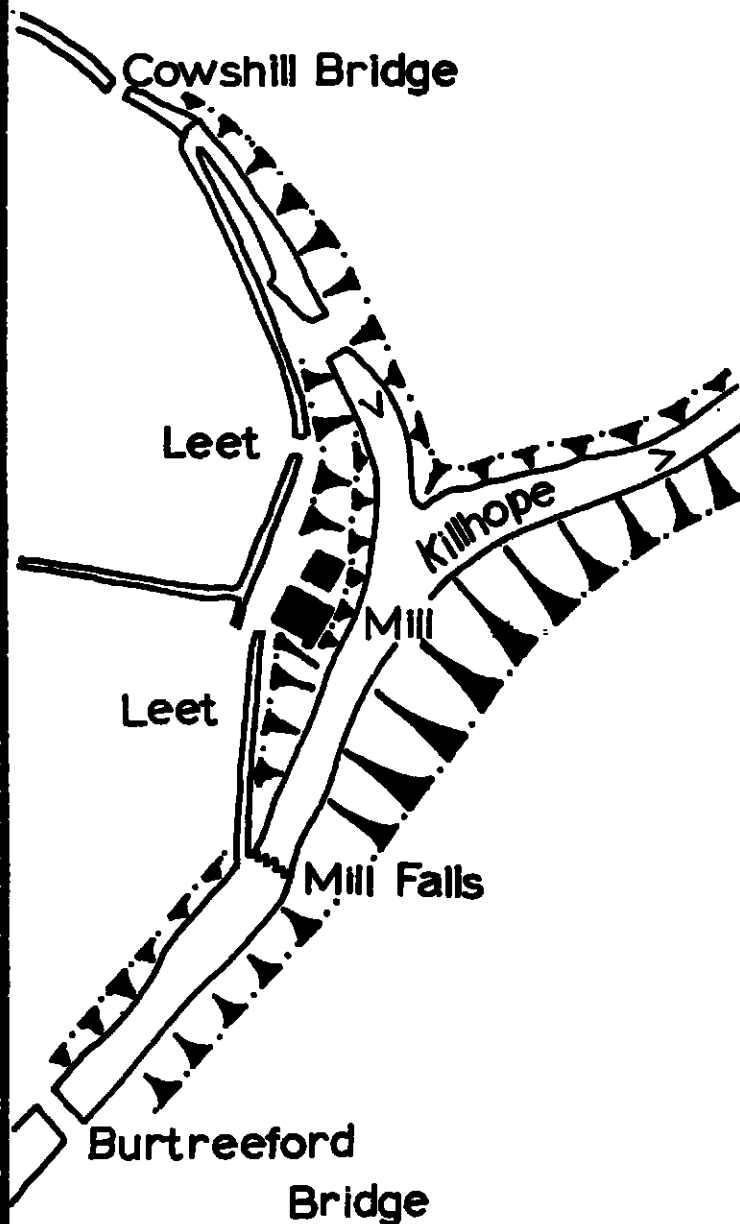
The site is first mentioned in 1622 (1) and was last mentioned in a trade directory in 1865, although much of the gearing and internal fittings of the mill remained until 1960. The house is now used as a farm, and the mill as a pig sty.

BURTREEFORD MILL

G.R. NY855406

The mill is built into the bank of the Killhope Burn, at this point some 12' high, so that the top floor is level with the top of the bank, and the ground floor at the level of a small terrace above the burn which here falls down very rapidly. Two watercourses are evident. The first would have brought water by means of a launder from a fall of 8' or 9' 60 yards upstream on the Killhope Burn. The other leads off the Sedling Burn immediately below Cowshill Bridge, and is joined by another course bringing water from springs behind Cowshill. It may be that these provided alternatives in times of Hushing in the lead mines.

The three-floored mill is built entirely of stone and was worked by an overshot wheel 3' by 12' which drove three sets of stones on the first floor which still remain. Although the wheel and the pit wheel have been taken away, the whole of the ground and first floors are much as they would have been when the mill was worked. The miller's house was latterly well removed from the mill and stands four square and double fronted on the hillside a quarter of a mile away. The first note of the mill is on Greenwood's map of 1818, and the present building would seem to have been built at around that date. It was in continuous use until 1939, although it was used intermittently in its latter years.



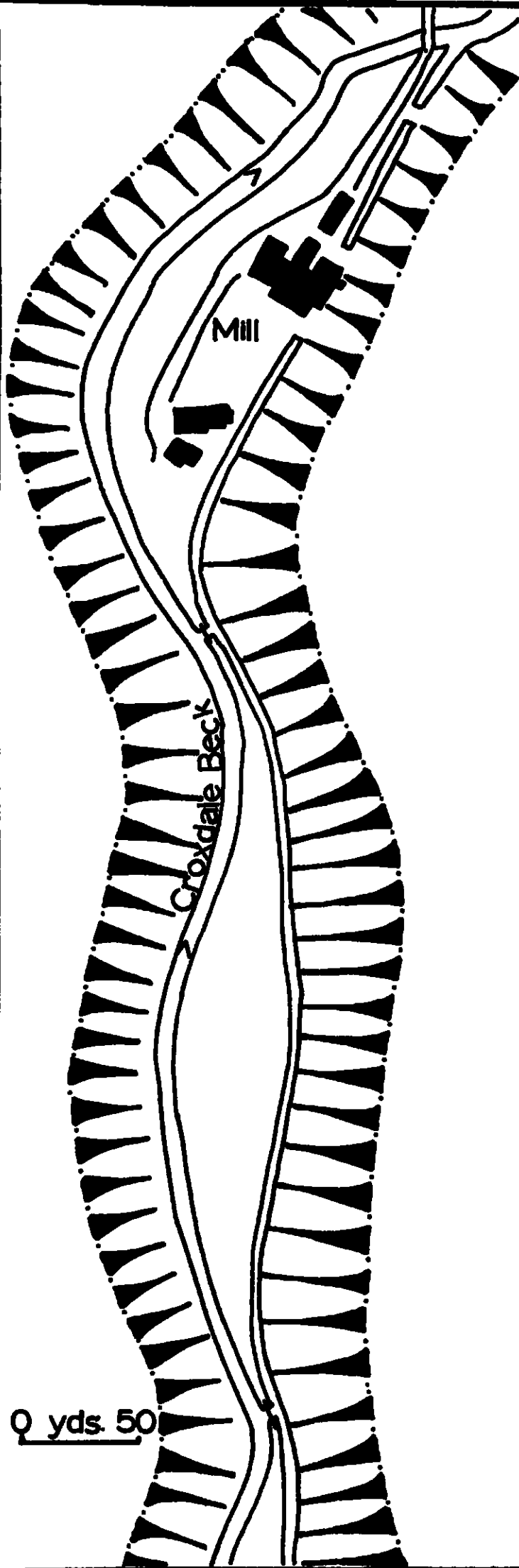
0 yards 75

BUTTERBY MILL

G.R. NZ278375

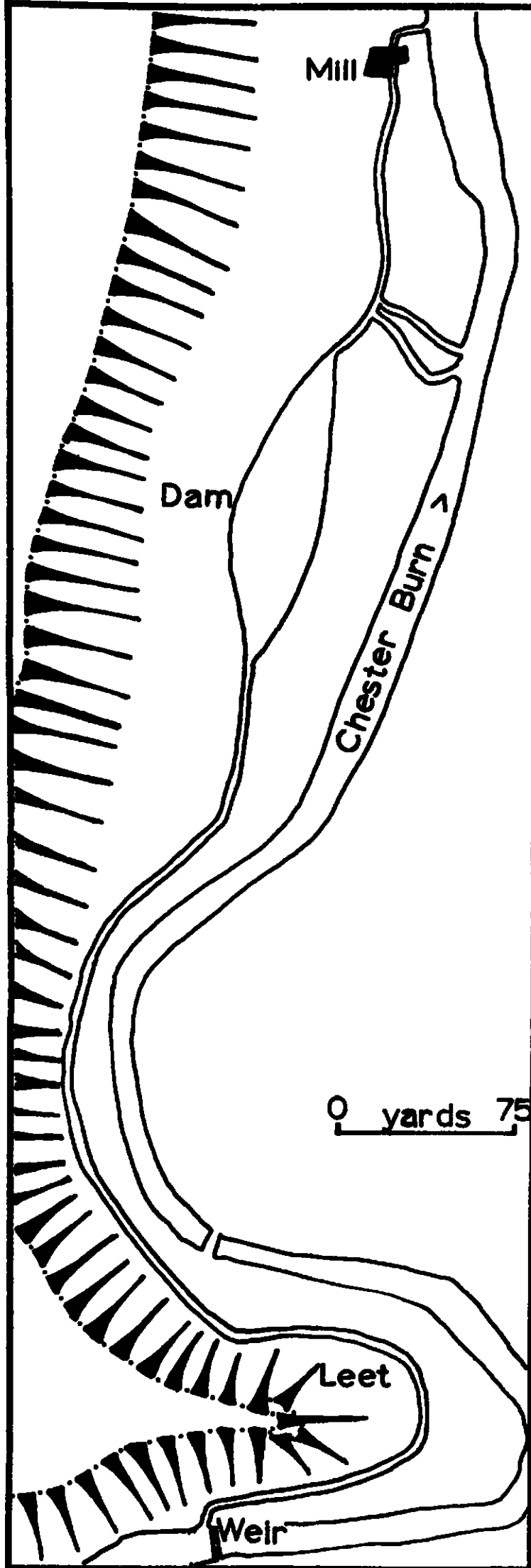
The mill stands on a level terrace 4' above the present level of the Croxdale Beck, and in a narrow gorge. A 1600 yard leet brought water along the side of the gorge from the beck to the mill and fed a high breast shot wheel 4' by 20'. Little remains of the mill itself. There is extensive concrete flooring, much tumble and the remains of pantiles, which suggests that the mill was of stone construction with a pantile roof. Separated from the mill by an orchard is a mean cottage with out-buildings of similar construction of late 19th century date.

The mill was originally a fulling mill, established before 1739 (1), when it came into the hands of the Salvins of Croxdale Hall, and was subsequently converted into a paper mill. In 1815 the mill was blown down by a high wind sweeping along the gorge (2). It is said to have been a building 100' long extending across the valley, the lower part of stone, the upper of wood with brick pillars which was used as a drying room. The mill was subsequently rebuilt and was used as a paper mill until at least 1855 (3). At some time between that date and the turn of the century the mill was converted to the manufacture of worsted yarn, and continued in use until at least 1915.



0 yds. 50

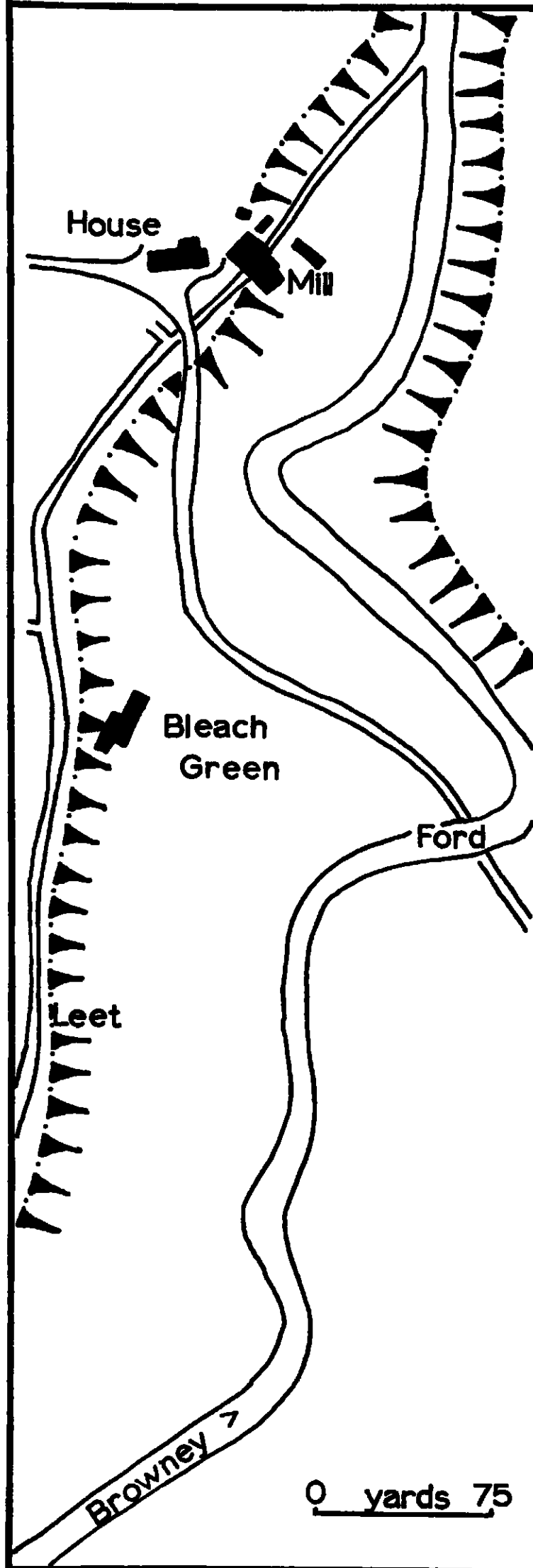
CHESTER MILL



G.R. NZ272517

Nothing remains at this mill site on the Chester Burn. The mill at Chester was mentioned in Boldon Book, and until the mid 16th century was leased with the Fishery on the Wear. It would seem that until this time the mill was worked off the Fishery Dam. By 1591 (1), however, the mill was sited on the Chester Burn and there is no later reference to a mill on the Wear at Lumley. In 1817 the wheel drove three pairs of stones and two cylinders (2), and in 1845 was said to be not worth more than £75 p.a. (3). There are directory entries for millers in Chester le Street until 1879, but a steam mill was established by 1827, and it may be that that mill lasted longer than the water mill.

COLEPIKE MILL

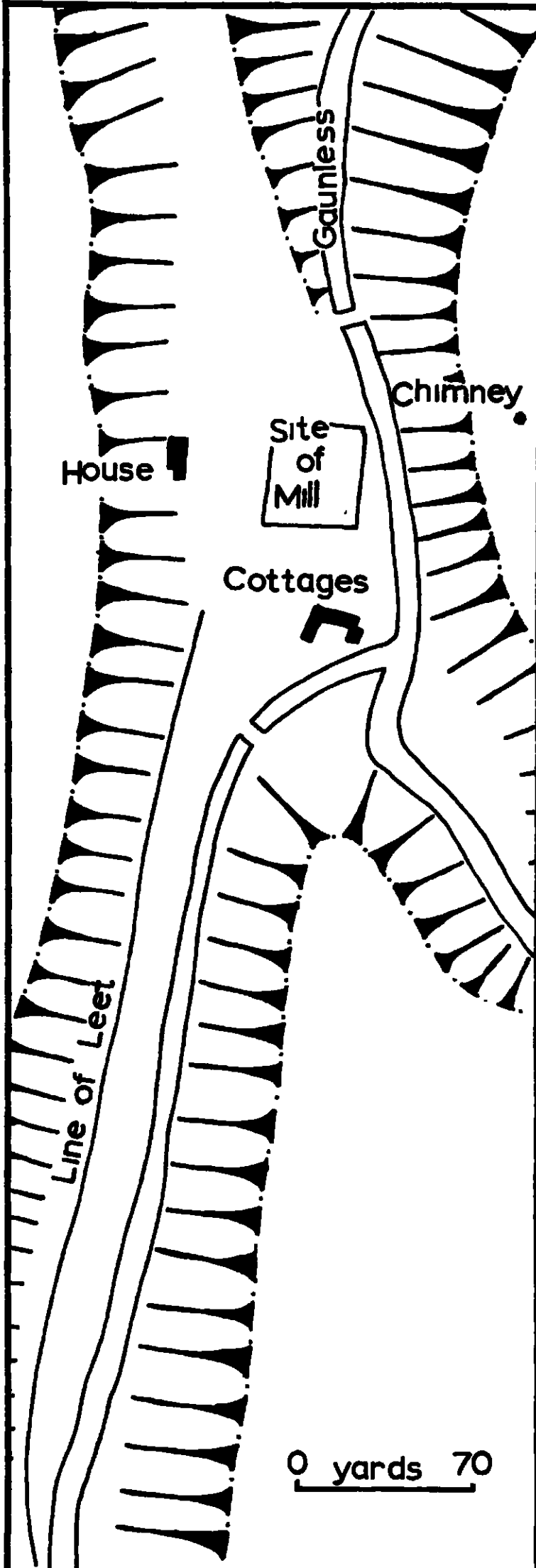


G.R. NZ158455

This mill was built upon a wide terrace 4' above the present level of the Browney, and into the side of a terrace wall 12' high. A 1200 yard leet made use of this terrace to bring water from the Browney directly to the mill. Only the miller's house and part of the mill remain, both constructed of stone with stone roofs, and of uncertain date, probably at some time 1750-1850. It would seem that the mill had three floors, and that the wheel was entirely within the building. The mill is now used for storage and the house as a milking parlour.

In 1710 there was both a fulling mill and a corn mill on this site (1), and the field name Bleach Green immediately adjacent to the mill is significant here. By 1838 there was only a corn mill (2), which continued in use until at least 1865. The mills stood upon the Colepike Hall estate.

COPLEY SMELT MILL



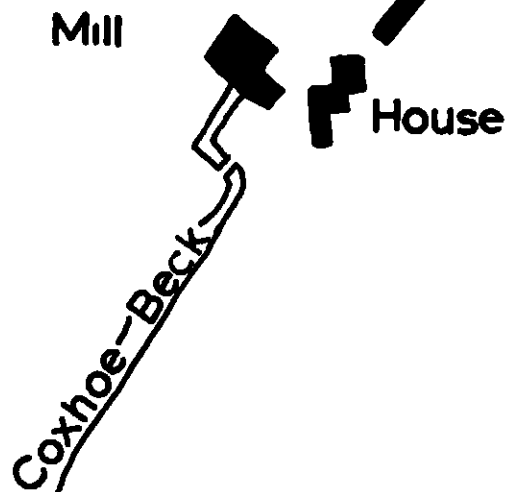
G.R. NZ085250

Everything has vanished from this site except the Manager's House, built of stone and not of elaborate construction, and a very fine chimney which stands high on the opposite side of the valley. The mill occupied the level floor of the Gaulness valley before that river descends steeply to Haggerleases. It would seem that the wheels were powered by water brought off the Gaulness some 400 yards upstream, but all trace of the leet has now disappeared. A smelt mill was established here in 1770 by the Earl of Darlington to smelt his duty ore. As his estates covered virtually the whole of Teesdale, they must necessarily have been of large size. According to Westgarth Foster the mill had 3 ore hearths, 2 cupolas, 1 roasting furnace, 1 reducing furnace and 2 refining furnaces (1). By 1857, however, the site seems to be used as a brick and tile works, and was said to be disused in 1870. The derelict works were finally demolished in the 1920's.

COXHOE MILL

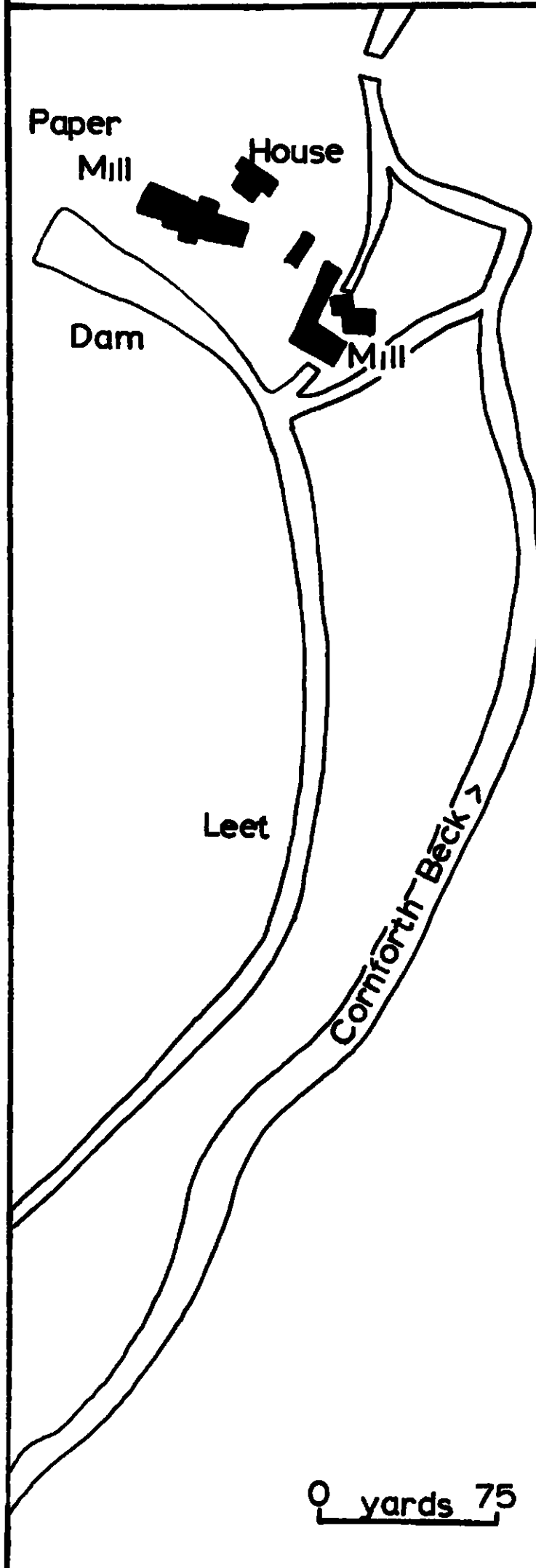
G.S. NZ332354

Nothing now remains of this mill which was demolished and the site cleared in 1956. The mill stood near the head of Coxhoe Beck, and the entire beck was funnelled through the mill. The mill was granted to the Priory at Finchale in 1250, although it seems possible that this was on a site nearer the village than the present site (1), and in the early 15th century it seems that there were two mills in the village (2). The mill on the present site was in use within living memory.



0 yards 75

CORNFORTH MILLS



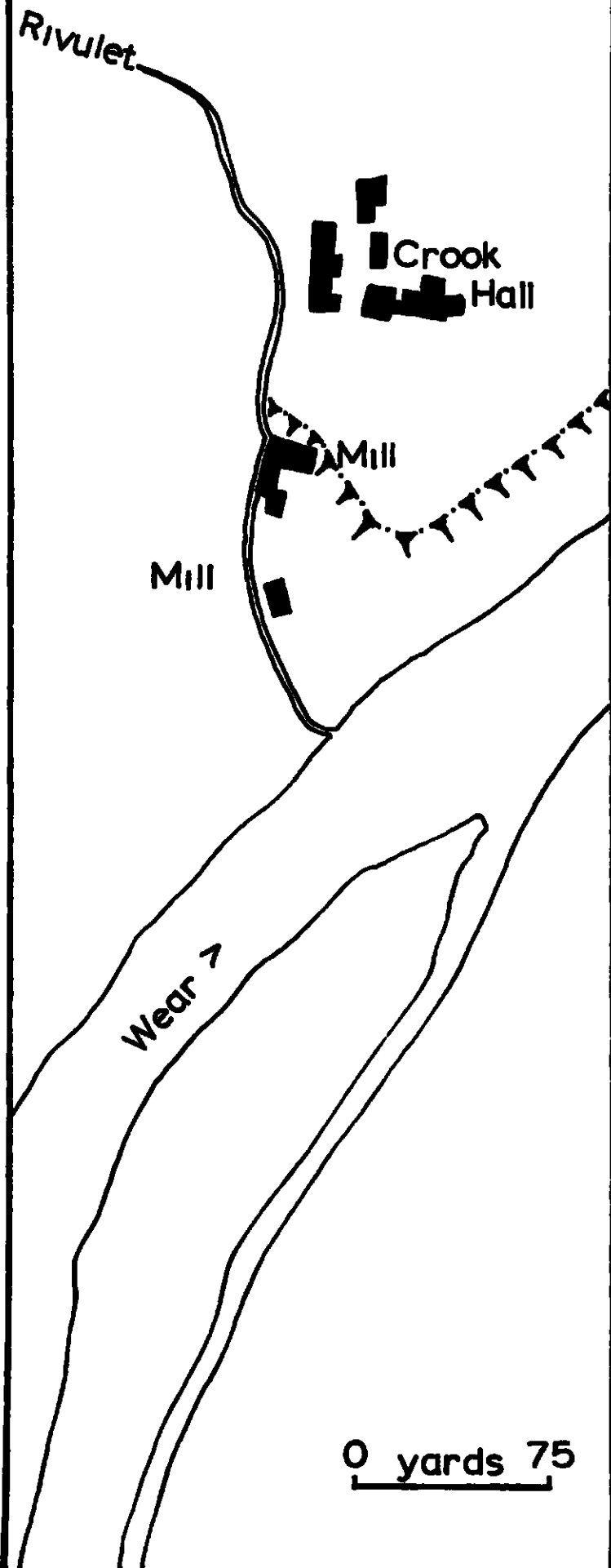
G.R. NZ 315349

Cornforth Mill stood on the left bank of the Cornforth Beck on an undulating hillside above a ford. The mill was fed by a 850 yard leet which also fed a dam which served the paper mill subsequently established on the site. Nothing now remains of either the corn mill or the paper mill except the miller's house and part of the wall of the paper mill which now serves as a garden wall. The house which has a faintly 18th century air is now covered with cement rendering and has a pantile roof.

The mill was first mentioned at Cornforth in the Boldon Book and by 1647 was said to be worth more than £15 p.a. (1). The paper mill was established on the site by at least 1793 but seems to have gone out of business in the mid 19th century. The corn mill continued in use until the 1914 war. Both mills were worked by the Egglestone family from the first decades of the 19th century until their disuse.

CROOK HALL MILLS

G.N. NZ274432



A small rivulet rising in the sandy hills behind Framwellgate at Durham once drove two mills belonging to the manor of Sidgate of which Crook Hall was the manor house. In 1636, Cuthbert Billingham, then lord of the manor, diverted water from the Framwell, supplying the City of Durham, to drive his mills (1), and in 1820, two mills can be seen on John Wood's map of the City of Durham. Only the upper mill can be seen to be working in 1838 (2), and by 1857 there is no indication that either building is used as a mill upon the first edition of the 25" Plans of the Ordnance Survey.

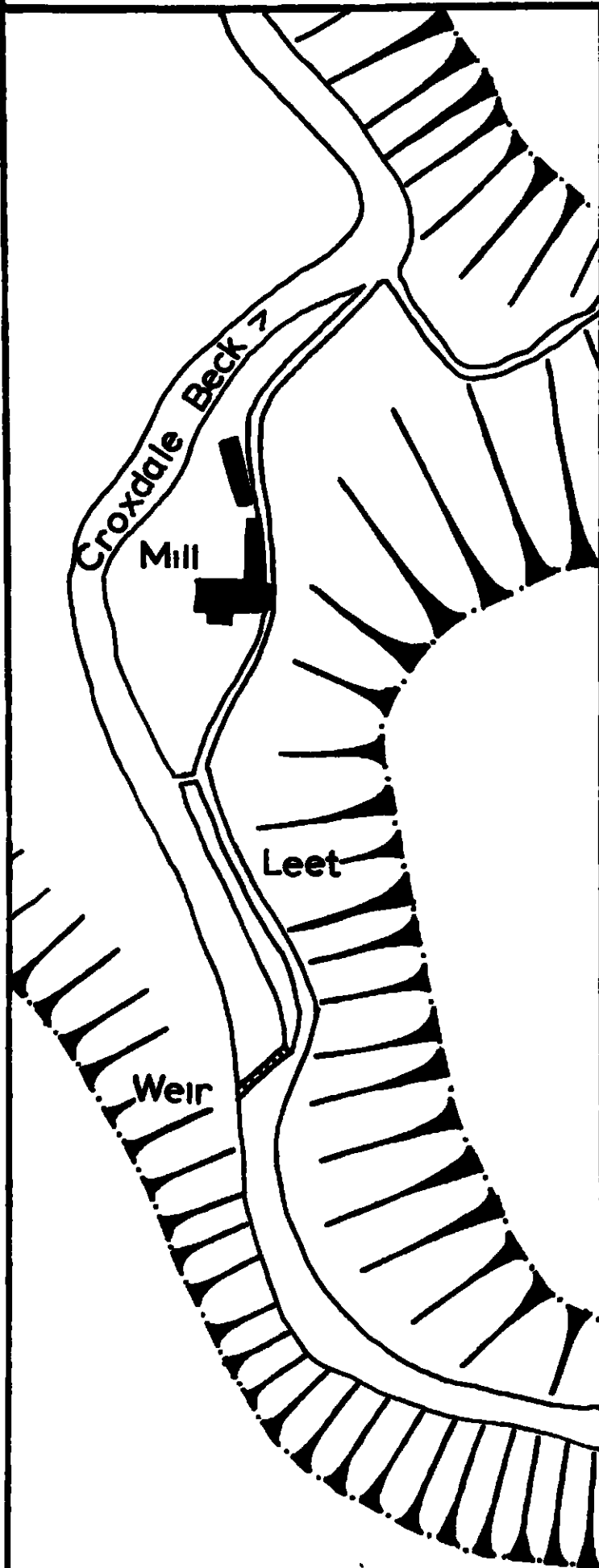
The mills stood in a little gully cut by this tributary of the Wear. The site of the bottom mill is now lost under road works, but the upper mill remains though extensively altered, now used as the house for Crook Hall Farm. It is constructed of stone with a new pantile roof, probably replacing an earlier, and is so built into the hillside that water could have supplied an overshot wheel.

CROXDALE CORN MILL

G.R. NZ272378

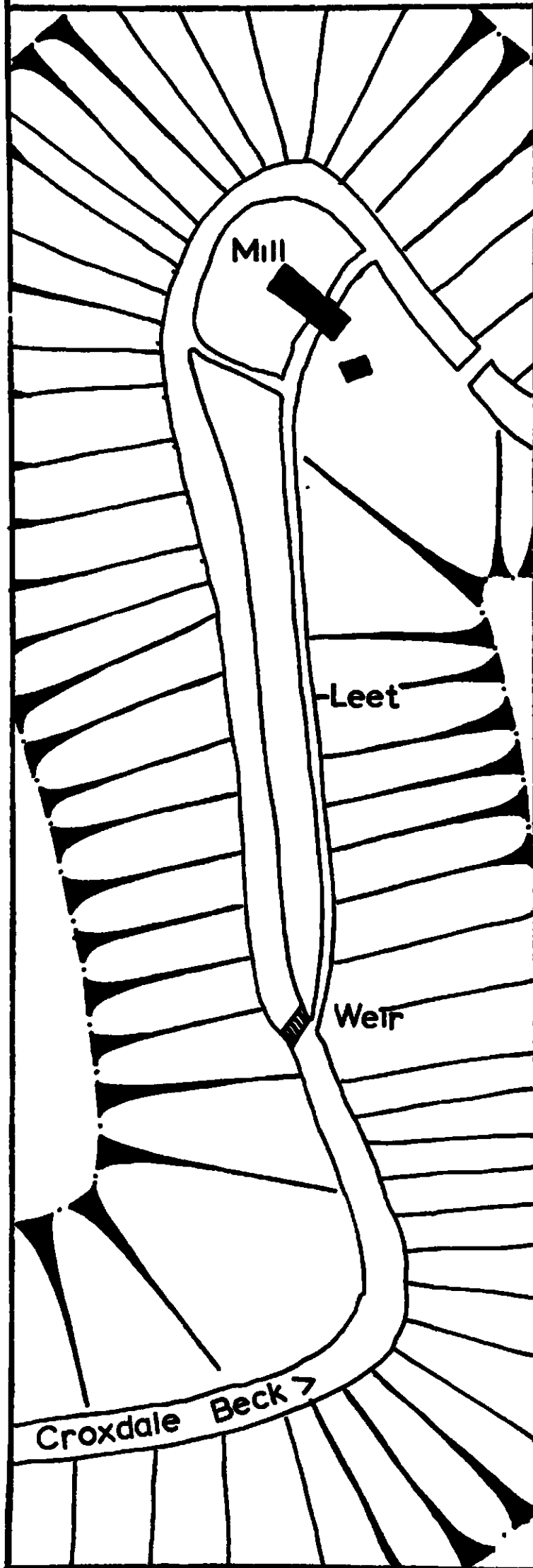
The mill stands at the foot of Croxdale Glen, on a level terrace 4'-6' above the present level of the beck which here flows down quickly from the Glen to the Wear below. Water was taken to the mill by a 170 yard leet along the side of the Glen. Nothing remains of the actual mill, but the house now provides a handsome stone residence of three floors. In 1812 the mill was powered by a 9' wide wheel and contained three sets of stones (1). The mill straddled the race and so the wheel would be inside the mill. After the rebuilding of the mill in 1845 the wheel was placed outside the mill and was a low-breast shot one 14' in diameter and $4\frac{1}{2}$ ' wide.

The mill stands on the Salvin estate, and it can be expected that the site is a particularly ancient one. First documentary evidence of the mill is in 1575, and it would seem that it was rebuilt in 1658. The mill was abandoned between 1879 and 1898.



0 yards 75

CROXDALE PAPER MILL



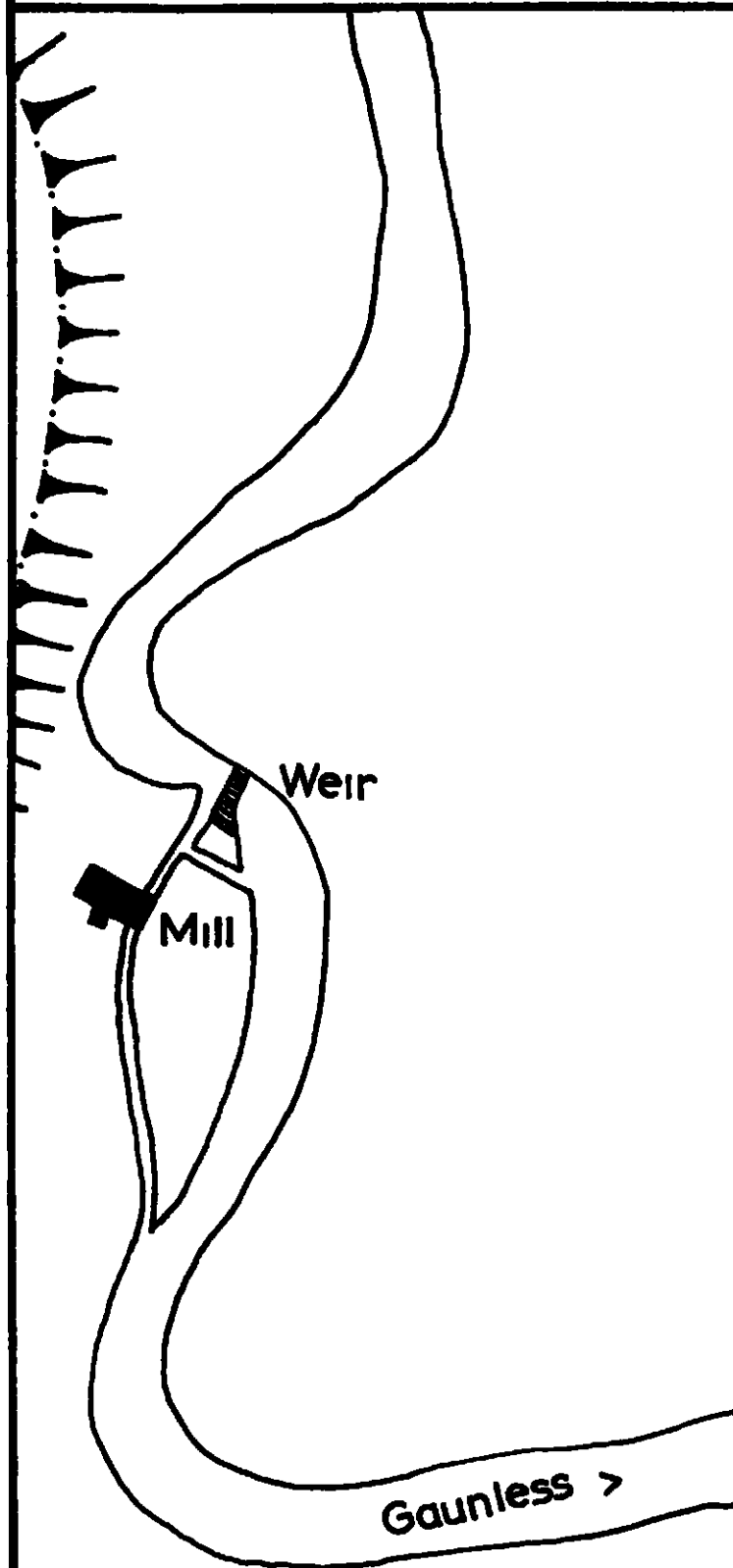
G.R. NZ273373

Little remains of this ancient mill, the site of which was abandoned about 1815. The mill stood on a level terrace deep in the heart of Croxdale Glen, where the stream makes a marked crook. The mill was served by a leet approximately 400 yards long, and it seems probably that the wheel was set inside the building. The mill, belonging to the Salvins, was built of local stone.

First documentary evidence dates from 1658 when a watercourse and fulling mill were mentioned as part of the property of Croxdale (1), and in 1678 there is a reference to a paper maker at Sunderland Bridge (2), with direct reference to the paper mill in 1682 (3). In 1783, the mill was worth £130 p.a. and a balance sheet of 1812 shows over £6,000 tied up in the business (4), and in 1813 it was decided to rebuild the mill. This decision was never executed, for with the Salvin's purchase of the Butterby estate, and the rebuilding of the paper mill there in 1816, this site was abandoned.

DEANERY MILL

G.R. NZ216284



The site of this mill is now used as a scrap metal yard, and consequently, is not easy to distinguish. The mill stood on a level terrace cut 10' above the present level of the Gaunless, into a bank 30' high. A 35 yard leet conducted water from the Gaunless along this terrace to the mill.

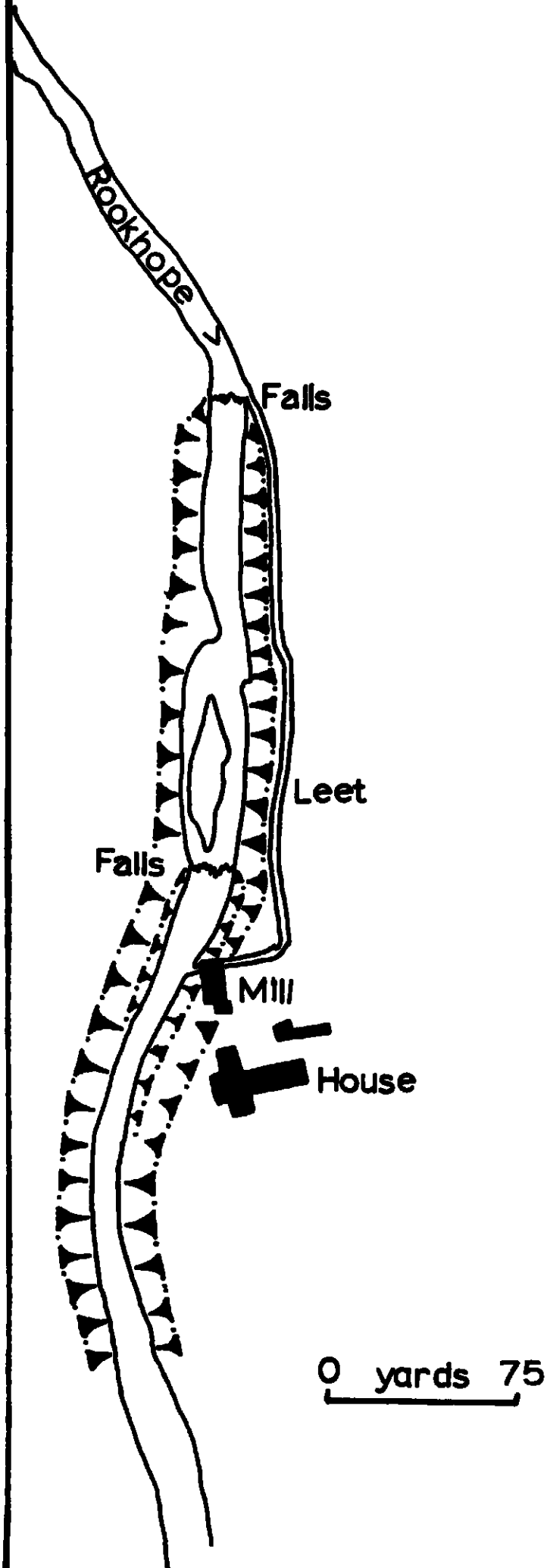
There is no doubt that this is an ancient site. The mill was attached to the Deanery of the collegiate church of St. Andrew Auckland, which was established in 1300. The present buildings which make up Deanery Farm date from the early 16th century at the very latest, and it is certain that a mill would have been established in the first days of the College. Unfortunately, although the mill was at work in the first half of the 19th century, there is no subsequent reference to its use, and all trace of the mill has now disappeared.

0 yards 75

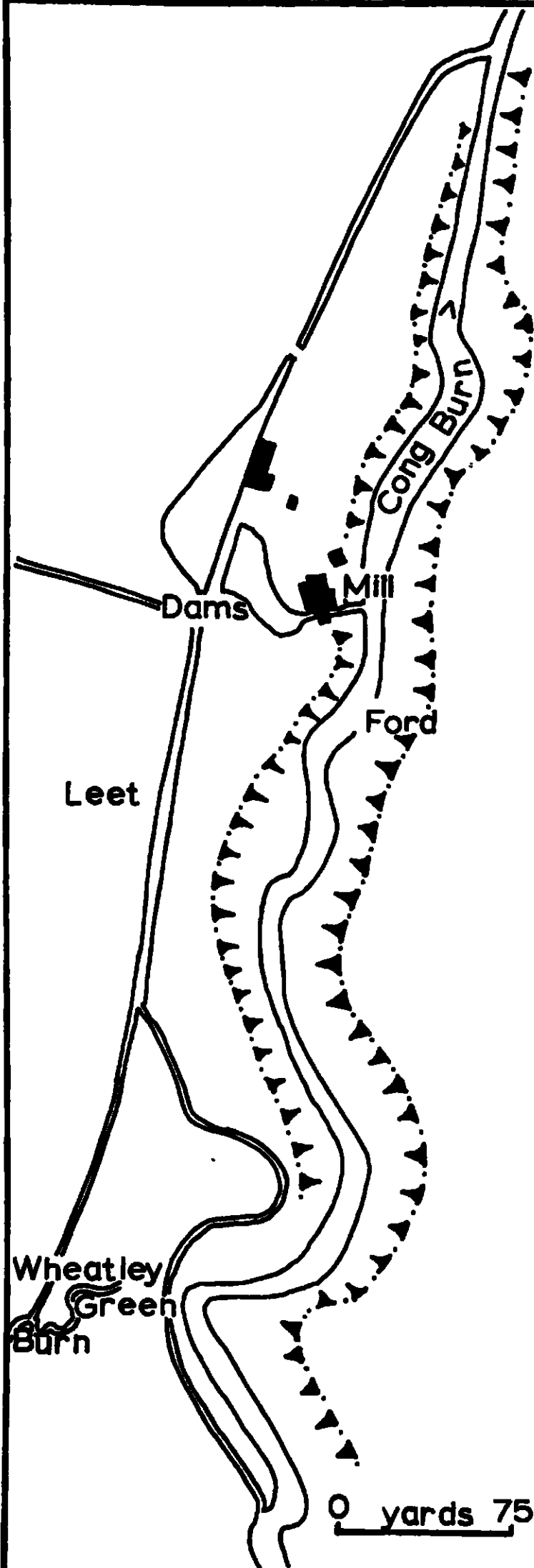
EASTGATE MILL

G.R. NY953389

The mill stands on a level terrace 6' above the rapidly flowing Rookhope Burn, and is built hard against the bank side here 10' high. A leet brought water from a fall 270 yards upstream from the mill along the crest of this 10' bank, to drive an overshot wheel entirely within the building. The mill is built of stone with a stone roof and could date from any time between the mid 18th century and the mid 19th century. The mill has two floors. The large miller's house is detached and stands nearby now divided into cottages. The first documentary mention of the mill is in 1595, and it continued working until at least 1905.



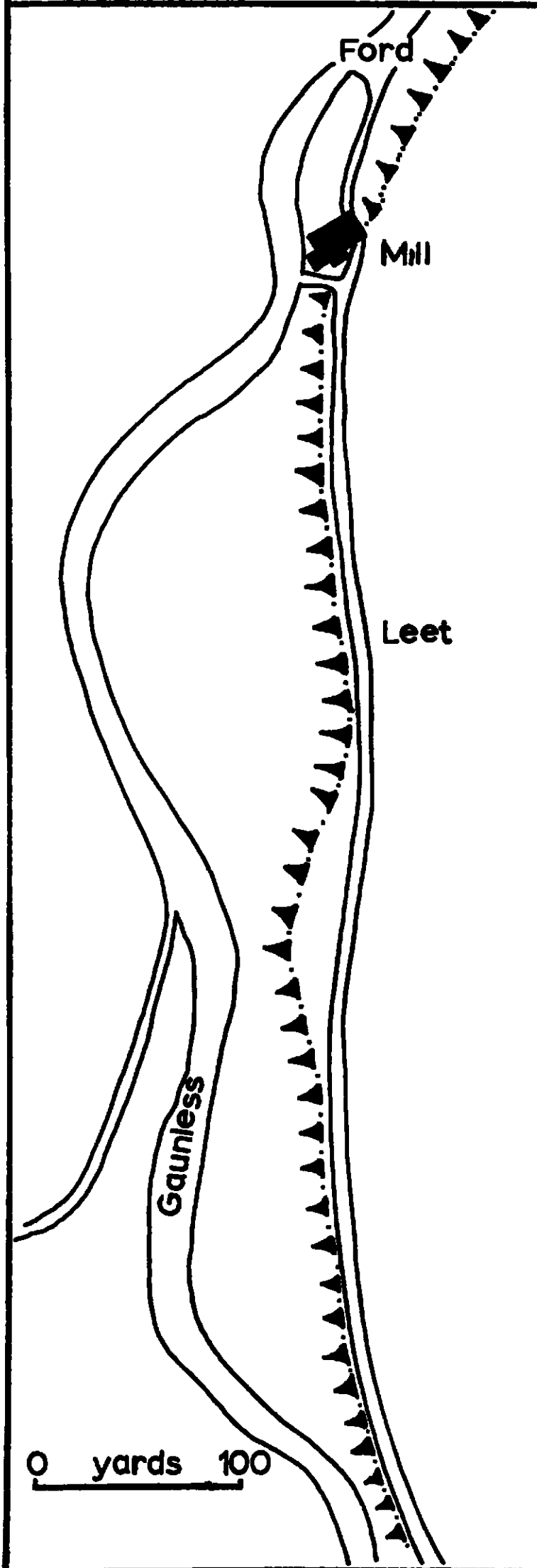
EDMONDSLEY MILL



G.R. NZ226495

The mill is built upon a 10' terrace above the swiftly flowing Cong Burn, with the land rising gently behind it. It would seem that the mill was fed from both the Cong Burn, the Wheatley Green Burn and field drainage, which filled two small dams behind the mill. The mill itself is now used as a house, but is in a poor state of repair. It was constructed of stone with a pantile roof and could date from the mid 18th century. The house now has two floors. Behind the mill the outline of the dam can be traced. The mill is first mentioned in trade directories in 1828, and would seem to be still in use by 1898, although there is no subsequent reference to it.

EVENWOOD MILL



G.R. NZ157261

This mill was built upon a level terrace 4' above the present level of the Gaunless River, and cut into the side of the hill so that a bank some 12' is formed. A 900 yard leet conducted water from the Gaunless along the crest of this bank to feed a high breast overshot wheel at least 16' in diameter, which was enclosed adjacent to the mill. This drove three sets of stones.

Little remains of the mill itself which was demolished as unsafe in 1956, but it would seem that it was formerly constructed of local stone with a pantile roof. The mill is first mentioned in the Hatfield Survey when both a fulling mill and a corn mill were present. In the 15th century there was a bloomery and a forge at Evenwood but there is no evidence to suggest that they were necessarily on this site. In 1647 only a corn mill stood here, said to be worth £13 p.a. (1) From at least 1827 until the mill's disuse in 1904 the mill was run by the Vart family, who have a long record of milling in the Auckland district.

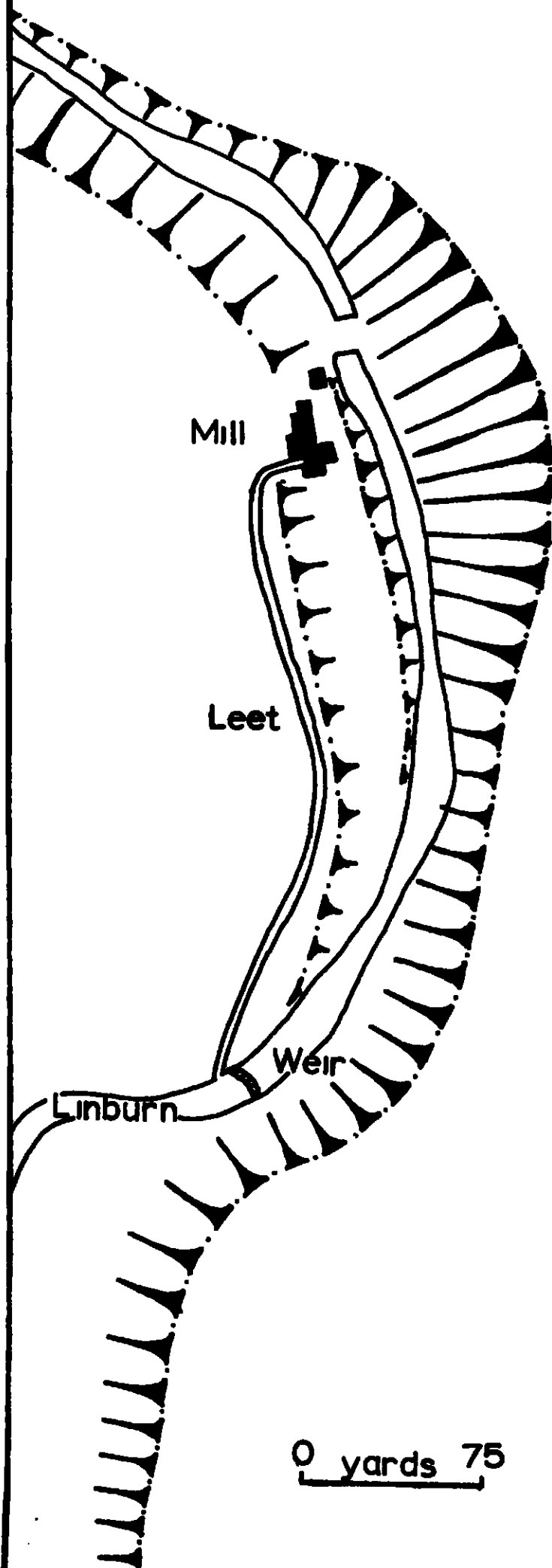
FITCHES MILL

G.R. NZ147300

This mill stands upon a level terrace 9' above the present level of the swiftly flowing Linburn Beck built into the bank side here 20' high. A 350 yard leet makes use of this bank to conduct water directly to the mill which housed a 20' overshot wheel driving three sets of 4' stones.

The mill, house and barn for storage are contiguous, set under the same stone roof, and both the mill and the house had two floors. The mill is now gutted and used as a cow house, although the wheel remains but is bricked up.

The mill is first mentioned in the Hatfield Survey, as part of the Fitches, later the Witton estate. In 1688 the Witton estate is said to have a forge, a fulling mill and a corn mill (1), but some, at least, of these were certainly on the Wear before the flood of November 1771 took away the dam and altered the course of the river (2). The mill is certainly mentioned at this present site in 1726, and in 1834 was said to be worth £50 p.a. The mill finally stopped working in the 1930's when a storm swept away the dam, although in its later years it was only being worked intermittently.

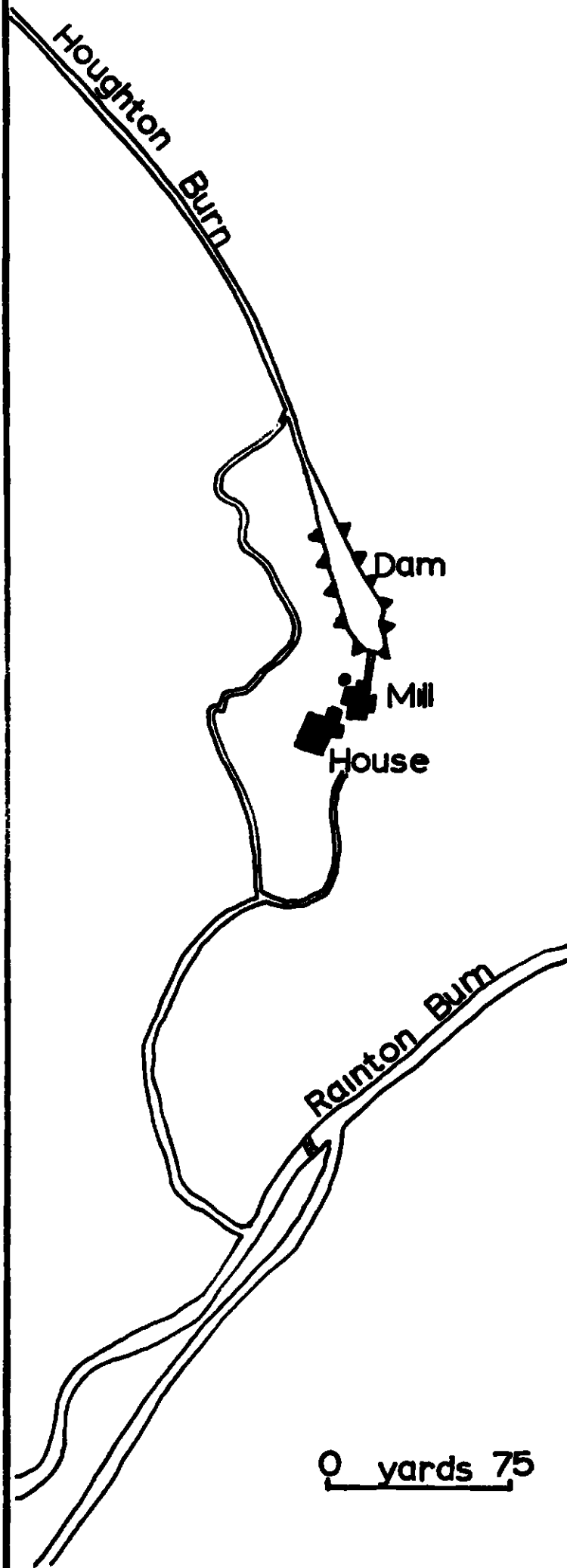


FLINT MILL

G.R. NZ 331505

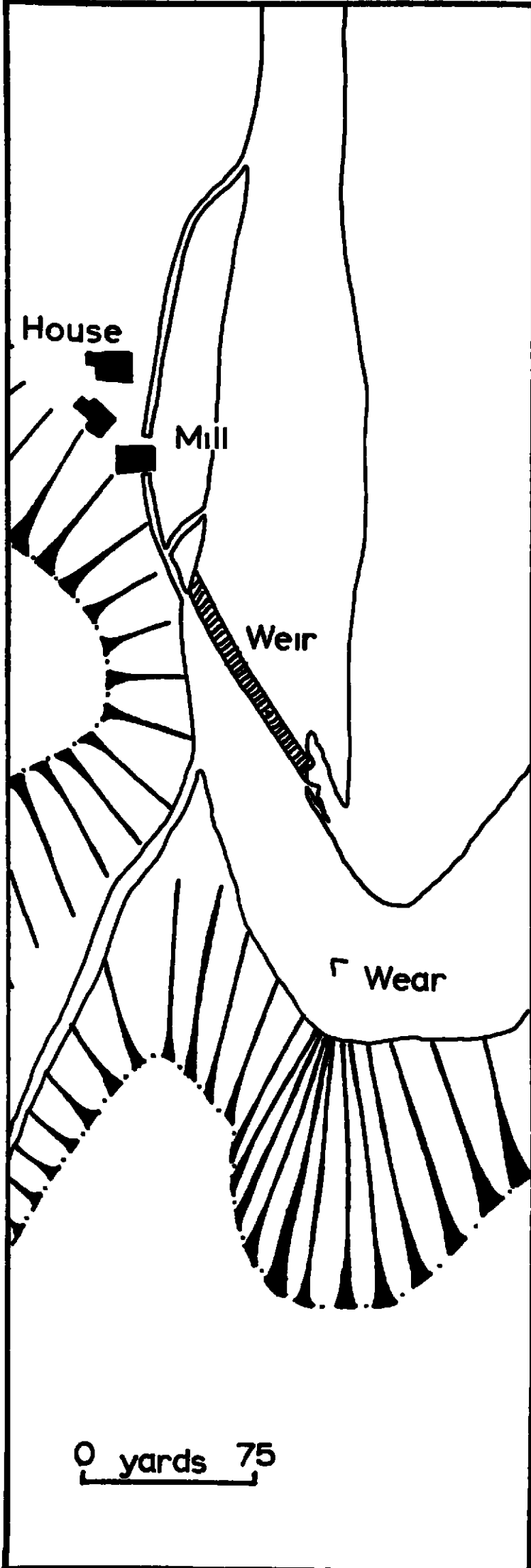
The mill stood in the open vale of the Herrington Burn below the Permian escarpment, and was fed by the small Houghton Burn, which was impounded behind the mill in a dam. Nothing now remains of the Mill, and the site has been used as a sewage works for Houghton le Spring U.D.C. since 1894.

The mill was formerly a corn mill, and it is not impossible that this was the Houghton Mill first mentioned in 1300 (1), but disappearing after 1647. This is the nearest mill to Houghton that can at present be recognised, but it might well be that on the erection of the windmill at Houghton after the mid 17th century the old water mill was allowed to disappear, and is not recognised on this site. By 1838 the mill was being used as a Flint Mill, and standing on the Londonderry estates was valued at £30 p.a. (2) Flints were imported at Sunderland and brought to several country mills to be ground ready for use in the glass and porcelain industries of Wearside.



FURNESS MILL

G.R. NZ199333



One of the few mills standing on the Wear itself, this mill was constructed of local stone on a level terrace 6' above the present level of the unstable river. The mill was served by a 30 yard leet from a dam which swept across the river making use of a natural shingle spit, and partly made up of rough stones thrown into the river and fastened down with iron stakes and wooden battens. The water turned a wooden 20' diameter wheel which drove two sets of 3' stones. After turning the wheel the water was allowed back to the river along a 100 yard course, suggesting that difficulty was experienced with backwater at this point.

Little remains of the mill except a couple of walls and the foundations, but it would seem that it was of older date than the house which stands nearby dating from the early 19th century. There is no ancient reference to the mill, although there are directory entries dating from 1828. The mill was still standing although unroofed in 1939, and it would seem that milling ceased at some time in the 1930's.

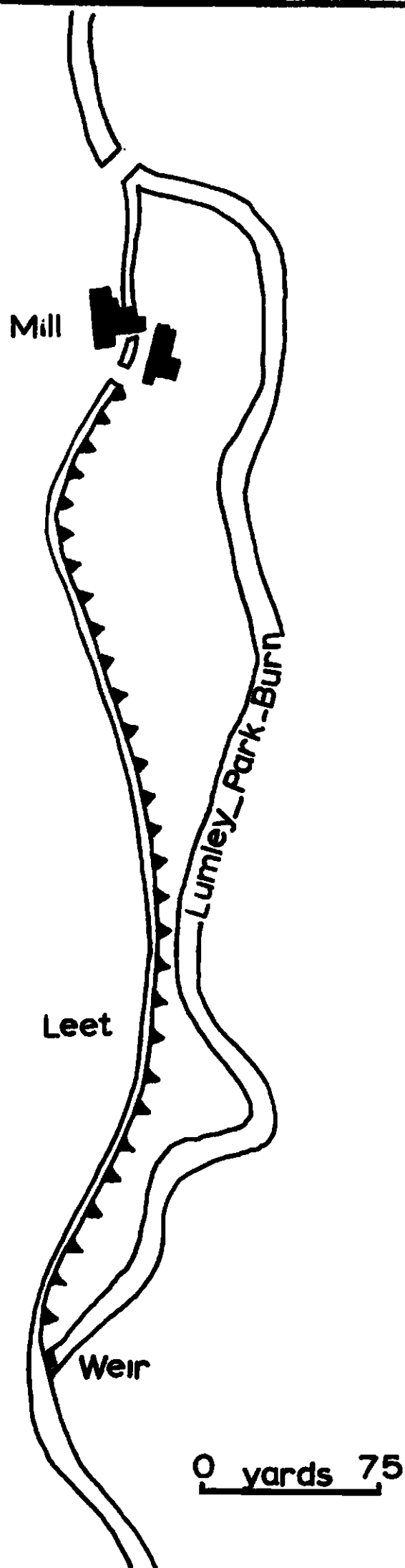
0 yards 75

FLOATERS MILL

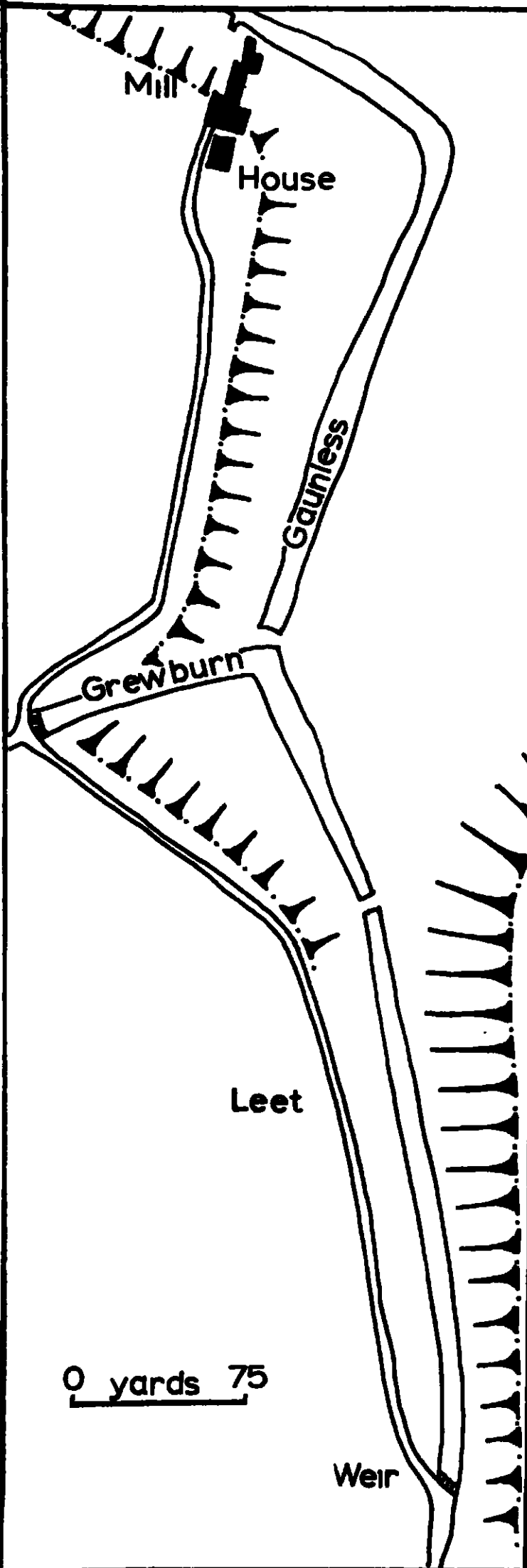
G.R. NZ312508

The mill stands on an open site on a level terrace 4' above the present level of the Lumley Park Burn before it descends its gorge to the Wear below. The 450 yard leet conducted water from the burn to an undershot wheel 18' in diameter by 4' housed within the mill. When there was sufficient water three pairs of stones were driven, but generally only two were used. The mill house and farm buildings are all composed of local stone with stone roofs, and the mill itself could date from the early 19th century or mid 18th century although there is no evidence that the mill was rebuilt at any time between 1768 and 1845 in the Lumley MSS. The mill anciently had three floors.

The mill stands upon the Lumley estate of the Earl of Scarborough, and the first mention of the mill in his papers is in 1768 (1), although there would seem no doubt that the mill was established before this date. It is possible that the mill was established when the Lumley Mill on the Wear was abandoned sometime in the early 18th century, but there is no evidence to support this. It is difficult to ascertain the value of the mill, as it was usually leased with the farm, but in 1845 the mill was worth £50 p.a. (2) in rent. Milling continued at this time until 1920.



GAUNLESS MILL

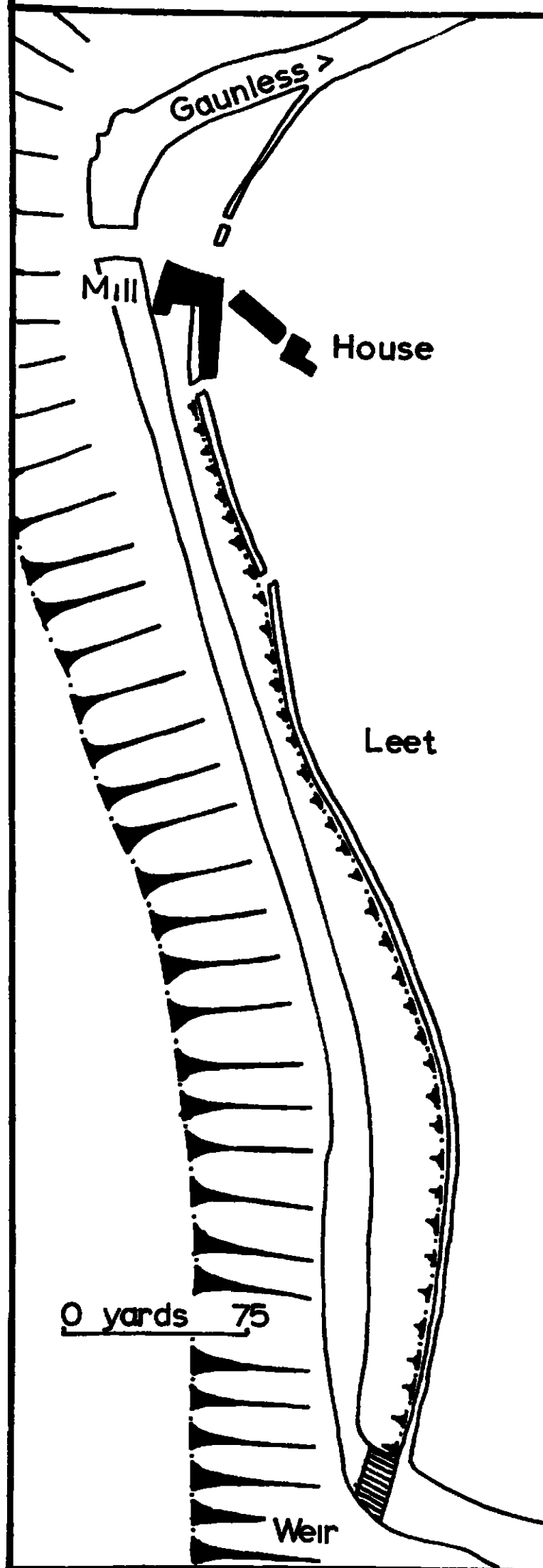


G.R. NZ115256

The mill stood on the left bank of the Gaunless, on a terrace 4' above the present level of the river, where a second terrace, 5' higher, allowed a 450 yard leet to be brought from the Gaunless above its confluence with the Grewburn Beck.

Nothing remains of the stone built mill of two floors, except a part of one wall, the remainder being demolished in 1964 after standing derelict for many years. The mill was powered by a low breast shot wheel, which drove three sets of 4' stones. The miller's house is now a cottage with both stone walls and roof, and would seem to date from the late 18th century. This mean house had two floors, and does not suggest it was the home of a wealthy miller. The mill is marked upon Greenwood's map of 1818, and ceased work some time after 1914, and before 1920.

GAUNLESS MILL



G.R. NZ214299

This mill stands upon a 6' terrace cut into the gently sloping hillside by the river Gaunless. A 530 yard leet conducted water along this terrace from a dam held by a 10' masonry apron, which still remains. The mill was powered by a 10' wide, 10' in diameter low breast shot wheel.

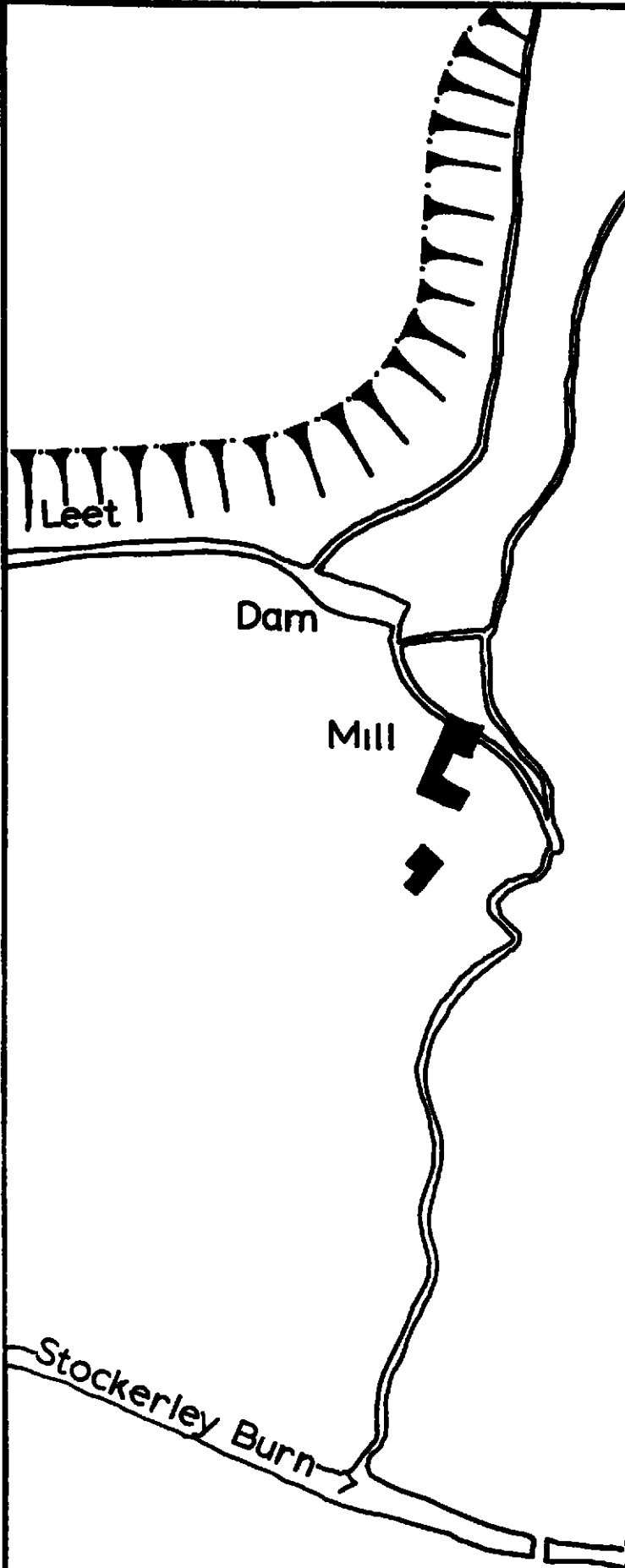
The present extensive buildings are an amalgam of early 19th century work, with additions at various dates, culminating in a recent brick extension dating from the 1920's. An early 19th century range of stables was constructed of brick with a pantile roof, but the main body of the mill, four floors high in parts, is built of stone with a slate roof.

A mill has stood on the Gaunless, at Bishop Auckland from before 1647 (1), and was responsible for the milling of corn for the use of the Bishop's household at the Palace. This was not, however, on this site, but stood within the Bishop's Park, with a leet coming off the Gaunless, near Durham road. In 1719, a special gate was cut through the park wall, into the mill, so that the dusty miller did not have to use the Bishop's gateway (2). The last traceable lease for this mill is dated 1719, and it may be that the present mill was erected in place of the older mill soon after this time. No trace of the ancient mill remains. The present mill turned over to steam milling between 1902 and 1914, but remained at work until 1958.

GREENCROFT MILL

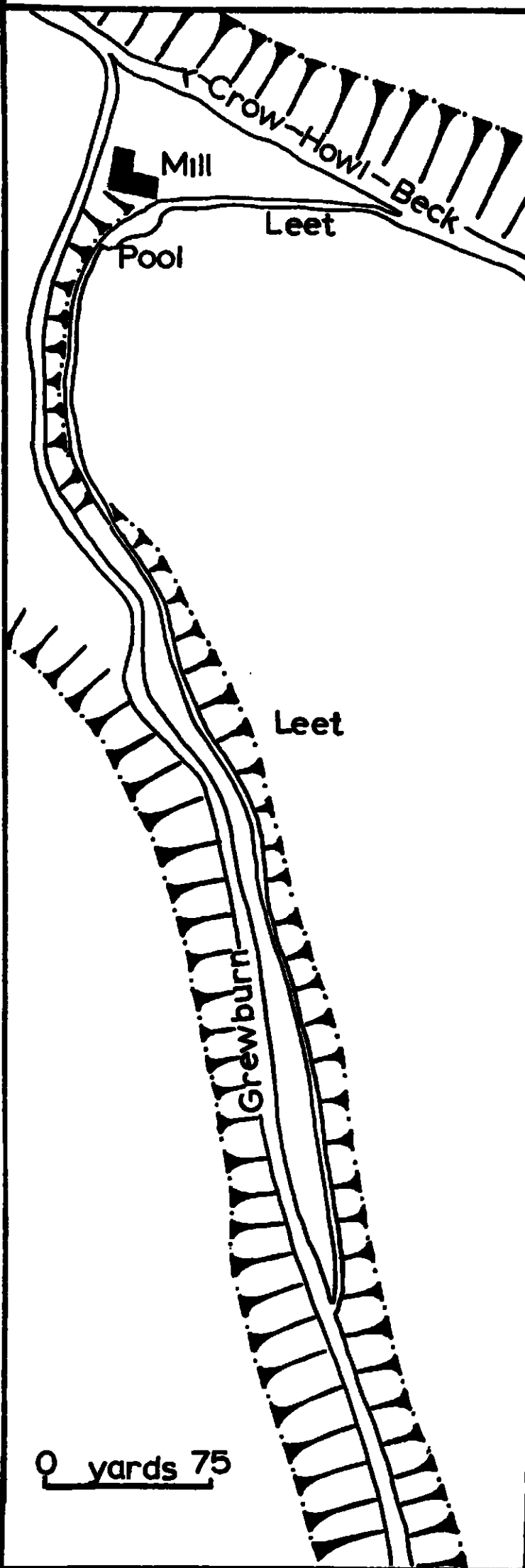
G.R. NZ158493

The mill stood in the open vale of the Stockerley Burn, which here received a left bank tributary. Nothing at all remains of the mill excepting a piece of French Stone built into a nearby privy wall. The privy is at least 60-70 years old. From the site it would seem that an undershot wheel would have been used, and from the amount of water present today it is difficult to imagine the mill ever being very powerful. The mill stood on the ancient Greencroft estate, and although no documentary evidence has come to light, it is probable that the mill stood for many years before the appearance of the first trade directory in 1827. There is no subsequent record of the mill after 1855.



0 yards 75

GREWBURN MILL



G.B. NZ111256

This mill stood at the junction of the Crow Howl and Grewburn Becks, and was fed by leets from both watercourses. The mill was built 10' above the present level of the confluence, into the steep hillside into which the streams are cut.

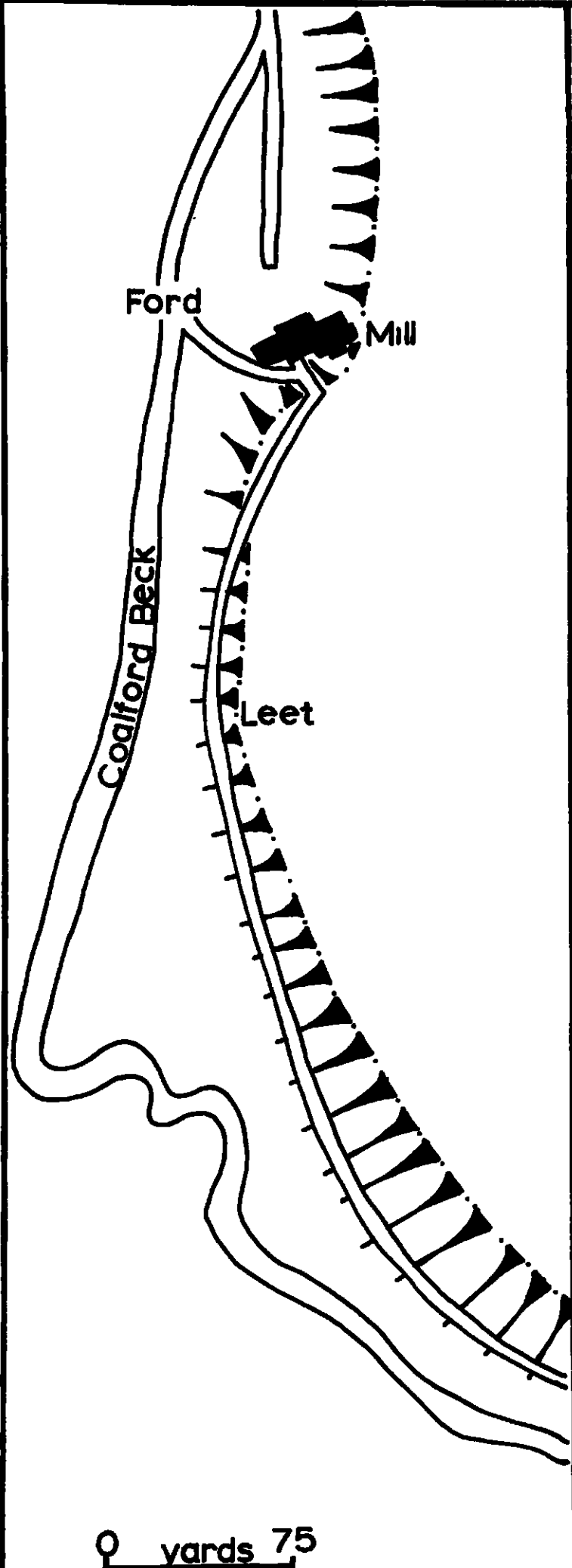
The mill was constructed of stone, with a stone roof, and would have had three floors, and was built next to the miller's house of two floors. The leets would have fed an overshot wheel housed within the mill. The first mention of the mill in trade directories occurs in 1865, but the fabric would seem to suggest an earlier date for the construction of at least the present building, perhaps in the first two decades of the 19th century. The mill ceased working in 1909, and it was subsequently converted into two cottages.

HALLGARTH MILL

G.R. NZ321435

The mill stood on a level terrace 4' above the present level of the Coalford Beck, and was built into the bank side here 14' high. A 725 yard leet brought water along this bank to an overshot wheel 16' in diameter. The wheel was within the mill which was constructed of stone, although nothing now remains except a few low walls and a large amount of tumble.

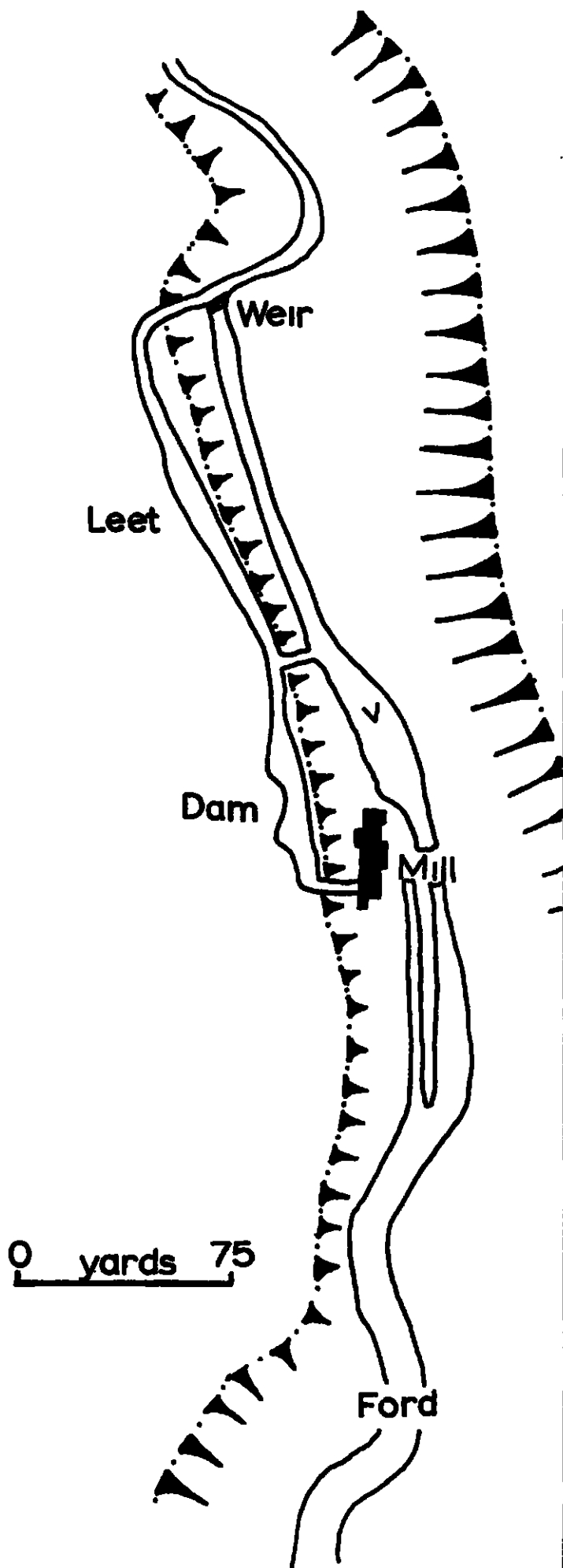
The mill was established in the early 12th century (1), and served the Prior's lodging at Pittington. Apart from the period of the dissolution of the Convent, there is a continuous record of this mill until 1914 (2) when it was being worked by the widow of the last miller. It ceased soon after this.



HARTHOPE MILL

G.R. NZ109322

This mill stands in a narrow valley on a level terrace 3' above the present level of the Harthope Burn, and built hard against the bank side which here is 10' high. A 260 yard leet conducted water from the Harthope Burn to a small dam on the bank above the mill, which probably fed a low breast shot wheel. The mill was built of brick and would seem to date from the mid 19th century, but has been substantially altered and little trace of its former use remain. It is now used as a cow shed. The last directory entry for the mill is in 1890. Very little is known of this isolated mill.

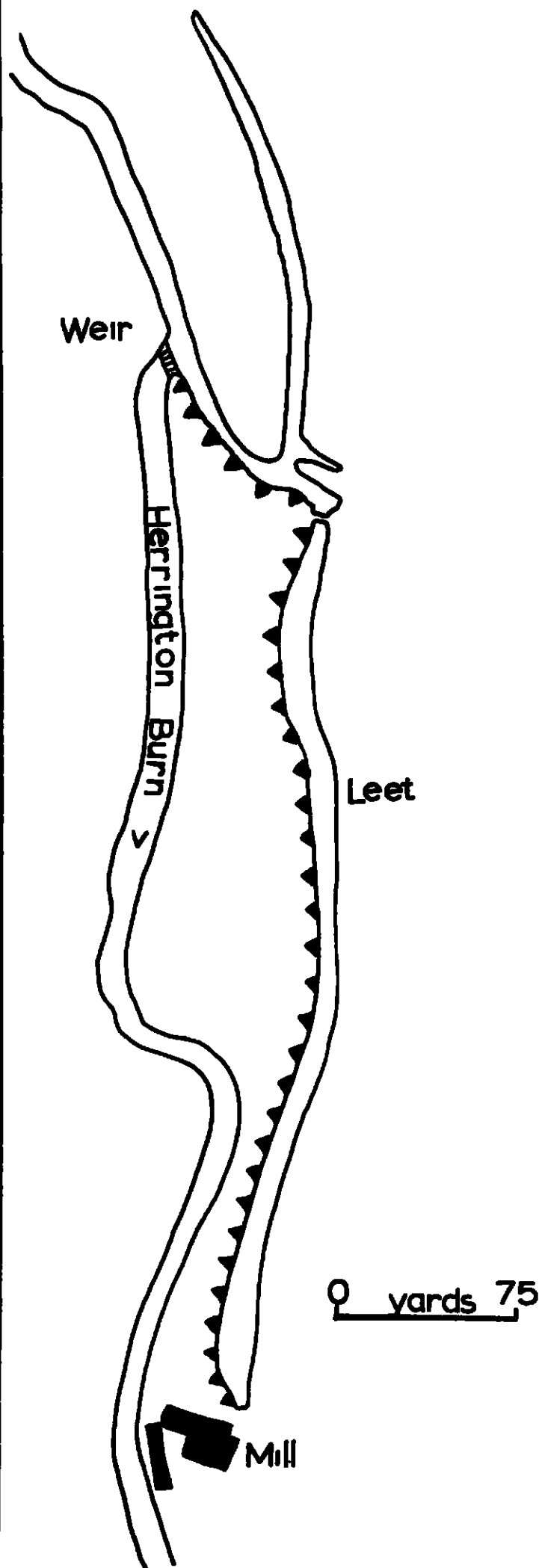


HERRINGTON BURN MILL

G.R. NZ332527

Nothing remains of this mill which stood on the Herrington Burn, and the site is now lost under a small spoil heap. From the general configuration of the land around, it would seem that the mill stood on a terrace 4' above the level of the Herrington Burn, in the gently sloping vale of Ellingbourn. It would seem that the mill was served by a leet also acting as a dam, coming off the Herrington Burn 400 yards upstream, and the mill would almost certainly have been powered by an undershot wheel.

The site itself is an ancient one which is first heard of in 1328 (1). The last directory entry for the mill is in 1855, and the neighbouring presence of a steam mill, marked upon the Ordnance Survey in 1857, might well explain the abandoning of the mill at about that time.

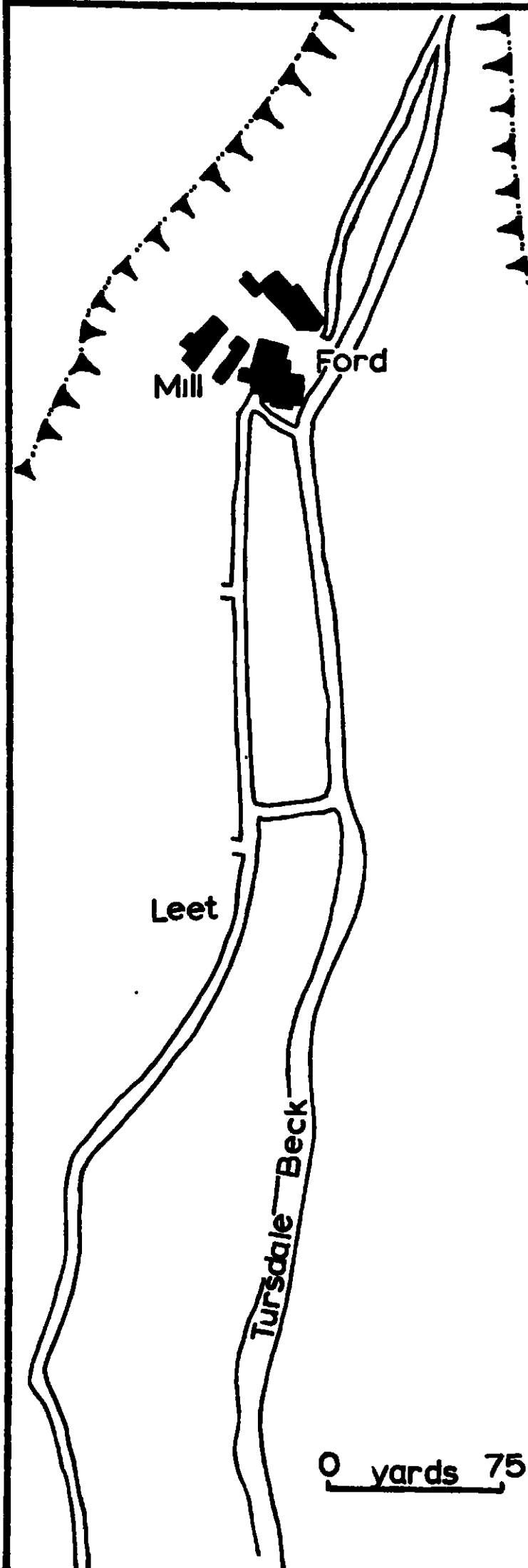


HETT MILL

G.R. NZ292370

Nothing remains of this once large mill, except traces of the leet, and the place name. The site is a pleasant open valley at the head of Croxdale Glen, where the Tursdale Beck begins to flow off the 300' surface and cut its way down to the Wear. A leet brought water 800 yards from the Tursdale Beck to the mill, which could be replenished with water by another sluice from the beck within 150 yards of the mill. The mill would certainly be powered by an undershot water wheel.

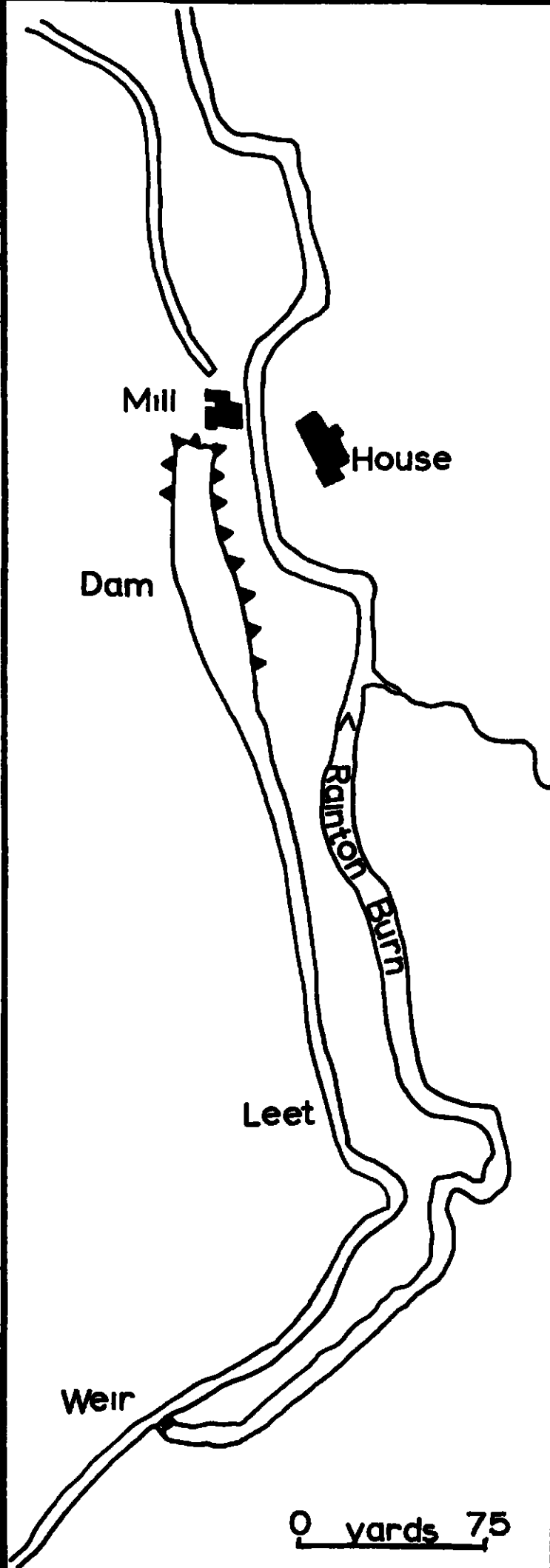
There was a corn mill here in (1) 1168, and in 1430 a rough plan shows the site of Hett, and two other mills belonging to the manor of Trillesden, or Tursdale within half a mile of each other on this stream (2). In 1779, the mill was rebuilt as a corn and paper mill, and continued as such until the last quarter of the 19th century when only corn milling was practised until the mill was disused by 1914.



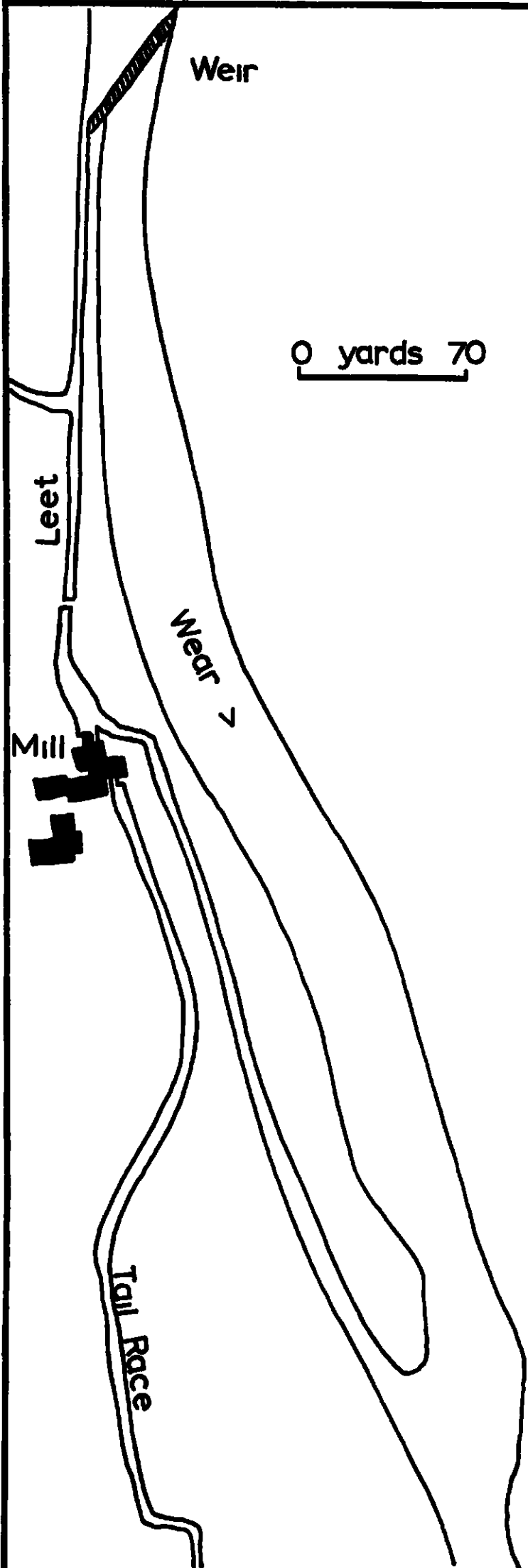
HETTON MILL

G.R. NZ342487

All trace of this mill is now lost, but it lay immediately upstream of Rainton Mill, and its tail race fed the dam of that mill. The site is a low terrace above the Rainton Burn from which it was fed by a 440 yard leet conducting the water to a dam which fed, in all probability a low breast or an undershot wheel. The first record of the mill at this place is in 1380, but it seems to have gone largely unchronicled, and little is known about it until an entry in a trade directory of 1827. About 1860 it was abandoned when the tenant took over the lease of Rainton Mill and nothing more is heard of Hetton Mill.



HOLEBECK MILL



G.R. NZ059369

Nothing remains of this mill except a re-constructed dam and traces of the leet. The mill stood in the open valley of the Wear on a terrace 8' above the present level of the river. A weir stretched directly across the river and allowed water into a 250 yard leet, which would have fed an undershot wheel.

The remains of the mill, then used as a cow byre, were finally demolished in 1956. It would seem that the mill was built of stone with a stone roof and had three floors. It could be that there has only been one building on this site, for an illustration of the mill of 1900 would date the mill as a late 18th century erection of considerable charm. The mill stood on the Holebeck House Estate and the first reference to it is when the estate was sold in 1773 in an advertisement in the Newcastle Courant. The last directory reference to the mill is in 1855.

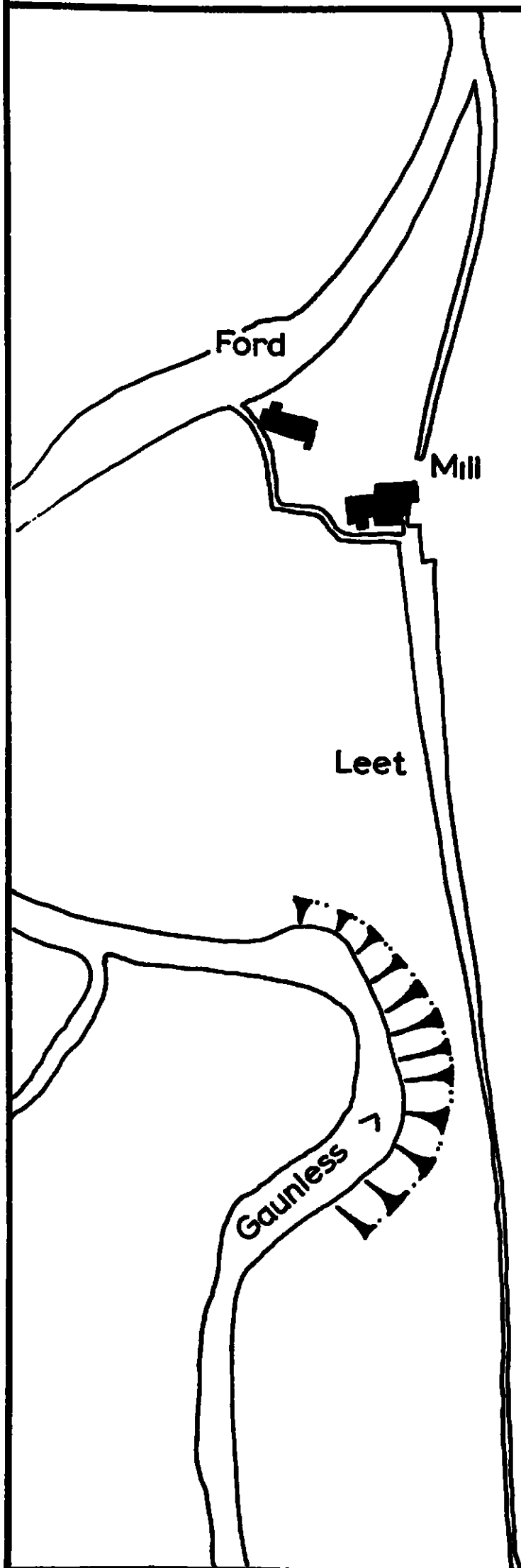
HOLME MILL

G.R. NZ171268

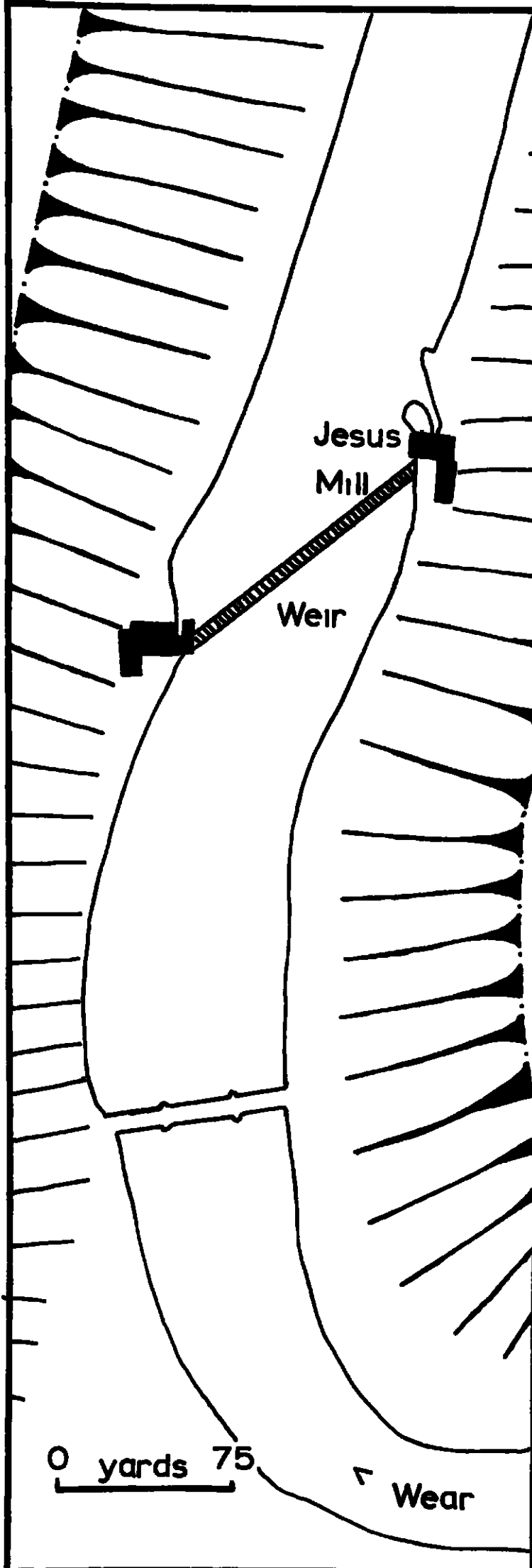
This mill stands on a level terrace 7' above the river Gaunless, and is built into the low hillside, along which a 500 yard leet formerly conducted water from a dam above a masonry weir to a 20' overshot wheel within the mill.

The present mill is a large and ugly building of three floors composed of late 19th century brick, built over and onto an earlier stone construction. The miller's house which stands adjacent is an earlier structure of two floors, built of stone but with a modern slate roof. Although the mill is rapidly falling into decay and is at present being dismantled, at the time of inspection it still remained largely as it would have been when it was at work. The large wooden water wheel besides working a dynamo to provide direct current electricity, worked the lifting apparatus and three sets of stones, one each for barley, oats and wheat. Cup conveyor belts lifted the grain into hoppers above the stones on the second floor. The grain was then allowed down onto the stones on the first floor, and ground into flour, being despatched from the ground floor.

The mill is first mentioned in 1726 (1), and for much of the 19th century was in the hands of the Fletcher family. In 1910 the mill came into the hands of the Vart family, who still own the property. The mill ceased milling in 1942 after a series of personal accidents to the family, and the destruction of the dam by a storm.



JESUS MILL



G.R. NZ272422

This well-known mill stands on the eastern end of the Abbey Weir on the river below the Cathedral at Durham, and is more popularly known as the Fulling Mill. The mill is built out into the stream from the side of the gorge, and was fed directly from the dammed river, powered by an undershot wheel. The present structure incorporates masonry of at least the early 15th century, but some may be considerably older. Much of the superstructure, however is of 18th century brick construction, and may date from after the flood of 1771.

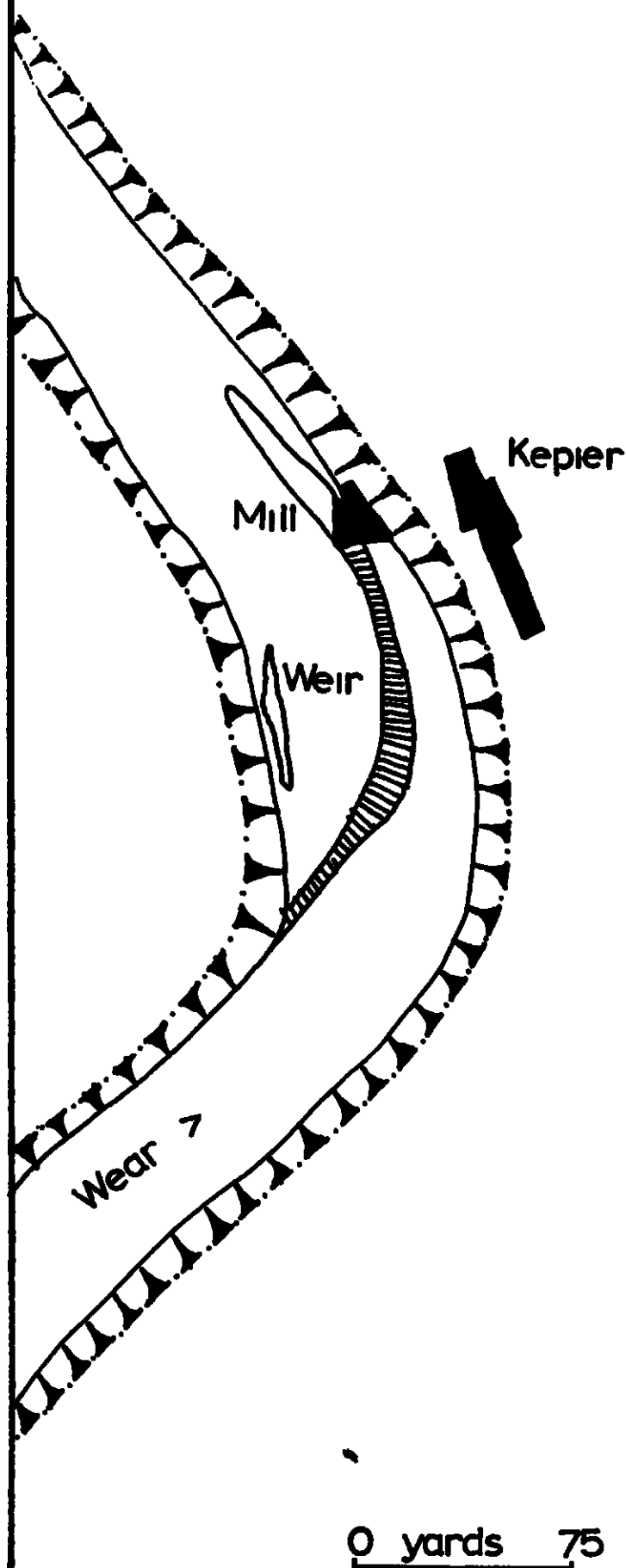
The mill was formerly owned by the bishop (1) and probably dates from the same time as the Abbey Mill. At the end of the 15th century, Thomas Castell, elected Prior of the Convent in 1496 gave the two corn mills then standing on this site to the office of the Sacrist for the support of the Jesus Altar in the Abbey, from whence the mill gained its name (2). After the dissolution the mills became known as the Abbey Mills, but for how long both mills were maintained is not known. In 1792 the mill was leased for the carding and spinning of wool and they continued in this function until their abandonment about 1830, (3). At some time after this a pump was installed and continued to use the wheel to pump water into the College Pant 150' above until at least 1861, (4). The mill was used as a University Museum for many years, and subsequently became a restaurant. Of latter years it has attained the dignity of housing a department of the University of Durham.

KEPIER MILL

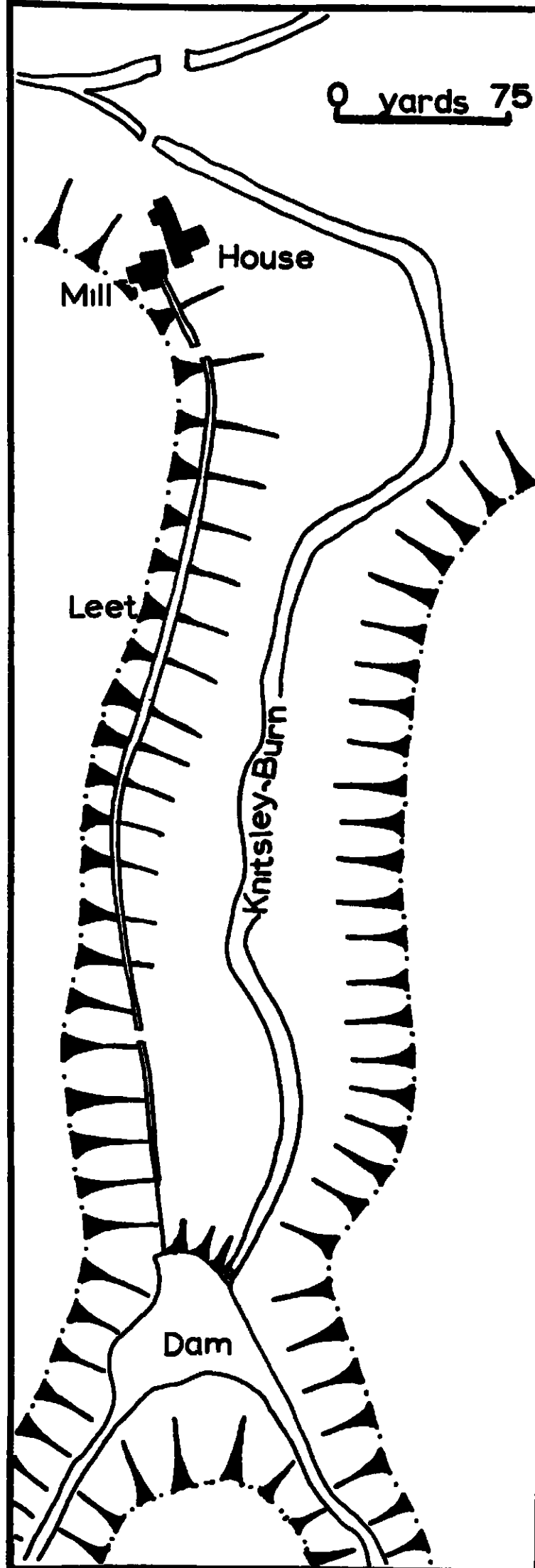
G.R. NZ228343

The mill was built out into the river at the end of a rough dam which was thrown diagonally across the Wear at this point. The mill was constructed of stone, but nothing now remains at this site except the line of the dam and a great deal of tumble.

The foundation of this mill can be exactly attributed to 1244 when the brethren of Kepier Hospital were given the right to establish a dam for a mill at Kepier (1). The mill thus became the manor mill for Gilesgate and passed to the secular lords of that manor after the dissolution of the hospital. The name of the place suggests that this is an ancient fishery site and a typical tumble dam with no attempt at masonry held up the river here until the 19th century. In 1863 the mill is said to be a very insignificant one, old and expensive to repair, but it continued to be used until it was accidentally burnt down in 1902, and never rebuilt.



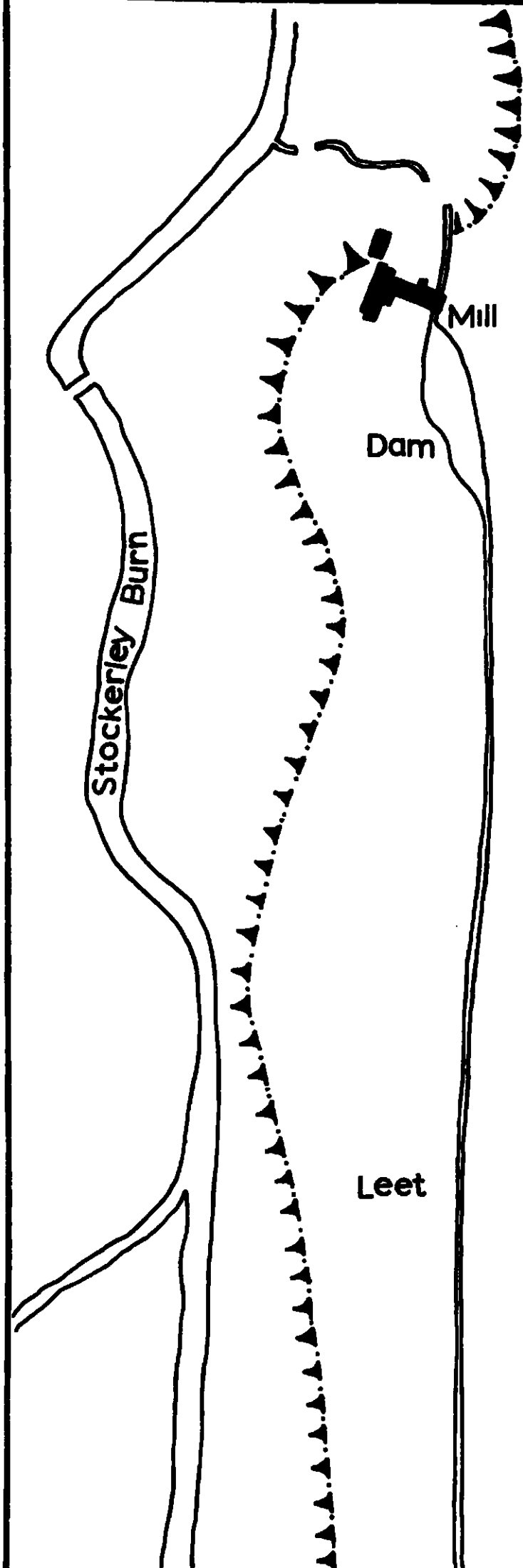
KNITSLEY MILL



G.R. NZ119481

A very handsome building this mill has been disused for many years, but it is still preserved and used as a barn. The mill stands upon the left bank of the Knitsley Burn, on a small second terrace some 6' above the present level of the burn. The mill is built into the hillside along which a 470 yard leet conducted water from a large storage reservoir filled by the confluence of the Knitsley and Beggarside Burns. An overshot wheel at least 20' in diameter stood outside the mill and drove three sets of stones on the first floor of this three storied building. Entrance to the ground floor from which the flour would be taken was gained by a handsome stone arch 8' across. The building is of superior stone construction and would seem to date from the early 19th century. It seems strange, therefore, that this mill should have fallen into disuse by 1879, but after that date no millers are recorded at Knitsley.

LANCHESTER MILL

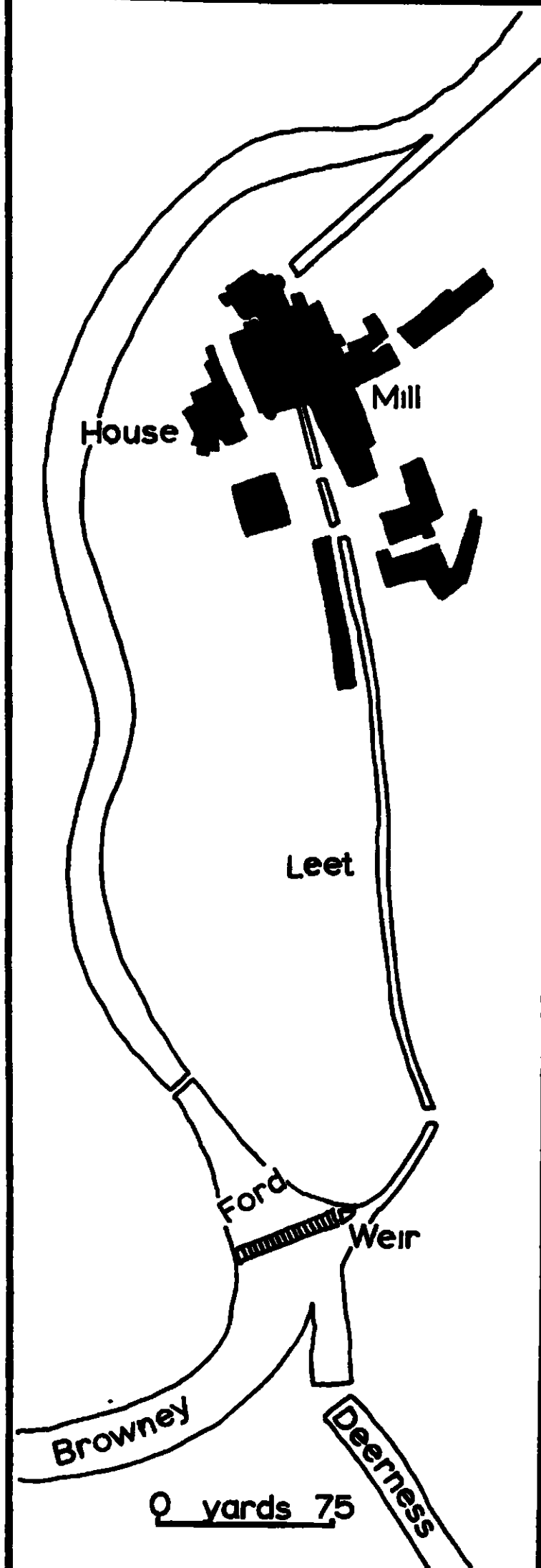


G.R. NZ164479

This mill is now converted into three cottages and little remains to give any indication of its former role. The mill stands in the wide valley of the Stockerley Burn at the head of Lanchester Village, on a level terrace 5' above the present level of the burn. A leet brought water 900 yards along this terrace through the meadows to feed an undershot wheel.

The present building is constructed of stone, with a slate roof of more recent erection. The mill was mentioned in Boldon Book and continued in use until the early part of this century, like the dog that never barked, its absence from chronicles and documents suggests its continuous ownership and efficient use.

LANGLEY GROVE MILL



G.R. NZ258408

Nothing remains of these once extensive works, except the remains of a few small buildings, composed of local stone with pantile roofs, suggesting a date of construction in the early 19th century. The mills were powered by water brought 300 yards from a dam below the confluence of the Browney and the Deerness, and stood upon the level flood plain of the Browney, some 6' above the present level of that river.

The mills were established by 1777 as both corn and paper mills, but by 1803 were taken over by the Smith family who continued to run them as paper mills until their abandonment in the last years of the 19th century. The buildings were burned down in 1828 (1), and extensive reconstruction must have taken place. At that date extensions had been erected to the old mill to provide a drying loft which was roofed with slate and not the local tiles. From 1855 the mills were run in conjunction with their upstream neighbour, Relly Mill, which closed down in 1905.

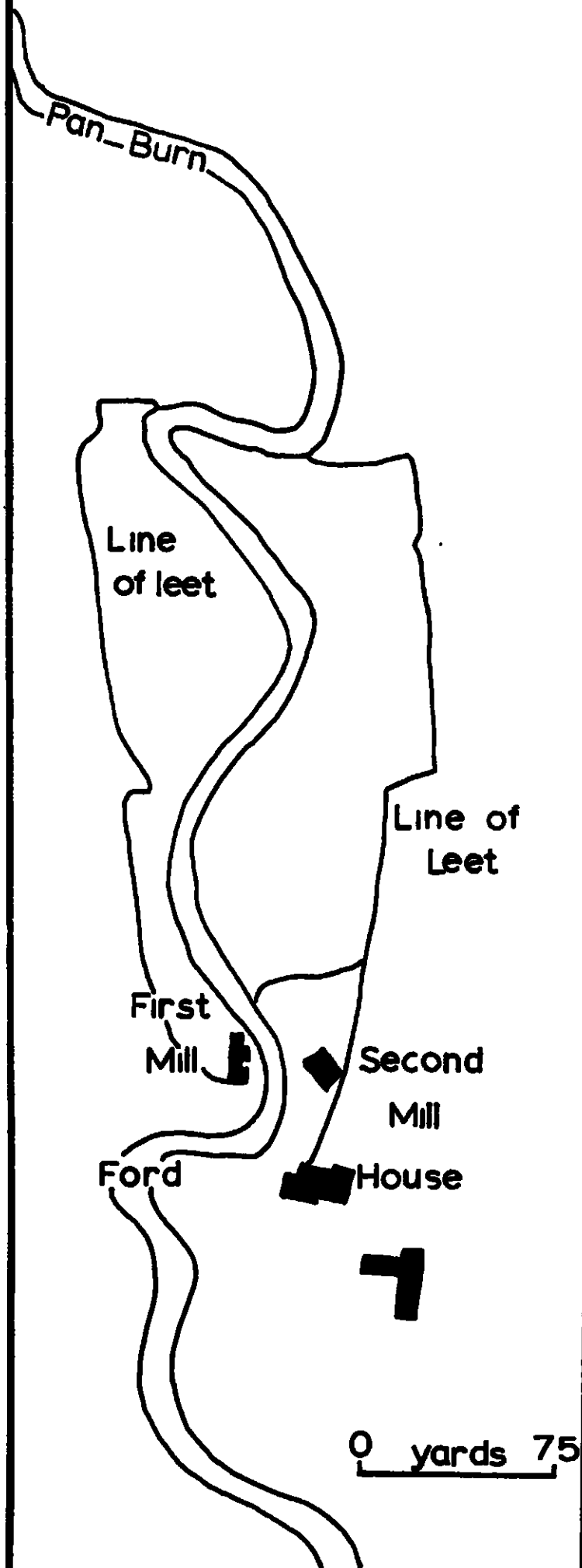
LOW MILLS

G.R. NZ144446

There was no mill working here in 1857, but definite traces of two mills can be seen. On the left bank of the Pan Burn on a low terrace 3' above the present level of the burn stand the charming remains of a small mill no more than 12' square, which was worked by a wheel 12' in diameter and 4' wide. The mill is built into the bank side and a leet made use of this bank, but is not traceable for more than ten yards. The building was of stone, of one floor, and the wheel drove two pairs of 4' stones.

In 1768 Armstrong's map of County Durham marks Low Mills on the right bank of the Pan Burn, as also does Greenwood's map of 1818. In 1857 this site is marked as "Old Walls" and today nothing remains but rough ground and a tell-tale field boundary that undoubtedly marks the site of a leet.

It would seem, therefore, that this was the original site of the mill which was subsequently abandoned, although no reason is apparent, and a mill built upon the other side of the river. Both banks are owned by the same landlord. Although there was a miller here in 1828, by 1865 the site has merely given its name to that of the farm, the house of which is a substantial stone building of three floors with a high stone roof.

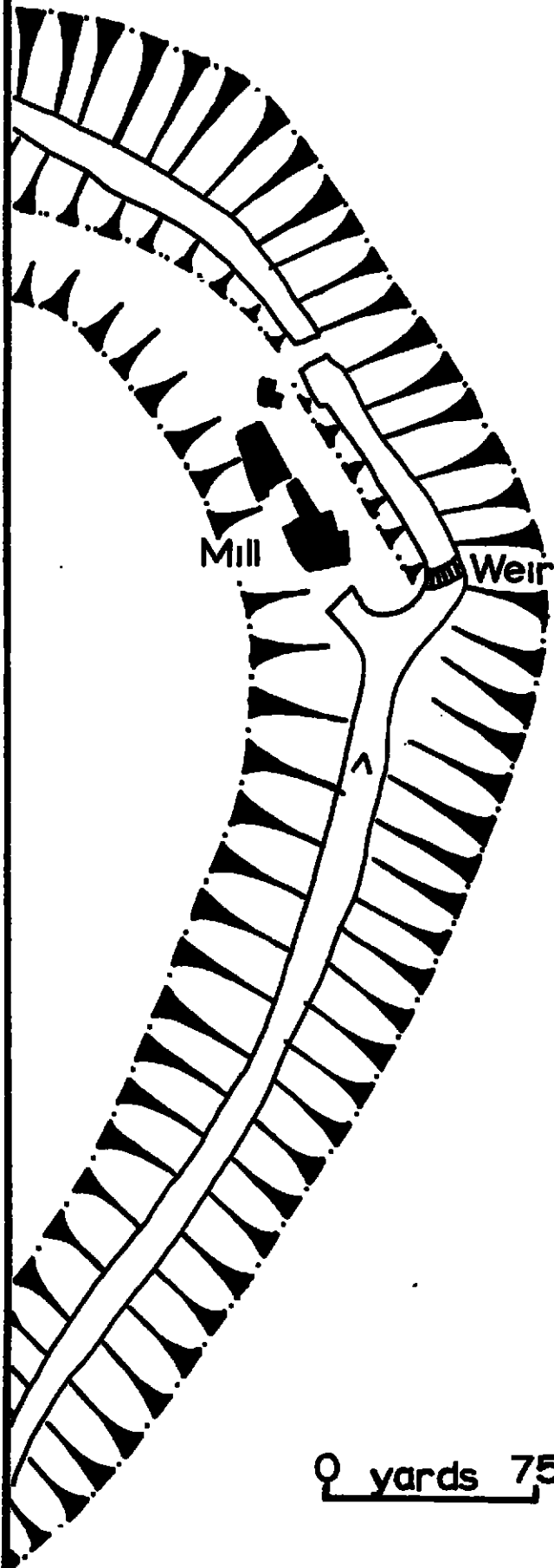


LUMLEY FORGE

G.R. NZ300509

Nothing remains at the site of this once famous forge, for it lay on the path of the Durham Motorway, and at the time of inspection in June 1966 was about to be buried under a road bridge. The forge could not have been of very large proportions as it stood on a constricted terrace 8' or 9' above the Lumley Park Burn which here falls down very rapidly through a narrow gorge to the Wear below. The mill was worked directly off the burn, which was here dammed at the crest of a 6' fall to give a powerful head to drive a bellows and hammer wheel.

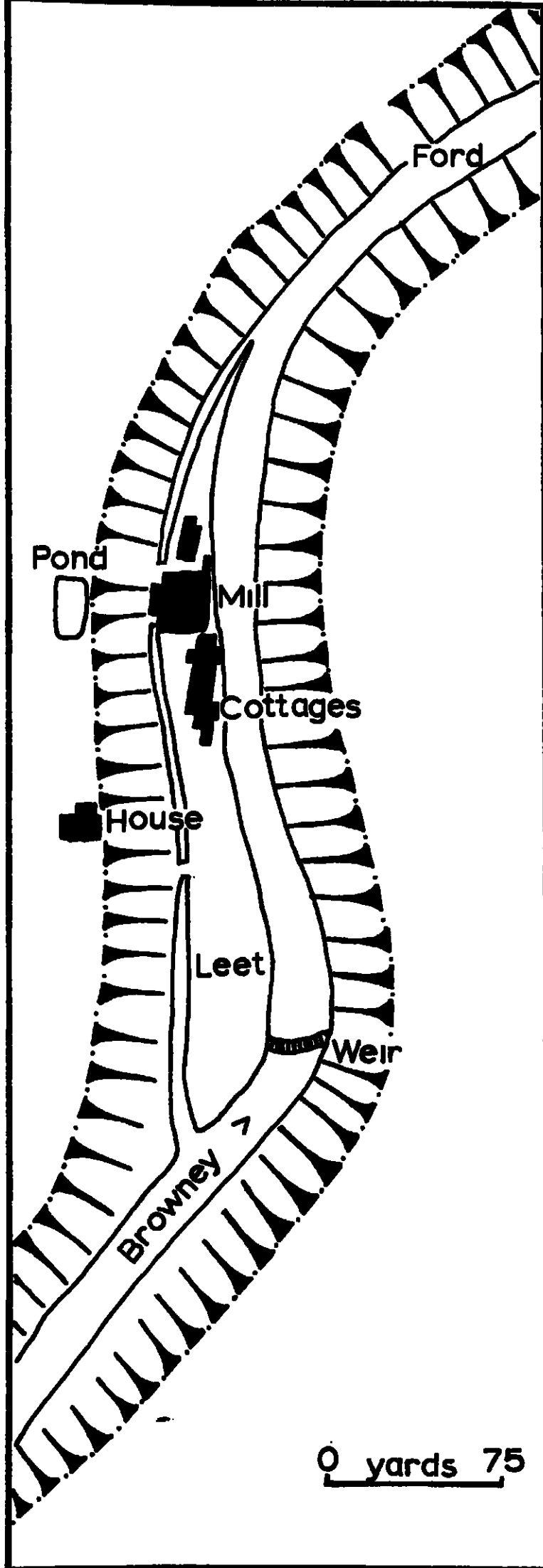
The forge had been erected some years before 1783 when William Hawkes leased the forge from Lord Scarborough for the manufacture of ordnance (1). Because of losses made by Hawkes on the Fishery at Lumley which was included in the lease, the refusal of Lord Scarborough to allow the firm to establish slitting mills and gunpowder mills on the site or on the river, Hawkes & Co., left the forge and set up the Team Iron Foundry in 1829. They leased the forge to Lord Durham who in 1837 sub-let the remaining buildings, which had subsequently been allowed to fall into disrepair, to John Ward who with his partner established mills for grinding charcoal and barley (2). The mill later became mainly concerned with charcoal and the last directory entry is in 1879.



0 yards 75

MOORSLEY BANKS MILL

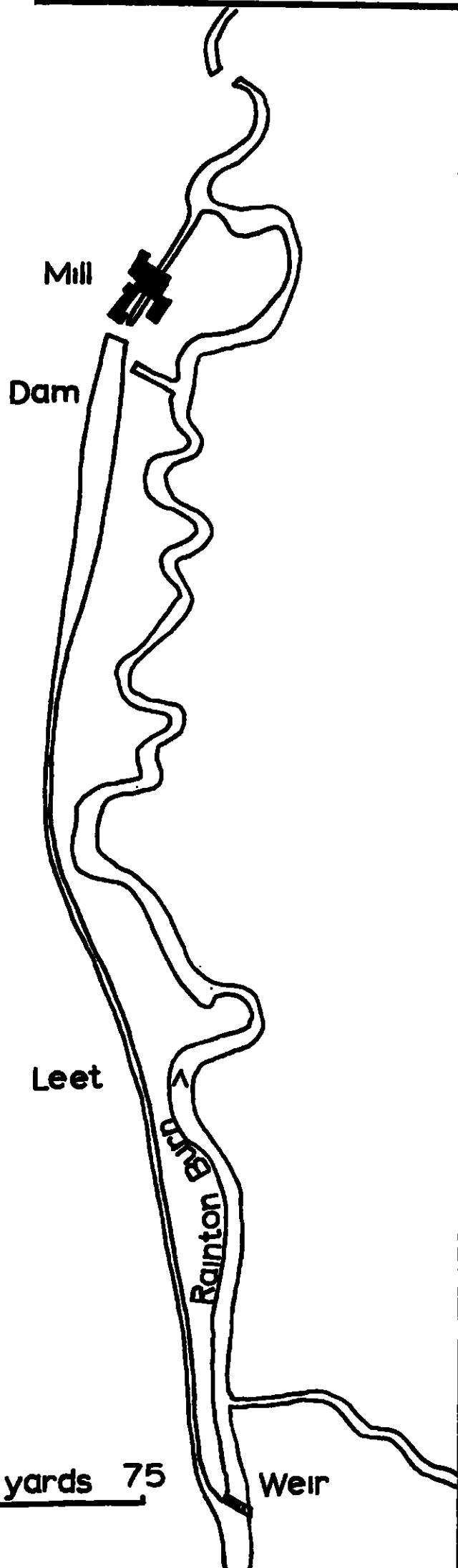
G.R. NZ255427



Apart from the cottages once attached to this mill, and the remains of a stone weir, little remains of this mill. The site is a low and level terrace 4' above the present level of the Browney, cut into the steep valley sides of Moorsley Banks, here 30' high. A 160 yard leet conducted water from the Browney above a 6' masonry dam to supply the paper mill which was the last of a series of mills on this site; nothing remains of this mill. An older stone construction is evident from a series of low stone walls 90 yards from the dam, on the line of the leet, and these could represent the site of the earlier corn and fulling mill, but the evidence is far from conclusive.

The site is mentioned in the 12th century, and it subsequently came into the hands of the cell of monks at Finchale, when it was used as a fulling mill, as which it continued until at least 1580 (1). When the mill was separated from the Aldin Grange estate in 1779, it was termed a water-corn-fulling-mill, but it may be that more corn milling than fulling was carried out. In 1816, however, the tenant sub let the mill to the Ord brothers who converted it into a paper mill, and as such it continued until it was abandoned at the end of the 19th century.

NEWBOTTLE MILL



G.R. NZ325508

There is no trace of this mill under its ancient name. Although the mill was first mentioned in Boldon Book, and is traceable until 1830, there is never any mention of this mill in any of the trade directories. Unfortunately, the person who leased a mill, in this case from the See, was not always the person who actually ran the mill, and advertised in such directories. Thus, although it is known who was the Bishop's tenant in 1830 (1), there is no reference to any such person in contemporary directories.

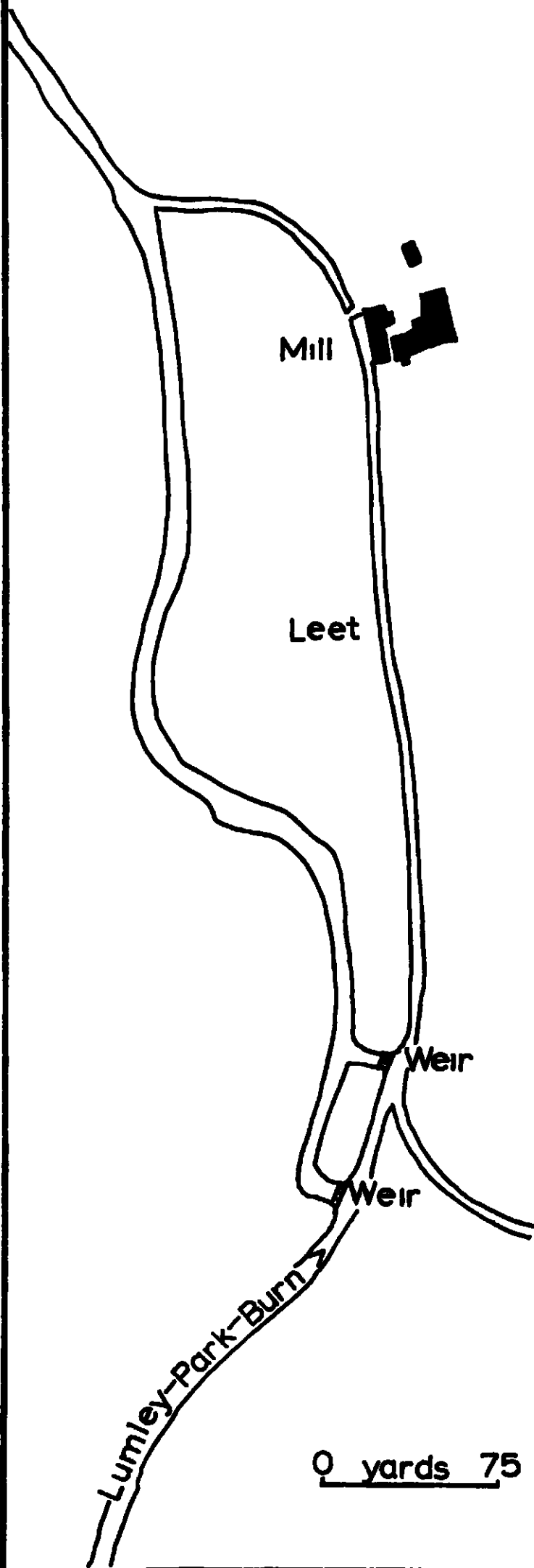
It is known that the mill stood upon the Rainton Burn (2) and on the Rainton Burn at this time stood one mill, under the name of Sedgeleth Mill. As this is only three quarters of a mile from Newbottle cross-roads, and is, moreover, the nearest point on the Rainton Burn to Newbottle, it can be assumed that this is the Newbottle Mill of old.

The mill stood on level ground on the bank of the burn, and was fed by a 450 yard leet. Nothing remains of this mill, which would not have seemed to be a large building. It was last recorded in 1855 and it must be presumed that it ceased working soon after this.

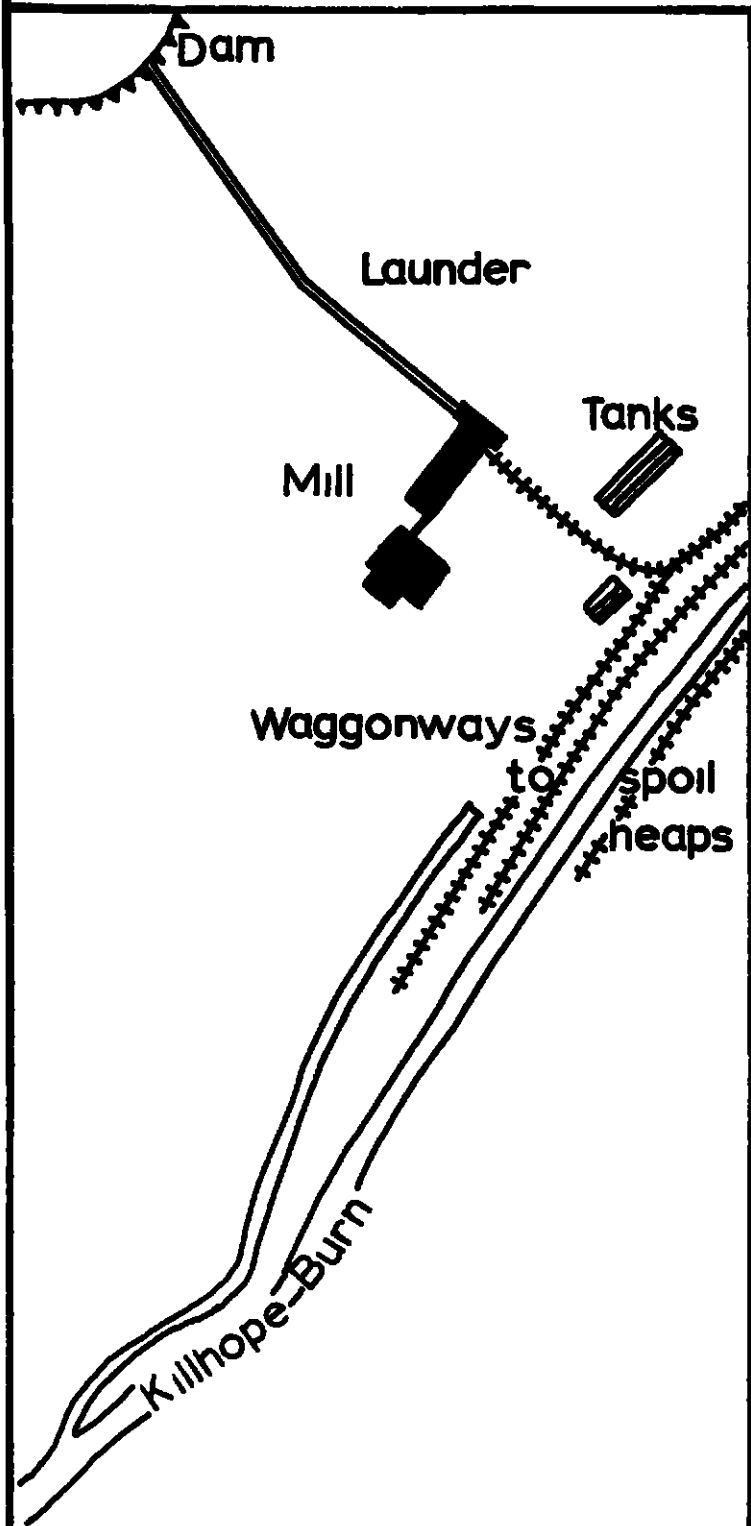
NEW LAMBTON MILL

G.R. NZ317507

Nothing remains of this mill, which was probably erected to serve the growing colliery population of this district towards the end of the 18th century. The site was on gently sloping land 5' above the Lumley Park Burn, which is here incised into the drift, and would seem to suggest the use of an undershot wheel. The mill stood upon the Lambton estate, and there is little doubt that some light could be shed on this mill, if access were allowed to the Lambton MSS.



PARK LEVEL MILL



G.R. NY827432

Much more remains of this crushing mill than of the others that were established throughout the lead mining districts of Weardale in the 19th century. A crushing mill was erected here in 1828 (1), but the present building is a reconstruction completed before 1857.

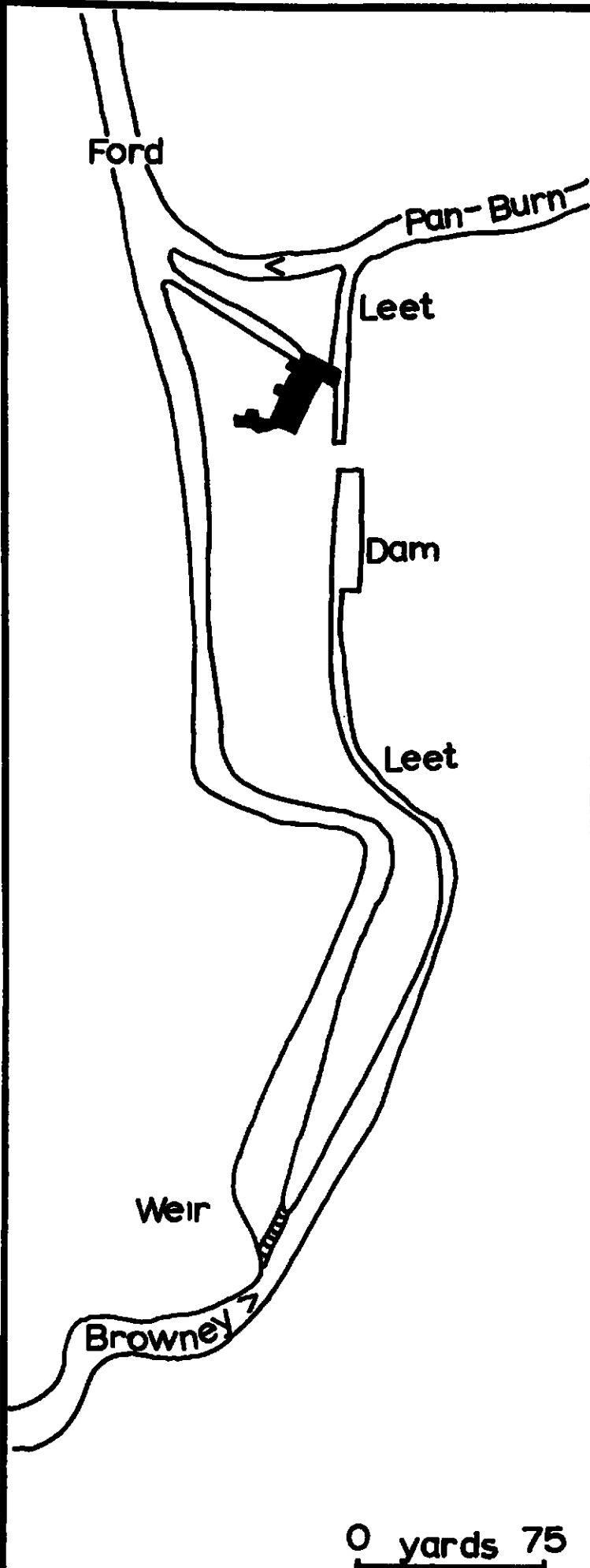
The mill stands upon the hillside 15' above the present level of the Killhope Burn. It was constructed of stone with a slate roof, and was powered by a 37' 6" overshot wheel. This was supplied with water by means of a wooden launder, supported upon stone plinths, from a dam on the hillside behind the mill. This dam was fed by a second 160' above and half a mile away from it.

The wheel drove three sets of rollers of which one pair were fluted, a pulley system to haul the laden carts up to the level of the rollers, and three sets of 'jiggers' which activated sieves in the separation of the crude bouse.

The cast iron wheel and part of the mill still stand, and were recently renovated by the Civic Trust. The area about is intended to be a 'Country Park' focussing upon the mill site.

0 yards 75

PATRICK'S CLOSE MILL



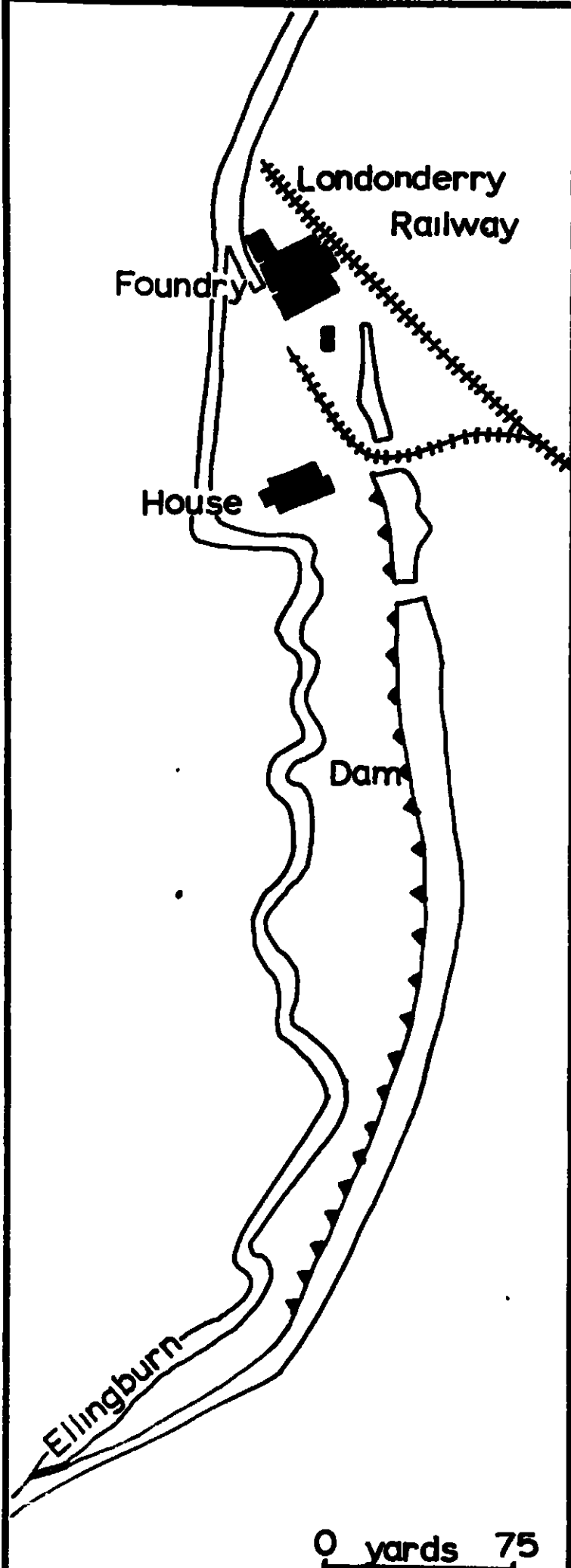
G.R. NZ143449

Little remains of this pleasant country mill except for a few low ruined stone walls. The mill stood on a low haugh 3' high above the present level of the streams, and at the junction of the Pan Burn and the Browney. The mill could be fed from both the streams, a 500 yard leet drawing water off the Browney, and a short leet conducting water from the Pan Burn. The undoubtedly undershot wheel was enclosed within the mill.

PENSHAW MILL

G.R. NZ325522

In the 12th century it is known that Penshaw Mill stood on the Ellingburn (1), and it is traceable in documents until 1718 (2). After this time, however, it disappears. The only 19th century mills standing upon the Ellingburn are Herrington Burn Mill, and Painshaw Foundry. Herrington Burn Mill is already accounted for as the ancient manor mill of West Herrington. It cannot be assumed that Painshaw Foundry necessarily stands on the site of Penshaw Mill, and indeed it would seem strange that the manor mill should be located so far away from the village centre when the stream flows within 700 yards of the church, at the centre of the township. It cannot therefore be concluded that the foundry stands on the site of the ancient mill, but for convenience both are here placed together. The Foundry was famous in its day as the producer of boilers for both locomotives and engines of all sorts.



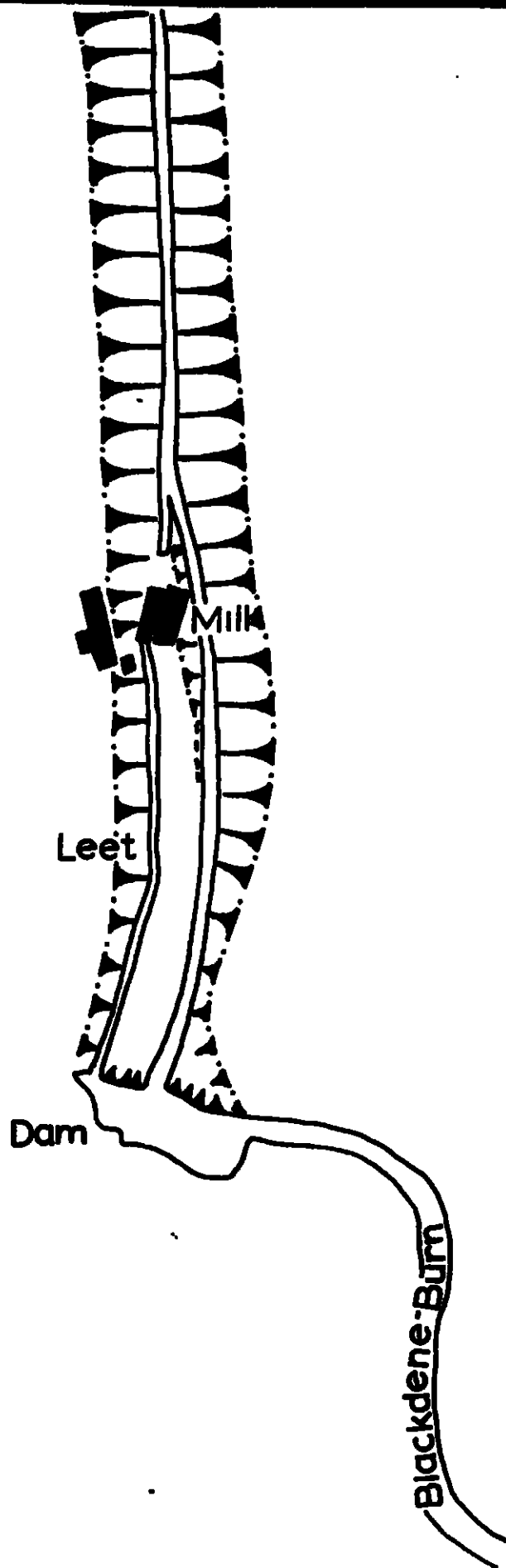
PLAWSWORTH MILL

G.R.NZ266476

The mill is built against the solid rock wall of the gorge of the Blackdene Burn which here falls rapidly down to the Wear from the 300' surface above. The mill stands on a terrace 10' above the level of the burn, and was fed by a 170 yard leet from a dam on the burn formed at the head of the gorge. The dam is now the site of a sewage disposal works. The leet conducted water to a 20' by 3' overshot wooden wheel with a cast iron axle tree, which was housed within the mill.

The mill was constructed of stone and had a stone hipped roof, although much of this has now been covered with asbestos. There were three floors, three sets of stones being worked upon the first floor. Access to the top floor of the mill was gained from the top of the gorge, and access to the bottom floor by means of the terrace. The building was well constructed and would seem to date from the 18th century. Its sequestered site makes it the perfect picture of a country mill.

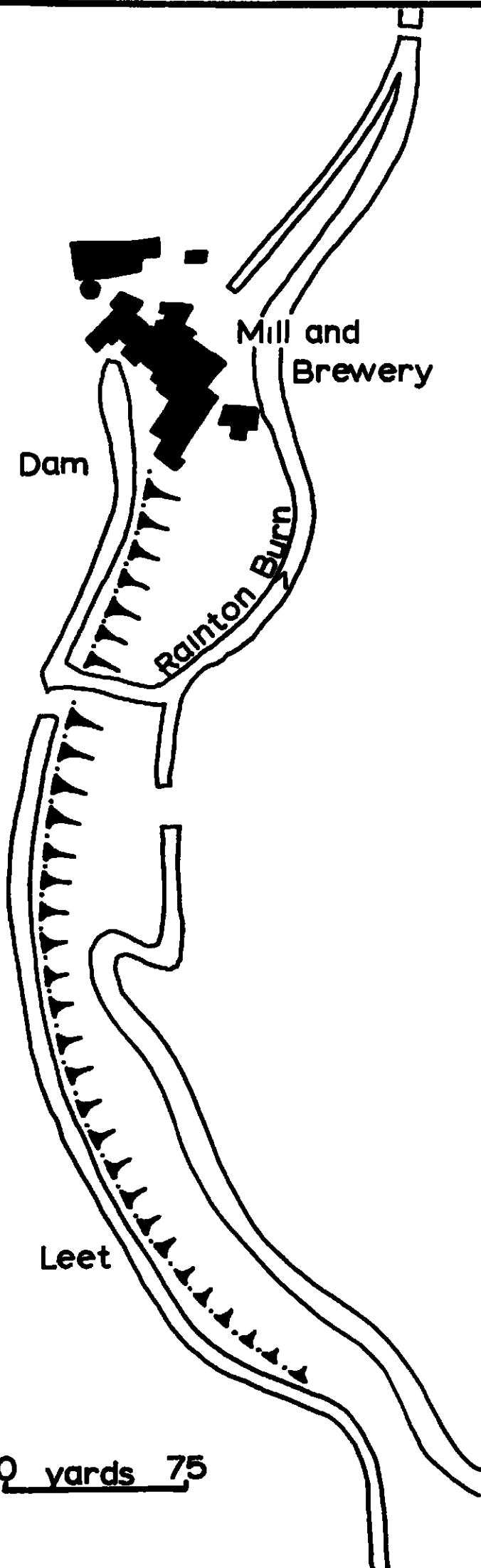
Nothing is known of its early history. The mill stands on the Plawsworth Hall estate, was marked upon Greenwood's Map of 1818, and continued milling until at least 1914.



0 yards 75

RAINTON MILL

G.R. NZ340488

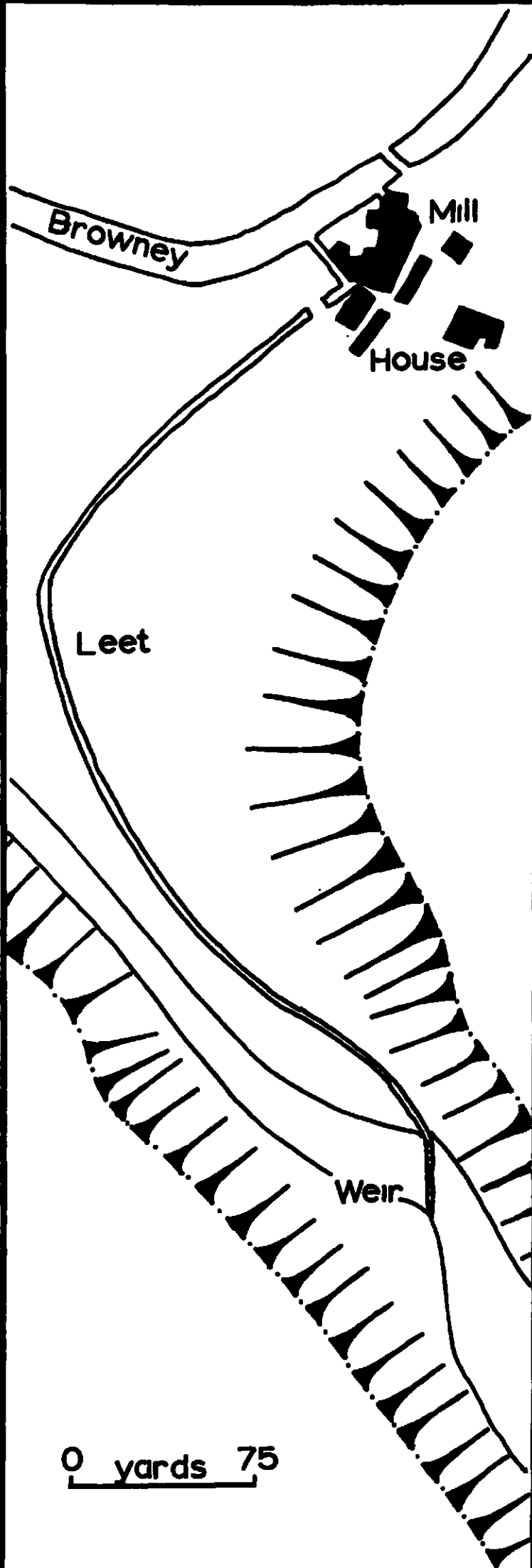


Nothing remains at this site which has now been cleared and a modern house erected in the place of the mill. The site is a level terrace 2' above the present level of the Rainton Burn. The mill was constructed on this terrace, built hard against a 10' terrace wall which carried the 600 yard leet from the tail race of Hetton Mill to a dam built hard against this terrace. It would seem from a little remaining tumble that the mill was at least partly built of stone, and would be driven by a low breast shot wheel.

The mill is mentioned in Boldon Book, and frequent entries for repairs at the mill were entered upon the Abbey Account Rolls. From 1865 until its abandonment during the first world war, the mill was worked by the Scott family.

RELLY MILL

*



G.P. NZ257419

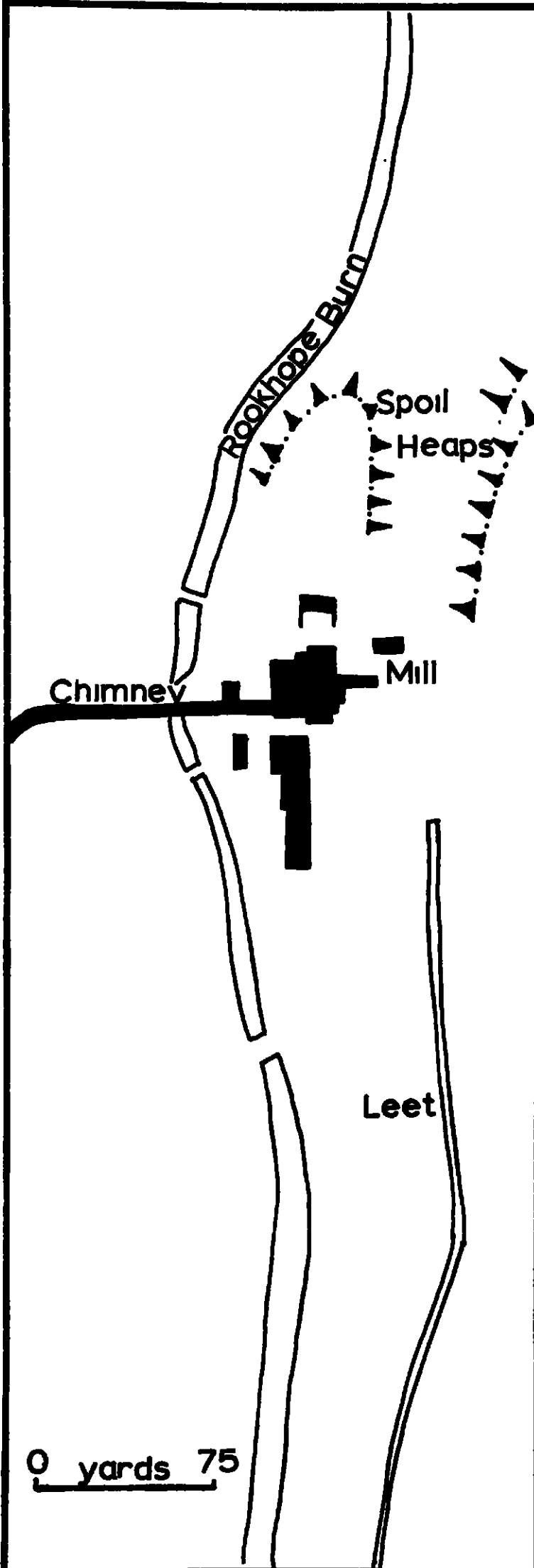
This mill stood on a level terrace 5' above the present level of the Browney and was fed by a 400 yard leet conducting water from a dam on the river 600 yards upstream. Nothing remains of the mill itself which would have been powered by an undershot wheel, although the house still stands, a brick and stone construction with a pantile roof that would seem to date from the mid 18th century. From map evidence it would seem that with small additions the buildings remained essentially the same from 1838 until its abandonment in the early years of this century.

The mill was in existence before 1326 (1), and was worked as a fulling mill for the Convent at Durham. Returns from the mill occur frequently upon the Account Rolls of the Convent, and there also seems to have been some connection with the cell at Finchale, but this is not exactly determined. The mill continued working through the dissolution and before 1798 would seem to have been converted into a paper mill, as which it continued until its abandonment in 1904, making coarse brown papers and paper bags. The mill was run in conjunction with Langley Grove Mill from at least 1855, after which both mills were under the same ownership.

ROOKHOPE SMELT MILL

G.A. NY926429

The only traces of this mill that remain are the 1400 yard leet which runs along the hillside by the Rookhope Burn to the site of the mill, and the long flue which ran up the opposite hillside to carry away the fumes. Two forlorn arches mark the site where this flue was carried across the road from the mill. The site is on the floor of the Rookhope Valley 4' above the present level of the burn. A 20' cast iron wheel powered bellows for the furnaces to smelt the lead ore brought out of Rookhope by the Beaumont Mines. The mill was established in 1726, and apart from a short time when a temporary mill was used, remained in use until 1883. In 1820 it housed 3 ore hearths and 1 roasting furnace (1).



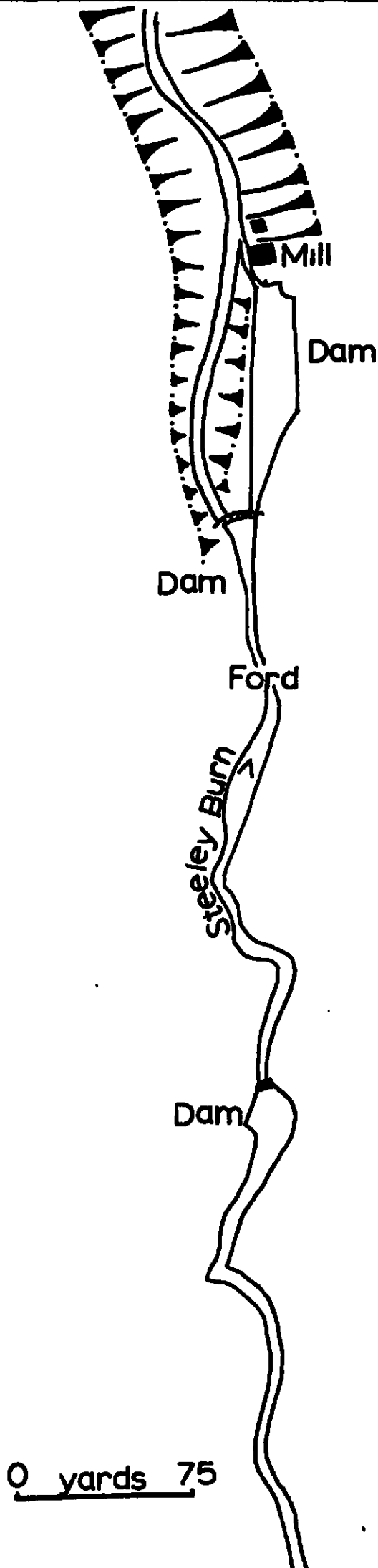
SATLEY MILL

G.R. NZ119438

This small country mill was constructed in the constricted valley of the Steeley Burn which here falls down 250' in less than a mile. Thus, although there is not a large amount of water, there is a considerable head to be developed. The mill is simply built into the bank side, and was fed by a series of three dams, the last of which was constructed on the gently sloping bank above the mill.

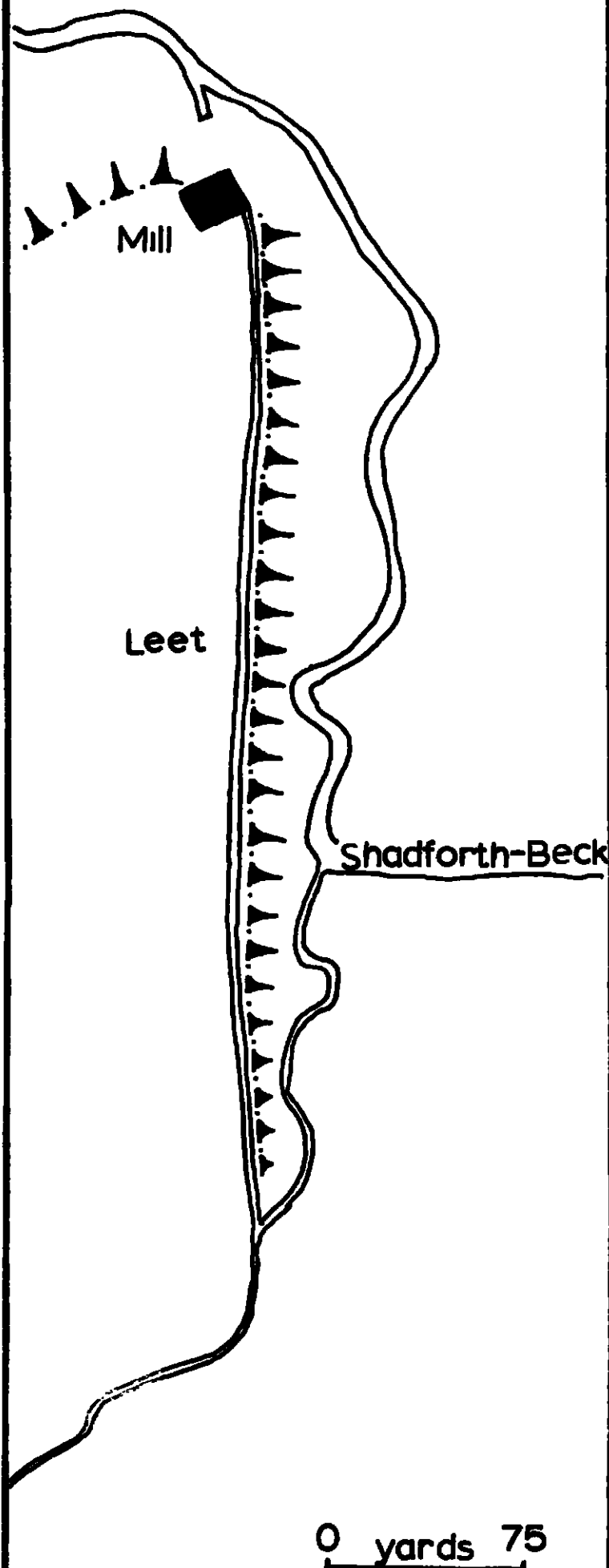
The mill still remains, a small stone building with a stone roof, 15' by 20', of one floor with a small loft. The mill contained two sets of 3' stones powered by an overshot wheel 16' in diameter and 2' 6" wide. Nearby is a small outbuilding of the same vernacular construction, of uncertain date, but probably not older than the 18th century.

The mill is first mentioned in 1324, when it was the manor mill of the vill of Satley (1). As a small country mill it is seldom found in trade directories, but it would seem that it was in use until after 1918.



SHERBURN EAST MILL

G.R. NZ335414



Little remains of this mill about which less is known. The site is a level terrace 4' above the present level of the Shadforth Beck, built into the gently sloping hillside which here forms a bank 10' high. The line of a leet can be traced off a small runner which joins the Shadforth Beck, 300 yards upstream. Although the amount of water at present in this runner is small, there is no trace of a storage or impounding reservoir in the vicinity of the mill.

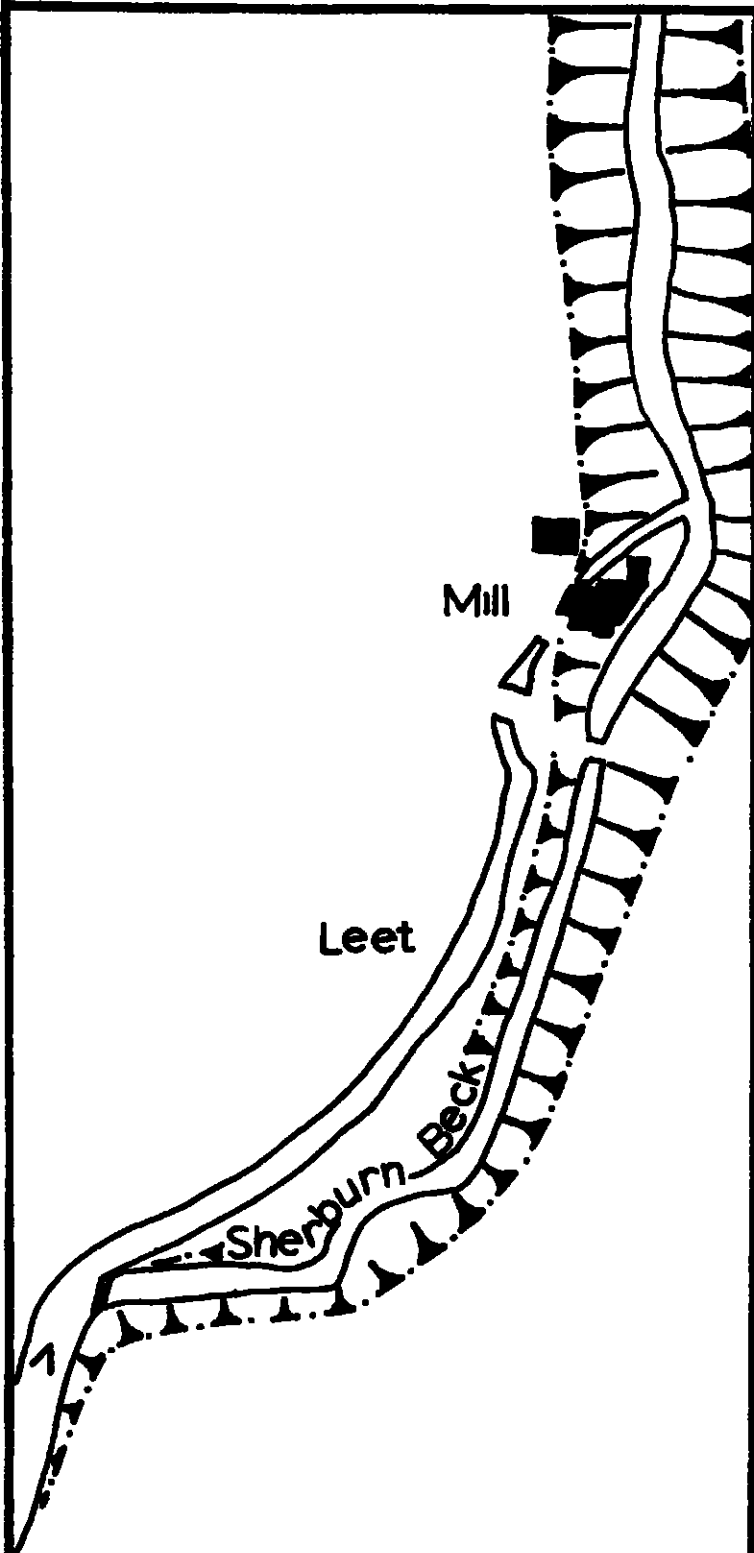
Nothing remains of the mill except a considerable amount of stone tumble and concrete flooring. It would seem that the mill would have been powered by a low breast shot wheel, housed within the mill. The first reference to a mill on this site is in 1818, and the last directory entry is in 1865. The mill is not marked upon the 1896 ordnance survey.

SHERBURN HOUSE MILL

G.R. NZ319419

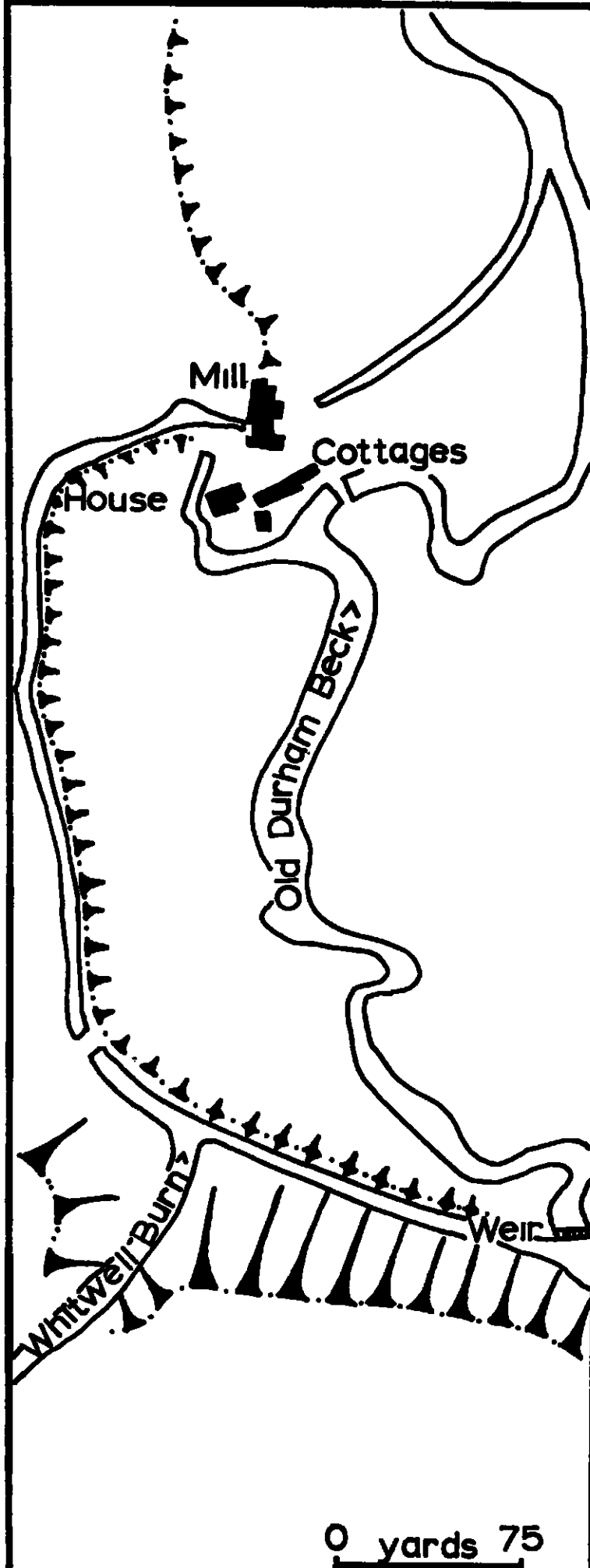
The mill stood on a narrow terrace 4' above the present level of the Sherburn Beck, and in a gorge 15'-20' deep made by the beck as it cuts down 60' in 600 yards. Nothing remains now of the mill except extensive tumble of stone and late 19th century brick, with a little pantiling. Part of the leet can be seen leading 200 yards from the stream at the head of the gorge, along the edge of this gorge to the mill to feed, probably, a high breast or an undershot wheel. Apart from a small pool immediately above the mill there was no large dam, a small apron would have been sufficient to divert the water into the leet which then fed the mill directly.

The mill was first mentioned in the original foundation charter of Sherburn Hospital before 1181, which gave the hospital the mill and vill of Sherburn. The mill continued to be worked until 1898, after which it fell into disuse. Part of the site is now used as a sewage disposal works for Durham Rural District Council.



0 yards 75

SHINCLIFFE MILL



G.R. NZ297414

The mill stood upon an open site on a level terrace 8' above the present level of the Old Durham Beck. A leet was cut into the sandy hill-side to conduct water 500 yards along, subsequently, another terrace 6' above the level of the first. This leet also carried the waters of the Whitwell burn, which now flows down the upper course of the leet to join the Old Durham Beck above the site of the brick dam, now demolished.

Nothing remains of the mill itself but a short terrace of slate-roofed cottages once associated with it. The mill is first heard of in 1355, when it is listed on the Hostillar's Roll of the Convent (1). Until the mid-seventeenth century, at least, however, the mill stood upon a now deserted course of the Old Durham Beck which used to enter the Wear at the site of the present Shincliffe Bridge (2). It would seem that the mill would have been built into the side of the 8' terrace upon which the later mill was erected higher up the beck. Nothing remains of this site.

The mill was worked until the first decade of the present century, when it was tenanted by the millers who worked the Bishops Mills at Durham. A temporary hospital was later erected on the site of the mill, which is now used as a kennels.

0 yards 75

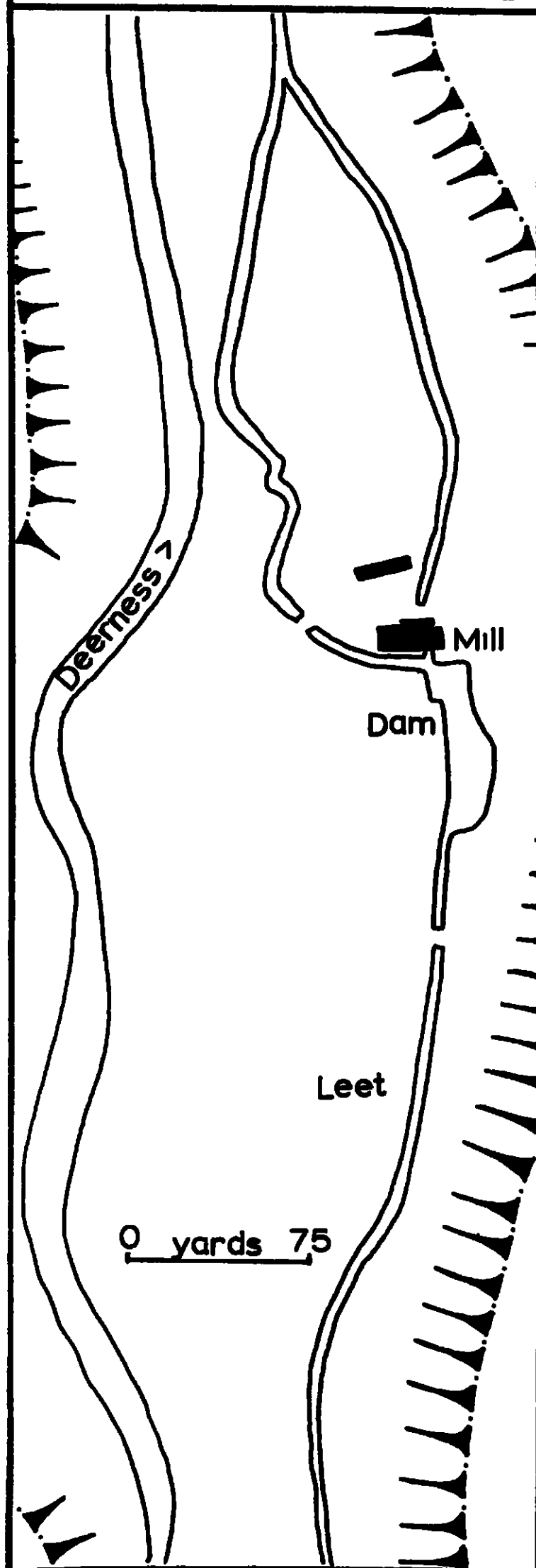
SLEETBURN MILL

G.P. NZ239418

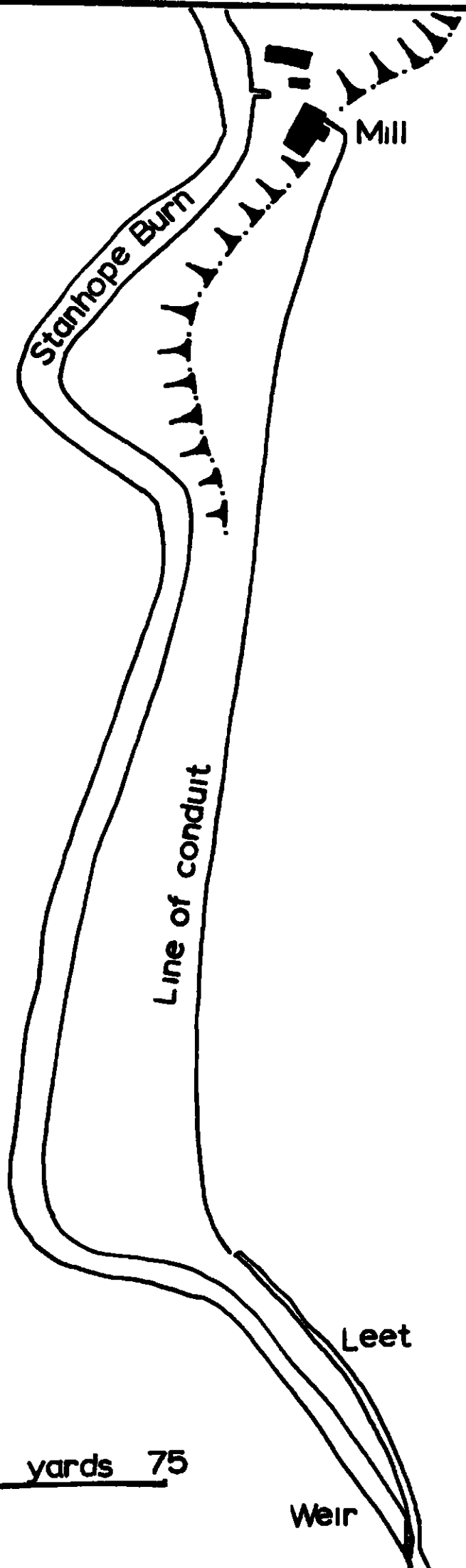
The Sleetburn Mill stands on the level terrace of the Deerness, at the foot of the hillside. A 600 yard leet conducted water along the edge of this hillside into a dam which subsequently turned a 16' diameter undershot wheel.

The mill at Sleetburn is of mean mid 19th century construction, and does not have the character of a corn mill, although millers are recorded here until 1873. The adjoining house is a two-floored stone construction with a pantile roof and could date from the mid 18th century. The first note of this mill is on a Brancepeth estate plan of 1747 (1), but until the Brancepeth MSS are listed, it will not be possible to find out anything else of the early history of this mill. By 1902 the mill was no longer used except for its present purpose as a store for the small-holding now occupying the land.

In 1827 a bleacher and fuller are recorded at Sleetburn, and it seems likely that this mill was established at Primrose Side 450 yards downstream. After turning Sleetburn Mill, the leet conducted water over the Bleach Green to Primrose Side, which is recorded in 1857, but of which no trace remains. It seems curious, moreover, that there is no record of the mill in any of the deeds of the Primrose Side estate in the Brancepeth MSS over the period 1803-1850, although it is definitely known that this mill existed for a time at least in the 19th century.



STANHOPE MILL



G.R. NY990395

Of the several mills that have been worked off the Stanhope Burn, it is likely that this site, close to the ancient hall, and leased with that building, is the oldest site. The present building stands on a level terrace 4' above the present level of the Stanhope Burn, set against the bank side here 20' high, across which a leet conducted water 600 yards from the Stanhope Burn, part of the way in a conduit. This fed an 18' backshot wheel housed within the mill, which is a fine stone building with a stone roof. There are three floors and the building would seem to date from the very early 19th century, with a small addition made very soon afterwards.

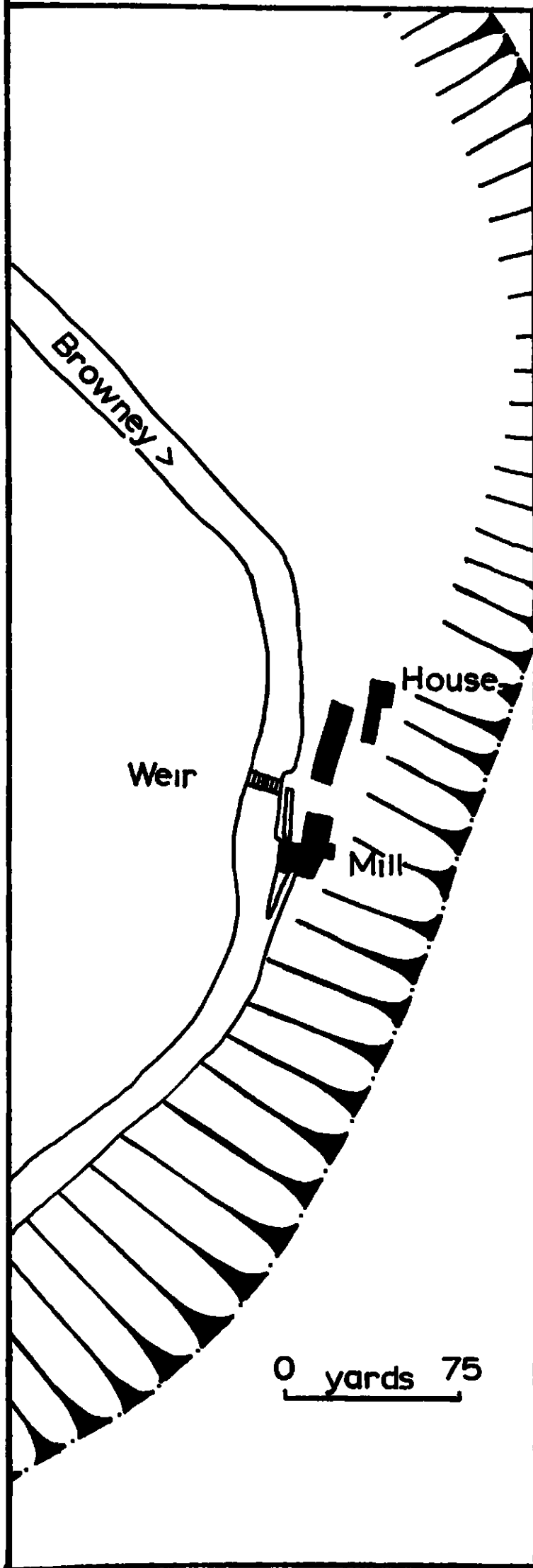
STONEBRIDGE MILL

G.R. NZ260413

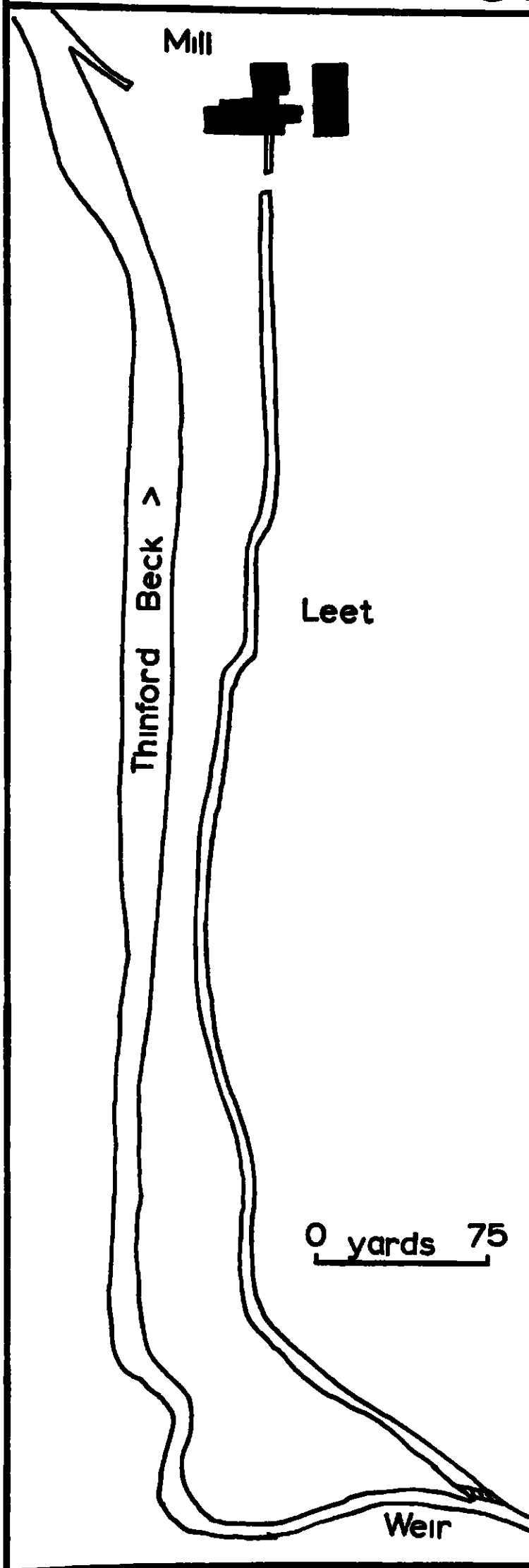
This left bank mill is now much decayed but sufficient remains to show that it was a small stone built erection, with a wooden loft dividing the interior into two floors. The stones were driven by a wooden wheel, 10-12' in diameter and 4' wide resting upon a cast iron axle tree, the wheel being undershot.

The mill stood upon a constricted terrace at the foot of a steep hillside, 4' above the present level of the Browney, the hillside being sufficiently steep to allow access directly onto the upper floor of the loft.

The building would seem to be of early 19th century construction, and it would seem to have become disused at some time in the 1880's.



THINFORD MILL



G.R. NZ305352

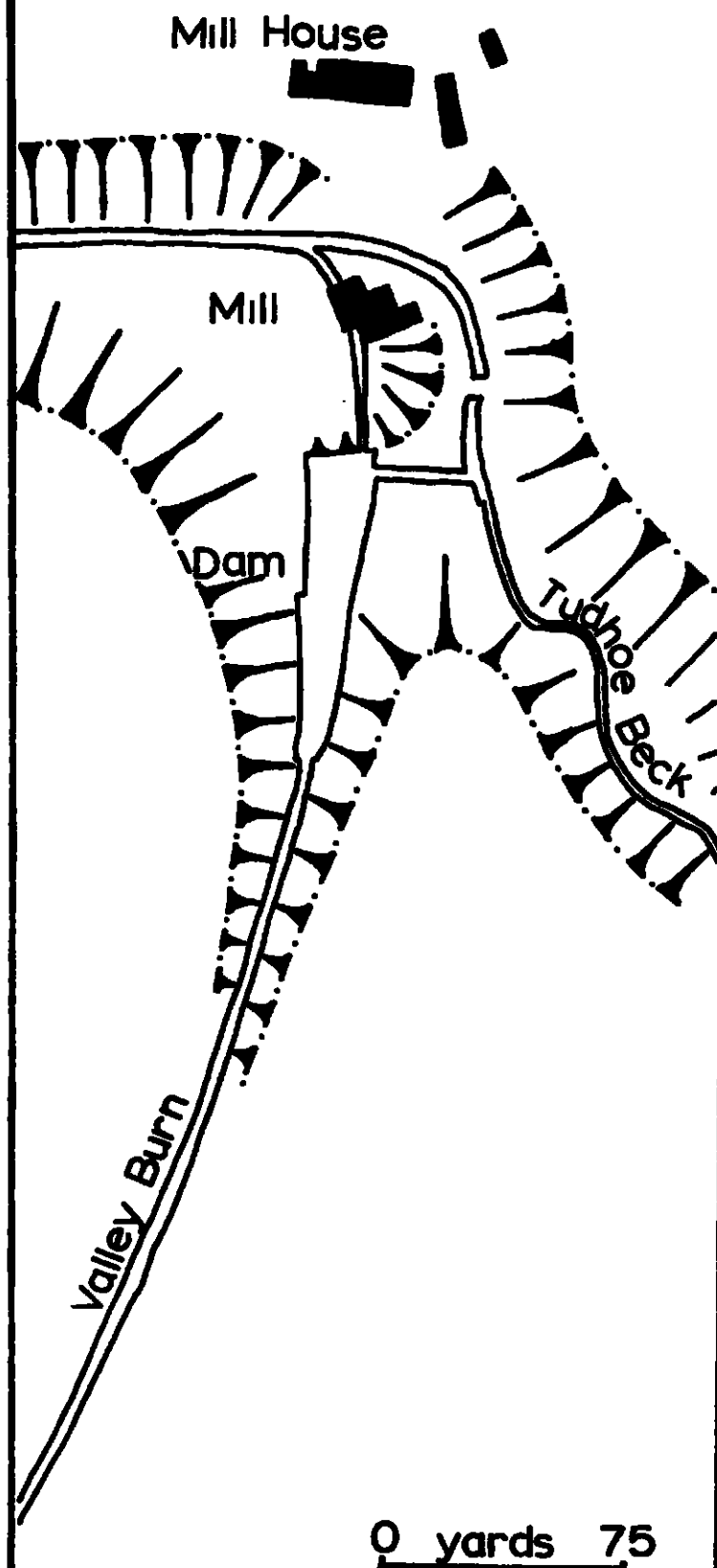
This mill stands on a terrace 4' above the present level of Thinford meadows which stand 2' above the present level of the Thinford Beck. A 740 yard leet conducted water from the Thinford Beck around a shoulder of rising ground, against which the mill is built, to what must have been a breast shot wheel within the mill.

The mill is now used as a Working Man's Club, and has been extensively modernised. It stands today a large, rectangular building covered with cement rendering and a modern slate roof. The mill was of three floors, the rising ground allowing access to them all from the outside.

The mill was in existence by 1813, as a paper mill, but by 1827 at least, corn milling was also carried out there, and by 1857 the mill was entirely put over to corn milling. The last directory entry for the mill is in 1890, when it was being run in conjunction with the mills at Cornforth, and it may be that soon after this the mill was abandoned, and milling concentrated at Cornforth.

TUDHOE MILL

G.R. NZ253355



The mill was constructed in a little dell formed by the Valley Burn as it descends from the 250'-300' surface to the hear below. The Valley Burn fed a storage dam constructed across the dell above the mill, which supplied water to feed an undershot wheel 18' in diameter on the outside of the mill.

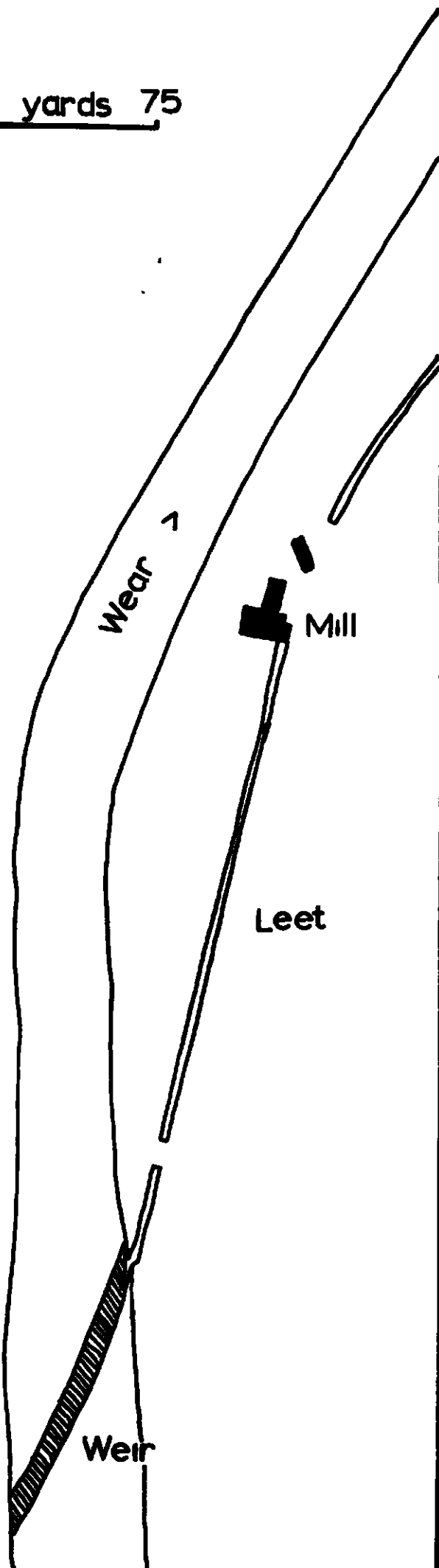
Nothing remains of the mill itself, its stones being used to build new farm buildings nearby. The farm house, once the miller's house is built of stone, of two floors, with a pantile roof, and is of considerable antiquity and could date from the 17th century.

The first reference to the mill dates from 1279 (1), when its water course is already referred to as old. Until 1793 the mill was run as a corn mill but it was then bought by Johnathon Ord, paper maker, who turned it into a paper mill (2), as which it continued until at least 1827. By 1857 it was being used as a saw mill, but fell into disuse by 1879, and was finally demolished in 1898.

UNTHANK MILL

G.R. NY994392

0 yards 75

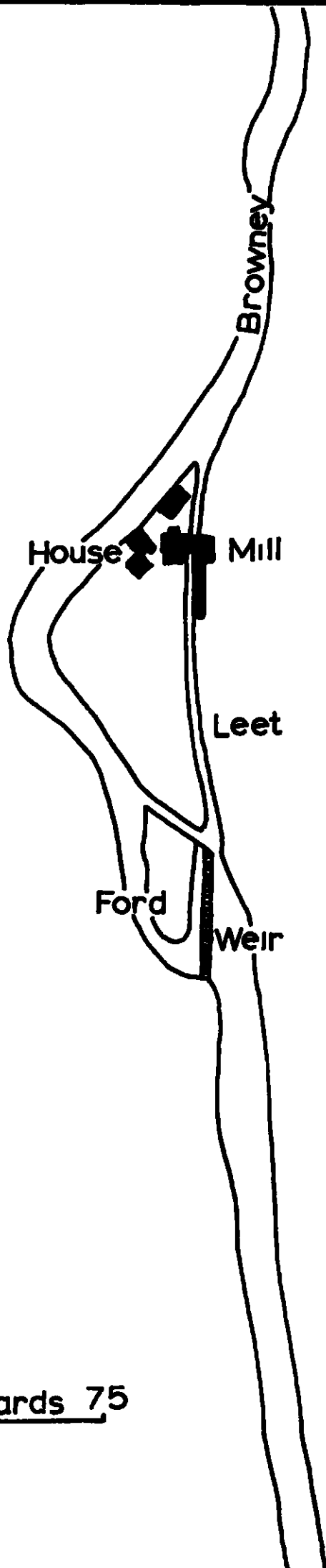


This mill stands upon a level terrace 5' above the present level of the Wear, immediately opposite Stanhope Town. A low tumble weir anciently diverted water along a 150 yard leet to turn an undershot wheel 16' in diameter and 3' broad, before returning to the river by means of a 450 yard tail.

The small mill is built of stone with a stone roof, and stood adjacent to the miller's house of similar construction. Both had two floors. At the time of inspection (May 1966) a considerable amount of gearing was still to be found in the mill, which would seem to date from the late 19th century, although the mill itself would seem to belong to the earlier part of that century.

The mill is first mentioned in 1595 when both a corn and a fulling mill were mentioned on the site, being freehold, and not part of the Bishop's lands (1). The mill was part of the Unthank estate. Directory references to the mill are to be found throughout the 19th century, and it stopped work in 1906 when the last miller died.

WALLNOOK MILL



0 yards 75

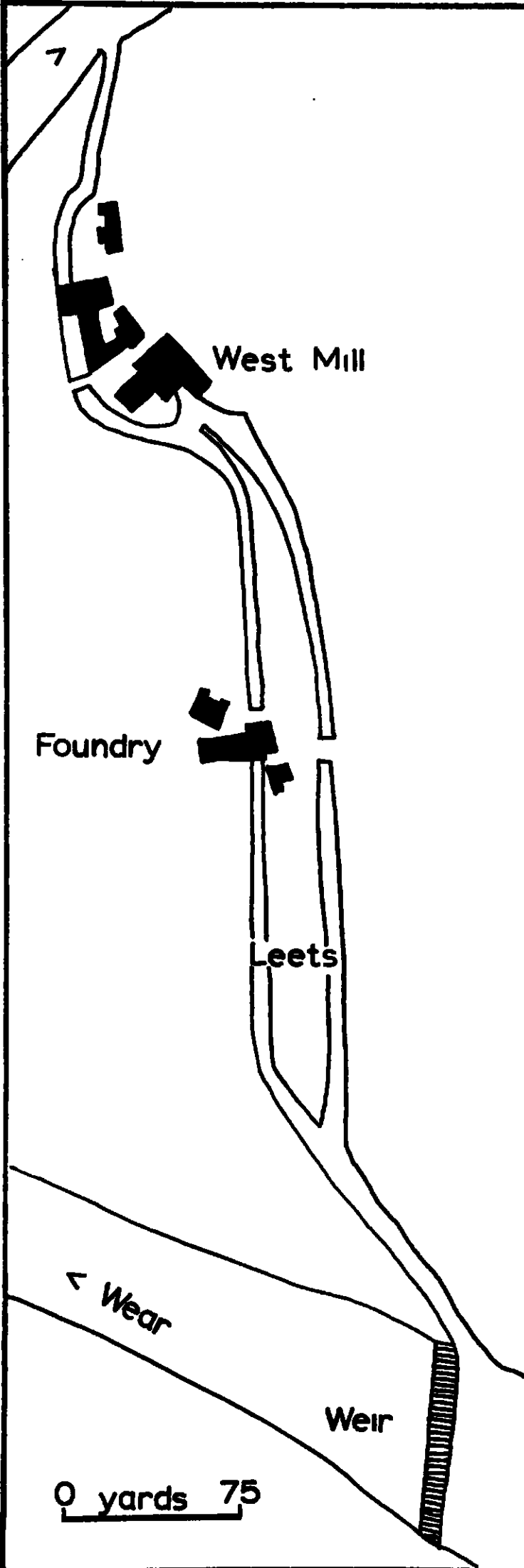
G.R. NZ216453

This mill stands in the wide valley of the Browney, on a level terrace 5' above the present level of that river. A masonry dam across the river allowed water into a 120 yard leet to feed an undershot wheel which drove three sets of stones.

The present building is well-constructed of stone with a slate roof, and would seem to date from the early nineteenth century. The miller's house is in a similar style, and with out-buildings forms a rough courtyard around the mill. At some time in the mid-nineteenth century a steam boiler was added to the mill to supplement the water wheel, but this latter was retained until the mill ceased working about the time of the 1914 war.

The mill was first mentioned in 1772 (1), being a corn mill, but there is little information available concerning its earlier history.

WEST MILLS



G.R. NZ202298

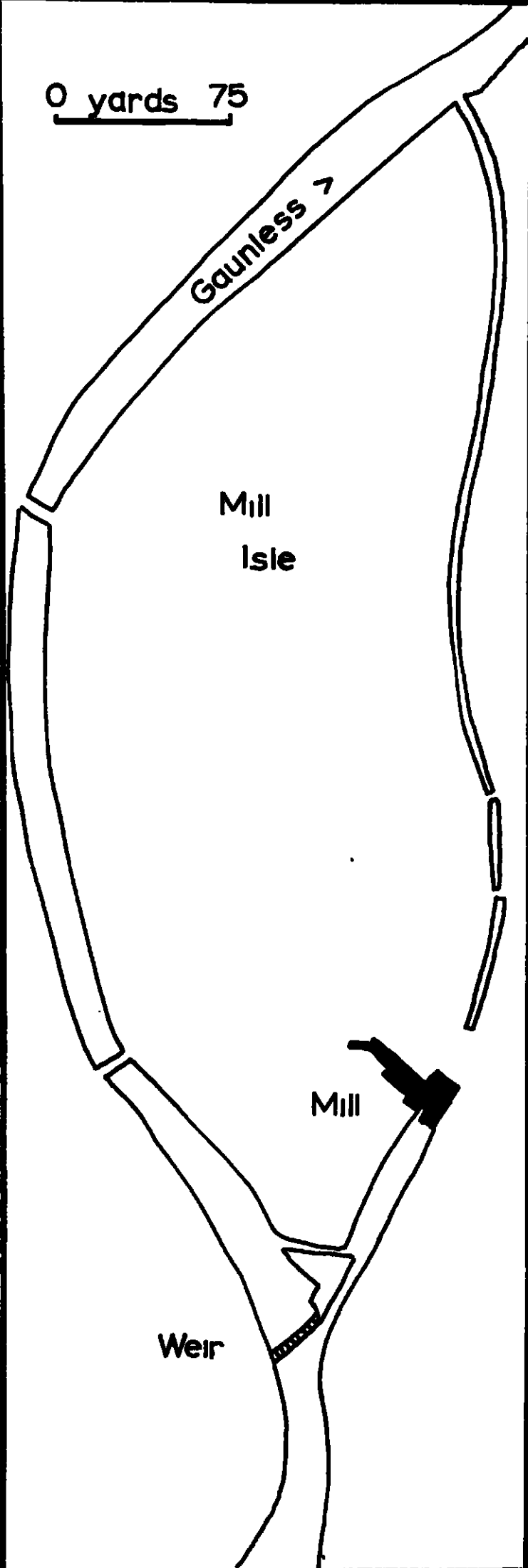
A dam 8' high across the Wear allowed water into a 700 yard leet that ran across a low sandy haugh 10' above the present level of the river. Several mills have been placed on this leet, the last, until 1966, housing a turbine pumping water for Bishop Auckland water supply works.

Although the mills of Aucklandshire were mentioned in 1183, it is not until 1300 that separate reference is made to the corn and fulling mills which then existed here. In 1608 a second fulling mill supplemented the first (1), but only one, much decayed, is mentioned along with the corn mill in 1647 (2). In 1810, the fulling mill was converted into a cotton printing factory, and later into a spinning mill (3), while in 1827, both a dyer and a spinner were at work at the mill. Between 1847 and 1855, the mill was turned into a foundry which lasted until 1890, although West Mill proper continued to be used as a corn mill, which still stands, a stone built mill of three floors, latterly powered by an 18' low breast shot wheel driving 3 pairs of stones.

In 1855 Bishop Auckland Local Board considered the site as a water supply station for the town, and in 1890 bought it for £7,000 (4). Two turbines were installed, but it was soon found necessary to take all the daytime water, and although the tenant of the corn mill tried running his mill only at nights, it was apparent that milling and the supply works were incompatible. His rent was halved in 1896, but by 1900 milling had ceased at West Mill (5).

WEST AUCKLAND MILL

0 yards 75

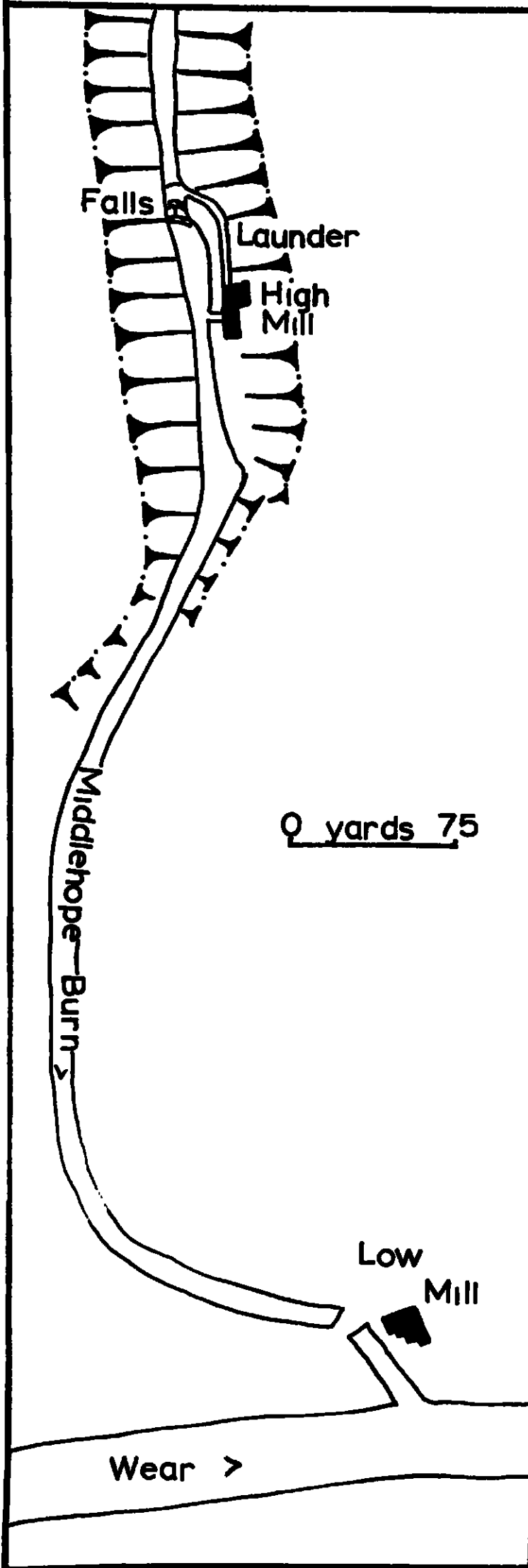


G.R. NZ184268

The mill stands on a level terrace 7' above the present level of the Gaunless, in West Auckland village. The mill stood 150 yards from a masonry weir which conducted water into a leet to the undershot wheel before returning 400 yards across the meadows to the river. The present building has been lately converted into a commercial garage and has been completely gutted inside, but was a large stone built erection with a stone roof and three floors.

The mill is first mentioned individually in 1300 (1), although the mills of Aucklandshire were mentioned in Boldon Book. In 1647 the mill was said to be worth £11 16 8d. p.a. (2) and in 1764 £35 p.a. At this date there was an Iron Forge and a Casting Furnace erected next to the mill, and using the same water which is said to be worth £10 (3). The mill was said to have a good dwelling house, although this is not now apparent. Between 1879 and 1902 the mill was turned over to steam milling, and seems to have gone out of business during the first world war.

WESTGATE MILLS



1. High Mill

G.R. NY907383

The mill stands on a 45' wide terrace, 10' above the present level of the Middlehope Burn, in the narrow defile made by the burn as it cut its way from the high moors to the Wear below in a series of rapids and short falls. The 16' diameter wheel, 3' wide stood outside the mill and was fed by a launder from one of the falls or whins 40 yards upstream. The house and mill are adjacent and both built entirely of local stone, and would seem to date from the early 19th century.

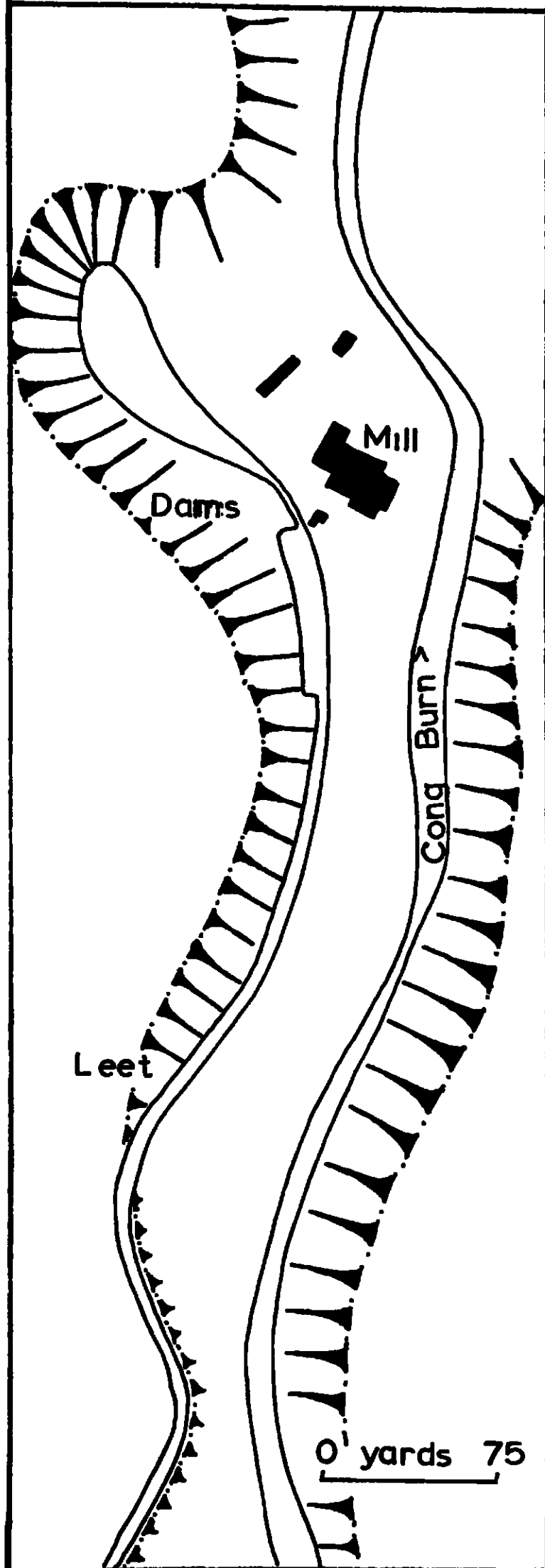
In 1647 it was reported that a newly erected mill at Westgate served the decayed mill at Stanhope, and it would seem that the mill continued working until at least the beginning of the present century.

2. Low Mill

G.R. NY908381

This mill was at work from at least 1818 until 1879 but curiously is omitted from the 1857 Survey. The mill was subsequently turned into what appears at first sight to be an ordinary 19th century terraced house on the main road 4' above the present level of the Middlehope Burn, but in an outhouse traces remain of the waterwheel 16' in diameter and 3' wide. Although the wheel must have been undershot there is no trace of the leet from the burn.

WHITEHILL MILLS



G.R. NZ256515

The paper mill stood on a level terrace 9' above the present level of the Cong Burn. A 900 yard leet conducted water from the burn to two storage dams behind the mill. All that remains of the mill are traces of this leet, extensive concrete floors and a few old walls. Less is known about the history of the mill except that it was established towards the middle of the 19th century and manufactured coarse brown paper. It ceased its activities at the end of the 19th century and the site has remained deserted ever since.

A furnace stood on a terrace 5' above the present level of the Cong Burn close to the hillside along which ran a water course from the Burn. The site of the furnace was cleared by 1820 (1) but it was the scene of the first blast furnace established in the North East. The furnace was established in 1745, and a blast was supplied by bellows worked by a waterwheel placed on the Burn. Local and imported ore from Robin Hood's Bay was used but frequent interruptions for want of water to drive the wheel led to the furnace being abandoned about the close of the 18th century (2).

This mill stood on the right bank of the stream, 400 yards downstream.

WOLSINGHAM MILLS

No less than eight mills have been established at Wolsingham over the last 800 years, two, probably, using water from the Wascrow Beck, and six from the Wear.

1. Demesnes Mill stood upon a level terrace 4' above the present level of the Wascrow Beck, and was built into the side of a 20' terrace, across which a conduit brought water 550 yards from the Wascrow to an overshot wheel, possibly 20' in diameter. Both the mill and the miller's house were constructed of local stone, but the site was completely cleared in 1965. The mill stopped work in 1930. Mention is made of a mill at Wolsingham, probably on this site, in the Boldon Book, and by the time of the Hatfield Survey there was both a corn and a fulling mill here. In 1647, the fulling mill had been converted into a smelt mill for lead, and was said to be worth £13.6.8d. p.a. The exact site of the smelt mill is not known except that it was 'in Wolsingham Town' (1) but it would seem probable that it shared the same leet as the bishop's corn mill, which is traceable on this site from documentary evidence since the 16th century.

On the Wear a masonry dam allowed water into a 1300 yard leet along a level terrace, 6' above the present level of the river. It seems likely that the dam was not erected until the late 18th century, but certainly by 1827 six mills were established upon this watercourse, all using undershot wheels.

2. Corn Mill. Nothing now remains of this mill the site of which is now lost under a tip.

3. Spinning Mill. This mill remains, a solid stone built early 19th century erection of two floors. The mill closed down at the end of the 19th century, but later became a garage. It now stands empty, and the house is now a private residence.

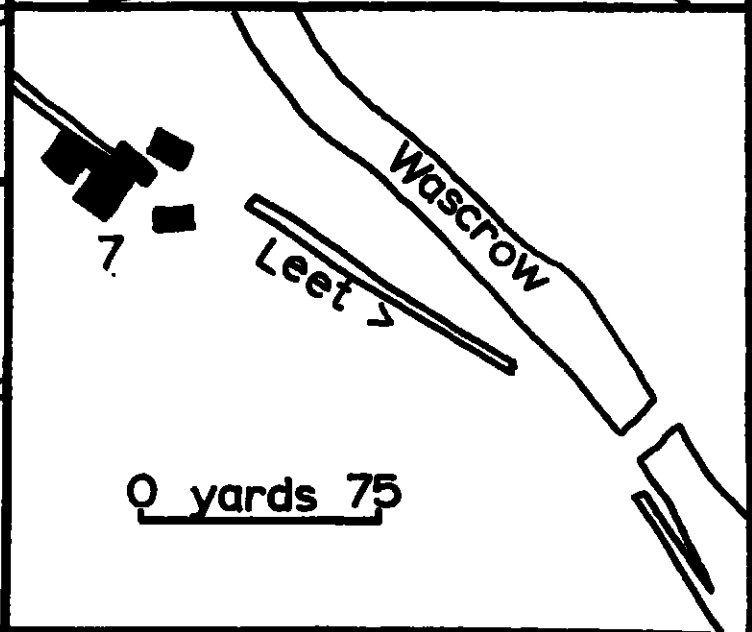
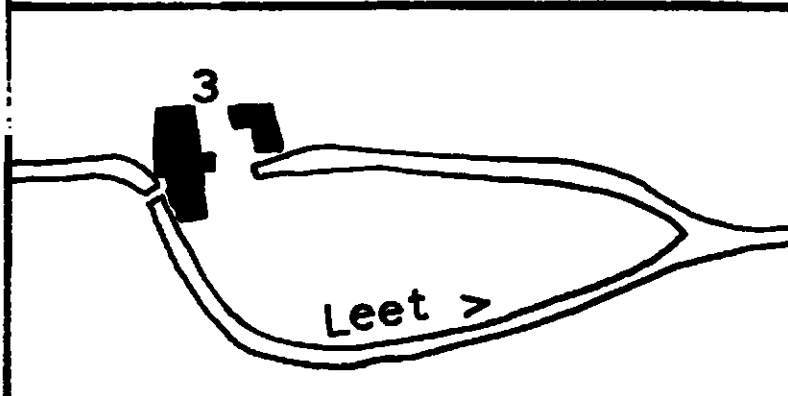
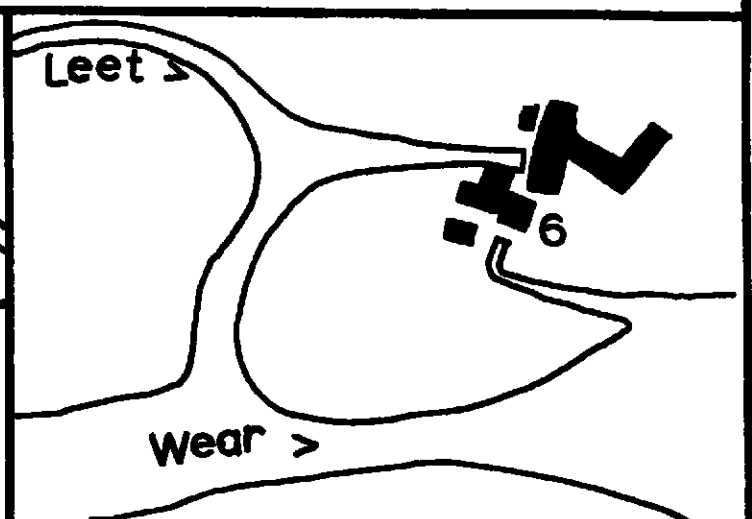
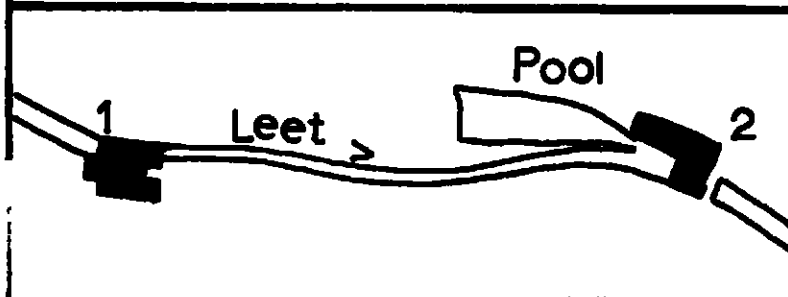
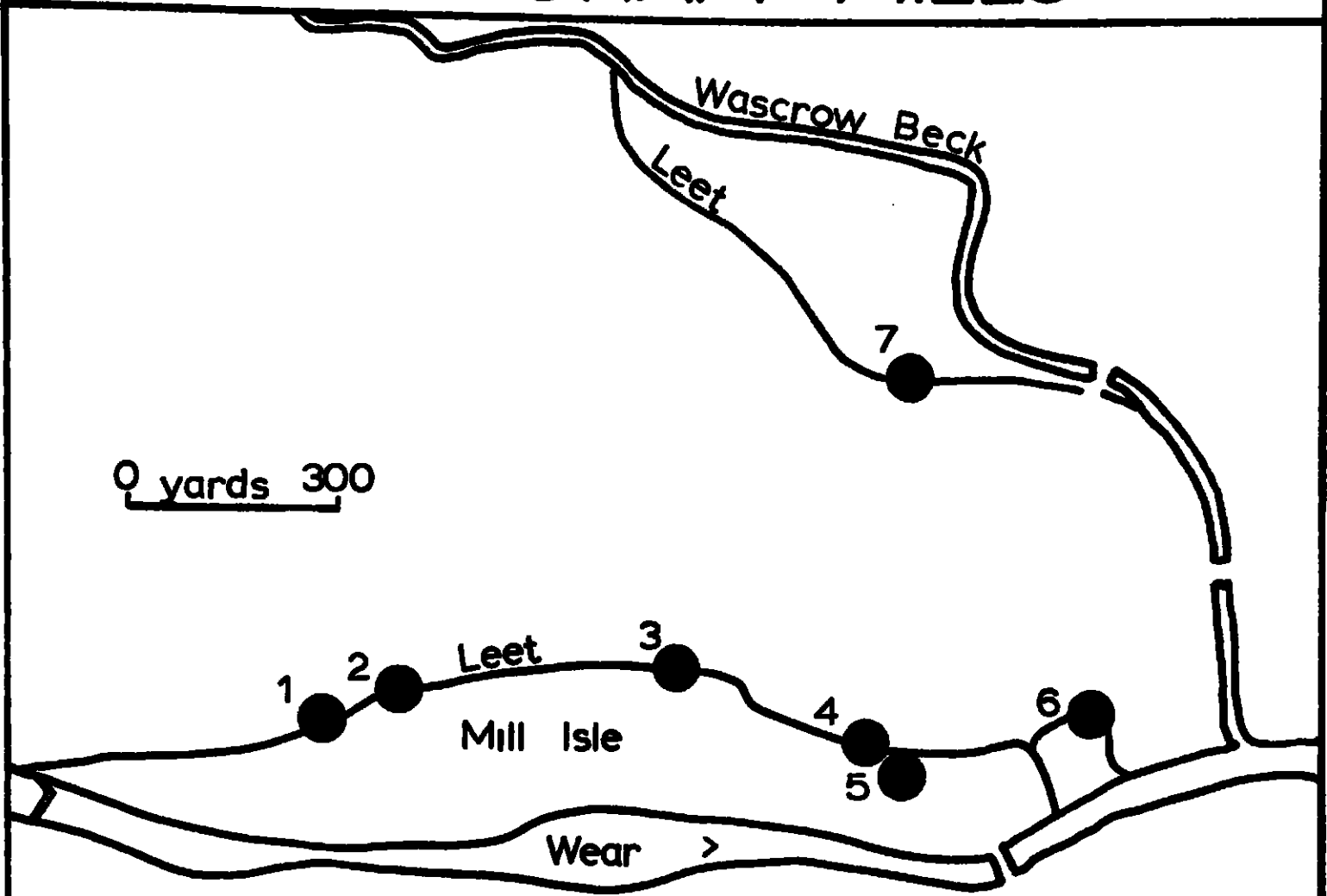
4. West Mill. This stone-built corn mill also remains. Along with the massive stone-built miller's house built adjacent it is now turned into several cottages, and along with the erection of two other cottages after the mill was closed in 1890, it is now hardly recognisable as a mill. Until its closure it ground corn from as far afield as Thornley near Tow Law.

5. Forge. This small forge also remains, now a one-floored, stone-built cottage with a new slate roof.

6. Forge. This mill was worked by a 16' diameter undershot wheel. Two main buildings survive, both stone built, and both dating from the late 18th or early 19th centuries. One of the buildings has a pantile roof, the other a slate roof. The wheel was fed by a small pool taking water off the common leet. Like the other forge mills in Wolsingham edge tools and spades were manufactured.

7. Humble's Forge. This mill was worked as a corn mill until after 1857, when it was enlarged and transformed into a forge mill. The forge was worked by water power until 1916, after which a steam boiler was introduced, which served the mill until its disuse in 1939. The stone-built three floored mill was demolished in 1963, and the flattened site is now used as a caravan park.

WOLSINGHAM MILLS



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