H. ROFE.

THIRD REPORT

OF

THE COMMISSIONERS

APPOINTED TO INQUIRE INTO

THE BEST MEANS OF PREVENTING THE POLLUTION OF RIVERS.

(RIVERS AIRE AND CALDER.)

VOL. I.

REPORT, APPENDIX, PLANS.

Presented to both Houses of Parliament by Command of Her Majesty.

LONDON:
PRINTED BY GEORGE EDWARD EYRE AND WILLIAM SPOTTISWOODE,
PRINTERS TO THE QUEEN'S MOST EXCELLENT MAJESTY.
FOR HER MAJESTY'S STATIONERY OFFICE.

1867.

17159.—1.

CONTENTS.

COMMISSION.

VICTORIA R.

Victoria, by the Grace of God, of the United Kingdom of Great Britain and Ireland, Queen, Defender of the Faith.

To Our trusty and well-beloved Robert Rawlinson, Esquire, John Thornhill Harrison, Esquire, and John Thomas Way, Esquire, greeting.

Whereas We have deemed it expedient for divers good causes and considerations that a Commission should forthwith issue for the purpose of inquiring how far the present use of rivers or running waters in England for the purpose of carrying off the sewage of towns and populous places, and the refuse arising from industrial processes and manufactures, can be prevented without risk to the public health or serious injury to such processes and manufactures, and how far such sewage and refuse can be utilised or got rid of otherwise than by discharge into rivers or running waters, or rendered harmless before reaching them; and also for the purpose of inquiring into the effect on the drainage of lands and inhabited places of obstructions to the natural flow of rivers or streams caused by mills, weirs, locks, and other navigation works, and into the best means of remedying any evils thence arising.

Now know ye, that We, reposing great confidence in your zeal and ability, have authorised and appointed, and do by these Presents authorize and appoint, you, the said Robert Rawlinson, John Thornhill Harrison, and John Thomas Way, to be Our Commissioners for the purposes aforesaid.

And for the better enabling you to form a sound judgment on the Premises, We do hereby authorize and empower you, or any two or more of you, to call before you, or any two or more of you, all such persons as you may judge most competent by reason of their situation, knowledge, or experience, to afford you correct information on the subject of this inquiry.

And it is Our further Will and Pleasure that you, or any two or more of you, do report to Us in writing, under your hands and seals, your several proceedings by virtue of this Our Commission, together with your opinion on the several matters herein submitted for your consideration.

And We Will and Command that this Our Commission shall continue in full force and virtue, and that you, Our Commissioners, or any two or more of you, may from time to time proceed in the execution thereof, although the same be not continued from time to time by adjournment.

And for your assistance in the due execution of this our Commission, We have made choice of Our trusty and well-beloved Godfrey Lushington, Esquire, Barrister-at-Law, to be Secretary to this Our Commission, whose services and assistance We require you to avail yourselves of from time to time, as occasion may require.

Given at Our Court at Saint James's, the Eighteenth day of May 1865, in the Twenty-eighth Year of Our Reign.

By Her Majesty's Command.

(Signed) G. GREY.

INSTRUCTIONS to the COMMISSIONERS.

GENTLEMEN, Whitehall, May 30, 1865.

HER Majesty having been pleased to appoint you to be Commissioners for Inquiry into the Pollution of Rivers, I am directed by Secretary Sir George Grey to send you the following instructions for your guidance in the proposed inquiry.

Although it may be taken as proved generally that there is a wide-spread and serious pollution of rivers both from town sewage and the refuse of mines and manufactories, and that town sewage may be turned to profitable account as a manure, there is not sufficient evidence to show that any measure absolutely prohibiting the discharge of such refuse into rivers, or absolutely compelling town authorities to carry it on the lands, might not be remedying one evil at the cost of an evil still more serious, in the shape of injury to health and damage to manufactures. It is, therefore, suggested that your inquiry should include selected river basins, illustrating different classes of employment and population; that these river basins might be :—

1st. The Thames Valley—both as an example of an agricultural river basin, with many navigation works, such as locks and weirs and mills affecting the flow of water, and many towns and some manufactories discharging their sewage and refuse into the stream from which is mainly derived the water supply of the metropolis.

2d. The Mersey Valley—including its feeders, particulary the Irwell, as an example of the river basin, most extensively polluted by all forms of manufacturing refuse, particularly that arising from the cotton manufacture and processes connected therewith.

3d. The Aire and Calder Basin, as an additional example of the same class, particularly in connexion with the woollen and iron manufactories.

4th. The Severn Basin, for the same reason, but in particular connexion with the great seats of the iron trade.

5th. The Taff Valley, in connexion with mining and industry applied to metals.

6th. A river Basin comprising a mining district in Cornwall.

Your special points of inquiry should, it is conceived, be in the Thames Valley. 1. The condition of the river as affected by mills, weirs, and locks, and as affecting the drainage of towns and villages and adjacent lands. 2. The condition of the river, as affected both by the discharge of sewage from towns and villages, and the refuse of manufactories, paper mills, &c., and the possibility of intercepting and rendering useful or innocuous these sources of pollution.

As to the other rivers mentioned, the main object of the inquiry should be how far the use or abuse of the rivers is, under present circumstances, essential to the carrying on the industry of these districts? How far by new arrangements the refuse arising from industrial processes in these districts can be kept out of the streams, or rendered harmless before it reaches them, or utilised or got rid of otherwise than by discharge into running waters? In the course of these investigations you will make inquiry into the effect on health and comfort of the existing system of sewage of towns and populous places in the districts examined, and into the best mode of protecting individual and public interests in the purity of running water.

Secondary questions will, no doubt, arise contingent on these leading points, in which case you will include them, as far as it is necessary, within the scope of your inquiry.

I am, &c.
(Signed) H. WADDINGTON.

R. Rawlinson, Esq.,
J. T. Harrison, Esq.,
J. T. Way, Esq.,
Commissioners to inquire into the Pollution of Rivers.

LETTER from H. WADDINGTON, Esq., to the COMMISSIONERS appointed to inquire into the POLLUTION OF RIVERS.

GENTLEMEN, Whitehall, July 7, 1865.

I AM directed by Secretary Sir George Grey to transmit to you an extract of a letter from Mr. Charles Neate, and to state that it will be desirable to include in your inquiry into the Pollution of Rivers, the subject of the water supply suggested by Mr. Neate, provided such extension of your inquiry will not materially impede or delay the completion of the primary object of the Commission.

I am, &c.
(Signed) H. WADDINGTON.

The Commissioners appointed to inquire into the Pollution of Rivers,
2, Victoria Street, S.

LETTER from CHARLES NEATE, Esq., M.P., to the Right Honorable Sir GEORGE GREY, Bart., G.C.B., M.P.

DEAR SIR, House of Commons, June 27, 1865.

I BEG to submit to you, with reference to the Commission recently issued to inquire into the means of remedying the pollution of rivers, that as the scope of that Commission has already been enlarged beyond its original and professed object, so as to include an inquiry into the drainage of " lands and inhabited places," it would be right to extend the inquiry still further as to include the great question of the water supply.

Even if the drainage referred to in the Commission is that only which is required for sanitary purposes, it may still be a question whether you might not subject the health of the country to far greater danger by wasting too rapidly the winter supply of water than it now is liable to from the temporary dampness of the soil in certain places.

The effect of drainage, even to the extent it has been already carried out for agricultural purposes, is a subject of serious alarm to many people, and I think it is matter of pressing interest to inquire how far the general level of springs in the country has been lowered, how far it depends upon the height at which the water is maintained in the neighbouring river, and what is the number of springs that have altogether failed, or at least that fail during the summer.

I believe it to be a matter of urgent necessity to provide reservoirs of water throughout the country, to be used for all purposes but drinking, and that the spring water should be habitually confined to that use.

If the Commission, as it stands, is intended to apply to agricultural drainage, the reasons for extending the inquiry are more, still more cogent, for then it is no longer a conflict between one sanitary purpose and another, but between the health of the country and some increase in the productiveness of the soil.

I remain, &c.
(Signed) CHARLES NEATE.

The Right Honorable Sir George Grey,
Bart., G.C.B., M.P., &c., &c., &c.

P.S. I think it would be a great point to inquire whether all the surface drainage of towns might not conveniently be kept out of the service and taken into the rivers.

Sir,

Whitehall, June 24, 1867.

I am directed by Mr. Secretary Hardy to transmit to you the Warrant under Her Majesty's Royal Sign Manual appointing Ralph Augustus Benson, Esquire, to be Secretary to the Rivers Pollution Commission, in place of Godfrey Lushington, Esquire, who has resigned such appointment.

I am, &c.

Robert Rawlinson, Esq., C.B. (Signed) H. Waddington.

VICTORIA R.

Victoria, by the Grace of God of the United Kingdom of Great Britain and Ireland Queen, Defender of the Faith.

To Our trusty and well-beloved Robert Rawlinson, Esquire, Companion of Our most honorable Order of the Bath, John Thornhill Harrison, Esquire, and John Thomas Way, Esquire, greeting.

Whereas We were pleased by Warrant under Our Royal Sign Manual bearing date the Eighteenth day of May 1865, constituting you, Our Commissioners, to make inquiry into the Pollution of Rivers, and for the other Purposes therein set forth, to appoint Godfrey Lushington, Esquire, barrister-at-law, to be Secretary to the said Commission:

And whereas the said Godfrey Lushington hath resigned such appointment:

Now know ye that, in room of the said Godfrey Lushington, we have made choice of Our trusty and well-beloved Ralph Augustus Benson, Esquire, barrister-at-law, to be Secretary to such Commission, whose services and assistance We require you to avail yourselves of from time to time, as occasion may require.

Given at Our Court at St. James's the Twenty-second day of June 1867, in the Thirty-first Year of Our Reign.

By Her Majesty's command.

(Signed) Gathorne Hardy.

THIRD REPORT.

TO THE QUEEN'S MOST EXCELLENT MAJESTY,

May it please Your Majesty,

We, Your Majesty's Commissioners appointed to inquire into the pollution of rivers and running waters, having reported on the main stream of the river Thames and on the river Lee, now proceed to report on the rivers Aire and Calder, the principal seat of the Woollen and Worsted trades in the West Riding of Yorkshire.

Having made preliminary inspections of the West Riding district during portions of the summer of 1866, we proceeded to hold our public inquiries during the autumn, in the following order:—

Name of Town.	Name of River.	October.	November.	December.
Wakefield	Calder	16th.	—	—
"	"	17th.	—	—
"	"	18th.	—	—
"	"	19th.	—	—
Dewsbury	Calder	22d.	—	—
"	"	23d.	—	—
Huddersfield	Colne, tributary of Calder	25th.	—	—
"	"	26th.	—	—
"	"	27th.	—	—
Leeds	Aire	—	6th.	—
"	"	—	7th.	—
"	"	—	8th.	—
"	"	—	9th.	—
Bradford	Bradford Beck, tributary of Aire	—	13th.	—
"	"	—	14th.	—
"	"	—	15th.	—
Halifax	Hebble Beck, tributary of Calder	—	16th.	—
"	"	—	17th.	—
Todmorden	Calder	—	19th.	—
Keighley	Worth, tributary of Aire	—	27th.	—
"	"	—	28th.	—
Skipton	Aire	—	29th.	—
Pontefract	Aire and Calder united	—	30th.	1st.

In prosecuting our inquiries we received all the assistance we required from the several Municipal Corporate bodies, Towns Commissioners, Local Boards of Health, Parish authorities, and others. In no instance did any of the manufacturers applied to decline to allow their works to be inspected, or to furnish information as to the materials used and pollutions caused to running waters. The evidence, as published in detail, shows that on the contrary, in many instances, considerable expense and labour were incurred to obtain special information for our use to enable us to ascertain the leading facts bearing on the question of rivers pollution which we were commanded to report upon.

The rivers Aire and Calder have this in common with the Thames and Lee, upon which we recently reported, that they are navigable streams, and are polluted by town sewage; but the Aire and Calder suffer to a far greater extent than the Thames and Lee from manufactures, by which they are in some instances polluted to the utmost limits of which they are capable.

While domestic water supply to the populations seated at various points upon their banks, and to 3,037,991 persons inhabiting the Metropolis, is by far the most important use to which the waters of the Thames and Lee are appropriated, the water of the Aire and Calder, and that of their numerous tributaries is, in consequence of its foul condition, not used so much as it formerly was for domestic purposes, but mainly for carrying on the Worsted and Woollen manufactures, and other important trades of the district. Thus the rivers Thames and Lee require to be purified, that their waters may be preserved wholesome for domestic uses. The rivers Aire and Calder require to be improved and conserved, that injurious flooding may be prevented; they should be protected from pollution, that the trades established in the district may be carried on to the greatest advantage, and means should be afforded to preserve the water pure for the domestic purposes of a large population.

YORKSHIRE: ITS TOPOGRAPHY, METEOROLOGY, GEOLOGY. &C.

Yorkshire, the largest county in Britain, containing 5,983 square miles, and in 1861 a population of 2,015,541, is bounded on the north by Durham, on the east by the North Sea, on the west by Westmoreland, Lancashire, and Cheshire, on the south by Derbyshire, Nottinghamshire, Lincolnshire, and the river Humber, and is divided into three ridings—North, East, and West. The Pennine mountain chain extends from Scotland, forming the western highlands of Yorkshire, on to Derbyshire. The highest points in this mountain range are Mickle Fell, 2,600 feet, Whernside, 2,384 feet, and Ingleborough, 2,361 feet above medium tide level. The north-western portion of the county consists of Cambrian, Silurian, Scar limestone, and Yoredale rocks; on the eastern slope of this range of mountains, Millstone grit of varying breadth forms moor and mountain from Durham to Derbyshire. The Yorkshire coal-field extends from Leeds in the north to Derbyshire in the south, and is in area about 700 square miles. A considerable breadth of Mid-Yorkshire is New Red Sandstone, with a strip of Permian strata on the west. In the south-eastern portion of the county, from the Humber to Filey Bay, the subsoil consists of Chalk. From Filey Bay northward to the Tees mouth are found Coralline oolite, Bath oolite, and Lias shales. Alluvium, such as boulder-drift, clay, silt, gravel, and sand is found in the valleys.

The geographical configuration of the West Riding of Yorkshire and its geology are alike favourable to the establishment and prosecution of manufactures requiring water. The mid-mountain ranges of this portion of England trending north and south are at a sufficient elevation to intercept rain-clouds and condense vapour brought from the Atlantic Ocean by the south and west winds. The strata are well fitted to receive the rain, and to pass it down through the numerous rivulets, streams, and rivers. The main dividing ridges being to the west, and for the most part forming the boundary of the county, the greater portion of rain precipitated flows through the county eastward to the North Sea. It has been calculated that, out of each 100 parts of rain-water falling on the surface and flowing off either from springs or floods, 80 parts find their outlet by the Humber, 13 parts direct to the North Sea, and only seven parts into the Irish Sea.

The West Riding is traversed from east to west by three valleys almost parallel. These are the vales of Wharfe, Aire, and Calder. Mountains of millstone grit, largely covered with moorland, bound the coal-field of Yorkshire on the north and west, and it is from this stratification that much of the pure spring water is derived. Bradford, Halifax, Dewsbury, and some other towns have recently constructed impounding reservoirs on the millstone grit for their domestic supply, and also for trade purposes.

The rainfall over Yorkshire varies with relative position and elevation. On the south and eastern part it is least, having an average annual fall of about 20 inches. The middle district, up to an elevation of 1,000 feet, averages about 30 inches; and on the mountain ranges and their slopes down to 1,000 feet of elevation the average rainfall varies from 30 inches up to 80 inches.

The surface area of a country, the amount of rain falling and of vapour condensing upon it, and the capacity of the subsoil-rocks for receiving and storing water form data from which to calculate the approximate yield of any watershed. Rain-gauges indicate the volume of rain falling in their immediate vicinity, but actual gaugings of water flowing off the ground give the only reliable data as to the dry weather and ordinary volume of water discharged. River floods cannot accurately be measured as to volume, neither can the injurious effects of such floods be easily estimated.

Over all this district dry and wet years vary about as 1 to 2. Where averages have been made from continuous observations over 30 or 40 years it will be found that deducting one third will indicate the total fall of rain in a dry year, and adding one third will give the fall or excess of rain in a wet year. On the south-east coast a dry year's rainfall will be 14 inches, and a wet year 28 inches. In the middle district a dry year will be 20 inches and a wet year 40 inches, or thereabouts. The dry weather flow of water on the surface is modified by aspect, elevation, surface-contour, and most of all by the geological character of the subsoil. The perennial flow is modified by

these conditions and by the amount of rainfall, as also its times and modes of falling. The actual flow of water from the ground as measured in springs, streams, and rivers varies in accordance with climate, volume of rain falling, the period or season within which the rain falls, the character of the subsoil, surface-contour, and some other conditions; but under the most favourable conditions much of the rain is again evaporated.

In the drainage areas of the Thames and Lee, where accurate gaugings of the rain and measurements of the rivers have been taken for waterworks purposes, it is found that out of an annual average fall of 27 inches over the area of the Thames watershed, one-sixth percolates and forms springs, one-sixth passes off as flood water, and four-sixths are evaporated; while in the case of the Lee watershed, where the average rainfall is 25 inches, nearly four-fifths pass off by evaporation.

These proportions are, however, only an approximation to the averages of rainfall given; with greater or less rainfalls on the same areas the proportions will vary. It might be supposed that some water is absorbed in the strata and so is lost or expended in the sea at great depths below the surface. No experienced geologist will, however, admit this as a practical solution. Springs, as a rule, deliver the absorbed rainfall of such a district as the West Riding of Yorkshire at the surface and at no great distance. There may be some small springs in the sea having their origin near the shore, but not of volume seriously to affect the question. Limestones, which are much fissured, are uncertain in their surface-delivery of water where small areas have to be considered, but are more conformable to a general law where large areas have to be relied upon. Limestones are wasted and more or less fissured and caverned by the solvent action of soft water, so that there may be areas of surface of many acres in extent receiving and absorbing or evaporating all the water falling on the surface; such areas are not fitted for the formation of impounding reservoirs, as fissures not showing themselves at the surface may exist, which, when covered with water under pressure, would receive and discharge the entire volume at some point below, as in the case of the water from Malham Tarn. The enormous waste in limestone strata constantly and silently taking place by the solvent action of soft water can only be roughly indicated. Rain water, when brought into contact with lime rocks possesses the power of dissolving and removing as much as 20 grains of carbonate of lime in each gallon; taking a mean of 15 grains to the gallon, more than one ton of carbonate of lime is removed with each million gallons of water.

The dry weather flow from the whole of Yorkshire may be about a half cube foot of water per second from each 1,000 acres. The flood flow on the mountain slopes is from 200 to 500 cube feet per second from each 1,000 acres for short intervals. The beneficial use of rivers depends on the dry weather and medium flow. Floods are to be guarded against as liable to cause injury, of which much experience has been gained during the autumn, winter, and spring of 1866 and 1867. Excessive floods have been hitherto very little modified, either by land drainage or by storage reservoir making, but abuse by throwing solids into the streams, encroachments, and general neglect have tended to aggravate their destructive effects. A full history of the neglect and abuse of the streams in Yorkshire during the last half century, and of the consequent losses by floods, ought to teach the manufacturers that nature will take her own mode of avenging herself.

Rainfall and rivers mould and modify the surface of the land. Sunlight, wet, frost, and wind expand, dissolve, disintegrate, and disperse the solid materials exposed to their unceasing action. Rain forms springs, and rivulets; these form rivers, and by their combined action solids are chemically dissolved and mechanically washed down to the ocean. Bright and sparkling water generally contains carbonate of lime. Bright brown (or coffee-coloured) water is usually soft and derives its colouring from dissolved peat. Muddy water contains the fine particles of rocks in suspension, the weight of the solids removed being in proportion to the volume and velocity of the water in the river, and the geological formation of the district drained. From the mountain sides of Yorkshire heavy rain washes down masses of rock, boulders, gravel, and sand to an enormous extent; these solids tend to block the beds of the streamlets and rivers, and where manufactures have been established much damage to property occasionally takes place by flooding.

District of the Rivers Aire and Calder.

The district watered by the rivers Aire and Calder forms part of the great drainage area of the river Ouse, which contains 4,207 square miles. The main watershed falls from the north and west to the east.

	Sq. Miles.
The basin of the river Aire is - - - - - -	$342\frac{1}{2}$
The basin of the river Calder is - - - - -	366
The basin of the united rivers from Castleford to the Ouse -	$85\frac{1}{2}$
Total area - - - - - -	794

The springs above and within Malham Tarn, situated on Scar limestone, at an elevation of 1,243 feet above Ordnance datum, form one of the main sources of the river Aire. This tarn, or small lake, is near the ridge dividing the watersheds of Westmoreland, Lancashire, and Yorkshire. It is bounded on the north and west by Kilnsea Craig, 1,475 feet elevation, Hard Flask, 1,746 feet, Bordley Mastiles, 1,346 feet, and Fountains Fell, 2,190 feet. The limestone is fissured immediately below the outlet of Malham Tarn, the whole volume of water being absorbed by "swallow holes," to re-appear at about two miles distance in Malham Cove.

The river Calder rises at an elevation of about 1,500 feet, on the mountain ridges of millstone grit dividing Lancashire and Yorkshire; two small streams, the Cal and the Der, united near Todmorden, becoming after this junction the Calder. The Aire and Calder, uniting their streams at Castleford become the Aire until joining the Ouse, which river finds an outlet through the Humber to the North Sea.

The watersheds of the Aire and Calder may be tabulated as respects their geological characteristics as under—

—	Area of Scar Lime-stone in Square Miles.	Area of Millstone Grit in Square Miles.	Area of Coal forma-tion in Square Miles.
The basin of the Aire - -	95	$137\frac{1}{2}$	110
The basin of the Calder - -	—	191	175
Total - -	95	$328\frac{1}{2}$	285

	Area of Permian in Square Miles.	Area of New Red Sand-stone in Square Miles.	Area of Alluvium in Square Miles.
The Aire after its junction with the Calder down to the Ouse - - -	30	$30\frac{1}{2}$	25
Total square miles -	30	$30\frac{1}{2}$	25

Abstract.

Area of Scar Limestone in square miles - - - -	95
„ Millstone Grit „ - - - - -	$328\frac{1}{2}$
„ Coal formation „ - - - - -	285
„ Permian formation „ - - - - -	30
„ New Red Sandstone „ - - - - -	$30\frac{1}{2}$
„ Alluvium „ - - - - -	25
Total area of the combined watersheds - - -	794

Obstructions and Pollutions of the Rivers Aire and Calder.

The rivers Aire and Calder throughout their whole course are abused, obstructed, and polluted (to an extent scarcely conceivable by other than eye-witnesses) from Skipton on the Aire, from Todmorden on the Calder down to Castleford. Our inspection

was corroborated by uncontested and overwhelming evidence; by the engineer to the Aire and Calder Navigation as also by the men employed in dredging. Pollution by solids—ashes, mud, and other "powse"—is increasing and will yearly become worse unless some remedial measures be rigidly enforced.

It is impossible to treat quite separately the questions of obstruction and pollution. In many cases, where solids are carried into a stream, both injuries are of course inflicted upon it.

The rivers Aire and Calder, and their tributaries, are abused by passing into them hundreds of thousands of tons per annum of ashes, slag, and cinders from steam-boiler furnaces, ironworks, and domestic fires; by their being made the receptacle to a vast extent of broken pottery and worn-out utensils of metal, refuse brick from brick-yards and old buildings, earth, stone, and clay from quarries and excavations, road scrapings, street sweepings, &c.; by spent dyewoods and other solids used in the treatment of worsteds and woollens; by hundreds of carcases of animals, as dogs, cats, pigs, &c., which are allowed to float on the surface of the streams or putrify on their banks; and by the flowing in, to the amount of very many millions of gallons per day, of water poisoned, corrupted, and clogged by refuse from mines, chemical works, dyeing, scouring, and fulling worsted and woollen stuffs, skin-cleaning and tanning, slaughter-house garbage, and the sewage of towns and houses.

The practice of periodically flushing out into the streams the mud which must under any circumstances accumulate in goits, culverts, mill reservoirs, or "lodges" and canals is also a palpable abuse.

It would be impossible to calculate the extent or the profit to which the natural products of the West Riding, stone, coal, iron, and other minerals, have been worked, while the profits realized in the textile manufactures of worsteds and woollens since the modern establishment of those trades (about the year 1735) might perhaps exceed the amount of our national debt; and the trade, according to the evidence we have received, is still on the increase in the few places where water fit for use can be obtained.

But the growth of manufactures, the accumulation of wealth, and the increase of population in the West Riding are intimately connected with the abuse and pollution of its rivers. Many streams, where, by reason of their foulness, no form of life can at present be found, persons now living recollect abounding in fish. These appear to have been totally destroyed by the accumulated filth and the amount of solid refuse carried in suspension, as, in a large reservoir into which the river water at Wakefield is passed and where the water being at rest is clarified by mere mechanical subsidence of the solids, fish live and breed; nor will they be killed, as has been ascertained, even by the flow of town sewage *while it is fresh*, where it does not exceed one-tenth the volume of the stream into which it passes, and where the water is in unceasing motion downwards, not tidal as in the Thames at London.

The rapid increase of all forms of manufacture, as now carried on in Great Britain, received an immense impetus by the maturing of mechanical power through the aid of steam. Water-power is uncertain and troublesome, and its utmost limits may soon be reached on streams such as those in Yorkshire. There are no large lakes in the West Riding to equalize the delivery of water, but the manufacturer must be subject to the irregularity of seasons involving excesses of droughts and floods. Artificial reservoirs, which have been in some places constructed, in proportion to their capacity and management, tend to equalize the delivery of water, but they are costly to construct; and if not efficiently managed, they may become eminently dangerous and awfully destructive, as at Holmfirth, and at Sheffield.

Steam-power has consequently been provided to an enormous extent, in many instances to supplement water-power, but in more instances to be the prime and sole agent; and it involves the annual use of millions of tons of coal. Of this there remains on an average about one-eighth, after combustion, in the form of solid cinder or ash; and in the numerous valleys where large mills have been erected with steam-power, mill above mill, cinder and ash resulting from their vast consumption of coal has been and is at this time being thrown into the adjoining watercourse, so that during dry weather periods the greater portion of the bed of the river opposite such mill or works is filled by the "cinder tip." A stranger to the district, looking upon such state of things for the first time, thinks it must be the deliberate intention of the manufacturer, for some trade purpose or other, entirely to block the river at this point. In other instances a "slag or cinder tip" is made parallel to the banks of a rivercourse to a depth of many feet, and at the steepest angle the materials will form. In both cases flood-waters are expected to wash the solids so arranged down the river, regardless of all contingencies to other riparian proprietors. To these the consequences are inevitably disastrous, and the practice can scarcely be considered an advantage to the manufacturers who so abuse the streams. One result of this form of abuse is the gradual raising of the beds of the rivers above their former levels, and so causing floodings over the adjoining lands, and in some cases damaging mills. For purposes of trade, many of the millowners on the streams and rivers where land is available, construct "*goits*" and "*lodges*" to store water and obtain head for power, as also to allow of subsidence that the water may be used for washing and dyeing purposes. There are lines of mills so provided for, one below the other on the same stream. The uppermost mill receives water in the purest state; but even in so advantageous a situation sludge accumulates, both in the goit and in the lodge. This mud is periodically flushed out into the river, to foul its bed below, and portions of such mud are necessarily received into the next goit and lodge; the same sort of process going on, with the addition of cinders and dye-waste, to the last or lowest mill on that stream, the river below being ultimately polluted by the whole accumulated mud, dye-waste, and refuse ashes of the entire district above. The streams and rivers are further abused by the inhabitants generally who live on their banks, whether residing in isolated houses, villages, or towns; and so far has this abuse grown into a general practice, that even legally constituted Parish and Township authorities, Local Boards of Health, and the more dignified Municipal Corporations either directly practise abuses or connive at them by permitting their continuance. The streams and rivers seem to be considered the cheapest scavengers and removers of waste solids.

The penalties which nature exacts of the inhabitants of a district who so violate common sense by systematic abuse of water-courses are severe. When we commenced our recent inquiries in the West Riding, one opinion was reiterated by the witnesses examined, namely, that floodings by the rivers were neither so common nor so severe as formerly. Reservoir making to impound flood waters, and land-draining, with general cultivation, were supposed to have so modified all former conditions that flooding, as in olden times, was deemed impossible. The inhabitants of the valleys of the rivers Aire and Calder, because damaging floods had not occurred for several years, concluded that no more such floodings would take place. But before we had completed our inquiries, and whilst we were sitting taking evidence in Halifax, on Thursday 15th of November 1866, rain had commenced, and continued for several days flooding the valleys of the Aire and Calder most destructively from the mountains to the sea.* This flood rose as high and did far more damage to property than any flood at any former period. In several instances persons were washed away and drowned. It is not possible to form any reliable estimate of the money value of the damage it caused in the worsted and woollen districts to the manufacturers, landowners, and others of the West Riding, the property of so many thousands of persons having been destroyed or damaged. The total loss was locally estimated at from half a million to one million sterling. The lesser sum, if laid out in works of permanent improvement, would have been sufficient to put the rivers in condition to render such destruction of human life and great waste of property impossible. The loss by many thousands of the working classes and their families of time, wages, and of health, consequent on this week's flooding must also have been great, as, when such floods subside, damp floors and damp walls remain for many subsequent weeks, causes of discomfort and of disease. But as previously stated these excesses may be guarded against. Making additional impounding reservoirs will tend to equalize the flow of flood waters from small areas, but there must not be less than 100,000,000 gallons of storage to each 500 acres of gathering ground to control floods, and even then a flood may come down upon a full reservoir, almost as strong as if no reservoir existed. Under-draining and cultivating land may pass surface or rain-flood waters more rapidly, but neither reservoir making, land draining, nor cultivation will affect the amount of evaporation from the oceans and consequent rainfall. This is and ever will be entirely independent of any works of man. Evaporation is continuous, and dependent on the sun's heat; condensation is due to terrestrial influences, and may be very unequal from local causes. It is sufficient to know that excesses in rainfall may be repeated, will inevitably be repeated, and cannot be prevented. Any work, to be useful, must provide means to lessen contingent damages: these floods warn us that neglect and abuse of rivers cannot be continued with safety either to life or to property. The neglect consists in allowing gravel, sand, and silt washed down from the mountains to raise the beds of the streams; the abuses consist in

* See Appendix No. I., p. lvii.

deliberately further filling those beds with cinders and ashes from steam-boiler furnaces, and with other refuse solids previously mentioned; or, as at some of the great ironworks, forming slagheaps parallel with the river, and tipping refuse along the slope; besides which obstruction has been offered to the free flow of flood waters by unjustifiable encroachments; dams, walls, culverts, &c., as also by bridges and other public works of defective construction. It is worthy of remark in respect of the most salient feature in this obstruction of rivers, namely, the practice of throwing in vast quantities of cinder and ash from the mills, that it is closely allied to another nuisance, that of polluting the atmosphere by the emission of dense volumes of smoke from factory chimneys. In our inquiries as to the weight of ashes produced and what became of them, we learned that in the use of any coal, rich and bituminous or poorer and more earthy, if there be careful firing and perfect combustion there will be less cinder as well as less smoke. Experiments have proved this fact. Some large mills have their machinery driven by steam boilers which do not produce smoke, but prolong the life of the boiler, work at less risk of explosion, and with greater economy; and yet this practice does not become general, because there is some expense in alterations to steam-boiler furnaces in the first instance, and care in firing, as also in general management, is required subsequently. As ashes must be removed at a cost proportionate to the distance to which they must travel, and the difficulty of finding places of deposit, it is satisfactory to find that their bulk can thus be materially reduced by smoke consumption with increased profit to the manufacturer.

Pollution by Sewage.

The pollution by which we found the rivers Aire and Calder most grievously affected consist partly of such as are common to all streams flowing through a densely populated district, as town sewage, but, in a greater degree, of refuse solid and liquid from the special manufactures established upon them and their tributaries.

The amount of solids taken into the streams by sewers is in the aggregate throughout the West Riding enormous. At Leeds the volume of sewage passing into the Aire is from eight to ten million gallons per day, the entire weight of solids being swept out therewith; and this is the case throughout the district wherever main sewers and drains exist. In no single instance did we find any system of intercepting the solids from sewage, such as has been enforced at Birmingham, the corporation has been compelled to construct tanks for the purpose. The dry weather flow of sewage of Birmingham is about ten million gallons per day, and it is found that the weight of solid intercepted amounts to some 25,000 or 30,000 tons per annum, including to some extent refuse from manufactories and grit from the roads, all of which formerly contaminated and silted up the banks and bed of the river Tame. Interception of solids in this manner is, however, not to be advocated as a substitute for sewage irrigation.

Most of the towns in the West Riding have been partially sewered, and some houses have also been drained; but in no single instance has this necessary work been thoroughly done. The entire volume of sewage at Leeds (fluids and solids) is passed direct into the river Aire. This is also the case at Bradford, by the Bradford Beck; and at Keighley, and at Skipton. The river Calder receives sewage from Todmorden, Halifax, Huddersfield, Dewsbury, Wakefield, and smaller towns, villages, mills, and houses. No town or village intercepts sewage. At most of the large mills the privies for the workpeople are arranged in such manner that the excrements fall into a receptacle which can be removed to land where they are applied to purposes of agriculture, but even at these places the arrangements are neither so cleanly nor so inodorous as they ought to be and may be. Where sewers and drains are not admissible, the dry-earth closet, or some such arrangement, if well attended to, will be less offensive than where no other disinfectant is used. *Dry-earth closets are partially in use at Wakefield House of Correction in separate cells, and they may be made to answer for mill hands, for villages, and for groups of houses, as also, of course, for single houses; they are, however, by no means to be advocated as preferable to sewers, drains, and water-closets. The present gross abuse of the rivers which we inspected may in a great measure be prevented, and in such manner and at such cost as to be beneficial to all parties. Sewage may be purified by passing it over the land, and the solids of dye-waters and other refuse waters may be filtered out so that the streams may become clean.

* See Appendix No. II., p. lix.

The dark and foul appearance of the West Riding rivers is mainly due to insoluble dye-matter discharged from the works; but dye-refuse in general, though in this sense highly objectionable, really tends to a considerable extent, by the disinfecting action of the mineral ingredients and acids it contains, to neutralize the corruption of town sewage. Where, on the other hand, the dye refuse is not discharged in sufficient quantity, that offensive matter, deposited on the beds and banks of the streams, becomes, in dry weather, putrid and stinking, and in floods is stirred up and floated forward to poison the navigable parts of the river and the canals, where deposit can again take place. The most notable case of extreme pollution on record is that of the Bradford canal.

The sewering of towns is a complex question and requires to be specially studied, so as to effect the greatest amount of good at the least risk of polluting water-courses; natural streams, as small brooks, should not be arched over and formed into sewers, neither should rivers be made the receptacles of sewage. The largest proportion of rainwater may in all cases be turned over the surface into the natural streams; it will not be necessary to form duplicate systems of sewers and drains, but it will require intelligent and careful attention to preserve surface gradients and natural outlets for storm waters, and, where these have been tampered with, to restore and improve them. The sewers and drains of a town should provide for the removal of subsoil water, the slop and waste water from houses, and the contents of waterclosets; these sewers and drains may have storm overflows in connexion with the natural streams of the district so arranged as to prevent flooding of houses or bursting of the sewers during thunder-storms. All dry-weather sewage and such portion of the surface water due to moderate falls of rain as finds its way to the sewers will flow down with the sewage to the outlet, and be a manageable volume either to apply by gravity, or to be pumped to land for agricultural uses.* The remark may be made that, when the sewers overflow, the streams will be polluted; this is true, but the pollution will be a minimum, the sewage will be in extreme dilution, and the natural streams of the district will be in flood and most probably muddy by grit and silt washed in from road surfaces, and by fine particles of soil from the banks and the surfaces of the land. Floods caused by heavy rains ever have been turbid and ever will be turbid.

There are large areas of land, both in the Aire and Calder valleys, which would be greatly benefited by a proper application of sewage. It may be profitably applied to the production of Italian rye-grass. Where sewage will flow over a sufficient area of land by gravity there ought to be the best return for the expenditure, but towns having populations of 10,000 and upwards may venture to incur the cost of pumping sewage, and so reach land less valuable than the rich garden or meadow land at lower elevations. The only general rules applicable to sewage irrigation in all cases are that the works should be simple and cheap. Land to be irrigated does not require costly work in shaping and levelling, neither need there be expensive tanks to receive and store sewage; heavy clay land which has been ridge and furrow ploughed may have the surface brought to an uniform slope by lowering the ridges and filling in the furrows so as to prevent sewage, when applied, falling into each furrow as into a conduit, leaving the ridges comparatively bare. Such work may cost about 5*l.* per acre. Small fields may have useless hedges removed, so as to have larger areas at command. Underdraining may or may not be necessary; this must be settled after an examination of the subsoil to be dealt with. If underdraining be adopted, deep drains answer best, and these should be laid so as to extract water and admit air. Where the surface-contours will allow of interception, sewage water from drains may be turned on to the land three or four times with advantage and with a certainty of extracting more of the salts of sewage. Sewage meadows ought to be laid out on a plan similar to that adopted for water meadows. Carriers should contour the surface, at intervals apart, in proportion to the character of the soil and the slope of the surface. Where main open carriers may be considered a nuisance, as near houses, roads, or foot-walks, they may be covered conduits having cheap outlet-valves at a chain apart; carriers in the fields may be open grips formed with plough or spade, and such as to be broken up if necessary when a change of crop is made. A cheap main carrier can be formed with common agricultural drain tiles, butt-jointed, laid half in and half out of the ground; a single pipe or length of pipes can then be removed by hand at any point to allow of irrigation, and these same pipes can be readily replaced again. Where foul smells are complained of as coming from sewage-irrigated lands the causes are in the state of the sewage and in the rude mode of using it. If old and putrid sewage is stored in large tanks or is conveyed in large open ditches which are never cleaned there will be offensive taint. Fresh sewage does not give off so offensive a taint, and if conveyed at once by covered conduits to land, all nuisance ceases immediately. Cast-iron piping and hose and jet application are costly to provide and expensive to manipulate. If they are adopted, some special reason must have been urged to warrant this form of extra outlay, as for lawns and fields near houses, or for gardens. The produce from properly irrigated land will be from five to tenfold that of the same land under ordinary cultivation. Sewage evenly and regularly applied to the growth of Italian rye-grass, on any soil, will produce from 30 to 60 tons weight of green grass on each statute acre per annum. The celebrated Craigentinny meadows near Edinburgh, principally sea sand, have produced from 40 to 60 tons per annum to each acre, and let by auction at rents varying from 25*l.* to 35*l.* the acre. At South Norwood and at Worthing clay land out of which bricks are made is irrigated with town sewage, and produces from 40 to 50 tons of Italian rye-grass to each acre. In neither case is the land underdrained, and Mr. Marriage, of Croydon, prefers to irrigate without draining. We would by no means be understood to undervalue the advantage of draining claylands in general. Sewage irrigation may be carried on throughout the entire year, and grass may be cut at Christmas. In early spring, and weeks before ordinary cultivation will produce green crops fit to cut, from four to five tons per acre may be got from sewaged land. At such times the grass sells at 15*s.* and 20*s.* per ton on the field. Six or seven crops of grass may be cut during the year, but until the watercloset system be more efficiently carried out than we found it in the towns of the West Riding, the full advantage of this mode of sewage application will not be realized.

* See Appendices III. IV. V., pp. lix, lx, lxi.

It has been asserted that sewage-grown grass is unwholesome, and will not make good hay. The grass is, however, not only wholesome, but cows fed upon it give richer milk from which first-class butter may be made. The chemist proves by careful analysis that both milk and butter are better than samples produced from the same land in its ordinary state of meadow. Hay made from sewage-grown grass is also sweet and nutritious if properly got, but there is great difficulty in fully drying it during ordinary seasons.

When a limited quantity of sewage or other water containing manure soaks into a fertile soil, the first effect is to displace part of the water already contained in the soil, occupying its place in the interstices, whence the organic matter it contains is held in temporary union with the active soil, to be afterwards absorbed by the roots of plants or decomposed by the air, so that in a short time, varying according to the activity of vegetation and of decomposition, no impurity whatever remains. If then the sewage which has soaked into the soil is not displaced by other water until a sufficient time for it to be purified has elapsed, it will when displaced be as pure as ordinary shallow spring water. If it be found that the depth of the active soil effecting this change is about half a yard, and that it contains about one fifth of its weight of water, a quantity of sewage may sink into it equal to about 500 tons or a depth of five inches, before the water previously in the soil within 18 inches of the surface is all displaced; and if considerably less than this proportion of sewage, say one to two inches in depth, be put on rich soil at once, though the drains from it will run freely, as they do after heavy rain, they will be carrying away the water previously in the soil, and not, as is often supposed, that just poured upon it, which may with good management be retained in the soil until it in its turn becomes completely purified; and the water passing from the deep drains of irrigated land not over-manured may be as pure as that from the shallow springs of such land, all that is necessary for this result being that considerably less water be added to the soil at once than it previously contains, and that excessive manuring be avoided. During rapid vegetation an additional purification of the sewage matter takes place from actual contact with the growing plants on the surface.

The area of land in proportion to population for sewage irrigation will vary. If the object be to clarify sewage on the least area, irrespective of obtaining the greatest weight of produce or the highest standard of purification, subsoils of sand or of gravel answer best; such land acts as a filter, absorbing large volumes of sewage, the water flowing through the subsoil; but this mode of dealing with excessive quantities of sewage on permeable soil is not to be recommended where there are wells or streams to be tainted. On poor land from 5,000 to 20,000 tons of sewage per acre per annum may be so filtered, whereas on good land, where paying crops and perfect purification are looked for, 6,000 tons per acre per annum is as much as can be profitably applied. One hundred tons of sewage represents about one inch in depth over one acre; and so in the same proportion for less or greater volumes. Where sewage is regularly and evenly applied over properly prepared surfaces, and the effluent water is as evenly and regularly removed, the surface is not turned into a swamp. In the neighbourhood of Edinburgh 70,000 and even 120,000 tons of sewage are said to have been floated over each Scotch acre of the sea sand without such result. There must be impeded surface and subsoil drainage, causing stagnation and saturation, to produce a swamp; ordinary rainfall can do it without any sewage being added. All natural bogs, marshes, and swamps are caused by water impeded in its flow and retained stagnant in the subsoil and on the surface. There are hundreds of thousands of acres in the river valleys of England, at elevations from a few feet to several hundred feet above the sea, which are swamps because arterial outlets and land drainage are neglected. If sewage irrigation produces a swamp in any case, it will be through faulty laying out of the land, deficient subsoil and surface drainage, and bad management generally, rather than in the volume of sewage applied.

Civilization in its arrangements and necessities may be compared to a machine. A rude and simple machine works well under the management of a peasant, but as it becomes more complex in construction, more delicate in its parts, more refined in its operations, so, in like proportion, must those to whose hands its working is entrusted be more and more specially educated, skilful, and attentive. Modern civilization in Great Britain abstracts population from the country to aggregate it in towns, and this has gone on during the last half century, with an ever increasing speed. Cities and towns in mediæval times had little in the way of sanitary works to be kept in order. There were no sewers or drains; pavements in streets were rude, and their cleansing was neglected; excrements and garbage were cast forth into the public ways, to be washed by rain into mud or dried into dust by sun, as the seasons favoured one action or the other. At all times the public health was deteriorated by the accumulated and neglected filth, and when several seasons of bad weather followed each other, ordinary fevers ripened up into sweating sickness, putrid typhus, and plague. The rude municipal machine of mediæval times, jolted to destruction. General district rates had not been invented, because there were no district works to keep in order, as the old Saxon law inculcated individual action or expended its powers in enforcing monopolist restrictions. A large modern town may be compared to a large modern mill or factory which is built story above story, each room being full of machines, complex in design, delicate in their parts, and requiring specially educated and skilled labour successfully to manipulate and work them. In a modern town there are main sewers and house drains, waterworks and gasworks, each interlacing streets, courts, and yards, with mains and branch-pipes; then there are surface pavements, channels, and foot walks to keep in order and to cleanse. Sewage poured into the nearest stream pollutes the water, and cesspits crowded amidst houses breed fever. If all cesspits are abolished in favour of the watercloset system there will be more sewage to contend with, and if this is to do the least injury and the greatest good, it must be used unceasingly in irrigation. Waterworks, gasworks, sewers, drains, and street pavements, to be of the greatest service, must not only be skilfully designed and executed, but they must be intelligently managed; and as with the working machine of refined and complicated parts there must be care and skilful management, so in like manner complicated sanitary arrangements in towns require the attention of specially educated men. Local self governors do not always recognise this necessity; and by attempting to work with uneducated and underpaid labour they bring discredit on their local works. If arrangements for the prevention of river pollution be added to the other duties of a local surveyor, the sanitary machine to be kept in order will be more complex. As neglect in mediæval times allowed all the terrible diseases incident to town populations to ripen up into devastating plague, so imperfect sanitary works and regulations in towns at the present day allow excessive rates of mortality to prevail, as set forth weekly, quarterly, and annually in the Registrar General's report. In this report we have shown that abuse and neglect of running waters and rivers has begun most seriously and injuriously to affect trade, both by spoiling the running waters for further uses, and blocking rivers so as to cause destructive floodings. These growing evils can only be diminished by wisely devised works and regulations. A complicated and delicate piece of machinery can only perform the work it was designed for when in perfect order and under perfect management. Sanitary works and arrangements in towns, and especially in manufacturing towns, will only produce beneficial results under skilful superintendence unceasingly applied. It will be in vain to multiply preventive works and establish new regulations unless they are managed and maintained with the necessary skill and care.

Woollen and Worsted Trade, Description, and Statistics.

A glance at table D of the interesting and valuable returns (pages xviii, xix.) will inform the reader that woollen and worsted products to the extent of 384,200,000 pounds in weight, and of a value of 64,400,000*l.* sterling are annually sent out of the mills of Great Britain.

The West Riding of Yorkshire is not the only district in which this vast industry is located, but it may safely be taken that from one-half to two-thirds of the woollen and worsted trade is carried on there.

This trade is of ancient date in England. The Romans had weaving establishments of woollen cloth at Winchester, where the copious springs from chalk afforded means both for power and for washing and dyeing. The mother of Alfred the Great is recorded to have been skilled in spinning wool. Flemish woollen weavers settled in England about the time of the Norman Conquest, and continued immigration of woollen weavers from Flanders took place in the reigns of Henry I., Henry III., Edward I., and Edward III. The woollen tissues first spun and woven at Worsted, in Norfolk, about the year 1388, became the staple trade of Norwich. Devonshire manufactured woollens soon after the introduction of the trade into England, and Worcestershire a little later. Friezes were also early manufactured in Wales. In the middle of the sixteenth century, Berkshire took the lead in woollen manufacture.

About the middle of the last century the West Riding of Yorkshire became the seat of the Worsted and Woollen trades. Halifax began to be specially noted for Kerseys. From about this date, these trades finding so much water available not only for power but also for washing, dyeing, scouring, fulling, and all other purposes, the Yorkshire manufacturers and traders were enabled to undersell those of other places.

The rivers Aire and Calder were made navigable by Act of Parliament about the year 1698, and have from time to time been improved so as to meet and supply the requirements of a growing trade. This navigation has such advantages, and has been so ably managed up to this date, that it successfully competes with the established railways.

It is of the utmost importance to study the rise, progress, and condition of any manufacture, especially if it has changed its locality. Successful trade is generally contingent upon local natural advantages which forethought and care may improve, or which continued abuse may deteriorate and even ultimately destroy. The West Riding of Yorkshire, and especially the Aire and Calder district, possesses many natural advantages favourable to the establishment and conduct of trades requiring good water. A range of mountains, composed principally of Scar limestone and Yoredale rocks, capped with Millstone grit, forms the western boundary, and sends down numerous spring-fed rivulets and streams to wind and flow over the entire breadth of this portion of the county. The graduated fall affords means of obtaining water-power, and the numerous valleys offer favourable sites for storage reservoirs. The vast numbers of mills and dyeworks (upwards of 5,000) established since the commencement of the present century, and the rapid growth of the worsted and woollen trades of the West Riding, clearly indicate that the natural advantages of this part of Yorkshire are great. There are not only spring and river water, but there is also cheap fuel obtained from the local coal-field, enabling the manufacturers to supplement water-power with steam, and, in numerous instances, to obtain all the power required from steam alone. Abuses in the district by throwing solids into running waters and by pollution have, however, become in some cases destructive to trade, and in numerous cases prohibitive to further extensions. Some branches of trade having migrated to Scotland where water less polluted is obtainable.

The various processes to which water is put in cleansing wool and in manufacturing Woollens and Worsteds may be stated as under:

1. Scouring the wool with a ley and hot water, to remove grease and dirt.
2. Washing with clean cold water.
3. Dyeing, when the cloth is to be wool-dyed.
4. Scouring cloth with fuller's earth to remove oil and size.
5. Dyeing, when piece-dyed.
6. Milling or fulling, with soap and warm water, either in the fulling-stocks or in the improved milling machines, where the cloth is squeezed between rollers.
7. Scouring, to remove the soap.
8. Boiling cloth to give it a permanent face.
9. Steaming, to take away the liability of the finished cloth to spot.

Dirty water may be used for power, but even for such purpose it is a nuisance, and, for washing and dyeing, water may be so polluted as to be injurious even to dark and coarse goods, and totally unfitted for cleansing and dyeing fine fabrics.

The vast interests involved in the Wool, Woollen, and Worsted trades of Great Britain are set forth in the following Statistical Tables kindly furnished to the Commission by Mr. Jacob Behrens, vice-president of the Chamber of Commerce of Bradford.

TABLE A.

ESTIMATE of the PRODUCE of WOOL in the UNITED KINGDOM, from 25,795,708 Sheep based upon a RETURN made for GREAT BRITAIN on the 5th March 1866, and for IRELAND in 1865.

MEM.—The number of sheep in Ireland under one year old is supposed to bear the same proportion to the whole number as that given in the Return for Great Britain.

—	Number of Sheep. Under one year old.	Number of Sheep. One year old and above.	Weight per Fleece.	Wool produced. lbs.
In England -	4,505,345	10,620,196	$6\frac{1}{2}$ lb.	69,031,274
„ Wales - -	380,854	1,287,809	$5\frac{1}{2}$ „	7,082,250
„ Scotland -	1,624,638	3,630,439	$6\frac{1}{2}$ „	23,597,853
„ Ireland - -	1,048,491	2,640,251	6 „	15,841,506
Isle of Man & Channel Islands	24,410	33,196	$6\frac{1}{2}$ „	215,774
	7,583,817	18,211,891		
Under one year old Hoggets -	5,583,817		6 „	33,503,293
Lambs killed and clipped.	1,000,000		3 „	3,000,000
Lambs killed and not clipped.	1,000,000		0 „	0
				152,272,650

TABLE B.

ESTIMATE of the QUANTITY and VALUE of WOOL and similar material worked up in Worsted and Woollens.

MEM.—Import, Exports, and Values from Board of Trade Tables for 1864, except quantity of English Wool, for which see A.

—	Produce and Imports.	Exports.	Retained for Home Consumption.	Price per lb.	Value. £
English Wool -	152,272,650	7,320,299	144,952,351	$2/4\frac{1}{2}d.$	17,213,075
Foreign „ -	206,473,045	55,993,803	150,539,242	$1/6\frac{1}{2}d.$	11,123,905
Goats' Hair or Wool	4,737,330		4,737,330	$2/8\frac{1}{2}d.$	650,191
Home-made Shoddy	52,000,000		52,000,000	5*d.*	1,083,334
Imported Shoddy -	22,482,880		22,482,880	$4\frac{3}{4}d.$	494,611
Wool Extracts -	5,000,000		5,000,003	6*d.*	125,000
Foreign Yarn -	4,479,984		4,479,984	4/6*d.*	1,008,004
	447,445,889	63,254,102	384,191,787		£31,698,120

TABLE C.

The EXPORTS of WOOLS, TISSUES, and YARNS, and the Quantity of Foreign Wool worked up in the years 1844, 1854, and 1864.

—	—	1844.	1854.	1864.
Exports of English Wools - -	£	535,134	734,490	673,446
Do. Worsted Yarns - -	£	958,217	1,557,459	5,417,377
Do. Wool Tissues - -	£	8,204,836	9,121,186	18,533,457
Do. British produce - -	£	50,642,306	97,092,308	160,449,053
Foreign Wool retained for Home Consumption.	lbs.	63,741,087	81,654,711	155,276,572

COMPARATIVE PER-CENTAGE of the EXPORTS of WORSTED and WOOLLEN Manufacturers to the other textile fabrics in 1864.

Exports of Worsteds -	£ 16,217,898	$17\frac{1}{2}$ per cent.	6 per cent.
Do. Woollens -	7,732,976	$8\frac{1}{2}$ „	
Do. Cottons - -	54,882,329	59 „	
Do. Linen and Jute	11,636,049	$12\frac{1}{2}$ „	
Do. Silks - -	2,274,927	$2\frac{1}{2}$ „	
Totals - -	£ 92,744,179	100 per cent.	
Total Exports of British produce.	£160,449,053		

TABLE D.

ESTIMATE of the VALUE and WEIGHT of WOOL and similar material MANUFACTURED into Worsted and Woollen Yarns and Tissues in the UNITED KINGDOM 1864.

35,000,000 lbs.	English Wool exported as yarns -		- Value £ 5,500,000
110,000,000 „	do. manufactured into tissues	4/	- „ 22,000,000
150,500,000 „	Foreign do. „ „ „	3/	- „ 22,600,000
4,700,000 „	Mohair do. „ „ „	5/	- „ 1,200,000
4,500,000 „	Foreign yarn „ „ „	8/	- „ 1,800,000
79,500,000 „	Shoddy and extracts „ „	1/	- „ 4,000,000
	Cotton, yarn, and other material -		- „ 7,300,000
384,200,000 lbs.			£ 64,400,000

TABLE E.

ESTIMATE of the VALUE and WEIGHT in 1864 of the WOOL and similar material worked up with it into WORSTED and WOOLLENS for EXPORT and HOME CONSUMPTION.

MEM.—In this Estimate all English Wool is considered as worked up into Worsted, and that which is worked up into Woollens is supposed to be more than balanced by the Foreign Wool (Russian, Australian and others) in Worsteds.

WORSTEDS.

	EXPORTS.		
£ 5,417,377	Yarns (31,824,296 lbs.) equal in Wool to - - - -		35,000,000 lbs.
7,945,633	Goods $\frac{1}{4}$th mixed with other material £6,000,000 Wool -	4/	30,000,000 „
2,852,815	Do. all Wool - - - - - - -	4/	14,000,000 „
	HOME.		
13,200,000	Do. mostly mixed with other material - - -	4/	66,000,000 „
1,200,000	Do. of Mohair „ „ - - - - -	5/	4,700,000 „
2,984,175	Cotton and other material worked up with the above exclusive of exports - - - - - - - -		
£ 33,600,000			149,700,000 lbs.

WOOLLENS.

	Exports.		
£ 1,186,815	Goods mixed with ¼th of other material £ 890,000	1/	18,000,000 lbs.
6,546,161	Do. all Wool (foreign)	3/	43,500,000 ,,
	Home.		
16,000,000	Do. of Foreign Wool	3/	107,000,000 ,,
1,800,000	Do. do. Yarns	8/	4,500,000 ,,
3,200,000	Do. Shoddy and Extract	1/	61,500,000 ,,
2,067,024	Cotton and other material mixed with Wool.		
£ 30,800,000			234,500,300 lbs.

Under the name of Shoddy, which occurs so conspicuously in the foregoing tables, an enormous weight of material is used which until recently was waste. Shoddy was first introduced into use about the year 1813, at Batley, near Dewsbury. Mungo was adopted in the same district but at a later period. Shoddy is the produce of soft woollen rags, such as old worn-out carpets, flannels, guernseys, stockings, and similar fabrics. "Mungo" is the produce of worn-out broad or similar cloths of fine quality, as also of the shreds and clippings of cloth. It was stated at our inquiry that the term arose in consequence of the difficulty at first of manipulation. A manufacturer gave some of the materials to his foreman, who, after trial in the shoddy machines, came back with the remark, "It winna go," when the master exclaimed, "But it mun go." These woollen rags are collected, packed in bales, and are imported from Russia, Egypt, Turkey, the entire area of Europe, India, China, and, in fact, from all parts of the world where woollen garments are worn and rags are produced and can be collected. They come to Yorkshire from districts where plague, fever, smallpox, and loathsome skin diseases extensively prevail. The bales are opened and the rags are sorted by human fingers before being placed in machines which break up, tear, separate, and cleanse the fibre for manufacturing uses. According to the evidence we obtained no disease has ever broken out amongst the persons who so manipulate these old woollen rags, although in many of the countries in which they are collected they are believed to be peculiarly plague-bearing materials. The lapse of time in collecting, storing, and transmitting these rags, as also the possible destruction of any special poisons by friction or otherwise, must be taken into account. The whole of the facts deserve, however, the serious attention of those persons who insist that the power of communicating disease is contained in a dangerous manner by woollen goods which have been worn by persons suffering from contagious diseases. The experience obtained by the manipulation of shoddy for upwards of 50 years proves that old woollen rags are not in any degree dangerous to the health of those who work amongst them.

The shoddy trade, as now carried on in the West Riding, is a remarkable instance of the utilization of waste material. The term "shoddy" was, in the first instance, one of reproach, but this has ceased to be. Shoddy now enters into honourable companionship in official returns with British and foreign wools, mohair, silk, and cotton, and is used by manufacturers throughout the woollen and worste ddistricts. By recent returns (1866) the total weight of wool and goat's hair of home and foreign growth used, was about 310 millions of pounds; the total weight of shoddy and extracts for the same period was about 74½ millions of pounds, or some 33¾ thousand tons, so that shoddy now forms near one-fifth by weight of the woollen and worsted manufacture of the district. The woollen trade of Great Britain could not be carried on to its present extent without shoddy.

Shoddy is mixed with wool in proportions from one-third to two-thirds shoddy or mungo, and is used in the manufacture of cheap broadcloths, finer cloths for ladies' capes and mantles, pilots, witneys, flushings, friezes, petershams, duffels, honleys, paddings, linings, cloths used for rough and loose great coats, office coats and trousers, pea-jackets, and blankets. A considerable quantity is used in the form of flocks for beds. Felted cloth is extensively manufactured; it dispenses with spinning and weaving, depending on the felting property of wool by reason of the curl in the fibre. The process is carried on by the aid of warm moisture, pressure, and milling; such cloth is used for table covers, horse cloths, carpets, paddings, druggets, and the coarser and thicker kinds for covering steam-boilers, steam-pipes, and ship's bottoms beneath the copper. Some of the finer and better class of felted cloths are printed.

The manufacture of shoddy and mungo need not produce any special pollution.

The rags are torn into fibre by machines specially prepared, and the dirt, dust, and fine particles of wool are blown out in such manner that this refuse can be collected and sold for manure. About one seventh by weight of shoddy is so cleansed out as waste in preparing it. The price obtained for it as manure varies from 10*s.* to 20*s.* per ton. Some of the richer sort of waste shoddy is sent into Kent as a dressing for hop-growing.

Pollution by Manufactures.

It has already been stated that, although the introduction and perfection of the steam-engine in the last century has enabled woollen manufacturers to dispense in great measure with water *as a source of power*, they are still absolutely dependent upon an abundant and tolerably pure supply of this element for the successful prosecution of their business. Indeed, mechanical power is now—thanks to steam—only a question of expense, and can be had at all times and anywhere by paying for it in the shape of fuel. In this respect the manufacturer is no longer so circumscribed in his choice of a site for his operations as he was formerly. But water, abundant and good, is only to be had within limits which are fixed rather by nature than by any efforts of man; without it the woollen trade would be impossible, and, although much may be done by combination to bring water from a distance for the use of manufacturers, its cost when so supplied is a heavy tax upon the woollen industry, and places the manufacturer at a disadvantage in the market as compared with those who derive their water from natural and readily accessible sources. If at this present time and with the full advantage derivable from steam power the woollen and worsted trade was to be established for the first time in England, the West Riding of Yorkshire, with its streams of bright pure soft water, and its productive coal-fields, would be, as it has been, the chosen site of this manufacture. But as old age, decay, and death in a plant or animal is the natural result of wear and tear of the vital processes, so it would seem that the successful prosecution of woollen manufactures is certainly, if slowly, leading to their destruction or removal from their ancient and favoured haunts, if some effort be not made to arrest the progress of pollution of which they themselves are the chief cause. In the two facts, first, that in one year (1864, Table D.) 384,000,000 pounds of wool were worked up into various tissues in Great Britain, and secondly, that every pound of this wool has to undergo operations necessitating the use of large volumes of water, and rendering that water foul and offensive, we have the history of all rivers on which the woollen trade is located, and notably of the Aire and Calder.

These rivers are indeed subject in common with those flowing through agricultural districts (as the Thames and Lee) to pollution from sewage, from tanneries, breweries, malting and other ordinary trades, and from exceptional manufactures, such as paper making, &c., but beyond all doubt their characteristic peculiarity is that derived from the different processes incidental to the worsted and woollen trade. To those who are familiar with the West Riding of Yorkshire it may seem unnecessary to describe the condition of the rivers which form the subject of this report, and yet it may well be doubted whether that very familiarity may not have rendered them all but unconscious of a state of visible pollution which strikes a stranger from the non-manufacturing districts with astonishment.

Moreover it is certain that very few persons even in the district possess an intimate knowledge of the causes of this pollution or can estimate their individual influence on the general result.

With very few exceptions the streams of the West Riding of Yorkshire run with a liquid which has more the appearance of ink than of water.

In the higher part of the country as is shown, in another part of this report, the water is of the purest description, but as it arrives at any point where conditions for the establishment of a woollen mill are sufficiently favourable, so does the character of the water commence to deteriorate, becoming fouler and more foul after leaving each successive mill, till as has been abundantly shown by the evidence, the stream has to be abandoned as a source of water either for domestic supply or for manufacturing purposes, (otherwise than furnishing power) and is looked upon and treated as little better than an open drain.

In order that we may learn to what extent and by what means a state of things so baneful alike to the towns and the country, to the manufacturer and the operative, the landed proprietor and the peasant, may be remedied, it is necessary to describe in some detail the different stages of the treatments of wool, and the dyeing and cleansing of fabrics as practised in the mills of the district.

*Wool Washing.**—The first process giving rise to pollution is that of washing the wool. The object of the washing is to remove ordinary dirt and the natural grease, as well as that which has been applied to the fleece, and to open the wool to the action of the dye.

The wool is immersed in a copper filled with stale human urine, diluted with water and heated by steam. In this bath it remains for a time varying from half an hour to two hours, when it is laid upon a grating placed over the copper to drain, and then removed to another vessel to be washed with cold water.

The action of stale urine probably depends upon the presence of free ammonia or its carbonate. Pigs' dung is sometimes employed instead of or in combination with the urine. Other substances, such as soda-ash, phosphate of soda, and salts of ammonia, are sometimes substituted or added to this bath, but the favourite material seems to be stale human urine.

The wool, after being drained, is washed in cold water. In the smaller mills this is performed by stirring up the wool in a tank of water with a strong pole, the water being let off through a " clow " or shuttle, furnished with a grating, at the bottom of the vat, which is again filled with cold water, the water being renewed several times in succession.

In late years a machine known as Petrie's wool-washing machine has been introduced. The wool, steeped as before, is here immersed in water contained in long tanks, and is made to pass forwards, being at the same time opened out by an ingenious arrangement of rakes worked by machinery. The principle in this case is to introduce the wool to liquid which is already fouled by having passed over a first portion, and so gradually to bring it into contact with clean water at the other end.

Three or four of these vessels are placed in series, and the wool is transferred from one to the other by endless bands of wire gauze.

The wool is put into a tank from which the waste water flows away, and issues from the tank to which the clean water is supplied. The use of this machine offers an opportunity of economizing water, which is of great advantage when the supply is limited, and as it appears to work effectually, its more general introduction would probably be of benefit in diminishing the quantity of foul water to be dealt with.

This " scour " water runs in either case from the vats to the nearest outfall. There is nothing in it that is considered worth saving, and we have not heard of its ever having been turned to account, or treated in any way. It will be easily conceived that the first of the "scour" is a most offensive liquid. In the case of the old, and still generally practised, method of hand-washing, the liquid differs very much at different periods of the process; the first vats let-off being very foul, whilst the last portions are nearly clean water.

In washing by machine the whole of the water will necessarily be of one character, more diluted than the first water from the old process and less so than the latter quantities, but as a whole equally objectionable.

The discharge into rivers of large quantities of water in which dirty wool has been steeped would be bad enough, even if water alone were used, but the nature of the filthy liquid which is actually employed makes it thoroughly disgusting.

The first portions of the washings are a yellowish glutinous stinking liquid, and this, as we have said, is passed into the rivers. If the wool is not to be dyed, or is to be removed from the premises for that purpose, or if it is to be woven before being dyed, it is dried in hot chambers of various constructions; but this part of the process is not productive of any nuisance or pollution.

Wool Dyeing.—The dyeing process is the second source of pollution from the woollen manufacture.

It would be out of place in this Report, even if it were practicable, to enter into a lengthened account of all the different processes of dyeing different colours as practised in the mills of the West Riding of Yorkshire, or even to enumerate the different materials which are employed. Every shade of colour, every form of fabric in woollen has its representative here, and it would require volumes of print to describe them even cursorily. One case, however, may be sufficient to illustrate the whole, and the best to select, because the simplest and that which leads to the greatest amount of pollution, is probably that of dyeing black goods.

It should, however, be stated that two forms of dyeing are practised which respectively produce modifications of the refuse materials.

The one is the dyeing *in the wool* (whence the goods are called *wool-dyed*), the other dyeing *in the piece*, that is to say after the cloth is woven. In this latter case the goods are called *piece* (or *stuff*) *dyed*.

We shall describe the process of dyeing in the wool.

The materials used in dyeing black, omitting indigo, are several different woods, such as logwood, barwood, camwood, peachwood, fustic, and various salts, principally copperas or sulphate of iron, alum, "argol," or crude bitartrate of potash; to these must be added, as inventions of a later date, "chrome," or bichromate of potash.

Every dyer may be said to have his own particular method of treating the wool; we do not pretend to give a description which shall be absolutely true of any one case, but in general the following may be taken as an outline of logwood-dyeing, *without* chrome.

A quantity of washed wool, say 200 lbs. is put into an iron vat or cistern holding from 700 to 1,000 gallons of acid liquid made by boiling camwood and barwood with a certain quantity of "argol" and alum; by this process, which is called "souring," a certain pink colour is given to the wool, and it is prepared for subsequent treatment by logwood. After boiling for two hours the acid liquid is let off from the bottom of the cistern by a valve or tap furnished with a grating, and the wool having been removed, the vessel is again filled up with water. Bags of logwood, reduced to the condition of sawdust, are now suspended in the liquor from a pole placed across the vat so that a clear extract may be obtained. A certain quantity of alum and argol is again added. When the soluble parts of the logwood are supposed to be dissolved in the water the bags of exhausted wood are removed, and the wool, which has been "soured" by the last process, is put into the vat. The whole is now kept at the boil for two or three hours, at the end of which time the copperas, dissolved in a small quantity of water, is added. The boiling is continued for some time longer, and, the fire being withdrawn, the whole is allowed to cool down to about 100° Fahrenheit, when the valve is opened and the waste liquid allowed to flow away.

This waste liquid is the great and chief source of pollution of the rivers, so far at least as their appearance is concerned. We shall return to it presently.

The dyed wool is now removed to a heated chamber or stove, to be dried. When dried, it is beaten or "scrabbled" in a machine, through which a current of air is made to pass so as to blow away any portion of dye-material adhering to it, and short pieces of wool unfit for weaving.

It is not proposed to describe the different mechanical treatment through which the wool is passed in the manufacture of cloth, but it is necessary to state that before it can be made into yarn it requires to be softened by being abundantly greased, and for this purpose large quantities of the finest olive oil are consumed. Another point to remember is, that in the machines there is always produced a rather large quantity of waste wool, which contains a high per-centage of oil. The cloth when made is subject to two other principal processes; one being that of "milling" or "fulling," and the other of washing.

The first of these is mechanical. Its object is by beating the cloth with heavy wooden beaters to spread out the fibres and fill up the interstices of the fabric so that its texture may become close and even; hence probably the term "fulling." This part of the process is carried on in contact with water, and soap is generally, though not always, used at the same time.

The washing process consists of passing the cloth many times through soap and water, and finally through fresh portions of water until all soluble matter is removed. The soap removes from the cloth the oil employed in working it, and all that part of the dyeing materials simply adhering to and not fixed in the cloth.

We have from this point no further interest with the cloth thus manufactured, which is dried, prepared, and sent to market.

It will be seen that the stages in the manufacture of black cloth at which liquid refuse is produced are:—

1. The washing or "scouring" of the wool.
2. The discharge of waste liquid from the dye-vats.
3. The discharge of soapy and coloured liquid from the fulling and washing process.

* See Appendix No. VI., p. lxi.

It is necessary to a proper understanding of the subject that these operations should be considered separately in some detail.

1st. It has already been stated that the wool is washed in stale urine and water, and then washed in ordinary water till the latter runs away clear. We have not found it easy to get at the exact quantities of water used in this process.

Mr. Henry Brooke, of Bradley Mills, Huddersfield, states, that about half a ton of water is used to 50 lbs. of wool in each washing, of which there are two or more; but, he adds, "there is a great difference. Some people use much more water than others."

Some returns lately made to us on this point give such divergent quantities for the water used in washing the wool that the only conclusion at which we have been able to arrive is that in all cases these quantities are very considerable.

2nd. The discharge of liquid waste from the dye-vats.

It may be taken for granted that each of the substances named as being used in dyeing black serves some purpose,—in heightening the colour, or rendering it more permanent; but essentially the black is produced by the action of the salt of iron (copperas) on the colouring matter of the logwood.

If we take a filtered infusion of logwood, and add to it a solution of sulphate of iron, a black colour is produced, and the black matter is solid and in suspension; that this is so can be seen by allowing the mixture to stand for a few hours, when the upper layers of the liquid will be entirely free from black matter. It is of the highest importance that a right understanding should be had of this subject, for upon it depends any hope that may be entertained of purifying the rivers of Yorkshire from the dye refuse. The black dyeing of wool depends upon fixing in its pores an insoluble compound of the colouring matter of logwood with iron. When the copperas is added to the boiling logwood liquid the formation of this product takes place, both in the wool and *outside of it in the liquid;* that which is formed in the wool, being insoluble, remains in the fibre, and cannot be removed by any subsequent washing.

But by far the greater part of the black precipitate is formed in the liquor itself; and it is this, and not any portion of spent dye-woods, which constitutes the blackness of the stream issuing from mills when the dye-vats are discharged.

If a quantity of the black liquid is filtered it will be found that what remains on the filter is a compound of the vegetable matter of the dye and oxide of iron; in the solution will also be found a large quantity of the salt of iron, which is used in excess.

It is difficult to form an accurate estimate of the quantity of this black suspended matter.

The results of several experiments give the quantity in 1,000 gallons at from 50 to 150 lbs. when dry.

There can be no question, as has been before mentioned, that it is to this material that the black appearance of the rivers is chiefly due. Its discharge in enormous quantities helps to silt up the stream and the mill goits. If it could be kept out of the streams they would be *comparatively* clean.

Very few attempts have been made to cleanse the dye-water before discharge into the rivers. Mr. Ripley of Bradford describes a plan adopted at his mills for arresting a portion of the dye refuse by means of subsiding reservoirs, but as he subsequently flushes out the deposit into the stream this system is simply, so far as the river is concerned, the conversion of a daily and regular into an intermittent and periodical fouling of the stream.

Mr. Townend, of Cullingworth, speaks of having very successfully dealt with dye-water by filtration through beds of ashes; but the dyeing operations at his mill are not on a large scale, and this method would not be available at many works.

It has been stated that the black dye-water will deposit and become clear on standing; but this change is very slow, and to cleanse dye-water in this way would be difficult in some cases, without extensive subsiding reservoirs.

Experiments in the laboratory prove, however, that the precipitation of black dye-water is readily practicable by chemical means. The black liquor discharged from the dye-vats is, as before said, a solution of sulphate of iron, in which insoluble dye is suspended. The addition of a little lime neutralizes the acid of the iron salt, and produces a flocculent precipitate which carries down with it the finely divided black matter. The action is rapid and complete, and in a few minutes the liquid becomes clear and nearly colourless. The quantity of lime required for the purpose does not exceed 10 lbs. to each 1,000 gallons of dye-water. The expense is therefore inconsiderable. By the use of properly constructed precipitating tanks it would be quite practicable to purify by this means the dye-water of the largest works. The clear liquid might be run off from the precipitated matter, and the latter, after draining, might be pumped or dug out of the tank, and set in heaps to drain.

The ready separation of the black dye-stuff from the water has appeared to us so important that we have taken into consideration every means by which it might be accomplished. The problem is the separation day by day of the solid matter in such form that it may be preserved, if of any value, or, if not worth preserving, be readily burnt or got rid of otherwise than by passing it into the rivers.

A form of mechanical filter which has been found very valuable in several manufactures early attracted our attention. It is a patented invention known as Needham's press, consisting of a number of narrow chambers lined with linen or calico, into which the liquid to be filtered is driven by a small force-pump. The liquid passes clear through the bags, whilst the solid portions are arrested. This action is maintained with low pressure until the chambers begin to be filled with solid residue, when it is necessary to increase the pressure. The machine is extensively used in the Potteries for the separation of clay from water in which it has been washed; it is also successfully adopted in papermaking, in breweries, and some other manufactures.

The thin mixture of clay and water known as "slip" was formerly dried on hot plates till it became fit for working. In many potteries the mixture is now pumped into Needham's machine under great pressure, and when the operation is complete the clay is taken out in solid cakes, which are strong enough to be readily handled and fit for the use of the potter.

By the kindness of Mr. Henry Brooke, and under the superintendence and at the expense of Mr. Needham, one of these presses was fitted up in the dye-house at Bradley Mills near Huddersfield, and experiments were made from day to day in the filtration of black dye. These trials were very satisfactory to us, as showing that it is perfectly practicable to separate from the dye-waste the most objectionable portion, and to discharge into the rivers a liquid comparatively pure.

The greater or less absence of colour in the filtered liquid depends upon the due adjustment of the lime, which is readily arrived at after a few trials. It is quite possible by this treatment to filter from the dye waste a liquid as bright and colourless as the water of ordinary rivers not contaminated by manufacturing refuse. On the occasion of a public exhibition of this process which was made at Bradley Mills in March and April 1867 samples of this water were taken, analysed, and found to contain in a gallon—

———	March 27.	April 4.
Organic matter - - - -	2·56	3·12
Mineral do. - - - -	32·94	34·33
Total solid contents - - -	35·50	37·45
Hardness in degrees of Clarke - -	14·4	18·60

Many waters of rivers are less pure than was this sample of chemically treated dye-water.

The machine actually employed at Bradley Mills, although only about 7 feet square by 3 feet in height, had a filtering area of 240 feet, and by it we were enabled to cleanse from 700 to 1,000 gallons of limed black dye-waste in an hour. The tank in which the dye-water was precipitated was capable of holding from 2,500 to 3,000 gallons, and was calculated for the treatment of from one to two day's discharge. Mr. Brooke considered that this tank and machine would enable him to purify all the dye-refuse produced at his mill before discharge into the river. With regard to the solid material which is found in the cloths when the machine is taken to pieces, this substance is, as has been already explained, a combination of oxide of iron and vegetable matter. It is not difficult to dispose of it when taken from the press. It is similar to damp sawdust, and may be got rid of by mixing it with small coal, and burning it under the furnaces; better still is it to allow the material to dry up (which from its light porous nature it readily does), and then to set fire to it; it burns like a slow match, without flame, but so persistently that a heap once alight will burn till all the vegetable matter is consumed. There remains, after combustion, a red powder which is almost entirely oxide of iron. It forms from ⅓th to ¼th the weight of the black stuff, and would undoubtedly find a market, either to be made into red or chocolate paint for external ironwork, or to be used in the purification of gas, or for conversion into perchloride of iron for purposes of deodorization.

It is impossible at present to say to what other purpose this black solid residue from the dye-wastes might be put. From the quantity of oxide of iron which it contains, and from its porous character, it acts, we find, as an excellent deodorizer, and would probably be eminently useful in some cases where charcoal would be employed. This peculiarity can also be taken advantage of in the treatment of the putrid scour water before mentioned. It was found impossible to filter this foul liquid in its natural state through Needham's press. When, however, a quantity of the black precipitate was mixed with it, the putrid smell was removed, and the liquid filtered became bright and colourless. In practice it is easy to take advantage of this property in the treatment of the scour-water, and thus to make one source of pollution of the river the means of counteracting another. The scour-water may be even more readily purified by mixing it with the dye-water before precipitation; but this necessitates a far larger capacity of retaining tanks.

Before leaving this part of the subject, we think it right to say, that although we are convinced by our experience of black dye-water that it is perfectly practicable to purify it, and thus greatly to improve the condition of the river, we have no intention of dictating *how* this should be done. One manufacturer may choose to have large precipitating and subsiding tanks, and to run off the clear liquor; another may filter it through ashes; a third may see his advantage in using Needham's press, or some other contrivance for the same purpose. It is our duty to recommend that any purification of the river, which we believe reasonable and practicable, should be enforced, but it is no part of that duty to specify the precise way in which that purification should be accomplished.

At the same time there are many circumstances in favour of a mechanical method of filtration of these refuse liquids, such as that of Mr. Needham's press; chief amongst which are the small amount of space necessary for working, the production of a nearly dry and manageable product, and a perfect security that no liquid shall pass unfiltered into the rivers.

We have not had the opportunity of trying the action of the centrifugal machine in filtering dye-water, but it is worth consideration.

We would wish to impress upon those who have to deal with this subject the absolute necessity of *chemically treating* the dye-water before attempting to cleanse it, whether by subsidence or filtration. The black matter is so finely divided that it is all but impossible to separate it without such treatment, except after long standing; and long standing means great capacity of tanks and consequent difficulty and expense.

In addition to this, if the dye-water be not so treated a large quantity of salt of iron will escape in solution with the water.

The addition of lime need be neither troublesome nor expensive, and its use greatly simplifies the problem of treating the refuse of dye-houses.

In dealing with the refuse of black dyeing we have only treated one branch, though a very important branch of the subject. There is of course a discharge, more or less coloured, from every kind of dyeing, and the treatment must be modified accordingly.

It would be manifestly impracticable for the dyer, especially for those who are called "public dyers," that is to say, who dye goods for manufacturers, and who are therefore called upon to dye on the same day or in the same week all shades of colours, to treat the refuse from every vat separately. In this case arrangements must be made for collecting the whole of the liquids into one, and by lime or other suitable agent obtaining the best purification possible.

It is obvious that whatever difficulty or impossibility may attend the removal of *all* impurity from the refuse liquids before discharge, it is practicable and comparatively easy to arrest all suspended matter, and to keep such matter out of the river.

All the witnesses agree that it is not so much the salts dissolved in the river water that would prevent its use by them in washing and dyeing as it is the *dirt* and matter suspended in it, and which in great measure is caused by the discharge from the dyeing and washing processes.

No solid matter from dye-works should under any pretence be allowed to pass into the streams.

There will be no want of skill on the part of manufacturers or others to meet difficulties as they arise, so soon as the prohibition is made absolute.

3rd. The third stage of refuse discharge, namely, fulling and washing dyed goods, remains to be described.

After the cloth has been woven it is subjected, as has been before stated, to a process of beating, or is passed through powerful rollers, by which the fibres are flattened out; this process is called *fulling*.

The cloth is caused to pass repeatedly through vessels containing a strong solution of soap. The combined action of the beaters and the soap causes the removal of the oil which had been applied to the wool, and of those portions of the dye which have not become permanently fixed in the fibre.

Removed to another apparatus, the cloth is now washed with an abundance of water until the last portions of soapy liquid are removed.

The liquids produced are known as the "soap waters," or "soapsuds." They vary very much in character, according to the goods which have been washed, being sometimes very black, and sometimes comparatively colourless. That portion also which is discharged from the fulling machine is much thicker and fouler than the washings, and of these the first portion is the strongest, getting less and less so till the washing is complete.

Formerly, as described by several witnesses, the whole of this soap water was discharged into the rivers, and was a source of serious pollution, causing a scum and froth, and coating with slime all objects with which it came in contact.

The large quantities of soap and oil employed, however, very naturally attracted attention to the possibility of dealing with these liquids for the extraction of grease. Mr. Teall of Wakefield stated that the extraction of grease had been carried on upon a small scale for 20 years past, his own connexion with this business dating 14 years back.

There are in the principal woollen districts persons who make a business of the extraction of grease from soapsuds. Contracts are made with millowners, by which the grease-extractor secures a right to the soap liquids, in consideration either of a fixed annual payment, or of a royalty computed on the amount of grease saved, or of the quantity of soap used in the mill. In most instances the millowner gives accommodation for the carrying on of the process, and in some cases is at the expense of the necessary tanks and other plant, as well as furnishing steam where required. For the privilege of treating the soap-waste very varying sums are paid to the mill-owner, according to the extent of his operations, and consequently of the soap and oil which he uses.

We have been told of an instance in which as much as 3,000*l*. a year was received by one millowner for the concession; but this was a very exceptional case, and the amount realized is more usually from 50*l*. to 150*l*. or 200*l*. a year.

Grease Extraction.—The process of extracting grease from soapsuds is sufficiently simple, and may be described in a few words.

The soapsuds from the fulling and washing machines are allowed to flow into a tank or tanks capable of holding all that may be produced in one or more days. In some mills the whole washings are collected; but in the larger number the flow to the tank is stopped by a simple "shuttle" or valve at a given period in the process of washing; that is, when the liquid is becoming poor and so nearly approaching to clean water that the contractor does not find it worth while to collect it for treatment.

The workman having charge of the washing process usually receives from the contractor a small gratuity to induce him to attend to this. In some cases, the power of diverting the flow is at the tanks, and within the control of the contractor's own servants. The separation of the grease is effected by the addition to the soapsuds of an acid which neutralizes its alkaline character and liberates the oily acids. Sulphuric acid is usually employed for this purpose, as being most economical, but hydrochloric acid is equally effective. The quantity of acid varies according to the material to be operated upon, but as its use constitutes a considerable proportion of the expense, it may be supposed that the grease extractor is careful to avoid any unnecessary excess.

In the majority of works the liquids are treated cold, but steam is sometimes employed, under a patent process for hastening the separation of the grease.

The addition of the acid causes a change in the appearance of the soap liquid; a portion of solid matter rises to the surface, but a quantity falls as sediment to the bottom of the tank. When the separation is considered complete, the water is run off from an opening in the tank near the bottom, but above the sediment, until the greasy matter floating on the top joins the sediment. This water flows away by the ordinary drainage channels of the mill to the rivers.

The semi-solid contents of the tanks are now taken out and placed to drain in large open bags made of cocoa-nut fibre lined with coarse canvas, and here an additional quantity of water is removed; in some cases the greasy matter is mixed with sawdust to render it portable.

The drained greasy mass is further subjected to a process of pressure and heat, which results in a crude oil, which flows into barrels, a solid cake remaining in the press. The oil is distilled for the production of refined oil, stearine, &c., with which we have no concern, and the cake is sold to manure manufacturers. In Appendix No. VI., page 62, will be found the returns made to questions which were addressed to some of the principal woollen and worsted manufacturers in the West Riding on this and other similar subjects; the following table compiled from such of the answers as could be made available* will give some idea of the value of oil and soap used by the trade, and of the royalty paid for the privilege of recovering the grease.

—		Oil.	Soap.	Both.	Royalty.
		£	£	£	
Akroyd, James & Sons	Copley	250	100	350	—
Armitage, Brothers	Huddersfield	1,460	280	1,740	80
Bates, John	Dewsbury	450	260	710	—
Barker, R. H. & Co.	Wakefield	3,000	700	3,700	100
Brooke, Jas. & Sons	Huddersfield	740	214	954	30
Brooke, John & Sons	Huddersfield	2,850	580	3,430	55
Clay, Daniel	Sowerby Bridge	3,020	480	3,500	150
Crowther, Alfred	Lockwood	4,000	600	4,600	70
Crosland, Geo. & Sons	Lockwood	2,300	700	3,000	40
Howgate, Jas. & Sons	Mirfield	3,500	1,389	4,889	55
Sugden, James Bros.	Bingley	400	520	920	80
Wormald, John	Dewsbury	8,000	1,700	9,700	130
Yewdall, David & Sons	Leeds	3,500	1,000	4,500	75
Not signed; post-mark	Bradford	1,000	2,250	3,250	100
Not signed; "	Halifax	800	1,020	1,820	150
Not signed; "	Huddersfield, Shepley	4,000	200	4,200	—
Not signed; "	Huddersfield, Honley	650	250	900	20
		39,920	12,243	52,163	1,085

From this table we learn that 17 manufacturers employ in the aggregate oil to the value of 40,000*l.*, and soap, 12,000*l.*, together 52,000*l.*; and that the amount received from the contractors for liberty to recover the grease is about 1,000*l.*, or *two per cent.* This calculation is not strictly correct, because in three of the cases no amount is paid, the grease not being extracted, but it is sufficiently so for all practical purposes.

The sums received by the manufacturers are indeed hardly worth consideration, and in some cases the cost of steam and of plant and working space has to be deducted.

As this trade of grease extraction is not confined to one firm, but is practised by many persons throughout the district, it would appear that the payments in question are the fair market value of the privilege, and that the profits are not of a nature to afford larger royalties to the manufacturer. If this be so, if the grease extractors do not realize excessive profits, what becomes of the large value which is put into the wool in the shape of actual oil and the grease in the soap?

The settlement of this question is of no slight importance: if it can be shown that the process for separation of grease is carried on in a slovenly and wasteful manner, that a large proportion of the grease is lost or injured, and that the refuse liquid which results from it is not nearly so cleansed as to satisfy the requirements of river purification, and if, further, improvements can be suggested which would be attended with greater pecuniary results as well as greater purification, it is obvious that there would be no injustice in calling upon manufacturers to adopt them.

We shall therefore as briefly as possible endeavour to trace the large sums spent in oil and soap, and see what becomes of them. For this purpose we shall select the return of Messrs. David Yewdall and Sons, Calverley Grange, Leeds.

This firm consumes annually 1,500,000 lbs. weight of wool, all of which is washed. In washing this wool they employ 28,000 lbs. of alkali and 12,000 gallons of human urine, besides a much larger quantity of urine in scouring the cloth subsequently; but our business is not now with either of these substances.

* Some of the returns are not fully made, and others are from manufacturers who do not use the ingredients we are here treating of.

In working the wool they use Gallipoli and other olive oils to the extent of 3,500*l.* which sum would represent about 58 tons of such oils.

In carding the wool 64,000 lbs. of waste is produced, which is sold to the waste dealers, who probably extract the oil and sell the residue as manure.

The goods are then washed at a cost of 1,000*l.* in soap, which amount would probably represent 33 tons of soap (at 30*l.* a ton), containing at a low estimate 11 tons (at 33 per cent.) of grease.

If the whole of the oil used and the grease of the soap were to be found in the soapsuds, it would simply rest with the skill of the extractor to recover them, but this is not quite so. In the process of carding a quantity of short wool is produced and separated.

This, which contains a large proportion of oil, is, as before stated, sold to the "waste" dealers. Messrs. Yewdall return 64,000 lbs. on 1,500,000 lbs. of wool, or $4\frac{1}{3}$ per cent., as their annual waste. Three samples were furnished for analysis by Messrs. Yewdall as representing three different qualities of this waste. When examined in the usual way they were found to contain of oil and fatty matter by weight—

No. 1.	No. 2.	No. 3.
30·53 per cent.	39·58 per cent.	43·15 per cent.

Quite recently we received three other samples of wool waste from Messrs. Yewdall who at the same time gave approximately the proportion in which these several kinds of waste were produced in their mill. The following table give these data together with the oil in the whole waste.

No.	lbs.	Oil per cent.	Total oil.
1	14·000	42·15	5,901 lbs.
2	20·000	30·79	6,158 "
3	30·000	33·05	9,915 "
			21,974

The whole quantity of waste (64,000 lbs.) contains 21,974 lbs. of oil, or 34·3 per cent.

Taking 35 per cent. as fairly representing the quantity of oily matter in the whole of the waste produced in Messrs. Yewdall's works, we find that the 64,000 lbs. of waste wool produced in the year would carry away with it 22,400 lbs. of oil or exactly 10 tons.

A further, but comparatively small quantity, of oil is accounted for as being left in the manufactured cloths as sold from the warehouses, and therefore out of the reach of the grease extractors.

The following determinations of oil in pieces of new cloth of different colours obtained from a tailor afford data for calculating the amount for which allowance is to be made under this head.

	Per cent.		Per cent.
Blue	1·27	Scarlet	1·14
Ditto	0·66	Dark Brown	0·60
Black	0·77	Chocolate	0·57
Ditto	4·32	Drab	0·56

or an average of 0·73 per cent.

Messrs. Yewdall of Leeds, also kindly furnished 18 samples of cloth, each one of a different shade of colour.

It was not thought necessary to examine these separately, but an equal weight of each was taken and the mixed sample when analyzed gave 0·76 per cent. as the proportion of oil present.

We may safely therefore consider that cloth on an average contains something like 0·75 per cent., or $7\frac{1}{2}$lbs. of oil to each 1,000 lbs. of cloth.

From statements made to us during our inquiry, it may be assumed that the weight of cloth is about half of that of the original wool used. We require therefore, to add to the quantity of oil removed in the wool waste a further amount equal to $3\frac{3}{4}$ lbs. for every 1,000 lbs. of wool used. Messrs. Yewdall use 1,500,000 lbs. of wool, and the 750,000 lbs. of cloth which they send to market must carry with it $2\frac{1}{2}$ tons of oil.

If, then, from 69 tons of oil and grease employed by Messrs. Yewdall (58 tons as olive oil and 11 tons in the soap used) we deduct $12\frac{1}{2}$ tons as the quantity removed in the waste and in the manufactured cloth, we still have $56\frac{1}{2}$ tons falling under the control of the grease extractor in the soapsuds. It rests with him to carry on his business in such a way as to recover a reasonable proportion of this grease. If he does so recover a fair proportion of this valuable material, and if the expense of the manufacture be not very great, the profits must be excessive. If, on the other hand, as we before suggested, the amount paid in royalties for the privilege of extraction is the fair market price of that privilege, and leaves only a sufficient margin for reasonable profit to the contractor, we must infer that his business is carried on in a very unsatisfactory manner, and is open to great improvements. In the particular case quoted we are unable to follow the matter further. We know that the yearly soapsuds of Messrs. Yewdall and Sons must contain nearly 60 tons of oily matter, and we know that the contractor pays to the firm 75*l.* a year for the opportunity of extracting as much of this grease as he thinks desirable. We have clear evidence that the oil extracted is worth 18*l.* or 20*l.* a ton. Supposing, therefore, that 50 out of these 60 tons were extracted, a sum of 900*l.* to 1,000*l.* would be applicable to meet costs of acid, labour, cartage, wear and tear of presses, &c., and profit upon operation. We shall immediately show that the grease extractor does not recover anything like the quantity of grease from the soapsuds which he might do, and that in a subsequent part of the operation he loses a further large proportion of that which he has separated.

Before proceeding to offer further instances of this kind it is necessary that we should state that the proportion of *waste* produced in combing and carding wool differs very greatly in different mills as shewn by the following table.

—	Wool lbs.	Waste.	Percentage.
Akroyd, James & Sons	343,000	15,000	23·8
Armitage Bros.	347,000	62,400	18·0
Bates, John	350,000	50,000	7·0
Barker, R. H. & Co.	1,000,000	35,000	3·5
Brooke, Jas. & Sons	170,000	56,000	33·0
Brooke, John & Sons	535,000	107,744	20·1
Clay, Daniel	1,117,600	132,440	11·9
Crowther, Alfred	500,000	No return	—
Crosland, Geo. & Sons	600,000	80,000	13·3
Howgate, Jas. & Sons	1,080,000	112,000	10·4
Sugden, Jonas Bros.	1,000,000	30,000	3·0
Wormald, John	3,600,000	348,000	9·7
Yewdall, David & Sons	1,500,000	64,000	4·3
Not signed; post-mark Bradford	1,440,000	48,000	3·4
Not signed; „ Halifax	2,400,000	No return	—
Not signed; „ Huddersfield, Shepley	300,160	No return	—
Not signed; „ Huddersfield, Honley	300,000	Burnt	—

It will be seen that the proportion of *waste* varies from 3 per cent. up to 33 per cent. depending no doubt in a great measure upon the quality of the wool and the nature of the fabric made. A knowledge of the proportion of *waste* is of importance to our present purpose, inasmuch as we seek to ascertain the quantity of oil in the soapsuds by the difference between that which is actually used, and that carried off in the *waste*, and the cloth.

In the following table, which extends the illustration given in the case of Messrs. Yewdall to a number of returns, we have calculated the oil in the *waste* at 35 per cent. in all cases, but it is probable that by so doing we have largely *over*-rated the oil removed, and consequently *under*-rated the quantity left in the soapsuds.

—	Oil at 60*l.*	Soap at 30*l.*	Oil in Soap at 33 per cent.	Total Oil.	Oil in Wool Waste at 35 per cent.	Oil in Cloth.	Oil in Waste and Cloth.	Oil in Soapsuds.	Value of Oil in Soapsuds at 18*l.* a Ton.	Royalty paid.
	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.	£ s.	£
Akroyd, Jas. & Sons	4¼	3¼	1	5¼	2	½	2½	2¾	49 10	—
Armitage, Bros.	24¼	9	3	27¼	9¾	½	10¼	17	306 0	80
Bates, John	7½	8½	2¾	10¼	7¾	½	8¼	2	36 0	—
Barker, R. H. & Co.	50	24	8	58	5½	1¾	7¼	50¾	913 10	100
Brooke, John & Sons	47½	19¼	6½	54	16½	1	17½	36½	657 0	55
Brooke, Jas. & Sons	12¼	7	2½	14¾	8¾	¼	9	5¾	103 10	30
Clay, Daniel	50¼	16	5¼	55½	20½	2	22½	33	594 0	150
Crosland, Geo. & Sons	38	24	8	46	12½	1	13½	32½	585 0	40
Howgate, Jas. & Sons	58	46½	15½	73½	18½	2	20½	53	954 0	55
Sugden, Jonas Bros.	6½	17	5¾	12¼	4¾	1¾	6	6¼	112 10	80
Wormald, John	140	60	20	160	55	6	61	99	1,782 0	130
Yewdall, David & Sons	58	33	11	69	10	2½	12½	56½	1,017 0	75
Not signed; postmark Bradford	16½	75	25	41½	7	2½	9½	32	576 0	100
Total	513	342	125¼	627¼	178½	21½	200¼	427	7,686 0	895

We learn that of 627 tons of oil and grease (in soap) used in thirteen mills 200 tons leave the works and warehouses in the waste wool and cloth, and 427 tons pass away in the suds. The value of this oil at 18*l.* a ton, deducting Messrs. Akroyd and Mr. Bates, whose suds are not treated, is 7,600*l.*, whilst the price which the contractors find it worth their while to give is 895*l.*, or 12 per cent.

We shall now endeavour to show how the great discrepancy in these figures is to be explained.

We have in a previous part of this Report described the method of treating the soapsuds, &c.

The quantity of acid employed will differ according to the greater or less richness of the soap water, but the following will give a fair idea of it. The Commissioners visited Mr. Lister's works at Halifax, and had an opportunity of seeing the acid added to a tank of soapsuds. The experiment was not made expressly, but came in the ordinary course of treatment.

To 3,600 cubic feet, or 22,500 gallons of soapsuds, three carboys of "brown acid" were added. This quantity of brown acid would weigh about 4 cwt., and would cost 15*s.* or 16*s.*

A sample of the liquid was taken for analysis, and was found to contain 653·4 grains of grease per gallon. According to this the whole quantity of grease in the tank was 2,350 lbs., or somewhat above a ton. To separate a ton of grease from soapsuds would therefore cost less (supposing the whole grease to be recovered) than 1*l.*, so far as the acid was concerned.

The water which is allowed to flow away from the tanks is more or less improved by the treatment to which it is subjected.

In answer to the question "Does the water from the grease process pass away clear or how nearly so?" Mr. Wormald makes no return; Messrs. Crosland say "Very dirty;" Messrs. Brooke say, "Not nearly clear at all;" Messrs. Barker say, "Nearly clear;" Messrs. Yewdall, "Very nearly;" Messrs. Armitage, "Not quite clear;" Messrs. Howgate, "Very clear," and so on.

Our own experience is not in favour of the success of this method of clearing the water. It has not been our fortune to see any instance of this process being carried out with the result of "very clear" effluent water. On the contrary, in the examples which we have seen the appearance of the liquid has not been sensibly affected by the treatment, and the water has escaped foul and objectionable.

When the liquid passes away foul and uncleansed we may take it for granted that grease is being wasted.

The following are analyses of samples of soapsuds and of refuse water from their treatment:—

—	Messrs. Rouse and Co's Mill at Bradford Wool-washing.	Soapsuds from Messrs. James Brooke & Son.	Mr. Lister's, Halifax.	Refuse Water from Grease Works. Messrs. Hamilton's, Bradford.	Refuse Water from Grease Works. Messrs. J. Smith & Co., Bradford.
Solid residue grains in a gallon	758·94	540·40	1,246·0	506·5	314·72
Fatty matter	518·7	266·20	653·4	117·0	67·9
Other organic matters	17·5	Not	—	189·1	90·3
Mineral matter	222·7	ascertained.	—	200·34	155·5

The two end columns show that grease, amounting in the one case to 68·9 grains, and in the other to 117 grains per gallon, are wasted in the cases quoted, but the table does not afford the means of calculating the proportion of the whole so lost.

By the kindness of Mr. Seed of Huddersfield we are enabled to supply this deficiency. Mr. Seed sent to the laboratory of the Commission for analysis samples from different mills where he separates grease from soap-waters. In each case a sample was taken from the tank of the soap-liquid when full and ready for addition of acid, and another sample of the liquid as discharged. The following Table shows the general character of these samples, the words "before" and "after" meaning before and after treatment for separation of grease:—

—	Mineral. Grains per Gallon.		Organic. Grains per Gallon.		Total. Grains per Gallon.		Grease. Grains per Gallon.		Grease separated.	Percentage of grease separated.	Percentage of grease lost.
	Before.	After.	Before.	After.	Before.	After.	Before.	After.			
Greenwood & Hansons	530·32	304·50	1204·21	282·80	1734·53	587·3	1099·56	193·76	905·8	82·4	17·6
Broadbent - -	103·27	223·30	261·43	284·62	364·70	507·92	220·64	176·96	43·68	19·8	80·2
Schofield . -	122·50	220·85	430·36	318·71	552·86	539·56	365·23	61·60	303·63	83·4	16·6
Mellor - - -	215·25	243·25	906·85	791·35	1122·10	1034·6	790·20	393·85	396·35	50·2	49·8
Shaw - - -	82·32	185·5	436·24	387·80	518·56	573·3	397·74	271·74	126·00	31·8	68·2

The two last columns show the percentage of grease recovered and lost. In no case is more than 83 per cent. of the grease obtained, which, however, is a fair success; but on the other hand, in one instance, half the grease is lost, in another nearly 70 per cent., and in another 80 per cent.

We have no reason to believe that Mr. Seed is less successful in the treatment of the soapsuds than other contractors, although it is probable that where heat is employed the separation is more effectual, and the inference is plain that the grease process, as practised, does not recover half the oily matter present in the soapsuds, and which might be recovered by a more perfect process.

But the loss of material suffered by the grease contractor does not end with the acidifying process. We have mentioned that the "magma," or thick greasy extract from the soap waters is carted from the mills to the premises of the contractor, where the oil is separated from the dirt. For this purpose coarse cloths are filled in a frame with perhaps 10 or 15 lbs. of the material, and are then placed one above the other with intervening sheets of iron in a screw press. This press is in the form of a cupboard, with a door closing the front. When the press is charged steam is thrown into it; the screw which works by a handle above and outside the case is turned from time to time till the oil ceases to flow. When this period is reached, the press is opened and the cloths containing the residue in the form of cakes are removed.

We have not the data for calculating what weight of this residual cake is produced in relation to a given quantity of oil, but it is certainly very considerable—heaps of the material of a great many tons in weight will be seen lying on the premises of the grease contractor. Samples of this cake have been examined to ascertain how much fatty matter was left after the action of the press.

The following is the result of such examination of three samples from Mr. Seed:—

	Per cent.
No. 1 fatty matter - - - - - -	28·89
No. 2 " - - - - - -	17·16
No. 3 " - - - - - -	18·01

Mr. Seed employs sawdust to help to dry up and render portable the greasy matter left in the precipitating tanks after the water has been run off. This sawdust would of course retain a good deal of the oil which would otherwise be separated from the cake by pressure, but under any circumstances this method of extracting could never remove the whole of the oil.

The cake is sold for manure, and is said to be very fertilizing. The following general analysis of a sample of it may not be without interest:

Moisture - - - - - -	24·42
Fatty matter - - - - - -	17·16
Other organic matter - - - - -	42·86
Mineral matter - - - - - -	15·56
	100·00

The organic matter contains nitrogen 3·34 equal to ammonia 4·0 per cent. of the cake. It is probable that to this nitrogen is chiefly to be ascribed the fertilizing action of the cake, and that the removal of the oil would not diminish its agricultural value. The mineral matter is principally mud and dirt of no value as manure.

The oil which flows from the presses is thick and nearly black; it is we understand usually sold by the smaller grease contractors to firms like Messrs. Teall Lepaige

and Co., of Wakefield, who distil it and obtain light coloured oils, stearine, &c. in a fit state for the market.

It must not be forgotten that the oil which is used in the manufacture of the cloth is bright nearly colourless olive oil, worth 60*l.* a ton, and that the grease which is recovered is black and turbid and worth less than 20*l.* a ton. Here in itself is a loss equal to two-thirds of all the money which is spent upon oil and soap in the West Riding of Yorkshire. It is probable that discolouration of the oil is to a certain extent due to the colouring matters of the dye stuffs, and is not preventible, but we incline to the opinion that some part of the injury is caused by the sulphuric acid aided by heat in the process of pressing.

Having shown that the grease extraction as at present practised is unsatisfactory in the extreme, we would beg to offer some suggestions for its improvement, founded on scientific and practical knowledge of the subject, which may have the double advantage of effecting important economies and of purifying the soap water before discharge into the rivers. It will be understood that there are in the soapsuds two forms of oil or grease; the oily matter united with alkali to form soap, and the free or uncombined oil which has been put to the wool and is removed in the fulling and washing process. Part of this oil may be combined in the washing process with soap, but the greater part is really present as oil in a high state of subdivision, similar to what doctors call an "emulsion." However this may be it will be evident that the addition of sulphuric acid has for its object the decomposition of the soap which occurs by the union of the acid with the potash or soda of the soap, and the separation of the oily acids from their combination with the alkali. After treatment with the acid we have therefore no longer any soap present; instead of it we have sulphate of soda or potash (according as hard or soft soap has been used) and the fatty matter both of the soap and the oil liberated. The fatty matter of this soap being lighter than water rises to the surface, carrying with it some of the oil which is distributed through the liquid. In the cold liquid this action would be anything but perfect, and we can readily understand how great advantage is gained by the employment of heat introduced and patented by Messrs. Teall & Co.

But the action of acid is not the only method by which this decomposition of the soap and separation of the grease could be effected; for the soda of the soap it is possible to substitute other bases, such as lime or oxide of iron, and the lime or iron soap so produced is insoluble. We believe that lime has been proposed, if not used, as a means of treating the soapsuds, but we have not heard that salts of iron have been thought of. If lime were employed it would be in the state of burnt lime, made into a thin paste with water, known as "milk of lime." We have made repeated trials of lime in the laboratory, and can speak very favourably of its action. When added judiciously and without excess, it causes a ready separation of the soapsuds into clot and clear liquid, and the action is greatly aided by the addition of a small quantity of alum. One of the witnesses at Huddersfield (Mr. Seed) spoke of alum having been used in conjunction with acid, but this would obviously be an improper employment of it, as the clearing action would depend upon the neutralization of its acid by an alkali.

The "magma" separated from the soapsuds by lime would not be greasy; it would be, as we before said, an insoluble soap. The liquid flowing away would be *alkaline* from free *soda*, not acid as it is by the present method; indeed the rivers would be doubly benefited by the discharge of clear instead of foul liquid, and soft water instead of water laden with salts. The insoluble lime compound would require to be decomposed by acid subsequently, but this would be done by the extractor at his works, and under favourable circumstances, and the sulphate of lime produced would not need to pass to the rivers.

The use of salts of iron for cleansing the soapsuds might prove equally beneficial. Perchloride of iron in solution, added to the soap waters, produces a ready separation of the fatty matters and a clear liquor for discharge. Sulphate of iron or "green copperas," which is largely used in the dyeing of black goods, is also available for this purpose. The iron-soap produced would be subsequently decomposed by sulphuric acid and the iron recovered as sulphate of iron for further use.

It might indeed be practicable, where black dyeing is carried on, to employ the dye water as a means of coagulating the soapsuds and separating the oil and grease, or if this should not answer, on account of the solid black matter of the dye interfering with the subsequent extraction of the oil, or injuring it in any way, the liquid of the dye waste filtered without the addition of lime, and therefore containing as we have shown much sulphate of iron in solution, might be employed with advantage.

So far we have mentioned some of the chemical agents by which the soap liquids may be treated. No doubt others may be found equally efficacious and will commend themselves for employment in particular circumstances. Then as to the system of discharging the liquid after the addition of the acid or other chemical agent; at present the great bulk of the liquid is run off without filtration, and it is only the thick stuff from the bottom of the tanks which is thrown on a coarse filter as before described and that not in all cases. But it is worthy of note that where this method of drainage is practised, the water runs away bright and comparatively unobjectionable. Of this fact we have proof in repeated personal observation as well as in the evidence of witnesses. What then is to prevent the *whole* liquid being made to pass through a filter before discharge into the streams? And might not some mechanical arrangement, such as the press of Mr. Needham, be advantageously used for this purpose? There is still another point to which the grease collector's attention should be directed, namely, the ultimate separation of the crude oil from the mass collected from the tanks. We have before stated that much of the colour and thickness of the expressed oil is due to the action of sulphuric acid in the process. Where the suds are treated cold it is probable that this injury occurs in great part in the press, which is heated by steam. To remedy this the greasy mass should previously be abundantly washed with water just warm enough to melt it; in this way the last portions of acid would be removed. Where steam is used to heat the soap water during the acidifying process, some small part of the mischief may occur at this point, and the employment of muriatic instead of sulphuric acid, would be preferable.

But it is questionable whether this system of expression of the oil is in any form the proper one to be adopted. We have shown that even after he has been at the expense of separating the greasy material, the extractor sacrifices a large but as yet undetermined proportion of his product in the grease-cake which is the residue from the press, and although this cake is sold for manure, at say 2*l*. or 3*l*. per ton, it is clear that no adequate return is thus obtained for the 20 or 30 per cent. of oil which it contains, and which would be worth 18*l*. a ton if recovered.

We would here suggest the possibility of employing bisulphide of carbon to extract the oil from this cake, or, better still, to extract the oil from the whole material without use of the press.

The use of this substance is sufficiently familiar to those persons in Yorkshire and elsewhere who are engaged in the recovery of oil from waste wool, and we do not see why it should be inapplicable to the purpose in hand.

With whatever results its employment in the case of waste wool may have been attended, and of this we are not in a position to speak, we learn that in France it is most successfully used in the very case for which it is now suggested, that is to say, in the recovery of grease from soap used in washing silk.

It is stated that "very large quantities of the sulphuret of carbon, the price of which "has fallen from one guinea per lb., which it was in 1847, to about three halfpence "per lb. for which it can at present be obtained, are used in France for this purpose. "Upwards of 50,000 tons of soap used in the silk manufacture were formerly "allowed to pass off to waste into the Rhone; most of this is now recovered to be "again employed in manufacture." It will of course be understood that it is the grease of this soap, and not the soap itself, which is so recovered.

There surely can be no reason either in the price of the chemical agent used or in other conditions peculiar to the case before us, why a similar process should not be introduced with advantage in the woollen districts of this country.

Before quitting the subject of this grease recovery a few general remarks may not be out of place. It has been shown, though perhaps less forcibly than it might have been by further experiments, that the treatment of the soap waters is far from satisfactory either as a measure of economy or as a means of preventing pollution of the rivers at present suffering from the woollen manufacture. Whatever may be the failing of the line of argument we have adopted, we certainly have not erred in the direction of excess in estimating the amount and value of material which *might be* but at present *is not* recovered from the water with which the goods are washed, and which is now wasted to the great detriment of the neighbouring streams.

The table (page 30) shows that 17 manufacturers dealing in the aggregate with 16,500,000 lbs. of wool use oil to the value of 40,000*l*. and soap 12,000*l*., together 52,000*l*. a year or at the rate of 3,000*l*. sterling for each million lbs. of wool.

Adopting this figure and applying it in a calculation of the cost of oil and soap used in the whole woollen and worsted manufacture of Great Britain, we have the following startling results. Mr. Behrens gives as the total wool worked, 384,000,000 of lbs., which at 3,000*l*. of oil and soap for each million, gives 1,152,000*l*. as the consumption of these materials in the wool trade; and taking the West Riding at two-thirds of the entire trade at least 750,000*l*. or 800,000*l*. may be set down as annually spent on these items in that district. Mr. Teall in his evidence speaks of 100,000*l*. worth of grease actually recovered and an equal amount recoverable in Yorkshire, but his estimate is obviously too modest; it is fair to say, however, that this gentleman did not include the small mills, at which, in his opinion, it would not be worth while to adopt any process of recovery; and of the 3,000 odd mills* distributed through the valleys of the Aire and Calder, a great proportion are, no doubt, on a comparatively small scale.

This Commission cannot, however, be expected to view the matter with the eyes or from the point of view of grease contractors. We have no quarrel with these gentlemen, and no intention to say one word in their disparagement collectively or as individuals, but our duty is with the rivers. Small mills which may not be worth the contractor's attention are probably in the agregate guilty of more pollution than the larger ones. It is with the owners and occupiers of mills great and small that the responsibility of discharging foul liquid rests, and the public will naturally look to them and not to their agents for redress.

The entire question of dealing with the soap waste must be met on the part of manufacturers in an earnest and intelligent spirit, and we do not doubt that, with the appliances which science offers, and of which the millowners of Yorkshire have shown themselves well able to take advantage in other respects, so large an economy may be secured that abundant funds will be forthcoming to deal with the other causes of pollution, such as dye and scour water, till such time as these in their turn become, as they surely will, a source of profit instead of a nuisance and a disgrace.

Tanneries.—In our first report we called attention to the necessity of preventing the pollution of the river Thames by the refuse of tanyards, and in the subsequent legislation by Parliament for the better conservancy of the river this question was included; but tanning on the Thames or on other rivers is unimportant as compared to that of which we received evidence at Leeds. Mr. Nickols, proprietor of the Joppa and Bramley tanyards, stated, as the result of information furnished at a meeting of the principal members of the trade, that as many as 2,750,000 hides were annually converted into leather in Leeds and the neighbourhood. The greater bulk of these hides were foreign—chiefly East Indian. These hides are, before shipment for this country, highly salted to prevent putrefaction, and before they can be subjected to the ordinary tanning process this salt must be removed. Hence arises an additional form of pollution requiring special notice.

It is not necessary that we should enter again at any length on this subject. The process of tanning at Leeds (with the exception just mentioned) does not in any respect differ from that usually practised, but the magnitude of the local trade, and the extensive pollution consequent upon it, demand some short notice.

At the Joppa tannery in Leeds Mr. Nickols tans about 12,000 skins of all kinds per week, and he uses 120,000 gallons of water in the same time; but a large portion of this quantity is consumed in the washing of sheepskins, of which 4,000 or 5,000 pass through the works every week. The water from the sheepskins is very foul and dirty; it runs direct into the river.

To remove the salt from East Indian hides, 100 or 120 of them are put into a tank with from 700 to 1,000 gallons of water; after soaking for a day or two, the brine produced is run off, and fresh water is let into the tank several times in succession until the salt is washed out.

A sample of the first soaking was analysed, with the following results:

Total solid residue in an imperial gallon	-	692 grains.
Containing organic matter - -	-	74 „
„ common salt - -	-	549 „

The organic matter contained nitrogen 13·66 grains per gallon.

It is here seen that each gallon of water has dissolved from the hides 550 grains of salt, and 1,000 gallons would at the same rate contain about 80lbs. of salt. Mr. Nickols stated that about 4lbs. of salt is required in salting a hide, in which case a very large portion must remain to be removed by the subsequent washing.

Taking the quantity of salt as determined by this analysis at about 1lb. per hide, which is only one-fourth that which is said to be used in salting, we have an enormous quantity discharged into the river in the course of the year.

* See Appendix No. X. p. lxxxi.

Before discussing the question of disposal of this salt liquid, a few words may be said in regard to the other waste matters of the tanneries. Before the hides or skins, whether English or foreign, can be converted into leather, it is necessary to remove the hair. For this purpose they are soaked in tanks with a mixture of lime and water to swell the skin and loosen the hair, which is subsequently scraped off.

From the evidence before quoted we learn that the water is never run off from these pits; but once or twice in the week water is added to make up for that brought out by the skins, which is considerable. The lime itself, when exhausted, is dug out from time to time and carted away for manure.

Now, although this lime liquor is not absolutely run out into the drains or the river, it is certain that little by little it is brought out with the skins on to the pavement on which the hides are scraped, and thus finds its way to these outlets. And it is not only the liquid which is so removed, but a large quantity of the solid matter which is necessarily stirred up by the removal of the hides.

A sample taken from one of these tanks gave the following results upon analysis:

Total solid residue per gallon	2,016	grains.
Containing organic matter	748	„
„ hydrate of lime	358	„
„ carbonate of lime	119	„

The organic matter contained 147½ grains of nitrogen.

The hair scraped from the hides is sold to the carpet and cheap blanket ("for workhouses") manufacturers, and the very short hair for manure; the fatty matter and skin go to the glue makers.

The hides and skins prepared by the two previous processes are converted into leather by being brought in contact with a variety of substances, which we need not enumerate.

The liquid in these tanks is very valuable, and every care is taken to prevent its being wasted; very little, therefore, finds its way to the river, except upon the rare occasion when the tanks are emptied. The spent bark and solid waste from other tanning materials is usually burned or otherwise disposed of without recourse to the rivers.

The following is an analysis of the liquid running from a spent tanpit at Bramley Hall, near Leeds:

Total solid residue per gallon	1,442	grains.
Organic matter	916	„
Chloride of sodium (common salt)	54	„

The organic matter contained 10½ grains of nitrogen.

Very few words need be said about the disposal of these three forms of refuse. Outside the tanning community itself, from whom we have no right to ask an unfavourable verdict, there can be but one opinion, which is that the refuse matters from a tanyard are disgusting in a high degree, and should on no account be allowed to pass into rivers.

On the other hand, their composition is favourable to the expectation that they would be very beneficial to growing crops.

Mr. Nickols, to whom we are indebted for much valuable information, has (amongst others) shown the practical use of these liquids in agriculture by experiments on his own land. The chief difficulty Mr. Nickols experienced was that he had not land enough for the proper distribution of the whole refuse liquid of his tanyard, and that the liquid from the hide-soaking tank was too strong. It is readily conceivable that a quantity of salt so great as that shown by the analysis would be destructive to vegetation unless the liquid were largely diluted.

In Leeds, and other similar towns, the disposal of the refuse of tanyards will naturally be into the sewers, and so on to land; and when this cannot be accomplished, arrangements must be made for its direct application after sufficient dilution.

Mr. Nickols told the Commissioners that if the tanners of Leeds were deprived of an outlet for their refuse waters, "it would shut up the entire trade, and throw perhaps 20,000 people out of bread."

Such a contingency we cannot, of course, contemplate for an instant; but we believe that the pollution of the river, which is undoubtedly very considerable, from tanning refuse may be prevented without injury to this very important industry.

Ochrey Water.—The water flowing from old coal-workings frequently contains much iron, which is extremely injurious to manufactures when it is brought down in any quantity to the mills.

Evidence was given at Huddersfield of mischief to the extent of thousands of pounds caused by a sudden influx of such water into the Colne and the Holme. This "ochrey" water contains oxide of iron in a soluble state, but the solution rapidly changes by exposure to air, and the iron is deposited as a yellow mud precisely similar to that which is formed from ordinary chalybeate waters and in the little streams flowing from peaty ground (as at the bottom of the embankment of the Redbrook reservoir at Standedge, near Huddersfield). To get rid of this iron nothing more is necessary than to cause the water escaping from the old coal-workings to traverse shallow pools or canals (made tortuous, if necessary, to economize space), so that the current may be arrested and the water freely exposed to the air. In these circumstances rapid and complete separation of the oxide of iron takes place; and this, when dug out from time to time, and allowed to dry, would find a market, and probably more than pay for the small expense incurred in arresting it from passing into the rivers to their injury for manufacturing purposes.

SPECIAL CONDITION OF PRINCIPAL TOWNS VISITED.

The following remarks are the substance of our observation of the individual condition of the towns we visited and the pollutions caused by them to the rivers on which they stand. Skipton is the town situated highest on the river Aire. The population is about 5,000; the rateable value about 9,000*l.* There is a local Board of Health, and waterworks for the supply of the inhabitants. The district is partially sewered and drained. Out of 1,100 houses some 300 have waterclosets; in all other cases there are privies and cesspits. At some of the factories the excreta of the workpeople is intercepted and is regularly carted away to the land. The town sewage is discharged into a stream, the dry weather volume of subsoil water and sewage being about 200,000 gallons per day; mixed and diluted in Ellar Beck with three or four times this volume of water, the whole falls into the river Aire. Cesspits are emptied from time to time, and the refuse is removed to the land for agricultural uses. Dyeworks, slaughterhouses, tan and lime works, paper mills, and the factories in the district, all discharge the fluid refuse produced into the nearest water-course, sewer, or drain, so that the volume flows into and down the river. There are water-wheels on the "*becks*" and small reservoirs or "*dams*" connected with the cotton factories. The sewage in dry weather is the cause of great nuisance at the water-wheels, and the foul sediment in the dams when flushed out "stinks awful." River improvements have been carried out near Skipton, which are fully described in the evidence, by Mr. Fenwick of Leeds.

Keighley is situate below Skipton and Bingley, on the "*North Beck*," which falls into the river Aire. There is a local Board of Health, and there are public waterworks. The population of Keighley is about 20,000. It has grown rapidly and is increasing, manufactories having recently been extended here. The principal business was worsted spinning and manufacturing; now there is a considerable trade in machine-making, such as spinning machinery for worsted, power looms, washing machines, castings in iron, and tool manufacture. There are 57 mills, large and small, on North Beck, Sladen Beck, Bridgehouse Beck, and the Worth paper mill power has been largely increased of late, and is at this time being further increased. The town has been partially sewered and drained, the fluid refuse flowing into the Worth and Aire. Until recently, solid refuse and furnace ashes from steam boilers were thrown into the natural water-courses flowing through the town, and were consequently swept down the river Aire. The sewage in dry weather is the cause of great nuisance at the water-wheels, and the workmen have frequently been obliged to leave the mills sick.

The amount of solids thrown into the North Beck and the Worth, such as material excavated from foundations, road scrapings, ashes from steam boilers, and other solids, has raised the beds of the streams within 30 years from three to four feet, choking the outlets of drains and sewers, and causing injurious floodings to adjoining lands. Gravel and sand are occasionally washed down by floods, which also tend to raise the bed of the river. Since the establishment of a local Board of Health, throwing ashes and other solids into the streams has been forbidden, but the law is evaded by many and openly defied by some; soapsuds are allowed to flow into the river, which in summer ferment and give off large volumes of foul gases. Local disease is imputed to this form of pollution.

Bingley is situate on the river Aire about four miles below Keighley, the town containing about 6,000 inhabitants; the parish about 10,000. The town is governed under the powers of a private Act of Parliament by Commissioners having a property qualification. There are 30 at present. Elections of commissioners do not take place by the ratepayers. Harden Beck flows through a portion of the town into the river Aire. Solids are thrown into the beck and into the river by the inhabitants. Refuse from mills and factories, as also sewage, flows in. Most of the sewage goes direct into the river Aire. There are privies and cesspits to most of the houses; waterclosets are exceptional.

Bradford is an ancient town, situated on a "beck," about four miles south of the river Aire, into which the water of this beck falls near Shipley. Bradford Beck flows down through the centre of the town. The area of the watershed at the lower part of the borough boundary is about 11,000 acres, and at its junction with the river Aire at Shipley the drainage area is 14,660 acres. The borough was incorporated 9th June 1847, and in 1841 contained a population of 66,000; in 1851, 103,000; in 1861, 106,000. The township of Bradford in 1801 contained a population of 6,393; in 1811, 7,767; in 1821, 13,064; in 1831, 23,223; in 1841, 34,560; in 1851, 52,493; in 1861, 48,646. During the time the population seemed to retrograde local trade was largely increasing, as is shown by returns made to the Board of Trade. Bradford is the centre of the worsted district, and, according to the returns of exports from that district, the value of the goods was, in the year 1862, about 9,750,000*l.*; in 1863, 13,250,000*l.*; in 1864, 16,250,000*l.*; in 1865, 18,750,000*l.*; and in 1866 they possibly reached 20,000,000*l.*, so rapidly is the trade of the district increasing, owing to the introduction of improved machinery, so that the producing power of the manufacturers has increased more rapidly than the population. The contamination of the streams has increased rather according to the growth of the trade than with the increase of local population. There is increased pollution from dyeworks, from soapsuds, and from refuse of various kinds produced in manufactures. The whole of the sewage of Bradford, and of the populous district above the town flows into the beck, producing an indescribable state of pollution. It has become a Yorkshire proverb of comparison for any foul stream to say of it that it is as polluted as Bradford Beck. At the time of our inquiry Bradford Beck was the source of supply to the Bradford Canal, the fluid in which became so corrupt in summer that large volumes of inflammable gases were given off, and although it has usually been considered an impossible feat to "set the River Thames on fire" it was found practicable to set the Bradford Canal on fire, as this at times formed part of the amusement of boys in the neighbourhood. They struck a match placed on the end of a stick, reached over, and set the canal on fire, the flame rising six feet high and running along the surface of the water for many yards, like a will-o'-the-wisp; canal boats have been so enveloped in flame as to frighten persons on board. Bradford Beck, like other streams in the West Riding on which population has grown up and manufactures have been established, has been choked with solids and polluted with fluid refuse, waste dyewater, soapsuds, and sewage. Throwing in of solids has been prohibited in the town, but on inspection it is evident to sight that any municipal rules to this effect are broken. At some of the large mills mounds of cinders from the steam boilers are placed against walls bounding the beck, evidently to fall or be washed in by rain, and in some instances trap-doors are suspiciously handy for the admission of such ashes into the beck. Although there is a preventive power within the borough, this does not extend beyond, and, consequently, solids, including furnace ashes, are systematically thrown into the tributaries of Bradford Beck.

Leeds is situated on the river Aire. There are tributaries flowing through the town; these are Sheepscar Beck, Holbeck, Benyonbeck, Balmbeck, and Dow Beck. In the year 1080 Leeds was a farming village, having a population of about 300. Bede, in 735, calls Leeds Levdys; in Domesday survey it is Leedes. The population of Leeds at present is about 228,000, the rateable value was 593,779*l.* in 1865, and is rapidly increasing. The parliamentary and municipal areas are coextensive. There are 15 townships within this area, and until the year 1866 each township exercised independent jurisdiction over highways, roads, and drains. The local municipal government has, however, been consolidated.

The principal trades now carried on in Leeds are, in manufactures, woollen, worsted, linen, flax, and silk. There are cloth dressers, large dyers, waste and mungo dealers, and the most extensive tanneries in Great Britain. Many tanneries are situate in a district called Joppa. There are paper mills, oil mills, corn mills, saw mills, chemical works, and glue works, bone mills, iron workers, wire grinders, machine makers, and most extensive iron and steel works. The worsted trade has of late years declined in Leeds.

Up to the year 1841 Leeds was partially supplied with water for domestic uses from the river Aire, being pumped by steam-power from near Leeds Bridge. This source became so polluted that the works were abandoned, and at present water is taken from the Wharfe; but a great extension of the Leeds water supply is under consideration from the district on the Washbourne, where water of a fine and pure character may be obtained from the millstone grit formation.

Leeds has been partially sewered and drained, the entire volume of sewage, solids and fluids (from 7,000,000 to 12,000,000 gallons per day) being turned into the river Aire above Thorpe Hall pastures, creating a great nuisance.

The whole of the becks flowing through the town are fouled with waste refuse from dyeworks, tanneries, and the various other manufactures, from their source beyond the municipal boundaries to the Aire, which river is also polluted along both margins. Carcasses of dead animals float down until intercepted by shoals and banks, where they remain to become putrid and most offensive. No adequate form of water conservancy is exercised either within or beyond the area of the borough. As the population of Leeds has increased, and manufactures have been extended, the local death rate has risen, until the town is ranked by the Registrar-General amongst the most unhealthy of Great Britain. In the township of Leeds the death rate from 1851 to 1860 was 28 per 1,000, and from 1860 to 1864 was 29·5 per 1,000.

At the skinneries and tanneries portions of the waste materials are utilized. Hair from hides is sold for the manufacture of carpets and cheap blankets; that which will not serve such purpose is sold for manure. The parings and fatty matter cut and scraped from the hides is sold for glue-making. Spent bark is carted away, or is burned in steam-boiler furnaces. An attempt has been made to irrigate grass land with the fluid refuse from tanpits near Leeds, but it appears to have been used in a state too strong, as some of the grass was injured. Sewage from a town or from a manure tank will kill vegetation, as will guano and other manures if applied in too great strength. Manures of any kind must be applied to land under proper conditions if the full benefits they are capable of giving are to be obtained. The site on which Leeds stands is flat on both sides of the river Aire, and also on the margins of some of the tributary becks, but middle and higher portions of the town are on sloping ground, affording good surface gradients. This natural advantage to the free flow of sewage of a quick gradient has been made a disadvantage by constructing sewers and drains having no adequate provision for full and constant ventilation. The houses in the older parts of the town are built in narrow streets and close courts, having common privies, and cesspits crowded in amongst the cottages; in upwards of one thousand instances parts of cottages (bedrooms) are placed over such foul receptacles of putrid matter. It is these mal-arrangements, in conjunction with stream and river pollutions, defective ventilation of sewers and drains, and defective river scavenging, which cause the mortality in Leeds to be so large. There are about 45,000 houses within the borough, and 12,000 privies and cesspits, besides waterclosets, of which there may be 4,000 or 5,000 at present in use. Storing human excreta in cesspits close to houses until the mass becomes putrid is one of the prime causes of preventible disease. Such cesspits are emptied at great cost in money, but they are never cleansed. The bottom and sides are saturated with the taint of rottenness, so that during summer an empty cesspit may cause more injury than when full. Typhus fever is one of the most fatal diseases of operatives, and is also most costly to the community. A labouring man in the prime of life, when killed by typhus fever, generated and intensified by filth allowed to accumulate near his dwelling, beneath his bedroom, in pigsties, in unventilated sewers and drains, or in polluted rivers, leaves his widow and children an abiding burden on the parish. This problem may be worked out stage by stage to the clearest demonstration in hundreds of instances. The privies and ashpits are said to be cleansed betwixt 10 o'clock at night and 7 o'clock in the morning, when the "stench" in the locality under such operation is described as "fearful." About 55,000 tons of such refuse is removed each year, at a gross cost of 7,000*l.*, and an actual loss of about 4,000*l.* The foul state of the becks and river Aire may be inferred by the number of carcasses of pigs, dogs, cats, &c., having been removed to the extent of fifty in a a day; but it must not be inferred that these carcasses are removed with any degree of regularity. Pollutions in Leeds may be placed in the following order as indicating their injurious effects on health:—Polluted subsoil and atmosphere by cesspits and pigsties, polluted water-courses from manufactures, and fouling of becks, river, and atmosphere by defective sewerage and deficient sewer ventilation; these nuisances may be mitigated by improved works and better regulations, so as to reduce the local sickness and materially lessen the annual death rate. The property in Leeds and the trade of Leeds may be fairly called upon to contribute by a small rate to pay for the necessary establishment charges, but they now pay a tax in the form of poor's rates and charities more than would be required to establish and continue preventive measures. The misery suffered by sickness, and the loss in wages to workmen, if fairly valued, would show that they and their families lose more by neglect of proper sanitary regulations than they would have to pay in money judiciously expended on sanitary rates for proper regulations and efficient works.

Todmorden is situated at the head of the river Calder, which rises at the base of the range of mountains dividing Yorkshire and Lancashire. Millstone grit forms the dividing ridge, and prevails down to the coal formation, which crops out at Halifax and Huddersfield. The mountains range from 1,200 feet up to 1,500 feet elevation, the average rainfall in the district being about 50 inches, in a dry year falling as low as 34 inches; in a wet year reaching up to 67 or 70 inches. The population of Todmorden was in 1801, 2,513, and at the census of 1861, 9,146. The principal trade carried on is cotton manufacture.

A great abuse of the river Calder takes place at Todmorden by general neglect and by throwing in ashes, road scrapings and other solids. The river water is also polluted by sewage, privy refuse, and by fouled water passed in from the several mills. The stream has been partially embanked, but so inefficiently that some portion of such banks usually give way during floods, causing heavy losses to manufacturers and work-people. The mills, machinery, and goods of the manufacturers are injured, and the working people are deprived of employment and wages during the intervals of restoration and repairs. The site on which the town stands is a tolerably level space of land several hundred feet above the sea. The river winds over this ground, and has been raised in its bed, partially by the action of rain-flood waters washing gravel sand and silt from the mountains, and partially by the inhabitants and manufacturers throwing in solids, such as road scrapings, steam-boiler ashes, and the ordinary rubbish common to a town population. There are also mills and weirs which pond the water at certain points; and road bridges have been constructed so low as to impede and back up flood waters, thus adding to the mischief and loss which occurs. At page 398 of the Evidence, a woodcut cross section is given of the river, showing its weak embankments, the relative level of the adjoining turnpike road, of the land, and also of the former bed of the river; the ordinary water line and the flood line to which the water rose on the 16th November 1866 has been added. Our local inquiry was made on the 19th of November, or three days after the flood of the 16th. We inspected the houses in the district, and found that the basements of large mills, containing carding machines and power looms, had been flooded so as to injure much of the partially manufactured goods and utterly to ruin portions of the machinery. Many cottages had been flooded to a depth of several inches, causing great discomfort to the inhabitants.

Some of the manufacturers do not throw their steam-furnace ashes into the river, but have them carted away. Others having always got rid of their ashes (to the extent of several hundred tons per annum) by throwing them into the stream, consider that they have acquired a prescriptive right to do so, which they will defend at law against any objecting manufacturer or riparian owner situated below; but here as elsewhere a prohibition against river abuse by solids and pollution by fluids exercised under Parliamentary river conservancy powers would obtain willing obedience from all parties.

Halifax is a corporate and parliamentary borough, having a population of 56,000 and a rateable value of 165,000*l*. The town is situated on the river Hebble, which is a tributary of the river Calder. The average rainfall is about 36 inches. It is one of the chief seats in the West Riding of the woollen and worsted manufactures. Millstone grit forms the stratification from the western dividing ridge of mountains down to the edge of the coal-field at Halifax. The town is built on ground sloping up from the river Hebble on both sides. Good building stone is obtained from quarries in the locality.

The corporation is proprietor of waterworks, consisting of extensive storage reservoirs, situate above the town: the water is of good quality. There are about 11,500 houses and some 960 waterclosets and 5,000 or 6,000 privies and cesspits. Main sewers have been constructed at a cost of 65,000*l*. The sewers pass the sewage into the Hebble, and so on into the Calder. Much solid refuse is thrown or is washed into the river within the borough, although there is a municipal bye-law against this form of abuse, but beyond and above the borough there is no local control.

The main sewers in Halifax had not been ventilated to such an extent as is necessary, neither had all the houses been drained. From these and from other sanitary defects there was a local death rate in 1861 of 34 per 1,000; by improved

management this has since been reduced to 24 per 1,000. At some large mills the privies are so arranged that the solid falls into receptacles specially provided, and is carted away at intervals to be applied for agricultural uses to land. This practice is not general, but may be made so with advantage.

The several large manufactures, both in Halifax and on the streams above the town, pollute the waters by fluid refuse from washing, scouring, and dyeing. Complaints are made as to special pollutions, but the law is powerless as it exists at present. Special nuisances may be proceeded against by indictment if they can be proved injurious to health, but the onus of such proof must be taken by the prosecutor, and as there is no independent tribunal empowered to provide, enforce, and levy rates to pay for works of prevention, the evil goes on unchecked and accumulating. The streams flowing into and through Halifax are polluted in proportion to the extent of local manufactures, and if no precautionary measures are taken to prevent or to diminish pollution, it will go on increasing with the growth of local trade. The great manufacturers experience the evils of river pollution to which they contribute, and foresee some of the inevitable consequences to which such pollution must ultimately lead, and are willing to aid in carrying out any well-devised remedy. Local association for prevention of abuse and pollution of the streams has been tried and has failed in Halifax.

Huddersfield is one of the principal seats of woollen manufacture. It is situate on the river Colne, which falls into the river Calder. The town stands on the edge of the Yorkshire coalfield, having millstone grit westward, rising up to the ridge of mountains dividing Yorkshire and Lancashire, and ranging from 1,200 to 1,800 feet elevation above the sea. In the year 1801 the inhabitants of the township numbered 7,268; at the census of 1861 the number had increased to 34,877, and this increase is going on. Huddersfield is at present governed by Commissioners. A charter of incorporation is contemplated. The Commissioners have provided waterworks, an extension of which is under discussion; they have also partially sewered and drained the town. Huddersfield is surrounded by manufactories and populations situated on the streams which flow down to and through the town. A list of these mills and of the owners or occupiers, with other details in full, will be found embodied in the Evidence, pages 104 to 109. The whole of the streams in the watershed of the Colne and its tributaries, from the dividing mountain-ridge down by the river Calder, are more or less abused by throwing in solids, as excavations from foundations, ashes from steam-boiler furnaces, road scrapings, &c. In some instances, soaps and oils used in washing and dressing cloth and wool are partially recovered, but not so as to remove all injurious matters from the water. Sewage, dye-waste, and other fouled liquids are poured out to pollute the streams. Mud from the several goits and lodges is flushed from the mills above to those below, and so on to the river Calder.

Dewsbury is an ancient township, situated on the river Calder, and in the midst of the Yorkshire coalfield. The population of the town and suburbs is about 25,000. Dewsbury, Batley, and Heckmondwicke have by joint parliamentary powers established waterworks. The local manufacture is chiefly heavy woollen goods, as witneys, Devons, pilots, kerseys, sealskins, flannels, baizes, serges, blankets, druggets, rugs, coverlets, collar-checks, carpets, cloths, and goods of finer sorts. Dewsbury is also the centre of the shoddy trade. The town has been partially sewered, and some of the houses drained. There are many common privies having cesspits. The town enjoys the accommodation of both water (river and canal) and railway communication. The several mills and dyeworks pollute the river by pouring in their fluid refuse; sewage is also discharged into the river. Urine is used in scouring heavy woollen goods, and is collected from the population around. Dewsbury and the other towns in the district are carrying on a large trade, which has rapidly increased and is increasing, but only so far by more and more abusing and polluting the several tributary streams and the river Calder. There are men living who fished and caught fish in these streams, where, at present, fish life in any form has been rendered impossible. An intercepting drain has been jointly made, parallel with the river Calder, by eight manufacturers, to receive the waste water and dye refuse from each mill, and pass it down beyond the lowest of these eight mills, so that as each mill pumps water from the river intervening, it is equally pure to the entire number. The volume of polluted water is, however, discharged at the lower end of the intercepting drain, so that the river is more polluted at this point than if each mill discharged its refuse water independently. This power of interception would be turned to common advantage if carried out, as it may be, on a greater scale, and the entire volume of polluted water clarified before discharging itself into any stream or river.

Wakefield is situated on the Yorkshire coalfield, at the north side of the river Calder, which is navigable to the town. It is a municipal and parliamentary borough, having a population of about 23,000 inhabitants. Near the town are the House of Correction, the West Riding Pauper Lunatic Asylum, and the Union Workhouse. There are a new market-place, market-house, and slaughterhouses. There is a weekly market for cattle and sheep, as many as 1,000 head of horned cattle and 13,000 sheep having been penned and sold in one day. The average sale is, however, about 800 beasts and 6,000 sheep. This special trade in live stock materially adds to the pollution of the river below the town. There is a large trade in corn, malt, and wool; worsted spinning is carried on, and there are several dyehouses. Cocoa-fibre mats and matting are made and woven extensively at the prison, as also by private firms. The town is partially sewered and drained, the sewage containing the washings of the cattle and sheep-pens, as also of the slaughterhouses, being delivered into the river Calder below the town. A private waterworks company pumps water from the river below the outlet of the sewage, and filters it for the domestic uses of the inhabitants. A description of the works and the processes of clarifying and filtering this water is embodied in the Evidence. The mayor and others remembered in their youth fishing in the Calder, opposite Wakefield; at present the water comes down containing the sewage and dye-water refuse, soap waste, and other forms of pollution as discharged from Todmorden, Halifax, Huddersfield, Dewsbury, and all the other towns, villages, mills, and dyeworks situate above. In dry weather the banks of the river are covered with dark thick slime, and the entire volume of water is stained with dye-refuse. There are many common privies and cesspits, causing local nuisance and excess of disease. The earth-closet system has been tried at the prison and a letter from the governor on the subject will be found, Appendix No. 2.

Pontefract, commonly called Pomfret, is an ancient borough and market town. It was a borough in the reign of Edward the Confessor, but it was not incorporated until the second of Richard III. The population is at present about 5,300, and the rateable value 15,000*l*. The local government is vested in the corporation and in 33 self-elected street commissioners; these two bodies act independently of each other, from which divided jurisdiction much injury arises in sanitary and other respects. The mortality has increased from 14·8 in 1861 to 29·1 in 1866. The Local Government Act has not been adopted. In such large towns as Birmingham, Sheffield, Leeds, and in other places, street commissioners have been superseded by the corporations, which in all cases are representative. Pomfret moves more slowly in consolidating her means of local self-government. The town has been partially sewered, the sewage flowing into the canal. There are 1,202 houses and 175 waterclosets. There are waterworks in the hands of the commissioners; water is pumped by steam-power. Pontefract is situate on the permian or magnesian limestone formation, at the eastern margin of the Yorkshire coalfield, and at some distance from the river Calder. The town of Castleford is situated near the junction of the rivers Aire and Calder. In neither town is there much of the woollen or worsted trades carried on. Inquiry was made at Pontefract because it is situate in the lowest drainage area of the combined watersheds, and though serious pollutions are not added either by Pontefract or by Castleford, the river Aire bears along the combined pollutions of the entire drainage areas of both itself and the Calder, and consequently the whole of the pollution of the woollen and worsted manufacturing district of the West Riding.

The injury inflicted by the river pollutions of these and other towns to the estates of many riparian owners is very great; streams which in the memory of men now living were comparatively pure and well stocked with fish, are now black and stinking. The land through which such polluted streams flow is ruined for residential purposes, and is injured and reduced in value even for mill purposes; the water is so bad as to be considered unfit for manufacturing uses, and other sites are selected where water can be obtained from canals, or by sinking wells and boring. In many instances cattle will not drink the local river water, and farms are depreciated in consequence. Large country-houses which formerly, with their river frontage, rights of fishing, and ornamental gardens and pleasure grounds, were valued as residences, have been abandoned, or are let merely at farming rents and for farm purposes. The cattle plague prevailed to a great extent in the Thorp Hall meadows below Leeds, and on lands bordering foul rivers in other districts. This fatal disease was considered by the tenants and riparian proprietors to have been aggravated by the foul state of the water, and by the tainted atmosphere caused by river pollutions. The towns are poisoned in some degree by their own sewage and cesspool matter, and are taxed to a considerable extent to remove this putrid refuse in a most barbarous manner. Manufacturers pollute the water for each other until the streams have to be abandoned for all but the coarsest purposes of trade, and clean water has to be purchased from waterworks companies, or must be sought at great cost in well-sinking and boring, to which must be added the charges for extra steam-power. In some cases the manufacture and dyeing of finer sorts of goods has been necessarily abandoned, and in other cases extension of manufacture is rendered impossible because there is no additional volume of clean water to be obtained in the district.

Water Supply.

We have already shown in previous sections of this Report how great a change has occurred in the condition of the rivers of the West Riding of Yorkshire during the last century and indeed within the last 25 or 30 years. Several witnesses examined at Wakefield and at Leeds spoke to the original purity of the rivers Calder and Aire, which at those points carry the combined waters of many subsidiary valleys and of large areas of country.

Mr. Rhodes, the Mayor of Wakefield, says, "In my early days the river here was "pure or nearly so. I am speaking of the river Calder: the water was sweet and clean, "and it was full of fish;" and Mr. Oxley, the Mayor of Leeds, in reply to the question, "Have inconveniences been suffered within the borough of Leeds from the pollution "of the river, and the water being rendered unfit for drinking purposes?" said, "So much so, that I know formerly the water that was supplied to Leeds for domestic "purposes was taken from the Aire; but it became so offensive that of necessity a "different supply was sought for." And this evidence was abundantly confirmed by many other witnesses. Of the condition of the river Calder at Wakefield, and the most important streams of the district at the present time, the Commissioners scarcely required evidence other than that afforded by their own observation; but such evidence abounds for those who will take the trouble to read the shorthand writer's notes of each day's inquiry in Vol. 2 of this report.

With this changed condition of the rivers, with foul instead of clean water flowing in the smaller streams, past hamlets and villages, and water still fouler because more repeatedly used and abused flowing in the rivers and through the large towns, we are prepared to find greatly diminished facilities for the domestic supply of the district, and ought to find corresponding arrangements for obtaining that supply from other sources.

Before the great extension of the woollen and worsted trades, the inhabitants of the West Riding obtained their supply of water for domestic uses from springs or from streams the product of springs, and in a great number of instances they do so now, both in villages and in small towns in the higher parts of the valleys.

The supply of water from springs is however for the most part limited in volume, and in some cases must either be carried home by hand or be purchased from itinerant water-carts at a cost which tends to reduce to a minimum the quantity consumed, and is provocative of uncleanliness and its attendant evils, whilst the streams have in great part ceased to be fit for drinking purposes or even for cleansing or culinary use.

As water becomes more and more monopolised for trade purposes, the sources now used for domestic supply will be still more irretrievably cut off, and unless remedial measures be adopted many of the working classes must be more and more driven to a use of discoloured and tainted water.

In dry seasons many of the inhabitants of the West Riding now suffer a water famine, and that even where there is an abundance of good and wholesome water available if it were properly collected, stored, and distributed.*

The question of the water-supply of the district of the Aire and Calder is so intimately associated with the well-being of the inhabitants, not only as a community requiring this necessary element for general and domestic use, but as a great centre of manufacturing industry to which good water is indispensable, that we require no apology for entering upon the subject in some detail, in order to show what has been, and what remains to be, done towards supplying a want which is now so widely experienced.

It has been seen that the united watershed of the Aire and Calder valleys down to Castleford comprises an area of 708½ square miles, of which the greater portion or about

* For some observations and suggestions in relation to the formation of Impounding or Storeage Reservoirs, see Paper Appendix No. VII., p. lviii.

600 square miles is covered by millstone grit and the coal measures in about equal proportion; nearly 100 by limestone, and the remainder by the Permian formation, new red sandstone and alluvium.

From the composition of these geological formations the waters of the different parts of the districts take as a matter of course their distinctive characters as to softness and purity. Analyses of some of them are given further on.

The *quantity* of water available for the supply of the West Riding is, as in other cases, materially influenced by the physical, as its *quality* is by the chemical characteristics and conformation of the districts.

The *Basin of the Aire* extends 45 miles above the junction of the Aire and Calder, and is about 8 miles in width. The ridge of the watershed varies in height from 500 feet (opposite Leeds) to 1,500 feet above Ordnance datum. The Aire issues from Malham Cove, a river apparently of much larger volume than the immediate gathering ground would yield. In many places beyond Malham the surface water escapes into swallow-holes, and this water finds its way by subterranean channels to the outlet at Malham Cove.

The *River Aire* flows throughout its course nearly parallel to the ridges of the watershed, at a distance of about three miles from the northern and five miles from the southern boundary in the upper part, and nearly midway between them below the junction of the Bradford Beck. The river falls rapidly from Malham to Gargrave, where it is 360 feet above Ordnance datum; thence it descends more gradually, but with uneven fall to Castleford, where it is 40 feet above Ordnance datum. The Aire for the most part flows at the bottom of a deep valley with hills rising steeply on each side of it.

The *Basin of the Calder* is about 35 miles long, and varies considerably in width; the ridge of the watershed is from 500 to 1,600 feet above Ordnance datum.

The *River Calder* flows nearly parallel to and about five miles from the northern boundary of the watershed. The Colne, which is its principal tributary, rises 13 miles towards the south. As in the Aire Basin the water passes rapidly to the river.

The river resulting from the junction of the two streams, and which below such junction is known as the "Aire" has a gentle fall for nearly 30 miles, till it joins the Ouse a few miles above Goole, collecting the rainfall from a limited area of about four miles in width.

The *rainfall* varies considerably in different localities over this area, for instance—

Mr. Fenwick gives the average rainfall at Holbeck, Leeds, as 21·91 inches (17·04 to 32·18).

The rainfall at Bradford is 36·00 inches.

" Huddersfield, 32·00 inches (24·39 to 43·83).

The average of 37 years at Halifax, 32·06 inches, varying from 24 to 41 inches.

On the ridge of the basin it reaches 50·00.

The annual average throughout this district is probably about 36 inches, and in droughty seasons about 24 inches per annum.

As regards the *extreme upper part* of the Aire basin which rests on limestone, the water both in the river itself and its tributaries is hard, but not inordinately so; and the question of water-supply, so far as quality is concerned, is not of pressing importance. The rainfall is abundant, the population sparse, and the river very little polluted.

The millstone grit supplies a large volume of the purest water, but many towns, as Bradford and Halifax, have quite outgrown the water resources of the vallies on which they are situated; with coal abundant on the one hand, and pure water from the millstone grit plentiful on the other, they were originally most advantageously placed to meet a rapid increase of trade. Coal is still abundant and cheap, but water, except from a distance, has failed them.

Large quantities of water are drawn from deep wells and bore-holes, but the incessant drain upon the substrata sensibly diminishes this source of supply as shown in the evidence, especially at Leeds and Bradford. The supply of water for trade as well as for domestic purposes has thus become rapidly dependent on distant sources.

Some of the large towns bordering on the millstone grit have at great expense obtained supplies of excellent water from gathering grounds on that formation within the Aire and Calder basins. Leeds and Bradford take water not only from these, but from the Wharfe valley as well.

The water supply of *Leeds* 30 years ago belonged to a private company, and was obtained from the Aire; it is now in the hands of the corporation, and is derived chiefly by pumping from the river Wharfe. The entire volume obtained appears to be about 4,500,000 gallons per diem, of which 500,000 gallons is taken by manufacturers, the

remainder being applicable for domestic and public purposes. The domestic supply is constant, but, as a whole, is becoming insufficient from the growth of trade. Many springs hitherto used for trade purposes are now failing from the increasing drain put upon them by wells and collieries; from one colliery alone belonging to the Low-moor Iron Company at Beeston 2,500,000 gallons being pumped daily. Fresh demands are in consequence made by manufacturers upon the corporation waterworks.

The quality of the present supply is also a ground of complaint. The water of the Wharfe, liable to occasional discolouration from peat, is now becoming deteriorated by the discharge of sewage and manufacturing refuse from towns and places on the banks above the pumping station. In consequence of this, and in anticipation of the increasing wants of a town growing both in population and manufactures, the corporation are now applying to Parliament for powers to resort to a new source, and to bring in a daily volume of 20,000,000 gallons of water.

The corporation of *Bradford* now supplies 1,500,000 gallons per day (or about 12 gallons per head), for domestic, 500,000 gallons a day for public, and 2,500,000 gallons per day for trade purposes, in all 4,500,000 gallons per day, and expects to bring into the town and neighbourhood 10,000,000 gallons per day when the works are completed.

The corporation of *Halifax* supplies now 1,250,000 gallons per day, or 12 gallons per head for domestic purposes, and 292,000 gallons for trade purposes, and will, when works now in progress are finished have a supply of 3,700,000 gallons per day.

Huddersfield has an insufficient and therefore unsatisfactory supply of water for domestic purposes, varying from seven to 10 gallons per head. In 1864 one reservoir was dry and the supply partially ceased. The waterworks are managed by commissioners. More happily situated than others, some of the manufacturers of Huddersfield have an abundant supply for their purposes drawn from the narrow canal, and from springs, and wells on their own premises, or from reservoirs in which they impound the water of the Colne and Holme when it comes down pure; the supply for domestic purposes is, however, acknowledged to be deficient, and the commissioners have applied to Parliament for powers to improve it, but hitherto without success. At present the poorer inhabitants of Huddersfield are occasionally very badly off for water. Mr. Abbey, the surveyor to the commissioners, remarks: "The millowners have fouled the stream, " which was the natural supply of the district. The water was used originally by many " people for culinary purposes, and while the millowners have taken away this natural " supply from these streams, they have not of themselves provided an artificial supply " for those poor inhabitants." As the necessities of *trade* require it there is a call for an improved water supply, and means will be found for accomplishing it.

The trade of Yorkshire is the very life of its inhabitants, poor as well as rich, and any measure would be a fatal blunder which should improve the state of the rivers and the water supply generally to the serious injury of that trade; but we contend that not only is a purification of the rivers and an improved water supply compatible with the best interests of the manufacturers of Yorkshire, but that if the woollen and worsted traders are to continue to progress as they have done up to this time, if even they are to hold their own and continue to prosper at their present developments, such improved water supply must be found and that without delay. We do not believe that any opposing class interests need exist or do exist in the matter, it concerns all alike.

As regards Huddersfield there are no physical difficulties in the way of obtaining an abundant supply of most excellent water.

Dewsbury, Batley, and Heckmondwicke have a combined system of water supply, and there was no scarcity of water during the droughty season of 1864.

The water brought to these towns is used not merely for domestic purposes, but largely and increasingly by the manufacturers. The importance of this for trade is insisted upon by many witnesses; soft water is in fact of great value, and has become an important source of revenue to some of the corporate bodies.

The population of the *lower part* of the Aire and Calder on the coal measures, magnesian limestone, and new red sandstone is very badly supplied with water. The demand for water is enormous, both for domestic and trade purposes. A population amounting to nearly 750,000 is congregated in a small area in dense masses, and vast works are carried on; both population and trade are rapidly increasing. There are not facilities for meeting this demand in a fit and adequate manner; not only are the rivers more impure, as they have received the pollution of the upper districts, but the same circumstances which cause the demand to be great have tended to spoil the supply, and the growth of population and of manufactures has caused a corresponding increase of discharge of sewage and manufacturing refuse into the running waters.

Thus the natural and obvious water supply—that from the rivers and streams in a great measure derived from the millstone grit—is ruined. The water of the subsoil is both inferior in quality and insufficient in quantity. The millstone grit formation, which abounds in water, is at a distance; the large towns of the lower district are consequently reduced to straits. Leeds has to seek for a reinforcement from sources beyond the basin of the Aire in the valley of the Wharfe. Wakefield has as yet provided no better supply for its inhabitants than the polluted Calder. Castleford and Knottingley have to choose between drawing from the foul river or from wells which are capable of yielding only an insufficient and precarious quantity of hard water.

Manufacturers frequently sink bore-holes in their own premises, but this source is apt to fail, so incessant is the drain upon the subsoil water; the richest dig the deepest, and drain the wells of their poorer neighbours, and in their turn are liable to have their own wells drained by pumpings from the collieries.

The water supply to *Wakefield* is a striking instance of the consequences of the uncontrolled pollution of the river. The Calder in its course to Wakefield has drained an area containing 400,000 inhabitants, chiefly engaged in manufacture, and has received directly as well as from its tributaries pollution by sewage, chemical and dye-waste, and many sorts of manufacturing refuse. To this pollution Wakefield, a manufacturing town of 20,000 inhabitants, adds the contents of its own sewers, and the discharge from its own manufactories, and having done so, draws from the stream three-fourths of its water supply. Such a source for human consumption is of course highly objectionable, and at a former period when the water was supplied without preparation or at the most only after sand-filtration it was no doubt unwholesome, as seems to be proved by some cases that were mentioned to us. But the company who own the waterworks, spare no pains by artificial means to improve the quality of the water. The time chosen for pumping from the river is after a fresh, when the volume of water, as compared with the pollution in the river, is the greatest. It is pumped into settling reservoirs of ample size, in drawing from which means are adopted that only the purest part of the water is taken, and this is then filtered by Mr. Spencer's process through carbide of iron. A water is produced bright in appearance, and not injurious to health; in short, as was described to us, "a very fair drinking water." But however free from impurity the water may thus become, the fact that it has been obtained from so impure a source remains, and accounts for if it does not justify the repugnance to it which is felt by many inhabitants of Wakefield.

Castleford has no regular water-supply; the inhabitants about 6,000 in number have to provide water for themselves. For this purpose they resort mainly to wells, but partially still to the river. The river is very foul, and the wells appear to be not sufficiently guarded against impurity, and are liable to be drained by the pumping of collieries in the neighbourhood. In consequence the inhabitants of Castleford suffer in health as well as comfort.

The inhabitants of *Knottingly* are in as bad a plight. They have abandoned drawing water from the river; their supply is now from wells and from the Goole canal, which three miles above receives the overflow from the Pontefract sewage tanks.

To many outlying villages the pollution of the river is an evil as yet without redress. Their natural supply has been taken from them and they are beyond the reach of town waterworks; it is only right that towns, as being the chief causes of river pollution, should extend as far as possible to neighbouring villages the advantages of their artificial water-supply, affording a district rather than merely a town supply. This has already been done in the case of some towns, as, for instance Halifax and Bradford.

But the present condition of the Aire and Calder does not injuriously affect the water-supply for domestic use only; loud complaints are made by manufacturers and landowners. Many who are obliged to use the river water for dyeing and other purposes complain very much of its pollution. In some cases cattle will not drink the river water, and occupiers of land suffer from this cause.

An abundant supply of water of good quality becomes indeed yearly of more vital importance in this district. New towns are springing up, villages expand into towns, whilst some of the large towns have increased twofold within the last 30 years, and an extensive area is rapidly being covered with manufactories of various kinds and residences for those employed in them, so that if the past rate of increase continues the lower part of these valleys will ere long become one connected and continuous hive of manufacturing industry.

We have elsewhere in this report shown that there is no excuse for the discharge

of any sewage or ochrey matter into the running streams and rivers, and that the pollution from soapsuds, dyeing, and other processes, may be prevented, or at all events greatly alleviated.

If stringent measures are adopted to this end the Aire and Calder will be immensely improved as a source of water supply for Wakefield, Castleford, Knottingley, and other towns and villages situated on these rivers.

This leads us to make some observations on the chemical composition of the water.

The waters of the Aire and Calder above the seats of manufacture are derived, as before remarked, almost exclusively from limestone and millstone grit. The following analyses of samples, mostly collected by ourselves during our inquiry, and all of them analysed in the laboratory of the Commission, show the relative purity of these waters before they were polluted.

From the Limestone.	Solid Residue. Grains per Gallon.			Hardness (Degrees of Clarke).		
	Mineral.	Organic.	Total.	Permanent.	Temporary.	Total.
Spring feeding Malham Tarn -	12·13	1·44	13·57	5·00	4·83	9·83
Aire at Malham, when low -	12·00	0·92	12·92	5·49	4·12	9·61
" " when flooded	10·53	1·09	11·62	5·88	2·87	8·75
Spring below village of Malham -	9·96	0·34	10·30	3·64	4·41	8·05
Average of four samples -	11·15	0·95	12·10	5·00	4·06	9·06
From the Millstone Grit.						
Bradford.—Stubden reservoir -	4·93	0·77	5·70	3·25	—	3·25
Second sample ditto - -	3·86	1·18	5·04	8·59	—	2·59
Manywells springs at Hewenden	5·40	0·12	5·52	2·24	—	2·24
Second sample ditto from service reservoir.	6·80	0·89	7·70	3·57	0·07	3·64
Halifax.—Ogden reservoir -	4·16	0·55	4·71	2·80	2·75	5·55
Huddersfield.—Holmfirth reservoir	3·33	0·76	4·09	1·86	—	1·86
Brook at Digley below Holmfirth reservoir.	3·81	0·60	4·41	1·89	0·18	2·07
Wessenden reservoir - -	2·82	0·68	3·50	1·69	0·83	2·52
Standedge reservoir - -	3·68	0·20	3·88	2·25	—	2·25
Average of 9 samples -	4·31	0·64	4·95	2·46	0·42	2·88

From this table it will be seen that whilst the water of the millstone grit contains about five grains of solid matter in the gallon, that derived from the limestone furnishes upon analysis 12 grains of such residue. The water of the limestone contains on the average half as much more organic matter as that of the millstone grit. Such a result would appear at first sight to militate against general experience; limestone waters in their natural state of purity are usually free from peaty and other organic matter, whilst water from rocks not containing carbonate of lime—such as the millstone grit—are liable to be coloured by peat.

The explanation in the present case is perhaps that whereas the Malham samples were taken from the open stream, almost immediately after the collection of the water upon the surface, the other specimens are from artificial reservoirs, where large volumes of the water remain in comparative rest, and have an opportunity by deposition, and the chemical action of air and light of becoming free from organic taint.*

The hardness of the water from the limestone is fully three times as great as that from the millstone grit. Omitting the sample from Ogden reservoir, which probably receives part of its hardness from limestone within the area of the gathering grounds, we have a total hardness of about 2½ degrees as the average of the eight samples from the neighbourhood of Bradford and Huddersfield. And with the same rectification nearly the whole of this hardness is seen to be "permanent," that is to say that the water is not reduced by the process of boiling as is the case with the waters from the limestone.

It is to be noticed that these latter, though derived from a limestone district, are not nearly so hard as those derived from *chalk*. From true chalk springs, as in the valley of the Thames, the water issues of a hardness of 17 or 18 degrees, and although

* It may be as well to state here that in these as in all cases the water is carefully filtered in the laboratory before analysis, and the figures given represent only the matter *in solution*.

in the streams themselves this amount is considerably reduced by the influx of surface water from clay and non-calcareous soils, still even when delivered to the London public the water has a hardness of about 15 degrees.

The following analyses of water of three of the London companies made in the Commission laboratory may serve for useful comparison with West Riding supplies.

—	Solid Residue. Grains per Gallon.			Hardness (Degrees of Clarke).		
	Mineral.	Organic.	Total.	Permanent.	Temporary.	Total.
New River, Nov. 5th, 1866 -	20·86	0·68	21·54	4·85	9·88	14·73
Grand Junction, Nov. 5th, 1866 -	20·79	0·99	21·78	5·98	8·75	14·73
Ditto, Dec. 3rd, 1866 -	21·83	0·35	22·18	4·12	10·81	14·93
East London, Nov. 2nd, 1866 -	21·66	0·76	22·42	4·43	9·88	14·31
Ditto, Dec. 3rd, 1866 -	23·35	0·76	24·11	5·46	9·98	15·44

Compared with the water supply of London the natural waters of Yorkshire even from the limestone have the advantage both in total solid contents and in hardness, whilst those of the millstone grit excel in a much higher degree. In speaking of "hardness" in water a Yorkshireman has indeed in his mind a different standard to that with which a resident in the south of England is familiar—a fact which should not be lost sight of in reading the evidence. Persons accustomed to the hard wells of many districts of England look upon London water as "soft" water, whilst witnesses at Leeds spoke of the present supply of that town derived from the Wharfe, and which is not more than nine degrees, as *too hard* for the purposes of the town.

The following are analyses of other samples collected during our inquiry.

—		Mineral Residue. Grains per Gallon.			Hardness (Degrees of Clarke).		
		Mineral.	Organic.	Total.	Permanent.	Temporary.	Total.
Bradford.	Tay beck, valley of the Wharfe	4·00	0·76	4·76	2·94	0·98	3·92
	Barden beck, valley of the Wharfe.	3·09	1·03	4·13	1·89	0·07	1·96
	Howgill, valley of the Wharfe, limestone districts.	7·85	1·32	9·17	4·62	0·21	4·83
	Holden beck, valley of the Aire.	9·04	0·54	9·58	5·04	—	5·04
	Heaton service reservoir, Bradford.	8·09	0·82	9·72	4·90	1·54	6·44
From "Bradley Spout," John William Street, Huddersfield.		26·38	0·62	26·69	11·89	—	11·89
Company's main at George Hotel, Huddersfield.		6·62	0·31	6·93	3·85	0 98	4·83
From spring at brewery of Messrs. Bentley and Shaw, Huddersfield.		9·56	0·45	10·01	5·95	—	5·95

From the first four analyses, and those which are given in preceding tables, it would appear that as to *quality* of water Bradford has nothing to complain of. The same is true of Huddersfield. Of the *quantity* supplied to these two towns we have elsewhere spoken. The water from "Bradley spout" is beautifully bright and pleasant to drink, and we were informed that it is much esteemed for that purpose; it is, however, exceptionally hard, and contains a high proportion of solid residue per gallon.

With examples of the natural and unfiltered water of the districts before him, let the reader now contrast its condition after receiving the impurities so liberally added to the rivers in their course past the different mills on their banks.

The Colne, which takes its rise in the hills above Huddersfield, is joined by another stream, the Holme, at Lockwood, and flows past Huddersfield on its way to the Calder.

The water of Redbrook reservoir at Standedge and of the Wessenden reservoir on the Colne, and of Holmfirth reservoir on the Holme, may fairly be taken as representing the natural and unpolluted water of this district, and we accordingly have associated the average analysis of these three reservoirs with that of the Colne at Lockwood above, and at Bradley below Huddersfield.

—	Solid Residue—Grains per Gallon.			Hardness (Degrees of Clarke).		
	Mineral.	Organic.	Total.	Permanent.	Temporary.	Total.
Reservoirs at Holmfirth - Wessenden - Standedge - Average of the three.	3·28	0·54	3·82	1·93	0·28	2·25
Colne at Lockwood, above Huddersfield	8·11	0·69	9·80	4·20	0·40	4·60
Colne at Bradley below Huddersfield	10·53	1·47	12·00	4·75	0·10	4·85

On the Colne and the Holme above Lockwood there are many mills, and their effect upon the water, assisted by sewage and other causes, is to increase the quantity of salts &c. in solution from $3\frac{3}{4}$ grains in the gallon to nearly 10, and this is further increased to 12 grains after passing through Huddersfield. The hardness of the water which at its sources is $2\frac{1}{4}$ degrees, becomes at Lockwood $4\frac{1}{2}$, and below Huddersfield nearly 5 degrees.

The Colne, at Huddersfield, is a considerable stream, and it may readily be understood how large must be the discharge of refuse from the mills on its banks to increase threefold the quantity of salts in every gallon of water passing down it. An easy calculation shows that the increase per gallon being somewhat more than seven grains, a thousand gallons will have received one pound, and a million gallons close upon half a ton of soluble salts, the greater part of which have undoubtedly originated in the woollen manufacture and dyeing processes.

In this estimate no account is taken of the quantity of solid suspended matter discharged from these mills, a subject to which a few words will be devoted further on.

The Calder, at Wakefield, is more polluted than the Colne, as shown in the following analyses:—

—	Solid Residue—Grains per Gallon.			Hardness (Degrees of Clarke).		
	Mineral.	Organic.	Total.	Permanent.	Temporary.	Total.
River Calder, above Wakefield -	19·11	1·02	20·13	5·56	3·23	8·79
River Calder, below Wakefield -	19·85	1·16	21·01	7·41	1·79	9·20

These analyses do not show any very great effect produced upon the river Calder by the impurities reaching it from the town of Wakefield itself, but it must be remembered that the volume of water is at this point very considerable, and it would require a large addition of pollution in the aggregate to make itself felt in the analysis. Nevertheless there is an increase in the solid matter, both mineral and organic, and in the hardness; some part of this matter, moreover, being changed from "temporary" to "permanent," or in other words, from carbonate of lime to sulphate of lime, by the action of the acids and salts discharged from mills.

But the analysis sufficiently shows the agencies that have been at work. The waters of the limestone districts contain not more than twelve grains of solid matter per gallon. Those of the millstone grit do not exceed three or four. Without attempting to determine in what degree each of these varieties of rock may contribute to the Calder by the time it arrives at Wakefield, we may safely assume that at least one half of the salts in the Calder at this point are due to extraneous sources.

The first two of the following analyses show the quality of the river Aire above and below Leeds, and the third exhibits the effect produced upon its composition by the discharge of the sewage of the town :—

—	Solid Residue—Grains per Gallon.			Hardness (Degrees of Clarke).		
	Mineral.	Organic.	Total.	Permanent.	Temporary.	Total.
River Aire, at Armley Foot-bridge, above Leeds	12·56	2·08	14·66	6·14	2·69	8·83
River Aire, below Leeds, but above sewage outfall.	16·80	1·13	17·93	6·48	2·81	9·29
River Aire, below Leeds and below Sewage Outfall.	20·22	1·44	21·66	7·08	3·86	10·94

There is an inconsistency in the proportion of organic matter in the sample from Armley Bridge, for which we are unable to account. It was taken by one of ourselves, with every care to obtain an average sample, but some exceptional cause must have intervened to raise the organic matter to such a proportion. With this exception, there is no question of the accuracy of the result. And we see that to the total solid residue of 14½ grains per gallon above the town, an addition of 3⅓ grains is made by direct discharge into the river during its passage through it, and of a further like amount by the main sewer below.

The river Aire, below Leeds, and the river Calder, below Wakefield, come thus to have a chemical composition very closely alike.

By the preceding analyses it has been sufficiently shown that the use of the water of the rivers of the West Riding for woolwashing, dyeing, and scouring, and its discharge into the rivers after these processes, has largely increased the proportion of the *mineral matters* of the water; but it must have occurred to an attentive reader that the *organic matter* of those waters has not increased in anything like a commensurate ratio. It is indeed true that whereas the average of three samples of water before given as representing the water of the Colne in a state of purity, namely, from the Wessenden, Standedge, and Holmfirth reservoirs, contains only 0·54 grains of organic matter, the water of the Calder below Wakefield has similar matter to the extent of 1·16 grains, and that of the Aire below Leeds contains 1·13 grains of such matter. This is not an extraordinary proportion to be found in a comparatively pure water, much less in one which is held to be highly polluted. Two of the samples from Malham, and the sample from Stubden reservoir, Howgill and Barden beck are shown to contain more than one grain per gallon of organic matter, and yet there is no question of their purity and freedom from manufacturing refuse.

Again, although it is highly desirable that water for drinking purposes should be as free as possible from organic impurity as well as from mineral salts, (and the water from the reservoir of Redbrook at Standedge near Huddersfield and that of the Manywells springs at Hewenden near Bradford are excellent representatives of such water,) yet it is no uncommon occurrence to meet with a perfectly wholesome water which shall contain considerably more than one grain of organic matter to the gallon. It would seem, therefore, that, so far as *soluble organic* impurities are concerned, the rivers of the West Riding are not really polluted to a great extent, and of this fact there cannot be a doubt, if we are to believe the evidence of chemical analysis. Are we then to believe either that no great quantity of soluble organic matter is thrown into these streams, or that having been so discharged it is removed from solution by some chemical agency? The explanation probably lies in both of these hypotheses. The quantity of soluble organic matter discharged is *not* very great as compared with the bulk of the water. Few of the towns are systematically sewered, and if we omit Leeds, Bradford, and one or two other places, only a small portion of the solid and liquid excrement of the population at present finds its way to the rivers.

Neither do the processes connected with the woollen and worsted trade discharge large quantities of soluble organic matter into the streams. With the first washing of the wool which, on account of the urine employed and other animal matter, gives rise to a sufficiently disgusting liquid, the discharge of organic impurity is practically at an end. A certain amount of vegetable matter, as gum, mucilage, &c., is no doubt dissolved from the dye-woods, and passes away in solution in the waste water from the vats, but this vegetable matter is small in quantity and not of a nature to be seriously injurious to the water. The soap-liquids in their untreated condition, or even after the imperfect purification to which they have been subjected by the grease extractors, are, as has been before shown, very objectionable when discharged into running waters, but very little of their organic contents is in a soluble condition and that little in contact with the salts of the water soon becomes insoluble.

The refuse matters of the woollen and worsted manufactures which are discharged in *solution* are indeed essentially *mineral*, and this constitutes the first reason why so small an increase of organic impurity is found in the rivers.

The second cause which operates in this direction is the peculiar nature of the mineral matters so discharged. Sulphate of iron and alum, which are largely used in dyeing, are powerful disinfectants and precipitators of putrid or putrifying organic matter. The mineral acids, such as sulphuric and hydrochloric, which are also used in some form, have somewhat similar properties. The mordants employed in dyeing, as salts of tin, zinc, chromium, &c., have all an antiseptic effect, and we have found that the suspended matter of black-dye, which is a compound of iron and colouring matter, is itself a powerful deodorant and precipitant. The quantity of some of these compounds passing into the river is of course small, but the sulphate of iron and the insoluble black matter of the dye-water are discharged in enormous quantity, and these act most powerfully and beneficially in arresting the putrefaction of animal matters of sewage and other organic refuse, separating them from solution, and thus preventing their power of mischief.

We must not be misunderstood to be apologizing for, still less to be justifying, the condition of the West Riding rivers, but we do say most unreservedly that the dye-refuse serves as an antidote to the other refuse discharges of the district, and that were it not so the state of the rivers would be far more offensive in reality, though not to the eye, than it is at the present time.

We repeat that if, by proper precipitation, and by subsidence or mechanical filtration, the solid suspended matter of the dye-waste, together with the iron in solution, could be prevented from passing into them, the rivers of Yorkshire would at once assume a new character. But concurrently with any measure of this nature it would be imperatively necessary to act with the utmost stringency against the pollution caused by sewage and other putrid discharge, a pollution the injurious effects of which are now kept within limits by the discharge of manufacturing refuse; otherwise we should be relinquishing the antidote whilst remaining subject to the bane.

One great argument for the purification of the rivers up to an available point should not be passed over in closing the consideration of this question. Manufacturers require *clean* rather than *pure* water. They cannot get on with water which is fouled by solid suspended matter; but a certain proportion of salts, if that proportion be not excessive, and if it does not include iron or too much lime, is not greatly objected to.

If the water of the rivers could be brought back to a state of sufficient purity for manufacturing purposes it would again come into use for such purposes, and large quantities of purer water now consumed by trade would become available for domestic supply. Renewed purity of the rivers for manufacturing purposes would be synonymous with increased supplies of pure water for human consumption.

Defects of Existing Law relating to Rivers Pollution.

The law, as it at present exists, is only applicable to local and individual cases. There is no power of general application. One town or one manufacturer may be proceeded against, but there is no authority having the means and the power to deal with nuisances throughout an entire drainage area.

We found the law relative to the pollution of these rivers to be the subject of general and well grounded dissatisfaction. Theoretically, the law recognizes that protection is due to public and private rights in running water. It prohibits all public nuisance, and imposes upon each riparian proprietor the obligation of allowing running water to pass on in its course without obstruction or pollution. But a person, judging from the present appearance of the streams in the West Riding, would infer the contrary to be the law, and would conclude that there existed a general license to commit every kind of river abuse. For, as we have shown to be the fact, the rivers and streams are polluted with sewage and dye-waste, and, except where special legislation for navigation purposes obtains, their course is obstructed by the casting in of solid rubbish. The cause of this variance between the law and the practice is to be found in the difficulties of enforcing the law and the exceptions which are allowed to it.

So far as river abuses affect only private rights, each individual is left to protect himself by putting the law in motion. An aggrieved proprietor has the option of bringing an action for damages in the Common Law Courts or of filing a bill in Chancery for an injunction. Either course is necessarily invidious, expensive, and doubtful in its result. It is invidious because neighbour is set against neighbour, and because it must seem unjust that one manufacturer should be proceeded against and mulcted for doing that which hundreds of others, who do not happen to offend a powerful neighbour, are doing with impunity. It is an expensive remedy. For the same money which is spent over a hardly fought litigation against a single manufacturer, a Conservancy Board, armed with proper powers, might for years keep safe from all abuse a long extent of the river with hundreds of manufactories situated on its banks. The expense incurred by the Aire and Calder Navigation in preventing solid materials from being cast into the *navigable* channel (for this is the limit of their powers) is very trifling indeed. Legal proceedings are also a very doubtful remedy. The plaintiff may prove that he has suffered injury from the pollution of the river and that the defendant has polluted the river above him; but this is not enough. The plaintiff has also to prove that what he has suffered has been caused wholly or in part by the special act of the defendant, which is always difficult—often impossible. For besides the defendant there is probably a multitude of manufacturers who, at various points higher up the stream, cast in liquid refuse from their works; these impurities are carried down by the current, and by the time that they reach the plaintiff's works they are all mingled confusedly together, and the offence of the defendant has ceased to be distinguishable. The plaintiff accordingly fails to establish his case.

Even where successful these private attempts to protect the river are but little gain to the public. Several instances have come before us where a manufacturer, sued for polluting running water, has brought the litigation to a close, not by ceasing to foul the river, but by simply removing the discharge into the river to a point below the works of the complainant.

Further, the law recognizes prescriptive rights to pollute running water and obstruct its flow, provided such abuse fall short of public nuisance. Such rights we do not hesitate to call privileged abuses.* A manufacturer who, in the exercise of a right so acquired, discharges into the river the solid and liquid refuse from his works may thereby do injury to the river to the extent of many times the money value of the right. But the loss to the public is too serious to be measured by a money standard. If some are permitted to pollute or obstruct the river, it is in vain that others abstain from abusing it. Thus by the maintenance of exceptions the law discourages those who are well disposed, and renders ineffectual voluntary combination, even upon a large scale, amongst manufacturers, to preserve the river. More than this, the law actually holds out a premium to those who abuse the river. A manufacturer is tempted to go on casting solid and liquid refuse into the river in order to establish a new right or to keep alive an old one.

The law prohibiting river abuse, when it amounts to a public nuisance, is not open to the same objection, because no length of toleration is held to justify a public nuisance. But the term "public nuisance" is a very equivocal one. In a manufacturing district no manufacturer is in danger of being indicted, still less of being convicted of causing a public nuisance, on the ground that the discharge of his dye waste renders the water of the river opaque, discoloured, unsightly, and quite unfit to drink, provided no smell is occasioned and there is no danger to public health. Again, in the neighbourhood of large towns it has come to be thought that a river foul with sewage is inevitable; inhabitants are reluctant to come forward as witnesses to denounce that to which they have become long familiar, and in like manner jurymen are slow to find such things to constitute a public nuisance. In the case of sewage pollution it is not usually difficult (as it is in the case of pollution from manufactory refuse) to trace the offence home, but, however serious the evil, it is very difficult to find a prosecutor. For the principal offenders are the governing bodies of large towns. These do not prosecute one another for the reason that each is guilty of the same offence towards his neighbour, and they are rarely prosecuted by private persons because few are willing to bear the expense and odium of acting as public prosecutors. To institute legal proceedings against a large town with a view to compel it to adopt a different mode of disposing of its sewage, at a cost perhaps of many thousand pounds, is to provoke a wealthy adversary to a conflict in which every step will be contested. The expense of such a litigation generally far exceeds the value of the personal interest of any individual in the stoppage of the nuisance. Accordingly, whatever the inconvenience to the public, the nuisance continues unabated. Rich and poor alike submit to it as to a sort of destiny.

* See a case decided by Lord Justice Cairns, reported in the "Times" of July 31, 1867. Appendix No. VIII., p. lxix.

From these public nuisances, injury often of an unexpected character results to individuals. Two instances may be cited from those which, in the course of our inquiry, have been brought to our notice. Through the grounds of a Mr. Wood, situated on the outskirts of Pontefract, and in front of his house, runs what until recently was a clear pure stream of water. Two years ago the Street Commissioners of the town commenced to discharge sewage from the northern part of the town into this brook, and the result upon the brook where it passes through Mr. Wood's ground, is not only that the water is foul, but that the putrid deposits brought down by the stream choke up the channel and occasion a nuisance. From this nuisance Mr. Wood has no appeal except to law, and in aggravation he last year received a notice from the Mayor of Pontefract calling upon him to clear out "the offensive drain."

The other instance is that of the Bradford Canal. Bradford Canal is fed from Bradford Beck. The beck is deeply polluted by the sewage of the town, and the polluted water, when passed into the canal and ponded up in a stagnant condition, becomes a nuisance. The corporation, though recognizing the nuisance to be very serious, have abstained from taking proceedings against the Canal Company, doubtless feeling that the town and not the canal was to blame in the matter. However, the nuisance became so intolerable, that some individual townsmen have combined together, and by private subscription have instituted proceedings against the Canal Company. The Queen's Bench has pronounced that the Canal Company, whatever may be their statutory rights to draw water from the beck, are not justified in causing a public nuisance. And the Court of Chancery has issued an injunction, which practically prevents the Canal Company from drawing from the beck, whilst the beck is in its present polluted condition, and in consequence of which the canal has been in disuse since the 1st of May last.

Conclusions.

Where manufactures have been established and a large resident population has grown up as before stated, the greatest amount of pollution takes place, the area of country over which such form of nuisance is spread having no defined boundary other than the dividing ridges of such watershed and the shores of the sea. In order to prevent the Pollution and legally control the Management of rivers, their basins or watersheds must be placed under supervision irrespective of any arbitrary divisions of County, Parish, Township, Parliamentary, Municipal, or Local Government Act boundaries; or, indeed, of any artificially established division. Running waters flow on from their source to the sea, and if the upland waters are polluted by town sewage and by refuse discharged from manufactures, as in the West Riding of Yorkshire, the entire length of a river is necessarily polluted, and will require to be Conserved or protected. Towns situated midway or on the lower branches of rivers, as Leeds, Manchester, Salford, and many other places, will establish and carry out local improvements, and would clarify their sewage and other refuse fluid to little practical purpose, if the towns, villages and manufactories on the same river with themselves and its tributaries are not placed under restrictions against sending down pollutions. This state of things applies equally to villages and even to single mills and factories as to large towns: it prevents local authorities, as also manufacturers, from taking up the question of separate purification. Thus, for instance, the Corporation of Salford, which occupies one side of the river Irwell opposite Manchester, entertained the idea of intercepting sewers. Plans were prepared and estimates made, and the project was discussed, but was abandoned on the plea that money expended in Salford alone on such works would not accomplish the purification of the river Irwell so long as Manchester and all the great manufacturing towns and mills of Lancashire, situated on the river and its tributaries, continued to pollute the running waters of their respective districts. Some towns have been placed under restrictions as to river pollutions by solids, and have been required to abate the intolerable nuisance caused, as at Birmingham and at Blackburn, where depositing tanks are at work; but in neither case is the requirement equitable, these towns being made the scapegoats for offences by no means confined to themselves. The river Tame, which flows through Birmingham, receives the pollutions from towns, mines, and manufactories situated above it on the South Staffordshire iron and coal-field. Blackburn in like manner, though in a much less degree, receives pollutions from manufactories beyond its area. Pollutions caused by sewage and by trades and manufactures ought, in our opinion, to be prevented, *at the cost of the communities and persons causing such pollutions.* At Croydon, at South Norwood, and at some other towns, it has been forbidden by injunction for the local authorities to pass town sewage into running waters below a defined standard of purity, and the result has been, after the failure of all other systems, a clarification of such sewage by irrigation, which not only proves successful for the purpose desired, namely to prevent river pollution, but in its operation is a source of profit to the ratepayers. However that be, the question of profit or loss in abating nuisances and in preventing either the undue pollution of the atmosphere, running waters or the seashore by town and house sewage, or by working mines and carrying on trades and manufactures, ought not too closely to be taken into account, as in some cases restrictive measures rigidly enforced would result in profit, whilst in others there might be a small loss, if that can be fairly called loss which is more than compensated by gain to the community. Towns can as well afford to pay for the means and appliances necessary to render sewage innocuous to running waters, as they can to pay for the sewers and drains which are necessary to their sanitary well doing. We have explained in this report that abuse and pollutions of running waters are of wide extent and affect entire watersheds, so that it may be inferred that any useful remedy must be capable of being applied as widely as the pollutions extend. Some districts are notoriously more polluted than others, as, for instance, those which we have just visited where the great woollen and worsted trades are established; there the abuses and pollutions of running waters have become almost intolerable, and even trade is seriously injured in consequence. The long catalogue of pollutions and of floodings, as set forth in the evidence and in the appendix to this report, indicates the extent to which such abuses may further grow if left uncontrolled. Every witness we examined admitted the existence of many great evils, and remedial measures are in the evidence over and over again suggested, the reiterated stipulations being, that such measures shall be as general as the trades to be affected by them, and that their enforcement shall be by Government authority.

One conclusion, therefore, forces itself upon anyone who honestly deliberates upon the existing state of things in regard to the rivers we have visited with a view to its permanent improvement. A stronger power than has hitherto been available must be brought to bear if the present abuse and pollution of streams is to be arrested, and Government supervision and inspection must enforce and strengthen the action of local authorities.

As previously mentioned, there is plenty of land in the Aire and Calder district suitable for sewage irrigation, and we have no experience of any town or locality where the application of that system would be impracticable. Should there be any place so exceptionally situated that the benefit of this system could not be secured by reasonable outlay, there the entire sewage should be so treated by mechanical deposition, aided by any available chemical process, that no portion of solid matter in suspension should pass into the streams, and that the effluent water should be as free from organic impurity as the best known method can make it.

All refuse from dyeworks, mills, factories, tanneries, breweries, malthouses, slaughterhouses, and the like, should be prevented from being cast into and polluting running waters.

No ashes, cinders, slag, waste-earth, mud from canals goits and reservoirs, road-scrapings, broken pottery and utensils, bricks and building rubbish, or any other solid calculated to impede the flow of water, raise the bed of the stream, or cause impurity, should be permitted to be cast in or so to be disposed on the banks of a river as to be carried in by its waters.

No water that has been used in washing, scouring, milling, fulling, &c., wool and woollen goods, should be allowed to pass into any running stream until all oil, grease, suspended matter and dirt, has been removed from it.

Water containing colouring matter from dyeing should be clarified, with or without chemical aid, by ordinary subsidence, by filtration through ashes or sand, or by mechanical filtration as Needham's press, before being allowed to flow into any running water or river.

Ochrey water from coal workings, which is highly objectionable to manufacturers if passed direct into running waters, may be greatly improved by mechanical deposition and should be so treated.

We do not consider it desirable to define the exact modes of treating dye-waters and other waste products of manufacture, solid and fluid, as the modes of operation vary at different places. The cheapest and best mode at one place might not in any way be equally applicable at others; but the prohibition against the practice of casting in solids *may at once be general without any exception.*

Sewage interception is always practicable. Where it can be applied fresh to the land there is least nuisance and least cost to the ratepayers. Where the solids are extracted by mechanical deposition, there is pecuniary loss on the operation, and running streams receiving the effluent water are still polluted, the pollution being greater as the volume in the stream is relatively small. No arrangements for treating sewage are satisfactory except its direct application to land for agricultural uses.

It is for the interest of manufacturers as well as of riparian owners and the community at large that a preventive law should be equitably but rigidly applied. For such legislation the successful operation of Lord Derby's Act which has abolished the nuisance from alkali works affords a fitting and encouraging precedent.

We have shown in this report how, with advantage to all parties, the main elements of river obstruction and pollution in the West Riding of Yorkshire may be eliminated; it will be our duty to inquire in districts specially affected by other trades or by mining, whether there exist any obstacles, which we do not at present anticipate, to such a general system of River Conservancy for the country at large as suggests itself as most desirable for local application to the valleys of the Aire and Calder.

Our experience of the weakness inherent in unaided and uncontrolled local authorities as at present constituted convinces us that a central board appointed by a State department is necessary to the efficient protection of running waters. For instance, under the Local Government Act, 1858, a Local Board may be established; and, after having executed works on borrowed money, the ratepayers may decline to elect a board, or the members of such Local Board, after election, may decline to act, there being no power in the Home Office to compel them to do so: such power, however, will be absolutely necessary in any Conservancy Act, to enforce the prevention of river pollution.

Economy in the working of a central board for the conservancy of rivers might probably be obtained by enabling it to avail itself of such parts as may be applicable of the existing system of Government inspection, as of factories, mines, alkali works, fisheries, land drainage, &c.

In respectfully submitting this suggestion for the establishment of central authority we would guard ourselves against being supposed to ignore the sentiment which exists throughout the country in favour of local representative bodies, with power to levy and control such rates as may be sanctioned, and to perform all necessary works within their respective neighbourhoods.

Essential to the wellworking of our plan would be the parcelling of river basins into conservancy districts or areas and sub-areas, larger in agricultural districts where the duties would be light, by grouping together several river catchment basins, and smaller in manufacturing and mining districts where river pollutions and obstructions are more general and numerous, and where the operation of local boards and their officers would be more frequently required.

The duties of such central and district conservancy boards might be,—

1. To aid the Salmon Fisheries Commissioners.*
2. To prevent the obstruction of rivers and running waters by casting in of solids or flushing in of mud, as also all forms of river pollution.
3. To take cognizance of all existing weirs, mills, dams, river-walls, embankments, reservoirs, goits, culverts, drains, &c., and of any new works proposed which may affect streams.
4. To hear appeals in cases of local dispute as to works of any character affecting the condition and free flow of rivers.

* See Mr. S. Walpole's first report, enclosing answers to questions submitted by Mr. Ffennell with regard to pollutions among other injuries to fisheries. (*Sixth Annual Report of the Inspectors of Salmon Fisheries, ordered by House of Commons to be printed July 15, 1867, 440.*)

With this report we publish four sketch maps, intended to explain our suggestions in reference to the district of the Aire and Calder, together with tables of its area and population, and statistics of the local manufactures in which water is used and polluted.*

1. Sketch map of the basin of the river Ouse, showing the combined sub-area of the rivers Aire and Calder.
2. Geological map of the Aire and Calder basin, reduced from Professor Phillips' "Geology of Yorkshire."
3. Sketch map of the basin of the rivers Aire and Calder, divided into ten suggested sub-conservancy districts, each being a complete sub-catchment basin, having a principal town within it.
4. Sketch map of the drainage area of the river Colne and its tributaries (above its junction with the river Calder), having Huddersfield as the principal town in this watershed.

Our views upon the important question of the prevention of the pollution and obstruction of rivers will, we trust, as far as the valleys of the Aire and Calder are concerned, be sufficiently evident from the general tenor of this report and its concluding paragraphs.

As we are now, in obedience to Your Majesty's Commission, about to visit rivers specially polluted by other manufactures and by mines, we respectfully reserve the absolute recommendations which would appear to be in this place due from us, partly in deference to the express objection on the part of West Riding manufacturers, to any legislation which should not also be enforced upon the textile trade of other districts, and partly in the hope and expectation that, by postponement of final judgment to experience of other pollutions and localities, our Recommendations will be more valuable and more capable of general application to the improvement of the rivers of England.

All which we humbly certify to Your Majesty under our hands and seals.

(Signed) ROBERT RAWLINSON. (L.S.)
JOHN THORNHILL HARRISON. (L.S.)
J. THOMAS WAY. (L.S.)

RALPH A. BENSON, *Secretary*.
August 15, 1867.

* See Appendix No. IX., p. lxx.

APPENDIX.

APPENDIX No. I.

FLOODINGS IN THE RIVERS AIRE AND CALDER VALLEYS, NOVEMBER 1866.

The following account of the disastrous flood which took place on the rivers Aire and Calder during the month of November 1866 is abstracted and condensed from local reports.—

On the 15th and 16th of November 1866 a general heavy rain commenced on the mountain ranges extending from Durham to Derbyshire, upwards of four inches of rain falling in some places during forty-eight consecutive hours. The Cal and the Der, united at Todmorden, rose above their banks and flooded houses and mills, Railway trains were stopped betwixt Todmorden and Manchester. In the flat district of the town cottages and mills stood in the midst of a vast sheet of water. The flood carried down sand, gravel, and ashes to spread them over land and gardens on both sides of the river below, spoiling the crops in many hundred cases. At Hebden Bridge roads, mills, and houses were flooded; women and children had to be removed by means of ladders from windows to escape drowning. The Hebble valley and the Black Brook valley were flooded and much damage suffered. River-side premises, cellars and houses were all under water; furniture and even provisions were floating about; sick people had to be removed in blankets; women carried their children to places of safety; fear and anxiety was expressed on every countenance. The manufacturers had many things which would float carried away, besides the damage done to buildings, machinery, and goods. At Huddersfield the rivers Holme and Colne, which have their junction at Folley Hall, were swollen to a great extent. A report was spread that Damhead reservoir had burst; this, fortunately, was not the case; adjoining lands, to the extent of many acres, were under water. Queen's mill was surrounded with water and flooded to such an extent as to imprison the workpeople for several hours. Riverside premises, roads, streets, yards, mill floors, cellars, and basements of shops and cottages were flooded so as to cause much damage and consequent loss. At Lockwood, the river Holme was in flood, and did much damage down the valley; at Dungeon mill, yards and mill floors were under water, and fires were extinguished; the water rose as high as at the bursting of the Holmfirth reservoir; fields and gardens were laid under water, and portions of river-wall washed down; the carriage road to Messrs. Bentley and Shaw's large brewery was two feet under water; the several large mills on the banks of the river were more or less flooded and injured; weaving-sheds were inundated, machinery and goods destroyed to a considerable value; steam-boiler fires were put out, and the mills had to cease working for several days, causing loss in wages to hundreds of working people. Lockwood baths were so much inundated that the occupants had to be removed. At Netherton the flood did much damage. At Bierley, part of a mill-dam was washed away. At Luddenden, mills and cottages were flooded, goods and furniture were damaged. At one mill a window had to be broken to remove a female from the interior. At Luddenden Foot, river-fence walls and railings were broken down; mill and shed floors were swamped with water and much damage done; timber, furniture (a chest of drawers), carcases of pigs, and other things were floated down the river. At Ripponden there had been river-walls built in places, but where no such protection was afforded, premises, mill floors, and cottages were flooded. Treadmill Bridge—a footbridge—was carried away, and four persons, a mother and three children, were drowned. At Sowerby Bridge the flood in the Calder rose higher than on any previous occasion, so that land on both banks, cellars, dwelling-houses, mill-floors, and yards were all flooded, causing great damage and loss; the flood carried down timber, tubs, barrels, carcases of pigs, and many other things; the gasworks were so flooded as temporarily to prevent the district being lighted until the waters subsided. In the holmes west of Sowerby Bridge much damage was done by the flooding of weaving-sheds, mill-floors, yards, and the basements of houses; looms, carding-engines, and other machinery were damaged, some piles of twist and pieces of cloth were washed away and others damaged. Prior to the erection of the new mills above the bridge inquiries had been made as to the range of floods, and the floors were thought to have been placed above this level, but this flood rose more than three feet higher than any one previously recorded, hence the flooding and loss. At Copley the river Calder flooded large areas of land, and caused much damage. At Sterne mill the basements were flooded to a depth of two feet six inches; all the holmes by the river side were covered with sand and mud; garden allotments were partially destroyed; the National School was flooded; boundary walls in fields parallel with the river were thrown down, and, in some cases, the stones were washed away. At Elland West-Vale the flood waters rose to the top squares of the windows of the old mill; and large quantities of goods were washed away and machinery damaged; large areas of farm land belonging to Major Waterhouse, M.P., were flooded and seriously damaged, by being covered with sand, silt, and rubbish washed on and deposited by the torrent; all down the course of the river great damage to land, mills, and other property was caused. At Brookfoot and Brighouse the land in the valley was flooded; further down the river the floors of new mills and new houses were placed under water. Broad Holme mill was flooded and much loss occasioned, the waters rushing across gardens and fields; many houses were inundated at Messrs. Sugden's old mill; horses had to be removed from the stables; Daisy-Croft, Mill Lane, and Clifton Bridge were flooded; in Bethel Street houses were flooded, fires were put out, and furniture floated about; at Victoria mill silk-cording engines were spoiled by water. Low mill, standing at the junction of the river and canal, was flooded to the ceiling, a water-wheel was smashed, soap and soda-ash melted, and blankets washed away; walls were washed down, the canal banks were injured, and a canal boat was carried on to the surface of the land, where it remained high and dry; at the Calder Dyeworks, vats and goods were damaged, and one house was swept away; at dyeworks belonging to Messrs. Burgess fires were put out, and much damage done; the mill belonging to the Messrs. Sugden had the entire length of river-wall carried away, as also a new house built for the engineer. At Mirfield the damage was very great, mill-floors, shops, and houses being flooded; canal boats were swept out of a building yard; a new branch railway was seriously damaged; six persons were drowned in attempting to drive over a bridge, and one man was washed out of the saddle and drowned in attempting to cross. In Dewsbury a dissenting chapel could not be used, and at the parish church the galleries only could be occupied, the floor of the church having been flooded more than three feet in depth; a blanket manufactory and bleaching-houses suffered much damage, a large number of finished blankets (part of a Government order) being damaged; some houses were swept away. In Calder vale, from the Dewsbury side to Thornhill, the damages were estimated at 100,000*l*. Uprooted trees, pigstyes, cowsheds, haystacks, and other floating wreck came down with the torrent of water. The damage at Wakefield was very great. Nearly every mill in the district had to cease work, the corn warehouses and their contents suffered much injury; pigs, cows, geese, and ducks were washed away. The Aire and Calder navigation works were seriously damaged, corn and grocery goods in the warehouse being destroyed; two barges were carried over the dam stakes; the traffic between Wakefield and Manchester was stopped for several days and eight boats sunk at Hosbury cut. The losses in damage to buildings and property of various kinds amounted to several thousands of pounds.

In the valley of the Aire, along its whole course, damage was done to an extent as great as in the valley of the Calder. At Skipton the banks of the Leeds and Liverpool canal behind the castle were damaged, the reservoir was damaged, and 20 sheep were drowned. Near Cononley cattle were drowned; at Bingley a wooden bridge was washed away; at and below Keighley the valley looked like a vast lake; near Dalton Mill much damage was done; in the valley of the Worth there also occurred much damage from flooding; as the Aire received the flood waters of the various tributaries it became more terrible in its force and more destructive; at Bradford, main sewers and the low parts of the town were flooded; surface of streets being placed from four to five feet under water, having the appearance of rivers; the Bradford and Leeds Railway was flooded in several places; on the Midland railway, at Esholt, near Apperley Bridge, a large stone viaduct of 10 arches was swept down with an engine and goods train upon it at this point; the valley is wide and open; if the foundations of the viaduct had been carried to a sufficient depth no such destruction would have taken place. The cost to the railway company in delay of traffic, and in reconstruction of the viaduct, must have been very great. At Leeds, quays, wharfs, and many streets, warehouses, shops, and dwelling-houses were flooded, in some places six feet deep; boats were employed in the streets to remove persons from their deluged houses, or to convey light, fire, and provisions to those who preferred remaining in their chambers until the flood should subside. Barges were carried from their moorings and sunk against Leeds bridge, and several persons were drowned by the breaking down of a balcony passage above the same bridge. A tall chimney was undermined, and fell across some houses, destroying them; the money losses in Leeds caused by this flood must have been very great; individual losses were in some cases upwards of 1,000*l*. At Castleford the main streets were partially under water, houses were flooded, large breadths of land on both sides of the river were inundated, and boats were drifted away. In Wharfdale the lowlands were all flooded, roads rendered unpassable. At Otley a farmer was drowned; near Ulleshelf thousands of acres were under water, and for two days imperilled the traffic of the North-Eastern Railway. From near Grimston upwards of 150 sheep were washed away. The total loss was locally estimated at from half a million to one million sterling.

APPENDIX No. II.

Report by Captain Armytage, Governor of West Riding Prison at Wakefield, on the use of Earth-Closets in separate Cells of Prisoners.

To the Rivers Pollution Commissioners.

West Riding Prison, Wakefield,
20th July 1867.

Gentlemen,

In reply to your letter of the 1st instant, requesting me to give the result of our experience in working dry-earth closets in this prison, I beg to inform you that we have about 100 in use in cells which have not been provided with waterclosets, and we are perfectly satisfied with them.

We do not, however, permit the prisoners to make water in them, but each prisoner is provided with an earthenware vessel for that purpose which is emptied every day. Had we not been so much engaged of late we should have had more earthclosets in use, as it is our intention to place earthclosets in all the cells in which waterclosets have not been provided.

I have, however, strong doubts about the earth-closets answering in the women's department. We shall try them, but I anticipate a failure.

We have about 740 waterclosets in use in the new prison (built in 1847) and (excepting in a few instances) the rest of the prison is without.

We pay a royalty of 2*s*. 6*d*. to the patentees for each earthcloset we make.

The cost, including royalty, may be roughly put down at 25*s*. each.

The only expense of maintenance would be in replacing the galvanised iron pan or scuttle when necessary. This would entail a cost of about 2*s*. per annum.

Probable annual cost of maintenance: One prisoner would be able to attend to the drying of the earth for any number of earthclosets up to 800. His labour and the cost of fuel for drying would not amount to more than 10*l*. or 12*l*. The cost, however, would materially depend upon the facility with which the earth could be obtained and the conveniences for drying. I should at present estimate the value of the soil after being once used at 10*s*. per ton. It seems to answer well for hand-dressings for grassland, onions, and potatoes.

In reply to your second question, wishing to know my opinion of the earthclosets as compared with the watercloset system, I think it best to let the present waterclosets remain and supply the remainder of the prison with earthclosets, and, by the time the present deficiency is made up, we shall be better able to form an opinion as to the advisability of replacing the waterclosets that get out of order with earth ones. Until such time I think it would be premature to consider the earth system as more than an experiment. The medical officers here do not object to the earth-closets, as they consider them far preferable to the pots the prisoners previously used.

You ask which system I would prefer in case it were made compulsory that the excrements of the prisoners should be kept out of Westgate Beck. You must be under a mistake in asking this question, as we have no drain from the prison into other than the large town drain, which has no connexion with Westgate Beck.

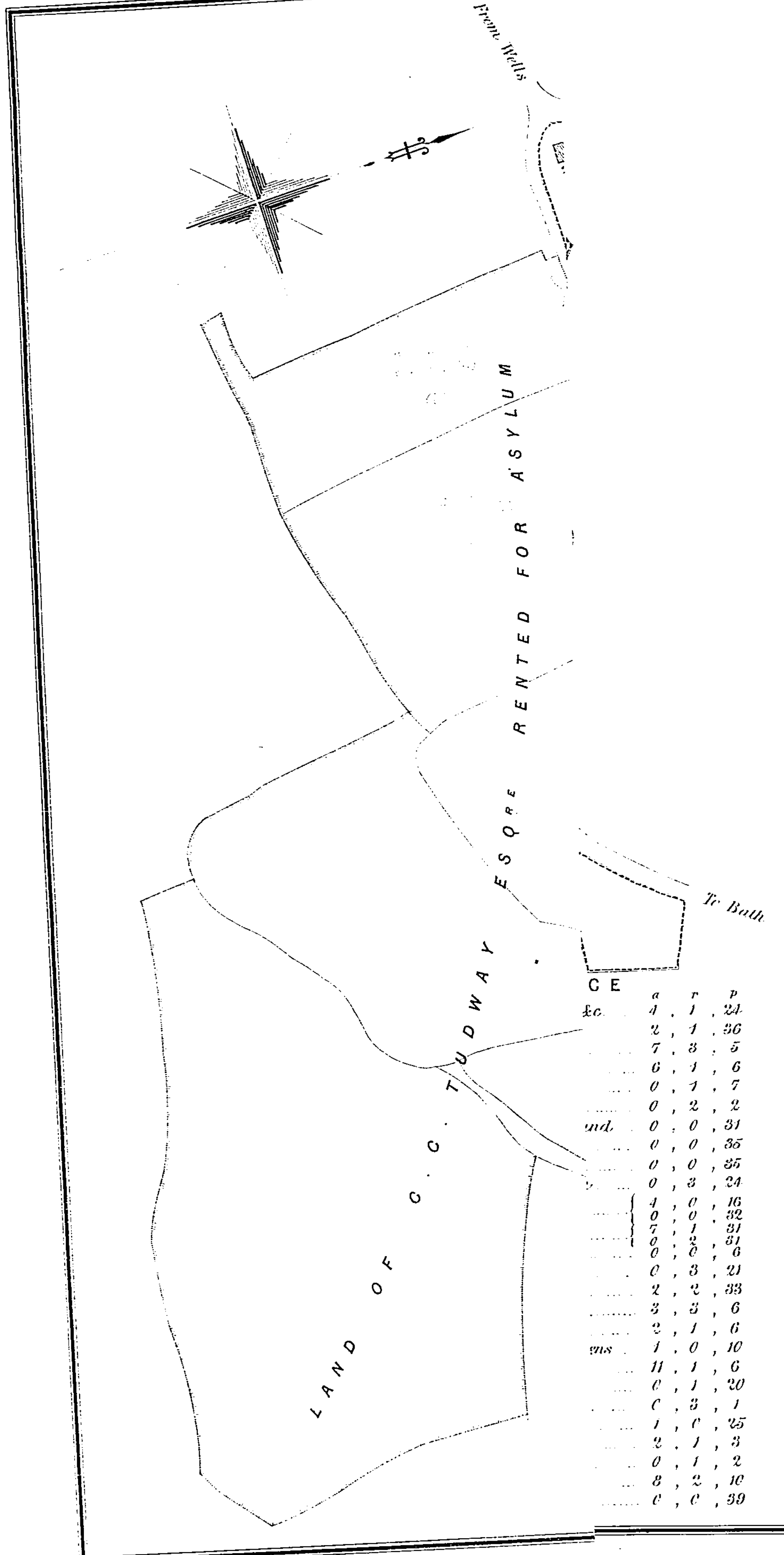
(Signed) G. Armytage, Governor.

Chinese and Japanese Manure Storing and Farming.

In tropical climates moisture and heat promote fermentation to such an extent that refuse of all sorts rapidly becomes putrid, offensive, and dangerous to health. In India the natives go beyond the precints of their dwellings as did the Israelites during their sojourn in the wilderness. In China and Japan, manure is collected and stored by the inhabitants until it becomes putrid and offensive. The process is described in the following manner: "Both in towns "and in the country there are numerous receptacles "exposed for preserving the odious compounds until "wanted, on the highways at frequent intervals so as "to render such roads almost impassable to people "afflicted with the sense of smell, making it difficult "to get a fresh walk from one end of the land to the "other, unless it be on the edge of the craters." Sir Rutherford Alcock, K.C.B., states in a narrative of a three years' residence in Japan—"Exercise in the "country in China throughout the year, had this "terrible drawback of stink attached to it. In Japan, "except in spring, during the months of March and "April, there is little of the manuring to complain of. "The vegetables grown under the excessive manuring "are, however, either rank or tasteless, and their fruit "is no better; the cause may probably be in seed,

APPENDIX No III.

REPORT 1867.



Edward Stanford, lith. 6 Charing Cross.

"soil, and climate. It is stated of Japan, that "amidst great natural beauty and fertility the birds "have no song, the flowers have no scent, and fruit "and vegetables no flavour." Agriculture in Japan is encouraged to the utmost, much of the land is a light friable loam easily worked; in the valleys irrigation is provided for and the hills are terraced to a considerable elevation. Cropping and rotation of crops are thoroughly understood by the Japanese.

Rice is the staple food of the whole population and it is grown abundantly over the country generally wherever the nature of the soil will admit the possibility under the strongest compulsion of unwearied labour, irrigation and manuring combined. The water required for irrigation is plentifully supplied by the streams and rivulets to be met with in all directions. The Japanese farmer keeps his farm scrupulously free from weeds, neat, and in good order. Men, women, and children may be seen in the fields early and late. The manure in use is urine and night-soil. The farm labour is chiefly manual—a plough drawn by bullocks or ponies is used sometimes, but generally speaking mattocks and hoes are the implements by which the land is prepared and every part of the field labour performed.

R. R.

APPENDIX No. III.

The following description of Sewage irrigation works at the Somerset County Lunatic Asylum, together with plans of same, were furnished to the Commission by Arthur Whitehead, Esq., C.E., County Surveyor :—

SOMERSET COUNTY LUNATIC ASYLUM, SEWAGE IRRIGATION, June 29th, 1867.

DESCRIPTION of the PLAN adopted in the year 1848, and still in operation, at the Somerset County Lunatic Asylum, for utilising the Sewage of the Establishment.

1. The number of inmates of the asylum, including attendants, is at the present time 550.

2. The water supply is taken off from a stream in the valley, at a sufficiently high level to fill by gravitation the reservoir shown on the drawing, and the consumption for every household purpose is about 50 gallons per head, or 27,500 gallons daily.

3. Three-fourths of the rain water falling on the roofs and airing yards is intercepted and stored in tanks for household use, and the remaining one-fourth is discharged through the sewage drains into the sewage tank by gravitation.

4. The sewage drain, having its outfall in the sewage tank, communicates with the waterclosets, the baths, the laundry, the lavatories, and the kitchen, and with the roof: these were the arrangements made originally by the architect in the year 1846; since that time the superintendent, Dr. Boyd, has collected the rain water from three-fourths of the area of the building and yards, and utilised it for the laundry, the brewhouse, and for the house generally.

5. The lands on which the sewage is utilised are coloured red on the plan; the soil is "dolomitic conglomerate," and of the whole quantity (18a. 1r. 27p.) 13a. 3r. 28p. are arable, and 4a. 1r. 39p. are old pasture land.

6. The sewage tank is an ordinary brick-built chamber 15 ft. × 15 ft. × 18 ft., and the delivery drain is of brick, 4 ft. × 2 ft., and iron pipes convey the liquid from the upper arable land to the two fields on the other side of the road.

7. The application of the sewage to the land is managed by means both simple and inexpensive: shafts, in 4½ brickwork, are built at intervals along the main delivery drain, as shown on the plan; each shaft is provided with a "hatch" working in a frame, by means of which the sewage may be intercepted and made to overflow at any of the several shafts along the course of the main delivery drain.

8. By the kindness of Dr. Boyd, the medical superintendent of the asylum, under whose advice this work was done nearly 20 years since, I am enabled to record the following results :—

a. There has been no manure but sewage used on No. 4 piece of the arable land for 19 years; the quantity of cabbage, mangold, and Italian rye-grass grown on it each year is very large; cabbage frequently weigh 56 lbs., and some have been cut weighing as much as 70 lbs.; the roots of mangold weigh from 17 lbs. to 23 lbs., and the Italian ryegrass has been cut four times between March and October, and seeded once; the produce per acre is 50 tons, and the land shows no sign of depreciation. The sewage has been extended more recently to the other two pieces of land with similar success.

b. As to the effect in a sanitary point of view, I can state nothing so satisfactory as the words of Dr. Boyd himself, recorded in one of his recently published reports. He says, "No unpleasant "odour is at any time perceptible from this "sewage, unless by going close to the tank or "shafts, and by the time the sewage has passed "off into the ground, a few feet distant, it is "deodorised." I have myself, this very warm day, walked over the land over which the sewage was flowing, and I am able fully to confirm this statement of Dr. Boyd's. Again, to quote Dr. Boyd's report, "No ill effects, as regards "the health of the patients or others in the "establishment, however, occurred from the "sewage; the apartments of the superintendent "are nearest to the sewage tank. It has been "stated that in one asylum where the sewage "was used on the land, several fatal cases of "dysentery had occurred, which were attri-"buted to this source. It is probable that "other causes may have been overlooked, or "that the nature of the soil is such that it "requires to be broken up, if impervious, to "deodorise the sewage. If irrigation with the "sewage were the sole cause, it is most likely "that disease would have occurred here in the "course of 18 years, but neither dysentery nor "fever have, thank Providence, ever prevailed. "Nearly all cases have been carefully examined "after death, and notes of the post-mortem "appearances, in each case, given in the annual "reports."

9. Much of the work having been done at intervals, the cost of it cannot be given with accuracy, but the expense of the tank, delivery main, shafts, and fittings would not exceed 70*l*., and the working expenses are almost nil.

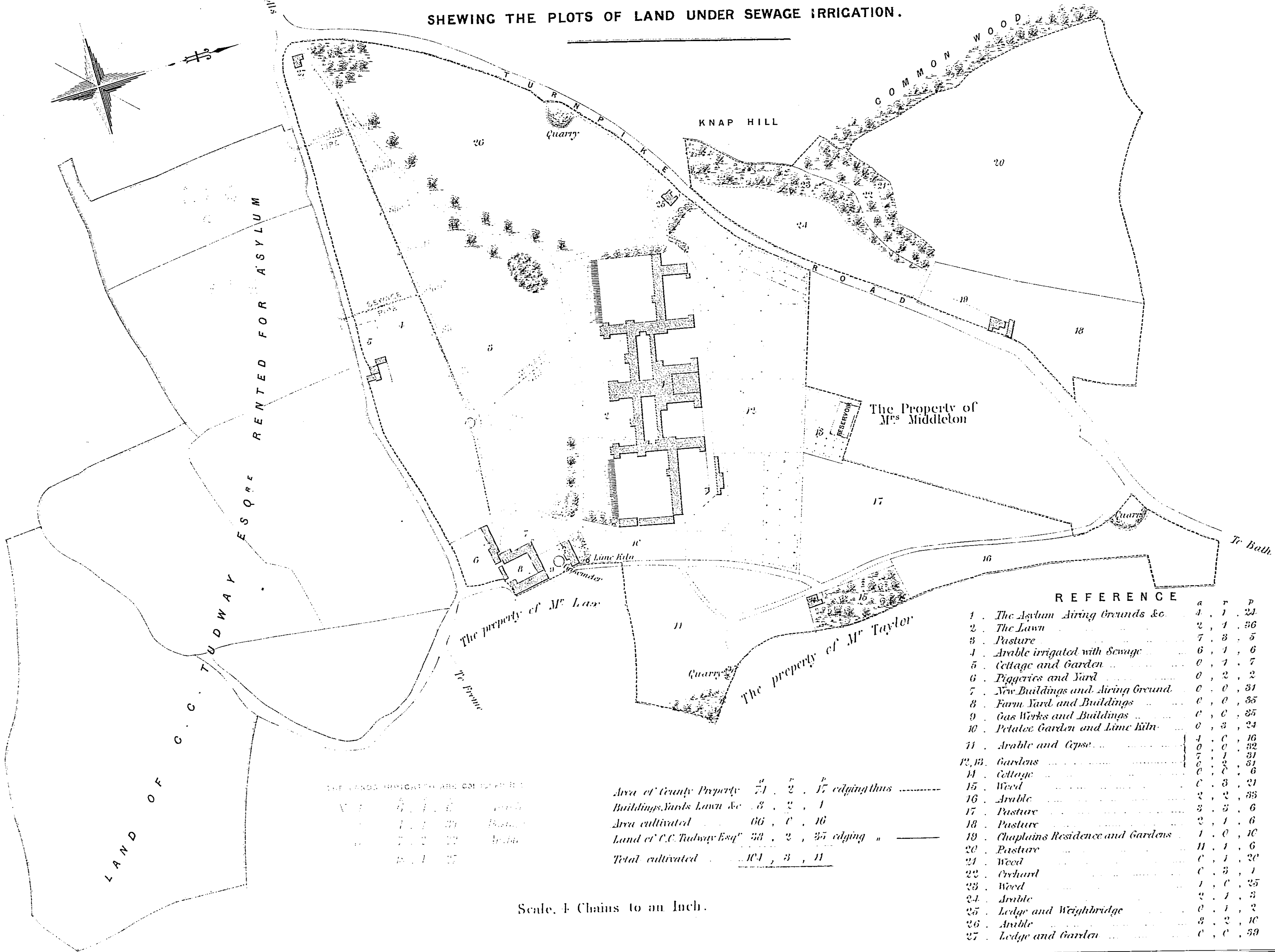
10. I believe that, with some modifications and inexpensive alterations, we shall obtain better agricultural results on our farm. In a sanitary point of view the medical testimony is most satisfactory, and I think the Chairman of the Committee of Visitors would be willing to confirm these statements.

11. There is no reason whatever why the utilisation of sewage should not proceed *pari passu* with the generation of sewage; under no circumstance can it be anything but a question of expense; under some circumstances it is clearly a question of profit; under all circumstances it is a question of true economy.

(Signed) ARTHUR WHITEHEAD, Civil Engineer,
County Surveyor of Somerset.

SOMERSET COUNTY LUNATIC ASYLUM

SHEWING THE PLOTS OF LAND UNDER SEWAGE IRRIGATION.



Area of County Property	71	2	17	edging thus ....
Buildings, Yards Lawn &c	8	2	1	
Area cultivated	66	0	16	
Land of C.C. Tudway Esqr	38	2	35	edging " ———
Total cultivated	104	3	11	

Scale, 4 Chains to an Inch.

REFERENCE

No.		a	r	p
1	The Asylum Airing Grounds &c.	4	1	24
2	The Lawn	2	1	36
3	Pasture	7	3	5
4	Arable irrigated with Sewage	6	1	6
5	Cottage and Garden	0	1	7
6	Piggeries and Yard	0	2	2
7	New Buildings and Airing Ground	0	0	31
8	Farm Yard and Buildings	0	0	35
9	Gas Works and Buildings	0	0	35
10	Potatoe Garden and Lime Kiln	0	3	24
11	Arable and Copse	4	0	16
		0	0	32
12, 13	Gardens	7	1	31
		0	2	31
14	Cottage	0	0	6
15	Wood	0	3	21
16	Arable	2	2	35
17	Pasture	3	3	6
18	Pasture	2	1	6
19	Chaplains Residence and Gardens	1	0	10
20	Pasture	11	1	6
21	Wood	0	1	20
22	Orchard	0	3	1
23	Wood	1	0	25
24	Arable	2	1	3
25	Lodge and Weighbridge	0	1	2
26	Arable	8	2	10
27	Lodge and Garden	0	0	39

Edward Stanford Lith. 6 Charing Cross.

APPENDIX No. IV.—SEWAGE IRRIGATION.

List of Questions relative to Sewage Irrigation, submitted by the Rivers Pollution Commissioners to the County Surveyor of Durham.

1. Ground plan of the county asylum, and of the land irrigated with sewage and waste-water from that establishment, as also other information relative to population, &c.?

2. Number of persons whose sewage is dealt with?
3. Volume of water used per head?
4. Volume of surface water admitted into sewers?
5. Area of land irrigated?
6. Mode of applying the sewage?

7. First cost of irrigation works?

8. Annual cost of management of sewage?

9. Description of crops grown?
Value of do.?

County of Durham.—Sedgefield Asylum Irrigation, 1867.

Answers to Questions contained in a Letter from the Rivers Pollution Commission, dated July 1st, 1867, a Copy of which is prefixed to this Report and each Question numbered.

1. A plan is enclosed showing plot A, containing 10a. 0r. 37p. of old grass land to which the sewage was applied in the year 1863, with metal piping and hydrants or standpipes, shown thus, —⊖—, from the collecting-tank F. by gravitation; plot B, also old grass, containing 11a. 2r. 35p. to which the sewage was applied in the same manner by the same means in the year 1864; plot C, of garden and ground, containing 9a. 3r. 33p., to which the sewage was applied in the year 1864, by pumping from the tank F, by an engine (used for many other purposes in the workshops G.); these pipes and hydrants are placed much nearer than on the grass-land, on account of not damaging the crops by the moving of the hose, (used in all cases for distributing the sewage on the land); plot D, containing 13a. 3r. 14p. is arable land, and the sewage is proposed to be applied to this plot as well as to plot E, containing 20a. 2r. 18p. of old grass, at some future time, by gravitation and metal pipes, as applied to plots A and B.

2. Number of persons, 503.
3. About 25 gallons per head.
4. None.
5. 32 acres, nearly.
6. By metal pipes, fitted with screw-caps as plugs, at the distances apart shown on the different plots thus —⊖—; the whole sewage is shut off from access to the pipes by a 4″ valve at the tank, and when so shut off the hose can be detached from one plug and attached to another, and when so fixed the valve re-opened till the whole land has been brought under the scope of the hose and so irrigated.

7. The cost of irrigating plot A was per acre, 11*l.* 7*s.* 4*d.* Plot B 8*l.* 15*s.* 0*d.* per acre. * Plot C 14*l.* 0*s.* 0*d.* per acre (including pump and section pipe).

8. The sewage is applied by the patients under the direction of the farm steward, and there is no cost except the keeping in repair the hose, which is a mere trifle.

9. The crops grown on plots A and B are old grass used as pasture a portion of the year, and meadowed afterwards; these fields before being irrigated produced very poor crops, indeed almost nothing, but now produce at the first crop (after only having been freed as a pasture for six weeks) as follows:

Plot A produced 3 to $3\frac{1}{2}$ tons of hay per acre, and plot B, 2 to $2\frac{1}{2}$ tons; another crop will be got off each, which will probably produce on plot A a ton and a half, and on plot B one ton per acre; the fields are after this pastured by sheep till the May following. According to these crops the value of the produce will be about as follows:

	£	s.	d.		£	s.	d.
Plot A (say average) $4\frac{1}{2}$ tons of hay at 6*l.* - -	27	0	0	Plot B (say average) $3\frac{1}{4}$ tons of hay at 6*l.* - -	19	10	0
Pasturage, say - -	1	10	0	Pasturage, say - -	1	5	0
Per acre	£28	10	0	Per acre	£20	15	0

The produce of Plot C, the garden ground is most remarkable, and is spoken of by everyone in this neighbourhood acquainted with agriculture; the produce is principally consumed in the asylum, but of late years, since the sewage has been applied, a great quantity of surplus garden produce has to be disposed of to parties coming with their carts a distance of 10 to 12 miles, and purchasing the same for re-sale at the different markets and colliery villages.

The crops that seem the most benefited by the irrigation are as follows:

The cabbage tribe, Rhubarb,
Celery, Beans, &c., &c.
Turnips,

In fact vegetables of every description where sewage is applied are at all times most luxuriant and productive, and when the sewage, for any reason, is not so applied they at once slacken in their growth, and in a few days (only a narrow walk dividing the compared plots) are nowhere in the race.

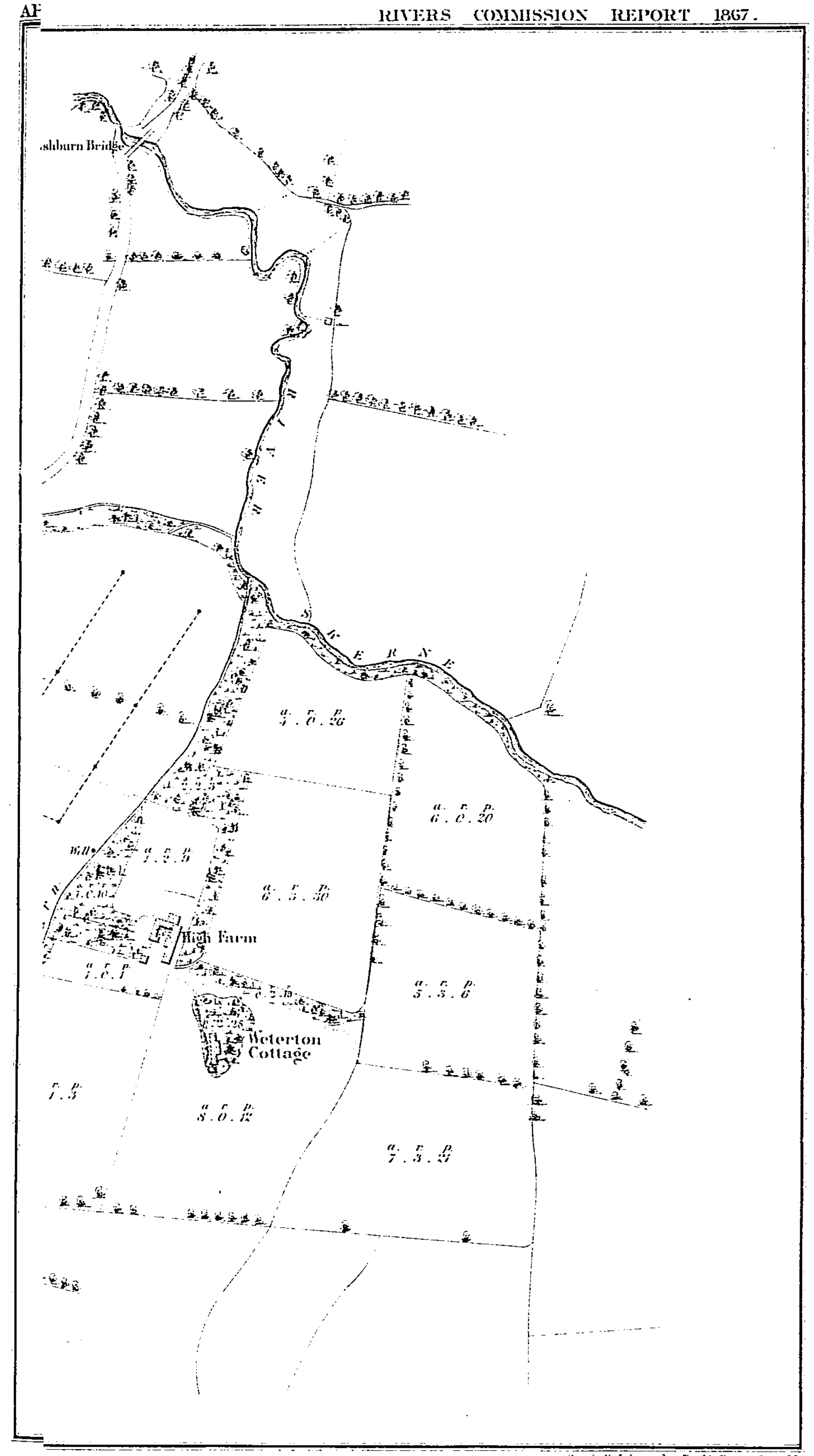
As an instance of the value of a crop of cabbages now on the ground they are being sold wholesale to parties leading them 10 or 12 miles to the adjoining towns (and they then re-selling them) at the rate of 100*l.* per acre, *i.e.* at 12*d.* per dozen, they are re-sold at 18*d.* per dozen, or at the rate of 150*l.* per acre.

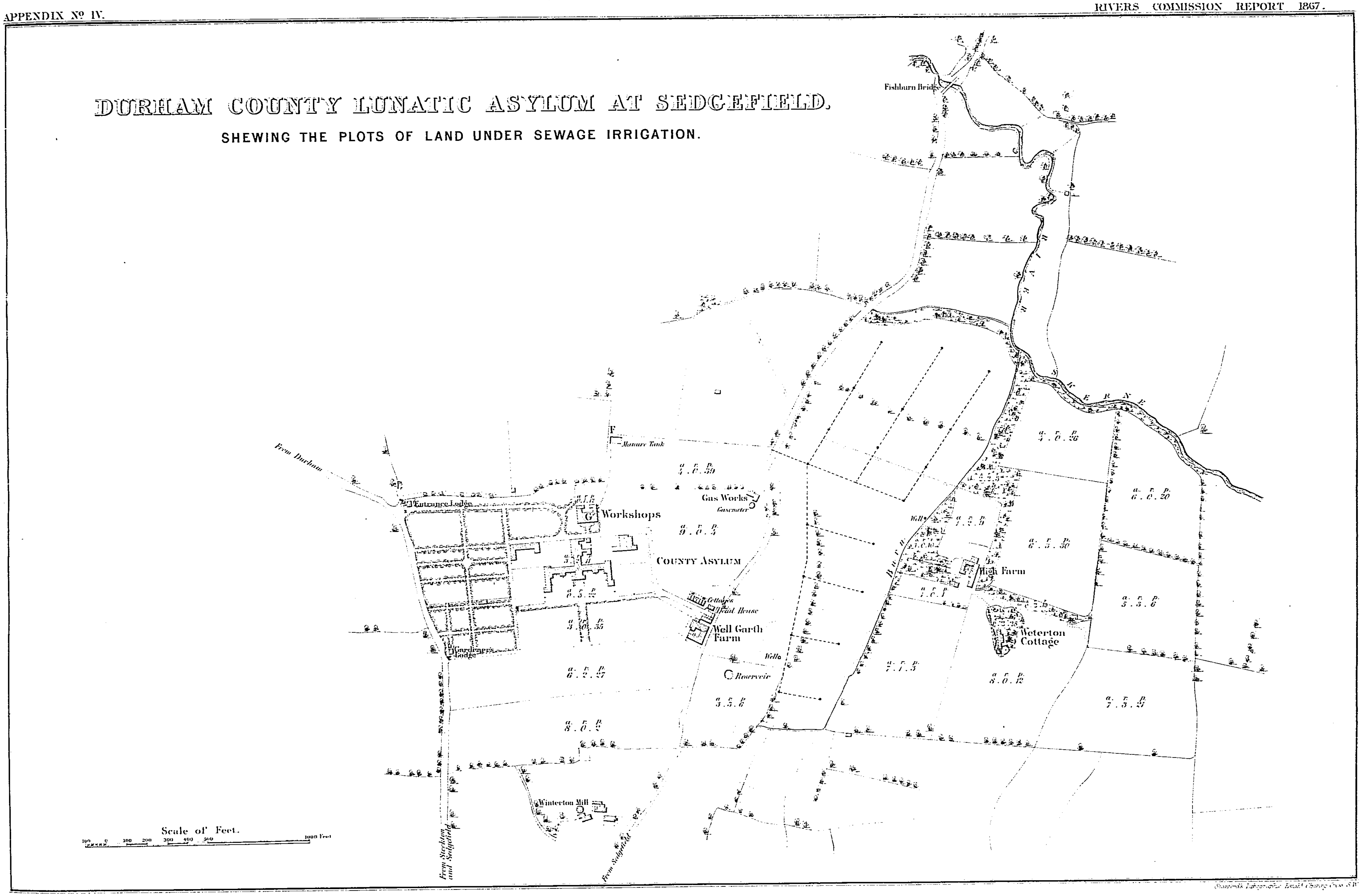
By proper rotation of garden crops, from $1\frac{1}{4}$ to $1\frac{1}{2}$ crops may be got off the land per annum, so that the produce of each acre per annum will be equal in value to from 180*l.* to 200*l.*

The land irrigated is a free working loamy soil, overlying 10 or 12 feet of sandy porous gravel.

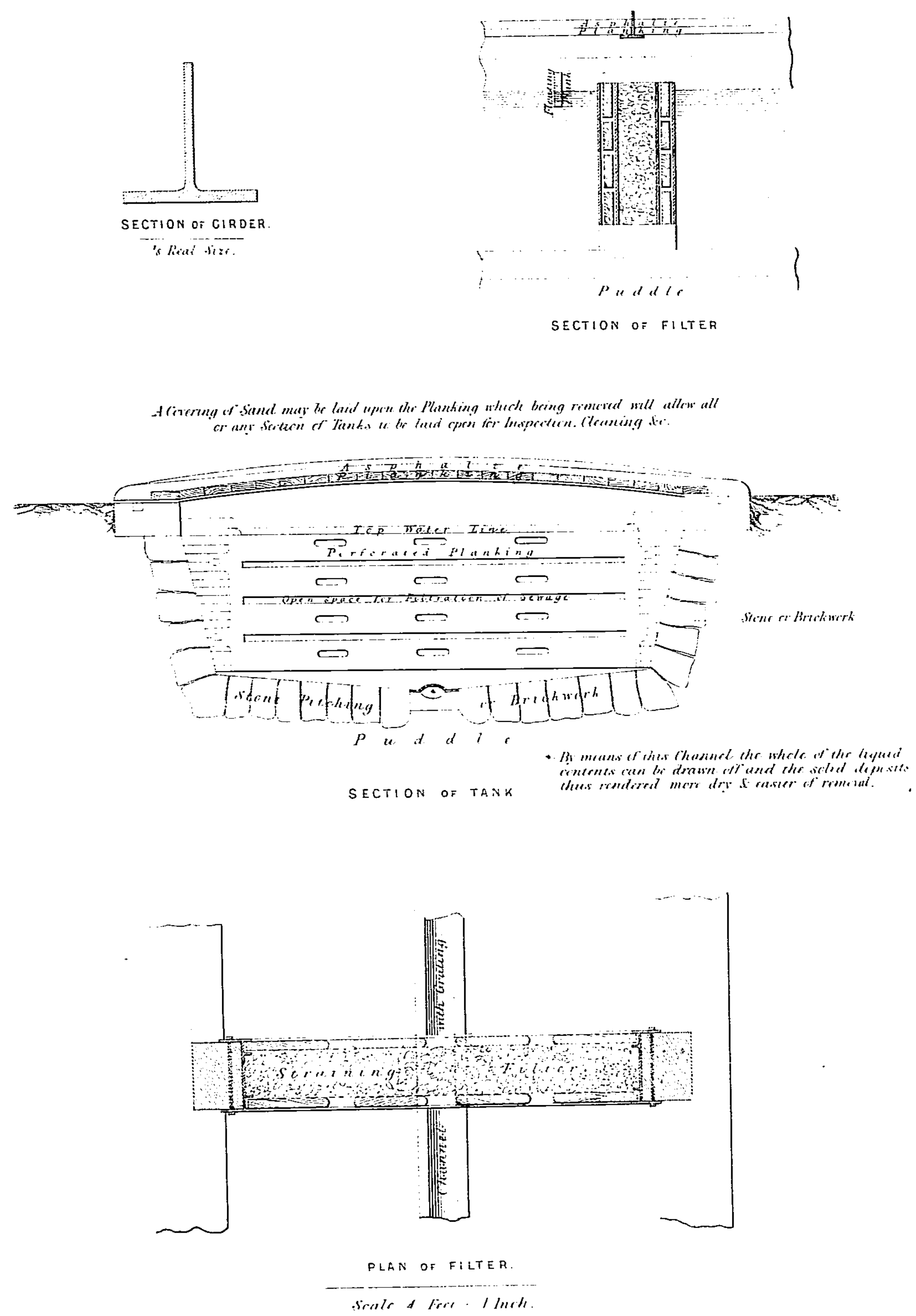
Durham, July 19, 1867. (Signed) William Crozier, M.I.C.E.

* Pipes laid much closer, being garden ground.




DURHAM COUNTY LUNATIC ASYLUM AT SEDGEFIELD.
SHEWING THE PLOTS OF LAND UNDER SEWAGE IRRIGATION.
Fishburn Bridge
SKERNE
From Durham
Manure Tank
Entrance Lodge
Workshops
Gas Works
Gasometer
COUNTY ASYLUM
Cottages
Dead House
Well Garth Farm
Wells
Reservoir
Gardener's Lodge
High Farm
Weterton Cottage
Winterton Mill
From Stockton and Sedgefield
From Sedgefield
Scale of Feet.
1000 Feet

BLACKBURN,
SEWAGE OUTLET WORKS.
DETAILS.



:here has been
into the river)
tter, estimated
: varied ejects
must form a
er.
g of the tanks

· as could be
) tons of solid
out 2,700 tons
: towards im-
t that the ad-
have shown
l up, will very
er as it leaves

RLEY, C.E.

e working it,
at value per

do you pro-
?

o, do you buy
to what value

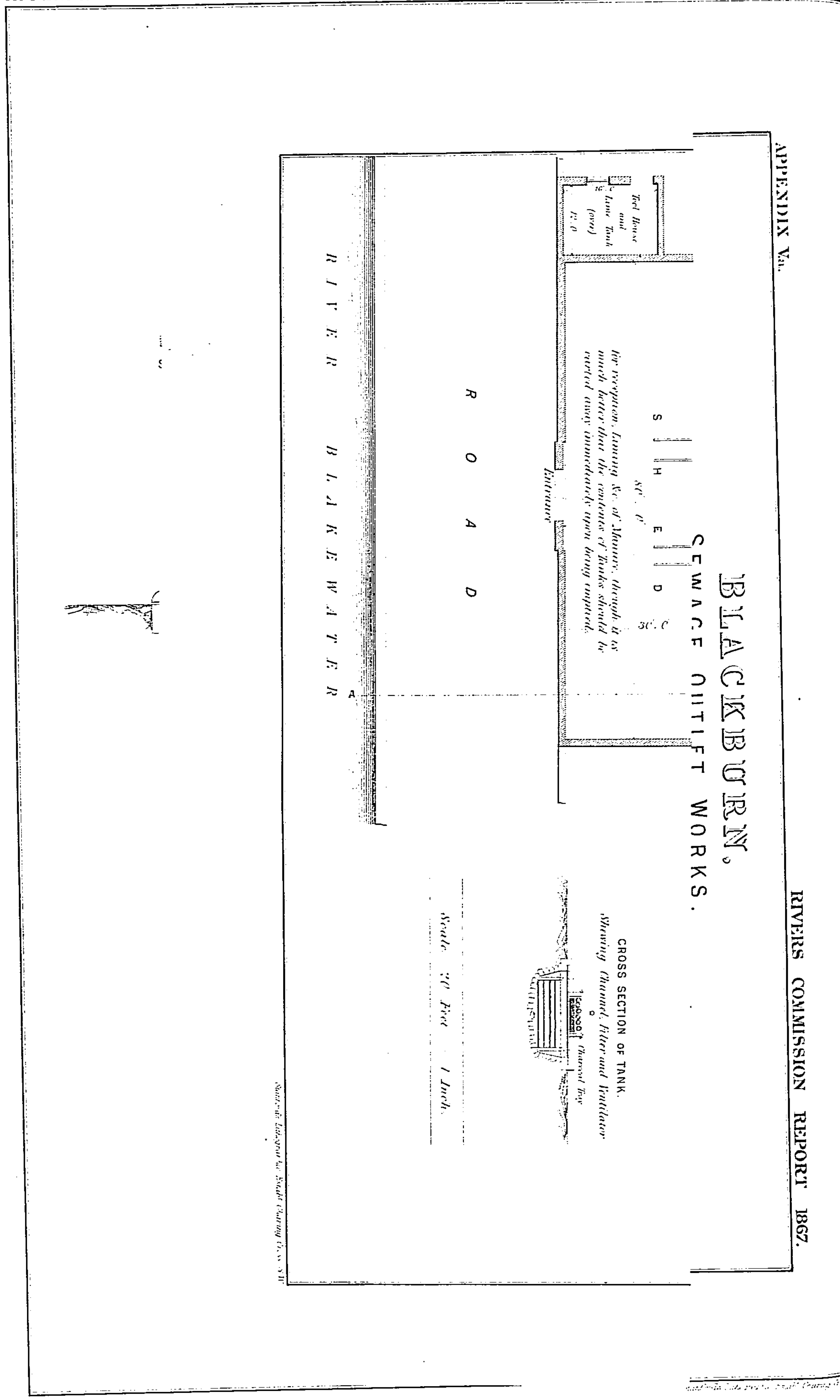
e in washing
r water?

works treated
ourself or by

ction of the

. or only the

process pass



APPENDIX No. V.

Blackburn Sewage Outlet Works.

The following description of the sewage outlet works at Blackburn, together with the accompanying plans, were furnished to the Commissioners by Joseph Brierly, Esq., C.E. :—

Blackburn, September 14th, 1866.

The value and the necessity of a sufficient and proper arrangement of "storm outlets" has been proved here during the past month; heavy rains have ested the sewers, and the main outfall 6.0 × 4.0 has been surcharged, shooting out its contents at full bore, and with immense force. By proper attention to the "storm outlets" all danger and inconvenience has been avoided.

The tanks are constructed on the Worksop model, —open trenches with brick or stone bottom and sides. They were set to work three weeks ago, and are now being emptied. In this period of time there has been accumulated (and arrested from flowing into the river) a quantity of solid refuse and sewage matter, estimated at 160 tons, consisting of road grit, the varied ejects from dwellings and W.C. refuse. This must form a very rich manure, and will be sought after.

I have carefully watched the working of the tanks with much interest.

The effluent water was not so clear as could be desired, but still the fact of arresting 160 tons of solid matter in three weeks, or at a rate of about 2,700 tons per annum, shows what has been done towards improving the river, and I have no doubt that the additional means of filtration, &c., which I have shown on plans, and which are now being fitted up, will very much improve the condition of the water as it leaves the tanks.

(Signed) Joseph Brierley, C.E.

APPENDIX No. VI.

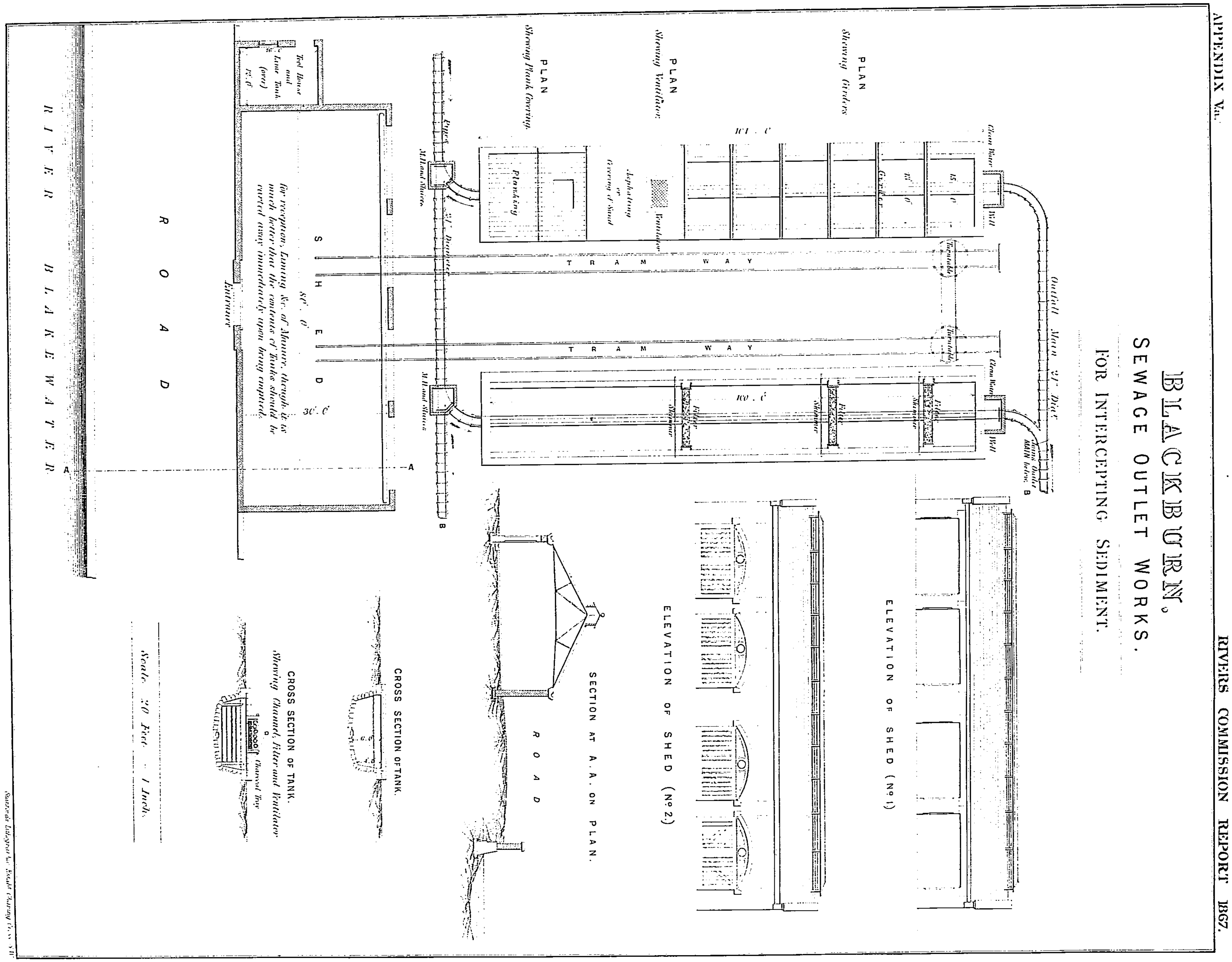
Previously to framing our report, we requested from about 60 of the leading manufacturers answers to the following queries. We received 28 replies, the substance of which are tabulated in pages

Rivers Pollution Commission.—Inquiry into the state of the Rivers Aire and Calder and their Tributaries, 1866-67.

Queries relating to the Woollen and Worsted Trades.

1. About what weight of wool do you use in a year?
2. How much of this wool do you wash?
3. Do you use soap or alkali as well as urine in washing the wool; if so how much?
4. How much water in gallons is used in washing?
5. About how much wool by weight do you dye, and what colours principally?
6. About what value of dyestuffs do you use annually?
7. What quantity of water do you use in the dye vats, and where does the waste water flow?
8. Do you put oil to the wool before working it, and if so, what oil and about to what value per annum?
9. About what weight of waste wool do you produce in carding, and what becomes of it?
10. Do you wash the goods? and if so, do you buy or make soap? About how much, and to what value per annum?
11. What quantity of water do you use in washing the goods, and what water, river or other water?
12. Are the soapsuds made on your works treated for recovery of grease? and if so, by yourself or by a contractor?
13. What do you gain by the extraction of the grease?
14. Are the whole washings treated, or only the first flow?
15. Does the water from the grease process pass away clear, or how nearly so?

The answers are tabulated, pp. lxii—lxvii.



BLACKBURN SEWA

The following descrip
works at Blackburn, toget
plans, were furnished to t
Brierly, Esq., C.E.:—

Blackbu

THE value and the n
proper arrangement of
proved here during the pa
ested the sewers, and the
been surcharged, shootin
bore, and with immense
to the "storm outlets" a
has been avoided.

The tanks are constru
—open trenches with bric
They were set to work t

Previously to framing c
about 60 of the leading m
following queries. We r
stance of which are tabul

RIVERS POLLUTION COM
state of the Rivers
Tributaries, 1866-67.

QUERIES relating to th
TR

1. About what weight
2. How much of this w
3. Do you use soap or
washing the wool; if so h
4. How much water in
5. About how much w
and what colours principa
6. About what value
annually?
7. What quantity of w
vats, and where does the

APPENDIX No. VI.

QUERIES relating to the WOOLLEN and WORSTED TRADES sent to the MANUFACTURERS and DYERS engaged therein in the Towns of Bingley, Bradford, Dewsbury, Halifax, Honley, Huddersfield, Keighley, Leeds, Lockwood, Mirfield, Mold-Green, Rastrick, Saltaire, Skipton, Sowerby-Bridge, and Wakefield, with the Answers received as under.

			1.	2.	3.	4.	5.									
No.	Name of Manufacturer.	Residence.	What Weight of Wool do you use per Annum?	How much of this Wool do you wash per Annum?	Do you use Soap or Alkali as well as Urine in washing the Wool? If so, how much per Annum?	How much Water per Annum is used in washing?	Weight of Wool, and of what Colours dyed, per Annum? Weight in lbs.	Blue.	Black.	Brown.	Crimson.	Drab.	Green.	Red.	Scarlet.	Yellow.
1	Armitage Bros.	Huddersfield.	347,000 lbs.	267,000 lbs.	No soap, but soda and urine.	- - -	167,000	+	+	—	—	—	—	—	—	—
2	Akroyd, James, and Sons.	Copley Mills, Skircoat, Halifax.	Nearly 343,000, the bulk of the wool used here having been washed at the other works in the borough of Halifax, and included in answers given from there.	343,000 lbs.	~~24,000 lbs. of~~ soap, 10,500 lbs. of alkali. No urine.	~~5 to 600,000 gal-~~ lons.	None -	—	—	—	—	—	—	—	—	—
3	Bates, John -	Dewsbury	350,000 lbs.	Spin wool unwashed. Scour and wash all wool produced.	No urine. About 15 tons of alkali and 3 tons of soap.	Unlimited: quantity not known.	290,000	+	+	+	+	+	+	+	+	+
4	Barker, R. H., & Co.	Wakefield	1,000,000 lbs.	Nearly the whole.	Soap, but not urine.	14,000,000 gallons.	280,000	+	+	+	—	—	—	—	—	—
5	Brooke, Henry	Huddersfield.	170,000 lbs.	127,000 lbs.	Use 8 cwt. of alkali.	About 300 gallons for 60lbs. of wool, that is 635,000 gallons.	About 115,000.	—	+	—	—	+	—	—	—	—
6	Brooke, John, and Sons.	Huddersfield.	In 1865 we used 506,500 lbs.; in 1866 we used 519,162 lbs.; in 1867, up to June, rather more than in the corresponding time of 1866. The average of three years, 535,000 lbs.	The whole	Soda occasionally used, but to a very small extent, and may be considered quite an exception.	About 78,000,000 gallons.	Nearly the whole quantity in wool or cloth is dyed on our premises.	+	+	+	—	+	—	—	—	—
7	Clay, Daniel -	Sowerby Bridge.	1,176,000 lbs. -	324,000 lbs.	38,400 lbs. of soap; 8,624 lbs. of ashes.	664,000 gallons	72,000	+	+	+	—	—	—	—	—	—
8	Clay, J -	Rastrick -	- - -	- - -	- - -	- - -	- - -	—	—	—	—	—	—	—	—	—
9	Clough, John -	Keighley -	750,000 lbs. -	660,000 lbs.	Soap and its equivalent in alkali and oil, but no urine; equal to 56,000 lbs. of soft soap.	Not known -	None -	—	—	—	—	—	—	—	—	—

		6.	7.	8.	9.	10.	11.	12.	13.	14.	15.
No.	Name of Manufacturer.	What Value of Dyestuffs do you use per Annum?	What Quantity of Water do you use in the Dye Vats per Annum, and where does the waste Water flow?	Do you put Oil to the Wool before working it? If so, what Oil, and about what Value per Annum?	What Weight of waste Wool do you produce in carding per Annum, and what becomes of it?	Do you wash the Goods? If so, do you buy or make Soap? How much, and what Value per Annum?	What Quantity of Water do you use per Annum in washing the Goods, and what Water, River or other?	Are the Soapsuds made on your Works treated for Recovery of Grease? If so, by yourself or by a Contractor?	What do you gain by the Extraction of the Grease per Annum?	Are the whole Washings treated, or only the first Flow?	Does the Water from the Grease Process pass away clear, or how nearly so?
1	Armitage Bros.	2,350l.	Waste water flows into river.	Yes. Gallipoli, 1,460l.	About 62,400 lbs. We work it up again.	Yes. Buy soap, about 17,000lbs., in value 280l.	Spring, but some of river water.	Yes, partly by a contractor.	30l.	Not entirely	Not quite clear.
2	Akroyd, James, and Sons.	None -	None -	Yes. Olive, 250l.	About 15,000 lbs. waste and sand or dust; the former sold, the latter used as manure.	Wash yarn. Buy soap about 7,200 lbs., in value say from 90l. to 100l.	300 to 400,000 gallons in washing the yarn. Spring water and water condensed from steam.	No - -	Nil.	—	—
3	Bates, John	1,200l.	470,000 gallons, waste water into river.	Yes. Rape, 450l.	50,000 lbs. Sold for manure.	Wash yarn. Buy soap, in value 260l.	Unlimited; river water.	No - -	The grease is not extracted.	- - -	The waste from all processes flows into river.
4	Barker, R. H., & Co.	5,000l.	2,200,000 gallons.	Yes. Gallipoli, 3,000l.	35,000 lbs. Sold to waste dealers.	Yes. Buy soap, 89,600 lbs. in value 700l.	4,700,000 gallons; river water, part filtered.	Suds from yarn and worsted are so treated by a contractor. Suds from wool-washing are not, but flow into river.	About 100l.	The whole washings.	Not clear.
5	Brooke, Henry	300l.	520,000 gallons, waste into river.	Yes. Galipoli, 740l.	About 56,000 lbs. Sold to oil extractor and maker of artificial manure.	Yes. Buy soap, about 14,224 lbs. in value 214l.	Quantity not known; part from canal, part from bore-hole.	Yes, by a contractor.	30l.	Only the first flow.	The water does not pass away clear. It may be compared to the water in the vats during the second washing of the wool.
6	Brooke, John, and Sons.	About 6,200l., i.e., about 4,800l. indigo, 1,400l. dyewoods and chemicals.	About 3,756,000 gallons, waste into river Holme.	Yes. Olive, 2,850l.	After reserving the best waste, say 3½ cwt., for our own use in manufacture, we sell about 15 cwt. of waste per week. Total waste per annum produced, 107,124 lbs. N.B.—This is carding waste only, not ends from subsequent process.	Yes. Buy soap, 40,320 lbs. in value 580l.	62,600,000 gallons. No river water is used. Three-fourths of supply from a bore-hole, and the remaining part from a stream flowing through our property.	Yes, by a contractor.	Nothing. The amount paid to us by the contractor is 55l., but that is absorbed by the expense of steam, &c.	Only the first flow.	Not nearly so at all.
7	Clay, Daniel	3,000l. -	70,000 gallons, waste flows into river.	Yes. 14,500 gallons, 3,020l.	51,800 lbs. of the best sort sold for mixing with the wool again, 80,640 lbs. of the lower sort sold to a grease extractor.	Yes. Buy soap 35,840 lbs. in value 480l.	75,000,000 gallons; principally river, but spring water when we can procure it.	Yes, by a contractor.	About 150l.	Only the first flow.	Pretty clear.
8	Clay, J	The value of the dye stuffs will not exceed 500l. Most of the valuable colours are dyed elsewhere, and only cleaned on the premises.	- - -	- - -	- - -	Yes. Buy soap, 58,000 lbs. in value 600l.	About 2,504,000 gallons of well water, say 5,008,000 gallons from stream, total 7,512,000 gallons, but this is variable as the supply from the stream is uncertain.	No, they are too much diluted to be of any value.	—	—	—
9	Clough, John	Nil - -	None -	Yes. Gallipoli, 650l.	None - -	No - -	None - -	Not yet, but we have erected buildings for the purpose.	—	—	—

NOTE.—The + in the above columns is placed opposite the names of the manufacturers and dyers to denote the colours they dye.

QUERIES relating to the WOOLLEN and WORSTED TRADES, &c.—*continued.*

No.	Name of Manufacturer.	Residence.	1. What Weight of Wool do you use per Annum?	2. How much of this Wool do you wash per Annum?	3. Do you use Soap or Alkali as well as Urine in washing the Wool? If so, how much per Annum?	4. How much Water per Annum is used in washing?	5. Weight of Wool, and of what Colours dyed, per Annum? Weight in lbs.	Blue.	Black.	Brown.	Crimson.	Drab.	Green.	Red.	Scarlet.	Yellow.
10	Crowther, Alfred.	Lockwood, Huddersfield.	500,000 lbs.	All - -	Urine only -	36,000,000 gallons.	We dye all or nearly so.	+	+	—	—	—	—	—	—	—
11	Crosland, George, and Sons.	Lockwood, Huddersfield.	600,000 lbs.	12 per cent.	Alkali and urine.	1,600,000 gallons.	400,000 lbs. per annum.	—	+	—	—	—	—	—	—	—
12	Dent, R.	Wakefield	- - -	- - -	About 7,840 lbs. of soap and 16,800 lbs. of soda and soda ash.	About 32,000,000 gallons.	- - -	—	—	—	—	—	—	—	—	—
13	Dewhurst, John and Sons.	Skipton -	We are not users of wool until after it is spun into woollen or worsted yarn.	- - -	- - - -	- - - -	None -	—	—	—	—	—	—	—	—	—
14	George, T. W., and Company.	Leeds -	- - - -	- - -	- - - -	- - - -	- - -	—	—	—	—	—	—	—	—	—
15	Holdsworth, J., and Sons.	Wakefield	- - - -	3,000 pieces, 5,600 lbs. of wool or waste.	No - - -	- - - -	3,000 pieces, 5,600 lbs. of wool or waste.	+	—	—	—	—	—	—	—	—
16	Howgate, Jas., and Sons.	Mirfield -	1,080,000 lbs. Wool and shoddy.	We buy our wool washed, except a very small portion.	Urine and alkali.	- - - -	240,000 lbs.	—	+	+	+	—	+	+	—	+
17	Ingham, Edward.	Halifax -	- - - -	- - -	- - - -	- - - -	3,505,600 lbs.	+	+	+	+	+	+	+	+	+
18	Kirk, Joseph M.	Halifax -	- - - -	- - -	No urine. About 22,400 lbs. of soap and 89,600 lbs. of soda ash.	- - - -	No wool -	+	+	+	+	+	+	+	+	+
19	Marriner, Edward.	Keighly -	960,000 lbs.	All - -	Soap. 124,800 lbs.	2,504,000 gallons.	None -	—	—	—	—	—	—	—	—	—
20	Oates, Ingham, and Sons.	Bradford -	1,800,000 lbs.	All - -	112,000 lbs. -	150,000,000 gallons.	1,200,000 lbs.	+	+	+	+	+	+	+	+	+
21	Salt, Titus, Sons, and Company.	Saltaire -	5,000,000 lbs.	3,823,000 lbs.	Soap 577,560 lbs., alkali 10,000 lbs. No urine.	4,000,000 gallons.	200,000 lbs.	+	+	+	+	+	+	+	+	+
22	Sugden, Jonas, Brothers.	Keighley -	About 1,000,000 lbs.	About 250,000 lbs.	Soft soap, about 40,000 lbs.	250,000 gallons.	Do not dye	—	—	—	—	—	—	—	—	—

NOTE.—The + in the above columns is placed opposite the names of the manufacturers and dyers to denote the colours they dye.

No.	6. What Value of Dyestuffs do you use per Annum?	7. What Quantity of Water do you use in the Dye Vats per Annum, and where does the waste Water flow?	8. Do you put Oil to the Wool before working it? If so, what Oil, and about what Value per Annum?	9. What Weight of waste Wool do you produce in carding per Annum, and what becomes of it?	10. Do you wash the Goods? If so, do you buy or make Soap? How much, and what Value per Annum?	11. What Quantity of Water do you use per Annum in washing the Goods, and what Water, River or other?	12. Are the Soapsuds made on your Works treated for Recovery of Grease? If so, by yourself or by a Contractor?	13. What do you gain by the Extraction of the Grease per Annum?	14. Are the whole Washings treated, or only the first Flow?	15. Does the Water from the Grease Process pass away clear, or how nearly so?
10	2,600*l.*	2,000,000 gallons waste flows into river.	Yes. Olive. 4,000*l.*	Weight not known. Clean waste we use again in low goods.	Soap used in milling only, in value 600*l.*	10,000,000 gallons; all from river.	Yes, by contractor.	70*l.* - -	Only the first flow.	Not nearly clear.
11	1,400*l.*	640,000 gallons; waste flows into river.	Yes. Olive. 2,300*l.*	80,000 lbs.; sold for the purpose of extracting the oil.	Yes. Buy soap 40,000 lbs., in value 700*l.*	9,000,000; all from river.	Yes, by contractor.	40*l.* - -	Only the first flow.	Very dirty.
12	3,000*l.*	6,260,000 gallons; waste water flows into river Calder.	- - -	- - -	Yes. Buy soap, in value 100*l.*	About 32,000,000; chiefly water from river Calder.	No.	—	—	—
13	About 1,200*l.* for dyeing cotton warps.	About 3,756,000 gallons; waste flows into Eller Beck.	- - -	- - - -	No.	—	—	—	—	—
14	- - -	About 6,260,000 gallons; waste flows into river Aire.	- - -	- - - -	We use a very small quantity of soap; and scarcely any in scouring.	About 46,950,000 river water, and 31,300,000 well water.	The quantity is so small as not to be worth collecting.	—	—	—
15	12,000*l.*	Waste water flows into river.	- - -	- - - -	- - -	About 37,560,000; river water.	—	—	—	—
16	1,500*l.*	18,780,000 gallons; waste flows into river.	Yes. Olive and Gallipoli, 60 tons, in value 3,500*l.*	112,000 lbs.; sold to extractors.	Yes. Buy soap 89,600 lbs., in value 1,389*l.* 2*s.* 11*d.*	About 7,825,000; river water.	Yes, and by a contractor.	55*l.*	The whole of the first and part of the second.	Very clear.
17	25 to 30,000*l.*	78,250,000 gallons; waste flows into sewers.	No.	- - - -	Yes. Buy soap 14,400 lbs., in value 150*l.* to 170*l.*	Spring water -	No; the soapsuds with other liquids flow into sewers.	—	—	—
18	15,000*l.*	31,300,000 gallons; waste flows into Hebble Brook.	Nil.	Nil.	Yes. Buy soap, in value 400*l.*	109,550,000; principally from river, part from springs and waterworks company.	No.	Nil.	—	—
19	- - -	- - -	Yes. Gallipoli, in value 250*l.*	About one-third, which is sold to short wool dealers.	Yes. Amount included in answer to No. 3.	1,252,000; pure spring water, the river being foul.	Yes, by a contractor.	3*s.* per pack on the soap used.	The whole	Not clear.
20	30,000*l.* We burn all our spent woods.	The whole quantity of water is used in scouring, dyeing, and washing off. Waste flows into Bradford Beck.	No.	- - - -	Yes. Buy soap, 1,200*l.*	The water we use is partly supplied by the waterworks company, but principally from wells. We do not use the river water, it is too dirty.	No.	—	—	—
21	2,000*l.*	Cannot say. The waste flows into river.	No.	All is sold - -	Only wash wool and yarn. We make 215,000 lbs. of soap. We also buy 360,000 lbs. of soap.	- - - -	Yes, by a contractor.	900*l.* for rent of a small shed and all the soapsuds.	The whole of the washings.	Very nearly clear.
22	None.	- - -	Yes. Gallipoli, in value 3 to 400*l.*	30,000 lbs.; sold to wool manufacturers.	Scour yarns. Soap 7,000 lbs., in value 130*l.*	62,600,000 gallons; spring water.	Yes, by a contractor.	30*l.*	The whole	Nearly clear.

QUERIES relating to the WOOLLEN and WORSTED TRADES, &c.—*continued*.

No.	Name of Manufacturer.	Residence.	1. What Weight of Wool do you use per Annum?	2. How much of this Wool do you wash per Annum?	3. Do you use Soap or Alkali as well as Urine in washing the Wool? If so, how much per Annum?	4. How much Water per Annum is used in washing?	5. Weight of Wool, and of what Colours dyed, per Annum?									
							Weight in lbs.	Blue.	Black.	Brown.	Crimson.	Drab.	Green.	Red.	Scarlet.	Yellow.
23	Wormald, John	Dewsbury	About 3,600,000 lbs.	None before manufacture.	Soap, alkali, urine, and pig's dung.	- - - -	About 240,000 lbs.	+	—	+	+	+	—	—	+	—
24	Yewdall, David, and Sons.	Leeds -	1,500,000 lbs.	All.	Alkali, 28,000 lbs.; urine for washing wool, 120,000 gallons; urine for scouring cloth, 108,000 gallons.	100,000,000 gallons.	96,000 lbs.	—	+	—	+	+	+	—	—	+
25	Not signed, postmark Bradford.	- - -	1,440,000 lbs.	All.	Soft soap, 168,000 lbs.	2,817,000 gallons.	- - -	—	—	—	—	—	—	—	—	—
26	Not signed, postmark Halifax.	- - -	2,400,000 lbs.	All.	Soap and alkali only, 76,800 lbs.	1,555,000 gallons.	Do not dye	—	—	—	—	—	—	—	—	—
27	Not signed, postmarks Shepley and Huddersfield.	- - -	300,160 lbs.	All.	Very little soap. About 2,240 lbs. of alkali.	About 7,160,400 gallons for wool, and 3,080,200 gallons for pieces.	289,200 lbs.	+	+	+	+	+	+	+	+	+
28	Not signed, postmarks Honley and Huddersfield.	- - -	300,000 lbs. wool, mungo, &c.	240,000 lbs.	Urine - -	- - - -	300,000 lbs.	+	+	+	—	—	—	—	—	—
a 29	John Shaw and Sons.	Staniland, near Halifax.	4,440,000 lbs.	2,880,000 lbs.	All soap - -	109,550,000 gallons.	We do not dye wool.	—	—	—	—	—	—	—	—	—

NOTE.—The + in the above columns is placed opposite the names of the manufacturers and dyers to denote the colours they dye.

a. This return was only received on August 7th, 1867, too late for use in the body of the report.

No.	6. What Value of Dyestuffs do you use per Annum?	7. What Quantity of Water do you use in the Dye Vats per Annum, and where does the Waste Water flow?	8. Do you put Oil to the Wool before working it? If so, what Oil, and about what Value per Annum?	9. What Weight of Waste Wool do you produce in carding per Annum, and what becomes of it?	10. Do you wash the Goods? If so, do you buy or make Soap? How much, and what Value per Annum?	11. What Quantity of Water do you use per Annum in washing the Goods, and what Water, River or other?	12. Are the Soapsuds made on your Works treated for Recovery of Grease? If so, by yourself or by a Contractor?	13. What do you gain by the Extraction of the Grease per Annum?	14. Are the whole Washings treated, or only the First Flow?	15. Does the Water from the Grease Process pass away clear, or how nearly so?
23	2,500*l*.	Cannot say. Waste flows into river.	Yes. Rape, Price's patent cloth, and olive. In value 8,000*l*.	About 336,000 lbs. called Kent muck, at one time used for hops now sold or put on land, and about 12,000 lbs. waste sold to low carpet makers.	Yes. Buy soap, about 112,000 lbs. In value 1,700*l*.	River water principally, sometimes waterworks company.	Yes, by Messrs. Teall, Le Paige, and Company.	130*l*.	The first flow.	—
24	150*l*.	Waste water into river Aire.	Yes. Gallipoli, olive. In value 3,500*l*.	64,000 lbs. per annum; sold to waste dealers.	Yes. Buy soap. In value 1,000*l*.	15,000,000 gallons from river Aire and waterworks company.	Yes, by a contractor.	75*l*.	The first flow and the finishing.	Very nearly.
25	- - -	- - -	Yes. In value 1,000*l*.	48,000 lbs. per annum; sold to clothiers.	Only wash wool. See No. 4.	Only wash wool. See No. 4.	Yes, by a contractor.	About 100*l*.	All - -	Clear.
26	None.	None.	Yes. Gallipoli. In value 800*l*.	Cannot tell quantity; all sold.	Don't wash goods. Buy soap. See answer to No. 3.	None - - -	Yes, by a contractor.	About 150*l*.	The second flow only.	Nearly so.
27	350*l*. to 400*l*.	374,400 gallons; waste pumped out to land.	Yes. Olive and patent. In value 4,000*l*.	896 lbs.; we sell it, or put it on to land.	Yes. Buy soap, 11,200 lbs. In value 200*l*.	3,080,200 gallons; from springs.	No - - -	Nil.	- - -	All pumped on to land.
28	400*l*.	Waste flows into beck.	Yes. Olive and patent. In value 650*l*.	Burnt chiefly -	Yes. Buy soap. In value 250*l*.	Spring water -	Yes, by a contractor.	20*l*.	First flow	Nearly clear.
a 29	22,000*l*.	15,650,000	Yes. Gallipoli and Price's patent oil. 4,000*l*.	336,000 lbs.; used on land, and also in Kent for hop growing.	Yes. Buy soap. In value 2,500*l*.	109,550,000 gallons; one-third from wells, and the remaining two-thirds from river.	Yes, by a contractor.	150*l*.	The whole	Quite clear.

APPENDIX No. VII.

Impounding Reservoirs.

The first consideration in any proposed impounding reservoir work should be as to the site of the bank, and how to deal with it. If the site is rock, limestone, millstone grit, or other open-jointed rock, care must be taken so to combine the material of the bank with the rock as to prevent "creeping" and washing of water from within the reservoir along the junction of the puddle and rock at the bottom and sides of the bank, as also through the beds and joints of the strata. The cheapest material which can be safely used will be concrete, made of the best hydraulic lime, and laid thickly over the entire surface of the puddle-trench. Concrete, or a thick bed of mortar, should in fact protect puddle from contact with rock, gravel, clay, or earth at every point. A trench (answering as puddle-trench), filled with concrete, may in some instances be necessary if the ground contains landsprings, or produces much water during its excavation. If a trench fills rapidly with water when open, it may admit water to act upon any clay-puddle when the work has been completed, and just in proportion as this admission of water takes place under pressure, and washing or wasting of clay-puddle takes place, will there be danger to the embankment. On the other hand, concrete which has set will neither be injured nor injuriously wasted by washing, but any melting out of portions of lime will tend to fill up the pores and channels in the rock along which lime-impregnated water finds escape. An embankment having its base and sides fully protected by concrete and good rough hydraulic mortar, might leak considerably through fissures extending below the embankment, and yet not leak dangerously, as there could not be any washing and wasting of the material forming such bank.

No embankment should ever depend solely on a "clay puddle-wall." Puddle-walls should be supported throughout the main body of the bank on both sides, by selected material, such as earth freed from stones, loam, shale, or clay, and in this state capable of resisting water. Such selected material, combined with the puddle, should form the central portion of the bank, and be in substance not less than one-third of the entire bank. It will, however, be far better and safer to select material for the entire bank, and place it in thin layers (not exceeding 12 inches in depth,) evenly over the entire surface of the bank, using neither railways nor waggons, but wheelbarrows and "dobbin-carts."

The "Bunds" or banks of the great "Tanks" or reservoirs in India, have no puddle-trench such as modern engineers excavate (120 feet in depth at times). These Indian embankments were most probably formed on the surface after precautions had been taken to prevent creeps of water betwixt the materials used and the ground. The earth to constitute the bank was then carried to the site by numerous labourers, male and female, and was trodden down by thousands of naked human feet, sometimes also by the feet of elephants, and so was alternately washed by monsoon rains, dried by a tropical sun, and thus grew slowly, through years of labour, to be the enduring mass which has weathered the storms and tempests of not less than 30 centuries. Embankments have from time to time been ruptured and washed away in India in consequence of bye-wash space being limited, but other great Indian embankments have stood, and are now standing, to attest the skill, patience, and labour with which they were first formed. Many of the reservoir embankments in England recently formed have been made too rapidly. The hot speed of railway works cannot be safely adopted in waterworks. There must be time for incorporation of material with material, and for slow consolidation.

Reservoir embankments ought to be executed with more care, and will then necessarily be proportionately more costly than ordinary railway embankment works. Cheap work and speed have, however, been cried out for, and engineers have committed the fatal mistake of allowing the lowest contractor to have the job. The inevitable results are either that the contractor fails before the work is far advanced; or, if allowed to complete the bank, that the work, on being tested by filling the reservoir, proves worthless. A sound, safe, and enduring reservoir embankment cannot have been constructed at much less than double the price paid for earthwork which safely serves for railway embankments.

Reservoir embankments should never have outlet-works (pipes, culverts, or sluices) placed beneath or in the bottom mass of the made bank, but such works should be formed in the solid ground, on one side, so as to be beyond the influence of any subsidence or motion caused by piling up the materials forming the bank. Clay and marl subsoils will compress, subside, and occasionally slip, in which cases any pipes or culverts if placed in such bank are damaged, if not broken and utterly ruined.

Outlet-culverts need not be laid with their inverts at the bottom level of the reservoir, but may be from 10 to 20 feet above the inner bottom level of the bank. This mode of working insures that the base of the bank shall be undisturbed. In the Dale dyke reservoir which gave way above Sheffield, and destroyed some 235 human lives, cast-iron pipes were laid beneath the mass of the bank, at its lowest depth, the same pipes having the fall or grade of the valley, which amounted to near 20 feet in the 500 feet width of the bank; thus adding 20 feet additional pressure on the valves, which were placed on the outer foot of the bank. If a level culvert had been formed in the solid rock on one side, having its invert 20 feet above the bottom of the reservoir on the inner sides, and the valves had been placed in such culvert, there would have been 40 feet less head, and consequently 40 feet less pressure on the deepest working valve. The inner 20 feet in depth of water in a V-shaped valley, having a rise of 70 feet in the mile, is of little consequence, and the space forms a receptacle for sediment. But even this volume of water can be provided for, so as to be drawn down by a syphon laid through the outlet culvert, that the last foot in depth of water may be abstracted.

Some large embankments have failed so as to prevent their use, and the money expended upon their construction has been wasted. A reservoir embankment may fail from several causes, as—

1. Where an improper site has been chosen, upon rock full of natural fissures which cannot be traced and stopped.
2. Where the subsoil is compressible, as on silt, clay, or marl, and where outlet works have been placed in the made portion of such bank, and subsidence, crushing, and slipping have taken place.
3. Where a puddle-trench is affected by springs which have not been drained; or where washing and wasting of the clay-puddle commences through some undiscovered fissure, in rock or vein of gravel or sand, if in alluvium, after the head of pressure brought to bear from a full reservoir has been established.
4. Where the material of which the embankment is composed is not calculated to become water-tight, as rocky material or gravelly earth tipped in from railway waggons an ordinary puddle-wall cannot be trusted under such arrangements; water under pressure finding its way to a puddle-wall so supported will have all its weakest points sought out and tested, and a leak once set up in such case must be a source of danger.
5. Where an embankment is made entirely of clay, which melts and slips as such material is liable to do if put together during wet weather.

A reservoir may also fail by a creep of water taking place through the embankment along the outer surface of either cast-iron pipes or outlet-culvert, or by drawing water from valves placed under too great pressure within the embankment. Water issues through valves with friction and velocity proportionate to the head; it obeys the law of gravity applicable to the falling of solid bodies. A solid body of cast-iron falling through 90 feet of space would only strike with a similar velocity to that with which water would rush through an open valve at this depth, and as the power of water to wear, wash, and injure is in proportion to its volume and velocity, the engineer should, in his reservoir arrangements, use all practicable means to control and prevent high velocities through valves, discharge-culverts, and over bye-washes. No outlet valve ought to be placed under a greater head of pressure than 20 feet. Vertical wells for overflow are not advisable even when constructed in solid ground, but if formed within the substance of embankments they are positively dangerous. A bye-wash should be formed down the solid ground, and by steps not exceeding 4 feet in depth. The usual slopes given to reservoir embankments formed of earth are, on the inside 3 horizontal to 1 vertical, and on the outside $2\frac{1}{2}$ horizontal to 1 vertical. Minor details of construction and general rules for maintenance and working of impounding reservoirs cannot be fully given here, they will require to be treated separately in some special waterworks report.

R. R.

Note.—In a valve-well there may be valves not more than 10 feet apart vertically, so as to reduce the pressure on any single valve to 10 feet, as the water is reduced.

APPENDIX No. VIII.

From the Times Newspaper of August 1, 1867.

Court of Chancery, Lincoln's Inn, July 31.

(Before the Lords Justices of Appeal.

Baxendale v. M'Murray.

This case has been already noticed in the *Times*. It will be remembered that it came on by way of an appeal from an injunction granted by Vice-Chancellor Stuart in July 1866, upon a motion for decree, restraining the defendant, Mr. M'Murray, from polluting the river Chess, near Rickmansworth, by the refuse from his paper mills. The operation of this decree was afterwards suspended by the Lords Justices pending the appeal. The plaintiff, Mr. Baxendale, is the occupier of Scotsbridge House, through the grounds of which the river Chess flows, this house and grounds being situate lower down the stream than Mr. M'Murray's mills. The mills were formerly occupied by the late Mr. Ingram. The plaintiff alleged great nuisance resulting to him in various ways from the refuse which flowed from the mills into the river, and in particular he said that whatever right to foul the stream had been acquired by the former owners of the paper mills, inasmuch as Mr. M'Murray had introduced into the manufacture of his paper the new material called Esparto grass, the fouling of the water thereby produced was a new kind of nuisance, with respect to which no prescriptive right had been acquired. The defendant maintained that he had a right to foul the stream in that way, provided he did so to no greater extent than his predecessors had done, and this he said that he had not done. The evidence was, as usual in cases of this kind, very conflicting. The appeal was argued at great length before Lord Cairns and the late Lord Justice Turner, and judgment was reserved, but was not delivered before the death of the latter. As the parties entertained some doubt whether, under the new Act, one Lord Justice could hear an appeal from a decree, even though made upon motion the appeal was placed on the paper to-day before both their Lordships for the purpose of being formally re-opened, and having the judgment of the Court.

Lord Justice Lord Cairns then stated, with a view to other cases of the same kind, that he had conferred both with his learned brother and the Lord Chancellor, and that they were all of opinion that under the new Act one Lord Justice had jurisdiction to hear appeals from decrees made upon motion for decree.

The appeal was then formally re-opened.

Mr. Bacon, Sir R. Palmer, and Mr. Fry appeared for the defendant; Mr. Dickinson and Mr. Birley for the plaintiff.

Lord Justice Lord Cairns then delivered the judgment of the Court. He said that the conclusion at which he had arrived was concurred in by the late Lord Justice. After a statement of facts of the case, his lordship proceeded thus,—Does the use of a new raw material in the manufacture of paper, from the mere circumstance that the material is raw and different from that formerly used, destroy the right previously possessed by the defendant to discharge polluted water into the stream? With great respect for his honour the vice-chancellor, I doubt whether the question on this part of the case is one as much of law as of fact. The question appears to me to be, what is the right or easement of the defendant? Is it a right, specific and defined, to pollute the stream by discharging the dirty water in which rags have been washed; or is it a right to discharge into the river the refuse liquor and foul washings produced by the manufacture at his mills of paper, in the reasonable and proper course of such manufacture, using the materials which are proper for the purpose, but not increasing, as against the servient tenement, to any substantial or tangible degree, the amount of pollution? In my opinion the right of the defendant would, upon the facts before us, be found, and be properly found, by a jury to be the latter and not the former. It is difficult to suppose the existence of an easement founded on and limited to the washing of rags. If made specific in this way, it would be confined to rags known and in use at the time the easement was acquired, and the rags of textile fabrics afterwards coming into use must, however valuable for the manufacture of paper, be excluded. Rags, again, would afford no standard by which to test or limit the amount of pollution. Some would be much more dirty than others; the washings from some might be harmless, and from others deleterious. In rags produced from vegetable substances the properties of the fibrous matter might be very different; in some, as in linen and cotton rags, the fibre being elaborately treated in the course of manufacture; in others, as in coarse sacking or bagging, especially of hemp or jute, the fibre retaining much more of its original character. I am therefore of opinion that it is not sufficient for the plaintiff to show that the defendant uses in the manufacture of paper a raw material different from that formerly employed; he must show, further, a greater amount of pollution and injury arising from the use of this new material; and the onus, of course, of showing this lies on the plaintiff. His lordship then commented at considerable length on the various heads of nuisance alleged by the plaintiff, and the evidence relating to them, and came to the conclusion that the plaintiff had failed to make out his case. The bill must therefore be dismissed with costs.

APPENDIX No. IX.

TOWNS, and PLACES, situate in the Basin of the Rivers AIRE and CALDER, divided into proposed CONSERVANCY DISTRICTS, with the AREAS and POPULATION, from 1801 to 1861, compiled from Census Tables.

Proposed Conservancy District.	City, Town, Borough, Township, Hamlet, or Place.	Area in Statute Acres.	POPULATION.						
			1801.	1811.	1821.	1831.	1841.	1851.	1861.
SKIPTON -	Malham - - -		262	306	262	259	233	188	184
	Kirkby-Malham - -		167	175	204	219	195	139	128
	Scosthrop - - -		90	80	102	95	48	75	64
	Hanlith - - -		81	51	46	42	25	36	40
	Malham Moor - -		98	97	88	94	102	92	115
	Airton - - -		139	176	187	179	217	225	236
	Otterburn - - -		26	47	40	66	48	54	59
	Calton - - -		98	89	76	79	79	75	56
	Flasby-with-Winterburn -		120	150	134	143	140	124	113
	Cracoe - - -		191	162	179	150	153	159	139
	Hetton-with-Boardley - -		172	212	180	176	191	187	124
	Rilston - - -		177	192	145	115	121	123	107
	Eshton - - -		84	63	69	82	74	84	81
	Cold-Conistone - -		343	257	345	336	242	289	265
	Gargrave - - -		728	897	972	1,062	1,176	1,214	1,103
	Embsay-with-Eastby - -		623	692	861	891	962	948	1,028
	Skipton - - -		2,305	2,868	3,411	4,181	4,842	5,044	5,454
	Stirton-with-Thorlby - -		134	149	168	170	132	182	127
	Bank-Newton - - -		68	102	139	125	129	120	106
	Coates - - -		45	108	97	88	101	138	122
	Marton - - -		322	348	382	443	381	341	256
	Broughton-with-Elslack -		380	581	427	407	407	335	386
	Carlton - - -		845	1,002	1,218	1,265	1,242	1,333	1,506
	Thornton-in-Craven - -		1,202	1,546	1,829	2,246	2,354	2,202	2,112
	Salterforth - - -		398	502	686	725	675	573	424
	TOTAL of the DISTRICT carried to Summary, p. lxxiv.	64,320	9,098	10,852	12,247	13,638	14,269	14,280	14,335
KEIGHLEY -	Bradleys-Both - -		385	412	506	614	557	571	442
	Silsden - - -		1,323	1,608	1,904	2,137	2,346	2,508	2,582
	Cononley - - -		876	1,045	1,350	1,567	1,159	1,272	905
	Farnhill - - -		..	..	..	..	459	581	464
	Kildwick - - -		209	216	175	190	189	206	170
	Glusburn - - -		533	654	787	987	1,052	1,320	1,475
	Cowling - - -		1,140	1,449	1,870	2,249	2,458	2,305	1,815
	Sutton - - -		809	953	1,092	1,153	1,292	1,660	1,699
	Steeton-with-Eastburn -		510	545	753	859	963	1,289	1,341
	Keighley - - -		5,745	6,864	9,223	11,176	13,413	18,259	18,819
	Morton - - -		838	987	1,199	1,219	1,693	1,902	2,113
	Bingley - - -		4,100	4,782	6,176	8,036	10,157	13,437	13,254
	Haworth - - -		3,164	3,971	4,668	5,835	6,303	6,848	5,896
	Wilsden - - -		913	1,121	1,711	2,252	2,684	3,454	2,888
	TOTAL of the DISTRICT carried to Summary, p. lxxiv.	60,480	20,545	24,607	31,414	38,274	44,725	55,612	53,863
BRADFORD -	Thornton - - -		2,474	3,016	4,100	5,968	6,788	8,051	7,627
	Allerton - - -		809	1,093	1,488	1,733	1,914	2,041	2,014
	Clayton - - -		2,040	2,469	3,609	4,469	4,347	5,052	5,655
	Shipley - - -		1,008	1,214	1,606	1,926	2,413	3,272	7,100
	Heaton - - -		951	1,088	1,217	1,452	1,573	1,637	1,673
	Horton - - -		3,459	4,423	7,192	10,782	17,615	28,143	30,189
	Manningham - - -		1,357	1,596	2,474	3,564	5,622	9,604	12,889
	Bradford - - -		6,393	7,767	13,064	23,223	34,560	52,493	48,646
	Bowling - - -		2,055	2,226	3,579	5,958	8,918	13,538	14,494
	Idle - - -		3,398	3,882	4,666	5,416	6,212	7,118	9,155
	Baildon - - -		1,719	2,073	2,679	3,044	3,280	3,008	3,895
	Esholt - - -		268	} 582 {	355	404	443	397	369
	Hawksworth - - -		227		323	327	339	295	237
	Guiseley - - -		825	959	1,213	1,604	1,971	2,572	2,566
	Yeadon - - -		1,695	1,954	2,455	2,761	3,379	4,109	4,259
	Calverley-with-Farsley - -		2,081	2,390	2,605	2,637	4,142	4,892	5,559
	Eccleshill - - -		1,351	1,608	2,176	2,570	3,008	3,700	4,482
	Bolton - - - -		474	581	634	671	683	874	937
	TOTAL of the DISTRICT carried to Summary, p. lxxiv.	33,600	32,584	38,921	55,435	78,509	107,207	150,796	161,746

Proposed Conservancy District.	City, Town, Borough, Township, Hamlet, or Place.	Area in Statute Acres.	POPULATION.						
			1801.	1811.	1821.	1831.	1841.	1851.	1861.
LEEDS -	Addle - - -		606	652	699	703	883	682	801
	Headingley-with-Burley -		1,313	1,670	2,154	3,849	4,768	6,105	9,674
	Bramley - - -		2,562	3,484	4,921	7,039	8,875	8,949	8,690
	Armley - - -		2,695	2,941	4,273	5,159	5,676	6,190	6,734
	Pudsey - - -		4,422	4,697	6,229	7,460	10,002	11,603	12,912
	Tong - - -		1,336	1,505	1,893	2,067	2,515	2,797	3,035
	Drighlington - -		1,232	1,365	1,719	1,676	2,046	2,740	4,274
	Gildersome - - -		1,232	1,409	1,592	1,652	1,917	2,126	2,701
	Morley - - -		2,108	2,457	3,031	3,819	4,087	4,821	6,840
	Churwell - - -		502	666	814	1,023	1,198	1,103	1,564
	Beeston - -		1,427	1,538	1,670	2,128	2,175	1,973	2,547
	Wortley - - -		1,995	2,336	3,179	5,944	7,090	7,896	12,058
	Holbeck - - -		4,196	5,124	7,151	11,210	13,346	14,152	15,824
	Leeds - - -		30,669	35,951	48,603	71,602	88,741	101,343	117,566
	Hunslet - - -		5,799	6,393	8,171	12,074	15,852	19,466	25,763
	Chapel-Allerton - -		1,054	1,362	1,678	1,934	2,580	2,842	3,083
	Potter-Newton - -		509	571	664	863	1,241	1,385	1,878
	Roundhay - - -		84	130	186	314	439	510	570
	Seacroft - - -		659	762	886	918	1,020	1,093	1,235
	Austhorpe - - -		103	150	150	169	173	219	231
	Thorpe Stapleton - -		5	5	25	19	15	36	44
	Templenewsam - -		1,033	976	1,166	1,458	1,428	1,693	1,806
	Swillington - - -		491	492	510	523	565	607	662
	Allerton-by-Water - -		331	292	329	375	490	550	704
	Middleton - - -		831	906	1,096	976	1,077	977	902
	Oulton-with-Woodlesford -		1,223	1,267	1,526	1,496	1,789	1,771	1,851
	Rothwell - - -		1,689	1,711	2,155	2,638	2,988	3,052	3,220
	Lofthouse-with-Carlton -		978	1,054	1,396	1,463	1,536	1,658	2,028
	Thorpe - - -		55	66	80	62	72	83	71
	TOTAL of the DISTRICT carried to Summary, p. lxxiv.	60,800	71,139	81,932	107,946	150,613	184,584	208,422	249,268

RIVER CALDER.

Proposed Conservancy District.	City, Town, Borough, Township, Hamlet, or Place.	Area in Statute Acres.	1801.	1811.	1821.	1831.	1841.	1851.	1861.
TODMORDEN -	Todmorden and Walsden -		2,515	3,652	4,985	6,054	7,311	7,699	9,146
	Stansfield - - -		4,768	5,447	7,275	8,262	8,466	7,627	8,174
	Langfield - - -		1,170	1,515	2,069	2,514	3,284	3,729	4,391
	Heptonstall - - -		2,983	3,647	4,543	4,661	4,791	4,177	3,497
	Erringden - - -		1,313	1,586	1,471	1,933	2,221	2,004	1,764
	Wadsworth - - -		2,801	3,473	4,509	5,198	5,583	4,491	4,141
	Midgley - - -		1,209	2,107	2,207	2,409	2,667	2,393	2,842
	TOTAL of the DISTRICT carried to Summary, p. lxxiv.	43,200	16,759	21,427	27,059	31,031	34,323	32,120	33,955
HALIFAX -	Warley - - -		3,546	3,958	4,982	5,685	6,857	6,408	6,482
	Sowerby - - -		4,275	5,177	6,890	6,457	8,163	7,908	8,753
	Norland - - -		1,181	1,316	1,665	1,618	1,670	1,706	1,718
	Ovenden - - -		4,513	4,752	6,360	8,871	11,799	12,738	11,067
	Halifax - - -		8,886	9,159	12,628	15,382	19,881	25,161	28,990
	Skircoat - - -		2,338	2,823	3,323	4,060	5,237	6,940	7,447
	Northowram - - -		4,887	5,306	6,841	10,184	13,352	15,285	16,178
	Shelf - - -		1,306	1,553	1,998	2,614	3,050	3,414	3,062
	Stainland-with-Old Lindley -		1,800	2,077	2,814	3,037	3,759	4,173	4,657
	Elland-with-Greetland -		3,385	3,963	5,088	5,500	6,479	7,225	8,716
	Barkisland - - -		1,799	2,076	2,224	2,292	2,391	2,129	2,003
	Rishworth - - -		960	1,211	1,588	1,536	1,710	1,540	1,244
	Soyland - - -		1,888	2,519	3,242	3,589	3,603	3,422	3,373
	Southowram - - -		3,148	3,615	4,256	5,751	6,478	7,380	7,245
	Hipperholme-cum-Brighouse -		2,879	3,357	3,936	4,977	5,421	6,091	7,340
	TOTAL of the DISTRICT carried to Summary, p. lxxiv.	52,160	46,791	52,862	67,835	81,553	99,850	111,520	118,275

Proposed Conservancy District.	City, Town, Borough, Township, Hamlet, or Place.	Area in Statute Acres.	POPULATION. 1801.	1811.	1821.	1831.	1841.	1851.	1861.
HUDDERSFIELD	Fixby - - -		346	336	345	348	399	399	388
	Rastrick - - -		2,053	2,442	2,796	3,021	3,482	3,917	4,516
	Lindley-cum-Quarmby -		1,377	1,686	2,040	2,306	2,881	3,584	4,259
	Kirkheaton and Whitley -		1,469	1,334	2,950	3,640	4,149	4,070	3,958
	Huddersfield - - -		7,268	9,671	13,284	19,035	25,068	30,880	34,877
	Lockwood and Crosland Hill -		1,253	1,490	1,881	3,134	4,303	5,556	6,755
	Golcar - - -		1,846	2,122	2,606	3,143	3,598	4,212	5,110
	Longwood - - -		1,276	1,461	1,942	2,111	2,418	3,023	3,402
	Linthwaite - - -		1,381	1,643	2,127	2,852	3,310	3,802	4,300
	Scammonden - -		626	647	855	912	972	1,067	1,012
	Almondbury - - -		3,751	4,613	5,679	7,086	8,828	9,749	10,361
	Farnley-Tyas - -		730	757	900	849	844	843	702
	Slaithwaite - - -		2,007	2,277	2,871	2,892	2,925	2,852	2,932
	Marsden - - -		1,958	1,845	2,330	2,340	2,403	2,665	2,689
	Kirkburton - - -		1,405	1,693	2,153	2,650	3,474	3,560	3,664
	Thurstonland - -		783	868	989	1,098	1,286	1,320	1,116
	Meltham - - -		1,278	1,430	2,000	2,746	3,263	3,758	4,046
	South-Crosland - -		1,221	1,424	1,583	2,258	2,705	2,784	2,794
	Lingards or Lingarths -		642	712	809	758	801	811	783
	Honley - - -		2,529	2,818	3,501	4,523	5,383	5,595	4,626
	Netherthong - -		679	787	927	1,004	1,156	1,207	1,097
	Upperthong - - -		1,033	1,015	1,437	1,648	2,258	2,463	2,690
	Austonley - - -		674	814	968	1,420	1,940	2,234	1,901
	Holmfirth - - -		302	347	459	630	713	849	2,466
	Cartworth - - -		997	1,121	1,211	1,796	2,247	2,538	2,503
	Wooldale - - -		2,620	3,083	3,445	3,993	4,806	5,600	5,322
	Hepworth - - -		804	828	1,048	1,229	1,436	1,532	1,530
	Fulstone - - -		1,128	1,139	1,264	1,573	1,856	2,257	2,414
	Shepley - - -		619	793	1,000	893	1,088	1,200	1,432
	Shelley - - -		416	1,057	1,329	1,319	1,772	1,880	1,901
	Lepton - - -		2,180	2,585	2,729	3,320	3,875	3,592	3,273
	Dalton - - -		1,222	1,625	2,289	3,060	3,906	4,310	4,692
	TOTAL of the DISTRICT carried to Summary, p. lxxiv.	65,280	47,873	56,463	71,747	89,587	109,545	124,109	133,511
DEWSBURY -	Bierley - - -		3,820	4,766	6,070	7,254	9,512	11,710	12,500
	Gomersal - - -		4,303	5,002	5,952	6,189	8,030	9,926	11,230
	Heckmondwike - -		1,742	2,324	2,579	2,793	3,537	4,540	8,680
	Liversedge - - -		2,837	3,643	4,259	5,265	5,988	6,974	8,176
	Batley - - -		2,574	2,975	3,717	4,841	7,076	9,308	14,173
	Soothill - - -		2,134	2,609	3,099	3,849	4,453	5,059	6,238
	Dewsbury - - -		4,566	5,059	6,380	8,272	10,600	14,049	18,148
	Mirfield - - -		3,724	4,315	5,041	6,496	6,919	6,966	9,263
	Lower-Whitley - -		819	746	903	1,012	1,125	1,068	1,042
	Thornhill - - -		1,499	1,619	1,932	2,371	2,816	2,791	3,479
	Horbury - - -		2,101	2,356	2,475	2,400	2,683	2,803	3,246
	Hartshead and Clifton - -		1,628	1,728	2,007	2,408	2,675	2,729	2,652
	TOTAL of the DISTRICT carried to Summary, p. lxxiv.	30,080	31,747	37,142	44,414	53,150	65,414	77,923	98,827
WAKEFIELD -	West-Ardsley - - -		1,032	1,332	1,515	1,450	1,420	1,429	1,646
	East-Ardsley - -		686	812	832	853	900	838	1,069
	Ossett-with-Gawthorpe -		3,424	4,083	4,775	5,325	6,078	6,266	7,950
	Wakefield - - -		8,131	8,593	10,764	12,232	14,754	16,989	17,611
	Stanley-with-Wrenthorpe -		3,260	3,769	4,620	5,047	6,625	7,257	8,257
	Methley - - -		1,234	1,385	1,499	1,593	1,702	1,926	2,472
	Ackton - - -		86	85	72	51	76	82	67
	Featherstone - -		305	320	337	328	318	347	353
	Normanton - - -		276	269	250	283	481	495	563
	Altofts - - -		334	408	404	502	704	603	1,210
	Carried forward - -		18,768	21,056	25,068	27,664	33,058	36,232	41,178

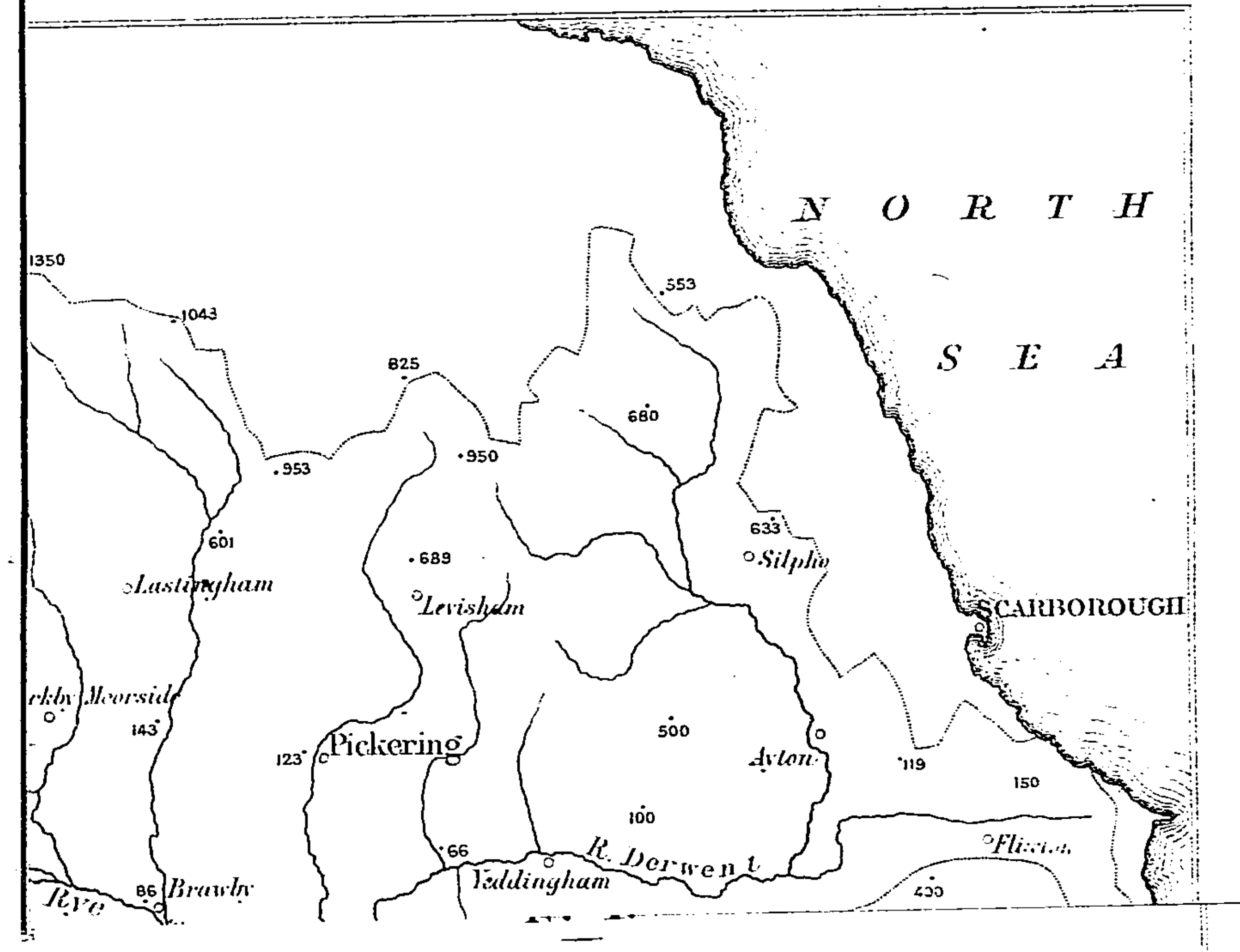
Proposed Conservancy District.	City, Town, Borough, Township, Hamlet, or Place.	Area in Statute Acres.	POPULATION. 1801.	1811.	1821.	1831.	1841.	1851.	1861.
	Brought forward - -		18,768	21,056	25,068	27,664	33,058	36,232	41,178
WAKEFIELD—*continued.*	Newland - - -		..	42	46	46	45	52	78
	Sharleston - - -		179	174	330	243	221	164	262
	Warmfield - - -		625	639	741	752	829	805	1,045
	Crofton - - -		535	424	459	361	389	363	402
	Snydale - - -		127	141	119	114	138	140	150
	Wintersett - - -		133	119	135	149	167	168	141
	Ryhill - - -		142	138	147	160	170	163	160
	Cold-Hiendley - -		180	162	189	153	141	112	109
	Walton - - -		315	311	385	376	510	473	471
	Sandal-Magna - -		765	789	888	1,075	1,278	1,536	1,590
	Crigglestone - - -		1,216	1,225	1,265	1,266	1,479	1,827	2,021
	Notton - - -		323	327	339	317	310	269	286
	Woolley - - -		565	543	482	553	418	450	531
	TOTAL of the DISTRICT carried to Summary, p. lxxiv.	43,520	23,873	26,090	30,593	33,229	39,153	42,754	48,424

RIVERS AIRE AND CALDER UNITED.

Proposed Conservancy District.	City, Town, Borough, Township, Hamlet, or Place.	Area in Statute Acres.	1801.	1811.	1821.	1831.	1841.	1851.	1861.
PONTEFRACT	Garforth - - -		234	610	731	782	1,195	1,335	1,504
	Kippax - - -		779	860	958	1,128	1,214	1,325	1,656
	Ledstone - - -		238	195	243	243	259	212	229
	Fairburn - - -		339	351	426	465	523	482	458
	Ledsham - - -		220	241	212	236	340	402	459
	Glass-Houghton - -		382	409	412	446	436	431	489
	Castleford - - -		793	890	1,022	1,141	1,414	2,150	3,876
	Pontefract - - -		3,097	3,605	4,447	4,832	4,669	5,106	5,346
	Taushelf - - -		378	371	356	423	502	601	776
	Monkhill - - -		..	..	40	39	48	62	66
	Pontefract Park - -		47	50	47	51	96	84	74
	Ferry-Frytone - -		705	768	777	833	951	908	904
	Monk-Frystone - -		277	319	409	430	429	474	560
	Hillam - - -		190	258	269	291	342	340	319
	Burton-Salmon - -		114	138	182	142	166	240	247
	Birkin - - - -		139	136	139	129	169	176	168
	Brotherton - - -		1,115	1,457	1,626	1,623	1,744	1,551	1,449
	Knottingley - - -		2,602	3,327	3,753	3,666	4,304	4,540	4,379
	Cridling Stubbs - -		83	94	96	118	159	139	154
	Kellington - - -		1,048	1,151	1,328	1,388	1,493	1,450	1,443
	West-Haddlesey - -		224	238	293	296	288	222	213
	Gateforth - - -		178	145	192	223	258	192	174
	Chapel-Haddlesey - -		152	165	199	196	216	230	210
	Hensall - - -		213	225	233	250	290	252	264
	Heck - - - -		194	215	228	236	265	252	278
	Temple-Hirst - -		119	121	141	135	114	112	104
	Hirst-Courtney -		132	152	145	117	134	137	126
	Gowdall - - -		218	227	243	260	237	229	223
	Snaith - - -		688	743	834	885	855	840	914
	Rawcliffe - - -		920	1,143	1,496	1,450	1,523	1,552	1,630
	Cowick - - -		709	656	905	928	882	919	849
	Carlton - - -		536	687	775	808	802	784	752
	Camblesforth - - -		190	231	257	260	321	335	322
	Newland - - -		179	219	269	282	305	353	301
	Armin - - -		391	451	570	567	593	561	557
	TOTAL of the DISTRICT carried to Summary, p. lxxiv.	54,720	17,823	20,848	24,253	25,299	27,536	28,978	31,473

SUMMARY.

No.	Proposed Conservancy District.	Area in Statute Acres.	POPULATION. 1801.	1811.	1821.	1831.	1841.	1851.	1861.
	RIVER AIRE.								
1	SKIPTON - - -	64,320	9,098	10,852	12,247	13,638	14,269	14,280	14,335
2	KEIGHLEY - - -	60,480	20,545	24,607	31,414	38,274	44,725	55,612	53,863
3	BRADFORD - - -	33,600	32,584	38,921	55,435	78,509	107,207	150,796	161,746
4	LEEDS - - -	60,800	71,139	81,932	107,946	141,613	184,584	208,422	249,268
	TOTAL in BASIN of RIVER AIRE - - -	219,200	133,366	156,312	207,042	272,034	350,785	429,110	479,212
	RIVER CALDER.								
5	TODMORDEN - -	43,200	16,759	21,427	27,059	31,031	34,323	32,120	33,955
6	HALIFAX - - -	52,160	46,791	52,862	67,835	81,553	99,850	111,520	118,275
7	HUDDERSFIELD - -	65,280	47,873	56,463	71,747	89,587	109,545	124,109	133,511
8	DEWSBURY - - -	30,080	31,747	37,142	44,414	53,150	65,414	77,923	98,827
9	WAKEFIELD -	43,520	23,873	26,090	30,593	33,229	39,153	42,754	48,424
	TOTAL in BASIN of RIVER CALDER - -	234,240	167,043	193,984	241,648	288,550	348,285	388,426	432,992
	RIVERS AIRE AND CALDER UNITED.								
10	PONTEFRACT - -	54,720	17,823	20,848	24,253	25,299	27,536	28,978	31,473
	TOTAL in ENTIRE BASIN of the RIVERS AIRE and CALDER - - -	508,160	318,232	371,144	472,943	585,883	726,606	846,514	943,677



SKETCH MAP OF THE BASIN OF THE RIVER OUSE.

SCALE OF STATUTE MILES.

0 5 10

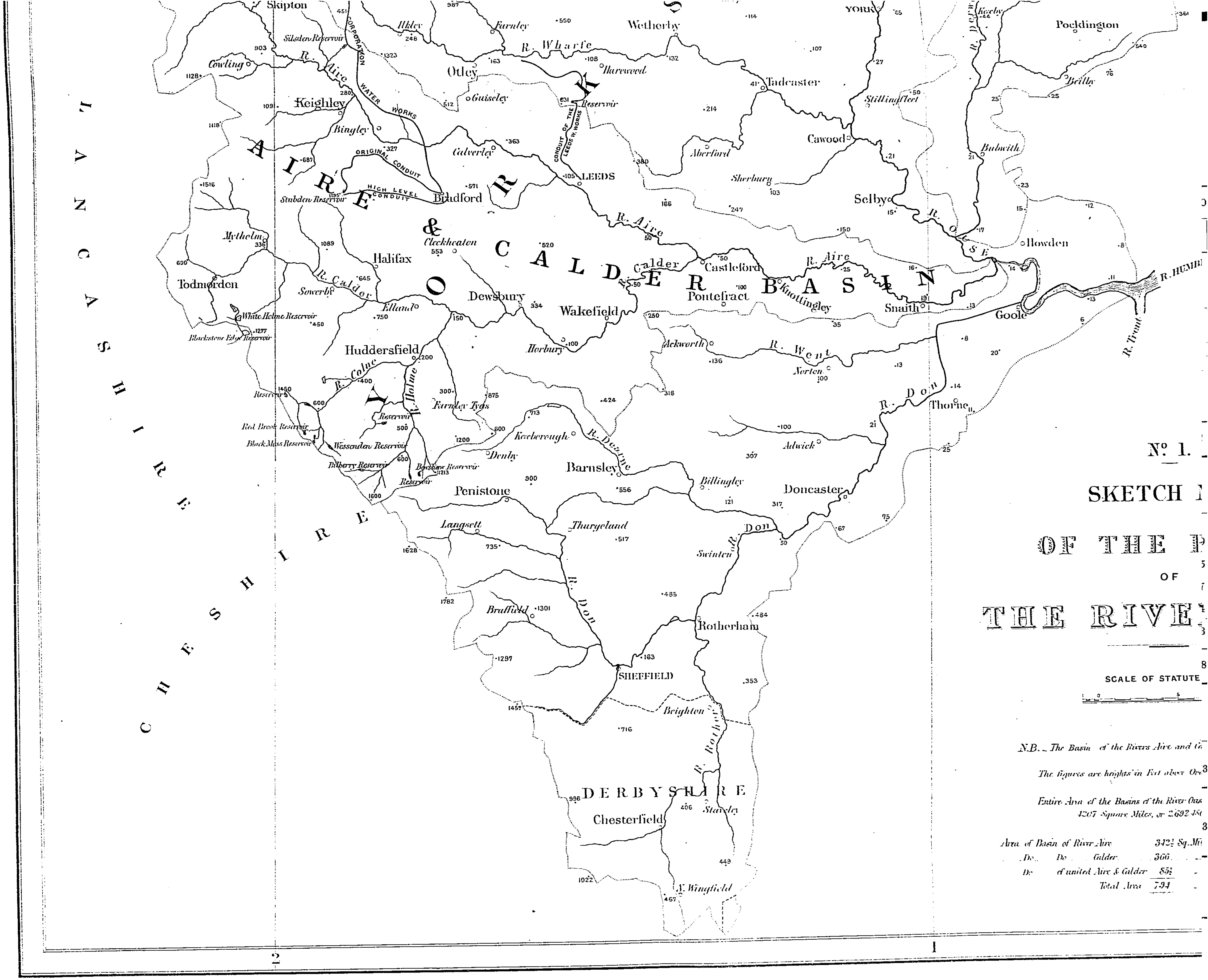
N.B.— The Basin of the Rivers Aire and Calder is colored Pink.

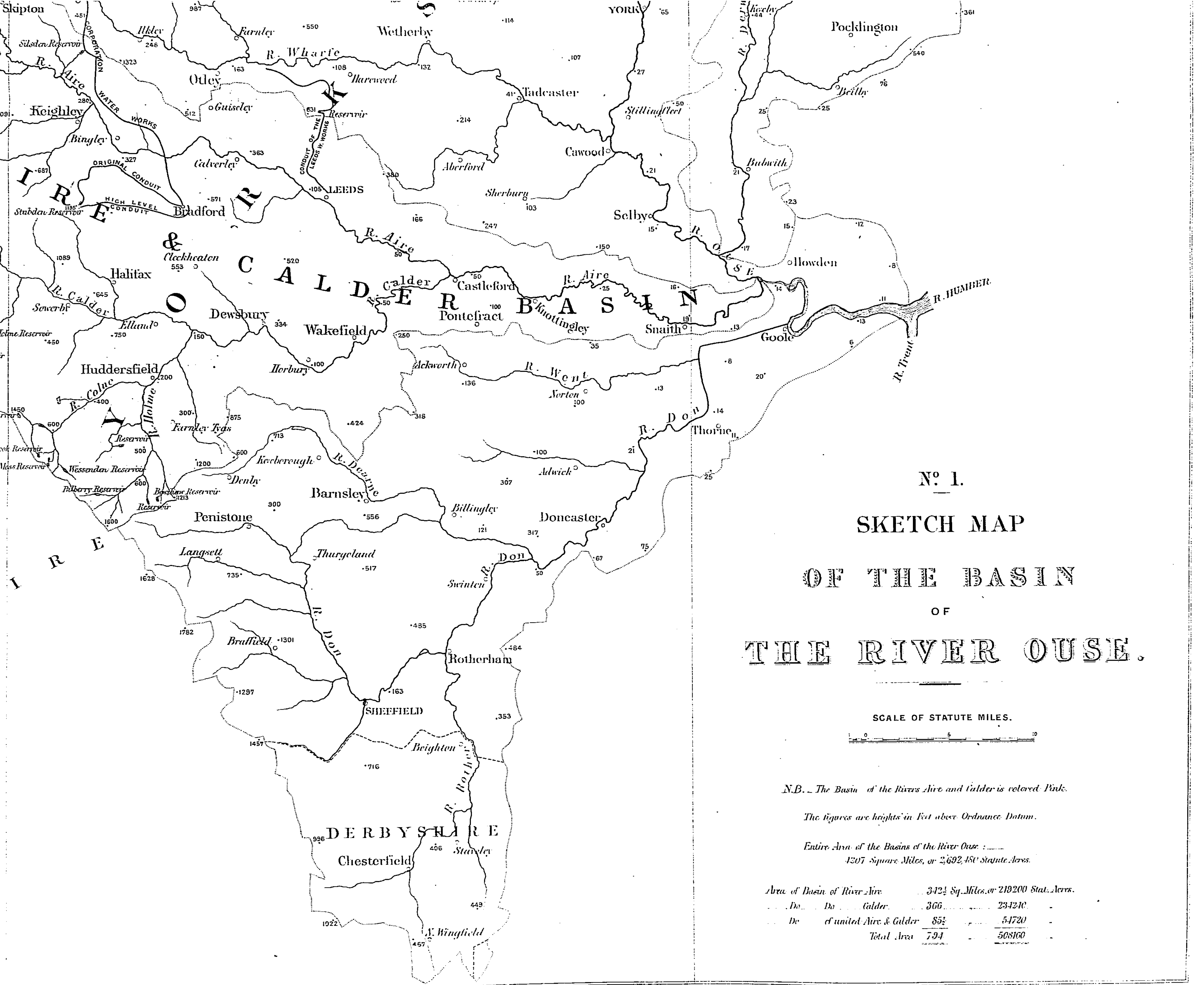
The figures are heights in Feet above Ordnance Datum.

Entire Area of the Basins of the River Ouse :—
4207 Square Miles, or 2,692,480 Statute Acres.

Area of Basin of River Aire	342½ Sq. Miles, or	219200	Stat. Acres.
Do. Do. Calder	366	234240	
Do. of united Aire & Calder	85½	54720	
Total Area	794	508160	

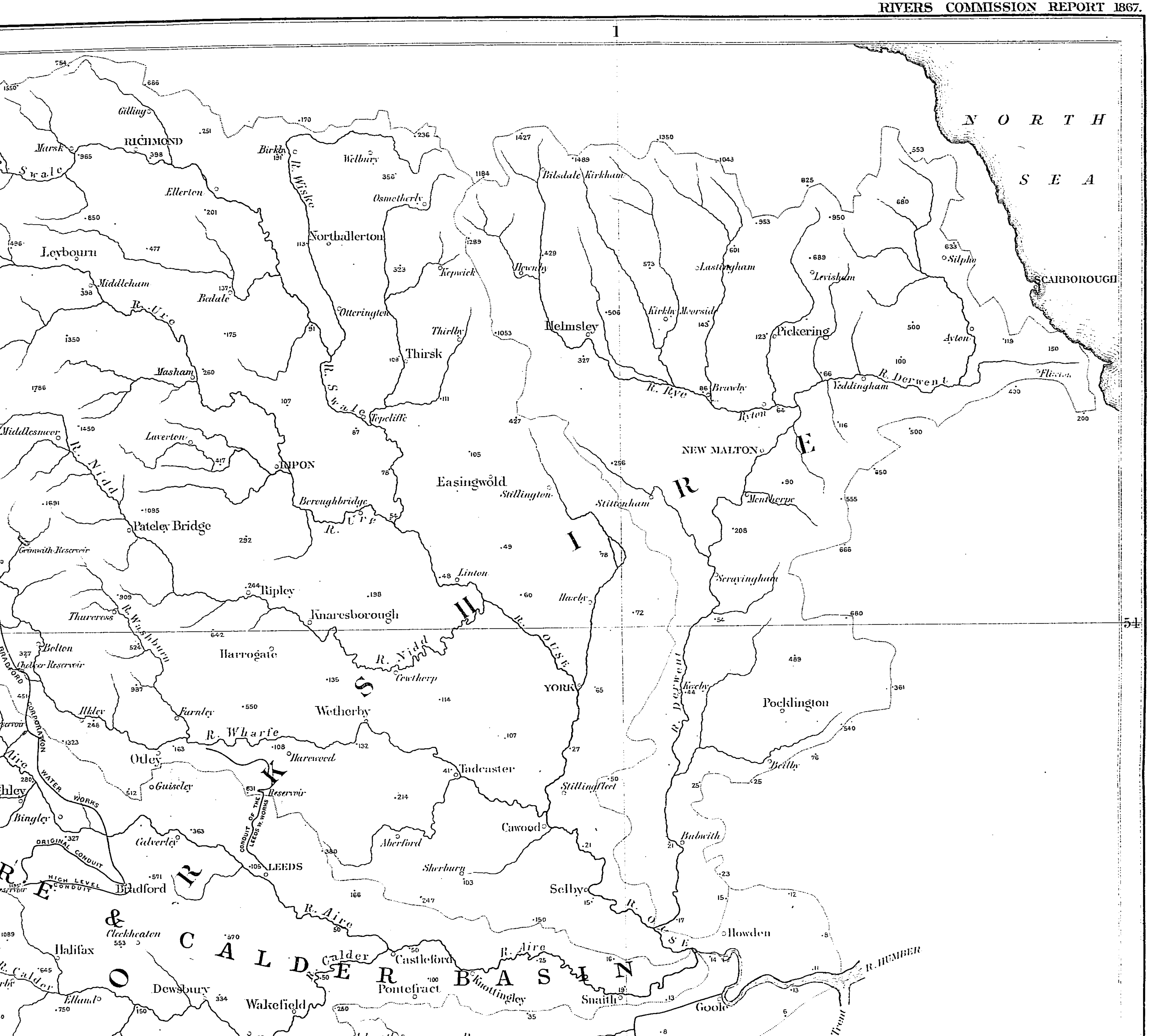
PULATION.			
1831.	1841.	1851.	1861.
13,638	14,269	14,280	14,335
38,274	44,725	55,612	53,863
78,509	107,207	150,796	161,746
141,613	184,584	208,422	249,268
272,034	350,785	429,110	479,212
31,031	34,323	32,120	33,955
81,553	99,850	111,520	118,275
89,587	109,545	124,109	138,511
53,150	65,414	77,923	98,827
33,229	39,153	42,754	48,424
288,550	348,285	388,426	432,992
UNITED.			
25,299	27,536	28,978	31,473
585,883	726,606	846,514	943,677

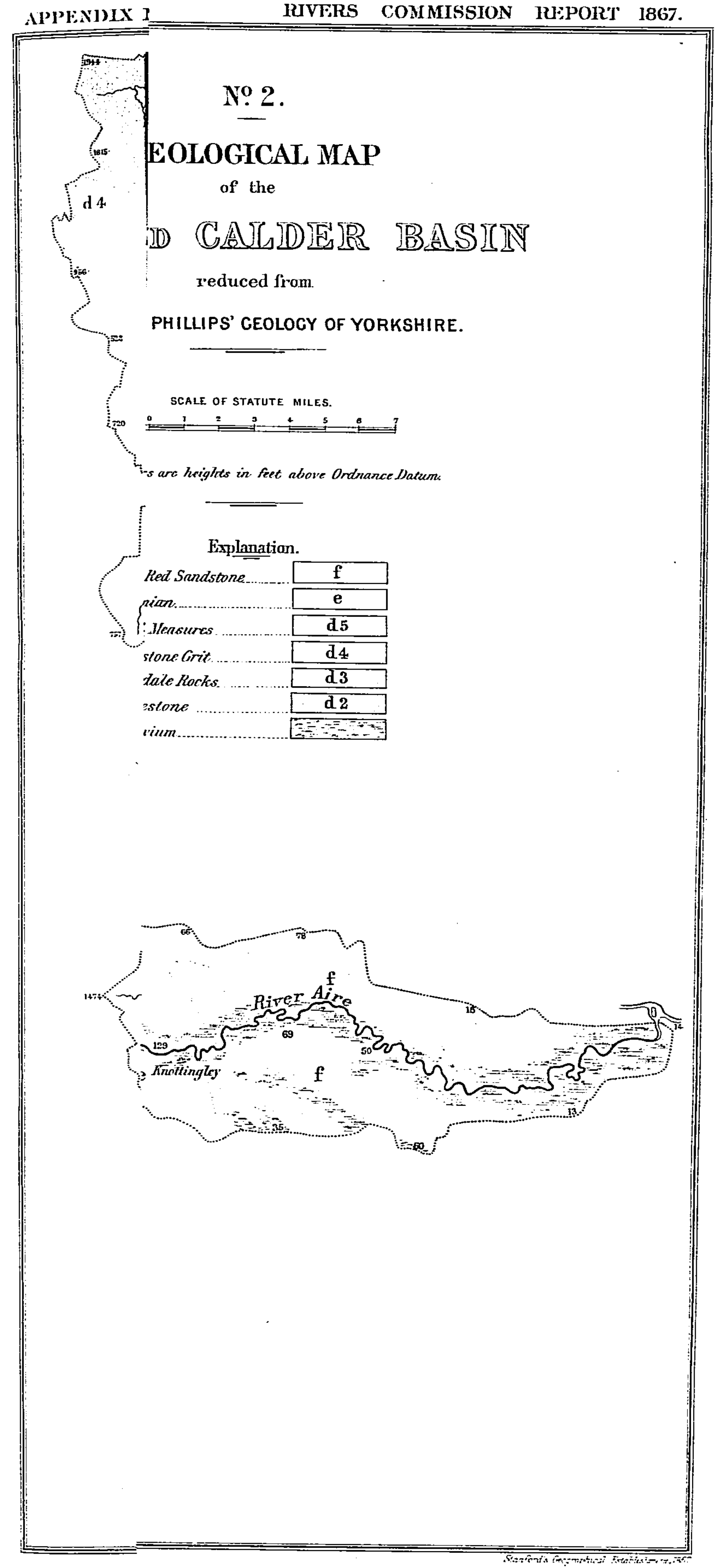




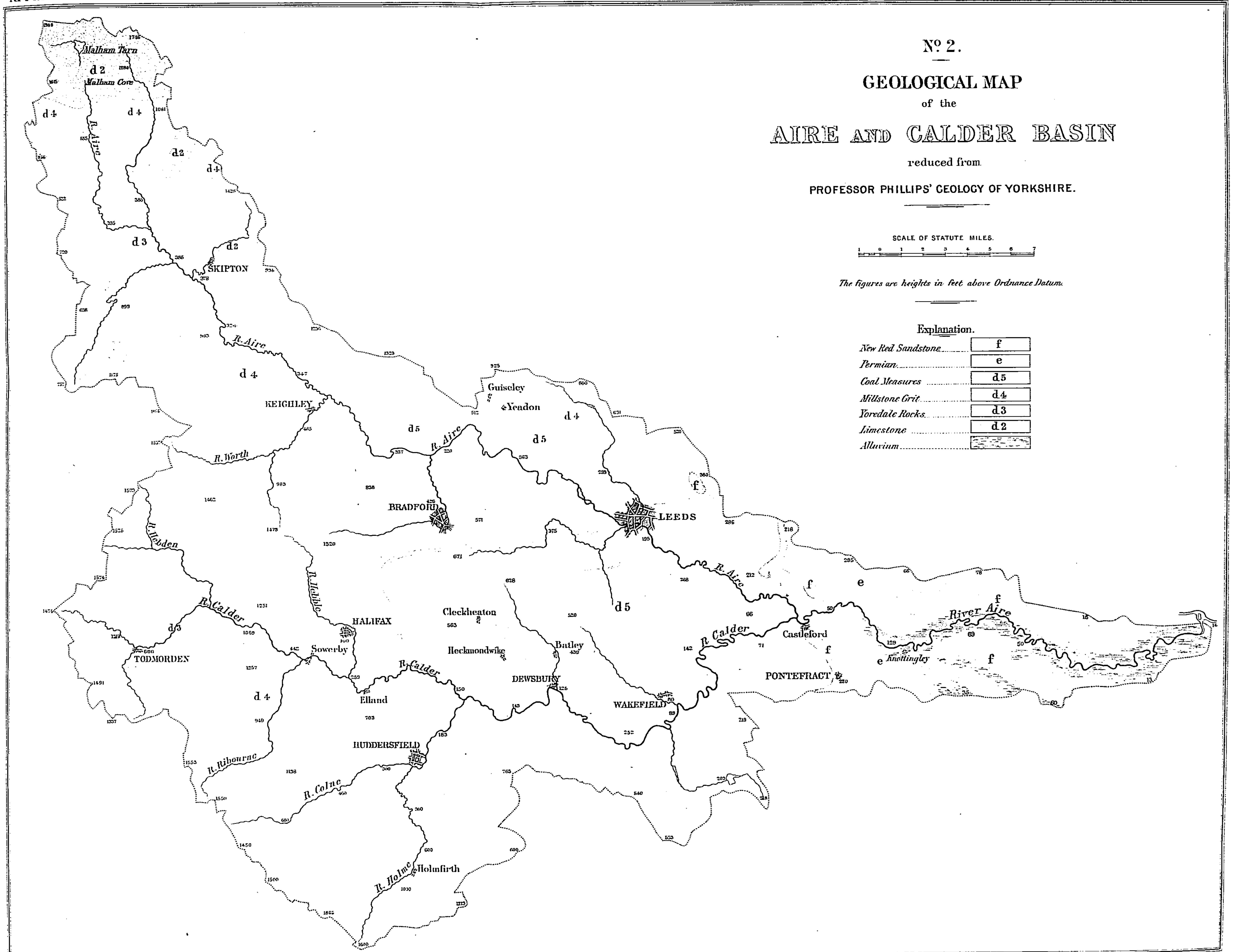
No. 1.
SKETCH MAP
OF THE BASIN
OF
THE RIVER OUSE.
SCALE OF STATUTE MILES.
0 5 10
N.B. _ The Basin of the Rivers Aire and Calder is colored Pink.
The figures are heights in Feet above Ordnance Datum.
Entire Area of the Basins of the River Ouse :__
4207 Square Miles, or 2,692,480 Statute Acres.
Area of Basin of River Aire .. 342½ Sq. Miles, or 219200 Stat. Acres.
Do. Do. Calder .. 366 .. 234240 ..
Do. of united Aire & Calder 85½ .. 54720 ..
Total Area 794 .. 508160 ..
AIRE & CALDER BASIN
YORK
DERBYSHIRE
Skipton
Ilkley
Farnley
Wetherby
Pocklington
Silsden Reservoir
Keighley
Otley
Harewood
Tadcaster
Guiseley
Bingley
Calverley
LEEDS
Bradford
Stubden Reservoir
Aberford
Sherburn
Cawood
Stillingfleet
Bubwith
Selby
Howden
Halifax
Cleckheaton
Sowerby
Elland
Dewsbury
Wakefield
Castleford
Pontefract
Knottingley
Snaith
Goole
Huddersfield
Horbury
Ackworth
Norton
Thorne
Farnley Tyas
Kexborough
Denby
Barnsley
Adwick
Penistone
Billingley
Doncaster
Langsett
Thurgoland
Swinton
Bradfield
Rotherham
SHEFFIELD
Beighton
Chesterfield
Staveley
N. Wingfield
R. Wharfe
R. Aire
R. Calder
R. Colne
R. Holme
R. Went
R. Don
R. Dearne
R. Ouse
R. Derwent
R. Humber
R. Trent
R. Rother
CORPORATION WATER WORKS
ORIGINAL CONDUIT
HIGH LEVEL CONDUIT
CONDUIT OF THE LEEDS W. WORKS
Wessenden Reservoir
Bilberry Reservoir

ON.		
1841.	1851.	1861.
4,269	14,280	14,335


1
54
NORTH SEA
SCARBOROUGH
Silpho
Ayton
Flixton
Yeddingham
R. Derwent
Pickering
Levisham
Lastingham
Kirkby Moorside
Brawby
Ryton
R. Rye
Bilsdale Kirkham
Hewenby
Helmsley
NEW MALTON
Menthorpe
Stillington
Stittenham
Scrayingham
Easingwold
Linton
Haxby
R. Ouse
YORK
Kexby
R. Derwent
Pocklington
Beilby
Stillingfleet
Cawood
Bubwith
Selby
Howden
Goole
R. Humber
Trent
Snaith
Knottingley
Pontefract
Castleford
R. Aire
Calder
Wakefield
Dewsbury
Elland
R. Calder
Halifax
Cleckheaten
Bradford
HIGH LEVEL CONDUIT
ORIGINAL CONDUIT
Calverley
Bingley
WATER WORKS
CORPORATION
BRADFORD
LEEDS
CONDUIT OF THE LEEDS W. WORKS
Reservoir
Sherburn
Aberford
Tadcaster
Harewood
R. Wharfe
Otley
Guiseley
Farnley
Ilkley
Wetherby
Cowthorp
R. Nidd
Harrogate
Knaresborough
Ripley
Belton
Chelker Reservoir
Thurcross
R. Washburn
Gouthwaite Reservoir
Pateley Bridge
R. Nidd
Boroughbridge
R. Ure
RIPON
Laverton
Middlesmoor
Masham
R. Ure
Middleham
Bedale
Leybourn
Ellerton
RICHMOND
Marsk
Swale
Gilling
Birkby
R. Wiske
Northallerton
Otterington
R. Swale
Topcliffe
Thirsk
Thirlby
Kepwick
Osmotherly
Welbury
YORKSHIRE
OUSE & CALDER BASIN



No. 2.
EOLOGICAL MAP
of the
D CALDER BASIN
reduced from
PHILLIPS' GEOLOGY OF YORKSHIRE.
SCALE OF STATUTE MILES.
s are heights in feet above Ordnance Datum.
Explanation.
Red Sandstone
f
e
d5
d4
d3
d2
River Aire
Knottingley


No. 2.
GEOLOGICAL MAP
of the
AIRE AND CALDER BASIN
reduced from
PROFESSOR PHILLIPS' GEOLOGY OF YORKSHIRE.
SCALE OF STATUTE MILES.
The figures are heights in feet above Ordnance Datum.
Explanation.
New Red Sandstone f
Permian e
Coal Measures d5
Millstone Grit d4
Yoredale Rocks d3
Limestone d2
Alluvium
Malham Tarn
Malham Cove
R. Aire
SKIPTON
KEIGHLEY
R. Worth
Guiseley
Yeadon
BRADFORD
LEEDS
R. Hebden
R. Calder
TODMORDEN
R. Hebble
HALIFAX
Sowerby
Cleckheaton
Heckmondwike
Batley
DEWSBURY
WAKEFIELD
Elland
HUDDERSFIELD
R. Ribourne
R. Colne
R. Holme
Holmfirth
Castleford
PONTEFRACT
Knottingley
River Aire

Nº 3.

SKETCH MAP

OF THE BASIN

of

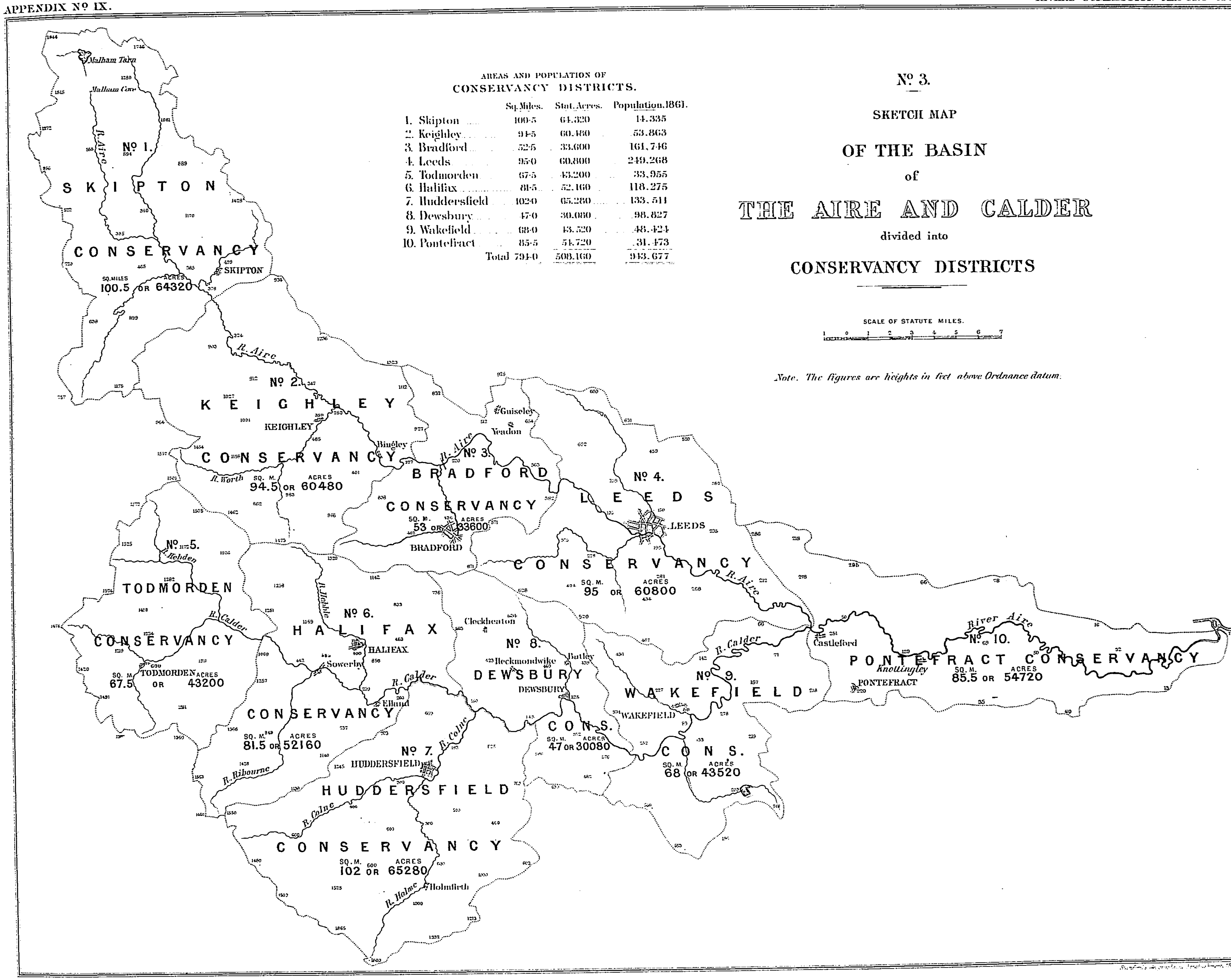
THE AIRE AND CALDER

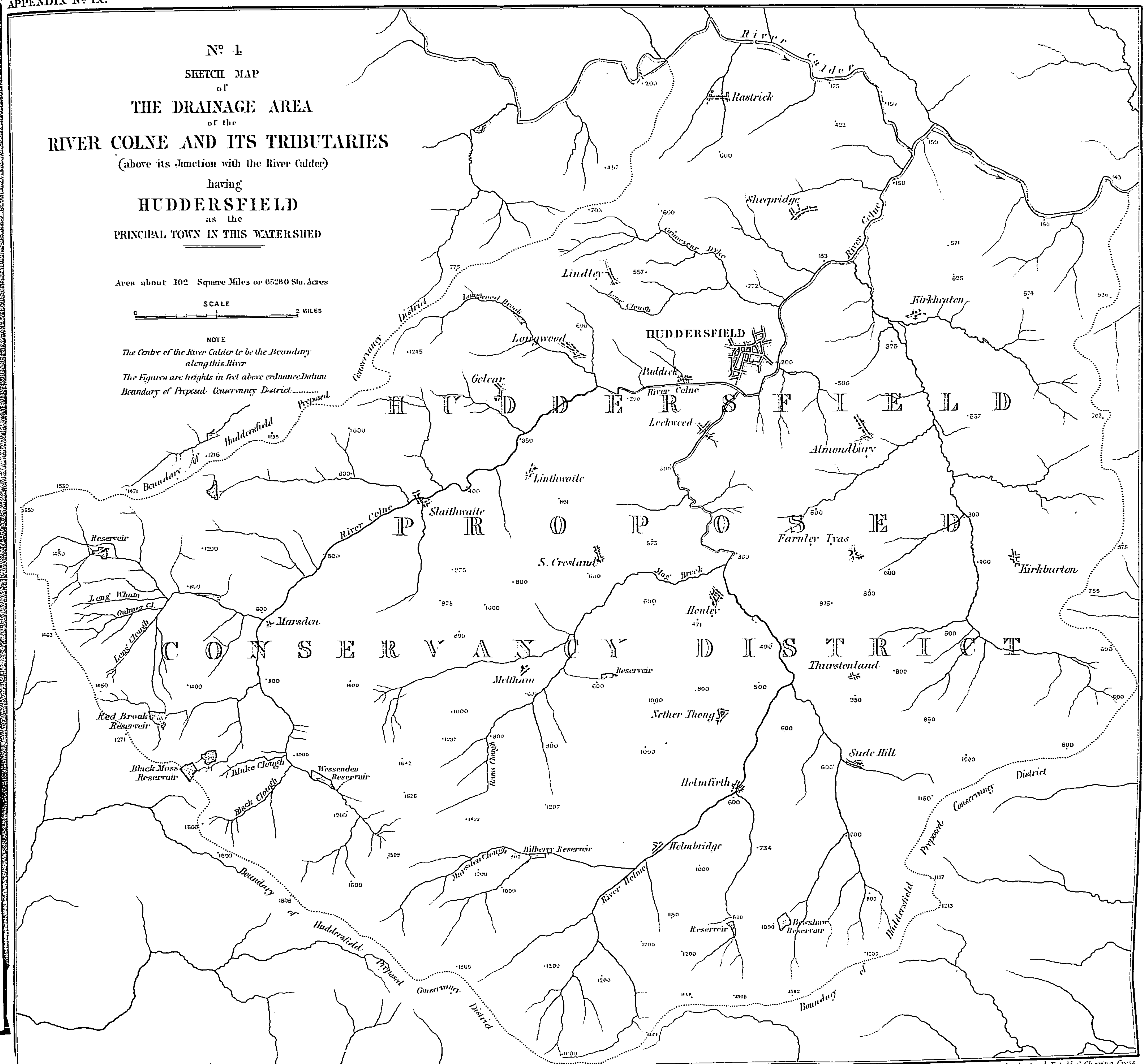
divided into

CONSERVANCY DISTRICTS

AREAS AND POPULATION OF CONSERVANCY DISTRICTS.

	Sq. Miles.	Stat. Acres.	Population. 1861.
1. Skipton	100·5	64.320	14.335
2. Keighley	94·5	60.480	53.863
3. Bradford	52·5	33.600	161,746
4. Leeds	95·0	60,800	249,268
5. Todmorden	67·5	43.200	33,955
6. Halifax	81·5	52.160	118.275
7. Huddersfield	102·0	65.280	133. 511
8. Dewsbury	47·0	30.080	98.827
9. Wakefield	68·0	43. 520	48.424
10. Pontefract	85·5	54.720	31.473
Total	794·0	508.160	943.677





Stanford's Geog! Estab! 6 Charing Cross

APPENDIX No. X.

STATISTICS of the TRADES and MANUFACTURES in the Basin of the Rivers AIRE and CALDER in the carrying on of which WATER is used and POLLUTED.

Name of Town.	Blanket Manufacturers.	Brewers.	Carpet Manufacturers.	Chemists, Manufacturing.	Corn Millers.	Dyers.				Finishers.	Fullers and Scribblers.	Glue Manufacturers.	Maltsters.	Paper and Paperhanging Manufacturers.	Linen Manufacturers.	Lead Manufacturers.	Short Wool, Shoddy, Waste, and Mungo Dealers.	Sizers.	Soap Manufacturers.	Grease Manufacturers.	Spinners and Manufacturers.					Stuff Manufacturers.	Tanners.	Woollen Manufacturers.	Woollen Card Manufacturers.	Wool-Combers.	Ware Grinders.	Wool and Stuff Printers.	Wire Manufacturers.
						Woollen Cloth.	Wool and Yarn.	Stuff.	Silk and Cotton.												Worsted.	Cotton.	Flax.	Silk.	Woollen Yarn.								
RIVER AIRE.																																	
SKIPTON Proposed Conservancy District.																																	
Carlton	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.
Connistone Cold	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.
Earby	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.
Gargrave	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.
Kirkby Malham	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	3	.	.	.	.	1	.	.	.	.	.	.
Skipton	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Total carried to Summary, page 12	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	9	.	.	.	.	1	.	.	.	.	.	.
KEIGHLEY Proposed Conservancy District.																																	
Bingley	.	.	.	.	3	.	.	.	.	.	.	.	6	.	.	.	.	.	.	.	27	.	.	.	.	.	3	.	.	.	.	.	.
Cowling	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3	1	.	.	.	.	.	.	.	.	.	.	.
Cullingworth	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.	.	.	.	.	2	.	.	.	.	.	.
Denholm	.	1	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.
Eastburn	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.
Glusburn	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	1	.	.	.	.	.	.	.	.
Haworth	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	19	1	.	.	.	.	.	.	.	.	.	.	.
Keighley	.	3	.	.	5	.	.	2	.	.	.	.	.	3	.	.	.	.	.	.	35	.	.	.	.	.	.	.	.	4	.	.	.
Kildwick	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Morton	.	.	.	.	1	.	.	.	.	.	.	.	.	2	.	.	.	.	.	.	6	1	.	.	.	.	.	.	.	1	.	.	.
Steeton	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.
Sutton	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	3	.	.	.	.	.	.	.	.	.	.	.	.
Wilsden	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	12	.	.	.	.	.	.	.	.	.	.	.	.
Total carried to Summary, page 12	.	4	.	2	13	.	.	2	.	.	.	.	6	5	.	.	.	1	.	.	111	3	.	.	1	.	5	.	.	5	.	.	.

Statistics of the TRADES and MANUFACTURES in the Basin of the Rivers AIRE and CALDER in the carrying on of which WATER is used and POLLUTED—*continued*.

Name of Town.	Blanket Manufacturers.	Brewers.	Carpet Manufacturers.	Chemists, Manufacturing.	Corn Millers.	Dyers.				Finishers.	Fullers and Scribblers.	Glue Manufacturers.	Maltsters.	Paper and Paperhanging Manufacturers.	Linen Manufacturers.	Lead Manufacturers.	Short Wool, Shoddy, Waste, and Mungo Dealers.	Sizers.	Soap Manufacturers.	Grease Manufacturers.	Spinners and Manufacturers.					Stuff Manufacturers.	Tanners.	Woollen Manufacturers.	Woollen Card Manufacturers.	Wool Combers.	Ware Grinders.	Wool and Stuff Printers.	Wire Manufacturers.
						Woollen Cloth.	Wool and Yarn.	Stuff.	Silk and Cotton.												Worsted.	Cotton.	Flax.	Silk.	Woollen Yarn.								
RIVER AIRE—*continued*.																																	
BRADFORD Proposed Conservancy District.																																	
Allerton	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3	.	.	.	.	20	.	.	.	.	.	.	.
Apperley Bridge	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Baildon	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.	.	.	.	7	.	.	.	.	.	.	.
Bolton	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.	.	.	.	.
Bradford	.	11	.	10	4	.	.	29	.	6	.	.	7	.	.	.	123	7	.	3	129	10	.	.	.	94	3	.	.	39	.	.	.
Calverley	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	1	.	.	.	.	.	.	.	28	.	.	.	.	.
Clayton	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	5	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Cottingley	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	1	.	.	1	.	.	.
Eccleshill	.	.	.	.	1	.	.	.	.	.	3	.	.	.	.	.	2	3	.	.	.	.	.	.	.	.	.	35	.	.	.	.	.
Farsley	.	.	.	.	.	.	.	.	.	.	2	.	.	.	.	.	3	3	.	.	.	.	.	.	.	.	.	30	.	.	.	.	.
Guiseley	.	.	.	.	.	.	.	.	.	.	4	.	3	.	.	.	1	.	.	.	.	.	.	.	.	.	.	98	.	.	.	.	.
Heaton	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	5	.	.	.	.	.	.	.	.	.	.	.	.
Horsforth	.	.	.	.	2	.	.	1	1	.	.	.	.	1	.	.	1	1	.	1	1	1	.	1	.	.	3	30	.	.	.	.	.
Idle	.	.	.	.	1	.	.	.	.	.	.	.	4	.	.	.	.	3	.	.	.	.	.	.	.	.	.	59	.	.	.	.	.
Rodley	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.
Shipley	.	.	.	.	.	1	.	.	.	.	2	1	.	1	.	.	.	.	.	.	7	.	.	.	.	.	.	.	.	.	.	.	.
Stanningley	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	7	1	.	.	.	.	.	.	.	.	.	24	.	.	.	.	.
Thornton	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	11	.	.	.	.	.	.	.	.	1	.	.	.
Yeadon	.	.	.	.	.	.	.	.	.	.	4	.	.	.	.	.	.	5	.	.	.	.	.	.	.	.	.	104	.	.	.	.	.
Total carried to Summary, page 12	.	12	.	10	9	1	.	30	1	6	16	1	14	2	.	.	148	19	.	6	159	11	.	1	.	121	7	410	.	41	.	.	.

Name of Town.	Blanket Manufacturers.	Brewers.	Carpet Manufacturers.	Chemists, Manufacturing.	Corn Millers.	Dyers.				Finishers.	Fullers and Scribblers.	Glue Manufacturers.	Maltsters.	Paper and Paperhanging Manufacturers.	Linen Manufacturers.	Lead Manufacturers.	Short Wool, Shoddy, Waste, and Mungo Dealers.	Sizers.	Soap Manufacturers.	Grease Manufacturers.	Spinners and Manufacturers.					Stuff Manufacturers.	Tanners.	Woollen Manufacturers.	Woollen Card Manufacturers.	Wool Combers.	Ware Grinders.	Wool and Stuff Printers.	Wire Manufacturers.
						Woollen Cloth.	Wool and Yarn.	Stuff.	Silk and Cotton.												Worsted.	Cotton.	Flax.	Silk.	Woollen Yarn.								
RIVER AIRE—*continued*.																																	
LEEDS Proposed Conservancy District.																																	
Armley	.	.	.	.	.	.	.	.	.	.	.	.	5	.	.	.	3	1	.	.	.	.	.	.	.	.	2	42	.	.	.	.	.
Beeston	.	.	.	.	1	2	.	.	.	3	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	6	.	.	.	.	.
Bramley	.	.	.	.	1	.	.	2	.	.	.	.	.	.	.	.	1	2	.	.	.	.	.	.	.	.	2	19	.	.	.	.	.
Chapel Allerton	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	2	.	.	.	.	.	1	1	.	.	.	.	.
Churwell	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	4	.	.	.	.	.	.	.	.	.	.	4	.	.	.	.	.
Drighlington	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.
Gildersome	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	12	.	.	.	.	.
Kirkstall	.	.	.	.	1	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	1	3	.	.	.	.	.
Leeds	.	13	10	29	21	24	9	10	19	46	11	3	36	21	17	.	63	2	7	.	8	.	25	1	9	.	28	150	.	.	6	.	.
Lofthouse and Carlton	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Morley	.	.	.	.	.	.	.	2	.	.	11	.	.	.	.	.	11	1	.	.	.	1	.	.	.	.	1	73	.	.	.	.	.
Oulton-cum-Woodlesford	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.
Pudsey	.	.	.	.	1	.	.	.	.	.	14	1	.	.	.	.	21	5	.	2	.	.	.	.	.	.	3	137	.	.	.	.	.
Rothwell	.	.	.	1	1	.	.	.	.	.	.	.	3	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	1	.	.
Tong	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.	.	.	5	.	.	.	.	.	.	.	.	.	.	.	.
Wortley	.	.	.	.	.	.	.	.	.	3	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	23	.	.	.	.	.
Newlay	.	.	.	.	.	.	.	2	.	.	.	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.	.	.	.	.	.
Total carried to Summary, page 12	.	13	10	31	28	27	9	16	19	52	36	7	45	22	17	.	108	14	7	2	15	1	26	1	9	.	41	470	1	.	8	.	.

STATISTICS of the TRADES and MANUFACTURES in the Basin of the Rivers AIRE and CALDER in the carrying on of which WATER is used and POLLUTED—*continued.*

Name of Town.	Blanket Manufacturers.	Brewers.	Carpet Manufacturers.	Chemists, Manufacturing.	Corn Millers.	Dyers. Woollen Cloth.	Dyers. Wool and Yarn.	Dyers. Stuff.	Dyers. Silk and Cotton.	Finishers.	Fullers and Scribblers.	Glue Manufacturers.	Maltsters.	Paper and Paperhanging Manufacturers.	Linen Manufacturers.	Lead Manufacturers.	Short Wool, Shoddy, Waste, and Mungo Dealers.	Sizers.	Soap Manufacturers.	Grease Manufacturers.	Spinners and Manufacturers. Worsted.	Spinners and Manufacturers. Cotton.	Spinners and Manufacturers. Flax.	Spinners and Manufacturers. Silk.	Spinners and Manufacturers. Woollen Yarn.	Stuff Manufacturers.	Tanners.	Woollen Manufacturers.	Woollen Card Manufacturers.	Wool Combers.	Ware Grinders.	Wool and Stuff Printers.	Wire Manufacturers.
RIVER CALDER.																																	
TODMORDEN Proposed Conservancy District.																																	
Hebden Bridge - -	.	.	.	.	2	.	.	.	4	6	.	.	.	.	.	.	6	.	.	.	.	26	.	.	.	.	.	.	.	.	.	.	.
Heptonstall - -	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.
Midgley - - -	.	1	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	5	.	.	.	.	.	.	.	.	.	.	.	.
Mytholmroyd - -	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	2	.	.	.	.	10	.	.	.	.	.	.	.	.	.	.	.
Todmorden - - -	.	.	.	6	.	.	.	.	3	.	.	.	2	.	.	.	10	3	.	.	.	85	.	.	.	.	.	.	.	.	.	.	.
Total carried to Summary, page 12 -	.	1	.	6	3	.	.	.	7	6	.	.	2	1	.	.	19	3	.	.	5	123	.	.	.	.	.	.	.	.	.	.	.
HALIFAX Proposed Conservancy District.																																	
Brighouse - - -	.	.	.	.	2	2	.	.	.	.	1	.	4	.	.	.	1	.	1	.	10	15	.	7	3	.	1	5	.	.	.	1	7
Elland - - -	.	.	.	1	1	3	.	.	.	.	.	.	.	1	.	.	3	.	.	.	4	10	.	.	.	.	.	61	7	.	.	.	.
Halifax - - -	.	8	5	6	3	10	5	10	5	6	.	.	2	2	.	.	29	2	.	.	44	15	.	2	.	24	3	13	18	6	3	.	6
Luddenden - -	.	.	.	.	2	.	.	.	1	.	.	.	2	.	.	.	.	.	.	.	6	9	.	.	.	.	.	.	.	.	.	.	.
Northowram - -	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	5	.	.	.	.	.	.	.	.	.	.	.	.
Ovenden - -	.	8	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	18	8	.	1	.	.	.	.	.	.	.	.	.
Ripponden - -	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.
Shelf - - -	.	.	.	1	1	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	4	.	.	.	.	.	.	.	.	.	.	.	.
Skircoat - - -	.	.	.	.	3	.	.	.	.	1	.	.	.	.	.	.	.	.	.	1	.	.	.	.	3	.	.	.	.	.	.	.	.
Southowram - -	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	.	.	.	3	.	.	.	.
Sowerby Bridge - -	.	.	.	4	2	2	.	.	.	.	1	.	5	.	.	.	6	.	.	.	7	7	.	.	.	.	4	16	.	.	.	.	.
Stainland - -	.	1	.	1	.	.	.	.	.	.	.	.	.	2	.	.	3	.	.	.	2	.	.	.	.	.	.	14	.	.	.	.	.
Total carried to Summary, page 12 -	.	19	5	14	15	17	5	10	6	8	2	.	13	5	.	.	42	2	1	2	100	65	.	11	7	24	8	109	28	6	3	1	13

Name of Town.	Blanket Manufacturers.	Brewers.	Carpet Manufacturers.	Chemists, Manufacturing.	Corn Millers.	Dyers. Woollen Cloth.	Dyers. Wool and Yarn.	Dyers. Stuff.	Dyers. Silk and Cotton.	Finishers.	Fullers and Scribblers.	Glue Manufacturers.	Maltsters.	Paper and Paperhanging Manufacturers.	Linen Manufacturers.	Lead Manufacturers.	Short Wool, Shoddy, Waste, and Mungo Dealers.	Sizers.	Soap Manufacturers.	Grease Manufacturers.	Spinners and Manufacturers. Worsted.	Spinners and Manufacturers. Cotton.	Spinners and Manufacturers. Flax.	Spinners and Manufacturers. Silk.	Spinners and Manufacturers. Woollen Yarn.	Stuff Manufacturers.	Tanners.	Woollen Manufacturers.	Woollen Card Manufacturers.	Wool Combers.	Ware Grinders.	Wool and Stuff Printers.	Wire Manufacturers.
RIVER CALDER—*continued.*																																	
HUDDERSFIELD Proposed Conservancy District.																																	
Almondbury - -	.	2	.	.	.	2	.	.	.	.	.	.	.	.	.	.	4	1	.	.	.	.	.	.	.	.	.	21	.	.	.	.	.
Crosland (South) -	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	8	.	.	.	.	.
Deighton and Sheepridge	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	11	.	.	.	.	.
Golcar - -	.	.	.	.	.	.	.	.	.	18	11	.	.	.	.	.	21	.	.	.	.	.	.	1	.	.	.	105	.	.	.	.	.
Holmfirth - -	.	.	.	.	.	2	.	.	.	3	10	.	.	.	.	.	4	2	.	.	.	.	.	.	.	.	.	30	.	.	.	.	.
Honley - - -	.	1	.	.	1	5	.	.	.	4	4	.	.	.	.	.	.	1	.	.	.	.	.	.	2	.	.	21	.	.	.	.	.
Huddersfield - -	.	19	.	22	4	26	.	.	.	36	.	.	.	.	.	.	100	.	1	.	45	.	.	6	.	.	.	347	3	.	.	1	.
Kirkburton - -	.	.	.	.	2	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	7	.	.	.	.	.
Kirkheaton - -	.	.	.	1	.	.	.	.	.	1	2	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	9	.	.	.	.	.
Lindley - - -	.	1	.	4	.	1	.	.	.	1	2	.	.	.	.	.	10	.	.	.	.	.	.	.	.	.	.	20	1	.	.	.	.
Linthwaite - -	.	3	.	.	1	2	.	.	.	2	1	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.	1	19	1	.	.	.	.
Lockwood - -	.	.	.	3	.	.	2	.	.	14	.	.	.	.	.	.	2	.	.	.	.	.	.	2	1	.	.	15	.	.	.	.	.
Marsden - -	.	.	.	.	1	.	.	.	.	1	3	.	.	.	.	.	1	.	.	.	.	.	.	1	.	.	.	17	1	.	.	.	.
Meltham - -	.	.	.	.	.	1	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	2	.	1	1	.	.	6	.	.	.	.	.
Rastrick - - -	.	2	1	1	.	1	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	1	.	2	.	.	.	15	1	.	.	.	.
Shelley - - -	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	1	.	.	5	1	.	.	.	.
Shepley - -	.	1	.	.	1	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	26	.	.	.	.	.
Slaithwaite - -	.	.	.	.	.	.	.	.	.	.	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	26	.	.	.	.	.
Thurstonland - -	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.
Farnley Tyas - -	.	1	.	.	1	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	.	.	.	.	.
Upper Thong - -	.	.	.	.	.	1	.	.	.	.	1	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	11	.	.	.	.	.
Total carried to Summary, page 12 -	.	30	1	32	14	43	2	.	.	81	40	.	.	.	.	.	146	5	1	.	45	4	.	13	5	.	3	720	8	.	.	1	.
DEWSBURY Proposed Conservancy District.																																	
Batley - - -	23	.	.	2	2	.	.	.	.	.	24	.	.	.	.	.	128	.	.	.	.	1	.	.	3	.	.	56	.	.	.	.	.
Bierley (North) -	.	1	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	12	.	.	.	.	.	3	.	2	.	.	.	1
Birkenshaw - -	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3	.	.	.	3	.	.	.	.	.	.	4	.	.	.	.	.

STATISTICS of the TRADES and MANUFACTURES in the Basin of the Rivers AIRE and CALDER in the carrying on of which WATER is used and POLLUTED.

Name of Town.	Blanket Manufacturers.	Brewers.	Carpet Manufacturers.	Chemists, Manufacturing.	Corn Millers.	Dyers. Woollen Cloth.	Dyers. Wool and Yarn.	Dyers. Stuff.	Dyers. Silk and Cotton.	Finishers.	Fullers and Scribblers.	Glue Manufacturers.	Maltsters.	Paper and Paperhanging Manufacturers.	Linen Manufacturers.	Lead Manufacturers.	ShortWool, Shoddy, Waste, and Mungo Dealers.	Sizers.	Soap Manufacturers.	Grease Manufacturers.	Spinners and Manufacturers. Worsted.	Spinners and Manufacturers. Cotton.	Spinners and Manufacturers. Flax.	Spinners and Manufacturers. Silk.	Spinners and Manufacturers. Woollen Yarn.	Stuff Manufacturers.	Tanners.	Woollen Manufacturers.	Woollen Card Manufacturers.	Wool Combers.	Ware Grinders.	Wool and Stuff Printers.	Wire Manufacturers.
	RIVER CALDER—*continued.*																																
DEWSBURY—*cont.*																																	
Birstal	.	.	.	.	1	2	.	.	.	.	2	.	.	.	.	.	.	1	.	.	2	.	.	.	.	.	.	4	.	.	.	.	.
Cleckheaton	.	.	.	9	.	.	.	.	.	.	3	.	8	.	.	.	.	.	.	.	.	3	.	.	.	.	.	35	30	.	.	.	.
Dewsbury	26	.	6	.	3	5	.	.	2	.	13	.	.	.	.	.	61	3	.	.	.	.	.	.	9	.	3	56	4	.	.	.	.
Earlsheaton	49	.	.	.	1	1	.	.	.	.	7	.	4	.	.	.	9	.	.	1	.	.	.	.	.	.	.	16	.	.	.	.	.
Gomersal (Great & Little)	.	.	.	2	.	.	.	.	.	.	1	.	3	.	.	.	5	.	.	.	3	.	.	.	.	.	.	15	2	.	.	.	.
Hangingheaton	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	15	1	.	.	.	.	.	.	.	.	.	13	.	.	.	.	.
Hartshead	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	9
Heckmondwike	29	.	6	.	.	2	.	.	.	.	8	.	.	.	.	.	20	.	.	.	.	.	.	.	8	.	.	9	3	.	.	.	.
Liversedge	8	.	5	9	1	1	.	.	.	2	4	.	2	.	.	.	2	.	.	1	1	.	.	1	3	.	.	6	16	.	.	.	5
Mirfield	.	.	.	.	3	.	.	.	.	.	16	.	15	.	.	.	3	.	.	.	.	2	.	.	.	.	6	23	5	.	.	.	2
Thornhill	.	.	.	1	.	.	.	.	.	.	.	.	2	.	.	.	.	.	.	.	1	.	.	.	.	.	.	1	.	.	.	.	.
Total carried to Summary, page 12	135	1	17	24	13	11	.	.	2	2	78	.	35	.	.	.	246	5	.	2	24	6	.	1	23	.	12	238	62	.	.	.	17
WAKEFIELD Proposed Conservancy District.																																	
Alverthorpe-with-Thornes	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	4	.	.	.	.	.	.	4	.	.	.	.	.
Horbury	.	.	.	.	1	3	.	.	.	.	6	.	1	1	.	.	11	.	.	.	7	.	.	1	.	.	1	13	.	.	.	.	.
Ossett-cum-Gawthorpe	4	.	.	.	.	1	.	.	.	1	11	.	.	.	.	.	69	.	.	1	5	.	.	.	.	.	.	83	.	.	.	.	.
Wakefield	.	5	2	4	9	7	.	.	.	.	.	.	32	.	.	.	.	.	2	1	4	.	.	.	10	.	5	2	.	.	.	.	.
Total carried to Summary, page 12	4	5	2	4	10	11	.	.	.	1	17	.	33	1	.	.	80	.	3	3	20	.	.	1	10	.	6	102	.	.	.	.	.
	RIVERS AIRE AND CALDER UNITED.																																
PONTEFRACT Proposed Conservancy District.																																	
Castleford	.	.	.	1	.	1	.	.	.	.	.	.	4	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Knottingley	.	1	.	1	2	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Pontefract	.	.	.	.	3	.	.	.	.	.	.	.	8	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.	.	.	.	.	.
Total carried to Summary, page 12	.	1	.	2	5	2	.	.	.	.	.	.	12	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.	.	.	.	.	.

SUMMARY.

Proposed Conservancy District.	Blanket Manufacturers.	Brewers.	Carpet Manufacturers.	Chemists, Manufacturing.	Corn Millers.	Dyers. Woollen Cloth.	Dyers. Wool and Yarn.	Dyers. Stuff.	Dyers. Silk and Cotton.	Finishers.	Fullers and Scribblers.	Glue Manufacturers.	Maltsters.	Paper and Paperhanging Manufacturers.	Linen Manufacturers.	Lead Manufacturers.	ShortWool, Shoddy, Waste, and Mungo Dealers.	Sizers.	Soap Manufacturers.	Grease Manufacturers.	Spinners and Manufacturers. Worsted.	Spinners and Manufacturers. Cotton.	Spinners and Manufacturers. Flax.	Spinners and Manufacturers. Silk.	Spinners and Manufacturers. Woollen Yarn.	Stuff Manufacturers.	Tanners.	Woollen Manufacturers.	Woollen Card Manufacturers.	Wool Combers.	Ware Grinders.	Wool and Stuff Printers.	Wire Manufacturers.
	RIVER AIRE.																																
SKIPTON	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	9	.	.	.	.	1	.	.	.	.	.	.
KEIGHLEY	.	4	.	2	13	.	.	2	.	.	.	.	6	5	.	.	.	1	.	.	111	3	.	.	1	.	5	.	.	5	.	.	.
BRADFORD	.	12	.	10	9	1	.	30	1	6	16	1	14	2	.	.	148	19	.	6	159	11	.	1	.	121	7	410	.	41	.	.	.
LEEDS	.	13	10	31	29	27	9	16	19	52	36	7	45	22	17	.	108	14	7	2	27	1	26	1	9	.	42	471	1	.	8	.	1
TOTAL in Basin of River AIRE	.	29	10	43	52	28	9	48	20	58	52	8	65	29	17	1	256	34	7	8	297	24	26	2	10	121	55	881	1	46	8	.	1
	RIVER CALDER.																																
TODMORDEN	.	1	.	6	3	.	.	.	7	6	.	.	2	1	.	.	19	3	.	.	5	123	.	.	.	.	.	.	.	.	.	.	.
HALIFAX	.	19	5	14	15	17	5	10	6	8	2	.	13	5	.	.	42	2	1	2	100	65	.	11	7	24	8	109	28	6	3	1	13
HUDDERSFIELD	.	30	1	32	14	43	2	.	.	81	40	.	.	.	.	.	146	5	1	.	45	4	.	13	5	.	3	720	8	.	.	1	.
DEWSBURY	135	1	17	24	13	11	.	.	2	2	78	.	35	.	.	.	246	5	.	2	24	6	.	1	23	.	12	238	62	.	.	.	17
WAKEFIELD	4	5	2	4	10	11	.	.	.	1	17	.	33	1	.	.	80	.	3	3	20	.	.	1	10	.	6	102	.	.	.	.	.
TOTAL in Basin of River CALDER	139	56	25	80	55	82	7	10	15	98	137	.	83	7	.	.	533	15	5	7	194	198	.	26	45	24	29	1169	98	6	3	2	30
	RIVERS AIRE AND CALDER UNITED.																																
PONTEFRACT	.	1	.	2	5	2	.	.	.	.	.	.	12	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.	.	.	.	.	.
TOTAL in entire Basin of the Rivers AIRE and CALDER	139	86	35	125	112	112	16	58	35	156	189	8	160	36	17	1	789	46	12	15	491	222	26	28	55	145	86	2050	99	52	11	2	31