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(PROVINCE OF NELSON.)

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ALFRED GREENFIELD, Provincial Secretary.

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Superintendent's Office,  
Nelson, 12th December, 1868.

THE SUPERINTENDENT directs the publication of the following Report for general information.

GEORGE HODGSON,  
*Clerk.*

Provincial Engineer's Office,  
Nelson, December 1st, 1868.

SIR,—I have the honor to forward, for the information of His Honor the Superintendent, the following report on the damage done to the banks of the river Buller, and on the means proposed for protecting them against further encroachments of the river.

In accordance with instructions received from His Honor, I proceeded to Westport on the 7th November, and remained at that place for a period of eight days, during which I was employed in taking a number of necessary observations.

I found that the jetties, lately constructed, have been almost entirely destroyed; a portion of the lower one yet remains, considerably out of level, to which has been fitted a temporary stage, so that it can be used as a landing wharf. A number of piles of No. 3 jetty are still standing; this structure was in progress on the occasion of the last heavy flood of 14th October, and a temporary staging has also been fixed to it, where goods can also be landed. The tracing

forwarded by Mr. Lowe very correctly shows the nature and extent of the damage done by the last floods, and it is evident that the damage is gradually extending along the river bank upwards.

The greatest amount of destruction has taken place along a length of about 30 chains above Gladstone-street, and we may expect still further ravages along the lower 15 to 20 chains of this length, where the river will form a still deeper curve; the rate of destruction will not, I apprehend, be so great as it has hitherto been; nor do I share the apprehensions said to be entertained by the inhabitants of Westport that the river will cut a new channel through the town and North Spit, and thus destroy the town.

In order to arrive at any just conclusion as to the nature of any future protective works, it will be necessary to examine and consider carefully the manner in which the destruction of the river banks is accomplished, which I will briefly explain:—During a heavy flood the river bed is scoured out to a great depth, the scouring action being greatest close to the bank, which is thus cut away to an almost perpendicular face, and to a depth (as explained in Mr. Lowe's report) of 30 feet below low water line. As the flood subsides the scouring action becomes less and less, and the river gradually deposits gravel in the deepest parts, being unable to carry it forward; the result of this being that a set of soundings, taken some time after a heavy flood, will give a greatest depth of 17 or 18 feet, in place of 30 feet as above stated, shewing a deposit of loose material of a depth of 12 feet. As the flood subsides

the upper parts of the bank fall in, a process which is immensely accelerated by the action of a swell from the sea, which extends a considerable distance up the river, and causes, at every flow of the tide, a tolerably heavy surf to beat against the upright bank. The action of this is to undermine the bank about 6 to 7 feet below its surface, and to cause large masses of it to fall in, which are gradually crumbled away by the surf, or carried away bodily by the next flood. This action of the surf, if left to itself, would be to form a flattish shore to the river bank, and its destructive effect (apart from floods) could be arrested by simple and comparatively inexpensive means.

It remains then to point out some means by which the scour during floods can also be arrested, and this being accomplished, the safety of the banks will be secured.

The ordinary piled and planked breastwork, well filled in behind, would appear to be calculated to resist both destroying agencies, were it put down deep enough, but it would require to be carried out in such a way and on such a scale, as would render it very costly; for, although I have stated 30 feet as the greatest depth of scour at low water, as yet experienced, this by no means points out the extreme limit which should be provided for, judging from the extremely treacherous and shifting nature of the river bottom, which appears to be little better than quicksand during floods.

The peculiar form of breastwork I should recommend, were this plan of protection adopted, would be to drive piles, at least 60 feet long, on a moderate inclination, all along the face of the work at a distance of about 3 feet from centre to centre, the top ends being surmounted by a capping piece, and strengthened by land ties.

Behind these I should fill in large pieces of rock, forming, in fact, a rough stone wall, say of 4 feet in thickness, and in front of the piles would also lay in an angle or footing of rocks, to resist the downward scour of the water.

These, as well as the rocks behind the piles, would gradually settle during the first few floods till they became firmly bedded and immovable.

The permanence of this work would be limited only by the decay of the timber used in its construction.

I have not yet ascertained, but search is now being made to determine, whether rock can be obtained at an available distance from Westport; I have hopes that it may be found in a spur near the Orowaiti, and within say two miles of the port.

Assuming that a supply can be got from this place, I should estimate the cost of this breastwork at about £500 per chain.

Another plan, and one, I think, most worthy of consideration, would be to throw out from the river bank, at a safe distance above the town, a projecting groin of such a character, as would withstand any flood, however severe, and of such a size and shape as would deflect the current sufficiently to protect the line of bank below from scour, and render the water below it comparatively still.

This being accomplished, we should then have to deal only with the destroying action of the surf, already described, from which the bank might be protected by a low breastwork of piles and planks, backed with stones and rock, which would also form an enduring edge to the bank, and protect it as well from the effects of traffic, &c.

The cost of this would be about £30 to £40 per chain.

As regards the construction of the groin itself, I have been forced to the conclusion, from careful observations,

that any work depending on the use of piles, however well strengthened and braced, will be found insufficient to withstand the forces brought to bear against it in heavy floods, and we must look to the use of some other material, in order to resist successfully the power of the river. I can confidently recommend heavy rock-work for this purpose as a certain means of attaining the desired object—and with it a solid substantial groin could be formed, which would resist the action of the stream, and deflect the current to any desired extent.

The manner of constructing it would be simple and safe; the tramway laid for the supply of stone would be continued to the edge of the river bank, and the stone itself in large masses would be tipped out of the trucks and left to find its own bed; the tramway being extended along the groin itself as the work progressed.

We have examples of groins thus formed *naturally*, both in the Buller and the Grey, by the action of tributary streams forcing masses of stone and rocks of all sizes into the main stream during floods, and which successfully withstand the heaviest floods in the main river.

A frequent inspection of these natural groins, and the manner in which they resist and divert the stream, has convinced me of the fitness of such a structure for the purpose intended. I estimate the cost of such a groin, projecting say  $2\frac{1}{2}$  chains from the edge of the bank, at a proper angle at about £4000. Its position would be opposite Henley-street, that is, about 33 chains above Gladstone-street. Should its action in stilling the water below it not reach as far as Gladstone-street, a smaller groin of the same character might be run out about half-way between the two places; and were it at any time thought desirable to control the action of the surf rolling into the river, it could be accomplished by constructing another immediately below Gladstone-street—where the channel becomes much shallower.

I will now summarize the works which, with a view to the greatest economy, combined with permanence and certainty of action, I should recommend to be undertaken for the defence of the river banks, viz:—

Large stone Groin at Henley-street ...	£4,000
Say 30 chains of Breastwork at £40 ...	1,200
Formation of Wooden Tramway, say	
2 miles at £500 ... ..	1,000
	£6,200
Middle Groin, if required, say ... ..	1,500
Lower do. do. say ... ..	2,500

While on the West Coast I took an opportunity of examining the protective works in progress at Grey-mouth, and also at Hokitika.

The former consists of about 51 chains of wooden breastwork, formed of piles about 32 feet long, driven 6 feet apart, capped, and planked over, about 10 feet down, to the water line; the whole being strengthened at intervals by land ties and braces. Between this and the edge of the bank, about 30 feet, there exists a triangular space; the river beach or shore shelving from the street level to a depth of about 23 feet at the line of piles, giving about 13 feet of water on this line. This space it is intended to fill up entirely with brushwood, tree tops, branches and logs, without any admixture of earth or gravel; and it is expected that this will effectually prevent the scour of the river banks, if not at once, gradually, as the mass of brushwood settles down firmly on the bottom.

There is a reasonable hope for the success of this

plan, if, as I have been informed, all the piles have been driven to a hard or solid bottom.

The entire cost of the work will be about £6000, a like sum having been expended on former protective works, all of which have been carried away.

At Hokitika, I observed a great variety of protective works, some completed, and some in progress; the wharf itself is protected in front by sheet piling, about 20 feet long, and is yet standing, while below it, and above it, wing-dams, or groins, of various character have been erected, some of which have not yet been tested by floods.

Breastworks of different kinds have also been erected, the most successful of which, I was informed, being made with piles deeply driven in two rows on different levels, between which a mass of brushwood has been forced down to the sloping bank of the river, and this has as yet not been destroyed, nor from its appearance does it seem likely that it will be.

The amount spent in Hokitika in these works, has I believe, exceeded £40,000. I examined these river works with interest, as being likely to exhibit amongst them some principle which might be favorably adapted to the Buller. In all, however, are points of weakness, even in their present situations, and as they stand, not one of them would resist the action of a single flood in the Buller, in which river the volume of water is immeasurably greater than in the Grey or Hokitika.

The use of the timber also, most of it of a very perishable nature, will lead in the course of a very few years to a large outlay for necessary repairs and maintenance.

On this account I should strongly recommend the use of stones and rocks in the formation of permanent protective works wherever practicable.

As a temporary protection of the river bank against the surf I authorised the erection of a low breastwork, not exceeding 15 chains in length, and guaranteed the payment of £3 per chain towards its cost, on conditions of the work being executed to a given specification, and to the satisfaction of the District Engineer.

This will prevent further destruction of the banks, unless against very high floods, and may last until something more permanent shall be decided on.

Meanwhile I must point out, in the most forcible manner, the danger to which a great portion of the Reserve is liable, and the certainty that a considerable amount of further damage must ensue, unless some work be undertaken to keep the river in check.

It has been suggested that an old barge, or other vessel of sufficient size might be sunk and filled with stones, at a convenient place, to act as a groin or wing-dam. This (were a vessel to be obtained conveniently) would be a ready and comparatively cheap manner of attaining the desired result, if fixed and laid carefully, and at a proper angle.

I have the honor to be, Sir,

Your Obedient Servant,

JOHN BLACKETT,

Provincial Engineer.

P.S.—Since writing the above, I have received a report as to the character of the spur from which I proposed and expected to have obtained rock. It is reported to be gravelly in places, but with no large boulders; it is composed mainly of very soft sandstone, which may easily be broken up by the fingers.

We should, therefore, have to look further for a supply of rock which might be obtained at the foot of the main range, at a distance of about 5 or 6 miles. This would add to my estimate for a tramway, and make the total, say for 6 miles (instead of 2), £3000 instead of £1000.

Should this tramway be formed, it would be of the greatest service in supplying goods, &c., to the diggings beyond the Orowaiti—such as the Caledonian, Giles' Terraces, &c., and its formation might possibly lead to a rapid settlement of the bush land, through which it passed.

JOHN BLACKETT.

The Provincial Secretary, Nelson.