1875.

NEW ZEALAND.

THE STATE OF THE SURVEYS IN NEW ZEALAND,

(CORRESPONDENCE RELATIVE TO, AND REPORT BY MAJOR PALMER ON.)

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

No. 1.

The Hon. the COLONIAL SECRETARY to Major PALMER, R.E.

SIR,— Colonial Secretary's Office, Wellington, 23rd December, 1874.

The Government are very desirous of obtaining a reliable professional opinion upon the state of the surveys in New Zealand, with a view to the initiation of a thorough system of trigonometrical surveys, for which a vote was taken in the last session of Parliament; and understanding that, on the completion of the special service for which you came to New Zealand, you will have some leisure at your disposal, I should feel much obliged if you would inform me whether you will be able to make the necessary inspection, and furnish the Government with a report of the nature indicated.

I enclose a number of papers on the subject for your consideration.

I have, &c.,
DANIEL POLLEN.

Major Palmer, R.E., Wellington.

No. 2.

Major PALMER, R.E., to the Hon. the COLONIAL SECRETARY.

SIR,— Wellington, 26th December, 1874.

I have the honor to acknowledge the receipt of your letter of 23rd December, with enclosures, asking me whether I shall be able, on the completion of my present duties, to investigate and report to Government upon the condition of the surveys in New Zealand, and to state in reply that I shall be at liberty to enter on a service of that nature about the 20th of January next.

Having read the documents which you have sent me, I think that a visit in person to most, if not all, of the Provincial Survey Offices would be the best plan for arriving at an exact knowledge of the state of the surveys; and, if desired, I could furnish you at once with suggestions as to the chief matters on which information would be needed, so that there might be no delay in the course of the inquiry.

I have, &c.,
H. S. PALMER,
Major, R.E.

The Hon. the Colonial Secretary New Zealand.

No. 3.

No. 33. CIRCULAR from the Hon. the COLONIAL SECRETARY to SUPERINTENDENTS of PROVINCES.

SIR,—

Major Palmer, R.E., who came to this colony in charge of the party sent out to observe the Transit of Venus, has kindly undertaken to examine and report upon the state of the surveys in New Zealand, with a view to assist the Government in the steps necessary to the initiation of the thorough system of trigonometrical surveys which it was decided to undertake during the last session of Parliament, and for the preliminary expenses of which a sum of £5,000 was voted by the House.

Major Palmer's tour will commence about the 20th January, extending till late in the following month.

I trust, therefore, that your Honor will instruct the Chief Surveyor of the Province of to afford Major Palmer every information in his power; and also to have prepared for him on his arrival—

1. A concise but explicit account of the manner in which each branch of the survey under his control is executed. This will include particulars as to base lines and system of triangulation where such exist, determinations of true meridian, execution of detail survey, plotting, drawing, levelling, computation of areas, &c., &c.
2. A small diagram of the state of the triangulation of the province on 31st September, 1874.
3. A small diagram showing the state of each stage of the field survey, and each stage of the mapping, on 31st December, 1874.
4. Specimens of maps and plans on every scale adopted by the province.
5. A return showing the state of original MS. surveys, and how far such surveys would be available for replotting if required.
6. A return of the number and condition of those surveying instruments and stores which would be available for secondary or tertiary triangulation.
7. Return of persons employed (or who might be employed) in trigonometrical work, showing their qualifications and salaries, usual field allowances, if any, &c.
8. Return showing the average cost per acre, as far as it is known, of each branch of survey work in the province.

I have, &c.,

His Honor the Superintendent . DANIEL POLLEN.

No. 4.

His Honor the SUPERINTENDENT, Wellington, to the Hon. the COLONIAL SECRETARY.

SIR,— Superintendent's Office, Wellington, 5th January, 1875.

I have the honor to acknowledge receipt of your circular letter dated the 30th ultimo, informing me that Major Palmer has kindly undertaken to examine and report upon the state of the surveys in New Zealand, with a view to assist the Government in the steps necessary to the initiation of a thorough system of trigonometrical surveys, and asking me to instruct the Chief Surveyor of the province to have certain information prepared for Major Palmer on his arrival.

In reply, I beg to inform you that I shall be happy to afford every information in my power, and have instructed the Chief Surveyor to have the information asked for in your letter prepared for Major Palmer on his arrival in Wellington, on or about the 20th January.

I have, &c.,

WILLIAM FITZHERBERT,

The Hon. the Colonial Secretary, Wellington. Superintendent.

No. 5.

His Honor the SUPERINTENDENT, Canterbury, to the Hon. the COLONIAL SECRETARY.

SIR,— Superintendent's Office, Christchurch, Canterbury, 6th January, 1875.

I have the honor to acknowledge the receipt of your circular letter No. 33, of the 30th ultimo, in which you inform me that Major Palmer has undertaken to examine and report upon the state of the surveys in New Zealand, with a view to assist the Government in the steps necessary to the initiation of the thorough system of trigonometrical surveys, which it was decided to undertake during the last session of Parliament, and request me to instruct the Chief Surveyor of the province to afford Major Palmer every information in his power.

In reply, I have the honor to inform you that instructions have been given to the Chief Surveyor, in accordance with your letter.

I have, &c.,

W. ROLLESTON,

The Hon. the Colonial Secretary, Wellington. Superintendent.

No. 6.

His Honor the SUPERINTENDENT, Nelson, to the Hon. the COLONIAL SECRETARY.

SIR,— Superintendent's Office, Nelson, 6th January, 1875.

I have the honor to acknowledge the receipt of your circular letter of the 30th December, informing me that Major Palmer, R.E., has undertaken to examine and report upon the surveys in New Zealand, and requesting me to instruct the Chief Surveyor to afford Major Palmer every information in his power, and also to have prepared for him, on his arrival, certain details and plans showing the existing state of the surveys in this province.

The Chief Surveyor has, in accordance with your request, been instructed to prepare the required information, so far as he is able to do so, and also to give every assistance in his power to Major Palmer in the performance of the task he has undertaken.

I have, &c.,
OSWALD CURTIS,
Superintendent.

The Hon. the Colonial Secretary, Wellington.

No. 7.

His Honor the SUPERINTENDENT, Taranaki, to the Hon. the COLONIAL SECRETARY.

SIR,— Superintendent's Office, New Plymouth, 7th January, 1875.

I have the honor to acknowledge the receipt of your circular, number and date quoted in the margin, in reference to Major Palmer, R.E., who came to this colony in charge of the party sent out to observe the Transit of Venus, having consented to examine and report upon the state of the surveys in New Zealand, &c.; and you ask me to instruct the Chief Surveyor of this province to afford Major Palmer every information, &c. No. 33, 30th Dec., 1874.

In reply, I beg leave to inform you that your request shall be attended to.

I have, &c.,
F. A. CARRINGTON,
Superintendent.

The Hon. the Colonial Secretary, Wellington.

No. 8.

His Honor the SUPERINTENDENT, Westland, to the Hon. the COLONIAL SECRETARY.

SIR,— Superintendent's Office, Hokitika, 9th January, 1875.

I have the honor to acknowledge the receipt of your circular noted in the margin, requesting me to instruct the Chief Surveyor to afford Major Palmer every information in his power with regard to the present condition of the surveys in the province. No. 33, 30th Dec., 1874.

In reply, I beg to state that I shall be most happy to afford Major Palmer the fullest information on the matters referred to, and the Chief Surveyor has received instructions to that effect.

I have, &c.,
JAMES A. BONAR,
Superintendent.

The Hon. the Colonial Secretary, Wellington.

No. 9.

His Honor the SUPERINTENDENT, Otago, to the Hon. the COLONIAL SECRETARY.

SIR,— Superintendent's Office, Dunedin, 15th January, 1875.

I have the honor to acknowledge the receipt of your circular letter of number and date quoted in the margin, informing me that Major Palmer, R.E., has kindly undertaken to examine and report upon the state of the survey in New Zealand, and requesting that he may be furnished with certain information by the Survey Department of Otago. No. 33, 30th Dec., 1874.

In reply, I have to state that the department is now so overworked in the preparation of surveys of land all over the province—lands which are urgently required for settlement, and which have been advertised as open for sale during the next three months—that it will be impossible to furnish the various particulars alluded to in your circular. At the same time, if I might be allowed to express an opinion, I would venture to observe that, in as far as this province is concerned, I fail to see that any great good can result from Major Palmer's report. The Provincial Government has already extended a trigonometrical survey, sufficiently accurate for settlement and record, over seven millions of acres of its best territory; and if there is any reason to doubt the practical accuracy of this work, the examination thereof, and of the sectional survey (works which have cost the province upwards of £150,000), must in my opinion be done leisurely and thoroughly, both in the office and in the field, in which case it will be advisable that a surveyor of colonial reputation and experience should either undertake or be associated with the investigation.

I have, &c.,
J. MACANDREW,
Superintendent of Otago.

The Hon. the Colonial Secretary, Wellington.

No. 10.

The Hon. the Colonial Secretary to His Honor the Superintendent, Otago.

Sir,— Colonial Secretary's Office, Wellington, 25th January, 1875.

I have the honor to acknowledge the receipt of your letter of the 15th instant, in which, in reply to the circular letter from this office, No. 33, of the 30th December last, upon the subject of the contemplated inquiry and report by Major Palmer on the state of surveys in New Zealand, you inform me that the Otago department is so overworked in preparing surveys of lands for sale, that it will be impossible to furnish the various particulars asked for.

You state that, as far as Otago is concerned, you fail to see that any great good can result from Major Palmer's report; and conclude by expressing your opinion that if there is any reason to doubt the practical accuracy of the trigonometrical survey which has been made by the province, the examination thereof, and of the sectional survey (works which have cost the province upwards of £150,000), must be done leisurely and thoroughly, both in the office and in the field, in which case it will be advisable that a surveyor of colonial reputation and experience should either undertake or be associated with the investigation.

2. I desire in the first place to point out to your Honor that the duty which, at the request of the Government, Major Palmer has so kindly undertaken to perform is not to criticise the state of the surveys in the province of Otago, which have notoriously been conducted by officers specially qualified for the duties they had to perform, but to report generally on the state of the surveys throughout the colony, as a preliminary step towards carrying out the wishes of the Legislature as expressed during the last session of Parliament, by utilizing what has already been done in some of the provinces, including Otago, in the initiation of a general system of survey by triangulation on an uniform basis throughout both islands. This is a work the great value and paramount importance of which no one who has thoroughly considered the subject has ever denied; and the Government considered themselves fortunate in the opportunity of securing the services of an officer of Major Palmer's reputation and experience, gained, as your Honor is doubtless aware, by long service in the Ordnance Survey of England, to make a preliminary report upon the surveys in the colony prior to his return to Europe at the termination of the special service on which he came to this colony.

3. I trust, therefore, that, under the circumstances, if the Survey Department in Dunedin should, from press of work, be unable to furnish Major Palmer with all the detailed information he asks for, your Honor will at least be able to direct that the maps of the province shall be placed at his disposal, and that such information as the officers of the department may be able to furnish shall be available to him on his arrival at Dunedin.

4. It is perhaps hardly necessary for me to add the assurance that if, either from Major Palmer's report or from any other cause, it shall now or hereafter appear necessary to revise the system of surveys which has heretofore obtained in Otago,—a contingency which as at present advised the Government do not in the least contemplate as probable,—such revision will be undertaken leisurely and thoroughly, both in the office and in the field, and by a surveyor or surveyors of sufficiently assured professional reputation.

I have, &c.,
W. H. Reynolds,
(In absence of the Colonial Secretary).

His Honor the Superintendent of Otago.

No. 11.

His Honor the Superintendent, Otago, to the Hon. the Colonial Secretary.

Sir,— Superintendent's Office, Dunedin, 5th February, 1875.

No. 35, 25th Jan., 1875

I have the honor to acknowledge the receipt of your letter of the number and date quoted in the margin, on the subject of the inquiry and report by Major Palmer on the state of surveys in New Zealand, and to acquaint you that the maps of the Survey Office have been placed at that gentleman's disposal, and such information as he required as to the state of surveys in this province has been given him.

I have, &c.,
J. Macandrew,
Superintendent.

The Hon. the Colonial Secretary, Wellington.

No. 12.

His Honor the Superintendent, Hawke's Bay, to the Hon. the Colonial Secretary.

Sir,— Superintendent's Office, Napier, 11th January, 1875.

I have the honor to acknowledge the receipt of your circular letter No. 33, of the 30th December, and in reply beg to inform you that the Chief Provincial Surveyor has been requested to get ready for Major Palmer's information such of the reports, diagrams, &c., as the

staff in the Survey Office can prepare. Mr. Weber will also furnish such other information as may be in his power.

I have, &c.,
J. D. Ormond,
Superintendent.

The Hon. the Colonial Secretary, Wellington.

No. 13.

Major Palmer, R.E., to the Hon. the Colonial Secretary.

Sir,— Wellington, 13th April, 1875.

I have the honor to forward you herewith a correct copy of my report on the surveys, signed by myself.

It is now ready for publishing.

I have, &c.,
H. S. Palmer,
Major, R.E.

The Hon. the Colonial Secretary, Wellington.

REPORT.

Major Palmer, R.E., to the Hon. the Colonial Secretary.

Sir,— Wellington, 5th April, 1875.

I have the honour to inform you that—in accordance with the request made to me in your letter of the 23rd of last December, that I should inspect and report to Government upon the state of the surveys in New Zealand, with a view to the introduction of a thorough trigonometrical system—I have visited, with one exception, all the chief Provincial Survey Offices in the colony, and the head office in Auckland of the surveys carried on under the General Government. In the course of this inspection I have sought to acquaint myself as fully as possible with the details of the work, both past and present, by examining the maps, field-books and other office documents, by collecting statistical information under various heads, and by eliciting all else that I needed to know from conversation with the officers in charge. To these gentlemen my thanks are due for the readiness and courtesy with which they helped me in my inquiry. I have also, during this somewhat extensive tour, seen a good deal of the colony at many points in both islands, and have thus been able to judge in person of its general character as an area for trigonometrical survey.

In order to comply fully with the wishes expressed in your letter, it will be best for me to begin this report with a sketch of the history of each survey separately, and of the manner in which it is being carried on, giving also my opinion of its worth, and a statement of progress made; and I may add that the facts which will be set forth in these accounts have been verified by the respective Chief Surveyors.[1] I shall in this way prepare the ground for subsequent remarks on the best means of ameliorating the present state of the surveys, and setting on foot a sound general system.

The only head office which, from want of sufficient time, I was unable to visit is that of the Province of Taranaki; but the progress of surveys there has been so small that the omission of a detailed notice of them will not sensibly affect the general question.

I.—GENERAL GOVERNMENT SURVEYS.

To this branch—presided over by Mr. T. Heale, Inspector of Surveys, who has his head office in Auckland—belong the surveys of Native and Confiscated lands throughout the colony. For convenience of description, the work may be divided into four heads:—

(1.) Surveys of Native lands for the operations of the Native Lands Court.
(2.) Surveys of Confiscated lands for purposes of sale.
(3.) Boundary surveys of blocks of land, for acquisition from Natives.
(4.) Triangulation in the North Island, as far as is required for the above surveys.

Surveys of Native Lands.

By the provisions of the Native Lands Acts, Natives wishing to be placed securely in tenure of their lands, whether individually or in groups or families, are empowered to obtain a Crown grant through the Native Lands Court, on the production of a survey by a sufficiently qualified person showing the position and boundaries of the property claimed, and on proof to the Court's satisfaction of their title to that property. Though the administration of Native lands has always

[1] Except in Nelson only, where they have been verified by the chief draftsman, Mr. Gully, who was deputed in the Chief Surveyor's absence to furnish me with necessary information.

been under the General Government, a special survey officer was not at first appointed; a sum was paid to the Provincial Surveyor, to test and certify to the maps as they came in. This service was not usually understood to include collating them on any general map, and, even as regards examining the plotting, it was often very perfunctorily performed. When, in 1867, Mr. Heale was appointed to the post of Inspector of Surveys, some hundreds of maps of detached pieces of lands in various parts had thus been accumulated, and the work of surveying claims scattered all over the country was rapidly going on. Most of these surveys had been made in a rude and unsystematic manner, by a class of surveyors who are said to have been very imperfectly acquainted with their profession. So great, at that time, were the fears and prejudices which, from causes that need not be dwelt upon here, the Natives felt towards surveyors in general, and particularly those of the Government staff, that it had been thought best to allow them to employ men of their own choosing. The only check—and it was a very slight one practically—upon the trustworthiness of these men was, that they were required to be licensed by the Government.

A general system thus became impossible, and the work fell into the hands of an incompetent set, many of them utterly ignorant of the commonest rudiments of sound scientific surveying. It was accordingly done, though at frightful cost to the Natives, in a vague and slovenly style, and by methods which did not admit of its being properly tested except by doing it over again. The geographical basis to which many of the surveys were referred was that of the Naval hydrographers, often seriously in error, especially in inland waters. No attempt had been made to connect all the various parts accurately together by reference to common points, or to collate them on general index maps. The work, in short, was so bad, and the descriptions of locality were often so vague, that not only was the whereabouts even of some of the claims uncertain within several miles—contiguous estates having been occasionally placed far apart—but there was no security that the same land might not be granted two or three times over to different persons. Blunders in detail too were numerous and large. Very often it happened that, owing to gross errors in detached surveys, claims were turned upside down, mapped altogether in the wrong places, and Crown granted accordingly. The method of survey was a periphery traverse[1] of the boundaries of the claim, which were commonly very sinuous and ill-defined, while the claims themselves were of all shapes and sizes. This traverse was sometimes made with a theodolite, but much oftener with a compass only; and in every case the work was drawn, and all bearings referred, to the magnetic meridian which might happen to be indicated by the needle of a small theodolite or compass. Bearing in mind that such needles cannot easily be read within 1°, and that, besides the regular daily and yearly changes of magnetic declination, the compass is liable to large accidental and local causes of disturbance, sometimes affecting it to the extent of 15° or 20°—such disturbances being, I believe, peculiarly frequent in New Zealand,—you will at once see how little trust could be placed in work done on this lame and makeshift plan, and how much twisting and humouring and falsification must have been resorted to in closing the traverses, and in the juxtaposition of contiguous surveys. The process, moreover, was not only unsound, but excessively slow and costly; for it required all the traverse lines which led through forest or other high vegetation to be cut as well as chained. Large sums of money were thus paid for cutting lines which after all were seldom properly surveyed, and fully one-half of which need not have been cut at all had there been a small triangulation with which to connect the terminal points.

In order to remedy this deplorable state of things, and to guard in future against the risk of gaps and overlaps, Mr. Heale at once set to work to build up a general index map, fitting in upon it as he best could the detached maps already drawn. Then, to insure that all future surveys should be laid down at least approximately in their true positions, a rule was made that titles should be refused, or at least delayed, in every case where the surveyor had not connected his work either with previous surveys or with some one or more well-defined neighbouring points or features which might be afterwards fixed. Then, in 1868, a triangulation was set on foot,[2] to be ultimately extended over the area in the North Island chiefly occupied by Native lands; and provision was made for gradually connecting previous and all future surveys with it, so that each one might eventually be brought accurately into its place. About this time also, a well-prepared manual for the guidance of his own staff was issued by Mr. Heale, laying down rules and principles for an accurate and uniform system of trigonometrical and detail surveys.

Against the evils of the Native-surveyor system, however, he for a long time struggled in vain: it is only within the last few months that the entire control of the method of survey and employment of staff has come into his own hands, and a beginning been made of a better state of things in this quarter.

It follows that the surveys executed since 1867, amounting, with those done previously, to more than 3,000 in number, have partaken of most of the inherent defects of the earlier ones. So long as the surveyors continued to be employed and paid by the Natives, it was not possible to insist on their doing more than they were paid for, *i.e.* just so much as was absolutely required by the rules of the Court. In a few cases men of the better class were prevailed upon

[1] Showing, of course, all features crossing the traverse lines.

[2] This was the beginning of regular trigonometrical survey: it was interrupted in 1869 by war, but resumed in the following year. A small triangulation, however, had previously been made by Mr. Heale in 1867, to correct an enormous discrepancy of four miles on the provincial map of Auckland, between Hokianga and the Bay of Islands.

to show some of the interior detail on their plans, or to connect their work with any trigonometrical points which might be easy of access. But these were exceptions, and the staff and the general style of working remained much as before. Nevertheless, by employing his own trigonometrical observers in making the necessary connections, by a close scrutiny of the surveyors' work, and by a great deal of painstaking labour, Mr. Heale has at length succeeded in bringing these surveys of the last seven or eight years into a fair state. Hundreds of cases of errors, and of gaps and overlaps arising from them, were detected in the course of this investigation and sent back for correction; and Mr. Heale is of opinion that the residual errors are now so small that no great future difficulties need be apprehended, and that nearly all of the work would, with some little rectification, be available for replotting on new sheets if required. These remarks, however, scarcely apply to the surveys made before 1867, which do not lie together, and therefore could not be resurveyed *en masse:* they have since been surrounded in most cases by other surveys, and their errors are approximately known. Perhaps no further special inconvenience will arise from them, but there are very few estates in which readjustment will not be required. Many of the plans are deficient in information, and the field-books are missing. The descriptions in Crown grants, moreover, are so loose that they could hardly be appealed to to establish boundaries; of these, possession, and oral evidence of original marks on the ground, must be the practical proofs.

The system laid down by Mr. Heale for the survey of Native claims will no longer, it is to be hoped, be so difficult of enforcement as hitherto. It insists, as its main features, on the connection of every survey with at least one, and as many more as practicable, of the trigonometrical stations; on the verification of common boundaries where two surveys join; on the abandonment of all compass bearings, and of the practice of cutting straight undefined lines of a traverse if the terminal points can be accurately fixed without cutting; on keeping field-books in ink, or at least in metallic pencil; and on the survey of all well-marked internal natural features, with such supplementary sketching and filling-in as shall furnish details for a fair topographical map. The surveyor draws the plan himself, on scales varying from four to eighty inches to the mile according to the size of the claim. The plotting is then checked in the office by the details given on the plan; edges common to former surveys are compared, and the work collated on the index map. The field-books, however, are not called for unless the plan is deficient in information. If errors are found, the work goes back for correction. The maps, when passed, form the real records, the indexes being only used for compilation and reference. The plans on Crown grants, which are reduced copies of the originals, show linkages but not bearings, and enough surrounding detail to identify the parcel and illustrate the description of boundaries in the grant, which also states the approximate acreage. As yet, no maps have been published.

On the whole, I gather that out of the 4,711,556 acres which make up the total area of Native claims hitherto surveyed in New Zealand, but little if any has been done with such accuracy and detail as would enable it to form part of a general cadastral survey. It is difficult to specify exactly how much is good and how much bad; though there can be little doubt that the least trustworthy surveys are those done before 1867, and the best some of those done recently in Auckland and Hawke's Bay in connection with the new triangulation, and those in Canterbury and Otago. Probably, however, large errors will occasionally be found in all parts, as outlying and surrounding surveys come to be closed in. The original danger was overlap; this, I think, Mr. Heale has effectually guarded against; and the elasticity of Crown grants has now been so well established that perhaps no great inconvenience need be anticipated from other kinds of error. If a sound system be introduced, and made the basis of Land Transfers, possession and documentary titles may gradually be brought into harmony as required, without any special active provision for the purpose.

The abstract of the Native claims surveyed and mapped is as follows:—

	Acres.
Auckland	2,330,760
Hawke's Bay	1,124,000[1]
Wellington	1,235,027
Canterbury and Otago	21,769
Total	4,711,556

Surveys of Confiscated Lands.

While, as I have shown, the Native lands surveys have not been executed hitherto in a satisfactory manner, still less can be said in favour of the section surveys of the Confiscated lands, which amount in all to about 1,916,000 acres, extending over large tracts in the Waikato[2] and Bay of Plenty districts. None of them are good; indeed those in the Waikato are as bad as bad can be, done mostly by contract several years ago, plotted to all kinds of compass meridians, unchecked, and unconnected. The greater part of these lands, nevertheless, have either been allotted, or sold, or Crown granted, on the basis of those worthless surveys. In one part the

[1] There is a discrepancy between the quantities returned by Messrs. Heale and Weber (Hawke's Bay) which I could not reconcile. I have rectified it as well as I could.

[2] The Waikato surveys were mostly in fifty-acre sections.

form of a triangulation was gone through, but no real use seems to have been made of it. As an example of the ignorance which characterized this latter work, it may be well to mention that an attempt was made to find the true meridian by directing a theodolite to the stars Alpha and Gamma *Crucis* when they appeared to be in the same vertical—an observation which, even if it could be accurately made with such means, would produce an error in azimuth of more than 3°. But although the maps of these so-called surveys are now in the custody of the Inspector of Surveys, he is not responsible for the quality of the work, of which nearly all had been done before he took charge. Small surveys of remnants or "ullages" have since been added under his direction, and attempts have been made to correct those cases of faulty work which have been brought to his special notice. The result, in every such instance, has been to disclose the most alarming blunders and distortions, and to cast discredit on the whole mass of the work. Often the Crown grants utterly fail to give a true description of the land conveyed: cases of five or six-sided plots having been granted as rectangles are not uncommon.

It has transpired, also, that numbers of lines were charged and paid for in the course of these surveys as cut lines which had not been cut at all, an additional proof of the carelessness with which the work must have been conducted. All efforts to incorporate the surveys accurately on the index maps, even after connection with trigonometrical points, have failed: some parts have been fitted in as they best could be, when absolutely required for map-making purposes; but there is no hope that they can ever be put on a proper footing except by complete revision, or until, by systematic replotting on new sheets, any good work that exists may possibly be separated from the bad. The maps, drawn on the scale of eight inches to a mile, are old and much worn; it is hardly necessary to add that they are nearly worthless as accurate records.

Boundary Surveys of Blocks.

This branch of work, which has only come into operation within the last few months, consists simply of a periphery traverse of the boundaries of any block about to be acquired, Natives and Government Agents agreeing on the ground as to the course of the boundary lines. The traverses are executed with a theodolite, connected with trigonometrical points either at the time or afterwards, and mapped on the scales of eight or four inches to a mile. About 520,000 acres under this class are now being surveyed.

Triangulation.

The triangulation conducted by Mr. Heale is mainly of the secondary order, the sides averaging about eight miles in length. It is in two parts, covering together an area of some 10,623,200 acres, in the Provinces of Auckland, Hawke's Bay and Wellington. These parts are long and straggling, owing in the one case to the shape of the land, in the other to the course of survey demanded by circumstances. The northern part rests on a base about four miles long, near Kaipara; the southern on a base about three miles long, near Napier. At these base lines, initial azimuths were determined by circumpolar stars at elongation, or by the method of high and low stars; and initial latitudes by meridian zenith distances of high stars, the observations being made with ten-inch instruments. At Kaipara there were ten determinations of azimuth, differing about 19 seconds among themselves, and nineteen of latitude differing 21 seconds. At Napier there were ninety determinations of latitude, differing about 29 seconds *inter se;* and true azimuth was found from several nights' observations with a ten-inch theodolite.

The Kaipara base was measured three times with standard chains in 1870, the greatest difference of measures being about twenty inches. The Napier base was measured three times in 1871, with a 66-feet steel band and straining apparatus. It was divided into two sections, each about one mile and a half long; and, though a single measurement of a section took but one day—so quickly was the work done, after much preparation and previous practice—yet the published results exhibit a very satisfactory degree of uniformity in the measures, and show that due care and vigilance were used: one-third of a link, or about $2\frac{3}{4}$ inches, was the greatest difference between the measures after correction for temperature. It appears, then, that the Napier work is a good deal the more trustworthy of the two, and if any discrepancy is found when the triangulations come to be connected together, superior weight will be given to the southern section. Of the absolute value of the Napier measure in feet there is less satisfactory proof. The band was compared with the 66-feet standard on the stone basement of the Supreme Court at Auckland, which had been originally laid down with a beam-compass from a standard yard at 62° Fahr. Mr. Heale thinks that the Auckland standard is no doubt correct within 1-25th of an inch, which would correspond with a probable error of about three inches per mile. Though this is fairly good, it falls short of a high class of accuracy for purposes of base-measurement; and, viewing the triangulation as a whole, its chief value for ulterior uses will no doubt lie in the observations of its angles, which have been made with good instruments of ten and twelve-inch circles, and with considerable care, three arcs at least having been used in every case, and all observations registered and preserved. The trigonometrical stations, too, have been well marked, and descriptions kept. For immediate purposes, residual errors of observations of angles have been corrected by a method closely resembling that devised by Sir A. Waugh, so as to make the various figures, regarded as parts of a plane survey, geometrically exact. The probable error, from all sources, of the Napier triangulation thus reduced is

set down by Mr. Heale, and I think justly so, as not greater than one foot in a mile. Of the errors of latitude and azimuth it is difficult to form an estimate: they are probably small, however, and in any case errors of this class would not prejudice the future usefulness of the work. The latitudes and longitudes of stations are computed for geographical purposes; but in the index maps on the scale of two inches to a mile, the work is simply laid down on a system of parallels and perpendiculars referred to the meridian of Auckland.

A topographical map on the scale of four miles to an inch is in course of preparation.

II.—PROVINCIAL SURVEYS.

Auckland.

About 2,400,000 acres in this province, in large detached parcels, nearly all of them situated to the north of the River Waikato, come under the head of Provincial lands. Some 1,474,000 acres of this area have been in a certain fashion sectionally surveyed; 850,000 acres have been surveyed, in blocks only, by rough boundary traverses. At present but little is being done, and there is no Chief Surveyor or regular salaried staff; and the facts for this report were supplied to me by the Waste Lands Commissioner, Mr. Tole, who recently held for a short time the office of Chief Surveyor.

The history of the Auckland surveys is one of lamentable confusion and neglect, and want of system and accuracy. In 1856 and following years, large blocks of Crown lands, from about 15,000 to 60,000 acres in extent, were from time to time thrown open for free selection and sale in those parts of the province which were suited for immediate settlement. The boundaries of these blocks were usually surveyed[1] only by rough compass traverses, and laid down to independent magnetic meridians: no attempt was made to connect the various blocks together, or to determine their positions separately, or to find a single true direction, or to establish trigonometrical stations within them as a basis for interior surveys. A block having been thrown open, selectors were allowed to take up sections, usually rectangular, anywhere within it, not less than eighty acres in extent, and to have them surveyed by men of their own choosing. The section surveys were most of them made by contract, with compass and chain; and they were seldom inspected or tested. As a single section might be taken up anywhere in a block, and as there was no obligation on the surveyor to connect his work with previous surveys, or with boundary lines, or with any fixed points whatever, it often happened that the whereabouts of a section could only be guessed at, until in course of time intervening areas became filled up, and a sort of connection formed. The results of this miserable system may be easily imagined—constant errors of survey in the first instance, leading, in the way I have already described, to overlaps and discrepancies between the maps and the ground, to a fair prospect of having to do much of the work over again, and to the certainty of a rich future crop of trouble, expense, and litigation. It is almost incredible that such a reckless mode of dealing with the lands should have been allowed to prevail for a single week; yet it did prevail for two years without any attempt at improvement, and under it large areas were sold and granted.

Later, in 1858, under a new land-law which required survey before selection or sale, an effort was made to have all section surveys tied upon well-marked points or temporary stations within the block, presumably with the idea of using these points at some future time as the stations of a minor triangulation. But in 1863 even this feeble move in the right direction had to be given up, partly from expense, partly from pressure of work, both of which were increased at this time by the necessity, under the new system, of laying out, and frequently cutting, all lines of road as well as section boundaries before selection or sale. The cost, indeed, of these latter operations, together with the practical working of certain provisions of what was termed the "forty-acre immigrant system," formed, ere long, excuses for introducing a new mode of preparing land for sale, to which even the old one with all its faults was scarcely if at all inferior. In a word, the evil system of "paper surveys" was resorted to as a cheap expedient. Blocks of land from 8,000 to 15,000 acres in area, with boundaries roughly traversed, were subdivided on the ground, by means of road traverses and main transverse lines, into blocks of from 1,000 to 1,500 acres. These traverses having been plotted on the surveyor's plan, *by himself*, sections were schemed out on the plan, in the office, of sizes suited to the wants of intending settlers, and sold and granted accordingly, by their theoretical dimensions. But owing to the generally loose style of the work, when these paper sections came to be laid out on the ground, the theoretical lines would seldom chain truly, and more or less adjustment became necessary. In this way direct and sometimes serious discrepancies between plan and ground must have been systematically introduced. All or nearly all of these surveys were made by contract, often with compass and chain only; and any field inspection on behalf of Government was of the most cursory kind, more pains apparently having been given to determining that work for which payment was claimed had really been done, than to seeing also that it had been accurately done. Thus the work, badly begun and never really improved upon, has drifted on from year to year, error being piled upon error as each new survey came to be engrafted on previous ones, and the evil consequences, as might be expected, becoming more embarrassing every day. Matters have now reached a stage which Mr. Tole considers to be beyond redemption by

[1] These block-boundary surveys were made by the Colonial Government, before handing the blocks over to the Province.

professional skill, except at considerable cost. No doubt there have been certain extenuating causes, such as want of funds, hurry caused by pressure for settlement, Native difficulties, and physical obstacles to survey. But as a matter of fact, whatever the causes may have been, I find that in system, and to some extent in execution, the surveys from beginning to end have been radically bad, and that consequently many of the record maps are next to useless for public purposes.

In order to illustrate the serious results of bad surveys as affecting individuals and the State, and to give point to what I have said on the general character of the Auckland surveys, I need only refer to the well-known case of Kelly *v.* O'Neill, in which, owing to a gross blunder in an old survey, a considerable piece of land at Waitakerei was granted twice over to different persons, and the second grantee, who has been ejected, claims £10,000 as compensation from the Government. In many other instances, large errors, both of displacement and areas, have been detected in the surveys and grants, and formed the subject of disputes and litigation; and the maps by which the lots in the town and suburbs of Auckland[1] were granted are well known to differ very seriously from the truth. An attempt has lately been made to engraft some of the provincial surveys on a skeleton map (two inches to the mile) supplied by Mr. Heale, containing the coast line, trigonometrical points, and his own work plotted in position; but it has resulted in showing large gaps and overlaps and discrepancies in many cases. Very possibly some parts of the old detail surveys may hereafter prove to be pretty accurate in themselves, and fall fairly into position when adjusted to the right meridian. They, however, cannot be tested until the work has been properly connected with the triangulation and replotted; though, as the whole of the field-books were unfortunately destroyed by fire in 1872, satisfactory replotting would be impossible in those cases where the plans do not show the survey details. In the same fire were lost the field-books and diagrams of a small triangulation of about 60,000 acres, the only trigonometrical work which the province had done. But, as the meridian in this case is said to have been found by the same method that I described in the section on Confiscated Lands, the character of the work was probably such that the loss of these records is of little moment. The manuscript plans of surveys, which form the record maps, were however rescued. They are mostly drawn on the scale of twenty inches (towns), eight inches (sections), and four inches (blocks) to the mile; and compiled on indexes at one, two, and four inches to a mile. Altogether about 1,474,000 acres of town and section surveys have been drawn, and 850,000 acres of block surveys. The whole of this work will need more or less revision. Grants show linkages and approximate acreage, but not bearings. There are no published maps.

As a general summary, then, of the subdivision of the land and the state of all surveys, colonial and provincial, in Auckland, we have,—

Subdivision of the Land.

		Acres.
Native Lands	Surveyed and mapped	2,330,760
	Under survey for purchase	520,000
	Undealt with	9,833,240
Confiscated Lands		1,916,000
Provincial Lands		2,400,000
Area of Auckland		17,000,000

State of Survey.

Triangulated—	
General Government	7,500,000
Surveyed, and Mapped—	
Native claims	2,330,760
Confiscated Lands	1,916,000
Provincial Lands—Town and section	1,474,000
Block	850,000
Total surveyed	6,570,760

All these surveys need some revision or verification or additions, to fit them for cadastral maps.

Hawke's Bay.

Though the surveys of this province are on the whole in a rather more satisfactory state than those of Auckland, the earlier work partook in a great measure of the same kinds of defects and errors, and was characterized by similar want of system and foresight. When, in 1858, the Government of the newly-formed province began to acquire large blocks of land by purchase, these blocks, after their boundaries had been roughly perambulated, often with compass only, and laid down to magnetic meridians, were leased, either in whole or part, as pastoral runs, averaging about 10,000 acres each; and at the same time were thrown open for free selection before survey in rural allotments of from forty acres upwards. In most of the rural blocks small detached

[1] See, for example, the map appended to the Report of the Secretary for Crown Lands, 1872.

triangulations were executed, generally by contract also, with base lines from one to two miles long chained three or four times with a common surveying chain, and sides from two to five miles long, the angles being observed with five-inch theodolites. There were no determinations of true position, nor of meridian; here, as elsewhere, recourse was had to the vague method of magnetic bearings. Nor were the various triangulations connected together, as Native lands intervened; the only basis on which they were collated was that of the Naval Coast Surveys. As many years generally elapsed before the whole of a block was taken up, the section surveys were accordingly spread over a long period, and thus were made by several different men, most of whom took the work at low contract rates and paid little attention to accuracy. If there was no former survey at hand for him to start from, or if, as often happened from the frequent burning of the fern, no pegs could be found,[1] the surveyor would perhaps connect his starting point with some of the trigonometrical stations; but it is not at all clear that the whole of the detail surveys were systematically founded on the triangulation, or that they were systematically corrected or tested in the office or field.

You will see from this description that the work, if a little better than some of that in Auckland, nevertheless had very many inaccuracies and shortcomings. I need not enumerate them all; they are just such as I have already described at some length, the most serious perhaps being that in very many cases errors and imperfections and discrepancies have crept into the record-maps and Crown grants, and that work done in this way is really work to a great extent wasted, whether for cadastral or geographical purposes. The errors of acreage are not perhaps so large as might have been feared, very few cases having come to light where they amounted to one per cent.;[2] and then the error has nearly always been on the side of the purchaser.[3] Their number also is less than might be supposed, inasmuch as several of the large pastoral licenses have since become freeholds, by sale from paper surveys, and remained in the same hands. Owing to these causes no great legal difficulties have yet arisen, and perhaps none such need be apprehended. Nevertheless, the errors are sufficiently many and large to create a good deal of trouble and inconvenience and public distrust, and to prejudice the working of the Land Transfer Act in a manner which has already caused bitter complaint. Perhaps the chief difficulties hitherto have been in the town of Napier, part of which covers a rough site broken into hills and steep narrow valleys. The first survey, made nineteen or twenty years ago, was rather careless and inaccurate, and the suburban lots of from two to fifteen acres in this part of the town, seem to have been especially ill laid out. Now that they are being subdivided and brought under the Land Transfer Act, the errors of survey are cropping up; and discrepancies which were of little moment when the land was worth from £2 to £3 per acre are regarded much more seriously now that its value has enormously increased. Here again, however, the discrepancy is in most instances in favour of the purchaser.

The system which I described above is unfortunately that under which the greater part of the Hawke's Bay surveys have been done. Slowly, within the last few years, some improvement has taken place, Care is now taken that proper connections are made with former surveys and (since 1872) with Mr. Heale's triangulation wherever practicable, that details are procured for a topographical map, and that the plotting and areas are checked in the office, and the field-books kept. The contract system, however, still prevails, there being no staff surveyors whatever, and there is very seldom any field examination.

Altogether, about 1,126,800 acres have been surveyed and 320,000 acres triangulated by the province. But the triangulation, from its rough and disconnected character, was of little use; nor was the detail generally, as I have explained, thoroughly connected with it. Hence, the only surveyed work which has been incorporated with a systematic triangulation is the small quantity, done since 1872, which has been tied upon Mr. Heale's triangles; this does not exceed 150,000 acres; the whole of the rest remains to be connected, and there can be no doubt that, on such connection being made, much if not all of it will need revision of some kind to set it right. Mr. Heale's triangles already overlap a large part of the area triangulated by the province, and the rest will also need to be absorbed by more perfect work; so that, for a summary of progress, it may all be omitted, and we shall have,—

	Acres.
Triangulated, General Government	2,242,560
Provincial Lands—	
Section surveyed and connected with triangulation	150,000
Surveyed, but needing connection and revision	976,000
Unsurveyed	800,000
Native Lands—	
Native claims surveyed for Native Lands Court	1,124,000
Total area of Hawke's Bay	3,050,000

[1] Even this system—namely that of starting from old pegs—is dangerous to accuracy unless excessive care be used, as boundary pegs are often wilfully removed.

[2] Up to April, 1873, thirty-five such cases had been discovered and rectified. It was considered that discrepancies up to one per cent. were covered in the words "more or less" in Crown grants.

[3] Generally on account of a liberal allowance having been made at creek and river margins, &c.

No maps have as yet been published by the department. The scales of manuscript maps are respectively eight and four inches to the mile for suburban and rural lands. Neither they nor the record maps prepared from them on the scale of four inches to the mile are drawn on any regular system of sheets or projections; they are just laid down as best suits the paper. The scale for towns is three chains to an inch. Many of the records are in a very worn state, no duplicates having been made, on account of expense. The department, indeed, is generally languishing—not from want of ability or energy on the part of its chief—but from want of money to do much that is very urgently needed. The sections are numbered consecutively, in each of twenty-two Crown-grant Districts, as granted; except in towns, where they are numbered upwards contiguously. The grants show linkage and approximate acreage, but not bearings. The field-books of the old surveys appear to have been kept, and many of them would doubtless be useful for replotting. The size for rural sections under the existing land-law is from 40 to 320 acres.

Wellington.

There is no occasion to enter at any length into the history of the early surveys in the Province of Wellington, because the old mistakes have been to a great extent redeemed within the last ten years by a more enlightened process of survey. The inheritance of blunders and chaos to which Mr. Jackson, the present Chief Surveyor, succeeded, on taking office in 1865, has been gradually swept aside under a system of trigonometrical survey, and is now so far reduced that more than two-thirds of the sold and granted lands in the province have been laid out and mapped within small limits of error, and may be brought at any time under the operations of the Land Transfer Act without further trouble.

Prior to 1850, a number of detached surveys had been made by the New Zealand Company, chiefly in the immediate neighbourhood of Wellington, Wanganui and Turakina, on the principle of survey before selection—altogether about 155,000 acres. The process seems to have been this. Rough chain traverses, inclosing and intersecting blocks of considerable size as acquired from the Natives, were carried round the coast and along the course of natural features, and laid down on paper to compass meridians. There was no trigonometrical basis, no connection of parts, and no system of inspection. Skeleton sections were then schemed on the plans, and sold accordingly. But, as the purchaser could not find his land until it had been laid out on the ground, surveyors were sent from time to time to mark off the paper sections as required. The disastrous effects of this random system may be easily anticipated. They were not felt at once, because it seldom happened that surveys were closed in upon one another over any considerable area, so that no crucial test was put upon the work—besides which, accurate definitions of boundaries for the purpose of grants were not then needed. It was for those who came after to reap the fruits of a system, easy and convenient in the first instance, but certain in the long run to prove excessively tedious and costly. A few years sufficed to give proof of this. When, in 1850, the Colonial Government assumed charge of the surveys, and introduced the system of granting titles to land, it at once became evident that no Crown grants could safely be issued on the basis of the old Company's surveys. Revision, therefore, was at once begun, at first in the neighbourhood of Wellington only, but apparently in such a blundering manner, that, though several surveyors were employed at it till 1854, matters were then in a worse state of confusion than ever. The whole staff were now engaged in a desperate attempt to reconcile new surveys with old. They worked on till 1859, the department having meanwhile been brought under the Provincial Government. Yet so appallingly slow was the progress made that at this date but 40,000 acres had been granted in the whole of the province. The work of revision was now brought to a standstill, by a sudden increase in the demand for land. Large surveys were urgently required, for purposes of sales, in the Wairarapa, East Coast, Rangitikei and other districts; and the staff, increased for the occasion, were drafted to these various places. But the lesson taught by past experience seems to have been almost entirely thrown away, for the surveys now made showed little if any improvement upon the old. The wretched system of paper sections was still followed to a great extent. Except in two or three isolated instances, triangulation was not attempted; and even in these cases the work was of a very indifferent quality. Incredible, too, as it may seem, the staff employed at that time were absolutely hostile to the principle of trigonometrical survey. It is hardly necessary to add that true bearings and geographical determinations were alike neglected. From the above causes it followed that most of the surveys turned out at this period were quite unfit for the purposes of granting land. Matters went on thus till the year 1865, when Mr. Jackson was made Chief Surveyor. The total area of granted land in the province had now reached to 147,346 acres, and the state of the survey was as follows:—

	Acres.
Area roughly triangulated	50,000
Area correctly surveyed	60,000
„ incorrectly „	442,000
Total surveyed	502,000

By this time a sum of at least £64,000 had been absolutely wasted on worthless surveys.

The trigonometrical survey so long needed was now at once set on foot by Mr. Jackson—at first in three separate sections,[1] in the Wellington, Rangitikei and Wairarapa districts, so as to include all those parts of the province that were immediately under survey. In each section a principal base was measured, while in the Rangitikei there were two, and in the Wairarapa three bases of verification—eight in all, varying from about 86 to 202 chains in length. Errors were distributed in these cases so as to bring all dimensions into conformity with the measured bases. The unit employed was a 66-feet standard chain, and due precautions were taken as to tension, correction for temperature, &c. The triangulations spread out from these bases varied in size according to the character of the country covered by them—from the so-called "major," with sides from seven to twelve miles long, to the "minor" with sides of from two to three miles. Where major triangulation was executed, it was afterwards broken down into minor. About three-fourths of the angles were observed with an eight-inch instrument, the rest with a six-inch, at least four arcs being used in every case; and residual errors were distributed by Sir A. Waugh's method so as to make each series geometrically consistent. Vertical as well as horizontal angles were observed in every case. When the work ultimately came to be tested by means of the verification bases the results proved satisfactory, the discrepancy between computed and measured lengths in no case exceeding the ratio of 14¼ inches per mile, while the average was but 6½ inches per mile. Thus, between the years 1866 and 1870, the relative positions of about 150 principal and 750 minor stations, in all 900 points, extending over 2,250,000 acres, were fixed with considerable accuracy at a cost of £7,000. The following is the basis on which the work was laid down. An initial latitude was computed from four observations of stars in the prime vertical, made by Mr. Jackson with a portable transit instrument, and agreeing very well with one another; and an initial longitude by combining (by means of the electric telegraph) results arrived at by Mr. Jackson at the Hutt, and by Mr. Thomson at Caversham, in Otago, from series of observations of lunar transits. This was used as the fundamental true position for all the triangulations, slight connexions between the three parts enabling it to be carried from one to the other. True meridian was determined by Mr. Jackson at the Hutt by finding the azimuth error of a portable transit instrument from circumpolar stars in the usual way (eighteen determinations in five nights); and at Opaki, in the Wairarapa district, by observing the sun at equal altitudes east and west of meridian with an eight-inch instrument, on two days. The Hutt meridian was used for the Wellington and Rangitikei triangulations, the Opaki meridian for the Wairarapa; and the two, when afterwards compared by observations at a point of junction, differed by about 30 seconds, a very creditable result considering the means employed. With these *data* the latitudes and longitudes of the chief trigonometrical points were computed, and the work rendered available for geographical purposes. Since 1870 the number of trigonometrical points has been increased to 1,200, and the area triangulated to 2,496,000 acres; and at present the work is in progress of connecting the three series by a system of large triangles extended across the main central range; this, when finished, will raise the triangulated area to about 3,917,000 acres. Records of the whole of the above trigonometrical operations have been systematically kept, and nearly all of the stations are erect; and, considering the degree of accuracy which has been achieved, it may fairly be assumed that the work thus zealously and persistently carried out by Mr. Jackson can be counted on for incorporation, with but little further trouble, into any general trigonometrical system.

Upon the triangulations, as they gradually progressed, all new section surveys were tied; thus the detail measurements were well checked at every two or three miles, and errors were confined within small limits. Concurrently with the new surveys, a great deal of old work also was gradually reduced to an accurate state by revision and resurvey, processes which brought to light no fewer than 2,400 cases of erroneous grants.

In the detail survey of sections before selection—which is usually made in the large blocks of from 5,000 to 150,000 acres in which the land is originally acquired and thrown open for settlement—a chain and theodolite traverse of the block boundaries, and of those main features which are likely to serve as section boundaries, is first made, and connected at all practicable points with the triangulation. Sections, and generally roads, are then designed on the plan. Agricultural sections are usually from 50 to 150 acres in area, as nearly rectangular as practicable, and arranged with due regard to road access and the general "lay" of the country. But if roads are not laid out at the time of survey, an addition of five per cent. to the acreage is made for that purpose. Pastoral lands are never laid out before purchase in allotments of less than 640 acres,[2] and the road allowance is then three or four per cent., according as the area is more or less than 1,000 acres. The roads and undefined boundaries of the sections are next marked on the ground by corner pegs fixed by a combination of chainage and intersections, the cutting of lines being as far as possible avoided. Reserves, if any, are also laid off. In the interior detail measurements, no greater error than 0·1 per cent. is allowed to pass without correction in the field. The surveyor's plan is now examined by Mr. Jackson. The bearings and distances written to every line being resolved by traverse tables into components perpendicular and parallel to the meridian of the work, a test can thus be applied at every intersection: this method of co-ordinates, indeed, is used in plotting in preference to that of laying off directions. Areas are also checked

[1] The connection between the Wellington and Rangitikei triangulations is so slight that it may be disregarded.

[2] But if pastoral land is applied for at 5s. per acre, the part applied for is put up to auction in parcels of 80 to 320 acres.

in the office. The scales generally used are eight inches to a mile for agricultural land, four or eight inches for pastoral lands, and sixteen to forty inches for towns. Topographical maps on the scale of two or four inches to a mile are also made, either before or after the section survey. The surveyor's fair plan, on being passed, becomes the record from which grants are prepared; it is not the custom to make duplicates. Like the survey itself, the record maps are generally completed by blocks, and the sections are numbered consecutively within such blocks; and as, in each trigonometrical district, every point is laid down on the sheets by its computed co-ordinates parallel and perpendicular to one central meridian, the common edges of all block maps within a district will of course agree.

When lands are selected before section survey—as is most frequently the case in the province of Wellington—selection is made from the best sketch-map that can be compiled, unless topographical survey has already reached the district. There is no upward limit to selections, but they are restricted to at least 40 acres of agricultural, and 640 of pastoral land. Survey is then made in accordance with the general principles already noted; and, by connecting the work with triangulation wherever practicable, the risk of erroneous grants is avoided.

Thus, by introducing a sound system at the first possible opportunity, and steadily and patiently adhering to it, Mr. Jackson has in ten years raised the total of correct detail surveys in the province from 60,000 to 1,099,200 acres, the revision or resurvey of 442,000 acres being included in the above total. He believes that the ratio of error in this work does not exceed three feet per mile; and whether his estimate be a little over-sanguine or not, I have no reason to doubt that the errors are small, and that the accuracy arrived at is at least sufficient for the purposes of the Land Transfer Act. A noteworthy example of the advantage of trigonometrical survey over the old method may here be given. The Wanganui district, containing about 45,000 acres, was surveyed on the New Zealand Company's system in 1846, and sections of about 100 acres each were designed on the plan. Twenty-five years later, more than 20,000 acres yet remained to be accurately laid out, though one or two surveyors had been engaged the whole of that time in surveying the section boundaries according to design. The survey up to that time must thus have cost little short of £1 per acre, or twice the value of the land, while the average cost of modern trigonometrical and section survey, all told, does not exceed one-fifteenth of that amount.

In order to complete the correct survey of the Crown lands as yet dealt with, there remain 412,800 acres to be resurveyed or revised,[1] and 106,800 acres selected but not yet surveyed. But this work has been begun, and Mr. Jackson hopes to finish it in three years. The only Crown lands undealt with are 832,000 acres, mostly of little value. The abstract of progress then at present stands thus:—

	Acres.
Provincial Lands—	
Sections correctly surveyed	1,099,200
Sections needing revision	412,800
Selected but not surveyed	106,800
Undealt with	832,000
Native Lands—	
Native claims surveyed	1,235,027
Undealt with	3,314,173
Total area of Wellington	7,000,000
Triangulated—	
General Government	880,640
Provincial Government	2,496,000
Total	3,376,640

It may be added that a one-inch index map of the East Coast surveys has been compiled and published; also diagrams of triangulations on various scales; and a geographical map of the province, on the scale of eight miles to an inch, is in course of preparation.

Taranaki.

As was explained in the preface, I did not visit this province, but the Chief Surveyor, Mr. Humphries, has sent me a written report, from which I gather such facts as are necessary. It seems that here, as elsewhere, false economy at the outset has resulted in confusion and constant trouble. Up to 1868, when the present Chief Surveyor took office, about 130,000 acres had been section-surveyed by the same loose and worthless methods as were pursued in the early surveys in other parts. A resurvey was necessary, and for this purpose a minor triangulation was begun on Mr. Humphries' recommendation, and was spread that year over about 12,000 acres, stations being set up on 8,000 acres more. This little piece of work was carefully done: though the base line was short (only 70 chains), its three measurements agreed well together, the true meridian was determined in proper fashion, and the angles were observed as accurately as

[1] This is work surveyed since 1865, but before the triangulation had time to take effect.

could be done with a six-inch theodolite. Unfortunately, it went no further at that time, and has never been resumed; but, little as it is, it is trustworthy and may be used again, and it served to reveal very gross errors in the old surveys which it embraced.

For some years past no new surveys of any extent have been made; the little that has been done has been chiefly in flat forest lands, systems of main and circuit traverses forming the basis of the work. Altogether there are probably some 10,000 acres of trustworthy section-surveys in the province. The old work is, in Mr. Humphries' opinion, valueless for further use; many of the field-books are missing, and for miles together no original survey-marks can be found. He cannot tell what in it is right and what wrong. The abstract of progress stands thus:—

	Acres.
Correctly section-surveyed	10,000
Section-surveyed, but needing revision	130,000
Unsurveyed	1,997,000
Total area of Taranaki	2,137,000

Accurately triangulated, 12,000 acres.

NELSON.

Out of the 7,000,000 acres which make up the area of this province, scarcely one-fourth has been reached by survey of any kind, some 225,000 acres only having been sectionally surveyed. and but 1,350,000 acres topographically surveyed. One-fifth of the province is still unexplored. It is perhaps fortunate in a certain sense that the work has made so little progress; for the general want of system and accuracy which affected the early operations in most of the provinces of New Zealand seems in Nelson to have prevailed to perhaps a greater extent than in any other. Such, indeed, was the state of confusion into which the surveys drifted steadily during many years of neglect and mismanagement, that the best efforts of later officers to put them on a proper footing have been well-nigh paralysed, hampered as these gentlemen have also been by want of funds and the pressure of their regular work. Naturally, under these circumstances, I did not find it easy to disinter the past history of the surveys, or to estimate their real value, although in my endeavour to do so I was very willingly helped by the officers of the department. I give an outline, however, of all that I could ascertain.

The first surveys seem to have been made between 1841 and 1844, under the New Zealand Company, in scattered blocks about Nelson and the north part of the province, amounting in all to some 100,000 acres of section surveys, the principle being mainly that of survey before selection. It is enough to say of them that they were of the same type as the many inferior surveys in other parts to which I have already drawn attention. Great difficulty has ever since been experienced in piecing together various parts of the same block done by different men. When surveys of opposite sides of the Waimea River came to be juxtaposed, it was found that they overlapped to such an extent as to completely block up the channel, and it took months to assimilate the two pieces of work. The town of Nelson, which was surveyed at this time, was also seriously affected by errors of the same class; and on some of the record plans in the office I found gaps and overlaps of three and four, and in one case of ten chains still left, with no present hope of rectifying them. A good deal of carelessness, too, seems to have prevailed in the preparation of the record-plans and grants, both of town and rural sections, many of which have since been found to differ from one another, as well as from the MS. plans. Most fortunately, whether from indifference, or despair, or fear of expense on the part of landowners, no serious legal difficulties have yet resulted from these various errors.

From 1844 to 1851, hardly any progress was made. But in the latter year, and up till 1856, small detached surveys were carried on here and there in a desultory way, under the Colonial Government. Nothing could well exceed the recklessness which now prevailed. Numbers of surveys of the roughest kind were made all over the country, and the only original records of them which remain are rude drawings—many of them mere pen and ink sketches—on half-sheets of note paper and scraps of all sizes, which have been collected together and pasted into volumes. Some of them have no scales marked on them; some have no bearings shown; and some are unconnected with anything to tell of their whereabouts. The lands, nevertheless, were sold and Crown granted on the strength of these documents, many of them absolutely unworthy of the name of plans. Several disputes have taken place in consequence. To cite an instance, the well-known case of Hunt *v.* Wells, which lasted for several years, arose out of an error by which, from the want of sufficient details on the surveyor's plan, a plot of land was wrongly placed on the record map, and Crown granted accordingly; while later, from the same map, the land where the first plot should have been was granted to another person, who then, on the strength of his paper grant, set to work to eject the actual possessor.

About 1856 the province began topographical surveys of the pastoral lands in the south-east; and between that year and 1867 a block of some 700 square miles was roughly surveyed in three or four different pieces, part by contractors and part by the staff. The maps of these surveys, which are on the scale of four inches to a mile, showed the chief natural features and the proposed boundaries of runs, as traversed in some cases with small theodolites, and in others

with compass only; interior details were filled in by intersections and sketching. But there was no inspection or check. When, on piecing the various parts together, they would not agree at the common edges, they were humoured until they did. All were laid down on a geographical basis furnished by the Naval charts. Then the several areas were ruled off on paper, in sections limited to 320 acres—the greatest size allowed—and sold and granted in batches of a number at a time. Besides these larger operations, a number of detached section surveys were made about this time, in various parts, on the same loose and inaccurate system, many of them having been left hanging without connection with known points. Rough topographical surveys, for leasing purposes only, were also extended northward from the above-named block, amounting in all to about 1,000 square miles.

The whole system of work in the department during this period seems to have been of the loosest kind. To say nothing of inaccuracies and even forgeries in field-work, and an absence of all inspection, paper surveys, as I have just shown, were had recourse to in the office. Nor were they confined to the class of cases quoted. Separate sections were often designed independently on the paper, or gaps between neighbouring surveys were taken to be correct, and the lands accordingly sold and granted; and all this on the faith of maps which must have been known to be very far from trustworthy. One case which I went into in the office affords a curious example of the way in which contiguous surveys were sometimes humoured. Two men, A and B, surveyed part of the Waiau River, and laid off sections, A on one bank and B on the other. As B's river differed from A's, a test survey was made which justified A's, and A's was therefore adopted; but B's sections abutting on the river were never resurveyed, and were humoured to A's river bank, notwithstanding that the process did violence to all B's section measurements; this doctored map became the basis of Crown grants. Other cases might be quoted to show the random way in which the work was carried on; as, for example, the Crown grant of a large area near Rotoiti Lake on the strength of a sketch map shown by later survey to be enormously in error;[1] and instances of large distortions and blunders in the plotting have very often been detected, as well as discrepancies in the record-plans and grants.

In 1858, an attempt was made to construct a system of sheets for a general record map of the province, on which the various surveys might be collated; and this, so far as I could gather, is how it was done. First, the boundary of the province was laid down on the scale of five miles to an inch—the coast portion by combining with the Admiralty charts certain explorations and surveys along shore which had been made from time to time by the department; the rest, so far as it had been surveyed at all, from records of various kinds in the office. Of the exact details of this compilation, as to projection, meridians, &c., I could get no certain information, but plainly it must have been at best a very rough affair. Nevertheless, the plot, with all its imperfections, was enlarged to the scale of two miles to an inch. Next, a reticule of squares of ten miles' side, formed by lines parallel and perpendicular to the meridian of Nelson, was ruled over the whole area. Then sheets on the scale of four inches to a mile were prepared in conformity to these squares, to serve as record maps, on which the surveys might be collated by reduction from the original MS. maps on the scale of eight inches to a mile. It is hardly necessary to point out the delusive and unsound character of this attempt. It may be that there were no means at the time for preparing a strictly accurate index-map, but a worse or more inexact method than this could hardly have been devised. Had the detail surveys ever been spread from distant parts of the province until they met, large discrepancies must almost infallibly have appeared; it is not possible that they could have closed at all accurately on the map, except by the merest chance. As it is, the work on adjoining square-edges can never be made to fit, and a traverse which has been carried from shore to shore in the south part of the province will not plot within two or three miles.

Since 1867, progress—except upon the West Coast, to which reference will be made presently—has been confined to a few scattered section and run surveys, *built upon the old work*. Certain improvements have been introduced, chiefly in the way of connections and of care and caution in the preparation of records and grants. But there still is no check upon the plotting, nor any field inspection; the geographical basis remains as imperfect as ever; and many of the record-maps, as I have shown, are in a very indifferent state. The work also is behindhand: 240,000 acres have been applied for, the greater part of which is urgently required to be surveyed. In short, the department is thoroughly crippled from want of means and men; and the radically bad state at which the work has arrived through former neglect is a dead weight which can only be removed by sweeping improvement and at considerable cost. It is possible that parts of the detail are good in themselves, and that proper connections alone are needed to establish their accuracy and to sever good work from bad; so that, by connecting old surveys where practicable with a triangulation and replotting them on new sheets, there is a chance that some of them may be re-utilised at no great expense, except in the New Zealand Company's work, the field-books of which are nearly all lost. But I estimate that all, or nearly all, of old as well as new work will need revision more or less, in order to make it available for incorporation upon a cadastral map. Ten years ago a beginning was made of a small triangulation, by poling an area of about 800 square miles in the Nelson district and measuring a base roughly once or twice; but here the work ended, and practically nothing in the way of triangulation has yet been done.

[1] This, however, has since been rectified, there having been an action at law about it.

The surveyors' plans show the bearing and linkage of each straight boundary line, distinguishing cut lines from those which have not been cut. The plans on Crown grants show approximate acreage, and usually linkages, but never bearings. Twenty inches to a mile is the scale for town plans.

West Coast Surveys.—On the West Coast gold-fields the surveyors are chiefly occupied with mining surveys—that is, surveys of blocks of ground for mining leases, extended claims, &c.; also in the surveys of tunnels, underground encroachments, and level, tail and head races, the miners paying Government at fixed rates for the work done. So long as adjoining claims are accurately laid down with respect to one another, collation of these surveys on general maps is a matter of no moment, as the claims are quickly worked out, often abandoned, taken up in different shapes, and altered every few months. A few blocks of land have however been surveyed for sale in the Grey and Inangahua Valleys; also a number of small blocks for leasing in various parts of the gold fields. Most of these detached surveys are correct in themselves, and could be made use of if connected with fixed trigonometrical points, the establishment of which would be a work of but little difficulty. The importance of thus collating them, and of connecting the various digging centres together and securing a basis for accurate maps, was strongly felt by the late Chief Surveyor, who repeatedly urged on the Provincial Government the necessity for a triangulation, though without success. Not having sufficient *data* nor the means of procuring them, he has declined to attempt a compilation; and at present, beyond a rough sketch-map, there is no general plan of the gold-fields. Trigonometrical survey, however, is urgently needed, as well as accurate plans of the district generally, especially of the "reefing districts" of the Inangahua, where they will soon become indispensable.

Summary of Progress.

	Acres.
Section-surveyed, correct	25,000
Section-surveyed; untrustworthy	200,000
Topographically surveyed, but needing revision	1,350,000
Unsurveyed	5,425,000
Total area of Nelson	7,000,000

MARLBOROUGH.

Before the separation of this province from Nelson, which took place in 1859, surveys made by the New Zealand Company and the Nelson Government had embraced the valley and plain of the Wairau, the Wakefield Downs, the valleys of the Pelorus, Kaituna, and Waitohi, and a number of isolated blocks on the bays in Queen Charlotte and Pelorus Sounds, and in various places all over the province, as required by the course of settlement. They comprised a total area of about 331,000 acres, of which 199,000 acres had been sectionally surveyed on the principle of survey before selection, and the rest topographically only. These surveys were exactly similar in their general character to those which I have already described as having been made during the period referred to in the existing area of Nelson. The details, therefore, may be very briefly reviewed, though I must point out that here, as at Nelson, I found it difficult to get at the real state of affairs, owing to the fatal confusion introduced by the early surveys.

The New Zealand Company's work, which included the Wairau and Wakefield Downs, had been done in blocks, by contract, with theodolite and chain, and drawn to compass meridians on the scale of four inches to a mile. It was neither triangulated nor checked. Traverses, carried through the different blocks into which the work was subdivided, seem to have formed the framework on which the sections were to be tied. Large errors, nevertheless, were often introduced—in this way. The traverses, as finished, were laid down on paper, and the sections were then designed on paper also. When these sections came to be laid out on the ground, it often happened that, owing to the generally shaky style of the work, they would not fit in as designed. But the plan was left unaltered, so that plan and ground were made to disagree, and do so still in many cases; and the plan on the grant does the same. Fortunately, the grant was usually made out for a smaller acreage, by about two per cent., than that of the designed section, so that only in a few cases was injustice done. The consequences, however, of this loose sort of work, and of the use of different meridians and perhaps different measures, did not stop here. Neighbouring blocks had frequently to be humoured at their common edges in order to bring them together, and everlasting trouble has been the result. In one case, in the Wairau, two surveys are known to have been juxtaposed on the map which would not really close within a couple of chains, and a dispute arising from this error is now going on. Again, whenever there has been occasion to piece new surveys on the old, it has often proved difficult, if not impossible, to assimilate the two edges, so carelessly had the old work been done. But perhaps the most serious feature in the character of these surveys is that, though the field-books exist, and the original maps (some of the latter in a very worn state), the books do not show the connections between the traverses and the section lines—if indeed, which is doubtful, systematic connections were ever made—and the maps show no bearings whatever. So that it is to be feared little or none of this work could be replotted or engrafted on a triangulation, except by surveying a large part of the detail over again.

In the Nelson Government's section surveys, on the scale of eight inches to a mile, the system was even rougher. Where they abutted on the coast, a rough compass traverse of the shore-line was generally made. Sections were then laid off with compass and chain, at intervals as required. Often, part only of the lines shown on the plan were really laid out, and the work was left unclosed and unchecked, and large errors have since been detected. Many sections were Crown granted by these surveys, but the work generally has proved so worthless wherever tested, that Mr. Clark, the present Chief Surveyor, now insists on having resurveys made of such parts as are required to be sold. The plans of some of these revised surveys on the coast have been collated in groups on record maps on various scales,[1] together with new surveys added since. But all of the rest—including the detached blocks inland, surveyed in the same fashion, and many of them never yet placed accurately in position—would need revision, the field-books being unintelligible, and the bearings being in few cases written on the plans.

Of the topographical surveys made prior to 1859, it is enough to say that they are of the same class as those described in my remarks on Nelson.

Since 1859, about 62,800 acres of section surveys, on the principle of survey before selection, and 490,000 acres of topographical surveys of pastoral lands, have been completed under the Marlborough Government. Rough sketches, hardly to be called surveys, have also been made of about 1,035,000 acres for leasing and licensing purposes. The topographical or "run" surveys consist of chain and theodolite traverses of the boundaries—nearly always following well-marked natural features—of the large pastoral tracts sought to be purchased as runs, interior details being roughly filled in by intersections and sketching in the usual way. As 320 acres is the maximum size allowed by law for a single section, the plan of the run is divided on paper into sections within that limit, which are then sold and granted in groups. Though this system, founded as it is on such loose surveys, is very faulty, it results rather in errors of plan and acreage than in overlaps of grants, the selection of natural features as boundaries luckily affording a pretty good safeguard against the latter evil. Until lately, it was the custom to allow intending purchasers to employ licensed surveyors of their own choosing, a plan which here, as in the surveys of Native claims, was found so fatal to accuracy and system that, on Mr. Clark's urgent recommendation, it has now been abandoned.

The section surveys have been made in scattered blocks, sometimes isolated, sometimes contiguous to old work. Theodolites are used, except in bush, when a circumferenter is preferred; connections with former surveys or well-defined objects is insisted on; and the plotting is tested in the office. Where new surveys abut on old, the old meridian is recovered and used, and the common edges are assimilated, wherever this is possible; though occasionally the new work has to be drawn separately without regard to the old. Most of the field-books of these section surveys have been kept; and the character of the work generally is such that probably about six-sevenths of it is sufficiently accurate for Land Transfer purposes, and could be incorporated without much further trouble into a general system. In one instance, in 1867, a rough trigonometrical survey was made of a block (two runs) of some 39,000 acres in the Awatere and Waihopai districts, with a base line about 140 chains long.[2] Beyond this, and the matters of detail above mentioned, no advance has been made upon the old system; and there are no means as yet of compiling a correct general map of the province. Consequently, the surveys of Marlborough, as a whole, are still in an unsatisfactory state, in spite of Mr. Clark's best efforts to set them right. Here, as in other places, the errors unhappily bequeathed by the early surveyors, and the want of sufficient funds to correct old mistakes and make a fresh start on an accurate basis, have very seriously hampered the Chief Surveyor, and checked all attempts at substantial improvement. At present there is no field or office staff, and the desultory surveys which now and then have to be made are carried out by contract, or by special terms with private surveyors.

Summary of Progress.

	Acres.
Section surveys, trustworthy	107,100
Section surveys, needing revision	154,700
Topographical surveys, rough	622,000
Reconnaissance surveys, for leases	1,035,000
Unsurveyed	1,081,200
Total area of Marlborough	3,000,000

WESTLAND.

Westland, regarded from a surveyor's point of view, is the most difficult province in New Zealand, being filled with lofty ranges and deep valleys and gorges, all covered with a dense impenetrable jungle. Considering the character of the country, it is perhaps fortunate that the demand for land has been much less rapid here than elsewhere. The survey was begun in 1863, before the separation of Westland from Canterbury. In that year and the next, rough coast traverses, mostly made by contract and with a compass only, were carried from Grey River

[1] The Nelson sheets, in ten-mile squares, proved utterly useless for this purpose.
[2] In this resurvey, eighteen cases of erroneous grants were detected, the result of a previous faulty survey.

to Big Bay: they were merely reconnaisance surveys, showing the high-water mark along the shore, with sketches of the chief river beds for a few miles from their mouths, and intersections to some of the most prominent peaks and other marked features inland. On the discovery of gold in 1865, settlement took place at Hokitika and Greymouth, and towns were laid out at those places by Canterbury surveyors, who also made detached settlement and mining surveys at various points on the diggings. Settlement now increased quickly, and a Survey Department was soon formed, which carried on a number of unconnected and somewhat rough traverse surveys at necessary points. In 1866 the Christchurch road was projected, and the traverse of it begun. But the difficulties of bush survey soon showed the necessity for some system of trigonometrical or other cardinal lines, on which to check and tie the traverse. A triangulation in the strict sense of the word was barely practicable, from there being no tract suitable for a base line; certainly the sea beach was level, but it was very narrow, and nowhere straight for more than a few hundred yards in one place. Therefore it was decided to execute a careful traverse along the sea beach from the Totara to Greymouth, a distance of about thirty-three miles, and to use it as a base line for fixing points inland. This was accordingly done—begun under the Canterbury Government, and finished after separation from Canterbury had taken place. Accurate chaining on the beach was of course difficult, but a fair result was got; and some peaks along the line of the Christchurch road were fixed from points on the traverse within small limits of error.

This *quasi* triangulation was afterwards spread southward to peaks along the sea-board and points on the coast, as far as Bruce Bay, where in 1869 it ended. From the Wanganui southward, it was worked in connection with Lieutenant Woods' coast survey, he using the points as a basis for his coast-line details. It cannot of course have any pretension to high accuracy—it was only observed with five-inch instruments—but it at any rate furnished a useful basis for future topographical and circuit surveys, and for collating detached parts; and, considering the immense physical difficulties of the country, and the slender resources of a small provincial department, a good deal of creditable energy must have been shown in carrying it out. Altogether there were about thirty stations, at an average distance of fifteen miles from one another, and scattered over an area of some 805,700 acres; they have been carefully marked, and their descriptions preserved, and they could be recovered and used again. The work was referred to a meridian determined in a somewhat rough fashion by Lieutenant Woods, and to an initial latitude and longitude also furnished by the coast survey.

But although a large area had thus been covered with triangles, the size of the triangles —namely, fifteen miles' side—and the very densely wooded character of the country prevented them from being conveniently used as a direct basis for the section surveys. By reason, also, of the dense forests, they could not be broken down into smaller triangles, except at great expense. Therefore recourse was had to a system of circuit traverses, most of them inclosing considerable areas, executed with care, and connected with the triangles at all practicable points. These traverses were taken along the chief natural features, and the lines were necessarily short, usually under ten chains. Errors, at closing, of from seven to twelve links in a mile according to country, were passed and distributed, so that all the work in any circuit should be confined within small limits of error. But as each part of each traverse was a common boundary between two blocks, there were two distributions of error, one for the survey on either side, thus introducing discrepancies of common edges, and making each circuit only complete in itself. These discrepancies are slight, and very possibly might be adjusted to a new system without much repetition of field work. This latter, indeed, would be attended with a good deal of difficulty, owing to the points on the traverse lines not having been permanently marked. Obviously, therefore, the longer a proper triangulation is delayed, the more adjustment and revision will there ultimately be required. As yet, the traverses only cover about 185,000 acres in 29 blocks. The circuit traverses thus executed form the basis for other surveys, as different parts are required for settlement. First comes a topographical and traverse survey of the internal area, mapped on the scales of half a mile and two miles to an inch, which maps are used for selection. The section surveys are then made, according to the applicants' descriptions of boundaries, all of them being rigidly tied to the traverse lines, and their plotting tested in the office. Field examination is almost precluded by the nature of the country; it would nearly come to doing the work over again: some check, however, is established by employing different surveyors in the same block, and the work generally has proved good. Old surveys, revised where necessary, have gradually been connected with the circuits. The scales are,—

Circuit and Section Surveys	8 inches to a mile
Towns	16 inches to a mile
Topographical, also Reconnaissance map of Province ..	2 inches to a mile, and 2 miles to an inch.

These maps are all lithographed and published as finished, a branch in which Westland is ahead of other places. Considerable care, too, is taken of the MS. record maps, lithographs being used instead of them in the Land Office; besides which the surveyor is obliged to furnish on a lithographed form a separate little plan, with full details, of each section he surveys, and this, after proper comparison, is used in preparing the Crown grants, thus saving the originals from being handled too much.

The summary of progress, neglecting triangulation, which would need to be done again, is as follows:—

	Acres.
Section surveyed	39,600
Topographically surveyed only	940,400
Reconnaissance and unsurveyed	2,065,760
Total area of Westland	3,045,760

The section surveys are sufficiently good for Land Transfer purposes, and will not need revision.

Canterbury.

While in Auckland and some other provinces one chief cause of the difficulties which beset the early land sales under the principle of selection before section survey was that they often had absolutely no topographical map with any pretension to accuracy as a basis to work upon; in Canterbury, on the other hand, we have the case of large areas having been triangulated and topographically mapped for purposes of land selection, with a certain show of accuracy, yet so carelessly in reality that but little good was gained; error and confusion of the usual types were introduced at the very outset, in spite of a large expenditure of money, and have never since been thoroughly eradicated.

The surveys in question were begun in 1849. A base near Christchurch, about three miles long, was measured in that year with a standard chain, and a triangulation was erected on it with a six-inch theodolite, and shortly extended to the Rakaia, a verification base near Oxford, about two miles long, having been measured meanwhile. At different times subsequently, up till 1870, other triangulations, not properly connected with this one or with one another, and each depending on one or more chained bases of its own, were carried southward to the Rangitata, and northward to the Hurunui. Though these various triangulations were mainly confined to the more level parts of the province between the mountains and the sea, a tract favourable for trigonometrical work, yet it does not appear that anything like mathematical accuracy was aimed at, or that a thorough and uniform system was pursued. Under a pressing demand for surveys, work of a rough kind was approximated as it best could be, which is tantamount to saying that errors were systematically concealed or overlooked. Everything was laid down to compass meridians; true meridian and geographical positions were altogether disregarded, except those which the Naval officers supplied. No descriptions were kept of the trigonometrical stations, several of which have since been removed and their positions on the ground lost; while of many of the observed angles no record whatever exists. Some of the work was done by contract, some by the staff. Though part of it no doubt was pretty good, a great deal was certainly very bad; the trigonometrical work in Banks Peninsula, for example, is notoriously in error to a very serious extent. This is no more than might have been expected; for, as there was no proper scrutiny or connection of parts, all depended on the trustworthiness of the surveyors. It is quite clear then that these triangulations, covering about 1,200,000 acres north of the Rangitata, are as a whole far from being accurate, and there is no pretence to the contrary. Mr. Hewlings, the present Chief Surveyor, has entered on the costly and troublesome task of revising them as he best can. Some parts stand the test well; others fail to do so; and, as it is impossible to tell before trial where the bad parts are, the whole must be gone over again, either to establish its accuracy or correct its errors, before it can be accepted as final.

In the topographical surveys nominally founded on these triangulations, a traverse was required of all natural features, such as ridges, watercourses, terraces, swamps, lakes, bush, &c., which might serve as section boundaries; main roads also had to be surveyed and marked out, and the whole mapped on the scale of eight inches to a mile, to serve as the basis for free selection, which might be made in sections of from twenty acres upwards without limit. A map of this kind, constructed with fair accuracy, should have been a sufficient safeguard against future complications. The boundaries and acreages of sections would sensibly be the same on the map and on the ground, and when the more minute section survey afterwards came to be made, any slight discrepancies could be met by corresponding corrections in the sums previously paid for license on application. But the system, though good in theory, was vitiated by the inferior quality of the maps actually produced. Not only was the triangulation in itself indifferent, but there is no evidence that the detail was systematically tied upon it. Besides this, the surveyor, who, it is to be feared, was in many cases but little skilled in his profession, was allowed to plot his own work; and, though parts were occasionally inspected, it does not appear to have been regularly subjected to field examination or other check. Thus large errors often crept into the maps, and it is easy to form an idea of the sort of trouble and confusion that might arise in consequence. If the map, for example, should make it appear that there is more land within certain limits than really exists, licenses might be issued for too many sections; and, on the section survey being afterwards made, the latest applicant would find himself mulcted of a good deal of the land he had counted on and paid for—if not altogether dispossessed—by the prior rights of those who had applied before him. Instances of this kind have actually happened in the Canterbury surveys.

[1] Including areas unconnected with circuit traverses.

But this is not the whole case. The same hurry, inaccuracy, and want of system and scrutiny which had affected the preliminary maps extended also to the later section surveys. Many of these surveys, moreover, were allowed to spread beyond the limits of the triangulation, and have never yet been properly connected with it, though the lands included by them have been sold and granted. Worst of all, the fatal system was introduced in the early days, apparently under official sanction, of allowing a liberal percentage to the purchaser in the survey of his section, in order, as it was imagined, to avoid risk of future litigation. Under this system, more land was marked off on the ground than the purchaser was entitled to, though the excess was not allowed to appear in the manuscript survey, nor yet in the record map or Crown grant. The documents, for example, might give a purchaser a section of 100 acres only, whilst the pegs on the ground gave him 101 acres. To add to the confusion, different surveyors interpreted this license in different ways. Serious complications of course arose from these direct contradictions between the surveys and grants. Plainly, there could never be space on the ground for all the land sold from the map, and erroneous descriptions of boundaries and acreages would creep into the grants, affecting their accuracy, and certain to be found out, if not at once, as soon as ever the property came to be brought under the operations of the Land Transfer Act.

From all these various causes, it follows that in Canterbury difficulties and disputes are not uncommon with regard both to town and rural sections, and fresh grants often have to be issued, generally at the cost of a revision of survey. This is exactly what was to be expected from the way in which the work had been done. Revision, always tedious and costly, must infallibly follow sooner or later on surveys carelessly executed in the first instance.[1] The trouble and expense of settling disputed cases are often moreover increased in Canterbury by the circumstance that fully one-third of the old field-books are not available for reference or for replotting, many of them having been lost, and others become illegible owing to their having been originally kept in pencil; so that, as the map often fails to supply their place, from its not showing dimensions and being liable also to shrinkage or expansion, accuracy can only be got by a resurvey on the ground.

I have dwelt here at some length, and at the risk of seeming tedious, on the various evils which flow from bad original surveys and other causes affecting the accuracy of Crown grants, in order to illustrate once for all the state of things which unhappily exists in many parts of the colony. There is, in short, no end to these evils. So far from litigation being averted, it is rather created and stimulated, bringing with it trouble and heavy expense. Puzzling questions of disputed or defective titles, and of overlaps and surplusage, are for ever cropping up, for decision by the Crown Commissioners or the Registrar-General of Land; and Government incurs the risk of having to pay large sums of money as compensation for erroneous grants.

It is pretty plainly established, then, that but little trust can be placed in the work north of the Rangitata as a whole. Though parts of it are no doubt good, all or nearly all will need more or less revision in order to place it on an accurate footing. The task indeed has already been begun by Mr. Hewlings, who gives to it such time as can be spared from the regular work, and is by degrees engrafting revised surveys on a revised triangulation, or preserving them in such a shape that this may be done hereafter. Little progress, however, has yet been made.

So far, reference has only been made to surveys north of the Rangitata. Between that river and the Waitaki, a separate triangulation was begun in 1856, and it has been spread since, in triangles of from about two to six miles' side, over some 500,000 acres of the maritime plain which occupies the south-eastern corner of the province. The first base, about 203 chains long, was measured three times with a carefully compared common chain. Other and shorter bases of verification were afterwards similarly measured, at two points distant 21 and 60 miles respectively from it, with results which show that the work is of a good class; and, as the observations were systematically registered and kept, and the stations permanently marked, all of this triangulation is capable of being incorporated into a larger system. The same remark applies to the contract topographical and section surveys founded on it, a large part of which have been checked by having the details plotted in the office from field-books kept in ink on the ground, precautions introduced generally by Mr. Hewlings upon his assuming office as Chief Surveyor, and adopted in all surveys south of the Rangitata.

The part of Canterbury (nearly 7,000,000 acres) to which triangulation has not been extended is chiefly mountain country. Its principal features have been mapped at various times since 1855 on the one-inch scale, from reconnaissance surveys, mostly done by contract, which are sufficiently good to serve the purposes of a rough topographical map, and to assist in the apportionment of licenses for runs. From these and the other surveys a general map of the province has been compiled, on the scale of four inches to a mile, and published by lithography. Also, a general Road Board index map on the same scale, and other special maps on that of two miles to an inch. Town plans are published on the scale of twenty inches to a mile.

The topographical plans on the scale of eight inches to a mile—with the sections marked off on them as surveyed, and numbered in order of purchase all over the province—become the record

[1] It is only fair, however, to the surveyors as a body to point out that not they alone are at all times to blame. Road Boards and road contractors do not always keep to the survey lines. Besides this, pegs are often removed or destroyed, and the boundaries lost, and fences afterwards put up in the wrong places. Not unfrequently the original purchaser never saw his land, but deputed an agent to meet the surveyor on the ground and verify the boundaries, or perhaps neglected it altogether.

maps. They are used for all purposes, and duplicates are seldom made except when the originals become too much worn for further use. The old maps, which were most inconveniently large, have since been traced and transferred to sheets of more convenient size, but without being made conformable to any uniform system or single meridian. This branch then, generally, needs thorough reform.

Summary of Progress.

	Acres.
Trigonometrically and topographically surveyed :—	
North of Rangitata, and needing revision	1,200,000
South of Rangitata, trustworthy	500,000
Reconnaissance only, or section survey without triangulation and needing revision	6,990,000
Total area of Canterbury	8,690,000

About 1,642,000 acres have been section-surveyed, part within and part without the triangulation; and 1,913,000 acres have been sold or reserved. The Chief Surveyor cannot tell me how much of the section surveys is thoroughly trustworthy; but I suspect that most of the work north of the Rangitata will need some revision or verification before it can be incorporated on accurate cadastral maps.

OTAGO.

It is important to explain, at the outset of my remarks on the survey of this province, that, although the principle of free selection before section survey is extended to the 2,250,000 acres, now absorbed into Otago, which once formed the Province of Southland[1]—also, at the discretion of the Provincial Government, to certain special lands in Otago proper—the system which very largely predominates is that of survey before selection; and this has from the first affected the plan and method of the provincial survey. To the surveyor and all connected with the land, as I hardly need point out, survey before selection is in many ways an enormous boon. It avoids the trouble, confusion, loss of time, inaccuracy and expense of the "spotting" system; and substitutes for it a methodical process, by which the sections, roads, and village and other sites are laid out and mapped beforehand on an intelligent and careful plan, and the purchaser put into possession of his land and his title to it without trouble or delay. Hence the surveys of Otago, which have mainly been carried out on this safe and steady system, are now on the whole in a better state than those of the other provinces. It must not, however, be supposed that the process of survey before selection makes all things easy for the surveyor. Though it enables him to dictate how the lands shall be laid out, and to adhere to order and accuracy, nothing is more obvious than that great exertions will often need to be made by the Survey Department to keep ahead of, or at least up to, the march of settlement. It is also clear that, to carry it on effectually and without waste, there must be a liberal supply of money and men, and a vigorous system of survey, which shall not only fulfil its immediate purpose of bringing lands measured with fair accuracy promptly into the market, but shall produce work sufficiently good to be afterwards incorporated into a better system if desired. In Otago these requisites have fortunately been met, and as a consequence there have been but few errors and very little waste. The late Chief Surveyor, Mr. J. T. Thomson, established in 1861 a uniform system of surveying, which, if not highly scientific or scrupulously exact, was at least simple and practical, and not likely to introduce inordinate errors or distortions. Upon this system, the surveys have been pushed on as quickly as possible, under the direction of Mr. Thomson, and latterly under that of his successor, Mr. McKerrow. They have generally kept pace with the demands of settlement, and are at present in a forward state.

A short account of the Otago system may now be given. As a first step, a reconnaissance survey of the province was made between 1856 and 1863, in three large subdivisions embracing all but the very wild mountainous district on the western seaboard. The main object in making this survey was to secure a fair map of the chief natural features of the country, partly for ulterior survey uses, partly as a guide for the apportionment of pastoral runs, reserves, &c., and for the subdivision of the province into districts of various kinds; the natural features as shown on the map being taken for boundaries in all these cases. No great accuracy was attempted; cross-bearings and sketches from a few selected points formed the process mainly relied on, though in one part the chief points were fixed by a rough triangulation. This survey was mapped on the scale of two inches to a mile, and gave a pretty good general knowledge of the country.

It had been intended in the next place to carry out a sort of triangulation from a series of bases some 60 miles long, whose lengths were to be found by determining the latitudes of their extremities with an eight-inch instrument. This plan, however, was abandoned from want of time, owing to the rapid spread of settlement which followed upon the discovery of gold; and the following one was adopted in its stead. Otago proper was divided, for survey purposes only, into

[1] Only 800,000 acres now remain for free selection.

five large districts, which were called "meridional circuits," mostly bounded by conspicuous natural features. In each circuit a station called an "initial station" was chosen, central where possible; and latitude and true meridian were there observed for with an eight-inch transit theodolite, the one by circum-meridian zenith distances of north and south stars, and the other by equal altitudes of stars east and west.[1] Then, from the initial point, long angular traverses, following the chief valleys suitable for settlement, were carried, without chaining, in various directions to the boundary of the circuit. The points on these traverses, styled "geodesic" stations, were usually from ten to fifteen miles apart; and the bearings of the traverse lines, all referring to the meridian of the initial station, became fundamental bearings for all subsequent surveying operations in that circuit. Wherever the lines of adjacent circuits met on the common boundary a comparison of bearings was made, and it is evident that the difference should be equal to the convergence of the tangents to the meridians at the initial stations of the two circuits.

For the third process, each circuit is divided in the office into "districts" about twelve miles square, their sides usually being parallel and perpendicular to the central meridian. Then, in each district, a base line from one to five miles long is measured three or four times with a standard chain; the accuracy of which can at any time be verified by reference to one of the various 66-feet standards which have been laid down from a three-feet brass scale at suitable points in the province. On the base line a small triangulation is constructed, with sides from two to three or four miles long,[2] and connected with the lines of the circuit traverse; the angles are taken from every station, on three arcs; the maximum of permissible error in the sum of the observed angles of a triangle is 1′, and there is no distribution of error. Vertical angles are also observed. Trigonometrical stations near the boundaries are used by the surveyors of the surrounding districts. From the reduced horizontal angles the direction of every line with respect to the meridian of the initial station is found, and thence the co-ordinates of each station on parallels and perpendiculars to the meridian, which form the *data* for plotting. The survey of each circuit is thus regarded as a plane survey spread out on either side from the initial meridian. Concurrently with his triangulation, the district surveyor makes a topographical sketch of the country; the principal features, existing roads, &c., being inserted by means of intersections and eye. All is now plotted and drawn on the scale of two inches to a mile, and the suggested lines for future roads are marked on the plan before sending it to the office. The district is then divided in the office into "blocks" about three miles square.

Last comes the "section survey," or subdivision of the blocks for occupation. In this, after laying out and marking the block boundaries, the surveyor designs and lays out his roads, connecting all traverses with the sides of the triangulation; and plots them on the block plan on the scale of eight inches to a mile. Then he designs the sections on the plan, their shape, size, and arrangement depending on the course of roads and "lay" of country, but they are usually quadrilaterals of from 40 to 300 acres. In laying out roads and sections, topographical details are also surveyed. About one-tenth of the plans are examined on the ground, the rest in the office only. When passed, the plan is published on a reduced scale by photo-lithography, and copies are issued to the necessary quarters as an index for the public in selecting land for purchase.

From the finished block plans Crown Record maps are constructed, on the scale of four inches to a mile, the trigonometrical points being scored, and the detail reduced by a pentagraph. Each record map usually embraces a "district," or series of blocks—usually from twelve to sixteen block-plans. The number of each section, name of original grantee and other detail are shown on it, and copies of the necessary parts are made and transferred to the grants. The record maps and most of the block plans are in a good state: the latter in some cases become so worn that duplicates have now and then to be made, but with these exceptions there is no preparation of duplicates.

On the general plan described above, about 7,000,000 acres have been triangulated and topographically sketched, leaving 9,038,400 acres untouched,[3] two-thirds of which is however little but mountain and forest; and 2,800,000 acres have been section-surveyed. These figures include Southland; but as that province, after union with Otago, was brought as far as possible under the general system, the isolated surveys which were required could fortunately be connected in most cases with the triangulations, and placed sufficiently well on the topographical maps to prevent confusion and overlaps. All the work hitherto done may accordingly be considered fairly accurate, showing that, as an expedient for promoting rapid and correct land sales, and preventing waste, the Otago system has answered well. Indeed, both of the cardinal branches, trigonometrical and detail, have been surrounded with most of the safeguards and precautions which should be looked for in a well-managed survey department. All original records, moreover, have been carefully kept and registered, and the trigonometrical stations, with few exceptions, are erect and permanently marked; so that every part will be available for further use if required.

When, as the surveys within circuits progressed, the various initial points came to be connected together by intervening minor triangulations, it became possible to test the accuracy of the work by making comparisons between the observed differences of latitude and the differences com-

[1] A method I by no means recommend.
[2] In some of the more mountainous districts the sides are from five to seven miles long.
[3] Except that a reconnaissance was made of 4,000,000 acres of it.

puted through the network of triangles; also by comparing the observed and computed convergence of meridians. The results of these tests were very satisfactory, considering the means and the instruments used; and they do high credit to the skill and care of Mr. McKerrow, by whom all the original observations for latitude and true azimuth were made. The various circuits were now, with a little necessary humouring at the common edges, brought together on a geographical projection on the scale of eight miles to an inch, and the details were filled in from the topographical maps as far as finished and the original reconnaissance surveys, thus furnishing a pretty good map of the province, which was lithographed and published in 1871. In this map, a new edition of which with later details is being prepared, the Admiralty longitudes of Port Chalmers and the Bluff have been taken as fundamental.

Summary of Progress.

	Acres.
Section surveyed, trustworthy	2,800,000
Triangulated and topographically surveyed only	4,200,000
Reconnaisance only	4,000,000
Unsurveyed	5,038,400
Total area of Otago	16,038,400

III.—SUMMARY.

Reviewing what has been written thus far on the progress and state of the various surveys, it appears that, out of the 66,961,160 acres which make up the area of the two islands,[1] about 20,631,200 acres,[2] or three-tenths of the whole, have been covered with triangles trustworthily observed; 4,730,900 acres have been accurately and 6,405,500 acres[3] more or less inaccurately section-surveyed. Of Native claims, the surveyed total[4] amounts to about 4,689,787 acres, most of it needing some adjustment before it can be accepted as correct. The topographical and block surveys comprise 7,962,400 acres, nearly two-thirds of it good, the rest of doubtful quality; and the remaining 43,172,573 acres are either untouched or have been surveyed by reconnaissance only. The point to be now considered is, how far these materials are or can be made available for accurate cadastral or topographical maps.

To take, in the first place, the triangulations. They, as has been shown, are spread in six or seven detached pieces over parts of the Provinces of Auckland, Hawke's Bay, Wellington, Canterbury, and Otago. In the various parts the base-lines and angles were measured with commendable care. A good deal of pains was taken in determining geographical positions. Details generally were carried out in a correct and orderly manner, and the records have been carefully kept. In short, high praise is due to the officers who have conducted these operations. But the work has been done piecemeal, and each piece in a different way. In its present state it rests on a multiplicity of bases and standards, and on eight or nine separate determinations of true meridian and geographical position—some of them doubtless good, others more or less imperfect according to the means and methods employed. In Otago alone there have been already at least seventy base-lines and seventy small triangulations, and there are many yet to follow. You have a number of disjointed details, of good enough quality in themselves, but as yet no means of piecing them together. To put them to their full uses, it will be necessary to bring the whole within the grasp of one exact and comprehensive system, and to refer them to a single standard of length and a single starting point. If this be done—and it can be done—the small errors and inconsistencies which must undoubtedly have crept into the present systems will be eliminated, and every part will be welded into a compact and homogeneous whole. The double purpose will also have been fulfilled of making all the trigonometrical work that has been done available both for cadastral record plans, and for the construction of accurate geographical maps of the country. In this way, hardly anything need be wasted.

The state of the section surveys, however, is much less encouraging. Piecemeal work and want of unity of plan have here been introduced wholesale. Ten different departments have been at work in as many different parts of the colony, and following systems so various that scarcely any two are exactly alike. Some of these systems have been good and others bad. Out of the 11,136,400 acres returned as finished under this head, 4,730,900 acres, mainly in the triangulated area, may be said to come up to that standard of accuracy which fits them to form the kind of map required by the country—that is to say, a cadastral map on the correctness of which all men may agree, and which will give safety and value to Crown grants, and protect individuals from litigation, and Government from the risks involved in the issue of titles under the Land Transfer Act. But there is an enormous arrear of faulty work. Of the remaining 6,405,500 acres, a very large proportion has been inaccurately done, and is next to valueless for the purposes named; the whole of it must sooner or later be submitted to tedious and costly revision,

[1] According to the Report of the Conference of Chief Surveyors, 1873. See also the Abstract at the end of this Report.
[2] These figures do not include the small imperfect provincial triangulations in Marlborough, Westland, and Hawke's Bay, nor the 1,200,000 acres in Canterbury which need revision.
[3] Including the Confiscated lands in Auckland.
[4] Excluding 21,769 acres in Canterbury and Otago.

and the costliness will be aggravated in some cases by the fact of the original field-books having been lost. Ample proof has already been given of the generally loose and unscientific character of these surveys. None of them are available, in their present shape at least, as parts of a national survey, and for these reasons:—In the first place they have not been founded on any systems of triangulation, and consequently the small detached surveys of which they are chiefly composed cannot be accurately placed with reference to one another: secondly, they are in the majority of cases incorrect in themselves. I have adduced many instances of errors and discrepancies, and of generally faulty detail. Some of the record maps are little more than pieces of patchwork, containing gaps and overlaps of alarming size, and of very slight use as a basis for Crown grants. The whole style of work in the areas referred to has, in fact, been pernicious and full of inaccuracies. Every year, with the spread of settlement, these inaccuracies increase. Every year the land increases in value, the effects of inaccuracy are more painfully felt, and the task of revision is thrown more hopelessly into arrear. The amount of money already squandered in section-surveys alone which do not come up to the degree of accuracy that is necessary cannot be estimated at less than £600,000. It would probably cost £300,000, in addition to triangulation, to set them all systematically to rights. This aspect of the case is certainly very serious; and so long as the surveys in some of the provinces continue to be made as they are at present, it is perfectly clear that wastefulness and disorder will go on and increase.

It will, of course, be understood that, in commenting on these defects and their consequences, I have no wish whatever to scatter blame broadcast upon those who are or have been connected with the surveys under discussion. My object rather is to show the need which exists for prompt and vigorous reform. Though undoubtedly there have been many shortcomings in the past, much of the existing state of things may be set down to hurry and demand for land-sales and maps, and to want of sufficient means, causes which must have contributed in a great degree to the introduction of loose styles of surveying, and have formed some excuse for maintaining them. In many cases it is the system rather than the men that has been at fault; and the system has been in a measure necessitated by political and financial circumstances. And loose systems spoil the best men. Moreover, it cannot be disguised that, under the demand for surveyors which prevailed in the early days of settlement, many men crept into the profession who had received no technical or scientific training, and who did their work accordingly. From these and other causes, the present state of disorder is by no means without palliation. In some cases better systems have been introduced, and the old evils have been more or less successfully combated; but it is to be noted that these efforts have been mainly limited to departments pretty well supplied with money.

The Native lands surveys, as was shown in Part I., are all, or nearly all, likely to need some revision in order to bring them up to such a state of accuracy that they would fit properly into their places on large-scale maps. In short, though fairly good, they hardly purport to have been done with a high degree of care; and besides, they are little more than boundary surveys of blocks, usually of large size, thus scarcely conforming to the cadastral character. The rest of the progress made obviously is non-effective as regards cadastral survey. The better Topographical work could be largely reutilised, and with certain supplementary processes would answer very well, for a new topographical map of the parts comprised. The indifferent topographical surveys, however, would need revision, perhaps resurvey. Few trustworthy details are furnished by the Reconnaissance surveys, though they are likely to prove of some little use.

IV.—RECOMMENDATIONS.

Triangulation.

It will have been seen from the preceding section that the effective progress made in the cadastral survey of New Zealand amounts to 4,730,900 acres of correct section surveys, and 20,631,200 acres of correct triangulation. To all the rest of the surveyed area something or other needs to be done, and there are 43,172,573 acres practically untouched. The next question is how best to remedy the existing state of things and to make careful provision for the future. On this point it is in my opinion perfectly clear that, whatever be the means introduced for systematizing and carrying on future detail surveys and revising old ones, the basis of all such reform must be a general triangulation of the colony. In support of this view there could, perhaps, be no more convincing proof than this—that nearly all of the really good work hitherto done is that which has been founded on triangulation. That nothing short of trigonometrical survey will produce accurate estate maps of extensive areas is an axiom familiar to every educated surveyor; and in New Zealand accuracy is of special importance, from the responsibilities incurred in granting land, from the preponderance of undefined section boundaries, and from the scattered nature of the surveys. Triangulation, moreover, is cheap, because it insures the desired accuracy and saves the cutting of lines; the country is favourable for it; the old difficulties of Native interference and want of roads are fast disappearing; it has been urged by the Conference of Chief Surveyors, and by successive Secretaries and Registrars-General of Crown Lands. Lastly, Government have already signified their assent to the principle, by taking a preliminary vote for this very purpose.

The question as to the best kind of triangulation to be adopted is perhaps a little more open to argument. For many reasons, however, I am led to recommend, as the fundamental framework, a system of major triangles of as large size, up to fifty or sixty miles' side, as the form of the country will allow; these to be afterwards broken down into secondary and tertiary triangles as required. The chief advantage of a triangulation such as this over one of a more limited kind is that, in conforming to the well-known principle of working inwards from the greater to the smaller, it largely reduces the probable errors of the work, and does so at but a slight extra outlay. Exactly the same number of stations are occupied in either case, and the only additional expenses incurred are in the purchase of a larger class of instruments, the greater difficulty of getting them from place to place, and the cost of using the heliostat for observing very distant points. A sum of from £8,000 to £10,000 would certainly cover the extra charge. By this moderate addition you would lay the foundation of the whole structure of the survey in a thoroughly accurate and efficient manner, at but a tithe more than the cost of doing it imperfectly; and there is perhaps no scientific undertaking to which the maxim that what is worth doing at all is worth doing well applies more truly than to this. The officers who conducted the English survey insisted from the very first on strictly good and correct work in every detail, and for a long time were well abused for their pains. Now, the country but too gladly acknowledges the wisdom that was shown in their timely and enlightened adherence to accuracy. A triangulation, once completed, stands for all time. It is the framework on which a survey on any scale whatever may be laid down; and if accurately carried out, it forms the basis for geodesical measurements. No pains, therefore, should be spared to do it thoroughly once for all. It will then repay its cost over and over again.

The sides of the Primary triangles should vary from fifteen or twenty miles up to fifty or sixty —the larger the better, if well-shaped triangles are preserved; and the angles should be observed with instruments of from twelve to eighteen inches circles, four of which would need to be bought, at a cost of about £1,200.[1] A base line from six to eight miles long should be measured in each island with the best apparatus. For that in the North Island, a good site might, I think, be found either on the Taupo or Napier plains; in the South, on the plains of Canterbury. The triangulation would be carried across Cook Strait, and the bases be thus connected and a verification obtained. One fundamental latitude, longitude and meridian should be determined at a convenient station of the survey, and used in computing the latitudes and longitudes of the remainder, azimuths of verification being observed at other distant points. This network of great triangles should cover the whole country, and a selection from existing points should be used if possible in the districts already triangulated.

In the Secondary series, the sides would vary from eight to fifteen or twenty miles, and the angles at these stations might be observed with eight and ten-inch instruments. Such triangles should only be extended over areas already occupied, or likely to be within say twenty years,[2] and not yet covered with a triangulation of this class.

For the Tertiary or minor series, sides of from two to three or four miles, and six-inch instruments, will answer. There will be no need to extend this branch of work to the areas already thus observed, but it should be systematically spread over all new survey districts, over all of the old work that needs revision and correction, and thereafter as required for settlement. Where minor triangulation is rendered impossible or too expensive by dense forest or other physical obstacles, cardinal lines, whether straight as in the direction of the meridian, or following the course of existing or probable main roads, should be laid out very carefully in connection with the secondary stations, as a basis for detail surveys, with permanent marks at about every mile.

To carry out the whole system of triangulation thus suggested, a special branch must be organized, and placed under the sole control of a permanent Surveyor-General, whom, for the present, we will consider as trigonometrical only. This officer should have a competent knowledge of both the practical and theoretical part of trigonometrical surveying, and of the sciences of astronomy and geodesy in their relation to it. It would be his duty to devise and control the whole system of trigonometrical operations, and the calculations connected with them; and he should be competent to superintend on behalf of the colony the determination of difference of longitude from the Sydney or Melbourne Observatory, an undertaking which cannot be very far distant. It seems fitting, also, that the central time establishment of the colony, which I understand is likely to be soon set on foot, should be placed under his direction. He would need as his immediate *aide* a Secretary accustomed to the use of instruments and with good mathematical knowledge, able to assist personally in the more delicate observations and other field processes and the higher calculations, and if necessary to carry on the work of the department in the temporary absence of his chief. The rest of the staff would vary in number as the work progressed. I think most if not all of them might with a little training be provided out of the existing departments. It would rest with the Surveyor-General himself to decide whether the introduction of a small leaven of highly experienced observers from home might be desirable or not; but I am disposed to think that the advantage to be gained by doing so is not equal to that

[1] The £5,000 already voted would more than cover all preliminary expenses and apparatus. There are (or will shortly be) in Auckland four ten-inch and two twelve-inch instruments, the property of the Colonial Government, all in good order, besides inferior ones; and there are five or six good eight-inch and six-inch instruments in the different provinces.

[2] In wild districts, however, a number of intermediate points should be fixed by observations *from* the stations of the great triangles, to serve as a basis for topographical surveys.

of employing observers already well acquainted with the country, and many of them speaking Maori. The selection of staff, their rates of salary and allowances, promotion, &c., should be left with the Surveyor-General. As soon as a few stations had been fixed upon and erected, three or four principal observers might at once be set to work. The erection of stations meanwhile should be vigorously pushed, and the secondary and tertiary observing parties increased in proportion. Base lines might be measured in winter. A clerk, a draftsman, an instrument maker, and three or four computers, would serve for the Trigonometrical Office staff. Due attention should of course be given to the systematic registration of all original observations and computations; everything ought to be most carefully kept.

I think that in this way the whole operation could be finished in from eight to ten years, as far as needed, at a cost of £100,000.[1] This assumes that the triangulations under Messrs. Heale, Jackson, and McKerrow, and part of that in Canterbury, are of the character I suppose them to be; that principal triangulation only is to be extended over the whole country; that secondary is to be limited to the lands available for early settlement; and tertiary to those (not yet observed) which may have been granted or otherwise disposed of up to the time of completion of the larger series. The estimate is also, for a reason which will presently appear, charged with half only of the probable salaries of the Surveyor-General and his Secretary.[2] I submit that, if Government decide on a triangulation such as I recommend, it is desirable that the sum named be set apart by a special appropriation, and placed at the disposal of the Surveyor-General, to be used as he might require. A work of this nature ought to be pursued steadily on one system. Nothing can be promised with any certainty as to what it will cost, or how long it will take to do, unless it is guaranteed against the changes and interruptions which might be incurred under the risk of an annual Parliamentary vote. In England, for example, a sum of £30,000 was absolutely wasted in a few years owing to the fluctuations in the annual vote which were caused by the vacillation of Parliament.

Besides the actual work of triangulation, the Trigonometrical Department would need to prepare projections for maps and systems of sheets for cadastral plans, and to supply them, with the co-ordinates or other *data* for plotting trigonometrical and main traverse stations, to the detail survey centres. Levelling also is a branch of work fairly appertaining to such a department. Nothing in this direction has yet been done in the colony, and I should not advocate any extensive system. But I think a few main lines of road levelling would be found of great value in geological, railway, or other engineering surveys, and for special scientific investigations; and they would not add much to the expense.

In this outline of a scheme for trigonometrical survey, I have not gone very minutely into details, because I do not suppose that you expect me to do so, nor do I think it would be of much use. The Surveyor-General, when appointed, must think out for himself the best way of dealing with matters of detail and routine. It may possibly be urged by persons unacquainted with the subject, that the proposed expenditure is nothing but a costly piece of scientific extravagance. But there is no occasion to go outside of the colony in search of facts to refute any such assertion. To take for example the history of the survey of this very Province of Wellington. The area completed up to 1865, without triangulation, was 502,000 acres, and it cost about £75,200; but out of this, only 60,000 acres were correct, and the rest, namely 442,000 acres, had to be done over again. Therefore, the virtual cost of the 60,000 acres was some 25s. per acre, or two and a half times the saleable value of the land. Since 1865, 1,039,000 acres—including the above 442,000—have been correctly surveyed under Mr. Jackson, at a total cost, including triangulation, of 1s. 4d. per acre, or about one-nineteenth part of the former rate. And although it might be illogical to argue that this immense difference is wholly due to the want of a triangulation in the first instance, it is nevertheless certain that by far the greater part of it must be attributed to this cause and no other. Numbers of similar cases might be quoted from the history of this and other countries to show that the process of triangulation is one which in the long run most fully repays its cost; and the scheme which I have outlined is only just sufficient in its scope to give a permanent and lasting character to the work. To recapitulate its leading features, I recommend,—

1. That a Trigonometrical Survey Department be formed, with its head-quarters at Wellington, and placed under the control of a permanent Surveyor-General, assisted by a Secretary.
2. That a Principal triangulation be spread over the whole country; a Secondary triangulation over as much of it as is likely to be settled within twenty years, not including the parts already done; and a Tertiary over all parts not yet observed which may have been disposed of up to the time when the general larger operations come to an end.
3. That the Department undertake also the preparation of one uniform system of projections and sheets for maps and plans of the country, on which the surveys may be drawn: also of any levelling operations which may be required.
4. That a sum of £100,000 be set apart for these purposes (levelling excepted), to be expended as the Surveyor-General may find most advantageous; but such expenditure to be spread over eight years at least, and not to exceed £20,000 in any one year.

[1] In addition to the £5,000 already voted.
[2] Leaving half to be charged to the detail surveys; *see* next page.

DETAIL SURVEYS.

It remains to consider a plan by which detail surveys throughout the colony may be so conducted and engrafted on the proposed trigonometrical framework that the country may gradually be put into possession of a complete, authentic, and uniform set of the maps and plans needed to fulfil all important public objects—that is to say, of geographical and topographical maps for general use, and of detailed cadastral plans on large scales for purposes more immediately connected with the land; for this I infer to be the object of Government in taking up the survey question. That such a state of things can only be brought about by a radical change in the existing organization is an assertion which hardly needs proof. I have, indeed, already pointed out that there are now no fewer than ten different departments, working in all sorts of ways; and the result of these disjointed operations is that, after thirty-five years and an expenditure of nearly a million and a half of money, New Zealand has not the materials for an accurate cadastral map of more than a fraction of her territory. Plainly what is needed is system and centralisation. Every survey department in the colony must be brought in some way into subordination to a Surveyor-General with his head-quarters in Wellington, and all of the detail work must be done in conformity with one comprehensive system, devised by him, in which the leading feature will of course be a proper connection of every part with the trigonometrical basis. There are, I believe, three possible ways in which this change might be effected:—

1. By simply requiring the Surveyor-General to lay down a code of rules for the guidance of Provincial Surveyors, and determining to refuse grants of all lands not surveyed in conformity with those rules.
2. By making every Provincial Chief Surveyor a General Government officer, and placing him under the Surveyor-General's authority, the provincial staffs remaining in other respects undisturbed.
3. By abolishing the Provincial survey systems, and substituting for them a large general department, presided over in every respect by the Surveyor-General.

I confess that the last-named method alone seems to me to be thoroughly efficient and practical. As regards the first of them, it will be clear to any one acquainted with the practice of surveying that, in addition to other obvious drawbacks, there would be no guarantee under this plan for the attainment of the objects sought; no code of rules could be framed which might not be evaded in many important respects, unless each Chief Surveyor and all his staff, in addition to being thoroughly efficient men, lent themselves heart and soul to the furtherance of a scheme propounded by an official of whom they would be practically independent. As regards the second, it seems to me that the system of divided authority which is involved in it would be little less likely to lead to failure. If the Surveyor-General is to be held responsible—and he certainly should be—for the proper conduct of the work in all its details, it is no less necessary that every one concerned in the production of that work should be approved of by him and subject to his authority, and that he should be able to exercise a direct as well as an official influence over the members of the staff and their mode of work. The Survey Department, moreover, should be a strictly independent and technical organization, free from the baneful influences of local politics. The system of working from district centres, as at present, might be maintained with great advantage, but there must be no direct break in the chain of authority.

One or two arguments from other authorities may be appropriately quoted here. It has been well pointed out by Mr. Moorhouse, in his reports as Secretary for Crown Lands, that it is both the duty and the interest of the Colonial Government to enforce a sound system of survey: its duty, in order to protect grantees against litigation and loss; its interest, in consequence of the risk involved in granting titles under the Land Transfer Act. Mr. Thomson, also, in a report to the Secretary for Crown Lands, dated May 13, 1873, shows that, while the provincial interest in surveys and lands gets less and less as the lands are parted with, the colonial interest, through the Land Transfer Act, is ever increasing. These arguments plainly point to supervision of surveys by the General Government, and I do not think effective supervision can be obtained except by absorption into one department. To be brief, I consider that the first scheme is impracticable, the second undesirable and only to be adopted as an alternative, the third that which should be carried out if political circumstances admit of it.

I recommend, then,—

1. That as soon as practicable the General Government take charge of all survey operations in the colony, abolishing for this purpose the present provincial organizations.
2. That the whole be then placed under the Surveyor-General at Wellington, whose duty it will be to organize and superintend all detail as well as trigonometrical operations.
3. That those of the existing staffs who may wish to take service under the new system at their present rates of salary be retained, subject to approval by the Surveyor-General, who may, if he wishes, introduce a test examination as a condition of their remaining.
4. That the existing system of centres and Chief Surveyors be adhered to for the present at least. (Should abolition of provinces take place, it might be desirable to rearrange the areas of district surveys, and perhaps to change the title of the superintending officers.)

To enter now a little more fully into details—I may remark that, under this system, the work of the future would resolve itself into three principal heads, namely, the Triangulation, the Prosecution of New Surveys, and the Revision to some extent of the old. With the Triangulation I have already dealt. With regard to the New Surveys, there are several points for improvement, on which I may offer suggestions, but as a groundwork merely, on which details must be afterwards worked out by the intelligence of the Surveyor-General. I recommend, in the first place, the absolute abandonment of compass surveys, of contract surveys, and of the present loose system which in too many cases prevails, of establishing no check whatever upon the work of the field surveyors. Efficient checks might be obtained by introducing, either separately or in combination as circumstances may permit, such precautions as regular field inspection, or plotting in the office, or withholding the real lengths of trigonometrical lines from the surveyor. Field-books should be kept in ink on the ground, and most carefully registered and preserved. The plan-drawing is now in many places indifferent, and there is a great diversity in style; also in the systems of sheets, and in the notation and characteristics, all of which should be assimilated. But the cardinal point of all reform must be to insist that every new survey shall be rigorously tied to trigonometrical points. There will be difficulty at first in this. Some time must necessarily elapse before the trigonometrical stations can be erected in the districts as yet unprovided with triangulation; still more before all the angles can be observed and the computations made. Hence the importance of "poling," as it is termed, the districts under survey as soon as possible, a work to which the trigonometrical officers—or, in necessary cases and with due instructions, the Chief Surveyors—would need to give attention. If the stations are once put up, and named or numbered, and rough diagrams of them made, that will answer for the time. Every detail survey can then be connected with them, and its traverse angles be referred to the line joining any two trigonometrical points. This will furnish means for plotting the work truly on the record map when the observations are in due course made and reduced. In the meantime, it could be laid down for temporary purposes to an approximate meridian. It will be understood, nevertheless, that due exertions should be made to cause the triangulation in all possible cases to precede the detail survey.

Two subjects here claim attention. One is that of scales for maps and plans; the other that of territorial subdivisions; and they have a certain connection with one another. The scales now in use in nearly every European country are expressed by simple fractions, such as $\frac{1}{500}$, $\frac{1}{2500}$, $\frac{1}{50000}$, indicating the proportions which the measures on the maps bear to the actual linear measures on the ground. They are generally in conformity to the decimal system, and have no reference whatever to national units of length. The principle aimed at is to insure simplicity and uniformity of system, and an easy means of reduction from one scale to another, and of comparison and juxtaposition of the maps of various countries. Evidently, maps on such scales as I have indicated are capable of direct and simple reduction from one scale to another, and their proportions are easily understood by every one, whether a foreigner or not. But, admirable though this system is, the insular position of New Zealand relieves her from all necessity of conforming to it. The scale of eight inches to a mile, or $\frac{1}{7920}$, for cadastral plans, which has been adopted all over the colony, seems to me to be as good as any that could be chosen. Making every allowance for New Zealand's growing prosperity, and for the possibility that maps may some day be required which shall show a good deal more detail than exists at present, I think it is as large as is needed. It is capable, moreover, of very convenient subdivision and multiplication; the staff and the public are accustomed to it; it is as easily (perhaps more easily) understood by the colonists as a scale of say $\frac{1}{7500}$; and it has the further advantage that a square inch on the map is exactly ten acres on the ground. I therefore recommend that it be adhered to for the manuscript maps of all section-surveyed country lands. For towns, the scale of 40 inches to a mile has chiefly found favour. Eighty would have been better. The larger scale costs but a fraction more, and the detail which may before long be required could not be shown without crowding and confusion on the smaller. I therefore recommend 80 inches to a mile for towns in future. For the topographical maps I recommend a scale of two inches to a mile in original manuscript, reduced to one inch to a mile for publication, and it should be gradually extended in sheets to the whole colony. A general map might be prepared from it on the scale of ten miles to an inch. This should be engraved.

The whole system then will be,—

General map, 10 miles to an inch	(to publish).
Topographical map, 1 inch to a mile	(to publish).
Cadastral plans,[1] 8 inches to a mile	(MS. only).
Towns, 80 inches to a mile	(to publish).

There is, secondly, the question of territorial boundaries, which, I think, need a good deal of adjustment and simplification. As matters stand at present, not only are the boundaries of provinces in some places technically unsatisfactory and indeterminate, but the interior subdivisions for various purposes are numerous and complicated in the highest degree, and are likely, unless soon reduced to simplicity and system, to give rise to a great deal of future inconvenience. There are, to begin with, the "survey districts:" these have no legal recognition, but are simply areas schemed out in the survey offices for convenience of description and registra-

[1] Time and experience must decide whether the publication of these plans on a reduced scale, say four inches to a mile, would be justified by the probable sale. At present I think it would not.

tion in connection with surveys and land sales. In some provinces they are very numerous, as, for example, in Hawke's Bay, where there are no fewer than twenty-two rural and ten town districts in an area of some three millions of acres. Then there are Provincial Electoral Districts, General Assembly Electoral Districts, Road Board, Sheriffs', Education Districts, and others—these having legal definition. The boundaries of these innumerable subdivisions, as at present constituted, cross and interlace with one another in the direst confusion; and each must be separately defined, described, and in some cases marked on the ground. It is very much to be desired in the future interests of public business—especially of that concerned with registration of any kind—that the boundaries under these various denominations should, if political circumstances admit, be made conformable to one another in the simplest practicable way. If it be urged that no particular inconvenience is felt under the present system, the case of England may well be quoted as one for this country to take warning by; the non-conformity of the old parish, hundred, lathe, county, and other boundaries, is at this moment a cause of the very greatest inconvenience and labour in the formation of new districts for various purposes; nothing but the cost of the undertaking and the counter inconvenience which might be inflicted on other transactions has hitherto prevented the country from remodelling and simplifying the whole system. Here it may not be too late now to begin, especially as there is some prospect of the abolition of provinces. The basis of the most convenient rearrangement is in theory very simple. Suppose, for example, that it were intended to divide New Zealand into parishes, hundreds, divisions, and counties. It would only be necessary to decide upon and describe and mark out every parish boundary: then to make every hundred contain an exact (not necessarily a fixed) number of parishes, every division an exact number of hundreds, and so on. If all boundaries of whatever kind were brought into conformity with this simple and intelligible plan, an immense deal of confusion and trouble would certainly be saved.[1] Public boundaries thus settled upon and marked should in every case be surveyed, and shown with proper characteristics on the cadastral maps. The principal subdivisions of territory would form a basis for the Surveyor-General's scheme of meridians and systems of sheets: probably divisions of from 3,000 to 5,000 square miles might conveniently be chosen for each separate group of cadastral plans, the sheets in each group being all laid out symmetrically with respect to a central meridian. Six miles by four (or 48 inches by 32 inches) would be a convenient size for the large-scale sheets. The sheet lines of town plans should conform to those of the eight-inch plans. For the topographical map, one central meridian for each island might be taken: for the ten-mile map, one meridian for the whole colony. It may be well, before leaving the subject of boundaries, to suggest that they ought to be so definite and explicitly described as to leave no room for doubt. Roads, streams, and banks make good parish boundaries. Straight undefined lines, marked at the extremities with stones, are convenient, lasting, and indisputable. Ridges or water-partings should be excluded, as too indefinite, and replaced by straight lines from point to point. The south boundary of Auckland, I may add, needs early amendment: nothing is harder to mark out than a parallel of latitude.

To resume the subject of the detail surveys. It has been explained that each centre will be supplied by the trigonometrical branch as soon as possible with all *data* for the preparation of the eight-inch sheets with trigonometrical stations accurately marked on them. On these sheets *every correct detail survey, new or old, should be laid down: those of doubtful accuracy should not be laid down at all.* These sheets will be of exactly the same size and kind all over the country. They will form the record maps, and when filled should be sent to head-quarters and stored there, transfers or lithographs or tracings on calico being retained for use in the various district Survey and Land Offices. As regards Crown grants, one result of the system proposed will be that, after certain dates, no grants will be issued for lands the survey of which has not been properly connected with the trigonometrical basis. And, by degrees, the descriptions in all Crown grants which may have been issued prior to the incorporation of the surveys to which the grants relate on the final record maps, ought to be amended, and brought into conformity to the particulars as to districts, sheets, and numbering which the new system would introduce; and this without extra charge to the grantee.[2] By these means one perfect and methodical system of registration would ultimately be extended to the whole country. It will of course be seen that the effects of the different measures of reform which I have advocated will not become apparent all at once. The changes can only be gradually made. It must be enough to promise that in due course order will be evolved out of chaos, and everything be brought into its place and shape as part of a systematic whole.

In the preparation of Topographical maps, the method to be pursued will vary according to the particular circumstances and the means available in different parts of the country. In some parts there are already accurate materials to hand; in others some revision and addition will be needed, to work up existing details. All future section surveys should be so made as to

[1] Might not a small Boundaries Commission of say three members (one of whom should be a topographical officer) be appointed, to visit the various centres, and ascertain how far such a re-arrangement would be practicable; and wherever possible, to recommend a definite plan of action. The advice of the Surveyor-General should be taken in the actual working out of details.

[2] Though I do not see any particular objection to the system now adopted in some provinces of writing the bearings to section boundaries, I am disposed to doubt its usefulness, and it adds to the work. The number of the section and sheet, and the name of the district, &c., with descriptions of boundaries, and the exhibition of surrounding detail on the grant plan, would be quite sufficient for identification.

furnish the chief necessary particulars. Lands already occupied should be first included, early attention being given to those which are now under lease from rough surveys; and the work could be afterwards pushed beyond these limits to the country at large. It might be desirable to station a small staff in each district, specially to prosecute this branch. The question of the amount of accuracy to be bestowed on hill-sketching is one of money, and must be left to the Surveyor-General's decision. Special attention should be given to the subject of nomenclature, and care be taken to adhere in all possible cases to accurate Native names: this is a matter of great philological and antiquarian importance.

For the superintendence of the various detail surveys, the Surveyor-General would need as his immediate assistant at head-quarters an able Executive Officer. His duties would be to assist in the control and direction of the district operations, in advice to officers, in the supervision of accounts, rates of salary, &c., and generally in the routine work of the department. Topographical and boundary surveys, the examination of cadastral maps, the revision of old surveys (to which subject I shall come presently), and the compilation and publication of the topographical maps, might be placed under his immediate charge; but a sub-officer should be appointed to help in these duties. Three or four clerks and accountants, a plan-examiner, a storekeeper, and one or two topographical draftsmen, would also be needed: and in course of time a small publishing staff. Possibly Native surveys might with advantage continue to be combined under a single officer, with some modification of present arrangements, though I am not clear on this subject. As the scheme progressed, occasion might arise for the appointment of one or two other principal officers, though I see none at present. The offices of "Chief Inspector of Surveys," and "Astronomer and Geodesian," which have been suggested, are in my opinion unnecessary, if you have a good system and a competent Surveyor-General. The Chief Surveyor in each district should of course be made responsible to the Surveyor-General for the accuracy of all work done under his direction. As regards sub-employés, none should in future be engaged until they have been approved by the Surveyor-General after an entrance examination. I recommend, lastly, that the Surveyor-General or his Executive Officer be required to visit annually each district office, and occasionally parties in the field.

It is not possible to enter into any precise estimate of the probable time that it will take to finish the cadastral survey: this must depend on the progress of settlement. Neither is it important to go minutely into the question of cost, since the execution of the detail survey is no voluntary undertaking, but one necessitated by the land-laws of the country: it is work that must be done. It is however most important that the cost should be reduced to the lowest figure that is consistent with due accuracy, and this is exactly the result which a scheme of reform such as I advocate will most surely bring about. All experience attests that large departments, properly organized and directed, produce far better and cheaper work than a multiplicity of small ones; and this is especially true of extensive surveys, which indeed cannot be made uniformly and cheaply in any other way. The cost at present, in the best of the provincial departments, seems to vary from 6d. to 1s. 6d. per acre. For the whole country, it is a good deal higher. It is safe to predict that the current average would be considerably reduced under a single system, provided that circumstances were not less favourable than at present, and that the rate of expenditure did not fluctuate much from year to year. You would get better work, and more too, for the money. The savings of a few years would fully repay the whole cost of the triangulation, and give you a good topographical map into the bargain.

The question of Revision of imperfect surveys alone remains to be considered. It is the most difficult part of the whole subject. I cannot possibly recommend the Government to enter upon so costly an undertaking as a systematic resurvey of the large area, amounting with Native and Confiscated lands to some fourteen millions of acres, the plans of which are known to be more or less imperfect. Nor is such a step by any means necessary. There are no doubt certain parts —those, namely, in which the consequences of inaccurate surveys are being seriously felt and causing trouble and litigation—to which early revision might be extended with advantage. Lands which have been sold from imperfect topographical surveys should also receive prompt attention. But a very large proportion of the whole may well be left for the present;—or at least there need be no expensively active process applied to it so long as serious difficulty does not arise. In my accounts of the surveys, I explained here and there that, even in parts where the work as a whole is unsatisfactory, much of it might very possibly be redeemed if such checks could be applied as would show where the bad parts are and enable the good to be picked out. In the triangulation and the principal traverses, will be found, I think, the system of checks desired. If old surveys are connected at all possible points with the trigonometrical basis, and replotted on the new sheets from original field-books (or from the maps, in cases where all necessary details are given), it is not unlikely that a good deal will be found to fit in in such a manner as to leave no doubt of its accuracy. But nothing must be humoured, and nothing be admitted on the new record maps which does not plot correctly; and it would be a safe rule to insist that no small detached surveys be laid down until they have been strictly verified and fixed. For the process of tentative revision thus suggested, a small staff might be formed by degrees, to consist at first of one or two field-men in each district to connect the surveys, and one or two office hands to test the plotting. The revision, of whatever kind, whether direct or tentative, should be an entirely separate work, and its cost should be kept distinct from that of parent survey. Its rate of progress will evidently depend on the supply of funds.

There are one or two other and less direct ways in which part of the revision may gradually be achieved. Much, for instance, may be looked for from the closing in of new surveys upon old. Still more from the working of the Land Transfer Act, under which persons wishing to subdivide and deal with their lands will doubtless themselves have resurveys made for the purpose. To aid and encourage such undertakings, and to afford accurate *data* connected with the triangulation upon which private surveys might be closed, roads passing through imperfectly surveyed areas ought to be very carefully traversed, and marked at intervals with permanent pickets. Landowners would then have every inducement to get their lands privately resurveyed, from the assurance that now at any rate the work could be done properly once for all. Due checks should be established on the accuracy of such surveys. Perhaps the best plan would be to allow the Government revising staff to undertake them at a fixed scale of rates. The working of these various direct and indirect modes of revision would necessarily be slow. But gradually all would be brought, bit by bit, into position on the cadastral map, and this at a comparatively very slight cost to the Public Treasury. The principle—now I believe pretty well established—that possession is to be taken as the chief proof of ownership, in cases where errors and discrepancies are not inordinately large, will no doubt contribute materially to a quiet settlement of such difficulties as may arise.

I have now touched—I hope at not undue length—on the chief matters for consideration, except the political question how the surveys are to be paid for, which I have purposely avoided as being beyond my province; I must ask your indulgence for such errors and shortcomings in this report as may be due to my not having been able to give as much time and study to the subject as I could have wished, and to my somewhat brief acquaintance with the colony. There can be little need for me to urge further the necessity for complete reform. No more instructive lesson on the enormous waste which is inseparable from bad systems of survey could well be given than that furnished by the history of this country during the last thirty-five years. Not that there is anything so very remarkable in the present state of affairs. The case has its parallels. Every country finds out, sooner or later, that the hasty and perfunctory methods of surveying which at first answer well enough and are often an absolute necessity, must be replaced by surer and more scientific processes. In New Zealand there has been rather a long delay in applying the needful remedies, so that the cost of cure and the time it will take have been proportionately increased. But this cost and this time will go on increasing every year that things remain in their present state. The sooner, therefore, reform is set about, the greater will be the ultimate saving of money and time, to say nothing of the advantages gained in the substitution of order for the present disorder, and in the suspension of widespread litigation and dispute. System and organization and vigorous superintendence are benefits which the surveys of this country stand sorely in need of. I believe that a plan such as I have sketched would gradually reduce them to a state of accuracy in which all might have confidence, and to a system intelligible to every one. I believe, too, that it would amply repay its cost, and prove a wise and beneficial outlay of public money.

I have, &c.,
H. S. Palmer,
Major, Royal Engineers.

The Hon. the Colonial Secretary.

Approximate Abstract of State of Surveys in New Zealand,[1] 1st March, 1875.

Provinces.	Detail Surveys.							Trigonometrical Survey.		
	Section Surveys.[2]		Topographically, or block-surveyed only.		Native Claims Surveyed.	Reconnaissance only or unsurveyed.	Total Area of Province.	Triangulated Correctly.		
	Accurate.	Needing more or less revision.[4]	Trustworthy.	Needing verification or resurvey.				General Government	Provincial Government.	Total.
	Acres.	Acres.	Acres.	Acres.	Acres.	Acres.	Acres.	Acres.	Acres.	Acres.
Auckland ...	...	3,390,000[5]	...	850,000	2,330,760	10,429,240	17,000,000	7,500,000	...	7,500,000
Hawke's Bay...	150,000	976,000	...	...	1,124,000	800,000	3,050,000	2,242,560	...	2,242,560
Wellington ...	1,099,200	412,800	...	...	1,235,027	4,252,973	7,000,000	880,640	2,496,000	3,376,640
Taranaki ...	10,000	130,000	...	...	...	1,997,000	2,137,000	...	12,000	12,000
Nelson ...	25,000	200,000	...	1,350,000	...	5,425,000	7,000,000	...	...	...
Marlborough ...	107,100	154,700	...	622,000	...	2,116,200	3,000,000	...	...	...
Westland ...	39,600	...	940,400	...	...	2,065,760	3,045,760	...	...	...
Canterbury ...	500,000[6]	1,142,000	...	...	...	7,048,000	8,690,000	...	500,000	500,000
Otago	2,800,000	...	4,200,000	...	...	9,038,400	16,038,400	...	7,000,000	7,000,000
Totals ...	4,730,900	6,405,500	5,140,400	2,822,000	4,689,787	43,172,573	66,961,160	10,623,200	10,008,000[7]	20,631,200

[1] This abstract does not include work in progress.
[2] The Canterbury and Otago totals include 21,769 acres of Native lands.
[3] Includes all unsurveyed Native lands.
[4] That is to say, they are not in their present state sufficiently trustworthy to be accepted as parts of a cadastral survey.
[5] Including the Confiscated lands.
[6] By estimation only.
[7] In addition to 1,200,000 acres needing revision in Canterbury, and some small imperfect triangulations in Hawke's Bay, Marlborough, and Westland.

H. S. Palmer, Major, R.E.

No. 14.

CIRCULAR from the Hon. the COLONIAL SECRETARY to the SUPERINTENDENTS of PROVINCES.

(Circular No. 11.) Colonial Secretary's Office, Wellington,
14th April, 1875.

SIR,—

With reference to my circular of the 30th December last, in which I stated that Major Palmer, R.E., had undertaken to examine and report upon the state of the surveys in New Zealand, I have now the honor to forward, for your information, a copy of his report, furnished to the Government on the 13th instant.

I have, &c.,
DANIEL POLLEN.

His Honor the Superintendent.

No. 15.

His Honor the SUPERINTENDENT, Taranaki, to the Hon. the COLONIAL SECRETARY.

SIR,— Superintendent's Office, New Plymouth, 22nd April, 1875.

I have the honor to acknowledge the receipt of your circular, number and date quoted in the margin, together with the report upon the state of the surveys in New Zealand by Major Palmer, R.E., for which I am much obliged. No. 11, 14th April, 1875.

I have not yet had time to peruse and study the report, but will make a point of doing so, and possibly may remark upon it at a future time.

I have, &c.,
F. A. CARRINGTON,
Superintendent.

The Hon. the Colonial Secretary, Wellington.

No. 16.

His Honor the SUPERINTENDENT, Canterbury, to the Hon. the COLONIAL SECRETARY.

Superintendent's Office, Christchurch, Canterbury,
22nd April, 1875.

SIR,—

I have the honor to acknowledge the receipt of your letter of the number and date quoted in the margin, forwarding, for my information, a copy of Major Palmer's report upon the state of the surveys in New Zealand, and to thank you for the same. No. 11, 14th April, 1875.

I have, &c.,
W. ROLLESTON,
Superintendent.

The Hon. the Colonial Secretary, Wellington.

No. 17.

His Honor the SUPERINTENDENT, Otago, to the Hon. the COLONIAL SECRETARY.

SIR,— Superintendent's Office, Dunedin, 21st April, 1875.

I have the honor to acknowledge the receipt of your letter of the number and date quoted in the margin, forwarding a copy of Major Palmer's report on the state of the surveys in New Zealand. No. 11, 14th April, 1875.

I have, &c.,
J. MACANDREW,
Superintendent.

The Hon. the Colonial Secretary, Wellington.

No. 18.

His Honor the SUPERINTENDENT, Westland, to the Hon. the COLONIAL SECRETARY.

SIR,— Superintendent's Office, Hokitika, 29th April, 1875.

I have the honor to acknowledge receipt of your circular No. 11, of the 14th instant, forwarding a copy of Major Palmer's report upon the state of the surveys in New Zealand.

I am glad to find that Major Palmer gives such a favourable report on the surveys of this province, and I have the honor to request that you will be good enough to cause me to be supplied with two additional copies of the report.

I have, &c.,
JAMES A. BONAR,
Superintendent.

The Hon. the Colonial Secretary, Wellington.

By Authority: GEORGE DIDSBURY, Government Printer, Wellington.—1875.

[*Price* 1*s*. 6*d*.]