1877.

NEW ZEALAND.

THE SURVEYS OF NEW ZEALAND

(REPORT BY THE SURVEYOR-GENERAL ON).

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

The SURVEYOR-GENERAL to the Hon. the SECRETARY for CROWN LANDS.

SIR,— Wellington, 7th December, 1876.

Having now finished my examination of the various Survey Offices of the colony, I have the honor to lay before you the following report. In order to save time, with the concurrence of the several Superintendents, I proceeded to inspect the offices of Canterbury, Marlborough, Nelson, and Westland, before they came under the charge of the General Government.

PREFACE.

As instructed by you, while I was at Christchurch I reported on the state of the Survey Office there, and at Timaru directly, to the provincial authorities; and though I shall have to go over the same ground here in regard to these, yet, as I had at that time to confine my remarks to the local aspect of the subject, I have found it now necessary in some measure to recast my notes, in order that they be made suitable in their proper connection in relation to other offices. My notes are unavoidably technical, involving much dry detail of office arrangement and matters of routine; but, I submit, to pass over these would be to keep back the grounds on which I rely for support in the measures of alteration that I shall propose before concluding.

As my inspections have been at various intervals extending over several months, I believe it will be better to give extracts of my journal, accompanied by the notes that I made on the spot: this will clear the way for entry on the general principles on which I propose to conduct the professional and practical operations of the department.

I left Wellington on the 28th July last, arriving at Christchurch on the next day, and I commenced my examination of the Survey Office there on the 31st. In my inquiries I was assisted by Mr. S. Hewlings, the Chief Surveyor, who gave me every facility.

CANTERBURY SURVEYS.

My first attention was directed to the Initial Station of the Foundation Surveys of Canterbury, and Mr. Hewlings informed me that this was situated on Mount Pleasant, an eminence above the harbour of Lyttelton. The true bearing from thence to Cooper's Knob was supplied by the officers of the "Acheron," Admiralty Marine Surveying Ship, S. 45° 51′ W.: this was about the year 1847. In the year 1849 a base line was measured on the plains, near Riccarton, in length 20,469 links, and on this a network of triangulation of two to three mile sides was carried from thence northward to Oxford, and southward to the Rakaia, but whether there were check bases measured at the extremes is not known. I found that in the field-books of 1849, which were kept in pencil, apparently only one reading to each station was noted, and that these are not copied on to the maps. There is no summation of the three angles of each triangle, but in a paper relating to the Oxford angles this is done in part, so far showing that the error in each triangle seldom exceeded thirty seconds. In the maps there is no proof that any attempt had been made to carry on the true bearing from the Initial Station. After the above operations a topographical survey was carried on by chain and theodolite traverse, which traverse was not referred directly to true or magnetic meridian, but ranges were selected on any azimuth at the convenience of the surveyor.

When this feature or topographical survey was completed the maps were ready for the marking of applications, and which ruled the actual surveys. These maps thus served a treble purpose of topographical application and working plans; on them the lengths of the sides of sections are given, but no bearings, and there is seldom any evidence how the lengths and positions of sections were connected with the trigonometrical points. If the field-books, however, were numbered and registered in relation to the maps, they might yet be of service in supplying this information, and which might be noted on the above plans.

The land regulations of this settlement from the very first allowed of free selection before survey, so in the same locality selections were of necessity surveyed at different periods, and by various officers. The mode of proceeding was to "build" the last section on its preceding neighbour, or on

the road and topographical traverses; thus a separate survey seldom closed on a trigonometrical point. The work was at the same time plotted by scale and compass. The field-books shown to me of this portion of the survey are generally in a fair condition, but many, having been kept in pencil, are being obliterated. The general maps, which are on a 40-chain scale, and of a large size (over 10 feet square), are decayed, but the original working plans of 10-chain scale and small size (2′ 2″ × 3′ 0″) are mostly in a tolerable condition. These small maps, however, were not continued to be made, as I was informed the office found large ones to create less confusion and difficulty in arrangement. Within the last ten years the working plans which were open to the public for selecting are of very large size (6′ 2″ × 30′ 0″); some of these are very much soiled and considerably creased.

The mode of recording applications is first to number them in ink, putting down the boundaries in pencil, which are also inked when the survey comes in. No distinguishing colour is used. In some cases these marks are now so faint as not to be recognizable. When the application map (which as stated before is also a topographical as well as a working plan) proves to be inaccurate by the traverses not closing, a separate plot is made of the sections built on these, and the Crown grants are made from such separate plots. This is owing to the impossibility of attaining any great accuracy by plotting, or owing to the roads to which the sections front not having been accurately surveyed at the beginning.

One of the worst application maps is of the Selwyn District (size 14′ × 6′), and which has been in use for twelve years. It is also plotted without triangulation, being based solely on traverse work. It is soiled and in shreds, so as to be for the most part illegible, and the marking of sections is confused and inextricable; but of this district there are separate plots in good order. The preservation of these is owing to the public only having special access to them. These separate plots are fixed by trigonometrical stations, but the bearings and distances of traverses are not given, only the sides of sections. The boundaries of these plots are irregular. All the application map is not thus plotted, but only where resurveys have been made, and which have been called for by disputes about boundaries.

Plan of Christchurch District No. 1 is also in a very dilapidated state; but there are small separate parts of it legible and in fair condition, constructed in the same manner above noted.

The Peninsula maps were originally partially triangulated in the same manner as described above. Here the section survey is very intricate, the traverses being tortuous and proceeding long distances without check or connection. In this district disputes have been endless, owing to inaccuracies thus arising. The application map of Akaroa is in the same state of dilapidation as that of Christchurch District No. 1.

Recently a minor triangulation has been executed by Mr. Walter Kitson, extending over Banks Peninsula and along the sea coast as far as Timaru, in sheets 7′ × 6′. The initial part of this triangulation is Burnham, where the true bearing was determined by the Transit of Venus Expedition. A base line was measured near Lake Ellesmere, in length 26,853 links, and which, as tested by triangulation and calculation from the Rakaia base, showed only an error of 4 links in the whole length. Test was also made of Cridland's base, near Ashburton, as follows:—

By Kitson's triangulation	24·368·5 links.
„ Cridland's measurement	24·367· „
Error	1·5

So also of Hewlings's base, near Geraldine—

By Kitson's triangulation	14·052·8 links.
„ Hewlings's measurement	14·053· „
Error	·2

This triangulation was conducted with 8″ and 6″ theodolites, but the bearings shown curiously are magnetic, valued at Burnham 16° E. of true meridian. Two verniers only were read. The summation of angles in a triangle shows an average error of only 5″ to 40″. All the stations are calculated on the magnetic meridian and perpendicular of Burnham, and to seconds, and the positions plotted from reduced tables. This is the only triangulation in the province so executed.

Recent section work has been based on this triangulation at Pigeon Bay, whose stations were Haylor, Wild Cattle Hill, Sinclair, and Pigeon Bay Peak. A subsidiary triangulation was cast to intervening points. Road traverses were run from point to point, and to which the sections were attached. The bearings and distances are not given in the maps, but references are made to the field-books, where they will be found. The traverses are not calculated on the meridian and perpendicular. This as yet has not been done anywhere.

In the safe the maps are kept in rolls on shelves. The field-books have a special place for themselves. No maps are kept in folios, nor in their special places marked or labelled.

In regard to extent of error in some districts, I first examined that of Little River. Here an error of six chains was pointed out to me in a distance of only two miles. The survey appears to be incongruous and inaccurate throughout. Thus the centre road line, instead of being straight as shown on the plan, is actually bent to an extent of five chains. Crown grants, notwithstanding this fact, are being issued. The Chief Surveyor is inundated with complaints from this quarter about disputed boundaries, both personally and by letter. A letter was shown me from Mr. A. D. Allen as an example, requesting that a surveyor be sent to place the pegs where they ought to be.

I then examined the plan of Akaroa. Here, in application 8916, differences between original pegs and present surveys were shown to amount to five, four, and three chains in different lines. The title is by Crown grant, and the actual holding exceeds in this case the land granted. This district has a most complicated system of sectional settlement, the back sections of which are especially "adrift" from their true positions.

This inaccuracy pervades all the old closely settled districts more or less, but which I need not enumerate.

The plotting is now done in the office by a draughtsman, the actual surveyor attending to read off the bearings and the distances from the field book. The surveyor sets off his work in the map on the magnetic meridian, correcting the bearings where he can refer to a trig. pole. The greatest error by this means is said not to exceed eight links to the mile, but intricate new traverses are not so strictly tested.

Where Crown grants are about to be issued this is the mode of proceeding. On its being drafted in the office the letters *Dfd* are put on the application map in pencil. A book of sections is also kept in the office, where a small red circle is marked against each number at the same time.

The mode of proceeding in taking in applications is as follows:—A person applying for land comes to the map room and points out to the draughtsman appointed for that purpose his choice on the application (*i.e.*, working plan) of the district. The application is then marked on the map, as stated before, in pencil. Then a written description is drawn out by the draughtsman on a printed form. After the Waste Land Board has approved of the application, the land is surveyed as soon as possible.

On this part of the subject I was shown on the plan of Lake Ellesmere District an example of what sometimes occurs:—The application or working plan showed a space between former surveys less than has been found actually to exist, but to the present purchaser has been given a Crown grant, not of the lesser quantity shown on the map, but the greater quantity existing in reality on the ground. Thus the evidence of a record map of the province is ignored by the department itself.

Nor are all the errors unintentional; as the price of land was high, good measure, it was thought, should be given. Thus in the towns of Christchurch and Lyttelton, a link more or less is added per chain on each section; as, for example, in block containing sections 177 to 198, the double row of sections have a length of 1111 links instead of 1100. Block containing 155 to 176 has a length of 1110 instead of 1100 links; and transversely, 502 instead of 500; and so on. The working plan of the Town of Lyttelton shows evidence of the same principle. Now I hold this to be injudicious, even for the sake of the purchaser, as in "cutting up" complications can easily arise whereby he may mark out to one purchaser too little, and to another too much, and so involve himself in law-suits.

On finishing my examination of the Christchurch Survey Office I proceeded to Timaru, accompanied by the Chief Surveyor. At the Survey Office there I first looked into the triangulation of the district south of Rangitoto. This was executed in its northern first part by Mr. Hewlings, on contract. He next proceeded with that portion between Washdyke and Pareora; then from Pareora to Waitaki. These were done before the year 1865. All the bearings were referred to magnetic meridian. The base line is in the plain between the Waihao and Waitaki, close to the beach, and whose length is 20,323½ links. The diagram of the triangulation gives the calculated sides only. The angles were taken by a 6″ theodolite. The readings were checked three times, but this was noted in a separate paper, and the average booked. The zero of the theodolite was adjusted to one station to get the arc contained between it and the next. The azimuths of zero were thus various; but a separate book of bearings was kept in which the magnetic readings of stations were noted. The object of this was to check traverse by chain and theodolite. Thus each trig. station had two visits paid to it. The triangles were calculated by the sides of the opposite angles; the magnetic bearings are still in the field-books. The calculations are carried out to seconds. This triangulation comes within the term minor, and is not ruled by a standard process. The triangles are plotted by scale and compass, not by mathematical reduction.

The section surveys of these districts are founded on triangulation, but also checked at mile intervals by intersection from trig. station. These points are not fixed by calculation, but by plotting; chain and theodolite traverses are thus carried from station to station, but merely plotted, not mathematically reduced. The first process of traverse was to run along all the features, such as rivers, ridges, terraces, forest, &c., and on these the section frontages were founded.

Over nearly the whole of the plains the third has been bought and surveyed in this manner; no overlappings are said to have taken place, excepting at Buckley's Point, where errors of fifty links occur. There are occasional errors also where four or five separate surveyors have been at work at different times; here errors extending from 50 to 180 links are apparent by the plotting of the maps. These are exceptions. The cause of the superior general accuracy of the South Rangitoto surveys is attributed to the fact of their having been executed by one officer and his assistants, but, I may add, also to the largeness of the holdings. The want of proper closings which was seen in one or two places near the margin of the sheets was explained by the plottings of traverses having extended from one plan into another; so these were affected by paper shrinkage. The maps were all in good condition, the size being 6′ × 28′.

I was also shown a reduced copy of all surveys—scale forty chains to one inch—used by the public these last seven years in making their selections. The sections are numbered as they are sold, and their positions, which are very dispersive, are found by a reference book. The purchased land is not coloured, and, as this one map is considerably soiled, the sold and unsold land may be difficult to distinguish. As all these maps are rolled, the tendency of the older to split into shreds was noticed.

The field-books were all in a good state and kept in ink. Mr. Hewlings said that, if the maps were all destroyed, he and his assistants could re-establish them by this means. I may here add that the system of survey and mapping introduced by the Canterbury Association at the founding of the settlement is here seen in its best phases, and carried out to the best advantage it is capable of attaining. That the triangulation, though not conforming to all the requisites considered necessary in other provinces, is reliably and creditably observed, is proved by the following tests:—

			Chained.	Calculated.
Verification base	+0	Otaio ...	179·53	179·52¼
"	115·116	Tengawai ...	115·45	115·48½
"	147·150	Opuha ...	134·48½	134·51

On returning to Christchurch, I met Mr. Thomas Cass, who long held intervening charge of the department. He informed me that the system of settlement and survey was designed by the Com-

mittee of the Canterbury Association, and that the carrying out of the latter devolved originally on Captain Joseph Thomas. The radical principle of the land regulations was what is termed "free selection before survey," and this extended over 1,000,000 acres of territory. The minimum purchase permitted was fifty acres; but on the dissolution of the Association, and the resumption of the powers over the land by the Crown (in 1856), the minimum purchase was fixed at twenty acres, while the area of selection was extended thirteen times, which largely added to the strain on the department and the resources of the Government in supporting the cost in administering to so dispersive and minute calls. I may here add that with the policy or impolicy of free selection the surveyor has nothing to do. Should it be the law of the land, it is his duty to support its successful working; but as it is his duty, so also is he bound to make known the professional difficulties thereof. That other countries have felt these difficulties is obvious to any one who has studied the question; and colonizing Governments have sought rapid modes of survey to gain an advance on actual settlement, and so obviate that very state of matters of which Canterbury now complains. This brings me to some of the difficulties of "free selection" that have been pointed out to me, not with the view in the remotest degree of depreciating its value, but to make plain my suggestions for meeting these difficulties in a manner creditable to the department. As after 1856 applications for land could be as low as twenty acres, I am informed that, with these minute pieces to survey in all directions, besides the most distracting labour of attending, the difficulties were enhanced by the onus of interpretation of the very loose written descriptions attached to them being laid on the surveyor. He thus in the field had the somewhat invidious duty of carrying out the purchaser's meaning by his own interpretation. Then again, on spurs, in valleys, and along streams of meandering courses, he had to adjust frontages at right angles, where no angles could be had of such description. In the course of time, as application after application was received, and the country thus gradually filled up, the whole face of it became a mass of survey and unsurvey; parts marked and parts left out. And as the roads, valleys, streams, and spurs had irregular and non-conforming courses, so likewise the sections took directions in all points of the compass, assuming a variety of directions most perplexing to follow. The regulations being such, the survey officers could not be responsible for this.

Some of the maps shown to me exhibit a medley of intricacies, the unravelling of which will call for the services of the most persevering and talented officers.

But if, under the regulations, inflowing small settlers have brought about these difficulties, there were counter operations of pioneers already in possession by lease or license which did likewise. These operations go under the local name of "gridironing"—that is, a licensee applies for twenty acres in many different parts, always leaving eighteen or nineteen acres interval. He thus secures close upon double the country that he cares about purchasing, and the intervals he runs little risk of losing, as these, by the law, when applied for must be put up to auction. But besides "gridironing," what is colonially called "spotting" on the part of the runholder, in his natural anxiety to preserve his interest against the inflowing colonists, goes on to a large extent. This process would be best described by supposing that the gridiron itself had been broken into a hundred pieces, the bits strewed at random over the ground: then you would see what would appear to be a mass of quadrilaterals utterly without design; yet the design is found to be most efficacious when we comprehend the purpose thereof.

Of these gridiron land-purchase operations (being according to law), I hope I may not be thought to speak disparagingly; they are only a portion of that strategy which prevents one class from demolishing the fortunes of another class who had gone in advance; but as they affect "survey," the subject on which I have to report, to mention them is unavoidable. It will be admitted they retard and complicate settlement survey. This is my object in stating them.

It will thus be admitted that in Canterbury Province there have been circumstances apart from the survey that have retarded, if not prejudicially affected, its correctness.

The next question that arises then is, does the Canterbury Association survey come within the limits of an approved system? The answer to this question must be, No; for leaving out of the discussion the original standard triangular operations, which have been admitted to be inferior, and in a state unfit for re-establishment, the actual section survey has no mathematical guidance or test. At the same time it must be unfair to condemn all that has been done. Where the applications have been large, and the sectional survey plain or uniform, I anticipate that the survey will be found to be essentially correct, and of which no revision will be necessary, for in these cases, supposing the triangulation to be tolerably well done, honest and well-executed traverse work between stations is of itself accurate, even though mathematical test be not applied throughout or at "closing." From the cursory inspection I have been able to make, I am of opinion that it will only be in the areas of small settlements, where the holdings are extremely intricate, that revision is absolutely called for. I would indicate the Lake Ellesmere, Little River, Akaroa, Rangiora Districts, and especially Banks Peninsula, as some of those areas that require resurvey; but such a work ought not to be undertaken hurriedly. Each district should be carefully scrutinized by the local officers, when the deficiently surveyed districts should be indicated, and set apart either for official resurvey or resurvey under specification by competent and trustworthy contractors. The Crown grant and land transfer operations should be delayed. In every case the surveyors should be instructed, after proper authority has been obtained, to delineate the boundaries as found on the ground, and in no case should he attempt correction or alteration, such a responsibility belonging to the Legislature or Courts of law.

To estimate the cost of this now I find to be impossible, but I respectfully suggest that it would be advisable to set apart specially for this purpose a sum of not less than £25,000 beyond the annual vote for survey, which sum should be kept and used for these revisions.

Before leaving Christchurch I recommended the following to the local authorities, and which was acted on, viz., that a qualified officer, competent to undertake standard operations, be at once appointed, and under whose direction either major triangulation or meridional circuit might be initiated, after which he would proceed to other provinces. The cost of major triangulation for the whole province will be about £16,000, consuming about fourteen years for one party, or seven years for two parties;

that of meridional circuit about £2,000, consuming nearly two years for one party, or one year for two parties; but it has a special advantage in point of time over and above this, in its being applicable at once in any district where claims for settlement are most urgently demanded. The cause of this is that true meridians may be observed at once wherever wanted, and the standard work extended from these to the settlements in the vicinity.

This being done, then all future actual section surveys would require to be sent in to the office with maps and tables complete in mathematical reduction. This would give to the surveys of this province a status co-equal with the most approved systems for settling an inflowing people.

On the mode of keeping and recording maps, I advised that all working plans be of a small size, kept flat, and placed in folios free from dust under a system of nomenclature and numbering, for ready and easy reference. Crown grant index maps—scale twenty chains to an inch—should also be prepared, on which all Crown grants passing the office should be recorded by colour as well as by number and name of grantee. Reference index maps should also be prepared—scale eighty chains to an inch—to be hung under glass in the corridor, in which the number of all applications should be given, bordered with colour where applied for, and distinctly washed with colour when sold and surveyed. By being under glass these maps would be kept clean, and by means of the colour settlers would readily distinguish the sold from the unsold land, which is not the case at present, and so much trouble is given to the officers as well as to the public. These index maps being accessible outside of the office would be time and patience saving to all concerned. If the regulations permitted it, I would also not require the survey draughtsman to draw up the written descriptions. They are of little value, the diagram in application map being the real object for surveyors' direction.

I noted also, as stated before, that the surveyor now comes into the office from the field to get a draughtsman to plot for him. This I conceive to be double work for one duty, which the surveyor should perform for himself. Under mathematical traverse reduction this office surveillance will not be necessary, field test and inspection serving all the purposes of checking errors and omissions before the maps come to the office for approval and record.

I noted the following remarks on the mode of employing surveyors, viz.:—Contract surveyors have been much employed. On inquiry I find that these officers have occupied positions under much the same arrangements as the licensed surveyors of New South Wales: that is, they are paid by acreage rates, and have districts permanently allotted to them. To this system, by my own experience of it, I see many and great objections of several kinds, some of which may be briefly enumerated. It has the effect of upsetting the salaried staff officers; of creating doubtful rights relating to work performed, much of which has to be done in advance of settlement, and so at the expense of the contractor; life claims are thus created, and ultimately vested rights in office of more or less value. It creates an independence above control, and a power in the surveyor to withhold records that are essential to the safety of landholders or purchasers. At best, this class of officers are difficult to deal with, and I would advise that such arrangements be avoided; further, being only semi-official, they may act as land agents, and thus create uneasiness in land transactions on the part of the public.

But on the contrary, I would respectfully press on the Government the propriety of encouraging contracting surveyors in the common meaning of the term—that is, surveyors capable of undertaking contracts for specified work to be completed within given terms and for given amounts. As these contracting surveyors can never set aside entirely their professional character, they should only be admitted as competent to tender for contracts on the recommendation of the Chief Surveyor, which should also be approved of by the Government.

There are numbers of private surveyors known to me, men of skill and integrity, who do not find it convenient to enter the salaried staff, but who will gladly undertake contracts. Such surveyors, if employed, would largely help in the work of settlement survey, by asking their tenders for any work that is capable of being specified and inspected, such as triangulation, major or minor topographical block and section survey, or surveys of stated areas enclosing certain sections.

By doing so, the Government would relieve itself of much responsibility, as the permanent staff could be kept at a low strength.

What work contractors cannot do, but which must be retained in the hands of the official staff, who are held to be in the interests of the public, is comprised in the higher branches of the standard operations; and in the survey and marking out of free selections, where roads, tracks, river frontages, ferry sites, village sites, water-holes, timber, stone, and other reserves require special and responsible attention.

The maintenance of a salaried staff for these purposes will always afford a nucleus for the Government to draw upon, when extra pressure for settlement surveys comes, and I may suggest that to dispense with such a body would be impolitic. An arrangement by which half the work would be done by contract, half by the staff, or nearly so, would be, I believe, advisable and satisfactory.

The following is a synopsis of work done in Canterbury, the nature and professional value of the different operations, and a comparative view of the work in hand:—

	Acres.	
Minor triangulation	3,000,000	On magnetic meridian mechanically plotted, but coast triangulation mathematically reduced.
Spotting section survey ...	2,014,696	Mechanically plotted.
Surveys in hand	150,000	In numerous localities, spreading over 240 miles in length and 60 miles in breadth.

On completing my inspection of the surveys of Canterbury, I returned to Wellington *via* Dunedin, where I was detained on the service of the Waste Land Board. It was thus not till September that I could proceed to other provinces. I arrived at Blenheim, the chief town of Marlborough, on the 9th of that month. On calling upon Mr. H. G. Clarke, the Chief Surveyor,

he at once entered on giving me all the information I sought, and which I noted to the following effect:—

Marlborough Surveys.

In this district the New Zealand Company's surveyors commenced their first operations in the year 1847, Marlborough being then a portion of the Province of Nelson. There was no initial station of surveys fixed, nor has latitude or longitude been observed. The surveys are all on magnetic meridian; nor has true meridian been observed lately. The original working plan of the delta of the Wairau Valley, of which the town of Blenheim is the centre, was made by W. Budge, in 1848. This plan is on the rectangular or chessboard system of section survey wherein the distances are given, but no bearings. It has, however, been found to be generally correct with one exception, where there has been an overlap in sections 49 and 50, Wairau West. The area of this generally correct work is 126,000 acres. There are no serious errors in these, though the Crown grants, in early days, were carelessly prepared; but these, if necessary, could be rectified. The sections were intended to be 150 acres each in size, but they are actually 154 acres, 4 acres having been thrown in to compensate for errors of survey.

Beyond this New Zealand Company's Block, the whole province was taken up in pastoral leases, which are always bounded by natural features, and within which applications to purchase were made. These applications could be made in any part of the province, and when made were surveyed so that the land comprised in them might be sold by auction. The surveys in various parts thus extended were connected with the road lines of the New Zealand Company's Block by traverses. The Wakefield Downs and District of Awatere were surveyed on the same principle, and the surrounding country was applied for and thus surveyed likewise.

Where applications were made far from any New Zealand Company's blocks, then their surveys were made on magnetic meridian.

Recently a minor triangulation has been executed on a block in Waihopai and Awatere, of about 20,000 acres. In this a base was measured 138 chains 36 links in length in the former district, from whence the triangulation was extended to two verification bases in the Awatere Valley—the first of which, by actual measurement, was found to be 3,108 links, and by calculation to be 3,110 links; the second, 3,881 and 3,882 links respectively. This work was done on magnetic meridian, and is not mathematically reduced. No altitudes were observed.

Mr. Clarke thinks that, when the separate surveys come to be put together, overlapping or contortions may be disclosed, but, owing to the many natural features, such as ridges and creeks, which confine them, no inconvenience has yet been felt. The Crown lands being in strips, well divided by features, no overlappings are (thought to be) possible where so divided; but the system of traverse survey, no doubt, creates an accumulation of error.

In this district surveyors are generally private and authorized—not official—and paid sometimes by the Government, sometimes by the applicants.

It will be already surmised that the land regulations admit of dispersive and isolated applications, though the sale of the land comprised in such applications, after they are surveyed, must go through the ordeal of public auction. Lately, also, land is being selected in lieu of cash payments for public works executed. There has never been a staff maintained that was competent to grasp or overtake the work on this system of application; in fact, practically, the Chief Surveyor was the only officer employed in the Government interest, and, as he could not be ubiquitous, he could not be responsible for imperfections.

The working plans are on a scale of 5 to 10 chains to the inch, and are of all sizes, the larger being kept in rolls, the smaller in drawers; all, however, neatly arranged. Some of the field-books and maps were damaged by the great flood of February, 1868, and, with this exception, all are generally in good condition. Some of the field-books are in pencil, but they are quite legible, so there would be no difficulty in referring to any section for its bearings and distances. Latterly the field-books have had their contents registered: this has been brought about by the Chief Surveyor now having more control over the surveyors, so he has thus been able to introduce improvements.

In the system in this office of Crown land record, the portions of the plans for which grants have been prepared are coloured yellow. This is done on the application maps, and on this is also placed the grantee's name. In this office, owing to the limited quantity of the business transacted, the record of Crown titles on application maps, instead of index maps, specially provided, is not found objectionable, as they remain yet in a good state of preservation.

On considering the subject of the advisability of revisal of surveys in Marlborough, I noted the following remarks:—It appears that the New Zealand Company's old surveys may stand as they are, but all others must be controlled by minor triangulation, as errors must have largely accumulated. A minor triangulation cast over the surveyed districts would test the work. Connected with the minor triangulation, topographical maps should be made showing connections at each station by actual bearing and measurement. These connections should be to the corners of sections or roads, and to two separate pegs or corners, if obtainable. Skeleton working plans (10 chains to an inch) could thus be commenced, and the old work plotted in on them.

During my investigations, Mr. Dobson, C.E. and surveyor, voluntarily pointed out to me certain surveys of territory made by selectors wherein the practice was to indicate the spots selected, but not the connections, the intervening spaces unselected on the plans of surveys whereon the connections were draughted being held to be the private property of the selector. In assuming this position towards the Survey Office, I was informed that the selector complied with the law; but it is evident from an inspection that the plans were not sufficient for denoting the correct relative positions of the separate surveyed parts. This being a very general practice, it is evident that the Chief Surveyor was put in a professionally false position, in which he could not meet the responsibilties ultimately devolving on him, and expected of him by the public. Mr. Dobson informed me that it was held in Marlborough that the proof as to a survey's correctness lay with the Chief Surveyor to find out, not with

him, the private practitioner; so, as the Chief Surveyor had no assistance, he was forced to accept the plans as given to him. I may remark, standard survey and minor triangulation would have stopped this improper state of things; and I am further of opinion that the cost, under the circumstances, should have been borne by the selector in the first place, if the Government were not able to bear this. It appears clear to me that the private surveyors, in not giving connections and casting the *onus probandi* on the official head, acted unfairly. The least that they should have done would have been to show the bearings and distances, which, if not checked by supervising officers at the time, would stand as a record of *bonâ fide* work, as in doing public work licensed surveyors cannot absolve themselves from all responsibility in the matter.

The effect of this practice was tantamount to strewing cards over the ground without order or arrangement. That the outcome of this can be satisfactory, no one can anticipate.

A synopsis of survey work in the Province of Marlborough stands as follows :—

	Acres.	
Minor triangulation	... 39,000	Mechanically plotted and unreduced.
Block section survey	... 888,000	,, ,,
Spotting ditto	... 5,000	,, ,,
Section surveys in hand	... 200	In three localities 80 to 100 miles apart.

Nelson Surveys.

I next proceeded to Nelson, commencing my inspection of surveys on the 15th September, and obtaining all necessary information of the present Chief Surveyor, Mr. J. S. Browning, who informed me that there were no data in the office of an initial point having been fixed upon, and whose latitude, longitude, and true meridian had been determined. The various separate surveys in this province have been built up into one map by the assistance of the Admiralty Nautical Surveys. Yet, for the objects of registration, there is an assumed initial point which is in the centre of the Town of Nelson, situated at the intersection of Nile and Trafalgar Streets. Hence this initial point is topographically but not geographically ascertained, and there are no direct connections geographically or geodesically with this and the other points of the province, though indirectly, by traverse and plotting, the connection for registration has been effected. The whole province has been divided into squares of ten miles, plans whereof are constructed on a scale of twenty chains to the inch. The sheets are thus 3′ 4″ square. The working plans are on a scale of ten chains to an inch, and are of all sizes.

The New Zealand's Company's original actual surveys were executed in rectangles, but exceptionally otherwise where there was detail work. These surveys included an area of 117,000 acres, and many of their field-books have been lost. An instance of loss is in the case of the Town of Nelson, of which there is no record as to how its streets were laid off. It is due to mention that the present Chief Surveyor has only been in charge for six months.

On the disbandment of the New Zealand Company's staff a small establishment was supported; the surveys were then conducted partly by contract, partly by officials. Minor triangulation was executed to the extent of 63,000 acres in Waimea East and South and Suburban North.

There is no safe attached to the office, and the working plans are kept on racks on the walls. The application maps, however, are kept in drawers. Working plans vary in size from 7′ × 15′ down to a few inches.

The triangulations are based on the magnetic meridian, but the data are not sufficiently recorded for use. The angles are yet in the field-books, nor are the bearings reduced on the meridian and perpendicular.

The practice in section survey has for many years been to use the theodolite, but on different magnetic meridians, building one on the other, and in this there is no mathematical reduction. In the year 1864, the West Coast gold fields broke out, which were administered from Westport, but the records were removed to Nelson in 1875. Here there was no attempt to preserve continuity, so the result was disorganization. From this fact it may be supposed that where surveys meet they overlap and show the greatest non-conformity.

The present land system may be shortly described as follows:—It is an agricultural leasing system, whose terms are for seven or fourteen years, with a purchasing clause inserted giving powers of purchase by leaseholder at any time. Survey before leasing is necessary, but choices extend to any part of the province. The system is therefore one of unrestricted application.

In the Chief Office application maps serve also as Crown grant record ones, and are 3′ 4″ square. The field-books are mostly in pencil. Those that are not so kept in pencil are mere copies; and all are now carefully kept in the cases, indexed for their districts.

The application maps used by the public are in a bad condition; but the working plans (except the early ones) are in a good state.

Since the accession to office by the present Chief Surveyor, he has commenced a system of mathematically reduced traverses, but, having no standard survey as a guide for true bearing, he has proceeded on the magnetic meridian.

The progress of the surveys have been greatly retarded by the surveyors being connected with Public Works Department.

Regarding the adoption of 10-mile square sheets, of which many have been constructed on a scale of 20 chains to an inch, these should be adopted if possible; but, as they may not be on a true meridian of any position within the province, and, if so, as the province is too large to make a single meridional circuit of it, it is doubtful if new survey districts will not have to replace them. There is the less objection to the latter course as the working plans (the really important part) are not surveyed under the square system, nor are their boundaries coterminous. If they, however, be on a meridian in a longitude of the province, part might be adopted, the rest being reconstructed on the 12½-mile square system. These professional points must be left to the direction of the Geodesical Surveyors. As it is, the 10-mile square sheets of Nelson being merely compiled maps of no professional though of much

official value, they remain merely as application records, and can form no intrinsic portion of an approved system of survey.

Having now inspected the survey systems of Canterbury, Marlborough, and Nelson, having 3,182,696 acres of unproved and in a large degree incorrect section surveys, and looking at the fact that the Crown lands are intersected and "spotted" by these, the first question that presents itself is, Should the unproven and incorrect surveys be revised? My answer to this professionally is, that it would be desirable to do so. Then have the Government the power at present? I think not. But had the Government the power, on whom would the corrections and re-adjustments devolve? Certainly not on the Survey Department, for a radical question arises to this effect, namely—A British subject having been placed on a certain area of land by Crown Land Surveyors, it is true, incorrectly measured, do the measurements or the actual marks on the ground give the possession? Till otherwise instructed, I will answer the question for myself in this way: that it is the marks on the ground that give possession; and I am further of opinion that, unless the strongest proofs were given that the holder had shifted the marks himself, a jury would keep him in possession, against all other subjects. Thus a revisal of unproven and incorrect surveys, whether expensive or inexpensive, would of themselves merely give information, but have no validity for the purposes of correction and readjustment of boundaries. Hence I conclude that, with the immense deal of work that there is pressing, no revisal in the meantime should be attempted, nor should this be recommended till the landholders themselves in different localities have petitioned Government or Parliament to this effect.

Under the above considerations, the duty of the survey adviser is clear—namely, to recommend the authorities to confine the operations of the Survey Department to meeting the wants and claims of present land purchasers and settlers now inflowing. In doing this the various surveyors cannot avoid coming in contact with previous surveys unproven or incorrect; when they do so it will be their business to note and record the boundaries of such surveys as they find them on the ground, or, if they cannot so find them, to establish what they ought to be by investigating the marks of adjacent or next lying properties.

Hence it will be the duty of the Chief Surveyors of the three provinces above named to commence and establish new maps for all new work, in which maps the adjacent boundaries of the old or previously surveyed sections only will be shown.

All old maps will thus have yet to be retained as records carefully preserved. The Crown titles must be issued on their authority, unless the landholders interested under the sanction of Government obtain an order for survey revisal, and Commissions having powers of re-adjustment. And what is the responsibility of the Survey Department in relation to Crown grant plans which they prepare in the meantime? My opinion is that, in regard to these past surveys, it extends to reporting actual errors from time to time, but making an exact copy of the plans in the archives, till otherwise ordered by Government.

The survey work of Nelson stands as follows:—

		Acres.	
Minor triangulation, ...	...	63,000	Not mathematically reduced.
Block section survey ...	...	117,000	Mechanically plotted.
Spotting ditto ...	...	158,000	„ „
Ditto ditto ...	...	42,000	Mathematically reduced.
Section surveys in hand	...	103,000	Diffused over all parts of the province.

Leaving Nelson I arrived at Westland by sea, and visited the Survey Office at Hokitika, on 20th September, where Mr. Gerhard Mueller, the Chief Surveyor, gave me every assistance in my inquiries.

Westland Surveys.

Westland formed a portion of the old Province of Canterbury, and from which it separated in 1868. The initial station of the survey is the Observatory, Hokitika, which is a meteorological one only. This is situated in latitude 42° 42′ 52·5″ S., longitude 170° 58′ 51″ E. of Greenwich. These determinations are supposed to have been made by Lieutenant Woods, for there are no records of the observations in the office, but they may yet be found in the Marine Department at Wellington.

The true meridian at Observatory has not been observed for, but there is an assumed one on which all the surveys in the Grey, Arahura, and Totara Districts are based. This assumed one is magnetic, equal to 15° 28′ 28″ east of true, but how this was found is not shown.

There are three separate districts in Westland apart from each other, the centre of the one being Hokitika, of another, Okarita, and of the third, Jackson's Bay—all having their special initial points, the meridians being magnetic.

That portion of the province extending from the Grey River to Bruce Bay has been triangulated with a 7″ theodolite, the sides being fifteen to twenty-five or thirty miles. But owing to the densely wooded nature of the country no base lines, in the usual sense of the term, have been possible, therefore long road and shore traverses have been had recourse to instead. Owing to the above natural cause also the actual or section surveys are executed by major and minor traverse circuit. The circuits are all mathematically reduced, and closings tested. This is correct as far as the coast surveys are concerned, but in the interior long traverses have been relied on. Closings under 16 links to the mile have been passed as a rule of the department.

The department is directly under the Provincial Secretary, and has always had the support of the local authorities, as far as they were able, but the work was often carried on under very straitened circumstances, which has prevented all being done that ought to have been.

The land system allows of selection before survey, but the applications are restricted to certain localities at the instance of the Waste Land Board. The reason of this is that, the province having auriferous lands, it is not advisable to sell land everywhere. Rural land is sold down to twenty acres and to any extent upwards. Suburban land may also be selected before survey in sizes of one to ten acres. This measure has not materially kept back the survey. By means of this system in a damp and forest

country this method of settling the people is by far the best in the peculiar point of view the surveyor looks at the question.

The maps are kept in rolls—the old Canterbury ones being in size 8′ × 10′, but later maps are reduced to the size of circuit traverses, ranging from 3′ to 4′ square. The field-books are all in good order and registered, the contents being indexed.

Lithograph plans are made of the districts, and these are used as application maps by the public, but where not lithographed a mounted tracing is used instead. Thus there is no necessity for the public having access to and so deteriorating the condition of the working plans. Hence the recent plans are in good order, but those constructed during the Canterbury administration are not so, being broken, cracked, and in shreds.

There are no Crown grant index maps, but another method is substituted in due routine, though it has not the advantage of showing the granted and ungranted at a glance. The District Surveyor plots his work on the district maps in the office, and at the same time makes a separate plot, which is recorded on a file of section plots. Here the name of the grantee is given, the acreage, name of surveyor, and name of the officer who makes the plan on the Crown grant.

My opinion, as noted at the time on the work of the Westland Survey Office, is as follows—viz., that considering the densely-wooded nature of the country, the present system of survey, whose introduction is due to Mr. Mueller, is a sound and practical one, the plans and records based on it being reliable; with the limit of error possible in such a rough country, where surveying is little better than underground "driving." To bring the work into conformity with the operations of the general survey certain alterations may be effected at leisure, such as the placing of all future work on true meridian, the extension of true bearing and distances to more points than have yet been observed. And it is necessary that these points should be more numerous than in open country. Crown grant index maps on 20-chain scale should also be commenced, wherein the granted sections should be plainly coloured, the name of the grantee and acreage also being inserted. Without this being done occasional mistakes in intricate surveys cannot be avoided.

Several practical modes of covering the province by standard survey present themselves, into which I need not here enter, further than suggesting that the summits of the secondary spurs and the open beds of the rivers give facilities for this.

The present major triangulation should as soon as practicable have bases measured in connection with it, after which its bearings can be reduced to true ones of each circuit.

The work of Westland stands as follows:—

		Acres.	
Major triangulation ...	...	805,700	On magnetic meridian mathematically reduced.
Spotting section survey	...	54,000	Mathematically reduced.
Section surveys in hand	...	9,000	In 25 localities, and spread over 150 miles.

On leaving Hokitika I crossed the mountains, and returned to Wellington *viâ* Christchurch.

It was not till November that I could proceed again with my inspection, and for which purpose I set out for Auckland. Having arrived there by sea, I called at the Provincial Survey Office, on the 13th of that month.

Auckland Provincial Surveys.

Here Mr. Tole expressed his desire to give me every information in his power, but he informed me at the same time that, though he held the office of Chief Surveyor, this was nominally only, his time and responsibilities lying entirely in the appointment that he held as Commissioner of Crown Lands. I therefore did not enter on an inspection, but confined my request to the filling up of two returns. It appears that all the original provincial survey records had been burnt in a conflagration that took place some years ago.

From the returns, as filled up by Mr. Tole, I extract the following synopsis of work for the provincial branch of the Auckland surveys:—

		Acres.	
Minor triangulation ...	...	60,000	Mathematically reduced.
Block section survey	...	2,500,000	Mechanically plotted.
Spotting section survey	...	30,000	„ „
Section surveys in hand	...	9,130	In 51 localities, spread over an area of 230 by 30 miles.

I next called at the Confiscated Lands Office, where I met Mr. Andrew Sinclair. This gentleman informed me that, though he was officially denominated Chief Surveyor of Confiscated Lands, yet his real charge consisted in the sale and disposal of them only—that in fact he had nothing to do with the surveys for ten years. Thus he had no technical information to give.

Native Land Surveys.

I then called on Mr. Theophilus Heale, Inspector of Surveys under the Native Lands Act, who informed me that the initial point of all surveys under his supervision was Mount Eden. There were three principal bases, one in Kaipara, one in Poverty Bay, and one in Hawke's Bay. True meridian was determined at each of these places. The initial station on Mount Eden is marked by a built pedestal, and all finished triangulation has been mathematically reduced on the meridian and perpendicular to that. But the actual observations for true meridian and latitude were made at his private residence, which was connected with Mount Eden by triangulation. From thence all the principal stations reached by the operations have their latitudes and longitudes calculated geodesically.

The Native Land Claims surveys have amounted to about 5,900,000 acres, whose sizes vary from ¼ of an acre to 150,000 acres, but they have not been under the control of triangulation till lately. Their inaccuracy is admitted, though they have been brought into accordance by means of the maps covered by triangulation. This accordance is effected by tying the corners of the separate claims to

trigonometrical points, so as to settle their relative positions. Thus the positions of Native land surveys are known, though the dimensions may not be accurate.

At present all traverse surveys commence on one trigonometrical station and close on another, and wherein the actual work is reduced on the meridian and perpendicular, thus proving accuracy.

The major triangulations have no referring marks for the use of the section surveyors, who necessarily use small theodolites. But it is the practice only to employ such surveyors as are in the confidence of the Inspector. Still, at times the Natives will not allow of this, when such surveyors as are acceptable to them are employed. In Native surveys there are difficulties not attached to others; thus the Native Land Act requires the surveyor to follow where the Natives direct or point out, and the sinuosities of their claim boundaries are often most intricate, and subversive of correct survey.

In the Native Lands Survey Office I found the maps to be of all sizes, from 6 feet square down to 18 inches. They are kept in drawers flat, but are not in a fire-proof safe. They are registered in a large folio, numbered in a manner by which they can be found in their special drawer, 100 maps going to the drawer.

The field-books of the official staff belong to the Government, but of the contracting surveyors not so. The field-books are not registered, and are of all sizes.

The reference maps are kept in rolls, and placed on racks on the walls.

This office has nothing to do with Crown grant record, but in issuing certificates the section is numbered in red on the district maps; the boundaries are also tinted red. The provincial surveys are tinted yellow on the same maps, but not numbered.

There has been a great deal of trouble from the old provincial surveys, but this has been overcome since they have been draughted on the maps and brought into consistency—that is, put into relative position in a topographical sense.

Speaking generally of Crown lands and Native land surveys in this part of New Zealand, I noted that it is evident that these have until recently been in no way ameliorated by the superior standard or regulating processes, which here consist of major triangulation, all sections and claims having been measured without the test of mathematical reduction, and under no definite bearing. The system of fitting mechanically by humouring has thus been, perforce, had recourse to; hence much of the Auckland settlement surveys must take the rank of sketch or reconnaissance only, and the maps thus constructed can only be looked upon as application maps, not as correct working plans. These, therefore, cannot be recommended, without special investigation of each separate survey, as fitted for the responsibilities of the Land Transfer Act. But in regard to the revisal of unproven surveys, the same remarks here apply as I made on those of Canterbury, Marlborough, and Nelson.

It appears to me that, owing to the generally difficult nature of the surface of Auckland Province by reason of fern, scrub, and forest, the surveys to be properly executed must be very costly: hence the system of the Government bearing the cost, as in Canterbury and Otago, would not be advisable here. But to keep the surveys in the hands of the Government, a measure most necessary to reliableness, it would be desirable if the Land Regulations were framed so as to permit of the cost of each survey being estimated, the amount of which should be deposited by the applicant with the Receiver of Land Revenue. Balance, if any, to be returned on completion.

In looking over the maps of major triangulations, I observed that the true bearings and distances were not set forth on them, and was informed that these were registered in a volume. On this subject—one that so closely affects the convenience of all practising surveyors and the pockets of their employers—I would suggest that not only should all maps in the office set forth these data, but that they should also be lithographed and sold at moderate prices for the easy reference of all persons surveying or dealing in lands.

As the return of this office gives all the triangulations as *major*, it is necessary to point out that the operations of the staff should not rest here. Settlement and section survey, being the real and most pressing responsibility of the Survey Department, require referring points at distances four or five times more close than the stations of the major series. It must also be noticed that the major series, as executed, not being furnished with referring marks at each station, the actual surveyor is put to great expense and inconvenience from this cause. Thus, in order to fix a single section, he has to travel generally thirty miles, or else neglect his duty and send in work *unproven*. Referring stations would save this, and enable the section surveyor to get to his work at once with economy to his employer.

The returns sent in regarding this office show the following work:—

	Acres.	
Major triangulation	9,647,390	Partly broken down by minor elements reduced in books.
Native claim surveys	7,502,966	Mechanically plotted till lately.
Native claim and other surveys in hand	684,000	In nine localities, spread over three-quarters of North Island.

Taranaki Surveys.

On leaving Auckland I proceeded to Taranaki by sea, and visited the Survey Office there on the 17th November, when I received every information desired from the present Chief Surveyor, Mr. T. Humphries. This officer informed me that at the origin of the settlement there was no initial station fixed for the surveys of the settlement of New Plymouth; nor was true bearing determined. What is termed the Devon line, stretching from Pari to Waitara, distant about twelve miles, was the base of the surveys. All surveys were originally set off at right angles, and the sections marked on the plans in chess-board fashion. The ground marks of this survey are all lost, and where old fences remain the measurements do not agree with the plans. These plans are still in existence. The extent is 10,000 acres.

In the year 1875 true meridian was determined near Waitara by Mr. Humphries at a position

which was found to be in latitude 39° 1′ 54″ S. The processes of determination of true meridian were by stars out of the meridian, then high and low stars, and greatest elongation of Sigma Octantis. By going over similar observations at another time the separate determinations were found to agree by 4″. Mr. Heale also tested the work afterwards, agreeing in latitude by 0″·4, and in true meridian by 3″·8. All the new surveys are based on this position, but longitude has not yet been independently observed. The sectional blocks now in progress are based on this meridian line, closing mathematically on it at certain intervals, and it is Mr. Humphries' intention to set off perpendicular standard lines to govern the block section surveys east and west of it. The Moa Block is thus in hand, and, besides it, there is the resurvey of the Hundreds of Hua and Wai Wakaiho, which resurvey is necessary owing to its excessive incorrectness. Here the chainages are in error to the extent of 100 to 300 links. The work was done before Mr. Humphries' time.

The land laws of Taranaki require survey before sale. There are objections of course to all systems, and to this one it has been alleged that the surveyors were sometimes over-pressed to push the work so as to allow of land sales before all the details could be completed.

The town maps are on a scale of 2 chains to the inch, and are of various sizes, from 4′ × 5′ to 2′ 6″ square. The rural plans are on a scale of 10 chains to an inch, and of various sizes likewise. These are kept mostly in racks on the office walls, and a very few are put into a small safe. The original field-books are mostly lost, and those remaining are in a bad state, from which no new maps could be plotted. The late ones are all in a good state, but all are not inked. They are partly indexed, and all are indexed in relation to the working plans.

The office is extremely small—hot in summer, cold in winter—quite unfit for occupation. The roof leaks, and floor boards are open.

Crown grant index record maps are kept of rural sections, scale 20 chains to an inch. When granted the sections are coloured pink.

The notes that I made on the Taranaki office at the time are as follow:—I quite concur in the propriety of Mr. Humphries' late determination of the true meridian at Waitara, and its intended continuation to the south coast. It will thus nearly bisect the province. I also agree in the propriety of his cutting lines at right angles to the meridian at intervals where blocks are being sectionized, also of his mathematical reductions of his chain and theodolite traverses, all of which give a thoroughly trustworthy character to the work under his control. The country here is level and covered with timber. His suggestions to cover by triangulation the hilly and undulating country east of the Waitara, extending southwards to the south coast, I also concur in, as also of his triangulating the similar country round the West Coast, but this only immediately before it is required for settlement. And in these latter surveys the standard operations by meridional circuit should precede the minor. The slopes of Mount Egmont might also, when open for sale, be triangulated under standard bearing in the same manner.

The maps in the office require to be systematized both in sizes, mode of keeping, and registry, according to the instructions contained in the General Survey Regulations about to be published. Beyond all, a healthy and habitable office should be built, attached to which should be a fire-proof safe, contained in which should be placed tin tubes for compiled maps, and shelves for folios on which working plans would be kept. The field surveyors should have better accommodation and appliances in the field fitted for their completing their maps and surveys ready for final inspection and approval by the Chief Surveyor or Field Inspector; and none of the maps should come into the office till so examined and approved of. This arrangement would save time and labour in travelling backwards and forwards from office to field and field to office on the discovery of each error at head-quarters, all of which is attended with inordinate delays and expense to the Government.

Before leaving Taranaki, Mr. Skeet, surveyor of Native lands, called to show me the nature of his duties in surveying land purchases. He informed me that the land was mostly under forest, and very rough.

A return of the Taranaki survey work is as follows:—

	Acres.	
Minor triangulation	12,000	Mathematically reduced.
Block section survey	130,000	Not so.
Ditto.	30,000	Mathematically reduced.
Section surveys in hand	15,000	In one locality.

Patea Office.

On the 21st of November I arrived at Patea by going round the coast road, and at which place I examined the District Office, under the charge of Mr. Williams. The trigonometrical work here is on the magnetic meridian, but mathematically reduced. This was derived from the Wellington survey. The traverse section surveys are checked by minor triangulation, and then these are mathecally reduced.

Mr. Williams brought to my notice the impossibility of executing the interior surveys, either by minor triangulation or by right lines, owing to the steepness of the cliffs and the denseness of the forest. He admitted at the same time that much of the interior was not worth the cost of survey, the land not being suited for settlement.

Wanganui Office.

On the same day, having arrived at Wanganui, I examined the District Office there, which is under the charge of Mr. Monro. Here the trigonometrical work is also on the magnetic meridian, this and the initial point being derived from the Provincial Government of Wellington's survey. Isolated blocks of section surveys have been done also on magnetic meridian, but mathematically reduced. The interior, to a breadth of about forty miles, is very rough bush, so major triangulation has been found to be the most applicable system; this also in consideration of the lands being mostly in Native hands, and Government purchases of Native lands being comparatively few. The maps in the office are of all sizes. Mr. Monro admitted that there was no immediate necessity to carry on major triangulation at present. What has been done has no referring stations for the use of section

surveyors or minor triangulation. There is no safe attached to this office, which also is in constant danger from fire, being in a street line.

Hawke's Bay Surveys.

I visited the Wellington office on the 24th November, but found the Chief Surveyor absent on leave, so I proceeded to Napier, at which place I arrived by sea on the 30th November, calling upon the Chief Surveyor, Mr. C. H. Weber, and from whom I received information as follows:—The initial station of the Hawke's Bay surveys is at Pa Tangata, but which was determined before Mr. Weber's time. The fact is given from hearsay also that the true meridian was observed by Captain Drury in 1854 at Napier, from which place it was transferred to Pa Tangata. Proceeding from thence there was a triangulation, maps of which were exhibited, executed about the year 1859. The area covered by this extends from Napier to Porongahau along the sea coast over about 1,000,000 acres. The field-books, however, show the work to have been done originally on magnetic meridian, the angles being observed only once, kept, noted, and registered in a most primitive manner. A base of verification was measured in 1865, the error proved being $5\frac{1}{2}$ links to the mile. This work is not reduced on the meridian and perpendicular, and the triangles are put together by "building." One cause of the incompleteness of this work was owing to the opposition of the Natives at that early time, who would not allow stations to be erected or pegs driven. Mr. Weber is, however, of opinion that it may yet be put into satisfactory connection with the major triangulation, as most of the stations may yet be found.

Mr. Weber also informed me that he held the appointment of Provincial Engineer as well as that of Chief Surveyor, to which latter office he could give only one quarter of his time—in fact, the former took up almost all his attention.

The major triangulation of the Native Land Department now covers the whole of this province, whose initial station or true bearing is at Marikako. The bearings, distances, and ordinates are not given in the maps, but these are registered on foolscap.

Most of the section surveys of the province have gone on in advance of triangulation: they are on magnetic meridians, but executed with the theodolite. The present operations of a similar nature, however, are controlled by triangulation. *Good measure* besides is given in these as an extra preventive against purchasers' complaints, but I may remark that the same objections that apply in the Canterbury surveys against *good* instead of *correct measure* are valid here. On scrutiny of the working plans, I found that in the section surveys the custom in the province has been to allow the work to be done by different surveyors at different times, some of which are executed by the needle only; that there is no system of mathematical reduction on the meridian and perpendicular by traverse surveyors, nor any exact mode of making section survey subordinate to triangulation even after it has been executed, previous to the section survey required.

The land laws were stated to affect the survey operations most injuriously, these being free selection prior to survey from forty acres upward, over all Crown lands without restriction. In the meantime, the Crown lands being let to tenants, these soon "spotted" their runs, and in the course of ten or twenty years, at their convenience, purchased the whole. And as no sooner had lands been applied for than they had to be surveyed, it followed that, if the Provincial Government was not in a position to employ a surveyor at once, the applicant had the right of employing a surveyor and receiving 5 per cent. in land for the survey of the block. These surveys of course could not be checked on the ground, at least rarely. There was in fact no means.

The sizes of the maps in this office vary from $6' \times 5'$ down to $2' \times 2'$, all kept rolled and mounted on cloth, the older generally in a dilapidated state owing to no charge having been made for their examination by lawyers' clerks, merchants, and land agents. Nearly all maps and field-books are kept in the safe. The field-books are for the most part in pencil. Indices are made of contents; they are yet intelligible, and the only ones lost are those of the Town of Napier, which disappeared sixteen years ago.

The office is very confined, and unfit for the duties in hand.

In the Crown grant system of record no special maps are kept for this duty, but a list is kept of the grants prepared, giving district, number, name, number of application, and acreages. The letters G.P. and number are also marked in red letters on the district maps when the grants are prepared and sent to the Crown Lands Office. These maps are on 10, 20, and 40-chain scales.

On looking into the system of "breaking down" the major triangles in this province, I found the operation was not done systematically, the practice of section surveyors being merely to observe two angles in the subsidiary triangles on which their traverses close. This is a very dangerous proceeding, as with small instruments distant trees or rocks may be mistaken for the actual trig. station. The work in many cases may therefore be all wrong. Added to this, the subsidiary stations are not mathematically calculated on the meridian and perpendicular.

It is thus evident that none of the actual surveys in this province can be classed as correct or out of the term "unproven," though the surface of the country appears to be eminently adapted for triangulation of the several kinds as well as for traverse survey.

My opinion is, as I have already said, in regard to other provinces similarly situated, that it would be inexpedient to revise old surveys, and it will require great personal exertion, knowledge, and facility in draughting on the part of the officer in charge to introduce and continue an approved and reliable system of survey and record.

In looking over some of the plans, the inefficiency of major triangulation without minor was apparent, consisting in the long distances required to be travelled by the subordinates to obtain connections, and the inferior value of such connections when made: this to a considerable degree would be ameliorated by referring stations being observed, attached to each trig. station.

The state of the provincial work in Hawke's Bay District is given as follows:—

		Acres.	
Minor triangulation ...	...	320,000	Plotted only.
Spotting section surveys	...	1,000,000	Ditto.
Section surveys in hand	...	6,000	In two localities near Seventy-Mile Bush.

WELLINGTON SURVEYS.

On my return from Hawke's Bay I visited the Survey Office of Wellington on the 5th December, and from Mr. Henry Jackson I received the following information. When this officer assumed direction of the department there was no survey system here. The office maps were in a most confused state. The surveys were on different meridians, and the operations most loosely and carelessly performed. There was no attempt whatever at triangulation, nor was there any determination of latitude, longitude, and true meridian. But the Admiralty Surveyors (H.M.S. "Acheron" and "Pandora") had in an approximate manner observed the latter at Pipitea Point, that is, Mr. Jackson added, speaking of the work in the language of scientific geodetic survey. Marks of true meridian, however, were not fixed in the ground by these surveyors.

The New Zealand Company's surveyors at the outset of the settlement (1841 to 1852) laid out about 268,000 acres in sections, nearly all being in the chess-board fashion termed here "paper survey:" that is, they did not exist on the ground. When sections were sold on these surveys it was the custom for surveyors then to be sent to mark out the purchases. This being inconsistently done, the work was inaccurate. These operations, however, have been nearly all revised and re-pegged, and pegging is now in progress.

On this subject, in asking for special examples of inaccuracies, none were shown.

The present survey system, commencing in 1865, is based entirely on triangulation. There are three principal triangulations, of which the initial points are Somes Island for Wellington, Windy Peak for the Wairarapa, and Taikoria for the Rangitikei Districts. A fourth triangulation, whose sides average twenty miles, connect together these three principal triangulations. With major triangulation, minor was executed, and, so far as the Crown lands of this province are concerned, the whole is covered by major and minor triangulations.

True meridian was observed at the Hutt private observatory, and reduced to Soames Island by computation. It was also observed at the Opaki base line, and reduced again to Windy Peak meridian. It was again checked at Castlepoint by comparison with Heale's meridian, taken at Hawke's Bay. True meridian was not observed at Wanganui, but absolute proof was had of the correctness of the bearing in this manner:—The true meridian of Somes Island was carried up along the West Coast by major triangulation to the Rangitikei-Manawatu District; thence it crossed the range, by the same major triangulation, to the Wairarapa District, when it was compared with an absolute observed true bearing at the Opaki base, with a difference of only 5″. The instrument used was an 8″ theodolite.

When Mr. Jackson first took charge, extensive section surveys had been completed and were in progress. These were in three ranges called magnetic meridians for the three separate districts. These surveys had perforce to proceed till true bearing could be extended to them by the triangulation, and consequently the whole of the sectional surveys are based on these three magnetic meridians. Thus, for practical purposes, all the traverse surveys are mathematically reduced on the magnetic meridian and perpendicular, and commence and end at trig. points.

Maps exhibiting practical work were shown, those of major triangulation being on a scale of eight miles to an inch; minor triangulation, forty to eighty chains also to an inch. All sectional work done by the present Chief Surveyor has been mathematically checked by these triangulations.

In Wellington Province the land system entails survey before sale as well as sale before survey, but the latter are generally for sales of large blocks of pastoral land, and consequently facilitates, rather than otherwise, the operations of the office. The small spotting applications before survey have given a great deal of trouble. The pressing nature of work widely separate has been the great difficulty to be contended with, and, again, the enormous arrears of survey before Mr. Jackson took charge. The sales were effected, but no surveys were performed on the ground; this fact has hitherto rendered surveys more than ordinarily expensive.

The Province of Wellington may be classed as rough bush hill country. The revisal of bush country cost 3s. per acre, whereas the new surveys cost only 1s. to 1s. 6d. per acre.

The sizes of maps are as follow:—Agricultural land, ten chains to an inch, varying in size from 72 × 52 inches down to 3 feet square. The maps of pastoral land are on 20 chains to an inch scale, and the maps of sizes same as above. All are kept in rolls on the walls of the office, and, the building being wooden, may be said to be always in danger.

The old maps are dilapidated, and the new in good repair, but the latter embrace, by revision, most of the former.

The system of recording Crown grants, at present, is to make a copy of the working plan on standard plan of district, stamping C.G. when the plan is put on the Crown grant. Crown grants for about 147,000 acres were issued before Mr. Jackson's time from the old maps, and from these it could not be ascertained what Crown grants had been issued; but a list is kept in the Crown Lands Department from which the issues could be recorded on the maps in the Survey Office.

Old maps have broken into shreds from the practice of rolling, and some of the new maps indicate the process as commencing.

I was now shown a plan of Wanganui District, by Park and Porter. It had much the form of an application map, but showing trig. stations and some traverses. These data must be held to be incomplete on the standard of recent approved systems in the colony. I was also shown one of the original Wanganui field-books. It had been kept in pencil in the handwriting of Mr. R. Park. I am of an opinion that by an expert, well acquainted with the district and the several estates, it ought to be unravelled; and I may add, from long experience in the southern portion of New Zealand, that in cases of disputed boundaries coming before a Court of law, the document, being an original one, such as it is, would be held as good evidence.

The original system of survey of Wellington appears to have been much the same as has held good in Canterbury to this present time, feature surveys having been made, and applications put down on these, fronting to rivers, roads, &c.

A synopsis of the Wellington survey work is as follows:—

	Acres.	
Major triangulation	3,500,000	Referred both to true and magnetic meridian, mathematically reduced.
Minor triangulation	3,000,000	Ditto.
Block section survey	1,446,954	Mathematically reduced.
Ditto	30,000	Old surveys not yet reduced.
Section surveys in hand ...	112,341	Unsurveyed applications.
Ditto	216,000	Old surveys requiring re-adjustment.

Both above, in 362 localities, spread over the province.

Though the provinces had now been abolished, I did not think it necessary to the expense of a voyage to Otago, being myself, from my long connection with the Survey Department personally, well acquainted with it in all its details. I therefore contented myself with writing to Mr. James McKerrow, the present Chief Surveyor, for returns of work made up to the present date, a synopsis of which is given below, taking it upon myself to give a description of the state of the office and a short account of the survey system.

Otago Surveys.

New Zealand Company's surveys were carried out (commencing in the year 1847) in this district to the extent of about 150,000 acres. They were in different districts, each survey in its separate range, which, in some, were magnetic, and in the others on natural features. There was no initial point, nor was true meridian, latitude, and longitude observed in connection therewith. Latitude and longitude, however, were observed at Observation Point, Port Chalmers, by the Admiralty Surveyors, about the year 1851, and which has since been selected as the initial point of all the provincial surveys.

These early or, as they are locally termed, "foundation surveys" were rectangular, and, in the more intricate harbour blocks, were based on unreduced triangulation. As this system forms the simplest species of major traverse circuit, they, where rectangular, proved themselves by mere measurement; where not rectangular, they fronted the shores of the harbour and ocean; and, being backed by right lines, have since been covered, closed, and proved by mathematically reduced minor triangulation. All the New Zealand surveys here, with slight exceptions, have been found to be faithfully executed, and they now form, by trigonometrical connection, an integral portion of more recent operations.

On the dissolution of the New Zealand Company, little was done, excepting some "spotting" surveys in different parts of the country, and which subsequent work absorbed.

In 1856 the principles of survey, which have since and now control the operations, were initiated. In this year true meridian was observed at Observation Spot, Bluff, and standard bearings were carried from thence to several localities where settlement and section survey were being executed. Triangulation mathematically calculated on the meridian and perpendicular was also commenced. In the year 1857 similar operations were cast over the central and northern districts. Though the land laws at this time permitted selection before survey, yet, by pushing forward uniformly or nearly uniformly surveyed blocks under triangulation, the wants of all selectors were systematically and correctly attended to; the Commissioner of the Waste Land Board arranging boundaries with the persons interested, after the plans were forwarded to his office.

But, in the years 1861 and 1862, an enormous influx of population took place, owing to the discovery of rich gold fields. The people now spread themselves in all directions over every corner of the province, taking up gold mining as well as agricultural claims, for which they demanded surveys in order to obtain titles. To temporize with this state of things, and allow the section or minute claim survey to go on haphazard without efficient standard control, would have been to sow discord and trouble amongst the settlers. Comprehensive measures had therefore to be considered, and immediate action taken. On this contingency the present meridional circuit system was decided on as the standard operation of the province. The slow-moving major triangulation, which had been commenced, was abandoned; and, in the course of thirty months, an officer (Mr. James McKerrow) placed 10,560,000 acres of territory under true bearing, whereby all triangular and sectional survey was put under mathematical control, by reduction on the meridian and perpendicular; and however various the localities, or minute or intricate the claims, however tortuous or un-uniform the boundaries, the exact method has been successfully adhered to, bringing out (what otherwise would be a medley of confusion) all details in a clear and intelligible manner.

A general system having been adopted, it became possible to have a regular method of plans and office record. The province was divided into circuits of about 60 to 100 miles in length or breadth, good natural features being selected as boundaries. Circuits were again divided into survey districts of 12 miles square, which again were divided into blocks of about 3 miles square. These again were divided into sections of such sizes as might be required. The scales of plans were respectively 320, 40, and 10 chains to an inch, which enabled all working plans to be put into sheets 30 inches square, which, being of similar size, went into folios of equal size. Thus the most valuable part of the survey records were in the Otago offices kept flat, well preserved, and free from dust. The New Zealand Company's maps, though of all sizes, were folded and kept in the same manner; and thus the old, as well as the new, records remain in good order, showing no signs of deterioration.

It will be unnecessary for me to touch on the system of astronomical and geodesical observations for the determination of the initial points of circuits, nor on the mode of reconnaissance, by which the pastoral pioneers were put originally in possession of their leases, as these are fully gone into in other reports and papers.*

The survey records are kept in a fire-proof safe. This is the case at the sub-office at Invercargill, as well as at Dunedin.

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* Outline of Otago Survey, 1861. Exposition ditto, 1875. Standard Survey ditto, 1876.

The following is a synopsis of work done and in hand:—

	Acres.	
Meridional circuit	13,240,000	On true meridian mathematically reduced.
Major triangulation	680,000	Ditto.
Minor „	5,800,000	Ditto.
Block section survey	2,103,000	Ditto, except early surveys.
Spotting „	800,000	Ruled by triangulation, and mathematically reduced.

Surveys in Hand.

Sectional and spotting ...	130,000	In ten separate localities.
Minor triangulation	140,000	Work in all parts of the province.

SURVEYS AS AFFECTING THE ABORIGINES.

Before leaving this branch of the subject, it is necessary to make a few remarks on the system of Native surveys, so as to show how they affect the Aboriginals and the Government. In these remarks we are first led to the system of survey in large blocks, which are principally for the purpose of purchase and extinguishment of Native title.

In looking at a survey consisting of 28,000 acres, near the source of the Rangitikei, which is a fair specimen, it is found to have been covered by major triangulation. The boundaries, which are for the most part marked by rivers and other natural features, are traversed by theodolite and chain. Of this portion of the work it is difficult to judge without ground inspection; the gross errors, however, amount to 50 and 70 links, and in one case to 119 links. It is, however, carefully checked by minor triangulation. The country is open, and the cost of the survey was £208, the time taken being nearly two months.

The cost of other blocks is as follows:—

	Acres.	£	s.	d.
Maungaporau	16,000	610	2	1
Tokomaru	17,000	327	0	0
Maunganui-o-tahu	8,500	629	8	1
Mangaoira (unfinished)	15,000	287	0	0
Ohauko	28,413	208	5	0
&c., &c., &c.				

These appear to be very heavy items of expenditure for interior blocks that may not be utilized immediately. I would therefore suggest the propriety of altering the system of such surveys from actual to reconnaissance, which latter, where the blocks are always bounded by natural features, are quite as intelligible, nearly as accurate, and sometimes more accurate, than the long intricate chain traverses, and whose cost is very much smaller, not averaging more than a tenth or twentieth in large areas. I am of opinion on this point that the whole of the interior of North Island could be quickly mapped by reconnaissance in an accurate and effective manner, by which means could not only present purchases be recorded, but future negotiated with perfect intelligence and satisfaction to all parties; and I may further suggest that, were the work taken in hand with mutual understanding by one or two active officers, they would give a far more lucid idea of the topography than a dozen working incongruously and independently. Again, as reconnaissance does not require large marks to be built, the prejudices of the Natives against the operations are less apt to be excited. In the remote positions, to go to the cost of actual survey, in its numerous and slow details, appears to me to be waste of force.

On scrutinizing the plans of village and tribal areas, this fact strikes the surveyor, that it is difficult to apply the modes and methods pertaining to civilized and highly artificial social states to people in a primitive condition. The efforts of the statesman, the judge, and the philanthropist seem to miscarry however benignly conceived. Thus, scanning several village plans, and selecting as a specimen that of Otaki, we find 150 claims (that have been surveyed from time to time and by different licensed surveyors) generally overlapping, promising to yield in after years a crop of litigation that will ruin the holders and bring down the value of the holdings to zero. This survey, executed for the purposes of the Native Lands Court, is not on any basis, such as triangulation, nor on any determined meridian. The compilation is constructed by "building" the claims together, but which cannot be made to coincide with each other.

A continuance of this mode of attempting to localize Native claims appears to me to be fraught with injury rather than benefit. They would be better in fact without such mis-records, for a property by occupation and prescriptive right is less dangerous than one which may have a paper title hanging over it, ready to dispossess with prior and forgotten survey and processes of law.

The Maoris, in their wants, imitate the Asiatic rather than the European. To survey their minute, complex, and irregular land tenures accurately, would be to eat up the value. It is better left alone unless their general consent can be had to a simple and regular re-arrangement such as we have in European districts and towns. Again, the partition of claims into immensely long narrow strips must make such holdings valueless when Crown-granted and brought under the fencing ordinances. Thus, as a specimen, I cite one of twenty-seven claims at Ngakaroro, No. 2A, 1933 acres, whose width is 26 chains, and length 780 chains—that is, length thirty times the breadth. Of course I notice these subjects from the peculiar aspect in which a surveyor scans them, so that, if thought sufficiently important, they may be considered by the proper authorities.

SUMMARY.

The survey work done in the entire Colony of New Zealand may be summarized as follows, and to which I have appended explanatory remarks:—

RETURN of SURVEYS EXECUTED in the COLONY of NEW ZEALAND up to JULY, 1876.

Districts.	Total Area.	Geographical and Standard Survey.			Settlement and Section Survey.						Remarks.
		Meridional Circuit.	Major Triangulation.		Minor Triangulation.		Block.		Spotting.		
			Reliable.	Unproven.	Reliable.	Unproven.	Reliable.	Unproven.	Reliable.	Unproven.	
	Acres.	Acres.	Acres.	Acres.	Acres.	Acres. [1]	Acres.	Acres.	Acres.	Acres. [2]	
Canterbury ... ... (1)	8,693,026	...	...	...	992,000	2,008,000 [3]	...	... [4]	...	2,014,696 [5]	[1] Mechanically plotted only, but a large part reducible. [2] Untested either by minor triangulation or mathematically reduced traverse. [3 4 5 6 7 & 8] Ditto. [9] Generally speaking, not ruled by minor triangulation nor mathematically reduced. [10] Untested. [11] Ditto. [12] Ditto, and unruled by minor triangulation. [13] Not ruled by minor triangulation. [14] The New Zealand Company's and other early block surveys, all separately accurate, have been closed by minor triangulation, while the spotting surveys have been re-surveyed and embodied in recent surveys. [15] Partly broken down to minor. [16] Subsequently closed (to major trig. points) to a considerable extent. Mechanically plotted till lately. Much of the Native land surveys must be classed as sketch or reconnaissance, being in rough inaccessible country, and for the most not executed for settlement purposes, but for extinguishment of Native title only.
Marlborough	3,000,000	...	...	...	...	39,000 [6]	...	888,000 [7]	...	5,000 [8]	
Nelson	7,000,000	...	...	...	...	63,000	...	117,000	42,000	158,000	
Westland	3,045,760	...	805,700	...	...	...	...	...	54,000	... [9]	
Auckland ... ... (2)	17,000,000	...	...	...	60,000	...	...	2,500,000 [10]	...	30,000	
Taranaki	2,137,000	...	...	...	12,000	... [11]	30,000	130,000	...	... [12]	
Hawke's Bay ... ... (3)	3,050,000	...	...	...	...	320,000	...	... [13]	...	1,000,000	
Wellington	7,000,000	...	3,500,000	...	3,000,000	...	1,446,954 [14]	30,000	...	...	
Otago ... ... (4)	16,140,000	13,240,000	680,000 [15]	...	5,800,000	...	2,103,000	... [16]	800,000	...	
Native and Confiscated Lands (5)	...	...	9,647,390	...	...	...	...	7,502,966	...	...	
	67,065,786	13,240,000	14,633,090	...	9,864,000	2,430,000	3,579,954	11,167,966	896,000	3,207,696	

(1) It is not to be understood that all section surveys unproven are incorrect; only that, till submitted to the test of minor triangulation or major traverse circuit, which would be a very expensive and laborious undertaking, they cannot as a whole be considered reliable, and that in the above return their practical usefulness is not questioned, though in this report special work has been stated to be wrong. What have been stated as reliable are such as are governed either by minor triangulation or what are mathematically proved in themselves.

(2) & (3) This includes the work only under the Waste Land Boards.

(4) Including Southland.

(5) Auckland, Wellington, and Hawke's Bay.

From the above return it appears that all standard survey, consisting of 27,873,090 acres or over one-third of the whole colony, is reliable for the purposes to which it is intended to apply; but this cannot be said of the settlement and section survey, for in minor triangulation, amounting to 12,294,000 acres, or about one-fifth of the whole colony, there are 2,430,000 acres unproven, though half of this is recoverable. In block section survey, amounting to 14,747,920 acres, or about one-fourth of the whole colony, 11,167,966 acres are unproven; but to say this without large qualification would be incorrect, for out of the unproven we must deduct the larger portion of 7,502,966 acres executed by the Native Lands Department, which, being for the extinction or localization of Native claims in large blocks, comes under different conditions from those surveys made for the settlement of Europeans on Crown lands, and to which process this area will yet have to be submitted. Thus the area properly coming under the term "Block Section Survey," and which is unproven, amounts to 3,665,000 acres, exceeding by little of the same class of survey which is noted as reliable. Different, however, is it with the spotting section survey, whose requirements involve the most difficult problem that a colonial surveyor can undertake. Here we see that 896,000 acres only are considered reliable, while 3,207,696 acres are unproven. And taking section survey as a whole—which is really the most important branch directly affecting the community—4,475,954 acres come under the heading "reliable;" 6,872,696 acres, or one-tenth the area of the whole colony, "unproven."

To fix the fault of this unproven work on any one would be difficult, for the political and economical state of a young and struggling colony, it will be already apparent by a perusal of this report, has had much to do with it; and those who have succeeded will be the least inclined to be critical, for they know best what obstacles they themselves had in early days to overcome.

Measures Proposed.

This brings me to the measures that I have to propose for the future conducting of settlement surveys on the demesne lands of the Crown; and, as I have already prepared specifications for these, I will now only explain the principles that guide me in my recommendations.

When, subject to the approval of Government, I was first asked to take the responsibility of the general survey by the then Secretary for Crown Lands, Mr. W. S. Moorhouse, it was pointed out to me that there was a double duty to be administered to—one in relation to sales and settlement, the other to registration of titles under the Land Transfer Act. With these instructions before me, and in which I understand the present Government concur, it will be seen that the work of the Survey Office is two-fold—one in regard to the settlement of an immigrant people, another in regard to permanently securing their titles, the former requiring rapidity of execution, the latter practical correctness. These circumstances throw responsibilities on the surveyor very different from what fall on him in old and already settled countries; and in respect to the several propositions of a professional nature that have from time to time been laid before the Government I will endeavour to give my reasons clearly in support of the particular system I advocate. Thus, taking by way of illustration the surveys of the United Kingdom of Great Britain and Ireland and the surveys of her powerful colony the Dominion of Canada, we find their approved processes of surveying in no way analogous. In the former, primary, secondary, and tertiary triangulation, spreading from a centre over the country in the course of ninety-one years, has been found applicable. In the latter no such processes are attempted, but traverse block surveys on astronomical bearing are executed whenever and wherever their immigrant settlers fix their locations. Thus the wants of our own countrymen in different conditions ignore cast-iron rules, and demand what is most appropriate to their wants, irrespective of professional survey systems. The Canadian system of survey is now founded on that in use in the United States,* which latter, as long as it is confined to the flat forest lands and the prairies, answers the purpose; but now that the Cordilleras have been reached, the system is at fault, inapplicable, and entirely unavailable.† This was much our case in New Zealand: the simple rectangular section surveys of the New Zealand Company answered very well on the plains, but had to be abandoned when the mountainous districts were reached. This dilemma in the southern portion of the colony occurred in 1856. What had to be done? Primary triangulation, while highly scientific, bore with it the fatal objection, in a colonial point of view, of inertness, tardiness, and great cost. Up to 1861, secondary or here termed major triangulation was initiated, but also had to be abandoned, as it could not, as stated before, keep pace with the dispersive nature of actual settlement. Thus, the approved British and American systems, or even modifications of these, being unsuitable, what was to be done? The plan designed was what is now called that of meridional circuit. This consists of carrying on true bearing by 8-inch theodolites from the initial points of circuits by the most ready roads through the valleys to the spots where the population locate themselves.

And what was the want of the southern districts of New Zealand twenty years ago is now in a greater degree the want of the whole colony. The returns that I have received from all the sub-offices show that there are 1,514,000 acres in 553 different localities, dispersed from Stewart's Island to the Three Kings, stretching over 13 degrees of latitude and 11 degrees of longitude, the surveys of which claims are immediately wanted, hence they can be administered to by no slow measures. Money means time. Now the cost of meridional circuit survey is 3s. 6½d. per square mile, while major triangulation costs £1 7s. 9d.: that is, the former is eight times less expensive than the latter, and hence eight times more expeditious. Thus, what we can do for dispersive settlement in one year by meridional circuit would take eight years by major triangulation. So on grounds of economy of time and money I recommend meridional circuit as our general standard system for the purpose of meeting the large calls on the department as they now stand, though I would prefer major triangulation in parts that can allow of delay, from the fact that by "breaking it down" the work is more homogeneous. But on grounds of correctness there is really little practical difference. Thus, in eighteen comparisons of separate major triangulations in the North Island, the average error was found to be 12·43 inches per

* Manual, by J. S. Dennis, Surveyor-General. Ottawa, Canada, 1871.
† J. D. Whitney, *North American Review*, July, 1875.

mile; in the comparisons of the standard work in fifty-one districts in Otago covered by meridional circuit, the error at closing over a distance of 195 miles was found to be 11·0 inches per mile; and of six districts, 15·84 inches per mile. Hence the systems in accuracy are nearly co-equal, and both far within what is necessary for governing actual survey.

By the adoption of meridional circuit as a standard system instead of secondary triangulation, while we practically do not deteriorate the work in accuracy, we attain an end fraught with the most important significance to the settlers and land purchasers—viz., we place their holdings on true bearing *ab initio*, thus giving their boundaries a fixity and certainty in relation to the general scheme. Their title descriptions are also thus made an integral portion of a mathematical system which secures them against boundary disputes, and the law expenses connected therewith.

Governed by meridional circuit, unless where delay admits of major triangulation, there will follow the actual processes of minor triangulation and settlement survey. I may further mention that each circuit will have its initial station on true meridian, and whose latitude and longitude will be determined by astronomical observation and electric signal. But this need not be commenced until the settlement surveys of the colony are fully under control, and the general system in operation in due routine.

Speaking of major triangulation and meridional circuit in relation to pure geodetic or meridian arc survey, such as those undertaken by primary triangulation, neither can be classed with these. Primary triangulation is measured with an approximation equal to half an inch per mile, and in its base lines to half the breadth of a sharp-pointed needle in each 100 feet. Nevertheless, though the standard operations of a colonial settlement survey cannot be called highly scientific, that is, microscopically exact, this in no way militates against their usefulness, nor prevents their stations ultimately being embodied in the more abstruse and refined analyses which the future wealth and leisure of the country may many years hence support and undertake.

National System of Survey.

The survey of Great Britain may be termed geodetic,* astronomical, and triangular; of Canada, astronomical, geodesical, and quadrilateral; of New Zealand, such as I propose it to be, astronomical, geodesical, triangular, and polygonal. And in support of my recommendation I have to state that the system has been in successful operation in the southern part of the colony for twenty years. The system has also been recently adopted in the Colony of Victoria, in lieu of what was there called the geodetic or meridian and parallel survey,† as well as in Western Australia.‡ Its recommendation, therefore, does not now rest solely on local opinion or experience.

Admitted Error.

As every national or colonial survey has a limit of error assigned to it beyond which the work should be rejected, and as the public can have no confidence in surveys whose accuracy is not attested and duly reported thereon, it now becomes me to enter on this branch of the actual operations. In British India the admitted error is eight links to the mile,§ and this latter is very generally adopted in New Zealand; also in various parts of the world. I may mention, however, that the best and most experienced surveyors here in fair country have no difficulty in bringing down the error of their field closings to two links per mile. But it is the gross or accumulated error allowed to creep into the work that is the most important consideration, and this is evidently affected for the better or for the worse by triangulation—in other words by the closeness or wideness of trigonometrical points. In Canada, where no triangulation is executed, owing to the nature of the surface, the allowed gross error in blocks (there called townships), six miles square, in actual survey is 200 links.|| In the southern portion of New Zealand, by means of having the trigonometrical points on an average 2½ miles apart, the gross error is reduced to 10 or 20 links at the most. On the inspection of various traverses in the north portion of the colony, where the country is sometimes difficult, sometimes easy, gross or accumulated error, which I extract from a table in the Wanganui District, varies as follows:—

In a 2-mile traverse	...	...	...	accumulated error	92	links
„ 9-mile „	...	...	...	„ „	54	„
„ 3-mile „	...	...	...	„ „	42	„
„ 5-mile „	...	...	...	„ „	130	„
„ 4-mile „	...	...	...	„ „	72	„
„ 4-mile „	...	...	...	„ „	134	„

In the traverses of some of the districts which extend fifteen and twenty miles without check, the gross error must greatly exceed any of the above, and in the course of time, when land becomes valuable, must induce law disputes between settlers. I would thus suggest that closer check of the chainages by the trigonometrical and standard operations should be by every effort applied.

Inspection.

To this end, field inspection is of far more value than office correction, a subject on which I have already touched. I am strongly of opinion that errors in field cannot be rectified in the office, nor can radical faultiness be eliminated by interpolation. As an example of this, I may allude to a traverse at Awahuri corrected by office interpolation, but which on being revised in the field, the error of a

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* I use the term "geodetic" as meaning operations which independently solve the form of the globe; "geodesical" as meaning operations which derive their data from the former.

† Inspector-General Allen's report. Melbourne, December, 1873.

‡ *Vide* the *Perth Gazette*. August, 1873.

§ Manual by Thuillier and Smyth. Calcutta, 1846.

|| Manual of Public Surveys. Ottawa, 1871.

missing chain was detected, and which would have remained in the records had it not been so detected. Office correction is perfectly appropriate in a service such as the Ordnance Survey of England, where twenty years may elapse between surveying and mapping without inconvenience to the landholders; but contrary conditions exist in a colony. No sooner is land bought than the titles are wanted by the purchasers. No sooner are the survey contracts completed than payment is demanded by the contracting surveyor. Then, if field work be done and paid for, so it should be in a fit state for record. Active outdoor inspection alone will allow this. Minor triangulation or major traverse circuit gives the bases of check; and the check to any traverse survey is easily and quickly effected at random points of the actual survey by the Chief Surveyor or his confidential inspector.

It will thus be surmised that by field inspection office assistance is curtailed, and greater burden placed on the responsible heads; yet professional and economical grounds, in my opinion, support this measure. I may also add that close check points enable the detail to be executed with so little accumulated or gross error that correction in office by interpolation is unnecessary.

Mapping.

In initiating a new system of survey which applies to the whole of the colony, it will be necessary also to introduce a method of mapping and record independent of former unproven or unconforming work, which will have to stand by themselves; but as I have entered fully into this in the new printed regulations, I need not do anything further here than allude to the matter.

Cost.

The total area of the colony is estimated at about 102,000 square miles, and, as the cost of the several processes of standard and ruling survey is known from actual examples, I give an estimate of the same as follows:—

Reconnaissance	...	by 4″	theodolite,	@ 2/3 per square mile ...	£11,475
Meridional circuit	...	8″	„	@ 3/6½ per square mile ...	18,062
Primary triangulation	...	36″	„	@ £1 11/9 per square mile ...	161,925
Secondary or major triangulation	...	12″	„	@ £1 7/9 per square mile ...	141,525
Tertiary or minor	„ ...	5″	„	@ £3 12/2 per square mile...	368,900

The cost of actual or section survey of course varies more than the superior processes, owing to difference in size of sections, surface of country, and distances to be travelled. Thus there would be no end served by naming an estimate, as it could not be even approximate. The rate in my experience has been as low as 6d. per acre, and as high as 7s., the average rate being between 10d. and 1s. 6d.

In Canada the rate is said not to exceed 3d. or 4d.; but the section surveys there are in the simplest form, generally on level country. They also do not undertake the road traverses nor mark the back lines.

Conclusion.

In conclusion, I may state that positions in the colony relative to Greenwich Observatory have been independently determined:—

1. Wellington Custom House, by Captain Carkeek.
2. Rockyside Observatory, Caversham, Dunedin, by myself.
3. Hutt Observatory, by Mr. Henry Jackson.
4. Burnham, Transit of Venus Station, Christchurch, by Major Palmer.

Reports of which may be seen in the General Government *Gazette*.

I have, &c.,

J. T. Thomson,

Surveyor-General.

The Hon. the Secretary for Crown Lands.

By Authority: George Didsbury, Government Printer, Wellington.—1877.

Price 1s.]

1877.

NEW ZEALAND.

THE SURVEYS OF NEW ZEALAND

(REPORT BY THE SURVEYOR-GENERAL ON).

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

The Surveyor-General to the Hon. the Secretary for Crown Lands.

Sir,— General Survey Office, Wellington, N.Z., 9th August, 1877.

In forwarding this annual report on work done by the department since the various Provincial Survey Offices were put regularly under the control of this office—which may date from the 1st January last—I have the honor to inform you that the measures proposed in my report to you of 7th December last year have been put in process, and as the Standard work, which governs all technical details, is the most important, I first allude to it.

I.—Standard Work.

As the accompanying statement by Mr. McKerrow (Appendix 1), who has charge of this branch, fully explains what has been done, I may confine my remarks to saying that the colony for standard survey operations has been divided into twenty-eight geographical areas, termed meridional circuits. True meridian at initial points had already been observed for in twelve of these, and which have been adopted; fourteen have been observed for since November last; so there now remains only two uncompleted.

Eight survey parties are now engaged in standard work, whose services, if continued, will bring all plane and section survey under the control of true bearing in twelve months' time.

Indeed, this work has so far advanced already, that in all parts of the colony surveys on magnetic or arbitrary and assumed meridians are exceptional.

II.—Operations for 1876-7.

The work executed within the Provinces prior to the 1st January, 1877, and since the date of the last return to the respective governments, has been:—

Nature of Work.	Area.	Rate per Acre.	Cost.
	Acres.	*s.* *d.*	£ *s.* *d.*
Major Triangulation	180,000	0 $0\frac{1}{3}$	250 0 0
Minor Triangulation without topography	71,600	0 $1\frac{2}{10}$	358 0 0
Topographical and Trigonometrical Survey	184,720	0 $2\frac{7}{100}$	1,593 4 2
Rural and Suburban Section Survey	296,083	1 $7\frac{1}{10}$	23,563 5 5
Town Section Survey (3,185 allotments)	2,617	10 $10\frac{4}{10}$	1,731 0 8
Native Land Court Survey	123,455	0 $4\frac{1}{4}$	2,186 3 7
Native Land Purchase Survey	361,833	0 $2\frac{1}{4}$	3,392 3 8
Miscellaneous work, Water-race, and Road and Mining Surveys	—	—	4,269 0 0
	1,220,308	—	37,342 17 6

The quantity of work executed for the half-year ending 30th June, 1877, has been :—

Nature of Work.	Area.	Rate per Acre.	Cost.
	Acres.	s. d.	£ s. d.
Minor Triangulation without topography	23,128	0 $3\frac{1}{4}$	313 3 10
Minor Triangulation and Topographical Survey	861,000	0 $1\frac{36}{100}$	4,879 0 0
Rural and Suburban Section Survey	278,747	1 5	19,744 11 7
Town Section Survey (740 allotments)	441	25 $3\frac{3}{10}$	557 6 3
Native Land Court Surveys	137,392	1 4	9,159 9 4
Native Land Purchase Surveys	62,236	0 $8\frac{1}{4}$	2,139 7 3
Miscellaneous work, Water-race and Road Surveys, Surveyors, Plotting Arrears of Field work, &c.	—	—	5,039 0 0
	1,362,944	—	41,831 18 3

Returns, Appendices Nos. 2 and 3, give the details for each Provincial District.

III.—Cost of Settlement Survey since Foundation of Colony.

Appendix 4 gives the cost of the surveys executed in the colony since its foundation. Thus what has been done, and the expense being known, the future cost may easily be calculated. The cost will be seen to exceed the acreage rate of America four times, the cause of which will hereafter be explained; but on this point it is also necessary to remark, that the value per acre received by Government is also four times that received in America. Knowing, however, the cost now, and in anticipation, I suggest that Government is in possession of data to found any measures in reduction of cost; but it is clear that such measures—in reduction—must necessarily curtail the offices and services of the department, and the privileges of settlers, in many ways. This will be more clearly seen on examination of the respective actual survey maps appended to this report.

The cost includes supervision and office expenses, but the return can only be considered approximate, owing to the defective nature of the early records. As a comparison between the several districts, there are also incongruities affecting the same, such as standard processes, minor triangulation, and road surveys having been carried out in some and not in others. Besides these, in some districts there are gold-field surveys, the sectionizing of towns and villages, ferry-sites, &c., to be borne in addition to the usual routine of settlement operations.

From consideration of the return, one fact is very patent—viz., the advantage of system. Thus, after an expenditure of £1,314,803 sterling on surveys, only 4,163,954 acres have proved to be reliable; 7,254,696 acres unreliable—system would have remedied this. Another fact is also elicited, and which runs counter to popular opinion—viz., that accurate work is not more costly than unreliable, but even less so.

IV.—Survey under Statute.

As I lately did myself the honor, in letter dated 15th May, 1877, to express an opinion that the general settlement and section survey system of the colony should be enacted, directed, and authorized by Parliament, I will now state the reasons for my advising such a course.

Not to mention the responsibilities of the "Land Transfer Act" now resting on the Government, and for the meeting of which an approved system is essential. There is in the interests of the colonists a primary principle at the root of the subject—viz., the unchangeableness of original boundaries. It is not improbable that English law would support the principle, if fairly tested in the Courts; but to settle the question at once and directly is in the power of the Parliament of New Zealand. By the acceptance of the principle as a legislative measure, a practical, concise, and rapid mode of marking out and surveying the colony under authority also becomes necessary.

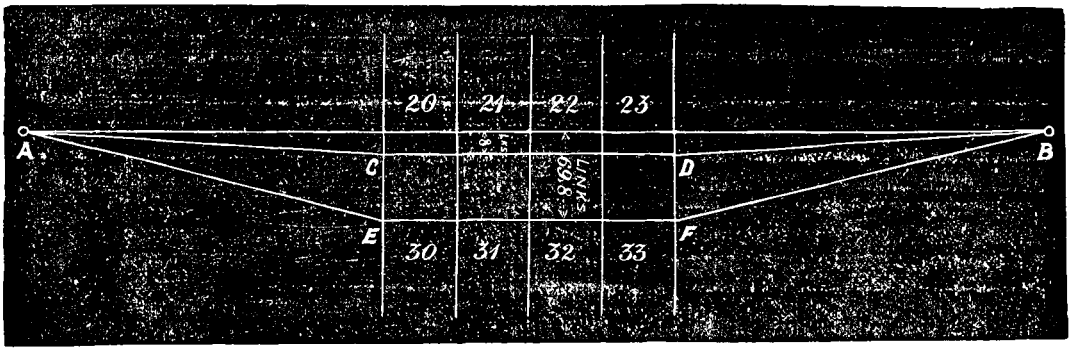
Where tenure is by grant from the Crown, this question, then, arises, Do the ground-marks, or the written descriptions, give possession in relation to extent and position? To my apprehension, the ground-marks give possession, they being actual and visible things done, the written descriptions being only accounts of these things which had been done. But why should not the written descriptions have the same validity as the ground-marks? Because they are not only secondary evidences of facts done, but also because they cannot in practice be made perfect, errors being attached to all the observations on which descriptions are founded—whether in bearing or distance—thus bearings and distances are always more or less in error, while the ground-marks may remain immoveable notwithstanding. The fact, then, is that all settlement survey maps and descriptions have errors attached to them more or less according to the nature of the service and the instruments in use. In New Zealand and Australia, Canada, and the United States, there are three modes of settlement or actual survey :—

1st. By 8″ theodolite ... admitted error 2 links per mile
2nd. ,, 4″ or 5″ ,, ... ,, ,, 8 ,, ,,
3rd. ,, Magnetic compass ... ,, ,, half a degree in bearing, or 69·8 links per mile. *

* But greatly more when subject to local attraction, as is frequently the case in New Zealand, and which makes the compass altogether unreliable.

Now admit, for argument's sake, that there was a possibility of measuring a mile absolutely correctly (but which human ingenuity has not attained): these two actual marks, put at a mile distance, while remaining absolutely immovable, yet might have their written descriptions in grants by the Crown differing 2 links, 8 links, or 69·8 links. Hence we are forced to conclude, that ground-marks give possession correctly, while descriptions and maps cannot do so, but only by approximation.

So by way of illustration this may occur, and which occurs more or less daily in actual settlement operations:—



In undulating or forest country, a line A, C, D B, is run between two trig. stations at three miles distance—by 5 theodolite with an error of 8 links, or by a magnetic compass (A, E, F, B) with an error of 69·8 links—both being tested by an 8 theodolite. Truly, in error, yet originally honestly executed by a surveyor to the best of his ability, and within the power of his respective instruments. Then the question in this colony crops up, and is cropping up continuously after one year, two years, or twenty years, on the divergence from correctness being found. Do the owners of sections 20, 21, 22, and 23, lose the 8 or 69·8 links in breadth of the land, in which they were actually and in good faith put in possession, and on which, in reasonable trust, they had put live fences, or it may be houses? Do they lose possession in favor of the owners of sections 30, 31, 32, and 33? In other words, are settlers placed on waste lands of the Crown, by process of survey which cannot be perfect, to be from time to time required to shift their fences and houses, as time passes on and wealth increases, bringing the newish survey practitioners having higher-classed instruments and more leisure?

As there is a great difference of opinion amongst professional surveyors on this point, and as land-owners in districts and towns in different parts are now being set by the ears, it would be well, as the law appears to be doubtful, to have an authoritative direction by Parliament for the future. For until this be done there can be no security to settlers—their boundaries being never ceasingly subject to question—thus each landholder may be said at present to have an ever-pending law-suit hanging over him.

The question has had to be disposed of by other communities. On referring to the great colonizing countries in the modern world, I find that in the United States of America, Congress, so early as 1805, laid down certain principles in regard "to the unchangeableness of the lines and corners "established by Government Surveyors, and which have had continued operation to the present time, "and are still in full force."* It is remarked by the author, whose work I quote, "that experience has "demonstrated the wisdom of this enactment, no law ever passed by Congress has contributed so "much to prevent disputes in regard to boundaries of public lands." Thus "when corners are "established by the proper officer in pursuance of the system of sub-division authorised by law, they "must be regarded as the true corners which they represent, even if it is subsequently found that the "post is out of line, or that the intervals are unequal or incorrect: and no party has a right to correct "such errors except the General Government, and it possesses that power only while the title to the "lands affected by the change is as yet in the United States."

Turning next to the practice of Canada, we find in the Dominion Lands Act Consolidated 1876, the same principle adopted—viz., that original boundaries are unalterable. Section 93 of the Act being to the following effect:—"All boundary lines of townships, sections, or legal sub-divisions, towns or villages, "and all boundary lines of blocks, gores and commons, all section lines and governing points, all limits "of lots surveyed, and all mounds, posts or monuments, run and marked erected, placed or planted at "the angles of any townships, towns, villages, sections or other legal sub-divisions, blocks, gores, "commons and lots, or parcels of land under the authority of this Act, or of any order of the Governor "in Council, shall be the true and unalterable boundaries of such townships, towns and villages, sections "or other legal sub-divisions, blocks, gores, commons, and lots or parcels of land respectively, whether "the same upon admeasurement be or be not found to contain the exact area or dimensions mentioned "or expressed in any patent, grant, or other instrument in respect of any such township, town, village, "section or other legal sub-division, block, gore, common, lot, or parcel of land."

Such is the decision of these colonizing countries: original ground marks are held to be unchangeable and unalterable, whether the written linkages in the grant agree or not. But to give the full benefit of this principle, a rigidly simple system of settlement survey had to be devised and brought under statute. And the system is the same in both countries, Canada having copied from the United States: thus when I describe one I describe the other. But before I go on with this, it may be asked—what caused these Governments to adopt so simple and yet so unswerving a method? I am not aware that the history of the surveys of these countries has been written, but on examining the section maps

* Hawes, p. 119.

of the older North-Eastern States, the cause is not far to seek—viz., in the complicated, unconforming, intricate, and necessarily inaccurate plots and plans, which must have created confusion, litigation and loss to the settlers. At the same time I must remark that I have not been able to detect any such excessive intricacies of selection as we have in New Zealand, in the Provincial District of Canterbury, for instance. I am therefore led to conclude that the rigidly simple and unmistakeable method of laying out allotments for settlement was owing to the experience of the tardiness of unsystematic surveys, combined with confusion and litigation: further, because no unmethodical mode would have administered to the wants and requirements of such volumes of population from Europe pouring over the waste lands of such extensive regions.

The map of Manitoba, Canada, is the best example of the system of survey in my possession, but anyone who has a large map of the United States will see the principle displayed now over half the continent.

Referring to the map, we find the Province of Manitoba extending between 49° and 51° north latitude and 96° and 101° west longitude. The Survey is primarily astronomical based in longitude on a principal meridian 97° 26′ 50″ west, and a first base line in latitude 49° north. The standard lines are carried northwards from the 49th parallel on the meridian at 12-mile intervals; or strictly speaking, allowing for roads, at intervals of 978 chains. As these lines are on true meridian of each separate longitude, they converge, so that in order to maintain 12-mile intervals corrections have to be made; these are technically called "jogs." Fig. I. illustrates the system of standard lines, and the mode in which the townships* and sections rest on these.

Thus, while in these countries, it has been enacted that the territories shall be cut up into square miles—multiples or divisions of these—this is only theoretically; strictly speaking they cannot practically be so, owing to the sphericity of the globe; hence the actual work is done with correction, into the precise manner of applying which I need not here enter. However many faults may be ascribed to the system, and however many insufficiences, yet its having stood the test of ninety years and more, is proof of its adaptability. And if I may venture an opinion on a system of operations that I have never seen, I would hazard the remark that none could be more appropriate in the conditions of a wide, level, feature-less expanse of country in process of rapid appropriation by an immigrant people. Thus, these great countries proceeding on the principle of unalterableness of original boundaries—independent of all European precedent—have devised for themselves a system of national settlement survey, comprehen-sive and enduring, also unequalled in certainty of record, and not to be excelled in giving security of tenure to the millions of selectors.

But the conditions of America are not the conditions of the narrow, hilly, and mountainous islands which comprise our colony of New Zealand; thus our survey measures cannot be entirely analagous. If we look to Europe, as naturally we would look for the highest perfection attainable, neither can we have direction; for there we see only such operations as are suited to a country already possessed and divided. But in the British Empire of India we have the example of a system, matured under the highest authority and in successful operation for half a century—and which I, from personal acquaintance of the same—dating thirty-eight years back, have no hesitation in recommending. Gale's method, which is the foundation of the Bengal system pursued in the revenue and settlement surveys of India, has further, with modifications and additions, been in operation for twenty-one years in the Southern Districts of New Zealand, and with, we believe, satisfaction to the Government and the public. It is also now the officially-authorised system in the colonies of Victoria and Western Australia. Like the American, its governing processes are astronomical and electric, but owing to the diversity of conditions above stated in detail, it diverges.

The existence of a North Pole Star, it may be suggested, naturally led to the adoption of standard converging meridian lines as a radical portion of the American Settlement Survey Scheme. In the Southern Hemisphere our pole is devoid of such an object, perceptible by the common theodolite. The tracing of meridians, closely and constantly, at twelve and six-mile distances, is, therefore, not an easy task for the actual surveyor; it was consequently decided that a meridian should, as in the Revenue and Settlement Surveys of India, only be observed (and that carefully with large instruments) for each geographical area on an initial station near its centre. Fig. 2 illustrates the principle.

Our method of blocking out the country for settlement survey will be seen to nearly coincide with the American; their 12-mile blocks, containing four townships six miles square; our 12½ miles square survey districts, containing sixteen blocks 3⅛ miles square. But the nature of the respective surfaces of the countries require us to again diverge. After this the American township is cut up into thirty-six square miles, called sections, which sections are again cut up into sixteen quarter-quarter sections of forty acres each. The country being for the most part plain and prairie; this is done irrespective of features and communications. Our blocks, which are 3⅛ miles square, are first intersected by roads according to the proper direction required by the valleys, ridges, and mountains which intersect the surface of the country; after which sections are surveyed of sizes from twenty acres up to two hundred acres—more or less—as may be suitable for settlement (this, of course, where sale before survey does not take place). Figs. 3 and 4 will show at a glance the practical mode of the sectionizing in the two systems.

To sum up the principles thus shortly brought in juxtaposition, they may be specified as follows:—Primarly, both are astronomical and electric. Secondarily, the American by convergencies and lesser circles; ours, by true bearing and distance on the meridian and perpendicular of initial station of circuits. Thirdly, both by squares; the American 12 and 6 miles; ours 12½ and 3⅛ miles, or 1,000 and 250 chains square respectively. Fourthly, the American still in squares of 1, ½, and ¼ miles; ours principally quadrilateral and polygonal, whose elements are mathematically reduced on the meridian and perpendicular of trigonometrical stations. Then the Americans, by their system, are compelled to eliminate, on the ground, the differences arising from sphericity, by the jog or correction already alluded to; we do not require to do this, but we mathematically calculate and allow for convergencies and curves of lesser circles in our geographical and geodesical maps only. The main feature of the American system

* Townships in America are 36 square miles, and are analogous in meaning to our term Survey Districts.

may be shortly stated as meridian and parallel; of ours, meridian and perpendicular, termed meridional circuit.

The average cost of the two systems may be stated as follows:—

New Zealand.

	£	s.	d.			
Standard	0	3	6¼	per square mile.		
Trigonometrical (2½-mile sides)	3	12	2	,,	,,	
Sectional (20 to 200 acres more or less) ...	32	0	0	,,	,,	or 1s. per acre.

American.

	£	s.	d.			
Standard (24 miles apart, average Colorado) ...	0	6	11¼	per square mile.		
Mile blocking	6	13	4	,,	,,	
Sectional (40 acres)	14	11	8	,,	,,	or 5½d. per acre.

Thus it will be seen that our standard and intermediate processes are cheaper than the American. This is mainly due to our fixing fewer points; while our actual or sectional process is more than double the cost, due to the greater labour taken in marking out roads, traversing the ridges, and designing the sections in relation to the complex configuration of the surface, and also in a great measure due to the Americans allowing of no isolated or spotting surveys, but on the contrary having, in their land laws, enactments stringently forbidding surveys "unless within the range of the regular progress of the public "surveys embraced by existing standard lines or bases for the township or sub-divisional surveys." Also, where special surveys are made under the above conditions, settlers depositing cost have no priority of claim or right to purchase the land.*

Before leaving this portion of the subject, it will be well for me to remark that both the American and our system of settlement survey being primarily based on astronomical data, the connection of the actual surveys with these are made in the same manner. What has been done in this branch here has as yet been preliminary, but with the approval of Government, I trust soon to be in a position to commence the operations with the best class instruments for observing latitudes, and for ascertaining electric difference in longitude of Initial Stations of Circuits from the Central Observatory, besides for observing the absolute longitude of the latter. It must also be noted that our actual survey is systematically subject to mathematical reduction and test; so also are the elements correctly made subservient in their geodesical values to the primary astronomical determinations as already hinted. The actual surveys in America, being so closely in connection with astronomically-observed true meridians, appear not to have mathematical reduction applied, but I observe by the specifications of the Canadian Surveys that their execution, as actual surveys, is unexceptionally careful, and that the work could be submitted to mathematical reduction if necessary; though from reading, I cannot learn that this is the case. Their standard lines, however, being chained, could not rank with our triangulation in this branch.

But it may be asked—is there no other comprehensive system of settlement survey besides those described? I know of none. Besides Canada and the United States, the only expansive modern settlement surveys that are going on are to be found in Australia.

Turning to New South Wales, and looking at the report of the Commission that enquired into the Surveyor-General's department there in 1855, we find the methods that had been used up to that time condemned as inaccurate and imperfect; and next, looking at the Instructions for Surveyors, dated 1872, we note that so far from the Commissioners' recommendations of 1855 (which were to carry out a general Major Triangulation) being found applicable to the wants of the people, we gather from certain clauses that the American system, or rather a modification thereof, has been decided by matured experience to be the most appropriate. Thus, in Clause 117, it is directed that "the plans for convenience in compilation "(are) to be plotted in sheets, and no one sheet (is) to embrace more than six miles of longitude." "Meridian lines are to be drawn through stations at which meridian observations have been taken, also "through stations at or near the extremities of each sheet, the lines to extend to the limits of the paper, "and the angle made with one of the adjacent traverse lines shown." Meridians are thus as contiguously observed in actual survey as in America, and their convergencies noted and allowed for, and to which end simple tables have been drawn up for the ordinary surveyors by which they can—by observing greatest elongations of circumpolar stars—obtain true meridian, with a degree of approximation attainable by small instruments; thus, in primary principle, their actual survey system is the American.

Then examining the survey system of the next great colony of Victoria, we find in the Report on the General Survey there, presented to both Houses of Parliament in 1859-60, the system previously in operation also condemned, and what is called a geodetic principle proposed; but in the Inspector-General's letter to Government, dated Melbourne, 12th June, 1876, we find it reported to be a failure, and a system identical with our own proposed in lieu. Thus referring to the report on the Land Act of Victoria 1869, dated 31st December, 1873, under the heading "Instructions for the Guidance of Surveyors," the Clauses bearing on the subject are to the following effect: "with the plan must be sent "in a copy of the computation of the figure and its area in the usual form for computation by reduction "of traverse and double areas. The two first columns shall contain the actual bearings and distances "noted in the field-book; the second two the same corrected for small practical errors (where neces- "sary). The other eight columns shall contain the usual northings and southings, eastings and westings, "double longitudes and double areas."

In regard to the Geodesical branch, Inspector-General Allen says that he, in 1859, pointed out the impossibility of the Geodetic system, and recommended instead "*the establishment without the least delay*" of true meridians in central localities all over the country, and of "*uniform chain standards.*" Thus we now see in the other great colony of Australia the Meridional Circuit system had recourse to, identical

* See Section 10, Land Act, 1862.

with ours practised in the southern part of this colony for twenty-one years. And I would suggest that the difference of choice as to system on the part of New South Wales and Victoria lies in the configuration of the country; Victoria, like New Zealand, being more hilly than New South Wales or America, and more devoid of extensive flat plains; the former making use of the natural prominent objects everywhere met with; the latter having recourse to artificial marks on an unmarked wilderness.

But America also has its mountainous regions, as rugged and more extensive than the whole of this colony—what about their meridian and parallel system there?—this difficulty has not escaped the attention of American geographers, nor has the subject been without ventilation in the leading journals, as I have already quoted in my report of 7th December last, one writer, while he admits the national principle to be appropriate for the flat-forest lands and prairies, now that the cordilleras are reached, the system is at fault, inapplicable, and unavailable.*

But the question may yet be asked, as it has already been proposed, Why cannot the Ordnance system of survey as applied to Great Britain be carried out here? One reason of its inapplicability has already been given in this report—viz., that Great Britain being already possessed and divided, the public wants are dissimilar. The other reasons are, that the time required to complete a primary triangulation (the geodetic basis of the Ordnance system) is too prolonged,† so the interest and comfort of the settlers forbid the delay. But the introduction of the Ordnance system is less advisable on another ground—viz., in its not attaining the accuracy in detail which is more essential here, its admitted error in chainages being two links in the thousand, or sixteen links per mile,‡ while ours is only eight links, or half that quantity.‖

The Commission that reported on the Surveys of New South Wales, constituted as it was of scientific officers,§ is invaluable as indicating their line of concession in the standard operations, between the pure geodetic and the practical; in other words, between globe-form survey and settlement survey—the one immediately interesting to "savans," the other of all importance to settlers. The Commission says, that "Having alluded very frequently to more perfect methods of surveying than have ever yet "been adopted in this colony, it became their duty to consider whether it is expedient to undertake a "trigonometrical survey of New South Wales in the true meaning of the term. To carry out a complete "system of triangulation founded on correctly measured bases, and to fill in the details with that scrupu-"lous regard to accuracy which has been observed in more settled countries, would be an undertaking, "whatever its ultimate advantages, entirely beyond the requirements and resources of the colony. At "the same time we are of opinion that steps should be taken to initiate a general system of survey in con-"nection with the detailed measurements which are of necessity carried on for immediate and particular "purposes, which would, we are convinced, be attended by no very great expense, at the same time that it "would lead to very important prospective advantages. The steps that we would recommend to be "taken are the following:—Points to serve as future trigonometrical stations should be selected, and "permanently as well as conspicuously marked. This duty might in a great measure be performed "by the district surveyors and their assistants; and all surveys within such districts should be con-"ducted with reference to the points thus marked, with a view to their final combination when the "actual positions of the stations are determined. A base line should be measured, every practicable "precaution being taken to ensure correctness, without, of course, pretending to imitate those most "accurate and most expensive measurements which in other countries, and under more favorable cir-"cumstances, have been carried out with such wonderful results. From this base a system of triangu-"lation might be gradually extended at an annual expense quite inconsiderable compared with the "total cost of the Survey Department. The observations should be reduced, and the necessary correc-"tions should be applied according to the most approved methods, and with every possible care. Other "base lines also being so measured to test the accuracy of the triangulation as it extends."

With these remarks I entirely concur, and it has been my practice to adhere to them, though the wants of settlers have many times and for long interfered with the processes. These considerations may then be allowed to settle the propriety of not attempting highly-refined geodetic observations as a basis of the first settlement, although a great deal of evidence might be adduced from other directions to a similar effect; nor would I have gone to any length on the question, had not the proposal been made in quarters demanding our attention and respect.

At this time I must remark, that of the actual sectional survey, the New South Wales Commission says nothing; so it gives no help in meeting the real problem of the Government in its responsibilities towards an immigrant people. But we would be wrong to dismiss the consideration of pure geodetic operations so cursorily. A process that can solve so many subtile problems connected with the physical condition of the earth, and which can measure one hundred feet in length with an exactness equal to one-half the breadth of the sharp point of a steel-pen—approaches so near infinity that in all advanced communities its functions, being useful in solving abstruse physical questions, have great weight in the sentiments of the learned; and its proper place and period in a colony will be best indicated by referring to what has been done in this direction, not in the old countries of Europe, but in similar though older communities than ours, that, like us, have gone from them. The pre-eminent example we find in the United States, for the Dominion of Canada, large and populous as it is, has no triangulation of any kind.¶

These States which were commenced to be occupied by English emigrants since 1620, afforded an arena for geodetic enquiry only twenty-six years ago, and this in connection with the Coast survey. This kind of survey evidently did not demand the haste required by the emigrant settler. The harbours for the most part were already mapped and sounded. The service instituted was for the most part to

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* J. D. Whitney, *North American Review*, July, 1875.
† See Colonial Standard Survey, "Trans. N.Z. Inst.," Vol. IX.
‡ See "Methods and Processes Ordnance Survey," by James, 1875, p. 43.
‖ See Survey Instructions, Otago, 1861, p. 10.
§ Mr. E. Pell, Chairman; Sir A. Clarke (now Minister of Works for India); J. S. Hawkins, Captain, R.E.
¶ Excepting only one connecting Peace River with the 1st Meridian. Letter from J. S. Dennis, Surveyor-General, to C. J. Hanning, Esq., 6th July, 1876.

do the work better. And what has been done there, and the manner of doing it, serves as an example of what we may do, and our manner of doing it at such time when the colony grows older and can spare the cost. Very willingly would many of our officers join such a service in New Zealand, for they would be relieved from the irksomeness of tending on the continuously urgent work of pioneer settlement, to be placed in the privileged position, above the people, of purely scientific observation.

To proceed. After a lapse of a quarter of a century, primary triangulation has only been yet partially cast over the Eastern States from Portland eastwards to Passamaquoddy Bay, and between Long Island and Blue Ridge, Virginia. In all the less populated or less educated States secondary triangulation is had recourse to—such as in Virginia, North Carolina, Mississipi, Washington, and Oregon, and in the more remote parts tertiary triangulation is the governing principle, advancing beyond the two former, such as in North and South Carolina, Florida, Alabama and Texas, in the harbours, gulfs, and estuaries of the Pacific Coast.

Thus even in this department, whose basis was originally intended to be purely geodetic, the operations subordinate themselves to the wants of the public by advancing the practical first.

The concurrent investigations of the American Coast Survey are—deep sea explorations, laws of tides, distribution of magnetism, geodetic connection with primary stations, special hydrographic operations, azimuth and magnetic observations combined, tests of coin weights, longitude by telegraphic signals, characteristics of Gulf Stream, &c., &c.

Such are the labours of a national surveyor when relieved from the more pressing cares of settlement survey, and such will be ours in due time. But if prematurely pressed on the work here must be done in a perfunctory manner, and at the same time retard the occupation of the waste lands.

Having arrived at this conclusion, then, it is clearly in the interests of the settling public, that the General Survey proceed on a practical system, unclogged with *finical elaboration* *—rapid, plain, and unmistakeable—imitating as far as our conditions will permit the great examples that I have cited. But who is to guarantee its continuation in this manner? The necessary limited efforts of one man, such as myself, the proposer, cannot do this. As in the United States and Canada, the Legislature alone can compass the end. Once the present or any other system of State Survey has but the support and approval of the representatives of the people, it may then be pursued with confidence that it will not be overturned, and so that it will complete its task. If this be not done the past history of the survey must be perforce repeated—bad work, doing and undoing, being the rule, not the exception.

Our primary principle of survey being astronomical as contradistinguished from the geodetic, it will be of interest to give an example from many that I might select for the information of Government, in order that it may be clearly shown how far dependence may be placed on the same.

The measurement of longitude between Greenwich and Harvard Observatories have been found by three submarine telegraph routes, with a greatest error of 0″06 of time or 0″9 of arc, equal to 64·8 feet.†

I now adduce an overland galvanic determination across the Continent of North America, between San Francisco, California, and Cambridge, Massachussets.‡

		h. m. s.	s.	h. m. s.	s.
1.	Cambridge to San Francisco direct			3 25 07·370	± 0·007
2.	Cambridge to Omaha	1 39 15·069	± 0·008		
	Omaha to San Francisco	1 45 52·294	± 0·010		
				3 25 07·363	± 0·013
3.	Cambridge to Salt Lake	2 43 04·187	± 0·008		
	Salt Lake to San Francisco	0 42 03·204	± 0·008		
				3 25 07·391	± 0·011
4.	Cambridge to Omaha	1 39 15·069	+ 0·008		
	Omaha to Salt Lake	1 03 49·101	± 0·008		
	Salt Lake to San Francisco	0 42 03·204	± 0·008	3 25 07·374	± 0·014
			Mean value	3 25 07·375	± 0·006

Differences—1st and mean − ·005 = 6·00 feet.
2nd ,, ,, − ·012 = 14·40 ,,
3rd ,, ,, + ·016 = 19.20 ,,
4th ,, ,, − ·001 = 1.20 ,,

Thus, at worst telegraphic signal for longitude, is superior in correctness to primary triangulation of 2nd class at 422·4 miles, and of 1st class at 844·8 miles.

With the approval of the Government it is my intention, at an early date, or as soon as the Standard Survey is sufficiently far advanced, to connect the various initial points of circuits by galvanic signal, using the instruments of most recent construction, so that our geography will rest on the accurate basis which these afford—which I anticipate will be admitted to be unquestionable.

V.—Spotting Surveys.

Figs. 5 and 6 give specimens of the forms which "spotting" and "gridironing" surveys take "under free selection before survey," a system which has had higher development in the Provincial District of Canterbury than in any other—though all possess it more or less—but none to such refinement and intricacy.

It would be out of place in me to venture on any remarks as to the policy of the same; for the policy must be adapted to the wants of the people; and what suits at one period of their progress does not suit at another. The attention of the Government is therefore solicited by me only to the aspects which affect the survey, marking, and record of the system.

* The term "finical elaboration" becomes applicable when high science is affected, where good practice alone is required, or is admissible by the public convenience.

† "Electric Telegraph Journal," London, October 15th, 1873.

‡ United States Survey, 1870-71. Page 100.

I may unhesitatingly state that free selection presents one of the *most difficult practical problems a surveyor has to meet*; but that on the plains of Canterbury, it is encountered under the *best advantages*, and under the fewest objections. Here, with due care in always preceding section or allotment surveys by standard points at sufficiently close distances, the problem might have been and may be worked out, economically and professionally, in a satisfactory manner. But when we leave the plains in any part of the colony the case is otherwise. It is true that while applications are confined to the valleys in hilly and mountainous countries, and their frontages alone pegged, free selection may be correctly administered to in survey; but immediately this initiatory process is passed, and back applications have to be marked on the ground, the surveyor encounters insurmountable difficulties. The disorganized state of the surveys in Banks Peninsula is an example of what occurs.* The objections have been so apparent to the Wellington Waste Land Board that that body now refuses to sell before survey.† In Nelson so impossible has it been found to map and record the ubiquitous applications there made, that Crown titles have actually been granted, the whereabouts *being unknown*. This state of matters, of course can only be temporarily admitted in any of the provinces, and the example of the Wellington Waste Land Board perforce—sooner or later—must be followed.

The cause of the difficulties entailed by free selection in hilly country is not far to seek. The applications being of different areas have various depths denoted to them by law. Thus, however easily their front corners in the valleys may be apportioned, their back corners fall upon all possible positions; seldom on the tops of the ridges, where they would be useful, but either in a gully or on the face of a precipice—ninety-nine times in the hundred in places least desirable and often quite inaccessible—hence the inaccuracies and complications that have arisen, and which affect so large a portion of the work done in the colony.‡

Spotting surveys, then, in hilly and mountainous country, bear the same objections as does the American system of squares§—corners of sections being arbitrarily fixed independently of natural features—and should give place to a system which recognises these and apportions the locations, properties, and lines of access in harmony with the valleys, spurs, and ridges—not counter to all.

The cost of surveys being a political rather than a professional subject, I need say little on this head, further than to remark that the cost of free selections increase with dispersiveness and minuteness. Thus in Westland, where the "spotting" claims of gold-fields largely affect the charge, the rate is 22s. 9¾d. per acre; in Nelson, where any applicant may have a survey, however inaccessible, by depositing 6d. per acre, the cost to Government has been 6s. 0¼d.; while in Canterbury, where the same mode has been in operation over a compact and easily accessible district, the rate is not more than 2s. 3¾d. per acre; for comparison, block survey, before sale, costing 1s. per acre, as already mentioned.

Of course as the colony grows, the matter of cost will become more and more important, if it is not a serious matter already, and I may observe that fifteen years ago the United States of America even seems to have felt this, for I observe that on the 30th of May, 1862, an Act to reduce expenses of survey and sale was passed by Congress, wherein by Section 10 it was enacted that settlers desiring a township (six square miles) to be surveyed, may apply and deposit estimated cost. Then the Surveyor-General may order a survey, provided it be "within the range of the regular progress of the public surveys, "embraced by existing standard lines or bases for the township and sub-divisional" surveys. Survey to be made by a competent United States Deputy-Surveyor. Settlers depositing cost having no priority of claim or right of purchasing the land, but township, when surveyed, to be subject to the general land laws.

As in New Zealand, the sum per acre received by Government is four to eight times greater than that of the United States, the time when such a contingency as a general measure to be taken may be distant. It may be only useful at present to note that as with them reduction of cost of survey must have as a corollary, curtailment of privileges in selection, though the homestead law of pre-emption of the bonâ fide settler, holding by actual possession, is in no way obstructed, nor need be here if it become authorised policy. We also learn by their example that it will never be advisable to ignore those standard processes, which in this colony have been so generally neglected, and to which must be ascribed at least three-fourths of the complications now existing.

VI.—Measures for Coming Season.

The rapid and correct marking-out of the boundaries for people selecting land, being the first object of a Colonial Survey, in the coming season, the services of the department will continue to be devoted to this. And the key to the several processes being in the establishment of indisputable points at two to three miles distances, the carrying out of this work must be pushed in every direction in which settlement is taking place. There are several modes of doing this duty according to the nature of the country operated on—such as minor triangulation (net-work or ray-trace, transversely or diagonally) major traverse circuit, and "square blocking." But on inspection of some of the districts, I find the surface so mountainous, precipitous, and impenetrable, that none of these ordinary means are available. I have therefore moved Government to order from England micrometer telescopes for ascertaining distances by small bases; thus "setting out" the work to section surveyors in such places as the sounds, deep gorges, and river-beds of Marlborough, Nelson, and Westland, &c. At present in many such positions, the section surveys are being made at haphazard without connection. This could not go on long without overlapping double granting and other complications, and to control this by the ordinary methods would entail such an enormous expenditure in ascending and clearing mountain tops, as to be quite prohibitory.

By the end of the season the standard work will be so far advanced as to admit of the electric and astronomical observations for determining the initial points of circuits to be commenced. With the view to this object, early after my appointment, I solicited you to move the Government of Victoria to assist us in this by observing for, and furnishing us with, certain astronomical data; a service which their excellently appointed observatory could do in a most perfect manner. On application through the

* See Extract from Mr. Baker's Report. Appendix No. 5.
† Resolution of Waste Land Board, 12th December, 1876.
‡ See General Reports, 26th December, 1874, and 7th December, 1876.
§ J. D. Whitney, "North American Review," July, 1875.

proper channel, the request was most readily acceded to by the Government of Victoria, and since then I have been advised by Robt. J. L. Ellery, Esq., the astronomer for that colony, that the work desired is now put in process.

VII.—Office Work.

The inspection of the various methods, pursued in the several Provincial Districts, soon placed me in a position to advise the Government as to the direction which a uniform system of survey applicable to the whole colony should take. The first of my time in office from travelling round the colony was therefore devoted to drawing-up instructions for settlement surveyors, and which were published under authority.

To the same end, specimens of maps for a uniform system have been prepared and forwarded to all practising surveyors—trigonometrical, topographical, and sectional.

Maps of the standard bearings in certain circuits have been completed, and others are in process. A projection for the colony has been designed, calculated, and the data tabulated. Forty-two circulars, giving directions in the various official and technical duties, have been issued.

A complete set of the lithographs published in each Provincial District has been obtained and arranged for reference and use.

The miscellaneous requirements of the Government Departments have been numerous, and have been attended to.

A photo-lithographic printing-office has been established in connection with the Head office, and maps of the surveys of the colony will now be reduced by McColl's process, and printed to scale.

I have, &c.,
J. T. Thomson,
Surveyor-General.

APPENDIX I.

Mr. McKerrow to the Surveyor-General.

General Survey-Office, Wellington, 26th July, 1877.

Sir,—

I have the honor to report on the observations for true meridians, the extension of standard bearings therefrom, the selection of meridional circuits and survey districts, and generally on what has actually been done towards bringing the survey of the colony under a uniform system of field practice and record. As I have only had charge of these operations for seven months, and as much had already been done in various parts of the colony, which has been adopted as standard work. It will also be necessary to refer to it in this Report, so that an estimate may be made of what is yet requiring to be done.

Before doing so, it may be as well to explain that the determinations of true meridian recently made, have been chiefly from transit observations of selected pairs of circumpolar stars, differing in right ascension close on twelve hours. This method gives a very reliable and satisfactory determination and on a clear night the observation can be repeated independently many times, as numerous suitable pairs of stars can be selected from the Melbourne catalogue, and by reversing the instrument and taking pairs alternately, with face east and face west. The meridian can, with an eight-inch or ten-inch transit theodolite and a chronometer to measure the siderial time interval, be established within a limit of ten seconds (10″) of arc. The eastern and western elongations of circumpolar stars were also observed for true meridian, as well as high and low stars, selected from Nautical Almanac. In Westland, where Mr. C. W. Adams was recently observing, during much bad weather, he relied on the observation of time azimuths of Sigma Octantis for true meridian. The advantage of this method is, that on a cloudy night, the observer is not baffled by missing the instant of transit or elongation; for, availing himself of the slow motion of this close circumpolar, he can, if there be but four or five minutes of clear sky, take the azimuth of the referring lamp, and of the star, on both faces of the instrument, read the times, and the observation is complete. In this way, even on a very indifferent night, may several independent observations be taken. Although the true meridian was the prime object sought at the initial stations, the latitude was also in each case determined by observations of circum-meridional altitudes of stars north and south of zenith. No time was expended in waiting on latitude observations, but such pairs of stars as were available, between the meridian observations, were taken, and thus for each station a geographical latitude has been obtained.

In assigning the meridional circuits and survey districts, the boundaries of existing registration and provincial land districts had to be considered and care taken that there were no conflict of boundaries, but that they were co-terminous wherever they abutted on each other. In so far as these boundaries, and the natural configuration of the country would permit, the meridional circuits and survey districts have been marked off on the maps, in accordance with the dimensions laid down in the printed survey instructions.

In the *Auckland Provincial District*, the true meredian had already been established at Mount Eden, Bay of Plenty, and Poverty Bay, by Mr. Heale, in connection with the major triangulations conducted under his direction. These meridians have been accepted, as also the sides of the intervening triangles —whenever available—as the standard bearings of the survey districts into which the Provincial District is now divided for systematic record. The want of a reference trig. at each major station will render it difficult in some cases for the settlement surveyor, with his five-inch theodolite, to get a start on the true bearing. Although it will not be advisable to set specially to work to establish reference trigs., yet every effort should be made to break down the large triangles into sides of two or three miles, and so render the triangulation of practical use in checking and keeping the sectional and spotting surveys within the prescribed limits of error. The extension of standard bearing

is still required in the Upper Waikato and Thames Valleys, to the country around Mercury Bay and along between Opotiki and East Cape. Mr. Goldsmith has all but completed the latter extension. The part of Auckland District, between Waikato and Taranaki, known as the King Country, is not yet open to survey.

Hawke's Bay Provincial District.—A major triangulation on true meridian has also been completed in this district under Mr. Heale. The same remarks apply here, as to Auckland, with regard to the necessity of having the lengths of the sides of triangles reduced to two or three miles before the triangulation can be of much use in controlling the settlement and land transfer surveys.

Taranaki.—Only one true meridian is required for this Provincial District, and it had already been well established by Mr. Humphreys before the amalgamation of survey departments. It runs from Waitara through the forest about nine miles due east of Mount Egmont. Mr. Brooks and party were engaged running and cutting this line for several months, and only left off lately. It is the boundary of a series of survey districts, and has been carefully measured and marked for about 20 miles. It is the base line to which all surrounding surveys are referred. Incidentally the running of this line affords accurate information as to the topography of that part of the district. Mr. H. M. Skeet has been selecting hills and clearing sites on them, for the stations of the standard bearings, which are to be established further in the forest, and east from the meridian line. This is necessarily expensive and laborious work, but it is absolutely necessary if the native and settlement surveys are to be kept free from confusion.

Wellington Provincial District.—The surveys have hitherto been referred to three (3) magnetic meridians. From the very nature of the case, the relation subsisting between the bearings of these meridians is quite accidental, and not according to the true differences arising from convergence. It is not necessary to enquire into the circumstances which led to the adoption of these arbitrary meridians. But on the close of their triangulations, and the observation of true meridians at south end of Opaki Base, and at the Hutt, by Mr. Jackson, the data was available for the computation of the corrections necessary to bring all the bearings in accord with true meridian. These computations have been made in the most thorough manner, not only for the initial station of each triangulation, but for all the main stations as well.

It will be manifest, however, that if one part of the survey were plotted on true meridian and another on magnetic or arbitrary meridians, there could be no uniform system of plans and maps in the colony, unless the copy draftsmen apply corrections, and that simply means, where you have a number of officers, a never-failing source of error and omission.

These considerations determined that for the future, the surveys in this, as in other districts, should be on the true meridian. Accordingly Mr. Jackson's determination at south end of Opaki Base, was adopted as the true meridian of Wairarapa Circuit. My determination at Mount Cook was taken for Wellington Circuit, and Mr. Marchant's determination at Mount Stewart, for Wanganui Circuit.

In the northern part of this Provincial District, there is a large area as yet untriangulated, and of which the topography is very vaguely known. Mr. Marchant determined the true meridian for it at Tuhirangi, near Murimotu Plain. He also ran a line of bearings across country, from Wanganui Circuit to Hawke's Bay Circuit, and observed a few triangles. He will resume, if Natives permit, the extension of standard bearings northwards next season. In any triangulations which may be undertaken in this part of the country, it will be advisable to proceed from a measured base, and not from a side of a former triangulation, as the closures of Hawke's Bay and Wellington triangulations reveal differences of from 2½ to 4 links per mile.

Nelson.—This Provincial District has been divided into six meridional circuits. Mr. Browning determined the true meridian for the Nelson and Grey circuits, and Mr. Marchant the Buller and Karamea circuits, and presently he is running a line of bearing between the initial stations of these two circuits. The Collingwood circuit will shortly be undertaken by Mr. Marchant, and the Amuri by Mr. Adams.

The extension of standard bearings up the Waimea Plain and on down the Buller, to meet a line from the Grey Valley and from Westport, is in hand and well forward, by Messrs. Sinclair and Thomson.

Standard chain-lengths have also been laid down at Nelson and Ahaura by Mr. Browning. The Nelson Provincial District has hitherto been utterly destitute of any reliable basis of survey. Triangulation should at once follow the lines of standard bearings.

Marlborough.—This Provincial District is all comprehended in one meridional circuit. I observed its true meridian at Goulter's Hill, near Renwick, in the beginning of April last. Mr. A. D. Wilson has since extended standard bearings from it along the Kaituna and Pelorus Valleys to the borders of Nelson district. He has also got the first stations selected and observed of lines to Upper Wairau, to Picton, and towards Awatere and the country further south. As regards starting and closing points for settlement or land transfer surveys, this district is in precisely the same state as Nelson.

Canterbury Provincial District has been divided into three (3) meridional circuits. Mount Pleasant comprehending all the country north of the Rakaia to the Hurunui. Gawler, the country between Rakaia and Rangitata. Timaru, all the country south of the Rangitata to the Waitaki.

Mr. Adams determined true meridan at Mount Pleasant in November last, and observed the true bearings of the lines of surrounding stations. By means of heliotrope signal, the true bearing of station on Mount Cass—35 miles distant—was observed, and from that station Mr. Kitson began the extension of standard lines throughout the circuit. He closed back on Mount Pleasant from the south and proved the accuracy of his work. Mr. Kitson's work also tested the minor triangulation over which it passed. In one district, discrepancies were brought to light, which necessitated a re-triangulation, now in progress.

The true meridians at Gawler Downs and at Mount Horrible, near Timaru, have also been observed by Mr. Adams for their respective circuits, and Mr. Wilkins ran lines of bearings between the two initial stations of these meridians, with extensions north of the Rakaia and south to Waimate, and connecting with the several minor triangulations passed over.

These operations have enabled Mr. Baker to base all the triangulation and sectional surveys, now in progress in Canterbury, on the true meridian.

The chain distance of 66 feet has has been laid down by Mr. Adams, at Christchurch, Ashburton, and Timaru, by brass scale and beam compass, to a temperature of 62° Fah. The extremities are marked on brass plates, let into stone blocks, sunk flush with the ground. On these the surveyors can test their chains.

A considerable extension of standard bearing is still required in Canterbury, more especially up the valleys to some back country, which has lately been applied for. Mr. Kelleher is at this work, and in the course of next month Mr. Adams will also engage in it. There is also the Mackenzie, Ohau, and Makarora country, which can easily be overtaken by extensions from the Lindis Peak meridian.

Westland has been divided into three (3) circuits—Hokitika, Okarita, and Jackson's Bay. Mr. Adams has determined the true meridian in each, and observed to the surrounding stations, which were selected and prepared under Mr. Mueller's direction. Mr. Adams also laid down chain-standards at Hokitika, Okarita, and Jackson's Bay.

Mr. Roberts is to extend the standard bearings through the Hokitika circuit. He has for three months, under the direction of Mr. Mueller, been engaged in selecting and preparing stations. Several of these are so high and difficult of access, that it could not be expected that the settlement surveyors would willingly resort to them for connection. Care is therefore being taken that there will be numerous reference stations on low and easily accessible positions. As minor triangulation would be unsuitable in this wooded, mountainous country, the high stations referred to will become the points of a major triangulation, whose lines will be above all obstructions. The Westland provincial district, on account of its dense forest and numerous rapid rivers, is the most difficult country in the colony to make survey progress.

Otago and Southland Provincial Districts have true meridians and standard bearings established for all their areas, excepting the Western Sounds, where as yet there have not been any permanent settlements.

General Summary.—All the meridians which, it is proposed, to establish in the colony, have now been astronomically observed, with the two exceptions, of Amuri and Collingwood, in the Nelson Provincial District.

Put in a tabulated form, the true meridians which have been adopted, those observed since November, 1876, those still to observe, and the number in each Provincial District will appear thus:—

Provincial Districts.	Adopted.	Observed since November, 1876.	Still to observe.	Total.
Auckland	3	0	0	3
Hawke's Bay	1	0	0	1
Taranaki	1	0	0	1
Wellington	1	3	0	4
Nelson	0	4	2	6
Marlborough	0	1	0	1
Canterbury	0	3	0	3
Westland	0	3	0	3
Otago	5	0	0	5
Southland	1	0	0	1
Totals	12	14	2	28

Eight survey parties are now engaged in the standard work. Should this number be kept in the field for the next twelve months, the extension of standard bearing throughout the colony ought to be about completed, in so far as is necessary for many years.

I have, &c.,

James McKerrow,

Assistant Surveyor-General.

APPENDIX II.

RETURN of FIELD WORK EXECUTED by STAFF and CONTRACT SURVEYORS, in the PROVINCIAL DISTRICTS of NEW ZEALAND, under the supervision of the CHIEF SURVEYORS, from the dates given to December 31st, 1876.

Districts.	Date of Commencement of Period.	Chief Surveyor.	Major Triangulation.		Minor Triangulation without Topography.		Topographical and Trigonometrical Survey.		Rural and Suburban Section Survey.			Town Section Survey.			Native Land Court Surveys.			Native Land Purchase Surveys.			Detention by Native opposition or other cause.		Other Work.	Estimated Cost.	Total Cost for Period.	Remarks.
	1876.		Acres.	Cost per Acre.	Acres.	Cost per Acre.	Acres.	Cost per Acre.	Acres.	Average size.	Cost per Acre.	Acres.	No. of Allotments.	Cost per Allotment.	Acres.	Average size blocks.	Cost per Acre.	Acres.	Average size blocks.	Cost per Acre.	Time.	Cost	Nature of Duty.			
										Acres						Acres.			(1)				£		£ s. d.	(1)
Auckland	30th June	T. Heale .. D. A. Tole	180,000	⅛d.	..	..	134,400	1⅝d.	28,918	149	1/4½	266	66	27/-	123,455	526	4½d.	342,665	..	4½d.	Survey stopped.	80	Checking Land Court Surveys, and revision of do., &c.	945	8,126 2 4	42,241 acres commenced in October, 1875. Includes £551 on account of work entered on last year's return. Of the trigonometrical survey, 84,000 acres open 50,000 acres bush country. Section survey, about 1-10th bush, rest open. In progress, 450,000 acres, major triangulation. ,, 5,000 ,, minor ditto. ,, 25,000 ,, rural and suburban.
Taranaki	1st. Jan.	T. Humphries ..	..	..	..	..	5,120	9½d.	16,556	106	1/11	..	..	..	..	..	..	..	..	..	..	..	Road surveys	187	2,860 11 4	All bush country.
Hawke's Bay	30th June	C. Weber	..	..	..	..	..	..	7,359	147	1/3	..	..	..	..	..	..	..	..	..	..	..	44 miles road survey ..	112	584 17 0	About one-half bush; 1,250 acres surveyed but not mapped; 14½ miles roads surveyed but not mapped. Roads to section surveys not laid out.
Wellington (Crown Lands)	1st July..	H. Jackson ..	..	..	3,600	1¾d.	..	..	37,520	161	1/1¾	..	..	..	..	..	..	..	..	..	..	..	Road surveys	87	5,672 9 7	All rough bush country. Roads not surveyed.
,, (Revision Surveys)	,, ..	..	..	..	..	..	..	..	20,366	107	1/7½	424	424	21/5¼	..	..	..	..	..	..	..	..	.. .. ..		..	8,600 acres open, rest bush. Roads not surveyed.
,, (Native Lands) ..	,, ..	J. W. A. Marchant	..	..	62,000	1¼d.	..	..	..	..	..	..	..	..	..	..	..	19,168	..	3½d.	..	..	.. .. ..	..	2,376 11 2	
Marlborough	1st October	H. Clarke	..	..	..	..	..	..	304	38	1/-	3	10	16/-	..	..	..	..	..	..	..	..	24½ miles road survey ..	107	131 0 0	
Nelson	1st July..	J. S. Browning ..	..	..	..	..	..	..	21,939	175	3/1	..	..	..	..	..	..	..	..	..	..	..	133½ miles topographical traverse, @ 1/4 per chain.	712	3,410 7 4	All spotting surveys. Seven surveyors on Gold-fields. Mostly rough timbered country.
Westland	1st July..	G. Mueller ..	..	..	..	..	..	..	8,173	50	1/7	..	..	..	..	..	..	..	..	..	..	..	Mining and road survey	604	1,774 1 3	22,608 acres topographical survey also executed. Average cost, 4d. per acre, Three surveyors on Gold-fields. Broken bush country.
Canterbury	1st July..	S. Hewlings .. J. H. Baker	..	..	..	..	..	..	53,925	248	1/10½	..	..	..	..	..	..	..	..	..	..	..	Geodesical and road surveys.	735	6,097 12 6	Besides this, 30,662 acres rural lands surveyed but not mapped. Mostly open and generally level country.
Otago	1st April	J. McKerrow .. W. Arthur J. McKerrow	..	..	..	..	45,200	3½d.	60,702	125	1/5	1,330	1,654	11/1	..	..	..	..	..	..	..	..	Mining surveys, water-races, Warden's Court business, &c.	780	6,236 6 9	Seven surveyors part of the time on Gold-field surveys. Principally spotting surveys.
Southland	1st April	John Spence ..	..	..	6,000	½d.	..	..	40,321	158	1/3	594	1,031	12/4¾	..	..	..	..	..	..	..	..	.. .. ..	..	3,847 14 9	Considerable portion of area surveyed in bush.
Totals and Averages			180,000	⅛d.	71,600	$1\frac{2}{10}$d.	184,720	$2\frac{7}{100}$d.	296,083	142	$1/7\frac{1}{10}$	2,617	3,185	13/2¾	123,455	526	4½d.	361,833	..	2½d.	..	£80	.. .. £	4,269	41,117 14 0	

APPENDIX III.

RETURN of FIELD WORK EXECUTED by STAFF and CONTRACT SURVEYORS in the COLONY of NEW ZEALAND, from 1st January, 1877, to 30th June, 1877.

Provincial District.	Chief Surveyor.	Revision Surveys.		Minor Triangulation without Topography.		Topographical and Trigonometrical Survey.		Rural and Suburban Section Survey.			Town Section Survey.			Native Land Court Surveys.			Native Land Purchase Surveys.			Detention by Native Opposition or other cause.		Other Work.	Estimated Cost.	Total cost of Field Work for period.	Total cost of Office Work and Inspection for period.	Remarks.
		Acres.	Cost per Acre.	Acres.	Cost per Acre.	Acres.	Cost per Acre.	Acres.	Average size.	Cost per Acre.	Acres.	No. of Allotments.	Cost per Allotment.	Acres.	Average size blocks.	Cost per Acre.	Acres.	Average size blocks.	Cost per acre.	Time.	Cost.	Nature of Duty.				
									Acres.						Acres.			Acres.								
Auckland	S. P. Smith ..	..	..	19,000	1½d.	540,037	1d.	29,392	476	1/8	..	..	..	137,392	..	1/4	49,797	..	10d.	..	£ 200	Road surveys; examining Native Land Court surveys.	£ 697	£ s. d. 7,547 14 7	£ s. d. 1,016 3 4	100,000 acres block surveys in progress. £141 7s. 7d. paid on account of work entered in last year's return. Generally bush country. In progress, 1,000,000 acres major triangulation; 250,000 acres minor and topographical survey; 68,500 acres section survey; and 5,000 acres Native Land Court survey.
Taranaki	T. Humphries ..	..	..	..	..	5,760	9½d.	22,457	340	1/1½	..	..	..	..	..	..	..	..	..	7 weeks	79	Native reserves, river traverses, &c.	770	3,357 1 10	667 0 2	All bush country. 11,300 acres Native block surveys in progress.
Hawke's Bay	H. Baker ..	..	..	..	..	..	..	12,674	189	10⅜d.	..	..	..	..	..	..	..	..	..	..	..	21 miles road traverse, and trig. connections.	241	1,171 16 1	733 3 8	Besides this, 1,322 acres rural lands surveyed and not mapped. In progress, 100,000 acres minor triangulation, and 2,000 acres rural land survey. Roads laid out to only part of the areas surveyed into sections.
Wellington (Crown lands)	H. Jackson ..	12,075 (average size, 124 acres).	11½d.	..	..	..	..	45,850	252	7½d.	..	..	..	..	..	..	..	..	..	..	..	15 miles traverse, and office work.	348	4,431 5 8	1,295 16 2	Two-thirds bush, one-third open country. Roads laid out to only part of the areas surveyed into sections for settlement.
,, (Native lands)	G. W. Williams ..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	12,439	..	5½d.	..	237	Office work	190	1,861 16 6	513 13 4	136,000 acres reconnaissance survey completed but not mapped; 25,000 acres section survey nearly completed, commenced in 1875.
Marlborough	H. Clarke ..	..	..	..	..	..	..	577	48	2/10	..	..	..	..	..	..	..	..	..	..	..	Traversing tracks ..	82	166 0 6	461 14 2	Isolated surveys
Nelson	J. S. Browning ..	..	..	4,128	1/-	..	..	17,062	105	3/7	22	80	4/9	..	..	..	..	..	..	..	..	Topographical traverses, 48½ miles, at 1/6 per chain.	292½	3,861 17 6	1,057 4 0	Two surveyors on standard work; seven on gold-fields. 2,856 acres rural lands surveyed but not mapped. All spotting surveys.
Westland	G. Mueller	..	..	..	..	..	..	5,462	44	1/9	..	..	..	..	..	..	..	..	..	..	..	Mining water-race, road surveys, &c. ..	1,336	2,149 16 8	1,385 4 0	All within gold-field; mostly rough bush country.
																						Topographical survey, 6,958 acres, at 3½d. per acre	101			
Canterbury	J. H. Baker ..	1,398	..	..	..	100,000	1⅛d.	34,686	88	2/6½	61	243	8/10	..	..	..	..	..	..	..	..	Office plotting Trig. stations, Re-chaining base lines	280	6,767 6 3	2,273 7 9	Besides this, 31,229 acres rural lands surveyed but not mapped.
Otago	W. Arthur ..	..	..	..	..	189,197	2d.	71,348	114	1/0 3/10	337	335	8/1½	..	..	..	..	..	..	..	..	Water-races, reports to Wardens, mining areas, school-sites.	523	5,475 7 6	1,835 17 0	Six surveyors on gold-fields, where surveys very scattered and costly.
Southland	John Spence ..	..	..	..	..	26,006	1 3/13d.	39,239	168	1/3	21	82	15/	..	..	..	..	..	..	..	..	Road traverse	179	3,637 3 8	795 12 0	13,000 acres section survey, Stewart Island and elsewhere, partially completed; besides 5,000 acres of work done entirely in bush.
Totals and Averages		13,473	..	23,128	3½d.	861,000	1 3 6/100d.	278,747	145	1/5	441	740	15/0½	137,392	..	1/4	62,236	..	8½d.	..	516	.. .. .. £	5,039	40,427 6 9	12,034 15 7	

APPENDIX IV.

COST OF SURVEYS IN NEW ZEALAND FROM THE FOUNDATION OF THE COLONY TO THE 1ST JANUARY, 1877, DRAWN FROM THE LATEST RETURNS.

For the Settlement of—	Section Survey.			Cost.	Remarks.	Cost per Acre.
	Reliable.	Unproven.	Total.			
	Acres.	Acres.	Acres.	£		s. d.
Auckland	..	2,530,000	2,530,000	260,008		2 1¼
Taranaki	30,000	130,000	160,000	53,813		6 8½
Hawke's Bay	..	1,000,000	1,000,000	92,437	To the cost per Return (£52,437) is added £40,000 for licensed surveys.	1 10¼
Wellington (Provincial)	1,134,954	342,000	1,476,954	152,575	Cost prior to 1853 not obtainable. Cost of Hawke's Bay old surveys included.	2 0¾
,, (General)	..	70,000	70,000	10,168		2 10¾
Nelson	42,000	275,000	317,000	95,564	Public Works were incorporated with surveys. The cost is also largely affected by gold-field administration, which shews little acreage results. £6,300 is deducted from Return (£101,864) for N. Z. Co.'s surveys in Marlborough.	6 0¼
Marlborough	..	893,000	893,000	52,649	£6,300 for N. Z. Co.'s surveys, and £25,000 for licensed surveys are added to £21,349 given in Return.	1 2¼
Canterbury	..	2,014,696	2,014,696	233,722	Return gave cost at £261,722, but £28,000 of this is here debited to Westland, being before separation.	2 3¾
Westland	54,000	..	54,000	61,604	£28,000 is added to cost (£33,604) given in Return, being money expended by Canterbury before separation. A great proportion of the cost must be debited to gold-field administration, which gives little or no acreage results. The surface of this province is also abnormal, being almost entirely covered with forest, and the settlements are made in small areas, at widely separate localities, demanding extensive line-cutting.	22 9¾
Otago (including Southland) ..	2,903,000		2,903,000	296,263	Otago £257,683; Southland 38,580. In these amounts are included the cost of the pastoral surveys, amounting to 12 millions of acres, also the gold-field surveys which return little or no acreage, and the sectionizing of 90 towns and villages.	2 0½
	4,163,954	7,254,696	11,418,650*	1,314,803		

* Per Major Palmer's Report, 1st March, 1875, 4,730,900 acres accurate—6,405,500 acres needing more or less revision. Total, 11,136,400 acres.

For Native Administration—	In Blocks and Allotments.			Cost.	Remarks.	Cost per Acre.
	able.	Unproven.	Total.			
	Acres.	Acres.	Acres.	£		s. d.
North Island		7,502,966	7,502,966	238,607	£216,706 in Auckland; 17,000 ,, Hawke's Bay; 1,300 ,, Taranaki; 3,601 ,, Wellington. Native surveys are generally over large blocks or areas, and not for settlement purposes; or are merely preparatory for the latter; they are therefore kept separate.	.. 7 4/7

APPENDIX V.

Extract from Letter of Chief Surveyor of Canterbury to Surveyor-General, dated 24th July, 1877.

"Surveys on Banks Peninsula."

"The inaccuracies of the former sectional surveys can hardly be exaggerated. The sections overlap one another many chains.

"In Wainui, opposite Akaroa, some points, by recent surveys, are found to be thirty chains out of the position shown on the present ten-chain map, and in another case, on the eastward side of the hills behind Akaroa, one section is proved to be over fifty chains from the position shown in the survey.

"The roads in many cases are not where they are shown to be, and, in numberless cases, have not been made where they were originally laid out, but are on private property.

"The arrears of survey on the Peninsula on the 30th June last, were 873 sections, containing 60,540 acres; but the rough, mountainous nature of the country, the heavy bush cutting, and the difficulty of establishing any of the old survey lines or pegs, which in many cases have been destroyed by bush fires, will render these arrears most tedious and costly surveys to complete.

"Any revision of the old surveys, and the issue of corrected titles must, from the very heavy arrears of surveys to be done in the Canterbury District, remain in abeyance for at least two years. Individual cases of very great hardship are almost daily pointed out to me of people who have not been put in possession of their land, purchased, in some cases, five or seven years ago; but as they occur in twenty different bays or valleys, I cannot send surveyors to all of them, but I purpose having at least six surveyors stationed on the Peninsula so soon as I can obtain suitable officers. In the present state of these surveys it would be quite useless to attempt to get the work done by contract, as the loss of time and delays in establishing old boundaries would make the contractors ask a price higher than that for which the work could be done by staff officers."

FIG. I

DIAGRAM OF THE
AMERICAN & CANADIAN SYSTEM
OF
STANDARD SURVEY

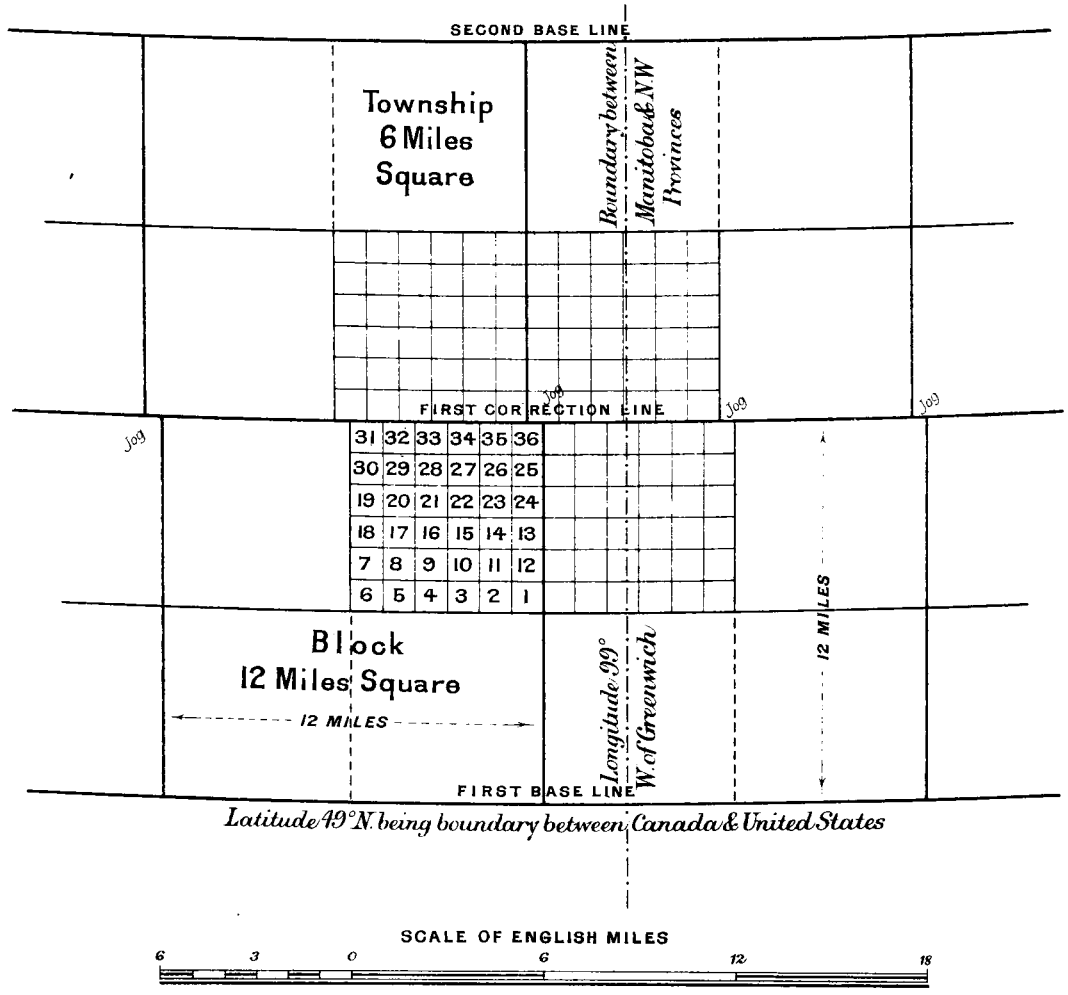


Photo-Lithographed by A. McColl

General Survey Department, Wellington N.Z.

Drawn by F.W. Flanagan, June 1st 1877

DIAGRAM OF THE
NEW ZEALAND SYSTEM
OF
STANDARD SURVEY

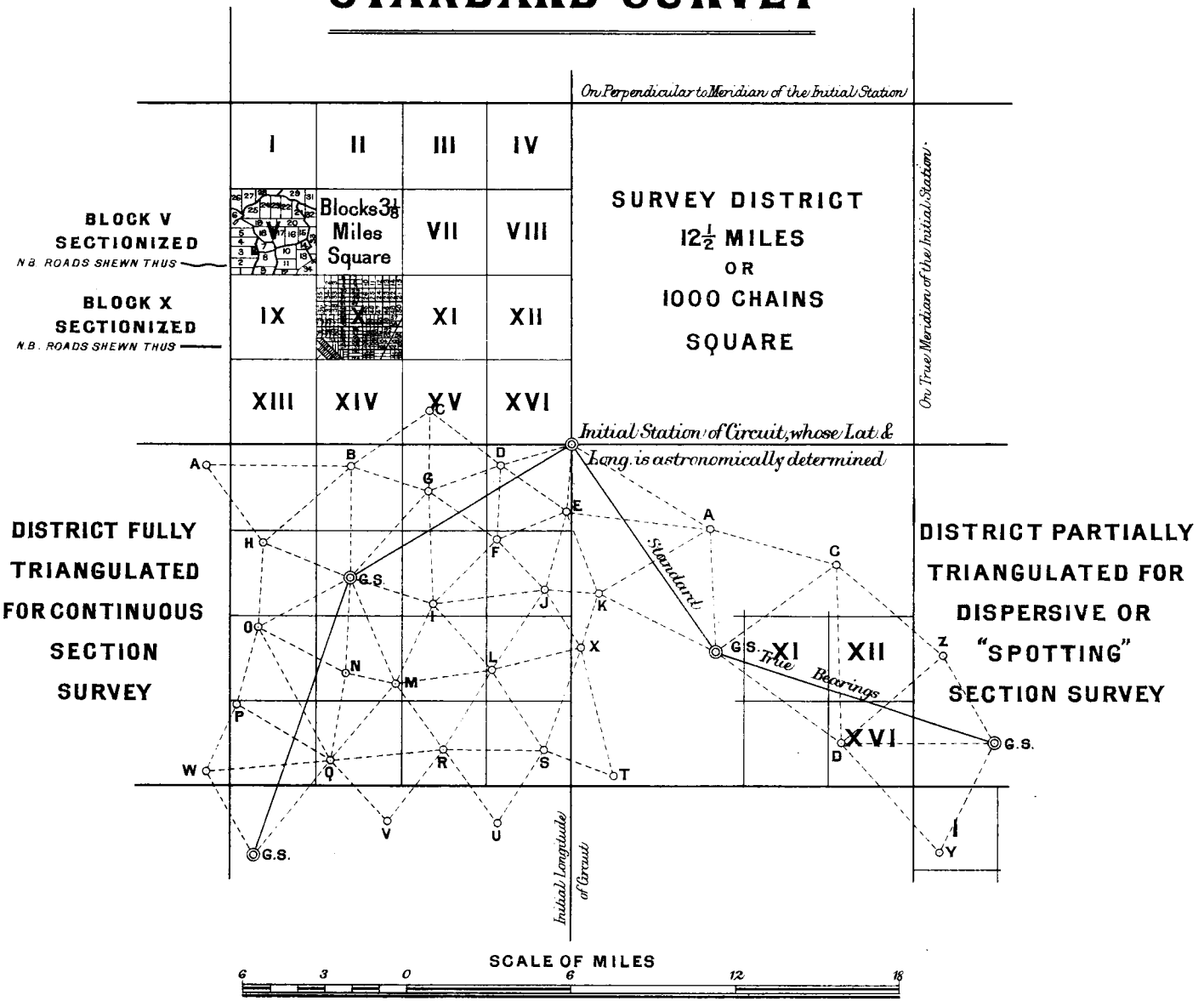


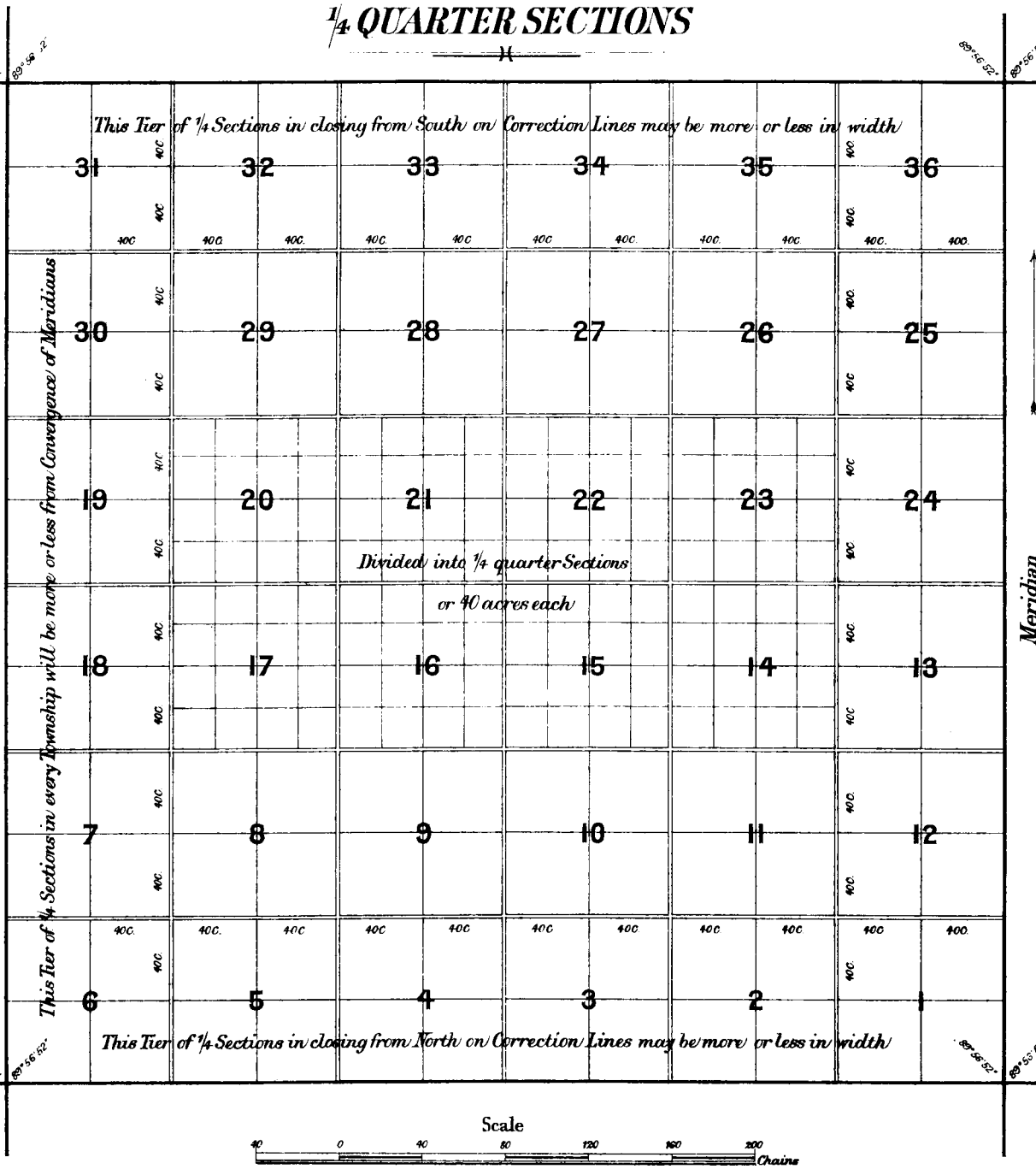
Photo Lithographed by A McColl

Drawn by F W Flanagan, May 30th 1877

General Survey Department, Wellington

Fig 3

Shewing a TOWNSHIP divided into SECTIONS, QUARTER SECTIONS & 1/4 QUARTER SECTIONS



Scale

40 0 40 80 120 160 200 Chains

NOTE—The angles with the true Meridian shewn above at the intersection of the Township lines give the true bearing from those Points respectively of the East and West Town lines. The above is the angle assumed as a mean for Manitoba, but in proportion as the Surveys extend to a higher Latitude the same will require to be corrected accordingly.

F W Flanagan delt. April '1877

General Survey Department, Wellington

Photo Lithographed by A. McColl

FIG. 4

Diagram
Shewing the same extent of Countryas FIG. 3
(6 Miles square)
Divided into sections on the
NEW ZEALAND system of Survey

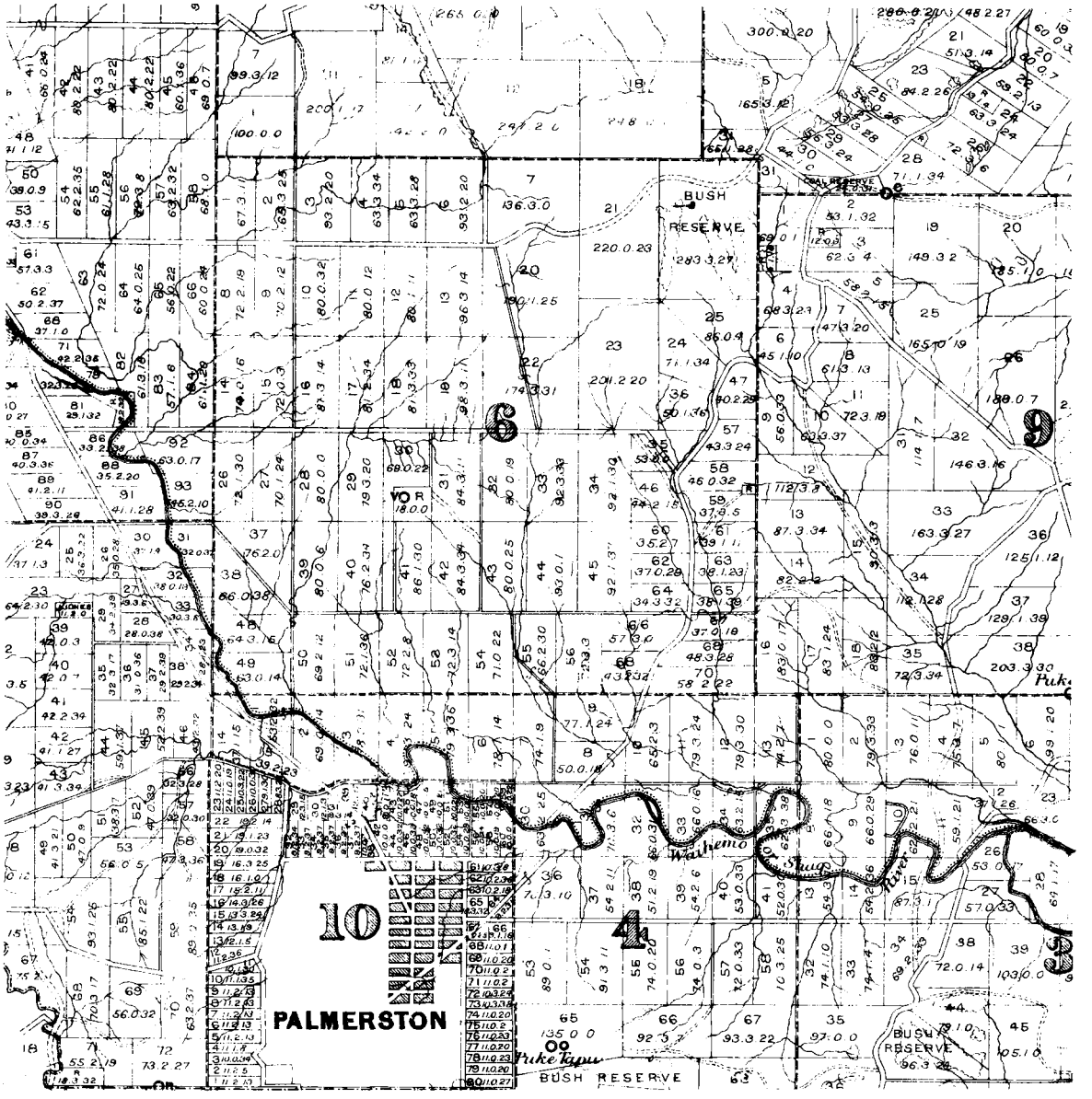
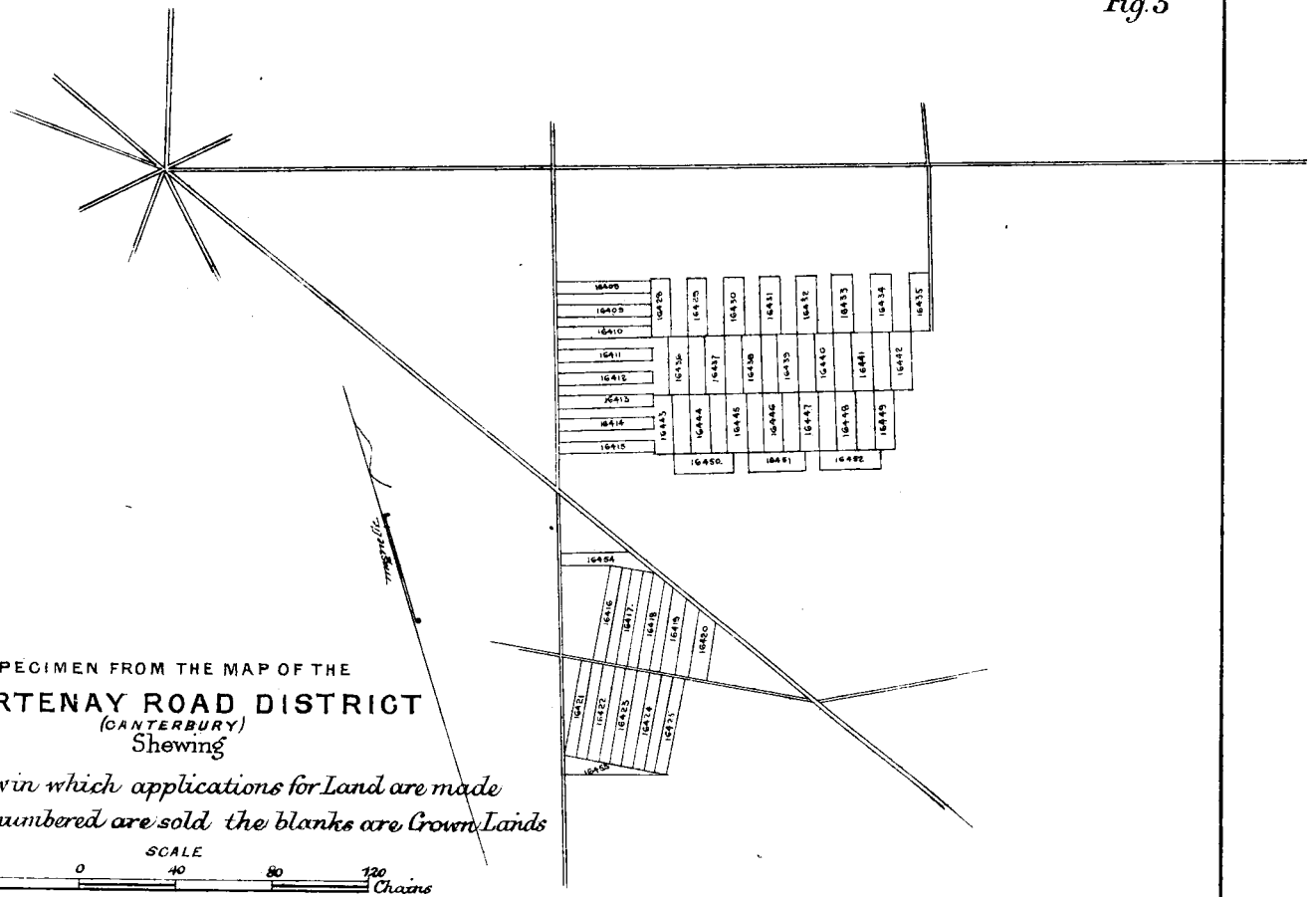


Fig. 5



SPECIMEN FROM THE MAP OF THE

COURTENAY ROAD DISTRICT

(CANTERBURY)

Shewing

The way in which applications for Land are made

The sections numbered are sold the blanks are Crown Lands

SCALE

40 0 40 80 120 Chains

Areas of sections applied for 20 acres each

Fig. 6

SPECIMEN FROM THE MAP OF THE

LAKE COLERIDGE ROAD DIST.—CANTERBURY N.Z.

Shewing

The way in which applications for Land are made

The sections numbered are sold—the blanks are Crown Lands

SCALE

40 0 40 80 120 *Chains*

Areas applied for, from 20 to 130 acres each