BANN AND LOUGH NEAGH DRAINAGE.

REPORT

BY

SIR ALEXANDER R. BINNIE,

TO

HIS EXCELLENCY THE LORD LIEUTENANT.

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

DUBLIN:
PRINTED FOR HIS MAJESTY'S STATIONERY OFFICE,
BY ALEXANDER THOM & CO. (LIMITED), ABBEY-STREET.

And to be purchased, either directly or through any Bookseller, from
E. PONSONBY, 116, Grafton-street, Dublin; or
WYMAN and SONS, Ltd., Fetter-lane, E.C., and
32, Abingdon-street, Westminster, S.W.; or
OLIVER & BOYD, Edinburgh.

1906.

[Cd. 2855]. *Price* 4*d*.

BANN AND LOUGH NEAGH DRAINAGE.

REPORT

BY

SIR ALEX. R. BINNIE.

16th January, 1906.

INDEX.

9, Great George Street,
Westminster, S.W.,
16*th January*, 1906.

To His Excellency the Lord Lieutenant of Ireland.

BANN AND LOUGH NEAGH DRAINAGE.

(1).—INTRODUCTION.

May it please Your Excellency,

In obedience to the instructions of the Irish Government conveyed to me by letter of the 25th April, 1905, I have the honour to report that I visited Lough Neagh and the River Bann, and devoted the time from the 7th August to the 26th September, 1905, to a thorough investigation of all the circumstances of the case, in which I had the use of a steam launch, obtained through the kindness of J. R. Wilson, Esq., of Ennismore.

By this means I was able to visit in detail almost every part of Lough Neagh, including, among other places, Ballyronan, Newport Trench, near Arbo, the lower part of the River Blackwater, the Upper Bann as far as Portadown, the Lagan Navigation, the Tunny Cut, which drains Portmore Lough, and the little harbour at Antrim, and made a thorough study of the discharge of the water from the Lake at Toome.

Much of my time was occupied in repeated visits to all the principal points on the Lower Bann between Toome and the Cutts of Coleraine, investigating the various weirs, shoals, and other obstructions on the river.

I made it my duty to consult with the authorities interested in the Fisheries, and particularly with those of the Eel Fisheries at Toome, with whom I made a detailed inspection from Toome to Carnroe. I also had an interview with Mr. MacDermot, representing the Salmon Fisheries at the Cutts; and I am much indebted for valuable information and assistance afforded me by Mr. Ellis, of Toome, who represents the Eel Fisheries at that place.

I had the good fortune to meet and confer with members of the Bann Drainage Conference Committee, who represent interests on the Upper Bann.

On another occasion I conferred with a deputation of the Agivey Bann Drainage Association who represent landowners on the Lower Bann.

I called on and conferred with William Moore, Esq., K.C., M.P., Colonel Bruce, of Ballyscullion, Percival Gauson, Esq., who is interested in land near Toome Bridge, Harry Barton, Esq., of The Bush, Antrim, and many small landowners, fishermen, and others. I also received valuable assistance from W. O'Neill, Esq., the Engineer of the Bann Drainage Commissioners.

I had the good fortune to be able to study the effects of the heavy rainstorm of the 25th and 26th August, 1905, both as regards flooding at Portadown, the rise of Lough Neagh, and the discharge of flood water down the Lower Bann.

I have given careful attention to the reports and evidence of the Royal Commissions, presided over by Lord Monck and Sir James Allport, and have studied the Reports of Mr. MacMahon, Mr. Manning, the copious notes furnished me of the investigations of Mr. Gamble, as well as the last report of Mr. Dick, and I have been materially assisted by the voluminous plans, sections and papers furnished for my information by T. H. Batchen, Esq., of the Office of Public Works.

The general result of my investigations convince me that the whole question is much more difficult and complicated than a first view would lead one to assume; this to a large extent arises not so much from engineering difficulties as from the conflicting interests involved, as there have to

be taken into account not only the flooded lands, but the considerable navigation now carried on between the Lagan Canal and the various points above noted on the shores of Lough Neagh, while on the Lower Bann from Toome to the Cutts of Coleraine the question is complicated by the valuable eel and salmon fisheries on the river; and by the existence of the Navigation, which was carried out on the lines suggested by Mr. MacMahon in his report of 1845.

As to the damage caused by floods on the shores of Lough Neagh, the opinions expressed to me were of a somewhat varying character. While there appeared to be a consensus of opinion that large winter floods, which submerged the land for some months, were the principal cause of complaint, some desired that all floods should be entirely prevented, while many others expressed the opinion that partial flooding, lasting for only a few days, or weeks, not only did no harm, but was in some cases a positive advantage.

On all sides there was, however, an unanimous consensus of opinion that the summer level of Lough Neagh should not be reduced, and I was much impressed by the considerable traffic which passes from Belfast through the Lagan Canal to Portadown, Moy, Coal Island, Antrim, Newport Trench, Ballyronan, and other points on the shores of the Lake.

Owing to the heavy rainstorm above spoken of, there is one fact which I was able to certify and to place beyond dispute, viz. :—That considerable flooding, although of a temporary character, occurs and must occur on the Blackwater and the Upper Bann, even when the Lake is at its summer level.

In fact, for some weeks previous to that rainstorm the lake had been below the summer level, and I heard of complaints being made on this account, but the flooding caused on this occasion was no more than might be expected as due to a similar rainfall in any flat area in England or Scotland, and soon passed off into the lake.

I should remark that the damage done on this occasion was principally due to the late hay harvest, and the washing away of haycocks which, according to the custom of this part of Ireland, are left standing in the fields till late into August, September or October.

(2).—DRAINAGE AREA.

In considering this question the first matter that engages attention is the area draining into Lough Neagh and into the Lower Bann between Toome and the Cutts of Coleraine.

I have carefully inquired into this subject and compared the estimate of former engineers with recent calculations made in my own office from the most modern Ordnance maps.

I am fully conscious that it is somewhat difficult in many cases owing to the flat nature of the country to determine the exact line of watershed, but believe that the figures given in the Table below are as accurate as the circumstances of the case permit :—

—	Per cent. of total area.	Square Miles.	Acres.	Square Feet.
Draining into Lough Neagh, ...	·79	1,749	1,119,360	48,759,321,600
Area of Lough Neagh, ...	·07	151	96,640	4,209,638,400
Total to Toome, ...	·86	1,900	1,216,000	52,968,960,000
Toome to Portna, ...	·06	134	85,760	3,735,705,600
Portna to the Cutts, ...	·08	182	116,480	5,073,868,800
		2,216	1,418,240	61,778,534,400

It will be noticed that the total area draining down to the Cutts of Coleraine is 2,216 square miles.

This, as far as I can make out, is about 16 square miles in excess of former estimates.

This large drainage area is bounded on the North-east by the high hills which form the sources of the river Main, running up to altitudes of 1,325 feet at Slieve Nahanagman, 1,782 at Slieve Nanee, and 1,040 at Neill's Top. They fall on the eastward to 1,316 at Doughlas Top, 1,558 at Agnew's Hill, and to 1,044 at Shane's Hill.

On the East also, at the head of the Six-Mile-Water, we find Ballyfore Hill 731, Carn Billy 941, and Carn Hill 1,025, Wolf Hill 1,210, Divis 1,567, Standing Stones 1,054, and White Mt. 820.

On the South-east the watershed falls to the low summit passed over by the Lagan Navigation.

To the South and South-east the drainage area of the Upper Bann runs up to considerable altitudes among the Mourne Mountains. For instance, 1,416 Cratlieve, Craigdoo 1,317, Slieve Muck 2,198, Shanlieve 2,053, and Cruggandoo 1,257. The watershed then falls to only about 30 feet above the level of the lake, where it passes the Newry Canal summit, rising again to altitudes of over 800 feet at Blackrock and Sugar Loaf Hill.

To the Southwards, at the head of the Blackwater by Newtownhamilton, Keady, and Monaghan, and the Ulster Canal, the dividing ridge is very low, but Westwards it rises to 1,255 feet at Doocarn, 958 at Ballyness, 1,035 at Slieve More, and 901 at Shanebarnagh's. Westwards near the head waters of the Ballindery and Moyola Rivers it rises to 1,261 at Oughtmore, 1,851 at Carnanelly, to 2,070 at Mullaghaneany, falling to 1,521 near Carntogher, and 1,479 at Carnhill, from which point to the coast it falls gradually to 1,318 at Donal's Hill, 1,077 at Boyd's Mountain, and then by gradual descents to the river at the Cutts.

Within the drainage area of Lough Neagh, and lying between its shores and the foot of the hills above noticed, is a large area of low-lying land, and the shores of the lake are somewhat flat and uninteresting.

I roughly estimate that of the total area of 1,749 square miles draining to the lake, about 643 square miles lie below the level of the 250 feet contour—in other words only averaging about 100 feet above what is called the summer level of the lake.

These circumstances lead to the flooding of the low areas near the mouths of the rivers entering the lake, particularly on the lower parts of the Upper Bann and the Blackwater, consequently the rapidity with which floods are discharged from the surrounding mountains is somewhat checked, besides which the large area of Lough Neagh, 151 square miles, also modifies the intensity of flood discharge down the Lower Bann.

(3).—RAINFALL.

In estimating the flood discharge down the Lower Bann I find that the flow at Toome Weir is so complicated partly by the peculiar dished form of the weir, the amount of water that passes by leakage through it, and owing to the fact that it becomes drowned out when more than about 160,000 c. ft. per min. are passing over it, that it is unreliable as a means of gauging floods.

The weir at Portna also, owing to its peculiar shape, is open to difficulties, and I find that various estimates of its discharge at different depths have been made. Consequently, to form some idea of the probable flood water to be dealt with, careful study of the rainfall of the district becomes necessary.

For this purpose I have investigated the rainfall at forty-three stations either in or immediately contiguous to the drainage area of the Bann as given in Table No. 1.

To establish a standard, I have abstracted from Symons' British Rainfall the long records which have been kept for forty years at (1) Banbridge (Milltown), (2) Armagh Observatory, (3) Garvagh, (4) Queen's College, Belfast.

These four records are unbroken over the whole period excepting 1883 at Garvagh, and in 1902 at Belfast, values for which have been interpolated from the ratios of the other three stations.

Each year in each case has been reduced to a ratio of the mean, and for the purpose of examining the other records and reducing them from their arithmetical to probable mean falls, the average ratios of (1), (2), (3), and (4) have been taken.

From these average ratios it will be seen that the wettest year was 1872, rising to 36 per cent. above the average, with 224 wet days in the year, but in the cases of No. 1 Banbridge and No. 3 Garvagh it will be noticed that the rainfall was 48 and 40 per cent. above the average, with 239 and 238 wet days respectively. But it is necessary to take into account not only the wettest, but the two consecutive wettest years in the record; these appear to be 1876-77, when it was 16½ per cent. above the average, and 1871 and 1872, when it was 15 per cent. above the average.

The above considerations should be borne in mind when flood discharge is being considered.

The driest year on the record appears to be 1887, when it fell to 27 per cent. below the average, and the two driest consecutive years were 1887 and 1888 with 16 per cent. below the average, and 1893-94 with 11½ per cent. below the average.

It will be noticed that we may have years in which there are 224 wet days per annum, and if we take the average of all the stations in Table No. 1 we may expect 196 wet days in the year.

If for a moment we compare this with the rainfall of equal amounts at similar stations in England, we find that there are only about 173 wet days per annum.

On the index map attached to this report will be found within black circles under their appropriate numbers the probable true mean rainfall of the forty-three stations dealt with in Table No. 1. These stations, it will be noticed, are fairly equally distributed except in the case of the Moyola and Ballindery Rivers, for which no records are available.

On the Lower Bann it will be seen that the rainfall amounts to from 37·7 at (No. 30) Ballymoney, to 39·3 at the long-established station at (No. 3) Garvagh.

Near the margin of the lake at Antrim (No. 13) it amounts to 31·9, but in the basin of the Maine at Ballymena (No. 12) it runs up to 40·8, and at Broughshane (No. 25) to 42·5.

At Crumlin (No. 43), near the lake, it is 34·6; at Aghalee (No. 22), near Lurgan, it is 32·6; at Lurgan (No. 20) it is 30 inches. In the Upper Bann drainage area (No. 1) Milltown, near Banbridge, it is 31·4. At Corbett Reservoir (No. 19) it is 30·5; at Katesbridge (No. 10) it is 29·2. At Rathfryland the average of the two stations No. 16 and 37 gives 34·1; at No. 41 (Hilltown) it rises to 43·7, and the average of the stations 15 and 28 at Lough Island Reavy give 43·2, showing heavier rainfall as we approach the Mourne Mountains.

In the flat area of the valley of the Blackwater it varies from 31·2, Caledon Glebe (No. 40), and 31·8 (No. 2) Armagh, up to 38·7 (No. 21) Dungannon.

In the Ballinderry area No. 11 (Stewartstown) it is 36·8, and at Ardtree Rectory (No. 29) it is 36·7.

From these forty-three scattered gauges, taking the whole table, we may say that the average of the district would work out at about 36·4, but we have seen in the case of the Maine and the Upper Bann that wherever the stations approach the hills, the rainfall is almost certain to exceed 40 inches per annum.

To give some idea of what amount of rainfall may be expected at great altitudes, I have been favoured by J. Smyth, Esq., of Milltown, with the gauges taken in the years 1875 to 1877 at Foffanny on Butter Mountain,

above Lough Island Reavy Reservoir, at an altitude of 920 feet above Ordnance datum. The results are given below:—

Year.	Rainfall.	Ratio from Table 1.
1875	83·86	98
1876	82·68	109
1877	84·15	124
Average,	83·56	110

Reducing this average fall by 10 per cent., we arrive at a probable rainfall at this altitude in the Mourne Mountains of practically 75·6 inches.

It will be noticed from what I have said above, that the average of the two years 1876-77 were the wettest on record, but allowance has been made for this by averaging the three together.

A general review, therefore, of the meteorological conditions of the district to be dealt with leads us to a conclusion that the greater portion of the area is subject to a rainfall of 30 to 38 inches per annum, running up in some cases near the hills to over 40 inches, and that although this rainfall cannot be deemed excessive, yet, considering its amount, it is very evenly distributed on the average over the whole year; consequently resulting in a more or less saturated state of the ground at all times, which tends much to the discharge of heavy rains which may occur at exceptional periods.

We now have to consider what is the probable monthly rainfall to be dealt with.

Table No. 2 gives the monthly falls, which have to be taken account of, and which in past years have exceeded 7 inches in the month, I have, as set out in the Table, records of such falls amounting to or exceeding 7 inches in the month occurring at Antrim (No. 13) on five occasions, varying from 7 up to 9·58 inches; at Monaghan (No. 31) on one occasion 7·31 inches; Ballymena (No. 12) on one occasion 10·10 inches; Stewartstown (No. 29) on two occasions varying from 7·26 to 7·59 inches; Armagh (No. 2) on two occasions varying from 7·04 to 7·09.

If we take the average of these eleven monthly falls which have taken place in the drainage area during the past thirty-five years we find that they average at the rate of 7·78 inches per month.

Of course in this calculation we are unable, excepting in the case of the Upper Bann about Castlewellan, to calculate what would be the heaviest monthly rainfall in the neighbourhood of the high hills and mountains which fringe portions of the drainage area.

In this case, however, during the years 1875-76-77 at Foffany there were fifteen months during which the monthly rainfall varied from 7 up to 19·05 inches per month, and averaged during the fifteen months of the record 11·08 inches. Consequently I think we should be only prudent in assuming that a rainfall of 8 inches may occur within the drainage area within a period of one month.

A reference to Table No. 3 will also show that quantities exceeding 10 and running up to as much as 13 inches may fall in two consecutive months.

Here, again, from the Castlewellan (Foffany Gauge) during the years 1875-76-77 there were twenty-four occasions on which the fall of two consecutive months range from 10·13 up to 35·20 inches in, say, sixty days, and the average of the twenty-four cases given amounts to 16·76.

Mr. Manning records in his report of June, 1877, that 7 inches of rain falling in two consecutive months, will flood the land.

Such a rainfall would so saturate the ground, especially in the low-lying portions of the drainage area, as to render floods due to the entire discharge of any rain which might fall upon it more than probable.

This leads us to an inquiry as to the greatest diurnal rainfall on record.

Table No. 4 shows us that at Armagh (No. 2) falls up to 1·74 may occur in one day; at Banbridge (No. 1) to as much as 1·59 and 2·26; at Garvagh (No. 3) up to 1·55; Antrim (No. 13) 3·00; Ballymoney (No. 30) 1·64; Stewartstown (No. 29) up to 2·25 and 4·16; Rathfryland (No. 16) 2·20; Ballymena (No. 12) 2·35; Broughshane (No. 25) 1·7; Corbett Resevoir (No. 19) 1·40; Lurgan (No. 20) up to 2·00; and Dungannon (No. 21) up to 3·57.

We, therefore, have to deal with a drainage area which may discharge 8 inches in a month, during which period a daily fall of between 2 and 4 inches may occur, the average of the above fourteen cases in Table 4 giving a daily fall of 2·24.

It will be observed that in these notes in Table 4 I have taken no notice of the possible heavy falls which may occur in the head waters of the Bann, the Main or other confluents of the lake.

(4).—FLOW FROM THE DRAINAGE AREA ABOVE TOOME.

In dealing with this subject it is necessary to examine somewhat in detail past records of flood discharge, in which, from the records kept, we have some important evidence to guide us.

Mr. MacMahon, in his report of 1845, pages 60-63, in dealing with the flood discharge of the Blackwater, says that it amounts to 500,000 cube feet per minute, equal to 720,000,000 cube feet in twenty-four hours from a basin of 618 square miles. I do not make the drainage area of the Blackwater quite so large as Mr. MacMahon, as I should place the figure at 560 square miles.

If this latter be correct the discharge, as recorded by Mr. MacMahon, would equal 0·553 inches flowing from the ground in twenty-four hours.

(5).—FLOOD OF NOVEMBER, 1866.

From the records kept at Toome I find that between the 17th and 18th November, 1866, the lake rose from 46·64 to 47·73, a rise of 1·09 feet in twenty-four hours. From the Table No. 4 of heavy diurnal falls, 1·03 inches of rain is recorded as having fallen at Antrim (No. 13) on November 15th, 1866.

From a comparison of the gauges kept at Toome and Portna, I estimate that about 350,000 cubic feet per minute were flowing from the lake at Toome during the twenty-four hours of the 17th and 18th November, 1866. This would amount to 504,000,000 cubic feet in twenty-four hours, and a rise of 13 inches on the surface of the lake during the same period would equal 4,561 million cubic feet, giving a total of 5,065 million cubic feet, which represents 1·15 inches of rain flowing from the 1,900 square miles above Toome, or a uniform discharge per minute of 3,517,000 cubic feet in twenty-four hours.

If this total quantity of 5,065 million cubic feet were discharged equally over thirty days it would represent a flow at the rate of 168,800,000 cubic feet per diem, or 117,000 cubic feet per minute as due to the rise of the lake and the discharge of the weir in twenty-four hours only.

It is unfortunate that I can obtain no further records of the rainfall of this period beyond that of Antrim above noticed.

(6).—THE GREAT FLOOD OF FEBRUARY, 1877.

It is somewhat difficult to estimate what in this case was the discharge at Toome, but from a comparison of the discharge at Portna, probably the volume of the flood at that place was at the rate of 1,027,000 cubic feet per minute; but from this quantity has to be deducted the flow which joins the Bann between Toome and Portna. This latter, for reasons which will subsequently be given, I estimate as approximately 108,000 cube feet per minute, deducting which from the flow at Portna we obtain a probable discharge at Toome of about 919,000 cube feet per minute; and this, it should be remembered, is the heaviest flood that has occurred during the existence of the Lower Bann Navigation.

(6A).—RAINSTORM OF 25TH AND 26TH AUGUST, 1905.

The spring and summer of 1905 had not been remarkable for any particularly heavy rainfall, and the level of the lake stood at 45′ 5″ on the 25th and 26th August; in other words, was about 7 inches below Mr. MacMahon's summer level.

The month of August, however, was a month of considerable rainfall. Table No. 5 gives the rainfall, showing the daily fall at twelve stations within the Bann drainage area. It averaged during the month 6·16 inches, varying from 4·03 inches at Ballymoney, up to 7·44 inches at Stewartstown. Up to the 13th of the month the average daily fall taken at the lowest possible amounted to 0·161, varying from about 0·01 up to 0·6 on the 3rd.

The latter end of the month was, however, characterised by the heavy rainfall of the 25th and 26th; that of the 25th averaged 1·79, varying from 0·20 at Broughshane up to 2·95 inches at Lough Island Reavy.

The rainfall of the 26th averaged 0·554, varying from 0·21 at Ballymena up to 1·17 at Broughshane. We may, however, consider the rainfalls of the 25th and 26th as one continuous storm, as there was practically no interval between the rainfall of these two days; there was also a slight rainfall, amounting to 0·14 of an inch, on the 27th.

The result of this rainfall was that the lake suddenly rose from 45 feet 6 inches on the 27th, to 46 feet 2 inches on the 28th—a rise of 8 inches in twenty-four hours. There, therefore, flowed into the lake 2,800 million cubic feet.

From a comparison of the records at Toome and Portna it would appear that there was an average discharge during this period of 200,000,000 cubic feet per diem, making a total discharge of the drainage area 3,000 million cubic feet; but of this quantity 842,000,000 is due to the average fall of rain, 2·4 inches, on the surface of the lake itself; consequently there must have flowed into the lake from the surrounding drainage area 2,158,000,000 cubic feet, which represents a flow from the ground of approximately 0·5 of an inch in twenty-four hours, which, it will be noticed, very nearly agrees with Mr. MacMahon's figures of the flow from the Blackwater drainage area above noticed.

By the 31st of the month the lake had risen to 46 feet 6 inches, and the water below the weir to 45 feet 2 inches, showing that the weir had become submerged, and had no longer a free fall over it.

As above noticed, this rainfall caused considerable flooding on the Upper Bann at Portadown and the lower reaches of the Blackwater, but passed down the Lower Bann without doing any damage, merely raising the water level to bank full.

(7).—PROBABLE DISCHARGE TO BE PROVIDED FOR AT TOOME.

The first point that has to be taken into account in considering this question is the lowest level to which it will be prudent to reduce the level of the lake.

From the above observations it will be noticed that I received a unanimous expression of opinion that, on account of the navigation on the lake, this level should not fall below 46 feet above Mr. MacMahon's datum.

As will be seen when discussing the rainfall and floods of the 25th and 26th August, 1905, I noticed that the surface of the lake, probably owing to the large leakage which is going on through the present weir, had fallen to 45 feet 5 inches, or 7 inches below Mr. MacMahon's summer level, and I received complaints on this subject from several persons.

The conclusion at which I have arrived, therefore, is that the lake should be kept at or about a minimum summer level of 46 feet. I should note in considering this and other matters connected with the lake level, that minute accuracy must not be expected, for the effect of the wind on the long reach of the lake often causes a disturbance of the mean level to the extent of two or three inches.

The next subject which requires attention is the storage capacity of the lake itself when raised above its summer level. Assuming the lake to be

at its summer level, a rise of 6 inches would represent a storage of 2,105 million cubic feet, representing an amount of rain flowing from the drainage area of 1,900 square miles to the extent of 0·48 inches.

Supposing the lake to be raised 1 foot above its summer level, 47 feet above Mr. MacMahon's datum, its storage capacity would be 4,210 million cubic feet, equalling a flow of rainfall from the ground of 0·96 inches.

Supposing it to be raised to 1 foot 6 inches, or to 47·5 feet above datum, its storage capacity would be 6,315 million cubic feet, equal to 1·43 inches flowing from the entire area.

Supposing it to be raised 2 feet, or 48 feet above Mr. MacMahon's datum, its storage capacity would be 8,420 million cubic feet, equal to 1·92 inches of rain flowing from the ground.

Of course, in the above calculations I am for the moment assuming that there is no discharge from the lake, but that I am regarding it simply as a modifying agent in its capacity of storing flood.

When considering the question of rainfall it will have been noticed that I considered that a depth of 8 inches in a month might not unreasonably be expected, and in two consecutive months a possible rainfall equal to or exceeding 10 inches.

Confining ourselves for the moment to the shorter period of one month, and assuming it to be the second of two wet months, it might occur that the whole rainfall of 8 inches in the month was discharged into the lake from the 1,900 square miles above Toome.

This would amount to 35,313 million cubic feet, averaging over thirty days 1,177 million cubic feet per day, or at the rate of, say, 817,422 million cubic feet per minute. A weir with a free overflow of 2 feet 2 inches in depth, and of the same length as the present weir at Toome, namely, 1,200 feet, would discharge this quantity.

I notice that Mr. William O'Neill, engineer of the drainage district of Lough Neagh, in his report of the 27th February, 1873, states :—" The flood passing over Portna Weir this winter measured 716,450 cubic feet per minute over a period of six consecutive weeks," and I think it is generally admitted that the floods of the winter of 1872-73 were not so great as those which occurred in the winter of 1876-77.

I think, therefore, from the above figures, that an exceptionally heavy flood may amount to about 800,000 cubic feet per minute over a whole month.

A second point of view, however, arises from the fact that although we may have a rainfall of 8 inches in the month the whole of it may not necessarily be discharged from the ground draining into the lake during that period.

On this assumption the following figures are worthy of consideration. It is clear that a rainfall of 8 inches falling on the area of the lake would raise it 8 inches, and amount to 2,806·4 million cubic feet; if from the 8 inches falling on the area draining into the lake we deduct one-quarter, or two inches, as held back by absorption to pass off slowly at a later period, we should have a discharge of 24,379·7 million cubic feet.

These two quantities make a total of 27,186·1 million cubic feet, which, if there were no exit from the lake, would raise its level about 6 feet 6 inches; but if equally discharged day by day it would represent 906·2 million cubic feet, or at the rate of 629,308 cubic feet per minute. A weir with a free overflow of 1 foot 10 inches in depth and of the same length as the present weir at Toome, namely, 1.200 feet, would discharge this quantity.

I, therefore, conclude that the flood discharge at Toome will vary from 600,000 up to 800,000 cubic feet per minute.

If there existed at Toome a perfectly water-tight weir 1,200 feet in length, with a perfectly free overflow for its discharge, and a crest level of 45 feet 8 inches above Mr. MacMahon's datum, I should anticipate the

normal discharge in winter, without taking into account exceptional floods, to be as follows :—

Discharge per min. when running 1 ft. 4 in. deep, ...	393,888	cubic ft.
Equalling a discharge per day of	567,198,720	„
In 30 days, ...	17,015,961,600	„
To which latter must be added for storage in the lake 1 ft. deep, ...	4,210,000,000	„
A total disposed of during the month of	21,225,961,600	„

equalling an actual discharge from the drainage area of 1,900 square miles above Toome of slightly under 5 inches of rain.

Under such circumstances as these the level of the lake would never be raised above 47 feet on Mr. MacMahon's datum, which he considered to be the flood height in the lake; but, as above shown, even in the extreme case of 8 inches of rainfall, or, say, 800,000 cubic feet per minute, being discharged from the drainage area in one month, the level of the lake need not be expected to rise more than to 47·83 above Mr. MacMahon's datum. And in the case of a flood flowing at the rate of 600,000 cubic feet per minute the level of the lake would be raised to 47·5 feet above Mr. MacMahon's datum.

(8).—SUMMER DISCHARGE AT TOOME.

This is a somewhat difficult matter to ascertain with any certainty owing to the leaky and decayed condition of the weir. During my stay at Toome I made several attempts to estimate its amount, but for the above reason without success.

I have seen several estimates of the summer discharge, varying from 30,000 up to 66,000 cubic feet per minute. I should, as far as my judgment goes after reviewing all the facts of the case, consider that 50,000 cubic feet per minute a fair average in summer.

A weir 1,200 feet in length with a free overflow would discharge this quantity when running about 4 inches in depth, so that in fixing the level of the crest of the weir it might be placed 0·33 feet below summer level, or, say, at 45·66 above Mr. MacMahon's datum. If the weir level were placed at this altitude it would give a margin of discharging power as noted above.

(9).—FLOOD DISCHARGE BELOW TOOME.

We have now to consider what would be the probable flood discharge from the 134 square miles which drain into the Lower Bann between Toome and Portna, as well as from the 182 square miles which drain into the same river between Portna and the Cutts.

From the observations of Mr. MacMahon on the Blackwater, and my own deductions from the figures of the floods of the 25th and 26th August, 1905, it will be noticed that by calculation the flow from the ground was approximately at the rate of 0·5 of an inch per twenty-four hours. On this assumption we may expect a flood discharge into the Lower Bann between Toome and Portna at the rate of about 108,000 cubic feet per minute, and between Portna and the Cutts of about 147,000 cubic feet per minute.

Consequently, if an extreme flood of 800,000 cubic feet per minute were passing out of the lake at Toome the discharge at Portna might rise to 908,000 cubic feet per minute, and at the Cutts to 1,055,000 cubic feet per minute. These figures, of course, are applicable to probably the heaviest floods.

In ordinary winter discharge, when 394,000 cubic feet per minute were passing over the weir at Toome, about 502,000 cubic feet per minute would be passing at Portna, and 649,000 cubic feet per minute at the Cutts.

(10).—CAUSES OF THE FLOODING ON THE SHORES OF LOUGH NEAGH.

There can be no doubt that the primary cause of this flooding, which raises the lake level to 48, 49 and 50 feet above datum, and in the great flood of 1877 to 52 feet above datum, is the want of a free discharge over the nominal 1,200 feet weir at Toome.

This has been ascribed as due to the more rapid discharge of rainfall consequent upon improved drainage; and although I am not at all prepared to deny this, yet there are other causes which, in my opinion, contribute to produce this effect and which it is possible to cope with.

The first fact that strikes the observer who has studied the figures of flood discharge on the Lower Bann is, that the weir at Portna, only 600 feet in length, has been able to pass all the floods with a depth running over it of 2 to 3 feet, and even in the great flood of 1877 the depth of water passing over it did not reach 4 feet.

The lower portion of the weir at Toome is, as above noticed, surcharged with very slight rainfall, and Mr. Manning, in his report of the 8th June, 1877, page 3, states that when discharging any quantity in excess of 160,000 cubic feet per minute the weir becomes surcharged.

The weir, although nominally 1,200 feet in length, can never act effectively until the lake has risen about 18 inches above the lower portion of the sill, for it will be remembered that the centre portion, 300 feet in length, has its crest at 45 feet above datum; on either side of this it rises to 46 feet above datum in a length of 150 feet, and the two flanks of 300 feet each rise another 6 inches, or to 46·50 above datum.

The level of the water in the long reach of fifteen miles from Portna to Toome is governed by the height of the weir at the former place, which is 41 feet above datum. Consequently, the still water below the weir at Toome would also stand at the same level if no water was flowing from the lake, and between it and the crest of the lower portion of Toome weir there is only a difference of 4 feet.

The result is, that to generate a velocity in this long length of fifteen miles the necessary head to overcome friction can only be obtained by the heaping up of the water immediately below Toome Weir. This, as noted by Mr. Manning, amounts to 4 feet when 160,000 cubic feet per minute are passing over it, and I observe this to be the case in the floods of August last; but in heavy floods it amounts to 5 and 6 feet, and in the great flood of January, 1877, it rose to 7 feet 5 inches.

At the end of the dry summer in August last, I found the head necessary to overcome friction in the fifteen miles between Toome and Portna to be about 10 inches, so that the difference in level between this water below the weir at Toome and the lowest part of the crest was only 3 feet 2 inches.

I notice that in previous reports it has been suggested that to remedy this state of things sluices should be introduced into the weir at Toome; but I am unable fully to understand what useful effect they would produce, seeing that the river at that point and immediately below it is completely gorged in times of flood.

The question arises—How can this head of 5, 6, or 7 feet which is found necessary to overcome friction in the Lower Bann on the fifteen miles between Toome and Portna be most economically obtained?

The clearing away of certain shoals which exist near Brecart Lodge, at Port Glennone, and in the rocks immediately above the weir at Portna, would not of themselves effect that object, as the still water at a level of 41 feet above datum would continue to be maintained by the weir at the latter place.

As pointed out by Mr. MacMahon on page 11 of his report of 1845, speaking of the ridge of rocks which crosses the river at Portna, he says, "the obstruction at Portna is that which impounds the surplus water of the great catchment area of 1,865 square miles of 1,190,000 acres," and from my observations the rocks and the weir at Portna are the governing factors when considering the flooding on the shores of Lough Neagh.

The circumstances of the case no doubt have been somewhat modified by the works of the Lower Bann navigation, but in all essential particulars Portna is still the place to which we must look for relief if a free discharge of the waters of Lough Neagh at Toome is to be effected.

In speaking above of the 1,200 feet weir not being effective until the level of the lake had risen 18 inches above the lower central portion, I should, in addition, remark that even the flow of water from the lake to the weir on its up-stream side is much obstructed, partly owing to accumulations of sand, on which bushes are growing, and to certain excavations

on both sides of the channel which are required, and which, apparently have never been carried out in the original works of the Lower Bann Navigation. And this is the more surprising, as I noticed that Mr. MacMahon, in his report of 1845, when speaking of the rise of the lake level as it existed before his proposed works were carried out, says, "it may fairly be attributed to the obstructions raised by the bar at Toome and by the inadequacy of the channel of the Lower Bann"; but it should be remembered that Mr. MacMahon died before the works were completed.

(11).—MAINTENANCE OF THE LOWER BANN NAVIGATION.

In considering this question of the obstruction caused by the weir and rocks at Portna, the subject of the maintenance of the Lower Bann Navigation in its present or some modified state at once claims attention.

At various times reports and estimates by different engineers have been prepared, with the object of dealing with the whole question of the drainage of the Bann and the prevention of floods, but as far as I have been able to notice they have all been based on the supposition that the Lower Bann Navigation will be maintained in some modified form.

I notice that in the report of Lord Monck's Commission, dated 8th February, 1882, it is stated that in 1880 the cost of maintenance on the average of the preceding five years was £1,154 15*s.* 8*d.*, as compared with annual receipts during the same time averaging £93 14*s.* 1*d.*

The Commission state that the conclusive testimony was to the effect that no considerable increase of traffic was to be expected, "and complaints are made that they (the works) are injurious, not beneficial to those who are taxed for their support"; and the Commission finally recommend that the Board of Navigation Trustees should be dissolved and the works handed over to the Drainage Trustees to be dealt with solely in the interests of drainage.

In the second portion of the first report of Sir James Allport's Commission, dated April 9th, 1887, it is stated that the receipts of the Lower Bann Navigation are less than £70 per annum, while the expenditure averaged about £1,100 per annum, and they sum up by saying, "we agree with Lord Monck's Commission that the navigation should be abandoned," but advised that this course should not be authorised without another appeal to the counties of Antrim and Derry.

From the Board of Trade returns, Railway and Canal Traffic for the year 1898, I notice that the total receipts from tolls on the Lower Bann Navigation only amounted to £42, and I notice that in the evidence of the engineers who have proposed certain modifications of the navigation, they did not anticipate that the works then suggested by them would lead to any increase of traffic.

During my residence of over seven weeks at Brecart Lodge, near Toome, on the banks of the Bann Navigation, I never saw any traffic of any kind with the exception of a pleasure steamer on two occasions, passing up or down the Navigation.

There was a very small amount of traffic, consisting of small fishing boats, which passed through the lock at Toome to the railway station at Toome Bridge; but this is of a very insignificant character. There is also a small amount of brick traffic carried on in open boats about Portglennone and near Agivey Bridge; but I doubt if it contributes any toll to the navigation.

From my own observations in repeatedly passing up and down the Navigation I found considerable difficulty in passing through Lough Beg with a launch drawing only 3′ 6″ of water, owing to the mass of weeds which obstruct the navigable channel.

On reference to Professor T. Oldham's Report of August, 1845, the following expression of opinion will be found:—

> "The smaller lake of Lough Beg is unquestionably filling up, and that not very slowly; and should the waters be kept at their Summer level it is probable that the greater portion of its surface will be silted up to that height, and the waters subsequently confine themselves to a defined channel through it."

This prediction is being gradually fulfilled, and I anticipate that if the works recommended in this report be carried out it will result in the formation of that definite channel through Lough Beg alluded to by Dr. Oldham.

The marshes which would be formed on either side of such a channel will no doubt be liable to floods, which in extreme cases will tend to modify the intensity of flood discharge down the Lower Bann.

The general result of a careful study of all the circumstances of the case has forced me reluctantly to the conclusion that if the question of reducing the winter level of Lough Neagh is to be accomplished at any reasonable expenditure, it will become necessary to entirely abandon the navigation, and I think that this can be accomplished without materially interfering with the eel fisheries at Toome, Portna, and Movanager, while at the same time improving the river as regards the salmon fisheries by removing those obstructions which to a certain extent prevent the fish passing up the river.

I cannot discover that there ever existed any traffic on the Lower Bann Navigation which is at all commensurate with the cost of its construction.

Putting all other matters on one side, and regarding it as a canal for economical traffic, it violates the first principles of canal engineering, for the whole economy of inland navigation is the maintenance of still water ponds between the different locks along which navigation can be hauled at a low cost.

In the case of the Bann Navigation, however, we have a canalised river, down which passes, against any upward traffic during the winter months, floods at the rate of 400,000 to 800,000 cubic feet per minute. It is, therefore, not surprising to me that the navigation has not proved a commercial success.

No towing path was ever provided, as I presume it was intended that the navigation should be carried on by sailing, polling, or steam power, and I do not contemplate any increase of traffic should a swing bridge, as suggested, be constructed at Coleraine.

Nor do I consider that, looking at the country generally, it has any chance of improving in the future, seeing that the whole district is well served by railways; they may be said to entirely encircle Lough Neagh, and there are practically two lines of railway down the Lower Bann, bringing the whole district into railway communication with Larne, Belfast, Newry, Dublin, Coleraine, Londonderry, and Portrush.

(12).—WORKS REQUIRED BETWEEN TOOME AND PORTNA.

I have above described the general formation of the weir at Toome; it is constructed partly of stone and partly of timber. The latter is much decayed, and there is a great leakage through the whole structure, which will render its practical reconstruction necessary at no distant period, whether the navigation be retained or not.

I should, therefore, advise its repair and partial reconstruction as absolutely necessary at the present time.

In carrying out the work, the weir, throughout its whole extent of 1,200 feet, should, in my opinion, be formed with a crest of uniform height at a level of 45·66 feet above Mr. MacMahon's datum.

As above pointed out, when 4 inches, or, say, 0·33 feet, is flowing over the weir throughout its whole length, it would discharge the average summer volume of 50,000 cubic feet per minute, and maintain the summer level of the lake, as proposed by Mr. MacMahon, at 46 feet above datum.

When 1·33 feet are flowing over it would, as above pointed out, discharge at the rate of, say, 394,000 cubic feet per minute, and bring the level of the lake up to what Mr. MacMahon considered should be its winter flood level. If 1·84 feet were flowing over it, it would discharge about 630,000 cubic feet per minute, and bring the level of the lake up to 47·50 feet, and when 2·16 feet were passing over it the lake would be raised to 47·82 feet, and be discharging at the rate of 800,000 cubic feet per minute, which, as I estimate above, would be the average quantity passing into the lake in a month of so large a rainfall as 8 inches without making any deductions for absorption or evaporation.

But, as proved by the discharge over the 600 feet weir at Portna, the existence of a weir at Toome 1,200 feet in length with a free fall over it, always ready to act throughout its whole length, will do much to prevent the lake ever rising to any great extent, and would make provision for those sudden rises of its level, such as the 13 inches in 1866, and the 8 inches in 1905, which took place within twenty-four hours.

To permit a free flow of water from the lake to the weir considerable excavation would have to be made on its up-stream side, the omission of which in the past has, I fear, contributed to some extent in causing the flooding complained of.

In carrying out the work I would suggest that to render the present weir watertight as much of the old timber as possible should be removed, and replaced by stone, and the whole structure thoroughly re-set in Portland cement; and that on the up-stream side a concrete wall should be built, the top of which would form the crest of the new weir, the existing structure being retained and made secure as an apron to prevent scouring below the weir.

Were it considered necessary to prevent the water in extreme floods rising so high as the above calculations suggest, the present lock at Toome could be formed into a basin for the small boat traffic on the lake, and a sluice placed in the position of the lower lock gate, to be opened on emergency when required.

To accommodate the small fish traffic which is carried on between the lake and Toome Bridge railway station, a line of tramway could be formed which would facilitate the transfer of fish from the boats to the railway station.

Such an arrangement of the weir as above indicated would preserve the present salmon pass and direct all except the most destructive floods through the eel weirs erected above and below the bridges which cross the Bann at Toome.

I do not know what authorities are charged with the supervision of the present eel fisheries, but I consider that some authority should be established in the interests of drainage and the preservation of the river channel to prevent the further encroachment on the river by these rather massive eel weirs, as I noticed tentative attempts being made to establish others on the Lower Bann between Brecart Lodge and Lough Beg.

At present the eel weirs are a great impediment to the free discharge of floods, and their increase should, if possible, be prevented.

At Portna the whole of the present weir should be removed and the rock excavated between its present site and the existing navigable channel, down to a level of about 32 feet above Mr. MacMahon's datum.

In this case, also, the alteration would not interfere with the flood water which passes to the present decayed eel weirs situated on the rapids below the Portna weir, as the present locks and navigable channel might be abandoned.

The removal of this weir would render the retention of the existing salmon passes unnecessary, as the fish would have a free run upwards into Lough Beg, Lough Neagh, and the tributary streams which feed them.

To render, however, the discharge of floods effective, the shoals at and about Port Glennone should be removed, as has already been suggested by other engineers who have formerly reported on this subject.

Works such as the above would, I believe, tend much to the improvement of the surrounding land between Toome and Portna by lowering the general level of the summer water in the river and in Lough Beg; but steps should be taken to prevent the neighbouring landowners encroaching on what are now the flooded lands, or, undoubtedly, future claims for further drainage will arise.

The sectional area of the river and the expanse now covered by Lough Beg in winter will tend largely to modify the flood discharge down the Lower Bann between Portna and the Cutts.

I should, however, notice that I observed between Lough Beg and Portna and a little above Port Glennone, that the neighbouring landowners have been permitted to cut down the natural banks of the river to summer water level, a practice which, if continued, cannot but lead to further flooding of the back lands and to increased complaints of areas being flooded which are now to a large extent protected except in periods of excessive flood.

(13).—THE LOWER BANN BETWEEN PORTNA AND THE CUTTS.

Any flooding which takes place between Portna and Movanagher is not, however, of a very serious nature, and I do not suggest that the weir at the latter place should be removed, as it is necessary to keep up the level of the water immediately below the Portna Rapids, so as to preserve the salmon breeding establishment at that place.

The eel fisheries at Movanagher would also not be interfered with, but remain in their present state.

Owing to the flooding in the neighbourhood of Carnroe, due, no doubt, to the surcharging of the weir at that place, I suggest that it should be entirely removed.

It is, however, on the nine miles between Carnroe and the Cutts that the principal complaints arise, as the want of free discharge in this portion of the river is due partly to the want of cross sectional area at certain points, as well as to the obstruction caused by the weir at the Cutts itself.

In my interview with the Agivey Bann Drainage Association I gathered that although, perhaps, some improvement had accrued due to the construction of the navigation works above Portna, yet in that length of the river between Carnroe and the Cutts the effect of the navigation works had been in the direction of increasing their former difficulties, which they ascribed rightly, in my opinion, to imperfect excavation in the river, and to the height at which the sills of the weirs at the Cutts had been placed.

But here, again, especially above Agivey Bridge, I observed a similar cutting down of the natural banks of the river to that which I noticed above between Lough Beg and Port Glennone, and which should be put a stop to at the earliest possible moment.

In this case, however, the principal obstruction is due to the weir at the Cutts. It was formed by Mr. MacMahon into two portions—the western weir, 350 feet long, has a crest the level of which is 10·40 above datum; the eastern weir, 173 feet long, has a crest 10 feet above datum. Between these weirs are situated four salmon cribbs 20 feet wide, the sills of which are 8 feet above datum; also, the King's Gap of 30 feet wide, with its sill at the same level.

There appears to have been some encroachment at some time on the King's Gap by the establishment of a new cribb 12 feet in width, which reduces the King's Gap to an available 12 feet.

There is also available for the discharge of floods the lock passage, 20 feet wide, and the sluice provided for a mill which has never been erected, and which lies westwards of the lock and between the lock-keeper's house and the public road.

I should explain that all the salmon cribbs and the King's Gap are open and free for the discharge of floods during the winter months. Had this not been the case the flooding complained of would have been much more serious than at the present time.

The passage of floods during the winter months can in no way interfere with the salmon fisheries as the fish do not come up the river until the spring.

I would suggest that the crests of both the east and west weirs should be lowered to a uniform level of 9 feet above datum, *i.e.*, the west weir would be lowered 1·4 feet and the east weir 1·0 foot, the sills of the salmon cribbs and the King's Gap being lowered to 7 feet above MacMahon's datum. This would leave the salmon gaps proportionally in the same position that they are at the present time, namely, with their sills 2 feet below the crest of the eastern weir; and I may note that when I visited the Cutts, in the early part of August, there was no water running over the west weir, the whole flow of the river passing either through the salmon cribbs, the King's Gap, or over the eastern weir.

To provide for exceptionally high floods in winter I would suggest that the lock gates should be removed and a sluice substituted, as well as a sluice on the proposed mill site above spoken of, west of the locks.

These works would, I am sure, provide for all exceptional floods, and facilitate rather than otherwise the passage of salmon and eels up the river.

To permit of the full discharge of flood water between Carnroe and the Cutts the cross sectional area of the river would have to be increased at the following points :—

(1.) Rock excavation in the river bed at the Cutts.
(2.) Excavation from the Cutts to the top of the Logan Shoal.
(3.) Excavation between the top of Logan Shoal and the railway bridge.
(4.) Excavation at the entrance of the Agivey River.

The above are the same as those proposed by Messrs. Gamble and Dick in their reports.

(14).—FISHERIES ON THE RIVER.

It is as well to note a few facts with regard to the fisheries on the river. The habits of the salmon and the eel differ in the following respects : the salmon come up the river about March for the purpose of spawning in the rivers and lakes, and the reduction of the long ponds between Portna and Toome would increase the facilities for spawning on the Lower Bann.

These fish return to the sea during the winter months about January. The close time for salmon net fishing extends, I believe, from the 19th August to the 1st March, for angling from 30th September to 1st March, in the Bann.

On the other hand, the eels spawn in the sea and come up the river as eel fry in April and May, and arrive in Lough Neagh about May and June. The eel fry keep along the banks and do not frequent the middle of the stream.

After developing in Lough Neagh the full-grown eels return to the sea in September and October, generally in high flood, the close time for eels being from January 10th to June 1st.

The works which I have proposed above I do not believe will in any way interfere with the eel fisheries, as all the floods at Toome, Portna, and Movanagher would pass through the eel weirs as at present, and I should remark that the principal eel weirs are situated at Toome, those at Portna and Movanagher appearing to be in a more or less decayed condition.

It is almost unnecessary to say that the removal of the weirs at Portna and Carnroe would facilitate the passage of salmon up the river, while the alterations in the weir at the Cutts would leave the position of affairs practically in its present state.

(15).—PROBABLE COST.

In contemplating the probable cost of carrying out the above suggestions, much will depend on the mode adopted for the execution of the works, and the probable time of their commencement and completion.

There are two modes in which the works could be carried out—one by the direct employment of labour, which, in a scattered district extending over thirty-two miles would be difficult of administration and inspection, and, I fear, would lead to needless expense and extend the work over an indefinite period; the other, and more preferable mode, would be to employ a good contractor experienced in similar work, which should be carried out expeditiously, and it is upon this latter assumption that I have based my figures.

As I have assumed that the navigation will be abandoned, the most economical mode of procedure, and that which will least and for the shortest time interfere with the fisheries, will be by opening or removing all the lock gates below Toome so as to lower the water level in the Lower Bann to the greatest possible extent during the summer half of one year.

This more particularly applies to the lower part of the Lower Bann between Movanagher and the Cutts. Consequently, I think that the first work undertaken should be the construction of the two sluices in the lock and at the old mill site at the Cutts.

The lowering of the weir and the sills of the salmon cribbs and King's Pass, together with the rock and other excavation between the Cutts and Carnoe, could then be most economically carried out.

Coincident with this work the weirs at Carnoe and Portna could be removed, so lowering the water between Portna and Toome and permitting the removal of the Port Glennone shoal at the least possible cost. The reconstruction of the weir, &c., at Toome, would also be facilitated.

I notice that in looking through the estimate prepared by Mr. Gamble and Mr. Dick that they have fixed on 3*s.* to 3*s.* 6*d.* per cubic yard as the price of rock excavation. This, I feel sure, is too low an estimate in either case, and I have assumed that the cost will be 5*s.* per cubic yard.

In the same way, I notice that the excavation of softer material—earth, gravel, sand, &c.—has been fixed by them at from 1*s.* to 1*s.* 6*d.* per cubic yard. For this class of material I have assumed that it will average about 2*s.* per cubic yard. The above prices for excavation are intended to include any compensation for spoil banks, &c.

I need not say, therefore, that in comparing my total estimate with those of former engineers, not only must the difference of the works proposed be taken into account, as they contemplated the retention of the navigation whereas I have assumed its abandonment, but these differences in prices should also be remembered.

As the work may not be immediately carried out, the prices I have allowed and the contingencies of 10 per cent. for which I have provided should, I think, balance the fluctuations in the cost of materials and labour for the next few years.

Appended to this report will be found the cost of the various works above mentioned set out under their various heads, amounting to a total of £76,000.

The actual quantities of excavation have been derived for the most part from previous reports and from the very voluminous cross sections of the river placed before me by the Board of Public Works.

Before, however, any contracts are let it will be necessary that careful working drawings, plans and sections, with a detailed specification, should be prepared, so that contractors tendering may have exact and full information of the work to be undertaken before them, so as to avoid, as far as possible, the introduction into their tenders of speculative prices.

CONCLUSION.

In conclusion I have to say that, having devoted some months to the careful consideration of this question, I venture to hope that it will be found that I have arrived at a result which will prove a solution of the difficulties placed before me, and acceptable as far as that is possible to the various important interests concerned.

I have the honour to be,

Your Excellency's most obedient,

humble Servant,

ALEX. R. BINNIE,

Pres. Inst. C.E.

BANN AND LOUGH NEAGH DRAINAGE.

ESTIMATE

TO ACCOMPANY

SIR ALEX. R. BINNIE'S REPORT.

	£
(1.) *The Cutts Weir.* Lowering weirs and salmon gapps, and inserting sluices at canal lock and mill culvert,	2,000
(2.) Excavation at and above the Cutts, as recommended by Messrs. Gamble and Dick, 10,000 cubic yards, at 5*s.*,	2,500
(3.) Excavation in river from the Cutts to the upper end of Logan's Shoal, as recommended by Messrs. Gamble and Dick, 70,000 cubic yards, at 2*s.*,	7,000
(4.) Excavation in river from the upper end of the Logan's Shoal to Derry Central Railway Bridge, as recommended by Messrs. Gamble and Dick, 110,000 cubic yards, at 2*s.*,	11,000
(5.) Excavation at the mouth of the Agivey River, as recommended by Messrs. Gamble and Dick, 6,600 cubic yards, at 2*s.*,	660
(6.) Removal of the Carnroe Weir,	1,000
(7.) Removal of the Portna Weir,	700
(8.) Rock excavation at Portna, between the weir and the navigable channel, 14,000 cubic yards, at 5*s.*,	3,500
(9.) Excavation in river, Portglenone Shoal, cross-sections 1–70, as recommended by Mr. Gamble. 156,000 cubic yards, at 2*s.*,	15,600
(10.) Reconstruction of weir at Toome, including sluice in lock,	10,000
(11.) Tramway from Toome Lock to Toome Railway Station,	1,000
(12.) Excavation in Lough Neagh (approach to Toome Weir), 50,000 cubic yards, at 2*s.*	5,000
(13) Compensation to Fisheries during construction,	5,000
	64,960
Add for contingencies,	6,040
	71,000
Law, Engineering, &c.,	5,000
Total,	£76,000

TABLE

BANN AND LOUGH

Determination of the probable true Average Rainfall at 43 Stations based which extend from 1865 to 1904,

Year.	No. 1. Banbridge, Milltown. Heights, Above Sea, 200′ Above Ground, 8′			No. 2. Armagh Obs. Heights, Above Sea, 208′ Above Ground, 1′			No. 3. Garvagh. Heights, Above Sea, 121′ Above Ground, 1′			No. 4. Belfast. (Queen's College). Heights, Above Sea, 68′ Above Ground, 7′ 4″			Mean of Columns 1 to 4.		
	Inches.	Ratio.	Days.	Inches.	Ratio.	Days.	Inches.	Ratio.	Days.	Inches.	Ratio.	Days.		Ratio.	Days.
1865	29·21	93	168	37·93	119	164	37·86	96	214	32·02	95	162	—	101	177
1866	28·23	90	208	34·10	107	211	41·75	106	232	35·56	106	204	—	102	214
1867	31·93	102	209	36·73	115	191	40·16	102	192	32·68	97	173	—	104	191
1868	28·11	89	191	29·59	93	221	38·80	99	182	30·14	90	179	—	93	193
1869	29·33	93	195	29·64	93	158	40·00	102	209	31·58	94	175	—	95	184
1870	27·68	88	172	22·29	70	125	33·87	86	173	32·57	97	160	—	85	157
1871	29·77	95	197	28·40	89	176	38·31	97	188	31·91	95	170	—	94	183
1872	46·60	148	239	39·66	125	220	55·00	140	238	44·46	132	199	—	136	224
1873	27·70	88	224	26·68	84	188	35·96	91	196	31·13	93	180	—	89	197
1874	28·50	91	198	28·73	90	201	40·29	102	212	34·78	104	176	—	97	197
1875	31·32	100	195	34·22	108	189	35·30	90	187	31·98	95	169	—	98	185
1876	35·94	114	202	30·67	96	187	41·57	106	178	39·89	119	176	—	109	186
1877	39·86	127	245	37·04	119	242	49·24	125	229	42·28	126	216	—	124	233
1878	26·83	85	191	28·59	90	185	40·15	102	201	29·14	87	171	—	91	187
1879	33·32	106	213	32·27	101	202	35·33	90	171	33·52	100	202	—	99	197
1880	27·57	88	180	32·65	103	173	34·75	88	165	28·76	86	151	—	91	167
1881	35·08	111	212	31·43	99	191	40·41	103	174	38·47	115	169	—	107	186
1882	37·48	119	228	37·82	119	247	45·77	116	221	39·32	117	188	—	118	221
1883	33·67	107	205	34·94	110	237	41·65	106	216	33·96	101	148	—	106	202
1884	30·36	97	207	34·55	109	239	44·38	113	234	33·28	99	190	—	105	217
1885	26·65	85	199	25·63	81	211	34·61	88	205	29·57	88	170	—	85	196
1886	36·15	115	241	35·82	113	232	40·25	102	226	36·88	110	196	—	110	224
1887	23·08	73	175	23·62	74	164	30·28	77	175	23·45	70	153	—	73	167
1888	30·32	96	207	29·60	93	194	36·56	93	217	32·80	98	179	—	95	199
1889	34·05	108	205	30·64	96	208	38·91	99	200	31·20	93	188	—	99	200
1890	29·92	95	208	30·08	95	229	38·38	98	214	32·58	97	201	—	96	213
1891	31·17	99	199	28·75	90	228	36·83	94	197	31·88	95	176	—	94	200
1892	31·20	99	209	32·44	102	217	38·71	98	213	31·21	93	177	—	98	204
1893	24·11	77	188	24·28	76	194	34·70	88	189	25·92	77	170	—	80	185
1894	28·85	92	213	33·06	104	225	38·90	99	189	31·63	94	184	—	97	203
1895	30·25	96	205	30·54	96	220	36·04	92	181	33·01	98	182	—	96	197
1896	30·59	97	208	31·21	98	214	39·33	100	190	32·83	98	172	—	98	196
1897	32·81	104	213	35·07	110	218	39·39	100	201	35·73	106	196	—	105	207
1898	30·99	99	205	31·76	100	219	35·99	91	192	30·26	90	204	—	95	205
1899	32·37	103	186	32·50	102	207	41·18	105	185	34·91	104	202	—	104	195
1900	34·02	108	204	36·45	115	227	43·36	110	191	40·56	121	200	—	114	205
1901	31·34	100	200	32·11	101	203	38·37	97	212	32·10	96	190	—	99	201
1902	31·02	99	198	31·73	100	215	36·14	92	202	33·35	99	185	—	98	200
1903	38·30	122	233	36·29	115	221	46·38	118	220	42·34	126	247	—	120	230
1904	29·21	93	—	30·88	97	—	38·77	99	—	31·84	95	—	—	96	—
Total, ..	1254·84	—	—	1271·29	—	—	1573·63	—	—	1341·48	—	—	—	—	—
Arithmetical Average, ..	31·37	—	—	31·78	—	—	39·34	—	—	33·54	—	—	—	—	—
Probable true Average, ..	31·37	—	—	31·78	—	—	39·34	—	—	33·54	—	—	—	—	—

No. 1.

NEAGH DRAINAGE.

on the recorded observations at Banbridge, Armagh, Garvagh, and Belfast, or over a period of 40 years.

No. 5. Waringstown. Heights, Above Sea, 190′ Above Ground, 4″			No. 6. Seaforde. Heights, Above Sea, 180′ Above Ground, 5″			No. 7. Bellarena. Heights, Above Sea, 12′ Above Ground, 1′			No. 8. Limavady. (Drenagh). Heights, Above Sea, 80′ Above Ground, 1′			No. 9. Bushmills. Heights. Above Sea, 33′ Above Ground, 1′			Year.
Inches.	Ratio.	Days.	Inches.	Ratio.	Days.	Inches.	Ratio.	Days.	Inches.	Ratio.	Days.	Inches.	Ratio.	Days.	
28·62	101	162	—	—	—	—	—	—	—	—	—	—	—	—	1865
31·46	102	221	—	—	—	38·50	102	253	—	—	—	—	—	—	1866
33·83	104	193	—	—	—	37·76	104	245	—	—	—	—	—	—	1867
29·84	93	200	40·19	93	207	33·94	93	227	—	—	—	—	—	—	1868
30·40	95	192	33·59	95	205	36·73	95	222	—	—	—	—	—	—	1869
28·54	85	173	37·29	85	172	30·98	85	169	—	—	—	—	—	—	1870
30·28	94	190	34·17	94	185	34·21	94	194	—	—	—	—	—	—	1871
44 74	136	228	57·57	136	234	47·36	136	250	—	—	—	—	—	—	1872
29·33	89	193	29·76	89	193	36·83	89	215	—	—	—	—	—	—	1873
29·66	97	184	32·20	97	185	38·85	97	245	39·07	97	—	—	—	—	1874
32·35	98	207	44·41	98	196	32·60	98	209	33·52	98	219	34·00	98	206	1875
36·44	109	221	50·26	109	200	38·36	109	210	38·82	109	232	38·96	109	210	1876
42·07	124	265	51·64	124	214	47·64	124	282	48·52	124	283	45·84	124	248	1877
31·97	91	220	36·89	91	193	41·00	91	222	42·67	91	247	44·54	91	210	1878
34·02	99	222	42·47	99	201	32·22	99	213	32·84	99	230	29·56	99	195	1879
31·81	91	190	34·51	91	169	33·50	91	192	33·85	91	219	32·75	91	186	1880
36·30	107	206	44·74	107	195	36·62	107	223	34·67	107	236	37·54	107	219	1881
30·55	118	225	42·83	118	207	45·25	118	249	44·24	118	263	45·23	118	236	1882
31·39	106	189	41·33	106	196	45·31	106	232	42·28	106	248	40·06	106	229	1883
31·94	105	201	35·94	105	215	41·12	105	219	39·83	105	241	41·24	105	244	1884
26·77	85	188	33·32	85	206	32·76	85	200	29·04	85	226	31·14	85	208	1885
40·23	110	210	46·42	110	238	42·56	110	228	38·47	110	238	36·23	110	242	1886
24·22	73	167	24·66	73	165	34·70	73	193	29·79	73	209	30·31	73	210	1887
32·51	95	182	39·75	95	204	39·00	95	225	34·60	95	234	37·24	95	228	1888
35·50	99	212	36·34	99	216	39·93	99	197	37·93	99	235	38·90	99	228	1889
35·17	96	223	33·35	96	211	37·36	96	203	38·48	96	234	40·22	96	231	1890
34·52	94	222	38·67	94	182	36·66	94	—	34·90	94	224	33·62	94	222	1891
36·09	98	208	36·98	98	196	40·79	98	203	36·91	98	235	36·74	98	225	1892
27·25	80	174	27·35	80	170	38·69	80	184	34·41	80	241	35·82	80	223	1893
30·16	97	203	40·88	97	200	35·27	97	186	36·55	97	243	34·36	97	238	1894
30·40	96	193	34·81	96	176	37·31	96	146	36·40	96	226	34·66	96	228	1895
35·24	98	194	34·60	98	180	—	—	—	38·56	98	247	38·19	98	221	1896
39·89	105	205	39·58	105	201	—	—	—	37·28	105	243	37·94	105	237	1897
35·17	95	184	33·07	95	202	—	—	—	40·08	95	241	34·64	95	235	1898
37·52	104	166	43·36	104	188	—	—	—	37·49	104	229	40·77	104	205	1899
37·36	114	166	44·07	114	205	—	—	—	42·33	114	248	42·29	114	226	1900
—	—	—	34·56	99	187	—	—	—	37·40	99	230	38·12	99	207	1901
—	—	—	42·68	93	203	—	—	—	33·34	93	235	32·57	93	197	1902
—	—	—	48·69	120	244	—	—	—	45·85	120	262	44·06	120	243	1903
—	—	—	33·97	96	—	—	—	—	36·73	96	—	36·34	96	—	1904
1203·44	3583	7179	1486·90	3689	—	1143·81	—	6236	1166·85	3097	—	1123·88	3000	—	Total,
33·43	99·50	199	38·84	99·70	—	38·13	—	215	37·64	99·90	—	37·46	100·00	—	Arithmetical Average,
33·60	—	—	38·96	—	—	38·57	—	—	37·68	—	—	37·46	—	—	Probable true Average,

[continued.

TABLE

BANN AND LOUGH

Determination of the probable true Average Rainfall at 43 Stations based which extend from 1865 to 1904,

Year.	No. 10. Banbridge. (Katesbridge.) Heights, Above Sea, 230′ Above Ground, 1′			No. 11. Stewartstown. (The Square). Heights, Above Sea, 350′ Above Ground, 1′ 4″			No. 12. Ballymena. (Harryville). Heights, Above Sea, 150′ Above Ground, 1′			No. 13. Antrim. (The Manse). Heights, Above Sea, 150′ Above Ground, 1′			No. 14. Donaghadee. Heights, Above Sea, 30′ Above Ground, 1′ 6″		
	Inches.	Ratio.	Days.	Inches.	Ratio.	Days.	Inches.	Ratio.	Days.	Inches.	Ratio.	Days.	Inches.	Ratio.	Days.
1865	—	—	—	—	—	—	—	—	—	29·41	101	161	—	—	—
1866	—	—	—	—	—	—	—	—	—	33·02	102	204	—	—	—
1867	—	—	—	—	—	—	—	—	—	31·72	104	182	—	—	—
1868	—	—	—	—	—	—	—	—	—	26·52	93	160	—	—	—
1869	—	—	—	—	—	—	—	—	—	26·66	95	158	—	—	—
1870	—	—	—	—	—	—	—	—	—	28·54	85	139	—	—	—
1871	—	—	—	—	—	—	—	—	—	32·73	94	171	—	—	—
1872	—	—	—	—	—	—	—	—	—	42·60	136	192	—	—	—
1873	—	—	—	—	—	—	—	—	—	32·06	89	173	—	—	—
1874	—	—	—	—	—	—	—	—	—	29·43	97	—	—	—	—
1875	29·53	98	170	37·44	98	178	—	—	—	—	—	—	—	—	—
1876	37·09	109	172	42·73	109	—	—	—	—	33·94	109	176	—	—	—
1877	37·93	124	214	44·07	124	240	53·13	124	265	41·48	124	239	36·33	124	230
1878	22·79	91	113	36·72	91	215	42·05	91	239	—	—	—	30·05	91	—
1879	33·25	99	172	38·17	99	197	39·88	99	245	—	—	—	34·56	99	209
1880	29·76	91	155	34·90	91	178	36·01	91	217	24·49	91	144	25·51	91	195
1881	32·03	107	167	37·92	107	200	43·26	107	255	—	—	—	36·48	107	203
1882	37·64	118	—	42·61	118	216	46·93	118	270	—	—	—	34·59	118	217
1883	33·59	106	182	36·55	106	187	43·54	106	278	31·65	106	176	33·83	106	213
1884	27·04	105	—	37·60	105	186	41·97	105	270	34·11	105	182	36·33	105	215
1885	22·85	85	—	29·35	85	179	34·12	85	248	25·28	85	171	28·07	85	—
1886	32·77	110	215	36·49	110	215	40·84	110	258	32·61	110	160	34·89	110	222
1887	19·55	73	—	24·77	73	154	29·78	73	219	21·67	73	134	21·74	73	—
1888	27·02	95	—	33·63	95	185	37·15	95	257	29·60	95	165	33·53	95	211
1889	30·69	99	—	35·20	99	189	40·45	99	248	30·62	99	156	30·80	99	229
1890	24·74	96	—	34·35	96	194	41·41	96	254	32·26	96	175	27·98	96	228
1891	27·37	94	—	35·28	94	185	37·61	94	235	33·55	94	175	30·61	94	218
1892	29·27	98	—	40·21	98	183	42·04	98	241	31·14	98	206	30·97	98	233
1893	22·91	80	—	32·31	80	190	36·23	80	224	29·52	80	158	24·19	80	208
1894	24·70	97	—	35·16	97	196	39·32	97	241	29·53	97	189	31·33	97	230
1895	23·07	96	—	32·60	96	194	38·23	96	236	—	—	—	31·43	96	216
1896	24·63	98	—	36·18	98	184	39·30	98	228	32·70	98	207	29·88	98	214
1897	28·97	105	—	39·85	105	204	41·46	105	241	40·72	105	—	34·13	105	222
1898	26·02	95	—	37·84	95	203	38·77	95	245	—	—	—	30·54	95	220
1899	32·23	104	167	37·64	104	191	40·90	104	232	—	—	—	32·80	104	212
1900	31·93	114	151	44·54	114	206	46·93	114	239	—	—	—	37·77	114	232
1901	28·62	99	144	34·75	99	182	42·50	99	225	—	—	—	29·60	99	201
1902	30·61	98	168	33·47	98	174	38·77	98	239	—	—	—	30·69	98	196
1903	27·11	120	213	44·68	120	240	46·82	120	265	—	—	—	37·86	120	253
1904	29·02	96	—	37·85	96	—	39·37	96	—	—	—	—	28·70	96	—
Total, ..	874·73	3000	—	1104·86	3000	—	1138·77	2793	—	847·56	2661	4345	885·09	2793	—
Arithmetical Average, ..	29·16	100·00	—	36·83	100·00	—	40·67	99·75	—	31·39	98·56	174	31·61	99·75	—
Probable true Average, ..	29·16	—	—	36·83	—	—	40·77	—	—	31·85	—	—	31·69	—	—

No. 1.—continued.

NEAGH DRAINAGE.

on the recorded observations at Banbridge, Armagh, Garvagh, and Belfast, or over a period of 40 years—*continued.*

No. 15. Lough Island. Reavy. Heights, Above Sea, 440′ Above Ground, 3′			No. 16. Rathfryland (Ballynagappoge). Heights, Above Sea, 300′ Above Ground, 3′			No. 17. Coleraine. Heights, Above Sea, 25′ Above Ground, 1′ 4″			No. 18. Sydenham (Alma House). Heights, Above Sea, 60′ Above Ground, 1′ 1″			No. 19. Banbridge (Corbett Resr.) Heights, Above Sea, 234′ Above Ground, 3′			Year.
Inches.	Ratio.	Days.	Inches.	Ratio.	Days.	Inches.	Ratio.	Days.	Inches.	Ratio.	Days.	Inches.	Ratio.	Days.	
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1865
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1866
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1867
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1868
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1869
—	—	—	—	—	—	—	—	—	35·49	85	191	—	—	—	1870
—	—	—	—	—	—	—	—	—	32·95	94	215	—	—	—	1871
—	—	—	—	—	—	—	—	—	53·00	136	259	—	—	—	1872
—	—	—	—	—	—	—	—	—	36·54	89	243	—	—	—	1873
—	—	—	—	—	—	—	—	—	38·48	97	225	—	—	—	1874
—	—	—	—	—	—	—	—	—	37·94	98	216	—	—	—	1875
—	—	—	—	—	—	—	—	—	49·49	109	218	—	—	—	1876
51·40	124	104	—	—	—	—	—	—	49·52	124	247	51·40	124	147	1877
31·40	91	—	—	—	—	—	—	—	33·60	91	208	28·20	91	114	1878
38·80	99	—	—	—	—	33·51	99	193	39·57	99	220	35·90	99	144	1879
33·20	91	—	30·93	91	—	33·50	91	156	31·62	91	187	29·20	91	—	1880
33·20	107	—	33·90	107	125	40·96	107	185	45·08	107	211	31·40	107	137	1881
51·80	118	129	41·40	118	164	47·25	118	200	45·39	118	244	43·00	118	171	1882
43·30	106	100	38·41	106	152	43·21	106	206	40·51	106	205	34·60	106	130	1883
40·60	105	107	31·40	105	129	45·68	105	198	41·24	105	212	30·20	105	135	1884
40·90	85	—	31·15	85	147	31·99	85	195	35·74	85	191	29·80	85	107	1885
42·30	110	—	37·45	110	152	40·38	110	203	47·20	110	218	35·50	110	—	1886
26·50	73	—	21·64	73	117	31·82	73	173	25·02	73	165	18·90	73	—	1887
—	—	—	34·90	95	118	37·51	95	198	37·56	95	177	29·35	95	112	1888
44·70	99	—	35·77	99	142	40·00	99	197	32·77	99	173	28·20	99	—	1889
46·30	96	168	31·05	96	152	38·23	96	208	33·60	96	204	23·05	96	114	1890
—	—	—	36·74	94	143	33·15	94	197	40·33	94	188	—	—	—	1891
41·26	98	147	28·24	98	143	36·03	98	—	36·17	98	201	—	—	—	1892
33·02	80	151	25·50	80	155	37·09	80	207	—	—	—	—	—	—	1893
48·04	97	181	37·49	97	187	34·21	97	214	—	—	—	26·90	97	139	1894
42·10	96	153	33·45	96	168	37·10	96	210	—	—	—	26·70	96	131	1895
40·33	98	161	32·25	98	167	37·46	98	216	—	—	—	27·74	98	140	1896
48·65	105	182	35·43	105	167	38·40	105	220	—	—	—	29·85	105	135	1897
43·03	95	172	32·92	95	173	39·34	95	228	—	—	—	25·83	95	139	1898
40·87	104	164	34·56	104	147	—	—	—	—	—	—	30·91	104	135	1899
49·19	114	193	37·23	114	174	45·09	114	241	—	—	—	32·31	114	152	1900
49·69	99	138	30·97	99	151	39·18	99	237	—	—	—	28·45	99	134	1901
59·22	98	154	35·40	98	175	35·82	98	221	—	—	—	31·02	98	149	1902
60·12	120	—	42·22	120	195	45·58	120	251	—	—	—	35·53	120	187	1903
40·97	96	—	31·79	96	—	—	—	—	—	—	—	26·04	96	—	1904
1130·49	2604	—	842·19	2479	—	922·49	2378	—	898·71	2299	48·18	767·98	2521	—	Total.
43·48	100·15	—	33·69	99·16	—	38·44	99·09	—	39·07	99·96	209	30·72	100·84	—	Arithmetical Average.
43·41	—	—	33·97	—	—	38·79	—	—	39·09	—	—	30·46	—	—	Probable true Average.

[continued.

TABLE

BANN AND LOUGH

Determination of the probable true Average Rainfall at 43 Stations based which extend from 1865 to 1904,

Year.	No. 20. Lurgan (Belle Vue). Heights, Above Sea, 200′ Above Ground, 2′			No. 21. Dungannon (Rockdale). Heights, Above Sea, 300′ Above Ground, ′			No. 22. Agha.ee (Lurgan . Heights, Above Sea, 105′ Above Ground, 1′			No. 23. Edward-street Station (Newry). Heights, Above Sea, 22′ Above Ground, 1′			No. 24. Newcastle (Fairleigh). Heights, Above Sea, 12′ Above Ground, 1′ 5″		
	Inches.	Ratio.	Days.	Inches.	Ratio.	Days.	Inches.	Ratio.	Days.	Inches.	Ratio.	Days.	Inches.	Ratio.	Days.
1865	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
1866	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
1867	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
1868	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
1869	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
1870	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
1871	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
1872	—	—	—	—	—	—	46·79	136	222	—	—	—	—	—	—
1873	—	—	—	—	—	—	31·94	89	178	—	—	—	—	—	—
1874	—	—	—	—	—	—	30·03	97	170	—	—	—	—	—	—
1875	—	—	—	—	—	—	33·63	98	172	—	—	—	—	—	—
1876	—	—	—	48·59	109	208	38·33	109	174	44·75	109	184	—	—	—
1877	—	—	—	48·74	124	229	41·68	124	229	49·76	124	216	73·30	124	206
1878	—	—	—	40·91	91	—	30·03	91	175	30·84	91	155	45·13	91	168
1879	—	—	—	39·66	99	—	35·60	99	182	36·63	99	167	58·21	99	174
1880	—	—	—	35·69	91	173	30·41	91	157	31·16	91	141	40·19	91	169
1881	—	—	—	41·07	107	211	36·49	107	201	41·33	107	143	58·69	107	179
1882	39·22	118	261	47·39	118	257	39·59	118	219	44·23	118	158	59·25	118	229
1883	31·53	106	208	40·53	106	230	31·92	106	176	36·69	106	130	55·06	106	216
1884	32·50	105	207	39·66	105	—	32·51	105	195	33·32	105	141	51·42	105	192
1885	26·19	85	195	32·78	85	214	26·31	85	172	28·41	85	122	45·24	85	166
1886	35·74	110	228	40·21	110	223	34·64	110	219	39·65	110	152	57·06	110	232
1887	21·94	73	166	25·04	73	161	21·12	73	166	28·27	73	113	31·01	73	163
1888	29·47	95	191	34·15	95	200	—	—	—	38·87	95	120	49·34	95	185
1889	32·06	99	194	34·51	99	205	—	—	—	41·03	99	136	49·35	99	193
1890	27·25	96	198	35·84	96	214	31·54	96	194	36·95	96	122	49·13	96	195
1891	28·54	94	196	36·39	94	197	30·23	94	168	40·86	94	119	55·55	94	171
1892	28·13	98	202	37·09	98	194	28·38	98	158	36·76	98	106	43·43	98	192
1893	23·41	80	192	35·04	80	218	22·72	80	—	26·52	80	—	38·50	80	166
1894	29·00	97	214	37·96	97	245	—	—	—	37·32	97	—	51·45	97	209
1895	29·28	96	196	32·99	96	227	—	—	—	36·52	96	100	38·80	96	171
1896	29·02	98	194	37·02	98	205	—	—	—	35·19	98	—	52·44	98	171
1897	30·07	105	200	—	—	—	—	—	—	43·42	105	221	—	—	—
1898	27·83	95	185	—	—	—	—	—	—	35·74	95	205	—	—	—
1899	29·56	104	175	—	—	—	—	—	—	40·44	104	206	—	—	—
1900	33·72	114	187	—	—	—	—	—	—	43·19	114	219	—	—	—
1901	28·67	99	175	—	—	—	—	—	—	39·02	99	202	—	—	—
1902	29·75	98	194	—	—	—	—	—	—	38·05	98	200	—	—	—
1903	33·49	120	235	—	—	—	—	—	—	49·24	120	241	—	—	—
1904	27·79	96	—	—	—	—	—	—	—	38·13	96	—	—	—	—
Total, ..	684·16	2281	—	801·26	2071	3811	653·86	2006	3527	1102·29	2902	—	1002·55	1962	3747
Arithmetical Average, ..	29·75	99·17	—	38·15	98·62	212	32·69	100·30	186	38·01	100·07	—	50·13	98·10	187
Probable true Average, ..	30·00	—	—	38·68	—	—	32·59	—	—	37·98	—	—	51·19	—	—

No. 1.—continued.

NEAGH DRAINAGE.

on the recorded observations at Banbridge, Armagh, Garvagh, and Belfast, or over a period of 40 years—*continued.*

No. 25. Broughshane (Quolie). Heights, Above Sea, 800′ Above Ground, 1′			No. 26. Moy (Derrygally). 5″ Gauge. Heights, Above Sea, 50′ Above Ground, 6′			No. 27. Moy (Derrygally). 10″ Gauge. Heights, Above Sea, 50′ Above Ground, 6′			No. 28. Castlewellan (Bann Reservoir). Heights, Above Sea, 440′ Above Ground, 1′			No. 29. Stewartstown (Ardtrea Rectv.) Heights, Above Sea, 191′ Above Ground, 1′			Year.
Inches.	Ratio.	Days.	Inches.	Ratio.	Days.	Inches.	Ratio.	Days.	Inches.	Ratio.	Days.	Inches.	Ratio.	Days.	
—	—	—	—	—	—	—	—	—	52·30	101	—	—	—	—	1865
—	—	—	—	—	—	—	—	—	54·60	102	155	—	—	—	1866
—	—	—	—	—	—	—	—	—	47·20	104	110	—	—	—	1867
—	—	—	—	—	—	—	—	—	43·30	93	109	—	—	—	1868
—	—	—	—	—	—	—	—	—	28·90	95	102	—	—	—	1869
—	—	—	—	—	—	—	—	—	48·10	85	95	—	—	—	1870
—	—	—	—	—	—	—	—	—	43·00	94	110	—	—	—	1871
—	—	—	—	—	—	—	—	—	61·20	136	149	—	—	—	1872
—	—	—	—	—	—	—	—	—	31·20	89	97	—	—	—	1873
—	—	—	—	—	—	—	—	—	35·50	97	—	—	—	—	1874
—	—	—	—	—	—	—	—	—	41·40	98	—	—	—	—	1875
—	—	—	—	—	—	—	—	—	52·90	109	—	—	—	—	1876
—	—	—	37·57	124	221	—	—	—	54·10	124	107	42·75	124	239	1877
—	—	—	29·58	91	188	—	—	—	31·90	91	—	35·73	91	223	1878
—	—	—	30·99	99	155	31·54	99	—	39·80	99	—	36·66	99	229	1879
—	—	—	29·64	91	135	29·94	91	135	33·80	91	—	35·03	91	204	1880
—	—	—	28·48	107	153	27·98	107	158	34·40	107	—	38·69	107	213	1881
57·60	118	208	37·79	118	192	36·74	118	192	53·20	118	129	43·35	118	232	1882
—	—	—	32·33	106	170	32·32	106	170	—	—	—	37·12	106	209	1883
51·13	105	207	35·74	105	—	33·34	105	173	—	—	—	37·66	105	209	1884
—	—	—	28·79	85	168	26·57	85	—	—	—	—	31·04	85	204	1885
34·97	110	244	—	—	—	37·96	110	168	—	—	—	37·58	110	216	1886
28·74	73	219	28·35	73	—	23·52	73	138	—	—	—	25·46	73	165	1887
41·04	95	245	35·64	95	175	30·21	95	175	—	—	—	34·30	95	198	1888
41·77	99	245	37·39	99	—	33·46	99	152	—	—	—	36·32	99	203	1889
38·62	96	242	35·83	96	—	31·11	96	155	—	—	—	34·63	96	219	1890
32·32	94	233	30·92	94	147	36·15	94	147	—	—	—	35·20	94	213	1891
44·16	98	220	37·59	98	146	34·15	98	146	—	—	—	36·82	98	197	1892
—	—	—	29·26	80	—	27·24	80	137	—	—	—	34·61	80	202	1893
41·03	97	228	37·52	97	194	34·84	97	194	—	—	—	—	—	—	1894
36·90	96	197	32·14	96	169	30·69	96	170	—	—	—	—	—	—	1895
43·77	98	211	—	—	—	—	—	—	—	—	—	—	—	—	1896
46·66	105	214	—	—	—	—	—	—	—	—	—	—	—	—	1897
43·20	95	242	—	—	—	—	—	—	—	—	—	—	—	—	1898
46·53	104	213	—	—	—	—	—	—	—	—	—	—	—	—	1899
46·83	114	252	—	—	—	—	—	—	—	—	—	—	—	—	1900
46·10	99	237	—	—	—	—	—	—	—	—	—	—	—	—	1901
44·88	98	245	—	—	—	—	—	—	—	—	—	—	—	—	1902
53·88	120	268	—	—	—	—	—	—	—	—	—	—	—	—	1903
80·21	96	—	—	—	—	—	—	—	—	—	—	—	—	—	1904
859·35	2020	—	595·55	1754	2208	537·76	1649	2410	786·80	1833	1163	612·95	1671	3575	Total.
42·97	101·00	—	33·09	97·44	170	31·63	97·00	161	43·71	101·83	116	36·06	98·29	210	Arithmetical Average.
42·54	—	—	**33·96**	—	—	**32·61**	—	—	**42·92**	—	—	**36·69**	—	—	Probable true Average.

[*continued.*

TABLE

BANN AND LOUGH

Determination of the probable true Average Rainfall at 43 Stations based which extend from 1865 to 1904,

Year.	No. 30. Ballymoney. (Balnamore). Heights, Above Sea, 50′ Above Ground, 1′ 5″			No. 31. Monaghan. (Rockcorry). Heights, Above Sea, 290′ Above Ground, 1′			No. 32. Aughnacloy Archdeaconry. Heights, Above Sea, 254′ Above Ground, 4′ 6″			No. 33. Ballynure. Heights, Above Sea, 400′ Above Ground, 1′ 4″			No. 34. Loughgall. Heights, Above Sea, 205′ Above Ground, 1′		
	Inches.	Ratio.	Days.	Inches.	Ratio.	Days.	Inches.	Ratio.	Days.	Inches.	Ratio.	Days.	Inches.	Ratio.	Days
1865	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
1866	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
1867	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
1868	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
1869	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
1870	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
1871	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
1872	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
1873	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
1874	—	—	—	—	—	—	35·75	97	206	—	—	—	—	—	—
1875	—	—	—	38·31	98	207	40·25	98	176	—	—	—	—	—	—
1876	—	—	—	37·56	109	201	40·43	109	177	—	—	—	—	—	—
1877	—	—	—	41·72	124	242	41·77	124	204	—	—	—	—	—	—
1878	—	—	—	35·52	91	192	33·91	91	196	—	—	—	—	—	—
1879	—	—	—	35·31	99	187	34·90	99	—	—	—	—	—	—	—
1880	—	—	—	30·65	91	191	33·28	91	163	—	—	—	—	—	—
1881	—	—	—	36·31	107	185	33·20	107	178	—	—	—	—	—	—
1882	—	—	—	45·70	118	219	40·41	118	182	—	—	—	—	—	—
1883	—	—	—	35·20	106	166	—	—	—	—	—	—	—	—	—
1884	—	—	—	31·54	105	191	35·19	105	—	—	—	—	—	—	—
1885	—	—	—	29·48	85	186	27·00	85	—	—	—	—	—	—	—
1886	—	—	—	39·23	110	201	39·68	110	—	—	—	—	—	—	—
1887	—	—	—	22·09	73	202	—	—	—	—	—	—	—	—	—
1888	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
1889	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
1890	37·27	96	236	—	—	—	—	—	—	42·07	96	202	—	—	—
1891	33·69	94	223	—	—	—	—	—	—	40·54	94	152	—	—	—
1892	36·03	98	230	—	—	—	—	—	—	42·45	98	195	—	—	—
1893	33·09	80	236	—	—	—	—	—	—	—	—	—	22·53	80	177
1894	33·81	97	254	—	—	—	—	—	—	46.56	97	211	30·80	97	210
1895	35·69	96	253	—	—	—	—	—	—	51·09	96	194	29·42	96	186
1896	37·60	98	254	—	—	—	—	—	—	44·66	98	198	30·17	98	195
1897	37·89	105	262	—	—	—	—	—	—	42·28	105	203	35·27	105	195
1898	35·46	95	270	—	—	—	—	—	—	42·42	95	222	29·47	95	187
1899	40·05	104	244	—	—	—	—	—	—	—	—	—	31·86	104	192
1900	40·75	114	231	—	—	—	—	—	—	46·55	114	—	36·84	114	201
1901	37·92	99	227	—	—	—	—	—	—	40·62	99	—	29·70	99	184
1902	36·60	98	236	—	—	—	—	—	—	37·74	98	—	32·38	98	210
1903	48·90	120	258	—	—	—	—	—	—	36·19	120	—	43·14	120	234
1904	36·33	96	—	—	—	—	—	—	—	33·30	96	—	29·81	96	—
Total, ..	561·08	1490	—	458·60	1316	2570	435·57	1234	1482	546·47	1306	—	382·39	1202	—
Arithmetical Average, ..	37·41	99·33	—	35·27	101·23	198	36·30	102·83	185	42·04	100·46	—	31·87	100·17	—
Probable true Average, ..	**37·66**	—	—	**34·84**	—	—	**35·30**	—	—	**41·85**	—	—	**31·82**	—	—

No. 1.—continued.

NEAGH DRAINAGE.

on the recorded observations at Banbridge, Armagh, Garvagh, and Belfast, or over a period of 40 years—*continued.*

No. 35. Rich Hill. Heights, Above Sea, Above Ground, 3′ 9″			No. 36. Newtownards. Heights, Above Sea, 10′ Above Ground, 1′ 7″			No. 37. Rathfryland. Heights, Above Sea, 500′ Above Ground, 1′			No. 38. Flurrybridge. Heights, Above Sea, 340′ Above Ground, 1′			No. 39. White Abbey (Abbeyville). Heights, Above Sea, 63′ Above Ground, 1′ 9″			Year.
Inches.	Ratio.	Days.	Inches.	Ratio.	Days.	Inches.	Ratio.	Days.	Inches.	Ratio.	Days.	Inches.	Ratio.	Days.	
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1865
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1866
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1867
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1868
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1869
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1870
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1871
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1872
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1873
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1874
—	—	—	32·14	98	171	—	—	—	—	—	—	35·49	98	186	1875
—	—	—	39·77	109	153	42·50	109	116	—	—	—	41·93	109	168	1876
—	—	—	37·48	124	177	—	—	—	—	—	—	44·47	124	214	1877
—	—	—	29·29	91	151	26·82	91	115	—	—	—	34·57	91	199	1878
—	—	—	36·46	99	176	36·23	99	—	44·12	99	153	35·64	99	196	1879
—	—	—	28·87	91	151	30·39	91	—	35·65	91	139	30·41	91	180	1880
—	—	—	35·79	107	163	37·57	107	124	42·70	107	153	—	—	—	1881
—	—	—	35·28	118	148	40·33	118	145	49·38	118	204	—	—	—	1882
—	—	—	31·79	106	149	37·54	106	101	40·04	106	181	—	—	—	1883
—	—	—	31·04	105	178	31·38	105	117	35·79	105	153	—	—	—	1884
—	—	—	—	—	—	—	—	—	29·24	85	138	—	—	—	1885
—	—	—	33·29	110	150	—	—	—	43·18	110	197	—	—	—	1886
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1887
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1888
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1889
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1890
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1891
30·61	98	200	—	—	—	—	—	—	—	—	—	—	—	—	1892
23·74	80	217	—	—	—	—	—	—	—	—	—	—	—	—	1893
33·01	97	213	—	—	—	—	—	—	—	—	—	—	—	—	1894
30·58	96	215	—	—	—	—	—	—	—	—	—	—	—	—	1895
31·38	98	211	—	—	—	—	—	—	—	—	—	—	—	—	1896
35·41	105	215	—	—	—	—	—	—	—	—	—	—	—	—	1897
32·60	95	218	—	—	—	—	—	—	—	—	—	—	—	—	1898
33·58	104	209	—	—	—	—	—	—	—	—	—	—	—	—	1899
34·41	114	—	—	—	—	—	—	—	—	—	—	—	—	—	1900
27·30	99	—	—	—	—	—	—	—	—	—	—	—	—	—	1901
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1902
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1903
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1904
312·62	986	1698	371·13	1158	1667	282·76	826	718	320·10	821	1318	222·51	612	1143	Total.
31·26	98·60	212	33·74	105·27	152	35·34	103·25	120	40·01	102·63	165	37·09	102	191	Arithmetical Average.
31·70	—	—	32·05	—	—	34·23	—	—	38·98	—	—	36·36	—	—	Probable true Average.

[*continued.*

TABLE No. 1—continued.

BANN AND LOUGH NEAGH DRAINAGE.

Determination of the probable true Average Rainfall at 43 Stations based on the recorded observations at Banbridge, Armagh, Garvagh, and Belfast, which extend from 1865 to 1904, or over a period of 40 years—*continued.*

Year.	No. 40. Caledon Glebe. Heights, Above Sea, 125′ Above Ground, 1′			No. 41. Hilltown. Heights, Above Sea, 430′ Above Ground, 1′			No. 42. Larne (Carnlough). Heights, Above Sea, 8′ Above Ground, 1′			No. 43. Crumlin (The Schools). Heights, Above Sea, 240′ Above Ground, 1′		
	Inches.	Ratio.	Days.	Inches.	Ratio.	Days.	Inches.	Ratio.	Days.	Inches.	Ratio.	Days.
1865	—	—	—	—	—	—	—	—	—	—	—	—
1866	—	—	—	—	—	—	—	—	—	—	—	—
1867	—	—	—	—	—	—	—	—	—	—	—	—
1868	—	—	—	—	—	—	—	—	—	—	—	—
1869	—	—	—	—	—	—	—	—	—	—	—	—
1870	—	—	—	—	—	—	—	—	—	—	—	—
1871	—	—	—	—	—	—	—	—	—	—	—	—
1872	—	—	—	—	—	—	—	—	—	—	—	—
1873	—	—	—	—	—	—	—	—	—	—	—	—
1874	—	—	—	—	—	—	—	—	—	—	—	—
1875	—	—	—	48·05	98	190	42·29	98	186	33·62	98	184
1876	35·46	109	234	53·16	109	180	51·72	109	185	38·14	109	209
1877	35·22	124	264	53·93	124	199	—	—	—	—	—	—
1878	29·96	91	221	31·77	91	148	44·54	91	192	31·46	91	194
1879	30·39	99	—	40·61	99	160	38·72	99	191	—	—	—
1880	29·08	91	180	—	—	—	37·81	91	170	—	—	—
1881	—	—	—	—	—	—	—	—	—	—	—	—
1882	—	—	—	—	—	—	—	—	—	—	—	—
1883	—	—	—	—	—	—	—	—	—	—	—	—
1884	—	—	—	—	—	—	—	—	—	—	—	—
1885	—	—	—	—	—	—	—	—	—	—	—	—
1886	—	—	—	—	—	—	—	—	—	—	—	—
1887	—	—	—	—	—	—	—	—	—	—	—	—
1888	—	—	—	—	—	—	—	—	—	—	—	—
1889	—	—	—	—	—	—	—	—	—	—	—	—
1890	—	—	—	—	—	—	—	—	—	—	—	—
1891	—	—	—	—	—	—	—	—	—	—	—	—
1892	—	—	—	—	—	—	—	—	—	—	—	—
1893	—	—	—	—	—	—	—	—	—	—	—	—
1894	—	—	—	—	—	—	—	—	—	—	—	—
1895	—	—	—	—	—	—	—	—	—	—	—	—
1896	—	—	—	—	—	—	—	—	—	—	—	—
1897	—	—	—	—	—	—	—	—	—	—	—	—
1898	—	—	—	—	—	—	—	—	—	—	—	—
1899	—	—	—	—	—	—	—	—	—	—	—	—
1900	—	—	—	—	—	—	—	—	—	—	—	—
1901	—	—	—	—	—	—	—	—	—	—	—	—
1902	—	—	—	—	—	—	—	—	—	—	—	—
1903	—	—	—	—	—	—	—	—	—	—	—	—
1904	—	—	—	—	—	—	—	—	—	—	—	—
Total, ..	160·11	514	899	227·52	521	877	215·08	488	924	103·22	298	587
Arithmetical Average,	32·02	102·80	225	45·50	104·20	175	43·02	97·60	185	34·41	99·33	196
Probable true Average,	31·15	—	—	43·67	—	—	44·08	—	—	34·64	—	—

16th January, 1906.

ALEX. R. BINNIE,
PRES. INST. C.E.

TABLE No. 2.

BANN AND LOUGH NEAGH DRAINAGE.

MONTHLY RAINFALLS OF 7 INCHES OR MORE.

Year.	Month.	Antrim 13.	Castlewellan (Foffany).	Monaghan Rockcorry, 31.	Ballymena, 12	Stewartstown, 29.	Armagh, 2.
1870	October, .	7·60	—	—	—	—	—
1872	December, .	—	—	—	—	—	—
1875	January, .	—	17·73	—	—	—	—
,,	September, .	—	11·60	—	—	—	—
,,	October, .	—	12·25	—	—	—	—
,,	November, .	—	9·30	—	—	—	—
1876	December, .	—	19·05	7·31	—	—	—
,	February, .	—	7·50	—	—	—	—
,,	August, .	—	7·82	—	—	—	—
,,	September, .	—	8·72	—	—	—	—
,,	October, .	—	9·15	—	—	—	—
,,	November, .	—	11·37	—	—	—	—
1877	January, .	7·42	16·15	—	—	—	—
,,	April, .	—	10·10	—	—	—	—
,,	October, .	—	7·00	—	—	—	—
,,	November, .	—	10·00	—	—	—	—
,,	December, .	—	8·50	—	—	—	—
1880	July, . .	7·00	—	—	—	—	—
1882	November, .	7·64	—	—	—	—	—
1890	November, .	9·58	—	—	10·10	7·59	—
,,	December, .	—	—	—	—	—	—
1892	August, .	—	—	—	—	—	7·04
1894	October, .	—	—	—	—	—	—
1895	October, .	—	—	—	—	—	—
1896	July, . .	—	—	—	—	7·26	7·09
1897	June, . .	—	—	—	—	—	—
1899	December, .	—	—	—	—	—	—
1903	October, .	—	—	—	—	—	—

TABLE No. 3.

BANN AND LOUGH NEAGH DRAINAGE.

CONSECUTIVE MONTHS WITH 10 INCHES, OR MORE, RAIN.

Year.	Months.	Bellarena, 7.	Armagh Observatory, 2.	Ballymena, 12.	Antrim, New Barnsley.	Stewartstown, 29.	Garvagh, 3.	Year.	Months.	Castlewellan (Foffanny).
Average Annual Fall,		38·57	31·81	40·76	—	36·74	39·36			
1866	Nov.–Dec.	10·39	—	—	—	—	—	1875	Jan.–Feb.	19·66
1870	Sept.–Oct.	10·60	—	—	—	—	—	,,	May–June	10·50
1872	Sept.–Oct.	10·90	—	—	—	—	—	,,	June–July	12·25
,,	Oct.–Nov.	10·07	—	—	—	—	—	,,	July–Aug.	11·86
1873	July–Aug.	—	10·42	—	—	—	—	,,	Aug.–Sept.	17·46
1876–77	Dec.–Jan.	—	12·30	—	—	—	—	,,	Sept.–Oct.	23·85
1879	June–July	—	—	10·89	—	—	—	,,	Oct.–Nov.	21·55
,,	July–Aug.	—	—	10·29	—	—	—	,,	Nov.–Dec.	14·05
1880	June–July	—	10·13	—	—	—	—			
1882	June–July	—	—	11·80	10·82	—	—	1876	Jan.–Feb.	12·50
,,	July–Aug.	—	—	10·23	10·29	—	—	,,	Feb.–Mar.	10·13
,,	Oct.–Nov.	—	—	—	10·61	—	—	,,	Aug.–Sept.	16·54
,,	Nov.–Dec.	—	—	10·70	12·38	—	—	,,	Sept.–Oct.	17·87
1882–83	Dec.–Jan.	—	—	10·21	—	—	—	,,	Oct.–Nov.	20·52
1883	Jan.–Feb.	—	—	10·23	—	—	—	,,	Nov.–Dec.	30·42
,,	Aug.–Sept.	—	—	10·84	12·00	—	—			
1885	Sept.–Oct.	—	—	—	10·50	—	—	1876–77	Dec.–Jan.	35·20
1886	Oct.–Nov.	—	—	—	10·24	—	—	,,	Jan.–Feb.	18·75
,,	Nov.–Dec.	—	—	—	11·58	—	—	,,	Mar.–April	14·00
1888	June–July	—	—	—	10·67	—	—	,,	April–May	16·60
,,	July–Aug.	—	—	—	10·19	—	—	,,	May–June	10·65
1889	July–Aug.	—	—	—	11·46	10·77	—	,,	June–July	10·15
,,	Aug.–Sept.	—	—	—	11·29	—	—	,,	July–Aug.	11·50
1890	Oct.–Nov.	—	—	12·95	12·72	—	—	,,	Sept.–Oct.	10·75
,,	Nov.–Dec.	—	—	11·90	12·02	—	—	,,	Oct.–Nov.	17·00
1895	July–Aug.	—	10·41	—	—	—	—	,,	Nov.–Dec.	18·50
1896	June–July	—	10·27	10·45	11·06	—	—			
,,	July–Aug.	—	—	—	—	—	—			
1901	Oct.–Nov.	—	—	10·09	—	—	—			
1902	Oct.–Nov.	—	—	11·48	—	10·45	10·14			
,,	Nov.–Dec.	—	—	—	—	—	—			
1902–03	Dec.–Jan.	—	—	10·43	—	10·79	—			
1903	Jan.–Feb.	—	—	10·01	—	—	—			
,,	July–Aug.	—	—	—	—	10·59	—			
,,	Sept.–Oct.	—	—	10·20	—	—	10·76			

TABLE No. 4.

BANN AND LOUGH NEAGH DRAINAGE.

SHOWING DAILY RAINFALL OF 1 INCH AND MORE.

Year.	Date.	Armagh, 2.	Banbridge (Milltown), 1.	Garvagh (Moneydig), 3.	Antrim, 13.	Ballymoney, 30.	Stewartstown, 29.	Rathfryland (Ballynagappoge), 16.	Ballymena, 12.	Broughshane (Quolie), 25.	Banbridge (Corbett R.), 19.	Lurgan (Belle Vue), 20.	Dungannon (Rockdale), 21.
1865	May 30th ...	1·74	—	—	—	—	—	—	—	—	—	—	—
„	Oct. 12th, ...	—	2·26	—	—	—	—	—	—	—	—	—	—
„	„ 29th, ...	—	—	—	—	—	—	—	—	—	—	—	—
„	Nov. 28th, ...	—	—	1·38	—	—	—	—	—	—	—	—	—
1866	July 4th, ...	·94	—	—	—	—	—	—	—	—	—	—	—
„	Oct. 23rd, ...	—	—	·93	—	—	—	—	—	—	—	—	—
„	Nov. 15th, ...	—	—	—	1·03	—	—	—	—	—	—	—	—
1867	Feb. 6th, ...	1·09	—	—	—	—	—	—	—	—	—	—	—
„	May 25th, ...	—	—	—	—	—	—	—	—	—	—	—	—
„	July 15th, ...	—	1·27	—	—	—	—	—	—	—	—	—	—
„	„ 16th, ...	—	—	1·55	—	1·64	—	—	—	—	—	—	—
1868	Nov. 29th, ...	—	—	—	—	—	—	—	—	—	—	—	—
1874	June 28th, ...	—	—	—	—	—	—	—	—	—	—	—	—
1875	Sept. 26th, ...	—	—	—	—	—	—	—	—	—	—	—	—
„	Nov. 13th, ...	—	—	—	—	—	2·25	—	—	—	—	—	—
1876	Aug. 2nd, ...	—	—	—	—	—	—	—	—	—	—	—	—
1877	Jan. 3rd, ...	—	—	—	—	—	—	—	—	—	—	—	—
„	Dec. 5th, ...	—	—	—	—	—	—	—	—	—	—	—	—
1882	Aug. 15th, ...	—	—	—	—	—	(½ in hr.) ·95	—	—	—	—	—	—
„	Oct. 18th, ...	—	—	—	—	—	—	—	—	—	—	—	—
1883	Sept. 1st, ...	—	—	—	—	—	—	2·20	—	—	—	—	—
„	Feb. 9th, ...	—	—	—	—	—	—	—	—	—	—	—	—
„	„ 11th, ...	—	—	—	—	—	—	—	—	—	—	—	—
„	„ 13th, ...	—	—	—	—	—	—	1·00	—	—	—	—	—
„	„ 14th, ...	—	—	—	—	—	—	—	—	—	—	—	—
„	„ 16th, ...	—	—	—	—	—	—	1·30	—	—	—	—	—
1886	Oct. 14th, ...	—	—	—	—	—	—	—	—	—	—	—	—
1887	Jan. 11th, ...	...	—	—	—	—	—	1·60	—	—	—	—	—
„	Sept. 1st, ...	—	—	—	—	—	—	—	—	—	—	—	—
1888	May 29th, ...	—	—	—	—	—	2·14	—	—	—	—	—	—
1889	May 14th, ...	—	1·12 (in 3 hrs.)	—	—	—	—	—	—	—	—	—	—
„	April 8th, ...	—	—	—	—	—	—	—	—	—	—	—	—
1890	Nov. 6th, ...	—	—	—	—	—	—	—	2·35	—	—	—	—
„	March 15th,	—	—	—	—	—	—	—	—	—	—	—	—
1892	Oct. 26th, ...	—	—	—	—	—	—	—	—	—	—	—	—
1893	June 27th, ...	—	—	—	—	—	4·16 (in 8 hrs.)	—	—	—	—	—	3·57 (3·33 in 6½ hrs.)
1894	Aug. 2nd, ...	—	—	—	—	—	—	—	1·14 (in 3 hrs.)	—	—	—	—
„	Oct. 23rd, ...	—	—	—	—	—	—	—	—	—	—	—	—
1899	Dec. 28th, ...	—	—	—	—	—	—	—	—	—	—	—	—
1900	July 27th, ...	—	—	—	—	—	—	—	—	—	—	—	—
1901	Aug. 10th, ...	—	1·50 (in 1½ hrs.)	—	—	—	—	—	—	—	—	—	—
„	Nov. 11th, ...	—	1·59	—	—	—	—	1·46	—	1·70	1·40	1·36	—
„	„ 12th, ...	—	1·13	—	3 (in 12 hrs.)	—	—	1·63	—	1·52	1·20	1·18	—
1902	April 21st, ...	—	—	—	—	—	—	—	—	—	—	2·00	—

TABLE No. 5.

BANN AND LOUGH NEAGH DRAINAGE.

RAINFALL OF AUGUST, 1905.

No.	Date—	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.	17.	18.	19.	20.	21.	22.	23.	24.	25.	26.	27.	28.	29.	30.	31.	Totals
1	Banbridge (Milltown), ...	0·03	0·15	0·59	0·62	0·07	0·15	—	0·06	0·15	0·09	—	—	—	—	—	—	0·12	0·02	0·29	0·10	0·02	0·08	0·02	0·22	2·25	0·50	0·03	0·38	0·02	—	—	5·96
2	Armagh Observatory, ...	—	0·09	0·07	0·31	0·02	0·15	0·01	0·10	0·21	0·01	—	—	—	—	—	—	0·15	0·15	0·07	0·09	0·04	0·01	—	0·34	2·64	0·66	0·12	0·36	0·16	—	0·02	6·38
3	Garvagh (Moneydig), ...	0·10	0·07	0·39	0·58	0·06	0·07	0·20	—	0·16	0·06	—	—	0·06	—	—	—	0·33	0·37	0·42	0·07	0·02	—	—	—	1·27	0·32	—	0·26	0·02	—	—	5·13
10	Banbridge (Katesbridge), ...	—	0·24	0·80	0·73	0·03	0·34	—	0·31	—	0·03	—	—	—	—	—	—	0·20	0·02	0·12	0·05	0·07	0·07	0·04	0·22	2·41	0·45	0·02	0·41	—	—	—	6·56
11	Stewartstown (The Square), ...	0·04	0·39	0·65	0·24	0·03	0·20	0·05	0·05	0·23	0·02	—	—	—	—	—	—	0·37	0·35	0·43	0·13	0·02	—	—	0·35	2·18	0·74	0·03	0·38	0·04	—	0·02	7·44
12	Ballymena (Harryville), ...	0·03	0·04	0·52	0·03	0·06	0·30	0·05	0·03	0·36	0·12	0·02	—	—	—	—	—	0·51	0·25	0·35	0·16	0·18	0·16	—	0·29	1·00	0·21	0·02	0·43	0·03	—	0·03	5·78
15	Lough Island Reavy, ...	—	1·32	1·35	0·32	0·24	0·05	—	0·01	0·20	0·10	0·02	—	—	—	—	—	0·21	—	0·18	0·11	—	0·40	0·03	0·53	2·95	0·84	0·05	0·18	—	—	—	9·12
19	Banbridge (Corbet Resr.), ...	—	0·30	0·70	0·35	0·10	0·10	—	0·20	0·15	—	—	—	—	—	—	—	0·25	0·05	—	0·10	—	0·20	—	0·40	1·75	0·40	0·10	0·30	—	—	—	5·45
20	Lurgan (Belle Vue), ...	0·07	0·20	0·51	0·46	0·01	0·25	0·02	0·06	0·12	0·04	—	—	—	—	—	—	0·25	0·13	0·17	0·11	—	0·13	—	0·19	2·06	0·40	—	0·23	0·01	—	—	5·52
25	Broughshane (Quolie), ...	—	0·06	—	0·66	0·86	0·13	0·30	0·02	0·01	0·22	0·14	0·09	0·03	—	—	—	—	0·53	0·20	0·62	—	0·20	0·13	0·03	0·20	1·17	1·10	—	0·23	0·14	—	7·07
30	Ballymoney (Balnamore), ...	0·04	0·05	0·45	0·45	0·06	0·02	0·20	0·04	0·13	0·08	0·02	—	—	—	—	0·02	0·29	0·30	0·31	0·08	0·03	0·12	—	0·19	0·65	0·28	0·18	—	0·02	—	0·02	4·03
34	Loughgall (Manor House), ...	0·02	0·11	0·70	0·25	0·03	0·11	0·03	—	0·28	0·01	0·02	—	—	—	—	—	0·22	0·07	0·08	0·08	0·01	0·02	—	0·28	2·11	0·68	0·04	0·24	0·16	—	0·02	5·57
	Totals, ...	0·33	3·02	7·33	5·90	1·57	1·97	0·86	0·91	2·00	0·78	0·22	0·09	0·09	—	—	0·02	2·90	2·24	2·62	1·70	0·39	1·39	0·22	3·04	21·47	6·65	1·69	3·67	0·69	0·14	0·11	74·01
	Averages, ...	0·028	0·252	0·611	0·492	0·131	0·164	0·071	0·076	0·167	0·065	0·018	0·008	0·008	—	—	0·001	0·241	0·187	0·218	0·141	0·032	0·116	0·018	0·253	1·791	0·554	0·141	0·306	0·057	0·011	0·009	6·167

A. T. & Co. (Ltd.) (1-22.) 1. 06. 750.—(12607.)