

Harnessing The Waihopai



Issued by
THE MARLBOROUGH ELECTRIC POWER BOARD
To commemorate the Official Switching on of Power,
AUGUST 6th, 1927.

FOREWORD.

August the 6th was regarded as a red-letter day in the history of Marlborough, for it marked the completion of the first section of the provincial hydro-electrical scheme, and the switching on of power and lighting current in Blenheim and the surrounding districts, known, for convenience's sake, as "The Delta" area.

Reticulation is proceeding apace in other parts of the province, and it is anticipated that within a few months electricity will be available in all parts of Marlborough, from Ward in the south to Rai Valley, at the opposite end of the province.

The harnessing of the Waihopai River, at a point about 25 miles from Blenheim, and the erection of transmission and reticulation lines, is expected to involve an expenditure of something in the neighborhood of £275,000, which sum has been borrowed by the Marlborough Electric Power Board. To meet interest and sinking fund charges on this loan, and to pay running expenses and allow for depreciation, an annual revenue of about £35,000 will be required.

The scheme will develop more than sufficient power for the requirements of the province for some years to come, and is capable of extension as the demand for power grows. In a word, there is power, and to spare, and all that is required to make the Waihopai scheme a financial success is that the people should make use of it.

£35,000 per annum has to be found, and it rests with the ratepayers as to whether they will use £35,000 worth and secure all the benefits of electricity, or whether they will find the money by way of rates.

It has been found that after two or three years almost every electrical undertaking in New Zealand has paid its way; but the Marlborough Electric Power Board confidently anticipates that the Waihopai scheme will pay from the start, being assured, as it is, of the active co-operation of the ratepayers.

IN these days of its wide application, there is hardly any need to extol the virtues of electricity in the service of man. It is an established fact that no energy yet discovered is of more universal use; wherever men and women toil there will be found a use for this power, be it in the home, the farm, or the factory. In a word, it is the universal servant of mankind.

CO-OPERATION.

The Marlborough Electric Power Board is not a private company established to make all the profits it can out of consumers; but it is a co-operative undertaking, in which every ratepayer in the district is a shareholder. The Board has been elected on a wide franchise by the ratepayers, and is in existence for the good of every inhabitant in the district. The Board has only to pay its way, and therefore is in a position to distribute electricity without looking for a profit. In the course of a few years profits will accrue, but these will be

handed back to the consumers, in one way or another—either by increasing facilities, or by reducing the rates charged for the current. The more consumers there are, the cheaper can current be supplied; but it requires the whole-hearted co-operation of all to bring about the desired end.

Experience in other districts has shown that the ratepayers are sometimes slow to grasp the opportunities offered to them, and are prone to overlook their share of responsibility in the Boards' undertakings. It has generally been found that for the first two or three years there are great financial difficulties to be faced, due to the delay in securing sufficient consumers to place the schemes on a payable footing, and, in order to overcome this as far as possible, the Marlborough Power Board, ever since the inception of the Waihopai scheme, has employed canvassing contractors, who have covered the district in an endeavor to enrol sufficient consumers to make the scheme payable from the start. With the same object, the Board has arranged a system under which it pays the initial cost of wiring-up

would-be consumers' premises, the consumers repaying the Board by instalments spread over an extended period. The canvassers have met with a fair measure of success in their efforts, and the Board's scheme of finance for consumers has been fairly freely availed of, so that there are already over a thousand consumers all ready to-day to use electricity from the instant it is made available.

But, satisfactory though this may seem at first glance, the Board is still a long way short of the number of consumers requisite to place the scheme on an immediately payable basis. A revenue of something over £35,000 a year has to be earned to make Waihopai pay, and at least 2000 consumers will have to be linked up before this objective can be attained. The Board, therefore, urges on the ratepayers the necessity for their active co-operation, and desires to impress upon them that it is their co-operative scheme, and that it is in their direct interest to help it to pay its way. The ratepayers can co-operate with the Board by using electricity themselves and by urging others to do likewise. There is plenty of current available for the whole of the province; but, in the early stages of the scheme, considerably more than half of it will be going to waste. In other words, it would cost the Board no more to produce the 1000 k.w. of which Waihopai is capable in its present stage of development than to produce the comparatively small amount of electricity which will be required from to-day.

THE PROBABLE REVENUE.

The probable revenue which the Board will obtain from the sale of current has been carefully investigated by means of an actual survey of the whole district, wherein every farm has been located and placed on a map, and every house and factory counted and considered. It was ascertained that there were some

3000 houses in the district, to say nothing of numerous factories and workshops where power will be required; and also disregarding the use of electricity for milking machines, shearing machines, etc. There is quite obviously a good market for the sale of the electrical energy produced, and the Board is asking for the active co-operation of each and every ratepayer, it being quite clear that that is all that is required to make the scheme a financial success.

RETICULATION POLICY.

The first areas to be connected up with the scheme are the Borough of Blenheim and the districts lying between Blenheim and the source of supply at Benopai, and these areas, being closely settled, are expected to bring in profits almost at once. A transmission line is now being run to the Awatere districts, and in due course the Pelorus Valley, the Wairau Valley, the Pieton Road district, and all other parts of the province within the scope of the scheme will be linked up. If in any district it is found that the prospective demand for current is not sufficient to warrant running a line, the districts will not be reticulated until such time as the Board is satisfied that the line can be made to pay, and in some cases—notably in the Awatere—the Board has required guarantees from groups of settlers that they will use sufficient energy to make the reticulation of their areas a payable proposition. There is authority, under the Electric Power Boards Act, for the Board to levy a rate on those non-consumers who may have the opportunity of using electricity, but will not avail themselves of it. However, it is not thought that it will be necessary to exercise this authority in Marlborough, as all the indications are that once electricity is switched on in the various districts, farmers and others will be only too willing to take advantage of it.

The Marlborough Electric Power Board.

PERSONNEL.

Chairman : R. F. GOULTER.

Representing Blenheim Borough : W. CARR and E. S. PARKER.

Representing Marlborough County : R. F. GOULTER, C. NEES, H. J. STACE, and
W. G. RUDD.

Representing Awatere County : F. LISSAMAN and J. MERRIFIELD.

Secretary : E. J. HARVEY.

Engineers to Board : VICKERMAN & LANCASTER, Wellington.

Resident Engineer, Blenheim : G. F. MacLEAN.

Assistant Resident Engineer : T. H. RANGER.

Station Engineer : H. LANGDON.

Assistant Station Engineer : K. MARTIN.

Solicitors : BURDEN, CHURCHWARD & REID, Blenheim.

Bankers : THE NATIONAL BANK OF NEW ZEALAND.



THE MARLBOROUGH ELECTRIC POWER BOARD. A Group of Past and Present Members.

Back Row: E. S. Parker, A. J. Murray (ex-member), W. J. Girling, M.P. (ex-member), W. Carr, E. J. Harvey (Secretary).

Front Row: Messrs F. Lissaman, C. Nees, R. F. Goulter (Chairman), H. J. Stace, W. G. Rudd, J. Merrifield.

Inset: E. A. We'd (ex-member).



GROUP TAKEN AT THE HEADWORKS DURING THEIR EXCELLENCIES' VISIT.

Harnessing the Waihopai.

Description of the Installation.

History of the Board's Operations.

Two Years Occupied in Construction.

SOMETHING in the nature of a record has been established in the introduction of hydro-electricity to Marlborough, for the first of the loan money required for the Waihopai scheme was not received until June 4, 1925, and actual work was not commenced until the following month, so that the headworks have been completed, and the principal part of the district reticulated, in a period of just two years.

A movement in the direction of forming a Power Board for Marlborough was made about 1920, when petitions with that object in view were circulated, but it subsequently transpired that there had been a misunderstanding in regard to witnessing some of the signatures in certain parts of the district, and this resulted in a long delay. In the end, certain of the petitions had to be again circulated for re-signature. They were finally completed about the middle of 1923 and were presented to the Government.

As a result, the district was constituted a Power Board District, by the following proclamation in the Gazette, dated October 25, 1923:—

Constituting the Marlborough Electric-Power District.

[L.S.] JELlicoe, Governor-General.

A PROCLAMATION.

In pursuance and exercise of the powers conferred by section three of the Electric-Power Boards Act, 1918, I, John Rishworth, Viscount Jellicoe, Governor-General of the Dominion of New Zealand, do hereby proclaim the district as described in the Schedule hereto to be an electric-power district, and I hereby assign to such district the name of the "Marlborough Electric-power District."

SCHEDULE.

All that area in the Marlborough Land District, comprising the Borough of Blenheim and the Counties of Awatere and Marlborough, all as at present constituted. As the said area is more particularly delineated on the plan marked P.W.D. 57794, deposited in the office of the Minister of Public Works at Wellington, in the Wellington Land District, and thereon bordered red.

Given under the hand of His Excellency the Governor-General of the Dominion of New Zealand; and issued under the seal of that Dominion, this 24th day of October, 1923.

J. G. COATES, Minister of Public Works.

God Save the King!

The election of the Board was held on November 24, 1923, when the following gentlemen were returned:—

Blenheim Borough: Messrs. William Carr and William James Girling, M.P.

Marlborough County: Messrs. Redwood Felix Goulter, Frederick William Charles Nees, William George Rudd, and Henry Joseph Stace.

Awatere County: Messrs. Everard Aloysius Weld and Arthur John Murray.

The Board's first meeting was held on December 11, 1923, when Mr. Goulter was elected as chairman. Mr. P. S. Boyes, who had acted as provisional secretary up to this stage, had notified the Board that he would be unable to continue the duties, and the Board decided to appoint Mr. E. J. Harvey as secretary. It was also decided to call for applications for an engineer to undertake preliminary surveys of the sources of electric power available in the district.

At the following meeting, on January 22, 1924, Messrs. Vickerman & Lancaster, of Wellington, were appointed as engineers and were commissioned to report on the various sources of electrical energy. Their report was received and considered by the Board at a meeting held on April 14, 1924, when they reported that they had considered the possibilities of supply by water power from the Pelorus River, Wakamarina River, the difference in tidal conditions between Queen Charlotte and Pelorus Sounds, the Wairau, Clarence, and Waihopai rivers, as well as generation by steam or oil; and, after going into the merits and demerits of the various localities named, they proceeded to recommend the harnessing of the Waihopai, at an estimated cost of £275,000, plus £25,000 to be borrowed for the purpose of assisting would-be consumers in wiring their premises.

Having, in the meantime, secured a report upon a proposal that Kaikoura should be included in the power district, the Board, at a meeting on June 25, 1924, adopted the engineers' recommendation and decided to place the Waihopai scheme before the ratepayers in the

form of a loan proposal. After the scheme had been formally approved by the Public Works Department, the Board placed the issue before the ratepayers in a series of memorable meetings held in various parts of the district between October 1 and October 10, 1924. Considerable opposition to the proposal to borrow such a large sum as £300,000 was in evidence, but the opposition turned out to be but a noisy minority, for the loan proposal was carried, on October 11, 1924, by a majority of 1334 votes to 300. There had also been opposition to the Waihopai scheme in the Awatere district, where the Clarence scheme was advocated; but a large part of this opposition vanished in the face of the explanation that the district would be unable to use the large amount of power available at the Clarence, and that, therefore, the development of this source of energy would be economically unsound.

Once the loan was carried, all difference of local opinion vanished, and the Board has since enjoyed the loyal co-operation of the whole province in carrying out the work.

At a meeting held on November 19, 1924, the Board appointed Messrs. Vickerman & Lancaster as engineers to prepare detailed plans for the development of the Waihopai scheme, and negotiations for the raising of the necessary £300,000 loan were also commenced. Finally a loan of the required amount was secured from the A.M.P. Society at $5\frac{1}{2}$ per cent. interest, plus 1 per cent. sinking fund, for a period of $36\frac{1}{2}$ years. It was arranged that £100,000 should be paid to the Board immediately on completion of the necessary securities, and £10,000 per month thereafter until the whole of the £300,000 had been received. The first instalment of the money (£100,000) came to hand on June 4, 1925, and the Board let its first contract on June 29, 1925, work being actually commenced in the following month.

The original members of the Board retained office until April, 1925, when Mr. Girling retired, his place being taken by Mr. E. S. Parker. In May, 1926, Messrs. Weld and Murray, the Awatere representatives, retired, Messrs. J. Merrifield and F. Lissaman being elected in their stead. The present membership of the Board is therefore as follows:—

Blenheim Borough: Messrs. William Carr and E. S. Parker.

Marlborough County: Messrs. R. F. Goulter, F. W. C. Nees, W. G. Rudd, and H. J. Stace.

Awatere County: Messrs. F. Lissaman and J. Merrifield.

Mr. Goulter has been Chairman since the Board's inception.

During the early part of the construction work, Mr. H. Langdon, of Messrs. Vickerman & Lancaster's staff, acted as resident engineer in Blenheim, but, after a few months, he was placed in charge of the construction work at Benopai, and Mr. Geo. F. MacLean was appointed resident engineer in Blenheim. He was recently, in view of the approaching completion of the scheme, appointed engineer to the Board, Mr. Langdon being appointed station engineer in charge of the headworks. Mr. T. H. Ranger has been appointed assistant to Mr. MacLean, and Mr. K. R. Martin as assistant to Mr. Langdon. Messrs. L. F. Row and H. H. Crabb are associated with the engineers as surveyors and draughtsmen.

Mr. W. K. Inder was appointed in May, 1926, as foreman in charge of pole and line erection, while Mr. H. M. Clark has acted as clerk of works at the headworks since May, 1926. Mr. E. Evans is foreman in charge of the concrete pole-making works at Renwick, and Mr. E. Eves is in charge of the Seddon pole works. Mr. W. R. Richardson has undertaken the duties of inspector of wiring installations.

SELECTION OF SOURCE OF POWER.

As mentioned above, all suitable sources of power in the district were investigated and carefully considered before a decision was reached by the Board to adopt the Waihopai, and you saw notwithstanding that the Waihopai was not unanimous, on account of the comparatively limited amount of power available there as compared with the Clarence. However, a review of the financial side of the two proposals, and of the power likely to be required for the first ten years of the Board's existence, showed that the power capable of generation would be sufficient and that, on account of the relative cheapness of the Waihopai development, especially for small blocks of power, the reduced overheads with that scheme when compared with those involved by the Clarence would effect an annual saving sufficient in ten years to wipe off the whole cost of the headworks at Waihopai. As the installation there would always, even though the Clarence might ultimately be required, remain a serviceable and valuable power supply unit, this decided the case, and a decision was made to go forward. The amount of power capable of being generated at Waihopai is, with 50 per cent. load factor and minimum river flow (110 cusecs), some 1910 h.p., thus admitting of installing a third 500 k.w. unit, and of, under average river flow, eventually developing in the neighborhood of 3000 h.p. there.

THE HEADWORKS.

The site chosen on the Waihopai was the gorge at Benopai, some 25 miles out of Blenheim. This spot had for many years been regarded as being favorable for a hydro-electric development for the province, owing to the comparative narrowness and height of the gorge and the apparently good rock foundations there available. After considering numerous alternatives, it was finally decided to build an arched concrete dam in the narrowest part of the gorge to raise and impound the water and to carry it thence by tunnel and pipe to the machinery to be erected in the power house, at a site some 19 chains downstream, the head thus rendered available after construction of the dam being 100 feet.

The first works to be undertaken were construction of a diversion tunnel, quarters for staff employees, branch road, and bridge across the Waihopai to give access to the power house site. The diversion tunnel, 9 feet x 7 feet and 300 feet long, was contracted for and completed by Mr. C. Anderson, of Blenheim, but not before meeting with great difficulties on account of very frequent floods in the river. The construction of a number of workers' huts was undertaken by Messrs Cresswell and White, and of a staff cottage by Messrs Ward, Tylor, & Co., Ltd., who also built the bridge across the Waihopai, using therein for the main beams stringy bark gum trees grown near by. A second staff cottage was later built by Mr. D. M. Wemyss. The access road was contracted for by Mr. D. Horgan, who,

unfortunately, died before its full completion, the work being finished by his trustees.

The major portion of the headworks, comprising the dam, intake, supply tunnel, surge tank, and road diversion required round the lake, were included in one contract, and let to Mr. W. Williamson, of Christchurch, who subsequently took contracts for the concrete supports required for the pipe line, and also for the erection of the power house building.

THE DAM.

The dam is a reinforced concrete structure of the arched type, of 90 feet radius, the top standing 120 feet above the bottom of the foundation and 107 feet above the old river bottom. The thickness at the base is 14 feet, and this gradually reduces till at a point 35 feet from the top it is 4 feet, this thickness continuing to the top. Naturally, the structure looked very slender whilst being erected, but it has already been severely tested by floods, and no fears need be entertained as to its stability. The dam is designed to divert surplus water over by-washes provided on each side at a level of 15 feet below the top of the dam, and, owing to the nature of the country on the right bank, it has proved necessary to construct a massive concrete wall there to confine the water to an area having a good rock foundation.

The intake is a reinforced concrete chamber attached

to the dam, and furnished along one side with four 6 feet x 4 feet gate openings situated some 20 feet below the by-wash level.

On the other side of the chamber is the entrance to the supply tunnel, which delivers the water through a spur to the surge chamber. This tunnel is 6ft. 6in. wide by 6ft. 6in. high and some 460 feet long, and is lined throughout with concrete of thickness varying from 3 inches to 12 inches.

The surge chamber links the tunnel to the pipe line and is a circular reinforced concrete structure, 45 feet high and 33 feet in diameter. It is provided with two openings, one for attaching the steel pipe now installed, and the other available for fitting a second pipe when the growth of the load makes this a necessity.

The pipe openings are each controlled by a pair of 6ft. x 4ft. gates operated by gear placed on the top of the tank. The pipe line which carries the water from the surge tank to the power house, where the turbines are located, was supplied and erected by the Dunedin Engineering Company. It is wholly of steel, the diameter being 5ft. 3in. and the length 316 feet, the support being provided by reinforced concrete pedestals.

The power-house building is also of reinforced concrete, and is 43ft. 6in. long by 25 feet wide, the roof top being about 60 feet above river level. It has two floors, one for the turbines 8 feet above ordinary water level, and the second for the generators and



Mr. G. F. MacLEAN, A.A.I.E.E., Resident Engineer,
Marlborough Power Board.



Mr. W. WILLIAMSON, of Christchurch,
Contractor for the Headworks.

switchgear, 25 feet higher, this arrangement being necessary to keep them well above flood level. Portion of the floor space is allocated for office and telephone equipment, and adjacent to this is a space for carrying out minor repairs. Overhead, and running the full length of the building, is a Morris 5-ton traversing crane, supplied by Messrs. A. D. Riley & Co.

70 ACRES INUNDATED.

One result of the building of the dam is to create a lake of about 70 acres in extent, and, in order to beautify this, and at the same time provide the Board with poles and other necessary timber, the surrounding country has been acquired and is being planted with suitable trees.

In the construction of the headworks, but not including the road works, it has been necessary to excavate some 24,000 tons of earth and rock, and mix and place some 12,000 tons of reinforced concrete, requiring some 1600 tons of cement and 120 tons of steel.

So far as materials and plant are concerned, it has been the aim of the Board to utilise New Zealand and British products to the fullest extent.

The power plant consists of two vertical shaft Gordon turbines, of the Francis type, with spiral casing (supplied by Messrs. John Chambers & Son), each driving a 500 k.w. 6600 volt generator, supplied by the British General Electric Company, Britain. The generators are raised some 22 feet above the turbines, so as to be protected from floods, the river in the neighborhood of the power house being in a narrow gorge and subject to a rise in level of some 25 feet during periods of high flood.

The switchgear is of the latest totally-enclosed armored type, supplied by Messrs. Reyrolle, Ltd., Britain, and is designed to give the utmost safety and reliability in the operation of the power units, and to control the supply to the transformer station, and to the local country feeder.

In designing the plant, provision has been made to shut down the generating sets automatically should any of the usual contingencies arise, such as the heating of bearings, shortage of water, over-speed or under-speed, or any electrical fault. The station will, therefore, be capable of running without continuous attendance, and will be the largest power station in New Zealand to be so arranged.

Special arrangements have been made to provide for the testing of the machinery and protective devices at any time without in any way affecting the supply to the Board's area. The station is arranged so as to be readily extended and a third or fourth unit installed, should such be warranted by the increase in load.

TRANSFORMER STATION.

The transformer station, which is of the outdoor type, is erected immediately above the power house, and has a capacity of from 1200 to 1500 k.w., with a stand-by transformer unit, and is used to step up the voltage from 6600 to 33,000 volts for transmission to Renwicktown, Blenheim, Seddon, and, at a later date, to Havelock and Pieton. The transformers are of Ferranti make, supplied by Messrs. A. D. Riley & Co., Ltd., and the switchgear and lightning and other protective apparatus of G.E. make, supplied by the National

Electrical and Engineering Co., Ltd.

The transformer station, as well as the sub-stations at Renwicktown, Blenheim, and Seddon, is built of steel designed and fabricated in New Zealand. Provision is made in all cases for increasing the capacity of the station.

The main transmission line, from Waihopai to Blenheim, has a length of 23 miles, and is constructed for operation at 33,000 volts. The cable consists of steel-cored aluminium, supplied by the Northern Aluminium Company, Canada, through Messrs. Richardson, McCabe, & Co., and is carried on Ohio brass insulators, supplied by Messrs. Carrick, Wedderspoon, & Co. Ltd. The transmission line to Blenheim is carried on galvanised steel towers, supplied by the Canadian Bridge Company, Canada, through Messrs. Dansey & Company, Auckland, and is capable of transmitting some 4000 horse-power.

At the Renwicktown sub-station provision is made for the future extension of the transmission system, at 33,000 volts, to Havelock. From Blenheim the 33,000 volts transmission line continues on 40-foot concrete poles, to a switching tower erected on Vickerman Road, at which point the line will branch northwards to Pieton, and also to Seddon in the South.

The Seddon line is to be erected principally on 40-foot concrete poles, with 101-foot steel towers at the crossing over the Opawa River, to allow for navigation of same. The hilly section over the Redwood Pass will also be traversed on steel towers, to avoid the difficulties in transport and erection of concrete poles on the steep hillsides.

The transmission line wires to Seddon will consist of No. 6 Copperweld, a conductor with a copper skin welded to a steel core; and the line is designed to carry a heavier conductor should it be required in the future owing to the extensive growth of load in the Awatere District and beyond.

SUB-STATIONS.

At Renwicktown the principal country sub-station is located of a capacity of 375 k.w., with a stand-by provision. The transformers, which were supplied by Messrs. A. D. Riley & Co., here break down the voltage to 11,000 volts for the supply of the reticulation system to Havelock, Mahakipawa, and Tua Marina.

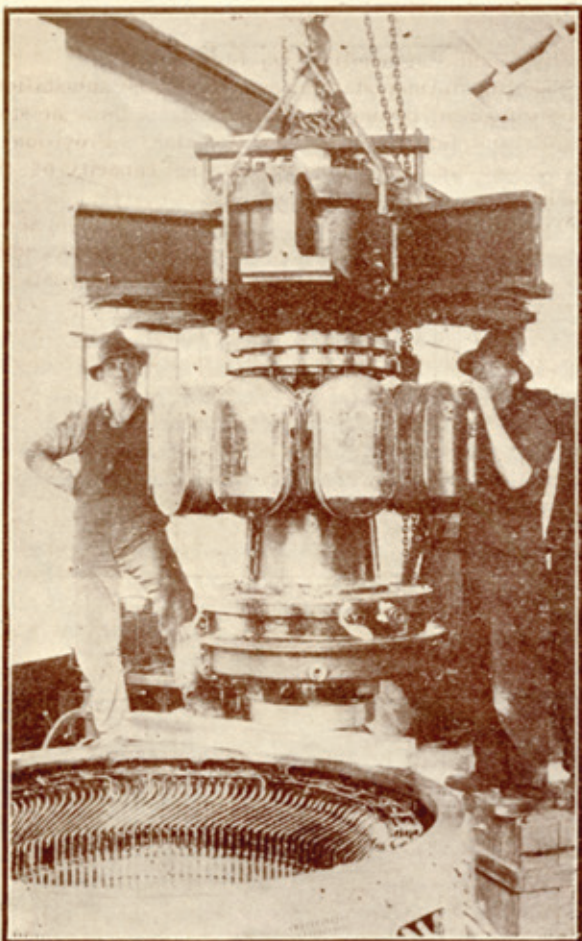
At Blenheim the principal city sub-station is located, of a capacity of 750 k.w., with a stand-by provision.

The 33,000-v. apparatus in the case of both sub-stations is of G.E. make, supplied by the National Electrical and Engineering Company, Ltd., and the 11,000 or 6600 volt switchgear of Ferguson & Pailin make, supplied by Messrs. A. D. Riley & Co.

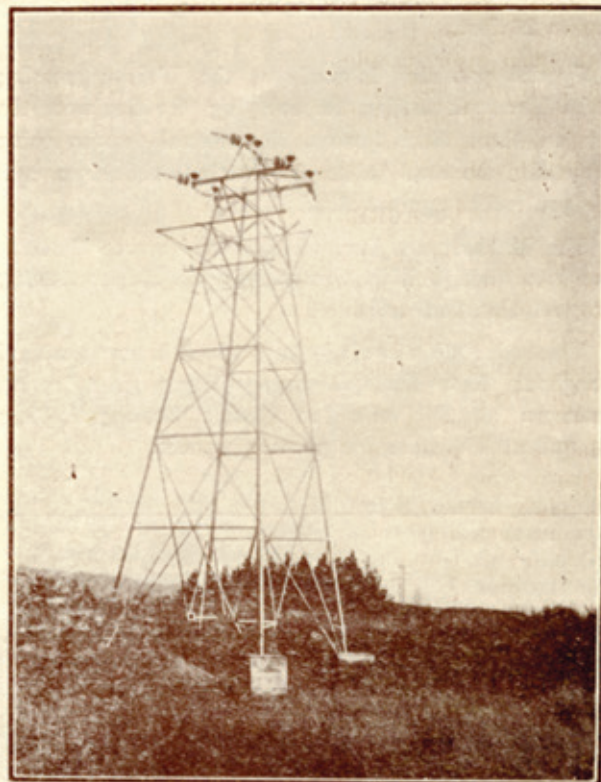
The sub-station at Seddon will be a duplicate of that at Renwicktown, and will have provision for a load of 375 k.w.

RETICULATION.

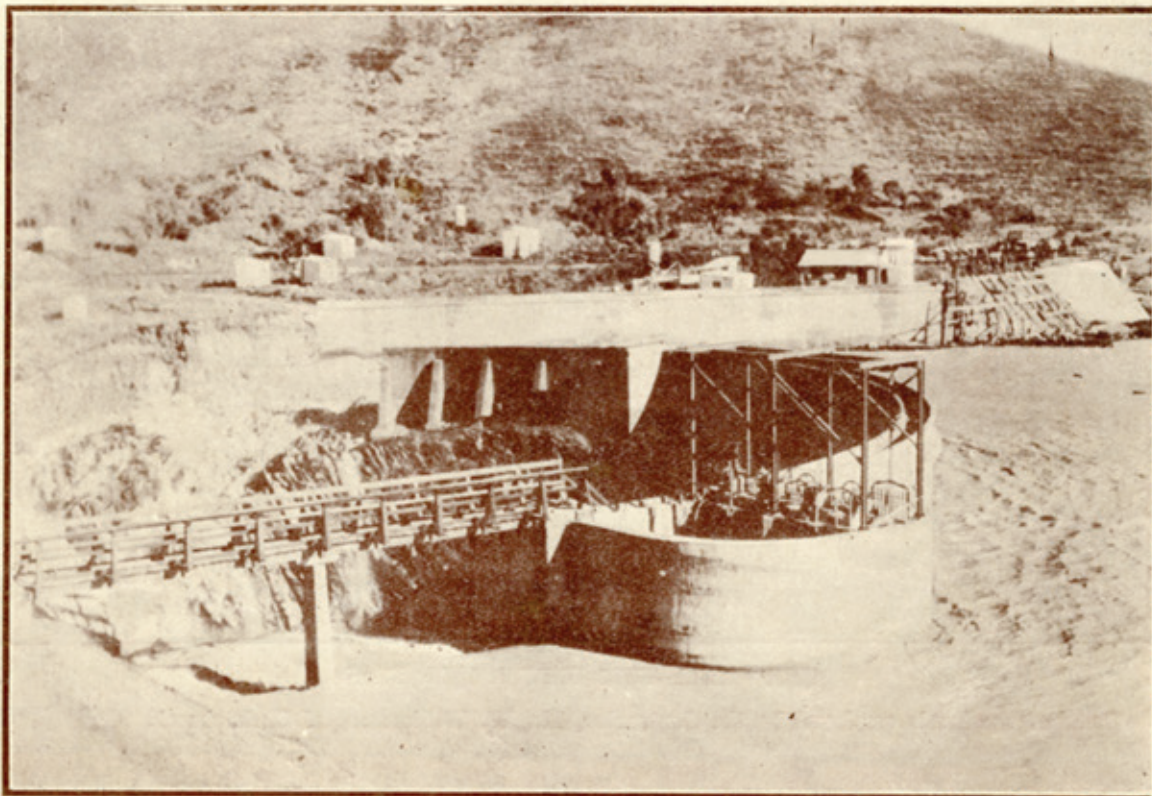
The reticulation system, so far, is designed to consist of three main zones—the Wairau-Havelock-Tua Marina area, supplied from Renwicktown at 11,000 volts; the Blenheim area, including Blenheim and suburbs, supplied from Blenheim at 6600 volts; and the Southern area, including Ward, Awatere, and the adjacent districts, supplied from Seddon at 11,000 volts. The lines throughout are being erected on concrete poles, made



FITTING AN ALTERNATOR ROTOR



Typical Tower at an angle in the Main Transmission Line
—33,000 volts.



VIEW OF THE HEADWORKS DAMMING THE WAIHOPAI RIVER.

at convenient depots, and varying in length from 40 feet down to 26 feet.

Special provision is made at the Wairau crossing on the Havelock section for carrying the line over the river on three steel towers, the central towers being supported from steel joists driven into the river bed, with protection against flood damage.

The Mahakipawa line, which will traverse the hills from Havelock to Mahakipawa, will be built on easily transportable steel rails.

The reticulation is of the type which is now standard throughout New Zealand, supply being given to all consumers at 230 volts for lighting, heating, cooking, etc., and at 400 volts for power purposes.

WIRING OF HOUSES.

Profiting by the experience of older Boards which proves that, in the first two or three years of operation, serious losses have been incurred through the fact that when power was switched on there were insufficient consumers to provide revenue to meet the expenses, the Marlborough Power Board has, from the outset, endeavored to induce prospective consumers to have their premises wired, so that an immediate market would be available for the current generated. To this end, provision was made in the loan proposal under which the Board has paid the initial expense of wiring consumers' premises, and is being recouped under the instalment system. A contract was also let to a firm of wiring contractors, under which the firm agreed to canvass the district for consumers, and wire such premises as they got orders for.



THE MEN WHO BUILT THE DAM.

Some of the hands employed by the Contractor, Mr. W. Williamson, of Christchurch.

The Concrete Pole.

New Departure in Construction.

Outstanding Marlborough Success.

Lines Practically Indestructible.

AN outstanding feature of the Marlborough hydro-electric installation is the fact that there is not a wooden pole to be found in any part of the 135 miles of transmission and reticulation lines so far erected. The main transmission line, from the headworks at Benopai to Blenheim—a distance of some 23 miles—is erected on steel towers, and the whole of the reticulation lines, at present about 112 miles in length, are strung on concrete poles, specially designed for the purpose.

It is understood that though concrete poles have been used experimentally in other parts of the world, the Marlborough Power Board has the distinction of being the first supply authority to adopt them in their

entirety, though the honor is closely shared by the Waitomo Board, which decided at about the same time as the Marlborough Board, to adopt concrete construction. The Waitomo scheme, however, is a comparatively small one.

It may be stated at the outset that some of the Marlborough concrete poles have been erected now for about 18 months and have been carefully observed throughout that period, with the object of noting the effect upon them of the extremes of heat and cold to which the province is subject, and they have emerged from the test of two winters of heavy frosts—the gauge frequently recording 16 degrees—and a summer of extraordinary heat, without the slightest sign of deterioration. The Board's engineers, the workmen



MANUFACTURE OF CONCRETE POLES AND SOME OF THE MEN EMPLOYED.

Note on the Benches the Steel Reinforcement in process of Manufacture.

handling the poles, and the members of the Board themselves are more than satisfied at the results which have attended what was, after all, a somewhat bold experiment, and are convinced that the way which Marlborough has pioneered will shortly be followed by the P. & T. Department and by all power authorities operating in districts where the natural advantages, such as shingle deposits, make possible the construction of concrete poles at a reasonable price.

Up to the present, the Marlborough Board has actually erected just over 4000 concrete poles, varying in size from 26 feet in length to 40 feet, and, aside from a dozen or so faulty poles manufactured at the very outset, when the workmen were inexperienced, not a single defective pole has been discovered. The poles are of a graceful and attractive design, and their uniformity results in the reticulation lines assuming a very pleasing and workmanlike appearance, in marked contrast to the straggling and uneven lines which frequently result from the use of wooden poles.

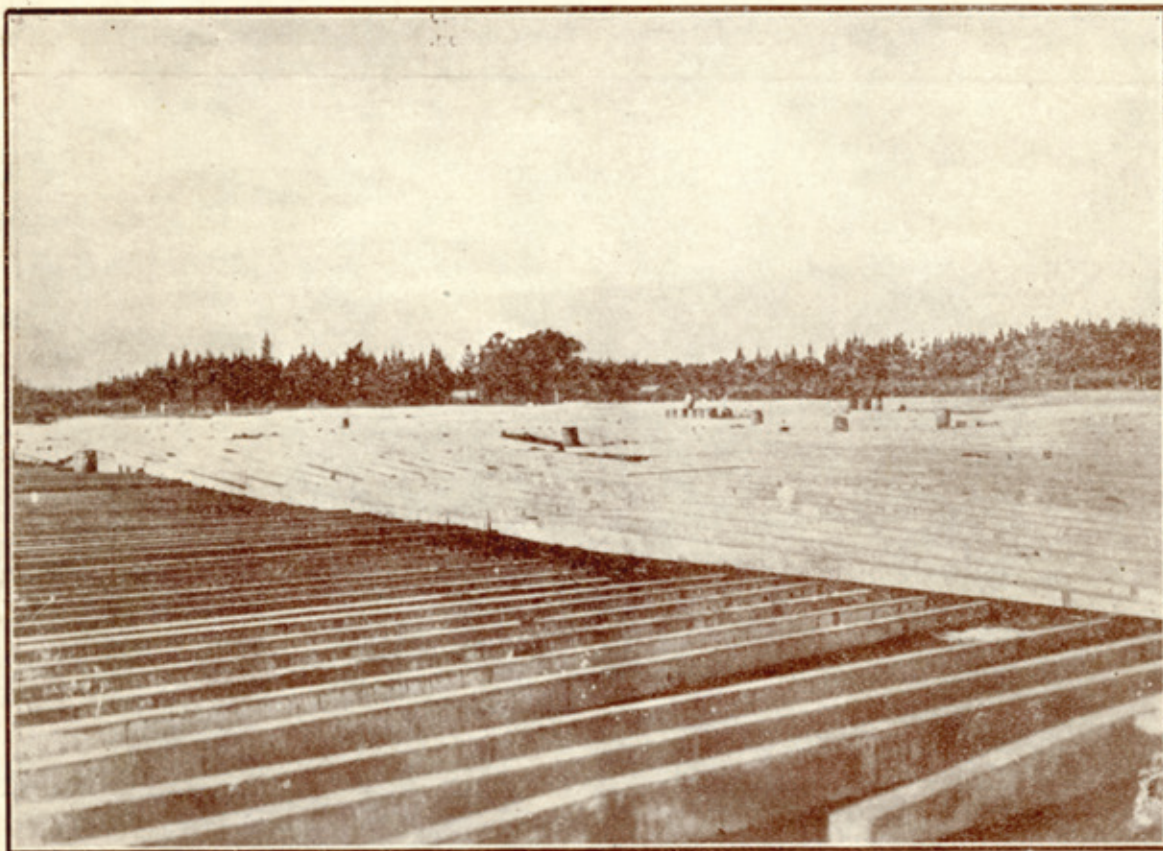
The poles are virtually indestructible, so that the cost of replacements—a very serious problem in many districts—is reduced to a minimum; and a further important factor which should not be lost sight of is that at least 33 1-3 per cent. of their cost was circulated, by way of wages, in the district, between 40 and 50 men being kept constantly employed at the pole-making depots throughout a winter when unemployment was rife from one end of New Zealand to the other.

There are virtually no hardwood or iron-bark poles

in New Zealand, the nearest source of supply being Australia. If wooden poles had been decided on for the Marlborough scheme, some £43,000 would have had to be spent in Australia, but the use of concrete kept the great bulk of the money expended in New Zealand, and a very large part of it in Marlborough itself.

At the outset the Board made most careful inquiries, from other electrical supply authorities, in regard to their experience with wooden poles, and among those from whom reports were received were the Thames Power Board, the Sumner Borough Council, the Christchurch Municipal Electricity Department, the Eyre County Council, the Public Works Department, Dunedin City Council, Kaiapoi Borough Council, and Taranaki Power Board. The general experience of these Boards was that the life of mixed hardwood poles was from five years to 15 years, and of ironbark between 15 and 20 years. It was indicated that many of the supply authorities were already faced with the necessity for extensive renewals in their pole lines. The consensus of opinion was that mixed hardwood poles had proved themselves uneconomical and that the best class of wooden pole was the ironbark, though the life of the ironbark was also strictly limited.

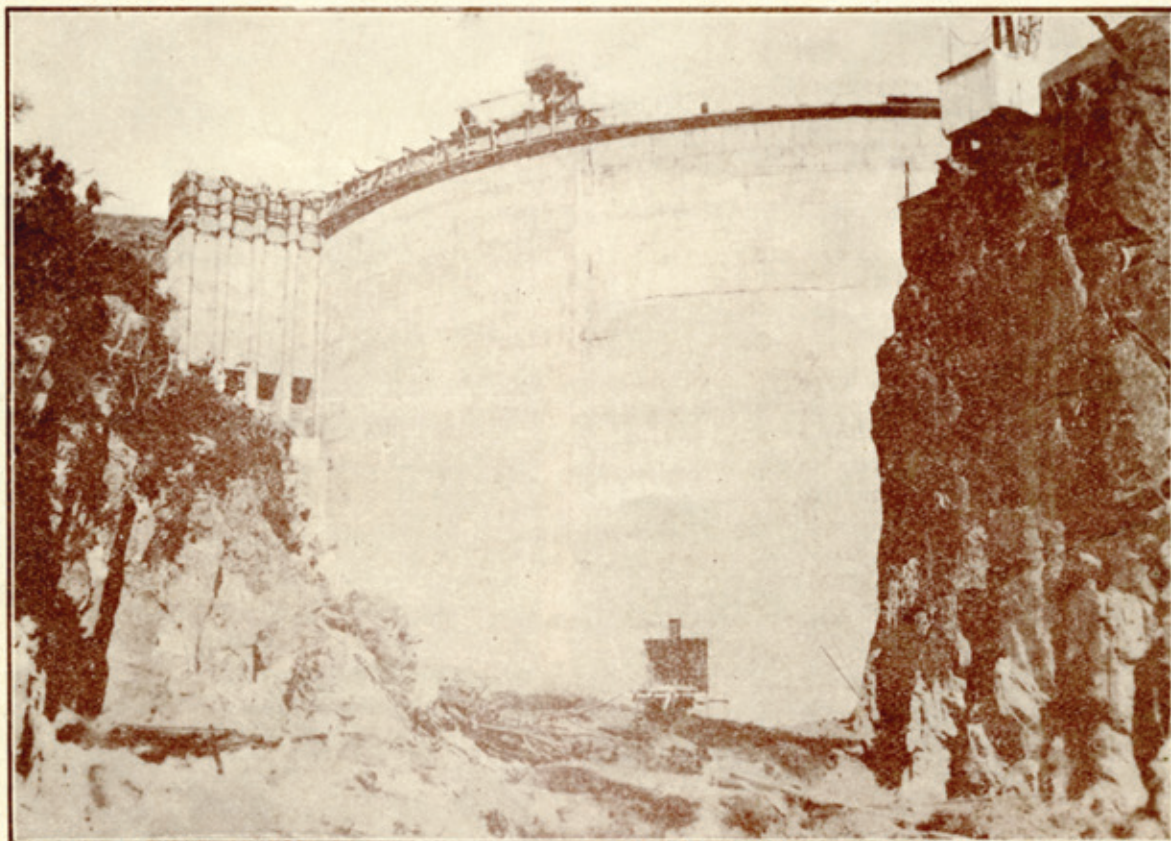
With these facts before it, the Board turned its attention to concrete poles, and, as the upshot of a report from the engineers, decided unanimously to use them. Figures prepared by the engineers, and based, as far as wooden poles are concerned, on actual quotations received at the time, showed that the cost of the various



CONCRETE POLES "SEASONING."
View of the Board's Principal Depot.



THE SITE OF THE DAM AT BENOPAI. View of the Gorge prior to commencement of operations.



THE DAM AT BENOPAI. A striking view of the Great Wall, taken from inside the dam.

classes of poles for the complete works would compare as follows:—

Ironbark	£43,750
Steel	£50,570
Concrete	£50,600

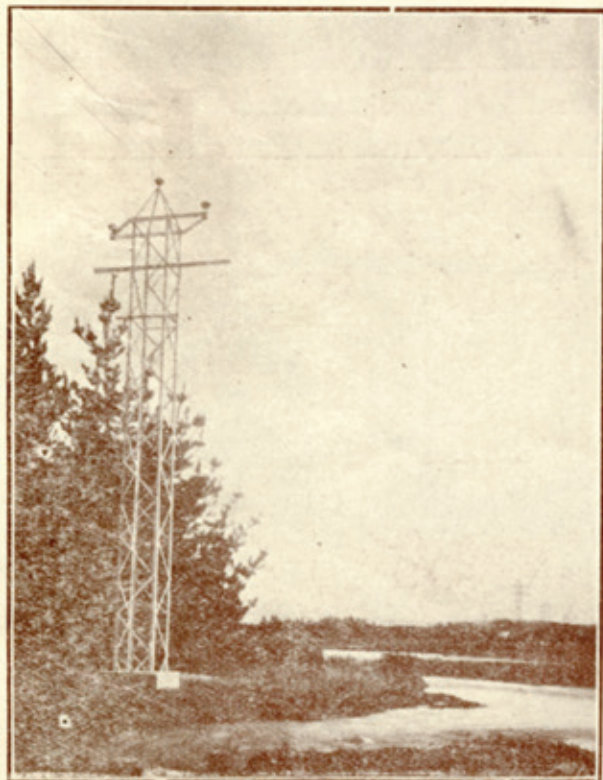
The annual capital charges in each case, allowing 6 per cent. interest, 1 per cent. sinking fund, and 5 per cent. replacement for ironbark; and 1 per cent. for steel and concrete, were worked out by the engineers as follows:—

Ironbark (£43,750 at 12 per cent.)	£5250
Steel (£50,570 at 8 per cent., plus £400 for painting)	£4440
Concrete (£50,600 at 8 per cent.)	£4048

Concrete and steel were thus shown to be ultimately cheaper than ironbark, though the initial outlay was heavier.

COMPARATIVE ACTUAL COSTS.

It is now possible to work out a comparison in the actual cost of concrete poles and of ironbark, pole for pole. The prices quoted for ironbark are based on the lowest tender quotations actually received by the Board, *i.e.*, prime paid Picton, and the prices quoted for concrete poles are the actual average cost of poles, as

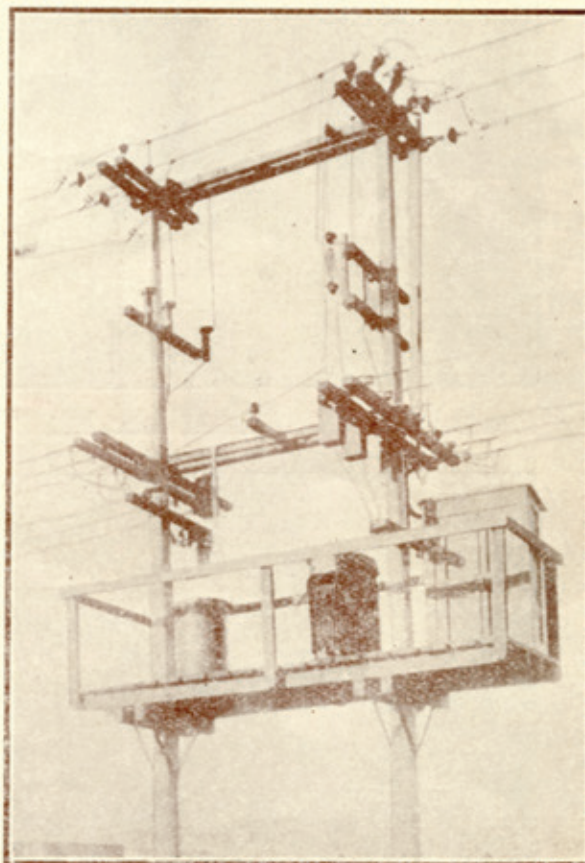


Towers on which the Main Transmission Line is strung.

manufactured at the depots in Marlborough, close to the scene of their erection:—

	Ironbark.	Concrete.
26-foot	£1 19 11	£2 17 6
31-foot	£2 18 1	£3 12 6
35-foot	£3 13 9	£5 0 0

It should be understood, in comparing these prices, that allowance has to be made in the case of ironbark poles, for handling at Picton, railage to Blenheim, and a certain proportion of cartage, which would have brought the cost of the two classes of pole closer together. In arriving at the actual average cost of the concrete poles, too, each pole has had to bear its proportion of the somewhat heavy capital cost of moulds, benches, and other equipment, and this allocation, per pole, will steadily decrease as more poles are made. It will be understood that the very first pole made would, on the basis adopted, be shown as costing some hundreds of pounds. The manufacture of the second pole would reduce the amount by nearly half, and so on. The more



TYPICAL OUTDOOR SUBSTATION,
Mounted on Two Concrete Poles.

poles made, once the equipment has been got together, the cheaper.

MANUFACTURE OF THE POLES.

The Board having decided upon the use of concrete poles, the engineers drew special designs for poles calculated to stand a breaking strain of 12 tons feet, and the Board immediately opened a pole-manufacturing depot on the banks of the Opawa River some six miles from Blenheim, and about in the centre of the main reticulation area. Here plentiful supplies of clean river shingle were available, and the works were so centrally situated that cartage of poles to their ultimate positions was reduced to a minimum. Only the best of English cement

was used in the construction, and the whole of the steel core work was carried out at the works from steel bars specially imported for the purpose. The core of the poles resembles steel basket work, the heavy upright members being interlaced and interwoven in a special design with lighter steel wire. The poles, after manufacture, were allowed to "ripen" for a period of least ten weeks.

As already mentioned, a dozen or so defective poles had to be rejected in the early stages of the work; but as the men employed became expert, the quality of the poles steadily improved. In all, 4539 poles have been manufactured at this depot, and the Board has more recently opened a similar depot at Seddon, in the Awatere district, where over 1300 poles have so far been made. Of the poles manufactured, 4000 odd have so far been erected.

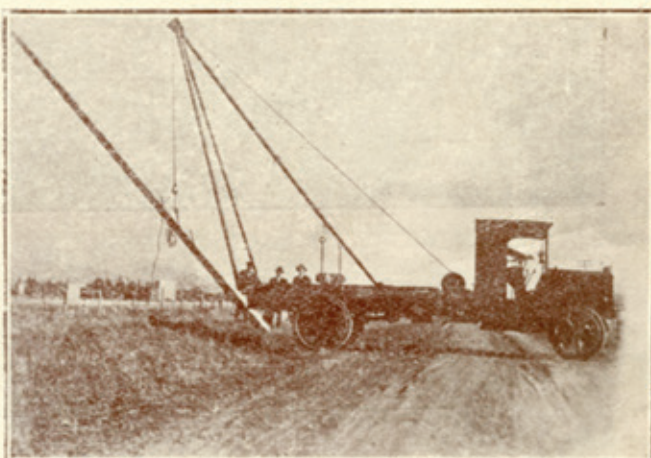
WORK OF ERECTION.

Naturally, the concrete poles, on account of their weight and their liability to fracture if roughly handled in transport, presented a more difficult problem than ironbark when it came to the matter of erection, and there were many people who proclaimed that it would be found more or less impossible to erect them satisfactorily. The use, however, of motor trucks fitted with winches solved the problem, and it is safe to say that the poles are erected with as much ease as are hardwood poles.

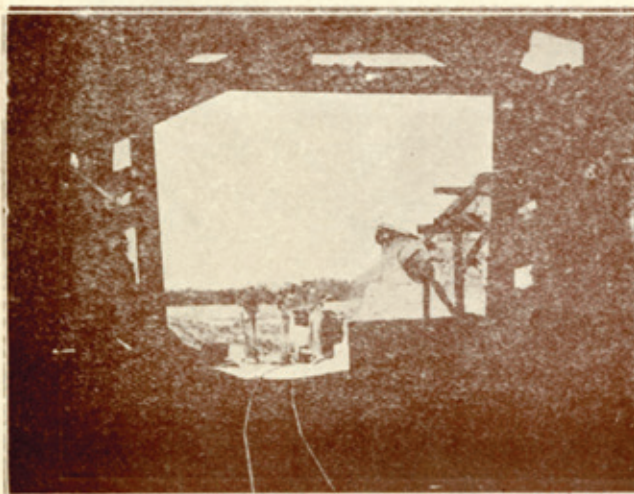
As a result of the experience with concrete poles in Marlborough and at Waitomo, the Bay of Plenty Power Board is using concrete poles for the whole of its reticulation work now in hand, and the Taranaki Board is also using concrete poles extensively.



During the progress of the work the partly-completed Dam was repeatedly submerged, the River being subject to sudden freshes. The view shows the water flowing right over the works in November.



METHOD OF ERECTING CONCRETE POLES.



View from the Intake Tunnel during construction.



A SUBMERGED VALLEY.

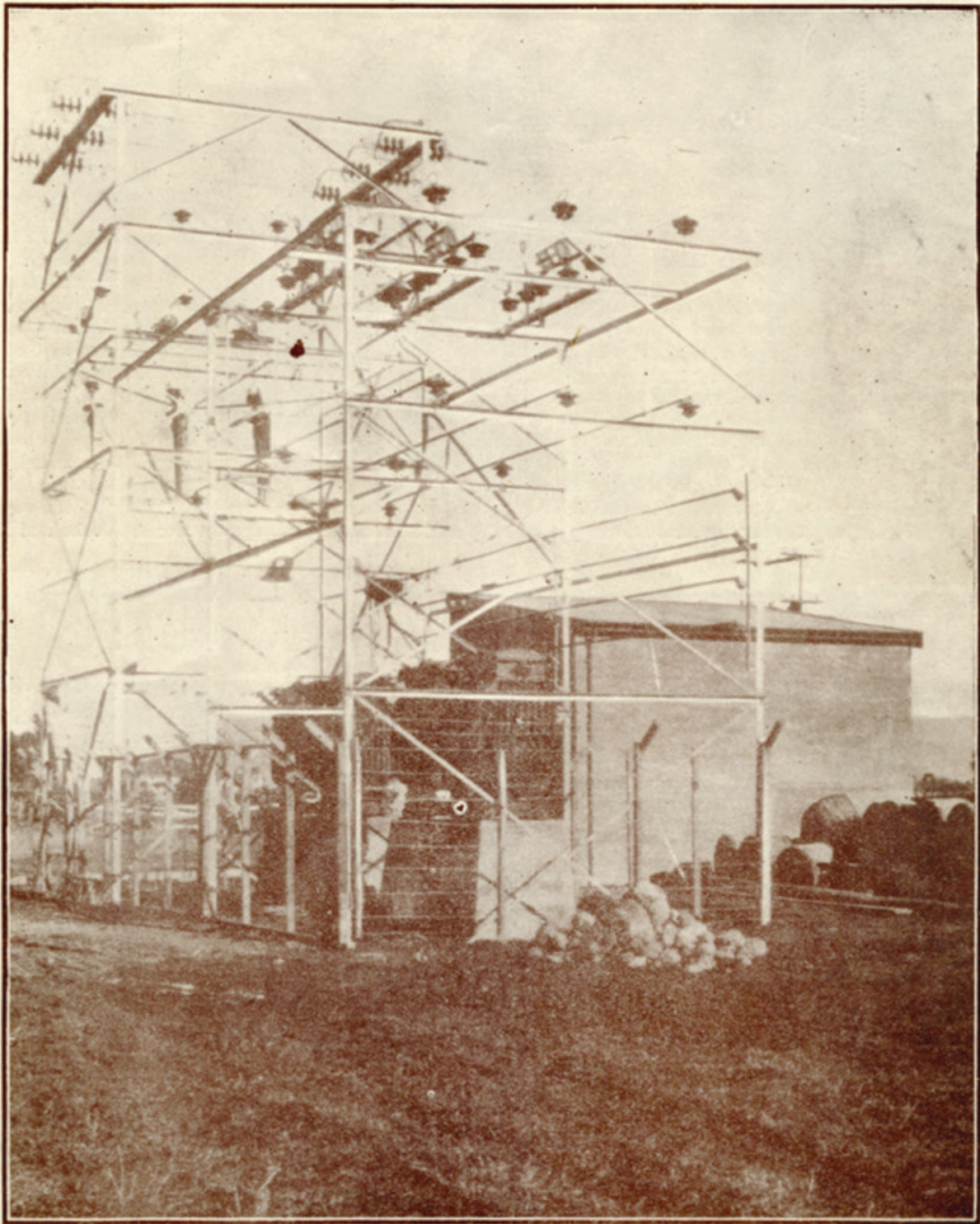
The whole of the Valley shown above is now a Lake, owing to the Dam raising the level of the River.



SPECIAL WINCHED LORRIES AND TRAILERS THE POLE-ERECTION GANGS AND
EMPLOYED IN THE WORK.



THE BOARD'S FLEET OF CARS AND TRUCKS.



THE SUB-STATION AT SPRINGLANDS.

A similar transformer station is in use at Renwicktown, and another will be erected at Seddon.

The Waihopai Scheme.

Its Early Advocates.

THE MARLBOROUGH EXPRESS records show that the earliest advocates of the development of the Waihopai River for hydro-electrical purposes were Messrs. J. A. Leslie and B. J. Cooke. In 1918, when both were members of the Blenheim Borough Council, they put up a strenuous fight in an endeavor to induce the Council to secure sufficient data to put a proposition before the ratepayers of Blenheim, but they were unsuccessful, except that they did secure a brief engineering report, based upon a flying visit to the site of the present headworks.

The Council was influenced against the scheme by a report which it had secured as far back as 1912 from Mr John Sturrock, then Borough Engineer. Mr Sturrock then estimated the requirements of Blenheim at 350 h.p., and stated that double this power would require to be generated in order to allow for losses in transmission. He considered that only 340 h.p. could be developed and

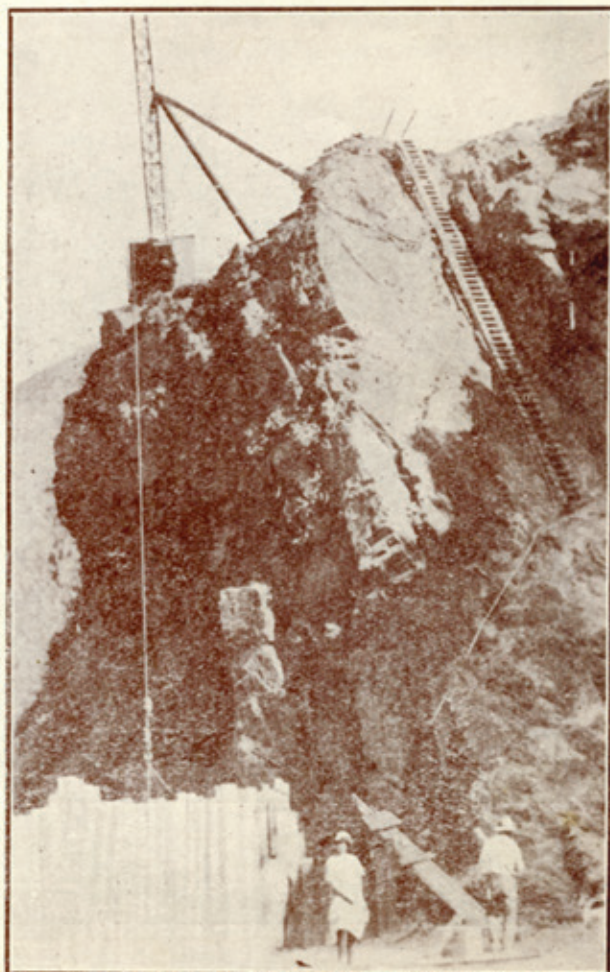
that the output, in times of drought, might be considerably less, and he described the project, therefore, as a risky one.

Even in the face of this report, Messrs. Cooke and Leslie urged the Council to secure a further opinion, pointing out that the site contemplated by Mr. Sturrock was in the lower reaches of the river, whereas there was a much better site further up stream—the site ultimately adopted by the Marlborough Power Board.

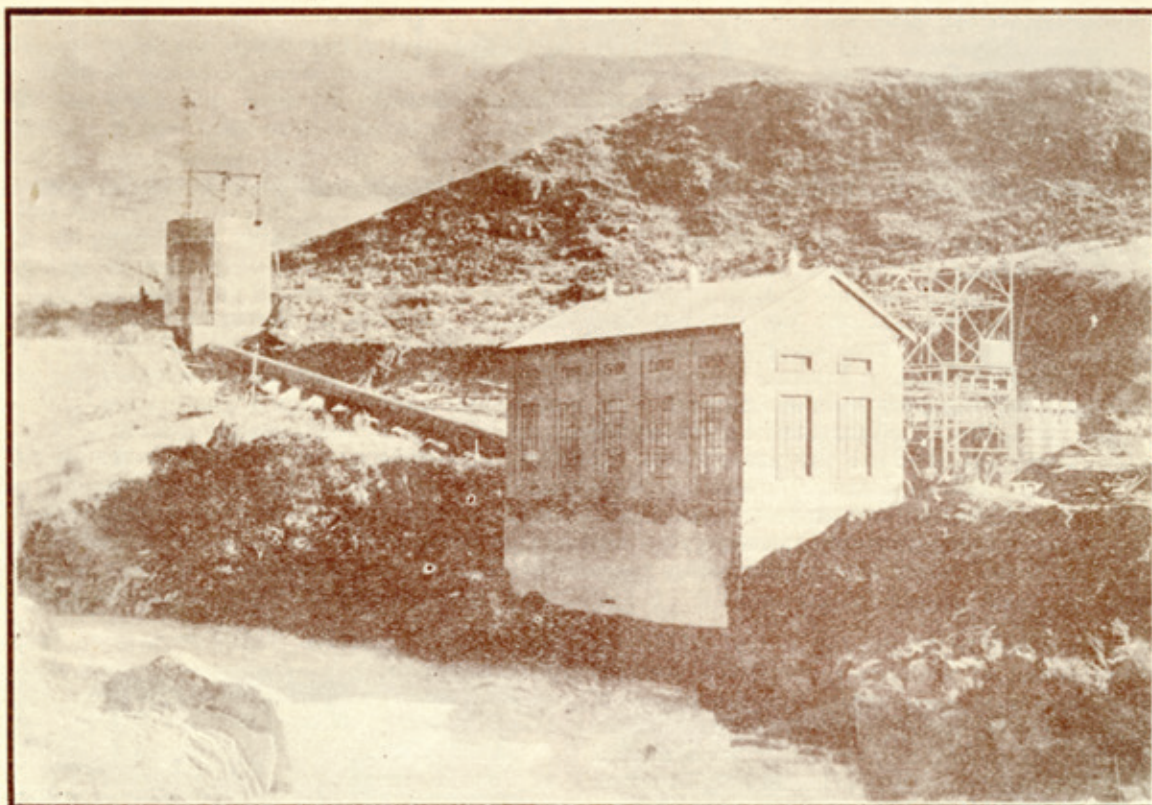
At the same time, however, the Chamber of Commerce got behind a larger scheme for the development of Lake Rotoiti to supply power for Marlborough, Nelson, and West Coast, and this effectually side-tracked the exponents of Waihopai. When the Rotoiti proposal faded out, nothing more was heard of hydro-electricity until the advent of the Marlborough Power Board, which decided, after most careful inquiries, to proceed with the development of the Waihopai River at the very site pleaded for nine years ago by Messrs Cooke and Leslie.



His Excellency conversing with Mr. H. Vickerman during his Inspection of the Works.



THE WAIHOPAI GORGE.
View taken shortly after commencement of the dam.



THE POWER HOUSE, PIPE LINE, AND SURGE CHAMBER.
Note the Outdoor Type Transformer Station behind the Power House.



DRIVING THE SUPPLY TUNNEL.
Mr. H. Langdon, Engineer in Charge of the Headworks, is seen seated on a box, working out data.

Keep Clear!

Danger in Electric Wires: The Necessary Precautions.

Great as are the benefits derived from electricity, there are also certain very real dangers, for electricity, though very useful, is a very deadly thing. It must be treated with great care, for fatal accidents are becoming very common indeed. In many cases they are due to ignorance, and the time has arrived, when everybody should be made aware of the dangers, and of the precautions needed to avoid them. Last year the N.Z. School Journal devoted a very instructive article, in simple language, to warning children to "Keep clear"; and it is reprinted below, with a view to emphasising the necessity for caution, in view of the fact that to-day "live" wires are criss-crossing practically all parts of Marlborough.

IF we were asked to describe in a few words the present period of civilisation, we should probably call it the era of electricity. Man has known of this force for many years, but it is very doubtful if he has ever before realised how great a force it is. To-day it is being developed to a remarkable extent in all countries where there is any desire for progress, and our own country is doing its share.

In various parts of the Dominion we see the overhead wires that carry the electric current from the generators at the power-houses. The rivers and lakes of the country are being harnessed to provide hydro-electric power, which is going to supply New Zealand not only with light, but also with power to drive the great machines in our manufacturing centres. The smoke nuisance will become a thing of the past. No doubt in time electricity will take the place of steam on our railways.

Certain substances allow the electric current to flow very readily through them, and they are known as good conductors. Examples of such substances are copper wire, most metals, water, and the human body. Other substances, such as glass, amber, india-rubber, porcelain, and wood, do not allow the current to flow freely, but offer resistance, and they are known as bad conductors, or insulators.

While the human body is a good conductor, yet a powerful current cannot pass through without much harm being done. A weak current will produce the sensation known as "pins and needles"; a stronger current will cause severe burns; while a very strong current will cause instant death.

In districts where there are electric-power wires overhead, children should be very careful to avoid touching any of these wires, particularly if the posts or marked "Danger, Live Wires," or with skull and cross-bones, or with any similar warning; they should never touch any broken wire which may be lying on the ground or wrapped round a pole.

It is, as a rule, impossible to know whether a wire is charged with electricity or not merely by looking at it, and the safest course to adopt is never to touch

any wire lying on the ground or hanging from a pole. As it is impossible for most people to tell what strength of current is passing along it, the safest plan is to leave it strictly alone.

Some time ago a boy, while playing in the streets of Dunedin, caught hold of a wire that had fallen from a pole. No doubt it seemed to him quite harmless; but he was instantly killed. Another boy in Dunedin was swinging on a wire attached to a flagpole, and in swinging round the pole accidentally touched another wire that was carrying an electric current, and he, too, was instantly killed.

Many of these fatal accidents are due to thoughtlessness or to ignorance. A schoolboy at Te Aroha climbed on to the roof of a building and touched a wire that passed over it. This was carrying a strong current, and he was killed at once. Another boy, in Christchurch, climbed up on top of a wash-house, and touched the electric wire that came into the house. It happened, fortunately, that this wire was not carrying a very strong current, but he was very severely burned.

Another instance of a fatal accident occurred in Hawera, where a child, finding the door unlocked, wandered into a building containing electric wires and machinery. He touched a "live" wire, and the shock killed him at once. Another school boy, in Taranaki, perhaps to show his skill in climbing, climbed up a pole carrying electric wires, touched a high tension one, and dropped dead on the spot.

Instances have even been known where a person has made contact with overhead electric wires by a piece of metal piping he was carrying and the current, passing down the pipe, killed him instantly. There are also records of many cases where the amputation of hands and arms has been rendered necessary on account of the severe injuries caused by touching "live" wires.

The list of fatal accidents is becoming a long one and should convince us that there is a real danger connected with overhead wires. The following instructions have been drawn up for the information of school-children in New Zealand, and we should be

careful to remember them:—

1. Do not, under any circumstances, touch any wire that has fallen or is hanging from a pole.

2. Do not climb any poles or towers carrying electric wires. It is sometimes possible to get a very severe shock through a leakage, especially in wet weather, when the water acts as a conductor. Therefore, avoid all poles and towers.

3. Do not climb trees through which electric wires pass. Leakage of the current may take place between the wires and the tree. In Canterbury there is a tree whose leaves have all been burned off by a leakage of current from the wires that pass through it.

4. Do not shake or touch stay wires on electric poles, for fear of receiving a shock from a stay-wire that may not be properly insulated.

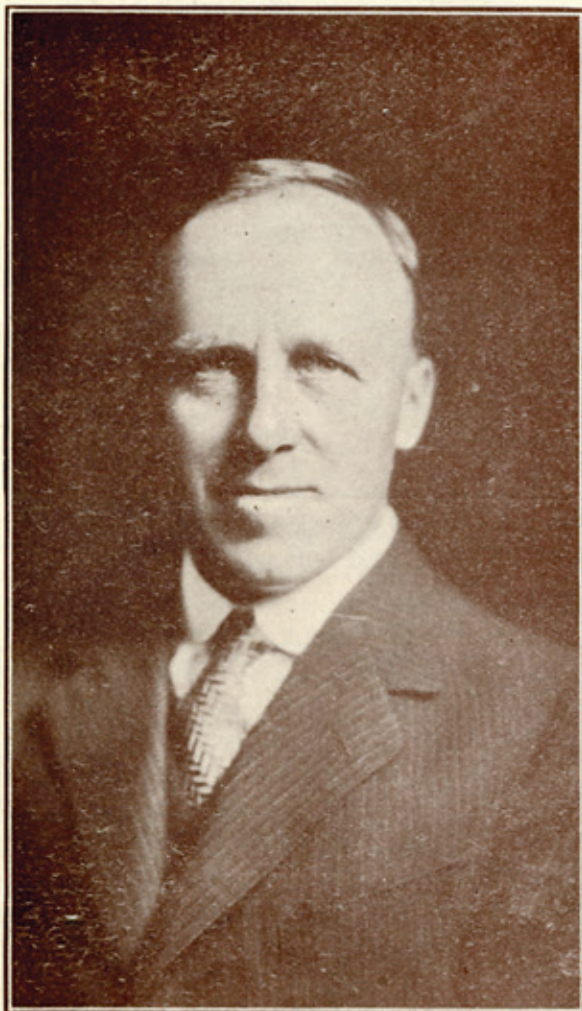
5. Do not throw stones or fire pea-rifles at the insulators. These little porcelain "cups" prevent the escape of current from the wires, and if the insulator is broken the leakage will flow down the pole. There is also the risk that the wire will fall to the ground when its support is broken. It is surprising how

many of these "cups," both for telegraph and other electric wires, are broken annually by thoughtless and mischievous boys. On one occasion, a person, taken seriously ill in the country, endeavored to telephone for the doctor, but, as some thoughtless boy had broken the insulator, connection could not be obtained, and the patient died. The doctor arrived too late to save him.

6. Do not stand below men working on poles carrying overhead wires. It is possible a wire may be accidentally broken, and on falling it may strike you, with fatal results. The men working on the pole protect themselves by wearing rubber gloves, and, therefore, they do not run the risk you do.

7 Do not fly kites where there are overhead electric wires. If the string is damp it will conduct the current from the wires to your body, should the kite or its tail make contact with the wires. Kites often become entangled in the wires, even when flown in dry weather, and when rain comes they become a source of great danger.

8. If you see a broken wire on the ground,



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Mr. J. G. LANCASTER, M.Sc., B.E., M.I.E.E., A.M.Inst.C.E., M.A.I.E.E., of Messrs. Vickerman & Lancaster, the Board's Consulting Engineers.

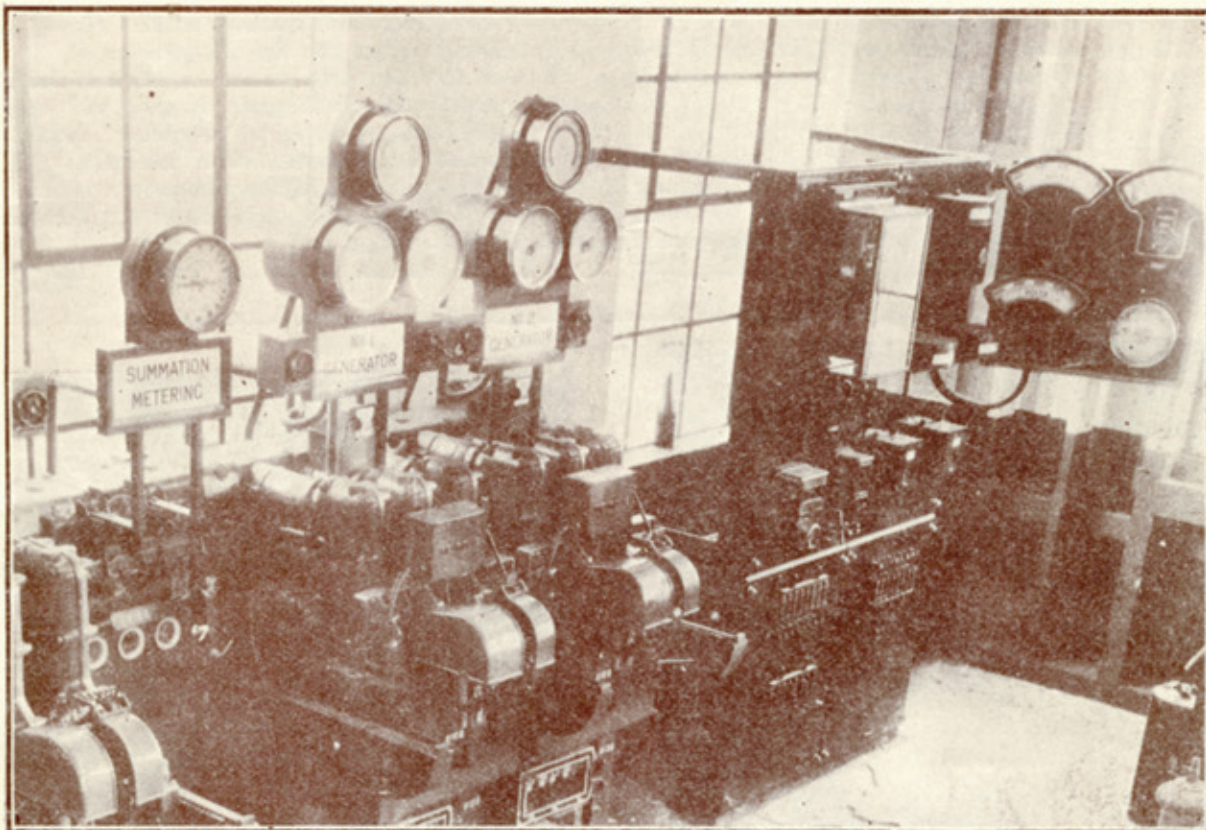
do not touch it, but report to the nearest policeman, or other person you may find.

9. If a fatal accident has occurred, do not attempt to remove the body from the wires, or you, too, will receive a fatal shock.

10. Keep away from all electric switching towers or structures, or buildings containing electric wires or machinery. All the wires to be seen on the street-poles carry electricity, often at great pressure, and it

is absolutely fatal to make contact. They should never be touched in any circumstances. Even if not fatal, the shock may cause burns that take much longer to heal than ordinary burns.

11. Remember, finally, to set a good example by protecting others as well as yourself, and do not allow them through foolishness or ignorance, to do anything that you know will cause them much harm, perhaps even death itself.



A CORNER OF THE POWER HOUSE AT THE HEADWORKS.
Showing a Section of the Automatic Switch Gear. The station is the largest Automatic Power Station in New Zealand.



ANOTHER VIEW OF THE GORGE
Prior to commencing operations.



Their Excellencies traversing the Intake Tunnel
during their Inspection of the Works.

Marlborough Electric Power Board.

SCHEDULE OF RATES.

SCALE A.—DOMESTIC.

(Except Long-hour Water Heating)

For Lighting, Ironing, Heating Cooking, and
Domestic Motors up to $\frac{1}{2}$ h.p.:-

All the current consumed in any one quarter will be charged for at the rate of 9d. per unit nett up to a number of units fixed according to the number of rooms in the house, and the season of the year, as set out in the following schedule, being the average consumption for lighting only, as generally elsewhere.

SCHEDULE.

(Units per Quarter at 9d.)

Rooms.	Jan.-March.	April-June.	July-Sept.	Oct.-Dec.
5 or less	24	30	30	24
6 or 7	27	33	33	27
8 or 9	30	36	36	30
10 or more	33	39	39	33

The balance of units consumed in the quarter, after charging as set out above, will be charged for at the lower rate given below, the complete scale of charges being as follows:-

Up to number of units as per schedule above..	9d.
Balance up to 20 units for quarter	2½d.
Next 180 units, per quarter	2d.
Balance	1½d.

Example A.—

Statistics show that the average consumption for lighting and ironing together in small houses, with from two to five persons in residence, is from 6 to 17 units per month, in which are included from 3 to 6 units per month for ironing only. In country houses the average is from 12 to 20 units per month.

Taking an average as, say, 50 units per quarter, the cost on the Board's scale would be as follows:-

For 6-Roomed House—

First 30 units at 9d	£1 2 6
Next 20 units at 2½d	0 4 2
	£1 6 6

or approximately £5 6s 8d per year for lighting and ironing. In general the units for lighting and ironing can be figured at from 3 to 4 units per month for each person.

For cooking, records show that the consumption per day varies from 1 unit per person for a household of 6 or 7 adults, to 2 units per person for a household of 2 adults only. Taking an average of 4 adults, the consumption is about 1.5 units per day per person; quarterly consumption for cooking would then be, say, 540 units.

The total quarterly account, allowing for lighting, ironing, and cooking, would then be:-

First 30 units at 9d	£1 2 6
Next 20 units at 2½d	0 4 2
Next 180 units at 2d	1 10 0
Balance, 360 units at 1½d	2 5 0
Total—590 units	£5 1 8

or less than £21 per year.

It will be noted from the above that the cost of electric cooking works out to about £15 per year, or less than 10d per day for 4 persons.

The above figures, of course, vary in the case of the lighting, with the season of the year, and in the case of the cooking, with the use that is made of the range, but can be considered as fair averages for the conditions as assumed.

SCALE B.—DOMESTIC.

(Long hour Water Heating only.)

For long hour water heating, with heater of capacity of not less than 500 watts, the current consumed is not metered, but is charged for at 5s. per quarter per 100 watts. A reduction of 20 per cent. is made, provided that the heater is on a change-over switch with milking motor, range, or cooking appliance of capacity of not less than that of the water heater.

For booster heating the current will be metered and charged for under Scale A above.

The cost of water heating where a 25-30 gallon cistern is used for continuous heating will be at a flat rate of £6 per year, less 20 per cent. where switches are provided so that the range and water heater are not in use at the same time.

SCALE C.—BUSINESS PREMISES:

Shops and Offices.

Lighting, 9d per unit.

Special rate for long hour window and advertising sign lighting: 4½d. per unit, with a minimum of £3 per k.w. per quarter.

Subject to installation of electrically-wound time switch to cut off power at 10 p.m. or later.

Heating—

3d per unit up to 120 units per quarter.
1½d per unit all over 120 units per quarter.

SCALE D.—BUSINESS PREMISES.

Hotels, Boarding Houses.

Lighting, 9d per unit.

Heating—

Per unit.

First 20 units, per quarter	2½d.
Next 180 units, per quarter	2d.
All over 200 units per quarter	1½d.

SCALE E.—MOTORS FOR MILKING.

£4 per h.p. per season, plus—

First 60 units per h.p. per quarter at 3d per unit.

Second 60 units per h.p. per quarter at 2d per unit.

All over 120 units per h.p. per quarter at 1½d per unit.

Example B.—The total units per cow per year vary over a wide range. With up-to-date plant the figure may be 20, but with an inefficient pump 30 units may be required. Statistics collected in a dairying centre in the North Island give 22 as an average. For estimating, we assume 25.

Assume 40 cows with a 2 h.p. motor:—

Units per year, 40 x 25=1000.

Units per quarter, 333.

First 120 (60 per h.p.) at 3d..360d.

Next 120 (60 per h.p.) at 2d..240d.

Balance, 93 at 1½d..139d.

Per quarter739d.

Total for 3 quarters 2317d..£9 13 1

Fixed charge, 2 h.p., at £4..£8 0 0

Total cost£17 13 1

or approximately 9s. per cow per year.

SCALE F.—**MOTORS FOR GENERAL POWER PURPOSES.**

First 80 units per h.p. at 3d per unit.

Next 600 units per quarter (irrespective of h.p.),
2½d per unit.

Balance at 2d per unit.

SCALE G.

All motors other than those on bulk supply rates used between 8 p.m. and 6 a.m. will be charged at a flat rate of 1d per unit. In this case a time switch shall be provided by the consumer.

Advantage should be taken of this rate, especially for pumping purposes.

SCALE H.—BULK SUPPLY.

Minimum guarantee, £45 per quarter.

£2 per k.v.a. quarter of maximum demand, plus ¼d per unit; or

£1 per k.v.a. quarter of maximum demand, plus £50, plus ¼d per unit.

MINIMUM CHARGES PER QUARTER.

The minimum charges per quarter will depend on the guarantee given per consumer on any branch lines and necessary to warrant its erection by the Board, and will not be less than as set out in (a) and (b) below:—

Per Quarter.

(a) For Borough and Town Board consumers, £0 15 0

(b) Country consumers—

2 and 3-roomed houses£1 0 0

4 and 5-roomed houses1 10 0

6 and 7-roomed houses2 0 0

8 and 9-roomed houses2 10 0

Above 9-roomed houses3 0 0

(c) Consumer being connected up during the quarter will pay a minimum charge for that quarter, proportioned to the time of receiving supply.

(d) Consumers being disconnected during any quarter will pay the full minimum charge for that quarter.

(e) There will be no minimum charge required for school buildings, public halls, churches, etc.

NETT CHARGES.

The above rates are all nett charges, payable quarterly.

The gross charges will be an additional 2d per 1s, which sum will be deducted if the amount is paid within two weeks of the date of account.

SPECIAL RATES.

Special rates will be arranged from time to time for special purposes, such as battery charging, etc., etc.

METER DEPOSIT.

Every consumer, whether owner of a property or tenant, must pay a deposit of 10s before power is turned on, as security for meters and for payment of account. Such deposit will be returned if at any time the connection be given up and the accounts, etc., are in order.

ACCOUNTS.

The Board reserves the right to read meters monthly or quarterly.

If accounts are more than one period in arrears, the current will be cut off, and a fee of 5s charged for re-connection.

ADVANCES TO CONSUMERS

The Board is prepared to assist consumers by financing—

THE WIRING OF HOUSES

THE PROVISION OF SERVICE LINES

THE PURCHASE OF ELECTRICAL APPLIANCES

FULL PARTICULARS ON APPLICATION

