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Missouri River Survey
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Brady Memorial Survey
Idaho student project
Triangulation station “Canyon Ferry” is a copper bolt leaded into a native rock. It was established in 1885 near Helena, Montana. Photo by Gary Little.
n July 5, 1884, the United States Congress created the Missouri River Commission. The purpose of this new agency was to oversee and insure the continuous, progressive development of the Missouri River which necessitated a complete and accurate survey. Although the Commission was a separate agency, it worked closely with the U. S. Army Corps of Engineers. In the years prior to the Commission’s formation, the Corps had initiated several areas of mapping along the Missouri River. To insure the lasting usefulness of the new project, the Missouri River Commission concluded that a precise geodetic survey of the highest order would be performed prior to a topographical survey.

Historically, steamboat traffic supplied the Missouri River communities with the raw materials used to develop the West, but at a high cost since many boats were grounded upon the unpredictable and shifting sand bars, while others were sunk by submerged trees, known as snags. As it is the longest river in North America, the Missouri River needed a long-range plan for development into a commercial corridor that would also benefit flood control. A five-member organization which tapped into the best advice from both the military and civilian communities led the Missouri River Commission.

The geodetic control for the earlier Corps surveys consisted of a triangulation network established along the bluffs and a rough sea-level based system of levels carried up from St. Louis. Neither the horizontal nor the vertical networks were of a precise nature, but only sufficient to enable the Corps to survey the Missouri River for a set of topographical maps produced from 1878-1881. Monuments of a lasting quality were not established, except for a few iron pipes occasionally set for triangulation stations. The bench marks usually consisted of spikes which were set in piers, trunks of trees, or other non-permanent structures.

The continuation of the surveys started by the Corps was of foremost importance after the Commission’s creation, but the extent to which these earlier surveys might actually be incorporated into the new survey was uncertain. On October 7, 1884, 1st Lt. Walter L. Fisk, Corps of Engineers, United States Army, reported for duty as the secretary of the Missouri River Commission and immediately began planning the survey.

In the spring of 1885, a force of fifty men converged along various sections of the Missouri River to create the most thorough and accurate survey ever attempted between the Mississippi River and the Rocky Mountains. Those working
on the triangulation network employed their own cooks and boatmen when their work separated them from the surveyors who were establishing the bench marks. The total monthly wages for the fifty men associated with the survey was nearly $4,000. The fuel for the boats and food for the men cost an additional $750 per month. Today’s monetary estimate would calculate this to be a monthly amount of well over $100,000.

The triangulation by the Missouri River Commission spared no expense and was far superior in every aspect to the work previously done by the Corps. The triangulation monuments consisted of precut stones measuring 18” square and 4” thick, with a small drill hole for the center point, for the lower monuments. The machine-engraved letters “U S” and a small triangle were located on the top surface of the stones. The surveyors set the stones approximately 4 feet into the ground, leveling and tamping them into place. Above the stones, they placed 4-inch diameter iron pipes, 3 feet long, over the center of the drill holes and backfilled the excavated pipes taking care to keep the pipe plumb and to not allow dirt to enter inside. On the top of the pipe, using a bolt, they secured a 5-1/4-inch diameter heavy cast iron cap bearing the lettering of the Missouri River Commission. The surveyors set the tops of these capped pipes close to the surface of the ground. The triangulation cap had a raised triangle with a hole in the center so that it was positioned directly over the drill hole in the stone. In theory, if a capped iron pipe was removed or disturbed, the drill hole in the stone would allow the pipe to be properly reset to its exact position. The monuments were well ahead of their time since it would still be several years before other government agencies would copy the idea of setting double geodetic monuments at triangulation stations.

As with the triangulation monuments, the new bench marks consisted of two separate monuments. Surveyors placed precut stones 18” square and 4” thick, with drill holes in the center, for the lower monuments. The drill hole had a small copper pin (known as a “bolt”) leaded into the hole, projecting just above the surface of the stone. The machine lettering on the surface of the stones was “U S B M” (United States Bench Mark). The surveyors placed a 4-inch diameter iron pipe, 4 feet long, on

**Left:** Surveyors stretch a steel tape while making a measurement on one of the ten baselines of the triangulation network.

**Below:** The steel tapes were stretched with this apparatus. The block on the right is pushed back with a threaded rod while a weighted can is attached to the end of the chain. A thermometer is also at the top of the block.
the top of each stone so that it surrounded the copper bolt. They backfilled the excavated holes and bolted a heavy cast iron cap to the top of the pipe. The top of each capped pipe projected one foot above the ground surface. A rounded projection in the center of the cap served as an additional elevation location, but the precise mark was the copper bolt in the stone. The elevations were published both for the top of the cap and for the copper bolt. The design required that the cap be removed and the level rod lowered inside the pipe to the top of the copper bolt for precise work. The elevation recorded on top of the cap sufficed for non-precise work. Unfortunately, over the course of a century, flood water and silt have since entered many of the pipes resulting in a nearly impossible situation for reaching the copper bolt without entirely excavating down to the stone. The design, however, was an excellent idea since the lower stone bench marks are still buried and have remained undisturbed.

The Missouri River Commission surveyors placed the bench marks on lines running across the valley between the bluffs, as perpendicular as possible to the river channel, and typically spaced about five miles apart. They referred to these as “stone lines”. Although the terrain and circumstances often dictated the placement of the bench marks, it was standard practice to place one bench mark near the foot of each bluff. The surveyors then placed the other bench marks further out on the line formed by the two closest to the banks. They designated bench marks on each individual line such as 103/1, 103/2, and 103/3. The top number (103) was the bench mark line while the bottom number (1) was one of the individual bench marks on that line. One or more of the bench marks on each line was connected with the triangulation network and the azimuth of the stone line was determined. This later aided in the topographical mapping along the river bottom since the bench marks could also be used as horizontal control points. The cost for each two-piece survey monument delivered to the Missouri River Commission at St. Louis was $1.75 each for the first 200, and $1.55 each for a subsequent 800.

The Commission repaired the steamer, the Missouri, formerly used by Corps surveyors during their mapping of the river, so that it could be used for transporting the Commission’s supplies, triangulation stations, and bench marks up the river for the new survey work. The Missouri was a tired old ship with too many days upon the river, but $2,744 in repairs brought her back to life. After repairs, her first trip began at St. Louis on April 13, 1885. The Missouri’s load included 300 triangulation stones and pipes, 800 bench mark stones and pipes, other necessary cargo, her crew, and most of the surveying party. The cargo, in addition to the monuments, consisted of the supplies needed for a surveying party of fifty men for five months, the usual duration of the working season. Although more bench marks would eventually be needed, the amount loaded was all the steamer could carry. The Missouri had neither the construction nor the power to make steady or swift progress.
up the river with this load. Windy days required the steamer to be tied up along the bank. During April and May, the Missouri docked for 16 different days due to the wind. Sailing up the Missouri River, she reached Kansas City on April 24, Omaha on May 4, Sioux City on May 12, and, eventually, Bismarck in Dakota Territory, on June 1, 1885. Fifteen tons of stones and pipe were transferred to the steamer Josephine at Bismarck. The other members of the surveying party and the rest of the monuments reached Bismarck by railroad. The Missouri continued up river to Fort Benton, Montana, reaching that location on July 4, 1885, with work scheduled to begin in that area the following day. The Josephine distributed survey monuments to various work locations. A small steamer known as the Emily proved an excellent vessel for transporting supplies and men for the surveying work during late 1885. After being tied up for the winter, and frozen in the ice seven miles above Bismarck, the Emily could not be retrieved and sunk in 12 feet of water. By the late 1880’s, the leveling party used a quarter-boat known as the Pipoose towed by the steamer Thetis to transport the bench mark monuments and ferry the crew from shore to shore. Various other quarter-boats were used to transport supplies and to carry workers back and forth across the Missouri.

The triangulation was done with a Troughton & Simms 10-inch theodolite and a Gambe-Wurdemann 10-inch theodolite. The Gambe-Wurdemann instrument did not prove to yield the high quality of work desired, so it was later replaced with a Troughton & Simms 12-inch repeating theodolite for the remainder of the work. The surveyors established the bench marks on the stone lines that stretched across the valley by coming up the river from where the precise level line originated at St. Louis. The Commission chose a mark known as the “St. Louis City Directrix” as a starting elevation of “0” (Zero) for the Missouri River Commission triangulation network, measured with 300-foot steel tapes.

The Commission’s survey work was not without a few early interruptions. A night watchman at Gallatin, Montana, assigned to watch over the government property, abandoned his post when what was described as a band of horse thieves and assassins under the name of the “Regulators” stormed into the stockpile of equipment to take whatever they thought could be useful. During the summer of 1885, at the Indian reservation in Dakota Territory just below the Cannonball River, Indians abruptly stopped a crew from working on a section of the triangulation. They were decidedly against having any survey work done on their land and were especially opposed to the placement of the permanent triangulation or bench mark monuments. An Indian agent had to be placed in authority to protect both the surveyors and the monuments. At night, the crew had to take down targets over the triangulation and hide the monuments. Another problem for the triangulation crews was the constant haze that was a result of the Indians setting the tall prairie grass on fire in search of old buffalo skulls and bones. Eastern markets had developed a demand for the bones, so it became a means for the Indians to make money by removing them from the prairie.

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Gary Little excavates for the lower monument at triangulation station “Benton” near Fort Benton, Montana, after the surface monument was not found. The location was determined by bearing and distance from a nearby USC&GS triangulation station. Photo by Kurt Luebke.
Surveys. When the Commission began their surveys, an exact sea-level elevation had not yet been established. In 1887, the starting bench mark at St. Louis was tied to a precise sea-level bench mark from a previously established bench mark of the Mississippi River Commission which was connected to their tide station in the Gulf of Mexico at Biloxi, Mississippi. The Missouri River Commission, however, continued to reference their bench marks from the “0” mark at St. Louis, but could easily convert them to true sea-level. The conversion factor at that time was to add 412.731 feet to the elevations based upon the St. Louis City Directrix bench mark to obtain true sea-level elevations.

The bench mark stone lines on the lower portion of the survey continued upriver in sequence until reaching Line 143 near Sioux City. The stone lines on the upper portion had originated in Montana and increased going downriver and also ended near Sioux City with Line 360. Upon the completion of the triangulation network and the establishment of the bench mark lines, the survey crews began the topography survey of the river and surrounding area. Once completed, the topography survey was placed on 83 sheets from St. Louis to Three Forks, Montana.

In an effort to establish better vertical control, the Missouri River Commission ran a precise line of levels north from Kansas City to Sioux City during the summer of 1892. This line originated at the USC&GS precise transcontinental survey line and followed the railroads to Council Bluffs and then on to Sioux City. Most of the bench marks on this precise line were placed along the right-of-way of the railroads well away from the river and consisted of the usual buried stones for the lower monument with a capped pipe as the surface monument. These bench marks were designated P.B.M. (Permanent Bench Mark) along with a consecutive number.

Upon completion of the precise level line, all bench marks on the stone lines across the valley were readjusted to be in agreement with the elevations determined on the precise level line of 1892. Most discrepancies in elevation were relatively small; however, one large discrepancy was found between Fort Benton and Three
Forks, Montana, which was 13.522 feet. This area had initially depended upon an elevation supplied by the Northern Pacific Railroad which had supposedly been carried westward to Montana by the railroads from a datum originating at the Great Lakes.

To commemorate the completion of the Missouri River Commission survey, a special monument was placed at the state capitol grounds in Jefferson City, Missouri. This commemorative monument consisted of a red granite stone 20” square and 81” tall and placed 4 feet into the ground. The four sides were lettered with the exact latitude, longitude, elevation above sea level, and “Missouri River Commission 1893”. The top on the monument terminated in a truncated pyramid 3” in height with the upper point being 1½” square. A smaller meridian stone 8” square and 57” long was placed 426 feet south of the main monument. Each monument had a one-half inch brass bolt in the top center. The stones were set in place on July 24, 1893, with much fanfare including participation from the Missouri governor and secretary of state. These monuments have since disappeared from the capitol grounds.

Over 700 triangulation stations and perhaps thousands of bench marks were placed between Three Forks, Montana and St. Louis, Missouri between 1885 and 1893. Since the cast iron caps on these monuments were highly decorative, most have since succumbed to theft by curio seekers. Other monuments have been torn out by urban development, and some triangulation stations were later remonumented by the U. S. Coast & Geodetic Survey crews with brass disks in concrete. It is likely that most of the lower stone monuments for both the triangulation and bench marks still exist today hidden below the surface of the ground.

This early survey along the Missouri River established horizontal and vertical control points through parts of seven different states and became the early standard for which later geodetic surveys in the west would be performed. The accuracy of this survey for its time was nothing less than outstanding. Since some of the original Missouri River Commission monuments were later utilized by the U. S. Coast & Geodetic Survey, a modern comparison can be made of its position. One triangulation station in southern South Dakota, “Bijou”, is a common point for both agencies. The Missouri River Commission’s latitude of 1893 for this point is only 2.39 seconds different while the longitude is only 0.97 seconds different when compared to the modern NAD83(1996) position of the National Geodetic Survey. Similarly, a comparison on a bench mark near Peru, Nebraska, named “108/1” that has been used by both agencies has the Missouri River Commission’s elevation of 1893 only 0.18 feet higher when compared to the National Geodetic Survey’s ortho elevation on the NAVD88 vertical datum.

As time passed, most of the monuments of the Missouri River Commission along the 2500-mile course of the river have slipped into obscurity and the more modern surveys made by USCGS and USGS became more familiar to surveyors. The Missouri River Commission monuments, however, are still out there and have provided a modern-day challenge to find when using descriptions that are now over a century old. The use of GPS while applying a modern conversion factor has located some of the buried triangulation stones where the surface marks no longer exist. The Missouri River Commission was discontinued by an Act of Congress on July 13, 1902, ending just 18 short years of existence.

Note: The sketches are from Appendix W of the Annual Report of the Chief of Engineers for 1885.

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