

SECTION 01721

SURVEY

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Schedule, coordinate, and provide all construction surveying, staking, measurement and calculations (including measurement and calculation of quantities for contract pay items measured or paid for by area or volume) essential to complete the project and properly control the entire work.
- B. Directed surveying as requested by the Engineer.

1.2 RELATED SECTIONS

- A. Section 02765: Pavement Marking Paint

1.3 MEASUREMENT PROCEDURES

- A. Directed Survey: If extra survey work is needed, a 2-Person Crew measured by the hour authorized. Department makes no additional payment for travel time to and from the project.
- B. Directed Survey: If extra survey work is needed a 3-Person Crew measured by the hour authorized. Department makes no additional payment for travel time to and from the project.

1.4 PAYMENT PROCEDURES

- A. If contract does not include separate pay item for survey, include the costs in all items of work that require survey. Failure to comply with any portion of this specification may result in withholding up to 25 percent of contract payments until the deficiencies are corrected.
- B. If needed and approved, directed survey work paid for in the accepted quantities at the following rates:

2 person survey crew	\$130.00 per hour
3 person survey crew	\$155.00 per hour
1 person computation and /or CAD	\$ 65.00 per hour

- C. The number of hours required for computations and/or drafting in total cannot exceed 33 percent of actual survey hours, established on a percent basis prior to directed survey work starts.

1.5 SUBMITTALS

- A. The Department requires that a Professional Engineer or Professional Land Surveyor registered in the State of Utah sign and seal all submittals.
- B. Resubmittals may be required depending on completeness and correctness of the work.
- C. Prior to beginning work, submit a statement indicating all Department-provided horizontal and vertical control have been field checked and the control has been determined to be accurate within the tolerances specified in this section. Attach field survey information used to verify control. If discrepancies are found, notify the Engineer verbally and in writing.
- D. Prior to beginning work, provide a written description of the equipment (including calibration certifications), manpower, methods, and data storage format proposed for use to complete all survey activities.
- E. Record keeping: Keep all field notes, diaries, and books according to standard surveying practice.
 - 1. Loose leaf books not acceptable.
 - 2. Make available at any time all survey records including field notebooks and forms used for the work to the Engineer upon verbal or written request.
- F. Submit electronic files, plots and calculations of appropriate contract pay item quantities to the Engineer for review and approval, a minimum of 3 working days prior to the pre-determined estimate cut-off date.
- G. After project completion, return to the Engineer all surveying and design data and provide a red-lined hard copy plan set showing as-constructed features denoting changes from the original design.

1.6 QUALITY ASSURANCE

- A. Contractor is responsible for survey and control of the work, and for correcting Contractor errors, whether the errors are discovered during the actual survey work or in subsequent phases of the project. Bear any cost overruns resulting from Contractor errors.

- B. Perform all work in accordance with the plans and specifications and standard Engineering and Surveying practices under the responsible charge of a Professional Engineer or Professional Land Surveyor duly and properly registered in Utah.
- C. The Engineer may spot check the work for accuracy and may reject unacceptable portions of work. Resurvey rejected work and correct work that is not within the specified tolerances at no additional expense to the Department.

PART 2 PRODUCTS

2.1 EQUIPMENT

- A. Furnish tools, supplies, and stakes suitable for use in highway survey work.
- B. Furnish stakes and hubs of sufficient length to provide a solid set in the ground with sufficient surface area above ground for necessary legible markings.
- C. Furnish survey instruments and supporting equipment capable of achieving the specified tolerances. Calibrate survey equipment for accuracy prior to beginning survey work and as required.

PART 3 EXECUTION

3.1 PREPARATION

- A. Discuss and coordinate the following with the Engineer before survey work begins:
 - 1. Required submittals
 - 2. Survey and staking methods
 - 3. Stake markings
 - 4. Grade control
 - 5. Referencing
 - 6. Structure control
 - 7. Any other procedures and control necessary for the work
 - 8. Documentation procedures

- B. Establish construction survey points, elevations and grades as necessary to control layout and complete the work. Verify all control surveying and staking meets specified tolerances for prior to beginning work.
- C. Calculate all grades, elevations, offsets and alignment data necessary for staking and/or setting items of work. Obtain approval from the Engineer for alternate methods of establishing grade control with wire lines, computer or laser controlled grading or other suitable methods.
- D. Provide appropriate traffic control for all survey activities.
- E. The Department furnishes:
 - 1. Plans showing locations of control points
 - 2. Plans showing locations of Bench Marks
 - 3. Cross sections developed during design, if any
 - 4. Electronic project data, if any
 - 5. Digital Terrain Model used for design, if any

CONTRACT PROVISION DISCLAIMER

RELEASE OF UDOT DATA: Contractor may obtain an electronic copy of the Data Points prepared by UDOT. UDOT provides data points in Microstation and/or Inroads format only. Contractor responsible for translation into other formats. This data does not include the commercial software needed to read the points. In order to obtain an electronic copy, Contractor makes a written request to the Engineer. Contractor agrees and understands that the data points are prepared by UDOT for its own purposes and not for the benefit of private individuals or businesses. Contractor waives any and all claims that may result from the use of or reliance upon the data points. Contractor indemnifies UDOT and holds it harmless for any damages, costs, attorneys' fees, or other liabilities that might be incurred as a result of the Department's use and reliance on the data.

3.2 DIRECTED SURVEY

- A. Conduct directed surveying if requested by the Engineer.
 - 1. Includes work needed for changes and extra work. Provide all labor, materials, and equipment including global positioning satellite equipment.
 - 2. Obtain prior written authorization from the Engineer documenting the affected work and requirements before performing work under these items.

3.3 COMPUTATIONS AND PLOTS

- A. Use cross-sections to calculate volume measurements.
 - 1. Superimpose final cross sections with original cross sections and calculate final quantities using the average end area method.
 - 2. Develop cross-sections from field measurements.
 - a. Take cross section measurements both before and after excavation and prior to backfill.
 - b. When the centerline curve radius is less than or equal to 500 ft, take cross sections at a maximum centerline spacing of 25 ft.
 - c. When the centerline curve radius is greater than 500 ft, take cross sections at a maximum spacing of 50 ft.
 - d. Take additional cross sections at breaks in terrain and at changes in typical sections.
 - e. For each cross section, measure and record points at breaks in terrain, but at least every 25 ft unless otherwise approved by the Engineer.
 - f. Measure and record points to at least the anticipated slopes and reference locations.
 - g. Reduce all cross section distances to horizontal distances from centerline.
 - h. Take cross sections at right angles to tangents and normal to curves.
 - i. Include in cross sections all grades, locations, and existing ground line profiles.
 - 3. May develop cross sections from digital terrain models provided that:
 - a. The ground survey locations do not exceed 100 ft in any direction
 - b. Major breaks in terrain are also included.
 - c. The horizontal and vertical control for the project is used
 - d. The DTM is verified accurate to require tolerances by spot checking throughout the length of the project.
- B. Engineer may approve alternate methods of calculating quantities.
- C. When requesting additional compensation on the basis of adjustment to quantities in the bid proposal for items paid as “plan quantity,” provide all computations, plots, and supporting documentation necessary for the Engineer to evaluate and verify adjusted quantities.
 - 1. All work associated with providing computations, plots, and supporting documentation is at no cost to the Department, except:
 - a. When the Engineer revises plan dimensions. Refer to Section 01280.
 - b. When the adjusted quantity differs from the plan quantity by more than 10 percent, work required to provide computations, plots, and supporting documentation will be paid for as extra work.

3.4 STAKE MAINTENANCE AND MARKING

- A. Maintain ALL staking necessary for the work until the construction has been completed and accepted by the Engineer.
 - 1. Legibly mark all survey stakes with station and offset referenced to their respective control line.
 - 2. Mark slope, reference and guard stakes with station.
 - 3. Renew illegible stakes at no additional cost to the Department.
- B. Provide and maintain reference stakes that identify stationing at least every 100 ft until all work has been completed and accepted by the Engineer.

3.5 CONTROL POINTS AND SURVEY TOLERANCES

- A. Relocate initial horizontal and vertical control points in conflict with construction to areas that will not be disturbed by construction operations. Furnish the coordinates and elevations for the relocated points before the initial points are disturbed.
- B. Protect benchmarks from construction activities. Position all benchmarks to allow a level rod to stand vertically and squarely on the mark. Reference benchmarks to centerline and horizontal measurements.

C. Survey and establish control within the following tolerances:

Description	<u>Horizontal</u>	<u>Vertical</u>
	Decimals of a foot	
Control points	± 0.01	± 0.01
Centerline points	± 0.03	± 0.02
Cross sections and slope stakes	± 0.10	± 0.10
Slope stake references	± 0.10	± 0.10
Culverts and Ditches	± 0.10	± 0.05
Minor drainage structures	± 0.10	± 0.03
Curb and gutter	± 0.02	± 0.02
Guardrail and concrete barrier	± 0.05	± 0.05
Retaining walls	± 0.05	± 0.01
Bridge substructure and overall	± 0.01	± 0.01
Bridge superstructure and overall	± 0.01	± 0.01
Environmental Control Limits	± 1.00	-----
Clearing and grubbing limits	± 1.00	-----
Right of Way Limits	± 0.02	-----
Roadway subgrade finish stakes	± 0.10	meet tolerance of succeeding layer
Roadway finish grade stakes	± 0.04	meet tolerance of succeeding layer
Signals and electrical	± 0.05	± 0.02
Striping	± 0.08	-----
Paving reference line	± 0.04	± 0.01

Coordinate the survey tolerances of any items not listed above with the Engineer. Tolerances given above are subordinate to any tolerances listed in other specifications.

D. Staking limits:

1. Stake clearing limits on both sides of centerline at each established station. Locate the clearing limit on the ground as shown by the cut and fill limits on the plans.
2. Stake right of way limits every 50 ft maximum on tangents, every 25 ft maximum on curves and at all right of way breaks. If staking distance is affected by line of sight, reduce the distance.

3. Stake environmental control limits on both sides of centerline at each established station. Locate the environmental control limits on the ground as shown by the slope rounding contours and environmental and silt fence locations as shown on the Plans. Stake environmental control limits every 50 ft and every 25 ft where environmental or silt fence is required.
- E. Furnish reference stakes for all slope stakes and stakes used for setting items for work.
1. Maintain the reference stakes for the duration of the project until the Engineer approves removal.
 2. Establish and set slope stakes and references on both sides of centerline at cross section locations.
 - a. When the centerline curve radius is less than or equal to 500 ft, place slope stakes at a maximum centerline spacing of 25 ft.
 - b. When the centerline curve radius is greater than 500 ft, place slope stakes at a maximum spacing of 50 ft.
 3. Establish slope stakes in the field as the actual point of intersection of the design slope with the natural ground line.
 4. Set slope stake references outside the clearing limits.
 5. Include all reference point and slope stake information on the reference stakes.
- F. After the slope staking is completed, record on the cross section guard stakes the vertical distance from the reference point (RP) to the construction grade, at a minimum horizontal distance of 10 ft outside the clearing limits or at right of way.
- G. Setting grade finishing stakes:
1. For grade elevations and horizontal alignment:
 - a. On centerline.
 - b. On each shoulder at roadway cross section locations and between centerline and shoulder with a maximum spacing of 15 ft.
 - c. At the top of subgrade and the top of each aggregate course.
 2. Locations:
 - a. Where turnouts are constructed, set stakes on centerline, on each normal shoulder, and on the shoulder of the turnout.
 - b. In parking areas, set hubs at the center and along the edges of the parking area.
 - c. Set stakes in all ditches to be paved.
 3. Maximum spacing between stakes along the alignment: 50 ft.
 4. Use brushes or guard stakes at each grade finishing stake.
 5. Reset grade finishing stakes as many times as necessary to construct the subgrade and each aggregate course.

- H. The following Advanced Traffic Management System (ATMS) As-Built requirements apply to all ATMS device installations, that include but are not limited to Ramp Meters, Closed Circuit Television (CCTV), Variable Message Sign (VMS), Roadway Weather Information System - Environmental Sensor Station (RWIS-ESS), Weigh In Motion (WIM), and Fiber Optic Communication Systems.
1. Department:
 - a. Provide project design files to Contractor in MicroStation format.
 2. Contractor:
 - a. Carefully document all changes and updates all files to accurately represent the system as-built conditions.
 - b. Plot three sets of the updated files on 11-inch x 17-inch bond paper and submit the plots to the Engineer for review and approval.
 3. As-built drawings will not be considered complete until the Engineer has given formal approval of the plots and design files.
 4. Include the following in as-built drawings:
 - a. Site plans with distances.
 - b. Final cabinet configuration, including wiring schematic.
 - c. Pin-outs for any custom connectors.
 - d. Laminated copy of the detector layout for the site, consisting of site map and including detector numbering, locations, and input file designation.
 - e. GPS coordinates for all junction boxes, conduit runs (250 foot intervals), and ATMS devices. Include latitude, longitude, and elevation in WGS 84 format to nine decimal place precision (XXX.XXXXXXX) in coordinates.

3.6 CONCRETE PAVING

- A. Develop a method of horizontal and vertical control for the placement of concrete pavement.
1. Utilize laser, wire, or string line, for example, to maintain horizontal and vertical control.
 2. Maximum spacing: 50 ft.
 3. Set control on both sides of roadway.
- B. Stake concrete joint and station stamp locations.

3.7 DRAINAGE STRUCTURES

- A. Stake drainage structures to fit field conditions and in coordination with the Engineer. The location of the structures may differ from the plans.
1. Survey and record the ground profile along the centerline of the structure.
 2. Determine the slope catch points at inlets and outlets.

3. Set reference points and record information necessary to determine structure length and end treatments.
4. Stake ditches or grade to make the structure functional.
5. Plot the profile along centerline of the structure to show the natural ground, the flow line, the roadway section, and the structure.
6. Mark guard stakes with the following, when applicable:
 - a. Diameter, length and type of culvert (for example 18 inch x 35 ft corrugated metal pipe (cmp))
 - b. The vertical and horizontal distance from the hub to the invert at the end of the culvert or any intermediate point as needed or directed
 - c. Flow line grade of the pipe
 - d. Station
7. For storm sewers and waterlines provide a reference at a maximum spacing of 50 ft. Reference inverts of pipe at all manholes.

3.8 BRIDGES

- A. Set a minimum of 3 horizontal and vertical control reference points to be used for surveying all bridge substructure and superstructure components, including but not limited to; pile locations and cutoffs, line and grade for abutments and bents, beam seats, anchor bolts and screed grades.
- B. Set intermediate slope stakes at bridge abutments to establish transitions. Place finish grade stakes on the centerline of abutment bearing and at the top of slope of all bridge berms. Place finish grade stakes on each side at top, mid-point or slope and toe of fill.

3.9 BOX CULVERTS

- A. Set horizontal and vertical control and reference points. Establish and reference the centerline, back of parapet, skew, and flow line elevations at inlet, outlet and breaks.

3.10 CURB AND GUTTER

- A. Set curb and gutter staking at 25 ft intervals on tangent and 10 ft intervals on curve radii. Set line and grade for curb and gutter within 0.02 ft. of the proposed or established grade line.

3.11 GUARDRAIL

- A. Stake guardrail vertical and horizontal control at a maximum spacing of 25 ft on tangent sections and 10 ft on curved sections unless otherwise approved.

3.12 EXISTING SURVEY MONUMENTS

- A. Under the direction of a surveyor licensed in the State of Utah, locate and reference all private and public land survey monuments that may be destroyed by project construction activities prior to disturbing those existing monuments.
- B. Complete referencing and reestablishing those existing monuments at no cost to the Department and before project completion.
- C. In some counties the county surveyor references and reestablishes the monuments.
 - 1. Notify the county surveyor at least 30 days prior to the destruction of any monument.
 - 2. Coordinate the reestablishment of section corner and quarter corner monuments with the county surveyor.
 - 3. Submit drawings and notes showing references to section corners and quarter corners to the Engineer.
- D. If a monument is found during construction but is not shown on the contract plans and must be reset, the Department pays for the additional work under the Directed Survey item.

3.13 RETAINING WALLS

- A. Set horizontal and vertical control and reference points. Establish and reference the centerline offsets for the walls, radius points, and the beginning and ending wall locations as shown on the plans.
- B. Stake retaining wall vertical and horizontal control at a maximum spacing of 25 ft on tangent sections and 10 ft on curved sections unless otherwise approved.

3.14 PAVEMENT MARKING

- A. Layout all temporary and permanent pavement markings per Section 02765.

3.15 CLEANUP

- A. Remove and dispose of all flagging, lath, stakes and other staking material after the project is complete.
 - 1. Place references for traffic striping a minimum of 150 feet apart on tangents and a minimum of 50 feet on curves.

3.16 UTILITIES

- A. As part of cooperating with the utility companies, stake control lines as needed so their facilities can be relocated to their proper final position. Also, stake crossings or potential points of conflict between facilities to give proper horizontal and vertical control for the relocation. Schedule this survey work with the utility companies to minimize delays and disruption of survey stakes. Replace all disturbed stakes as necessary to facilitate the relocations. The Contractor is responsible for costs incurred to relocate any utility more than once due to inaccurate or incomplete staking.

END OF SECTION