SECTION 31 09 00

GEOTECHNICAL INSTRUMENTATION AND MONITORING OF EARTHWORK

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Boreholes insulations

B. Observation wells

C. Inclinometer system

D. Type 1 settlement marker

E. Type 2 settlement marker

F. Identification devices for inclinometers, observation wells, and settlement markers

G. Replacement parts and supplies

1.02 RELATED SECTIONS

A. Requirements for dewatering are specified in Section 31 23 19 - Dewatering.

B. Shoring and underpinning for existing structures are specified in Section 31 40 00 - Shoring and Underpinning.

C. Excavation support systems are specified in Section 31 50 00 - Excavation Support and Protection.

D. Earthwork requirements are specified in Section 31 00 00 - Earthwork.

1.03 MEASUREMENT AND PAYMENT

A. Measurement: Earthwork instrumentation will be measured for payment by the lump-sum method, acceptably performed and completed.

B. Payment: Earthwork instrumentation will be paid for at the Contract lump-sum price, as indicated in the Bid Schedule of the Bid Form.

1.04 SUBMITTALS

A. General: Refer to Contract Specifications Section 01 33 00 - Submittal Procedures, and Section 01 33 23 - Shop Drawings, Product Data, and Samples, for submittal requirements and procedures. Submittals for earthwork instrumentation shall be submitted to the Engineer for review and approval.

B. Information, Drawings, and Data: Submit the following listed information, instructions, drawings, and data:

1. Manufacturer's installation instructions and recommendations for installation of instrumentation;

2. Detailed plan of instrumentation locations;

3. Proposed schedule for installing instrumentation;

4. Two sets of operating manuals, specifications, calibration certificates for each instrument, and descriptions of each type of instrument, including read-out devices and appurtenant supplies required for a complete instrumentation installation;

5. Manufacturer's product data for lockable access covers;

6. Drill logs for each hole where instrumentation will be installed; and

7. Materials and mix proportions for grout backfill.

C. Permits: Submit copies of special permits required by jurisdictional authorities for installation of observation wells and inclinometers.

D. Qualifications: Submit qualifications of the personnel proposed to install and maintain instrumentation services.

1.05 QUALITY ASSURANCE

A. Installation and calibration of instruments shall be performed by an individual or organization which is regularly engaged in, and that maintains a regular force of personnel skilled in, the installation and maintenance of instrumentation of the types specified herein.

B. The Contractor shall install, maintain, and calibrate the instruments in accordance with the instrument manufacturer's recommendations.

1.06 REGULATORY REQUIREMENTS

A. Comply with applicable requirements of the California Code of Regulations, Title 8, Chapter 4, Subchapter 4 — Construction Safety Orders, and Subchapter 19 — Trench Construction Safety Orders.

1.07 SITE CONDITIONS

A. Instrumentation shall be maintained by the Contractor.

B. Damaged or non-functional installations shall be replaced by the Contractor immediately.

C. Provide access to monitoring instruments, and facilitate monitoring by temporarily stopping or interrupting certain portions of the Work as may be required for monitoring and taking readings. Perform monitoring and measuring in a manner that will not delay the work unnecessarily, and schedule and perform the work in a manner that will not delay monitoring and measuring.

1.08 SEQUENCING AND SCHEDULING

A. Schedule installation of instrumentation to be performed in advance of excavation work.

B. Observation wells and inclinometers shall be installed in time to allow observations at least 10 days before excavation in the vicinity begins.

PART 2 - PRODUCTS

2.01 BOREHOLE INSTALLATIONS

A. Steel casings shall be employed where necessary to avoid caving of the hole.

B. Grout shall be Class 2000 concrete in accordance with Section 03 05 15 - Portland Cement Concrete; maximum aggregate size: 3/8 inch.

C. Lean concrete where required shall comply with requirements of Section 03 05 15 - Portland Cement Concrete.

D. Access cover shall be heavy-duty cast or forged steel frame with solid lid and locking device, of dimensions appropriate to the borehole diameter.

E. Provide asphalt pavement repair materials as required in accordance with Section 32 11 23 - Aggregate Base Course, and Section 32 12 16 - Asphalt Paving.

2.02 OBSERVATION WELLS

A. Provide standpipe observation wells, each consisting of a Schedule 40 PVC tube with a slotted end section that can be isolated at the appropriate level. The observation wells shall be installed in boreholes. Access to the top of observation well shall be provided. The observation well top shall be protected against vandalism.

2.03 INCLINOMETER SYSTEM

A. Provide an inclinometer system with sensitivity of plus or minus 0.001 foot per two feet of casing, and total system accuracy of 0.3 inch per 100 feet of casing. Provide biaxial sensors in waterproof housings, with 0.42-inch outside diameter six-conductor cable, 1/16-inch stranded steel core, and waterproof neoprene cover with external marks at one-foot intervals.

B. Provide a combination readout instrument, data storage and retrieval system, and microcomputer to digitize and store inclinometer readings, and to present the data for immediate representation by the printer in either tabular or graphic form, or both. The system shall allow editing, correction and adjustment of data, and shall provide error-checking routines. In addition, the system shall have the following capabilities and accessories:

1. At least 10,000 data points distributed in a maximum of 40 data sets;

2. Splash-proof with waterproof connections;

3. Rechargeable battery with a capacity adequate for eight hours of operation in "Record" mode at 70 degrees F, without printer operation; and

4. "Power on" and "Low Battery" indications.

C. Casing shall be aluminum or plastic pipe with internal longitudinal grooves, and with telescoping couplings, caps, and fittings, as indicated or required. Casing shall have a minimum inside diameter of 3 inches.

D. Provide inclinometer sensor with 100 feet of cable and one data recorder-processor manufactured for the purpose.

2.04 TYPE 1 SETTLEMENT MARKER

A. Provide 1-inch long, powder-actuated concrete nail, set approximately 7/8-inch deep with head exposed in top of concrete or asphalt concrete. The nail shall be set a minimum of 3 inches from any edge of concrete to avoid damage to the structure.

2.05 TYPE 2 SETTLEMENT MARKER

A. Provide 3/4-inch diameter by 5-feet long deformed reinforcing bar in accordance with requirements of Section 03 20 00 - Concrete Reinforcing. Reinforcing bar shall be driven into the ground, centered in a 6-inch deep, 1-foot diameter hole.

B. Provide cast or forged steel frame and cover, with cover being lockable or provided with locking device.

C. Center the frame and cover over the reinforcing bar and place grout in the annulus between soil and cover in hole. Top of cover and grout shall be level with adjacent ground surface.

2.06 IDENTIFICATION DEVICES FOR INCLINOMETERS, OBSERVATION WELLS, AND SETTLEMENT MARKERS

A. Provide an alpha-numeric identifier at each inclinometer, observation well, and settlement marker location.

B. Identification devices shall be selected as appropriate to each individual location and shall consist of materials that can be removed at the end of the Contract, leaving no residual effect on the mounting surface.

2.07 REPLACEMENT PARTS AND SUPPLIES

A. Provide replacement parts and other equipment and materials required for operation of the instrumentation equipment throughout the life of the Contract.

PART 3 - EXECUTION

3.01 LOCATIONS

A. Install observation wells, settlement markers, and inclinometers as indicated. All locations shall be field verified before installation. Install the instruments as close as practicable to the locations indicated, based upon actual conditions in the field.

B. After the instruments have been installed or, if damaged, repaired and reinstalled, prepare drawings and a report summarizing the installation of each instrument. Include the following information:

1. Instrument identification number and type;

2. Principal features of the work and existing construction;

3. Installation procedures and the date of installation;

4. The "as installed" configuration of each instrument, including depths, lengths, elevations, station, offset, and other dimensions of key elements of each installed instrument; and

5. Verification that inclinometer casings meet specified tolerances for alignment of longitudinal grooves and vertical inclination.

3.02 INSTALLATION

A. Boreholes:

1. For each hole, maintain a log, recording soil and groundwater conditions encountered.

2. Verify that the hole is drilled so that the instrument casing, when installed, is within two degrees of vertical (plumb) throughout its length and is at the correct depth.

3. When the drill hole will not remain open, advance the drill hole using a steel outer casing or an approved drilling fluid. Withdraw outer casing after instrument casing is installed and as the hole is being backfilled. Steel outer casings shall remain the property of the Contractor.

4. Fill annular void between drill hole and instrument casing as indicated.

B. Observation Wells:

1. Install observation wells as indicated.

2. Install a well-drained, lockable surface box for every observation-well installation.

C. Settlement Markers: Install settlement markers as indicated.

D. Inclinometer System:

1. Install inclinometer casing as indicated.

2. Orient inclinometer casing so that the orthogonal grooves are positioned parallel and perpendicular to the excavation. Cap the top of the casing.

3. Install inclinometer a minimum of 10 feet below bottom of excavation.

4. Verify that inclinometer casings meet specified tolerances for alignment of longitudinal grooves and vertical inclination.

3.03 PROTECTION AND MAINTENANCE

A. Access covers shall be lockable and keyed alike. Provide three keys for each cover to the Engineer.

B. Protect and maintain all instruments. Keep protective covers locked. Maintenance shall include draining or flushing the terminal boxes and piezometers.

C. Repair or replace damaged or missing instrument components or entire instruments as required within five days. Damage to any instrumentation shall be repaired by the Contractor.

3.04 REMOVAL OF INSTRUMENTS

A. Prior to Substantial Completion, remove and dispose of settlement markers and the top three feet of casings for inclinometers.

B. Plug remaining open portions of settlement markers with lean concrete. Construct new pavement repair in paved areas of the same material and to the same thickness as existing adjacent pavement. Restore disturbed or damaged surfaces to the conditions existing prior to the installation of the instruments.

C. Abandonment of observation wells and inclinometers shall conform with the requirements of jurisdictional authorities.

D. Remove instrumentation identification devices and protective barriers.

3.05 INSTRUMENTATION PROGRAM

A. Refer to the Contract Specifications, Section 31 09 00 - Geotechnical Instrumentation and Monitoring of Earthwork, for specific requirements.

END OF SECTION 31 09 00