Public Land Survey System (PLSS) Retracement and Remonumentation

2 Hours

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Final Exam

1. The first State that was surveyed using the PLSS system was:
    a. Maine
    b. Ohio
    c. Virginia
    d. Texas

2. Government Lots are created when the following conditions occur:
    a. Along the north tier of a Township
    b. Along Rivers and Lakes
    c. Along Closing Lines
    d. All of the Above

3. Original notes tell the surveyor:
    a. The distance to the Corner
    b. If a replat occurred
    c. What was set for the corner
    d. Both a and c

4. Which of the following corners are double proportioned?
    a. Closing Corners
    b. Section Corners
    c. Quarter Corners
    d. Meander Corners

5. Documentation on subsequent surveys can be found at:
    a. Timber Companies
    b. State Agencies
    c. Register/Recorder Offices
    d. All Above

6. Natural feature calls should be used to:
    a. Support the corner's location
    b. Set the corner
    c. Ignored the calls
    d. Refence the corner

7. Which of the following is/are examples of subsequent surveys that could be used to locate a corner?
    a. A survey tied to the PLSS Corner
    b. A reference mark with no ties to the PLSS Corner
    c. A right of way plat with ties to a PLSS Corner
    d. Both a and c

8. An obliterated corner is:
    a. A corner that is missing but can be reestablished by other means
    b. A corner that is found
    c. A corner along a lake
    d. A corner at a state line

9. Instruction to Surveyors Manuals can be found at:
    a. County Surveyors Offices
    b. Bureau of Land Management
    c. Highway Departments
    d. Register/Recorder's Offices

10. An obliterated corner can be remonumented based on information from the following documents:
    a. Right of way plats that only reference the Section Line
    b. GIS corner locations
    c. Landowner testimony
    d. Survey plats with no reference to the corner

11. Which of the following PLSS corners are double proportioned when they are considered lost?
    a. Section Corners on Township Lines
    b. Interior Section Corners
    c. Quarter Corners
    d. Section Corners on Range Lines

12. Which of the following PLSS corners are single proportioned when they are considered lost?
    a. Quarter Corners
    b. Meander Corners
    c. Section Corners on Township Lines
    d. Both a and c

13. Meander Corners were set:
    a. At the intersection of section lines and rivers
    b. At all Government Lot Corners
    c. Periodically along the line
    d. In the Lake

14. A method of calculating the bearing of a lost Meander Corner is:
    a. Using the bearing of the east line of the Section
    b. Calculating the weighted mean bearing
    c. Using the record bearing from the original notes
    d. Both b and c

15. Closing Corners are set:
    a. At the terminus of Section Lines
    b. At the intersection of a Section Line with a State Line
    c. At Rivers
    d. Both b and c

Public Land Survey System (PLSS)

Retracement and Remonumentation

Introduction

As the United States started expanding west, it became apparent that a system was needed to be put in place to provide an organized way for the Government to map and sell land. The Rectangular Survey System was first proposed and enacted through the Land Ordinance of 1785. As time has passed, many of the corners set by the original surveyors have been lost. This class will give the surveyor an insight to the history of the Public Land Survey System (PLSS) and how it was established. Along with the history, the class will discuss the layout of the PLSS system and the instructions used by the original surveyors. Information on original notes, and where to find them, will be provided as these notes will be critical during the retracement and remonumentation the a PLSS survey. Field methods that will be used to retrace and remonument PLSS corners will be discussed, along with how this field data will be used to remonument a corner. Some other items the class will cover are:

- Obliterated Corners
- Lost Corners
- Meander Corners and how and why they were set
- Omitted Lands and how they are handled
- Closing Corners and how and why they were set
- How corners should be marked when setting new monuments

When completed, the surveyor should have a good understanding of what tasks will need to be completed and where to find information to successfully complete a PLSS retracement and remonumentation project.

History of the PLSS System

In the late 1780's Ohio was the first State to be mapped using the PLSS system. It wasn't until 1812 that the General Land Office (GLO) was proposed. The GLO was then charged with implementing the PLSS system. As a result, the GLO issued Instructions to Surveyors to provide guidelines on the process of dividing the land. As time went on, the GLO (and now the Bureau of Land Management (BLM)) have amended updated these instructions as they felt necessary. As such, depending on which State you are surveying in, will determine which instructions were used in the original surveys. These instructions are important in doing the retracements, since they were the guidelines to how the original survey was done. It should be noted that all States are not part of the PLSS system. The States that are not in the PLSS system are Connecticut, Delaware, Georgia, Hawaii, Kentucky, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, North Carolina, Pennsylvania, Rhode Island, South Carolina, Tennessee, Texas, Vermont, Virginia, and West Virginia. These States were mapped using systems prior to the development of the PLSS. This class will not address retracement in these non-PLSS States. Figure 1 depicts the PLSS states and non-PLSS States.

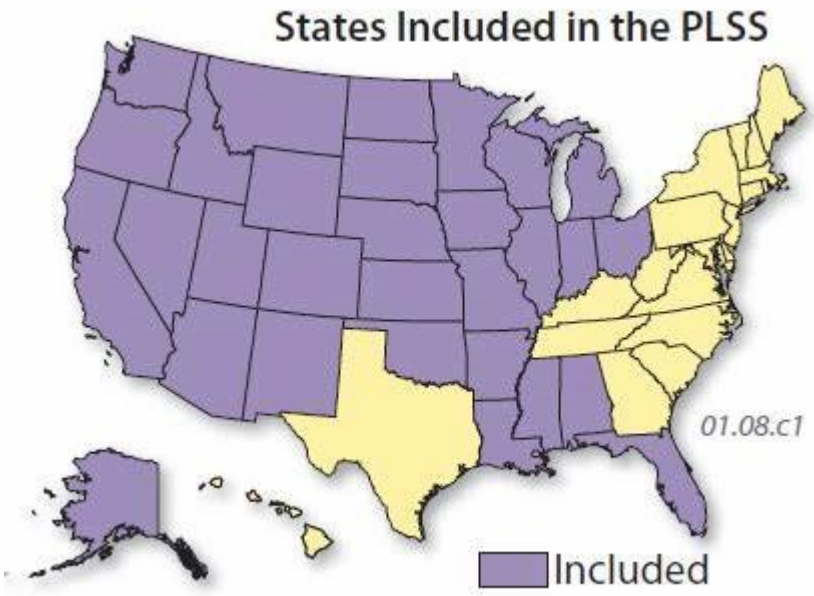


Figure 1 – PLSS States

Layout of the PLSS System and Instructions

In order to start a PLSS system remonumentation project, you need to understand how the original survey was laid out. Each Territory/State of the PLSS system was surveyed according to the Instructions to the Surveyor General of the Territory/State being surveyed. There have been many variations of the Instructions over the years. Depending on when the original survey took place will determine what Instructions were used for the surveys. Below is a list of some of the Instructions to the Surveyor General/Manual of Instructions.

- 1851Oregon Instructions to the Surveyor General
- 1855 Instructions to the Surveyor General
- 1864 Instructions to the Surveyor General
- 1871 Instructions to the Surveyor General
- 1881 Instructions to the Surveyor General
- 1890 Manual of Instructions
- 1894 Manual of Instructions
- 1902 1890 Manual of Instructions
- 1909 Restoration of Lost or Obliterated Corners
- 1910 Arizona Special Instructions
- 1930 Manual of Instructions
- 1973 Manual of Instructions
- 2009 Manual of Instructions

In addition to these instructions, some States had provided independent Instructions to Surveyors and there were additional Special Instructions to Surveyors and circulars that gave direction to surveyors regarding the surveying in the PLSS system. Knowing what instructions were used in the area that is being surveyed is important because it gives the surveyor insight to what the original surveyor's methods and means to conduct the survey. Today a surveyor will be able to find the various instructions at the BLM website. Also, State's surveyor's associations will carry the Instructions and manuals that are relevant to their State. Other places the Instructions/Manuals can often be located at State offices and

the Library of Congress. These instructions can be found at the following website Directory Listing of /surveys/Library/. The 2009 Manual of Instructions is the most recent guideline for remonumentation projects in the PLSS system. The 2009 Manual of Instructions has updated instructions to address subsequent surveys, found monumentation, and updated instructions that address the best way to use subsequent surveys and found monumentation as they relate to section breakdowns. This manual will give detailed guidance to the surveyor that will be used during a remonumentation project.

Before the Townships and Sections were surveyed, Baselines and Principal Meridians were established. These Baselines and Principal Meridians were used as a starting point for various regions of the country. The Baselines and Principal Meridians would then be used as the basis for a starting point to lay out the Township and Range lines that would be the first breakdown on the PLSS system. Figure 2 Show the Principal Meridians and Baselines that were established and the year they were established.

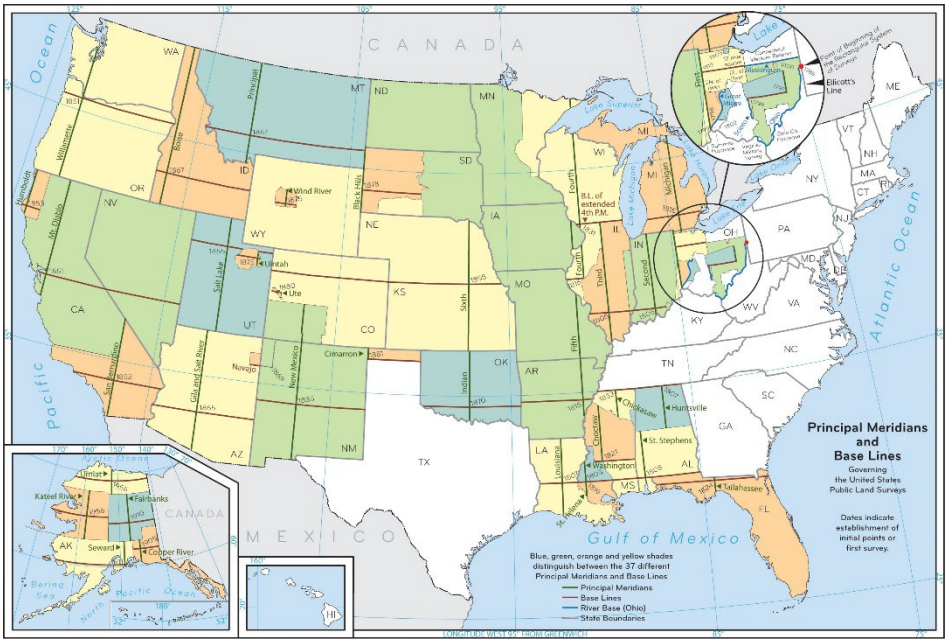


Figure 2 - Principal Meridians and Baselines

It should be noted, as shown in Figure 2, that the base point for the Principal Meridians and Baselines may not be in the State you are surveying in. After the Principal Meridians and Baselines, the PLSS Townships were then established in six-mile squares. The numbering of Townships and Ranges started at the basepoint of the intersection of the Baseline and Principal Meridian. This result in Township and Range numbers that are larger than if they were started at state lines.

Once the Principal Meridians and Baselines were established, surveyors were sent out to lay out the six-mile PLSS Townships by running the Township and Range lines according to the Instruction to Surveyors guidelines for the timeframe and area they were surveying. As previously mentioned, not all areas of the country were using same Instructions to Surveyors. These instructions changed as the system was developed and new situations were encountered. Depending on the base point, the Township lines were run on a random line from then corrected back to the known point, usually from west to east on a random line and from east to west on a

corrected line. The Range lines similarly were run on a random line from then correct back to the known point, usually, from north to south on a random line and from south to north on corrected line. Although this was the typical method, there are occasions that reverse the direction of running the random lines and the corrected lines. To determine the actual running of the lines, the original notes would need to be reviewed as they give the direction of the random line and the direction of the corrected line. To account for the curvature of the earth, correction lines were established. Depending on the State/Territory the survey was taking place in determined how the correction lines were set. These correction lines meant that the corner for the Township to the south will not be in the same location as the corresponding corner for the Township to the North. As shown in Figure 3, correction lines were established every so often to correct for the curvature of the earth. These correction lines typically occurred every 4 Townships. This interval can be different depending on the instructions that were in place. For instance, portions of Illinois and Iowa had correction lines at every Township line. How often these correction lines were established depends on the Instructions that were used by the original surveyor. While the surveyor was running the Township and Range lines, they would establish corner every half mile (the Section and Quarter Corners) on the Township and Range lines.

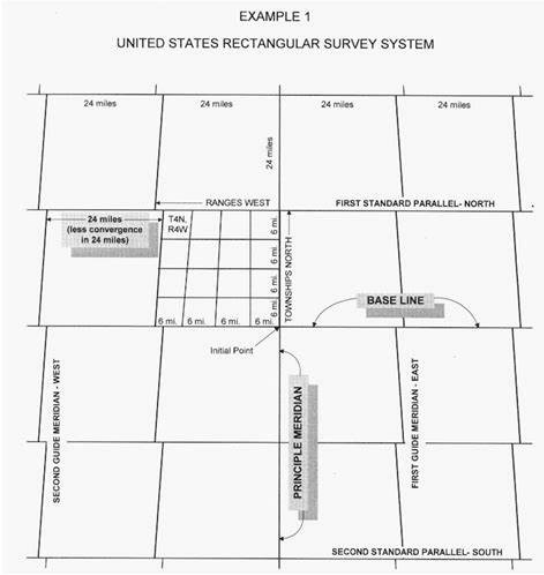


Figure 3 – Township Layout with Correction Lines.

After the PLSS Townships were established, another Deputy surveyor would then begin running the interior Section Lines. These lines were run in one-mile sections (both in the east-west and north south directions). The Section Lines were usually run on a random line, usually in the east direction. These lines were then corrected back to the known point, usually in the west direction. The north-south lines were run in the north direction. While running the lines, interior Section Corners were established at one-mile intervals and at half mile intervals Quarter Corners were set. At the Section and Quarter Corners, the original surveyor would also take two refence points (trees in areas where tree occurred or other types of reference (such as stones) when trees were not available). The references were noted in the original notes and can be used to remonument the corner if the reference is found. Often the Quarter Corners were never set for the Sections to the south on the correction line.

In areas where the lines intersected lakes, and rivers, a Meander Corner was set. At State Lines, Indian Boundaries, or other boundaries that would terminate the line, Closing Corners were set. Meander Corners were set to reference a Section or Quarter Corner could not be set along rivers and lakes. Often these lakes and rivers were meandered to assist in mapping these features. While meandering the lakes and rivers, additional Meander Corners were set. These Meander and Closing Corners would result in the creation of non-typical Section subdivisions, which are Government Lots. When a remonumentation project, often times the rivers have moved since the original survey. Lakes can also often shrink or grow since the original survey. How these situations will be handled will be discuss in later sections of this class.

The Townships were broken down into sections and the sections were number from 1 to 36. Section number 1 was always in the northeast corner of the Township, with Section 36 in the southeast corner of the Township. The numbering goes east to west, down a tier, west to east, down, then east to west again until section 36 is in the southeast corner. This is numbering system is shown in figure 4.

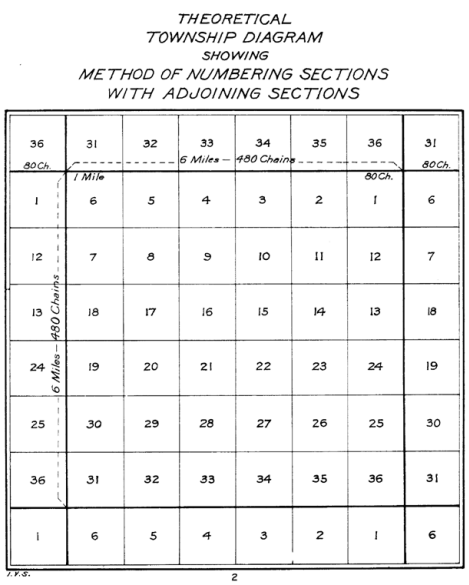
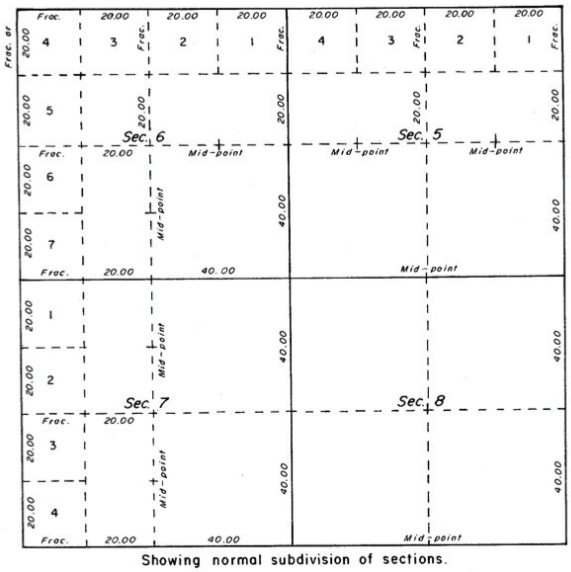


Figure 4 – Section Numbering System

Since the Townships were broken down from south to north and east to west, all the error was put in the north and west side of the PLSS Township. The error from the north-south lines were thrown into the north quarter mile tier of Sections 1 through 6. The error from the east-west lines were all thrown into the west quarter mile tier of Sections 6, 7, 18, 19, 30, and 31. A Section was intended to be established as 640 acres. The Sections was intended to be subdivided into quarters and quarter-quarters. When subdivisions of any Section that does not fit the typical subdivision the quarter -quarter is called a Government Lot on the original plat. Because the error was thrown in the north and west side of the PLSS Township, Government Lots were created on the north tier of Sections 1 through 6 and the west tier of Sections 6, 7, 18, 19, 30, and 31. The original notes and original plat will have the dimension, in chains, for the quarter mile Government Lots of Sections 1 through 6 and Sections 6, 7, 18, 19, 30, and 31. This method results in the greatest error being in the northwest of Section 6. The diagram in Figure 5 depicts the fractional

locations of the Section Government Lots that are created when subdividing the sections.



Showing normal subdivision of sections.

Figure 5 – Subdivision of Sections

The above describes the typical layout of the PLSS system. This information will be used when retracing the original surveyor in order to determine the location of the corner being remonumented.

Original Notes and Subsequent Survey Evidence

Since remonumenting PLSS corners is a retracement of the original surveyor, the surveyor doing the remonumenting will need to know how and what the original survey did. The previous section generally went into the how they surveyed the Townships. As mentioned, the instructions they were given depended on when and where the surveys took place. Once the surveyor knows how the original survey was instructed, the next question to answer is what the original surveyor did. This can be found in the original notes and the original Township Plat. There are a few ways to obtain the original notes. The BLM is the holder of all original notes and original plats. These notes and plats can be obtained from the BLM website at Home - BLM GLO Records. In addition to the BLM, State governments and County Surveyors may also be a source for these original notes and plats.

What the original notes will tell you is more than just the corners that were set. The other information that was set included reference marks, such as bearing trees or reference ties to the corner. Also, as part of the original surveyors' duties was to map out terrain, lakes, rivers and vegetation type. To do this the original surveyors made call in their notes when they came across various natural features such as hills, ravines, swamps, lakes, and rivers, along with other unique features. In addition to these features, marks were made periodically to help define the line being surveyed. These feature marks could be line trees, or other natural features that fall on the line being run. These calls were noted as to how far they were from the corner being surveyed. This is some additional evidence that can be used to help remonument the corner. In addition, at the corner the original surveyor set

witnesses to the corner. Figure 6 is an example of original notes from Wisconsin.

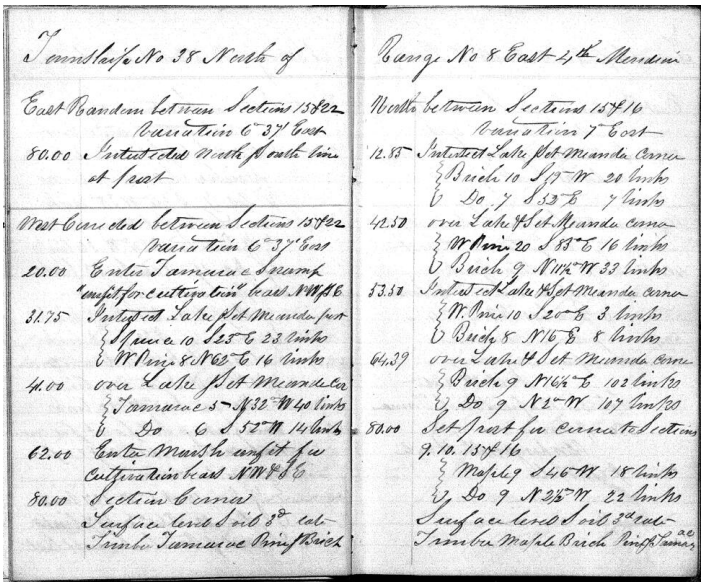


Figure 6 – Original Notes

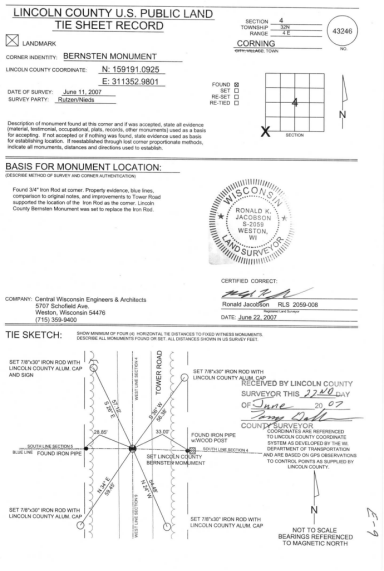
The original plat will also show some of this information in a map format. The map will also give distances between the corners and distances for the Government Lots. Figure 7 is an example of an original plat from Wisconsin.

Figure 7 – Original Plat

In addition to the original surveys, the GLO/BLM has periodically conducted resurveys of certain areas. Most resurveys occurred in Tribal lands and areas that it was determined a fraudulent survey occurred. The resurveys were done to either correct or clarify original surveys. In addition to the Section Corners and quarter Corners, there were also could have been Sixteenth Corners set during these resurveys. These Sixteenth Corners would be considered original corners and would be held when found. These resurveys have the same weight as the original survey. The notes and plats can be found in the same areas as the original surveys.

Subsequent Surveys

In addition to the original notes and resurveys, the surveyor should also look at subsequent surveys that reference the corner. These surveys could include plat of surveys, subdivision plats, right of way surveys and other documents that could possibly help reference the corner's location. As part of gathering information, the surveyor should search Register/Recorders offices for recorded documents that often reference PLSS corners. Other places that information on subsequent surveys can be found is county surveyors offices, State and Federal agencies, highway departments, railroads, timber companies and private surveyors. County surveyors (if the County still has that office) are holders of survey records that include plats of surveys, PLSS documents, such Corner Certificates, Section Summaries and other surveys that could help perpetuate the corner's location. Figure 8 is an example of a PLSS Tie Sheet Record in Wisconsin. Figure 9 is an example of a corner certificate in Michigan. As you can see the format may be different in each State, but the information regarding the corner, how the corner was established and references to the corner will be on the form. Additional information at the County offices could include a Section Summary Map, such as the one shown in Figure 10.



LINCOLN COUNTY U.S. PUBLIC LAND
TIE SHEET RECORD

LANDMARK

CORNER INDENTITY: BERNSTEN MONUMENT

LINCOLN COUNTY COORDINATE: N: 159191.0925
E: 311352.9801

DATE OF SURVEY: June 11, 2007
SURVEY PARTY: Rutzen/Neds

Description of monument found at this corner and if was accepted, state all evidence (material, testimonial, occupational, plats, records, other monuments) used as a basis for accepting. If not accepted or if nothing was found, state evidence used as basis for reestablishing corner. If reestablished through lost corner proportionate methods, indicate all monuments, distances and directions used to establish.

BASIS FOR MONUMENT LOCATION:

Found 3/4" Iron Rod at corner. Property evidence, blue lines, comparison to original notes, and improvements to Tower Road supported the location of the Iron Rod as the corner. Lincoln County Bernsten Monument was set to replace the Iron Rod.

WISCONSIN RONALD K. JACOBSON S-2059 WESTON, WI LAND SURVEYOR

CERTIFIED CORRECT:

Ronald Jacobson RLS 2059-008

DATE: June 22, 2007

COMPANY: Central Wisconsin Engineers & Architects
5707 Schofield Ave.
Weston, Wisconsin 54476
(715) 359-9400

TIE SKETCH:

SET 7/8"x30" IRON ROD WITH LINCOLN COUNTY ALUM. CAP AND SIGN

TOWER ROAD

RECEIVED BY LINCOLN COUNTY SURVEYOR THIS 22ND DAY OF June 20 07

COUNTY SURVEYOR

FOUND IRON PIPE

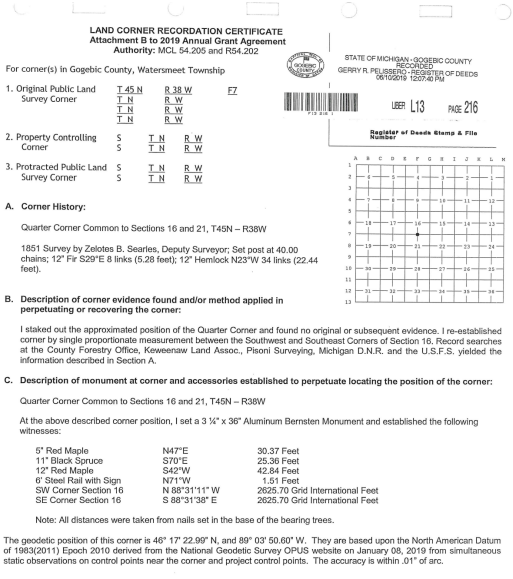
FOUND IRON PIPE w/WOOD POST

967' LINCOLN COUNTY BERNSTEN MONUMENT

SET 7/8"x30" IRON ROD WITH LINCOLN COUNTY ALUM. CAP

NOT TO SCALE
BEARINGS REFERENCED TO MAGNETIC NORTH

Figure 8 – Wisconsin Corner Record Form



LAND CORNER RECORDATION CERTIFICATE
Attachment B to 2019 Annual Grant Agreement
Authority: MCL 54.205 and R54.202

STATE OF MICHIGAN - GOGEBIC COUNTY RECORDING
GERRY R. PEUSSENS - REGISTER OF DEEDS
06/10/2019 12:07:40 PM

LIBER L13 PAGE 216

Register of Deeds Stamp & File Number

For corner(s) in Gogebic County, Watersmeet Township

1. Original Public Land Survey Corner — T 45 N R 38 W F7
2. Property Controlling Corner — S T N R W
3. Protracted Public Land Survey Corner — S T N R W

A. Corner History:

Quarter Corner Common to Sections 16 and 21, T45N – R38W

1851 Survey by Zelotes B. Searles, Deputy Surveyor; Set post at 40.00 chains; 12" Fir S29°E 8 links (5.28 feet); 12" Hemlock N23°W 34 links (22.44 feet).

B. Description of corner evidence found and/or method applied in perpetuating or recovering the corner:

I staked out the approximated position of the Quarter Corner and found no original or subsequent evidence. I re-established corner by single proportionate measurement between the Southwest and Southeast Corners of Section 16. Record searches at the County Forestry Office, Keweenaw Land Assoc., Pisoni Surveying, Michigan D.N.R. and the U.S.F.S. yielded the information described in Section A.

C. Description of monument at corner and accessories established to perpetuate locating the position of the corner:

Quarter Corner Common to Sections 16 and 21, T45N – R38W

At the above described corner position, I set a 3 ¼" x 36" Aluminum Bernsten Monument and established the following witnesses:

5" Red Maple	N47°E	30.37 Feet
11" Black Spruce	S70°E	25.36 Feet
12" Red Maple	S42°W	42.84 Feet
6' Steel Rail with Sign	N71°W	1.51 Feet
SW Corner Section 16	N 88°31'11" W	2625.70 Grid International Feet
SE Corner Section 16	S 88°31'38" E	2625.70 Grid International Feet

Note: All distances were taken from nails set in the base of the bearing trees.

The geodetic position of this corner is 46° 17' 22.99" N, and 89° 03' 50.60" W. They are based upon the North American Datum of 1983(2011) Epoch 2010 derived from the National Geodetic Survey OPUS website on January 08, 2019 from simultaneous static observations on control points near the corner and project control points. The accuracy is within .01" of arc.

Figure 9 – Michigan Corner Corner Certificate

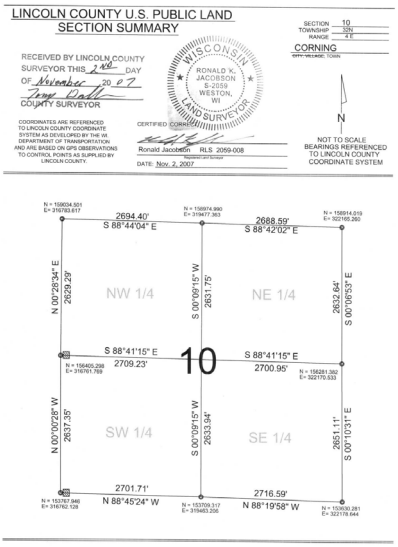


Figure 10 – Section Summary Map

Railroads and highway departments are another area where documents can be found that reference the perpetuated corner position. Often times railroads and highway departments have located and refenced PLSS corners in order to help monument their right of ways. Various State and Federal agencies also carry records that include references to PLSS corners. For instance, the Department of Natural Resources of a State may have records relating to PLSS corner locations. There may be other State agencies that also carry land records that reference PLSS corners. As far as Federal agencies, other than the BLM, the Forest Service, Department of Defense, Natural Resources Conservation Service, and other agencies that deal lands. Over the years, timber companies also have located PLSS corners to help manage their timber lands. These timber companies often reference original corners they found when marking lines for timber sales. When the timber companies found evidence of PLSS corners, often times they would add additional reference marks to help perpetuate the corner. All this additional information should be used to evaluate and reestablish a PLSS corner position.

Field Surveys for Remonumenting PLSS Corners

As the surveyor begins a remonumentation project, the first thing they need to do is review the original notes and plats along with any subsequent survey documents they obtained. Reviewing this original notes and plat will give the surveyor an understanding of what was set for the corner and where to look for the evidence of the original PLSS corner. The subsequent survey information will tell the surveyor what to look for in addition to the original corner monument and reference marks. The first step in starting a PLSS remonumentation project is to locate the known PLSS corners (controlling corners) that will be used to help determine search areas for the unknown corners. These search areas will be used to give the field crews a general area to look for evidence of the corner. To start determining the search areas, the unknown PLSS corners would be single and double proportioned, depending on the PLSS corner being searched. The instructions indicate corners along Township and Range Lines are to be single proportioned, Township Corners are to be double proportioned, interior Section Corners are to double proportioned and Quarter Corners are to be single proportioned. Following this process can help

narrow down search areas for locating a corner. How many controlling corners will be needed will be determine on whether the corner will need to be double or single proportioned. As corner evidence is found and surveyed, the above process will need to be redone in order to establish new search areas.

Original Evidence

Once in the field the surveyor should be looking for any evidence of the original corner. In rural areas, it is still possible to find original evidence of the corner. In some areas of the country, this could be a wood post, a stone mound or a stone with markings, as some examples. As stated, the original notes will tell the surveyor what was set. Other items to look for would be bearing trees, reference points, line trees/objects, or natural features called for in the original notes. Figure 11 is an example of an original bearing tree that was found in Michigan. This bearing tree had the markings from the original surveyor. It is more frequent to find an original bearing tree will only have scars from the blaze or measuring notches, with no scribing visible. These reference items will have a distance and a bearing called for to the corner from the reference item. This information can be used to locate the corner's position. To help assist the field crew in locating original evidence of the corner, they should be aware of how the corner mark's material could affect the area it was set in. For instance, if a wood post was set, there could be a discoloration of the soil around the post or there could be some decayed wood that could help identify the post. In some areas of the country, stone mounds were set. To help define the stone mound, the original surveyor would often bury something in the mound so it could be identified from other natural mounds of stones.

Figure 11 – Portion of an Original Bearing Tree

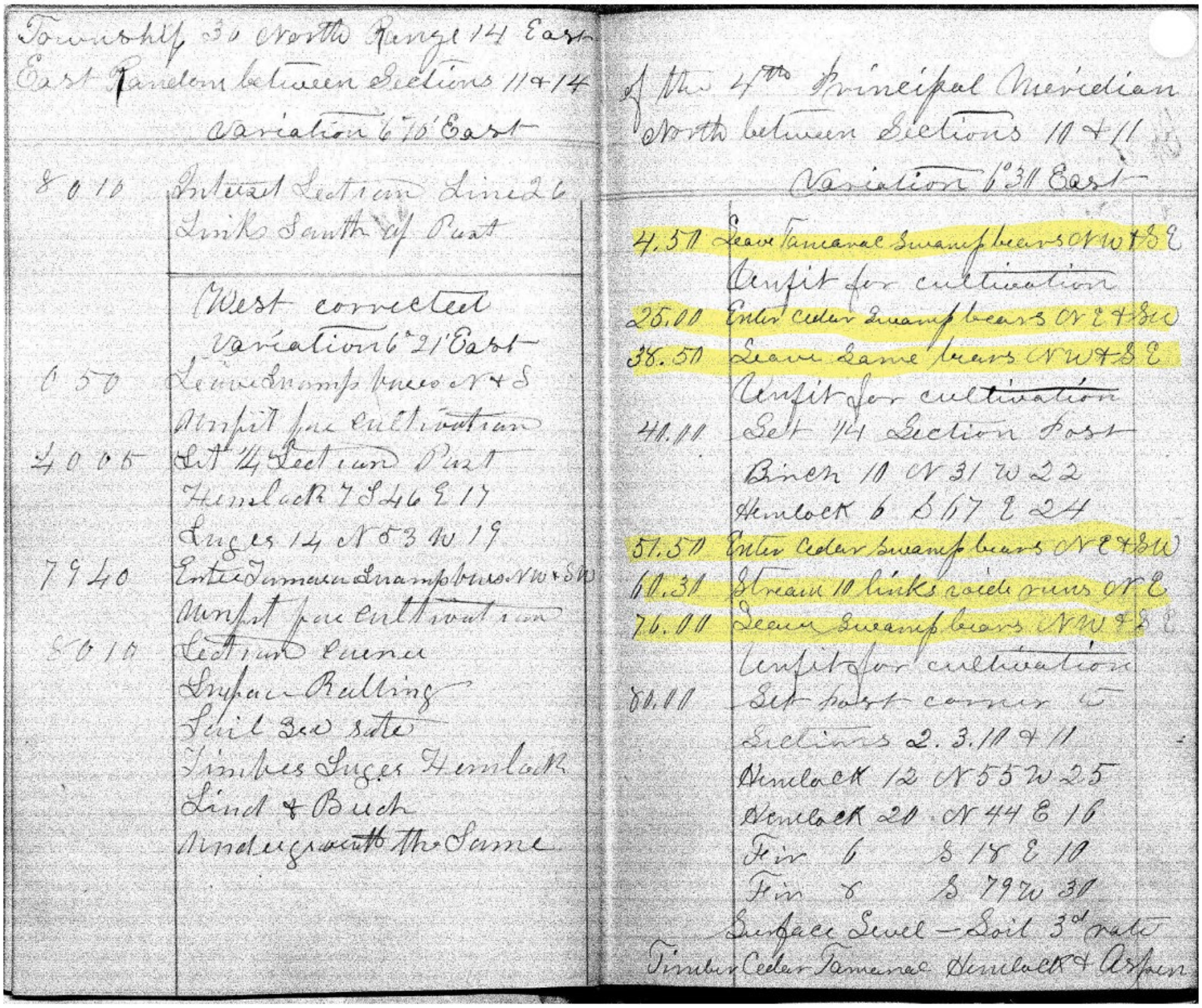
Many times, original evidence is not able to be located in rural areas. This does not mean the corners location is cannot be reestablished without proportioning. There could still be evidence of subsequent surveys to look for. Thes subsequent surveys could have ties to the PLSS corner. As a result, the surveyor may have to search beyond the corner's location. This may mean locating property or lot corners from plats and subdivisions that refence the PLSS corner. In cases of road or railroad right of way, the surveyor may have to locate the centerline and other monuments that help establish the road or railroad. These can then be used to calculate in the PLSS corner location. In addition, there may be additional reference marks that were reestablished and documented that could help determine the PLSS corner's location. All this subsequent survey evidence can be used to perpetuate the corner.

During the field surveys, the surveyor should also locate other evidence of the PLSS corner's location. This may be fence lines, roadways, abandoned railroad grades, stonewalls or any other evidence that may help them determine the corner's location. These types of features often indicate property lines which could be used, when taken in consideration with other evidence, to help determine a PLSS corner's location. Another step the surveyor may need to take is digging up rural roadways. Many times, corners were set below the roadway to save them from being destroyed. There are often instances that a stone monument was located three to four feet below the roadway surface. There also have been cases where the roadway was built up over six feet a above fence line and the corner that was left in place.

In urban areas, the chance of finding original evidence is extremely unlikely. This is due to the development that has occurred over the years. This means the surveyor will be looking for subsequent surveys as was mentioned above. These subsequent surveys would be used to perpetuate the corner. This evidence could include locating property corners, roadways, subdivision corners, right of way and centerline markers on roads or railroads, or any other evidence that might help perpetuate the corner's location.

Natural Features Evidence

As mentioned, the original surveyors were instructed to locate natural features they came across as part of their running the lines during the original surveys. These features included locations of swamps, lakes, rivers, streams, ravines and distinct hills. As the original surveyor ran the lines, they made notes as to the distance from these features to the corner they were surveying to. Locating these features can help assist the surveyor in supporting the corner's location. It should be noted that not all original surveyors were diligent in making theses natural feature calls. As a result, these calls can sometimes be inaccurate. These calls should not be used to set a PLSS corner's location, but only be used to support the surveyor's opinion of the location. In other words, the natural feature calls would only be a supplement while evaluating the corner's location. Figure 12 has the natural feature calls highlighted. For instance, at 4.5 chains the surveyor left a tamarack swamp, at 25.00 chains they entered a cedar swamp, at 38.5 chains they left the cedar swamp, at 51.5 chains they entered another cedar swamp, at 60.3 chains they crossed a stream 10 links wide, and at 76 chains they left the swamp. These calls should be used to support the corner's location.



Township 30 North Range 14 East of the 4th Principal Meridian

East Random between Sections 11 & 14

Variation 6°10' East

80.10 Intersect Section Line 26 Links South of Post

West corrected

Variation 6°21' East

0.50 Leave Swamp bears N & S

Unfit for cultivation

40.05 Set 1/4 Section Post

Hemlock 7 S 46 E 17

Sugar 14 N 53 W 19

79.40 Enter Tamarack Swamp bears NW & SW

Unfit for cultivation

80.10 Section Corner

Surface Rolling

Soil 3rd rate

Timber Sugar Hemlock

Lind & Birch

Undergrowth the Same

North between Sections 10 & 11

Variation 6°31' East

4.50 Leave Tamarack Swamp bears NW & SE

Unfit for cultivation

25.00 Enter Cedar Swamp bears NE & SW

38.50 Leave Same bears NW & SE

Unfit for cultivation

40.00 Set 1/4 Section Post

Birch 10 N 31 W 22

Hemlock 6 S 67 E 24

51.50 Enter Cedar Swamp bears NE & SW

60.30 Stream 10 links wide runs NE

76.00 Leave Swamp bears NW & SE

Unfit for cultivation

80.00 Set post corner to Sections 2, 3, 10 & 11

Hemlock 12 N 55 W 25

Hemlock 20 N 44 E 16

Fir 6 S 18 E 10

Fir 8 S 79 W 30

Surface Level – Soil 3rd rate

Timber Cedar Tamarack Hemlock & Aspen

Figure 12 – Highlighted Natural Feature Calls

Supplemental Original Evidence

Besides natural feature calls, the original surveyors often made notes to items that help locate the corner. These calls could be trees on line, reference marks that may have been set, or other items that would help locate the line. In wooded areas, trees that were on line were blazed to identify them as line trees. The line trees or marks were measured to the corner the original surveyor started from. In the original notes, these items will be noted as to the size and type of tree (if a tree was used), along with the distance in chains and links to the corner. If they can be found and located, these items are another way to support the corner's position. These line trees or reference marks should be evaluated closely since the further they are from the corner, the more error the references could have. As with the natural feature calls, the surveyor should use these calls as supporting evidence of the corner's location.

Subsequent Surveys Evidence

It was mentioned that besides the original surveys, often other surveys were conducted that refenced PLSS corners. When original evidence cannot be located the field surveys should also locate the evidence from these subsequent surveys.

As mentioned, there are various areas you can locate these subsequent surveys. In the field, the retracement surveyor should be looking for any evidence that will help reestablish the corner's location. This could be locating property corners or subdivision corners that are tied to the PLSS corners. Highways and railroads are often referenced to PLSS corners. The field crews should be locating any item that can reestablish the right of way or centerline of highways or railroads that is referenced to the corner. Timber companies also added additional references to the corner while marking their timberlands. The references to the corner could include new bearing trees or references, blaze lines along the Section/Quarter Lines or other notes tied to the corner. These references should be located as evidence of the corner. Once all field evidence is located, then the next step of the evaluation of the evidence can begin.

In addition to locating the field evidence, the surveyor should also talk to the land owners. Often times the land owner will have knowledge that will help determine the location of the PLSS corner. This communication can be done be directly speaking with the landowner. Another way that is effective is sending a letter or other correspondence the explains the survey and requesting any information that the landowner has be provided. In the process of requesting this information, explaining that the information would help avoid conflict in the future will often help entice the landowner to provide information that will be relevant to the survey.

Evaluation of Field Surveys

Once the initial field surveys are complete, the process of evaluating the field data to the original notes and other subsequent surveys begins. The evaluation starts with determining if the original monument that was set for the corner was found. If the original monument was found, then a new monument (that will help perpetuate the corner) can be placed at the location of the found original monument. Also, if original reference monuments or bearing trees were located, the corner can be set based on the bearing and distance from original reference monuments or bearing trees to the corner. By using original evidence, the survey is using the best evidence corner's original location. However, since most of the surveys were done in the 1800's, finding original evidence is getting harder to find.

Obliterated Corners

An obliterated corner is a corner that original evidence does not exist and there is not any monument at the corner's location. Even though there a monument doesn't exist, and there is no original evidence, the obliterated corner can be remonumented based on subsequent surveys or other evidence, including testimony from landowners. For obliterated corners the surveyor will need to expand the search well beyond the corner's estimated location. These subsequent surveys, or landowner testimony, can be used to perpetuate the corner as the best available evidence of the corner's location. As mentioned, If the corner is determined to be obliterated, other means will need to be used to determine the corner's position.

Subsequent Surveys

There are often times that surveys were done and had a reference to the corner being remonumented. These surveys may not give any indication of how the PLSS corner was established. However, these surveys can be used to reestablish a

reliable location of the obliterated corner. For instance, a subdivision plat that shows a PLSS corner on the plat. In this case, there may not be any mention of how the corner was established, but a surveyor can, with extreme confidence, locate lot corners of the subdivision plat. Then the lot corner locations can be used to establish the PLSS corner location. This method is often used in urban areas where there has been development since the original surveys. Figure 13 shows a subdivision plat with a tie to the North Quarter Corner of the Section. If nothing was found at the North Quarter Corner, the corner would be considered obliterated since the plat can be used to replace the corner. Just like the subdivision plat, a plat of survey can be used to establish the location of an obliterated corner, if the survey has a tie to the corner being remonumented.

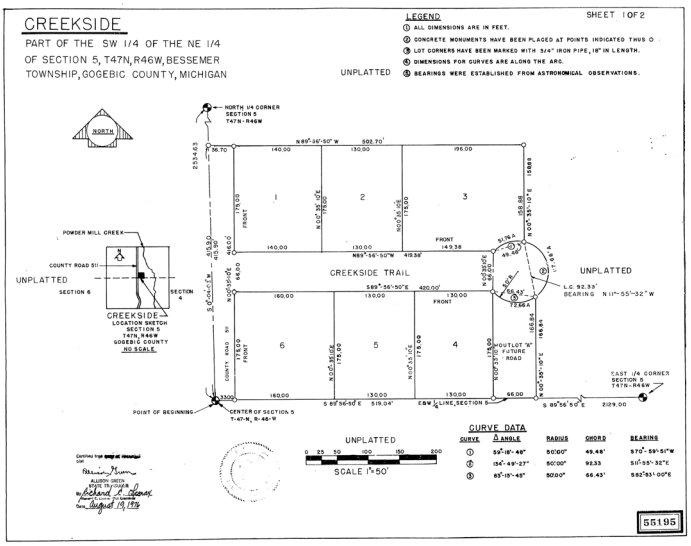


Figure 13 – Subdivision Plat with a tie to the North Quarter Corner of the Section

In addition to subdivision and survey plats, roadway and railroad documents can be used to remonument an obliterated corner. There can be various types of roadway documents that can be used. Right of way plats often have ties to PLSS corners. These ties may be to the centerline of the roadway or to right of way monuments. The monumentation from the right of way can be used to calculate the PLSS corner being remonumented. In addition, Counties and Municipalities often have roadway orders or ordinances that established the roadway. These orders or ordinances can sometimes note the corner location. Most of the time they just note “the centerline of the roadway was to run down the section line”. In this situation, the surveyor would know the corner was intended to be on the centerline of the roadway, but would not know where along the centerline. The surveyor would then have to have additional information to be able to establish the corner’s location, such as a property line running along the section or quarter line.

Railroads are another good source for PLSS corner locations. The railroads, in the process of documenting their lands, kept detailed notes on how their lands were tied to PLSS corners. The railroad maps often have bearings and distances the tie the PLSS corner to a location on their track. They may also have what type of monument was set if they remonumented the corner. The one difficulty with railroad maps is finding the maps. Many time railroads were abandoned or sold. Trying to

find who has the records can be challenging. However, if these records can be found, they can be very helpful for remonumenting PLSS corners.

Landowner Testimony

Another way the surveyor can replace an obliterated corner is by getting information from landowners. This can be done in many ways. Often the survey would send letters to a landowner explaining the survey they will be doing. In this letter, there can be a request for any information the landowner has regarding the PLSS corners being remonumented. Another way is either a phone call or meeting with the landowner. If a meeting is held, often times the landowner will take the surveyor to the corner's location. They could also give the surveyor verbal testimony regarding how the landowner knows the that is the location of the PLSS corner. Another thing the landowner could tell the surveyor is if a fence or other improvement was established along a Section Line or Quarter Line. In this case the fence or improvement cannot be used to reestablish the corner location, unless the landowner states the corner was at a fence corner or something of that nature. One instance that the corner can be reestablished using the fence line would be if there additional evidence that helps identify the corner's location. For instance, the landowner tells the surveyor they are aware that a fence was built on the Section Line and the surveyor has documents indicating a roadway centerline was built along the perpendicular Section Line. The surveyor can then remonument the corner's position and the extension of the fence line where it intersects the centerline of the roadway. If the landowner does give the surveyor verbal testimony, the surveyor should make notes of the testimony, have the landowner sign the note and witness the landowner's signature. This way the landowner's testimony is documented if any conflict would come up in the future.

Lost Corners

If a PLSS corner is not found in the field and cannot be reestablished by any other means, the corner is considered "lost". In urban areas a lost corner does not occur very often since there usually are previous surveys or other means to reestablish the corner. In the case of lost corners, the surveyor will need to recalculate the position using mathematical means. Since the mathematical means is the least reliable method to determine the corner is in the position that was established by the original surveyor, this should be the last resort to determine a PLSS corner's position. As the time since the original surveys keeps growing, the possibility of lost corners in rural areas is increasing.

Calculations to Remonument Obliterated and Lost Corners

Obliterated Corners

As mentioned, obliterated corners can be remonumented based on supplemental surveys or information. In order to establish the corner, the information located in the field will need to be evaluated against the documents that referenced those supplemental monuments. If the supplemental monuments support the document being evaluated, then the corner's location can be calculated using the bearings and the distances on the document. The corner can also be calculated using bearing - bearing intersects or distance – distance intersects from various documents and testimony. Figure 14 is an example how supplemental surveys can give the surveyor

information regarding a obliterated PLSS corner's location.

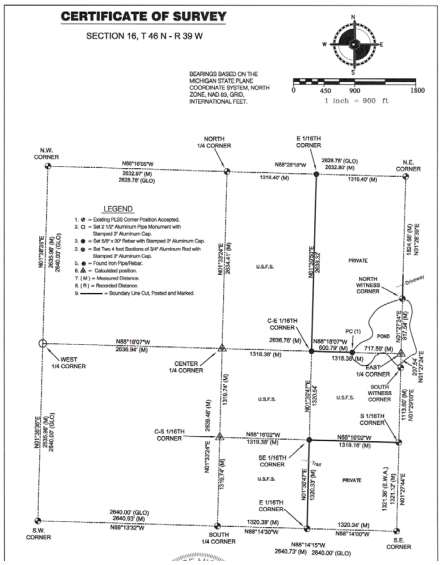


Figure 14 – Survey Showing PLSS Corner Locations

Lost Corners

When all efforts have been exhausted to restore the corner from subsequent surveys or landowner testimony, and there is no other information regarding the original corner's location, it is considered "lost". In order to remonument the corner, the surveyor will then calculate a position for the lost corner. Lost corners will be calculated based on proportioning using measured distances between known corners and comparing the measurements to the original notes. Per the Manual of Surveying Instructions, lost corners will be proportioned as follows.

Township Corners and Interior Section Corners will need to be double proportioned to determine the corner's location. To double proportion a corner's position, a known (controlling) corners will need to be located north, south, east, and west of the lost corner's position. The original survey distances between the controlling corners will be compared to the measured distance of those corners to determine a ratio between measured and record distances. This ratio will then be used to determine a measured distance to the unknown corner from the known corner. It should be noted that the double proportioned distance will not put the corner' location on a line between controlling corners. This is because the distance from each controlling corner is held and the intersection of the four distances is the double proportioned location. Figure 15 is page 167 from the 2009 Manual of Surveying Instructions. This figure gives a good visual of double proportioning a PLSS corner. Double proportioning is further described in the 2009 Manual of Surveying Instructions in Chapter 7-8 to 7-15.

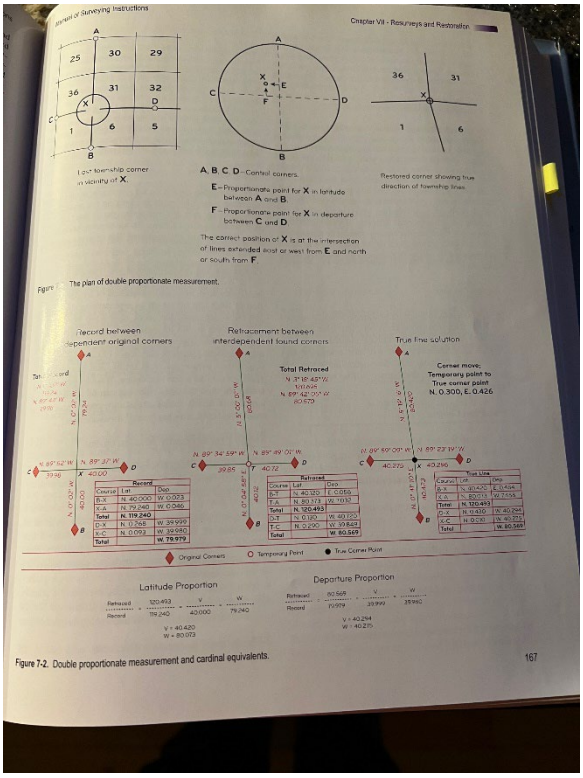


Figure 15 – Double Proportioning on Page 167 of the 2009 Manual of Surveying Instructions

Section Corners along the Township and Range Lines and all Quarter corners that are considered lost will need to be single proportioned to determine the corner's location. If the lost corner being single proportioned is on a north-south line, controlling corners to the north and south of the lost corner will need to be located. As with double proportioning, the original survey distances between the known corners will be compared to the measured distance of those corners. This will give the ratio between original (record) and measured between the controlling corners. Again, this ratio will be used to determine a measured distance to the unknown corner from the known corner.

If the lost corner being single proportioned is on an east-west line, controlling corners to the east and west of the lost corner will need to be located. As with double proportioning, the original survey distances between the known corners will be compared to the measured distance of those corners. This will give the ratio between original (record) and measured between the controlling corners. Again, this ratio will be used to determine a measured distance to the unknown corner from the known corner. When single proportioning in the east-west direction, the proportioned location is along the latitudinal curve since the original surveyors were instructed to set these corners on the latitudinal curve. This means the location is not on a straight line between the two controlling corners, but on a curved line. Single proportioning is further described in the 2009 Manual of Surveying Instructions in Chapter 7-16 to 7-20.

Meander Corners and Closing Corners

Rivers
Meander Corners were set by the original surveyors when they came across lakes and rivers. When the original surveyor came across rivers while they were running the section lines, they meandered the river if it was considered navigable. The original surveyors set corners (Meander Corners) along the section lines at the intersection with the top of bank of the river. During the original surveys, a navigable river was considered three chains wide. Non-navigable rivers also were meandered if the river was considered important or could be considered a boundary. While they meandered the river, monuments were set periodically along the river. These meander corners were used to map out Government Lots that were created by the river. Figure 16 is an example of a river that was meandered.

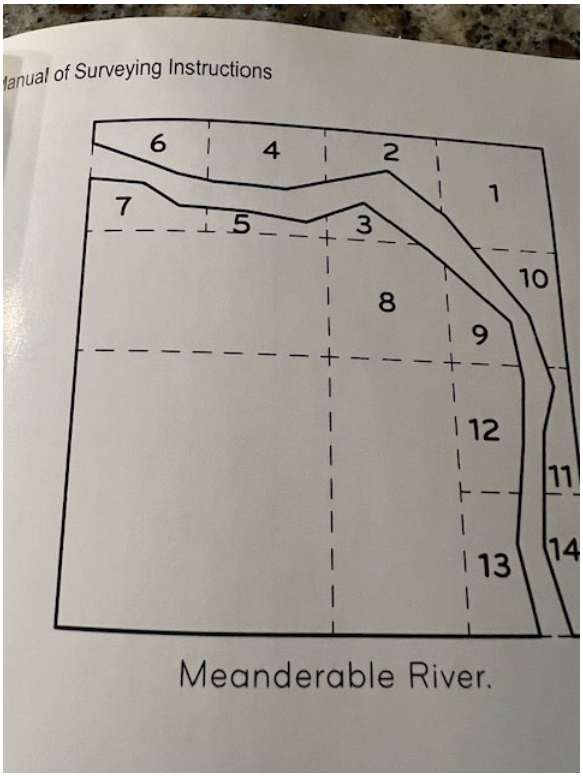


Figure 16 – Example of a meandered river from the 2009 Manual of Surveying Instructions

As can be seen by the example in Figure 16, as the original surveyor meandered the river, they created Government Lots. At the intersect of the Government Lot lines with the meander lines, Meander Corners were set to monument the meander line.

Lakes
When the original surveyor came across lakes, they also meandered the lake in order to map it. The lakes that were meandered were lakes of 50-acres or more. The original surveyors set corners along the section lines at the intersection with the ordinary high-water mark of the lake. In addition, the lake was meandered to help map the lake. While meandering the lake, Government Lots were created by the lake. These meander corners were used to map out Government Lots that were created by the lake. Figure 17 is an example of a lake that was meandered.

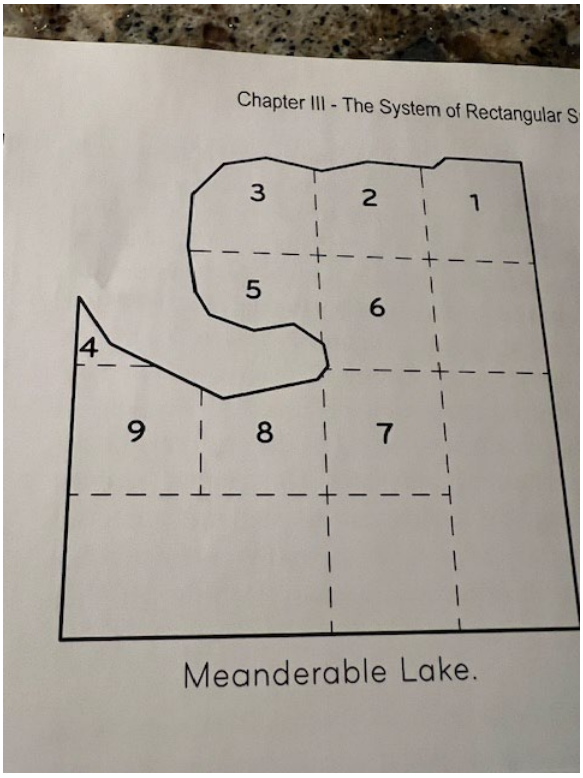


Figure 17 – Example of a meandered lake from the 2009 Manual of Surveying Instructions

As can be seen by the example in Figure 17, as the original surveyor meandered the lake, they created Government Lots. At the intersect of the Government Lot lines with the meander lines, Meander Corners were set to monument the meander line.

Calculating Lost Meander Corners

As the surveyor doing a remonumentation project, these Meander Corners will need to be searched for. The process for determining search areas will be the same as with Section and Quarter Corners. The one difference is the record bearing and distance will be used to set the search area. Another difference is that only one reference monument was set for the Meander Corner. Once the search area is made, the surveyor should search for any evidence of the original corner or the reference. If the original corner cannot be found, or there is not any evidence of subsequent surveys, the Meander Corner will need to be calculated. The bearing of the line to the Meander Corner can be calculated by three possible methods. The first way to calculate the bearing is to use the record bearing from the original notes.

The second way to establish the bearing to the lost Meander Corner is by the mean bearing method. This method evaluates the measured bearing from the section line north of the line to the meander corner compared to the original bearing in the notes. The measured bearing from the section line south of the line to the meander corner is also evaluated and compared to the original bearing in the notes. The average of these two bearings will be used for the line to the meander corner.

An example of calculating the Meander Corner by mean bearing method is if the

north line of Section 16 recorded as east-west. This line is measured at North 89 degrees 30 minutes West. The south line of Section 16 was a line to the meander corner recorded as east-west. The south line of Section 21 was also recorded as east-west. This line was measured at North 88 degrees 30 minutes West. The line to the meander corner, being the south line of Section 16, would then have a bearing of North 89 degrees West, based on the average bearing method. The Meander Corner would then be placed on the mean bearing line and at the record distance from the controlling PLSS corner.

The third way to establish the bearing to the lost Meander Corner is by the weighted mean bearing method. This method uses the measured bearing from the section line north of the line to the meander corner, along with the distance to the corner. The bearing and distance from the section line south of the line to the meander corner is then is used. The difference in the bearings will then be multiplied by the ratio between the two distances. The resulting bearing will then be used for the line to the meander corner and the corner will be set at the record distance from the controlling PLSS corner.

An example of calculating the Meander Corner by weighted mean bearing method is the north line of Section 16 recorded as east-west at 2,640.00 feet. This line is measured at North 89 degrees 30 minutes West at 2,645.00. The south line of Section 16 was a line to the meander corner recorded as east-west at 1,840.00 feet. The south line of Section 21 was also recorded as east-west at 2,200.00 feet to a Meander Corner. This line was measured at North 88 degrees 30 minutes West at 2,245.00 feet to the Meander Corner. The unknown line would be created by multiplying the ratio of the measured distances from the lines to the north and south of the unknown line to the difference of the bearing to the north and south of the unknown line. In this example the bearing of the line to the Meander Corner will be North 89 degrees 20 minutes 56 seconds West. The Meander Corner would then be set at the record distance on this weighted men bearing line.

During the process of remonumenting Meander Corners, the surveyor may come across situations where the river has moved, or the lake has grown or shrunk. In cases of a river moving, the surveyor will still determine a calculated position of the original Meander Corner. The calculated original corner will then be located in the field to determine if it falls short of the river, in the flood plain of the river, or in the river itself. If the original corner falls short of the river, the corner will be monumented as calculated. A second corner, called a Point on Line, could be set to define the line being retraced.

If the calculated position of the original Meander Corner falls into the river or the river flood plain, a witness corner to the Meander Corner would be set. The witness corner to the Meander Corner will be set on line and at a point away from the river so that it will not be destroyed by river flooding, usually at a point back from the top of bank. The witness corner to the Meander Corner will be marked as a WCMC (Witness Corner to the Meander Corner). In addition, notes and the cap will be marked with the bearing and distance to the original Meander Corner.

When calculating Meander Corners at lakes, the same situation could occur. The lake could have grown, shrunk, or just could have been meandered in error. As with river meanders, these situations could result in the Meander Corner being short of the lake, in the lake, or being in the shore of the lake where the corner is susceptible

to being destroyed. As with rivers, if the corner is short of the lake, the original corner would be set as calculated. Again, as with rivers, if the calculated corner falls into the lake or on the shore, a witness corner to the Meander Corner would be set. The witness corner to the Meander Corner will be set on line and at a point away from the lake so it will most likely not be destroyed by lake action. Just as with the rivers, the witness corner to the Meander Corner will be marked as a WCMC (Witness Corner to the Meander Corner). In addition, notes and the cap will be marked with the bearing and distance to the original Meander Corner. An example of changes in lakes is shown in the 2009 Manual of Surveying Instructions. Figure 18 from the 2009 Manual of Surveying Instructions shows an example of a lake as meandered by the originals survey.

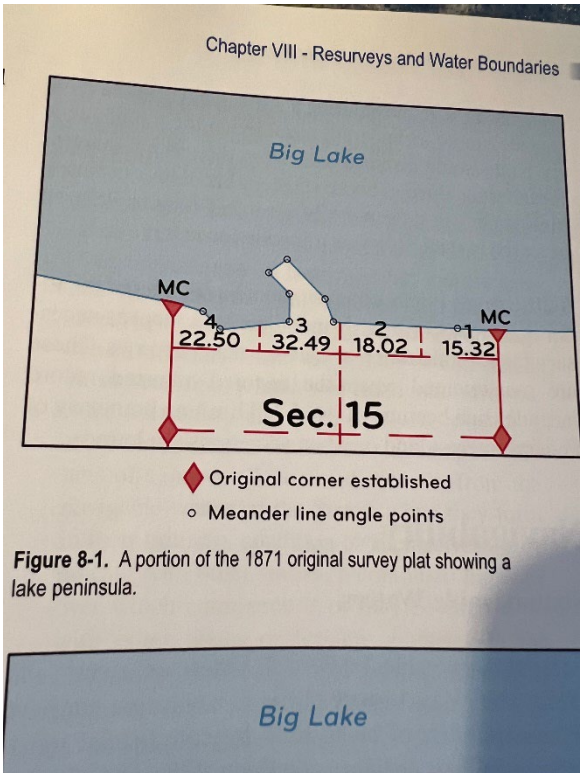


Figure 18 – Example of an original Meander from the 2009 Manual of Surveying Instructions

This same lake from Figure18 was resurveyed in 2009. Figure 19, from the 2009 Manual of Surveying Instructions, depicts the changes based on a resurvey in 2009.

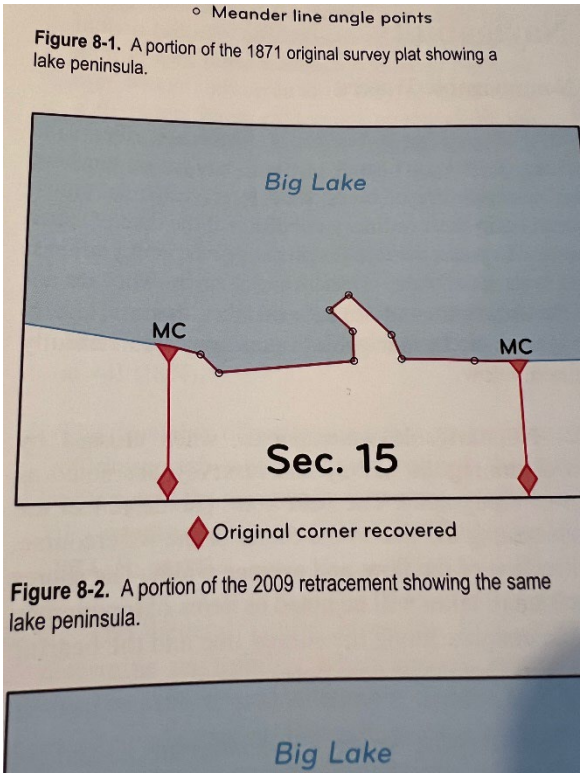


Figure 19 – Example of a resurvey of the same lake in Figure 18 from the 2009 Manual of Surveying Instructions

Based on the resurvey in 2009, Section 15 would then be subdivided and the Government Lots would be determined as shown in Figure 20 from the 2009 Manual of Surveying Instructions.

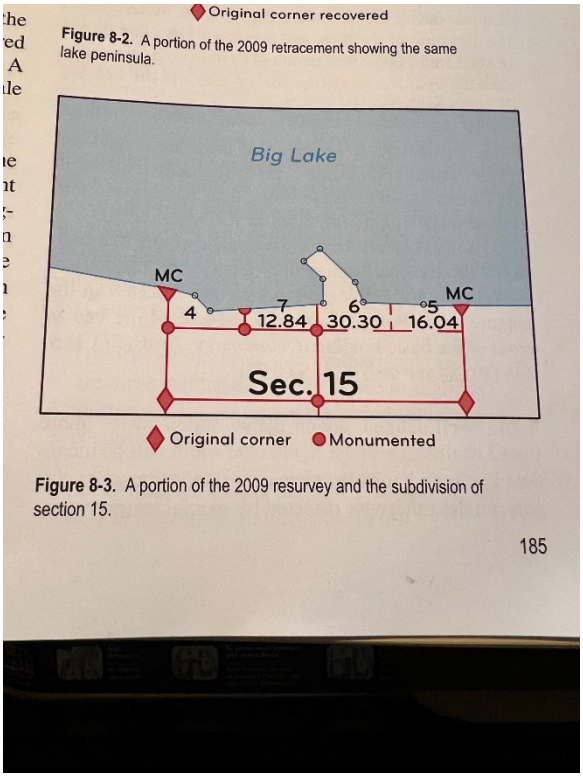


Figure 20 – Example of determining the breakdown of Section 15 on the same lake

in Figure 18 from the 2009 Manual of Surveying Instructions

Figure 18 through 20 show how changes in lakes or rivers over time can affect the resurvey of lands along the lake or river.

When rivers move, or lakes shrink, these situations create areas of lands that were never surveyed in the original surveys. These lands are referred to a “omitted lands”. Omitted lands can also occur when a lake was meandered incorrectly or erroneously. In some cases, the BLM has conducted dependent resurveys to address omitted lands. In other cases, the surveyor doing retracement surveys will need to address the omitted lands. The retracement surveyor will the survey lines from the original Meander Corner to the lake or river. At the lake or river, Auxiliary Meander Corners will be set. This will create new Government Lots along the lake or river. This is a brief summary of how to address omitted lands. Chapter 8-166 to 8-178 of the 2009 Manual of Surveying Instructions goes into details on how to address omitted lands. In addition, Chapter 8 of the 2009 Manual of Surveying Instructions discusses how boundaries of adjoining parcel will be addressed in cases of omitted lands. In some cases, additional field searches will need to take place to determine how the river or lake changes take place. This may be locating evidence of old river beds or lake shores.

Calculating Lost Closing Corners

Closing Corners will be corners that are set along a section, range or township line that intersects a line that is not part of the PLSS system. Lines that create closing corners include, State Lines, Indian Boundaries, Private Claims, and other surveys that occurred prior to the PLSS surveys that defined land. As with Meander Corners, the process for determining search areas will be the same as with Section and Quarter Corners. Closing Corners use the same methods the determine search areas as is done with Meander Corners. One difference is that the boundary the section, range, or township line will also need to be surveyed. Once the search area is made, the surveyor should search for any evidence of the original corner or the reference. If the original corner is found, the surveyor will need to determine if the original corner falls on the closing line. Since the closing lines of State Lines, Indian Boundaries, Private Claims, and other surveys that occurred prior to the PLSS surveys are considered superior, these lines will be held. If the original corner cannot be found, or there is not any evidence of subsequent surveys, the Closing Corner will need to be calculated. The bearing of the line to the Closing Corner can be calculated using the same three methods that were used for Meander Corners. With Closing Corners, the closing line that the section, range, or township line intersects with will need to be surveyed. The Closing Corner will then be set at the calculated bearing and the intersection of the section, range, or township line and the closing line. Closing corners also occur along township and range lines that are correction lines. Chapter 7-41 to 7-49 of the 2009 Manual of Surveying Instructions discusses Closing Corners and how to address them.

Monumenting Corners

Once all initial field surveys have been completed and the corner's location that best represents the original corner has been determined, the surveyor can now monument the corner. Each State will have requirements that will determine what can be used for monuments and what, and how many references, will need to be set with the corner. In urban areas, and often rural areas, the corners often will fall in roadways. Based on if the roadway is gravel, asphalt, or concrete, will determine what type of monument could be set. Asphalt or concrete roadways could have survey spikes or PK Nails set for the corner. In some cases, the surveyor could be required to set a monument with a cap that is inset into a monument box. In gravel roadways, a monument will be set. This monument should be set below the roadway surface, typically three-inches to a half a foot.

In all these cases, reference marks are taken using objects such as building corners, hydrants, power poles, or other features. The number of reference marks will depend on the requirements of the State the remonumentation project is occurring in. The typical number of reference marks are three or four. The reference marks or monuments will be set to help locate the corner that is in the roadway. No matter what is used for the reference, a bearing and distance will be taken to the actual corner. These references can then be used to restore the corner if the corner should be destroyed. Since these references are intended to be used to help restore a corner, the references should not be taken too close to the corner so that if the corner gets destroyed the reference will survive. Also, since the references are intended to be used to help restore a corner, they also should not be taken at distance that they will be unusable for reestablishing the corner by measuring from the reference mark with a tape. Ideally the reference marks should be no less than 20 feet and no more than 120 feet from the corner.

Corners that do not fall in roadways, will be monumented with monuments that meet the State or Federal requirements. In cases where the corner falls in bedrock or other material that will not allow for a standard monument to be set, either a survey spike or survey monument cap will be drilled into the rock or material and the survey spike or survey monument cap will be epoxied or concreted into the rock or material. As mentioned above, reference marks will be taken to help locate the corner in the future. The reference marks in rural areas off roadways could be features such as buildings or power poles or trees, if nearby. In some cases, the surveyor will set additional reference monuments or place posts with signs to be used to reference the corner.

The monuments set for the corner often will have a monument cap placed on the actual monument. Depending on the corner being set, the cap should be stamped (or marked) to help others identify it as to the PLSS corner being set. The 2009 Manual of Surveying Instructions details the markings for the PLSS corner that is being remonumented. These cap markings are depicted in the 2009 Manual of Surveying Instructions in Chapter 4-25 thru 4-51. In addition, to the PLSS markings, the cap should also note the year the monument was set. In some States, the surveyor's license number may also be required to be put on the monument cap. Once the corner is reset, the surveyor will then need to complete a corner monument record that will help perpetuate the corner. The monument record will be determine based on the rules and regulations of the State the surveyor is in.

Conclusion

Having completed this class, the surveyor should have gained an understanding of the PLSS System and what will be needed to complete a remonumentation project. The surveyor would have gained an understanding of the Instructions that were used by the original surveyors and where to find the Instructions and original notes from the original surveyors. The surveyor should also have gained knowledge of other documentation that will help recreate the PLSS Corner location and how it can be used to remonument a PLSS Corner. Field methods and what to look for were discussed to help with remonumentation project. Finally, calculations that will be needed to monument obliterated or lost corners were discussed for various PLSS Corners.

As the class did discuss various corners, such as Meander Corners and Closing Corners, there are other corners that were set by the original surveyors. These other corners are discussed in the 2009 Manual of Surveying Instructions. The PLSS Retracement and Remonumentation class, as presented, should give the surveyor a general understanding of how to setup and complete a successful PLSS remonumentation project. Although this class gives general concepts of the remonumentation process, there are always situations that the surveyor could come across that were not addressed in this class. If the surveyor should run across a situation not addressed here, they can refer to the 2009 Manual of Surveying Instructions, which attempts to address additional situations. Another possible source of information to address situation not covered here, is to contact a local BLM surveyor. They have a wealth of information and are willing to help out fellow surveyors.