THE PUBLIC LAND SURVEY SYSTEM (PLSS) – PART 1

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Introduction

The orderly network of roads and fences that divides the North Dakota landscape into its familiar checkerboard of squares and rectangles (fig. 1) is the result of a land survey system that has been in use for more than two hundred years.

Figure 1. The method of survey that divides North Dakota into an orderly array of rectangular parcels like these near Northwood (bottom left) in Grand Forks County predates the U.S. Constitution.

What we refer to today as the Public Land Survey System (PLSS) began with the Land Ordinance of 1785. The Revolutionary War had left the fledgling United States deeply in debt, and with no power to levy taxes, the only feasible way for Congress to raise the millions of dollars needed to pay its creditors and put money in the treasury was through the sale of public lands. The areal extent of the public domain at that time was considerable and its disposal into private ownership would require the survey and division of a region of more than 260,000 square miles of largely unmapped wilderness. A land survey of this magnitude was unprecedented and the question of how it was to be accomplished engendered a prolonged debate. The final result of that debate was the Land Ordinance of 1785.

Based on a rectangular survey system proposed by Thomas Jefferson, the ordinance established a methodical, all-encompassing process for the survey, description, and transfer of land. It was not perfect by any means, as many of the early surveys showed (White, 1991); but by the beginning of the 19th century the necessary refinements had been made and, apart from periodic revisions of instructional guidelines, the system has changed little since.

How the PLSS works

Simply put, the PLSS (also referred to as the system of rectangular surveys or rectangular survey system) divides land into 6- by 6-mile square parcels called townships. Townships are subdivided into 36 sections, each a mile square and containing 640 acres or as close to that amount as possible.

Figure 2. The Fifth Principal Meridian governs the surveys of all or part of six states (shown in green).

Every survey has to start somewhere. A rectangular survey begins with the establishment of an initial point: a point on the earth's surface from which a pair of perpendicular control lines, a principal meridian, which runs true north-south and a base line, which runs true east-west is surveyed. The initial point for North Dakota is in Arkansas where the Fifth Principal Meridian intersects its base line at 34° 38' 44.455" north latitude and 91° 03' 07.337" west longitude (Bureau of Land Management, 2009) (fig. 2). The Fifth Principal Meridian was established in 1815 by Prospect K. Robbins to survey the lands acquired by the United States under the Louisiana Purchase. He began on October 27 of that year by running a line northwards from the confluence of the Arkansas and Mississippi Rivers. On the same day a second crew, led by surveyor Joseph Brown, set out from the confluence of the St. Francis and Mississippi Rivers to survey the base line. Two weeks and 58 miles later, on November 10, Robbins crossed Brown's baseline at the abovementioned point, about 26 miles west of the Mississippi River. This is one of several examples where the initial point was defined by its meridian rather than the other way round. So it was probably more by bad luck than design that the initial point for the Fifth Principal Meridian ended up in the middle of a swamp (fig. 3).

Figure 3. The initial point for the Fifth Principal Meridian is in the middle of a swamp in eastern Arkansas. Its position is marked by a granite monument, which may be viewed from an elevated walkway that extends 950 feet into the swamp from a nearby parking lot. The inscription reads: *"This stone marks the base established Nov. 10, 1815, from which the lands of the Louisiana Purchase were surveyed by United States Engineers. The first survey from this point was made to satisfy the claims of the soldiers of the war of 1812 with land bounties. Erected by the Arkansas Daughters of the American Revolution. Sponsored by the L'Aguille Chapter."* Photo courtesy of the Arkansas Department of Parks and Tourism.

The Fifth Principal Meridian governed the surveys of what are now the states of Arkansas, Iowa, Missouri, and North Dakota as well as most of Minnesota and the eastern half of South Dakota. In addition to land from the Louisiana Purchase, the survey area also included the tract south of the 49th parallel drained by the Red River of the North that was ceded to the U.S. by Britain in 1818. All land parcels throughout this region are uniquely described in terms of their location with respect to the meridian's initial point in Arkansas.

Once the principal meridian and base line are in place, the area is surveyed into quadrangles (fig. 4). Standard parallels are extended as true lines of latitude from the meridian at intervals of 24 miles north and south of the base line. Parallels are numbered sequentially, starting with 1 for the first 24-mile increment from the base and are given a north or south designation depending upon which side of the base line they fall. Thus, the first parallel north of the base line is the First Standard Parallel North, the next the Second Standard Parallel North, and so on. For reasons that will shortly become clear, standard parallels are also called correction lines. Guide meridians are extended true north from the base line, or standard parallels, at intervals of 24 miles east and west of the principal meridian[1]. They are numbered in the same way as standard parallels, east and west of the principal meridian.

Figure 4. Survey of quadrangles (white squares) and their division into townships (green squares).

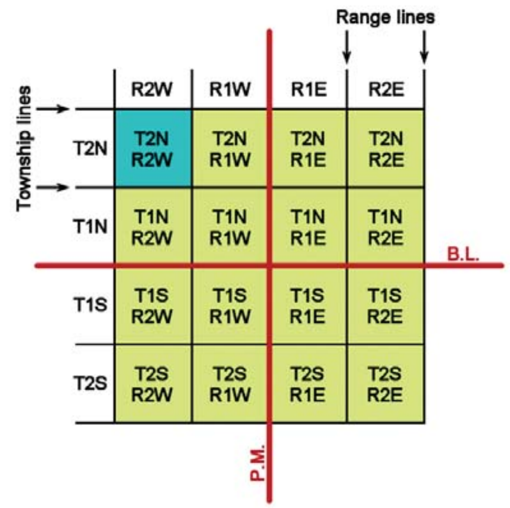

Figure 5. Coordinate system for numbering townships. For color coding see figure 4 and text. P.M. = principal meridian, B.L. = base line.

Quadrangles are divided into townships six miles square, known variously as congressional townships, government townships, survey townships, or simply, PLSS townships. PLSS townships are not the same as civic townships (see box). A standard quadrangle is 24 miles square and contains sixteen townships (fig. 4). Each township is uniquely identified by its position relative to the governing principal meridian and base line (fig. 5). Rows of townships that run east-west parallel to the base line are also (unfortunately) called townships and the boundaries between them, township lines. (Some states avoid ambiguity by calling them tiers, but not so in North Dakota.) Beginning with 1 for the first row of townships on either side of the baseline, they are numbered north and south to the full extent of the territory surveyed under the principal meridian. Rows of townships that run north-south are called ranges and the boundaries between them, range lines. Ranges are numbered in the same way as townships, east and west of the principal meridian. So the blue PLSS township in figure 5 is identified as Township 2 North, Range 2 West (T. 2 N., R. 2 W.)

[1] The practice of spacing of guide meridians at 24-mile intervals was not adopted until 1881 (White, 1991, p. 514). Prior to that, they were established more or less at the discretion of the surveyor. Current procedures (BLM, 2009) require that auxiliary guide meridians be surveyed to replace those that do not conform to the 1881 standard.

because it is in the 2nd row of townships north of the base line and 2nd range of townships west of the principal meridian.

Townships are subdivided into 36 sections, each a mile square and containing 640 acres, or thereabouts (fig. 6). Sections are numbered 1 to 36 beginning with 1 in the northeast corner and proceeding alternately east to west and west to east, row by row, ending in the southeast corner with section 36. Sections may be divided into half-sections (320 acres), quarter-sections (160 acres), quarter-quarter-sections (40 acres), and other half or quarter subdivisions (fig. 7). As a rule, section lines are public rights of way[2], which is why roads or trails throughout the 30 states[3] in which the PLSS is in effect tend to be spaced an exact number of miles apart.

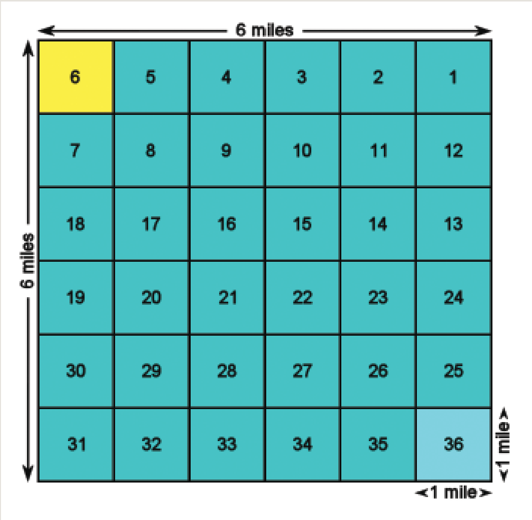

Figure 6. Numbering sections. Sections 36 and 6 are shown in detail in figures 7 and 9 respectively.

PLSS townships vs civil townships

PLSS (congressional/government/survey) townships are 6- by 6-mile square subdivisions of the public land survey system. Each PLSS township is identified by a unique township (T) and range (R) number, which describes its position relative to the principal meridian (PM); e.g., T. 1 N., R. 2 W., 5th PM. Except in formal land descriptions the name of the principal meridian is usually dropped.

Civil townships are semi-autonomous political subdivisions of a county. In North Dakota they are managed by a locally elected board of township supervisors and other officers, and provide services such as road maintenance, tax assessments, land use planning (zoning), and representation for township citizen's issues and concerns. Civil townships have names like Apple Creek Township or Wing Township (both in Burleigh County), or else are unorganized, which means they are governed by the county. Many civil and PLSS township boundaries coincide but quite a few do not.

The PLSS requires that public lands be surveyed into townships six miles square containing 36 sections one mile square by lines run as true meridians and true parallels of latitude. But to do this is a

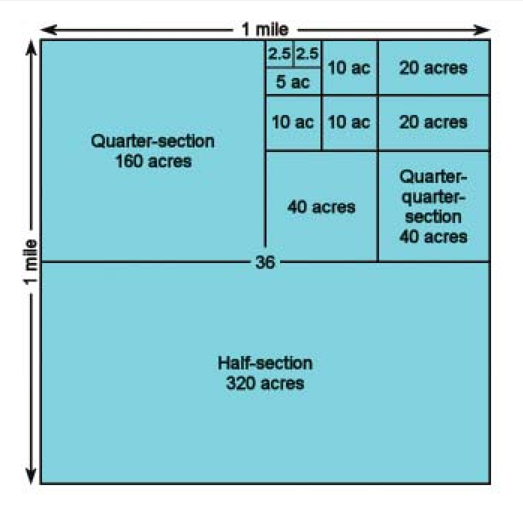

Figure 7. Subdividing sections.

mathematical impossibility because true meridians (including all range lines and north-south section lines) converge on the geographic north pole. Left uncorrected, this would mean that the north end of every township (and section) would be narrower than its south end. In order to maintain a rectangular survey pattern, periodic adjustments are therefore necessary. These are made every 24 miles on the standard parallels (which is why they are also called correction lines) by a longitudinal shift that restores the guide meridians to their original spacing. The result is a slight eastward or westward offset between each row of quadrangles or every fourth township line. It is also the explanation for the occasional left-then-right or right-then-left turns in so many of our north-south public roads, especially the ones in more rural areas (fig. 8).

Figure 8. McLean County Roads 7 and 9 turn abruptly west where they meet the Twelfth Standard Parallel between Townships 148 and 149 North before resuming their northward track near the community of White Shield. The Twelfth Standard Parallel is a correction line that allows surveyors to compensate for the earth's curvature by resetting the six-mile interval between range lines. The adjustment causes a slight westward shift in the rows of townships north of the line.

Finer adjustments are made at the township and section level. Sectional surveys begin in the southeast corner of a township

[2] *In North Dakota these are regulated under Title 24 of the North Dakota Century Code.*

[3] *Ala., AK, Ariz., Ark., Calif., Colo., Fla., ID, Ill., Ind., IA, Kans., La., Mich., Minn., Miss., Mo., Mont., Nebr., Nev., N. Mex., N. Dak., OH, Okla., Oreg., S. Dak., UT, Wash., Wis., Wyo.*

and proceed systematically northward and westward at 1-mile intervals. In this way, corrections for the earth's curvature and any errors in measurement (of which there were many, given the field conditions and crude instrumentation of the day) are corralled into the northernmost row and westernmost column of sections, that is, numbers 1 to 7, 18, 19, 30, and 31. These eleven sections are allowed to deviate from the 1-mile-square rule in favor of the other 25. Where possible the excess or shortage of land is further concentrated into the quarter- and quarter-quarter-sections (fig. 9). A similar process is used to subdivide sections bordering lakes and large streams, and partial sections adjacent to state or international boundaries. Non-standard parcels are called fractional or government lots.

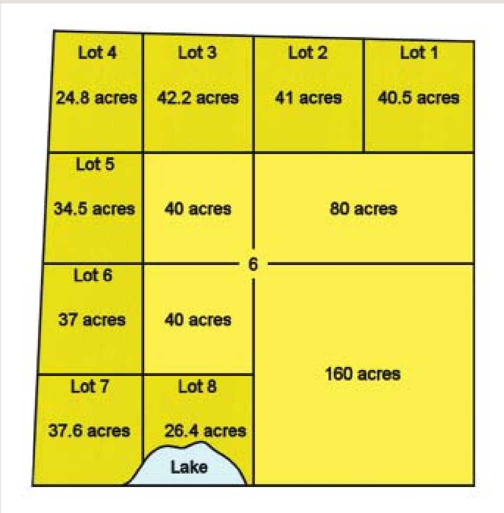

Figure 9. Fractional lots (shaded areas).

The PLSS in North Dakota

The survey of North Dakota's public lands took place between about 1867 and 1906 using the standard parallels established for the survey of western Minnesota. The Minnesota-Iowa boundary, at 43.5° north latitude, was used as an auxiliary base line for these surveys and the standard parallels were numbered from that line. The Seventh Standard Parallel eventually became the border between the states of North Dakota and South Dakota and is the southernmost of nine parallels that run across North Dakota (fig. 10). The guide meridians in eastern North Dakota are interesting because they were measured at 42-mile intervals from the Principal Meridian – a practice that ended when the spacing was standardized at 24 miles in 1881. The last one to be surveyed using the old regime was the Twelfth Guide Meridian, which coincided with the western boundary of Range 87 W. Thereafter, auxiliary meridians were surveyed to conform to the new standard.

There are about 1800 full and 140 partial (fractional) townships in North Dakota, arranged in 35 rows of townships and 60 ranges. Because they are all north and west of the Fifth Principal Meridian and its base line, the identifier of each one follows the format T. # N., R. # W. The southernmost row of townships is T. 129 N., which is approximately 129 x 6 = 774 miles north of the initial base line in Arkansas. The most northerly is T. 164 N., a row of fractional townships that is truncated by the Canadian border. Similarly, the easternmost range of townships is R. 47 W. at a distance of 47 x 6 = 282 miles west of the Fifth Principal Meridian.

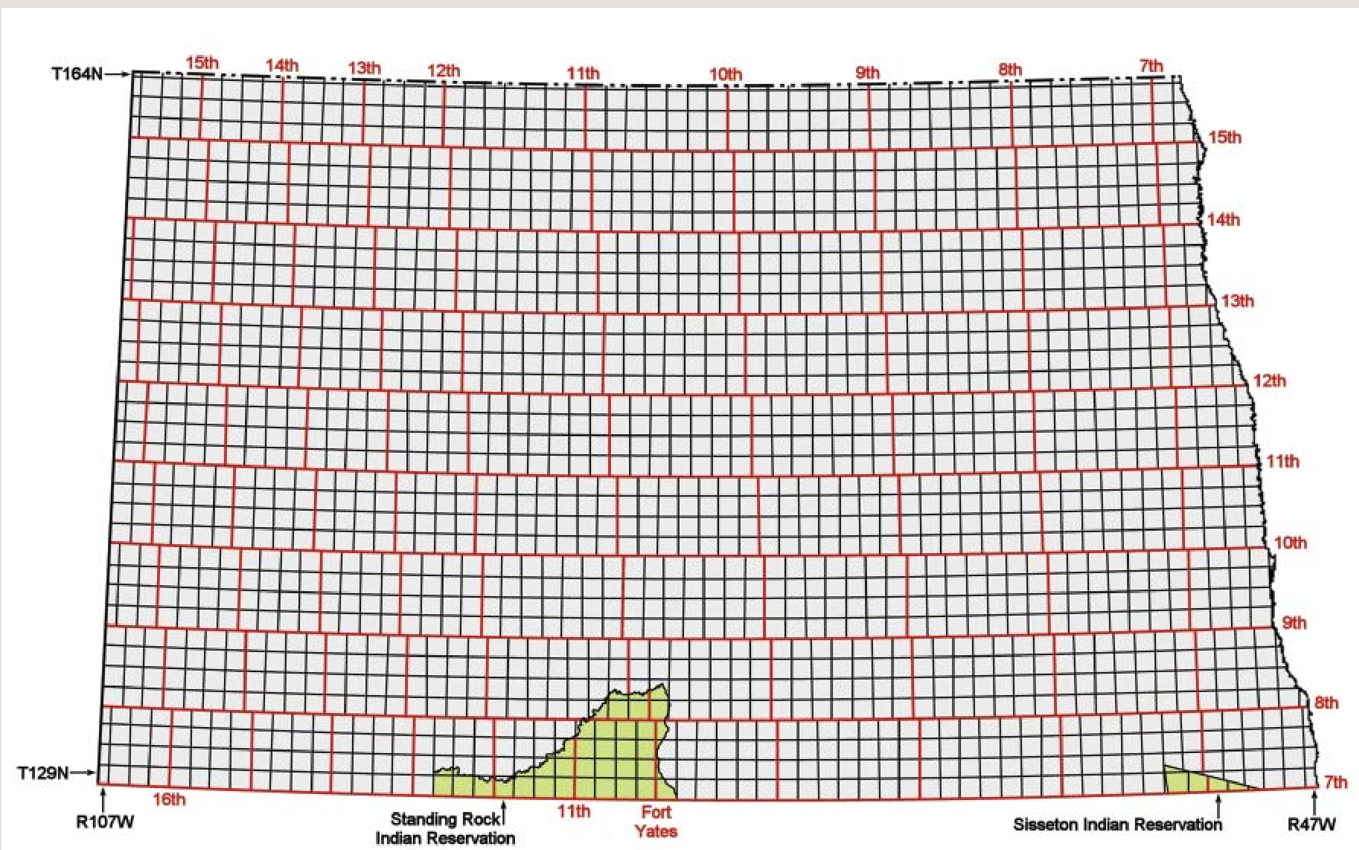

Figure 10. North Dakota's PLSS survey grid. Each square represents a 6- by 6-mile township, with township (T) and range (R) lines shown in black. The numbered lines are guide meridians (north-south) and standard parallels (east-west). Note that, except on the Standing Rock Indian Reservation, which was surveyed independently; the 7th to 12th guide meridians are spaced at 42-mile intervals, indicating they were established before the adoption of the 24-mile standard introduced in 1881.

Figure 10 gives the impression that R. 47 W. consists of just five fractional townships in southeastern Richland County but this is an illusion. Provided they are governed by the same principal meridian, the layout and numbering of townships are generally not affected by state lines or other political boundaries, so the greater part of R. 47 W. is actually in Minnesota, as are most of R. 48 W. and sizeable portions of R. 49 W., R. 50 W., and R. 51 W. In far southwestern North Dakota, however, the four fractional townships that make up R. 107 W. are real, as are all the fractional townships along the Montana border. These townships mark the western limit of the Fifth Principal Meridian's influence. Montana has its own principal meridian so the PLSS townships there are numbered differently.

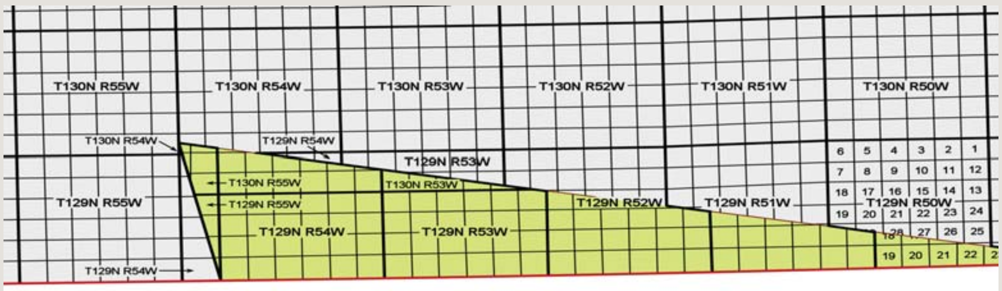

Figure 11. The Sisseton Indian Reservation (green area) was surveyed from a Seventh Standard Parallel that was erroneously placed about two miles south of its correct position (it is in the right place in this drawing). The resultant confusion means that some townships have duplicate section numbers and are missing others. For example, in T. 129 N., R. 50 W. section numbers 15 to 24 are wholly or partially repeated at the expense of section numbers 26 to 36. There is also a horizontal offset between the reservation and North Dakota townships because the Twelfth Standard Parallel is also a correction line.

We have already seen how the PLSS affects the layout of North Dakota's public roads. Because they often follow survey lines, County boundaries are influenced in a similar way. A quick look at the North Dakota Department of Transportation's official highway map (or any other map on which county lines are marked) will show this. The 90° bends in adjacent north-south boundaries such as those between Renville, Bottineau, Rolette, Towner, and Cavalier counties reveals where they cross a correction line (township line 161 or the 15th standard parallel in this case) and many follow guide or auxiliary meridians. Most of the east-west boundaries follow standard parallels. In fact it is possible to locate all fourteen of the latter just from the position of the county lines. And it will come as no surprise then, to discover that some counties; Logan and McIntosh for example, measure exactly 24 miles from north to south and others, like Burleigh and Kidder, forty-eight.

A problem with the 7th Standard Parallel

The rigorous accuracy demanded of the surveyors who measured and divided up the nation's public lands appears to have been lacking in a small group of townships in southern Sargent and Richland counties. Between Ranges 49 W. and 55 W. in the 129 and 130 rows of townships a wedge-shaped piece of the Sisseton Indian Reservation extends into North Dakota, throwing the township boundary lines and section numbers into apparent chaos (fig. 11). Did the unrelenting hardships of the job finally push some hapless surveyor over the edge? Not really, the muddle is the result of a simple human error.

Because Indian reservations are politically distinct entities they were surveyed separately from the public lands surrounding them. Some, such as the Standing Rock Reservation, even had their own standard parallels (fig. 10). Preparations for the survey of the Sisseton Indian Reservation began in 1865 when Carl C.P. Meyer was contracted to extend the Seventh Standard Parallel westward from the Minnesota border and through the reservation. Unfortunately, some data he was given by the surveyor general's office in Minnesota had been inaccurately recorded, and the resultant error in his calculations put the line a little over two miles south of its correct position. Unaware that anything was wrong the survey of the reservation went ahead and was completed in 1869. The problem was eventually discovered when the Seventh Standard Parallel was resurveyed by Rollin J. Reeves a year later, and until it was fully resolved in 1872, the Sisseton Indian Reservation had two Seventh Standard Parallels. Meyer's survey was ultimately discarded but by then his mistake had left an indelible mark on the landscape.

The survey of the Sisseton Indian Reservation and those of the surrounding public lands in North and South Dakota are out of alignment because a critical line of reference was not where it should have been. Complicating matters even further is the fact that this reference, the Seventh Standard Parallel, is also a correction line; so not only are the surveys mismatched north to south, there is a horizontal discrepancy as well. This can be easily demonstrated by repositioning all the township and section lines on the Sisseton Reservation a mile or so to the west so that they line up with their counterparts on the North Dakota side, then moving them north about 2¼ miles, whereupon everything will magically fall into place.

To be continued . . .

References and recommended reading:

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