SESSION II.
1921.

NEW ZEALAND.

WAIRAU RIVER

(REPORT OF RIVERS COMMISSION ON).

Presented to both Houses of the General Assembly by Command of His Excellency.

To His Excellency the Right Honourable John Rushworth, Viscount Jellicoe, Admiral of the Fleet, Knight Grand Cross of the Most Honourable Order of the Bath, Member of the Order of Merit, Knight Grand Cross of the Royal Victorian Order, Governor-General and Commander-in-Chief in and over His Majesty's Dominion of New Zealand and its Dependencies.

MAY IT PLEASE YOUR EXCELLENCY,—

The Governor-General's Commission, dated the 8th April, 1919, directed us to inquire into certain matters in respect of the Clutha, Orari, Rangitata, Waimakariri, Ashley, and Maerewhenua Rivers, and such other rivers as might be added thereto from time to time. The Governor-General's further Warrant dated the 22nd July, 1919, added to the Commission the Waihi, Wairau, Waiau-uha, Taieri, and Aparima Rivers. The time within which we were required to furnish our reports was extended by the Governor-General to the 7th June, 1920, further extended to the 7th December, 1920, and still further extended to the 7th March, 1921. The present report deals only with the Wairau River. The reports upon the Maerewhenua, Clutha, Aparima, Taieri, and Rangitata Rivers have already been presented; the reports upon the remaining rivers will be submitted in due course when the requisite data have been collected.

The Governor-General's Commission directed us, in respect of each river,—

"(1.) To inquire into the cause or causes of the silting-up of the channel, the flooding of the adjacent lands by the said river, the erosion of its banks, and the damage to the surrounding country;

"(2.) To ascertain the nature and extent of the damage done to the lands adjacent to the said river, and what area of land is affected by such floods or erosion, or both, and whether it is practicable at reasonable expense to prevent such flooding or erosion, or both, either wholly or partially;

"(3.) To ascertain the best method of providing for the control of the said river and its tributaries so as to safeguard the lands affected, and to provide for the effective control and improvement of the said river and its banks;

"(4.) To ascertain the nature and extent of any drainage-works that may be required, and the best method of carrying out such works;

"(5.) (*a.*) To furnish estimates of the cost of such remedial measures as you may recommend should be taken for the effective control and improvement of the said river and its banks;

"(*b.*) To report what area or areas of land should be constituted a district in respect of which a rate may be levied to secure and pay the interest on and provide a fund for the repayment of any loan that may be raised to carry out any river-improvement works which you may recommend should be undertaken;

"(*c.*) To report your opinion as to what matters, if any, should be adjusted by legislation; and

"(*d.*) Generally, to report your opinion on all matters arising out of or touching the premises, including the question as to whether or not one or more competent authorities shall be appointed to control the whole or any portion of the said river, and what statutory powers should be possessed by such authority."

The Governor-General's Commission also required us to report separately in respect of each river.

Investigations made.

Sittings, Evidence, and Inspections.—On the 18th June, 1920, the Chairman and Mr. Hay proceeded from Wellington to Blenheim to make the necessary inspection of the Wairau River, Mr. Hunter being unable to accompany the other Commissioners on account of indisposition. It was arranged, however, that Mr. Hunter should visit the district at a later date and make an inspection of the salient features of the river.

On the 19th June the Chairman and Mr. Hay, accompanied by the Assistant Engineer, Public Works Department, Blenheim, inspected the Wairau River between Blenheim and Dillon's Point, from which place, in company with the Chairman of the Wairau Harbour Board and the Harbourmaster, an examination by launch and rowing-boat was made of the training-wall and entrance of the river at the bar. After completing the inspection of this locality the Commissioners proceeded up the left bank of the Wairau, inspecting the Marukoko and Pukaka drains, and continuing up to where the Pukaka Stream debouches from the hills, and out to the sea-coast at White's Bay.

On the same day the Commissioners motored via Springlands and the Middle Road and Renwicktown up the right bank of the Wairau River, examining the groynes to the junction of the Waihopai with the Wairau.

On the following day the Commissioners motored up the Taylor River to Renwicktown, thence up the right bank of the Wairau as far as its confluence with the branch river, a distance of forty-four miles; on the return journey a detour was made, the Commissioners crossing the Wairau Bridge near Renwicktown and inspecting the protective works in the locality, and returning to Blenheim via Grovetown.

On the 21st June the Commission held a sitting in the Courthouse at Blenheim, examining eleven witnesses, chiefly members of the various River and Drainage Boards on the Wairau River.

On the following day the Commissioners made an inspection of the Spring Creek and Tuamarina districts.

Subsequently, on the 27th August, Mr. Hunter proceeded to Blenheim and, in company with the Assistant Engineer, Public Works Department, Blenheim, made an inspection of the salient features of the district, covering practically the same ground as that inspected by his colleagues in June.

Nomenclature.

The Wairau River divides into two branches near Renwicktown, the north branch, which is the main river, retaining its name of "Wairau," while the south branch, which flows through the Town of Blenheim, is known as the "Opawa."

The Omaka River, which at one time flowed through Blenheim, has been cut off by a diversion near Renwicktown, and now flows into and is a tributary of the Opawa.

The Fairhall River, Mill Creek, and Taylor River flow into the old Omaka River channel; but to prevent confusion this old Omaka channel below its junction with the Fairhall, and until it flows into the Opawa below Blenheim, will be referred to as the "Fairhall River," the Taylor River junctioning with it just west of Blenheim.

The Tuamarina River enters the Wairau just above the railway-crossing.

The Pukaka Stream rises in the hills between the Tuamarina and the coast and has no defined natural channel into the Wairau, but the waters, instead of

losing themselves in swampy country, are conveyed to the Wairau by artificial channels.

Below Rose's Overflow cut the Opawa down to its reunion with the Wairau will be referred to as the "Lower Opawa."

Physical Features.

The Wairau River rises in the Spenser and St. Arnaud Mountains, which attain to an altitude of 7,000 ft. Its approximate length before entering the sea at Cloudy Bay is 100 miles. On the north side of the river precipitous hills rise very close to the river, while on the south side a very considerable area of river-plain extends before reaching the foothills. Roughly speaking, over two-thirds of the drainage area of the main river is on its right or south side.

Near Renwicktown the Wairau bifurcates and a subsidiary channel known as the "Opawa River" has been formed, which, after flowing through the eastern portion of Blenheim, rejoins the main Wairau River near its outlet to the sea. According to the evidence of old settlers, the Opawa River, the bed of which is now a considerable width, was at one time a very small stream, and its present dimension is due to the overflow from the Wairau during exceptionally high floods having gradually cut a larger and larger channel, so that now, even when the Wairau is at normal level, a fair amount of water flows down the Opawa channel.

Above Renwicktown the Waihopai flows into the Wairau. This tributary drains a large area of country. Near its junction with the Wairau a small subsidiary channel known as "Gibson's Creek" has been formed, which in the past has been fed by the Waihopai when in flood and endangered the Township of Renwicktown. Protective works have been carried out here in order to cope with the threatened damage.

The Omaka River, which formerly, in conjunction with the Fairhall and Taylor Rivers, ran through Blenheim, has recently been cut off east of Renwicktown and diverted by a cut into the Opawa channel, thus augmenting the flood-discharge of the Opawa, but at the same time reducing the flood-discharge by way of the old Omaka channel through the principal portion of Blenheim.

The Tuamarina River, which has its headwaters near Picton, flows down a comparatively narrow valley bounded by precipitous hills on either side. The bed of the valley is more or less of a flax and raupo swamp, through which the river-channel meanders as a very sluggish stream until it is crossed by the railway, when the channel becomes well defined with solid banks on both sides. Although the whole valley-bottom above the railway-crossing is at present a very wet swamp, there appears to be no reason, judging from the available fall, why the partial drainage of this area should present any great difficulty.

The Pukaka Stream has no defined channel after it debouches from the hills, and except for the construction of certain main drains carried down to the Wairau River would flow over the intervening swamp lands. As it is, during exceptionally heavy rains these drains fail to prevent flooding of the low-lying plains on the left bank of the Wairau. These lands are also more or less subject to flooding from floods in the Wairau itself.

The drainage areas of the Wairau River and its tributaries are approximately as follows:—

	Square Miles.
Wairau River: Main branch, including all tributaries on the left bank down to but not including the Tuamarina, and all tributaries on the right bank down to but not including the Waihopai	1,100
Waihopai River and its branches	340
Omaka River and its branches	60
Fairhall River and its branches	50
Taylor River and its branches	20
Tuamarina River	40
Pukaka Stream	20
Total	1,630

The Wairau River outlet and harbour-mouth: About 1907 the Wairau Harbour Board constructed a training-wall shutting off the old outlet of the Wairau flowing north to the sea, and by making a cut through the boulder-bank diverted the river straight out to the sea. This had the effect of giving a shorter and more direct outlet for the escape of flood-waters. To what extent this advantage will be maintained depends altogether upon the preponderating influence as between river-floods and south-east gales. An interesting series of blue-prints (Plan No. 10) is attached to this report showing the constant fight for supremacy that is going on between the river and the littoral drift.

History and Condition of Present Works.

This has been so well and fully described in the report of the Wairau River Commission of June, 1917, that your Commissioners consider it unnecessary to further enlarge on this aspect of the matter, except in regard to the following particulars:—

(*a.*) "Opawa Breach": A careful examination of this spot, where the Opawa leaves the Wairau River, convinces us that the danger of floods in the Wairau River becoming more and more diverted down the Opawa channel is a very serious one and calls for immediate remedial measures. The injunction granted some years ago restraining the Lower Wairau River Board from closing the Opawa breach, whilst possibly legally justifiable, was in our opinion quite opposed to what was necessary when viewed from an engineering standpoint.

(*b.*) The Fairhall River, at present running along the original Omaka channel, has, where it flows through Sections 21 and 23, built itself in so that it is now running along a well-defined ridge which is higher than the adjoining lands. The result of this is that when the Fairhall overflows its banks at this point the whole of the country right down to the Taylor River and for some mile and a half to the south is flooded. The suggestion to divert the Fairhall from near this point direct into the Opawa has for its object the prevention of this overflow, with its consequent flooding of some four to five square miles of country.

(*c.*) The Waihopai River, which, near its junction with the Wairau, threatens to break into the old channel, known as "Gibson's Creek," running down through Renwicktown and into the Opawa, has so far been prevented from doing so by the construction of groynes at its confluence with Gibson's Creek. The largest of these groynes, owing to its pointing somewhat down-stream, is being considerably undermined—in some places as much as 3 ft.—for nearly half its length. To prevent the ultimate collapse of this portion of the groyne short spur groynes should be constructed at intervals along its upper side, and the willow plantation continued farther down towards the river-edge.

Travel of Shingle in Rivers.

It is repeatedly asserted by witnesses, in regard to shingle-rivers, either that the bed is rising or that more shingle comes down than formerly, or both. The fact that a shingle-bank appears in some reach of the river where formerly no bank existed doubtless leads people to the belief that the bed as a whole is rising, but it will be found as a rule that where such a bank has been formed a corresponding channel has been cut or deepened, and that the mean level across the river-bed at any point is fairly constant, or fluctuates within very narrow limits of a constant level. (This does not apply where large quantities of mining debris enter a river.) An instructive instance of this is seen in the bed of the Wairau River at the Renwicktown traffic-bridge (Plan No. 3), where two cross-sections of the river-bed, taken in 1918 and 1920, while showing considerable divergence in the surface contour of the bed—channels having been formed where formerly banks existed, and *vice versa*—yet the mean level of the bed as a whole taken right across does not show a variation of more than 3 in. On the other hand, the cross-sections taken over a number of years at the railway-bridge crossing the Wairau show not only changes in the surface contour of the bed, but also considerable differences in the mean bed-level, the maximum difference between 1911 and 1916 amounting to nearly 3 ft. The lowest observed bed-level was in 1916, and this may be

accounted for by there having been three large floods in May, July, and November of that year. It is pretty evident that the river at this point shoals up and scours out alternately, and that the mean bed-level fluctuates above and below an average of probably 52 ft. or 53 ft. above datum. The bed appears now to have reached a point of maximum shoaling, and will require a few big floods to scour it out. In any case this is the point at and below which, on account of tidal influence and the flattening of the hydraulic gradient, transient shoaling may be looked for, and for that reason the stop-banks for some distance up-stream and down-stream in this vicinity should be made correspondingly higher.

A reference to the longitudinal section of the Wairau River above the railway-bridge (Plan No. 6) shows a distinct shoaling and raising of the river-bed for some four miles above the bridge, the maximum being probably about 5 ft. The shingle appears to have accumulated in this reach, due to a restriction in the width of the channel for a length of about three miles. It is more than likely that this shingle-wave is of a permanent character and not likely either to increase or diminish, but at the same time its presence indicates the necessity of allowing the Wairau to carry all the flood-water it possibly can, in order to keep the bed-level as low as possible. That this may be effected the flood-discharge must be assisted in every possible way, more especially in the lower reaches or where the river gradient begins to flatten out, by cutting off balloon and other sharp bends such as those below the railway-bridge, which will probably have the effect of extending the present toe of the shingle a little further down-stream; also by keeping the channels and sides clear of all obstructions, and ensuring, with the assistance of sufficiently high stop-banks, an adequate cross-sectional area of channel for the safe passage of the biggest flood reasonably likely to occur.

Your Commissioners are not inclined to think that, taken as a whole and on the average, the quantity of shingle entering and travelling down the river is much greater now than in the past. Bearing in mind the fact that it is the normal flow all the year round that gradually reduces shingle to sand sufficiently fine to be carried out to sea, and that the effect of small floods and big freshes is merely to carry some of the surface shingle a short distance down-stream, your Commissioners are inclined to attribute any recent shoaling of the river-bed in places to the cumulative effect of a succession of small floods and big freshes during the past few years having brought down more than the normal quantity of shingle from the steeper to the flatter slopes of the river. We do not consider that this matter calls for any remedial measures in the shape of dredging, as such, even if practicable, would not have any permanent effect.

One great cause of permanent shoaling in many reaches of the river is the growth of gorse and other vegetation on the shingle-beds, as this may become so firmly established as to defy the scouring-action of floods, and induces the river to form new channels, and on this account the river-bed should be cleared of all willows, gorse, and other vegetation likely to secure a firm footing in the shingle-beds.

Floods and Flood-discharges.

In this case, as in almost all cases your Commissioners have met with where local Boards have had control of river-works, no attempt has been made in the past to collect and note any reliable data as to heights, velocities, duration of the flood-peak, and other phenomena connected with floods. Consequently,y our Commissioners have had some difficulty in arriving at any close approximation of what the flood-discharge in the different branches and tributaries of the Wairau has been in the past.

Wairau River floods: Floods in the Wairau may come from some of the tributaries, in which case they are comparatively small, or they may come from the main drainage area of the Wairau itself and from the melting of the snow on the ranges forming the watershed, in which case the floods may be large. Finally, floods may happen very rarely from a combination of both of these contributing factors, the result being what is known as an "old-man flood."

From what data is available we estimate that in the case of a big flood happening occasionally, and of a still larger one happening rarely, the quantity of

water discharged into the different branches and tributaries of the Wairau might be approximately as follows :—

	Square Miles.	(A) Occasional Floods. Cusecs (Cub. Ft. per Sec.).	(B) Rare Floods. Cusecs (Cub. Ft. per Sec.).
1. Waihopai and tributaries	340	34,000	61,200
2. Omaka and tributaries	60	12,600	18,000
3. Fairhall and Spring Creek	50	11,100	15,500
4. Taylor	20	9,200	12,600
5. Tuamarina	40	9,200	12,600
6. Pukaka	20	5,000	6,600
7. Balance : Wairau and its tributaries north and west	1,100	60,500	104,500
Largest possible total to sea at outlet		141,600	231,000

Taking 1(B), 2(B), 5(B), and (7B) as flowing under the Wairau railway-bridge gives 196,300 cusecs, while 1(A), 2(A), 5(A), and 7(A) gives 126,500 cusecs. Mr. Widdop's calculated flood-discharges under this bridge are: November, 1915, flood, 100,450 cusecs; July, 1916, flood, 106,800 cusecs; November, 1916, flood, 116,100 cusecs; but if allowance is made for the escape of a portion of the Wairau flood-waters down the Opawa and over the stop-banks at other places it is probable that the actual discharge in the Wairau, just below its junction with the Waihopai, of the biggest flood recorded, would be in the neighbourhood of 160,000 cusecs. The biggest flood-discharge in the Opawa under the railway-bridge may be estimated at about 60,000 cusecs, which is made up of flood-water from the Omaka, say, 18,000 cusecs, and the balance, 42,000 cusecs, from the main Wairau River at Renwicktown. Of this Opawa discharge it is estimated that some 41,000 cusecs flow down Rose's Overflow channel, since below that point at the Nelson Street traffic-bridge the maximum flood-discharge appears to be only some 19,000 cusecs.

As regards the Fairhall and Taylor Rivers, flowing through Blenheim Township, it is estimated that the probable flood-discharge from these two rivers at their junction may, in the case of ordinary floods, amount to 20,000 cusecs, and that in the case of exceptional floods this quantity may be increased by at least 30 per cent. These rivers flow into the old Omaka channel which winds through the Township of Blenheim; and since the average discharging-capacity of this channel does not exceed 16,000 cusecs, it will at once be seen that the projected diversion of the Fairhall River into the Opawa would be a step in the right direction, as it would divert probably some 11,000 to 15,000 cusecs from flowing right through and flooding the township. If this were done, however, since it would add some 11,000 to 15,000 cusecs to the Opawa discharge, and as the Opawa channel down to Rose's Overflow is already taxed to its full capacity, it would be necessary at the same time either to close up the entrance to the Opawa altogether and so prevent any Wairau flood-water from entering it, or else, by some method of control at the entrance, to so regulate the admission of flood-water from the Wairau that the maximum quantity admitted in time of flood would not exceed, say, 10,000 cusecs. This latter method would, in the opinion of your Commissioners, be the most advisable one to adopt, as in that case the navigable depth of water in the lower Opawa channel would be scarcely interfered with, whereas if the Opawa entrance were closed up altogether the average water-level in the reaches of the Opawa below Blenheim might be permanently lowered, to the detriment of navigation.

By this latter method the actual flood-waters passing through or adjacent to Blenheim are reduced from a total of 88,100 cusecs to 56,100 cusecs, and are passed down two channels as follows: the Opawa, carrying 10,000 cusecs from the Wairau, 18,000 from the Omaka, and 15,500 from the Fairhall, discharges 43,500 cusecs, and the Taylor, taking only its own flood-waters, carries 12,600 cusecs. These quantities are within the carrying-capacities of the channels, so that Blenheim, by getting relieved of 32,000 cusecs of flood-waters, becomes immune from flood-overflows.

Doubtless some opposition to such a scheme will come from settlers on the lower banks of the Wairau and Spring Creek district, seeing that a certain portion of the Wairau flood-water at present diverted down the Opawa would be thrown back into the Wairau, and so to some extent augment the floods in the latter. But, as already pointed out, your Commissioners are of the opinion that in order

to prevent the aggregation of shingle in the bed of the Wairau this river should be allowed to carry all the flood-water possible, and that consequently the proposal, if carried out, would be likely eventually to do more good than harm. A further matter to be considered in this connection is the fact that the present improved valuation of Blenheim Township amounts to nearly £1,000,000, and that on this account alone every effort should be made for its protection from floods.

Your Commissioners now beg to submit their findings on the various heads in the order of reference, as follows:—

REFERENCE NO. 1.

To inquire into the cause or causes of the silting-up of the channel and flooding of the adjacent lands by the said river, the erosion of its banks, and the damage to the surrounding country.

Although the evidence submitted is in the direction of proving an accumulation of shingle in the river-bed at places, yet your Commissioners are not inclined to regard such as being of a permanent character, but as representing phases in periodic shoaling and scouring of the river-bed, which has been going on for many years past. Had mining operations been in progress in this river the case might have been different, but seeing that any additional siltation derived from farming operations, tussock-burning, or rabbits is of such a fine character as to be readily transported to sea, whereas the river-beds are formed of fairly large and not easily moved shingle, your Commissioners think that, taken as a whole and on an average, there has been very little real alteration in the river-bed level within recent years. Any slight accretion of shingle in the bed of the Wairau within the last few years may be attributable either to the absence of a succession of big floods or to the abstraction of a certain portion of the flood-waters by diversion down the Opawa channel, or possibly to both causes combined. The presence of vegetable growth in the bed and shoal-banks undoubtedly assists in the gradual local accumulation and piling-up of the shingle in these rivers.

REFERENCE NO. 2.

To ascertain the nature and extent of the damage done to the lands adjacent to the said river, and what area of land is affected by such floods or erosion, or both, and whether it is practicable at reasonable expense to prevent such flooding or erosion, or both, either wholly or partially.

The damage is of a manifold nature, and may be referred to under the following headings:—

(*a.*) Actual erosion of banks;
(*b.*) Damage to crops and permanent pastures, and loss of stock by drowning; also damage to house property and furniture;
(*c.*) Damage to roads and railway, including monetary loss due to interruption of traffic; and
(*d.*) Indirect loss to the district as a whole, owing to the ever-present threat of flood-damage preventing farmers from cropping or in other ways improving their land.

The approximate area flooded from the Wairau, the combined Fairhall and Taylor Rivers, and the Tuamarina and Pukaka Streams amounts in the aggregate to 28 square miles, made up as follows:—

	Square Miles.
Tuamarina Valley	$1\frac{1}{2}$
Pukaka lands and Native Reserve	8
Spring Creek district and down to Rose's Overflow	$7\frac{1}{2}$
Between Fairhall and Taylor Rivers	$5\frac{1}{2}$
East of Blenheim and south of Rose's Overflow	$5\frac{1}{2}$
Total	28

Speaking generally, so far as loss of land by erosion is concerned, your Commissioners do not consider that this, viewed from an economic standpoint, is

such as to warrant any special or expensive remedial works. On the other hand, there are certain points near bridges and elsewhere where special protection is required.

As regards the flooding of the land, we are of the opinion that by a proper system of stop-banking in conjunction with other works, the whole or at least the greater portion of the land above referred to may be made immune from flood-damage; but in the absence of full detail survey plans and levels we are not prepared to say at what cost, beyond expressing the opinion that the interests at stake will fully justify the necessary expenditure.

Reference No. 3.

To ascertain the best method of providing for the control of the said river and its tributaries so as to safeguard the lands affected, and to provide for the effective control and improvement of the said river and its banks.

The works recommended by your Commissioners are as follows:—

(*a.*) The repair and safeguarding from undermining of the big groyne on the Waihopai at the entrance to Gibson's Creek, by the construction of short spur groynes built along its upper side; also further works to close up this channel and safeguard it from the entrance of either the Waihopai or the Wairau River flood-waters.

(*b.*) The closing-up of the breach on the right bank of the Wairau River which forms the entrance to the Opawa channel, and leaving only sufficient opening from the Wairau into the Opawa to ensure a maximum flow from the Wairau to the Opawa, when the former river is in high flood, of a quantity not exceeding 10,000 cusecs. This recommendation may be given effect to by the construction of a bridge across the Opawa having a width of waterway about one-twentieth of that of the present Renwicktown bridge across the Wairau, the new bridge to be in line with the existing bridge or on the same contour-line: the two bridges to be connected by a roadway the same height as the bridges, and this and the approaches to be well protected from scour by groynes, stop-banks, and gabion work. This proposal if given effect to will necessitate some heavy and expensive work, but your Commissioners are very strongly of the opinion that if it is not carried out there is a very great danger of the Wairau taking greater and greater control of the present Opawa channel, and gradually augmenting the flood-discharge therein, thus threatening Blenheim with possible disaster in the near future.

(*c.*) The further stop-banking and protection of the right bank of the Omaka River, with its diversion into the Opawa, in order to prevent any possibility of its again breaking into and flowing down its old channel through Blenheim.

(*d.*) The diversion of the Fairhall River and its tributary Mill Creek from a point below the junction of the latter, by a cut passing through Sections 21, 60, and 63 into the Opawa channel. The line of this proposed diversion has been surveyed (see Plan No. 5), and the scheme offers no difficulties.

(*e.*) The enlarging of the various river-channels by means of stop-banks sufficiently far apart and of the necessary height to ensure their being capable of carrying, with a reasonable margin of safety, the following quantities of water per second:—

Wairau River below its junction with the Waihopai River, 160,000 cubic feet per second.
Omaka River, 18,000 cubic feet per second.
Fairhall River, 15,500 cubic feet per second.
Taylor River, 12,600 cubic feet per second.
Opawa River below the junction with the Omaka, 28,000 cubic feet per second. (This is assuming that our recommendation *re* the partial closing of the Opawa inlet is carried out.)
Opawa River below the junction with the proposed Fairhall diversion down to its junction with Rose's Overflow, 43,500 cubic feet per second.

This leaves the old Omaka channel through Blenheim with nothing to do but carry flood-water from the Taylor, estimated at about 12,600 cubic feet per second

as the maximum likely to occur. The estimated extreme carrying-capacity of this channel at present, without the water overtopping the School Bridge (Hutcheson Street), is about 13,000 cubic feet per second.

In order to carry out the above recommendations it will be necessary to ease all sharp bends, remove all obstructions in the shape of willows, &c., remove some of the stop-banks farther back from the river, and also to materially increase their heights in places. This work also includes the straightening of the Wairau River at Maori Point and at the Peninsula.

(*f.*) Protective measures in the shape of groynes and other works where necessary to prevent erosion of the river-banks.

(*g.*) The Pukaka Main Drain should be cleared and enlarged if necessary, and stop-banked a sufficient height to prevent overflow. The stop-banks should be made to conform to the amended levels of the stop-banks on the main river.

(*h.*) The stop-banking of the sides of the Tuamarina River must be made to conform to the amended levels of the stop-banks on the main river.

(*j.*) Rose's flood overflow channel, at its intake or junction with the Opawa, should be rough-pitched or otherwise protected in the bottom and sides so as to prevent undue scouring and deepening of the channel at its intake, with the possible ultimate diversion of the whole of the Opawa down this channel.

(*k.*) As regards the present harbour entrance, we recommend that necessary works be carried out with a view to keeping the present straight-out channel as open as possible. This may be effected in some degree by a reasonable extension of the present wall.

Reference No. 4.

To ascertain the nature and extent of any drainage-works that may be required, and the best method of carrying out such works.

Apart from the above-mentioned improvements to existing main drains, your Commissioners do not at present recommend the construction of any new drainage-works. Until complete surveys with accurate levels are made over the whole of the Pukaka district, it is impossible to say where, or to what extent, new drains are required or possible. We may, however, state our belief that, as regards drainage of the Tuamarina Valley, considerable improvement could be effected in view of the available fall in the lower end of the valley.

Reference No. 5.

(*a.*) *To furnish estimates of the cost of such remedial measures as you may recommend should be taken for the effective control and improvement of the said rivers and their banks;*

(*b.*) *To report in the case of each river what area or areas of land should be constituted a district in respect of which a rate may be levied to secure and pay the interest on and provide a fund for the repayment of any loan that may be raised to carry out any river-improvement works which you may recommend should be undertaken;*

(*c.*) *To report your opinion as to what matters, if any, should be adjusted by legislation; and*

(*d.*) *Generally, to report your opinion on all matters arising out of or touching the premises, including the question as to whether or not one or more competent authorities shall be appointed to control the whole or any portion or portions of the said rivers, and what statutory powers should be possessed by such authority.*

(*a.*) In the absence of complete surveys of the different river branches, showing all existing stop-banks and other works, with their levels, &c., it is impossible for your Commissioners to furnish an estimate of the cost of the remedial measures as herein outlined. But we may state that in our opinion the sum of £50,000 should cover the cost of such works as are necessary to give protection from all but abnormal floods. With a view to formulating a comprehensive scheme of works on the lines indicated by us, we recommend that the surveys should be completed forthwith so that an estimate of the cost may be made.

(*b.*) We recommend that the whole of the drainage area of the Wairau River and its tributaries should be constituted a district or districts in respect of which a rate may be levied.

(*c.*) Your Commissioners consider that the whole of their findings as set forth in this report should be enacted in special legislation, to be called the "Wairau and Opawa Rivers Improvement Act."

(*d.*) At present there are no less than five River Boards directly controlling different portions of this river and its branches, and also six other local bodies more or less interested in the operations of the former. Such a multiplicity of governing bodies has in the past led to much misdirected and wasted effort, with the result that no definite or comprehensive scheme of works as a whole has ever been formulated, and that works have been designed by rule-of-thumb and carried out piecemeal, and further that as a consequence of this divided control one body has sought and obtained an injunction against another body carrying out work which the former considered would have a harmful effect on themselves. It has been suggested that all these bodies at present controlling the river should be amalgamated and formed into one elected River Board for the whole district. Although such an arrangement might be an improvement on the existing state of affairs, yet there appears to your Commissioners to be certain objections thereto. In the first place, it may be stated that between the residents of Blenheim and the settlers on the banks of the Wairau or of the lower Spring Creek district there can be no community of interest whatever so far as river-protection is concerned. Blenheim is mainly concerned with the overflowing of the Opawa, the Fairhall, and the Taylor Rivers, while the settlers along the Wairau are mainly concerned about the floods in the Wairau, and are in no way interested in what takes place in the Opawa. Rating for flood-protection works would be on the capital value and also in the ratio of benefits to be derived, in which case Blenheim, the capital value of which is not far short of £1,000,000, would be the largest contributor, and it may therefore be safely assumed that Blenheim would expect the greater share of expenditure to be in the direction of protecting Blenheim.

We are of the opinion that in this particular case the river might be treated as in two parts—viz., the Wairau River proper, including all its tributaries with the exception of the eastern half of the Waihopai River, and also excluding that portion of the southern half of the Wairau River between the Waihopai River and the existing Renwicktown traffic-bridge, as the one part; and, as the other part, the eastern half of the Waihopai River, the southern half of the Wairau River between the Waihopai and the Renwicktown traffic-bridge, the Omaka, Opawa, Fairhall, and Taylor Rivers with their tributaries, together with Rose's Overflow channel.

In this case the rating district as above recommended would be divided into two, which might be referred to respectively as the "Wairau River District" and the "Opawa River District," each district to be represented by a separate River Board or River Trust, as hereinafter described.

The Opawa River Trust should have control of those rivers or portions of rivers, together with their tributaries, lying south of a line running down the centre of the Waihopai River to its junction with the Wairau River; thence down the centre of the Wairau River to below the Renwicktown traffic-bridge; thence in a south-easterly direction to the main Spring Creek Road, and along this road in an easterly direction to Trig. J; thence south along the road-line to the south-west corner of Section 97; thence generally in an easterly direction along the southern boundaries of Sections 97, 88, 79, 71, 66, 62, 58, and 54 to the main road; thence along the main road in a south-easterly direction to Rose's Overflow; thence along the north side of Rose's Overflow to its outlet into the Wairau River; and thence along the centre of the Wairau River to its outlet into the sea: all as indicated by dotted red line on the accompanying Plan No. 1.

The Wairau River Trust should have control of all the other portions of the Wairau River, with its tributaries lying to the north of the above-described boundary-line, and as indicated on Plan No. 1.

Your Commissioners recommend that two River Trusts controlling the above areas be formed, each River Trust consisting of five elected members and two

Government nominees. The Government nominees to be designated "River Commissioners," and to be appointed for three years by the Minister of Public Works, one of the Government nominees being preferably a Stipendiary Magistrate and the other an engineer with expert knowledge of river-control. The same Government nominees to act on both trusts.

Your Commissioners further recommend that the duties of these controlling authorities be clearly set out as follows:—

(1.) To have detail surveys, plans, estimates, and specifications made for carrying out the works recommended above. These plans shall be approved by the Government nominees on the trust.

(2.) To assess the total sum to be derived from each district, and to fix the rates on all properties in each district on a classification basis in the ratios of the benefits to be derived, according to the principles laid down in the River Boards Act, 1908, and its amendments.

(3.) To submit the proposals to the ratepayers and obtain their authority by poll to raise the necessary loan.

(4.) To carry out the necessary work, either by contract or direct labour, in as expeditious a manner as possible.

(5.) To maintain the works efficiently, and to do whatever extra work may be necessary to improve the regimen of the rivers and secure the fullest protection for their district from floods.

(6.) To take all necessary observations and keep records that will assist in the study of the hydrology of the river, changes in its regimen, heights, and duration of floods, &c.

The trusts should have all the powers of a local body, and, further, should have absolute jurisdiction over the channel and banks of the rivers, inasmuch as proposals for all drains emptying into the rivers, all locks, tide-gates, bridges, ferries, wharves, &c., should be submitted to and approved by the trust before being carried out. No planting or cutting of willows to be done except by the trust.

Drainage: Any portion of the districts mentioned may be formed into a Drainage Board to do the drainage-work of its particular area, and may obtain reports, plans, and estimates of drainage-works required from the River Trust. The Drainage Board shall then proceed to raise the money from its area, and, having done so, shall carry out the work itself or request the River Trust to do so. The maintenance of the drainage-works shall be done by the Drainage Board.

Government nominees: The River Commissioners may be appointed as Government representatives on any River Trust similarly constituted, and they shall report progress to the Minister of Public Works after each meeting of the River Trust. It shall also be their duty to see that all valuable data are collected and forwarded to Wellington for embodying in the Government archives.

No river-control work shall be carried out by the trust unless and until the plans of same have been first submitted to and approved by the Minister of Public Works.

Your Commissioners further recommend, should their proposals regarding river-improvements be carried out, that the Opawa River Trust should to some extent subsidize the Wairau River Trust for the additional cost of flood protective works and river-maintenance occasioned by the augmented flood-discharge in the Wairau River below the entrance to the Opawa. Seeing that the proposed partial closing of the Opawa channel against excessive floods is solely in the interests of Blenheim and adjacent lands, this appears to your Commissioners to be only a fair and equitable proposition, and after careful consideration it is recommended that the amount of such subsidy should be 20 per cent. of the actual cost in the future to the Wairau River Trust of all flood protective works and all maintenance undertaken on the Wairau River below the Renwicktown bridge and the outlet of Rose's Overflow. The Government nominees on the trust to be the sole arbiters in deciding the value and extent of such above-mentioned works.

Furthermore, if any works are found to be necessary at the mouth of the river and the Harbour Board is unwilling or unable to carry out such works, then for the purpose of carrying out the works the two River Trusts shall amalgamate and act as one, bearing equally the cost of such investigations and work, if done.

This our report, which has been unanimously adopted, we have the honour to respectfully present for the consideration of Your Excellency, together with the transcript of the evidence taken by us in the course of our investigations, and the following plans illustrating our report:—

(1.) General plan showing the whole of the rivers together with their watersheds, suggested river-diversions, boundaries of proposed Wairau and Opawa River Trust Districts, recently flooded areas, &c.
(2.) Township of Blenheim.
(3.) Cross-sections of rivers at bridges (by Mr. F. Widdop, District Engineer, New Zealand Railways); also cross-section of Wairau River at Renwicktown traffic-bridge.
(4.) Cross-sections of Fairhall and Taylor Rivers at bridges.
(5.) Sections, Fairhall River diversion, &c.
(6.) Longitudinal section, Wairau River, and sketch-plan, Opawa control intake.
(7.) Diagram illustrating shoaling of bed at Wairau railway-bridge.
(8.) Large scale plan, inlet to Opawa River and Gibson's Creek works.
(9.) Blue-prints, Wairau Harbour, showing condition of boulder-bank on different dates.

Given under our hands and seals, this 14th day of December, 1920.

F. W. FURKERT, Chairman.
ASHLEY J. HUNTER,
F. C. HAY,
} Commissioners.

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