Restoration of Lost Corners

2015 LS REVIEW COURSE

8741. (a) The first division of the examination shall test the applicant's fundamental knowledge of surveying, mathematics, and basic science. The board may prescribe by regulation reasonable educational or experience requirements including two years of postsecondary education in land surveying, two years of experience in land surveying, or a combination of postsecondary education and experience in land surveying totaling two years for admission to the first division of the examination. Applicants registered by the board as a California civil engineer are exempt from this division of the examination.

The second division of the examination shall test the applicant's ability to apply his or her knowledge and experience and to assume responsible charge in the professional practice of land surveying.

(b) The applicant for the second division examination shall have successfully passed the first division examination, or shall be exempt therefrom. The applicant shall be thoroughly familiar with (1) the procedure and rules governing the survey of public lands as set forth in **Manual of Surveying Instructions (2009),** published by the federal Bureau of Land Management and (2) the principles of real property relating to boundaries and conveyancing.

8773. (a) Except as provided in subdivision (b) of Section 8773.4, a person authorized to practice land surveying in this state shall complete, sign, stamp with his or her seal, and file with the county surveyor or engineer of the county where the corners are situated, a written record of corner establishment or restoration to be known as a "corner record" for every corner established by the Survey of the Public Lands of the United States, except "lost corners," as defined by the **Manual of Surveying Instructions (2009)**, published by the federal Bureau of Land Management and every accessory to such corner which is found, set, reset, or used as control in any survey by such authorized person.

(b) After the establishment of a lost corner, as defined by the **Manual of Surveying Instructions (2009)**, published by the federal Bureau of Land Management a record of survey shall be filed as set forth in Section 8764.

(c) Any person authorized to practice land surveying in this state may file such corner record for any property corners, property controlling corners, reference monuments, or accessories to a property corner.

(Amended by Stats. 2012, Ch. 661, Sec. 14. Effective January 1, 2013.)

6-11. An *existent corner* is one whose original position can be identified by substantial evidence of the monument or its accessories, by reference to the description in the field notes, or located by an acceptable supplemental survey record, some physical evidence, or reliable testimony.
A corner is existent (or found) if such conclusion is supported by substantial evidence. The substantial evidence standard of proof is such relevant evidence as a reasonable mind might accept as adequate to support a conclusion. Substantial evidence is more than a scintilla of evidence but less than a preponderance of the evidence.

6-17. An *obliterated corner* is an existent corner where, at the corner's original position, there are no remaining traces of the monument or its accessories but whose position has been perpetuated, or the point for which may be recovered, by substantial evidence from the acts or reliable testimony of the interested landowners, competent surveyors, other qualified local authorities, or witnesses, or by some acceptable record evidence.
An obliterated corner position can be proven by substantial direct or collateral evidence. When both categories of evidence exist, direct evidence will be given more weight than collateral evidence. A position that depends upon the use of collateral evidence can be accepted only as duly supported, generally through proper relation to known corners, and agreement with the field notes regarding distances to natural objects, stream crossings, line trees, and off-line tree blazes, etc., or reliable testimony. Collateral evidence must include some component that relates to the position of the original survey corner, including measurement evidence, historical record, testimony, or any reasonable tie.

2009 Manual 6-17. An *obliterated corner* is an existent corner where, at the corner's original position, there are no remaining traces of the monument or its accessories but whose position has been perpetuated, or the point for which may be recovered, by substantial evidence from the acts or reliable testimony of the interested landowners, competent surveyors, other qualified local authorities, or witnesses, or by some acceptable record evidence.

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1973 Manual 5-9. *An obliterated corner is one at whose point there are no remaining traces of the monument or its accessories, but whose location has been perpetuated, or the point for which may be recovered beyond reasonable doubt by the acts and testimony of the interested landowners, competent surveyors, other qualified local authorities, or witnesses, or by some acceptable record evidence.*

A position that depends upon the use of collateral evidence can be accepted only as duly supported, generally through proper relation to known corners, and agreement with the field notes regarding distances to natural objects, stream crossings, line trees, and off-line tree blazes, etc., or unquestionable testimony.

Restoration of Lost Corners

7-1. When every means of identifying the original position of a corner has been exhausted, the surveyor will restore the lost corner by applying proportionate measurement, which harmonizes surveying practice with legal and equitable considerations involved in controversies concerning lost land boundaries.

7-2. A *lost corner* is one whose original position cannot be determined by substantial evidence, either from traces of the original marks or from acceptable evidence or reliable testimony that bears upon the original position, and whose location can be restored only by reference to one or more interdependent corners.

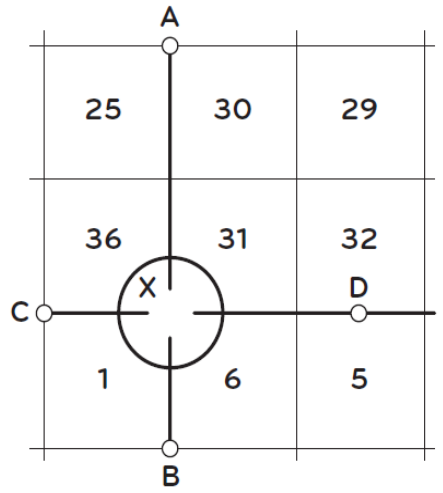
Thus, if substantial evidence of the position of the original corner exists, it is an existent or obliterated corner. This position shall be employed in preference to applying the rule that would be proper only in the case of a lost corner.

In addition, once a corner is considered lost, it is the surveyor's responsibility to assure that the restoration method and the restored position comply with the statutory protection of bona fide rights requirements delineated in 43 U.S.C. 772 and 773 and as described in this Manual.

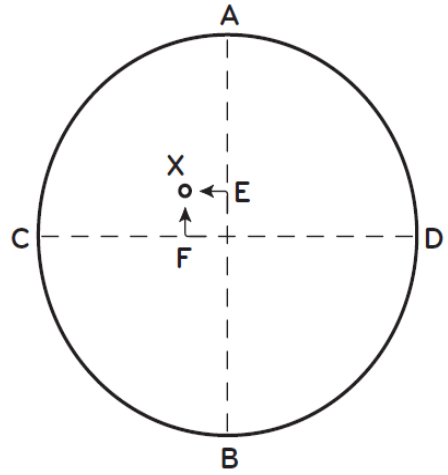
Double Proportionate Measurement

7-8. The term "double proportionate measurement" is applied to a new measurement made between four known corners, two each on intersecting meridional and latitudinal lines, for the purpose of relating the cardinal equivalents intersection to both.

In effect, by double proportionate measurement the record directions are disregarded, excepting only where there is some acceptable supplemental survey record, some physical evidence, or testimony that may be brought into the control. Corners to the north and south control any latitudinal position. Corners to the east and west control the position in longitude. One identified original corner is balanced by the control of a corresponding original corner on the opposite side of a particular lost corner that is to be restored. Each identified corner is given a controlling weight inversely proportional to its distance from the lost corner. *Lengths of proportioned lines are comparable only when reduced to their cardinal equivalents* (section 7-9). The method may be referred to as a "four-way" proportion. The method of double proportionate measurement is generally applicable to the restoration of lost corners of four townships and of lost interior corners of four sections.



Lost township corner in vicinity of **X**.



A, **B**, **C**, **D**—Control corners.

E—Proportionate point for **X** in latitude between **A** and **B**.

F—Proportionate point for **X** in departure between **C** and **D**.

The correct position of **X** is at the intersection of lines extended east or west from **E** and north or south from **F**.

Figure 7-1. The plan of double proportionate measurement.

Cardinal Equivalent

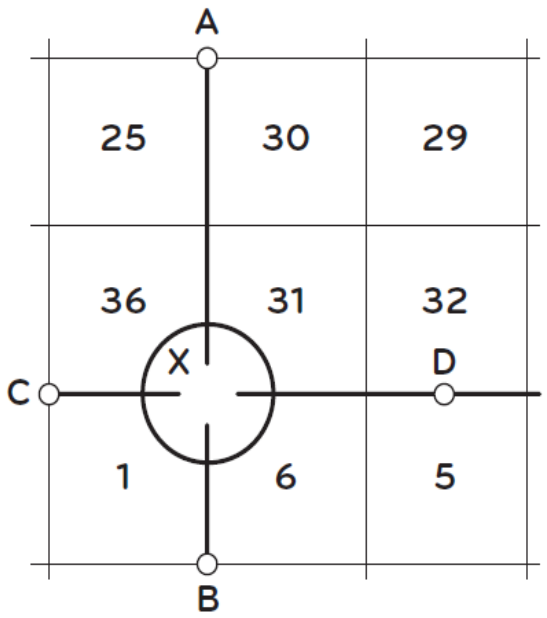
7-9. Use of cardinal equivalent employs only the northerly components (latitudes) of the north and south controlling record lines to compute the latitudinal position, and only the easterly components (departures) of the east and west controlling record lines to compute the longitudinal position. This is different from using distances of the controlling record lines in the computation of proportionate measurement.

Failure to determine the direction of each line with reference to the true meridian (cardinal) could produce erroneous results. Distortion encountered while using grid bearings on a coordinate system could introduce errors and thus incorrect results if factors of geodesy are not accounted for. In State plane coordinate systems, the grid scale factor varies across the project. Datum differences could introduce errors into the computations. Error can also be introduced if the lines are at dramatically different elevations, since the Public Land Survey System datum is based upon measurements at actual average ground elevation along the line.

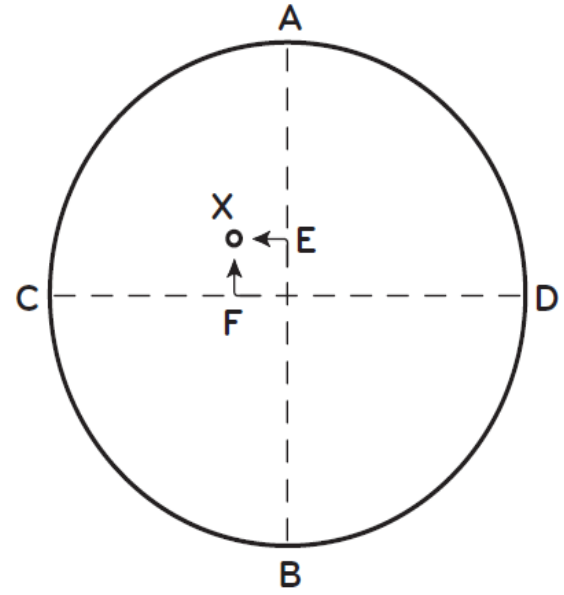
Three-Point Control

7-13. Where the line has not been established in one direction from the lost township or section corner, "three-point control" should be used to reestablish the position of the corner. The record distance (reduced to its cardinal equivalent) to the nearest identified corner in the direction opposite from the missing line will be used, along with proportionate measurement between the other two corners.

Thus, in figure 7-1, if the latitudinal line in the direction of the point D has not been established, the position of the point F in departure would have been determined by reference to the record departure from the point C. The position of the point E in latitude would be determined by proportionate measurement between the points A and B.



Lost township corner in vicinity of **X**.



A, **B**, **C**, **D**—Control corners.

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F—Proportionate point for **X** in departure between **C** and **D**.

The correct position of **X** is at the intersection of lines extended east or west from **E** and north or south from **F**.

Figure 7-1. The plan of double proportionate measurement.

Two-Point Control

7-14. Where the intersecting lines have been established in only two of the directions, “two-point control” should be used to reestablish the position of the corner. The record distances, reduced to their cardinal equivalents, to the nearest identified corners on the intersecting lines will control the position of the corner. The record latitude on the meridional line will determine the latitudinal position and the record departure on the latitudinal line will determine the meridional position of the corner. What is intended by record distance is the measure established in the original survey.

Index Correction

7-15. An index correction for systematic error in measurement should be made in applying the record measurements for two or three-point control (section 7-57) if it is obvious that a more harmonious relation to the representations of the approved plat or plats would be thus accomplished.

Experience and good judgment are required in applying an index correction. If the original survey was carelessly executed, no definite standard of length or direction of lines can be set up as representing that survey. On the other hand, the work may have been reasonably uniform within its own limits, yet inaccurate with respect to exact base standards. It is only a demonstrable and consistent excess or deficiency of the original work, determined within practical limits, that can justify the application of an index correction. If such consistency is not established the only rule that can be applied is that a record of 80.00 chains in distance means just that by exact standards, true horizontal measurement

Single Proportionate Measurement

7-16. The term “single proportionate measurement” is applied to a new measurement made on a line to determine one or more positions on that line.

By single proportionate measurement the position of two identified corners controls the direction of that line. The method is sometimes referred to as a “two-way” proportion, such as a north-and-south proportion or an east-and-west proportion. Examples are a quarter-section corner on the line between two section corners, all corners on standard parallels, and all corners occupying intermediate positions on a township boundary line.

7-17. In order to restore a lost corner on a line by single proportionate measurement, a retracement is made connecting the nearest identified corners on the line. These corners control the position of the lost corner. The lost corner is then reestablished at proportionate distance on the line connecting the recovered corners. Proper adjustment is made on an east and west line to secure the latitudinal curve. Any number of intermediate lost corners may be located on the same plan.

Irregular Boundary Adjustment

7-51. Some township boundaries are not established as straight lines and are termed "irregular" exteriors. Parts of the boundaries were surveyed from opposite directions and the intermediate portion was completed later by random and true line, leaving a fractional distance. Such irregularity involves some material departure from the basic rules for the establishment of original surveys. A modified form of single proportionate measurement is used in restoring lost corners on such boundaries. This is also applicable to a section line or a township line that has been shown to be irregular by a *previous* retracement (figure 7-7).

7-52. In order to restore one or more lost corners or angle points on such irregular exteriors, a retracement between the nearest known corners is made on the record courses and distances to ascertain the direction and length of the closing distance. A position is calculated for each lost corner or angle point at the record position. The closing distance is then reduced to its equivalent latitude and departure.

The adjustment to be applied along the line is single proportion, and the adjustment to be applied perpendicular to the direction of the line is compass rule.

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On a latitudinal line the calculated angle points will be placed to suit the usual adjustments for the curvature

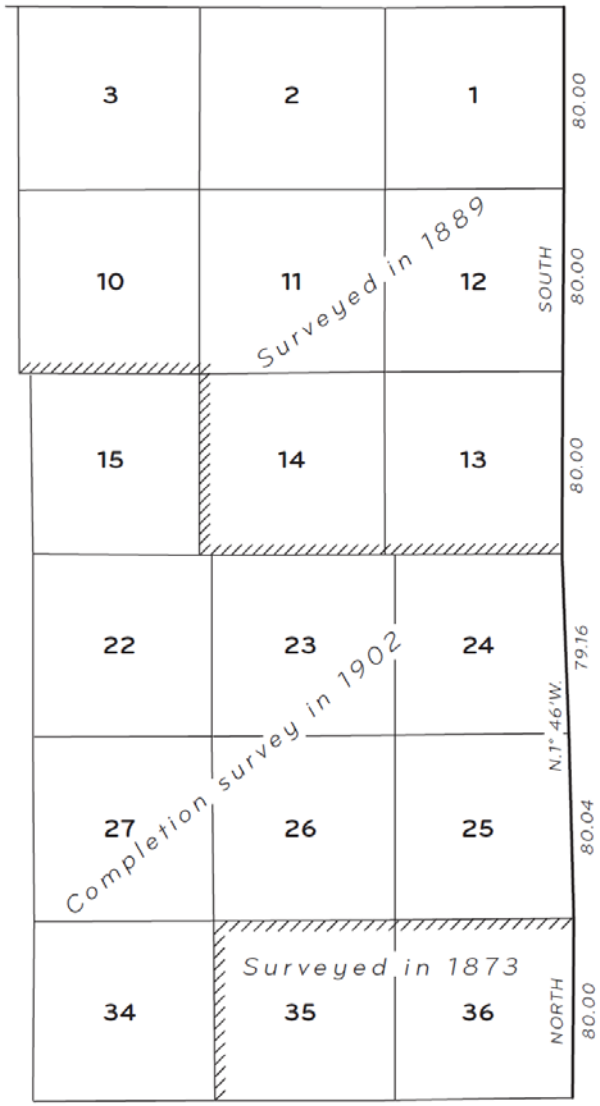


Figure 7-7. Irregular exterior resulting from the piecemeal survey of a township line.

Grant Boundaries

7-54. In many of the States there are irregular grant and reservation boundaries that were established prior to the public land rectangular surveys. In these cases, the township and section lines are regarded as the closing lines. The grant boundary field notes may call for natural objects, but these are often supplemented by metes-and-bound descriptions. The natural calls are ordinarily given precedence then the existent angle points of the metes-and-bounds survey. The lost angle points are then restored by uniformly orienting the record courses to left or right and adjusting the lengths of the lines on a constant ratio. Both angular and linear corrections are made in the direction needed to reduce the falling of the trial lines laid down according to the record. This is essentially a rotate and scale procedure.

The retracement of the grant boundary is begun at an identified corner. Calls for natural objects are satisfied and the existent angle points are recovered. Then, between the identified or acceptable points, the position of lost angle points is determined by the following steps, which serve to apply an identical scale factor and rotation to each of the lines on the grant boundary between the two identified or acceptable points:

(1) Reduce the *record* courses and distances to the total differences in latitude and departure. Compute the direction and length of a line connecting the identified points.

(2) Determine the *actual* differences in latitude and departure between the same identified points by retracement. Compute the direction and length of the connecting line based on these figures.

(3) The angular difference of direction between the connection lines computed in (1) and (2) gives the amount and direction of the adjustment to apply to the *record* bearing of each intermediate course.

(4) The ratio of the length of the line computed in (2) to that computed in (1) gives the coefficient to apply to the *record* length of each intermediate course.

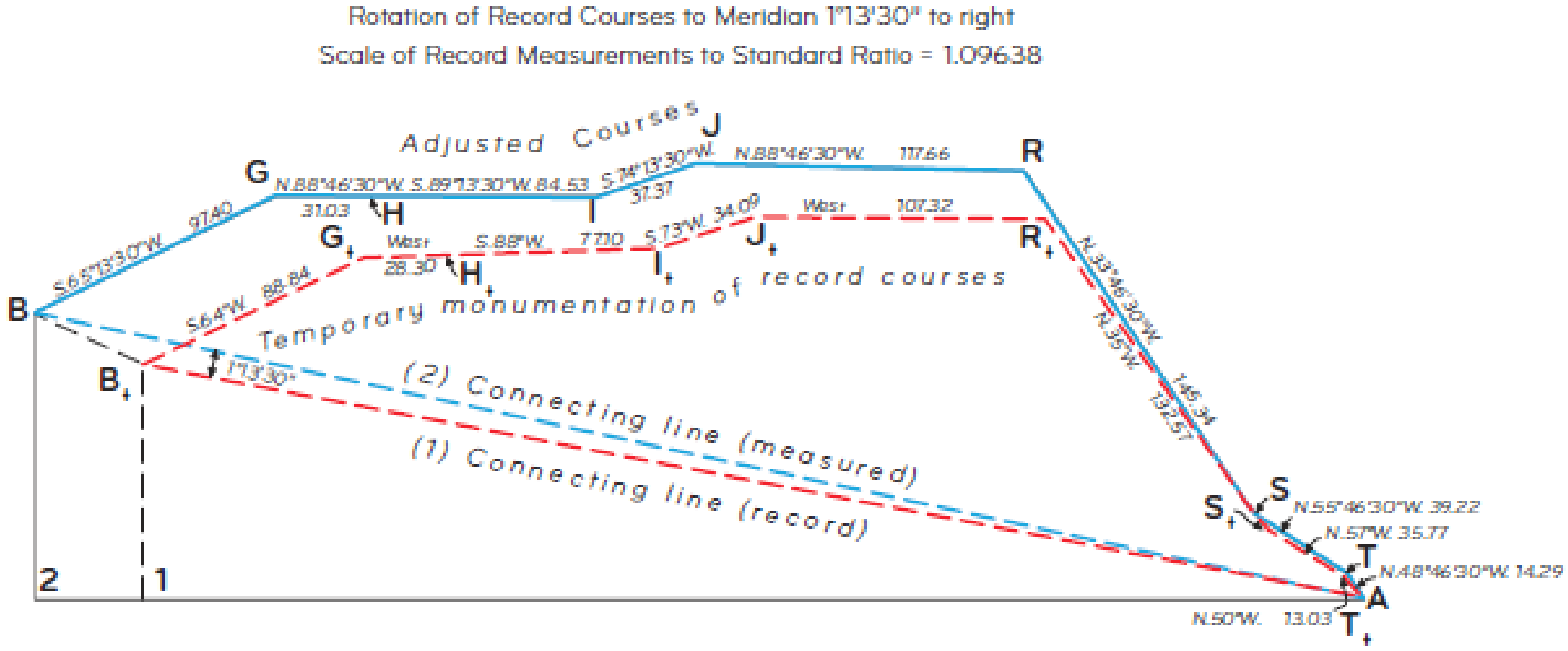


Figure 7-10. Adjustment of a grant boundary.

Original and One-Point Control

7-56. Where a line terminates with measurement in one direction only, a lost corner should be restored by record bearing and distance, counting from the nearest identified or restored regular corner. Examples will be found where lines have been discontinued at the intersection with large meanderable bodies of water or at the border of what was classed as impassable ground.

The use of one-point control is only applicable where the prior survey was discontinued at a recorded distance or where it can be shown conclusively that the line(s) to all other interdependent corners were never established. If the line was discontinued, the field notes may be followed explicitly. An index correction should be applied to the record bearing and/or distance when applicable.

Index Correction

7-57. In cases where a retracement has been made of many miles of the original lines, between identified original corners, and there has been developed a definite and consistent surplus or deficiency in distance, or a definite and consistent angle from cardinal that characterizes the original survey, it is proper to make allowance for the average difference(s). Such adjustment will be incorporated automatically in all cases where there exists a suitable basis for proportional measurement. Where control in one direction is lacking or nonexistent, an index correction, if supported by conclusive evidence, should be applied to the record courses and/ or distances. If there is no conclusive evidence of applicability of an index correction, the record courses and distances should be allowed to prevail.

Summary

7-62. When reestablishing a lost corner, an attempt must be made to harmonize the process with the methods used in the original survey. Factors to consider in determining whether the decision is supported by the record include:

(1) Is the end product in harmony with the original plat?

(2) Are the corner points, lengths of lines and bearings of lines in harmony with the original and each other?

(3) Is there a degree of harmony between the topographic calls in the retracement and those of the record?

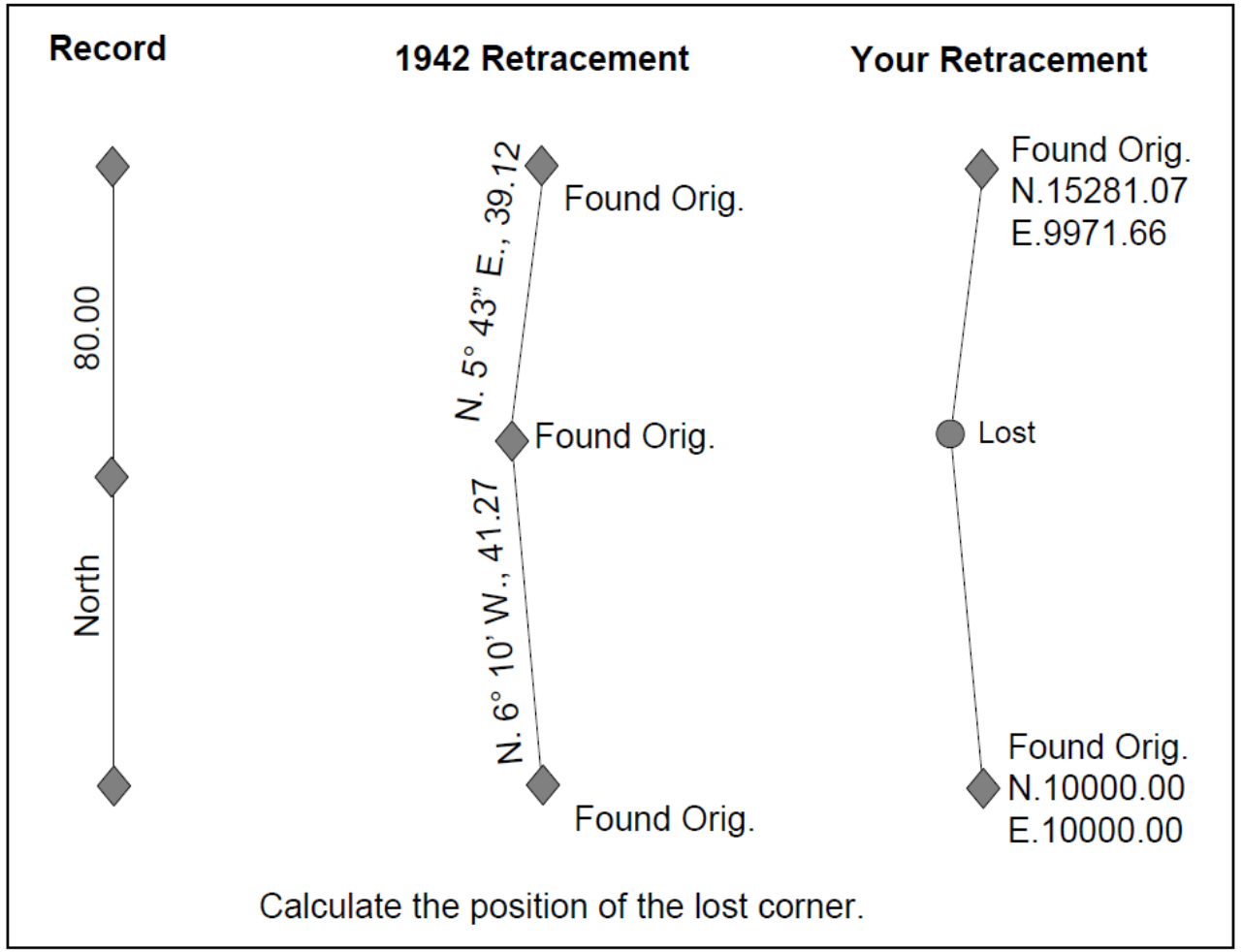
(4) Are the elements of evidence nearest the particular corner in question given the greatest weight and are they harmonious with each other?

(5) Is the form of proportionate measurement used that most nearly harmonizes surveying practices with legal and equitable considerations in determining boundaries?

(6) Is there harmony between the end product and the evident faithfulness of the original survey?

The above methods of restoring lost corners have been described in a way that allows adjustments to be made in the field with minimal computations. Surveying software can incorporate most of these adjustments. Cardinal equivalent and the Public Land Survey System datum (section 2-9) will be taken into account in almost all of these calculations. Reference should be made to previous editions of the Manual for more detailed field techniques

Irregular Boundary (Manual Sec. 7-52)



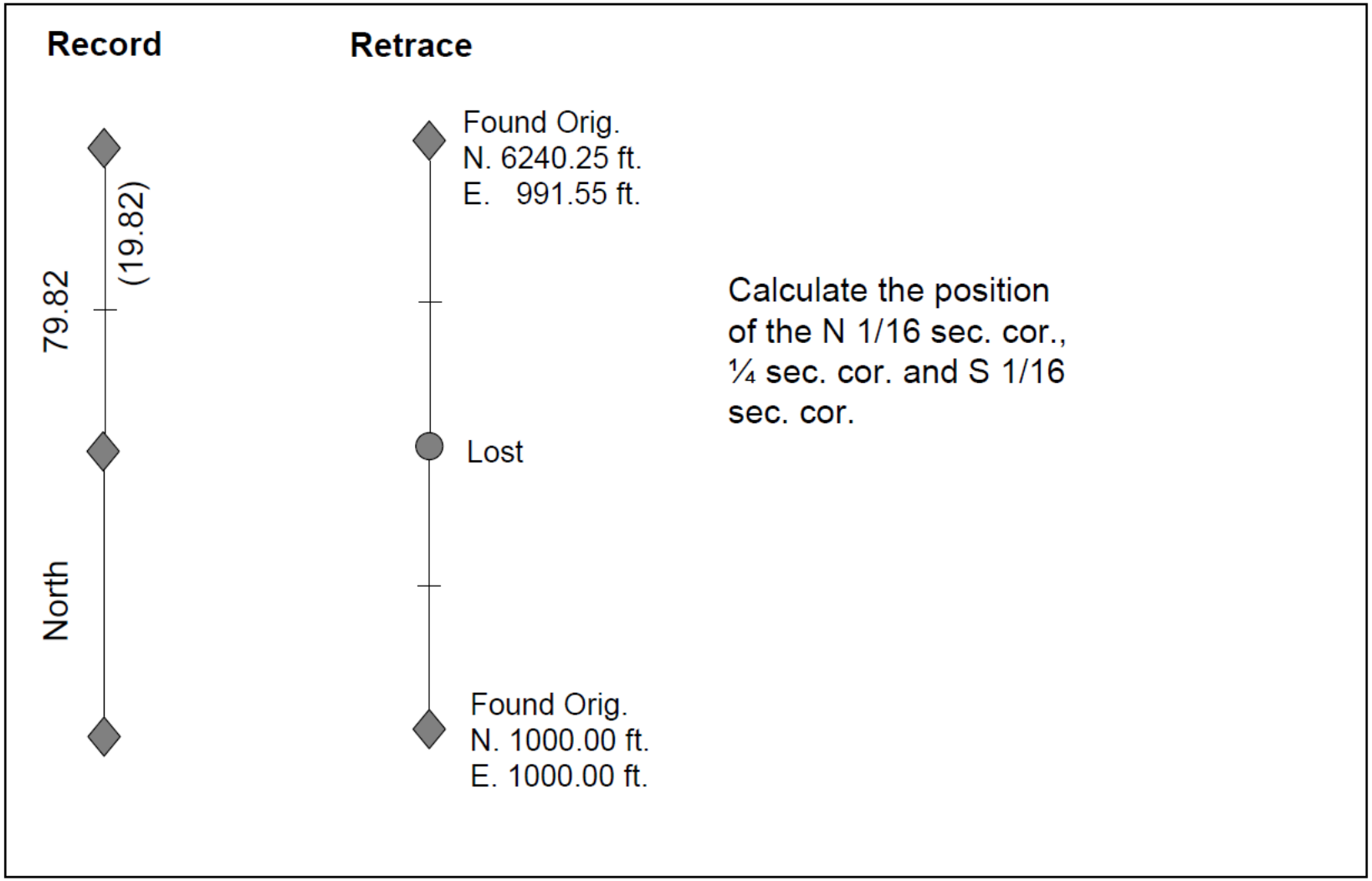
Irregular Boundary (Manual Sec. 7-52)

Calculate N-S
(single proportion for latitude on N-S lines)
1942 latitude S1/2: N.2708.06
1942 latitude N1/2: N2569.08
1942 total latitude: N.5277.14
Your retracement latitude: N.5281.07
Latitude of the S1/2
N.2708.06 (1942 lat. S1/2) ÷ 5277.14 (1942 total lat.) = 0.513168
0.513168 x 5281.07 (your retracement lat.) = **N.2710.08 Ft**.
Latitude of the N1/2
N.2569.08 (1942 lat. N1/2) ÷ 5277.14 (1942 total lat.) = 0.486832
0.486832 x 5281.07 (your retracement lat.) = **N.2571.01 Ft**.

Calculate E-W
(compass rule for departure on N-S lines)
1942 dist. of S1/2: 2723.82 ft.
1942 dist. of N1/2: 2581.92 ft.
1942 total dist.: 5305.74 ft.
Difference in departure: 7.08 ft.
Departure of S1/2
2723.82 (1942 dist. S1/2) ÷ 5305.74 (total dist.) = 0.513372
0.513372 x 7.08 (diff. in departure) = E.3.63 ft.(correction)
E.-292.60 (1942 departure of S1/2) + 3.63 (correction) = **E.-288.97 ft**.
(departure of this course is minus because it is a NW bearing, the correction is + because it is E.)
Departure of N1/2
2581.92 (1942 dist. N1/2) ÷ 5305.74 (total dist.) = 0.486628
0.486628 x 7.08 (diff. in departure) = 3.46 ft.
E.257.18 (1942 departure of N1/2) + 3.45 (correction) = **E.260.63 ft**
(the correction is + because it is E.)

Coordinates of the proportioned point: N.12710.10, E.9711.03
Bearing and distance of S1/2: N. 6° 05’ 11” W., 2725.46 ft. (41.295 chs.)
Bearing and distance of N1/2: N. 5° 47’ 19” E., 2584.16 ft. (39.154 chs.)

SINGLE PROPORTION EXERCISE



SINGLE PROPORTION EXERCISE

Record: North, 79.82
Retrace: N. 5240.25 ft.
W. 8.45 ft.

Calculate True Bearing and Distance

Dep. ÷ Lat. = Tan of the bearing
8.45 ÷ 5240.25 = 0.001613
ArcTan of 0.001613 = 0° 05‟ 33” = Retrace bearing: N. 0° 05‟ 33” W.

Dep. ÷ sin of the bearing = Dist.
8.45 ÷ 0.001613 = 5240.26

SINGLE PROPORTION EXERCISE

Calculate Proportion

Retrace distance ÷ Record distance = K

5240.26 ÷ 5268.12 = 0.994712

K x record dist. = Proportionate dist.

0.994712 x 1320.00 = 1313.02

" x 1320.00 = 1313.02

" x 1320.00 = 1313.02

" x 1308.12 = 1301.20

5240.26

Proportionate Position of the Corners

Sin 0° 05" 33" x 1313.02 = 2.12

" x 1313.02 = 2.12

" x 1313.02 = 2.12

" x 1301.20 = 2.10

S 1/16: N. 1000.00 + 1313.02 = **N. 2313.02**

E. 1000.00 - 2.12 = **E. 997.88**

N. 1/16: N. 3626.04 + 1313.02 = **N. 4939.06**

E. 995.76 - 2.12 = **E. 993.64**

Cos 0° 05" 33 " x 1313.02 = 1313.02

" x 1313.02 = 1313.02

" x 1313.02 = 1313.02

" x 1301.20 = 1301.20

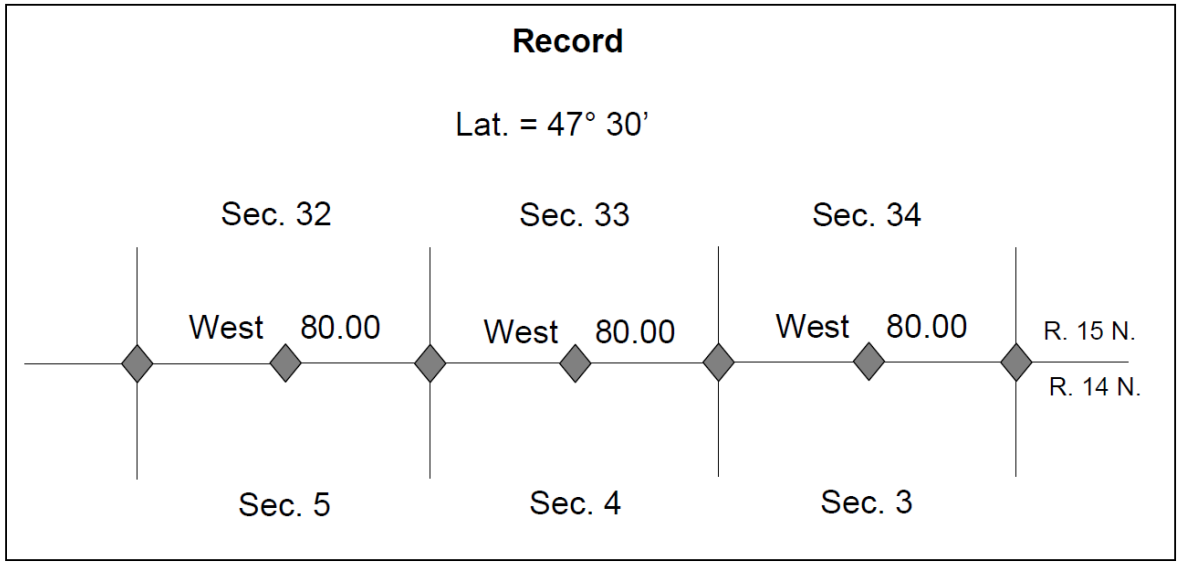
¼ Sec. Cor.: N.2313.02 + 1313.02 = **N. 3626.04**

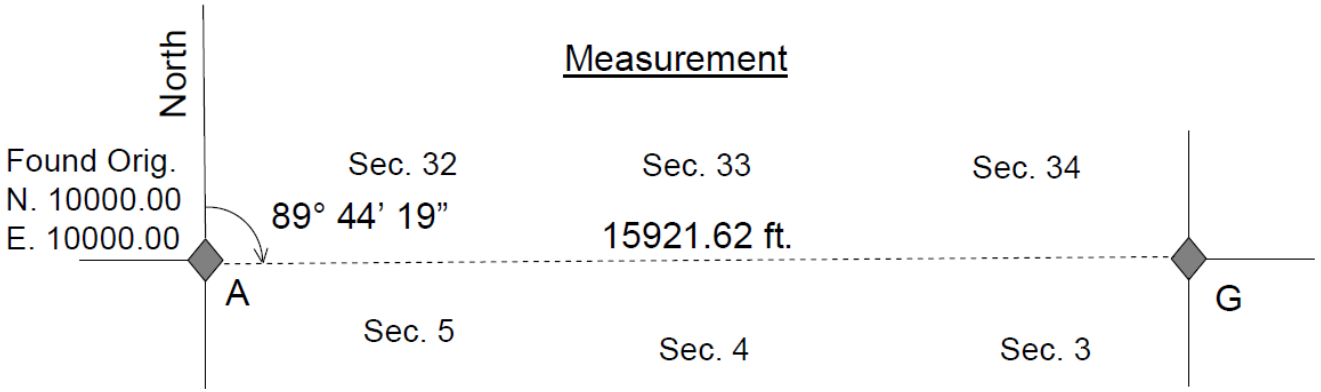
E. 997.88 - 2.12 = **E. 995.76**

Sec. Cor.: N. 4939.06 + 1301.20 = **N. 6240.26**

E. 993.64 - 2.10 = **E. 991.54**

Single Proportion with Curvature





Calculate the proportionate position of the 5 lost corners.

Single Proportion with Curvature

Calculate the True Mean Bearing of the Line

Calculate forward bearing

Forward bearing at A (cor. of secs. 5, 6, 31 and 3)2: N. 0° 00' 00" E. + 89° 44' 19" = **N. 89° 44' 19" E.**

Calculate angular convergence:

Angular convergence for meridians 6 miles apart at Lat. 47° 30':

From Table 11: Convergence at 47° = 0° 05' 34"

Convergence at 48° = 0° 05' 46"

Convergence at 47° 30': (0° 05' 34" + 0° 05' 46") ÷ 2 = 0° 05' 40"

0° 05' 40" = 340"

340" ÷ 31680.00 ft.(6 miles) = 0.010732" per ft. of departure

0.010732" x 7960.73 ft. (1/2 departure of the line) = 0° 1' 25.44"

Mean bearing: N. 89° 44' 19" E. (forward bearing) + 0° 1' 25.44" (correction) = **N. 89° 45' 44.44" E.**

(The correction is applied clockwise because the bearing is easterly and we are going from forward bearing to true bearing)

TABLE 11.—CONVERGENCY OF MERIDIANS, SIX MILES LONG AND SIX MILES APART, AND DIFFERENCES OF LATITUDE AND LONGITUDE.

Lat.	Convergency.		Difference of longitude per range.		Difference of latitude for—	
	On the parallel.	Angle.	In arc.	In time.	1 mi.	1 Tp.
°	*Lks.*	′ ″	′ ″	*Seconds.*		
25	33.9	2 25	5 44.34	22.96		
26	35.4	2 32	5 47.20	23.15		
27	37.0	2 39	5 50.22	23.35	0.871	5.229
28	38.6	2 46	5 53.40	23.56		
29	40.2	2 53	5 56.74	23.78		
30	41.9	3 0	6 0.26	24.02		
31	43.6	3 7	6 3.97	24.26		
32	45.4	3 15	6 7.87	24.52	0.871	5.225
33	47.2	3 23	6 11.96	24.80		
34	49.1	3 30	6 16.26	25.08		
35	50.9	3 38	6 20.78	25.39		
36	52.7	3 46	6 25.53	25.70		
37	54.7	3 55	6 30.52	26.03	0.870	5.221
38	56.8	4 4	6 35.76	26.38		
39	58.8	4 13	6 41.27	26.75		
40	60.9	4 22	6 47.06	27.14		
41	63.1	4 31	6 53.15	27.54		
42	65.4	4 41	6 59.56	27.97	0.869	5.216
43	67.7	4 51	7 6.29	28.42		
44	70.1	5 1	7 13.39	28.89		
45	72.6	5 12	7 20.86	29.39		
46	75.2	5 23	7 28.74	29.92		
47	77.8	5 34	7 37.04	30.47	0.869	5.211
48	80.6	5 46	7 45.80	31.05		
49	83.5	5 59	7 55.05	31.67		

Single Proportion with Curvature

Calculate departure of the line
Departure of the line: Sin 89° 44’ 19 x 15921.62 = E. **15921.45 ft.**

Calculate the single proportion
The record calls for 6 equal 40 ch. segments, therefore: E. 15921.45 ÷ 6 = **E.2653.58 ft.**

Calculate the forward bearing from A to each of the lost corners

Line A-B:
E.2653.58 ÷ 2 = 1326.79 ft. (1/2 the departure of line A-B)
E.1326.79 x 0.010732” (angular convergence per ft. of departure) = 0° 00’ 14.24” (angular convergence)
N. 89° 45’ 44.44” E. (mean bearing line A-G) - 0° 00’ 14.24”(angular convergence) = **N. 89° 45’ 30.24” E.**
(We are going from true bearing to forward bearing therefore the correction is applied counterclockwise for easterly lines and clockwise for westerly line. The opposite is true when going from forward bearing to true bearing.)
Distance of line A-B: 2653.58 ft. (departure of A-B) ÷ sin 89° 45’ 30.24” = **2653.60 ft.**

At Pt. A the forward bearing and distance to Pt. B on the curve is:
N. 89° 45’ 30.24” E., 2653.60 ft

Coordinates of the proportioned point: N.10011.19, E.12653.58

Single Proportion with Curvature

Line A-C:
E.5307.16 ÷ 2 = 2653.58 ft. (1/2 the departure of line A-C)
E.2653.58 x 0.010732” (angular convergence per ft. of departure) = 0° 00’ 28.48” (angular convergence)
N. 89° 45’ 44.44” E. (mean bearing line A-G) - 0° 00’ 28.48”(angular convergence) = **N. 89° 45’ 15.96” E.**
(We are going from true bearing to forward bearing therefore the correction is applied counterclockwise for easterly lines and clockwise for westerly line. The opposite is true when going from forward bearing to true bearing.)

Distance of line A-C: 5307.16 ft. (departure of A-C) ÷ sin 89° 45’ 15.96” = **5307.21 ft.**
At Pt. A the forward bearing and distance to Pt. C on the curve is: N. 89° 45’ 15.96” E., 5307.21 ft
Coordinates of the proportioned point: N.10022.75, E.15307.16

Single Proportion with Curvature

Line A-D:

E.7960.74 ÷ 2 = 3980.37 ft. (1/2 the departure of line A-D)
E.3980.37 x 0.010732" (angular convergence per ft. of departure) = 0° 00' 42.72" (angular convergence)
N. 89° 45' 44.44" E. (mean bearing line A-G) - 0° 00' 42.72"(angular convergence) = **N. 89° 45' 01.72" E.**
(We are going from true bearing to forward bearing therefore the correction is applied counterclockwise for easterly lines and clockwise for westerly line. The opposite is true when going from forward bearing to true bearing.)
Distance of line A-D: 7960.74 ft. (departure of A-D) ÷ sin 89° 45' 01.72" = **7960.81 ft.**

At Pt. A, the forward bearing and distance to Pt. D on the curve is:
N. 89° 45' 01.72" E., 7960.81 ft.

Coordinates of the proportioned point: N.10034.67, E.17960.74

Line A-E:

E.10614.32 ÷ 2 = 5307.16 ft. (1/2 the departure of line A-E)
E.5307.16 x 0.010732" (angular convergence per ft. of departure) = 0° 00' 56.96" (angular convergence)
N. 89° 45' 44.44" E. (mean bearing line A-G) - 0° 00' 56.96"(angular convergence) = **N. 89° 44' 47.48" E.**
(We are going from true bearing to forward bearing therefore the correction is applied counterclockwise for easterly lines and clockwise for westerly line. The opposite is true when going from forward bearing to true bearing.)
Distance of line A-E: 10614.32 ft. (departure of A-E) ÷ sin 89° 44' 47.48" = **10614.42 ft.**

At Pt. A, the forward bearing and distance to Pt. E on the curve is:
N. 89° 44' 47.48" E., 10614.42 ft.

Coordinates of the proportioned point: N.10046.96, E.20614.32

Single Proportion with Curvature

Line A-F:
E.13267.90 ÷ 2 = 6633.95 ft. (1/2 the departure of line A-F)
E.6633.95 x 0.010732” (angular convergence per ft. of departure) = 0° 01’ 11.20” (angular convergence)
N. 89° 45’ 44.44” E. (mean bearing line A-G) - 0° 01’ 11.2”(angular convergence) = **N. 89° 44’ 33.24” E.**
(We are going from true bearing to forward bearing therefore the correction is applied counterclockwise for easterly lines and clockwise for westerly line. The opposite is true when going from forward bearing to true bearing.)
Distance of line A-F: 13267.90 ft. (departure of A-F) ÷ sin 89° 44’ 33.24” = **13268.03 ft.**
At Pt. A, the forward bearing and distance to Pt. F on the curve is:
N. 89° 44’ 33.24” E., 13268.03 ft.
Coordinates of the proportioned point: N.10059.61, E.23267.90

Single Proportion with Curvature

Line A-G:

E.15921.48 ÷ 2 = 7960.74 ft. (1/2 the departure of line A-G)

E.7960.74 x 0.010732" (angular convergence per ft. of departure) = 0° 01' 25.43" (angular convergence)

N. 89° 45' 44.44" E. (mean bearing line A-G) - 0° 01' 25.43"(angular convergence) = **N. 89° 44' 19.01" E.**

(We are going from true bearing to forward bearing therefore the correction is applied counterclockwise for easterly lines and clockwise for westerly line. The opposite is true when going from forward bearing to true bearing.)

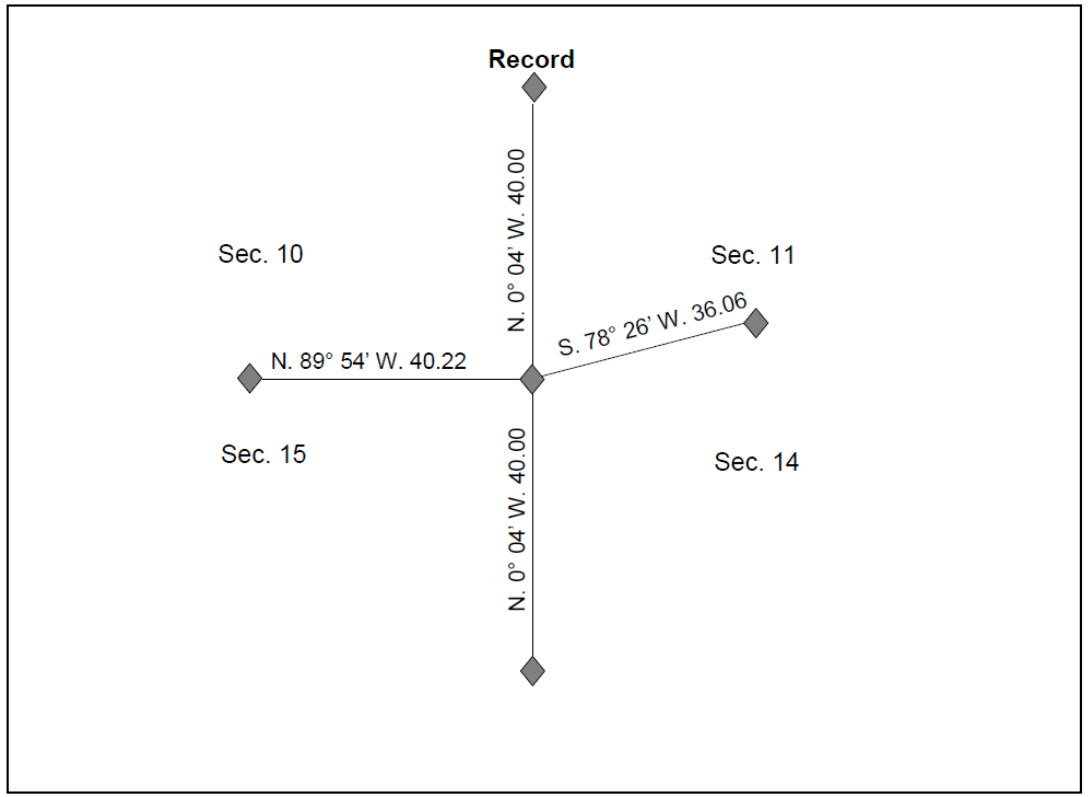
Distance of line A-G: 15921.48 ft. (departure of A-G) ÷ sin 89° 44' 19.01" = **15921.65 ft.**

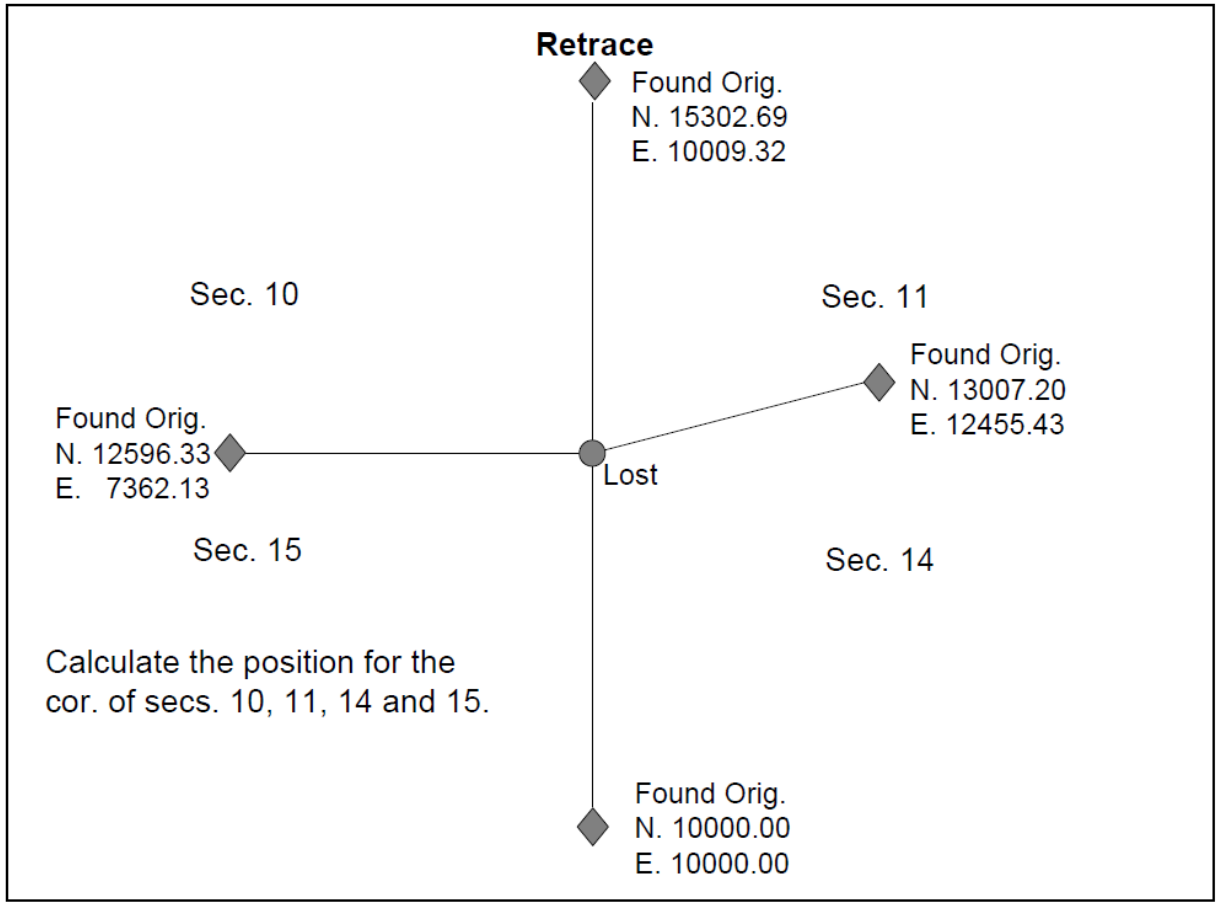
At Pt. A, the forward bearing and distance to Pt. F on the curve is:

N. 89° 44' 19.01" E., 15921.65 ft *(notice this agrees with the measured forward bearing and distance of line A-G. The minor difference in distance is the result of rounding)*

Coordinates of the proportioned point: N.10072.64, E.25921.48

DOUBLE PROPORTION EXERCISE





DOUBLE PROPORTION EXERCISE

N-S Proportion:

Record latitude between controlling corners: N. 80.00 chs. = 5280.00 ft.
Retrace latitude between controlling corners: N. 5302.69 ft.
Record proportion is midpoint, therefore the latitude to the lost sec. cor. is: 2651.35 ft.
N. 10000.00 + 2651.35 = N. 12651.35

E-W Proportion

Record:
Cardinal equivalent of the departure of the E ½ mile: Sin 78° 26' x 36.06 = 35.328 chs. = 2331.63 ft.
Cardinal equivalent of the departure of the W ½ mile: Sin 89° 54' x 40.22 = 40.220 chs. = 2654.52 ft.

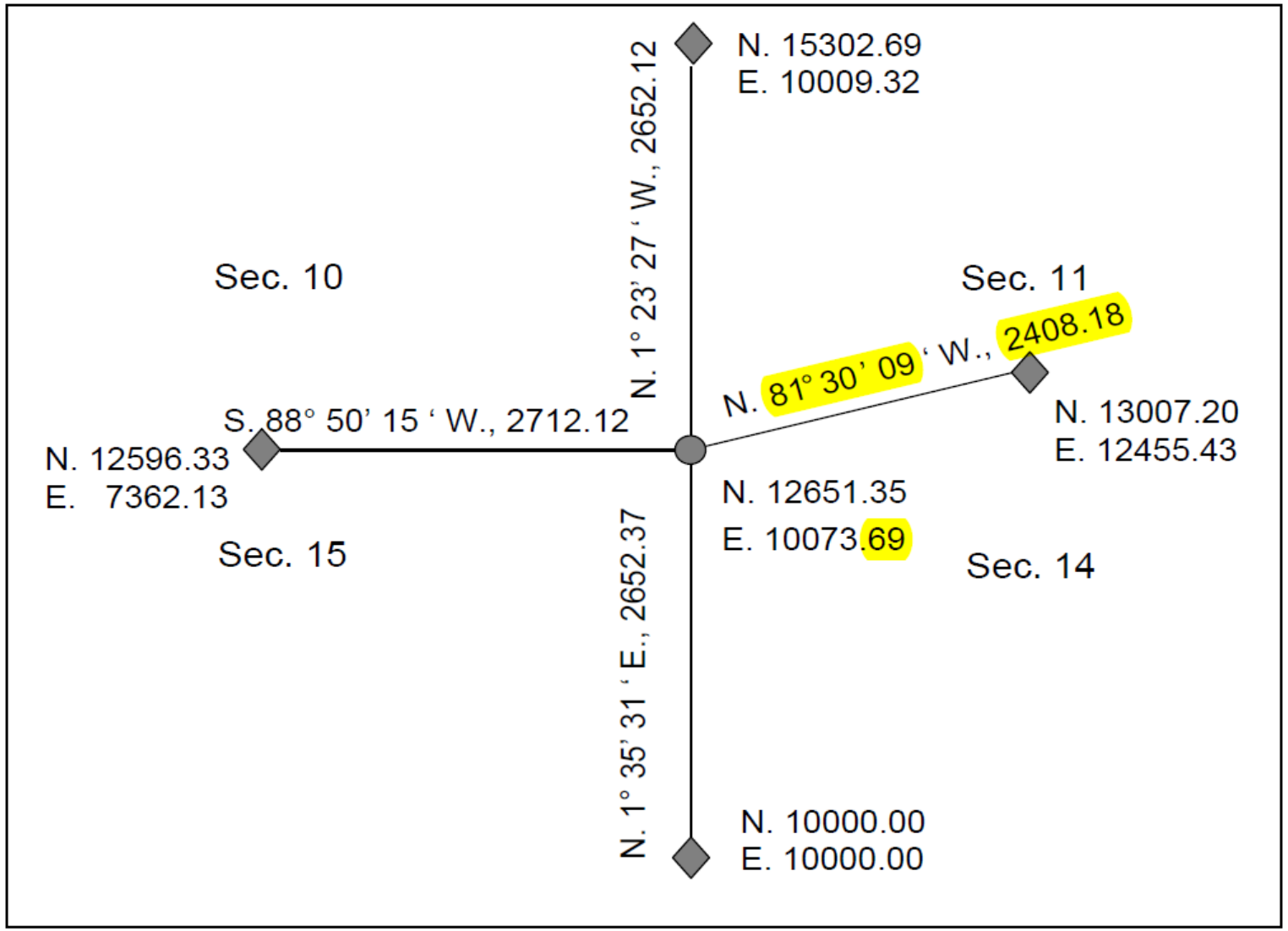
Record departure between controlling corners: 4986.17 ft.
Retrace departure between controlling corners: 5093.30 ft.

Retract departure ÷ Record departure = K
5093.30 ÷ 4986.15 = 1.021490

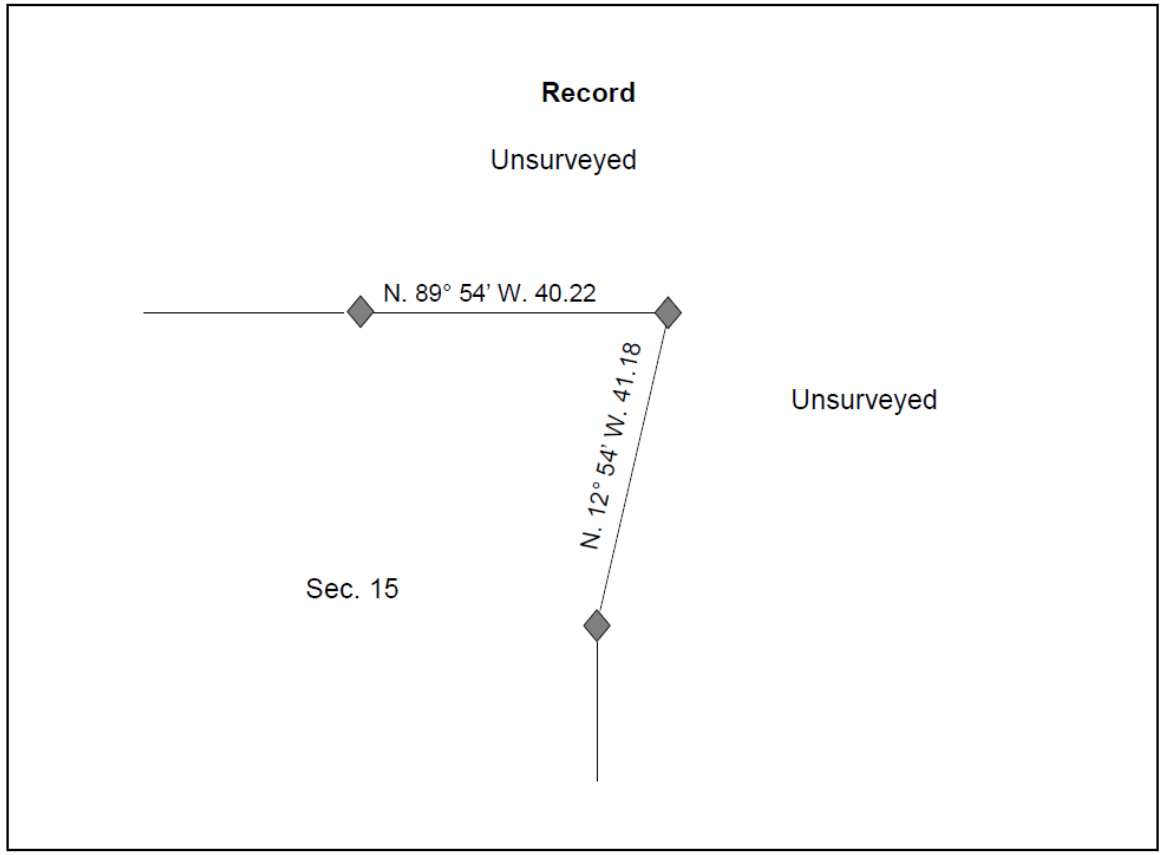
K x Record departure of each segment of the line = Proportionate departure of each segment of the line
1.021490 x 2331.63 = 2381.74 ft.
" x 2654.52 = 2711.56 ft.
E. 12455.43 - 2381.74 = E. 10073.69 ft.

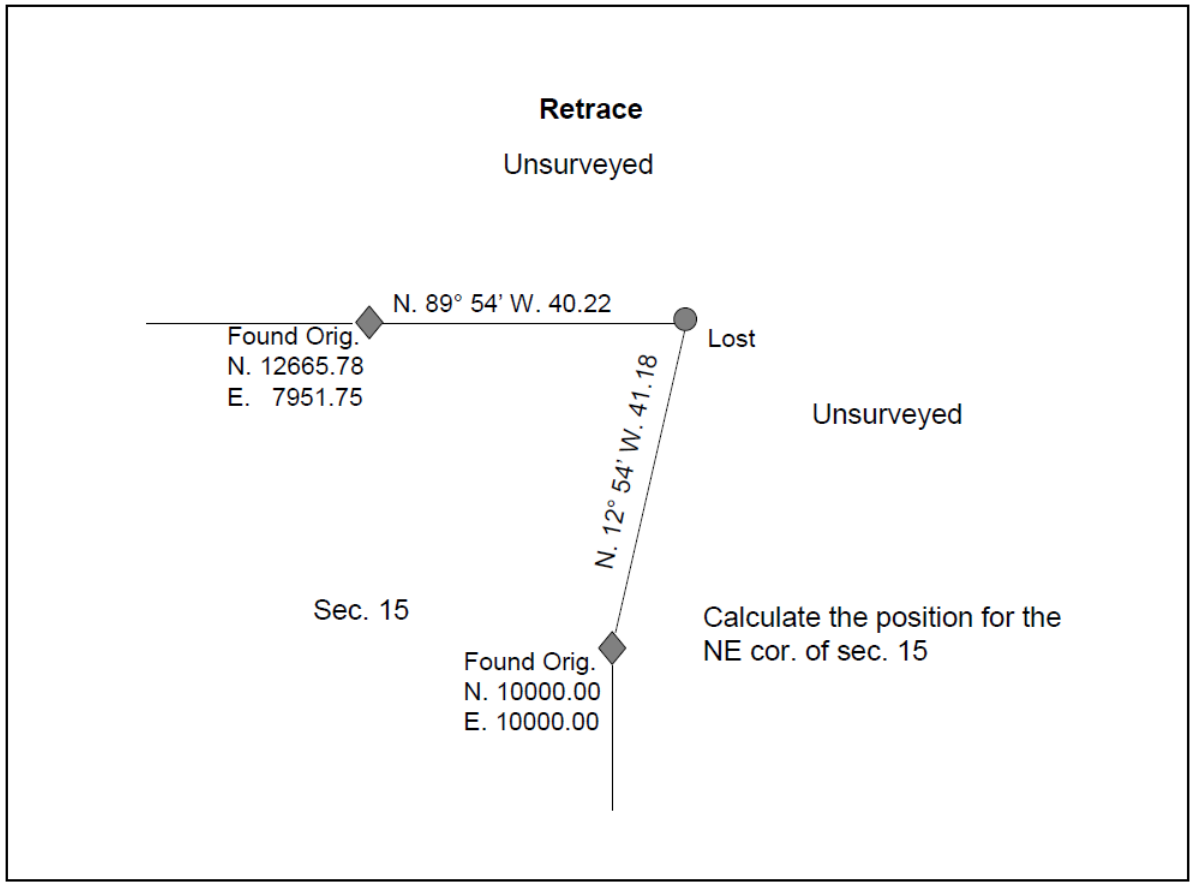
DOUBLE PROPORTION EXERCISE

Proportionate Position of the Section Corner
N. 12651.35
E. 10073.69



Two Point


Record
Unsurveyed
N. 89° 54' W. 40.22
N. 12° 54' W. 41.18
Unsurveyed
Sec. 15


Retrace
Unsurveyed
N. 89° 54' W. 40.22
Found Orig.
N. 12665.78
E. 7951.75
Lost
N. 12° 54' W. 41.18
Unsurveyed
Sec. 15
Calculate the position for the
NE cor. of sec. 15
Found Orig.
N. 10000.00
E. 10000.00

Two Point

Calculate N-S

Record latitude: Cos 12° 54’ x 2717.88 ft. (41.18 chs.) = 2649.28 ft.

N.10000.00 + Record Latitude = Proportionate latitude for the corner
N.10000.00 + 2649.28 = **N.12649.28**

Calculate E-W

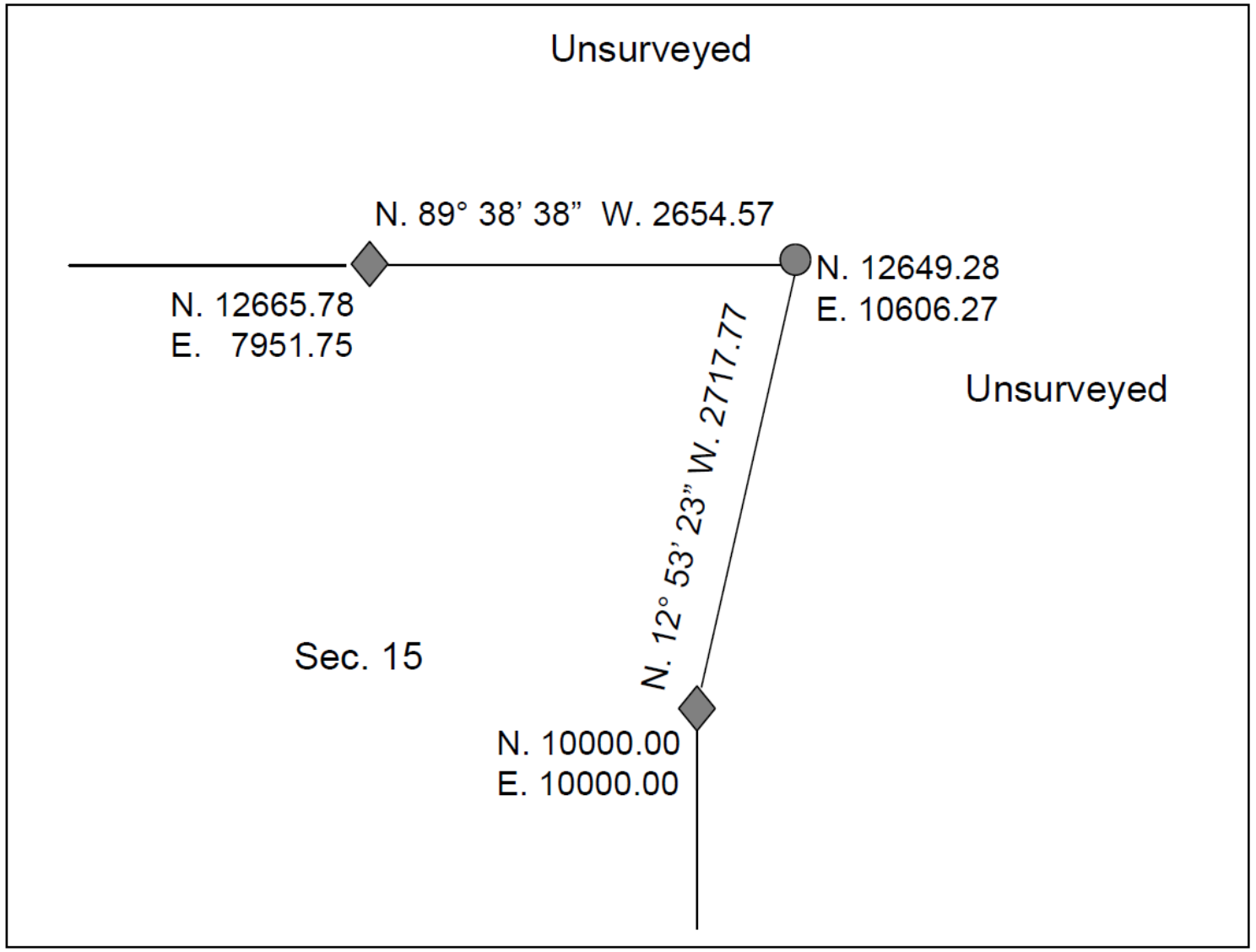
Record departure: Sin 89° 54’ x 2654.52 ft. (40.22 chs.) = 2654.52 ft.

E. 7951.75 + 2654.52 = **E.10606.27**

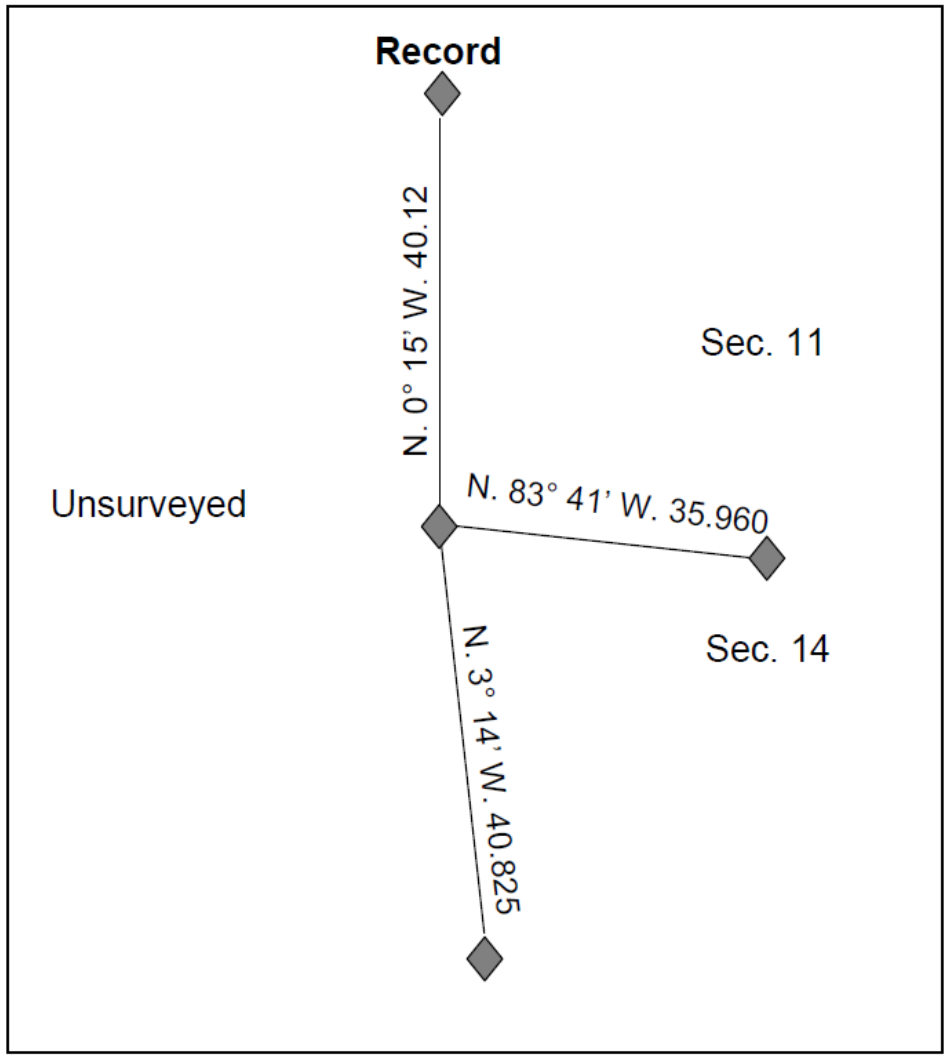
Proportionate Position of the Section Corner

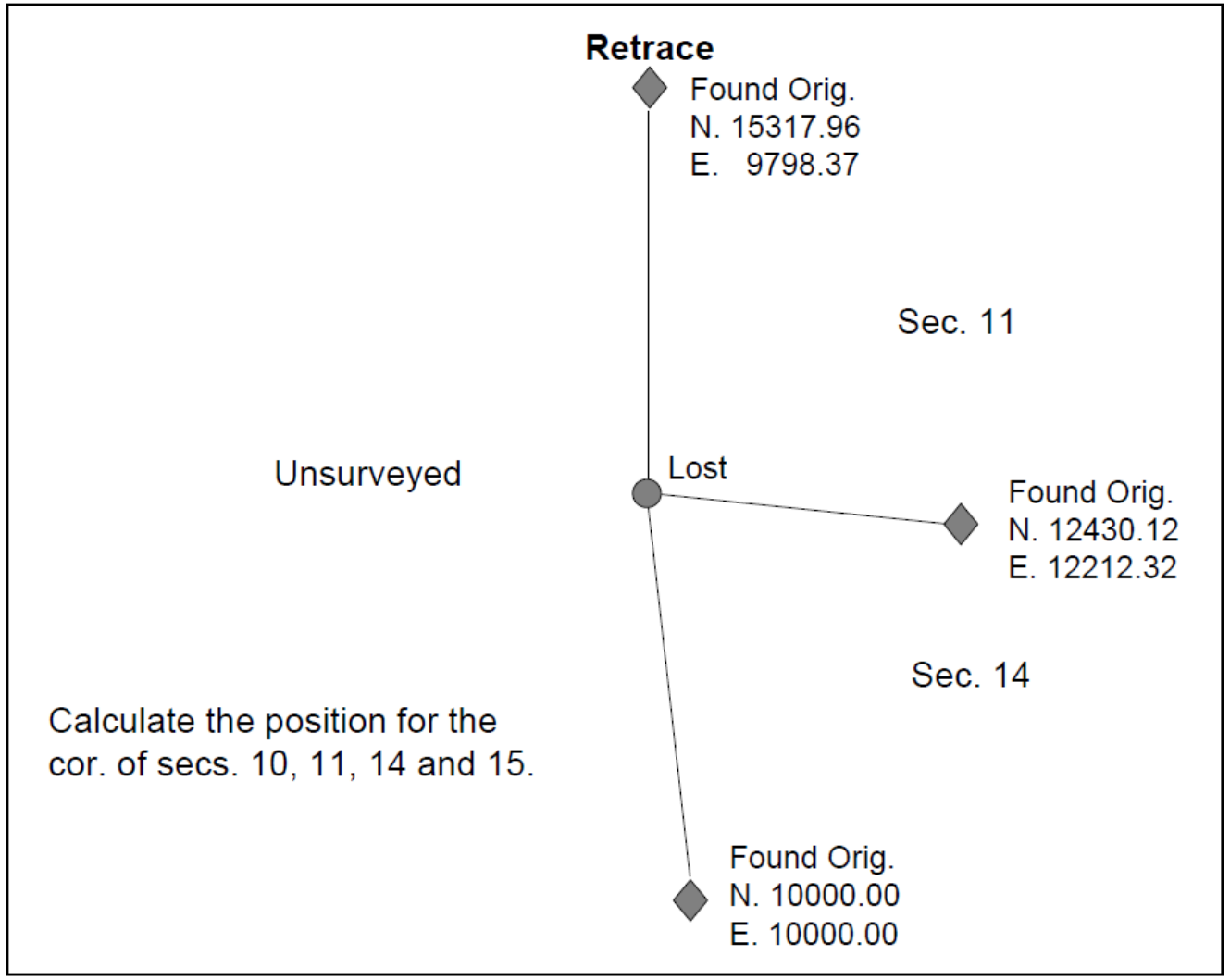
N.12649.28
E.10606.27

Two Point


Unsurveyed
N. 89° 38’ 38” W. 2654.57
N. 12649.28
E. 10606.27
N. 12665.78
E. 7951.75
Unsurveyed
N. 12° 53’ 23” W. 2717.77
Sec. 15
N. 10000.00
E. 10000.00

Three Point


Record
N. 0° 15' W. 40.12
Sec. 11
Unsurveyed
N. 83° 41' W. 35.960
Sec. 14
N. 3° 14' W. 40.825


Retrace
Found Orig.
N. 15317.96
E. 9798.37
Sec. 11
Unsurveyed
Lost
Found Orig.
N. 12430.12
E. 12212.32
Sec. 14
Calculate the position for the
cor. of secs. 10, 11, 14 and 15.
Found Orig.
N. 10000.00
E. 10000.00

Three Point

N-S Proportion:

Record latitude between controlling corners: N. 5338.06 ft.
Retrace latitude between controlling corners: N. 5317.96 ft.
Retrace ÷ Record = K
5317.96 ÷ 5338.06 = 0.996235

K x Record latitude of each segment of the line = Proportionate latitude of the line segment
0.996235 x 2690.16 ft. (40.760 chs.) = 2680.03
" x 2647.90 ft. (40.120 chs.) = 2637.93
N.10000.00 + 2680.03 = **N.12680.03**
N. 12680.03 + 2637.93 = N.15317.96

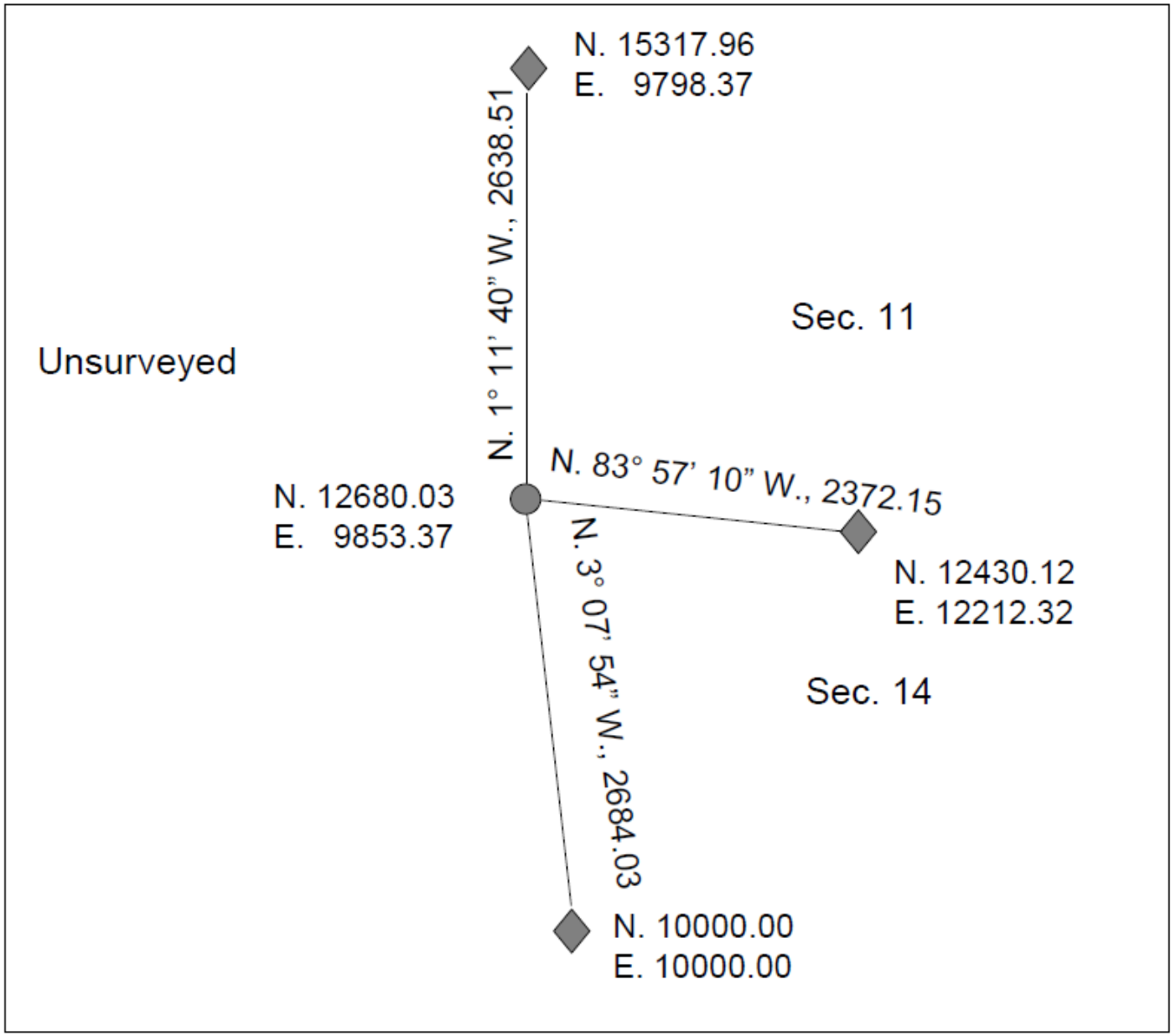
E-W Proportion

Sin 83° 41' x 2373.36 ft. (35.960 chs.) = Record departure (minus because the line is West)
0.110023 x 2373.36 = -2358.95 ft.

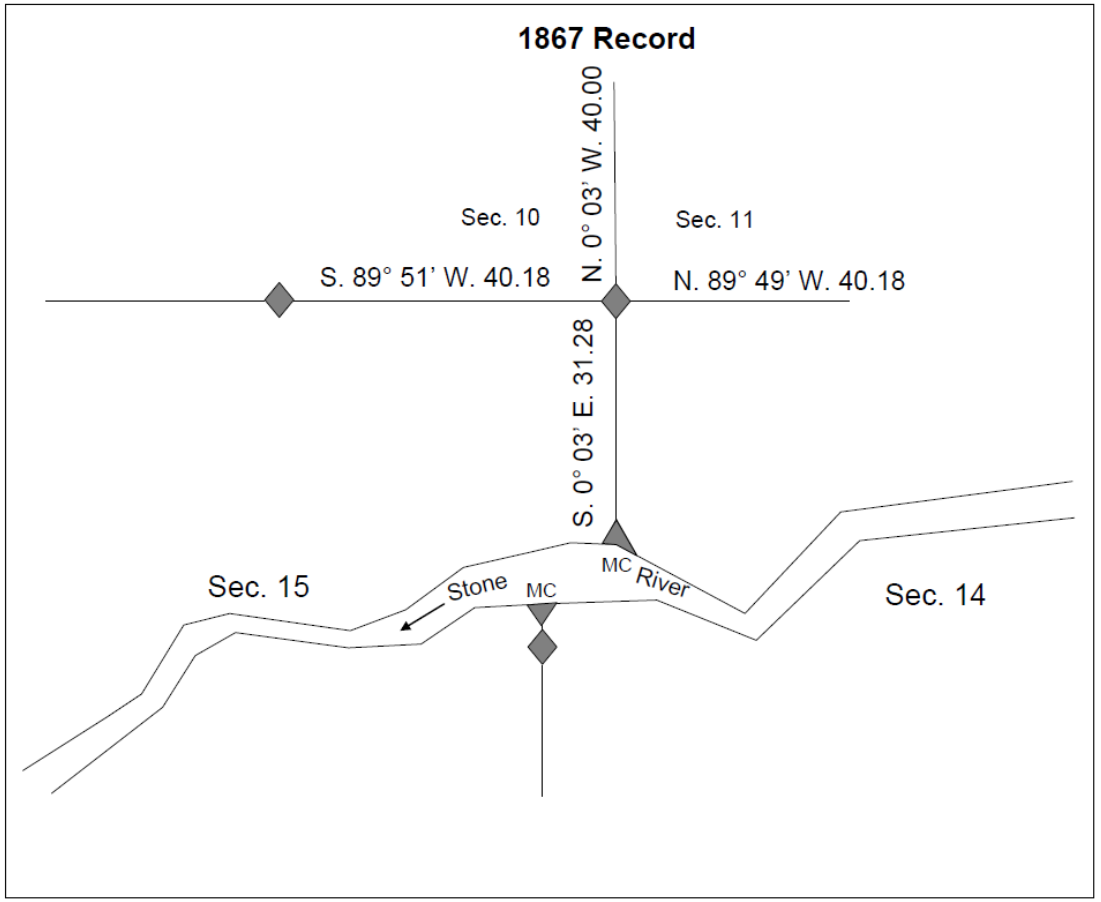
12212.32 - 2358.95 = **E. 9853.37**

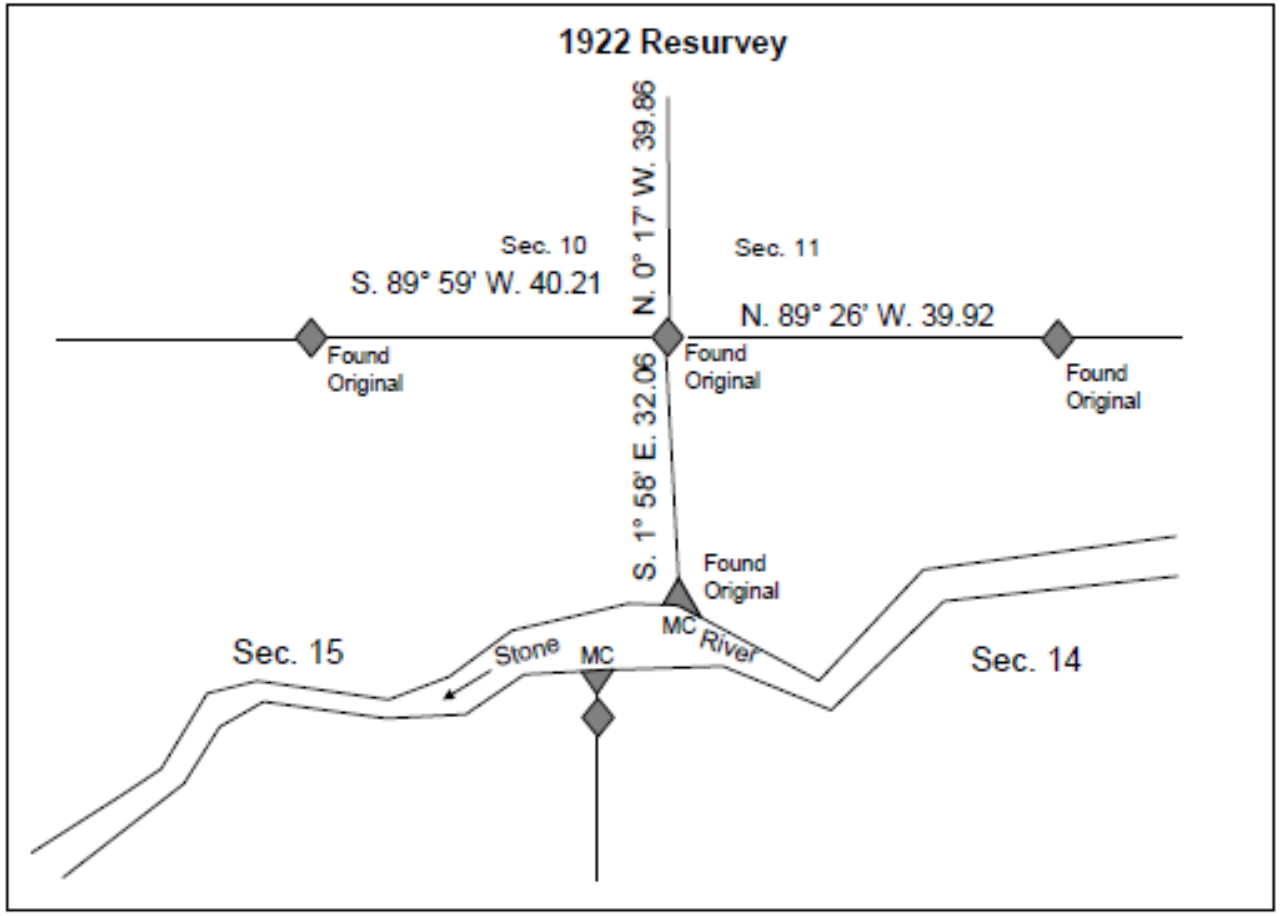
Three Point

Proportionate Position of the Section Corner
N. 12680.03
E. 9853.37

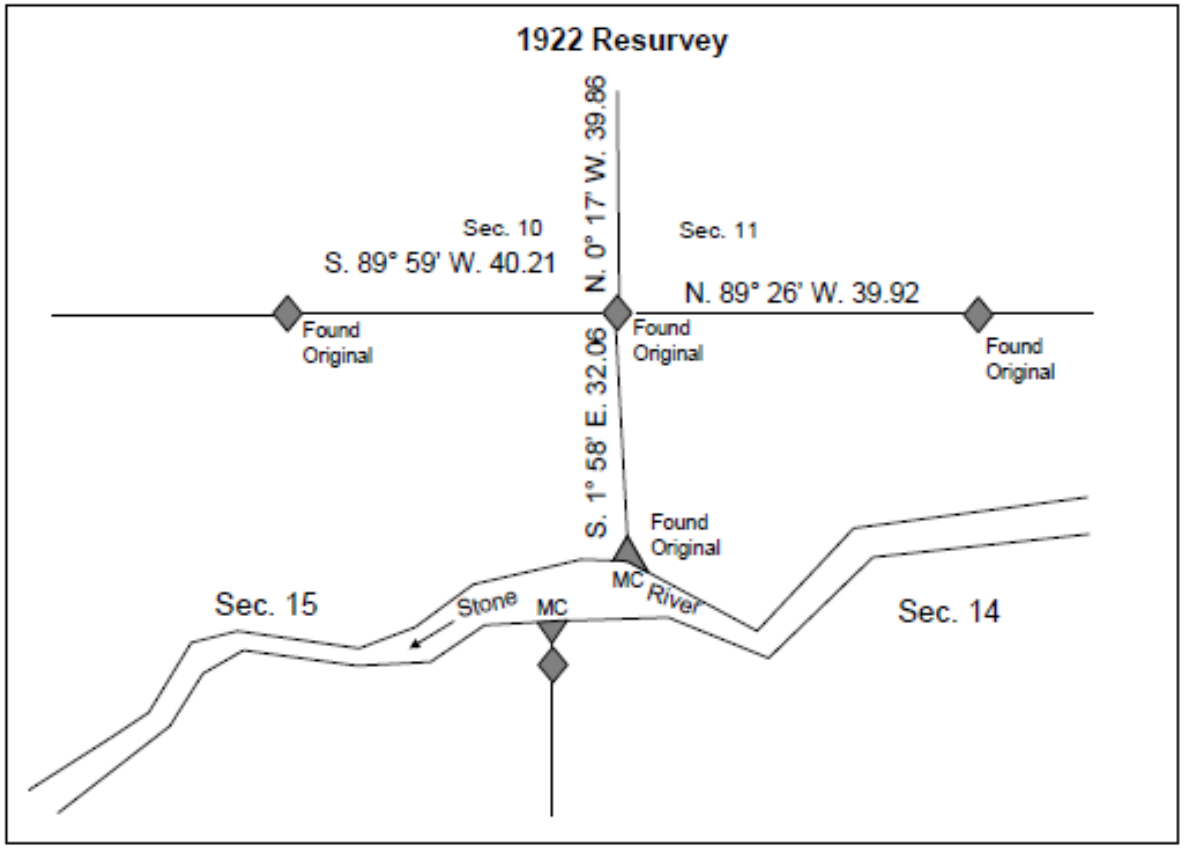


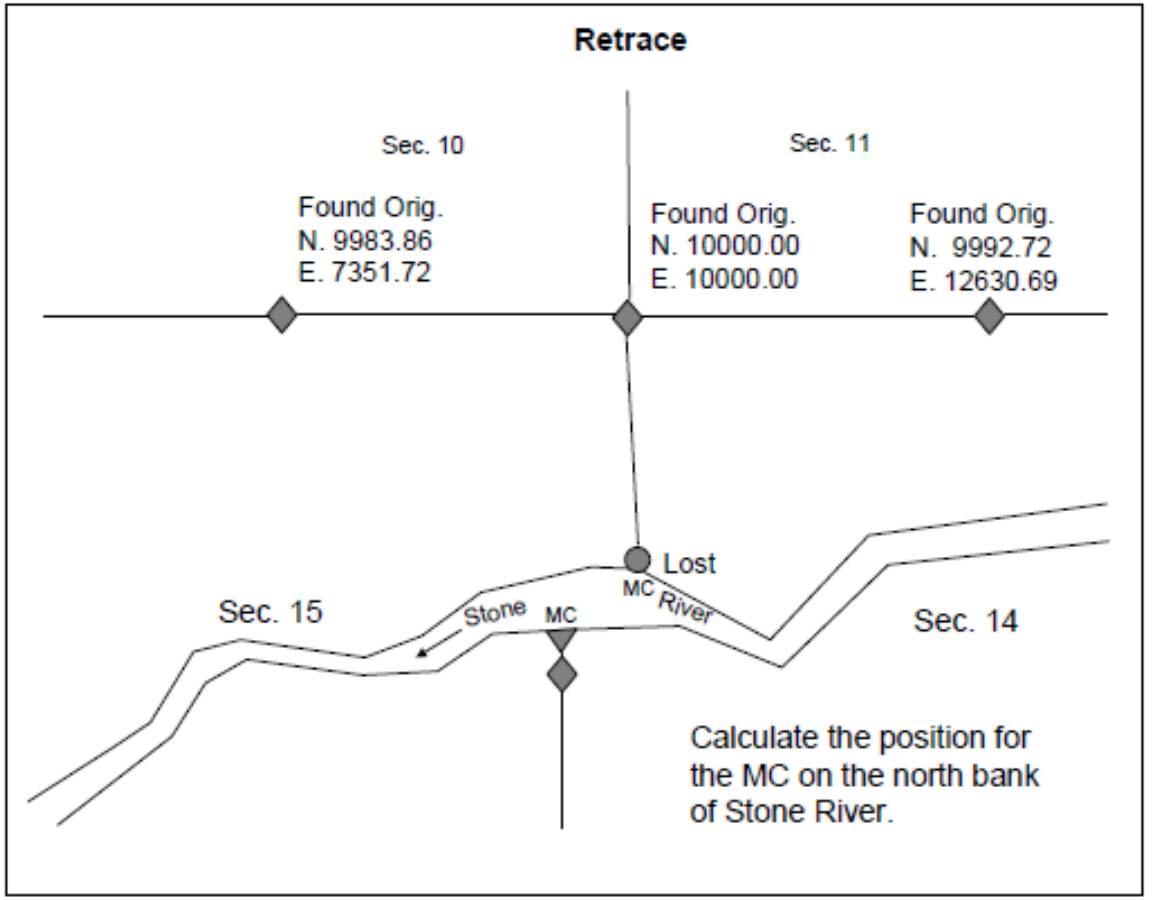
Original Control (one point)





Original Control (one point)





Original Control (one point)

Sec. 7-56 Original Control

Where a line has been terminated with measurement in one direction only, a lost corner will be restored by record bearing and distance, counting from the nearest regular corner, the latter having been duly identified or restored.

An index correction for average error in original measurement should be used, if appropriate, as discussed in section 5-29.

Calculate N-S

(An index correction is not appropriate because we have not retraced enough of the retracement survey)

Cos 1° 58' x 2115.96 ft. (32.06 chs.) = S. 2114.71

N.10000.00 - 2114.71 = **N.7885.29**

Calculate E-W

(An index correction is not appropriate because we have not retraced enough of the retracement survey)

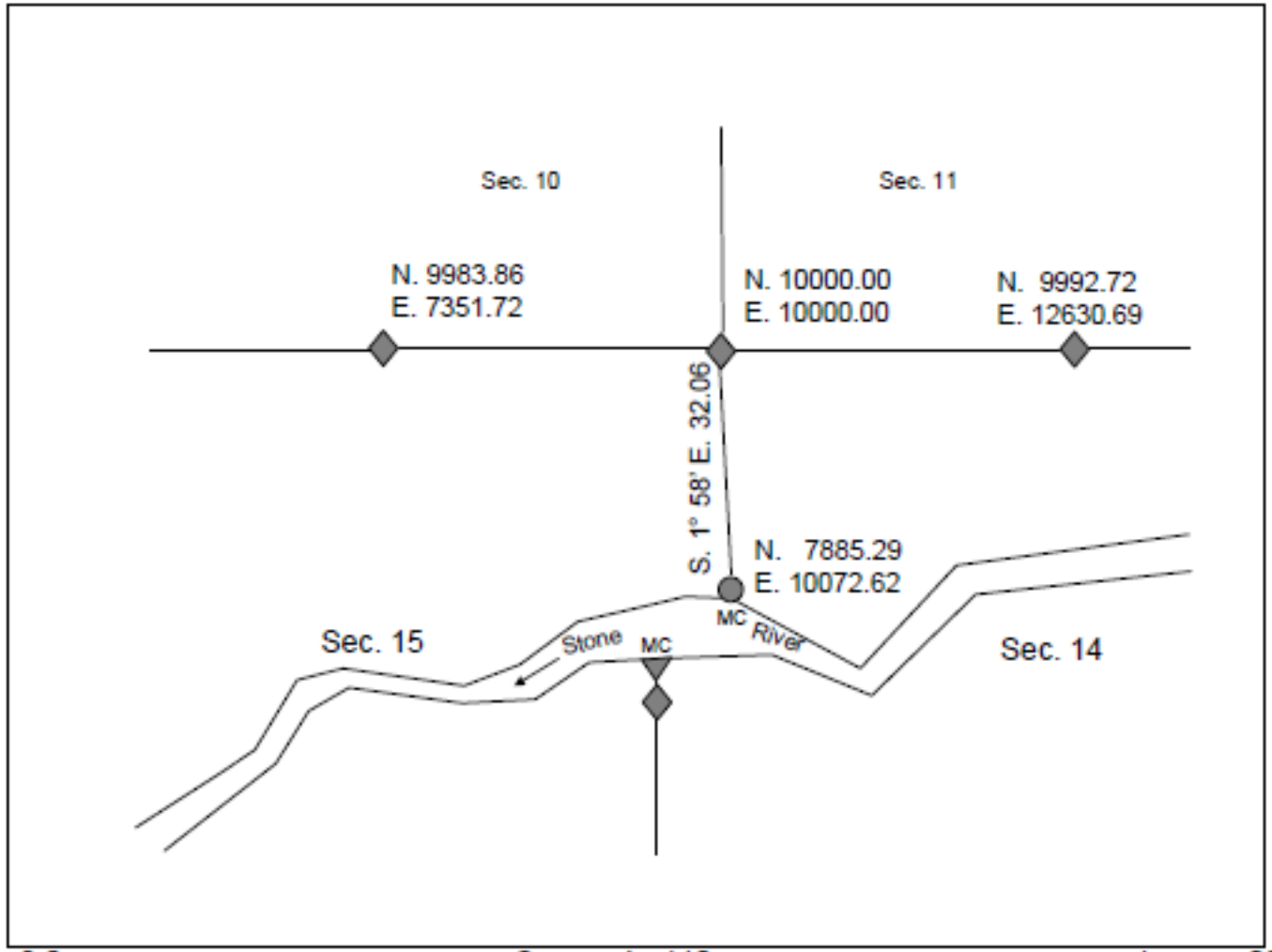
Sin 1° 58' x 2115.96 ft. (32.06 chs.) = E.72.62 ft.

E. 10000.00 + 72.62 = **E.10072.62**

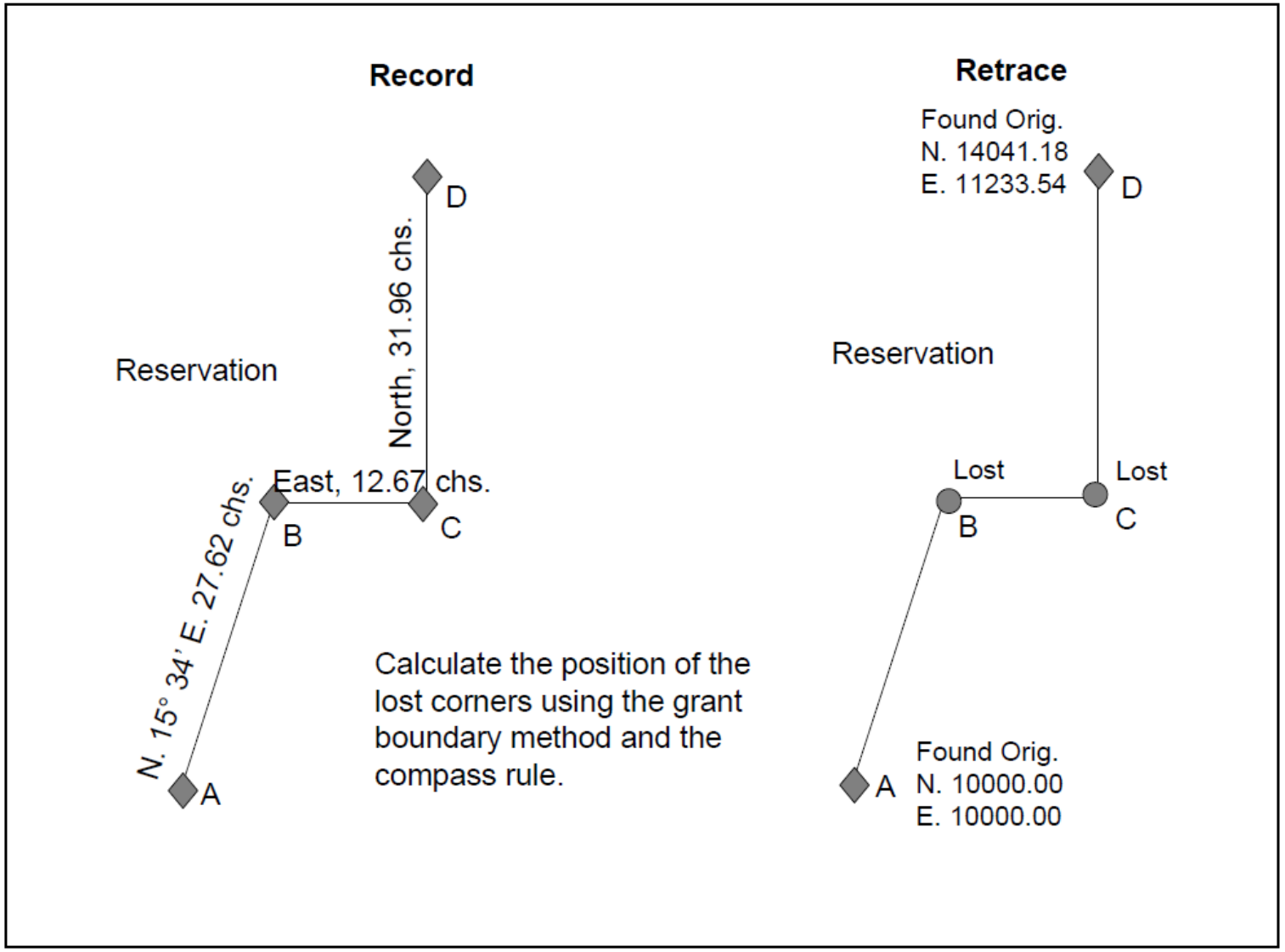
Original Control (one point)

Proportionate Position of the Section Corner

N.7885.29
E.10072.62



Grant Boundary and Compass Rule



Grant Boundary and Compass Rule

Grant Boundary Calculation

Inverse between controlling corners: **Record** = N. 3865.42 ft., E.1325.41 ft.
N. 18° 55' 35" E., 4086.33 ft.
Retrace = N. 4041.18 ft., E. 1233.54 ft.
N. 16° 58' 28" E., 4225.25 ft.

Angular rotation: 1° 57' 07" counter-clockwise (from record to retrace)
Line A-B: N. 15° 34' E. - 1° 57' 07" = **N. 13° 36' 50" E.**
Line B-C: N. 90° 00' E. - 1° 57' 07" = **N. 88° 02' 53" E.**
Line C-D: N. 0° 00' W. - 1° 57' 07" = **N. 1° 57' 07" W.**

Proportion: 4225.25 ft.(retrace) ÷ 4086.33 ft.(record) = 1.033996
1.033996 x 1822.92 ft. (27.62 chs.) = **1884.89 ft.**
" x 836.22 ft. (12.67 chs.) = **864.65 ft.**
" x 2109.36 ft. (31.96 chs.) = **2181.07 ft.**

Lat. and Dep. of each course:

Line A-B:	N. 13° 36' 50" E., 1884.89 ft	N.1831.93 ft.,	E.443.66 ft.
Line B-C:	N. 88° 02' 53" E., 864.65 ft.	N.29.45 ft.	E.864.15 ft.
Line C-D:	N. 1° 57' 07" W., 2181.07 ft.	N.2179.80 ft.	W.74.29 ft.

Proportionate Position Corners B and C

Corner B: N.10000.00 + 1831.93 ft. = **N.11831.93** E.10000.00 + 443.66 ft. = **E.10443.66**

Corner C: N. 11831.93 + 29.45 ft. = **N. 11861.38** E.10443.66 + 864.15 ft. = **E.11307.81**

Grant Boundary and Compass Rule

Compass Rule Calculation **Misclosure Record vs. Retrace**

Record coordinates at D: Lat. N. 3865.41 ft., Dep. E. 1325.42 ft.
Retrace coordinates at D: Lat. N. 4041.18 ft. Dep. E. 1233.54 ft.
N. 175.77 E.-91.88 Length of all the courses: 4768.50 ft.

Correction to course AB: 1822.92 ft. (27.62 chs.) ÷ 4768.50 = 0.382284
0.382284 x N.175.77 = N.67.19
0.382284 x E. -91.88 = E. -35.12

Correction to course BC: 836.22 ft. (12.67 chs.) ÷ 4768.50 = 0.175363
0.175363 x N.175.77 = N.30.83
0.175363 x E. -91.88 = E.-16.11

Correction to course CD: 2109.36 ft. (31.96 chs.) ÷ 4768.50 = 0.442353
0.442353 x N. 175.77 = N. 77.75
0.442353 x E. -91.88 = E.-40.64

Record Lat and Dep. of each course plus correction

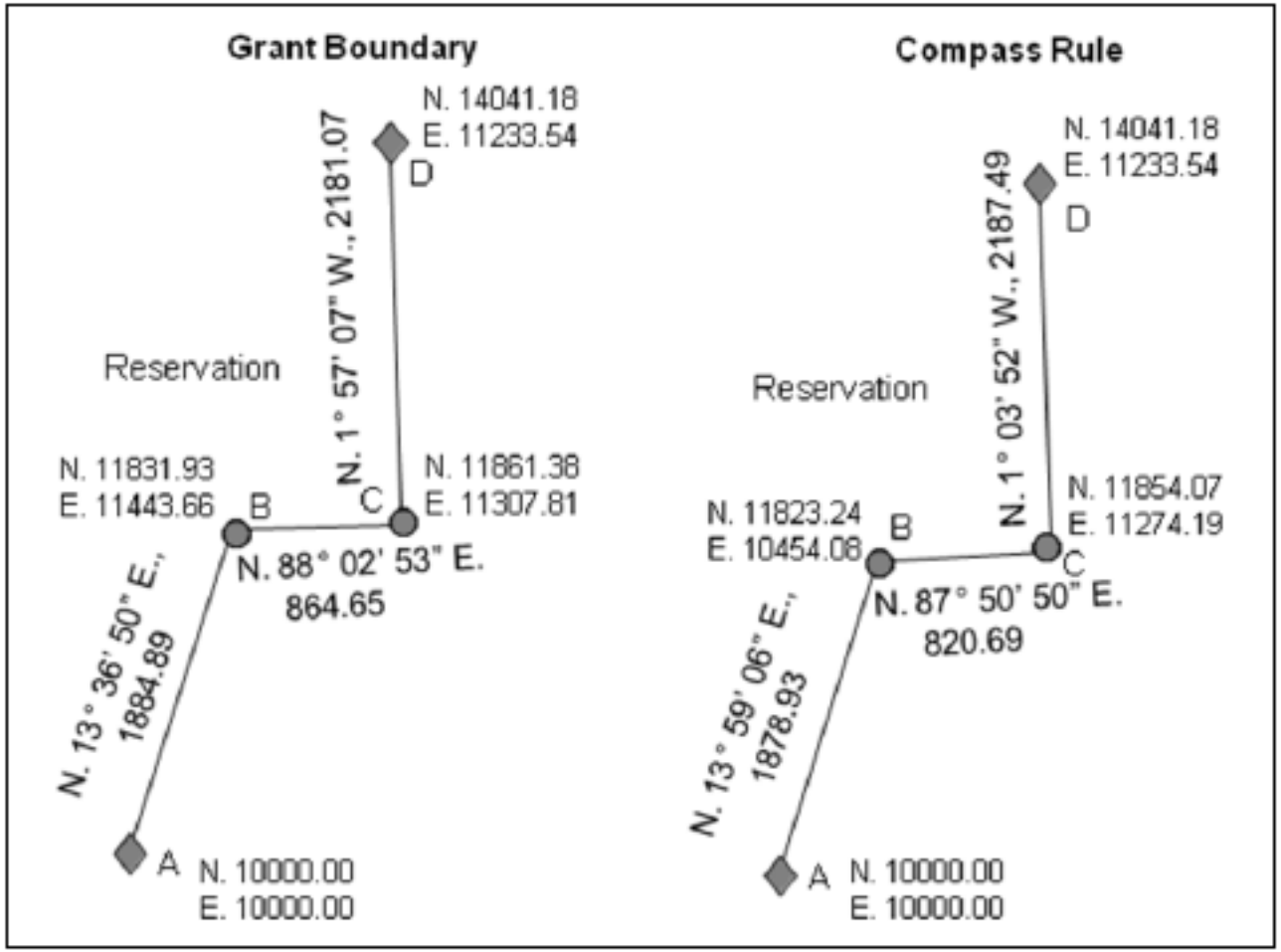
Course A-B: N.1756.05 + 67.19 = **N. 1823.24** E. 489.20 - 35.12 = **E.454.08** **N. 13° 59’ 06” E., 1878.93 ft**.
Course B-C: N. 0.00 + 30.83 = **N. 30.83** E. 836.22 - 16.11 = **E.820.11** **N. 87° 50’ 50” E., 820.69 ft.**
Course C-D: N.2109.36 + 77.75 = **N.2187.11** E. 0.00 - 40.64 = **E.-40.64** **N. 1° 03’ 52” W., 2187.49 ft.**

Grant Boundary and Compass Rule

Proportionate Position Corners B and C

Corner B: N.10000.00 + 1823.24 ft. = **N.11823.24** E.10000.00 + 454.08 ft. = **E.10454.08**

Corner C: N. 11823.24 + 30.83 ft. = **N. 11854.07** E.10454.08 + 820.11 ft. = **E.11274.19**



3-120. The law provides that where no opposite corresponding quarter-section corners have been or can be fixed, the subdivision-of-section lines shall be ascertained, by running a line from the monumented corners due north and south, or east and west, as the case may be, to the water-course, reservation line, or other external boundary of such fractional section, as represented upon the official plat.

Under this subdivision-of-section method, the law presumes the section lines actually run and marked in the survey are due north and south, or due east and west lines, but usually this is not the case. Hence, in order to carry out the spirit of the law, it will be necessary in running the center lines through fractional sections to adopt mean courses, as ascertained from opposite corresponding section lines. Where an opposite corresponding section line does not exist, or the center line is platted parallel to one section boundary, run the center line parallel to the corresponding east, south, west, or north boundary of the section, as conditions may require.