650 Construction Staking

650.1 Description

(1) This section describes the contractor-performed construction staking, or automated machine guidance (AMG) methods, required under individual contract bid items to establish the horizontal and vertical position for the following:

Storm sewer	Subgrade	Base
Curb, gutter, and curb & gutter	Pipe culverts	Structure layout
Concrete pavement	Concrete barrier	Resurfacing reference
Electrical installations	Supplemental Control	Slope Stakes
Curb Ramps	Sidewalk	

650.2 (Vacant)

650.3 Construction

650.3.1 General

(1) Department and contractor responsibilities for construction staking are specified in 105.6. Conform to 105.6 and the additional requirements specified here in 650.3 for the individual contractor-staking bid items the contract includes.

(2) Protect and preserve known property and survey marks and land monuments as specified in 107.11.3. The contract may require related work under the 621 bid items.

(3) Obtain or calculate benchmark data, grades, and alignment from plan information. The engineer will furnish data for the horizontal and vertical control points, control point ties, horizontal alignments, profiles, and elevations. Reestablish, set additional, and maintain the horizontal and vertical control points and control point ties, as needed for bid items.

(4) Check horizontal and vertical information including but not limited to alignments, locations, elevations, and dimensions, that either the plans show or the engineer provides, for compatibility with existing field conditions. Conduct similar compatibility checks and accuracy checks of horizontal and vertical positions either the department or the contractor establishes in the field.

(5) Perform survey work using conventional methods or AMG methods capable of achieving the lines and grades the plans show for the work in question. Establish additional benchmarks and control points as necessary to support the method of operation.

650.3.1.1 Staking

(1) Furnish, set, reference, and maintain stakes and markings necessary to establish the alignment, location, benchmarks, elevations, and continuous profile-grades for road and structure work as needed for bid items. Supervise and coordinate construction staking.

(2) Maintain neat, orderly, and complete survey notes, drawings, and computations used in establishing the lines and grades. Make the survey notes and computations available to the engineer within 24 hours, upon request, as the work progresses.

(3) Furnish surveying equipment, stakes, flags, pins, lath, whiskers, and other materials necessary to perform this work, subject to the engineer’s approval.

650.3.1.2 Automated Machine Guidance

650.3.1.2.1 General

(1) The contractor may substitute AMG for conventional staking on all or part of the work under the individual staking bid items. Coordinate with the engineer throughout the course of construction to ensure that work performed using AMG conforms to the contract tolerances and that the methods employed conform to the contractor's AMG work plan and accepted industry standards. Revert to conventional staking methods for all or part of the work at any point during construction if AMG is producing unacceptable results.

650.3.1.2.2 AMG Work Plan

(1) Submit a comprehensive written AMG work plan for department review at least 5 business days before the preconstruction conference. In that plan discuss how AMG technology will be integrated into other technologies employed on the project. List the staking bid items that will have work performed using AMG and, for each bid item listed, include the following:

1. Designate which portions of the contract will be done using AMG and which portions will be done using conventional staking.
2. Designate a single staff person as the primary contact for AMG technology issues.
3. List and map the primary and secondary control points required under 105.6.2 enveloping the site.

4. Describe the contractor's quality control procedures. Include the frequency and type of checks performed to ensure that the work conforms to the contract plans.

(2) The engineer will review the plan to determine if it conforms to the contract. Do not perform AMG work until the engineer approves the governing portion of the AMG workplan. Perform the work as the contractor's AMG work plan provides. Update the plan as necessary.

650.3.1.2.3 Geometric and Surface Information

650.3.1.2.3.1 Department Responsibilities

(1) At any time after the contract is awarded the contractor may request the contractor data packet. The department will provide the packet within 5 business days of receiving the contractor's request.

650.3.1.2.3.2 Contractor Responsibilities

(1) Develop and maintain a contractor construction model for areas of the project employing AMG. Confirm that the resulting model agrees with the contract plans.

(2) If the engineer requests, provide the construction model to the department in LandXML or other engineer-approved format.

650.3.1.2.4 Managing and Updating Information

(1) Notify the department of any errors or discrepancies in department-provided information. The department will determine what revisions may be required. The department will revise the contract plans, if necessary, to address errors or discrepancies that the contractor identifies. The department will provide the best available information related to those contract plan revisions.

(2) Revise the construction model as required to support construction operations and to reflect any contract plan revisions the department makes. Perform checks to confirm that the revised construction model agrees with the contract plan revisions. If the engineer requests, provide construction model updates to the engineer. The department will pay for costs incurred to incorporate contract plan revisions as extra work.

650.3.1.2.5 Construction Checks

(1) Check the work against the plan elevation at randomly selected points on cross-sections located at stations evenly divisible by 100 at the frequency the engineer approved as a part of the AMG work plan. Submit the results of these random checks to the engineer daily. Notify the engineer immediately if a check exceeds the tolerances specified in 650.3.1.2.6 below.

(2) Check the work at additional points as the engineer directs. The department may conduct periodic independent checks.

650.3.1.2.6 Construction Tolerances

(1) Ensure that the finished work vertically matches existing or other completed features. Ensure that the work conforms to revised plan elevations as follows:

- Subgrade: +/- 0.10 feet.
- Base: within the tolerance specified in 301.3.4.1(2).

650.3.2 Storm Sewer Staking

(1) Set and maintain construction stakes or marks as necessary to achieve the required accuracy and to support the method of operations. Locate pipe, inlet, catch basin, manhole, and endwall construction stakes to within 0.02 feet horizontally and establish the elevations to within 0.01 feet vertically. Determine that the final elevations of storm sewer pipe outfalls and inlets match the existing field elevations, and provide this information to the engineer at a mutually agreed upon date or least 14 calendar days before ordering inlets, catch basins, manholes, endwalls, and storm sewer pipe.

650.3.3 Subgrade Staking

(1) Set construction stakes or marks at intervals of 100 feet, or more frequently, for rural sections and at intervals of 50 feet, or more frequently, for urban sections. Include additional stakes at each cross-section as necessary to match the plan cross-section, achieve the required accuracy, and to support construction operations. Also set and maintain stakes as necessary to establish the horizontal and vertical positions of intersecting road radii, auxiliary lanes, horizontal and vertical curves, and curve transitions. Locate stakes to within 0.25 feet horizontally and establish the grade elevation to within 0.03 feet vertically.

650.3.4 Base Staking

(1) Set construction stakes or marks at 100-foot intervals for rural sections and 50-foot intervals for urban sections. Set and maintain sufficient stakes at each cross-section to match plan cross-section, achieve the required accuracy, and to support the method of operations. Set and maintain stakes as necessary

to establish horizontal and vertical position along intersecting road radii, auxiliary lanes, vertical and horizontal curves, and curve transitions. Locate stakes within 0.25 feet horizontally and establish the grade elevation to within 0.03 feet vertically.

650.3.5 Curb, Gutter, and Curb & Gutter Staking

(1) Set construction stakes or marks at 50-foot intervals, maximum. Set and maintain stakes as necessary to achieve the required accuracy and to support the method of operations. Set additional construction stakes as necessary to establish location and grade of curb, gutter, and curb & gutter, including points where the alignment or grade changes, along intersecting radii, and at the radius points of intersecting road radii. Locate stakes to within 0.02 feet horizontally and establish elevations to within 0.01 feet vertically.

650.3.6 Pipe Culvert Staking

(1) Set and maintain construction stakes or marks as necessary to achieve the required accuracy and to support the method of operations. Locate stakes for pipe culverts and appurtenant inlets and catch basins to within 0.25 feet horizontally and establish the grade elevation to within 0.03 feet vertically. If installing pipe culverts at existing drainage ditches, verify the existing ditch location, elevations, and skew for a minimum of 150 feet from pipe ends, and provide this information to the engineer at a mutually agreed upon date or 14 calendar days before ordering pipe culverts.

650.3.7 Structure Layout Staking

(1) Set construction stakes or marks on a line offset from the structure centerline or on a reference line, whichever is appropriate, for both roadway and substructure units. Establish the plan horizontal and vertical positions to the required accuracy. Also, set and maintain stakes and marks as necessary to support the method of operations. Locate stakes and marks to within 0.02 feet of the true horizontal position, and establish the grade elevation to within 0.01 feet of true vertical position.

(2) For girder bridges, the department will compute deck grades with contractor-supplied girder elevation data.

(3) For slab span bridges, the department will compute slab grades using contractor-supplied falsework settlement and deflection data at tenth points along slab edges, the crown, and reference line locations. Before releasing falsework, survey top-of-slab elevations at the centerline of the abutments and at the 5/10th point along slab edges, the crown, and reference line locations to verify the camber.

650.3.8 Concrete Pavement Staking

(1) Set construction stakes or marks at 25-foot intervals. Set and maintain additional stakes as necessary to establish location and grade along intersecting road radii; and for auxiliary lanes, vertical curves, horizontal curves, and curve transitions according to the plans. Locate stakes to within 0.02 feet horizontally and establish elevations to within 0.01 feet vertically. Set and maintain sufficient additional stakes at each cross-section to achieve the required accuracy and to support the method of operations.

650.3.9 Concrete Barrier Staking

(1) Set construction stakes or marks at 50-foot intervals, maximum. Set and maintain additional stakes as necessary to establish location and grade of concrete barrier including points where the grade changes, along intersecting radii, and at the radius point of intersecting radii to achieve the required accuracy and to support the method of operations. Locate stakes to within 0.02 feet horizontally and establish the grade elevation to within 0.01 feet vertically.

650.3.10 Resurfacing Reference Staking

(1) Set construction stakes for pulverized and re-laid pavement before beginning milling operations. Place construction stakes or pins for offsetting the roadway reference line at 100-foot intervals, minimum, or as the engineer directs.

(2) Place construction stakes or marks for other types of resurfacing work at 300-foot intervals, minimum, or as the engineer directs.

(3) Set and maintain additional stakes as necessary to establish location and grade along intersecting road radii, auxiliary lanes, and curve transitions according to the plans.

650.3.11 Electrical Installation Staking

(1) Set and maintain construction stakes or marks as necessary to achieve the required accuracy and to support the method of operations. Locate stakes to within 0.02 feet horizontally and to establish the grade elevation to within 0.01 feet vertically.

650.3.12 Supplemental Control Staking

(1) Set and maintain construction marks as required to support the method of operations consistent with third-order, class I horizontal and third-order vertical accuracy. Check the department-provided horizontal and vertical control information and notify the engineer of any discrepancies. Provide marks to establish and maintain intermediate vertical and horizontal control for reference line alignment, side road alignments, radius points, bench level circuits, and offsetting the horizontal roadway alignment. These marks constitute the field control used to govern and prosecute the work.

(2) Document and provide to the engineer complete descriptions and reference ties of the control points, alignment points, and benchmarks to allow for quick reestablishment of the plan data at any time during construction and upon project completion. Document additional control on department forms DT1291 and DT2262 as described in CMM 710, table 710-1.

650.3.13 Slope Staking

(1) Verify the existing ground elevations as shown for roadways on cross-section sheets for accuracy. Take and document a minimum of 7 shots per roadway section, one at the centerline or at an engineer-approved offset from the centerline and 3 on each side of the roadway. For the shots on the roadway sides, take one shot at the subgrade shoulder point, one shot at the slope stake, and one shot at the slope intercept. If the elevation at the slope intercept is off by more than 0.4 foot, notify the engineer.

(2) Set and maintain slope stakes on each side of the road at each cross-section location the plans show. Locate stakes to within 0.25 feet horizontally and establish elevations to within 0.1 feet vertically. Stake additional clearing & grubbing and marsh excavation limits.

650.3.14 Curb Ramp Staking

(1) Set and maintain construction stakes as necessary to establish the location and grade of curb ramps and the adjacent sidewalk. Locate stakes to within 0.02 feet horizontally and establish the grade elevation to within 0.01 feet vertically. Adjust elevations as required to conform to the plans.

650.3.15 Sidewalk Staking

(1) Set construction stakes or marks at 50-foot intervals, maximum. Set and maintain stakes as necessary to achieve the required accuracy and to support the method of operations. Set additional construction stakes as necessary to establish location and grade of sidewalk, including points where the alignment, grade or cross slope changes, along intersecting radii, at intersecting driveways, and at the radius points of intersecting road radii. Locate stakes to within 0.02 feet horizontally and establish elevations to within 0.01 feet vertically.

650.4 Measurement

(1) The department will measure the Construction Staking bid items for subgrade, base, concrete pavement, resurfacing reference, and slope stakes by the linear foot acceptably completed, measured along each roadway centerline. The department will not measure staking for base underlying concrete pavement.

(2) The department will measure Construction Staking Curb Gutter and Curb & Gutter by the linear foot acceptably completed, measured along the base of the curb face. The department will measure Construction Staking Concrete Barrier by the linear foot acceptably completed, measured along the base of the barrier. The department will not measure these bid items if abutting concrete pavement.

(3) The department will measure the EACH bid items under this section as each individual unit acceptably completed as follows:

- Construction Staking Storm Sewer: as each individual inlet, catch basin, manhole, and endwall.
- Construction Staking Pipe Culverts: as each individual pipe culvert.
- Construction Staking Structure Layout: as each individual structure.
- Construction Staking Electrical Installations: as each individual project.
- Construction Staking Curb Ramps: as each individual curb ramp opening with location-specific layout information that includes elevations in the plan details.
- Construction Staking Sidewalk: as each individual project.
- Construction Staking Supplemental Control: as each individual project.

650.5 Payment

(1) The department will pay for measured quantities at the contract unit price under the following bid items:

ITEM NUMBER	DESCRIPTION	UNIT
650.4000	Construction Staking Storm Sewer	EACH
650.4500	Construction Staking Subgrade	LF
650.5000	Construction Staking Base	LF
650.5500	Construction Staking Curb Gutter and Curb & Gutter	LF
650.6000	Construction Staking Pipe Culverts	EACH
650.6501	Construction Staking Structure Layout (structure)	EACH
650.7000	Construction Staking Concrete Pavement	LF
650.7500	Construction Staking Concrete Barrier	LF
650.8000	Construction Staking Resurfacing Reference	LF
650.8501	Construction Staking Electrical Installations (project)	EACH
650.9000	Construction Staking Curb Ramps	EACH
650.9500	Construction Staking Sidewalk (project)	EACH
650.9911	Construction Staking Supplemental Control (project)	EACH
650.9920	Construction Staking Slope Stakes	LF

(2) The department will not make final payment for any staking item until the contractor submits survey notes and computations used to establish the required lines and grades to the engineer within 21 days of completing this work. The department will deduct from payments due the contractor for the additional costs specified in 105.6.

(3) Payment for the Construction Staking bid items is full compensation for locating and setting construction stakes; for adjusting stakes to ensure compatibility with existing field conditions; and for relocating and resetting damaged or missing construction stakes.

(4) Payment for Construction Staking Supplemental Control also includes resetting damaged or missing preliminary construction stakes, and protecting and reestablishing the alignment of roadways.

(5) Payment for Construction Staking Storm Sewer also includes setting construction stakes as necessary for storm sewer pipe associated with each inlet, catch basin, manhole, or endwall staked.

(6) Payment for Construction Staking Pipe Culverts also includes setting construction stakes for appurtenant inlets and catch basins as necessary associated with each pipe culvert staked.