T. S. Nash.

MANUAL

SHOWING THE

SYSTEM OF SURVEY

OF THE

DOMINION LANDS

WITH

INSTRUCTIONS TO SURVEYORS

Published by authority of the Honourable the Minister of the Interior for Canada.

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1892

NOTICE TO DOMINION LAND SURVEYORS.

This Manual is prescribed for the official guidance of Surveyors of Dominion Lands, who are required, in making any survey of these lands to govern themselves by it, in so far as its provisions are applicable to the particular survey then being executed. Any Dominion Land Surveyor taking or subscribing the affidavit mentioned in clause 121 of the Dominion Lands Act, is to consider this Manual and the instructions embodied in it as forming part of the instructions of the Surveyor-General referred to in the said affidavit.

E. DEVILLE,
Surveyor-General.

DEPARTMENT OF THE INTERIOR,
11th June, 1892.

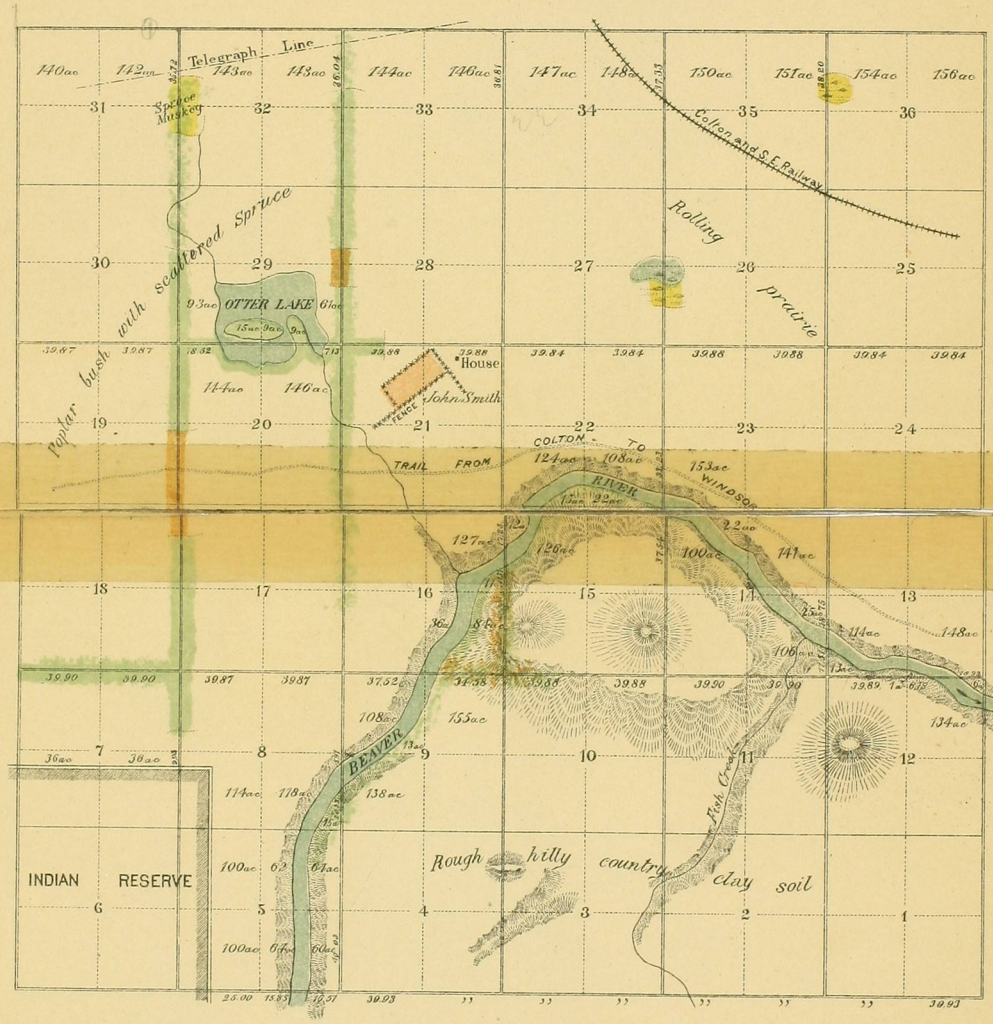
DIAGRAM No. 1

TOWNSHIP PLAN

(SOUTH OF CORRECTION LINE)

Explanation of Colors

Bush — Scrub or Brush — Brulé — Ploughed or Cultivated Land — Swamp



Surveyed by the Undersigned

Thomas Anderson D.L.S.

June and July 1886

Dominion Lands Office
Ottawa

188

Approved and confirmed

Surveyor General

Contents

Land in Sections	21217.00	Acres
Roads	424.80	"
Water	613.00	"
Total Area	22254.80	"

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SYSTEM OF SURVEY

AND

INSTRUCTIONS

TO

SURVEYORS.

1. The Dominion lands are laid off in quadrilateral townships containing thirty-six sections, each of six hundred and forty acres or one square mile, subject to the deficiency or surplus from the convergence or divergence of meridians, as hereinafter mentioned, together with allowances for roads in certain cases. Township contains thirty-six square miles, more or less, exclusive of road allowances.

2. The sections are bounded and numbered as shown by the following diagram : Sections.

N

	31	32	33	34	35	36
	30	29	28	27	26	25
	19	20	21	22	23	24
W	18	17	16	15	14	13	E
	7	8	9	10	11	12
	6	5	4	3	2	1

S

Fig. 1.

3. The lines bounding townships on the east and west sides are true meridians, and those on the north and south sides are chords of the parallels of latitude passing through the corners of the township. Lines bounding townships.

How townships are numbered.

4. The townships number in regular order, northerly from the International Boundary or forty-ninth parallel of latitude, and lie in ranges which are numbered east and west from a meridian line styled the Principal Meridian ; ranges lie also and are numbered west from other meridians called initial meridians and styled the Second, Third.....Meridians, according to their order westward from the Principal Meridian.

Initial meridians.

5. The Principal Meridian passes about twelve miles west of the City of Winnipeg in approximate longitude 97° 27' 9" west of Greenwich.

The Second Meridian is placed in longitude 102° (very nearly), the Third in 106° and so on, each initial meridian after the second being four degrees west of the preceding one.

There is also the Coast Meridian of British Columbia upon which are based the townships of the "Fifth System," hereinafter described.

Sections are 80 chains on base lines.

6. The sections are laid out of the precise width of eighty chains, as aforesaid, together with the road allowance, on certain lines called "*base lines*," and the meridians between the townships are drawn from such bases, north or south, to the depth of two townships, that is to say, to the correction lines hereinafter mentioned. The townships south of the base measure therefore in an east and west direction more than four hundred and eighty chains together with the roads, while those north of the base measure less than this. The interval between a base line and the next one is equal to the depth of four townships.

"Jog" allowed on correction lines.

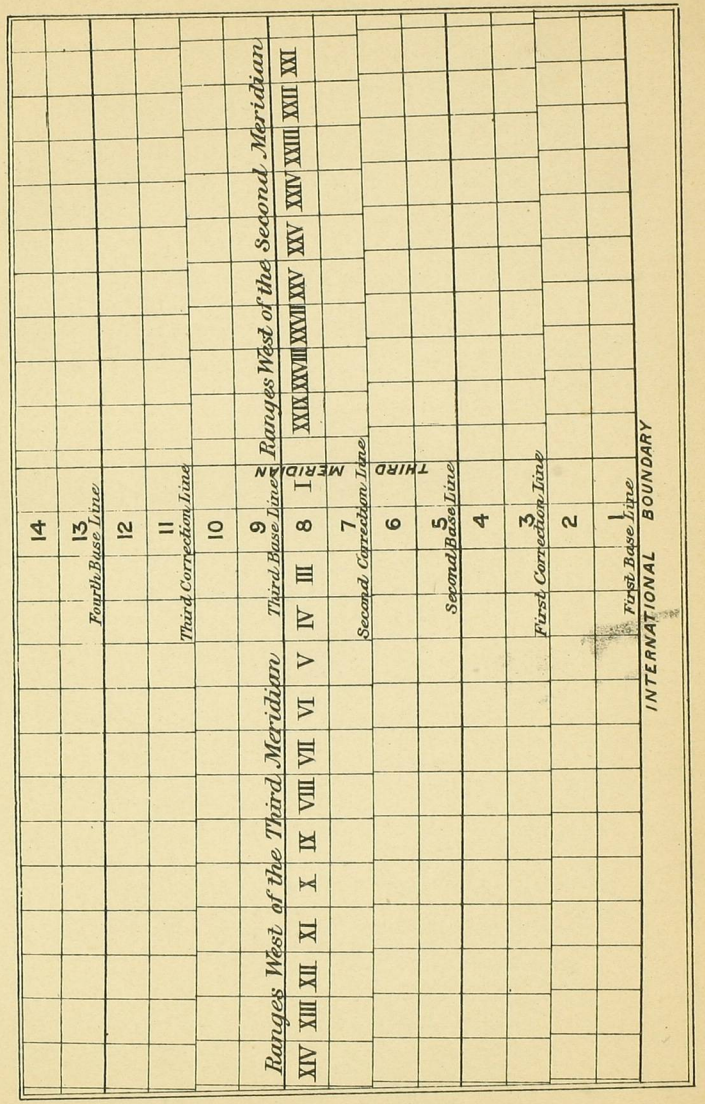
7. The "*correction lines*" are those upon which the "*jog*" resulting from the want of parallelism of meridians, is allowed, or, in other words, they are those township lines running east and west which are equidistant from the bases at the depth of two townships. The interval between the correction lines is equal to the depth of four townships.

Base lines in the system.

8. The first base line is the forty-ninth parallel of latitude or International Boundary ; the second base is between townships four and five ; the third between townships eight and nine ; the fourth between townships twelve and thirteen ; the fifth between townships sixteen and seventeen, and so on, northerly, in regular succession.

Correction lines in the system.

9. The first correction line is between townships two and three ; the second between townships six and seven ; the third



between townships ten and eleven, and so on, northerly, in regular succession.

Division of sections.

10. Each section is divided into quarter sections of one hundred and sixty acres, or one-half mile square, more or less.

Country laid out into townships and how.

11. Preliminary to the subdivision into sections of any given portion of country proposed to be laid out for settlement, the same is laid out into townships by projecting the base lines and the east and west meridian outlines from the base lines to the correction line, and connecting by straight lines the township corners on the meridians.

Exception.

12. In the case of the townships between the first and second bases, the meridians are to be surveyed south from the second base to the first correction line, and thence south to the first base line, giving the "*jogs*" their theoretical lengths.

Allowance for deficiency or surplus on meridian lines.

13. In the survey of any township outlines or the subdivision of any township, the surplus or deficiency found on meridians when closing on the correction line is left in the last quarter section adjoining said line.

Except on meridians across townships one and two, on which meridians the quarter sections adjoining the correction line shall be given the theoretical depth of forty chains, and the deficiency or surplus, as the case may be, shall be allowed in the quarter sections adjoining the first base line or International Boundary.

In the case of the fractional range adjoining an initial meridian, when the initial meridian intersects the "jog" (that is when there is one more range south of the correction line than north of it), the last quarter section on the meridian township outline surveyed from the south shall be made of the same depth as that on the next meridian township outline on the east. See Fig. 17.

Corners.

14. On the township outlines, at the time of the survey, all township, section and quarter section corners are marked, which corners govern respectively in the subsequent subdivision of the block or township.

Posts and monuments.

15. Only a single row of posts or monuments to indicate the corners of the townships or sections (except as hereinafter provided) is placed on any survey line. These posts and monuments are placed in the west limit of the road allowances on north and south lines, and in the south limit of road allowances on east and

west lines or on the line between the sections where there are no road allowances ; and in all cases fix and govern the positions of the boundary corners of the adjoining townships, sections or quarter sections on both sides of the road allowance or line.

Posts and monuments on correction lines, &c.

16. The township, section, or quarter section corners on correction lines, or on lines between different systems of surveys, are in all cases indicated by posts or monuments planted and marked independently for the townships on each side ; those for the townships north or east of the line, in the north or east limit of the road allowance, and those for the township south or west, in the south or west limit. Indian reserve boundaries are also posted on both sides of the road allowance ; on one side for the reserve and on the other side for the township.

Quarter quarter sections.

17. To facilitate the descriptions for letters patent of less than a quarter section, the quarter sections composing every section in accordance with the boundaries of the same as planted or placed in the original survey, are supposed to be divided into quarter quarter sections, or forty acres, and such quarter quarter sections are styled legal subdivisions and are bounded and numbered as shown in the following diagram :

N.

13	14	15	16
12	11	10	9
5	6	7	8
4	3	2	1

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Fig. 2.

Surveys performed by contract.

18. The township subdivision surveys of Dominion lands, according to the system above described, are carried out and performed by contract at a certain rate per township, per mile or per acre, fixed from time to time by the Governor in Council, or by competitive tender, as the Governor in Council from time to time directs.

In special cases, where circumstances render it advisable to effect otherwise the survey of a township or townships, the Governor in Council may order the same to be done.

SYSTEMS OF SURVEY IN DIFFERENT DISTRICTS.

Different systems of survey.

19. All Dominion lands in Manitoba, the North-west Territories and British Columbia, are laid out in the manner above described, but the number and widths of road allowances between sections are not the same in all parts of the country, and there are also some differences in the methods of subdividing townships. Hence arise different "systems of survey," five in all, styled the "first," "second," &c., system of survey.

Instructions apply to third system mainly.

20. The instructions hereinafter are drawn up for the third system, but, unless otherwise expressly provided, apply also to the other systems.

Broken closing township.

21. Since in all the systems of survey the townships and ranges are based upon the forty-ninth parallel and the initial meridians, and are not, on account of the varying widths of the road allowances, of the same dimensions, there occur fractional townships and ranges at the junction of different systems.

How to designate the fractional township or range adjoining the line between two different systems of survey.

22. The fractional township or range between two townships or ranges surveyed according to different systems, when its number is the same as the number of the adjoining one surveyed under the former system, is designated by that number, followed by the letter A, as for instance :

Tp. 19, A,

For the fractional township between townships 18 and 19 west of the Second Meridian, and

Range 21, A,

For the fractional range between ranges 20 and 21 west of the Second Meridian.

Marking of dividing line between systems.

23. The line between two parts of the country surveyed according to different systems is established as a correction line, that is to say, posts are planted on both sides of the road allowance on such line, each row governing the position of the boundary lines on its own side. Such road allowance is one chain and fifty links wide, except in the case of the dividing line between the third system of survey in the North-west Territory, and the fourth system in force in the "Railway Belt" in British Columbia hereinafter described. Here the road allowance between the systems is one chain wide. Also between the fourth system and

the fifth system, no road allowance is to be left, but a double row of posts is to be planted on the line dividing the systems, to govern the townships and sections on each side respectively.

FIRST SYSTEM OF SURVEY.

Road allowances.

24. In the first system of survey, there is a road allowance of one chain and fifty links on every section line.

Townships measure 489 chains on each side, more or less.

25. The township, therefore, measures on each side four hundred and eighty-nine chains, subject to the deficiency or surplus resulting from the converging or diverging meridians.

Closing errors left in the western range of quarter sections.

26. In the survey of a township the deficiency or surplus resulting from the want of parallelism of the meridians is set out and allowed in the range of quarter sections adjoining the western boundary of the township. It follows that generally the lines bounding sections on the east or west sides are not meridians, but lines parallel to the eastern boundary of the township. All quarter section sides are exactly forty chains, except in the western range of quarter sections of a township and in the sections adjoining a correction line which are subject to the discrepancies of the survey.

Area surveyed under the first system.

27. The operation of the first system of survey is restricted to the area bounded as follows, viz.:

To the south, by the International Boundary Line, to the west by the Second Meridian, as far as the eighth correction line; by said correction line as far as the meridian between ranges twenty-eight and twenty-nine west of the Principal Meridian; by said meridian between ranges twenty-eight and twenty-nine, as far as the seventh correction line; by said correction line as far as the meridian between ranges seven and eight east of the Principal Meridian; by said meridian between ranges seven and eight east as far as the north boundary of township nineteen; by the north boundary of township nineteen in ranges eight, nine and ten east of the Principal Meridian as far as the meridian between ranges ten and eleven east of the Principal Meridian; by said meridian, between ranges ten and eleven east, as far as the third correction line; by the said correction line, as far as the eastern boundary of the Province of Manitoba; by said eastern boundary as far as the International Boundary Line.

Also Township 44, R. 21; Tp. 45, R. 21, 22, 26, 27, 28; Tps. 46 and 47, R. 24, 25, 26, 27 and 28; Tp. 48, R. 24, 25, 26 and 27, west of the Second Meridian.

Townships 42 to 47 inclusive, R. 1; and Tps. 43 and 44, R. 2 and 3, west of the Third Meridian.

SECOND SYSTEM OF SURVEY.

Deficiency or surplus from converging or diverging meridians divided equally between all quarter sections. Area surveyed under the second system of survey.

28. The second sytem of survey is similar in all respects to the first system, except in regard to the deficiency or surplus from the converging or diverging meridians which is distributed equally among all quarter sections as in the third system.

29. The operation of the second sytem of survey is restricted to Tps. 1 and 2, R. 1 to 8 inclusive; Tps. 19 to 30, R. 1 to 12 inclusive; and Tps. 27 to 30, R. 13 to 16 inclusive; the above ranges being all west of the Second Meridian.

THIRD SYSTEM OF SURVEY.

Territory of third system.

30. The third system of survey covers all the territory not expressly reserved for the other systems.

Road allowances.

31. Road allowances of one chain in width are allowed on every section line running north and south and on every alternate section line running east and west, that is, along the north and south boundaries of the township and along the second and fourth section lines north of the south boundary of the township.

Townships measure 483 chains on east and west sides, and 486 on north and south sides.

32. The township, therefore, measures along its east and west boundaries, four hundred and eighty-three chains, and along its north and south boundaries four hundred and eighty-six chains, subject to the deficiency or surplus from the converging or diverging meridians, as the case may be.

Equal distribution of deficiency or surplus.

33. The deficiency or surplus from the converging or diverging meridians is distributed equally among all quarter sections involved, so that the lines bounding sections on the east and west sides are true meridians, and those on the north and south sides are parallel to the north and south boundaries of the township.

Closing errors on correction lines.

34. In the survey of township outlines, the surplus or deficiency found on meridians when closing on the correction line is divided equally between the quarter sections adjoining that line, except in the case of the closing on the first correction line, where the deficiency or surplus, as above stated, is carried to the first base line, or forty-ninth parallel of latitude.

FOURTH SYSTEM OF SURVEY, OR SYSTEM OF SURVEY IN RAILWAY BELT, BRITISH COLUMBIA.

35. The system adopted for the survey of the lands within the belt of twenty miles on each side of the Canadian Pacific Railway in British Columbia, is the third system of the North-west Territories, modified by adding to each quarter section of 160 acres, an allowance of three acres for roads, instead of locating this allowance on the section lines.

36. This allowance is provided for by making each quarter section on the base lines 40 chains and 50 links, and on the meridians 40 chains and 25 links.

Closing between third and fourth systems.

37. The dimensions of the townships are therefore the same as those in the third system of survey, namely, four hundred and eighty-three chains north and south, and four hundred and eighty-six east and west. Since the townships of the third and fourth systems are based upon the forty-ninth parallel and the same initial meridians, there is no fractional township or range between them where the systems adjoin one another, but the northern boundary of the fourth system township coincides with the line of posts marking the southern limit of the road allowance on the southern boundary of the third system township adjoining it to the north, and the eastern boundary of the fourth system township coincides with the western limit of the road on the western boundary of the third system township next east of it.

Marking of correction line.

38. In the fourth system of survey correction lines are marked by a double row of posts to govern the positions of the boundary corners of the townships, sections and quarter sections on each side of the line.

South side township to govern correction line.

39. The correction line is to be established by projecting the township lines from the base lines on each side of the correction line, and dividing the surplus or deficiency equally between the quarter sections on each side of the correction line. The corners thus established for the townships south of and adjoining the correction line are to be joined by straight lines, upon which are to be placed the posts marking the township, section and quarter section corners for townships on both sides of the correction line.

Modified rule for re-establishing correction line.

40. In the case of these correction lines the rule prescribed for re-establishing lost corners on a township outline in Manitoba and the North-west Territories (see sub-clause *b* of clause 126 of the Dominion Lands Act) is modified, in that the straight line joining the corners of the township south of the correction line must govern the alignment of the posts.

41. The western limit of the third system follows the summit of the Rocky Mountains, which is the boundary between the North-west Territories and the Province of British Columbia, except between the northern boundary of Township 25, Range 15, and the eastern boundary of Township 31, Range 19, west of the 5th Meridian, where the following lines separate it from the fourth system, namely :

That part of the northern boundary of Township 25, Range 15, which lies west of the summit of the Rocky Mountains ; then, in succession, the eastern boundary of Township 26, Range 16, to 7th Correction Line ; the 7th Correction Line as far as the south-east corner of Township 27, Range 17 ; the eastern boundaries of Townships 27 and 28, Range 17 ; the northern boundary of Township 28, Range 17 ; the eastern boundaries of Townships 29 and 30, Range 18 ; the 8th Correction Line as far as the south-east corner of Township 31, Range 19 ; the eastern boundary of Township 31, Range 19, as far as the summit of the Rocky Mountains ; thence northerly along the said summit ; all these ranges being west of the Fifth Meridian.

All Dominion lands to the west of the above described boundary are surveyed under the fourth system, excepting the territory in which the fifth system, hereinafter described, is in force.

FIFTH SYSTEM OF SURVEY.

Fifth system described.

42. Certain townships in the railway belt in the lower valley of Fraser River, previous to the transfer of the lands to the Dominion, were surveyed by the Provincial Government according to the local system of survey. The townships are six miles square and are divided into 36 sections, as in the other systems. There are no allowances for roads. The basis of the system is the forty-ninth parallel and a meridian which passes near the junction of Fraser and Pitt Rivers. This meridian is called the Coast Meridian. The townships are individually numbered, and not according to the general system of townships and ranges. The common designation of a township is "Township No. N. W. D." (New Westminster District.)

Boundary of fifth system.

43. The boundary of the fifth system is as follows :—Beginning at the point where the eastern boundary of Township 25, N. W. D., intersects the international boundary between Canada

and the United States; thence northerly upon the eastern boundaries of Townships 25 and 26, N. W. D., to the north-east corner of said Township 26; thence easterly upon the southern boundary of Township 27, N. W. D., to the south-east corner of said Township 27; thence northerly upon the eastern boundary of said Township 27 to the first correction line of the Dominion Lands System of Survey; thence westerly upon the said correction line to the Seventh Meridian of the Dominion Lands System of Survey; thence northerly upon the said Seventh Meridian to the northern boundary of Township 24, N. W. D.; thence westerly upon the northern boundaries of Townships 24, 21, 18, 15 and 12 to the south-east corner of Section 6, in Township 42, N. W. D.; thence northerly upon the eastern boundaries of Sections 6, 7, 18, 19, 30 and 31, in said Township 42 to the northern boundary of said township; thence westerly upon the northern boundary of said Township 42 to the south-east corner of Township 41, N. W. D.; thence northerly upon the eastern boundary of said Township 41, to the north-east corner of Section 12, in said township; thence westerly upon the northern boundaries of Sections 12 and 11, in said Township 41, to the north-west corner of Section 11, in said township; thence southerly upon the western boundaries of Sections 11 and 2, in said Township 41, to the northern boundary of Township 40, N. W. D.; thence westerly upon the northern boundaries of Townships 40 and 39, N. W. D., to the western limit of the Forty-Mile Railway Belt; thence southerly following upon the said western limit to the International Boundary between Canada and the United States; thence easterly upon the said International Boundary to the point of beginning.

INSTRUCTIONS TO SURVEYORS.

FIELD WORK.

Surveys to be astronomical.

44. The surveys of the Dominion lands are to be astronomical; that is to say, the directions of their lines must be referred to the astronomical meridian. The use of the magnetic needle on Dominion land surveys is forbidden.

Chain to be used.

45. All measurements shall be made with the ordinary sixty-six feet chain or steel band. It is to be tested and corrected, during use, by the subsidiary standard of the surveyor. If stopping at any point where a standard section has been established, the surveyor will train his chainmen there until they can chain correctly. Eleven pins should be used, so as to leave one in the ground when exchanging tallies.

Chainmen to be sworn.

46. Previous to entering on their duties the chainmen shall be sworn according to the form below and such oath shall be filed with the returns of the survey.

(Form of Oath.)

I, A. B., do solemnly swear that I will discharge the duty of chaining and measuring with exactness according to the best of my judgment and ability and that I will render a true account of my chaining and measuring to Dominion Land Surveyor by whom I have been appointed to such duty. So help me God.

(Signed) A. B.

Sworn before me at this day of 18 } ....C.D..... D.L.S.

Precautions in chaining over broken ground.

47. In chaining over uneven ground, should the same be so broken as not to permit of the full chain being levelled, the measurement should be made with such portion thereof as may be easily levelled, and particular care should be taken at such times, in plumbing and dropping the pins, in order to obtain the accurate horizontal measurement.

Obstacles on the line

48. In case the survey line be obstructed by a lake, pond, deep marsh or other obstacle, the surveyor will pass it by right-angled

offsets, or, if more convenient, by a trigonometrical operation. The angle opposite to the base should be, whenever practicable, at least thirty degrees. It must never be less than fifteen degrees.

Blazing.

49. All lines established as boundaries in woods are to be well opened out and to be further marked by blazed trees. The tree is to be blazed on three sides, namely, on the side on which the line passes, and on the two adjacent sides.

When the closing error of a trial line, which has been opened out, is less than the maximum error allowed in this Manual for such lines, the posts may be established by offsets from the trial line, and then it is not necessary to open out the true line, but the posts may be connected with the trial line by oblique lines, which must not make angles greater than 5° with the trial line. The broken lines thus established connecting the posts are to be marked by blazes as above, for a blazed line, not being a legal boundary under the Dominion Lands Act, need not be straight.

No blazes or permanent marks of any description are to be made on traverse lines.

Surveys under different systems to be distinct.

50. When a township, whether fractional or otherwise, adjoins lands surveyed under a different system, all lines within such township must be stopped at the inner side of the road allowance dividing the two systems and a corner post or monument erected at the point of intersection. In no case must a line be extended across the aforesaid road allowance.

Road allowance to be left on Indian reserve boundaries.

51. A road allowance of the same width as in the adjoining township is to be left on the boundaries of all Indian reserves, and the intersections of the section lines with that side of such road allowance which adjoins the township are to be indicated by proper posts or monuments. When a reserve not yet surveyed is to be formed of a certain number of full sections, the surveyor, in establishing the same, shall plant the posts as usual on the west and south boundaries ; but on the north and east side they are to be planted in the north or east limit of the road allowance. The side of the road allowance adjoining the township is the only one to be posted by the surveyors employed by the Department of the Interior.

Lines crossing Indian reserves,

52. As a general rule, no lines are to be run in Indian reserves. If, however, it is necessary, in surveying a base line or other

DIAGRAM No 3

EARTH MOUND AND PITS

PERSPECTIVE.

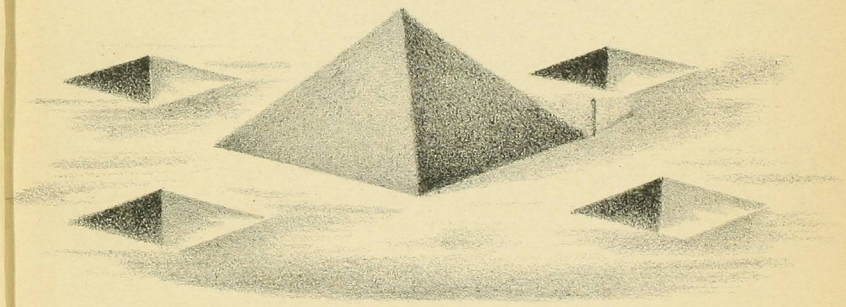


DIAGRAM Nº4

EARTH MOUND AND PITS

SECTION

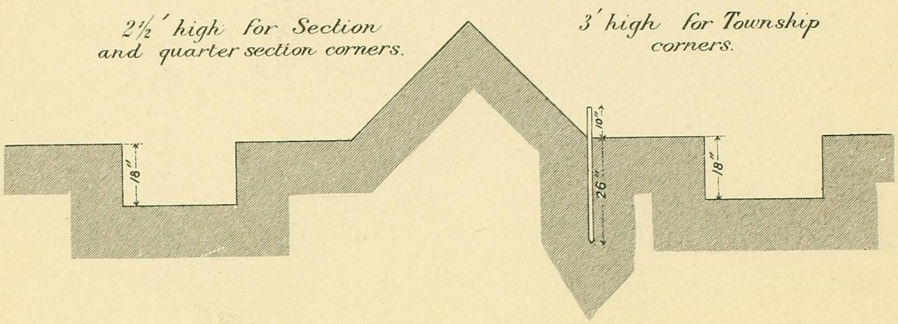


DIAGRAM Nº5

POST AND PITS FOR PRAIRIE SPOTS.

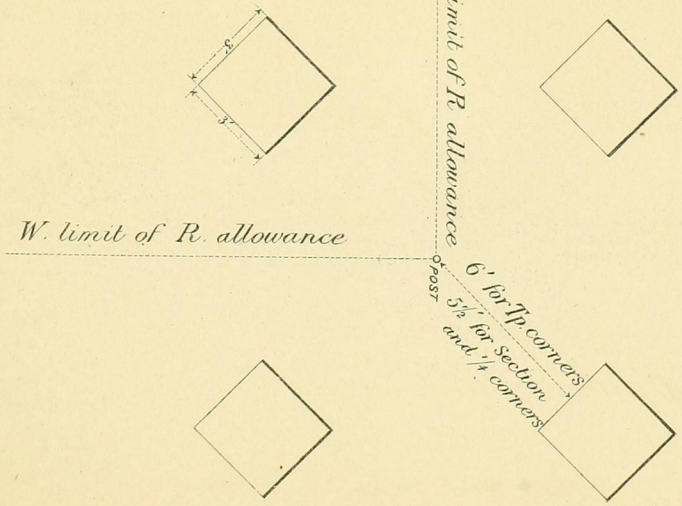
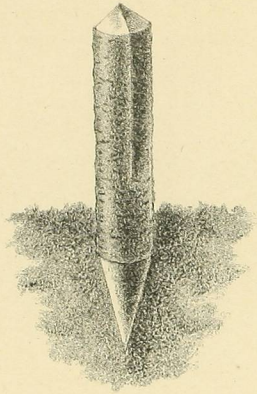


DIAGRAM No. 6

POST

QUARTER SECTION

3 INCHES WIDE FLATTENED.



STONE MOUND

PERSPECTIVE.

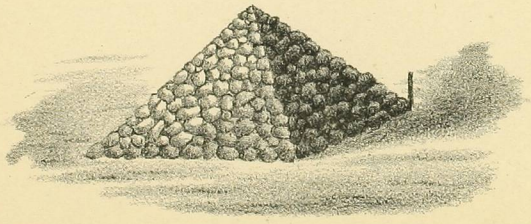


DIAGRAM No. 7

ORDINARY MOUND FOR WOODED SPOTS

6 FEET SQUARE FOR TOWNSHIP CORNERS.
5 FEET SQUARE FOR ALL OTHER CORNERS.

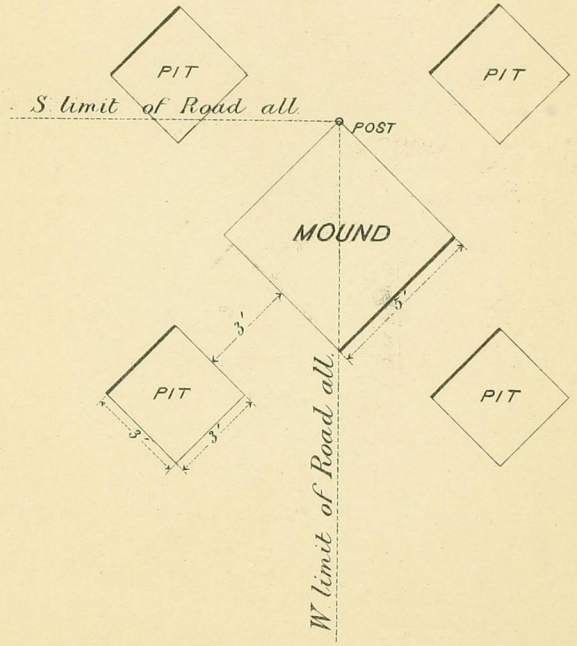


DIAGRAM Nº8

MOUND ON CORRECTION LINE

6 Feet Square for Township Corners.
5 Feet Square for all Other Corners.

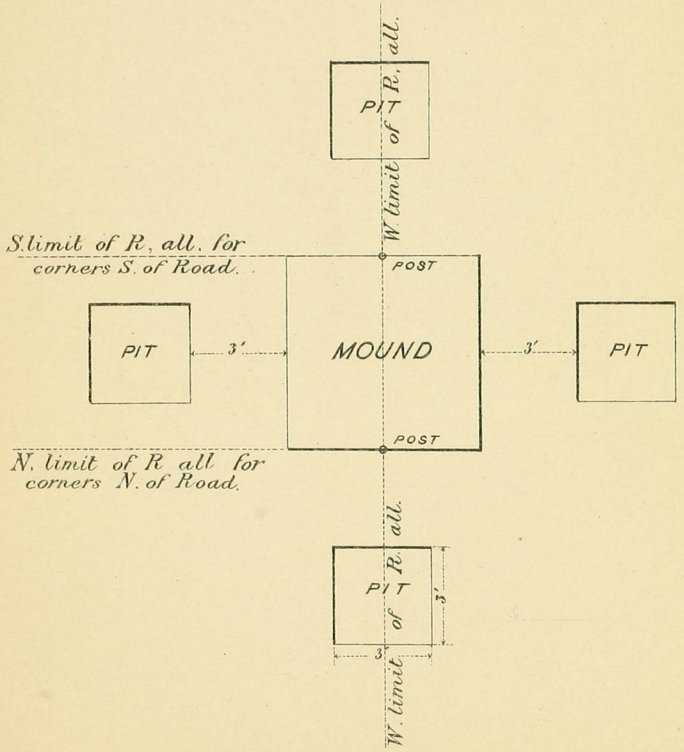


DIAGRAM Nº9

PITS ON CORRECTION LINE

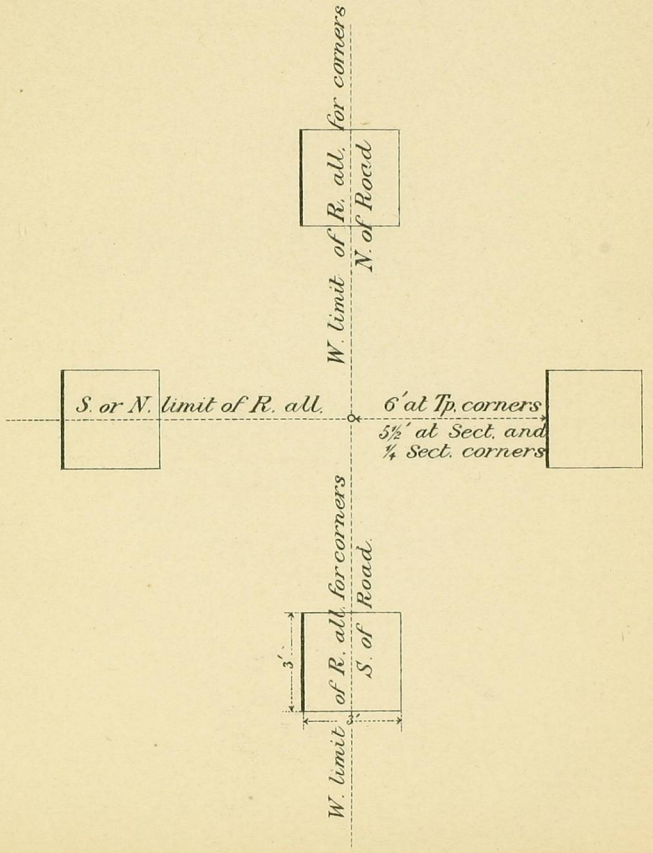
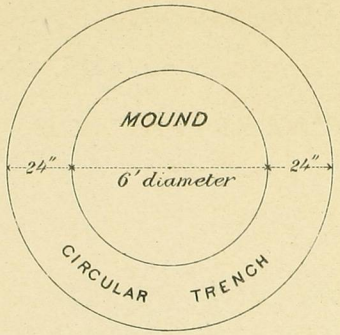


DIAGRAM Nº10

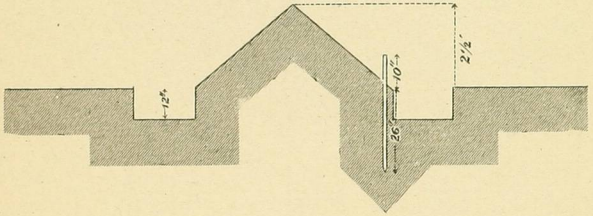
WITNESS MOUND

PLAN.



WITNESS MOUND

SECTION.



WITNESS MOUND

PERSPECTIVE.

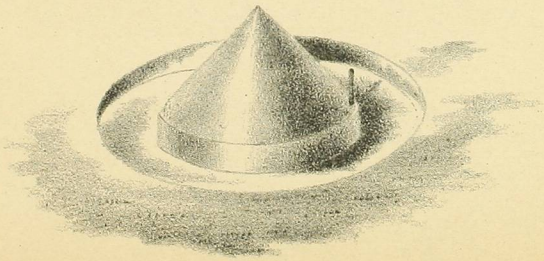
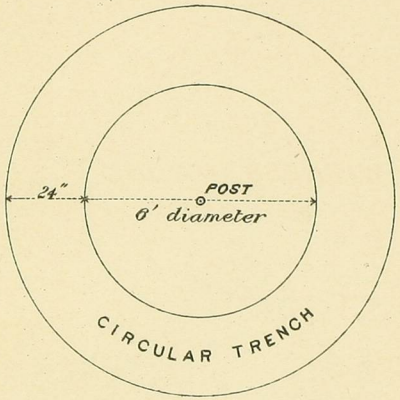
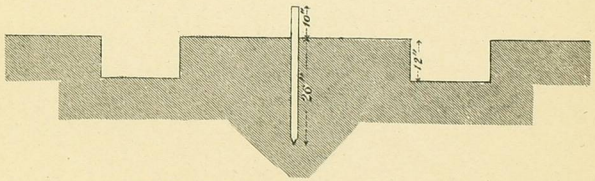


DIAGRAM Nº11

WITNESS TRENCH

PLAN.





WITNESS TRENCH

SECTION

important governing line to cross an Indian reserve, no posts are to be planted, nor permanent marks of any kind to be left within the boundaries of the reserve.

53. The instructions contained in this Manual are to be strictly followed, even when there appears to be evident advantage in departing therefrom. Neither errors in the lines previously surveyed, nor any other reason, justify such departure. Instructions to be strictly followed.

BOUNDARY CORNERS.

54. Having ascertained by exact running and measurement the proper point for establishing the township, section or quarter section corner, as the case may be, the surveyor, in marking the same, is to be governed by the following directions :—

55. Township and section corners are marked by pointed iron tubes, marked as hereinafter described, and driven perpendicularly with a sledge to within ten inches of the top. The iron tube is five feet long and one and three-eighths of an inch in diameter for township corners, and three feet long and three-quarters of an inch in diameter for section corners. Iron tube to mark township and section corners.

56. A quarter section corner is marked by a wooden post flattened on two sides and marked with the fraction $\frac{1}{4}$ (fractionwise) to identify it as a quarter section post. The post is two feet six inches long and three inches wide on the flat face. It is driven eighteen inches into the ground, the flat sides facing in the direction of the line. The post is to be bevelled on top to turn rain. When wood for the post is not to be found within three miles from the site of a quarter section corner, no post need be planted, but the corner will be indicated simply by the four pits, as hereinafter provided. Wooden post for quarter section corners.

57. The post or tube is in all cases to be placed exactly at the corner it is meant to indicate. A mound, or pits, or both, must also be made. Mounds or pits to be made at corners.

58. Mounds are to be of the form of square-based pyramids, six feet square at base and three feet high for township corners, and five feet square by two and one-half feet high for section corners. No mounds are erected at quarter section corners. Description of mound.

59. In the formation of mounds, the earth will be taken from four several "pits" three feet square and eighteen inches deep, Description of pits.

the centres of the pits to be four feet six inches outside and opposite the centres of the respective bases.

To be formed of solid earth.

60. Mounds are to be formed of solid earth, roots and all foreign substances being excluded, and the earth well pressed down with the spade during the process. The post is to be firmly planted in the solid ground before beginning to build the mound. In order to facilitate the speedy erection of a mound, a rope skeleton may be used. By taking hold of each corner and making a knot of the three lines running to it, the line is carried without becoming tangled; or the spade used may have marked on it the distance from the centre to the corners of the mound and to the sides of the pits, and small pickets may be planted at those distances and in the proper directions.

Stone mounds.

61. Whenever stones can be readily procured, mounds must be built of stones properly piled so as to conform as nearly as possible in size and shape to the earth mounds. A mound must not be made partly of stone and partly of earth.

62. When a mound is not built, the pits are to be placed at the same distances from one another and from the corner as they would be if the mound were built. In prairie, at township, section and quarter section corners, pits are dug, but no mound is built. The earth from the pits is to be scattered about.

In woods, willows or other scrub a mound and pits are to be made at township and section corners, but neither mound nor pits at quarter section corners.

Pits in wooded spots.

63. In wooded spots, the positions of the pits relative to the directions of the lines may, when necessary, be altered to suit circumstances, provided the distances between themselves and from the centre of the mound are preserved, and one of the pits may be omitted, when, on account of large trees or other obstacles, it is found impracticable to dig the four pits.

In prairie the rule as to size, depth and position of pits will be rigidly enforced.

Mounds at township and section corners.

64. The mounds thrown up at township and section corners in the woods will be so placed that the post will stand at the northerly angle or point thereof, and that the mound will stand diagonally to the cardinal points.

Exception.

65. Except that on correction lines, the lines between different systems of survey, the outer limits of the roads around Indian

reserves, and generally all lines the posts on which mark the boundaries of lands on one side only of the line, the township and section corner mounds will be so placed that the post will stand precisely in the centre of the north, east, south or west side of the base of the mound, according as the corner is intended for lands south, west, north or east of the line, the mound being placed square to the cardinal points.

Square formed by pits without mound to face the same way as it would were a mound built.

66. In prairie, where there is no mound, the square formed by the four pits stands square with the cardinal points at corners which govern lands on both sides of the line, and diagonally to the cardinal points at corners governing one side only. The post stands at the intersection of the diagonals of the square.

Pits for quarter section corner.

67. The pits for a quarter section corner in prairie are the same in size and position as those for a section corner.

Witness post.

68. If a township or section corner fall in a lake, or bed of a stream, on an inaccessible mountain or in any other locality unfavourable to the planting of a post, the digging of pits or the erection of a mound, the surveyor shall perpetuate such corner by a witness iron post with trench or mound and trench, at the nearest suitable point of the surveyed line, that is either north, south, east, or west of the true corner. The distance in chains and the bearing of the site of the true corner from such witness post are to be cut on the post, the bearing being indicated by one of the letters N., S., E., or W. By placing the post at an even number of chains from the corner the marking of the post will be simplified. Care must be taken to indicate the bearing from the witness post to the true corner; thus a witness post south of the true corner is to be marked with letter "N" for north.

No witness post required for quarter section corners.

69. No witness post, mound or trench is required to mark the position of a quarter section corner.

Witness mound or trench.

70. A witness trench is circular, of six feet inside diameter. The trench proper is twenty-four inches wide and twelve inches deep.

In prairie, the earth taken from the trench is scattered about, but in the woods it is employed to build a conical mound, six feet in diameter and two and a half feet high. The post stands

at the point of the base of the mound nearest to the corner while in prairie the post is at the centre of the trench.

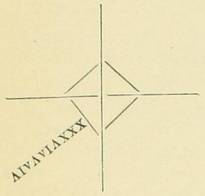
Posts must be planted on line.

71. Care must be taken that all corner and witness posts be planted *exactly on line*, as well as at the correct chained distance.

Posts at township and section corners generally.

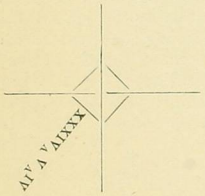
72. The post planted at a township or section corner not on a correction line or on a line between different systems of survey or on an Indian reserve line is to be marked on its south-west side with the number of the section the north-east corner of which the post is to indicate, followed by the numbers of the township and the range in which that section lies.

MARKS ON POSTS.



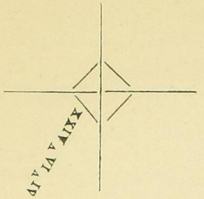
For the corner between Townships 5 and 6, and the 3rd and 4th Ranges.

Iron post.
Fig. 3.



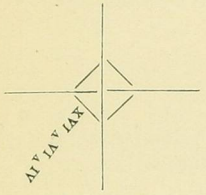
For the northerly corner between Sections 34 and 35, Township 5, Range 4.

Iron post.
Fig. 4.



For the easterly corner between Sections 24 and 25, Township 6, Range 4.

Iron post.
Fig. 5.



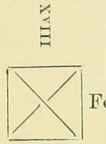
For the corner between Sections 15, 16, 21, 22, Township 6, Range 4.

Iron post.
Fig. 6.

Posts at corners on correction lines.

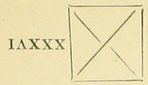
73. Posts at township and section corners on correction lines are to be marked exclusively for the townships and sections on the respective sides of the road allowance. They will have the number of section on the west side and the number of township and range on the north or south side for posts north or south of the road allowance respectively.

For instance :—



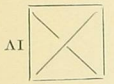
For the south-east corner of Township 3, Range 10.

Iron post.
Fig. 7.



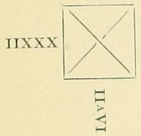
For the north-east corner of Township 6, Range 5.

Iron post.
Fig 8.



For the southerly corner between Sections 3 and 4, Township 7, Range 5.

Iron post.
Fig. 9.



For the northerly corner between Sections 32 and 33, Township 2, Range 6.

Iron post
Fig. 10.

Posts on east and west lines between different systems of survey.

74. Posts at township and section corners on east and west lines dividing two systems of survey are to be marked in the same manner as posts on correction lines.

Posts on north and south lines between different systems of survey.

75. Posts at township and section corners on north and south lines dividing two systems of survey are to be marked on their south side with the number of the section the north boundary of which they indicate, and with the number of the township and range on their east or west side, according as the posts are on the east or west side of the road allowance respectively :—

For instance :—

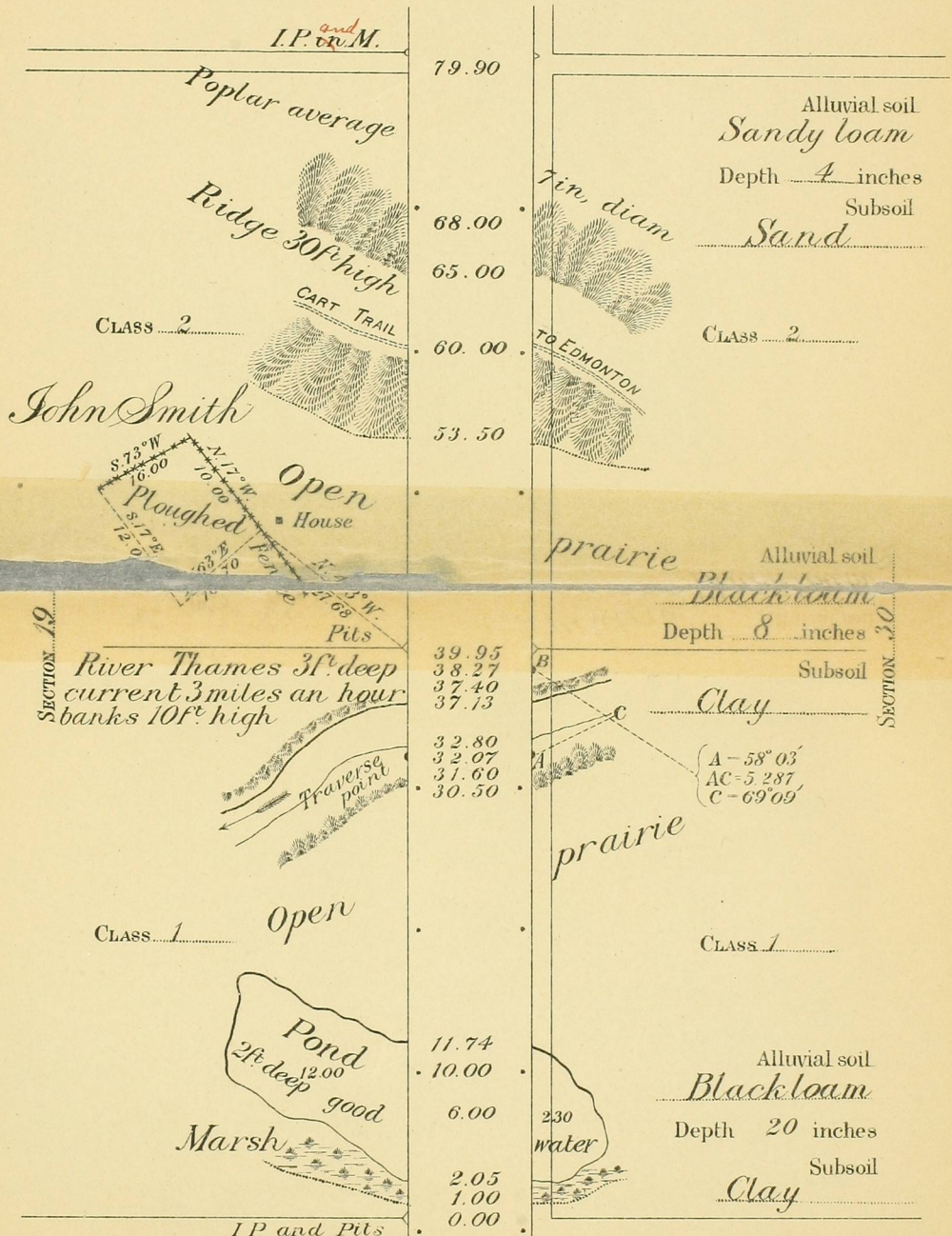
Fig. 11.

For the post marking the north-westerly corner of Section 7, Township 28, Range 16, west of Second ~~Initial~~ Meridian, on the east side of the road allowance dividing the second from the third system of survey.

DIAGRAM No 12

Township ..... , Range ..... West of ..... Meridian

North Boundary of Section 19 Course: S 89°30'W



The above line was run on the Twelfth day of August 1883

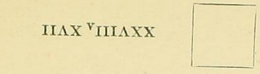


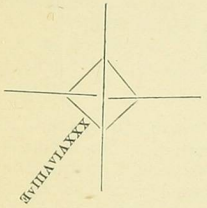
Fig. 12.

For the north-easterly corner of Township 28, Range 17, west of the Second ~~Initial~~ Meridian.

Similarly with posts planted on the limits of road allowances adjoining Indian reserves, and on the lines of other reserves, settlements, &c., the general rule being that mounds, pits, &c., which govern townships and sections on both sides of the road allowance are to be set diagonally, and the posts are to be marked accordingly; but those which govern only townships and sections on one side of the road are set square to the cardinal points. General rule.

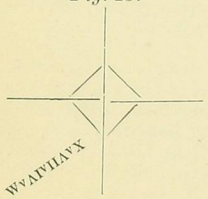
Quarter section posts are always set so that the flat sides face the direction of the line, and they are marked with the fraction $\frac{1}{4}$.

76. In ranges numbered from the Principal Meridian, the letter W. or E. will be marked on the post after the number of the range, to denote that it is west or east of the meridian, as for instance: Marks of boundaries in ranges numbered from the principal meridian.



Iron post.
Fig. 13.

For the township corner between Townships 5 and 6, and the 3rd and 4th Ranges east of the Principal Meridian.



Iron post.
Fig. 14.

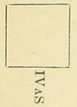
For the corner between Sections 10, 11, 14, 15, Township 7, Range 4, west of the Principal Meridian.

Letters W. and E. to be marked only for principal meridian.

The letters W. and E. are not to be marked for any meridian other than the Principal Meridian. The number of meridian is never to be marked.

Witness post.

Witness posts are marked on the side facing the corner with the distance in chains and the bearing thereto, thus :



For witness post standing four chains north of the corner of the section.

Fig. 15.

Marks to be neat and distinct.

77. All marks on posts are to be cut neatly and distinctly.

THE FIELD BOOK.

Field notes.

78. The field notes sent in to be placed on record in the Dominion Lands Office are to be a fair and exact copy of the original notes taken in the field, and are to be written in the books furnished for that purpose ; the forms supplied for field use are not accepted as office copies.

Of the field book.

79. The first page will give the title, showing the nature of the survey, by whom surveyed, and the dates of commencement and completion of the work. The second page will contain the names and duties of all assistants, and whenever a new assistant is employed or any one changed, an appropriate entry thereof with the reasons therefor will be made in the field book previous to entering any notes under the changed arrangements. The third page will contain a skeleton diagram, with each section line numbered to correspond with the page of the notes.

80. The field notes must be a faithful, distinct and minute record of everything officially done and observed by the surveyor and his assistants pursuant to instructions in relation to running, measuring and marking lines, establishing boundary corners, laying off road allowances, &c., and present, as far as possible, a full and complete topographical description of the country surveyed.

Each page to be complete.

81. The field notes of every section line surveyed must be complete in themselves, and be placed on a separate page. Section lines are to be entered in the Field Book in the order in

which they are run. The chaining must, in all cases, commence on the inside of the road allowance, so as to show for the quarter section and section corners the distances from the true corner of the section, and the measurements are to be given in all cases exclusive of road allowances.

Description of section lines.

82. Section lines are to be described as north and east boundaries of sections, not as south or west boundaries, except on the north side of a correction line, where they are properly described as south boundaries of sections 1, 2, 3.....&c. On Indian reserve boundaries and on lines between different systems of survey, cases will also occur in which the lines surveyed are to be designated as the south or west boundaries of sections.

Abbreviations allowed.

83. The following abbreviations of words, but no others, will be allowed in the notes, that is to say :—

"Sec." for "Section," "Tp." for "Township," "R." for "Range," "N." for "North," "S." for "South," "E." for "East," "W." for "West," "diam." for "diameter," "chs." for "chains," "lks." for "links," "dist." for "distance" or "distant," "I.P." for "Iron Post," "M." for "Mound," "T." for "Trench," "W.P." for "Wooden Post," and "Wit." for "Witness."

Information to be given in notes.

84. The field notes must be always written down on the spot, leaving nothing to be supplied from memory, and are to give the following information in relation to the survey :—

(a.) The length and exact bearing of every line run, noting all necessary offsets therefrom, with the reasons for the same.

(b.) The course and distance for all witness mounds.

(c.) The character of boundary corners ; if wooden post, mark "W.P."; if iron post and mound, "I.P. and M."; if iron post and pits "I.P. and pits" ; stone mound "Stone M." The above information is to be given on each page for every corner shown thereon, whether it was established by a previous survey or not.

(d.) The distances at which the line first intersects, and, also, where it leaves settlers' claims or improvements, lakes, ponds, rivers, bottom lands, swamps, marshes, brush and woods ; also the beginning of ascent, the top and the foot of descent, of all

remarkable hills or ridges, with their estimated height in feet above the bottom lands near which they may be situated; also where a stream, lake or pond is crossed, the data used for ascertaining the distance across it.

(e.) The course, average width and depth, and rate of current of all streams, and whether the water is fresh or salt in the lakes which may fall within the survey.

(f.) Whether the surface of the country is level, rolling, broken or hilly.

(g.) The nature of the soil, classifying it, according to its fitness for agriculture, as first, second, third, or fourth rate,—entering the class, at the time of survey, on each quarter section where indicated in the notes.

(h.) Depth of loam and kind of sub-soil, where pits are dug.

(i.) If there is timber, the kinds, quality and average dimensions thereof.

(j.) Rapids or falls of water affording mill sites, with estimated fall and supply of water in general terms.

(k.) Coal deposits, minerals (transmitting specimens of the same), and salt springs, &c., &c.

Field notes to be distinct and neat.

85. The field notes must be distinctly and neatly made out in language precise and clear, and their figures, letters, words and meaning, are always to be unmistakable.

Road allowances to be ruled in.

86. The road allowances in the Field Book are to be ruled in the proper position, and the position of boundary corners indicated.

Affidavit to be made.

87. Following the field notes the surveyor will make the following affidavit:—

I.....of the.....of .....in the Province of.....Dominion Land Surveyor, make oath and say that I have, in my own proper person, according to law and the instructions of the Surveyor-General, faithfully and correctly executed the survey shown by the foregoing field notes and accompanying plan, and that the said field notes and plan are correct and true to the best of my knowledge and belief. So help me God.

Sworn before me at.....\
this.....day of.....18..} .....
D.L.S.

SUBDIVISION OF TOWNSHIPS INTO SECTIONS.

INSTRUMENT AND METHOD OF SURVEY.

Instrument.

88. The instrument used in subdivision surveys is to be a transit, transit theodolite or solar compass, reading at least to minutes; before use it shall be submitted for the inspection and approval of the Surveyor-General.

As explained in the exposition of the system of survey, all surveys are to be astronomical; they shall, therefore, be performed independently of the magnetic needle.

Outline diagrams.

89. The subdivider will receive from the head office, or from the surveyor of outlines, diagrams showing the outlines surveyed.

Chaining to be compared with previous lines.

90. Before the subdivider enters on his survey he will measure carefully one or two miles of the township outline; this will enable him to compare his chaining with that of the lines previously run, and to modify it so as to obtain the best agreement with the township outlines.

Subdivider to establish the north and south boundaries of the township before commencing the subdivision.

91. The meridian exteriors of a township are established by the surveyor of township outlines. The subdivider will, therefore, commence his operations by running the north and south boundaries of the township, if they have not been previously surveyed.

In order to do so he will join, by a trial line, the opposite township corners on the meridians, and then plant the posts permanently on the true line, making all quarter sections equal. Table No. XIX. gives the number of minutes by which the course of the trial line is to be altered in order to strike the post. The true course is to be given in the field notes.

The surveyor will note that in townships of the first system of survey quarter sections are to be made exactly forty chains in width, except the western tier of quarter sections in the township.

Only one side of a correction line is to be surveyed at one time. The process will be the same as described above.

Correction lines near an initial meridian.

92. When a correction line has to be deflected across the last fractional range in order to close on an initial meridian, the south or the north side, as the case may be, of the road allowance is to be broken in such a way as to leave the full width of one chain for the road. (One chain and a half in the first and second systems of survey.)

The general case is represented in fig. 16.

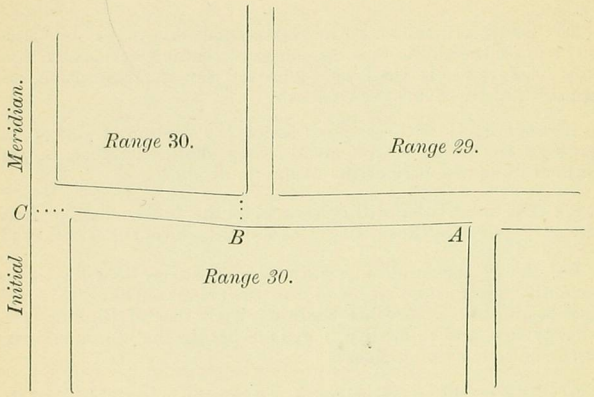


Fig. 16.

The north-east corner, A, of the last range is joined by a straight line to a point, B, one chain south of the post at the west end of the "jog," and this last point is again joined by a straight line to the corresponding post, C, of the initial meridian. The northern boundary of the township is thus a line, ABC, broken at B.

When the initial meridian intersects the jog.

93. Another position of the lines is shown in fig. 17, the initial meridian intersecting the "jog." The south-east corner, A, of the last range on the north side of the correction line, is joined by a straight line to a point, B, one chain north of the post at the eastern end of the jog, and this last point is again joined by a straight line to the corresponding post, C, of the initial meridian. The southern boundary of the township is thus a line, ABC, broken at B.

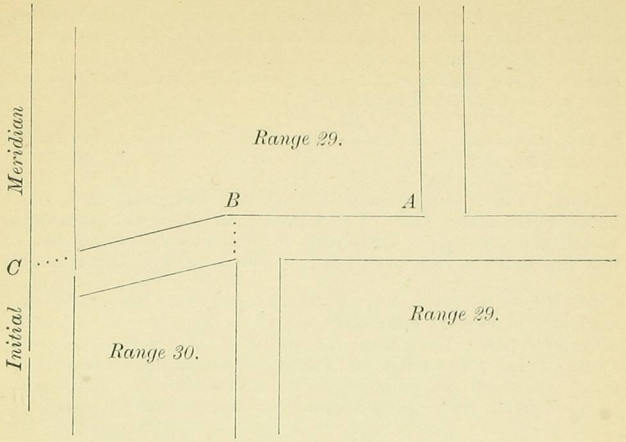


Fig 17.

The bearings of all deflected lines or portions thereof and the points of deflection must be given in the notes.

How townships are to be subdivided.

94. A township is to be subdivided by first projecting the meridians, and then joining the corresponding section corners on them first by trial and then by true lines. The appended table may be used in this case for correcting the trial lines.

The true course of each line referred to the meridian of its initial point must be shown in the field notes. It is wrong, for instance, to enter a course as west, when the direction although westerly, is not exactly west.

In subdividing a township, the quarter section posts on east and west lines are placed midway between the section corners on the respective meridians, that is to say, both quarter section sides are made equal, with the exception noted above for the first system of survey. In all the systems of survey also the quarter section on the east side of an initial meridian contains all the deficiency.

In closing with a meridian on the north or south boundary of a township, the last section post on such meridian is at once

planted permanently and connected by a straight line with the section corner on the outline of the township. The true course of the deflected line and also the distance east or west from the corner, of the intersection of the township outline by the trial line, are to be entered in the notes.

The directions given above (§ 49) in regard to blazed lines apply in this case.

Should a meridian strike more than fifty links from the corner on the outline, the whole of such meridian must be resurveyed across the township. Offsetting the posts is not sufficient, a new line must be run and, if in the woods, opened throughout.

Lines to be surveyed.

95. The only section lines to be surveyed, established and permanently marked as boundaries are those along which the road allowances are. Their total length for a township of the third system is forty-two miles and twenty-seven chains, more or less, exclusive of township lines and for a township of the first or second system sixty-one miles and ten chains, more or less.

In the fourth system the lines to be surveyed are those corresponding to those surveyed in the third system ; that is, all the north and south, and the alternate east and west section lines.

Indian reserve boundaries and other lines must also be retraced, when the areas of the quarter sections adjoining cannot be found without such a survey.

Quarter sections adjoining correction lines.

96. In starting from a correction line, the surveyor will give to the adjoining quarter section, a depth proportional to those of the quarter sections at each end of the tier, as shown on the diagram of the township outlines.

He will be careful to connect with the posts in the inner limit of the road allowance and not with those in the outer limit.

Convergance of meridian section boundaries.

97. It has been explained, in the exposition of the system of survey, that sections in all the systems except the first, are of unequal width, on account of the convergence or divergence of meridians. To better illustrate this fact the convergence has been exaggerated in Fig. 18.

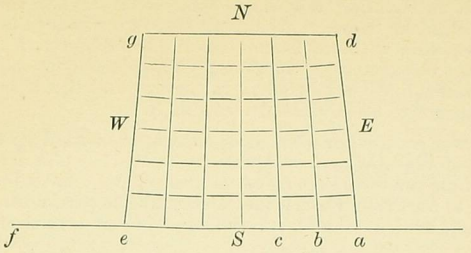


Fig. 18.

The angle formed by the meridians with the east and west lines is different for each meridian and varies uniformly from one corner of the township to the other. The surveyor shall not, therefore, start his meridians at right angles to the township lines, but he must, in each case, calculate the angle formed by these two lines from the data supplied to him with the diagram of township outlines.

Supposing, for instance, the angle *daf* to be 90° 03′, and *gef* 90° 09′, he will use as angles at *b*,*c*,*S*, &c., 90° 03′, 90° 05′, 90 °06′, 90° 07′, 90° 08′.

The angles between the meridians *ad* or *eg*, and the east and west lines, would be deduced in a similar manner.

Exception in first system of survey.

98. In the first system of survey, as already stated, the lines between sections are not true meridians, but are parallel to the eastern boundary of the township, and make with the south boundary of the township angles equal to the south-eastern angle of the township.

Limits of error allowed.

99. It follows, from the foregoing, that all quarter sections on meridians are to be forty chains except in the tiers of quarter sections adjoining the correction lines, where they should be proportional to the quarter sections at each end of the tier. Should all the survey lines be perfectly correct, all other sections should have the theoretic width. The maximum error in distance that will be allowed in the closing of any section cornor will be fifty links. When the closing error exceeds this quantity, the lines involving the error must be resurveyed. The opposite boundaries of sections are to be within fifty links of equal length.

All distances are to be entered in the field book such as measured on the ground.

Rivers, lakes and islands to be surveyed.

100. In subdividing townships, such rivers as are specially mentioned in the instructions and all lakes over twenty acres in extent, together with any islands containing not less than twenty acres, are to be accurately surveyed. The plans must show the actual water line at the time of the survey and the deductions from areas are to be calculated accordingly.

Whenever a marsh or other body of water is so deep that it cannot be forded by men or horses, it is to be considered as a lake, coming under the operation of this clause ; but when it is possible to ford it and carry the survey line across, no traverse of the same or deduction from the area of the section is to be made.

Lakes occurring entirely within a section and islands in lakes and rivers must have their traverse properly connected with the rest of the survey. When a river which is to be traversed exceeds three chains in width, the surveyor will traverse both banks of the same referring to such traverse in his field notes as on the "right" or "left" bank, as the same would be on his right or left, respectively, looking down the stream.

Points of the feature traversed shall be so determined that the distance of any point from the next one does not exceed ten chains ; they may be fixed either by offsets or by auxiliary bearings and distances. Traverse lines are to be connected with the nearest post on all section lines which they intersect, and the angle between the traverse line and the section line is to be determined and given in the returns.

The use of the micrometer for such work will be allowed, provided that the closing error does not exceed one chain in one hundred chains. The micrometer must be of an approved pattern, and must be submitted to the Surveyor General before being used on the survey.

Settlers' claims or improvements.

101. Traverse lines shall be run to settlers' claims or improvements, and the extent and position thereof shown on the plans of the survey.

Statutory declarations to be obtained from settlers.

102. The surveyor will also obtain from every settler a statutory declaration, on the form supplied. The surveyor will see that all the questions on the form are answered, and the answers entered in the form.

All declarations from squatters are to be accepted, no matter how many there may be on a quarter section. The only case in which a declaration should be refused is when it is clearly untrue, or in opposition to the facts.

A statutory declaration does not give any right or legal status to the declarant ; it is simply for the information of the Department.

Surveyors are strictly forbidden to make any charge to squatters for receiving their declarations, and it is no part of their duty to explain the law or to give directions to intending or actual settlers for securing land. Surveyors in the employment of the Department are recommended to abstain from giving such advice.

PROGRESS REPORTS.

Sketches of survey to accompany the progress reports.

103. Each progress report shall be accompanied by sketches prepared on the forms supplied showing work done up to date. Such sketches shall show the main topographical features of the country, that is to say, the rivers, lakes, trails, hills, &c., and the section and traverse lines surveyed must be indicated in red.

It is not necessary to use a scale for plotting, a rough estimate of distances is all that is required.

The sketches may be drawn with pencils of different colours.

It should be understood that only the main topographical features are to be shown, and that it is not necessary to indicate every little swamp, pond, or rise that may be found.

RETURNS OF SURVEY.

Accounts to be placed at the end of the field notes.

104. In addition to what is prescribed for field notes in general, there will be in the case of contract surveys an account at the end of the field book, signed by the surveyor, showing in miles and decimals of a mile, the distances run on section and traverse lines in the township, with the rates in each case, according to contract, and the total amount for the township.

Final returns.

105. The final returns of survey consist of :—

(*a.*) Field notes.

(*b.*) A plan of each township.

(*c.*) A timber report for each township.

(*d.*) Oaths of chainmen.

(*e.*) Statutory declarations of settlers.

(*f.*) Accounts in duplicate on the forms supplied.

Report.

106. The surveyor will also subjoin in a concise report such further description or other information connected with the township surveyed as he may be able to afford, which may be useful or necessary to be known, giving a general description of the character of the country, its soil and geological features, timber, minerals, waters, &c.

He will also furnish a general report upon his operations and the resources of the district in which his work lies, for publication in the annual report of the Department of the Interior.

Plans.

107. The plans shall be on a scale of forty chains to the inch, on the forms supplied by the Department. Every fractional township, however small, is to be shown on a separate plan.

Township outlines, when surveyed by the subdivider, are to be shown on the same plan as the subdivision.

Length of quarter section lines.

108. The plans shall exhibit the lengths of all quarter section lines as measured on the ground when not exactly forty chains, and the length of every broken part of a section line.

Topography.

109. The plans shall show all the topographical features of the country as referred to in the field books. The topography is to be represented in the following manner :—

Bush,—a wash of light green without any imitation of trees.

Brulé, a wash of light brown without any imitation of trees.

Swamps,—a wash of light yellow, with small strokes of green representing reeds, &c.

Water,—a wash of blue.

Areas.

110. The plans shall also show the areas in acres and hundredths of all irregular quarter sections, *i.e.*, quarter sections adjoining correction lines, initial meridians, boundaries of reserves, or lines separating different systems of survey, and quarter sections broken by lakes or streams that have been traversed. All other quarter sections will be considered as regular, and reckoned as 160 acres in area.

In cases where a quarter section is divided into two or more parts by a stream or lake large enough to require traversing, each of the parts is to have its separate area shown.

Contents of township.

111. A table on the plan shall exhibit the contents of the township thus :

Land in sections	acres.
Roads	"
Water	"
Total area	"

The "Land in Sections" is the sum of the net area of all the quarter sections in the township, and in a township in which there are no irregular quarter sections and no deductions for water, amounts to 23,040 acres.

In the area of "Roads" are included all the road allowances within the township, together with those on the west and south outlines ; in a regular township this area is 872·10 acres for townships of the first and second systems, and 433·80 for townships of the third system.

The area of "Water" is the area of all water that has been traversed within the sections, and should not include any part of the road allowances.

Traverse lines.

112. Traverse lines are not to be shown on the plan, but to be plotted on one of the blank pages at the end of the field book, on which are also to be shown the shore lines of the lake or stream. In case the lake, pond, &c., is of too great an area to admit of its being plotted on a page, then the plot should be made on tracing linen and pasted in the end of the field book.

Traverse lines are to be plotted on a scale of 20 chains to an inch. Astronomical bearings (not angles), distances and offsets must be given ; none of these need be marked on the plot ; it is preferable to give them separately in table form, numbering the stations to correspond to numbers on the plot.

Settlers' improvements.

113. The extent and position of settlers' improvements are to be shown in the notes and on the plan ; also the names of the settlers who have made statutory declarations on the quarter sections which they claim. The names of settlers who have made no declaration are not to be shown on the plan or in the field notes.

Timber report.

114. In the timber report the surveyor will state whether, in his judgment, from the knowledge gained on the ground, it would be desirable to reserve the timber for the needs of the settlers, or whether it would be advisable to set apart the same

as a timber berth; if the latter, he will give a general statement of the quality and extent of timber over 10 inches in diameter, suitable for lumbering purposes. If reporting on several timbered townships he shall make a statement as to their relative value, taking into account the extent, quality and facilities afforded by streams, &c., for getting out the timber.

A timber report shall be furnished for every township. Should there be no wood in the township, the fact is stated. One page of the report is given for each township.

Plans and field notes returned to surveyor in certain cases.

115. The field notes shall be neatly written, in a clear manner and fair hand. The plans shall be drawn with care and should be fair specimens of draughtsmanship.

Any plans or field notes not complying with the above conditions will either be returned to the surveyor, to be written or drawn again, or prepared by the Department, and the cost charged to the surveyor.

Returns to be prepared without delay.

116. Immediate preparation of returns after the surveyor has completed his field work will be insisted upon.

General reports.

117. Attention is particularly drawn to the necessity for devoting care and attention to the preparation of general reports. The object should be not merely to give an account of the surveyor's operations and the quality of the land, but to describe comprehensively the resources of the country visited and its industries, whether farming, stock raising, lumbering, mining, &c., furnishing such details as may enable the prospective emigrant to choose judiciously the locality in which to settle according to his calling, and to form an idea of the expectations which he may reasonably entertain.

SECOND PART.

SURVEY

OF

BLOCK AND TOWNSHIP OUTLINES.

Block in first system.

118. In the first system of survey, a block contains four townships, being bounded by a base line, a correction line and two meridians. The base line is first surveyed, then the meridians, and the correction line across the two ranges is surveyed, first as a trial line, then as a true line. The block is "quartered" into townships by straight lines by the township subdivider. Otherwise the manner of survey is the same as under the third system, and since very little of the territory in which this system is in force remains to be surveyed, no further description of it is necessary.

Block in second system.

119. In the second system the block contains sixteen townships included between successive correction lines and meridians four ranges apart. All the territory of this system having been already laid out into townships, no description of the method of survey of blocks is necessary.

Block in third system.

120. In the third system a block embraces sixteen townships, bounded by two base lines and the meridians, four ranges apart, from them to the intermediate correction line.

Whenever the nature of the country permits, the first operation in laying out a given portion of country for settlement consists in the survey of the outlines of the blocks, according to the rules hereinafter set forth. The surveyor of township outlines then divides the block into townships by projecting the interior meridians of the block, and surveys the other outlines of the townships by joining the corresponding corners on the meridians by straight lines although this latter operation is very generally left for the surveyor charged with the duty of subdividing the townships into sections. Frequently, however, mountains, large lakes, or other natural obstacles prevent the survey of the

block as a whole. In such cases the interior lines of the block are projected according to the general rules in so far as they apply to the case.

The eastern and western exterior boundaries of the blocks are broken lines each consisting of two meridians separated by the "jog" at the correction line. The northern and southern limits (base lines) are parts of a polygon described on a parallel of latitude, by laying off, as chords thereto, the successive township sides, forming, as the case may be, the northern or southern outline of the block.

The road allowances along meridians are in all cases to be of the prescribed theoretic width, one chain. That the distribution of excess or defect is among the sections, and is not applied to the roads, will not materially affect the azimuth of those north and south lines involved; the displacement at the extremes—but two-thirds of a link on each mile—being less than ordinary chaining is at all accurate enough to indicate.

Closing of blocks.

121. Except in the case of the blocks south of the 2nd Base, where the meridians are to be surveyed from the 2nd Base to the 1st Correction Line, and then, laying off the theoretical jog, south to the 1st Base, leaving all the north and south closing error at the 1st Base, the surveyor will invariably close his block on the correction line, projecting first the part on one side of the correction line and then the other half of the block. The north and south error in closing is to be divided equally between the two quarter sections north and south of and adjoining the correction line. In order to correct for it, and to prevent the accumulation of errors, the surveyor may deviate the two base lines of the next block equally and in opposite directions, so as to effect the required correction at the end of the four ranges. Supposing, for instance, the two quarter sections adjoining the correction line to be each 20 links short, the closing error might be corrected in the next block by deviating each base 21 seconds, the north base to the north and the south one to the south. It does not necessarily follow that the whole amount of the closing error is to be corrected for; the surveyor should take into account the probable cause of the discrepancy and correct only for such part of it as he believes will best ensure the closing of the next block. The jog on the correction line is to be left such as found, unless it should show an error of more than one chain and fifty links in the lines of the last block, in which case they would have to be resurveyed. The limit allowed for the north and south closing error on the correction line is also one chain and fifty links.

The block surveyor will mark, on the correction lines, only the township corners; all other posts are to be planted by the subdivider.

Deflection of base lines.

122. When it becomes necessary to deflect the base lines to place them in their proper latitudes, such deflection, unless instructions to the contrary be received from the head office, shall not exceed two minutes, and shall be carried to such a distance as to effect the required correction, except in closing on an initial meridian, where the last township corner is to be connected with the post on the meridian by a trial line, the deviation never extending beyond the range or fraction of a range adjoining the meridian.

Measurements.

123. The method of establishing the lengths and directions of the lines of the survey is to be the following:—

All lines are to be twice measured. This shall be effected by having two sets of chainmen, using the continuous steel band chain. The leading one is to be of the length of a standard Gunter's chain; by it all topographical and other notes are to be kept and posts to be planted. The following band, to be used solely as a control, is to be 100 feet in length.

When, at a section or quarter section corner, the distances registered by the respective chainings for the length of the quarter section side, differ, in prairie country, more than two links, or, in woods or brush, more than three links, the two sets of chainmen shall return to the last post and measure over again, repeating their measurements until accordance within the limit here prescribed is attained.

Where the surface is so broken or uneven that it would be unreasonable to expect such accordance, and therefore, in a still greater measure, to look for any proper approximation to the absolute length of the interval chained, the surveyor, while continuing to establish the direction and carry on the production of his line in the usual manner, shall have recourse to such application of trigonometric methods, for obtaining the distances along it, as his judgment and the necessities of the case may lead him to employ. If using triangles, it is to be remembered that the result obtained is more accurate when angles are measured than when they are laid out with the chain.

Standard chains.

124. The surveyor shall have a standard steel band with which the field bands are to be frequently compared.

This standard will be furnished to him by the Secretary of the Board of Examiners of Dominion Land Surveyors, after it has been tested and stamped by the Department of Inland Revenue. With each standard will be furnished a table of its corrections under varying strains and temperatures.

In using the standard band for comparison, it should be stretched with a proper tension, applied by means of a spring balance.

As every ten degrees Fahr. more or less heat would give to measurements a corresponding increment or decrement of somewhat more than half a link to the mile, and since in the North-west Territory a season of field work, extending from early spring to beginning of winter, will include variations of temperature covering a range of at least 80 degrees, and sometimes 100 degrees, the side of a block chained in July or August might, from this cause alone, differ from that of an adjacent one measured in November, fully a chain.

Correction for temperature.

125. In ordinary summer weather, however, the corrections for temperature would, compared with the order of precision of the work generally, be inappreciable, yet they must not be entirely neglected. The temperature error might, in any given case, happen to have the same sign as other uncorrected constants, or accidental errors, whose effect it would then go to aggravate. That in another case, further on, it might tend to counteract these, would not lessen the inaccuracy of position of the boundary monument planted under the first condition.

The surveyor will, therefore, apply this correction for all variations of 10° and over, from the temperature for which the chains are compared or adjusted to standard. This he can conveniently do, by allowing half a link to the mile for each ten degrees Fahr., not attempting to note or estimate the temperature of his chain to less than ten degrees. This will keep his corrections in the convenient form of multiples of half links, and render tables unnecessary.

A thermometer attached to the end of a chain near the hand, fails to give the temperature of the rest of the chain ; fastened to the middle and allowed to drag on the ground, it is liable to derangement and injury, it is therefore extremely difficult for the surveyor to obtain even a rough approximation of the temperature of his chain. By repeating at convenient times, and under varied conditions, the experiment of placing a pocket thermometer on, or in, the grass or brushwood, as nearly as possible, similarly to the average position of the chain during

the trial, and comparing the temperature attained by the thermometer so placed with that of the air, or indicated by a thermometer attached to the leading end of the chain, a rough idea may be got of the allowances that should, in practice, be made in taking the indications of the latter, or in rudely estimating the temperature of the chain from that of the air at the time.

Attention should be paid to the condition of the chain during measurement, whether wet or dry ; a wet chain will have its temperature lowered to a great extent, especially in dry weather. The colour of the chain also has some influence ; a black or dark blue chain will absorb more heat than a bright one.

Steel bands are very liable to break ; this fact cannot be impressed too strongly upon the chainmen. In case such an accident should happen, the surveyor ought to be provided with a small steel punch with sharp edges, a few copper rivets and some brass plates cut to the width of the chain. Holes can be punched through the steel band and the repair effected with two fish plates riveted to the chain.

Correction for inclination.

126. Besides the small plummet line that should be carried by the chainmen to enable them to get correctly past minor irregularities of surface, the assistant should carry an Abney or Locke pocket clinometer, by which he can obtain the inclination and thus permit the chainmen to use the more accurate method of chaining on the inclined surface, instead of the one requiring them to hold their chain level and entailing a continuous repetition of plumbing down from the high end to the pin in the ground.

Use of clinometer.

In using his clinometer, the assistant will stand at one end of the slope, one of the chainmen standing at the other end, and he will sight through the instrument to some part of the chainman's body, the height of which shall have been previously ascertained to be the same as the height of his own eye. Such point will easily be found by using the clinometer at zero, the assistant and chainman standing close together and on the same level.

Chainage—how entered in the Field Book.

127. The field books supplied to block surveyors contain a table of the correction per chain for given angles of slope and also a form for applying the corrections to the chainage. The first number to be entered in this form is the length, in links of the chain used, of the quarter section to be laid out. When the chain can be adjusted for length it is adjusted so as to be standard at same given temperature ; the number to be entered

is then the theoretic length of the quarter section, forty chains or forty-one chains as the case may be. When it cannot be adjusted the surveyor ascertains its length at the given temperature by comparison with a standard, and computes the number of links of *his chain* required to give, at the above temperature, the proper length to the quarter section. With a chain too long, the number of links will be less than the true length and *vice versa*. This number being entered in the Field Book form, the corrections for slope will be written underneath ; they are in all cases to be added. The correction for temperature, one-quarter of a link to the quarter section for every ten degrees Fahr., is to be entered next ; it is added when the thermometer is below the standard temperature and subtracted when above the same.

At the end of the quarter section, the algebraic sum of the quantities entered will show the number of chains and links to be actually measured on the ground in order to give to the said line its exact length, forty or forty-one chains. The same process will be followed to find the distance to be measured for the section corner.

It will be seen that the distance for the topography, being entered as found in the field, will be in error by the amount of the correction to the chainage. This quantity being generally small, may be neglected for the topography, but the posts should be entered at their true distances.

The method of chaining along the slopes and correcting for inclination, will be applied only with the Gunter's chain, by which posts are planted and boundaries ascertained ; the 100 feet chain, being solely a control, will be used in the ordinary manner, breaking chain when its full length cannot be levelled.

All calculated distances to be checked.

128. When the distance across an obstacle is determined by a triangle, the surveyor must be careful to check it by another independent operation, either another triangle or a micrometer measurement, so as to conform to the principle of double independent chainage.

If a second triangle be adopted, having the side to be calculated common with the first triangle, it will be sufficient to set up the instrument at both ends of this side ; any error in the angles would be shown by the calculation. In all triangles, calling the angle opposite to the base B, the angle opposite to the side to be calculated C and the third one A, the calculation is to be made according to the form given on p. 45. The distance to the nearer side of the obstruction being entered at the proper place, it is only necessary to fill the form to have the

distance to the farther side. From this last point the chainmen start with the number of tallies and pins and the fraction of a chain found by the calculation.

GENERAL INSTRUCTIONS.

SPECIMEN Page of Field Book with form for calculation of triangles and corrections for slope and temperature.

¼ Sect.	40·140	TRIANGLE No. 43			b =	9·442
Slope.	3	*Observed Angles.*		*Corrected Angles.*		
"	13	A =	64° 43′	64° 44′	log. b =	0·97506
"	7	B =	55 56	55 57	cosec. B =	0·08168
"	24	C =	59 18	59 19	sin. C =	9·93450
"			179 57	180 00	log. c =	0·99124
"					c =	9·800
"		Distance to nearer side of obstruction =				0·050
"		Distance to farther side " =				9·850
"						
"		TRIANGLE No. 44			b =	5·287
"		A =	58° 03′	58° 02′	log. b =	0·72321
"		B =	52 51	52 50	cosec. B =	0·09861
"		C =	69 09	69 08	sin. C =	9·97054
Th. cor.	— 5		180 03	180 00	log. c =	0·79236
¼ Sect.	40·182				c =	6·200
Sect.	41·140	Distance to nearer side of obstruction =				37·000
Slope.	11	Distance to farther side " =				43·200
"	6					

SPECIMEN Page of Field Book with form for calculation of triangles and corrections for slope and temperature.

Slope.	18	TRIANGLE No.	b =
"	23	A =	log. b =
"	2	B =	cosec. B =
"	1	C =	sin. C =
"	1		
"			log. c =
"			c =
"		Distance to nearer side of obstruction =	
"		Distance to farther side " =	
"			
"			
"			
Th. cor.	— 7		
Sect.	81·377		

Surveyor to pass round large lakes or deep marshes.

129. Should the extension of a block line be hindered by a very large lake or marsh, the surveyor may pass round the same, projecting for the purpose the adjacent township lines. In working round in this way to arrive at and take up the continuation of the block line on the opposite side of the obstruction, the surveyor will regularly post off all township, section and quarter section corners on the several lines, reporting the circumstance fully and sending all the field notes of such additional work forward with the returns of survey.

INSTRUMENTS.

Description of transit theodolite.

130. The surveyor of block outlines shall use a six-inch transit theodolite of what is known as the "Dominion Lands pattern," or an equivalent instrument. The "Dominion Lands" instrument is a reiteration transit theodolite, with a six-inch horizontal circle reading by three verniers to 0·004, and a three-inch vertical circle with two verniers to 0°·02, as a finder for stars in day time.

The telescope has an objective of one and a half-inches diameter, and nine inches focus, supplied with direct eye pieces of power equal to 12, 18 and 32 for terrestrial work, and a diagonal eye piece with powers of 30 and 60 for star work. In using his instrument, the surveyor should always employ the highest power compatible with satisfactory definition. The instrument is provided with three verniers, because, by reversing the telescope and turning the azimuth plate 180°, readings will be obtained on the same object, at six equidistant points of the circle, thus tending to eliminate periodical errors of graduation to the same extent as an instrument having six verniers.

Decimal graduation.

131. The degree is subdivided decimally, instead of, as usual, into minutes and seconds, in order to facilitate the taking of a mean of a number of readings of the three verniers, and to lessen the chances of blunder, in so doing, by substituting the more familiar process of division of quantities counted by tens to that of dividing quantities counted by sixties.

A small magnetic needle, attached to the instrument, is useful in finding stars in day time, when the surveyor may happen to be elsewhere than on a line of known azimuth.

Assistant's instrument.

132. The assistant will be provided with a reiteration transit having a four-inch horizontal circle reading to minutes or to 0°·01; it will be used for measuring the angles of small triangles, laying out offsets for passing obstacles on the line, placing corner or witness posts on the line, giving to the axemen the direction of the line to be opened out in the bush, and generally doing whatever will be done with sufficient accuracy and more conveniently than with the larger instrument used in the production of the line.

For his astronomical work the surveyor must be provided with a sidereal pocket chronometer or watch conforming in quality and performance to what is here set forth as desirable for the purpose.

Pocket chronometer or watch for astronomical work.

133. For use in this service a watch with good lever escapement is to be preferred to one with chronometer escapement; the latter is not so well fitted to withstand the unavoidable vicissitudes of rough carriage while the wearer is jolting over lumpy prairie in a waggon, riding on horseback, or climbing over the trunks of prostrate trees in a windfall. In jumping down from one of these, or from his saddle, the escapement is very liable to catch, and in doing so injure the point of one of the fine escape-wheel teeth, rendering the watch useless till repaired by skilful hands.

The best suited to the purpose is a well-made lever watch, having a compensation balance that has been subjected to trial in temperatures of opposite extremes, say freezing and 80 Fahr., and carefully adjusted to good performance in both, and with good hard Breguet hair spring, well coiled and properly pinned, that is to say, being, by trial, in conjunction with its balance, fastened at such points in its length, and given such initial and terminal curves, as to secure isochronal vibrations of the balance.

This may be tested by varying the conditions of resistance to the driving power, which may be conveniently done by varying the position of the watch so as to produce change in the length of arcs of vibration.

A good watch should include in a range of 5 seconds all the differences of daily rate that would occur in running it for twenty-four hours in each of the six positions—flat on back, on face, on edge XII up, VI up, III up, IX up.

DIRECTIONS OF LINES.

Azimuth of lines.

134. The directions of the east and west exteriors of a block being throughout coincident with those of meridians, their azimuth is constant; but, on its northern and southern outlines, consisting of the four successive chords to a parallel of latitude that are formed by the bases of the townships standing on that parallel, the azimuth varies with the progression along a chord from one corner of a township to the other, because the direction of the line is the same throughout, whilst that of each successive meridian to which it is referred, differs from the direction of any preceding one by the amount of their convergence.

Reckoning azimuth from zero at the north point round through east, south and west, 90°, 180° and 270°, and representing the convergence of the two meridians forming the east and west outlines of a township by C, the azimuths of the chord forming its base would, at each successive section corner, beginning at the eastern corner of the township, and going westward, be $270+\frac{C}{2}$, $270+\frac{C}{3}$, $270+\frac{C}{6}$, 270, $270-\frac{C}{6}$ $270-\frac{C}{3}$, $270-\frac{C}{2}$ the deflection angle between a chord produced and the next one equalling C.

The quantity given in the appended Tables Nos. V., VI., VII. and VIII., under the heading of "chord azimuth," is equal to $90°-\frac{C}{2}$, which subtracted from 360° gives the above quantity $270° + \frac{C}{2}$. C is given in those tables under the heading "Deflection."

Azimuth observations to be made on Polaris.

135. The reference of lines to an astronomic meridian, in order to obtain their direction, or to check the accuracy of their production, is most readily made by observations on Polaris.

The telescopes used being amply powerful to show stars of the second magnitude within a few hours from noon, and stars of the third magnitude in twilight when it is still clear enough to read the graduation, the observations should be taken in daylight, whenever practicable.

Besides avoiding the errors peculiar to all artificial illumination, and likely to be specially developed in the case of field work in unsheltered positions, and with light from reading lamps held by hand, inconstant in direction and unsteady, daylight observations have the advantage that they are conveniently made with the instrument at one of the stations for the ordinary production of the line, and during its progress, without materially, if at all, interfering therewith. Day observations also give the surveyor more time in evening in camp for their reduction, and for checking his own and his assistants' work generally.

Programme for observing.

136. In observing for azimuth, the surveyor will adopt the following programme :—

The instrument being in the position which places the vertical circle to the observer's right hand when looking through the telescope, it will be directed to the reference object and the verniers read, then to the Pole Star, noting the time of pointing and the reading of the verniers. The level of the azimuth plate is read or the inclination of the horizontal axis measured with the striding level.

Reversing the instrument by revolving the telescope and turning the upper plate 180° in azimuth, so that the vertical circle is now to the left of the observer, the telescope is directed to the Pole star, the level recorded and readings taken on the reference object, as before reversal.

In strong daylight, the surveyor will experience some difficulty in finding Polaris, unless his telescope be in the precise direction of the star. He will readily place it so by help of the quantities given in Table XIV. Its use does not require any explanation.

Other methods which may be employed are, transits of stars across the meridian, observation of Polaris at or near elongation, transits of stars across the same vertical as Polaris, &c.

Causes of error—yielding of stand.

137. In making these observations, as in angular measurements generally, care should be taken when turning the instrument in azimuth by hand, to use the same forward or backward motion throughout for every pair of pointings in same position, the angle between which is intended to be read on the horizontal circle. This tends to obviate the effect of any yielding in the instrument stand to that part of the impulse of revolution that passes down through the foot screws to the stand head. In some much-used forms of stand this occurs to a notable extent, and as there is no certainty that in springing back, or "untwisting," the stand resumes exactly its original position, serious errors are to be apprehended in their use, unless the utmost care is taken. A source of similar error is looseness of foot screws in their nuts. The pinch screws closing these last should always be screwed up so tightly as to have the levelling screw turning stiffly in the nut. Even though this may entail more rapid wear of the screws, and be less convenient to the observer in bringing quickly, and with nicety, his level bubbles to their desired position, the certainty that it ensures warrants it.

Direction of motion of tangent screw.

138. The tangent screw should always be turned so as to push against its counterpoise spring; because in turning in the opposite direction, the spring might fail to bring back the azimuth plate at once and do so only during the interval between the observation and the reading of the verniers. Should there be any drag of the verniers, this will also prevent it affecting the measure, as the motion will always be in the same direction.

Observations with a two vernier instrument.

139. If a two-vernier instrument be used in observations for azimuth, then, after the two observations as above, the operation should be repeated, shifting for the purpose the lower limb 90° in azimuth, if the instrument be a repetition one; 120° by lifting it off stand, and changing foot screws one interval round, if it be a reiteration instrument, *i. e.*, one which has no motion of lower limb.

Reference object.

140. The reference objects for azimuth work, whether in the daytime a picket on the line, or at night a bulls-eye lantern, should be, if possible, at least half a mile from the observer.

Such a lantern having to slide on over the lens a tin cap, across which there is a vertical slit having an opening in width of about quarter of an inch, makes an excellent reference object.

In the case of night observations, the angle between line and reference object is to be determined before observing, and not to be left till morning, thus subjecting the reference object to the risk of accident or removal.

Surveyors to observe for azimuth every clear day.

141. Surveyors are expected to observe for azimuth every clear day. With proper care in transporting the instrument, the levels will seldom get much out of adjustment, and then the complete observation for azimuth as above does not require more than ten minutes; generally it can be done without interfering with the work on the line. The reduction will take about fifteen minutes. It is hoped that with the forms and tables supplied to surveyors, the work has been made so short and easy that no objection to the frequency of observation should fairly exist.

Watch error.

142. The watch error is required for the reduction of the observations; it may be found very simply, when on the line, by placing the telescope in the meridian and observing the transit of a star. The time thus deduced is sufficiently accurate for the purpose.

When not on the line, the transit of a star across the vertical of Polaris may be observed, and the time found by following the directions given in the explanation of Table XV. The observations for time are entered in the form at the end of the book of record of astronomical observations.

Vatue of one division of the level.

143. The value of one division of the level is required for the reduction of azimuth observations. To obtain this, the level is placed on the azimuth plate parallel to the plane of revolution of the telescope, and a rod, with two marks upon it, is placed vertically at a certain carefully measured distance from the instrument and in the direction of one of the foot screws. The bubble is brought, by turning the foot screw, close to one end of the tube, and the telescope directed to one of the marks on the rod and firmly clamped. The foot screw is then moved until the telescope be directed to the other mark and the displacement of the bubble noted. The difference between the inclinations of the level in the two positions will be deduced from the distance of the rod and the interval between its marks; dividing it by the number of divisions of displacement will give the value of one division.

Formula for azimuth.

144. Surveyors are at liberty to use any formula or process for reducing their observations, but, as forms and tables could not be prepared for every method, the following formula has been adopted; for convenience, with regard to future reference, it is desirable that all surveyors should adopt it:

$$\text{Tan } Az = \frac{\text{Tan } P \text{ sec } \phi \text{ sin } t.}{1 - \text{tan } P \text{ tan } \phi \text{ cos } t.}$$

where P, ϕ, t, are polar distance, latitude and hour angle respectively.

Reduction of azimuth observations.

145. In the form of record of astronomical observations (see pages 54 and 55), the letters R and L represent the positions of the instrument, circle right and circle left, H. C. R. is for horizontal circle reading ; R. O. reference object ; R. A. right ascension, and Az. azimuth.

Representing by W. and E. the readings of the west and east end of the level, the level correction will be equal to the inclination

$$[\tfrac{1}{4}\,(\text{W}-\text{E}) \times \text{value of one division}]$$

multiplied by the inclination factor (cotangent of the zenith distance of Polaris).

It is to be added to or subtracted from the mean H. C. R. according to signs, that is to say, added when the west side is high or when W. is greater than E., and subtracted when smaller.

The logarithms of secant and tangent ϕ are given in Table X for the north side of every section.

The subtraction logarithm is found in Table XII., using as argument A the logarithm of "tan P tan ϕ cos t." The corresponding logarithm, B, is to be added to the logarithm of "tan P sec ϕ sin t" when t lies between 0^h and 6^h, or 18^h and 24^h ; it is to be subtracted when t lies between 6^h and 18^h.

The following examples, one in each quadrant of a revolution of the Pole star, will show how the calculation is to be made :

Ex. Required for the 9th July, 1880, at a point on the 6th base line, or 20 townships north of the 49th parallel, the azimuth of Polaris for hour angles of $2^h\ 10^m$, $9^h\ 32^m$, $16^h\ 44^m$, and $19^h\ 52^m$.

	For t = 2h. 10m.		For t = 9h. 32m.	
Tan P.....	8·36640	8·36640	8·36640	8·36640
Sec. ϕ (Table X.)	0·19877	Tan ϕ, 0·08772	0·19877	0·08772
Sin t	9·73022	Cos t, 9·92603	9·77946	9·90235
	8·29539	8·38015	8·34463	8·35657
Subt. log (Table XVII.).....	+0·01030		−0·00976	
Tan Az.....	8·30569	Az=—1·1581	8·33487	Az=-1·2386

	For t = 16h. 44m.		For t =19h. 52m.	
Tan P.....	8·36640	8·36640	8·36640	8·36640
Sec ϕ (Table X.)	0·19877	Tan ϕ, 0·08772	0·19877	0·08772
Sin t.....	9·97567	Cos t, 9·51264	9·94593	9·67161
	8·54084	7·96676	8·51110	8·12573
Subt. log Table XVII.).....	--0·00400		+0·00576	
Tan Az	8·53684	Az = 1·9715	8·51686	Az= 1·8829

The log. tan Az. is transformed into logarithm of the arc by adding log. T. (see page 158 Table XVI.,) thus avoiding the calculation of proportional parts.

The azimuth by account, when the R. O. is one of pickets on the line, is the theoretic azimuth of the line at the place of observation.

The direction of the line is corrected by placing the instrument a certain number of inches from its former position at right angles to the line. This offset is found by multiplying the distance of the back picket by the tangent of the correction.

SPECIMEN OF RECORD OF

Place, 45 chs. E. of N.E. corner Sec. 31, Tp. 28, R. 17, W. of 2nd M.

Face.	Object observed.	Chronometer Time.	Horizontal circle reading. A.	B.	C.
R.	R. O.	h. m. s.	173·082	080	084
	Polaris.	13 53 25	83·445	443	447
L.	Polaris.	13 56 33	·473	475	477
	R. O.		173·079	082	084

Chr. Time.	13 53 25	13 56 33	Tan. P.
Chr. Error.	— 2 13	— 2 13	Sec. and tan. ϕ
			Sin. and cos. t
Sid. Time.	13 51 12	13 54 20	Sum.
Polaris R. A.	1 15 43	1 15 43	
			Subt. log.
t	12 35 29	12 38 37	Tan. Az.

Log. 792.	2·89873	Distance of back picket = 53·65chs
Log. tan. corr.	5·68904	
Log. distance.	1·80380	
Log. offset.	8·39157	Log. T.
Offset in inch.	2·46	Log. Az.

TABLE OF INCLINATION FACTORS.

No. of Township.	Hour angle of Polaris. 0h or 24h	3h or 21h	6h or 18h	9h or 15h	12h	
0	1·20	1·18	1·15	1·12	1·10	Az.
20	1·28	1·25	1·23	1·20	1·17	H.C.R. on star.
40	1·37	1·34	1·30	1·28	1·25	True North.
60	1·46	1·42	1·39	1·36	1·33	H.C.R. on R.O
80	1·56	1·52	1·49	1·45	1·42	Azimuth R. O.
						Mean.
						Az. by account.
						Correction.

AZIMUTH OBSERVATIONS.

Date, 21st July, 1881. One division of level = 0·0011

Level W +	Level E —	Level Correct.	Mean H. C. R.	Corrected mean H.C.R.
				173·0820
10·2	8·5	+0.0019	83·4450	83·4469
11·3	7·4		·4750	·4769
				173·0817

8·36465	8·36465	8·36465	8·36465
0·20533	0·09855	0·20533	0·09855
9·18811	9·99447	9·22454	9·99381
7·75809	8·45797	7·79452	8·45701
— 1229		— 1226	
7·74580		7·78226	
1·75812		1·75812	
9·50392		9·54038	
0·3191		0·3470	
83·4469		83·4769	
83·1278		83·1299	
173·0820		173·0817	
89·9542		89·9518	
		89·9530	
		89·9502	
		·0028	

TABLE OF LOG T.

Tan. Az.	Log. T.
7·875	1·75811
8·045	10
·137	09
·207	08
·259	07
·299	06
·335	05
·366	04
·391	03
·415	02
·435	01
·454	00
·472	·75799
·490	98
·505	97
·519	96
·532	95
·544	94
·556	93
·567	92
·579	91
·588	90
·598	89
·608	88
·617	87

Record of azimuth observations to be part of the returns.

146. The observations will be entered in the note book of astronomical observations at the time they are made, the calculations made either in pencil or in ink, and the book will be sent in as part of the returns of survey. No copy will be accepted.

(See specimen pages 54 and 55.)

PRODUCTION OF LINE.

Only one flagman to be employed.

147. In producing the line the surveyor will employ but one flagman, a forward picketman; a back flagman is not necessary, as the surveyor can when about to leave an instrument station set a picket there himself.

Pickets.

148. Perfectly straight pickets are not indispensable; a part of the picket, exactly in the line, may be indicated by some visible mark and only this part used in the production of the line.

The flagman carries an ordinary surveying picket, about nine feet long, and terminated at the lower end by an iron point exactly in the axis of the picket. A small bubble, placed at right angles to the axis, would be a valuable adjunct to ensure verticality.

Production of the line.

149. The following method is recommended to ensure accuracy in the production of the line. When the flagman comes to the place where a new station is to be established, the surveyor will give him roughly the direction of the line. A wooden slab, held to the ground by two small wooden pins or by stones on the ends, may then be placed at right angles to the line at the point determined as above and in all subsequent operations, the picket will be held on the slab, and its position marked with a pencil.

In setting a point forward on his line, the surveyor will be careful never to do it in one position only of his instrument; in all cases, first making his back and forward sights circle right, then reversing his instrument, repeating them circle left, and having his flagman instructed to make in each case a separate and independent setting of his picket. If there be any difference between the settings, the surveyor is carefully to mark the middle point. Then the process is to be once repeated, so that there shall be two pointings in each position of the instrument on the back and forward pickets respectively, or eight pointings in all.

The same rule as to the reversion and number of pointings is to be observed in offsetting the line to get past long reaches unfavourable to chaining or triangulation.

It will be seen that the slab ought to be of such a length as to allow play for collimation.

Deflection angles turned off by deflection offsets.

150. The deflection angles at township corners on the base lines can be turned off without any reading of the graduation, by using the "deflection offset" given in Tables V. to VIII. This deflection offset is the length, at the distance of one chain, of the tangent of the deflection angle, or the angle between the chord forming a township side and the next chord. When the surveyor comes to a township corner, the last picket before the corner is placed south of the line, at a distance equal to the deflection offset as given by the table multiplied by the distance from the corner, and the instrument, instead of being set up over the forward point previously ascertained, is placed north of the line, at a distance equal to the deflection offset multiplied by the number of chains between the instrument and the corner. The line is then produced from the back picket in the ordinary manner.

Supposing, for instance, that it should be required to turn off the angles at a township corner on the seventh base line, the back picket being 12 chains behind the corner and the instrument 15 chains beyond the same corner, the back picket will be planted at $12 \times 1{\cdot}501$ or 18·01 inches south of the line, and the instrument set up at $15 \times 1{\cdot}501$, or 22·51 inches to the north.

How to turn at the corners of a block.

151. At the corners of the block, the surveyor will turn the required angle approximately, and the flagman will hold his picket at the point so determined, while the surveyor measures accurately the angle thus turned off, in the manner explained below for measuring the angles of triangles. If the angle is not what it should be, the direction of the line will be corrected by offsetting the instrument at the next station.

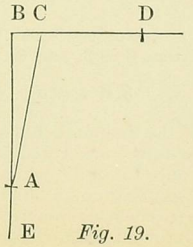


Fig. 19.

Should the corner fall in such a place that the angle could not be measured correctly, as for instance at B (Fig. 19), one of the stations, C, being too near the corner, the surveyor will have the angle at B approximately turned off by his assistant with the small transit, and measure the angle EAC. He will then set up his instrument at C, determine approximately the next station D, and measure ACD. The sum of the two angles EAC and ACD, should be equal to 180° plus the angle to be turned off at B. The error, if any, is corrected by offsetting the instrument at D.

Scheme for triangulation.

152. In cases where a triangulation would be necessary, the following would be the scheme of direction readings at a station in a chain of triangles. Numbering the stations on one side of the chain 1, 3, 5, 7, &c., and on the other 2, 4, 8, &c., and assuming for instance the observer to be at Station 6, and representing by the letter r the respective azimuthal circle readings, corresponding to the successive pointings on the station under whose number the letter is placed, the series of readings would be ;—

		St. 4.	St. 3.	St. 5.	St. 7.	St. 9.	St. 8.	St. 4.
Circle	R	r	r	r	r	r	r	r
"	"	r	r	r	r	r	r	r
"	L	r	o	r	r	o	r	r
"	"	r	o	r	r	o	r	r
		r_4	r_3	r_5	r_7	r_9	r_8	r'_4,

Representing the sum of the readings on such station by the letter r, with the subscript number of that station. The mean direction reading for each, would, representing it by letter d with similar subscript number, be—

$$d_4 = \frac{r_4 + r'_4}{8},\ d_3 = \frac{r_3}{2},\ d_5 = \frac{r_5}{4},\ \text{\&c., \&c.}$$

And for one of the triangles 3..4..6 the angle at station 6, between the directions 6 to 3, and 6 to 4, is :

$$3 \cdot 6 \cdot 4 = d_4 - d_3.$$

The direction of the diagonals 6·3 and 6·9 are taken out but once in each position, because they are not intended for calculation of sides, but only to serve where a gross error may have occurred, such as sighting on an object not a station, in detecting by combining therewith the various directions involved, at what station the error has been committed.

Great care should be exercised in setting station poles, to place them truly over their central marks, and in making them securely and exactly vertical ; also, in centering the instrument over these station marks when observing. Any neglect in this respect completely neutralizes the approximation to accuracy that is aimed at by the reiteration of the angles laid down in the programme.

MARKING THE SURVEY.

Posts must be placed on line.

153. The attention of the surveyor is especially directed to the necessity of his making sure that the posts planted for township, section and quarter section corners are placed in their correct positions as indicated by the chainage and *exactly on the line*. He is reminded that otherwise all refinement of astronomical observations and of line measurements will be absolutely thrown away.

Neglect of precautions in this behalf inevitably leads to serious errors in the subsidiary subdivision work.

REPORTS AND RETURNS.

Monthly returns.

154. Block surveyors shall send reports of progress at intervals as nearly monthly as circumstances will allow ; such reports to be accompanied by sketches, on the scale of six miles to the inch. On these sketches the lines surveyed up to date shall be shown in red, and the main topographical features of the country, rivers, lakes, trails, hills, &c., as well as the deviations of the base lines, the depth of quarter sections adjoining the correction lines, and the length of the jogs on correction lines shall be shown. The general character of the surrounding country shall be indicated.

Block surveyors must also inform the township outline surveyors, when any are working within their blocks, of the depths of quarter sections adjoining the correction lines, the lengths of the jogs on the correction lines and the deviations of the block lines.

Final returns.

155. The final returns of the survey will consist of—

1. A diary for the time the surveyor has been employed.
2. Plans of the survey, on the scale of forty chains to the inch on the forms supplied. They will show all the topographical features of the country crossed by the block lines, in the manner prescribed for subdivision surveys. (See § 109.)
3. A copy of the field notes.
4. The record of astronomical observations.
5. Oath of chainmen.
6. A general report of the survey. (See § 117.)

SURVEY OF THE TOWNSHIP OUTLINES.

Instruments.

156. The instrument to be used for the survey of the township outlines shall be a transit theodolite with a vertical circle, both circles reading at least to minutes. It shall be inspected and approved by the Surveyor-General.

Method of subdividing blocks.

157. In surveying the meridian exteriors, the surveyor will commence at one of the township corners of the base line.

He will carefully measure one or two miles of the base before beginning the subdivision of the block; this will enable him to compare his chaining with that of the lines previously run.

The meridian is to be carried only as far as the correction line, where a temporary post is left. The corresponding meridian is then surveyed from the township corner on the next base to the same correction line, and the jog run between the ends of the two meridians, on the proper azimuth. The north and south closing error is distributed equally between the two quarter sections, adjoining and on each side of the correction line, so as to make both quarter sections of the same depth. The marks for township corners are now permanently established.

No posts are to be planted by the surveyor of township outlines, between the township corners on the correction line.

Measurements.

158. Any difference in the chainage of two meridians will cause corresponding deviations in the east and west lines joining the same; great care should therefore be bestowed on the measurements. Chesterman's steel band chain shall be used and every precaution taken to ensure accuracy.

Observations for azimuth.

159. The direction of the line with reference to the meridian can be obtained by the method hereinbefore explained. But if the instrument be too small to observe stars in the daytime, the direction can be obtained by observing the sun's altitude before or after noon. If care be taken, this method will give all necessary accuracy.

The instrument should be provided with a coloured glass to enable the surveyor to look at the sun through his telescope.

Azimuth by the sun.

160. The observations will be made first with the vertical circle to the right of the observer and then with the circle to the left, reversing the telescope and turning the azimuth plate 180° in azimuth.

In the first instance the image of the sun is to be brought in one of the angles formed by the wires in the telescope so as to be tangent to both wires at the same time, and the same process is to be repeated with the instrument in the second position, but with the sun's image in the opposite angle. In order to bring both wires tangent to the sun's limb at the same time, the sun's image should be placed so as to move towards one wire while going off the other; the former wire is kept tangent to the sun's limb by the proper slow motion screw until both wires are tangant at the same time. In the opposite angle of the wires, the same

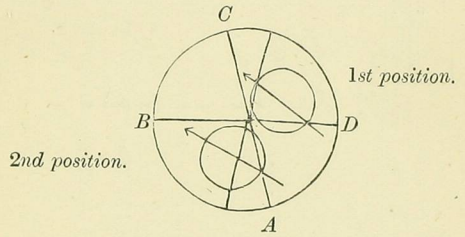


Fig. 20.

process is repeated with the other slow motion screw. Fig. 20 illustrates how the sun's image should appear in the afternoon with an inverting telescope, the apparent direction of the sun's motion being shown by the arrows. In the first position the wire AC should be kept tangent to the limb with the slow motion in azimuth, until DB is also tangent. In the second position DB would be kept tangent to the limb with the slow motion in altitude until AC is also tangent.

DATE—21st November, 1881—3 18 P.M.
PLACE—2nd base line—50 chs. W. of N.E. corner section 31, R. 14 W. of 3rd Meridian.

CIRCLE.	SUN'S ALTITUDE.	H. C. R. ON SUN.	H. C. R. ON LINE.
R	6° 44′ 00″	323° 07′ 00″	184° 35′ 30″
L	6 50 00	322 12 00	184 36 30
Mean.	6 47 00	322 39 30	184 36 00

GREENWICH TIME.

Local time=November 21	.....	3*h*. 18*m*.
Longitude	.....	7 08
Greenwich time=November 21	.....	10 26

Correction of altitude.

Obs. altitude	=6° 47′ 00″
—Refraction	= 7·38
Difference	=6° 39′ 22″
Parallax	= 9
h	=6° 39′ 31″

Sun's Polar Distance.

Decl. at 0*h*	=20° 01′ 35″
Var. for 10*h*. 26*m*.	=+ 5·42
Decl. at 10*h*. 26*m*.	=20° 07′ 17″
△	=110° 07′ 17″

h =	6° 39′ 31″
φ =	49 20 58
△ =	110 07 17
2*S* =	166 07 46
S =	83 03 53
S--△ =	27 03 21

sec. *h*	= 0·00294
sec. *φ*	= 0·18612
cos. *S*	= 9·08188
cos. (*S*—△)	= 9·94966
$\cos.^2 \frac{z}{2}$	= 19·22060
$\cos. \frac{z}{2}$	= 9·61030
$\frac{z}{2}$	= 65° 56′ 30″
z	=131 53 00
Az	=228 07 08
H. C. R. on Sun	=322 39 30
North point	= 94 32 30
H. C. R. on line	=184 36 00
Az. of line	= 90 03 30
Az. by account	= 90 02 51
Error	= 39″

DATE—June 15th, 1881—7.20 A.M.
PLACE—8th base line—25 chs. W. of N.E. corner section 36, R. 17 W. of 2nd Meridian.

CIRCLE.	SUN'S ALTITUDE.	H. C. R. ON SUN.	H. C. R. ON LINE.
R	29° 50′	175° 43′	176° 38′ 00″
L	30 34	176 51	176 40 00
Mean.	30 12	176 17	176 39 30

GREENWICH TIME.

Local time=June 14	.....	19*h*. 20*m*.
Longitude	.....	6 57
Greenwich time=June 15	.....	2 17

Correction of altitude.

Obs. altitude	=30° 12′ 00″
—Refraction	= 1 40
Diff.	30 10 20
+Parallax	= 8
h	= 30 10 28

Sun's Polar Distance.

Decl. at 0*h*	= 23° 20′ 16″ N.
Var. for 2*h* 17*m*	= + 14
Decl. at 2*h* 17*m*	= 23 20 30
△	= 66 39 30

h =	30° 10′ 28″
φ =	51 26 45
△ =	66 39 30
2*S* =	148 16 43
S =	74 08 21
S—△ =	7 28 51

sec. *h*	= 0·06324
sec. *φ*	= 0·20533
cos. *S*	= 9·43664
cos. (*S*—△)	= 9·99629
$\cos.^2 \frac{z}{2}$	= 19·70150
$\cos. \frac{z}{2}$	= 9·85075
$\frac{z}{2}$	= 44° 50′ 00″
z or *Az*	= 89 40 00
H. C. R. on sun	=176 17 00
North point	= 86 37 00
H. C. R. on line	=176 39 30
Az. of line	= 90 02 30
Az. by account	= 90 03 08
Error	= 38″

The reading of the horizontal circle on the reference object, generally one of the line pickets, should be taken in both positions of the instrument, and the approximate time of observation noted.

The best time for observation is when the sun is near the prime vertical, that is to say nearly due east or west.

Reduction of observations.

161. The following formula may be used for the calculation :

$$\cos. \tfrac{1}{2}z = \sqrt{\cos S \cos (S - \triangle) \sec \phi \sec h}$$

$$\text{where } S = \frac{h + \phi + \triangle}{2}$$

h being the true altitude of the sun, ϕ the latitude, $\triangle$ the sun's polar distance, and z the angular distance between the sun and the north point. Reckoning the azimuth from 0° to 360° from the north point through east, south and west, z is the azimuth in the forenoon and 360° minus the azimuth in the afternoon.

The latitude and its secant are given in Table IX. for the north side of every section.

On pages 62 and 63 two examples are given, one in the afternoon and the other in the forenoon.

Reports and returns.

162. The surveyors of township outlines shall send in reports of progress at intervals as nearly monthly as possible, such reports being accompanied by sketches on the scale of one-half mile to the inch, showing the work done and the character of the country, in the manner directed for block surveyors.

These sketches shall exhibit the length of every quarter section line when different from 40 chains. Such information is also to be sent directly by the township outline surveyor to the subdivider, when requested by the latter.

The final returns of the survey are the same as for block surveys.

SURVEYS IN THE RAILWAY BELT OF BRITISH COLUMBIA.

Dominion lands in British Columbia.

163. The Dominion Lands in British Columbia comprise all the lands lying within twenty miles of the main line of the Canadian Pacific Railway from the summit of the Rocky Mountains to Port Moody on Burrard Inlet.

How surveyed.

164. They are surveyed into rectangular townships in the manner hereinbefore described.

Surveys based on traverse of railway line.

165. Owing to the mountainous character of the country it is impracticable to survey the base lines and block and township outlines as on the prairie. All the surveys are based upon a traverse survey made along the railway line, from which the positions of the corners of the sections through which the railway passes have been computed.

Tables of positions of stations.

166. These positions have been tabulated, and printed in a list of "Positions of Stations on the C.P.R. Traverse," copies of which are furnished to surveyors making surveys in the railway belt.

Use of the tables.

167. In this list the position of the actual point at which the instrument was placed in the traverse survey is given with reference to the north-east corner of the section in which it is.

The surveyor therefore first finds the instrument station, and then measures the given distances east and north ; this gives him the point at which he is to place the section corner post.

Since, however, the instrument station was usually on or near the track, and hence the hub is generally not to be found, being covered with ballast, reference is made to bearing trees or posts, called C.P.T. (Canadian Pacific Traverse) posts. The given bearings and distances from the station to the post will enable the surveyor to locate the station when he finds the bearing post.

Caution.

168. Surveyors are cautioned that some of these bearing posts have been moved, and, to avoid error, it is therefore necessary to connect with two or more of them.

Survey continued from initial corner.

169. When the section corner has been placed in manner aforesaid, the survey of the section lines is to be continued therefrom by laying off the theoretical widths and depths of sections.

Marks of the mountain triangulation.

170. Where cairns or posts have been established by the trigonometical survey in the mountains, the sectional survey can be based, in like manner, on their tabulated positions.

Outer limit of the railway belt defined.

171. The outer limit of the railway belt is defined to be a line, each point of which is exactly twenty miles distant from the point of the railway nearest to it.

Establishment of outer limit.

172. In making a survey for the purpose of determining the limits of the belt, the surveyor may run township or section lines or make a traverse of some stream, road or lake leading to the limit, from which he can locate the section lines in that vicinity.

The exact position of the intersections of the belt limit with the section lines is given by a table published by the Topographical Surveys Branch of the Department of the Interior.

Tables of the positions of the monuments of the triangulation and topographic survey of the railway belt will also be published, from time to time, as the survey progresses.

The surveyor may connect with the monuments by a three-point, or other triangulation.

EXTRACTS

FROM THE

DOMINION LANDS ACT.

49 VIC., CHAP. 54.

Board may suspend or dismiss negligent or corrupt surveyor.

§120. The board may, in its discretion, suspend or dismiss from the practice of his profession, any Dominion land or topographical surveyor whom it finds guilty of gross negligence or corruption in the execution of the duties of his office; but the board shall not suspend or dismiss such surveyor without having previously summoned him to appear in order to be heard in his defence, nor without having heard the evidence offered both in support of the complaint and on behalf of such surveyor; and, if, after being summoned as aforesaid, the surveyor does not appear, the board may appoint a fit and proper person to present the evidence on behalf of the surveyor. 49 V., c. 27, s. 20, *part*.

Surveyor or some one on his behalf to be heard.

Surveyors to add to their returns of survey an affidavit of the faithful and correct execution thereof.

If statement is false, proceedings to be instituted on the bond.

Effect of such suit.

§121. The Surveyor-General shall require every Dominion land or topographical surveyor, in addition to the oath by this Act required to be administered to him on receiving his commission as such, to take and subscribe an oath, or make and subscribe an affirmation, on the return of his surveys of Dominion lands, that the same have been faithfully and correctly executed according to law and the instructions of the Surveyor-General; and if it is proved, on satisfactory evidence, before any court of competent jurisdiction, that such surveys, or any part thereof, have not been so executed, the Attorney-General of Canada shall, upon the application of the Surveyor-General, immediately institute a suit upon the bond of such surveyor; and the institution of such suit shall operate as a lien on any property owned or held by such surveyor, or his sureties, at the time the suit is instituted. 46 V., c. 17, s. 107, *part*.

CHAIN BEARERS.

Chain bearer to be sworn.

§124. Every chain bearer employed in the survey of Dominion lands shall, before he commences his chaining or measuring, take an oath or affirmation that he will discharge such duty with ex-

actness, according to the best of his judgment and ability, and render a true account of his chaining or measuring to the surveyor by whom he has been appointed to such duty ; and any Dominion land surveyor may administer such oath or affirmation. 46 V., c. 17, s. 108.

STANDARD OF MEASURE.

Standard to be English measure of length.

Measuring instruments to be regulated thereby. Testing subsidiary standard.

§125. The measure of length used in the surveys of Dominion lands shall be the English measure of length ; and every Dominion land surveyor shall be in possession of a subsidiary standard thereof—which subsidiary standard, tested and stamped as correct by the Department of Inland Revenue, shall be furnished to him by the secretary of the board on payment of a fee of eight dollars therefor ; and all Dominion land surveyors shall, from time to time, regulate and verify, by such standard, the length of their chains and other instruments for measuring ; and the said standard measure shall be returned to the secretary of the board as often as it requires to be tested again :

Penalty for surveyor without standard.

2. Every surveyor who is found performing his duties without being in possession of the standard measure which, by this clause, he is required to have, shall be liable to be suspended for a period not exceeding twelve months. 49 V., c. 27, s. 21.

RENEWAL OF LOST CORNERS AND OBLITERATED LINES.

Provision where the original mound or post is lost.

§126. Whenever a Dominion land surveyor is employed to run any dividing line or limit between sections or other legal subdivisions, and the mound, post or monument erected, marked or planted in the original survey, to define the corner of such section or other legal subdivision, cannot be found, he shall obtain the best evidence that the nature of the case admits of, respecting such corner mound, post or monument ; but if the position of the same cannot be satisfactorily so ascertained, he shall proceed as follows :—

If a township corner.

(*a.*) If the lost corner mound, post or monument is that of a township corner, he shall report the circumstances of the case to the Surveyor-General, who shall instruct him how to proceed ;

If on one of the outlines of a township.

(*b.*) If the lost corner mound, post or monument is on one of the outlines of a township, he shall join, by a straight line, the nearest undisputed section or quarter section corners on such outline, and divide such straight line into such number of sections or quarter sections or other legal subdivisions as the same contained in the original survey,—giving to each an equal breadth ;

As to correction lines.

(*c.*) If, in re-establishing the east or west boundary of a township, one of the nearest undisputed corners is on a correction line, every quarter section shall be made exactly forty chains, and the deficiency or surplus, as the case may be, shall be left in the quarter section adjoining the correction line ;

Where a deficiency shall be left.

(*d.*) If, in re-establishing the north or south boundary of a township surveyed under the first system of survey, one of the nearest undisputed corners is the western corner of the township, every quarter section shall be made exactly forty chains, and the deficiency or surplus, as the case may be, shall be left in the western quarter section ;

Township corner to be re-established.

(*e.*) When the position of the township corner is also lost, it shall be re-established as aforesaid, previously to re-establishing the outline of the township ;

When the lost corner is in the interior of a township.

(*f.*) When the lost corner is in the interior of a township, on the limit of a meridian road allowance, the surveyor shall connect the two nearest undisputed corners on such limit by a straight line, and divide the distance into such number of sections or other legal subdivisions as the same contained in the original survey, giving to each an equal breadth ;

When nearest undisputed corner is on a correction line.

(*g.*) If one of the nearest undisputed corners is on a correction line, he shall make each quarter section exactly forty chains and leave the deficiency or surplus, as the case may be, in the quarter section adjoining the correction line ;

When nearest undisputed corners are in different townships.

(*h.*) When the nearest undisputed corners on the said limit of a meridian road allowance are in different townships, the outline between such townships shall be re-established previous to re-establishing the meridian ;

When of a quarter section on a line running east to west.

(*i.*) When the lost corner is that of a quarter section on a line running east and west, the surveyor shall join, by a straight line, the opposite section corners on the meridians on each side, and give to each quarter section an equal breadth ;

When in western row under first system of survey.

(*j.*) If, in townships surveyed under the first system of survey, the lost corner is in the western row of sections of a township, the first quarter section shall be made exactly forty chains, and the deficiency or surplus, as the case may be, shall be left in the western quarter section ;

When meridian shall be re-established.

(*k.*) When the position of one of the corners on the meridians is also lost, such meridian shall be re-established previously to re-establishing the east and west line ;

Allowance for road to be considered.

Effect of such survey.

(*l.*) Whenever a surveyor erects, plants or places a mound, post or monument as aforesaid, to renew a lost or obliterated corner, he shall duly take into account any allowance for road or roads; and the corner, or division or limit so established, shall be the true corner, or division or limit of such section or other legal subdivision. 46 V., c. 17, s. 110.

SURVEY OF LEGAL SUBDIVISIONS.

Method of proceeding in laying out a half or quarter section or other legal subdivision.

§127. When, in the survey of legal subdivisions, it is necessary for a Dominion land surveyor to establish the division line between two sections, he shall effect this by connecting, by a straight line, the opposite original section corners, if they exist, and if not, by similarly connecting the points established in renewal thereof, in accordance with the next preceding clause, giving, in either case, the quarter sections involved an equal breadth:

Half or quarter section.

2. In laying out a half section or a quarter section he shall connect the opposite quarter section posts by straight lines:

Other subdivisions.

3. In laying out other and minor legal subdivisions he shall give to every such subdivision its proportionate share of frontage and interior breadth, and connect the resulting terminal points by a straight line:

Lines drawn to be true limits.

4. The lines or limits so drawn on the ground in the manner above prescribed shall, in the respective cases, be the true lines or limits of such section, half section or other legal subdivision, whether the same correspond or do not correspond with the area expressed in the respective patents for such lands. 46 V., c. 17, s. 111.

DIVISION LINES IN FRACTIONAL SECTIONS.

Dividing lines to be drawn from original corners.

§128. The dividing lines or limits between legal subdivisions, in fractional sections, shall be drawn from the original corners (or the points representing such corners, as defined on the ground, in accordance with the provisions of this Act), in the section line intended as the front of the lot:

Northerly and southerly lines.

2. Northerly or southerly lines shall be drawn due north or due south:

Easterly and westerly lines.

3. Easterly or westerly lines shall be drawn at an angle with the meridian equal to the mean of the angles formed with the same meridian by the lines which are the northern and the southern boundaries respectively of the section. 46 V., c. 17, s. 112.

Extracts from the Act 52 Victoria, Chap. 27, amending "The Dominion Lands Act."

R.S.C., c. 54, s. 11, repealed, new provision.

§1. Clause eleven of the said Act is hereby repealed and the following substituted therefor:

Width of townships on base lines.

"11. Except as herein otherwise provided, townships shall be given their prescribed width on the base lines hereinafter mentioned; and the meridians between townships shall be drawn across such bases, northward and southward, to the depth of two townships thereform, that is to say, to the correction lines hereinafter mentioned:

Certain meridians how surveyed.

"2. The meridians between those townships situated between the International Boundary or first base line and the first correction line, shall be surveyed to the south from the said first correction line to the said International Boundary or first base line."

§2. Clause fifteen of the said Act is hereby repealed and the following substituted therefor:—

S. 15 repealed, new provision. Allowances for deficiency or surplus.

"15. In the survey of a township, the deficiency or surplus, resulting from convergence of meridians, shall be allowed in the range of quarter sections adjoining the west boundary of the township, and the north and south error in closing on the correction lines from the north or south shall be allowed in the ranges of quarter sections adjoining, and north or south respectively of, the said correction lines; excepting in the case of the north and south closings in those townships between the first correction line and the International Boundary or first base line, which error is to be left in the last quarter section adjoining the said first base line; but the Governor in Council may order such deficiency or surplus, and such north and south error, or either of them, to be equally distributed among all the quarter sections involved."

Exception.

Section 129, repealed, new provision.

§7. Clause one hundred and twenty-nine of the said Act is hereby repealed and the following substituted therefor:—

Boundaries under this Act are to be deemed the true ones,

"129. All boundary lines of townships, sections or legal subdivisions, towns or villages, and all boundary lines of blocks, gores and commons, all section lines and governing points, all limits of lots surveyed, as defined by mounds, posts or monuments, erected, placed or planted at the angles of any townships, towns, villages, sections or other legal subdivisions, blocks, gores, commons and lots or parcels of land under the authority of this Act or of the Governor in Council, shall, subject to the provisions hereinafter in this clause contained, be the true and unalterable boundaries of such townships, towns and villages,

sections or other legal subdivisions, blocks, gores, commons and lots or parcels of land respectively, whether the same, upon admeasurement, are or are 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 subdivision, block, gore, common, lot or parcel of land :

Township survey may be cancelled.

"2. Whenever the Minister of the Interior has reason to believe that any gross irregularity or error has been made in the survey of any township surveyed under the authority of this Act, the Governor in Council, upon the recommendation of the Minister of the Interior, may direct that such survey shall be cancelled and a new survey made, and the said new survey shall be made accordingly :

Boundary marks in such case.

"3. In effecting any new survey as provided by the preceding sub-clause, all posts, mounds or other marks placed to mark the original survey which is to be corrected, may be removed, and the new posts, mounds or other marks placed to mark and define the new survey, shall become the original marks of such survey :

Amendment of plans.

"4. The plan of any survey performed under the provisions of this Act, and of record in the Department of the Interior, or any tracing or lithographed copy of the same, may be altered and amended so as to show any and all alterations made by a new survey effected as provided by this Act."

ACCOUNTS OF SURVEYORS UNDER DAILY PAY.

Surveyors who are employed by the day, will receive, before leaving for their surveys, advances sufficient to procure their outfit and supplies.

When a payment is applied for, a statement must be furnished on the printed forms supplied, showing the disposal of the moneys received and those applied for.

No draft on the Department, or order, or power of attorney for moneys on account of the survey will be accepted until the returns of the survey have been examined and approved.

At the completion of the survey, the horses and outfit shall be sold, but when directed to do so, surveyors shall winter such of their horses and such part of their outfit as are in sufficiently good condition for another year's service.

The accounts are to be in duplicate, and the original and duplicate must be exactly alike in all respects and made up in separate bundles.

Each is to consist of :—

1st. An account of personal services.

2nd. A pay-list of party, showing the date of engagement and discharge of every man, his occupation and rate of pay, and the number of rations for the party. It must be signed by each of the men.

3rd. A transport account, with vouchers duly numbered, accompanied by a separate and detailed statement of travelling expenses.

4th. A balance sheet showing on the credit side the gross amounts of personal services, pay-list and transport accounts, and camp equipage and stationery allowances, and on the debit side the payments received on account of the survey.

Each of the accounts is to have its vouchers attached and statements of sales, if any, attested by the purchasers.

The vouchers must give the detail of articles purchased, with the price of each.

The items of boarding allowance, camp equipage and stationery, for which specific amounts are allowed, are to be charged each in one lump sum, without giving details or vouchers.

ALLOWANCES TO SURVEYORS.

Service.	Number or Quantity.	$ cts.
Personal Services and Alcowances.		
Salary of Surveyor in charge, per diem		
Ration allowance in the field do	1	
do at office work do	1	1 00
Pay-list.		
Assistant, per diem	1	
Chainmen do (if allowed by instructions)	2	
Cook do	1	
Labourers do		
Ration allowances, per diem		
Transport.		
Horses		
Buckboard		
Carts		
Cart covers		
Sets of harness		
Hobbles		
Horse bells		
Oats and horse-keeping		
Leather, twine, oil, for repairing harness, horse-shoes, axle grease		
Freight and storage, west of Winnipeg		
Railway fare and sleeping car for surveyor in charge, east of Winnipeg		
Travelling expenses of party, west of Winnipeg		
Boarding allowance		
Camp Equipage and Plant.		
All articles, tents included		
Stationery.		
All articles		

The preparation of the returns of survey immediately after the surveyor has completed his field work for the season will be insisted upon.

CONTRACT SURVEYS.

The subdivision of townships is to be made, according to law, at certain rates per mile. These rates are generally determined in advance for each township.

Where not so fixed, the mileage will be classified as follows:—

1st Class. Any land not classified as second or third class.

2nd Class. Poplar, and other soft woods, where occurring in alternation with prairie.

3rd Class. Contracts composed of townships all woods, and wherever they occur, heavy underbrush, hard woods, windfalls, thick willows.

Traverse lines are paid for at the rate of nine dollars per mile east of the fourth initial meridian, and ten dollars per mile west of the same. The distances for the account are measured along the shore from each point determined by an offset, on a straight line, to the next one.

Nothing will be paid for trial lines, offsets or triangles.

In addition to the above rates, the surveyor will receive one dollar for each settler's declaration of occupation.

It is to be clearly understood that the above prices are to include the making of plans, field notes, reports, &c., as well as the cost of survey. Nothing will be paid for lines the marking of which in the manner provided for in this Manual is not completed.

When the number of offsets in a traverse is less than required by the Manual, a deduction of one dollar will be made for every offset missing. Should any part of the work not be performed in accordance with the instructions, a sum sufficient to cover the cost of corrections will be deducted from the amount of the contract.

A surveyor, upon obtaining a contract, will be required to enter into a bond, jointly with two securities each, in a sum equal to the estimated amount of his contract, for the due and faithful fulfilment thereof.

Surveyors will receive, with their contract, blank books for field use, blanks of progress accounts, statutory declarations, oath of chainmen and township sketches.

Blank books for office copies of field notes, skeleton township plans, timber reports and forms of general account will be supplied on the application of the surveyor,—stating the number of each required. It is recommended that such blanks should only be applied for at the time they are required for use, as, when carried in the field, they are liable to be spoiled.

Iron posts will be supplied free of cost, provided they are all used on the survey. Those not so used will have to be returned to store, otherwise they will be charged for at 40c. each.

The lines embraced in any survey under contract must be run by the surveyor *in person*, and no payment will be made on such contract work if otherwise performed.

A rigid inspection of the work will be made. On satisfactory evidence of any impropriety or unfaithfulness in the execution of a contract being reported to the Department, the survey will be cancelled and steps taken at once to recover from the surveyor or his sureties.

On receipt of the bond, properly executed, from a survey to whom a contract has been given, an advance of $200 will be sent to his address, and a further advance of $800 on account of contract, will be placed in the Bank of Montreal at Winnipeg, Regina or Calgary, payable there to himself in person.

Seventy-five per cent on account of the work performed will from time to time, be paid to the contractor or be placed to his credit, as he may direct. Such payments will be made on receipt of the progress accounts accompanied by sketches of the work. Credits may be telegraphed to the Bank of Montreal, if urgently required, but only after receipt of the sketches.

All payments are made by cheques, issued either in favour of of the payee, or in favour of the Bank of Montreal to be placed to the payee's credit. It is therefore useless to ask that bank bills be sent instead of cheques.

When a payment on account is applied for, the letter should state whether a cheque is wanted or a credit, and where.

It is of the utmost importance that the Department should be kept well informed of the surveyors' post office addresses. Every letter sent should state where the answer is to be forwarded to.

Particular attention is called to this matter, as the most vexatious delays, due to this cause, are continually occurring, and surveyors are the first to suffer therefrom.

Charges for returns of survey prepared by the Department are as follows:— Charges for returns of survey prepared by the Department.

Township plan (old system)	$ 8 00
do (new system)	6 00
Copying a Field Book (old system) per township	13 00
Copying a Field Book (new system) per township	10 00

These prices include only a small amount of traverse lines. Extra work on that account will be charged for. Plots of traverses are to be furnished in all cases, as the Department will not undertake to plot a traverse for a surveyor.

CONSTRUCTION AND USE OF THE TABLES.

TABLE I.

Length of Arcs of Meridians, Parallel, &c., in Different Latitudes.

According to Col. A. R. Clarke, R.E., in his "Comparison of Standards of Length" (1866), the spheroid of revolution most nearly approaching the form of the earth has for its major or equatorial semi-axis 20926062 feet, and for its minor or polar semi-axis 20855121 feet.

Representing the major and minor axis by a and b respectively, we have for the compression, $C=\frac{a-b}{a}=\frac{1}{294\cdot98}$, and the eccentricity e is given by the formula

$$e^2=\frac{a^2-b^2}{a^2}=\frac{1}{148} \text{ nearly.}$$

The unit of measure in the Dominion Lands surveys is the Gunter's, or sixty-six feet chain. The equatorial semi-axis in chains is 317061·545+

Representing by ϕ the geographical latitude of a place, or the angle which its vertical line makes with the equator, we have for the radius of curvature of the meridian

$$R=\frac{a\,(1-e^2)}{(1-e^2\,\sin^2\phi)^{\frac{3}{2}}},$$

for the length of the normal to the meridian terminated by the minor axis

$$N=\frac{a}{(1-e^2\,\sin\phi)\,\frac{1}{2}},$$

and for the radius of the parallel of latitude ϕ

$$P=N\cos\phi.$$

The length in chains of one second of latitude is equal to R sin 1″; one second of the great circle perpendicular to the meridian is equal to N sin 1″; and one second of longitude is equal to P sin 1″. The logarithms of these quantities are placed in

the second, third and fourth columns of Table I. They have been calculated by means of the logarithmic expansions of R and N.

Thus putting n for $\frac{a-b}{a+b}$ we have

$$\log\,(R\,\sin 1'')=\log a+\log\sin 1''-M\left(n+\frac{3n^2}{2}\right)$$
$$-3\,M\left(n\cos 2\phi-\frac{n^2}{2}\cos 4\phi\right)+\text{\&c.}$$

where M is the modulus of the common system of logarithms, and powers of n higher than the second are neglected as being insensible in the eighth decimal place.

Substituting the value of a in chains, as given above, and taking

$$n=\frac{a-b}{a-b}=\frac{1}{588\cdot96}\text{, we get}$$

$\log(R\ \sin 1'') = 0\cdot18597916-0\cdot00221218\cos 2\phi + 0\cdot00000188\cos 4\phi.$

In calculating the two last terms by logarithms five places are sufficient.

For N sin 1″ we have

$\log(N\ \sin 1'') = \frac{1}{3}\log(R\ \sin 1'') + \frac{2}{3}\left\{(\log a+\log\sin 1''+2\ Mn)\right\} = \frac{1}{3}\log(R\ \sin 1'') + 0\cdot12546215.$

For P sin 1″; $\log P\ \sin 1'' = \log(N\ \sin 1'') + \log\cos\phi.$

The calculation has been made to eight places of decimals to ensure accuracy in the seventh place. In tabulating, the eighth figure has been dropped.

The calculation of the logarithms of R sin 1″ and N sin 1″ has also been made directly from the formulæ for R and N, by the use of a subsidiary angle.

Thus, finding an angle Ψ such that $\sin\Psi = e\sin\phi$ we have

$$R\ \sin 1'' = a(1-e^2)\sec^3\Psi\ \sin 1''$$
$$N\ \sin 1'' = a\sec\Psi\ \sin 1''.$$

Seven figure logarithms were used, and consequently the results could not be depended upon to the seventh figure, but they have been serviceable as a check upon the series computation.

Log N sin 1″, log P sin 1″ and log R sin 1″ are given in the table for every 10′ of latitude from 42° to 70°. Their values for intermediate latitudes can be obtained by simple interpolation. Where, however, log P sin 1″ is required with accuracy for an intermediate latitude, it is better first to obtain log N sin 1″ for that latitude by interpolation from the table and then to add log cos ϕ.

Under the heading "Chains in 1″" are given the natural numbers corresponding to the logarithms of R sin 1″ and P sin 1″. These natural numbers are useful in reducing small differences of latitude and longitude to chains by simple multiplication, being preferable in many cases to the logarithms.

The converse operation of reducing short distances north and south or east and west to seconds of latitude or longitude may be performed by multiplying by the quantities in the two columns headed "seconds in one chain." These columns contain the reciprocals of the quantities in the columns "chains in one second."

In the last two columns of the table are given the lengths of one degree of latitude and longitude in English miles.

Radius of Curvature of a Section of the Spheroid inclined at any angle to a Meridian.

In some operations it is necessary to find the radius of curvature of the trace on the earth's surface of a "straight" or "transit" line making a given angle with the meridian.

Representing this radius of curvature by S, and θ being the angle with the meridian, we have the formula

$$\frac{1}{S}=\frac{\cos^2\theta}{R}+\frac{\sin^2\theta}{N}$$

and introducing an auxiliary angle X determined by the formula

$$\tan X=\sqrt{\frac{R\sin 1''}{N\sin 1''}}\tan\theta, \text{ we have}$$

$$S\sin 1''=N\sin 1''\frac{\sin^2 X}{\sin^2\theta}$$

a formula adapted for ready calculation by means of logarithms.

Radius of Spherical Curvature.

The mean of the values of S when θ is given all possible values is $\sqrt{NR}$. This is the radius of curvature of the surface or the radius of the sphere most closely approximating to the form of surface at a given point. Its logarithm is readily found from Table I., being the arithmetical mean of the logarithms of N and R.

TABLE II.

Corrections to Table I for Change in Elements of Figure of Earth.

In Table I. the data used are Clarke's 1866 values, viz. :—

$$a=20926062 \text{ feet}$$

$$n=\frac{1}{588\cdot 96}$$

and all the following tables are based on Table I., and therefore on these values. Clarke's later values (Geodesy, 1880) are,

$$a=20926202 \text{ feet}$$

$$n=\frac{1}{585\cdot 93}$$

If, for any purpose, it is desired to use these values, Table I. can be corrected by means of Table II., which has been computed thus :

Differentiating the formulæ,

$$\log R\sin 1''=\log a+\log\sin 1''-M(n+\tfrac{3}{2}n^2)-3Mn\cos 2\phi+\tfrac{3}{2}Mn^2\cos 4\phi$$

$$\log N\sin 1''=\log a+\log\sin 1''+M\left(n-\frac{n^2}{2}\right)-Mn\cos 2\phi+\tfrac{1}{2}Mn^2\cos 4\phi$$

and putting $\frac{1}{n}=p$, we have

$$d(\log R\sin 1'')=M\frac{da}{a}+Mn^2dp+3Mn^2\cos 2\phi dp$$

$$d(\log N\sin 1'')=M\frac{da}{a}-Mn^2dp+Mn^2\cos 2\phi dp$$

M being the modulus of the common system of logarithms. Terms involving the cubes and higher powers of n are insensible and may be neglected.

To change Clarke's earlier to his later values, we have

$$da=+140 \text{ (feet)}$$

$$dp=-3\cdot 03$$

$$a=20926062 \text{ (feet)}$$

$$n=\frac{1}{588.96}$$

and $M=0\cdot 43429448$

whence $d\log(R\sin 1'')=-\cdot 00000089-\cdot 00001138\cos 2\phi$

$d\log(N\sin 1'')=+\cdot 00000670-\cdot 00000379\cos 2\phi$

These quantities are tabulated in Table II, with the proper signs of application to log R sin 1″ and log N sin 1″ in Table I.

Table III.

Latitudes of Base and Correction Lines and Lengths of Arcs of Meridian, Parallel, &c., for First and Second Systems of Survey.

This table is constructed for the first and second systems of survey only. It accordingly stops at the 13th Base, Township 48, north of which there are no surveys under these systems.

Each township measuring 489 chains each way, the 1st correction line is 978 chains north of the 49th parallel.

The latitude of the 1st correction line is therefore

$$49^\circ + \frac{978}{R \sin 1''};$$

Here R sin 1″ must be taken from Table I. for the middle latitude between the 1st base and the 1st correction line. For accuracy it is therefore necessary to compute an approximate difference of latitude, using an approximate value of R sin 1″. For instance R sin 1″ may be taken from the table for latitude 49°.

The approximate difference of latitude being thus determined, the middle latitude is found from it (this being a sufficiently close approximation), and the final R sin 1″ is taken from Table I. for that latitude. Then dividing 978 by this we have a very close approximation to the difference of latitude between the base and the correction line.

From the latitude thus obtained of the 1st correction line, that of the 2nd base line is found by a similar process, and so on in succession as far as the table extends.

The table is checked by applying the same process to a longer distance than 978 chains. For example the latitude of the 6th base can be directly determined from that of the first by using 9,780 chains instead of 978. When long distances are thus taken, a second approximation to the middle latitude may become necessary.

The columns log N sin 1″ and log R sin 1″ are taken from Table I. by interpolation, and log P sin 1″ is found by adding log cos ϕ to log N sin 1″.

The width of a township along a base line is 489 chains. The longitude corresponding to this length measured along the

parallel of latitude is given in the column headed "Longitude covered by 489 chains westing," not only for the base lines but also for the correction lines.

The longitude for 489 chains, along a base line, is the longitude covered by one range of townships. Along a correction line it does not correspond to the longitude covered by a range, since the width of a township along a correction line is greater or less than 489 chains according as the township north or south of the correction line is considered. The tabulated quantity, however, for correction lines can be used to calculate the narrowing or widening of sections at the correction lines.

The township width 489 chains is measured along the base line which has such azimuth that its terminal point falls in the same latitude as its initial point.

Thus every township corner along a base line has the same latitude, and the base line is a succession of chords of the latitude circle.

The difference of longitude between one township corner and the next is given by the formula

$$\mathrm{d}\lambda = \frac{486}{P \sin 1''}$$

It is assumed here that the chord of the arc of the latitude circle is equal to the arc. That the difference between the chord and the arc is inappreciable may be shown thus :

By spherical trigonometry

$$\sin \frac{\text{chord}}{2\,N} = \sin \frac{\mathrm{d}\lambda}{2} \cos \phi$$

$$\text{whence chord} = N \cos \phi \, \mathrm{d}\lambda - N \cos \phi \sin^2 \phi \frac{\mathrm{d}\lambda^3}{24}$$

$$= \text{arc} - \text{arc} \times \frac{d\lambda^2}{24} \sin^2 \phi$$

So that the difference between the chord and the arc is equal to

$$\text{arc} \times \frac{\mathrm{d}\lambda^2}{24} \sin^2 \phi$$

$d\lambda$ being in circular measure.

For a chord of 489 chains this amounts to less than one-hundredth of a link.

The chord always lies north of the arc. The distance between them is greatest at their middle points, amounting there to about

$6\frac{1}{2}$

10 links. Hence, at the International boundary line, which is the first base line, since the actual territorial boundary is the curve, and the base line a series of chords, the road allowance which lies along the north side of this base is increased in width by 10 links at the middle of the chords.

The non-coincidence of the chord and arc also has the effect of increasing and decreasing the widths of roads on correction lines. This will be referred to again.

In the first column of Table III. are given, for convenience, the number of the townships corresponding to the several base and correction lines. Thus the sixth base is the northern boundary of Township 20, and so on.

Table IV.

Latitudes of Base and Correction Lines, &c., for 3rd and 4th Systems of Survey.

This is exactly similar to Table III., except that it is made for the third system of survey, where the widths of townships are 486 instead of 489 chains, and their depths, in a north and south direction, 483 instead of 489 chains.

This table also applies, without change, to the fourth system (British Columbia).

In this table, as well as in Table III., the latitudes given are those of the line of posts on the south side of the road allowance. To get the latitude of the posts north of the road on correction lines, the latitude of the correction line, as given in the table, must be corrected by adding the equivalent in latitude of the width of the road, *i.e.*, one chain and a-half for the first and second systems (Table III.), and one chain for the third system (Table IV.).

Table V.

Chord Azimuths, &c., for Base Lines, First and Second Systems of Survey.

The extremities of the township chord, as above stated, are in the same latitude. Hence the chord is equally inclined to the meridians passing through its terminal points, and its azimuth, east or west of north, is equal to the complement of half the change in azimuth, that is, of half the "convergence of meridians."

Let dA represent the change in azimuth or convergence of meridians, $d\lambda$ the difference of longitude, and ϕ the latitude.

Then, by spherical trigonometry,

$$\tan \tfrac{1}{2} dA = \tan \tfrac{1}{2} d\lambda \sin \phi,$$

whence, by expansion of the tangents in terms of the arcs,

$$dA = d\lambda \sin \phi + \frac{d\lambda^3}{12} \sin \phi \cos^2 \phi$$

or, if dA and $d\lambda$ be expressed in seconds,

$$dA = d\lambda \sin \phi + \frac{d\lambda^3}{12} \sin \phi \cos^2 \phi \sin^2 1''.$$

The second term is inappreciable, amounting in latitude 51° to less than one ten-thousandth of a second.

$$\therefore dA = d\lambda \sin \phi.$$

The convergence or "deflection" (dA), given in Table V., is thus calculated from the difference of longitude ($d\lambda$) in Table III.

The "chord azimuth" is the complement of half the deflection.

The chord azimuth and the deflection are given in the table in degrees, minutes and seconds, as well as in decimals of a degree, for sexagesimally and decimally divided instruments respectively.

In the survey of a base line, the surveyor, when he arrives at a township corner, deflects his line to the north through an angle equal to the "deflection," and thus establishes in azimuth the chord across the next range of townships.

This deflection angle may be turned with the instrument, but more readily by the use of the "deflection offsets" in the table. The tabulated offset is the linear distance in inches between one of the chords and the prolongation of the other, at one chain from the township corner.

Their distance apart at any point is found by multiplying the tabulated offset by the distance, expressed in chains, of the point from the township corner.

For example, if the instrument is standing on the prolongation of the first chord at 5 chains past the corner, and the back picket be 15 chains on the other side of, that is, behind the corner, then the instrument must be moved north five times, and the back picket south fifteen times, the "deflection offset for one chain." The line of the instrument and picket is now in the correct bearing for the prolongation of the base line.

The angle is thus turned as accurately as a straight line can be produced with the instrument, and much more accurately than the angle can be measured with the graduated arc, while the setting of the instrument at the corner (which may be in low ground, unsuitable for accurate line production) is rendered unnecessary.

"Longitude covered by one range" in the seventh column is merely the longitude in the seventh column of Table III., reduced to time by dividing by 15. This gives the number of seconds which a watch will gain or lose on local time in being carried across a range. The gain or loss in travelling over any other distance along the base line is proportional to the distance. The column is added for astronomical purposes, especially the determination of azimuth by observation of Polaris at any hour angle.

This Table V. applies to the first and second systems of survey.

Table VI.

Chord Azimuths, &c., for Base Lines, 3rd and 4th Systems of Survey.

This table is exactly similar to Table V., but is made for the third system of survey.

The calculation is made by the same formulæ, changing only the width of the range, which is 486, instead of 489 chains, and using the latitudes of the base lines from Table IV., instead of those from Table III.

$$d\lambda = \frac{486}{P \sin 1''} \qquad dA = d\lambda \sin \phi.$$

This table also applies to the fourth system.

Table VII.

Chord Azimuths, Jogs, &c., for Correction Lines, 1st and 2nd Systems of Survey.

This table gives quantities for correction lines similar to those given in Table III. for base lines. This table applies to the first and second systems of survey.

The correction lines are posted on both sides of the road. The chord azimuths and deflections are given for the south side of the road, which is that side for which the latitudes of correction lines are given in Table III.

The calculation of the chord azimuth for correction lines is somewhat different from that for base lines.

For the base lines we have

$$d\lambda = \frac{489}{P \sin 1''}$$

$$\text{deflection} = d\lambda \sin \phi.$$

For the correction lines, one range is not 489 chains, but the distance between meridians which include 489 chains on the nearest base line.

Hence in the formulæ—

$$d\lambda = \frac{489}{P \sin 1''}$$

and deflection $= d\lambda \sin \phi = \frac{489}{P \sin 1''} \sin \phi$, we must take $P \sin 1''$ for the next base line south of the correction line, if the difference of longitude and the deflection for the south side of the correction line road are required; while for the north side of that road we must take $P \sin 1''$ for the next base line north. ϕ, of course, is the latitude of the correction line itself.

The length of one range on the correction line is $d\lambda \times P \sin 1''$.

If, then, P_1 and P_2 represent the radius of parallel for the base lines next north and south, respectively, P that for the correction line itself

$$d\lambda_1 = \frac{489}{P_1 \sin 1''}$$

$$d\lambda_2 = \frac{489}{P_2 \sin 1''}$$

and we have for the length of one range on the correction line

$$\text{North side} = \frac{489}{P_1 \sin 1''} \times P \sin 1''$$

$$\text{South side} = \frac{489}{P_2 \sin 1''} \times P \sin 1''$$

The values of these quantities are tabulated in the seventh and eighth columns of Table VII.

For extreme accuracy $P \sin 1''$ for the north side of the road should be taken out for a latitude greater by 1·50 chains, or 0″·98 greater than that tabulated in Table III. ; but the difference in the result would be almost inappreciable.

The difference of length of the township lines north and south of the correction line road gives the overlap or jog.

The jog for one range is given in the ninth column of the table. As this jog occurs in each range of townships, its value at any range is the product of the jog for one range by the number of ranges.

The excess of the length of the north side over, or the defect of the south side from 489 chains, is the linear divergence or convergence of the township lines. Since there are twelve half sections in a township side, the convergence or divergence for one-half section is one-twelfth of the convergence or divergence for the township, or one-twenty-fourth of the jog, the excess of the north side and the defect of the south side being very nearly, though not quite, equal.

This convergence or divergence for one half section is entered in the tenth column of the table. It is used in the second system, where the surplus or deficiency caused by the convergence of meridians is divided equally among all the quarter sections. Hence in surveying a correction line under the second system, the width of each quarter section (exclusive of the roads) is forty chains *plus* or *minus* this tabulated quantity. The surplus or deficiency on the township line midway between the base and the correction line is half of that on the correction line.

In the first system the whole of the surplus or deficiency is thrown into the western tier of quarter sections. This surplus or deficiency is the difference between 489 chains and the quantities in the seventh and eight columns of Table VII. For example, on the north side of the road on the 1st correction line the surplus is 1·75 chains, and the westerly quarter section of the township is therefore 41·75, all the others being 40 chains.

It is to be observed that in all cases the whole divergence or convergence is applied to the section itself, and that the road allowance retains its width of 1 chain or $1\frac{1}{2}$ chains, with the exception of the roads on correction lines, which are subject to a widening or narrowing as hereinafter explained.

Table VIII.

Chord Azimuths, Jogs, &c., for Correction Lines, Third and Fourth Systems of Survey.

This table gives for the third and fourth systems the same quantities as are given in Table VII. for the first and second systems.

The surplus or deficiency is in all cases divided equally among all the quarter sections.

Table IX.

Latitudes, and Widths in Chains, of Northern Boundaries of Sections in First and Second Systems of Survey.

This table gives the latitudes in degrees and decimals of a degree for the northern boundaries of all sections in the first and second systems.

The sections numbered in the second column are those adjacent to the eastern boundary of the township. The latitudes of interior sections lying west of these are the same. Thus the northern boundaries of sections 14, 15, 16, 17 and 18 have the same latitude as the north boundary of 13, and so for the other east and west tiers of sections.

These latitudes are computed by converting the latitudes given in Table III. into degrees and decimals, and interpolating for the intermediate limes.

The logarithmic secant and tangent of the latitude are given in the table for use in calculation of azimuth observations.

In the last column of the table are given the widths of the north boundaries of the quarter sections (in the second system of survey). These are calculated for the correction lines in the manner explained under Table VII. and for the intermediate lines by interpolation.

Table X.

Latitudes and Widths in Chains of Northern Boundaries of Sections in Third and Fourth Systems of Survey.

This table gives for the third system the same quantities as are given in Table IX. for the first and second.

The table may also be applied to the fourth system by correcting the latitudes of the alternate section lines, viz., the north boundaries of sections 1, 13 and 25 in each township, by subtracting therefrom 0°·0001, the equivalent in arc of 50 links. The change in the logarithmic secant and tangent is inappreciable, as these logarithms are given to only five places of decimals. The widths of quarter sections in the last column must be increased by 50 links.

TABLE XI.

To Reduce Chains to Decimals of a Township Side.

This is a short table giving the equivalents of chained distances in terms of a township side, for township sides of the first and second systems (489 chains), for east and west lines of the third and fourth systems (486 chains), and for north and south lines of these last systems (483 chains). The table is useful in calculating the difference in azimuth of an east or west line between a township corner and any other point upon it, and for similar purposes.

TABLE XII.

Correction to Widths of Roads on Lines on Account of Curvature.

The township corners on the north and south sides respectively of the road on correction lines lie on two circles of latitude, which are one and a half chains apart in the first and second systems, and one chain apart in the third system. The township sides are chords of these circles, and therefore lie north of them.

Hence, since on account of the jog the township corners north and south of the road are not opposite to one another, the township side south of the road will pass the township corner north of the road at a distance less than the theoretical one chain; while the township side north of the road will pass the corner south of the road at a distance greater than one chain.

The correction to the width of the road on this account for various lengths of the jog, is given in the table. The width of the road at points other than the township corners, varies in proportion to the distance.

This table may be used in the exceptional cases where it is necessary to establish the posts on one side of a correction line, by offsets from the other side.

The calculation of the differences of width is made as described below for Table XIII. the difference being merely the offset from the township chord to the parallel.

In Table XII. are also given corrections to the chord azimuths and deflection offsets on correction lines (given in Table VII.) when the north side of the road allowance is surveyed instead of the south. The correction is small and of little importance in surveying, except in the case of the second system of survey, where the correction lines were surveyed instead of the base

lines, as the basis of the townships, across four ranges before closing, and the azimuth was consequently of importance.

In the first system the correction line is surveyed across two ranges as a trial line, and afterwards corrected to the true line; and in the third system the correction line is only surveyed across one range at a time, and as a trial line. In these systems, therefore, the azimuth used in the survey is of little importance.

TABLE XIII.

Difference of Latitude between Township Corners, Section and Quarter Section Corners.

This table is used when it is required to find accurately the latitude of any point within a township, as when it is desired by connecting with an astronomically determined latitude point to find the error of the survey lines.

If A be the initial azimuth of the township chord, A^1 its azimuth at a distance x from the corner of the township, ϕ the latitude of the township corner, ϕ^1 the latitude of a point on the chord distant x from the corner,

Then by spherical trigonometry

$$\frac{\cos \phi^1}{\cos \phi} = \frac{\sin A}{\sin A^1}$$

whence

$$\tan \frac{\phi^1 - \phi}{2} \tan \frac{\phi^1 + \phi}{2} = \tan \frac{A^1 - A}{2} \cot \frac{A^1 + A}{2}$$

put

$$A = \tfrac{1}{2}(\pi - \theta)$$
$$A^1 = \tfrac{1}{2}(\pi - \theta^1)$$

where θ and θ^1 are expressed in circular measure, and are very small, so that their cubes may be neglected. Also $\phi^1 - \phi$ is very small, and $\phi^1 + \phi$ is very nearly equal to 2ϕ.

$$\text{Then } \phi^1 - \phi = \frac{\theta - \theta^1}{2} \cdot \frac{\theta + \theta^1}{4} \cot \phi = \frac{\theta^2 - \theta_1^2}{8} \cot \phi$$

and θ = convergence of meridians for one township chord;

$$\therefore \theta = \frac{c}{N} \tan \phi, \text{ } c \text{ being the length of the chord,}$$

$$\text{and } \frac{\theta_1}{\theta} = \frac{c - 2x}{c}, \text{ whence } \theta^2 - \theta_1^2 = \frac{4(c - x)x}{c^2}\theta^2$$

Therefore

$$\phi^1 - \phi = \frac{(c - x)\, x}{2\, N^2} \tan \phi$$

or difference of latitude in chains =

$$R\,(^1 - \phi) = \frac{R}{2\, N^2}\, x\, (c - x) \tan \phi$$

The computation has been made for the first system of survey, but may be used for any system without sensible error.

Table XIV.

This table is intended to facilitate the observation of the pole star in strong daylight, by placing the telescope precisely in the direction of the star. The second column gives the approximate azimuth at different times and for townships 0 to 80. The last column contains the distance of Polaris above or below the pole, which added to or subtracted from the latitude, gives the approximate altitude.

Table XV.

This table is for determining the watch error by the observation, at any time, of the transits of Polaris and another star across the same vertical plane.

Let ϕ be the latitude of the place, α' and δ' the right ascension and declination of Polaris, α and δ the same quantities for the other star, and T′ and T the chronometer times at which each of the stars was respectively observed to cross the same vertical. Let p be the arc of the great circle from the pole star perpendicular to this vertical circle.

The hour angle of the time star, at the instant it was observed, was equal to

$$t = p\, (\tan \phi - \tan \delta)$$

which, when p is known is easily calculated by taking $(\tan \phi - \tan \delta)$ from a table of natural tangents to three places of decimals. If there is no such table at hand the following logarithmic form of the same formula may be employed :

$$t = p\, \frac{\sin\, (\phi - \delta)}{\cos \phi \, \cos \delta}$$

For stars below the pole the formula would be :

$$t = p\, (\tan \phi + \tan \delta)$$

or

$$t = p\, \frac{\sin\, (\phi + \delta)}{\cos \phi \, \cos \delta}$$

Table XV. gives the values of p computed for the mean declination.

$$88^\circ\, 41' = 88^\circ{\cdot}6833.$$

For any other value of δ', p must be multiplied by

$$\cos \delta' \div \cos 88^\circ\, 41'$$

The logarithm of the above factor is very simply found by adding

$$1{\cdot}63857$$

to the logarithmic tangent of the polar distance of Polaris, taken from the Ephemeris.

The arguments of the table are the declination of the time star, δ, and

$$t - t' = (\alpha - \alpha') - (T - T')$$

With carefully adjusted collimation and axis well levelled, the surveyor needs to observe but one star to obtain a chronometer correction sufficiently approximate for azimuth work.

It may be remarked that p, multiplied by the secant of the latitude gives at once the azimuth at the time of observation :

$$\mathrm{Az} = p \sec. \phi$$

The table has been computed by the following formula :

$$p = P \sin\, (t - t') + \frac{P^2}{2} \sin 2\, (t - t') \tan \delta$$

Only in exceptional cases will the neglected terms of the development cause an error of one quarter of a second in the time deduced.

The example given will show the calculation by both formulas.

To deduce the chronometer error from the following chronometer times of transit across the same vertical plane.

Polaris.....	6h.	33m.	27s....	15th April 1881.
αCanis Majoris..	6	36	42	do

Chronometer supposed to keep sidereal time without daily rate. Place, 6th base line.

a (Ann. Ephemeris) = 6h. 39m. 55s. 4				T = 6h. 36m. 42s.			ϕ (Table V) = 50·75		
a' do	=	1	14	29 ·8	T' = 6	33	27	δ (An. Eph.) = −16·56	
$a - a'$ =	5	25	25 ·6	T − T' =	3	15		$\phi - \delta$ = 67·31	
T − T' =		3	15 ·0						
$t - t'$ =	5	22	10 ·6						
log p (Table VII.) = 2·49293									

By Natural Tangents.		By Logarithms.	
	Const. log. = 1·63857		Const. log. = 1·63857
Nat. tan ϕ =	1·2239	log. tan P (Ann. Eph.) = 8·36363	log. tan P (Ann. Eph.) = 8·36363
Nat. tan δ	−0·2974	log. p (Table VII.) = 2·49293	log. p (Table VII) = 2·49293
tan ϕ − tan δ =	1·5213	log (tan. ϕ − tan. δ) = 0·18221	log. sin. $(\phi - \delta)$ = 9·96502
			log. sec. ϕ (Table V) = 0·19877
		log. t = 2·67734	log. sec. δ = 0·01840
		t = 7m. 55s ·7	
		a = 6 39 55 ·4	log. t = 2·67732
			t = 475s ·7
Sid. time of transit =		6 31 59 ·7	
T =		6 36 42 ·0	
Chronometer error = −		4 42 ·3	

Table XVI.

This gives the logarithm of the ratio of a small arc expressed in seconds of arc, to its tangent ; by adding it to the log. tangent, the logarithm of the arc is obtained, and the arc itself is found with a table of logarithms of numbers, without having to compute proportional parts. This table is intended to replace the table printed on the record of astronomical observations, when the instrument employed is divided sexagesimally.

Table XVII.

This is the part of the table of addition and subtraction logarithms, useful in reducing time azimuth observations with Polaris. Suppose two numbers a and b, and $a > b$; then we have, as long as A is less then 10.

For sums.	For differences.
Take 10 + log. b − log. $a = A$ and then	Take log. a − log. $b = B$ and then
Log. $(a+b)$ = log. $a + B$.	Log. $(a-b)$ = log. $b + A$ — 10.

Table XVIII.

This gives the correction for refraction to be applied to the sun's polar distance when using solar instruments. It is always to be subtracted from the tabular distance.

This table was computed from the following formulas :

$$r = 57'' \text{ cotg. } (\delta + N)$$

$$\text{Tan. } N = \text{cotg. } \phi \cos t.$$

Where δ is the declination, ϕ the latitude and r the refraction.

Table XIX.

This is useful in running trial lines. It gives the angular deflection of a line for deviations of one to 149 links at the end of eighty-one chains.

Problems Connected with the System of Survey.

Correction for Height above Sea Level.

The tables have been calculated from the dimensions of the earth's surface at sea level.

The township sides are actually measured on surfaces elevated above sea level, and therefore the differences of latitude and longitude calculated from the tables are greater than those actually covered by the township sides.

Any measured distance may be reduced to sea level by subtracting the correction $\frac{h}{r}x$, x being the distance, h the elevation above sea level, and r the radius of curvature of the line under consideration.

In general N (see Table I.) can be used instead of r.

Base lines when the system of survey is exactly followed are established by direct measurement from the 49th parallel, northward along an initial meridian.

Hence the latitude of a base line should be less than that given in table by $(\phi - 49°)\frac{h}{R}$ where h is the mean elevation of the initial meridian between the 49th parallel and the base under consideration.

Many base lines, however, have been established, not by this direct measurement, but by the survey of township meridians from other bases. If the actual latitudes of these base lines are required, account must be taken of the elevations of all the north and south lines through which the connection with the 49th parallel has been made. It is obvious, however, that the average elevation of the country above the sea will give a sufficiently accurate result, since the small errors due to difference of elevation are masked by errors of survey.

On the base lines the effect of elevation above sea level is to decrease the difference of longitude covered by one range, and this must be allowed for in establishing an initial meridian by means of chainage along a base line, or in estimating the accuracy of measurement of a base line by its closing on an initial meridian, since the initial meridians, except the first, have been placed on even degrees of longitude (every fourth degree).

The correction for elevation above sea level is, in latitude 51°, 0·00382 chains for one mile distance at an elevation of 1,000 feet, and varies directly as the elevation and distance. It changes somewhat with the latitude, but slightly, and the correction in any particular case may be taken as the same as that for latitude 51°. If extreme accuracy be required, the formula given above, $\frac{h}{r}x$ may be used.

The error in the length of township chords of course involves an error in deflection angles and azimuths, but this is too small to be appreciable.

Latitudes and Longitudes of Points in the System.

By "points in the system" is meant the corners of specified sections, or points referred to them by connecting lines. In the latter case the lines, if short, may be reduced to latitude and longitude by means of "latitude and departure" from a traverse table, and by using Table XVIII.

Thus, the problem is reduced to the determination of the latitude and longitude of any section corner.

Latitude.

The latitude of the section corner can be at once found by interpolation from Table III. or Table IV., according as the section is in the first, second or third system.

It must be remembered that in the first and second systems, the section posts on a meridian are 81·50 chains apart, and that in the third system they are alternately 81 and 80 chains.

The latitude can also be taken directly from Table IX. or X. to the fourth decimal place of degrees.

Since the section corners are presumed to be at distances of even sections from the north and south boundaries of the township, being established by survey from those boundaries, the latitude found as above must, when the section corner is not on the meridian outline of the township, be increased by the correction given by Table XIII.

In the first system the sections are not measured on meridians from the north or south boundary of the township, but on lines parallel to the eastern boundary of the township. Hence theoretically the difference of latitude between the given corner and the township outline should be decreased in the ratio of cosine azimuth of the section line to unity ; but this correction is practically insignificant. The correction for height above sea level may also be applied.

Longitude, Third System.

In the second and third systems the section lines are true meridians from the base line north and south two townships. Hence the longitude of a section corner is the same as that of the corresponding corner on the base line from which the township has been surveyed.

Then if $d\lambda$ be the longitude covered by one range on that base line, and if n be the number of the range in which the section lies, m the number of sections lying between the given section and

the eastern boundary of the township, the number of ranges which intervene between the initial meridian and the eastern boundary of the given section is $n - 1 + \frac{m}{6}$, and the difference in longitude between it and the initial meridian is

$$\left(n - 1 + \frac{m}{6}\right) d\lambda.$$

This added to the longitude of the initial meridian gives the longitude of the eastern boundary of the section.

The longitude of the Principal or First Meridian is 97° 27′ 08″·4.

The longitudes of the Second, Third, Fourth, &c., Meridians are 102°, 106°, 110°, 114°, &c., subject to certain errors of survey, which cannot be discussed at present.

The difference of longitude should be corrected for height above sea if precision is required. This can be done by multiplying it by $\left(1 - \frac{h}{N}\right)$

For example :

The N.E. corner of Sec. 16, Tp. 23, R. 17, W. of the Fourth Meridian (third system of survey). Here $n = 17$, $m = 3$, and the township is surveyed from the 7th base, for which we find from Table IV. $d\lambda = 8'\ 22''{\cdot}411 = 502''{\cdot}411$. Therefore longitude of the section line

$$= 110° + (502''{\cdot}411 \times 16\tfrac{3}{6}) = 112°\ 18'\ 09''{\cdot}78.$$

The corner is three sections, *i.e.*, 242 chains north of the 5th correction line, and its latitude is therefore (from Table IV.)

$$50°\ 34'\ 20''{\cdot}77 + 10'\ 28''{\cdot}88 \times \frac{242}{966} = 50°\ 34'\ 20''{\cdot}77 + 157''{\cdot}55$$

$$= 50°\ 36'\ 58''{\cdot}32.$$

Longitude, First System.

In the first system the procedure for the longitude is a little different. The section lines are drawn parallel to the east side of the township, so that the difference of longitude between the section line and the east boundary of the township is not the same as on the base line, but is equal to the actual distance from the boundary of the township divided by $P \sin 1''$, $P \sin''$ being taken from Table I. for the actual latitude of the section post.

Thus using the same notation as before

$$\text{Diff. of longitude from initial meridian} = (n-1)\, d\lambda + \frac{81{\cdot}50 \times m}{P \sin 1''},$$

$d\lambda$ being taken from Table III. (1st system) for the governing base line, or it may be calculated by the equivalent formula

$$\text{diff. of longitude} = \left(n - 1 + \frac{m}{6}\right) d\lambda + \frac{Q}{P \sin 1''}$$

where $Q = 2\, m\, (40 - w)$, w being the width of quarter sections as taken from the last column of Table IX.

Longitude, Second and Fourth Systems.

Longitudes in the 2nd system are calculated in the same way as those in the 3rd, taking $d\lambda$ from Table III. instead of Table IV. In the 4th system the process is the same, as for the 3rd system, and the same table is used—Table IV.

Effect of Errors of Survey.

An error in the latitude of the base line, or an error in the longitude of the initial meridian, of course increases or decreases by the amount of the error the latitude or longitude of the section corner. Similarly a chainage error on the base line affects the longitude directly. In the computation all known errors of this kind must be allowed for.

An error in the latitude of the base line also affects the longitude covered by 486 chains (or 489) chains measured along the base line, since 486 chains covers more longitude if the base line be moved north. The manner in which the effect of an error of this kind may be estimated will be best shown by an example.

Suppose the 6th base line (3rd system) to be placed 10 chains too far north, we find from Table IV.

$d\lambda$, for 6th base line $= 498''{\cdot}662$

$d\lambda$ for 6th correction line $= 500''{\cdot}527$

The 6th correction line is two townships, *i.e.*, 966 chains north of the 6th base line, and the difference in $d\lambda$ for these lines is $1''{\cdot}865$. Therefore, $d\lambda$ for the actual position of the 6th base line, 10 chains north of its theoretical position, is

$$498''{\cdot}662 + 1''{\cdot}865 \times \frac{10}{966} = 498''{\cdot}681$$

The correction, in the case supposed, to $d\lambda$ for one range is $0''{\cdot}019$, and in 29 ranges, (about the distance apart of two initial meridians) it amounts to $0''{\cdot}019 \times 29 = 0''{\cdot}55$, or 54 links.

Given the Latitude and Longitude of a point, to find its position with regard to the Survey System, *i.e., to find in what section it is, and the township and range, and its distance from the N. E. corner of the section.*

Second, Third and Fourth Systems.

This is the converse of the preceding problem. The first step is to find, in the manner explained above, the latitude of the section line next north of the given latitude. The difference between these two latitudes is reduced to chains by Table I. This gives the distance (x) in chains to be measured from the point to find the north boundary of the section.

The number of sections by which the section line is north of the southern boundary of the township in which it lies is to be noted. Call this number a, and the number of the township t.

We also know the number of the nearest base line, *i.e.*, the base line on which depends the survey of township t. From table IV. we take out $d\lambda$ for this base line.

From the given longitude of the point subtract the longitude of the initial meridian. Divide the difference by $d\lambda$, with quotient n and remainder r. Divide r by $\frac{d\lambda}{6}$ with quotient b and remainder s; s reduced from seconds of longitude to chains by Table I. with argument, latitude of the given point, gives the distance (y) to be measured east from the point to find the eastern line of the section.

We now know that the given point is x chains south and y chains west of the north-east angle of some section in township No. t and range No. $(n + 1)$ west of the initial meridian; and also that the northern boundary of the section is a sections north of the southern boundary of the township, and that the eastern boundary is b sections west of the eastern boundary of the township.

It is now easy by means of a skeleton township diagram to determine the number of the section; *e.g.* if $a=5$, $b=3$, the section is 28.

Without a township diagram, the section number can be found from the formula

$$\text{No. of section} = \tfrac{1}{2}\left\{12a - 5 \pm (2b - 5)\right\}$$

The upper sign being taken when a is odd, and the lower when a is even. These two rules are comprised in the general formula

$$\text{No. of section} = \tfrac{1}{2}\left\{(12a - 5) - (-1)^a\,(2b - 5)\right\}$$

The calculation for the second system is the same as above, using the proper tables for that system. It is also the same for the fourth system.

In this manner have been computed the positions of a great many section corners in British Columbia (fourth system of survey) with reference to points along the line of the Canadian Pacific Railway, the latitudes and longitudes of these points having been first determined by a traverse survey.

First System of Survey.

The procedure in this system is the same as above, except that the total difference of longitude from the eastern boundary of the township (instead of the nearest section line) must be reduced to chains, and from the chain distance must be subtracted the nearest multiple of 81·50.

Fractional Township or Range between parts of the Country Surveyed under different Systems of Survey.

Townships of the first and second systems adjoin each other without overlap or deficiency, since the townships in these two systems are of the same dimensions. Similarly of the third and fourth systems.

But where townships surveyed under the latter systems abut on townships of the first or second system, a fractional township or range occurs. It is only necessary to consider the case of the third system abutting on the first or second, since the fourth does not occur in juxtaposition with these latter systems.

Fractional Township.

Townships of the third system are 6 chains shorter, measured north and south than the others. The townships in both cases are measured north from the 49th parallel, and hence the third system falls short of the other by 6 chains for each township, and the northern boundary of a township of the third system is therefore south of the northern boundary of the same township of the first or second system by 6 chains multiplied by the number of the township.

Thus the 5th correction line (Tp. 18), as surveyed under the third system, is $6 \times 18 = 108$ chains south of its position under the second system. For twelve ranges west of the Second Meridian, the territory from the 5th correction line northward to the 8th correction line was surveyed under the second system, while the country south of the former line has been surveyed under the third system. There is therefore an additional township (measuring 108 chains from north to south) lying between Township 18 of the third system and Township 19 of the second system. (This fractional township is called Township 19A, and is subdivided according to the third system. See § 22.

Fractional Range.

Townships of the third system are 3 chains narrower (measured east and west along the base line) than those of the first and second systems. The overlap of the latter systems over the third, however, is not equal to 3 chains multiplied by the number of ranges, but exceeds this, since the widths are laid off along base lines which lie in different latitudes, and hence the convergence of meridians comes into play.

The readiest method of calculating this overlap is as follows :—

Let $d\lambda_1$ be the longitude covered by one range of the base line in the first or second system as found from Table III.

Let $d\lambda$ be the same quantity for the base line of the third system (from Table IV.)

Then $d\lambda_1 - d\lambda$ is the difference of the longitude between the exterior meridians of range one, as surveyed under the two systems.

The difference of longitude at the eastern boundary of the nth range will be

$$(n - 1)\ (d\lambda_1 - d\lambda)$$

This reduced to chains is

$$(n - 1)\ (d\lambda_1 - d\lambda)\ P \sin 1''$$

$P \sin 1''$ being taken from the proper table for the latitude of the base or section line on which the overlap is required.

Example.

The meridian outline between Ranges 12 and 13, west of the 2nd Meridian, from Township 19 to Township 22, inclusive, is the western boundary of a tract of country surveyed under the second system of survey. Required the width of Range 13, as surveyed under the third system, on the northern boundaries of Townships 19, 20, 21 and 22.

The base line on which this meridian outline is based, is the 6th base line, or northern boundary of Township 20.

From Table III., $d\lambda_1$ = 8′ 21″·972
do IV., $d\lambda$ = 8′ 18″·662

whence $d\lambda_1 - d\lambda$ = 3″·310

and at the eastern boundary of the thirteenth range, the difference of longitude is $3{\cdot}310 \times 12 = 39''{\cdot}72$.

We have then for the northern boundary of Township 19 (third system) :

Log. 39·72 = 1·5990092
Table IV., Log. $P \sin 1''$ = 9·9896352
1·5886444
Nat. number = 38·783

For the northern boundary of Township 20 :

Log. 39·72 = 1·5990092
Log. $P \sin 1''$ = 9·9888297
1·5878389
Nat. number = 38·711

For the northern boundary of Township 21 :

Log. 39·72 = 1·5990092
Log. $P \sin 1''$ = 9·9880192
1·5870284
Nat. number = 38·639

For the northern boundary of Township 22 :

Log. 39·72 = 1·5990092
Log. $P \sin 1''$ = 9·9872086
1·5862178
Nat. number 38·567

Hence the north boundaries of Townships 19, 20, 21 and 22, surveyed under the third system in Range 13, have their eastern tiers of sections narrowed by 38·783, 38·711, 38·639 and 38·567, respectively.

Now, the full widths of these sections when regular is got from Table X., by multiplying the "width of quarter section" by 2.

Thus, the width of the eastern tier of sections in Range 13 are :

For Township	19,	80·15 — 38·78	= 41·37	chains.
do	20,	80 — 38 71	= 41·29	do
do	21,	79·85 — 38·64	= 41·21	do
do	22,	79·70 — 38·57	= 41·13	do

These widths must be increased by one chain for road, if the widths from post to post are required.

For the township lines to the north of the correction line, viz. : 23, 24, 25 and 26, the width of Range 13 may be found in the same way, using the $d\lambda$ from Tables III. and IV. for the seventh base instead of the sixth.

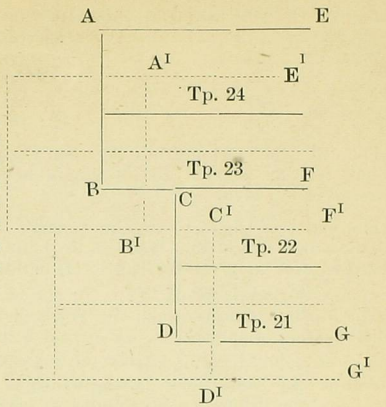
If the width of the section on the north side of the 6th correction line is required, that is, the south boundary of Township 23, it must be remembered that here, on account of the correction line being thrown south, from the less depth of the townships of the new system, the southern boundary of Township 23 of the third system, which is brought from the 7th base, intersects the second system south of the correction line, *i. e.*, on a line brought from the 6th base.

Therefore we have

For the second system, Table III.,	$d\lambda_1$	6th base	= 8′ 21″ ·972
third do	do IV., $d\lambda$	7th do	= 8′ 22″ ·411
		$\therefore$ $d\lambda_1 - d\lambda$ =	— ·439
and for twelve ranges	12 ($d\lambda_1 - d\lambda$) =		— 5″ ·268

With the difference of longitude 5″ ·268 and the P sin 1″ for the 6th correction line, third system, we get the required jog.

It will be noticed that the overplus is negative, *i. e.*, the third system line falls to the west of that of the second system.



The heavy lines represent the second system, the dotted ones the third. The line $A^1 B^1$ is the one which we have just considered; it falls to the east of AB, but to the west of CD.

The lines in the figure are all township lines. Thus it will be seen that there is a small piece of land, B_1 C, which is in fact a township of itself. Its designation would be Township 23 A, Range 12.

Second Example.

Required the depth, north and south, of Township 27, Range 19, west of the Principal Meridian.

The north boundary of Township 26 is the northern boundary of a tract of country surveyed under the first system.

Since each township of the third system is 6 chains shorter north and south than one of the first system, the northern boundary of Township 26 in the third system is 6 x 26 = 156 chains south of the same boundary under the first system.

Therefore the distance from the north boundary of Township 26, first system, to the north-east angle of Section 12, Township 27, third system, is 161 — 156 = 5 chains.

Since 1·50 chains must be allowed for road, 3·50 chains is the available width of the strip of land.

Fractional Sections adjoining an Initial Meridian.

The longitude of the Principal Meridian is 97° 27′ 08″·4.

That of the 2nd ~~Initial~~ Meridian 102° 00′ 00″
" 3rd " 106° 00′ 00″
" 4th " 110° 00′ 00″
" 5th " 114° 00′ 00″
" 6th " 118° 00′ 00″
" 7th " 122° 00′ 00″

The difference of longitude between the first meridian and the second is 4° 32′ 51″·6 = 16371″·6, and between the others successively 4° = 14400″.

The width of the last range in seconds on a given base line is got by subtracting from 16371″·6 or 14400″ the nearest integral multiple of $d\lambda$ as given by Table III. or IV. (according to which system of survey is used). Thus for the width of the last range on the 5th base line between the 2nd and 3rd ~~Initial~~ Meridians (third system of survey) we have from Table IV. $d\lambda$ = 494″·988 and we find, by dividing 14400″ by 494″·988, a quotient 29 with remainder 45″·348. That is, the width of Range 30 on the 5th base, or the difference of longitude between the 3rd ~~Initial~~ Meridian and the meridian forming the eastern boundary of Townships 15, 16, and 18, Range 30, west of the second ~~Initial~~ Meridian is 45″·348. This can be converted into chains by multiplying by log. P sin 1″, taken from Table IV. for the section line whose length is required—whether the southern boundary of Township 15, or the northern boundary of Townships 15, 16, 17 or 18, or any of the intermediate section lines.

If the width of the last broken section be required, and if the remainder, after tracting the integral multiple of $d\lambda$ is greater than one sixth of $d\lambda$, integral multiples of $\frac{1}{6}\,d\lambda$ (difference of longitude covered by one section on the base line) must be subtracted until the remainder is less than $\frac{1}{6}\,d\lambda$. This remainder may then be converted to chains by multiplying by P sin 1″ taken out of the table for the latitude of the line under consideration. The reason for this is that the widths in seconds of longitude are the same for all sections from the base to the correction line (in the third system).

The result thus found should be corrected for the mean height of the base line above sea leved, and also for any error in the positions of the 2nd and 3rd Meridians, relative to each other.

TABLES.

TABLE I.—Radii of Curvature of Meridians and Parallels, &c.

Latitude.	log N sin 1″.	log P sin 1″.	log R sin 1″.	Chains in 1″.		Seconds in one Chain.		English Miles in a Degree.	
				Lat-itude.	Long-itude.	Lat-itude.	Long-itude.	Lat-itude.	Long-itude.
° ′						′	″		
42 00	0·1873775	0·0584510	0·1857461	1·5337	1·1441	0·6520	0·8741	69·02	51·48
42 10	3818	73144	7589	1·5338	1·1411	0·6520	0·8764	69·02	51·35
42 20	3860	61711	7717	1·5338	1·1381	0·6520	0·8787	69·02	51·21
42 30	3903	50212	7845	1·5339	1·1351	0·6520	0·8810	69·02	51·08
42 40	3946	38645	7973	1·5339	1·1320	0·6519	0·8834	69·03	50·94
42 50	3988	27009	8101	1·5339	1·1290	0·6519	0·8857	69·03	50·81
43 00	4031	15306	8230	1·5340	1·1260	0·6519	0·8881	69·03	50·67
43 10	4074	0·0503534	8358	1·5340	1·1229	0·6519	0·8905	69·03	50·53
43 20	4117	0·0491693	8487	1·5341	1·1199	0·6519	0·8930	69·03	50·39
43 30	4160	79782	8615	1·5341	1·1168	0·6518	0·8954	69·04	50·26
43 40	4203	67802	8744	1·5342	1·1137	0·6518	0·8979	69·04	50·12
43 50	4245	55750	8872	1·5342	1·1106	0·6518	0·9004	69·04	49·98
44 00	4288	43629	9001	1·5343	1·1075	0·6518	0·9029	69·04	49·84
44 10	4331	31437	9129	1·5343	1·1044	0·6518	0·9054	69·04	49·70
44 20	4374	19173	9258	1·5344	1·1013	0·6517	0·9080	69·05	49·56
44 30	4417	0·0406838	9387	1·5344	1·0982	0·6517	0·9106	69·05	49·42
44 40	4460	0·0394430	9515	1·5344	1·0951	0·6517	0·9132	69·05	49·28
44 50	4503	81949	9644	1·5345	1·0919	0·6517	0·9158	69·05	49·14
45 00	4546	69396	9773	1·5345	1·0888	0·6517	0·9185	69·05	49·00
45 10	4588	56768	0·1859901	1·5346	1·0856	0·5616	0·9211	69·06	48·85
45 20	4631	44067	0·1860030	1·5346	1·0824	0·6516	0·9238	69·06	48·71
45 30	4674	31292	0159	1·5347	1·0793	0·6516	0·9266	69·06	48·57

TABLE I.—Radii of Curvature of Meridians and Parallels, &c.—*Continued.*

Latitude.	log N sin 1″.	log P sin 1″.	log R sin 1″.	Chains in 1″.		Seconds in one Chain.		English Miles in a Degree.	
				Lat-itude.	Long-itude.	Lat-itude.	Long-itude.	Lat-itude.	Long-itude.
° ′						″	″		
45 40	0·1874717	0·0318442	0·1860288	1·5347	1·0761	0·6516	0·9293	69·06	48·42
45 50	4760	0·0305517	0116	1·5348	1·0729	0·6516	0·9321	69·06	48·28
46 00	4803	0·0292516	0545	1·5348	1·0697	0·6515	0·9349	69·07	48·14
46 10	4846	79439	0673	1·5349	1·0665	0·6515	0·9377	69·07	47·99
46 20	4889	66285	0802	1·5349	1·0632	0·6515	0·9405	69·07	47·85
46 30	4932	53054	0931	1·5349	1·0600	0·6515	0·9434	69·07	47·70
46 40	4974	39745	1059	1·5350	1·0568	0·6515	0·9463	69·07	47·55
46 50	5017	26358	1188	1·5350	1·0535	0·6515	0·9492	69·08	47·41
47 00	5060	0·0212893	1316	1·5351	1·0502	0·6514	0·9522	69·08	47·26
47 10	5103	0·0199349	1445	1·5351	1·0470	0·6514	0·9551	69·08	47·11
47 20	5146	85726	1573	1·5352	1·0437	0·6514	0·9581	69·08	46·97
47 30	5188	72021	1701	1·5352	1·0404	0·6514	0·9612	69·08	46·82
47 40	5231	58237	1829	1·5353	1·0371	0·6514	0·9642	69·09	46·67
47 50	5274	44372	1957	1·5353	1·0338	0·6513	0·9673	69·09	46·52
48 00	5316	30425	2085	1·5354	1·0305	0·6513	0·9704	69·09	46·37
48 10	5359	16396	2214	1·5354	1·0272	0·6513	0·9736	69·09	46·22
48 20	5402	0·0102285	2341	1·5354	1·0238	0·6513	0·9767	69·09	46·07
48 30	5444	0·0088090	2469	1·5355	1·0205	0·6513	0·9799	69·10	45·92
48 40	5487	73812	2598	1·5355	1·0171	0·6512	0·9831	69·10	45·77
48 50	5530	59449	2725	1·5356	1·0138	0·6512	0·9864	69·10	45·62
49 00	5572	45001	2852	1·5356	1·0104	0·6512	0·9897	69·10	45·47
49 10	5615	30469	2980	1·5357	1·0070	0·6512	0·9930	69·11	45·32

49 20	0·1875657	0·0015849	0·1863106	1·5357	1·0037	0·6512	0·9964	69·11	45·16
49 30	5699	0·0001143	3234	1·5358	1·0003	0·6511	0·9998	69·11	45·01
49 40	5742	9·9986351	3361	1 5358	0·9969	0·6511	1·0031	69·11	44·86
49 50	5784	71470	3488	1·5358	0·9935	0·6511	1·0066	69·11	44·71
50 00	5826	56501	3615	1·5359	0·9900	0·6511	1·0101	69·12	44·55
50 10	5869	41444	3742	1·5359	0·9866	0·6511	1·0136	69·12	44·40
50 20	5911	26296	3870	1·5360	0·9832	0·6510	1·0171	69·12	44·24
50 30	5953	9·9911058	3995	1·5360	0·9797	0·6510	1·0207	69·12	44·09
50 40	5995	9·9895730	4122	1·5361	0·9763	0·6510	1·0243	69·12	43·93
50 50	6037	80309	4248	1·5361	0·9728	0·6510	1·0279	69·13	43·78
51 00	6079	64797	4374	1·5362	0·9693	0·6510	1·0316	69·13	43·62
51 10	6121	49192	4500	1·5362	0·9659	0·6510	1·0353	69·13	43·46
51 20	6163	33493	4626	1·5363	0·9624	0·6509	1·0391	69·13	43·31
51 30	6205	17701	4751	1·5363	0·9589	0·6509	1·0429	69·13	43·15
51 40	6247	9·9801813	4877	1·5363	0·9554	0·6509	1·0467	69·14	42·99
51 50	6289	9·9785830	5002	1·5364	0·9519	0·6509	1·0506	69·14	42·83
52 00	6330	69750	5127	1·5364	0·9484	0·6509	1·0544	69·14	42·68
52 10	6372	53574	5252	1·5365	0·9448	0·6508	1·0584	69·14	42·52
52 20	6413	37299	5376	1·5365	0·9413	0·6508	1·0624	69·14	42·36
52 30	6455	20926	5501	1·5366	0·9378	0·6508	1·0664	69·15	42·20
52 40	6496	9·9704454	5625	1·5366	0·9342	0·6508	1·0704	69·15	42·04
52 50	6538	9·9687882	5749	1·5366	0·9307	0·6508	1·0745	69·15	41·88
53 00	6579	71208	5873	1·5367	0·9271	0·6507	1·0786	69·15	41·72
53 10	6620	54435	5997	1·5367	0·9235	0·6507	1·0828	69·15	41·56
53 20	6661	37558	6120	1·5368	0·9199	0·6507	1·0870	69·16	41·40
53 30	6703	20579	6244	1·5368	0·9163	0·6507	1·0913	69·16	41·24
53 40	6744	9·9603495	6367	1·5369	0·9127	0·6507	1·0956	69·16	41·07
53 50	6785	9·9586307	6490	1·5369	0·9091	0·6507	1·0999	69·16	40·91
54 00	6825	69012	6612	1·5370	0·9055	0·6506	1·1043	69·16	40·75
54 10	6866	51612	6735	1·5370	0·9019	0·6506	1·1088	69·16	40·59
54 20	6907	34104	6857	1·5370	0·8983	0·6506	1·1132	69·17	40·42
54 30	6948	9·9516488	6979	1·5371	0·8946	0·6506	1·1178	69·17	40·26
54 40	6988	9·9498764	7101	1·5371	0·8910	0·6506	1·1223	69·17	40·09
54 50	7029	80928	7222	1·5372	0·8873	0·6505	1·1270	69·17	39·93
55 00	7069	62982	7343	1·5372	0·8837	0·6505	1·1316	69·17	39·77
55 10	7109	44924	7464	1·5373	0·8800	0·6505	1·1363	69·18	39·60
55 20	7150	26754	7585	1·5373	0·8763	0·6505	1·1411	69·18	39·44

TABLE I.—Radii of Curvature of Meridians and Parallels, &c.—*Continued.*

Latitude.	log N sin 1″.	log P sin 1″.	log R sin 1″.	Chains in 1″.		Seconds in one Chain.		English Miles in a Degree.	
				Latitude.	Longitude.	Latitude.	Longitude.	Latitude.	Longitude.
° ′						″	″		
55 30	0·1877190	9·9408470	0·1867705	1·5373	0·8727	0·6505	1·1459	69·18	39·27
55 40	7230	9·9390072	7825	1·5374	0·8690	0·6505	1·1508	69·18	39·10
55 50	7270	71557	7945	1·5374	0·8653	0·6504	1·1557	69·18	38·94
56 00	7310	52927	8065	1·5375	0·8616	0·6504	1·1607	69·19	38·77
56 10	7349	34177	8184	1·5375	0·8579	0·6504	1·1657	69·19	38·60
56 20	7389	9·9315310	8304	1·5376	0·8541	0·6504	1·1708	69·19	38·44
56 30	7429	9·9296324	8422	1·5376	0·8504	0·6504	1·1759	69·19	38·27
56 40	7468	77218	8541	1·5376	0·8467	0·6503	1·1811	69·19	38·10
56 50	7508	57987	8659	1·5377	0·8429	0·6503	1·1863	69·20	37·93
57 00	7547	38635	8777	1·5377	0·8392	0·6503	1·1916	69·20	37·76
57 10	7586	9·9219158	8894	1·5378	0·8354	0·6503	1·1970	69·20	37·59
57 20	7625	9·9199557	9012	1·5378	0·8317	0·6503	1·2024	69·20	37·43
57 30	7664	79829	9128	1·5378	0·8279	0·6503	1·2079	69·20	37·26
57 40	7703	59974	9245	1·5379	0·8241	0·6502	1·2134	69·20	37·09
57 50	7742	39991	9361	1·5379	0·8203	0·6502	1·2190	69·21	36·92
58 00	7780	9·9119877	9477	1·5380	0·8166	0·6502	1·2247	69·21	36·75
58 10	7819	9·9099633	9593	1·5380	0·8128	0·6502	1·2304	69·21	36·57
58 20	7858	79257	9709	1·5381	0·8090	0·6502	1·2362	69·21	36·40
58 30	7896	58747	9824	1·5381	0·8051	0·6502	1·2420	69·21	36·23
58 40	7934	38102	0·1869938	1·5381	0·8013	0·6501	1·2479	69·22	36·06
58 50	7972	9·9017321	0·1870052	1·5382	0·7975	0·6501	1·2539	69·22	35·89
59 00	8010	9·8996403	0167	1·5382	0·7937	0·6501	1·2600	69·22	35·72

59 10	0·1878048	9·8975347	0·1870280	1·5383	0·7898	0·6501	1·2661	69·22	35·54
59 20	8086	54150	0393	1·5383	0·7860	0·6501	1·2723	69·22	35·37
59 30	8123	32812	0506	1·5383	0·7821	0·6501	1·2786	69·23	35·20
59 40	8161	9·8911331	0619	1·5384	0·7783	0·6500	1·2849	69·23	35·02
59 50	8198	9·8889706	0731	1·5384	0·7744	0·6500	1·2913	69·23	34·85
60 00	8236	67936	0843	1·5385	0·7705	0·6500	1·2978	69·23	34·67
60 10	8273	46018	0955	1·5385	0·7667	0·6500	1·3044	69·23	34·50
60 20	8310	23952	1066	1·5385	0·7628	0·6500	1·3110	69·23	34·32
60 30	8347	9·8801735	1176	1·5386	0·7589	0·6500	1·3177	69·24	34·15
60 40	8384	9·8779367	1287	1·5386	0·7550	0·6499	1·3245	64·24	33·97
60 50	8420	56845	1397	1·5386	0·7511	0·6499	1·3314	69·24	33·80
61 00	8457	34169	1506	1·5387	0·7472	0·6499	1·3384	69·24	33·62
61 10	8493	9·8711336	1615	1·5387	0·7432	0·6499	1·3454	69·24	33·45
61 20	8529	9·8688345	1724	1·5388	0·7393	0·5499	1·3526	69·24	33·27
61 30	8565	65194	1832	1·5388	0·7354	0·6499	1·3598	69·25	33·09
61 40	8601	41882	1940	1·5388	0·7315	0·6498	1·3671	69·25	32·92
61 50	8637	9·8618406	2048	1·5389	0·7275	0·6498	1·3745	69·25	32·74
62 00	8673	9·8594766	2155	1·5389	0·7236	0·6498	1·3820	69·25	32·56
62 10	8708	70958	2261	1·5390	0·7196	0·6498	1·3896	69·25	32·38
62 20	8744	46982	2368	1·5390	0·7156	0·6498	1·3973	69·25	32·20
62 30	8779	9·8522835	2474	1·5390	0·7117	0·6498	1·4051	69·26	32·03
62 40	8814	9·8498516	2579	1·5391	0·7077	0·6497	1·4130	69·26	31·85
62 50	8849	74022	2684	1·5391	0·7037	0·6497	1·4210	69·26	31·67
63 00	8884	49352	2789	1·5391	0·6997	0·6497	1·4291	69·26	31·49
63 10	8919	9·8424503	2893	1·5392	0·6957	0·6497	1·4373	69·26	31·31
63 20	8954	9·8399475	2997	1·5392	0·6917	0·6497	1·4456	69·26	31·13
63 30	8988	74262	3099	1·5393	0·6877	0·6497	1·4540	66·27	30·95
63 40	9022	48866	3202	1·5393	0·6837	0·6497	1·4626	69·27	30·77
63 50	9056	9·8323288	3305	1·5393	0·6797	0·6496	1·4712	69·27	30·59
64 00	9090	9·8297512	3407	1·5394	0·6715	0·6496	1·4800	69·27	30·41
64 10	9124	71546	3508	1·5394	0·6767	0·6496	1·4888	69·27	30·23
64 20	9158	45389	3609	1·5394	0·6677	0·6496	1·4978	69·27	30·04
64 30	9191	9·8219035	3709	1·5395	0·6636	0·6496	1·5069	69·28	29·86
64 40	9224	9·8192482	3809	1·5395	0·6596	0·6496	1·5162	69·28	29·68
64 50	9258	65730	3909	1·5395	0·6555	0·6495	1·5256	69·28	29·50
65 00	9291	38774	4008	1·5396	0·6514	0·6495	1·5351	69·28	29·32
65 10	9323	9·8111610	4106	1·5396	0·6474	0·6495	1·5447	69·28	29·13

TABLE I.—Radii of Curvature of Meridians and Parallels, &c.—*Concluded.*

Latitude.	log N sin 1″.	log P sin 1″.	log R sin 1″.	Chains in 1″.		Seconds in one Chain.		English Miles in a Degree.	
				Latitude.	Longitude.	Latitude.	Longitude.	Latitude.	Longitude.
° ′						″	″		
65 20	0·1879356	9·8084240	0·1874205	1·5396	0·6433	0·6495	1·5544	69·28	28·95
65 30	9389	56659	4302	1·5397	0·6392	0·6495	1·5644	69·29	28·77
65 40	9421	28862	4399	1·5397	0·6352	0·6495	1·5744	69·29	28·58
65 50	9453	9·8000850	4496	1·5397	0·6311	0·6494	1·5846	69·29	28·40
66 00	9485	9·7972618	4592	1·5398	0·6270	0·6494	1·5949	69·29	28·21
66 10	9517	44164	4688	1·5398	0·6229	0·6494	1·6054	69·29	28·03
66 20	9549	9·7915485	4783	1·5398	0·6188	0·6494	1·6160	69·29	27·85
66 30	9580	9·7886577	4877	1·5399	0·6147	0·6494	1·6268	69·29	27·66
66 40	9612	57439	4972	1·5399	0·6106	0·6494	1·6378	69·30	27·48
66 50	9643	9·7828065	5065	1·5399	0·6065	0·6494	1·6489	69·30	27·29
67 00	9674	9·7798454	5158	1·5400	0·6023	0·6494	1·6602	69·30	27·11
67 10	9705	68602	5250	1·5400	0·5982	0·6493	1·6716	69·30	26·92
67 20	9735	38506	5342	1·5400	0·5941	0·6493	1·6833	69·30	26·73
67 30	9766	9·7708163	5434	1·5401	0·5900	0·6493	1·6951	69·30	26·55
67 40	9796	9·7677568	5525	1·5401	0·5858	0·6493	1·7070	69·31	26·36
67 50	9826	46718	5615	1·5401	0·5817	0·6493	1·7192	69·31	26·17
68 00	9856	9·7615610	5705	1·5402	0·5775	0 6493	1·7316	69·31	25·99
68 10	9886	9·7584241	5795	1·5402	0·5734	0·6493	1·7441	69·31	25·80
68 20	9916	52605	5883	1·5402	0·5692	0·6492	1·7569	69·31	25·61
68 30	9945	9·7520699	5972	1·5403	0·5650	0·6492	1·7698	69·31	25·43
68 40	0·1879974	9·7488520	6059	1·5403	0·5609	0·6492	1·7830	69·31	25·24
68 50	0·1880004	56064	6147	1·5403	0·5567	0·6492	1·7964	69·31	25·05
69 00	0·1880032	9·7423324	0·1876233	1·5404	0·5525	0·6492	1·8100	69·32	24·86
69 10	0061	9·7390298	6319	1·5404	0·5483	0·6492	1·8238	69·32	24·67
69 20	0090	56983	6405	1·5404	0·5441	0·6492	1·8378	69·32	24·49
69 30	0118	0·7323371	6490	1·5405	0·5399	0·6492	1·8521	69·32	24 30
69 40	0146	9·7289460	6574	1·5405	0·5357	0·6491	1·8666	69·32	24·11
69 50	0174	55244	6658	1·5405	0·5315	0·6491	1·8814	69·32	23·92
70 00	0202	9·7220719	6741	1·5405	0·5273	0·6491	1·8964	69·32	23·73

TABLE II.

CORRECTIONS to be applied to the logarithms of R sin 1″ and N sin 1″ in Table I. for Clarke's later values of the dimensions of the earth.

Latitude.	*d* (log R sin 1″).	*d* (log N sin 1″).	Latitude.	*d* (log R sin 1″).	*d* (log N sin 1″).
°			°		
42	−0·0000021	+0·0000063	56	+0·0000034	+0·0000081
43	17	64	57	37	82
44	13	66	58	41	84
45	09	67	59	45	85
46	05	68	60	48	86
47	−0·0000001	70	61	51	87
48	+0·0000003	71	62	55	88
49	07	72	63	58	89
50	11	74	64	61	90
51	15	75	65	64	91
52	19	76	66	67	93
53	23	77	67	70	93
54	26	79	68	73	94
55	30	80	69	76	95
			70	78	96

TABLE III.

LATITUDES, &c., of Base and Correction Lines. 1st and 2nd Systems of Surveys.

No. of Township.	Number of Line.	Latitude.	Log. N sin 1″.	Log. P sin 1″.	Log. R sin 1″.	Longitude covered by 489 Chains of westing.
		° ′ ″				′ ″
0	1st Base	49 00 00·00	0·1875572	0·0045001	0·1862852	8 03·959
2	Correction	10 36·86	5618	0 0029573	2989	05·681
4	2nd Base	21 13·70	5662	0·0014047	3122	07·421
6	Correction	31 50·52	5707	9·9998425	3256	09·177
8	3rd Base	42 27·33	5751	9·9982704	3391	10·951
10	3rd Correction	49 53 04·12	0·1875797	9·9966886	0·1863527	8 12·743
12	4th Base	50 03 40·89	5842	9·9950968	3662	14·552
14	Correction	14 17·64	5887	9·9934951	3797	16·379
16	5th Base	24 54·37	5932	9·9918831	3931	18·225
18	Correction	35 31·08	5976	9·9902611	4064	20·089
20	6th Base	50 46 07·77	0·1876021	9·9886289	0·1864198	8 21·972
22	Correction	56 44·44	6065	9·9869863	4331	23·875
24	7th Base	51 07 21·09	6110	9·9853334	4466	25·796
26	Correction	17 57·72	6154	9·9836700	4599	27·737
28	8th Base	28 34·33	6199	9·9819961	4733	29·698
30	8th Correction	51 39 10·92	0·1876243	9·9803116	0·1864867	8 31·678
32	9th Base	49 47·49	6287	9·9786163	4998	33·680
34	Correction	52 00 24 04	6332	9·9769104	5131	35·701
36	10th Base	11 00·57	6376	9·9751934	5264	37·744
38	Correction	21 37·08	6420	9·9734657	5395	39·808

40	11th Base	52 32 13·57	0·1876464	9·9717267	0·1865529	8 41·894
42	Correction	42 50·04	6508	9·9699768	5661	44·001
44	12th Base	53 26·49	6552	9·9682156	5791	46·130
46	Correction	53 04 02·92	6595	9·9664429	5920	48·282
48	13th Base	14 39·33	6640	9·9646592	6055	50.456

TABLE IV.

LATITUDES, &c., of Base and Correction Lines.
(Third System of Survey.)

Number of Township.	Name of Line.	Latitude.	Log. N sin 1″.	Log. P sin 1″.	Log. R sin 1″.	Longitude covered by 486 Chains.
		° ′ ″				′ ″
0	1st Base	49 00 00·00	0·1875572	0·0045001	0·1862852	8 00·990
2	Correction	10 29·05	5617	0·0029764	2987	02·681
4	2nd Base	20 58·07	5661	0·0014431	3119	04·388
6	Correction	31 27·08	5705	9·9999003	3251	06·112
8	3rd Base	41 56·08	5749	9·9983480	3383	07·852
10	3rd Correction	52 25·05	5794	9·9967861	3518	09·610
12	4th Base	50 02 54·01	5838	9·9952143	3650	11·385
14	Correction	13 22·96	5883	9·9936329	3786	13·178
16	5th Base	23 51·88	5927	9·9920418	3918	14·988
18	Correction	34 20·77	5971	9·9904407	4050	16·816
20	6th Base	44 49·65	6015	9·9888297	4182	18·662
22	Correction	55 18·51	6059	9·9872086	4314	20·527
24	7th Base	51 05 47·35	6103	0·9855774	4446	22·411
26	Correction	16 16·17	6147	9·9839365	4578	24·313
28	8th Base	26 44·98	6191	9·9822842	4710	26·235

TABLE IV—*Concluded.*

LATITUDE, &c., of Base and Correction Lines—*Concluded.*

(Third System of Survey.)

Number of Township.	Name of Line.	Latitude.	Log. N sin 1″.	Log. P sin 1″.	Log. R sin 1″.	Longitude covered by 486 Chains.
		° ′ ″				′ ″
30	8th Correction	51 37 13·76	0·1876235	9·9806224	0·1864842	8 28·176
32	9th Base	47 42·53	6279	9·9789500	4974	30·136
34	Correction	58 11·26	6322	9·9772671	5103	32·117
36	10th Base	52 08 39·98	6366	9·9755737	5235	34·118
38	Correction	19 08·69	6409	9·9738694	5364	36·139
40	11th Base	29 37·37	6453	9·9721545	5496	38·181
42	Correction	40 06·04	6497	9·9704288	5628	40·245
44	12th Base	50 34·69	6540	9·9686921	5757	42·329
46	Correction	53 01 03·31	6582	9·9669442	5883	44·436
48	13th Base	11 31·92	6626	9·9651855	6015	46·564
50	13th Correction	22 00·52	6670	9·9634156	6147	48·714
52	14th Base	32 29·09	6712	9·9616342	6273	50·887
54	Correction	42 57·65	6756	9·9598417	6405	53·083
56	15th Base	53 26·19	6799	9·9580375	6534	55·302
58	Correction	54 03 54·71	6841	9·9562218	6660	57·545
60	16th Base	14 23·21	6884	9·9543945	6789	8 59·811
62	Correction	24 51·69	6927	9·9525554	6918	9 02·102
64	17th Base	35 20·15	6969	9·9507044	7044	04·417
66	Correction	45 48·59	7012	9·9488415	7173	06·758
68	18th Base	56 17·01	7054	9·9469665	7298	09·123

70	18th Correction	55 06 45·42	0·1877096	9·9450792	0·1867424	9 11·515
72	19th Base	17 13·82	7139	9·9431798	7553	13·932
74	Correction	27 42·20	7181	9·9412680	7679	16·376
76	20th Base	38 10·55	7223	9·9393437	7805	18·847
78	Correction	48 38·89	7264	9·9374066	7928	21·345
80	21st Base	59 07·20	7305	9·9354569	8051	23·871
82	Correction	56 09 35·49	7347	9·9334945	8177	26·424
84	22nd Base	20 03 77	7390	9·9315192	8306	29·006
86	Correction	30 32·03	7431	9·9295307	8429	31·618
88	23rd Base	41 00·28	7472	9·9275290	8552	34·258
90	23rd Correction	51 28·51	7513	9·9255140	8675	36·929
92	24th Base	57 01 56·70	7554	9·9234856	8798	39·630
94	Correction	12 24·89	7595	9·9214436	8921	42·362
96	25th Base	22 53·07	7637	9·9193880	9047	45·125
98	Correction	33 21·22	7678	9·9173186	9170	47·919
100	26th Base	43 49·36	7718	9·9152351	9290	50·747
102	Correction	54 17·48	7759	9·9131376	9413	53·607
104	27th Base	58 04 45·57	7799	9·9110259	9533	56·500
106	Correction	58 15 13·66	7839	9·9088998	9653	9 59·427
108	28th Base	25 41·73	7879	9·9067591	9773	10 02·389
110	28th Correction	36 09·78	7919	9·9046039	0·1869893	05·386
112	29th Base	46 37·81	7959	9·9024339	0·1870013	08·418
114	Correction	57 05·83	7999	9·9002490	0133	11·487
116	30th Base	59 07 33·83	8039	9·8980490	0253	14·593
118	Correction	18 01·81	8078	9·8958337	0370	17·735
120	31st Base	28 29·77	8117	9·8936029	0487	20·917
122	Correction	38 57·71	8157	9·8913568	0607	24·136
124	32nd Base	49 25·64	8196	9·8890948	0724	27·396
126	Correction	59 53·55	0·1878235	9·8868170	0·1870840	10 30·695

TABLE V.

CHORD AZIMUTHS, Deflections, Deflection Offsets, &c., for Base Lines.

(First and Second Systems of Survey.)

Number of Base Line.	Chord Azimuth.	Chord Azimuth.	Deflection.	Deflection.	Deflection Offset for 1 Chain Distance.	Longitude covered by 1 Range.	Number of Township.
	° ′ ″	°	′ ″	°	Inches.	s.	
1	89 56 57·4	89·9493	6 05·2	0·1014	1·402	32·3	0
2	55·1	·9486	09·8	·1027	1·420	32·5	4
3	52·8	·9480	14·5	·1040	1·438	32·7	8
4	50·4	·9473	19·2	·1053	1·456	33·0	12
5	48·0	·9467	24·0	·1067	1·474	33·2	16
6	89 56 45·6	89·9460	6 28·8	0·1080	1·493	33·5	20
7	43·1	·9453	33·8	·1094	1·512	33·7	24
8	40·6	·9446	38·8	·1108	1·531	34·0	28
9	38·1	·9439	43·8	·1122	1·551	34·2	32
10	35·5	·9432	49·0	·1136	1·570	34·5	36
11	89 56 32·9	89·9425	6 54·3	0·1151	1·591	38·8	40
12	30·2	·9417	59·6	·1165	1·611	35·1	44
13	27·5	·9410	7 05·0	·1180	1·632	35·4	48

TABLE VI.

CHORD AZIMUTHS, Deflections, Deflection Offsets, &c., for Base Lines.

(Third System of Survey.)

Number of Base Line.	Chord Azimuth Sexagesimal.	Chord Azimuth Decimal.	Deflection Sexagesimal	Deflection Decimal.	Deflection Offset for 1 Chain Distance.	Longitude covered by 1 Range.	Number of Township.
	° ′ ″	°	′ ″	°	Inches.	s.	
1	89 56 58·5	89·9496	6 03·0	0·1008	1 394	32·1	0
2	56·3	·9490	07·5	·1021	1·411	32·3	4
3	54·0	·9483	12·0	·1033	1·429	32·5	8
4	51·7	·9477	16·6	·1046	1·447	32·8	12
5	49·4	·9471	21·3	·1059	1·465	33·0	16
6	47·0	·9464	26·1	·1072	1·483	33·2	20
7	44·6	·9457	30·9	·1086	1 501	33·5	24
8	42·1	·9450	35·8	·1099	1·520	33·7	28
9	39·6	·9443	40·8	·1113	1·539	34·0	32
10	37·1	·9436	45·9	·1127	1·558	34·3	36
11	34·5	·9429	51·0	·1142	1·578	34·5	40
12	31·9	·9422	56·2	·1156	1·598	34·8	44
13	29·3	·9415	7 01·5	·1171	1·619	35·1	48
14	26·6	·9407	06·9	·1186	1·639	35·4	52
15	23·8	·9399	12·4	·1201	1·660	35·7	56
16	21·0	·9392	18·0	·1217	1·682	36·0	60
17	18·2	·9384	23·7	·1232	1·704	36·3	64
18	15·3	·9376	29·4	·1248	1·726	36·6	68
19	12·4	·9368	35·3	·1265	1·749	36·9	72

TABLE VI.—*Concluded.*

CHORD AZIMUTHS, Deflections, Deflection Offsets, &c., for Base Lines.

(Third System of Survey.)

Number of Base Line.	Chord Azimuth Sexagesimal.	Chord Azimuth Decimal.	Deflection Sexagesimal	Deflection Decimal.	Deflection Offset for 1 Chain Distance.	Longitude covered b 1 Range.	Number of Township.
	° ′ ″	°	′ ″	°	Inches.	s.	
20	89 56 09·4	89·9359	7 41·3	0·1281	1·772	37·3	76
21	06·3	·9351	47·4	·1298	1·795	37·6	80
22	03·2	·9342	53·6	·1316	1·819	37·9	84
23	00·1	·9334	59·8	·1333	1·843	38·3	88
24	89 55 56·9	·9325	8 06·3	·1351	1·867	38·6	92
25	53·6	·9316	12·8	·1369	1·892	39·0	96
26	50·3	·9306	19·5	·1387	1·918	39·4	100
27	46·8	·9297	26·3	·1406	1·944	39·8	104
28	43·4	·9287	33·3	·1426	1·971	40·2	108
29	39·9	·9277	40·3	·1445	1·998	40 6	212
30	36·2	·9267	47·6	·1465	2·026	41·0	116
31	32·6	·9257	54·9	·1486	2·054	41·4	120
32	28·8	·9247	9 02·4	·1507	2·083	41·8	124

TABLE VII.

CHORD AZIMUTHS, Deflections, Deflection Offsets, Jogs, &c., for Correction Lines.

(First and Second Systems of Survey.)

Number of Correction Line.	Chord Azimuth.	Chord Azimuth.	Deflection.	Deflection.	Deflection Offset for one chain distance.	Length of one Range on Correction Line.		Jog.	Convergence or Divergence on half Section.	Number of Township.
						North side of Road.	South side of Road.			
	° ′ ″	°	′ ″	°	in inches.	chains.	chains.	chains.	links.	
1	89 56 56·9	89·9491	6 06·2	0·1017	1·406	490·751	487·266	3·485	14·5	2
2	54·6	·9485	10·8	·1030	1·424	·773	·244	·529	14·7	6
3	52·3	·9479	15·5	·1043	1·442	·796	·222	·574	14 9	10
4	49·9	·9472	20·2	·1056	1·460	·818	·200	·618	15·1	14
5	47·5	·9465	25·0	·1069	1·478	·841	·177	·664	15·3	18
6	89 56 45·1	89·9459	6 29·8	0·1083	1·497	490·865	487·154	3·711	15·5	22
7	42·7	·9452	34·7	·1096	1·516	·888	·131	·758	15·7	26
8	40·2	·9445	39·7	·1110	1·535	·913	·107	·806	15·9	30
9	37·6	·9438	44·8	·1124	1·554	·937	·083	·854	16·1	34
10	35·0	·9430	50·0	·1139	1·574	·962	·058	·904	16·3	38
11	89 56 32·4	89·9423	6 55·2	0·1153	1·594	490·987	487·034	3·953	16·5	42
12	29·7	·9416	7 00·6	·1168	1·615	491·012	·008	4·004	16·7	46

TABLE VIII.

CHORD AZIMUTHS, Deflections, Deflection Offsets, Jogs, &c., for Correction Lines.

(Third System of Survey.)

Number of Correction Line.	Chord Azimuth Sexagesimal.	Chord Azimuth Decimal.	Deflection Sexagesimal.	Deflection Decimal.	Deflection Offset for one chain distance.	Length of one Range on Correction Line.		Jogs.	Convergence or Divergence on half section.	Number of Township.
						North side of Road.	South side of Road.			
	° ′ ″	°	′ ″	°	Inches.	chains.	chains.	chains.	chains.	
1	89 56 57·4	89·9493	6 05·2	0·1014	1·403	487·719	484·297	3·421	0·143	2
2	55·1	·9486	09·8	·1027	1·420	·740	·276	·463	·144	6
3	52·9	·9480	14·3	·1040	1·438	·762	·255	·507	·146	10
4	50·5	·9474	19·0	·1053	1·456	·784	·233	·551	·148	14
5	48·2	·9467	23·7	·1066	1·474	·806	·212	·594	·150	18
6	45·8	·9461	28·5	·1079	1·492	·829	·188	·641	·152	22
7	43·3	·9454	33·4	·1093	1·510	·852	·167	·685	·154	26
8	40·9	·9447	38·3	·1106	1·529	·875	·144	·731	·155	30
9	38·3	·9440	43·4	·1120	1·548	·899	·120	·779	·157	34
10	35·8	·9433	48·4	·1134	1·568	·923	·097	·826	·159	38
11	33·2	·9426	53·6	·1149	1·588	·947	·072	·875	·161	42
12	30·6	·9418	58·8	·1163	1·608	·972	·047	·925	·164	46
13	27·9	·9411	7 04·2	·1178	1·629	487·997	484·024	3·973	·166	50
14	25·2	·9403	09·6	·1193	1·650	488·023	483·998	4·025	·168	54
15	22·4	·9396	15·2	·1209	1·671	·049	·972	·077	·170	58
16	19·6	·9388	20·8	·1224	1·693	·075	·946	·129	·172	62
17	16·7	·9380	26·6	·1241	1·715	·102	·919	·183	·174	66

18	89 56 13·8	89·9372	7 32·4	0·1257	1·737	488·130	483·892	4·238	0·177	70
19	10·9	·9364	38·3	·1273	1·760	·158	·865	·293	·179	74
20	07·8	·9355	44·4	·1290	1·783	·187	·837	·350	·181	78
21	04·8	·9347	50·5	·1307	1·807	·215	·809	·406	·184	82
22	89 56 01·7	·9338	56·7	·1324	1·831	·245	·779	·466	·186	86
23	89 55 58·5	·9329	8 03·0	·1342	1·855	·275	·750	·525	·189	90
24	55·2	·9320	09·6	·1360	1·879	·306	·720	·586	·191	94
25	51·9	·9311	16·2	·1378	1·905	·338	·690	·648	·194	98
26	48·6	·9302	22·9	·1397	1·931	·369	·658	·711	·196	102
27	45·1	·9292	29·8	·1416	1·957	·402	·627	·775	·199	106
28	41·6	·9282	36·8	·1436	1·984	·434	·594	·840	·202	110
29	38·0	·9272	44·0	·1456	2·012	·469	·561	·908	·204	114
30	34·4	·9262	51·2	·1476	2·040	·503	·528	4·975	·207	118
31	30·7	·9252	58·6	·1496	2·068	·538	·493	5·045	·210	122
32	89 55 26·9	89·9241	9 06·2	·1517	2·097	488·574	483·458	5·116	·213	126

TABLE IX.

LATITUDE, with Logarithms of Secant and Tangent for the North Boundary of each Section, and the widths of Quarter Sections on such Boundaries.

(First and Second Systems of Survey.)

Township.	Section.	Latitude ϕ.	Sec .	Difference for 10 Chains.	Tan ϕ.	Difference for 10 Chains.	Quarter Section.
	36	49°·0000	0·183 06		0·060 84		40·000
1	1	0147	18		0·061 06		39·988
	12	0295	31		29		976
	13	0442	44		51		964
	24	0590	57		74		952
	25	0737	70		97		940
	36	0885	83		0·062 20		928
2	1	1032	96		42		915
	12	1180	0·184 09		64		903
	13	1327	22		87		891
	24	1475	35		0·063 09		879
	25	1622	48		32		867
	36	1769	61	0·000 02	54	0·000 03	{ 39·855 / 40·146
3	1	1917	74		77		134
	12	2064	87		0·064 00		122
	13	2212	99		23		110
	24	2359	0·185 12		45		097
	25	2507	25		68		085
	36	2654	38		90		073
4	1	2802	51		0·065 13		061
	12	2949	64		35		048
	13	3097	78		58		036
	24	3244	90		81		024
	25	3391	0·186 03		0·066 04		012
	36	3538	16		26		40·000
5	1	3685	29		49		39·988
	12	3833	42		71		976

TABLE IX.—Latitude, with Logarithms of Secant and Tangent, &c.—*Continued.*

(First and Second Systems of Survey.)

Township.	Section.	Latitude ϕ.	Sec ϕ.	Difference for 10 Chains.	Tan ϕ.	Difference for 10 Chains.	Quarter Section.
	13	49°·3980	0·186 55		0·066 94		39·964
	24	4128	69		0·067 16		951
	25	4275	82		39		939
	36	4422	94		61		927
6	1	4569	0·187 07		84		915
	12	4717	21		0·068 07		902
	13	4864	34		29		890
	24	5012	47		52		878
	25	5159	59		74		866
	36	5307	73		97		{ 39·854 / 40·148
7	1	5454	86		0·069 20		136
	12	5602	99		42		124
	13	5749	0·188 12	0·000 02	65	0·000 03	111
	24	5897	26		88		099
	25	6044	38		0·070 11		087
	36	6191	51		33		074
8	1	6338	64		56		062
	12	6486	78		78		050
	13	6633	91		0·071 01		037
	24	6781	0·189 04		24		025
	25	6928	18		46		013
	36	7076	31		69		40·000
9	1	7223	44		91		39·988
	12	7371	57		0·072 14		976
	13	7518	70		37		963
	24	7666	83		60		951
	25	7813	96		82		939
	36	7960	0·190 09		0·073 05		926
10	1	8107	23		27		914
	12	8255	36		50		902
	13	8402	49		72		889
	24	8550	62		95		877

TABLE IX.—Latitude, with Logarithms of Secant and Tangent, &c.—*Continued.*

(First and Second Systems of Survey.)

Township.	Section.	Latitude ϕ.	Sec ϕ.	Difference for 10 Chains.	Tan ϕ.	Difference for 10 Chains.	Quarter Section.
	25	49°·8697	0·190 76		0·074 19		39·865
	36	8845	89		41		{ 39·852 / 40·150
11	1	8992	0·191 02		64		138
	12	9140	16		86		125
	13	9287	29		0·075 09		113
	24	9435	42		32		100
	25	9582	55		54		088
	36	9729	69		77		075
12	1	49·9876	82		99		063
	12	50·0024	95		0·076 23		050
	13	0171	0·192 08		45		038
	24	0319	22		68		025
	25	0466	35		91		013
	36	0614	49	0·000 02	0·077 13	0·000 03	40·000
13	1	0761	62		36		39·988
	12	0908	76		58		975
	13	1056	89		81		963
	24	1203	0·193 02		0·078 03		950
	25	1351	16		27		938
	36	1498	29		50		925
14	1	1645	42		72		913
	12	1793	55		95		900
	13	1940	69		0·079 17		888
	24	2087	83		40		875
	25	2235	96		63		863
	36	2382	0·194 09		85		{ 39·850 / 40·152
15	1	2530	23		0·080 08		139
	12	2677	36		31		127
	13	2824	49		54		114
	24	2972	63		77		101
	25	3119	77		99		089
	36	3266	90		0·081 22		076

TABLE IX—Latitude, with Logarithms of Secant and Tangent, &c.—*Continued.*

(First and Second Systems of Survey.)

Township.	Section.	Latitude ϕ.	Sec. ϕ.	Difference for 10 Chains.	Tan .	Difference for 10 Chains.	Quarter Section.
16	1	50°·3414	0·195 03		0·081 45		40·063
	12	3561	17		67		051
	13	3709	31		90		038
	24	3856	44		0·082 13		025
	25	4003	57		36		013
	36	4151	71		59		40·000
17	1	4298	85		81		39·987
	12	4446	98		0·083 04		975
	13	4593	0·196 11		27		962
	24	4741	25		50		949
	25	4888	39		72		937
	36	5035	52		95		924
18	1	5182	66		0·084 17		911
	12	5330	80		40		899
	13	5477	93		63		886
	24	5625	0·197 06	0·000 02	86	0·000 03	873
	25	5772	20		0·085 09		861
	36	5920	34		32		{ 39·848 / 40·153
19	1	6067	47		54		140
	12	6214	61		77		128
	13	6362	75		0·086 00		115
	24	6509	88		22		102
	25	6656	0·198 02		45		089
	36	6804	15		68		077
20	1	6951	29		91		064
	12	7098	43		0·087 14		051
	13	7246	56		37		038
	24	7393	70		60		026
	25	7540	84		82		013
	36	7688	97		0·088 05		40·000
21	1	7835	0·199 11		28		39·987
	12	7983	25		50		974
	13	8130	39		73		961

TABLE IX.—Latitude, with Logarithms of Secant and Tangent, &c.—*Continued.*

(First and Second Systems of Survey.)

Township.	Section.	Latitude	Sec. ϕ.	Difference for 10 Chains.	Tan ϕ.	Difference for 10 Chains.	Quarter Section.
	24	50°·8278	0·199 52		0·088 96		39·949
	25	8425	65		0·089 19		936
	36	8572	79		42		923
22	1	8719	93		65		910
	12	8867	0·200 07		88		898
	13	9014	21		0·090 10		885
	24	9162	35		33		872
	25	9309	48		56		859
	36	9457	62		79		39·846 40·155
23	1	9604	75		0·091 02		142
	12	9751	89		25		129
	13	9899	0·201 03		48		116
	24	51·0046	17		70		103
	25	0193	31		93		090
	36	0341	45	0·000 02	0·092 16	0·000 03	078
24	1	0488	59		39		065
	12	0635	72		62		052
	13	0783	86		84		039
	24	0930	0·202 00		0·093 07		026
	25	1077	14		30		013
	36	1225	28		53		40·000
25	1	1372	42		76		39·987
	12	1520	56		99		974
	13	1667	69		0·094 22		961
	24	1815	83		44		948
	25	1962	97		67		935
	36	2109	0·203 11		90		922
26	1	2256	25		0·095 13		909
	12	2404	39		36		896
	13	2551	53		59		883
	24	2699	67		82		870
	25	2846	81		0·096 04		857
	36	2994	95		28		39·844 40 157

TABLE IX.—Latitude, with Logarithms of Secant and Tagent, &c.—*Continued.*

(First and Second Systems of Survey.)

Township.	Section.	Latitude ϕ.	Sec ϕ.	Difference for 10 Chains.	Tan ϕ.	Difference for 10 Chains.	Quarter Section.
27	1	51°3141	0·204 09		0·096 51		40·144
	12	3288	23		73		131
	13	3436	36		96		118
	24	3583	50		0·097 19		105
	25	3730	64		42		092
	36	3878	78		65		078
28	1	4025	92		88		065
	12	4172	0.205 06		0·098 11		052
	13	4320	20		34		039
	24	4467	34		57		026
	25	4614	48		79		013
	36	4762	62		0·099 02		40·000
29	1	4909	76		25		39·987
	12	5056	90		48		974
	13	5204	0·206 04		71		961
	24	5351	19	0·000 02	94	0·000 03	947
	25	5498	33		0·100 17		934
	36	5646	47		40		921
30	1	5793	61		63		908
	12	5940	75		86		894
	13	6088	89		0·101 09		881
	24	6235	0·207 03		32		868
	25	6382	17		54		855
	36	51·6530	0·207 31		0·101 78		842
41	36	52·6255	0·216 79		0·116 99		918
42	1	6402	94		0·117 22		904
	12	6549	0·217 09		45		891
	13	6697	24		69		877
	24	6844	38		92		863
	25	6991	53		0·118 15		850
	36	7139	68		38		39·836 40·166
43	1	7286	82		61		152
	12	7433	96		84		138

TABLE IX.—Latitude, with Logarithms of Secant and Tangent, &c.—*Concluded.*

(First and Second Systems of Survey.)

Township.	Section.	Latitude ϕ.	Sec .	Difference for 10 Chains.	Tan ϕ.	Difference for 10 Chains.	Quarter Section.
	13	52°·7581	0·218 11		0·119 08		40·124
	24	7728	26		30		111
	25	7875	40		54		097
	36	8023	55		77		083
44	1	8170	70		0·120 00		069
	12	8317	85		24		056
	13	8465	0·219 00		46		042
	24	8612	14		70		028
	25	8759	29		93		014
	36	8907	44		0·121 16		40·000
45	1	9054	58		40		39·986
	12	9201	73		62		972
	13	9349	88		86		958
	24	9496	0·220 03		0·122 09		945
	25	9643	18		32		931
	36	9791	33	0·000 02	56	0·000 03	917
46	1	9938	48		79		903
	12	53·0085	63		0·123 02		890
	13	0233	77		25		876
	24	0380	92		49		862
	25	0527	0·221 07		0·123 71		848
	36	0675	21		95		{ 39·834 / 40·168
47	1	0822	36				
	12	0969	51		0·124 19		154
	13	1117	66		41		140
	24	1264	81		65		126
	25	1411	96		88		112
	36	1559	0·222 11		0·125 12		098
					34		084
48	1	1706	26		58		070
	12	1853	41		81		056
	13	2001	56		0 126 04		042
	24	2148	71		28		028
	25	2295	86		51		014
	36	2443	0·223 00		74		40·000

TABLE X.—Latitude, with Logarithms of Secant and Tangent for the north boundary of each Section, and width of Quarter Sections on such boundaries.

(Third System of Survey.)

Township.	Section.	Latitude ϕ.	Sec ϕ.	Difference for 10 Chains.	Tan ϕ.	Difference for 10 Chains.	Quarter Section.
	36	49°·0000	0·183 06		0·060 84		40·000
1	1	0147	19		0·061 06		39·988
	12	0291	31		28		976
	13	0438	44		51		964
	24	0582	57		73		953
	25	0729	69		95		941
	36	0874	82		0·062 17		929
2	1	1020	95		40		917
	12	1165	0·184 08		62		905
	13	1311	20	0·000 02	85	0·000 03	893
	24	1456	33		0·063 07		882
	25	1603	46		29		870
	36	1747	59		51		{ 39·858 / 40·143
3	1	1894	71		74		131
	12	2039	84		96		119
	13	2185	97		0·064 18		107
	24	2330	0·185 10		41		095
	25	2476	23		63		084
	36	2621	35		85		072
4	1	2768	48		0·065 08		060
	12	2912	61		30		048
	13	3059	0·185 74		52		036
	24	3203	87		74		024
	25	3350	0·186 00		97		012
	36	3495	12		0·066 19		40·000
5	1	3641	25		42		39·988
	12	3786	38		64		976
	13	3932	51		86		964
	24	4077	64		0·067 08		952
	25	4224	77		31		940
	36	4368	90		53		928

TABLE X.—Latitude, with Logarithms of Secant and Tangent for each Section, and width of Quarter Sections—*Continued.*

(Third System of Survey.)

Township.	Section.	Latitude ϕ.	Sec ϕ.	Difference for 10 Chains.	Tan ϕ.	Difference for 10 Chains.	Quarter Section.
6	1	49°·4515	0·187 03		1·067 76		39·916
	12	4659	15		98		904
	13	4806	28		0·068 20		892
	24	4951	41		43		880
	25	5097	54		65		868
	36	5242	67		87		{ 39·858 / 40·145
7	1	5388	80		0·069 10		133
	12	5533	93		32		121
	13	5680	0·188 06		54		109
	24	5824	19		77		097
	25	5971	32		99		085
	36	6115	45		0·070 21		073
8	1	6262	58	0·000 02	44	0·000 03	060
	12	6407	71		66		048
	13	6553	84		89		036
	24	6698	97		0·071 11		024
	25	6844	0·189 10		33		012
	36	6989	23		56		40·000
9	1	7136	36		78		39·988
	12	7280	49		0·072 00		976
	13	7427	62		23		964
	24	7571	75		45		951
	25	7718	88		68		939
	36	7863	0·190 01		90		927
10	1	8009	14		0·073 12		915
	12	8154	27		35		903
	13	8300	40		57		891
	24	8445	53		79		879
	25	8592	66		0·074 02		867
	36	8736	79		24		{ 39·855 / 40·147
11	1	8883	93		47		135
	12	9027	0·191 06		69		122

TABLE X.—Latitude, with Logarithms of Secant and Tangent for each Section, and width of Quarter Sections—*Continued.*

(Third System of Survey.)

Township.	Section.	Latitude ϕ.	Sec ϕ.	Difference for 10 Chains.	Tan ϕ.	Difference for 10 Chains.	Quarter Section.
	13	50°·9174	0·191 19		0·074 92		40·110
	24	9319	32		0·075 14		098
	25	9465	45		36		086
	36	9610	58		59		073
12	1	9756	71		81		061
	12	9901	84		0·076 03		050
	13	0047	98		26		037
	24	0192	0·192 11		48		024
	25	50·0339	24		71		012
	36	0483	37		93		40·000
13	1	0630	50		0·077 16		39·988
	12	0775	63		38		975
	13	0921	77		60		963
	24	1066	90		83		951
	25	1212	0·193 03	0·000 02	0·078 05	0·000 03	939
	36	1357	16		28		926
14	1	1503	29		50		914
	12	1648	43		72		902
	13	1795	56		95		890
	24	1939	69		0·079 17		877
	25	2086	82		40		865
	36	2230	96		62		{ 39·853 / 40·149
15	1	2377	0·194 09		85		137
	12	2522	22		0·080 07		124
	13	2668	35		30		112
	24	2813	49		52		099
	25	2959	62		75		087
	36	3104	75		97		074
16	1	3250	89		0·081 20		062
	12	3395	0·195 02		42		050
	13	3542	15		64		037
	24	3686	28		87		025

TABLE X.—Latitude, with Logarithms of Secant and Tangent for each Section, and width of Quarter Sections—*Continued.*

(Third System of Survey.)

Township.	Section.	Latitude ¢.	Sec. ¢.	Difference for 10 Chains.	Tan ¢.	Difference for 10 Chains.	Quarter Section.
	25	50°·3833	0·195 42		0·082 09		40·012
	36	3977	55		32		40·000
17	1	4124	69		54		39·988
	12	4269	82		77		975
	13	4415	95		99		963
	24	4560	0·196 09		0 083 22		950
	25	4706	22		44		940
	36	4851	35		67		925
18	1	4997	49		89		913
	12	5142	62		0·084 12		901
	13	5289	76		34		888
	24	5433	89		56		876
	25	5580	0 197 02		79		863
	36	5724	16	0·000 02	0·085 01	0·000 03	{39·851 40·150
19	1	5871	29		24		138
	12	6016	43		46		125
	13	6162	56		69		113
	24	6307	69		91		100
	25	6453	83		0·086 14		088
	36	6598	96		36		075
20	1	6744	0·198 10		59		063
	12	6889	23		81		050
	13	7035	37		0·087 04		038
	24	7180	50		27		025
	25	7327	64		49		013
	36	7471	77		72		40·000
21	1	7618	91		94		39·987
	12	7762	0·199 04		0·088 17		975
	13	7909	18		39		962
	24	8054	31		62		950
	25	8200	45		84		937
	36	8345	58		0·089 07		925

TABLE X.—Latitude, with Logarithms of Secant and Tangent for each Section, and width of Quarter Sections—*Continued.*

(Third System of Survey.)

Township.	Section.	Latitude ¢.	Sec. ¢.	Difference for 10 Chains.	Tan ¢.	Difference for 10 Chains.	Quarter Section.
22	1	50°·8491	0·199 72		0·089 29		39·912
	12	8636	85		52		899
	13	8782	99		74		887
	24	8927	0·200 13		97		874
	25	9073	26		0·090 20		862
	36	9218	40		42		{39·849 40·152
23	1	9365	53		65		140
	12	9509	67		87		127
	13	9656	81		0·091 10		114
	24	9800	94		32		102
	25	9947	0·201 08		55		089
	36	51·0091	21		77		076
24	1	0238	35	0·000 02	0·092 00	0·000 03	064
	12	0383	49		22		051
	13	0529	62		45		038
	24	0674	76		68		025
	25	0820	90		90		013
	36	0965	0·202 03		0·893 13		40·000
25	1	1111	17		35		39·987
	12	1256	31		58		975
	13	1402	44		81		962
	24	1547	58		0·094 03		949
	25	1694	72		26		936
	36	1838	85		48		924
26	1	1985	99		71		911
	12	2129	0·203 13		93		898
	13	2276	27		0·095 16		885
	24	2420	40		39		873
	25	2567	54		61		860
	36	2712	68		84		{39·847 40·154

TABLE X.—Latitude, with Logarithms of Secant and Tangent for each Section, and width of Quarter Section—*Continued.*

(Third System of Survey.)

Township.	Section.	Latitude ϕ.	Sec. ϕ.	Difference for 10 Chains.	Tan ϕ.	Difference for 10 Chains.	Quarter Section.
27	1	51°·2858	0·203 82		0·096 07		40·141
	12	3003	95		29		129
	13	3149	0·204 09		52		116
	24	3294	23		74		103
	25	3440	37		97		090
	36	3585	51		0·097 19		077
28	1	3731	64		42		
	12	3876	78		65		064
	13	4023	92		87		051
	24	4167	0·205 06		0·098 10		039
	25	4314	20		33		026
	36	4458	33		55		013
29	1	4605	47	0·000 02	78	0·000 03	40·000
	12	4749	61		0·099 00		39·987
	13	4896	75		23		974
	24	5040	89		46		962
	25	5187	03		69		949
	36	5332	17		91		936
30	1	5478	31		0·100 14		923
	12	5623	44		36		910
	13	5769	58		59		897
	24	5914	72		82		884
	25	6060	86		0·101 05		871
	36	6295	0·207 00		27		858
							{39·846 / 40·156
31	1	6351	14		50		143
	12	6496	28		72		130
	13	6642	42		95		117
	24	6787	56		0·102 18		104
	25	6934	70		41		091
	36	7078	84		63		078
32	1	7225	99		86		
	12	7369	0·208 12		0·103 08		065
							052

TABLE X—Latitude, with Logarithms of Secant and Tangent for each Section, and width of Quarter Section—*Continued.*

(Third System of Survey.)

Township.	Section.	Latitude ϕ.	Sec. ϕ.	Difference for 10 Chains.	Tan ϕ.	Difference for 10 Chains.	Quarter Section.
	13	51°·7516	0·208 26		0·103 31		40·039
	24	7660	40		54		026
	25	7807	54		77		013
	36	7951	68		99		40·000
33	1	8098	82		0·104 22		39·987
	12	8243	96		45		974
	13	8389	0·209 10		68		961
	24	8534	24		90		948
	25	8680	38		0·105 13		935
	36	8825	52		35		922
34	1	8971	66		58		909
	12	9116	80		81		896
	13	9262	94		0·106 04		883
	24	9407	0·210 08	0·000 02	26	0·000 03	869
	25	9553	22		49		856
	36	9698	36		72		{39·843 / 40·158
35	1	9844	51		95		145
	12	9989	65		0·107 17		132
	13	52·0135	79		40		119
	24	0280	93		63		106
	25	0427	0·211 07		86		092
	36	0571	21		0·108 08		079
36	1	0718	36		31		066
	12	0862	50		54		053
	13	1009	64		77		040
	24	1153	78		99		026
	25	1300	92		0·109 22		013
	36	1444	0·212 06		45		40·000
37	1	1591	21		68		39·987
	12	1735	35		90		974
	13	1882	49		0·110 13		960
	24	2027	63		36		947

TABLE X.—Latitude, with Logarithms of Secant and Tangent for each Section, and width of Quarter Section—*Continued.*

Third System of Survey.)

Township.	Section.	Latitude ϕ.	Sec. ϕ.	Difference for 10 Chains.	Tan ϕ.	Difference for 10 Chains.	Quarter Section.
	25	52°·2173	0·212 77		0·110 59		39·934
	36	2318	92		81		921
38	1	2464	0·213 06		0·111 04		907
	12	2609	20		27		894
	13	2775	34		50		881
	24	2900	49		73		868
	25	3046	63		0·111 96		855
	36	3191	77		0·112 18		{39·841 40·160
39	1	3337	92	0·000 02	41	0·000 03	147
	12	3482	0·214 06		64		134
	13	3628	20		87		120
	24	3773	34		0·113 09		107
	25	3919	49		32		093
	36	4064	63		55		080
40	1	4210	77		78		067
	12	4355	92		0·114 01		053
	13	4501	0·215 06		24		040
	24	4646	20		46		027
	25	4794	35		69		013
	36	4937	49		92		40·000
41	1	5084	64		0·115 15		39·987
	12	5228	78		38		973
	13	5375	92		61		960
	24	5519	0·216 07		83		946
	25	5666	21		0·116 06		933
	36	5810	35		29		920
42	1	5957	50		52		906
	12	6101	64		75		893
	13	6248	79		98		879
	24	6392	93		0·117 21		866
	25	6539	0·217 08		44		853

TABLE X.—Latitude, with Logarithms of Secant and Tangent for each Section, and width of Quarter Section—*Continued.*

(Third System of Survey.)

Township.	Section.	Latitude ϕ.	Sec. ϕ.	Difference for 10 Chains.	Tan ϕ.	Difference for 10 Chains.	Quarter Section.
	36	52°·6683	0·217 22		0·117 66		{39·839 40·162
43	1	6830	37		89		149
	12	6974	51		0·118 12		135
	13	7121	66		35		122
	24	7266	80		58		108
	25	7412	95		81		095
	36	7557	0·218 09		0·119 04		081
44	1	7703	24		27		068
	12	7848	38		49		054
	13	7994	53		73		041
	24	8139	67		95		027
	25	8285	82		0·120 18		014
	36	8430	96		41		40·000
45	1	8576	0·219 11	0·000 02	64	0·000 03	39·986
	12	8721	25		87		973
	13	8867	40		0·121 10		950
	24	9012	55		33		946
	25	9158	69		56		932
	36	9303	84		79		919
46	1	9449	98		0·122 02		905
	12	9594	0·220 13		25		891
	13	9740	28		48		878
	24	9885	42		70		864
	25	53·0031	57		93		851
	36	0176	71		0·123 16		{39·837 40·164
47	1	0321	0·220 86		39		151
	12	0467	0·221 01		62		137
	13	0612	15		0·124 85		123
	24	0758	30		08		110
	25	0903	45		31		096
	36	1049	59		54		082

TABLE X.—Latitude, with Logarithms of Secant and Tangent for each Section, and width of Quarter Sections—*Continued.*

(Third System of Survey.)

Township.	Section.	Latitude ϕ.	Sec ϕ.	Difference for 10 Chains.	Tan ϕ.	Difference for 10 Chains.	Quarter Section.
48	1	53°·1195	0·221 74		0·124 77		40·068
	12	1340	89		0·125 00		055
	13	1486	0·222 04		23		041
	24	1631	18		46		027
	25	1777	33		69		014
	36	1922	48		92		40·000
49	1	2068	63		0·126 15		39·986
	12	2213	77		38		972
	13	2359	92		61		958
	24	2504	0·223 07		84		945
	25	2650	22		0·127 07		931
	36	2795	36		30		917
50	1	2941	51		53		903
	12	3086	66	0·000 02	76	0·000 03	889
	13	3233	81		99		875
	24	3377	96		0·128 22		861
	25	3524	0·224 10		45		848
	36	3668	25		68		39·834 / 40·166
51	1	3815	40		91		153
	12	3959	55		0·129 14		139
	13	4106	70		37		125
	24	4250	85		60		111
	25	4397	0·225 00		83		097
	36	4541	14		0·130 06		083
52	1	4688	29		30		069
	12	4832	44		53		055
	13	4979	59		76		042
	24	5123	74		99		028
	25	5270	89		0·131 23		014
	36	5414	0·226 04		45		40·000
53	1	5561	19		68		39·986
	12	5705	34		91		972

TABLE X.—Latitude, with Logarithms of Secant and Tangent for each Section, and width of Quarter Sections—*Continued.*

(Third System of Survey.)

Township.	Section.	Latitude ϕ.	Sec ϕ.	Difference for 10 Chains.	Tan ϕ.	Difference for 10 Chains.	Quarter Section.
	13	53°·5852	0·226 49		0·132 14		39·958
	24	5996	63		37		944
	25	6143	79		60		930
	36	6287	93		83		917
54	1	6434	0·227 08		0·133 07		903
	12	6578	23		30		890
	13	6725	38		53		875
	24	6869	53		76		861
	25	7016	68		99		847
	36	7160	83		0·134 22		39·833 / 40·169
55	1	7307	99		45		155
	12	7451	0·228 13		68		140
	13	7598	29		91		126
	24	7742	44	0·000 02	0·135 14	0·000 03	112
	25	53·7889	59		38		098
	36	8033	74		61		084
56	1	8180	89		84		070
	12	8324	0·229 04		0·136 07		056
	13	8471	19		30		042
	24	8615	34		53		028
	25	8762	49		77		014
	36	8906	64		0·137 00		40·000
57	1	9052	79		23		39·986
	12	9197	95		46		972
	13	9343	0·230 10		69		958
	24	9488	25		92		944
	25	9634	40		0·138 16		930
	36	9779	55		39		915
58	1	9925	70		62		901
	12	54·0070	85		85		887
	13	0216	0·231 01		0·139 08		873
	24	0361	16		31		859

TABLE X.—Latitude, with Logarithms of Secant and Tangent for each Section, and width of Quarter Sections—*Continued.*

(Third System of Survey.)

Township.	Section.	Latitude ϕ.	Sec ϕ.	Difference for 10 Chains.	Tan ϕ.	Difference for 10 Chains.	Quarter Section.
	25	54°·0507	0·231 31		0·139 55		39·845
	36	0652	46		78		{39·831 / 40·171
59	1	0798	62		0·140 01		157
	12	0943	77		24		142
	13	1089	92		48		128
	24	1234	0·232 07		71		114
	25	1380	23		94		100
	36	1525	38		0·141 17		085
60	1	1671	53		41		071
	12	1816	68		64		057
	13	1962	84		87		043
	24	2107	99		0·142 10		028
	25	2253	0·233 14	0·000 02	34	0·000 03	014
	36	2398	29		57		40·000
61	1	2544	45		80		39·986
	12	2689	60		0·143 03		971
	13	2835	76		27		957
	24	2980	91		50		943
	25	3126	0·234 06		73		929
	36	3271	21		96		914
62	1	3417	37		0·144 20		900
	12	3562	52		43		886
	13	3708	68		66		872
	24	3853	83		89		857
	25	3999	98		0·145 13		843
	36	4144	0·235 14		36		{39·829 / 40·173
63	1	4290	29		59		159
	12	4435	45		83		144
	13	4581	60		0·146 06		130
	24	4725	75		29		115
	25	4872	91		53		101
	36	5016	0·236 06		76		086

TABLE X.—Latitude, with Logarithms of Secant and Tangent for each Section, and width of Quarter Sections—*Continued.*

(Third System of Survey.)

Township.	Section.	Latitude ϕ.	Sec ϕ.	Difference for 10 Chains.	Tan ϕ.	Difference for 10 Chains.	Quarter Section.
64	1	54°·5163	0·236 22		0·146 99		40·072
	12	5307	37		0·147 22		058
	13	5454	53		46		043
	24	5598	68		69		029
	25	5745	84		93		014
	36	5889	99		0·148 16		40·000
65	1	6036	0·237 15		39		986
	12	6180	30		63		971
	13	6327	46		86		957
	24	6471	61		0·149 09		942
	25	6618	77		33		928
	36	6762	92		56		913
66	1	6909	0·238 08		80		899
	12	7053	24		0·150 03		884
	13	7199	39		26		870
	24	7344	55		50		855
	25	7490	70	0·000 02	73	0·000 03	841
	36	7635	86		96		{38·827 / 40·175
67	1	7781	0·239 02		0·151 20		161
	12	7926	17		43		146
	13	8072	33		67		131
	24	8217	49		90		117
	25	8363	64		0·152 13		102
	36	8508	80		37		088
68	1	8654	96		60		073
	12	8799	0·240 11		84		058
	13	8945	27		0·153 07		044
	24	9090	43		31		029
	25	9236	58		54		015
	36	9381	74		77		40·000
69	1	9527	90		0·154 01		39·985
	12	9672	0·241 05		24		971
	13	9818	21		48		956

TABLE X.—Latitude, with Logarithms of Secant and Tangent for each Section, and width of Quarter Sections—*Continued.*

(Third System of Survey.)

Township.	Section.	Latitude ϕ.	Sec ϕ.	Difference for 10 Chains.	Tan ϕ.	Difference for 10 Chains.	Quarter Section.
	24	54°·9962	0·241 37		0·154 71		39·941
	25	55°·0109	53		95		927
	36	0253	68		0·155 18		912
70	1	0400	84		42		898
	12	0544	0·242 00		65		883
	13	0691	16		89		868
	24	0835	31		0·156 12		854
	25	0982	47		36		839
	36	1126	63		59		{39·824 40·177
71							
	1	1274	79		83		163
	12	1417	95		1·057 06		148
	13	1563	0·243 11		30		133
	24	1708	26		53		118
	25	1854	42	0·000 02	77	0·000 03	104
	36	1999	58		0·158 00		089
72							
	1	2145	74		24		074
	12	2290	90		47		059
	13	2436	0·244 06		71		044
	24	2581	22		94		030
	25	2727	38		0·159 18		015
	36	2872	53		41		40·000
73	1	3018	69		65		39·985
	12	3163	85		89		970
	13	3309	0·245 01		0·160 12		956
	24	3454	17		36		941
	25	3600	33		59		926
	36	3744	49		83		911
74	1	3891	65		0·161 07		896
	12	4035	81		30		881
	13	4182	97		54		867
	24	4326	0·246 13		77		852
	25	4473	29		0·162 01		837

TABLE X.—Latitude, with Logarithms of Secant and Tangent for each Section, and width of Quarter Sections—*Continued.*

(Third System of Survey.)

Township.	Section.	Latitude ϕ.	Sec ϕ.	Difference for 10 Chains.	Tan ϕ.	Difference for 10 Chains.	Quarter Section.
	36	55°·4617	0·246 45		0·162 24		{39·822 40·180
75	1	4764	61		48		165
	12	4908	77		72		150
	13	5054	93		95		135
	24	5199	0·247 09		0·163 19		120
	25	5345	25		43		105
	36	5490	41		66		090
76	1	5636	57		90		075
	12	5781	73		0·164 13		060
	13	5927	90		37		045
	24	6072	0·248 06		61		030
	25	6218	22		85		015
	36	6363	38		0·165 08		40·000
77	1	6509	54		32		39·985
	12	6654	70		55		970
	13	6800	86		79		955
	24	6944	0·249 02	0·000 02	0·166 03	0·000 03	940
	25	7091	19		27		925
	36	7235	35		50		910
78	1	7382	51		74		895
	12	7526	67		98		880
	13	7672	83		0·167 21		865
	24	7817	0·250 00		45		850
	25	7963	16		69		835
	36	8108	32		92		{39·820 40·182
79	1	8254	48		0·168 16		167
	12	8399	64		40		152
	13	8545	81		64		137
	24	8690	97		87		122
	25	8836	0·251 13		0·169 11		106
	36	8981	30		35		091

TABLE X.—Latitude, with Logarithms of Secant and Tangent for each Section, and width of Quarter Section—*Concluded.*

(Third System of Survey.)

Township.	Section.	Latitude ϕ.	Sec. ϕ.	Difference for 10 Chains.	Tan ϕ.	Difference for 10 Chains.	Quarter Section.
80	1	55°·9127	0 251 46		0·169 59		40·076
	12	9272	62		82		061
	13	9418	79		0·170 06		046
	24	9562	95		30		030
	25	9709	0·252 11		54		015
	36	9853	27		77		40·000
81	1	56·0000	44	0·000 02	0·171 01	0·000 03	39·985
	12	0144	60		25		970
	13	0291	77		49		954
	24	0435	93		72		939
	25	0581	0·253 09		96		39·924
	36	0726	26		0·172 20		909
82	1	0872	42		44		893
	12	1017	58		68		878
	13	1163	75		92		863
	24	1308	91		0·173 15		848
	25	1454	0·254 08		39		833
	36	1599	24		63		{39·817 40·185

TABLE XI.—To Convert Chains into Decimals of a Township Side.

Chains.	Equivalent Decimal of a Township Side.			Chains.	Equivalent Decimal of a Township Side.		
	Side=489c	Side=486c	Side=483c		Side=489c	Side=486c	Side=483
1	0·00204	0·00206	0·00207	30	0·06135	0·06173	0·06211
2	·00409	·00412	·00414	40	·08180	·08230	·08282
3	·00613	·00617	·00621	50	·10225	·10228	·10352
4	·00818	·00823	·00828	60	·12270	·12346	·12422
5	·01022	·01029	·01035	70	·14315	·14403	·14493
6	·01227	·01235	·01242	80	·16360	·16461	·16563
7	·01431	·01440	·01449	90	·18405	·18519	·18634
8	·01636	·01646	·01656	100	·20450	·20576	·20704
9	·01840	·01852	·01863	200	·40900	·41152	·41408
10	·02045	·02058	·02070	300	·61350	·61728	·62112
20	·04090	·04115	·04141	400	·81800	·82305	·82816

TABLE XII.

CORRECTIONS to be applied to the tabular quantities in Table VII. when the north side of the road allowance on Correction Lines is run instead of the south ; also correction to road allowance on account of curvature.

Number of Correction Line.	Correction to Chord Azimuth	Correction to Deflection Offset (for one chain distance).	Correction to width of road allowance on account of curvature.									
			jog = 30 chs.	jog = 40 chs.	jog = 50 chs.	jog = 60 chs.	jog = 70 chs.	jog = 80 chs.	jog = 90 chs.	jog = 100 chs.	jog = 110 chs.	jog = 120 chs.
	″	inches.	lks.	lks.	lks.	lks.	lks.	lks.	lks.	lks.	lks.	lks.
1st	—1·3	+0·010	2·5	3·2	3·9	4·6	5·2	5·8	6·4	7·0	7·5	7·9
11th....	—1·7	+0·013	2·8	3·7	4·5	5·2	6·0	6·7	7·3	7·9	8·5	8·9
21st	—2·2	+0·017	3·2	4·2	5·2	6·0	6·9	7·7	8·4	9·1	9·8	10·4
31st	—2·9	+0·022	3·7	4·8	5·9	6·9	7·9	8·8	9·6	10·4	11·2	11·9

TABLE XIII.

SHOWING the difference of Latitude between Township Corners and Section and Quarter Section Posts on a Township Chord.

Number of Line.	$d\varphi$ For $\frac{1}{2}$ sec. from Corner.	$d\phi$ For 1 sec. from Corner.	$d\phi$ For $1\frac{1}{2}$ sec. from Corner.	$d\phi$ For 2 secs. from Corner.	$d\phi$ For $2\frac{1}{2}$ secs. from Corner.	$d\phi$ For 3 secs. from Corner.
	″	″	″	″	″	″
1st Base.....	0·02	0·04	0·05	0·06	0·07	0·07
	lks.	lks.	lks.	lks.	lks.	lks.
do	3·2	5·9	8·0	9·5	10·3	10·8
	″	″	″	″	″	″
11th Base.....	0·02	0·04	0·06	0·07	0·08	0·08
	lks.	lks.	lks.	lks.	lks.	lks.
do	2·6	6·7	9·1	10·8	11·8	12·1
	″	″	″	″	″	″
21st Base	0·03	0·05	0·07	0·08	0·09	0·09
	lks.	lks.	lks.	lks.	lks.	lks.
do	4·2	7·7	10·3	12·3	13·3	13·8
	″	″	″	″	″	″
31st Base	0·03	0·06	0·08	0·09	0·10	0·11
	lks.	lks.	lks.	lks.	lks.	lks.
do	4·8	8·8	12·0	14·4	15·6	16·2

TABLE XIV.—For finding the Pole Star.

Hour Angle.	Azimuth.									Distance above or below Pole.	Hour Angle.
	Tp. 0.	Tp. 10.	Tp. 20.	Tp. 30.	Tp. 40.	Tp. 50.	Tp. 60.	Tp. 70.	Tp. 80.		
H. M.											H. M.
0·10	0·09	0·09	0·09	0·09	0·09	0·09	0·09	·10	0·10	1·32	11.50
0 20	·18	·18	·18	·19	·19	·19	·20	·20	·21	·32	11.40
0.30	·26	·27	·27	·28	·28	·29	·30	·30	·31	·31	11.30
0.40	·35	·36	·36	·37	·38	·38	·39	·40	·41	·30	11.20
0.50	·44	·45	·46	·47	·47	·48	·49	.50	·51	·29	11.10
1.00	·52	·53	·54	·55	·56	·57	·59	·60	·61	·28	11.00
1.10	·61	·62	·63	·64	·65	·67	·68	·70	·71	·26	10.50
1.20	·69	·70	·71	·73	·74	·75	·77	·79	·81	·24	10.40
1.30	·77	·78	·80	·81	·83	·85	·87	·89	·91	·22	10.30
1.40	·85	·87	·88	·90	·92	·94	·96	·98	1·00	·20	10.20
1.50	·93	·95	·96	·98	1·00	1·02	1·05	1·07	09	·17	10.10
2.00	1·01	1·02	1·04	1·06	·08	·11	·13	·16	·18	·14	10.00
2·10	·08	·10	·12	·14	·17	·19	·22	·24	·27	·11	9.50
2.20	·15	·18	·20	·22	·24	·27	·30	·33	·36	·08	9.40
2.30	·22	·25	·27	·30	·32	·35	·38	·41	·44	·05	9.30
2.40	·29	·32	·34	·37	·39	·42	·45	·49	·52	·01	9.20
2.50	·36	·38	·41	·44	·47	·50	·53	·56	·60	0·97	9.10
3.00	·42	·45	·48	·50	·53	·57	·60	·64	·67	·93	9.00
3.10	·48	·51	·54	·57	·60	·63	·67	·70	·74	·89	8.50
3.20	·54	·57	·60	·63	·66	·70	·73	77	·81	·85	8.40
3.30	·60	·63	·66	·69	·72	·76	·80	·84	·88	·80	8.30
3.40	·65	·68	·71	·74	·78	·81	·85	·89	·94	·76	8.20
3.50	·70	·73	·76	·79	·83	·87	·91	·95	·99	·71	8.10
4.00	·74	·77	·81	·84	·88	·92	·96	2·00	2·05	·66	8.00
4.10	·78	·82	85	·89	·92	·96	2·01	·05	·10	·61	7.50
4.20	·82	·86	·89	·93	·97	2·01	·05	·10	·14	·56	7.40
4.30	·86	·89	·93	·97	2·01	·05	·09	·14	·19	·51	7.30
4.40	·89	·92	·96	2·00	·04	·08	·13	·17	·22	·45	7.20
4.50	·92	·95	·99	·03	·07	·11	·16	·21	·26	·40	7.10

TABLE XIV.—For finding the Pole Star—*Concluded.*

Hour Angle.	Azimuth.									Distance above or below Pole.	Hour Angle.
	Tp. 0.	Tp 10.	Tp. 20.	Tp. 30.	Tp. 40.	Tp. 50.	Tp. 60.	Tp. 70.	Tp. 80.		
H.M.											
5·00	1·94	1·98	2·02	2·06	2·10	2·14	2·19	2·23	2·28	0·34	7.00
5.10	·96	2·00	·04	·08	·12	·16	·21	·26	·31	·29	6.50
5.20	·98	·02	·06	·10	·14	·18	·23	·28	·33	·23	6.40
5.30	2·00	.03	·07	·11	·15	·20	·24	·29	·35	·17	6.30
5.40	·01	·04	·08	·12	·16	·21	·25	·30	·36	·12	6.20
5.50	·01	·05	·09	·13	·17	·21	·26	·31	·36	·06	6.10
6.00	·01	·05	·09	·13	·17	·21	·26	·31	·37	·00	6.00

TABLE XV.—For finding the Time by Transits across the vertical of Polaris.

t-t'		Declination North. 0°	5°	10°	15°	20°	25°	30°
H.	M.							
0 or 12	10	1·13925	1·14019	1·14114	1·14176	1·14301	1·14395	1·14489
	20	·43996	·44091	·44170	·44264	·44358	·44451	·44560
	30	·61542	·61627	·61721	·61805	·61899	·62003	·62107
	40	·73933	·74020	·74107	·74194	·74288	·74390	·74500
	50	·83506	·83588	·83677	·83765	·83860	·83954	·84067
1 or 13	00	1·91270	1·91355	1·91440	1·91529	1·91619	1·91719	1·91824
	10	·97782	·97864	·97950	·98046	·98127	·98223	·98327
	20	2·03375	2·03455	2·03539	2·03627	2·03715	2·03810	2·03914
	30	·08254	·08332	·08415	·08500	·08586	·08682	·08782
	40	·12564	·12643	·12723	·12808	·12892	·12985	·13085
	50	·16412	·16489	·16566	·16649	·16732	·16823	·16921
2 or 14	00	2·19866	2·19943	2·20016	2·20096	2·20181	2·20268	2·20363
	10	·22991	·23065	·23139	·23215	·23297	·23381	·23475
	20	·25828	·25900	·25971	·26045	·26124	·26207	·26298
	30	·28414	·28484	·28554	·28625	·28702	·28782	·28868
	40	·30775	·30841	·30910	·30980	·31052	·31131	·31214
	50	·32938	·33003	·33068	·33135	·33205	·33280	·33361
3 or 15	00	2·34918	2·34980	2·35042	2·35106	2·35174	2·35247	2·35324
	10	·36732	·36791	·36851	·36912	·36977	·37046	·37120
	20	·38394	·38449	·38507	·38566	·38627	·38693	·38762
	30	·39915	·39969	·40023	·40078	·40137	·40199	·40264
	40	·41306	·41357	·41407	·41459	·41514	·41572	·41636
	50	·42572	·42619	·42665	·42714	·42767	·42820	·42880
4 or 16	00	2·43722	2·43767	2·43810	2·43856	2·43905	2·43955	2·44010
	10	·44762	·44803	·44843	·44886	·44929	·44977	·45028
	20	·45697	·45734	·45772	·45818	·45850	·45894	·45941
	30	·46529	·46562	·46597	·46634	·46668	·46708	·46749
	40	·47268	·47297	·47328	·47360	·47392	·47428	·47465
	50	·47911	·47937	·47965	·47995	·48021	·48051	·48084
		0°	5°	10°	15°	20°	25°	30°
		Declination South.						

35°	40°	45°	50°	55°	60°	t-t' H.	M.
1·14613	1·14768	1·14922	1·15106	1·15320	1·15625	11 or 23	50
·44685	·44824	·44979	·45163	·45393	·45682		40
·62232	·62366	·62521	·62706	·62931	·63225		30
·74617	·74749	·74904	·75089	·75312	·75603		20
·84180	·84317	·84466	·84652	·84874	·85163		10
1·91939	1·92070	1·92226	1·92402	1·92624	1·92906	11 or 23	00
·98444	·98574	·98722	·98900	·99118	·99401	10 or 22	50
2·04025	2·04155	2·04301	2·04477	2·04693	2·04969		40
·08895	·09019	·09167	·09339	·09552	·09823		30
·13194	·13316	·13459	·13628	·13836	·14101		20
·17026	·17149	·17286	·17452	·17658	·17918		10
2·20466	2·20586	2·20721	2·20884	2·21082	2·21338	10 or 22	00
·23575	·23697	·23825	·23982	·24178	·24425	9 or 21	50
·26397	·26507	·26637	·26793	·26980	·27221		40
·28966	·29072	·29199	·29347	·29531	·29763		30
·31306	·31412	·31534	·31677	·31854	·32079		20
·33449	·33552	33668	·33806	·33977	·34193		10
2·35409	2·35507	2·35618	2·35751	2·35916	2·36124	9 or 21	00
·37201	·37295	37401	·37528	·37685	·37883	8 or 20	50
·38841	·38929	·39032	·39151	·39301	·39491		40
·40339	·40422	·40520	·40634	·40775	·40955		30
·41706	·41783	·41875	·41984	·42116	·42287		20
·42945	·43022	·43104	·43206	·43331	·43491		10
2·44070	2·44140	2·44218	2·44314	2·44430	2·44579	8 or 20	00
·45083	·45148	·45220	·45307	·45415	·45553	7 or 19	50
·45992	·46050	·46117	·46197	·46295	·46421		40
·46796	·46849	46911	·46982	·47071	·47186		30
·47506	·47554	·47608	·47673	·47753	·47856		20
·48122	·48163	·48210	·48267	·48337	·48429		10
35°	40°	45°	50°	55°	60°		

TABLE XV.—For finding the Time by Transits across the vertical of Polaris—*Continued.*

t-t'		Declination						
		0°	5°	10°	15°	20°	25°	30°
H.	H. M.							
6 or 17	00	2·48462	2·48486	2·48508	2 48533	2·48557	2·48583	2·48612
	10	·48927	·48946	·48966	·48985	·49006	·49028	·49052
	20	·49304	·49319	·49335	·49350	·49367	·49385	·49405
	30	·49596	·49607	·49620	·49631	·49643	·49657	·49671
	40	·49803	·49811	·49818	·49827	·49835	·49844	·49853
	50	·49927	·49931	·49935	·49938	·49944	·49948	·49952
6 or 18	00	2·49969	2·49969	2·49969	2·49969	2·49969	2·49969	2·49969
	10	·49927	·49923	·49919	·49917	·49911	·49907	·49903
	20	·49803	·49795	·49789	·49780	·49772	·49763	·49754
	30	·49596	·49585	·49572	·49561	·49549	·49535	·49521
	40	·49304	·49289	·49273	·49258	·49241	·49223	·49203
	50	·48927	·48908	·48889	·48869	·48848	·48826	·48802
7 or 19	00	2·48462	2·48440	2·48417	2·48393	2·48369	2·48341	2·48313
	10	·47911	·47885	·47858	·47828	·47802	·47771	·47738
	20	·47268	·47239	·47208	·47176	·47144	·47108	·47070
	30	·46529	·46497	·46463	·46426	·46390	·46351	·46309
	40	·45697	·45661	·45623	·45583	·45543	·45500	·45452
	50	·44762	·44722	·44682	·44638	·44595	·44546	·44495
8 or 20	00	2·43722	2·43678	2·43635	2·43589	2·43540	2·43489	2·43433
	10	·42572	·42524	·42477	·42428	·42376	·42322	·42261
	20	·41306	·41256	·41207	·41154	·41098	·41039	·40974
	30	·39915	·39861	·39808	·39752	·39693	·39630	·39564
	40	·38394	·38339	·38281	·38222	·38161	·38093	·38023
	50	·36732	·36672	·36613	·36551	·36485	·36416	·36340
9 or 21	00	2·34918	2·34856	2·34794	2·34729	2·34661	2·34587	2·34508
	10	·32938	·32873	·32807	·32746	·32669	·32593	·32510
	20	·30775	·30709	·30641	·30570	·30496	·30417	·30333
	30	·28414	·28344	·28274	·28201	·28124	·28042	·27955
	40	·25828	·25756	·25684	·25610	·25529	·25445	·25353
	50	·22991	·22917	·22843	·22766	·22683	·22598	·22502
		0°	5°	10°	15°	20°	25°	30°
		Declination						

North.

35°	40°	45°	50°	55°	60°	*t-t'*
						H. H. M.
2·48643	2·48678	2·48721	2·48769	2·48830	2·48907	7 or 19 00
·49077	·49108	·49142	·49184	·49234	·49300	6 or 18 50
·49425	·49449	·49477	·49510	·49550	·49603	40
·49687	·49706	·49726	·49751	·49782	·49821	30
·49864	·49876	·49890	·49907	·49927	·49954	20
·49958	·49965	·49972	·49979	·49989	·50003	10
2·49969	2·49969	2·49969	2·49969	2·49969	2·49969	6 or 18 00
·49897	·49890	·49883	·49875	·49865	·49852	5 or 17 50
·49742	·49730	·49717	·49700	·49679	·49652	40
·49505	·49486	·49465	·49440	·49410	·49370	30
·49182	·49158	·49130	·49097	·49056	·49003	20
·48776	·48745	·48711	48668	·48618	·48551	10
2·48281	2·48245	2·48203	2·48154	2·48093	2·48014	5 or 17 00
·47701	·47659	·47611	·47553	·47481	·47388	4 or 16 50
·47029	·46981	·46926	·46860	·46779	·46673	40
·46261	·46209	·46146	46072	·45980	·45862	30
·45400	·45342	·45274	·45192	·45091	·44961	20
·44439	·44373	·44300	·44211	·44099	·43957	10
2·43372	3·43302	2·43222	2·43123	2·43005	2·42849	4 or 16 00
·42195	·42116	·42032	·41927	·41799	·41633	3 or 15 50
·40904	·40824	·40730	·40618	·40481	·40303	40
·39487	·39403	·39303	·39185	·39039	·38851	30
·37944	·37853	·37747	·37623	·37468	·37269	20
·36257	·36162	·36051	·35921	·35757	·35549	10
2·34422	2·34321	2·34207	2.34068	2·33897	2·33678	3 or 15 00
·32420	·32315	·32195	·32052	·31873	·31645	2 or 14 50
·30237	·30129	·30003	·29855	·29669	·29432	40
·27854	·27745	·27614	·27460	·27268	·27021	30
·25251	·25137	·25003	·24841	·24645	·24388	20
·22398	·22275	·22141	·21977	·21772	·21508	10
35°	40°	45°	50°	55°	60°	

South.

TABLE XV.—For finding the Time by Transits across the vertical of Polaris—*Concluded.*

t-t'		Declination 0°	5°	10°	15°	20°	25°	30°
H.	H. M.							
10 or 22	00	2·19866	2·19789	2·19714	2·19634	2·19549	2·19459	2·19362
	10	·16412	·16334	·16256	·16173	·16089	·15996	·15897
	20	·12564	·12486	·12405	·12320	·12235	·12139	·12037
	30	·08254	·08175	·08092	·08005	·07918	·07820	·07718
	40	2·03375	2·03294	2 03209	2·03121	2·03032	2·02934	2·02829
	50	1·97782	1·97699	1·97612	1·97516	1·97433	1·97336	1·97230
11 or 23	00	1·91270	1·91185	1·91100	1·91009	1·90918	1·90816	1·90709
	10	·83506	·83423	·83334	·83245	·83149	·83046	·82937
	20	·73933	·73846	·73759	·73672	·73576	·73472	·73360
	30	·61542	·61458	·61363	·61278	·61183	·61077	·60970
	40	·43996	·43902	·43823	·43727	·43632	·43537	·43425
	50	·13925	·13830	·13735	·13672	·13545	·13450	·13354
		0°	5°	10°	15°	20°	25°	30°
		Declination						

North.

35°	40°	45°	50°	55°	60°	*t-t'* H.	H. M.
2·19257	2·19134	2·18994	2·18822	2·18614	2·18341	2 or 14	00
·15788	·15661	·15518	·15345	·15128	·14851	1 or 13	50
·11926	·11800	·11651	·11474	·11254	·10972		40
·07602	·07475	·07220	·07140	·06915	·06625		30
2·02715	2·02580	2·02428	2·02243	2·02015	2·01720		20
1·97109	1·96974	1·96820	1·96633	1·96402	1·96099		10
1·90590	1·90455	1·90293	1·90108	1·89873	1·89570	1 or 13	00
·82821	·82679	·82523	·82393	·82092	·81783	0 or 12	50
·73239	·73102	·72941	·72746	·72509	·72198		40
·60842	·60703	·60541	·60347	·60108	·59791		30
·43297	·43152	·42991	·42797	·42553	·42243		20
·13226	·13066	·12905	·12710	·12483	·12156		10
35°	40°	45°	50°	55°	60°		

South.

TABLE XVI.

For Converting the Logarithm Tangent of Small Arcs into Logarithm of Seconds of Arc.

Log. tan.	Log. T.	Log. tan.	Log. T.	Log. tan.	Log. T.
7·920	5·314 42	8·419	5·314 33	8·547	5·314 25
8·071	41	·440	32	·558	24
·157	40	·459	31	·570	23
·221	39	·477	30	·581	22
·269	38	·493	29	·591	21
·309	37	·508	28	·601	20
·342	36	·521	27	·610	19
·371	35	·535	26	·619	18
·396	34				

TABLE XVII.

Addition and Subtraction Logarithms.

A.	0	1	2	3	4	5	6	7	8	9	A.
	B										
5·0	0·0 0000	0001	0001	0001	0001	0001	0002	0002	0003	0003	5·0
6·0	0·0 0001	0004	0005	0005	0005	0005	0005	0005	0005	0005	6·0
1	0005	0006	0006	0006	0006	0006	0006	0006	0007	0007	1
2	0007	0007	0007	0007	0008	0008	0008	0008	0008	0008	2
3	0009	0009	0009	0009	0010	0010	0010	0010	0010	0011	3
4	0011	0011	0011	0012	0012	0012	0013	0013	0013	0013	4
5	0014	0014	0014	0015	0015	0015	0016	0016	0017	0017	5
6	0017	0018	0018	0019	0019	0019	0020	0020	0021	0021	6
7	0022	0022	0023	0023	0024	0024	0025	0026	0026	0027	7
8	0027	0028	0029	0029	0030	0031	0031	0032	0033	0034	8
9	0034	0035	0036	0037	0038	0039	0040	0041	0041	0042	9
7·0	0·0 0043	0044	0045	0047	0048	0049	0050	0051	0052	0053	7·0
1	0055	0056	0057	0059	0060	0061	0063	0064	0066	0067	1
2	0069	0070	0072	0074	0075	0077	0079	0081	0083	0085	2
3	0087	0089	0091	0093	0095	0097	0099	0102	0104	0106	3
4	0109	0111	0114	0117	0119	0122	0125	0128	0131	0134	4
5	0137	0140	0144	0147	0150	0154	0157	0161	0165	0169	5
6	0173	0177	0181	0185	0189	0194	0198	0203	0207	0212	6
7	0217	0222	0227	0233	0238	0244	0249	0255	0261	0267	7
8	0273	0280	0286	0293	0299	0306	0313	0321	0328	0336	8
9	0344	0352	0360	0368	0377	0385	0394	0403	0413	0422	9
8·00	0·0 0432	0433	0434	0435	0436	0437	0438	0439	0440	0441	8·00
01	0442	0443	0444	0445	0446	0447	0448	0449	0450	0451	01
02	0452	0453	0454	0456	0457	0458	0459	0460	0461	0462	02
03	0463	0464	0465	0466	0467	0468	0469	0470	0471	0473	03
04	0474	0475	0476	0477	0478	0479	0480	0481	0482	0483	04
05	0485	0486	0487	0488	0489	0490	0491	0492	0494	0495	05
06	0496	0497	0498	0499	0500	0502	0503	0504	0505	0506	06
07	0507	0508	0510	0511	0512	0513	0514	0515	0517	0518	07
08	0519	0520	0521	0523	0524	0525	0526	0527	0529	0530	08
09	0531	0532	0533	0535	0536	0537	0538	0540	0541	0542	09

TABLE XVII—*Continued.*

Addition and Subtraction Logarithms—*Continued.*

A.	0	1	2	3	4	5	6	7	8	9	A.
	B										
8·10	0·0 0543	0545	0546	0547	0548	0550	0551	0552	0553	0555	8·10
11	0556	0557	0558	0560	0561	0562	0564	0565	0566	0567	11
12	0569	0570	0571	0573	0574	0575	0577	0578	0579	0581	12
13	0582	0583	0585	0586	0587	0589	0590	0591	0593	0594	13
14	0595	0597	0598	0599	0601	0602	0604	0605	0606	0608	14
15	0609	0611	0612	0613	0615	0616	0618	0619	0620	0622	15
16	0623	0625	0626	0628	0629	0630	0632	0633	0635	0636	16
17	0638	0639	0641	0642	0644	0645	0646	0648	0649	0651	17
18	0652	0654	0655	0657	0658	0660	0661	0663	0664	0666	18
19	0667	0669	0671	0672	0674	0675	0677	0678	0680	0681	19
8·20	0·0 0683	0684	0686	0688	0689	0691	0692	0694	0696	0697	8·20
21	0699	0700	0702	0703	0705	0707	0708	0710	0712	0713	21
22	0715	0716	0718	0720	0721	0723	0725	0726	0728	0730	22
23	0731	0733	0735	0736	0738	0740	0741	0743	0745	0747	23
24	0748	0750	0752	0753	0755	0757	0759	0760	0762	0764	24
25	0766	0767	0769	0771	0773	0774	0776	0778	0780	0781	25
26	0783	0785	0787	0789	0790	0792	0794	0796	0798	0799	26
27	0801	0803	0805	0807	0809	0810	0812	0814	0816	0818	27
28	0820	0822	0823	0825	0827	0829	0831	0833	0835	0837	28
29	0839	0841	0842	0844	0846	0848	0850	0852	0854	0856	29
8·30	0·0 0858	0860	0862	0864	0866	0868	0870	0872	0874	0876	8·30
31	0878	0880	0882	0884	0886	0888	0890	0892	0894	0896	31
32	0898	0900	0902	0904	0906	0908	0910	0912	0915	0917	32
33	0919	0921	0923	0925	0927	0929	0931	0933	0936	0938	33
34	0940	0942	0944	0946	0948	0951	0953	0955	0957	0959	34
35	0962	0964	0966	0968	0970	0973	0975	0977	0979	0981	35
36	0984	0986	0988	0990	0993	0995	0997	0999	1002	1004	36
37	1006	1009	1011	1013	1016	1018	1020	1022	1025	1027	37
38	1030	1032	1034	1037	1039	1041	1044	1046	1048	1051	38
39	1053	1056	1058	1060	1063	1065	1068	1070	1073	1075	39

TABLE XVII—*Concluded.*

Addition and Subtraction Logarithms—*Concluded.*

A.	0	1	2	3	4	5	6	7	8	9	A.
	B										
8·40	0·0 1077	1080	1082	1085	1087	1090	1092	1095	1097	1100	8·40
41	1102	1105	1107	1110	1112	1115	1117	1120	1122	1125	41
42	1128	1130	1133	1135	1138	1140	1143	1146	1148	1151	42
43	1153	1156	1159	1161	1164	1167	1169	1172	1175	1177	43
44	1180	1183	1185	1188	1191	1193	1196	1199	1202	1204	44
45	1207	1210	1213	1215	1218	1221	1224	1226	1229	1232	45
46	1235	1238	1240	1243	1246	1249	1252	1255	1257	1260	46
47	1263	1266	1269	1272	1275	1278	1280	1283	1286	1289	47
48	1292	1295	1298	1301	1304	1307	1310	1313	1316	1319	48
49	1322	1325	1328	1331	1334	1337	1340	1343	1346	1349	49
8·50	0·0 1352	1355	1358	1361	1364	1368	1371	1374	1377	1380	8·50
51	1383	1386	1389	1393	1396	1399	1402	1405	1408	1412	51
52	1415	1418	1421	1424	1428	1431	1434	1437	1441	1444	52
53	1447	1450	1454	1457	1460	1464	1467	1470	1474	1477	53
54	1480	1484	1487	1490	1494	1497	1501	1504	1507	1511	54
55	1514	1518	1521	1525	1528	1531	1535	1538	1542	1545	55
56	1549	1552	1556	1559	1563	1566	1570	1574	1577	1581	56
57	1584	1588	1591	1595	1599	1602	1606	1610	1613	1617	57
58	1621	1624	1628	1632	1635	1639	1643	1646	1650	1654	58
59	1658	1661	1665	1669	1673	1676	1680	1684	1688	1692	59
8·60	0·0 1695	1699	1703	1707	1711	1715	1719	1722	1726	1730	8·60

TABLE XVIII.

CORRECTION for Refraction when using Solar Instruments.

LATITUDE 50°.

Apparent Time, a.m.	Declination North.										o	Declination South.									Apparent Time, p.m.
	25°		20°		15°		10°		5°			5°		10°		15°		20°		25°	
h. m.	′	″	′	″	′	″	′	″	′	″	′ ″	′	″	′	″	′	″	′	″	′	″	h. m.
12 00		27		33		40		48		57	1 08	1	21	1	39	2	02	2	37	3	33	0 00
11 00		28		34		41		49		59	1 10	1	24	1	43	2	07	2	45	3	48	1 00
10 00		32		38		46		55	1	06	1 18	1	35	1	57	2	28	3	19	4	53	2 00
9 00		39		47		56	1	06	1	19	1 36	1	59	2	31	3	23	5	02	9	33	3 00
8 30		44		53	1	03	1	15	1	31	1 52	2	21	3	06	4	27	7	40	.....		3 30
8 00		52	1	02	1	14	1	29	1	48	2 16	2	58	4	12	6	58	.....		.....		4 00
7 30	1	02	1	13	1	28	1	48	2	16	2 57	4	11	6	56	.....		.....		.....		4 30
7 00	1	15	1	30	1	51	2	19	3	04	4 23	7	28	.....		.....		.....		.....		5 00
6 30	1	34	1	56	2	27	3	16	4	47	8 40	.....		.....		.....		.....		.....		5 30

TABLE XVIII—*Concluded.*

LATITUDE 52° 30′.

h. m.	′	″	′	″	′	″	′	″	′	″	″ ″	′	″	′	″	′	″	′	″	′	″	h. m.
12 00		30		36		44		52	1	02	1 14	1	29	1	49	2	18	3	01	4	17	0 00
11 00		31		38		45		54	1	04	1 17	1	33	1	54	2	24	3	12	4	39	1 00
10 00		35		42		50	1	00	1	11	1 26	1	45	2	10	2	49	3	56	6	17	2 00
9 00		42		50	1	00	1	12	1	26	1 45	2	11	2	50	3	58	6	22	.....		3 00
8 30		48		57	1	08	1	21	1	39	2 02	2	36	3	32	5	22	.....		.....		3 30
8 00		55	1	06	1	18	1	35	1	57	2 29	3	19	4	54	9	04	....		.....		4 00
7 30	1	05	1	17	1	33	1	55	2	26	3 14	4	24	8	31	.....		.....		.....		4 30
7 00	1	18	1	34	1	56	2	27	3	16	4 47	8	42	.....		.....		.....		.....		5 00
6 30	1	36	1	58	2	30	3	21	4	59	9 21	.....		.....		.....		.....		.....		5 30

LATITUDE 55°.

h. m.	′	″	′	″	′	″	′	″	′	″	′ ″	′	″	′	″	′	″	′	″	′	″	h. m.
12 00		33		40		48		57	1	08	1 21	1	39	2	02	2	37	3	33	5	23	0 00
11 00		34		41		49		59	1	10	1 24	1	43	2	08	2	45	3	47	5	57	1 00
10 00		38		46		55	1	05	1	18	1 34	1	56	2	27	3	16	4	47	8	42	2 00
9 00		46		54	1	05	1	18	1	34	1 55	2	26	3	14	4	44	8	34	.....		3 00
8 30		51	1	01	1	13	1	27	1	47	2 14	2	55	4	05	6	41	....		.....		3 30
8 00		58	1	10	1	24	1	42	2	06	2 43	3	44	5	48	.....		.....		.....		4 00
7 30	1	08	1	21	1	39	2	02	2	37	3 33	5	23	....	...	.....		.....		.....		4 30
7 00	1	20	1	37	2	00	2	34	3	28	5 13	.....		.....		.....		.....		.....		5 00
6 30	1	38	2	01	2	35	3	30	5	16	.....	.....		.....		.....		.....		.....		5 30

TABLE XIX.

DEFLECTION of a Trial Line for Deviations from 1 to 149 Links at the end of eighty-one chains.

Links.	Decimal Division.	Sexagesimal Division.	Links.	Decimal Division.	Sexagesimal Division.	Links.	Decimal Division.	Sexagesimal Division.	Links.	Decimal Division.	Sexagesimal Division.
	°	′ ″		°	′ ″		°	′ ″		°	′ ″
0	0·000	0 00	30	0·212	12 44	60	0·424	25 28	90	0·637	38 12
1	·007	25	31	·219	13 09	61	·432	53	91	·644	37
2	·014	51	32	·226	35	62	·439	26 19	92	·651	39 03
3	·021	1 16	33	·233	14 00	63	·446	44	93	·658	28
4	·028	42	34	·241	26	64	·453	27 10	94	·665	54
5	·035	2 07	35	·248	51	65	·460	35	95	·672	40 19
6	·042	33	36	·255	15 17	66	·467	28 01	96	·679	44
7	·050	58	37	·262	42	67	·474	26	97	·686	41 10
8	·057	3 24	38	·269	16 08	68	·481	52	98	·693	35
9	·064	49	39	·276	33	69	·488	29 17	99	·700	42 01
10	·071	4 15	40	·283	59	70	·495	43	100	·707	26
11	·078	40	41	·290	17 24	71	·502	30 08	101	·714	52
12	·085	5 06	42	·297	50	72	·509	33	102	·721	43 17
13	·092	31	43	·304	18 15	73	·516	59	103	·729	43
14	·099	57	44	·311	41	74	·523	31 24	104	·736	44 08
15	·106	6 22	45	·318	19 06	75	·531	50	105	·743	34
16	·113	47	46	·325	31	76	·538	32 15	106	·750	59
17	·120	7 13	47	·332	57	77	·545	41	107	·757	45 24
18	·127	38	48	·340	20 22	78	·552	33 06	108	·764	50
19	·134	8 03	49	·347	48	79	·559	32	109	·771	46 15
20	·141	29	50	·354	21 13	80	·566	57	110	·778	41
21	·149	55	51	·361	39	81	·573	34 23	111	·785	47 06
22	·156	9 20	52	·368	22 04	82	·580	48	112	·792	32
23	·163	46	53	·375	30	83	·587	35 13	113	·799	57
24	·170	10 11	54	·382	55	84	·594	39	114	·806	48 23
25	·177	37	55	·389	23 21	85	·601	36 04	115	·813	48
26	·184	11 02	56	·396	46	86	·608	30	116	·820	49 14
27	·191	28	57	·403	24 12	87	·615	55	117	·828	39
28	·198	53	58	·410	37	88	·622	37 21	118	·835	50 05
29	·205	12 19	59	·417	25 02	89	·630	46	119	·842	30

TABLE XIX.—DEFLECTION of a Trial Line for Deviations from 1 to 149 Links at the end of eighty-one chains—*Concluded.*

Links.	Decimal Division.	Sexagesimal Division.	Links.	Decimal Division.	Sexagesimal Division.	Links.	Decimal Division.	Sexagesimal Division.
	°	′ ″		°	′ ″		°	′ ″
120	0·849	50 55	130	0·919	55 10	140	0·990	59 25
121	·856	51 21	131	·927	35	141	·997	50
122	·863	46	132	·934	56 01	142	1·004	60 16
123	·870	52 12	133	·941	26	143	·011	41
124	·877	37	134	·948	52	144	·018	61 06
125	·884	53 03	135	·955	57 17	145	·026	32
126	·891	28	136	·962	43	146	·033	57
127	·898	54	137	·969	58 08	147	·040	62 23
128	·905	54 19	138	·976	34	148	·047	48
129	·912	45	139	·983	59	149	·054	63 39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