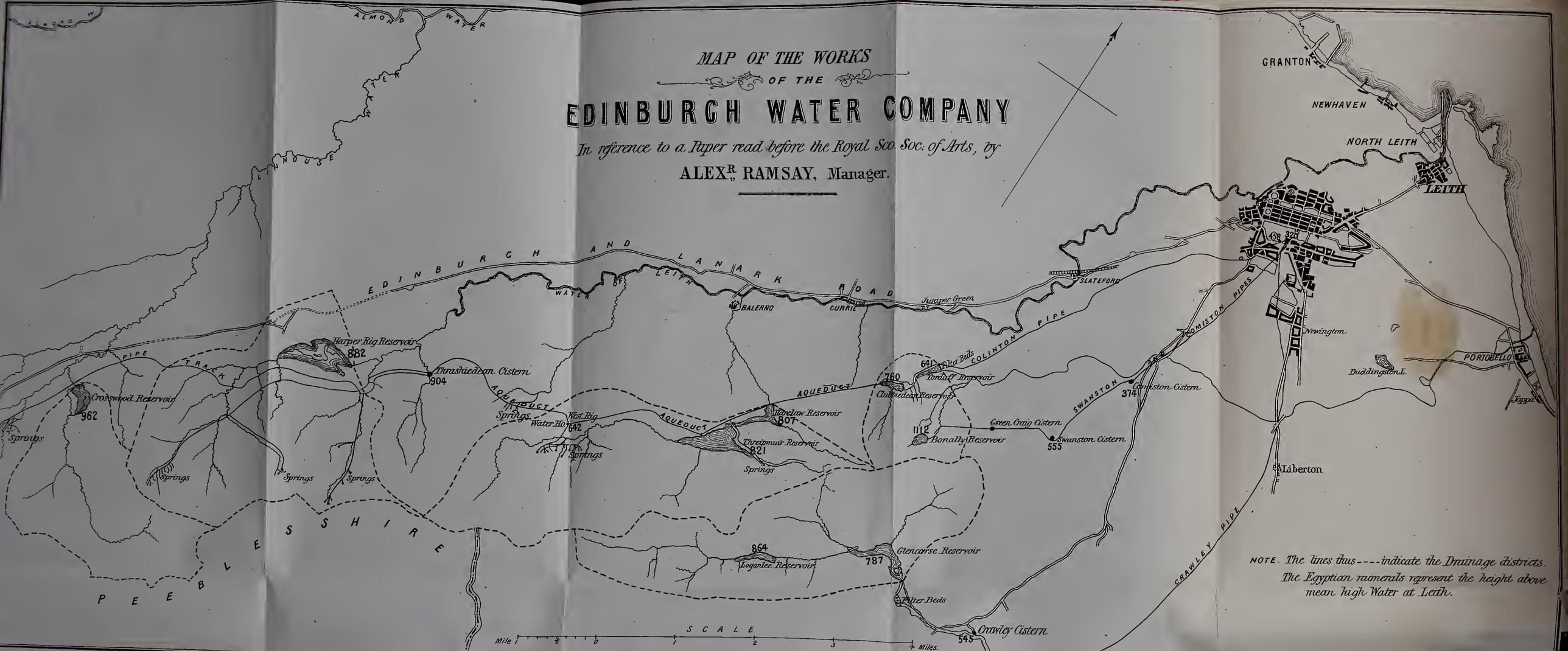
MAP OF THE WORKS OF THE EDINBURGH WATER COMPANY

In reference to a Paper read before the Royal Sco. Soc. of Arts, by

ALEX^{R} RAMSAY, Manager.



ON THE

WATER SUPPLY OF EDINBURGH:

BEING A

PAPER READ BEFORE THE ROYAL SCOTTISH SOCIETY OF ARTS,

23D NOVEMBER 1863.

BY

ALEXANDER RAMSAY,

MANAGER EDINBURGH WATER COMPANY.

EXTRACTED FROM THE TRANSACTIONS OF THE SOCIETY.

WITH A MAP.

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ON THE

WATER SUPPLY OF EDINBURGH.

The history of the Water Company, and its sources of supply, have been made so familiar to the public of Edinburgh by the public press and otherwise, that any detailed notice of the one or the other to the members of this Society may seem somewhat a work of supererogation. In order, however, that what I am going to say may be more intelligible, I shall briefly, with the aid of the map now before you, point out the various sources from which the water supplied to Edinburgh and its vicinity is derived, and, at the same time bring under your notice any circumstances connected with its introduction and use, that may seem to possess sufficient interest to justify me in occupying your attention.

Up to the year 1681, when the water of Comiston was introduced, the inhabitants were wholly dependent for the supply of water on public and private pump-wells. Such of these wells as were destined to public use, were few in number, and all of them subject to the inherent objections that the water was hard, and in dry seasons liable altogether to fail. I refer to a period of time before the introduction of water from the country by the Town Council; and although that period is far beyond any living memory, the distress which must then have been suffered was not inadequately represented by what the community endured in more recent times, and up to the year 1822, when the Crawley springs were brought in.

The springs rising in the estate of Comiston, had been brought in by the Town Council in 1681, and in 1762 certain springs originating on the north slope of the Pentlands, on

the estate of Swanston, were introduced. These were conveyed to Edinburgh in wooden pipes, and after furnishing a supply to the few private houses into which water was then introduced, the surplus was distributed amongst certain public wells which still exist. These springs could never, in the aggregate, have yielded more than 60 cubic feet per minute, and in dry seasons must occasionally have been as low as 12 or 13 feet. The amount of the supply, therefore, ranged between 12 and 60 cubic feet per minute, according to the state of the weather; and the misfortune was, not only that the yield diminished during that season of the year when it was most required, but simultaneously with that of the pump-wells. With a view to relief, a reservoir, or rather two reservoirs, were constructed on a piece of flat or hollow ground, partly occupied by the present reservoir, high up on the hill, nearly due south from Bonaly House, and a pipe was laid from the lower one in a north-easterly direction to join the Swanston pipe at Greencraig. These reservoirs, however, were very much dependent for their supply on surface drainage, the area of which was limited, and the quantity of spring water was comparatively small. The flat and rather soft ground on which they were situate produced a difficulty which had not been anticipated. The water obtained from them swarmed with animalculæ and tadpoles, and, when the Crawley water was subsequently introduced, these reservoirs were abandoned, both as being objectionable on account of the extent of animal life in the water, and as being unnecessary, on the introduction of what was thought to be a full supply from the Crawley district.

The distress from the want of water up to this time must have been intolerable. I remember well the scenes which, during summer and autumn, between 1806 and 1822 were of nightly occurrence at the public wells. Water could only be procured at these wells at intervals of many days, and generally had the peculiar infelicity of being turned on, and available only at night. When it was obtained or expected, the wells were attended by crowds of persons of both sexes and all ages; and it was ruled by an acknowledged etiquette, that with the exception of the water porters, or water cadies as they were called, whose claims to a priority of

supply were not usually disputed, all others should obtain their modicum strictly in the order in which their vessels were set down. An array of vessels extending from the well in the High Street east of the North Bridge, half way down to the Nether Bow, was a matter of common occurrence. These vessels consisted of every variety of household utensil, from washing-tubs to tea-kettles and porridge-pots, down to articles of still baser uses; and from some misarrangement not easily explained, it often happened that when the supply came it was near or after midnight; while from six or seven o'clock in the evening, till perhaps three in the morning, many of the long array of men, women, and children, were detained watching for the happy moment, when they could obtain the miserable driblet which was to tide them over during the intervening days till their vessels could be again replenished.

But this waiting and watching and exposure were not always successful in obtaining the coveted supply. It happened not unfrequently, that before the half of the expectant crowd was served, the water was turned off; and then woe betide the old and the infirm. Even the family of the hardy tradesman and labourer, the condition of whose household threw the burden of carrying a supply of water for domestic necessities on the husband, was often reduced to straits and difficulties not more endurable than those of the most helpless in the crowd. These men, after a day spent in laborious employment, and after waiting till long after midnight at the public wells, after all this long waiting and deprivation of necessary rest, had sometimes to return empty-handed to their homes, to endure the misery and discomfort arising from the want of an article scarcely secondary, for the necessities of the household, to bread itself. In those days the public press concerned itself little with the sanitary condition of the city, and the scanty patriotism of the Town-Council was not such as to occupy itself deeply with matters connected with the dwellings of the lower classes. It seemed enough that there were the springs at the Well-house Tower, the Bull Stank, the Wells of Weary, and the Powburn; and as the most distant of these was not more than a couple of miles from the Cross of Edinburgh, those

who could procure no water elsewhere, and those who were *recherché* in their taste, according to the taste of those days, could, with stoup or tea-kettle, find the necessary driblet there.

This was the state of matters up to 1822, and I refer to it only as a feeble illustration of the distress which must have existed in older times, previous to the introduction of the waters of Comiston and Swanston, when the whole supply was obtained from wells within the town, and from the adjacent springs and stream to which I have referred.

The clamour of the inhabitants had become loud and incessant, and the Town Council seemed disposed to remedy the evil, in so far as is shown by their endeavour to obtain, about the year 1817, a supply of water, by putting a compulsitor on the proprietors of the Union Canal. The public impatience gradually extended itself to the upper classes, and at last, resolved to endure the delay no longer, a public meeting was convened, and presided over by the late Lord Jeffrey, when resolutions were passed, out of which was originated the present Water Company. In 1819 the Company was incorporated under an Act of Parliament, under which they obtained the works and sources of supply up to that time in the hands of the Town Council; and under the same authority were empowered to bring in the Crawley springs, and a portion of the water of the stream called Glencorse Burn. Authority was at the same time given for the construction of the Glencorse Reservoir, for the purpose of affording compensation to the mill-owners on the Esk for the spring-water to be diverted for the supply of the inhabitants of Edinburgh. The necessary works had been very skilfully devised by the late Mr Jardine. Difficulties, however, occurred in the course of their construction, which it was feared for some time would lead to the abandonment of the whole scheme. The site for the embankment was chosen at a point where the channel of the stream is narrowed by a projecting spur of rock on the north, and by a precipitous hill on the south. In excavating for a foundation the bed of gravel was found to be of no less than 53 feet in depth, and in removing it to make way for the necessary clay-puddle dyke, the hill on the south side, consisting of a loose and somewhat friable

felspathic trap, slipped in, and presented difficulties so great in the farther prosecution of the necessary operations, that for some time it was doubted whether success was possible. The necessity for water, however, was so clamant, that it was determined to push forward the works so long as a hope of their successful execution remained; and at last, through the skill and genius of Mr Jardine their engineer, the directors had the happiness, in 1822, of bringing the whole works to a successful completion, and introducing what was then, and many years afterwards deemed to be an overflowing supply of water; and it was with a just pride that the inhabitants of Edinburgh pointed to the skill with which the works had been designed, the success of their completion, and the abundant supply of water, as it was then thought, for all the necessary wants of the inhabitants, which had thus been rendered available.

The main pipe was constructed of a capacity to deliver 253½ cubic feet per minute in Edinburgh, and on its being afterwards tested by measurement of the delivery, was found to convey 267 feet.

A primary obligation was imposed by Parliament on the Company, to the effect that before supplying water to Edinburgh, 130 cubic feet per minute was to be sent down the Glencorse Burn for the supply of the millowners on the Esk. So long as that supply could be maintained the Company had the command of the whole water of the reservoir and the yield of the Crawley Springs, and were thus free to keep the main pipe constantly full, so long as they were in a condition to discharge the preferable obligation to the millowners.

The relief afforded by the introduction of the new supply of water was immense, and at that time, and for a number of years after, realised all the hopes and promises that the scheme originally held out. The demand, however, for water increased rapidly, and although the service was only intermittent, the consumption per head increased from 7·85 gallons per head per day of the population in 1824, to 16 gallons in 1830. It continued at that rate with but little variation till 1842, when it fell to 13·41 gallons per head per day, and in 1844 to a fraction under 12 gallons.

Notwithstanding that the water brought in, in 1822, was thought to be sufficient for several generations, a scarcity was complained of from about the year 1836 or 1838; and the excessive drought of 1842 having emptied the reservoir, and the Company being no longer able to maintain the statutory supply to the mills, the millowners applied to the Sheriff for power to turn the Crawley Springs into the river. This they were quite entitled to do, and would have done, if the Directors of the Water Company had not come promptly forward to undertake the payment in money of the loss and damage to the whole mills on the Esk, from the Glencorse or Logan Burn to the sea. For being allowed thus to retain the use of the springs to the inhabitants of Edinburgh for a short period, they paid compensation to the millowners of upwards of L.4500.

It was now clear to every one, that the supply of water from the Glencorse district was insufficient for the increased and still growing wants of the inhabitants. The Directors therefore prepared a bill, and obtained power from Parliament in the following year (1843) to bring in the springs originating on the estates of Bavelaw and Listonshiells, along with the valuable group of springs called the Black Springs, all of which rise on the north slope of the Pentlands. The bill was opposed by the millowners on the Esk, who were successful in obtaining an additional supply of 50 feet to the 130 feet previously allowed. Reservoirs at Threepmuir and Harlaw were at the same time authorised, for the exclusive purpose of compensation to the mills on the Bavelaw Burn and Water of Leith. The springs were to be collected in pipes and conveyed to a stone aqueduct at a place called Westrig, and thence eastward to the present reservoir at Clubbiedean, and from thence to Edinburgh in a cast-iron pipe. These works were designed by Mr Jardine, and five years from 1843 was allowed for their completion. In the meantime public impatience, especially during the summer and autumn months, when the supply fell short, was strongly manifested. Indeed it became evident, before the Act of 1843 was two years old, and three years before the water which was authorised by that Act to be conveyed to Edinburgh, could be introduced, that it would still be

insufficient. The additional quantity thus provided was equal to fully 160 cubic feet, or 1000 gallons per minute; but the necessities and demands of the inhabitants were great, and, in order still further to augment the supply, a bill was carried through Parliament in 1847, authorising an increase in the height of the Glencorse Reservoir—the construction of additional reservoirs at Loganlea, Bonaly, Clubbiedean, and Torduff, and a cistern in the Castlehill. The object of the works at Glencorse and Loganlea was to secure the means of maintaining at all times the full supply of the Crawley pipe. This part of the scheme, however, was opposed by the millowners, who again obtained an addition to their previous quantities of 130 and 50 feet, a farther quantity of 40 feet, thus raising the compensation from the original quantity of 130 to 220 cubic feet per minute. A claim was at the same time made by the millowners on the Bonaly or Portobello Burn, and 60 cubic feet per minute was awarded to them for the springs and surface water to be collected in the Bonaly, Clubbiedean, and Torduff reservoirs. The scheme was prepared by Messrs Rendal and Beardmore, and finally carried out under the direction of Mr Leslie. Its more important features consisted in the value of the new reservoirs, as stores for collecting the surplus water at those seasons when it was abundant, and would otherwise have gone down to the sea, and thus affording the means of equalizing the delivery to the inhabitants over the whole season.

Filters were constructed at Torduff and Glencorse, and the water obtained from these, and from the new reservoirs, was conveyed to the main pipes previously laid.

There are three-filter beds at Torduff, and a similar number at Glencorse, each measuring 92 feet by 92, and capable of filtering in whole 1,824,000 gallons per day. They were designed and completed by Mr Leslie, and their efficiency has been thoroughly tested by the experience of the last fifteen years. They are works of a costly character, and the object they accomplish in purifying the water is so important, that I venture to trouble you with a brief description of them.

In the first place, the ground was excavated, or made up,

according to circumstances to the depth of 12½ feet, and the bottoms and sides of the beds made perfectly water-tight by clay puddle. Over the bottom part of the beds there was placed 3 inches of carefully washed sand; and over that a layer of 3 inches of fine screened gravel. Passing down the centre, along the whole length of the beds, is a drain of dry mason-work, to receive and carry off the filtered water. Over the 3 inches of gravel already mentioned, there is a bed of gravel of coarser quality from 1 foot 6 to 3 feet 6 inches in depth, the upper surface being formed in ridges and furrows. There is next a layer of 6 inches of fine gravel. Then a layer of 6 inches of sea-shells. Again a layer of coarse sand, and the whole finished with a layer of 1 foot 6 inches of the finest sand. These successive layers form the filtering material, all of which was carefully washed before being put into its place.

The water to be filtered is conveyed from the burn at Glencorse in a stone aqueduct, and at Torduff by a cast-iron pipe, and distributed over the surface of the filter-beds, through which, consisting of the 6 feet of filtering material I have already mentioned, it passes into the interior aqueduct, and is thence conveyed into a measuring cistern, on its way for distribution in town.

In order that you may have a connected view of the state of the supply, I now revert to the remarkably dry year of 1842. In the autumn of that year the supply for some time was under 80 cubic feet per minute, and during the time of this excessive scarcity, could only be served out to the different districts in succession, once in four days. The delivery for the year fell to 249·56 cubic feet per minute, and afforded a supply of only 13·41 gallons per head per day, to a population of 166,878.

In 1844 it fell to 229·6, and the daily supply to 11·95 gallons per head to 172,286 persons.

In the autumn of 1848, the supply, authorised by the Act of 1843, became available, and the average delivery rose to 460·06 cubic feet per minute, or 22·21 gallons per head per day, to a population of 185,806.

The water authorised to be brought in under the Act of 1847, was introduced in 1852, and during the following year

(1853), when it had become fully available, afforded a delivery of 518·68 cubic feet per minute, representing a supply of 23·74 gallons per day to a population of 195,984.

In 1856 the delivery had risen to 560·41, or 25·17 gallons per head per day, to a population of 199,782 persons.

The delivery had thus risen in the twelve years commencing 1844, from 229·6 cubic feet per minute, to 560·41 in 1856; and the supply to the population from 11·95 gallons per head per day, in the former year, to 25·17 gallons per head per day, in 1856.

To meet this rapidly increasing consumption, and the increasing demand for the introduction of water into houses occupied by the working population, the Directors of the Water Company, in 1856, carried a bill through Parliament, authorising them to bring in the copious springs rising on the estate of Colzium and adjoining districts to the east of that property, and to construct a reservoir at Harperrig, for the purpose of affording compensation to the millowners on the water of Leith. The plans for these works were prepared by Mr Leslie, and the works completed under his superintendence.

The reservoir was finished, and the springs brought in, in the summer of 1859.

The water for the use of the City is conveyed partly in pipes, and partly in a built stone aqueduct to a cistern at Westrig, and thence to Edinburgh by the previously existing line of works.

In the following year (1860), when this additional supply was fully available, the delivery amounted to 636·04 cubic feet per minute, equal to a supply of 27·85 gallons per head per day, to a population of 203·580. In 1861, the delivery had increased to 663·63 cubic feet per minute, or 28·88 gallons per head per day, to a population of 206,115.

In 1862, the delivery had risen to 702·3, or a daily supply of 30·38 gallons per head, to a population of 207,381.

In the year ended Whitsunday last, it had increased to 723·92 cubic feet per minute, and the delivery per head, to 31·12 gallons per day, to a population of 208·647.

That this enormous increase in the consumption may be more readily comprehended, I have divided the period

between 1842 and 1863, into three periods of seven years each, and the following table shows the delivery in cubic feet per minute, and the consumption per head per day of the population at each of these Septennial periods:—

Years.	Delivery of Water in Cubic Feet per Minute.	Population.	Gallons per Head per Day.
1842	249·56	166,878	13·41
1849	460·06	185,806	22·21
1856	560·41	199,782	25·17
1863	731·80	208,647	31·2

In the face of this large and increasing consumption, it should not seem surprising that the Directors of the Water Company, while proposing to augment the supply, should be desirous at the same time to place some restrictions on excessive and useless waste.

Mr Leslie was instructed to make the necessary survey, and to prepare plans for bringing in the springs on the lands of Crosswood, and adjoining district on the western boundary of the county of Edinburgh. Indeed, there was little room for choice in the matter. The Water of Leith, and the North and South Esk, were either already appropriated, or in such a state of pollution from paper mills and other manufactories, as to render them totally unfit for domestic use. The short distance to which the Crosswood springs had to be conveyed to the aqueduct at Rushiedean, which had been constructed with a view to their being brought to Edinburgh by that line, was an important recommendation, and left no room for doubt as to that branch of the scheme.

It was necessary, at the same time, to provide compensation to the millowners on the Crosswood, Linhouse, Muiriston, and Almond Waters, of which the Crosswood Springs are feeders, for the abstraction of these springs for the use of the city. A site for a reservoir, therefore, was selected on the farm of Crosswood; and that reservoir, and the conveyance of the springs to Rushiedean, are the only works

necessary to render the springs available to the inhabitants of Edinburgh.

It is expected that from 80 to 100 cubic feet of water per minute will be derived from them; and looking, not only to the benefit of this large additional supply to the inhabitants, but to the means the scheme will afford of keeping up the supply in the Torduff and Clubbiedean reservoirs during dry seasons, it would be difficult to overrate its importance.

Like other things, however, water can be abused and wasted, and there seems somehow an unfortunate propensity in human nature, in respect of property held in common, to waste what it cannot beneficially consume; and, no doubt in the case of water, that propensity is sometimes exercised without much regard to the cost at which the water has been provided, or the injury inflicted on those who use, and desire to use, no more than their fair and legitimate share of the common property. The present supply of water has cost upwards of L.500,000. The mere magnitude of this sum, should in itself, and without reference to any higher motive, induce some consideration as to the waste of an article so indispensable, and obtained at so heavy a cost. Unhappily, however, the experience of all large towns furnishes too abundant confirmation of this tendency to waste. The necessity, therefore, for some restraining power is obvious, and is all the greater from the difficulty there is in making people understand, either the extent of waste from what is apparently a small cause, or from the fact that the supply of water is limited by the Legislature. Being the joint and common property of the public, those who by a system of waste consume more than is required for their necessary uses, are encroaching on the property of their neighbours; and in such circumstances it is scarcely too much to say that waste partakes in no inconsiderable degree of the character of profligacy.

A certain quantity of water is necessary for the domestic wants of every one, but that quantity has a proper and definable limit; and on considering this most important point, in circumstances where the supply of water is constant, and may be drawn off any moment by night or day, it must be kept in view, that the system of constant service, with

its manifold comforts and advantages, and the protection against fire which it affords, gives at the same time the greatest possible facilities for waste. No inconsiderable portion of this waste is wilful, and a scarcely smaller portion arises from defective apparatus.

It has been ascertained beyond all doubt or question, that in numerous towns in England, a quantity varying from 15 to 20 gallons per head, per day, of the population, inclusive of every purpose, is found not only ample in itself, but satisfactory to the inhabitants. Amongst these towns I may mention Nottingham, Norwich, Sunderland, Durham, Leeds, Derby, Salford, and others; and there the limited consumption, to which I have referred, is due exclusively to the means adopted for preventing waste. In other towns, where similar means or powers do not exist, the contrast is most striking. In Glasgow the consumption is upwards of 42 gallons; in Dublin 70; and in Oxford has increased to the amazing quantity of 110 gallons per head, per day, of the population. Now, looking to the consumption of from 15 to 20 gallons per head per day in the towns I have named, and remembering that the supply there is constant; without restriction as to use; and guarded only against waste, it seems abundantly plain that the latter quantity of 20 gallons per head ought to be sufficient in every town in the kingdom, and that any excess over that quantity must be attributed only to reckless or wilful waste.

The delivery in Edinburgh during the week ended 17th instant was 780 cubic feet per minute, or 33 gallons per head per day to a population of 208,647 persons. It is hardly conceivable that, including every purpose, a quantity of 33 gallons per head per day is necessary for the community of Edinburgh, Leith, and Portobello; and that there may be no misapprehension as to the quantity consumed in trade, manufacturing, and sanitary purposes, I think it right to state that the quantity disposed of for these purposes is a fraction over ten per cent. of the whole consumption.

Estimating the aggregate supply after the completion of the works, authorised by the last Act of Parliament, to be equal to 900 cubic feet per minute, and assuming the consumption to continue at the rate of 33 gallons per head, it

would furnish a supply to a population of not more than 245,454, or only 36,807 in addition to the present estimated population of 208,647.

Now, supposing that the inhabitants here, and in Leith and Portobello, could be induced, by the avoidance of waste, to limit themselves to 20 gallons per head per day, which has been found to be an abundant supply elsewhere, the present delivery, with the addition of the water to be derived from the new works, would be a sufficient supply at that rate till the population should amount to 388,840 persons; and even at 25 gallons per head would supply a population of 324,000.

If, on the other hand, the rate of consumption per head should go on to increase, the total quantity of water at command would furnish a supply of not more than 39 gallons per head to the present population, estimated, as has been said, at 208,647,—which 39 gallons per head, must be held as the highest possible maximum rate of delivery to a population of that number. But the population in the meanwhile would gradually increase, and the rate per head would accordingly be diminished as the maximum supply was distributed over a larger population.

Looking to the physical peculiarities of the country adjoining Edinburgh, it will be observed that there is no large river or lake from whence an additional quantity of water may be obtained. The present supply is derived chiefly from a vast multitude of springs, most of them small, and scattered over a great extent of country, yet forming when united a large aggregate; and the only source from which farther supplies are likely or readily to be obtained is Crosswood Hill, where there are some good springs which drain by the Medwyn Burn into the Clyde. If any farther quantity beyond the yield of these springs should be required, it could only be obtained at a great distance, and at an enormous proportional increase of cost.

Considering all circumstances therefore, the patriotism, or the sense of justice of the inhabitants, might, and probably does, go a considerable way in preventing the consumption per head from encroaching too closely on the means of supply. It has attained, however, as has been already stated, to 33 gallons; and with a view of reducing it, if not to the

scale of the English towns I have mentioned, at least to keep it within the means of rendering the maintenance of the system of constant service possible, certain powers for the prevention of waste were, by the recent Act, conferred on the Company, concurrently with the power to bring in the additional supply of water.

Besides the waste of water from defective apparatus, it is known that a large quantity is wasted wilfully by such practices as tying up the handles of water-closets. The persons who indulge in this most reprehensible practice are under the impression that to do so is to cleanse the pipes, or flush the drains; and are not generally aware that it fails in producing these effects in any beneficial degree; while its only certain result is to fill the house with the poisonous air thereby returned from the drains. The consequences of this practice are so deleterious, that at least in one large town in England, the Board of Health has interfered to prevent it. It should be known that drains can only be effectively flushed by the sudden discharge into them of a sufficient body of water, and that the continuous pouring in of the small stream, derived from the usual construction of a water-closet cistern, is quite inefficient for the purpose intended, and that its chief or only effect is to cause the admission into the house of the fetid air generated in them.

It is a most difficult matter to impress on the minds of the public an estimate of the waste arising from ill-constructed or defective apparatus. Mr J. M. Gale, the engineer for the Glasgow Water Works, has been at much pains to elucidate this important subject, and to prevent the evils arising from it. In a printed report prepared by him, dated June 1860, and laid before the Glasgow Corporation, the result of his examination shows the waste of certain descriptions of apparatus in a very striking manner. This is stated to be in twenty-four hours from one tap of a certain description 2500 gallons; in another 2656; in another 1594; in another 1992; another 1000; another 797, and a great many other similar instances.

I now lay before you three varieties of tap,—namely, the common ground tap; Kennedy's patent screw-down; and two specimens of loose valve screw-downs, one by Guest and

Chrimes of Rotherham, and the other by Messrs James Milne and Son of Edinburgh. With regard to the first of these taps, it is impossible to keep it in repair for any considerable time, and both in order to save expense to the consumer, and to avoid waste of water, it should be abolished. The solid matter which all water, as a common rule, more or less contains, acts like emery on the plug and inside metal of the tap every time it is opened or shut, and grinding the metal rapidly away, waste of water becomes unavoidable, while the owner is subjected to constant expense for repair or renewal. The other varieties are less liable to leak or to fall into disrepair, and in those by Guest and Chrimes, and Milne in particular, leakage, when it occurs, is easily and cheaply corrected by the substitution of fresh leather washers for those which may have become worn out. In mentioning the names of Kennedy, Guest and Chrimes, and Milne, I do so because of the excellent quality of their work, but without disparaging, in the least degree, the work of other brassfounders in Edinburgh or elsewhere. I submit these taps to your examination, merely as specimens of an excellent variety of article, the cost of which in the case of half-inch loose valve screw-downs, being the size most generally in use, is not more than that of the greatly inferior ground tap.

In preparing to give evidence before a Committee in Parliament in the course of last Session with a view to illustrate the extent of waste, I wished to show the quantity of water which would pass through circular orifices of various diameters, each being represented in decimals of an inch. Having prepared the necessary discs, beginning with the decimal ·05 up to decimal ·4 I ascertained the discharge through these orifices under various degrees of pressure; and, in order that the accuracy of my experiments might not be subject to question, I had them repeated in the presence of Messrs Stevenson, Leslie, and Bell, civil-engineers, and several other persons. I now submit these discs to your examination, and the following table shows the diameter of the orifices, the vertical pressure, and the respective discharges in 24 hours:—

Diameter of Orifice in Decimals of an inch.	Pressure in Vertical Feet.	Discharge in 24 Hours.
·05	150	613 Gallons
·10	150	2,380 ,,
·15	149	4,837 ,,
·20	146	8,520 ,,
·25	143	13,416 ,,
·30	140	19,547 ,,
·35	130	25,412 ,,
·40	120	34,285 ,,

Referring again to Mr Gale's printed report, it is there stated, that in 102 common ground ball-cocks examined by him, the aggregate waste in twenty-four hours was 12,483 gallons, of which one cock alone had the merit of wasting 2500 gallons. In eight valves of water-closets furnished with cisterns, also examined by him, the aggregate waste was 4588 gallons in twenty-four hours, of which there was due to one alone 1992 gallons. These cocks were examined simply in the order of rotation, and not because of any known defects. Some idea therefore may be formed of the enormous waste of water from imperfect apparatus, when the average waste from the 102 ground cocks was 122·3 gallons each; and in the eight water-closet valves, 573·5 gallons each, in twenty-four hours.

In an appendix attached to the same report, Mr Gale shows a daily waste in Glasgow of 7,200,000 gallons of water, which, as calculated by him at the rate of 40s. per 100,000 gallons, represents an annual loss in money of no less than L.52,500.

If I am correct in assuming, as I believe I am, that 20 gallons per head per day is a sufficient supply for every domestic, trade, or manufacturing purpose, the quantity wasted in Edinburgh, Leith, and Portobello, valued only at Mr Gale's rate of 40s. per 100,000 gallons, would represent an annual loss of upwards of L.21,000.

It must not for a moment be imagined that this is merely a Water Company's question. The inhabitants are even

more deeply interested in it than the Company. The dividend of 6½ per cent. to which the Company is limited, may be said to be already attained and secured; and any surplus that may accrue, after paying that dividend, and the working expenses, must be accumulated under a statutory provision till it shall become available in the reduction of the water rates. How soon that reduction, and to what extent it may be accomplished, is a matter very much in the hands of the inhabitants, whose interest in that respect it is the duty of the Company to protect and support.

I have already stated that the present delivery is 780 cubic feet per minute, and affords a supply of 33·31 gallons per head per day to the present population, estimated at 208,647 persons; and taking the total available supply when the works authorised by the last Act are completed, to be 900 cubic feet per minute, I submit the following table as showing briefly and at a glance the number of persons that quantity would supply at the different rates per head per day therein specified:—

38·8	gallons per day to the present population,		208,647
33	do.	to a population of . . .	245,454
25	do.	do. . . .	324,000
20	do.	do. . . .	388,840

The possession of a quantity of water capable of supplying a population of from 208,647 to 388,840 persons on different scales, even the lowest of which (20 gallons per head per day) is found sufficient in other large towns, is unquestionably a matter of great public value and importance, of which the simple fact, that within a short time the quantity of water at command will be capable of furnishing that large daily supply to every man, woman, and child, of a population exceeding by 86 per cent. the present number of inhabitants, is a striking illustration. The period of time when the population of Edinburgh, Leith, and Portobello, shall have attained to that vast increase is necessarily so uncertain as to elude accurate calculation; but the certainty of that large quantity per head being secured to so immense an addition to the number of the inhabitants, can hardly fail to be a matter of satisfaction and congratulation to all

persons who consider how much the health, comfort, and general prosperity of the community, depend upon a sufficient supply of pure and wholesome water.

I have only to add, that of the whole delivery of 780 cubic feet per minute during the past week, fully 590 was spring water, brought in in under-ground pipes direct from the sources of the springs, and that the remainder, under 190 feet, was burn water, and subjected to filtration before being brought to town.

I have thus endeavoured to give a brief outline of the history of the introduction of water from the country, from the time when the first supply was brought in, in 1681, to the present month. I have shown the extent of the available supply at different periods; the successive additions which have been made to that supply, and the quantity per head per day thereby afforded, from time to time, to the population.

I have endeavoured, also, to show, by a comparison of the consumption per head in certain towns in England, where an abundant supply on the system of constant service is furnished, that the great increase in the consumption per head which within recent years has taken place in Edinburgh, Leith, and Portobello, is due in great part to bad apparatus and wilful waste; and that, if used only with moderate economy, the water at present available is sufficient to supply a vastly increased population.

I have, on the other hand, suggested, that if excessive waste is continued, it will be necessary, sooner or later, to seek for increased supplies, probably at a great distance from Edinburgh, the additional cost of which must alike fall on the inhabitants, whether the diminution in the rates be merely postponed or altogether defeated by a system of waste of such extent as to render it necessary to make any considerable increase in the quantity of water already within the command of the Water Company.