(1)

PLSS HOMEWORK LESSON

The PLSS covers much of the U.S. and Surveyors need to know the basic configuration and rules even if they intend to practice only in non-PLSS states. Most (if not all) of the retracement rules we have discussed apply in the PLSS. Think of the PLSS as a large subdivision (simultaneous conveyance), although senior rights also exist in some situations. And, remember that the PLSS had differing rules, methods, and procedures at different times and so in different areas. The homework problems are designed to familiarize you with the theoretical system. I have scanned a handout that you can refer to in the course of solving these problems.

1) The first problem has to do with convergence of meridians.

The first step in the survey of a new area was to pick a conspicuous spot for an "initial point". Then run the "principal meridian" astronomic north and south, and run the "baseline" on a true parallel of latitude east and west. True meridians and parallels were run every 24 miles. These are "guide meridians" and "standard parallels" numbered E-W and N-S of the baseline. The area contained is called a "quadrangle" and is 24 miles on 3 sides and 24 less convergence on the north side (figure 1). Convergence can only be computed up to 24 miles in a north south direction within the Quadrangle because then a new Quadrangle is started with a south line of a full 24 miles.

The quadrangle is divided into "townships" and "ranges" 6 miles on 3 sides and 6 less convergence on the north side (figure 2). These lines are again true meridians and true parallels and are run every 6 miles. "Townships" are numbered north or south of the baseline. "Ranges" are numbered east or west of the principal meridian.

The township is divided into 36 "sections" (figure 3). The east-west lines are true parallels. **However, the north-south lines are run parallel with the east line of the township. All of the error due to convergence is placed in the last ½ mile or ¼ mile(40 chains or 20 chains) of the most westerly sections (figure 4 and figure 6).** All of the sections are therefore 1 mile on all 4 sides except sections 6,7,18,19,30,31; all of which have a north line of less than 1 mile due to convergence (all east west measurement error goes here as well). All of the north south measurement error is placed in the last half mile of the northerly sections 1,2,3,4,5,6. These odd lot portions are given "government lot" numbers instead of "aliquot part (1/4, ½, etc.)" notation (figure 4 and figure 6).

Sections are divided by intersecting lines drawn from midpoints of opposite lines.

2) So, we need to find linear and angular convergence in order to stake a true parallel of latitude which is any east-west line not interior to a section. We also need linear convergence in order to figure out the dimensions and areas of the government lots in the westerly sections 6,7,18,19,30,31.

3) If a corner is "lost" (no evidence at all), which is hard to prove, we can use the rule of last resort to proportion it in (PLSS is a subdivision remember). All lost corners inside the township boundaries and the corner where 4 townships converge are restored by double proportion. All lost corners on the township boundaries except where 4 townships converge are restored by single proportion.

Problem #1 – Find the length of the north line of T10N R3W, 5th Principal Meridian, in Chains.

(1) North line of a Township is 6 miles less Convergence from the nearest standard parallel south. We are 10 N of baseline and standard parallels are every 24 miles.

(10)(6) = 60 miles N of baseline.

60/24 = 2.5 So we are 2.5 Quads N of BL

our nearest standard parallel to S. is 2 N.

(2) Formula for Linear Convergence

C.0202 (Dist. from nearest S.P. S.)(width)(Tan mean lat. Quad)
miles miles

(3) Width is 6 for the township or any of the government lots in the Westerly Sections.

(4) Mean Latitude of Quad.

(a) get latitude of BL for Principal meridian from table = 34° 38' 45" (see attached Table)

(b) 69 miles in 1° Latitude

(c) Miles to mean Lat. of Quad from BL. = 24+24+12=60

(4) (d) $60/69 = 0.8696^{\circ}$

(e) $34^{\circ}38'45'' + 0.8696^{\circ} = \boxed{35^{\circ}30'56''}$

↑ Because No. of BL

(5) Distance from nearest S.P. to So. to No. Line of the Township.

This is the 2.5 Quads we found in Step (1).
So our parcels North line is 0.5 Quad or 12 miles From nearest S.P. South.

Note: If calculating a section convergence within this Township, then this is the only number that might change.
Simply subtract in increments of 1/4 mile to get to the line in question.

(6) $(0.0202)(12)(6)(\text{Tan } 35^{\circ}30'56'') = 1.038$ chains

Note: This is the Total convergence along The North Line of this Township.
All would be placed in the last 20 Chains of section 6.

— So, Government lot 4 of section 6 would have a north line length of
$20 - 1.038 = 18.962$ chains

☆ Refer to Figure 6

Problem #2 – Find angular Convergence at same line as problem #1. Again, this is computed within the Quadrangle, so from nearest Standard Parallel to South; The 12 miles we already calculated.

① formula = $\text{Arctan}\left(\frac{\frac{\text{linear convergence in chains}}{80}}{\text{miles in Latitude}}\right)$

② $\text{Arctan}\left(\frac{\frac{1.038}{80}}{12}\right) = 0°10'54''$

Problem #3 – Staking the Line.

- In order to use either the Tangent or Secant method one must first compute the Tangent method.
- In both cases the instrument is set on the Township line and a 90° angle turned off Astronomic North. Temporary points are set every ½ mile (40 chains). The instrument is then set on these points and the offsets staked Astronomic north or south.
- offset from Tangent to parallel is ½ linear convergence within same distance or width and Height.

Problem #3 – continued

① Compute offset in feet at 6 miles.

Note: Because of the definition underlined on the last page, we need to compute linear convergence in 6 by 6 miles.

(a) $(0.0202)(6)(6)(\text{Tan } 35^\circ 30' 56'') = 0.5190 \text{ chains}$

(b) $\left(\frac{0.5190}{2}\right)\left(\frac{66 \text{ ft}}{1 \text{ chain}}\right) = \boxed{17.13 \text{ ft.}}$

② Compute offset at each ½ mile point.

Formula – $\left(\frac{d^2}{36}\right)(\text{offset at 6 miles})$

d = miles along line.

Example: offset at 2.5 miles

$$\left(\frac{(2.5)^2}{36}\right)(17.13) = 2.97 \text{ ft.}$$

③ Compute secant offsets per previous downloaded sheet.

Example: secant offset at 0 miles = Tan offset at 3 miles − Tan offset at 2 miles

is $(SC)_0 = a_3 - a_2$

Problem #4 — Example of Solving for Area, Dimensions, Description of shaded parcels in sections.

Notes You must calculate convergence if a parcel is within the west 20 chains of a westerly section.

- Solve for section 30 parcels in Homework

① Section 30 is a westerly section and the parcels in the NW ¼ are in the west 20 chains. There will be government Lots and convergence must be calculated for N. and S. Lines. The Parcel in the SE ¼ is an aliquot part.

② Easy one first - SE ¼:

ⓐ Find Range — 29 miles from 3rd guide meridian W.

(3)(24) = 72 miles + 29 miles = 101 miles to East line section 30.

5 miles back (East) is start of this Range

It is 96 miles to start of this Range

So 96/6 = 16 = This is Range 17 W.

ⓑ Find Township — 37 miles from 2nd standard Parallel.

(2)(24) = 48 miles + 37 miles = 85 miles to South line section 30.

1 mile South is start of this Township

It is 84 miles to start of this Township

So 84/6 = 14 = This is Township 15 N.

(2) (c) Describe

E½, NE¼, SE¼, Section 30, R17W, T15N, 3rd PM

(d) Area

Sections are 1 mile on a side or 80 chains

1 Acre is 10 square chains

section 30 is $\left(\frac{80 \times 80}{10}\right) = 640$ Acres

$SE\frac{1}{4} = \frac{640}{4} = 160$ Acres

$NE\frac{1}{4}, SE\frac{1}{4} = \frac{160}{4} = 40$ Acres

E½ of that is then $\frac{40}{2} =$ **20 Acres**

(3) Find Convergence for other Parcel NW¼, same process as problem #1 in this lesson.

(a) mean Lat. of Quad. = Lie found in step 2b that this parcel is in 4th Quad or above 3rd S.P.)

So midpoint is $(3 \times 24) + 12 = 84$ miles from BL.

$84/69 = 1.2174°$ north of BL.

From table 3rd PM BL Lat = 38° 28' 27"

38° 28' 27" + 1.2174° = **39° 41' 30"**

(b) Distance from nearest S.P. to South, to S. + N. lines of parcel.

Found in step 2b that S. Line Sect 30 is 85 miles from BL. Also, problem states 37 miles from 2nd S.P.

It is 37 - 24 from nearest S.P. to S. Line 30.

(3b) continued

37-24 = 13 miles

To get to S. line of parcel go another 5/8 mile
To get to N. line of parcel go another 7/8 mile

S. line = 13.625 from nearest S.P. south
N. line = 13.875 " " " "

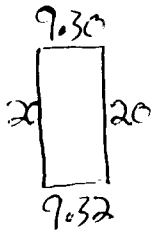
Convergence S. line = (0.0202)(13.625)(6)(Tan 39°41'30") = 1.3706 ch.

convergence N. Line = (0.0202)(13.875)(6)(Tan 39°41'30") = 1.3957 ch.

(c) Area

North Line = 20 - 1.3957 = 18.60 ch.
South Line = 20 - 1.3706 = 18.63 ch.

our parcel is only 1/2 of last 20 chains
so we'll cut both in 1/20
9.30 + 9.32



$$\text{Area} = \left(\frac{9.30+9.32}{2}\right)20$$

$$= \frac{186.20 \text{ ch}^2}{10}$$

$$= \boxed{18.62 \text{ Acres}}$$

(D) Description – Refer to figure 6

SW 1/4 Gov. Lot 4 and NW 1/4 Gov Lot 5, Sect. 30, T15N, R17W, 3rd P.M.

INITIAL POINTS

3-6. During the period since the organization of the system of rectangular surveys, numbered and locally named principal meridians and base lines have been established as listed in the accompanying table. These bases and meridians are shown on the large wall map of the United States published by the Bureau of Land Management, on a special map entitled "Principal Meridians and Base Lines Governing the United States Public Land Surveys" published by the Bureau, and on the various State maps and topographic maps published by the United States Geological Survey.

Meridians and Base Lines of the United States Rectangular Surveys

			Initial Points	
Meridian	Adopted	Governing surveys (wholly or in part) in States of	Latitude ° ' "	Longitude ° ' "
Black Hills	1878	South Dakota	43 59 44	104 03 16
Boise	1867	Idaho	43 22 21	116 23 35
Chickasaw	1833	Mississippi	35 01 58	89 14 47
Choctaw	1821	--do--	31 52 32	90 14 41
Cimarron	1881	Oklahoma	36 30 05	103 00 07
Copper River	1905	Alaska	61 49 04	145 18 37
Fairbanks	1910	--do--	64 51 50.048	147 38 25.949
Fifth Principal	1815	Arkansas, Iowa Minnesota, Missouri, North Dakota, and South Dakota	34 38 45	91 03 07
First Principal	1819	Ohio & Indiana	40 59 22	84 48 11
Fourth Principal	1815	Illinois	40 00 50	90 27 11
--do--	1831	Minnesota, & Wisconsin	42 30 27	90 25 37
Gila and Salt River	1865	Arizona	33 22 38	112 18 19
Humboldt	1853	California	40 35 02	124 07 10
Huntsville	1807	Alabama & Mississippi	34 59 27	86 34 16
Indian	1870	Oklahoma	34 29 32	97 14 49
Kateel River	1956	Alaska	65 26 16.374	158 45 31.014
Louisiana	1807	Louisiana	31 00 31	92 24 55
Michigan	1815	Michigan & Ohio	42 25 28	84 21 53
Mount Diablo	1851	California & Nevada	37 52 54	121 54 47
Navajo	1869	Arizona	35 44 56	108 31 59
New Mexico Principal	1855	Colorado & New Mexico	34 15 35	106 53 12
Principal	1867	Montana	45 47 13	111 39 33
Salt Lake	1855	Utah	40 46 11	111 53 27
San Bernardino	1852	California	34 07 13	116 55 48
Second Principal	1805	Illinois & Indiana	38 28 14	86 27 21
Seward	1911	Alaska	60 07 37	149 21 26

Sixth Principal	1855	Colorado, Kansas, Nebraska,S. Dakota, Wyoming	40 00 07	97 22 08
St. Helena	1819	Louisiana	30 59 56	91 09 36
St. Stephens	1805	Alabama & Mississippi	30 59 51	88 01 20
Tallahassee	1824	Florida & Alabama	30 26 03	84 16 38
Third Principal	1805	Illinois	38 28 27	89 08 54
Unitah	1875	Utah	40 25 59	109 56 06
Umiat	1956	Alaska	69 23 29.654	152 00 04.551
Ute	1880	Colorado	39 06 23	108 31 59
Washington	1803	Mississippi	30 59 56	91 09 36
Willamette	1851	Oregon & Washington	45 31 11	122 44 34
Wind River	1875	Wyoming	43 00 41	108 48 49

3-7. The rectangular system was initiated in the State of Ohio in 1785 from a point on the west boundary of Pennsylvania, on the north shore of the Ohio River, in longitude 80°32'20". The State boundary served as the first reference meridian. A number of other reference meridians and bases were employed in Ohio to govern particular areas for purposes of disposal. In its early stages the system was somewhat experimental, and Ohio may well be referred to as the proving ground for the present rectangular system of surveys. The rectangular surveys that have no initial point as an origin of township identification are listed in the following table.

Public Land Surveys Having No Initial Point as an Origin for Both Township and Range Numbers

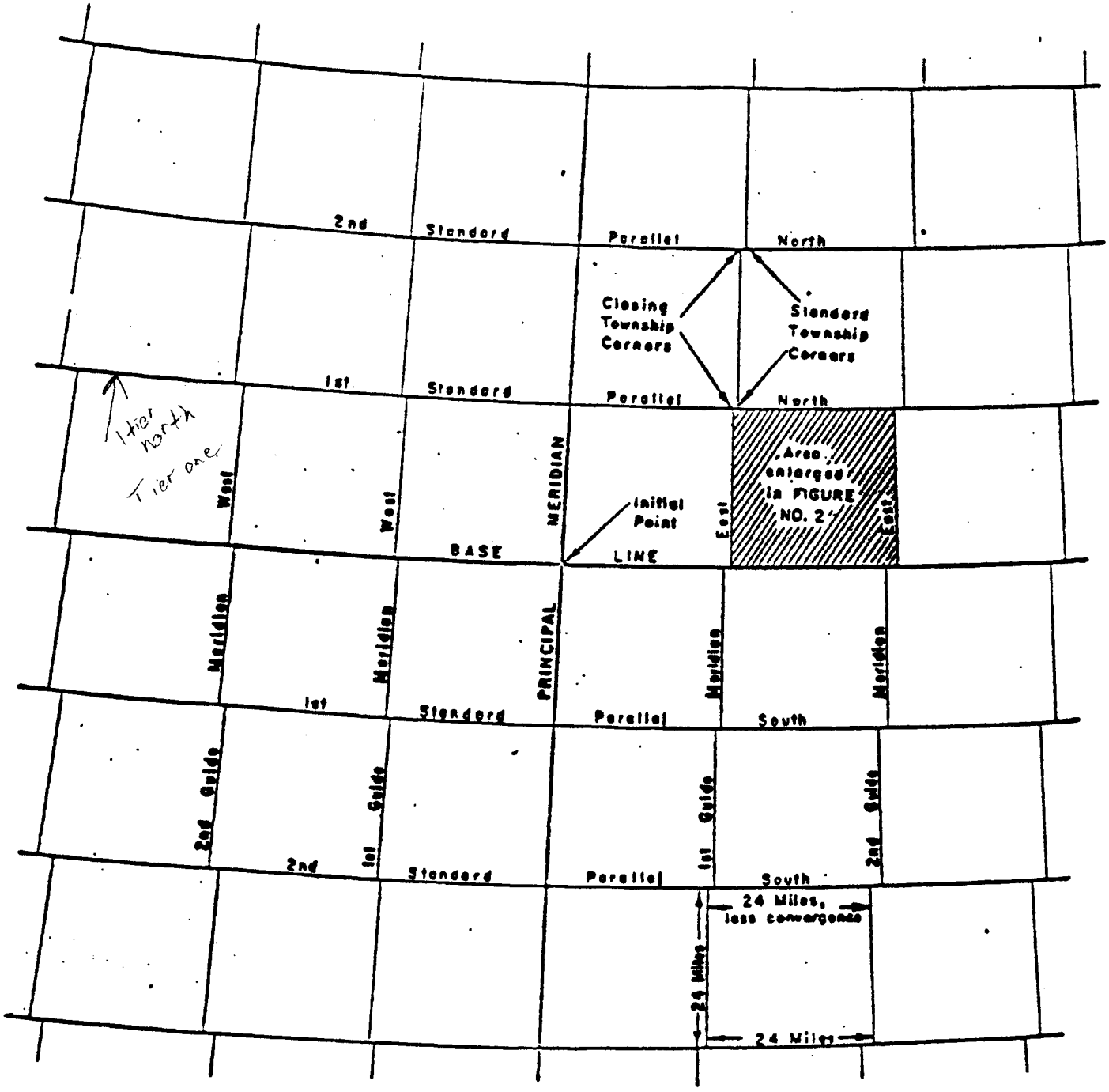
Survey (and year commenced)	Townships numbered	Ranges numbered
Ohio River Survey 1785 (Ohio)	North from Ohio River	West from west boundary of Pennsylvania
U.S. Military Survey 1797 (Ohio)	North from south boundary of military grant	West from west boundary of the Seven Ranges
West of the Great 1798 Miami (Ohio)	North from Great Miami River	East from Ohio-Indiana boundary
Ohio River Base 1799 (Indiana)	North from Ohio River	From Ohio-Indiana boundary and its projection south
Scioto River Base 1799 (Ohio)	North from Scioto River	West from west boundary of Pennsylvania
Muskingrum River 1800 Survey(Ohio)	1 and 2	10
Between the Miamis 1802 , North of Symmes Purchase (Ohio)	*East* from Great Miami River	North from Ohio River (continuing numbers from Symmes Purchase)
Twelve-Mile-Square 1805 Reserve (Ohio)	1, 2, 3, and 4	None

RESOURCE SHEET # 1-1

5th 4th

GUIDE MERIDIANS & STANDARD PARALLELS

Figure 1

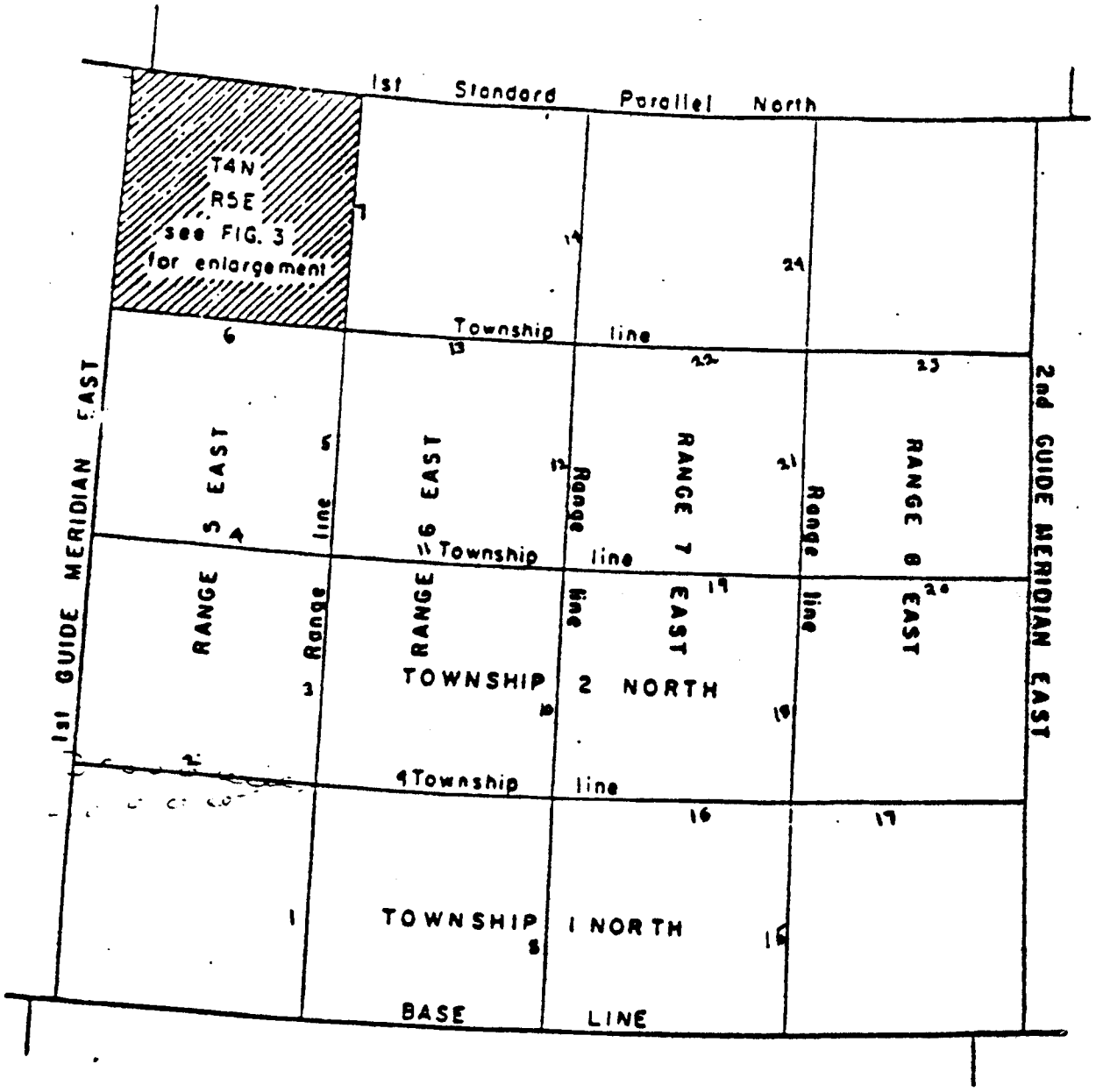


UNIT	PAK	SEGMENT	PAGE	PROGRAM
05	04	01	4	Surveying Technology

RESOURCE SHEET # 1-1

DIVISION INTO TOWNSHIPS

Figure 2



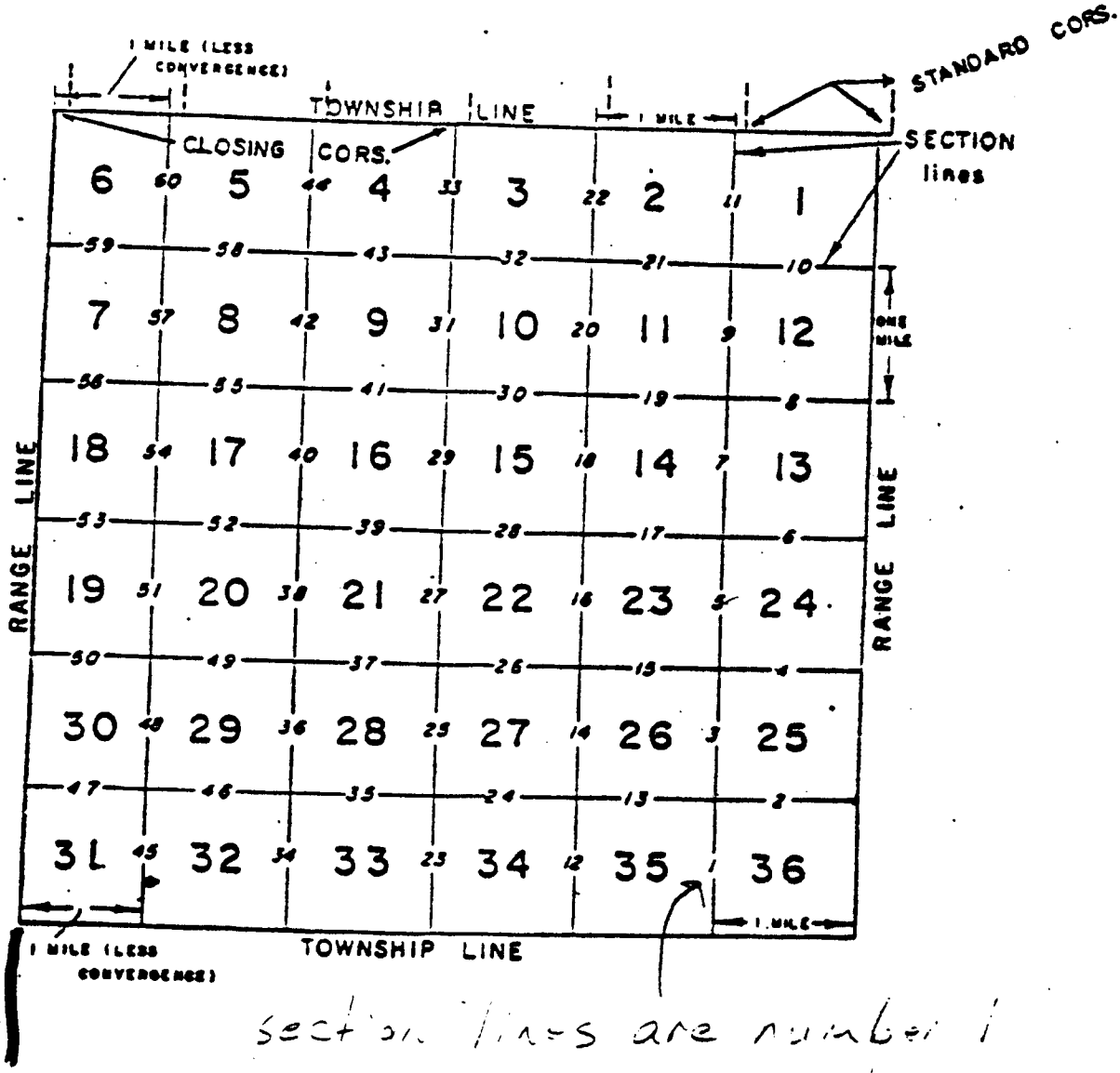
Range lines are true MERIDIANS. (They run North and South).
Township lines are true PARALLELS (They run East and West).

UNIT	PAK	SEGMENT	PAGE	PROGRAM
05	04	01	6	Surveying Technology

RESOURCE SHEET # 1-1

THE DIVISION OF TOWNSHIP INTO SECTIONS

Figure 3

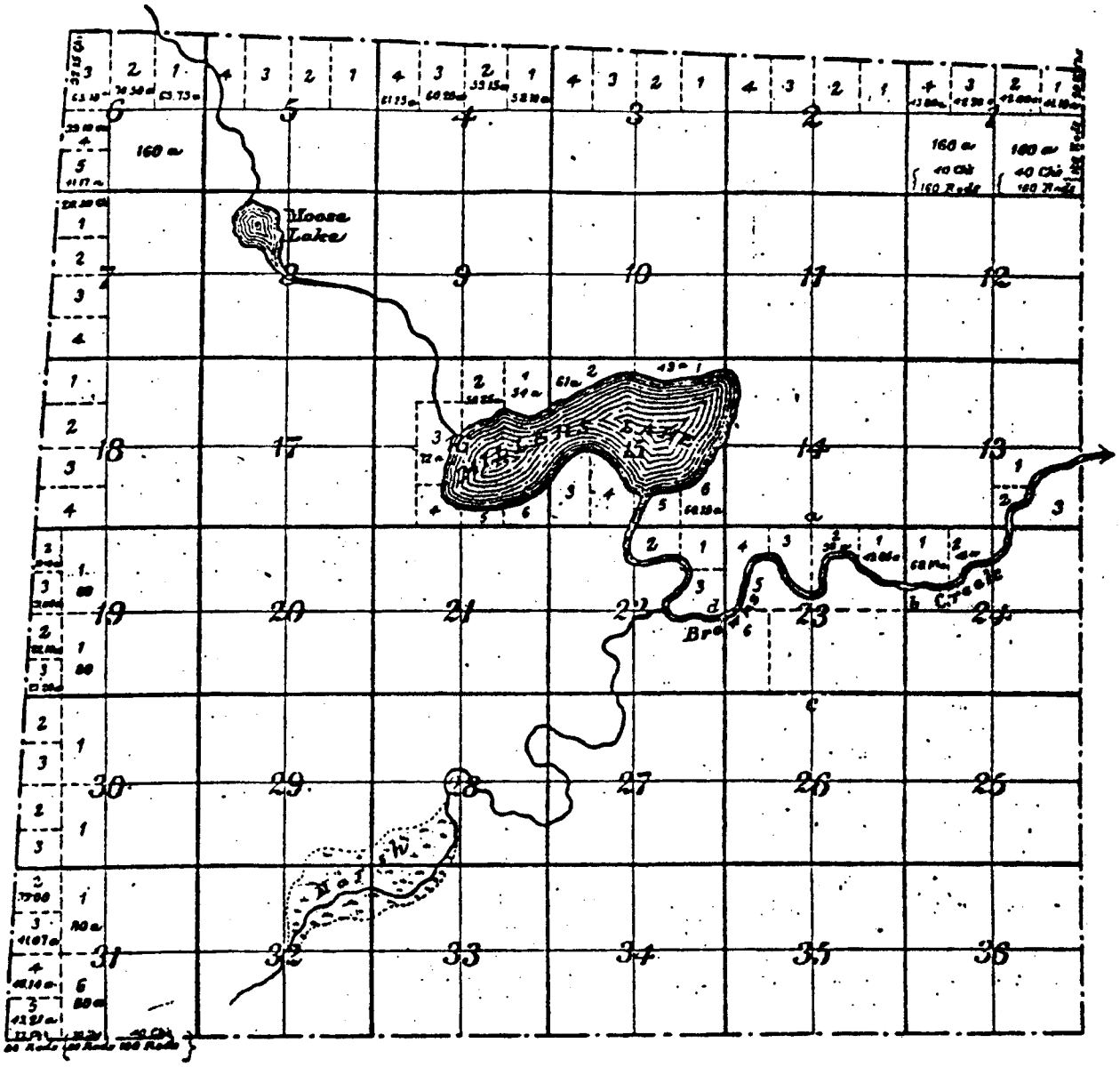


section lines are numbered

UNIT	PAK	SEGMENT	PAGE	PROGRAM
05	04	01	8	Surveying Technology

RESOURCE SHEET # 1 - 1

Figure 4

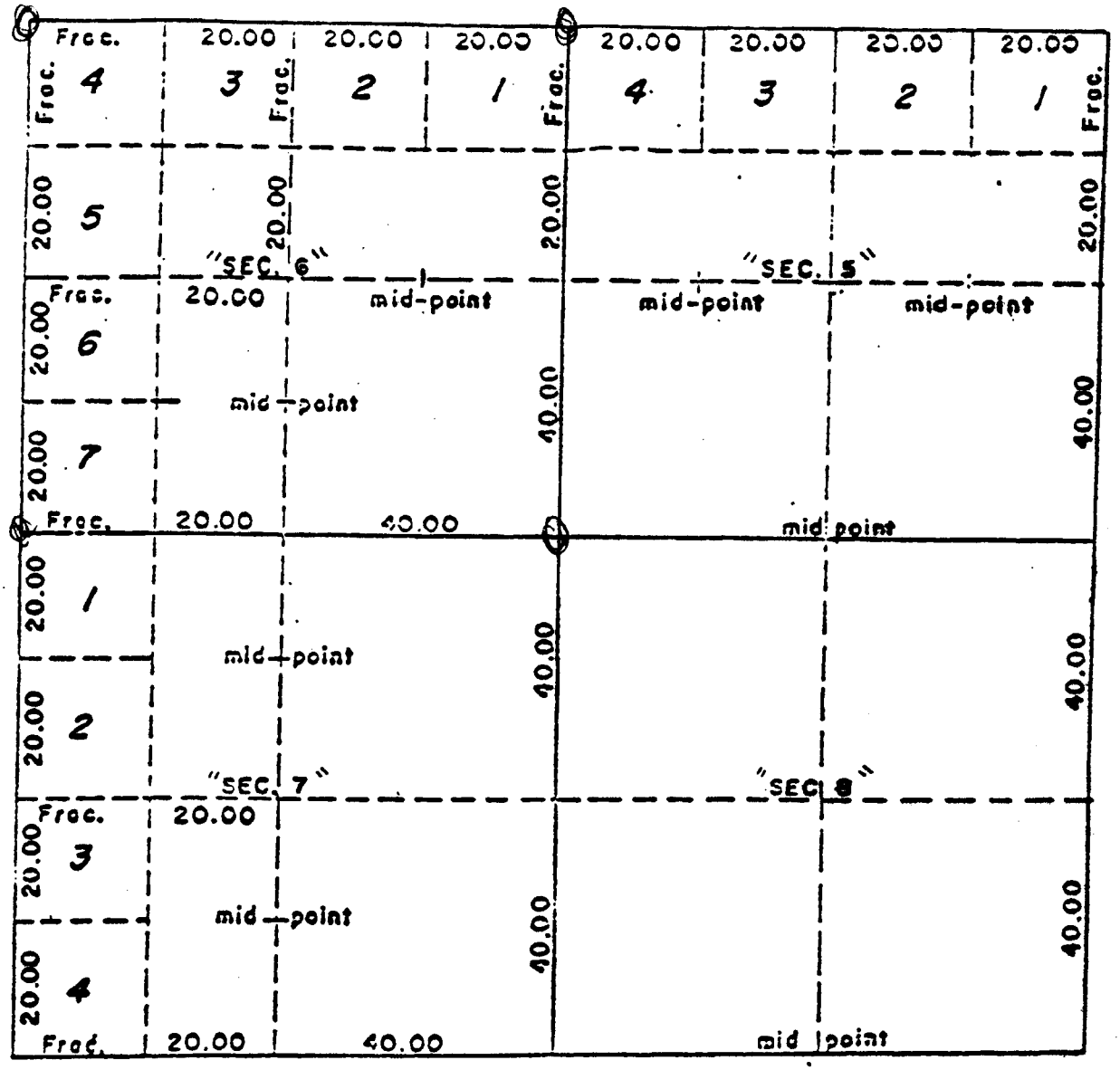


UNIT	PAK	SEGMENT	PAGE	PROGRAM
05	04	01	7	Surveying Technology

RESOURCE SHEET # 1-1

SUBDIVISION OF AN IRREGULAR SECTION WITH FRACTIONAL LOTS

Figure 6



UNIT	PAK	SEGMENT	PAGE	PROGRAM
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