

802 - CONTRACTOR CONSTRUCTION STAKING

SECTION 802

CONTRACTOR CONSTRUCTION STAKING

802.1 DESCRIPTION

Provide land surveying and construction surveying services and set right-of-way survey monuments according to the Contract Documents, KDOT's Construction Manual and consistent with standard surveying practices.

BID ITEMS

Contractor Construction Staking
Right-of-Way Survey Monument
Benchmark Monument (Concrete Cylinder)
Monument Box

UNITS

Lump Sum
Each
Each
Each

802.2 MATERIALS

a. General. Provide the necessary materials to complete the specified surveying services. Provide materials and equipment that comply with the current requirements of the Kansas Statutes, Kansas State Board of Technical Profession's Regulations and the Contract Documents.

b. Benchmark Discs. Provide standard manufacture 2 inch diameter, domed, metal (either brass or bronze) survey monuments to be set in concrete. Factory stamp the discs as shown:



Refer to **subsection 802.3.c.(5)** for individual stamping requirements.

c. Concrete. Use commercial grade concrete that complies with **DIVISION 400**. Volumetric proportioning and hand mixing of concrete is permitted for concrete footings where small quantities are required.

d. Miscellaneous Materials. Provide the following miscellaneous materials:

- Commercially available steel posts that comply with the physical requirements for steel delineator posts, **DIVISION 1600**;
- 3 inch x 8 inch x 16 gage metal sign blanks;
- Commercially available galvanized 2 inch x 5/16 inch bolts, with 2 flat washers, 1 lock washer and 1 nut per bolt;
- Commercially available 5/8 inch x 30 inch reinforcing steel bars (non-coated); and
- Other miscellaneous materials for R/W Survey Monuments detailed in the Contract Documents.

e. Monument Box. Provide a monument box of the brand and type of the type shown in the Contract Documents.

f. Acceptance of Materials. The Engineer will accept materials for the specified surveying services, right-of-way survey monuments, miscellaneous materials and monument boxes based on compliance with dimensional and other specified requirements and visual inspection for condition.

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802.3 CONSTRUCTION REQUIREMENTS

a. General.

(1) With the Engineer's approval, the Contractor's surveying operations may begin after the contract is signed, but prior to issuing the Notice to Proceed.

(2) Surveying Personnel. Before performing any surveying operations on the project, inform the Engineer of the Contractor's personnel responsible for land surveying, construction surveying and staking. Provide a Land Surveyor, trained and experienced in the construction staking and licensed by the Kansas State Board of Technical Professions according to Kansas Statutes to perform the required land surveys, the setting of all section corners, right-of-way survey monuments and reference point monuments set on the right-of way lines.

(3) Provide surveying equipment that complies with the following tolerances:

- Slope Staking: Horizontal and Vertical tolerance of ± 0.10 feet (per KDOT Construction Manual - Cross Sections 3.06.02). Use a GPS system, a Total Station, or a Level & Transit.
- Finish Staking: (grade hubs, string lines etc.) and Structures: Horizontal = ± 0.05 feet; Vertical = ± 0.01 feet (per KDOT Construction Manual - Finishing Stakes 3.09.01 and 3.09.02). For Horizontal, use a GPS system or a Total Station. For Vertical, use a Level.
- Critical Bridge Member Staking: Horizontal = ± 0.02 feet; Vertical = ± 0.01 feet (Vertical as per Construction Manual - Finishing Stakes 3.09.01 and 3.09.02). For Horizontal, use a GPS system or a Total Station. For Vertical, use a Level. See **subsection 802.3c.(2)** for Critical Bridge Member Staking.
- Right of Way Survey Monuments: For relative precision of all R/W Survey Monuments, comply with the precision expressed in the Kansas Minimum Standards for Boundary Surveys from the project coordinate data. Use a GPS system or Total Station.
- Project Control Points: The relative precision of any project control point ± 0.05 feet from the project coordinate data. Use a GPS system or Total Station.
- Field Notes: For all land surveying and construction staking, record 2 measurements for verification in the field notes for all PLSS corners and all project control points.
- GPS equipment: Take 2 GPS measurements at a minimum interval of 2 hours with the base station at 1 or 2 project control points. Include in the field survey notebooks a copy of the site calibration. The site calibration includes an area extending a minimum of 200 feet beyond the beginning and ending of the project and the construction limits furthest offset to the left and right of the project centerline. Take a minimum of 4 calibration points or as directed by the Engineer. Use the sum of the maximum residual of the site calibration and the delta of the point being staked.
- Total Stations: To verify the tolerances, record total station measurements from 2 project control points (set-up or backsight) to the point being established. Use the average of the 2 resulting coordinate values for the point being staked for the specified tolerances.
- Levels: Record in the field notes a turn through each project benchmark as they are encountered during staking activities (per KDOT Construction Manual - Elevations 3.23.05).

(4) Before proceeding with the field surveys, provide the Engineer with a written report of any errors or apparent discrepancies found in previous surveys or the Contract Documents. The Engineer will provide the corrections or necessary interpretations.

Correct any deficient engineering layout or construction work that is the result of inaccuracies in the Contractor's surveys or staking operations, or the failure to report inaccuracies found in the work previously done by KDOT, at no additional cost to KDOT.

(5) The Engineer will perform final checks, measurements and surveys involving the determination of any pay quantities. The Engineer may check the accuracy and control of the Contractor's construction staking at any time throughout the duration of the project.

b. Land Surveying.

(1) Before any construction activity starts in the immediate area of an endangered Public Land Survey System (PLSS) corner, recover all endangered section corners and accessories of the PLSS on the project. Endangered PLSS corners are those as defined by Kansas Statutes and/or shown in the Contract Documents as lying within the range from the project centerline to a distance 100 feet outside the construction limits, throughout the length of the project. Establish a minimum of 6 reference ties for each endangered PLSS corner. Each reference tie shall be a direct measurement to a precise (hard defined) point. Specify slope or horizontal measurement.

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Complete a Land Survey Reference Report marked as a "Notice of Endangerment Activity" for each endangered PLSS corner. File the reports with the appropriate governmental custodian responsible for maintaining those records, as required by Kansas Statutes. Provide the Engineer with copies of the completed reports.

(2) Before any construction activity starts in the immediate area, clearly establish the right-of-way as shown in the Contract Documents. If the R/W Survey Monuments are set initially, determine each monument's position with the project coordinates, project stationing and offset. Provide the Engineer with a written report of each monument's position for each R/W Survey Monument set supplementary to those shown in the Contract Documents including additional monuments, monuments requested by the Engineer and monuments offset near obstructions.

(3) Recover and verify, or reset all of the PLSS corners previously reported as endangered PLSS corners. Verify the top of all PLSS corners monuments are $\frac{1}{4}$ to $\frac{1}{2}$ inch below the finish grade on concrete pavement and 4 to 6 inches below the finish grade on asphalt pavement. Establish a minimum of 6 reference ties for each of the PLSS corners. Each reference tie shall be a direct measurement to a precise (hard defined) point. Specify slope or horizontal measurement.

Complete a Land Survey Reference Report marked as a Notice of Completion of Endangerment Activity and Report of Restoration for each restored PLSS corner previously reported as endangered. File the reports with the appropriate governmental custodian responsible for maintaining those records, as required by Kansas Statutes. Provide the Engineer with copies of the completed reports.

(4) Before the completion of project construction, set all of the R/W Survey Monuments shown in the Contract Documents. If the R/W Survey Monuments were set initially, visually inspect each R/W Survey Monument to determine if it was either disturbed or destroyed. Reset all of the R/W Survey Monuments that are determined as disturbed or destroyed, at no cost to KDOT. Determine each reset monument's position with both the project coordinates and the project stationing and offset. Provide the Engineer with a written report of all right-of-way survey monuments set.

c. Construction Surveying and Staking.

(1) General.

- Check alignment and reference or re-reference all necessary control points.
- Establish or re-establish project centerline.
- Run a level circuit to check or re-establish plan benchmarks; set other benchmarks as needed.
- Take original cross-sections that are not incorporated in the plans.
- Stake or re-stake right-of-way where needed (to be done by a Licensed Professional Land Surveyor).
- Perform all construction layout and reference staking necessary for the proper control and satisfactory completion of all structures, grading, paving, drainage and all other appurtenances required for the completion of the work and acceptance of the project.

(2) Bridge. Set project control points (alignment and elevation references and offsets for abutments and pier bents) under the supervision of a Licensed Professional Land Surveyor. A Licensed Professional Land Surveyor will perform an independent check of the initial survey. The Contractor may stake the control points for critical bridge elements including, but not limited to piling, drilled shafts, and spread footings. A different Licensed Professional Land Surveyor (from either the same surveying company or another surveying company) will check the accuracy of the location of the control points for critical bridge elements. Resolve discrepancies before constructing the bridge elements. After the critical bridge elements have been constructed, the Licensed Professional Land Surveyor who checked the Contractor will verify the locations and elevations of the critical bridge elements. The original survey and the check survey shall agree within the tolerances for that bridge element allowed in the Contract Documents. Report any discrepancies in excess of the tolerances to the Engineer.

(3) Documentation. Provide and maintain a current copy of all field survey notebooks at the project site at all times. Produce the original field survey notebooks for inspection upon request by the Engineer. Include a detailed list of any abbreviations, codes, formatting or other nomenclature contained in the notebooks to facilitate clarity of the notes. Provide either one or a combination of both of the following types of notes, as directed by the Engineer:

- Provide standard, bound field notebooks where the handwritten field notes are indexed and kept in a clear, orderly and neat manner consistent with standard surveying practices and according to KDOT's procedures.

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- Provide a legible ASCII file for electronic field notes where the “theoretical (calculated) point” can be checked against the “established point” set in the field. This method allows for a check of the inverse distance and direction for error tolerance. This procedure should be utilized for points with elevations. Before any construction staking begins, the procedures for all electronic field notes must be approved by the Engineer.

(4) Monuments. Upon completion of the surfacing, recover and verify or reset all of the field survey monuments (such as P.I.’s, P.O.T.’s, P.C.’s, P.T.’s, P.O.S.T.’s,) on the project centerlines or baselines, as shown in the Contract Documents. Verify that the top of the field survey monuments are set a maximum of ½ inch below the finish grade on concrete pavement, or a maximum of 6 inches below the finish grade on asphalt pavement. Verify the accuracy of the locations of all field survey monuments versus those of the project centerlines or baselines shown in the Contract Documents. Establish a minimum of 4 reference ties for each of the field survey monuments on the project centerlines or baselines.

(5) Reports. Provide a written report to the Engineer indicating the descriptions of all field survey monuments and their 4 reference ties, regardless if the information in the Contract Documents was revised or not. Include in the report “station calls” for each of the field survey monuments (such as P.I.’s, P.O.T.’s, P.C.’s, P.T.’s, P.O.S.T.’s) on the project centerlines or baselines shown in the Contract Documents.

Recover and verify all of the project benchmarks shown in the Contract Documents. Establish permanent replacement benchmarks for all project benchmarks that were destroyed during the construction using one of these methods:

- A benchmark disc “set in place” on new concrete structure.
- A benchmark disc “drilled and grouted” on existing concrete structure.
- A benchmark disc set in the top of a reinforced concrete cylinder (6 inch diameter x 4 foot depth into the ground, minimum) cast in place.
- As directed by the Engineer.

Stamp the benchmark caps with the “Project Number” and the permanent replacement benchmark number as a letter designation following the benchmark it is replacing (i.e.: destroyed BM #21 is replaced by BM #21A). Without exception verify that the maximum spacing between benchmarks is a maximum of 30 feet in vertical difference, 500 feet in horizontal distance in urban areas or 1500 feet in horizontal distance in rural areas.

Provide the Engineer with a written report of all post project benchmarks, listing the benchmark number, elevation, project stationing and offset, and a complete description of the monument type and its physical location. Include in the report, all of the remaining benchmarks shown in the Contract Documents, the permanent replacement benchmarks and the remaining additional “construction benchmarks” used for the staking of the project. Do not include in the report any “temporary benchmarks” used for the construction staking of the project that are classified as “temporary” or “degradable” in nature.

d. Right-of-Way Survey Monuments. Set all right-of-way survey monuments on and along the KDOT right-of-way lines at these locations:

- All P.I. locations along normal/tangent sections.
- All P.C. and P.T. locations along curved sections.
- At an offset where a physical obstruction impedes the exact location.

Set all Reference Point monuments on and along KDOT right-of-way at these locations:

- At points a maximum of 1320 feet apart where the right-of-way is straight, or on a continuous horizontal curve of constant radius.
- At the crest of a sharp hill or the shoulders of a large/rounded hill.
- At radial/perpendicular lines to all horizontal changes in the project centerline alignment (i.e., P.C. and P.T. offsets).
- As directed by the Engineer.

Set all right-of-way survey monuments according to the Contract Documents.

Fasten the R/W sign to the witness post in this sequence: bolt, flat washer, sign, post, flat washer, lock washer and nut.

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When conditions warrant, the Engineer may adjust the specified depth. When it is impossible to set a right-of-way survey monument at the exact point because of an obstruction, set the right-of-way survey monument along the right-of-way line, or the extended right-of-way line, on both sides of the obstruction. Use 1 foot increments for the offset distance from the exact point to the set monument. Field stamp the aluminum cap "O/S" either below or to the right of the "R/W" stamping.

Provide the Engineer with a complete list of the locations of all right-of-way survey monuments set.

e. Concrete Footings. When required, construct footings of commercial grade concrete according to the Contract Documents.

Extend the top of the footing slightly above the ground line and steel trowel to a smooth finish with a slope to drain away from the post.

f. Monument Box. When required, install the monument box and survey marker by a Licensed Professional Land Surveyor as shown in the Contract Documents.

If the monument box is installed in concrete pavement, use the same mix as used in the pavement.

g. As-Built Construction Plans and Survey Notebooks. Upon completion of the project, provide the Engineer with a set of as-built construction plans with the following information:

- The monument descriptions and the 6 reference ties for all restored PLSS corners.
- The monument descriptions and the 4 reference ties for all field survey monuments on the project centerline or baseline.
- The project stationing and offset of the final position of every right-of-way survey monument and project alignment reference point that was set.
- The permanent replacement benchmarks and remaining construction benchmarks with benchmark number, project station and offset, elevation and description.

Deliver the original field survey notebooks to the Engineer upon completion of the project.

802.4 MEASUREMENT AND PAYMENT

The Engineer will measure each right-of-way survey monument, benchmark monument (concrete cylinder) and monument box as a unit. Contractor construction staking will be measured by the lump sum.

The Engineer will make partial payments according to **TABLE 802-1**. The Engineer may adjust the **TABLE 802-1**, based on Contractor's progress and project complexity.

TABLE 802-1: CONSTRUCTION STAKING PAYMENT SCHEDULE	
Percent of Original Contract Amount Completed	Percent of Bid Item Paid
Work Started	25%
5%	40%
25%	60%
50%	80%
70%	95%
All field books and records have been submitted to the Engineer.	100%

The Percent of Original Contract Amount Completed = the amount earned by the Contractor divided by the total dollar value of the original contract (all bid items).

Payment for "Contractor Construction Staking", "Right-of-Way Survey Monument", "Benchmark Monument (Concrete Cylinder)" and "Monument Box" at the contract unit prices is full compensation for the specified work.