

1911
NEW ZEALAND

DRAINAGE OPERATIONS IN HAURAKI PLAINS:

REPORT FOR THE YEAR ENDED 31st MARCH, 1911, TOGETHER WITH STATEMENT
OF ACCOUNTS.

*Presented to both Houses of the General Assembly pursuant to Section 10 of the Hauraki Plains
Act, 1908.*

SIR,—

Department of Lands, Wellington, 24th June, 1911.

I have the honour to submit herewith the report on the drainage operations in the Hauraki Plains for the past year, in accordance with the provisions of the Hauraki Plains Act, 1908.

Whilst leaving the Land Drainage Engineer's report to speak for itself, I will briefly sum up the results of the Department's operations to the 31st March, 1911:—

Lands reclaimed and disposed of on the occupation-with-right-of-purchase and renewable-lease tenures, or sold for cash	Acres.	Capital Value. £
... ..	21,530	101,870
Town lands offered but not disposed of	89½	3,180
Rural lands withheld from sale... ..	414½	1,590
Land now being drained preparatory to being opened for settlement during the coming summer	6,800	27,200 (at least).
Land set apart as reserves	69½	1,425
Land occupied by roads and drains, &c.	1,175	...
		£135,265

(NOTE.—The estimated value of land occupied by roads and drains is approximately £5,875, but such value is more or less included in the value of the lands opened for selection that such works benefit.)

The works completed consist of twenty-seven miles of stop-banks; thirty-five flood-gates in actual position; 19 miles 23 chains of cart-roads completely formed, with drains on both sides; 27 miles 63 chains of drainage-banks to be converted into roads; 211 miles 69 chains of drains now in operation; seven wharves built with hardwood piles; thirty small sill bridges across drains; fourteen miles of private-telephone line, erected by the Department in accordance with Telegraph Department's specifications; floating plant—two improved Priestman dredges, fully equipped, one steamer for towing, four oil-launches, two large pontoons, and numerous small punts; nine artesian bores put down.

A glance at the above will show the magnitude of the work already accomplished; and when it is considered that an average of nearly three hundred men are being employed, and that there have been no less than 187 separate contracts in progress, whilst the whole of the operations has been carried out from first to last without any friction, it will be conceded that the greatest praise is due to the Engineer in charge (Mr. J. B. Thompson) and his staff of able assistants and foremen of works. Personally, I cannot speak too highly of the nature of the work performed, nor too favourably of the intense interest manifested by all classes of the employees. What was a few years ago a useless swamp, always subject to continuous flooding, is now being converted into a richly settled district, with the probability of its shortly becoming a great dairying country.

I have, &c.,

WM. C. KENSINGTON,

Under-Secretary for Lands

The Right Hon. Sir J. G. Ward, Bart., P.C., K.C.M.G., Minister of Lands.

STATEMENT OF ACCOUNTS (as required by Section 10 of the Hauraki Plains Act, 1908), for the
Year ended 31st March, 1911.

<i>Receipts.</i>			<i>Expenditure.</i>		
1910.	£	s. d.	1911.	£	s. d.
April 1. To Balance—Cash in Public Account ..	7,092	11 7	Mar. 31. By Expenditure—		
1911.	£	s. d.	Salaries	388	10 10
Mar. 31. To Land-sales ..	2,263	0 0	Travelling allowances and expenses, camp allowances, and general expenses of administration ..	235	0 0
Rents ..	3,710	13 10	Purchase and equipment of dredges and launches, maintenance, and working-expenses ..	4,310	6 6
Miscellaneous ..	40	15 10	Buildings, erection and maintenance of ..	236	2 9
Sales of cattle, &c. ..	1,662	1 1	Cattle, purchase of ..	390	8 3
			Drainage-works: Clearing channels, building stop-banks, tramways, and all expenses incidental thereto ..	25,331	9 8
Advances made by the New Zealand State-guaranteed Advances Office ..	40,000	0 0	Compensation for lands acquired ..	377	7 6
			Interest and sinking fund on loans ..	834	8 6
			Balance—Cash in Public Account ..	22,044	11 3
			Advances in hands of officers of the Government ..	620	17 1
	<u>£54,769</u>	<u>2 4</u>		<u>£54,769</u>	<u>2 4</u>

LOAN ACCOUNT.

1911.	£	s. d.	1910.	£	s. d.
Mar. 31. To Balance	83,131	1 5	April 1. By Balance due to Loans to Loans Bodies' Account ..	32,108	19 9
			1911.		
			Mar. 31.		
			Year's interest on above to 31st March, 1911, at 4 per cent. per annum ..	1,284	7 2
			Advances made by the New Zealand State-guaranteed Advances Office—		
			No. 1 Loan—Balance ..	4,920	12 6
			No. 2	4,920	12 6
			No. 3	4,965	4 6
			No. 4	9,931	5 0
			No. 5	25,000	0 0
	<u>£83,131</u>	<u>1 5</u>		<u>£83,131</u>	<u>1 5</u>

REPORT UPON HAURAKI PLAINS DRAINAGE OPERATIONS FOR THE YEAR ENDED
31st MARCH, 1911, by THE LAND DRAINAGE ENGINEER.

SIR,—

Thames, 24th April, 1911.

In accordance with the provisions of the Hauraki Plains Act, 1908, I have the honour to report upon the various operations carried out during the past year.

A great deal of work has been done by the different branches in connection with gradually completing and drawing the various systems of drainage together, and in improving and maintaining same. All the most promising areas have had suitable drainage-schemes devised to adequately cope with the local conditions, and fresh development-works are well forward.

This past year has seen a great improvement and change in the condition of the land now disposed of, and I am quite satisfied that the future will see a most thriving settlement. During the year some 21,521 acres of rural lands, subdivided into small farms, was disposed of by ballot, and all selected, the number of applications constituting a record. From a tally kept by the guides it would appear that some 680 land-seekers inspected these lands. Naturally it takes time to bring raw swamp country into conditions to warrant its being opened for selection, as the drainage thereof is tedious.

In each particular class of work dealt with hereafter the totals are given showing the position at 31st March, 1911. The details of all classes of work executed during the year are shown separately under heading "Works performed." This is convenient and at the same time necessary, as you thus see the existing stage of completeness the works have reached.

PRIESTMAN DREDGERS.

Both dredger No. 1 and dredger No. 2 are in active commission, and are doing excellent work under the improved conditions, and have excavated 50,179 cubic yards and 60,174 cubic yards respectively during the past twelve months. In accordance with authority given, automatic steel "chutes" were erected on each dredger, and have been in use for six months and ten months respectively, with results up to our most sanguine expectations. The spoil dredged up is dumped into a hopper at head of each chute, and is then automatically discharged at a distance of 47 ft. from centre of dredge, on either side. No gear is required to operate the chutes, the discharge of spoil being done by inclination of chutes aided by roll of dredge.

Under ordinary conditions, and allowing for a small margin of timber being met with, the capacity of each dredge is about 6,500 cubic yards per month, but where much timber is encountered the capacity of each dredge would be about 4,000 cubic yards per month. Heavy timber is successfully handled by the dredgers, aided, of course, by explosives where the timber is long or deeply rooted. The Department is fortunate in having the services of two capable dredgemasters who thoroughly understand their business. It is interesting to note that while dredger No. 1 is now covering more length per month than dredger No. 2, yet the cubic yards lifted are about equal, as the former dredger excavates to a lesser depth than dredger No. 2.

PUHANGA CANAL OVERFLOW.

The above work was let in two contracts to Messrs. Onion and Duffy, but they later on transferred their interests to Mr. R. R. McGregor. It is a matter for regret that more progress has not been made with this work, but what has been completed has been well done. The contractor, however, on instructions having been given him, stripped the peat throughout for a considerable width, so that in the event of a flood a decided easement will be effected in the locality.

The total amount of material so far excavated under both contracts, and used to form combined road and stop-bank, totals some 28,780 cubic yards. No doubt scarcity of labour has materially contributed to the slow progress made by the contractor. Two motor-machines, operating buckets filled by hand, and hoisted and run round on a jib, are being used in addition to other labour. Dredger No. 2 constructed some 25 chains of this canal, excavating 20,709 cubic yards of material, prior to letting contract for balance.

WAITAKARURU—MAUKORO CANAL.

The excavation of this canal is being done by Priestman dredger No. 1, and a total length of 142 chains by 42 ft. in width is now completed. This shows a distance of 92 chains dredged during the past year. The construction of a dam some months ago materially assisted dredging operations, the water thereby always being kept at one level, instead of, as formerly, being subject to rise and fall of tides. A very great deal of heavy timber has been met with, which materially affected the rate of progress. There is still some 30 chains ahead of dredger stripped of peat, and the timber is exposed to view. As required, explosives are used to break up the heavier logs and deep-seated roots.

As regards this canal, it will pay well to push it through so long as the automatic chutes can handle the spoil, but should the face of peat ultimately become too high and the chutes be unable to cope with same, it might be necessary to discontinue this method of working. This contingency, however, is not to be anticipated for some considerable time, and as the canal progresses the face of the country drops, being relieved of the water. The depth of peat at head-works is not as much as was anticipated, being about 50 per cent. less.

WAIKAKA CANAL.

This is being cut by dredger No. 2, and will on completion greatly relieve the flood-waters, and shorten the distance on Piako River by one mile. A very ugly bend will be cut off by our operations, and navigation assisted. A total of 35 chains by 42 ft. wide has been completed, some 40,005 cubic yards having been excavated. A lot of timber has also been met with. Owing to the Piako River being very low this season, dredging had to be carried to a greater depth than was anticipated, but as soon as the winter rains come on less depth will be necessary, as there will be more water to work in.

STOP-BANKS.

The total length of stop-banks completed to date is 27 miles 2 chains, and these are continuous as to the several localities of same. Flood-gates are placed therein at fairly frequent intervals throughout, but more will be added as circumstances permit. These stop-banks will require materially strengthening in places, and from time to time must be raised as the banks settle and consolidate. Naturally, some small local failures must be expected from time to time until the adjacent country dries and the subsoil becomes less "soupy." Considerable trouble has been experienced in connection with the stop-banks extending for about one mile in from the mouth of the river, on account of the very unstable and "soupy" ground upon which stop-banks had to be constructed. This is generally experienced in estuaries where tidal conditions are prominent. The ground is practically a crust for a depth of 4 ft., and under that lies soft blue mud which, upon pressure of the banks, oozes up and causes trouble. All lands disposed of are now protected by stop-banks up to the level of ascertained ordinary flood conditions.

FORMED ROADS.

The total length of completely formed cart-roads—*i.e.*, drains on both sides of road, and formation full width—is 19 miles 23 chains.

ROAD-BANKS.

The total length of road-banks—*i.e.*, spoil from road-drains removed 4 ft. from edge thereof and spread 12 ft. in width—is 27 miles 63 chains. As circumstances allow another drain will be placed on opposite side of road, and the properly constructed cart-road duly made.

DRAINS IN OPERATION.

The total mileage of drains in operation on the Hauraki Plains is now 211 miles 69 chains, and includes stop-bank drains, road-drains, subdivisional drains, service-drains, and outfalls of all descriptions.

SNAGGING PIAKO AND WAITOA RIVERS.

Two special votes are being expended very satisfactorily upon the snagging of the above rivers. That of the Piako River is being done by special contract, while day labour is being utilized on the Waitoa River. Both works are progressing well, as the season has been a very dry one. The work will, of course, be discontinued when the floods set in, but will be taken up again when circumstances

warrant it. Some 150 chains of the Piako River bed has been fully snagged, while some 240 chains of the Waitoa River has been weeded and snagged. It is a matter for regret that water-lilies are so prevalent in both rivers, and there seems no adequate way of getting rid of the weeds cheaply.

FLOOD-GATES.

The total number of flood-gates now in position is thirty-five, and of these twenty-one are of a more simple construction than formerly, and are fitted with iron doors. This change in design was brought about mainly by the difficulty experienced in building the large double gates in position, owing to bad formation of the river-banks. The new style of flood-gates are much more quickly placed in position and appear equally as satisfactory as the double flood-gates, and are much cheaper. Another factor to be considered was that after a lapse of time it would be possible to economically lower the various outlets, and then build reinforced-concrete flood-gates for permanency; the cost of discarded wooden gates would be nominal, as the timber lends itself to other purposes, while that from the double flood-gates does not do so to nearly the same extent. The existing "flappers" have been replaced by flood-gates, as the former proved too small. Great trouble has been experienced during the year in obtaining adequate supplies of totara timber for flood-gates.

WHARVES.

There are now seven wharves or jetties in position, but only four of these can be considered as being up to requirements, and the remaining three will require rebuilding. A supply of jarrah and tanekaha piles is now on the ground for purposes of building three new wharves in addition to those mentioned above. It will also be more economical to build a few light service stages at different points on the Piako River in preference to making roads.

SILL BRIDGES AND CULVERTS.

The total number of small sill bridges erected across road-drains to date is thirty, but a considerable number are still required. However, no inconvenience is being caused, as temporary crossings have been made as required. The total number of culverts in position is six.

TELEPHONE-LINES.

The fourteen miles of private line that was erected by this Department and referred to in my last annual report has been of the greatest use to all on the works, and under certain conditions settlers have been allowed to make use of the same in communicating with Thames.

BUILDINGS.

The total number of buildings of all descriptions is twenty-six, and they are all in occupation or used as stores, &c. The accommodation-hut erected at Pipiroa last year for first ballot was afterwards pulled down and the timber used to construct the foreman carpenter's cottage. Another accommodation-hut was built at "Bush Shanty" for last ballot, and is now being temporarily used by settlers. One hut has been fitted up at Tahuna as office and quarters for foreman. All buildings are in very fair order.

FLOATING PLANT.

The floating plant used in connection with the drainage and reclamation works consists of two Priestman dredges, one steamer, four oil-launches, two large pontoons, and sundry small punts. All are in good order and well equipped, and are in constant use. The steamer "Hauraki" brings stores and timber to the works from Auckland and Thames, &c., while the launches are always in commission.

ARTESIAN BORING PLANT.

The total number of artesian bores is nine, of which number five have been sunk on behalf of settlers. Arrangements have been made with settlers whereby actual cost only is charged, and the financial aspect has also been considered so as to allow settlers a little time to pay charges. In every instance water has been found when a bore has been sunk, so that its general presence is clearly demonstrated. The flows run from 4,000 gallons per day to 115,000 gallons per day.

As duly authorized, a boring plant was bought on behalf of the Department, and all work is now done by our own men. The cost per foot is less than charged by proprietors of similar plants, and varies from 1s. 7d. to 2s. per foot inclusive of piping and all other expenses. Schedules are attached giving particulars of some seven bores sunk during the past year.

Considerable diversity of opinion has existed as to the soda and iron nature of the water, but it has now been made very clear that, notwithstanding the mineral nature of the water, cattle take readily to same after the first day and appear very fond of it. The Hauraki Plains Settlement has no special monopoly of this mineral artesian water, as from inquiries made it is found in all artesian bores sunk as far south as Waihou. Established farms have had the same class of water for years past, and have carried out dairying operations with same. Very slight hopes can be held out of finding non-mineral water, as one bore has been sunk to a depth of 600 ft., and only mineral water obtained. In very many districts settlers are dependent on tanks for domestic water-supply, and this will apply to settlers on Hauraki Plains; as for stock, they can be provided for by artesian water. Experience has shown that all casing of black iron put down is useless, and that only galvanized casing is at all suitable. The black-iron tubes become perfectly honeycombed after six months or less.

WORKS PERFORMED

The following works have during the last year been executed by co-operative, piecework, and special contracts: Excavation Puhanga Canal, 28,760 cubic yards; snagging upper reaches Piako River, 1 mile 70 chains; combined drain and stop-banks, 3 miles 3 chains; raising stop-banks, 14 miles 70 chains; sinking artesian bore, 1; combined new drain and road-banks, 27 miles 63 chains; deepening drains, 13 miles 7 chains; combined deepening and widening of drains, 8 miles 46 chains;

fencing, 64½ chains; road-formation, 17 miles 49 chains; Waitoa outfalls, 1 mile 9 chains; clearing and grubbing roads, 5 miles 44 chains; cleaning drains, 7 miles 12 chains; clearing and widening streams, 54 chains; removing timber from drains, 1 mile 6 chains; staking steamer-channel in Piako River; and the supply of 1,000 poles for stop-bank fillings.

The following works were performed by day-labour: Fencing, 15 chains; raising stop-banks, 1 mile 74 chains; road-formation, 1 mile 54 chains; clearing roads and grubbing, 2 miles 75 chains; drain and road-bank formation, 3 miles 8 chains; township-roads formation, 20 chains; deepening drains and road-forming, 3 miles 66 chains; deepening and clearing drains, 4 miles 5 chains; cleaning drains, 1 mile; sinking artesian bores, 6; deepening and widening drains, 73 chains; widening drains only, 1 mile 75 chains; sowing 400 acres in grass; sowing stop-banks, 20 miles; moving spoil from banks, 1 mile 60 chains; dam, 1; rough service jetties, 2; rough service bridges, 2; poles for fillings, 500; snagging and weeding Waitoa River, 3 miles 65 chains; flood-gates erected, 23; wharves built, 3; buildings erected, 4; bridges built, 22; stop-bank fillings, about 40 chains; and dredging of canals, 110,353 cubic yards. Many other services too numerous to mention have been performed by day-labour. About 105 men are employed on day-labour works, and the cost of works done by them does not exceed that of similar work done by contract.

About 175 men are employed on the general-contract works. The total daily average number of men on all works during past year was 280.

GRASSING.

Some 400 acres of burnt swamp land was roughly sown in grass during past year, and the same has taken very well. The clovers have done particularly well. The grassing of stop-banks was not very successful, as the native growth seemed to choke out the Blue Kentucky sown; however, it is a slow-moving grass, and will probably show up better next spring.

CATTLE.

The stock purchased for purposes of demonstration to shew the suitability of the land for grazing were all sold after the conclusion of the first ballot of past year. Some 522 head of mixed cattle realized the net sum of £1,627 7s. 4d., showing a substantial profit upon the original purchase of same. The original number purchased was 550 head of mixed cattle, costing £1,167 5s. 3d. Some twenty-eight head died or were otherwise lost.

WATER.

Constant supplies of fresh water were conveyed to the various works commanded by the Piako River and Waitakaruru Stream, and no cases of fever occurred as the men were always supplied with good drinking-water.

FLAX-AREAS.

Some £38 16s. 10d. was derived from two flax-areas during past year, and no other areas have been dealt with, as the market is and has been dull. A good deal of flax was burnt during the summer, and the experimental plot at Waikaka was destroyed. Generally speaking, the losses are not more than might reasonably be expected with such a dry season.

FIRES.

With the exception of the flax burnt as above, no damage was done by fires, and settlers suffered no damage. A staff of men was kept employed busily for some weeks in fire-prevention.

SURVEYS.

Three survey parties have been actively engaged upon the surveys of lands for selection. Up to date some 22,109 acres 3 roods 2 poles have been surveyed into small farms, town and suburban sections, and reserves. The plans of above have also been completed. Surveys are now in progress in connection with further lands it is proposed to open. Some 7,843 acres of Crown awards and Native lands were also surveyed, and, in addition to above, engineering surveys were carried out by the staff.

VALUATIONS.

The valuations of lands surveyed for selection were duly completed, and work out at £108,065.

COST OF DRAINAGE-WORKS.

The total cost as estimated to end of financial year 1910–11 of all drainage and constructional works, &c., is £66,011, of which sum £32,103 has been expended during financial year 1910–11. This has been the heaviest year experienced, as most of the work undertaken was of a more substantial nature, on account of previous operations having dried the ground and made it possible to enlarge the scope of the works.

PRINCIPAL WORKS PROPOSED.

The principal works to be carried out during current financial year are as follows:—

- (1.) The completion of Waikaka Canal.
- (2.) The continuance of dredging operations on Waitakaruru-Maukoro Canal.
- (3.) The completion of Puhanga Canal overflow.
- (4.) The cutting of a canal from Waitoa River to Piako River near the junction.
- (5.) The transformation of existing road-banks into finished cart-roads.
- (6.) The general strengthening of stop-banks.
- (7.) The completion of wharves, flood-gates, bridges, &c.
- (8.) The continuance of snagging upper reaches of Piako and Waitoa Rivers.
- (9.) The completion of drainage, road-formation, and outfalls on the areas known as Waitoa Block and Waikaka respectively.
- (10.) And generally the improvement of existing works.

ACQUISITION OF NATIVE LANDS.

Proclamation plans covering some 1,027 acres 2 roods 31·6 perches have been prepared of areas immediately intersecting land disposed of. These Native areas are an impediment to the more successful drainage of the adjoining land, besides being detrimental to the interests of settlers who are anxious to fence and are mulcted in the whole cost of fencing Native boundaries. The intention to take the land has been gazetted. The attached plan shows in solid red colour the lands it is intended to take.

LAND PROPOSED TO BE OPENED.

Regarding land that will be available for selection during the current financial year, it is estimated that about 6,800 acres will probably be sufficiently drained for the purpose. Of this area some 2,000 acres is in the locality of Tahuna, and some 3,000 acres adjoins the Waitoa Estate, and some 1,800 acres (inclusive of proposed acquisitions) adjoins lands already disposed of. Every effort is being made to facilitate opening of same, and the survey of the Waitoa area is well advanced. Drainage operations are also in a forward stage, and all being well the areas will be available before next March. The offering of the above lands, and the areas of Native blocks it is intended to acquire, will to all intents and purposes see the more readily drainable swamp country disposed of, and a period must then expire before other lands are available.

OFFICE.

Both clerical and draughting staffs have been kept very busy during the past year. The drafting branch completed all the plans of Native land, proclamation, road, and other surveys. Three photolithographic tracings were also made in addition to engineering plans and general work.

The local imprest discharged liabilities of contracts, workmen's and survey parties' wages amounting to £25,114 12s. 6d. Some 887 vouchers were certified to for payment through local imprest and Treasury. The number of co-operative and general contracts dealt with was 129.

New quarters were obtained for the Department at Thames during the past year, and are very convenient.

GENERAL.

A glance at the attached plan shows that the scope of operations has very materially altered during the past year, and that every effort is being made to give effect to the Department's desire that all readily available land should be brought to profit as early as possible.

The confidence of yourself expressed as regards the ultimate success of the Hauraki Plains is fully justified at the present stage, and there is no doubt that substantial benefits will accrue to the surrounding district by the settlement of same. Already two large adjoining properties subdivided into small farms are on the market for disposal.

A progressive movement is now on foot amongst settlers to establish the dairy industry, and the use of home separators will probably be the form decided upon.

The staff has to a man taken more than ordinary interest in all operations of the past year, and my thanks are due to them for their loyalty and unremitting attention in all departments.

The accompanying plan shows in distinct colours, &c., the present state of operations, and the reference notes thereon clearly distinguish the various classes of drainage-works, lands disposed of, and future proposals in this connection.

I have, &c.,

J. B. THOMPSON,

Drainage Engineer.

The Under-Secretary for Lands, Wellington.

ARTESIAN BORE NO. 3 (WAITAKARURU).

Depth in Ft.		Depth in Ft.	
0 to 18	18 blue mud.	273	12 pumice sand.
38	20 white clay, shell.	276	3 mud.
54	16 dark clay with shell.	278	2 sand.
59	5 sand.	281	3 clay.
70	11 peaty.	307	26 pumice sand.
85	15 peaty swamp.	309	2 peaty swamp.
101	16 sandy mud.	313	4 clay.
107	6 peaty swamp.	325	12 pumice sand.
127	20 white clay and sand.	336	11 clay.
141	14 blue clay.	342	6 pumice sand.
166	25 sand.	346	4 pumice clay.
176	10 slatey mud.	348	2 peaty clay.
182	6 peaty sand.	352	4 sand.
202	20 sand.	372	20 rough sand.
205	3 rough sand.	382	10 pumice sand.
215	10 rough shingle.	395	13 blue mud.
221	6 sand.	397	2 sand.
231	10 white clay.	399	2 blue clay.
233	2 swamp.	409	10 blue clay.
234	1 sand.	421	12 sand.
244	10 white clay.	432	11 sand.
247	3 pumice sand.	434	2 clay.
261	14 clay and sand.	450	16 shingle.

Flow, 6,000 gallons per day.

ARTESIAN BORE NO. 4 (KOPUARAHI).

Depth in Ft. in.	Ft. in.		Depth in Ft. in.	Ft. in.	
0 to 29	11	29 11 shell and mud.	270	0	4 0 hard fine sand.
45	11	16 0 sand.	279	0	9 0 blue clay sand.
59	7	13 8 sand.	297	2	18 2 hard fine sand.
74	9	15 2 clay.	312	6	15 4 clay.
76	9	2 0 peaty swamp.	324	6	12 0 hard sand.
120	9	44 0 sandy pumice.	327	8	3 2 clay.
137	1	16 4 fine sand.	328	8	1 0 peaty swamp.
149	4	12 3 pumice sand.	337	8	9 0 sand.
152	4	3 0 blue clay.	353	8	16 0 clay.
182	7	30 3 pumice sand.	356	8	3 0 sand.
198	6	15 11 clay.	358	8	2 0 clay.
204	0	15 6 hard pumice sand.	388	8	30 0 sand.
219	0	15 2 grey clay.	391	8	3 0 clay.
221	2	2 0 blue clay.	428	8	37 0 sand.
250	5	29 3 blue clay and sand.	431	8	3 0 clay.
266	0	15 7 blue clay and sand.			

Flow, 115,200 gallons per day.

ARTESIAN BORE NO. 5 (FLYNN).

Depth in Ft.	Ft.		Depth in Ft.	Ft.	
0 to 123	123	clay and shell.	422	15	sand.
138	15	pumice and sand.	442	20	clay.
141	3	peat and rotten timber.	443	1	sand.
153	12	brown clay.	446	3	pumice mud.
155	2	peat.	451	5	sand.
171	16	sand.	453	2	clay.
296	125	sand.	456		sand.
298	2	peat.	462	6	clay.
299	1	pumice.	464	2	sand.
303	4	clay.	476	12	clay.
313	10	pumice.	483	7	sand.
319	6	peaty clay.	485	2	clay.
321	2	sand.	489	4	sand.
333	12	clay.	490	1	pumice mud.
335	2	sand.	492	2	sandstone bar.
365	30	clay.	503	11	sand.
366	1	sandy pumice.	518	15	sand.
376	10	clay.	533	15	clay with sand bars.
377	1	pumice.	548	15	sand.
385	8	clay.	560	12	clay mud.
391	6	sandy pumice.	570	10	sandy pumice.
401	10	clay.	579	9	clay with seams of sand.
403	2	sand.	590	11	sand.
407	4	clay.	614	24	blue clay.

Flow, 12,000 gallons per day.

ARTESIAN BORE NO. 6 (HIGGINS).

Depth in Ft. in.	Ft. in.		Depth in Ft. in.	Ft. in.	
0 to 58	3	58 3 clay and shell.	289	5	3 9 clay.
63	3	5 0 pumice sand.	304	9	15 4 clay.
91	4	28 1 clay.	320	9	16 0 pumice.
93	4	2 0 fine sand.	325	9	5 0 clay peat.
101	8	8 4 brown clay.	341	0	15 3 blue clay.
108	8	7 0 peaty timber.	350	0	9 0 blue clay.
123	6	14 10 blue clay.	356	7	6 7 sand.
138	8	15 2 blue clay.	364	7	8 0 clay.
147	8	9 0 sand.	368	7	4 0 hard bars sand.
153	6	5 10 clay.	370	7	2 0 clay.
168	2	14 8 sandy pumice.	385	7	15 0 clay and hard bars sand.
183	4	15 2 blue clay.	408	7	23 0 clay.
198	11	15 7 sandy pumice.	414	7	6 0 sand.
211	11	13 0 clay.	427	7	13 0 clay.
244	11	33 0 sand.	431	7	4 0 sand.
257	11	13 0 swamp peat.	440	7	9 0 clay.
259	11	2 0 shingle sand.	450	7	10 0 sandy clay.
274	8	14 9 sandy clay.	456	5	5 10 peaty clay.
285	8	11 0 sandy clay.	458	5	2 0 sand.

Flow, 4,000 gallons per day.

ARTESIAN BORE NO. 7 (LINDSAY).

Depth in			Depth in		
Ft. in.		Ft. in.	Ft. in.		Ft. in.
0 to	78 6	78 6 clay and shell.	157 8	4 0	sand.
	88 6	10 0 brown clay.	235 1	77 5	clay.
	90 0	1 6 sand.	249 10	14 9	sand.
	93 0	3 0 clay.	250 10	1 0	peat.
	94 0	1 0 peaty clay.	260 10	10 0	pumice sand.
	96 3	2 3 sand.	262 10	2 0	clay.
123 8	27 5	brown clay.	265 10	3 0	sand.
129 8	6 0	sand.	275 10	10 0	peaty clay.
138 8	9 0	peaty clay.	297 7	21 9	sandy clay.
145 8	7 0	white clay.	299 1	1 6	hard sand.
151 8	6 0	pumice sand.	302 1	3 0	sandy clay.
153 8	2 0	brown clay.			

Flow, 5,000 gallons per day.

ARTESIAN BORE NO. 8 (GRUNDY).

Depth in			Depth in		
Ft. in.		Ft. in.	Ft. in.		Ft. in.
0 to	63 3	63 3 blue clay and shell.	163 0	4 0	sand.
	64 3	1 0 peaty swamp.	168 0	5 0	peat.
	74 3	10 0 clay.	170 0	2 0	sand.
	76 3	2 0 sand.	182 0	12 0	peaty swamp.
	89 3	13 0 clay.	186 0	4 0	sand.
	92 3	3 0 peaty swamp.	193 0	7 0	peaty swamp.
	93 3	1 0 sand.	215 4	22 4	pumice sand.
110 6	17 3	clay.	216 4	1 0	peaty swamp.
116 6	6 0	sandy clay.	221 4	5 0	sand.
124 6	8 0	clay.	236 4	15 0	peaty clay.
130 6	6 0	peat.	248 4	12 0	sand.
140 6	10 0	sand.	251 4	3 0	clay.
142 0	1 6	hard sand bars.	272 4	21 0	sand.
152 0	10 0	sandy clay.	275 4	3 0	peat.
155 0	3 0	peaty swamp.	290 4	15 0	sand clay seams.
156 0	1 0	sand.	300 4	10 0	clay.
159 0	3 0	peat.			

Flow, 8,640 gallons per day.

ARTESIAN BORE NO. 9 (PEAT).

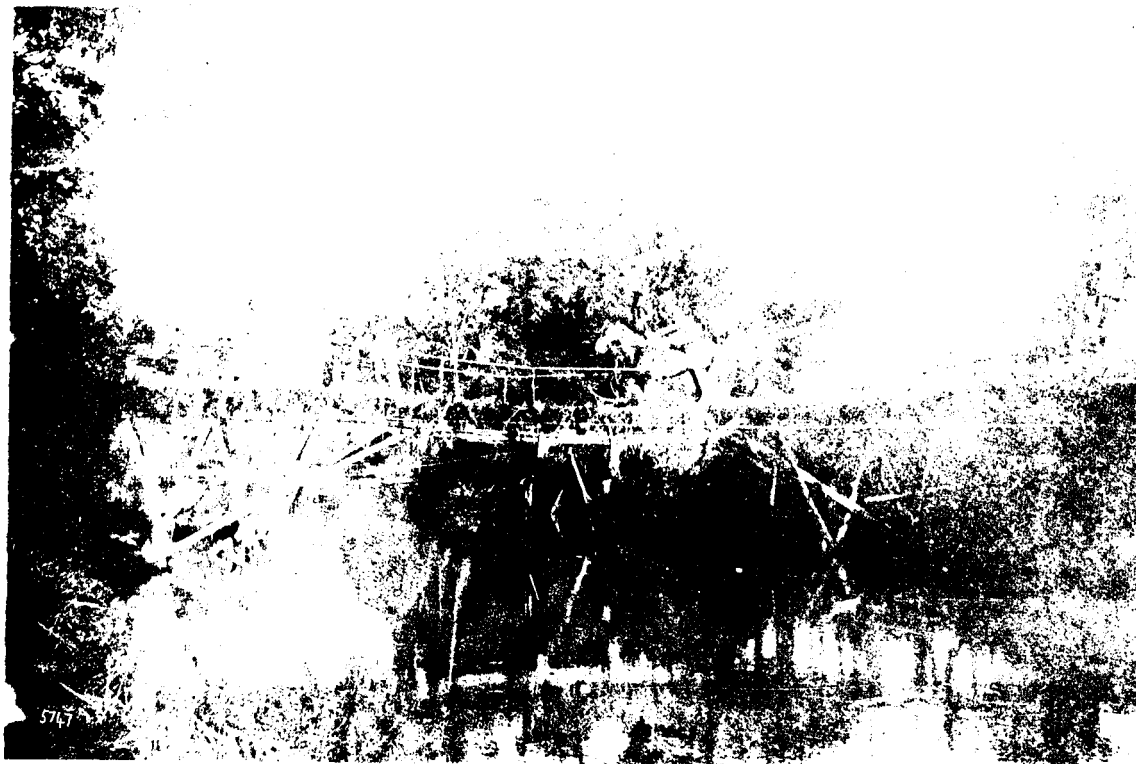
Depth in			Depth in		
Ft. in.		Ft. in.	Ft. in.		Ft. in.
0 to	63 5	63 5 blue clay and shell bars.	205 3	8 0	sand.
	69 5	6 0 peat swamp.	208 3	3 0	clay.
	82 5	13 0 clay.	218 3	10 0	sand.
	94 5	12 0 sand.	221 3	3 0	clay.
	95 5	1 0 peaty swamp.	223 3	2 0	sand.
	96 11	1 6 logs.	249 3	26 0	clay.
	98 11	2 0 sand.	252 3	3 0	sand.
107 11	9 0	peat.	263 3	11 0	clay.
110 11	3 0	clay.	275 9	12 6	sand.
120 11	10 0	pumice sand.	285 9	10 0	clay.
129 11	9 0	clay.	309 9	24 0	sand.
136 11	7 0	sand.	327 11	18 2	sandy clay.
142 11	6 0	peaty clay.	330 11	3 0	clay.
151 11	9 0	sand.	333 11	3 0	sand.
165 11	14 0	peaty clay.	335 11	2 0	clay.
187 3	22 4	sandy pumice.	338 11	3 0	sand.
195 3	8 0	sand.	349 11	11 0	peaty clay.
197 3	2 0	clay.	387 6	37 7	sand.

Flow, 11,520 gallons per day.

Approximate cost of paper.—Preparation not given; printing (1,600 copies, including map and illustrations), £36 10s.

By Authority: JOHN MACKAY, Government Printer, Wellington.—1911.

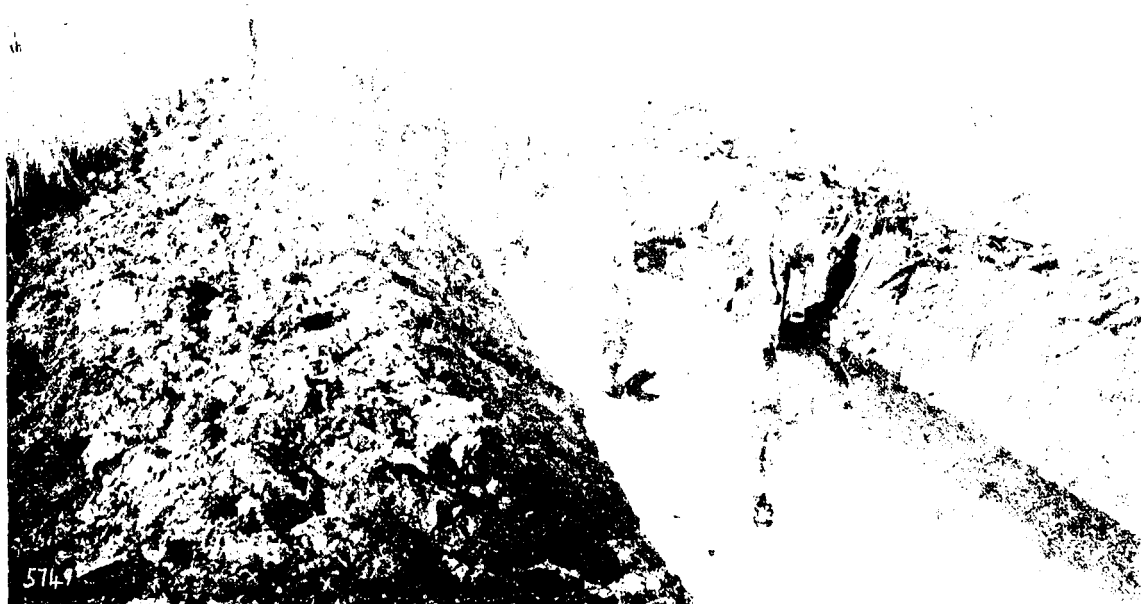
Price 9d.]



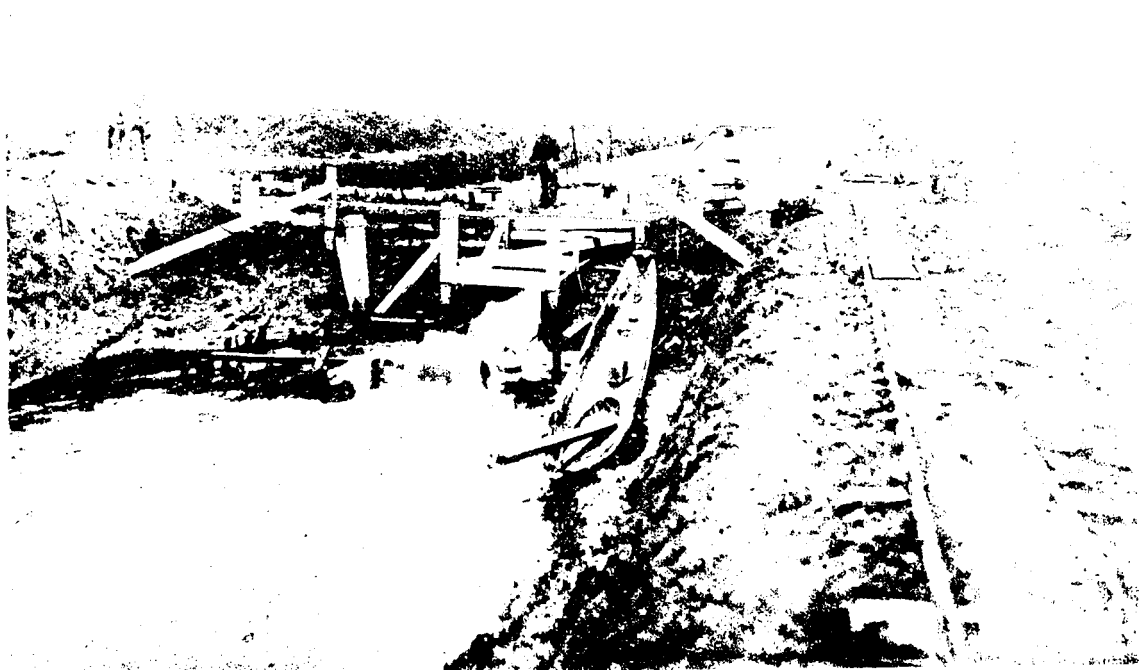
SERVICE BRIDGE, UPPER PIAGO RIVER



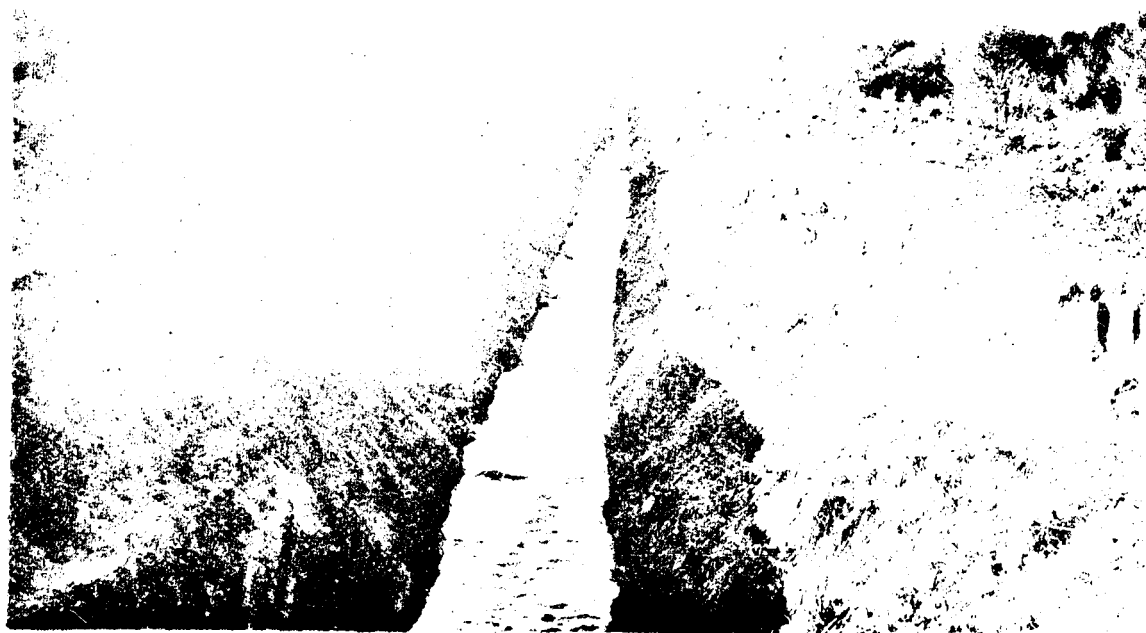
OUTFALL DRAIN TO PIAGO RIVER



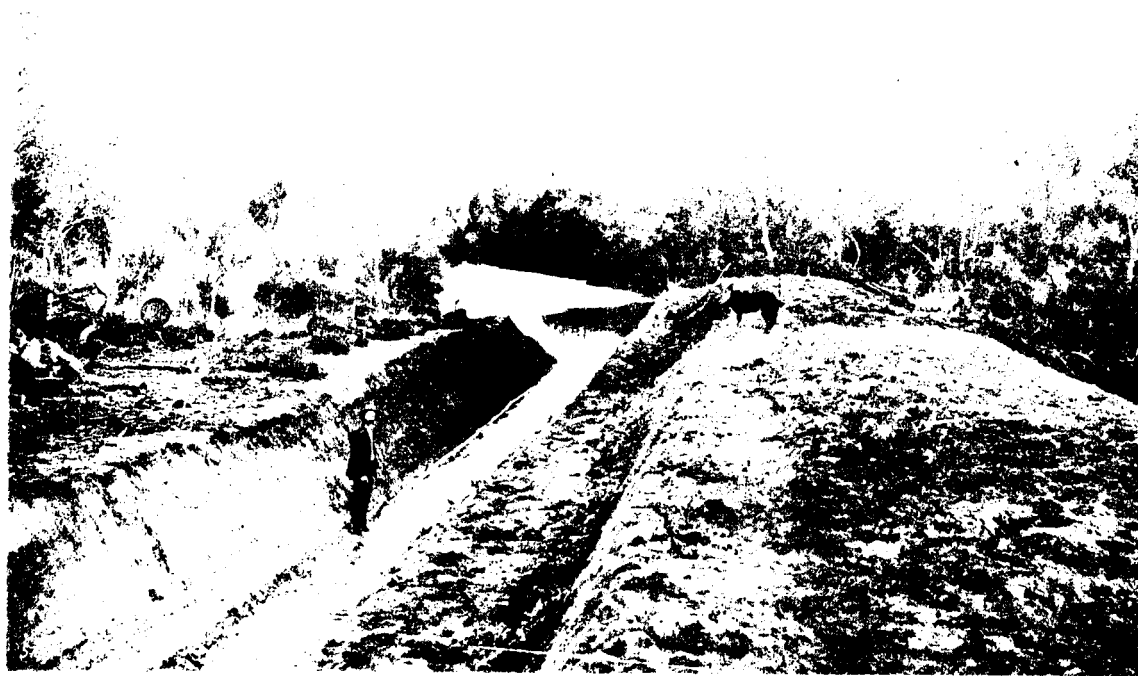
DEATH VALLEY, CALIFORNIA



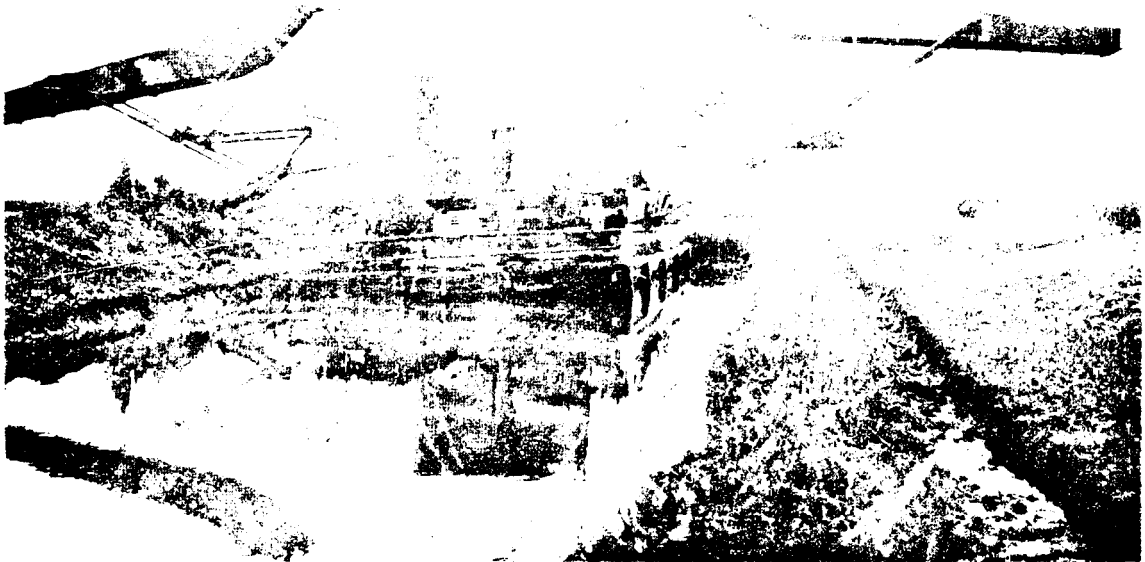
DEATH VALLEY, CALIFORNIA



WHAKAPOHO DRAIN.



NO. 7. OUTFALL TO PIKO RIVER.



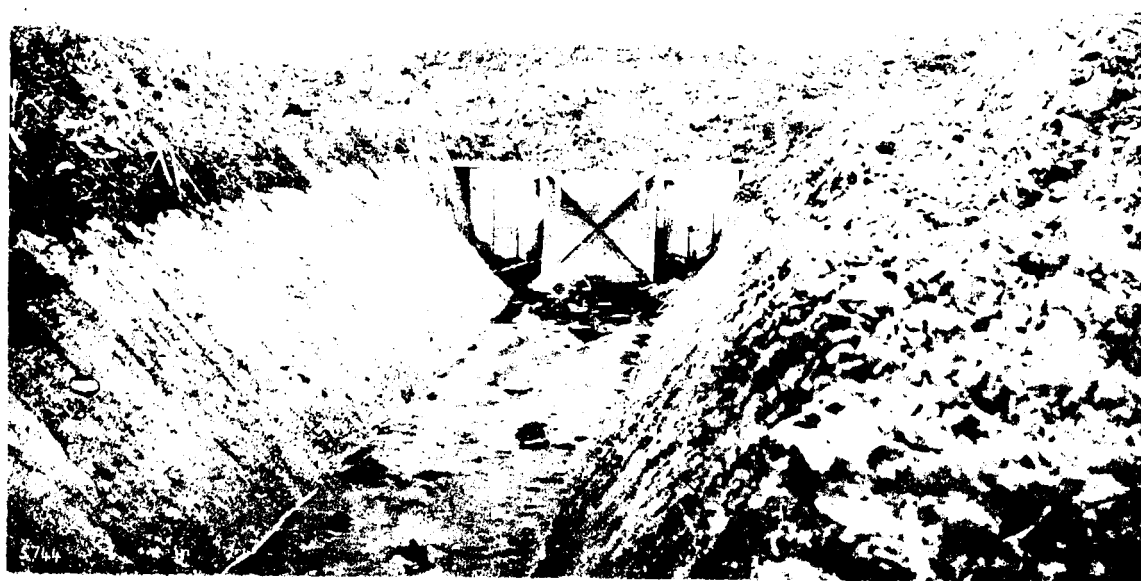
NO. 2 DREDGE CUTTING WAIKARA CANAL.



"SNAGGING PLANT," WATIDA RIVER.



STOP-BANK UNDER CONSTRUCTION.



SINGLE-DOOR FLOOD-GATE.



Kom. V. and K. on the Pass



S. on a Climb, Pass, P. on the Climb

