

APPENDIX C1

SPECIFICATION FOR DRILLING AND INSTALLATION OF WELLS USING DIRECT-PUSH TECHNOLOGY

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. Furnish all labor, materials, equipment, and all other facilities and incidentals required to construct up to 25 direct push technology peizometers (monitoring wells) in unconsolidated alluvial deposits.
- B. Furnish all labor, materials, equipment, and all other facilities and incidentals required to develop each monitoring well.
- C. This Appendix is intended to give a general description of what is required, but does not cover all variations that may occur during well construction. This Appendix is intended to cover the successful completion and testing of the monitoring wells as herein specified, whether every detail is specifically mentioned or not.
- D. In the event of a conflict between the this specification and the Procedures listed in Section 1.02, this specification will be followed unless otherwise directed by ENGINEER.

1.02 RELATED WORK

- A. Refer to Geoprobe Large-Bore Soil Sampler, Standard Operating Procedure.
- B. Refer to Geoprobe 1-in. x 2.5-in. OD and 1.5-in. x 2.5-in. OD Prepacked Screen Monitoring Wells, Standard Operating Procedure.
- C. Refer to Direct Image Electrical Soil Conductivity System and Probing Procedures, Field Procedures Manual.

1.03 SUBMITTALS

- A. Submit, at least 5 days before beginning the well installation, the following:
 - 1. A complete list of construction materials and supplies including the name of the manufacturer, for the items listed below:
 - a. Casing
 - b. Well screen
 - c. Gravel pack
 - d. Grout
 - e. Caps

f. Protective steel cover

- B. During drilling of each well, a daily detailed driller's report shall be maintained and submitted as requested by the ENGINEER. The report shall give a complete description of, number of feet drilled, number of hours on the job, shutdown due to breakdown, feet of casing set, and other pertinent data requested by the ENGINEER.
- C. During drilling of each well, formation samples shall be collected in a manner approved by the ENGINEER.

1.04 REFERENCE STANDARDS

- A. The latest revisions of standards of AWWA, ASTM, and API shall apply as referenced herein. Standards shall include, but are not restricted to the following:
 - 1. American Society for Testing and Materials (ASTM)
 - a. ASTM D1784 - Standard Specification for Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds
 - b. ASTM F480 - Standard Specification for Thermoplastic Well Casing Pipe and Couplings Made in Standard Dimension Ratios (SDR), Schedule 40 and 80
 - 2. The latest revisions of the Office of the State Engineer's Rules and Regulations for Water Well Construction, Pump Installation and Monitoring and Observation Hole/Well Construction including any additional special provisions of Denver Basin Rules.
- B. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.05 QUALITY ASSURANCE

- A. The CONTRACTOR is responsible for employing only competent workmen for the execution of this work and all such work shall be performed under the direct supervision of an experienced well driller who is satisfactory to the ENGINEER.
- B. The well driller shall be capable of maintaining complete and current well logs and daily notes for the well completion report and developing and testing the wells.
- C. The ENGINEER may make any other investigations deemed necessary to determine the ability of the CONTRACTOR to perform the work and the CONTRACTOR shall furnish to the ENGINEER all such information and data for this purpose as the ENGINEER may request.
- D. Complete the work described in this Appendix in accordance with applicable portions of the Office of the State Engineer's Rules and Regulations for Water Well Construction, Pump Installation, and Monitoring and Observation Hole/Well Construction

1.06 DESCRIPTION OF WELLS AND SITE

- A. Up to 25 nominal one-inch inner diameter PVC monitoring wells will be constructed up to a depth of approximately 60 feet and have well screens up to 20 feet in length. Wells will be constructed of materials and in a manner sufficient to accommodate a 0.8-inch diameter water level measurement and data logging device. The location of each well is to be determined by ENGINEER.
- B. The drilling sites will be located on public rights-of-way or private property and will be accessible for the duration of the drilling and monitoring under agreements to be provided by the OWNER. No electrical, sanitary, or water service is available at the sites. It is anticipated that the drilling sites will be accessible to normal drilling equipment without significant grading or road construction. Upon completion of the work, the CONTRACTOR shall disperse all cuttings, debris, drilling fluid, and promptly remove all unused materials, trash, and debris and restore the site as nearly as possible to its original conditions.
- C. The unconsolidated alluvial deposits into which these wells are to be installed are known to contain stiff cohesive clays, swelling clays, and/or flowing/heaving sands at some locations. It will be the CONTRACTOR's responsibility to control these conditions to the extent necessary to permit proper construction of the wells as outlined in these specifications. The above information regarding subsurface conditions is intended to assist the CONTRACTOR in preparing his bid and the OWNER or ENGINEER does not guarantee its accuracy or that it is necessarily indicative of conditions to be encountered in drilling the wells. No additional compensation will be awarded to the successful bidder for any equipment, time, or and materials required to control such conditions. ENGINEER is not responsible for any lost, stolen, or broken tools.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. All parts and materials shall be properly protected so that no damage, deterioration, or contamination occurs from time of shipment until installation is completed.

1.08 PERMITS

- A. The ENGINEER will acquire notifications and permits from the Colorado State Engineer to construct the monitoring wells.
- B. Any permits required to access the drilling site will be provided by the ENGINEER.
- C. The ENGINEER shall obtain any state, or local notices or permits required for constructing the wells, including discharging water from the site, or clearing the site.
- D. Do not perform any work on the well until directed by ENGINEER.

1.09 UNDERGROUND AND OVERHEAD UTILITIES

- A. The ENGINEER will secure information concerning the location of underground and overhead utilities at the site, prior to the start of well construction and provide to CONTRACTOR.

1.10 NOTIFICATION

- A. Supply to the ENGINEER in writing at least 10 days before mobilization, the proposed work schedule including the following:
 - 1. The starting date of the well construction.
 - 2. Any anticipated work stoppage of greater than 24 hours with exception of weekends and holidays.
 - 3. The number of well drilling rigs and personnel to be used on the project. Any change in the number of rigs and personnel shall require written notification of the ENGINEER, 48 hours prior to the change.
- B. The ENGINEER shall be notified 24 hours prior to the start of any well construction activities.
- C. No work shall be performed prior to authorization from ENGINEER and without completing the notification requirements specified above.

1.11 WELL ACCEPTANCE CRITERIA

- A. All observation wells shall be developed until, in the opinion of the ENGINEER, they are:
 - 1. Producing water substantially free of sand and silt.
 - 2. Responsive to water level changes in the aquifer.
- B. All casings, screens, grout, and gravel packs, shall be set to the depths directed by the ENGINEER.
- C. Well shall be constructed to securely accommodate a 0.8-inch diameter water level measurement and data logging tool installed in the well with approximately 10 feet of rolled data cable and data port connection stored at the top of the well.
- D. No payment for the well will be due in the event of failure to meet all above requirements.

1.12 MEASUREMENT AND PAYMENT

- A. Payment for work performed shall be on a basis of unit and lump sum prices bid and actual work performed. The bid items are intended to cover all costs involved in completing the work specified herein. The Bidder shall include all incidental costs in the applicable unit or lump sum prices.

PART 2 PRODUCTS

2.01 CASING

- A. All observation well casing shall be new, Schedule 40, PVC pipe. Casing shall be 1-inch nominal inside diameter.
- B. Casing shall be as manufactured to meet or exceed specifications according to ASTM F480.
- C. All casing joints shall be flush threaded with O-ring seals

2.02 SCREEN

- A. Well screens shall be a minimum of nominal 1-inch inner diameter, new, mill slotted Schedule 40 PVC. Slot size shall be 0.010-inch.
- B. Well screens shall be as manufactured to meet or exceed specifications according to ASTM F480.
- C. The wells shall have screen sections up to 20 feet in length. The actual length of screen for each well will be determined in the field by the ENGINEER.

2.03 GRAVEL PACK

- A. Filter pack material shall be clean, well-rounded size 10-20 sized silica sand as manufactured by Colorado Silica Sand Inc., or approved equal.
- B. If field conditions warrant, formation collapse will be allowed as filter pack.
- C. If field conditions warrant, Geoprobe prepack screens will be allowed.

2.04 GROUT

- A. Grout used to fill the annular space from the top of the sand cap to ground surface shall be proportioned of Type I/II (ASTM C150) neat portland cement mixed with no more than 7 gallons of water per 94-pound sack of cement with 5 percent bentonite additive, with an additional 3/4 gallon added per sack of cement and each 1 percent bentonite added. All other additives shall have prior approval of the ENGINEER.
- B. Other grout types will be acceptable, if approved of by ENGINEER, and if allowable under Colorado well construction rules.

2.05 CAPS

- A. Bottom caps shall be new, Schedule 40 PVC, attached with flush-threaded joints.
- B. Top caps will be lockable expandable plugs as manufactured Morrison debuque, or equal, installed in a manner that will prevent access to the monitoirng well by unauthorized persons.

2.06 DRILLING FLUIDS

- A. No drilling fluid other than clear, fresh water acquired from a potable source will be used during the drilling and installation of the alluvial wells without prior written permission of the ENGINEER.

2.07 PROTECTIVE COVERS

- A. A 4-inch by 4-inch steel protective casing with hinged lid and locking hasp will be installed over the PVC well casing to provide well security. If site-specific conditions warrant, flush mount vaults shall be a minimum of 8-inches diameter as manufactured by the Universal Valve Co., or approved equal.

PART 3 EXECUTION

3.01 WELL CONSTRUCTION

- A. The monitoring wells shall be installed by DPT.
- B. During drilling of each well, formation discrete samples of the *in situ* soils shall be collected using a large-bore discrete-depth sampler as manufactured by the Geoprobe Systems Inc. of Salina Kansas, or equivalent, or other equivalent method to be approved by ENGINEER.

3.02 CASING AND SCREEN INSTALLATION

- A. An outer casing will be advanced to target depth. Upon reaching the total depth of the borehole, the ENGINEER will be informed and the depth verified before installation of the well materials.
- B. The string of the well materials (casing and screen) shall then be lowered through the inside of the outer casing to the depths specified by the ENGINEER in the field.
- C. Every effort shall be made on the part of the CONTRACTOR to assure casing plumbness and centralization of well materials within the borehole.
- D. The expendable bottom point on the outer casing will be disengaged from the outer casing and the outer casing will be withdrawn as annular materials are installed.

3.03 GRAVEL PACK, SAND CAP, AND CEMENT INSTALLATION

- A. Install filter pack by pouring the filter pack material into the annulus between the inside of the outer casing and outside of the well string while withdrawing the outer casing until the top of the filter pack material is a minimum of 2 feet above the top of the well string as directed by the ENGINEER in the field. Placement shall be performed such that the filter pack is free from excessive amounts of cuttings, sloughed formational material, or voids and will be verified by lowering a tape measure into the annulus. If approved by the ENGINEER, natural formation collapse or prepack screen will be used.
- B. After placement of the filter pack, the annular seal consisting of granular bentonite shall be placed to a level of at least 2 feet above the top of the filter pack.
- C. The remainder of the annular seal shall consist of neat grout mixture shall be placed by pressure-grouting or other method as approved by ENGINEER.
- D. All grouting and sealing of the well shall be performed in the presence of the ENGINEER. The grouting shall be done continuously and in such a manner that will assure the filling of the annular space in one continuous operation. No other work in the well will be permitted until at least 24 hours after grouting the well unless authorized by the ENGINEER.
- E. CONTRACTOR will take full responsibility for cementing operations, including volumes to be used and insuring the well screens and gravel packs are not cemented or casing deformed by the heat of curing cement.

- F. A protective steel cover with locking hasp will then be installed over the PVC well casing, The cover shall be set such that it extends 3 feet below the ground surface and be embedded in a concrete pad that extends at least 2 feet on all sides of the protective cover and is sloped to divert water away from the well. The cover shall contain a weep hole above the concrete pad. Alternatively, at some locations the protective steel cover shall consist of a vault mounted flush with the ground surface and embedded in concrete as specified above.
- H. If directed by the ENGINEER, bollards shall be installed to protect the well from traffic. The bollards shall consist of 4-inch diameter steel pipe, 6 feet in length and set to a depth of 3 feet below the ground surface in a 12-inch diameter hole filled with concrete. The pipe shall then be filled with concrete rounded at the upper end and painted with high visibility weatherproof enamel paint.

3.04 WELL DEVELOPMENT

- A. The monitoring wells shall be developed by surging, or over-pumping, or other methods as approved by the ENGINEER.
- B. Development of the monitoring wells shall continue until the wells conform to the Well Acceptance Criteria as stated in paragraph 1.11 above, or to the satisfaction of the ENGINEER.

3.05 WELL ABANDONMENT

- A. Well abandonment will be required in the event of failure to meet the Well Acceptance Criteria as stated in paragraph 1.11 above, because of loss of tools, cementing well screens, gravel packs, casing collapse, or for other cause. The CONTRACTOR shall abandon the well in accordance with the standards and procedures specified in the Colorado Rules and Regulations for Water Well Construction.
- B. The CONTRACTOR shall receive no payment for time and material for well abandonment and shall receive no compensation for the abandoned well.
- C. Replace the abandoned well at the unit prices outlined in paragraph 1.12, above.
- D. Compensate the ENGINEER for the additional cost of inspection associated with the abandoned well. It is understood and agreed that aside from any other liquidated or other damage per day for such delay from such time until the same is completed and accepted as herein provided; all costs of engineering and inspection on behalf of the OWNER will be charged to the CONTRACTOR hereunder and deducted from any estimate or payment otherwise due and payable to him/her from time to time. The costs of engineering and inspection which may be charged to the CONTRACTOR by the OWNER under this article shall be equal to the ENGINEER's charges to the OWNER under the terms of the ENGINEER's agreement with the OWNER.
- E. The CONTRACTOR shall receive payment for the abandonment of the observation wells as specified in the Schedule of Prices if the CONTRACTOR is authorized by the ENGINEER to abandon some or all the monitoring wells for reasons other than stated in paragraph 3.05A above. The well casings shall be cut off approximately 3-feet below land surface and abandoned with the standards and procedures specified in the Colorado Rules and Regulations for Water Well Construction.

3.06 PROTECTION AND SITE CLEAN-UP

- A. At all times during the progress of the work, use all reasonable precautions to prevent either tampering with the wells or the entrance of foreign material.
- B. Immediately upon completion of the well construction and development, remove all of the equipment, materials and supplies from the site of the work, remove all surplus materials and debris, fill in all holes or excavations and grade the site to elevations of the surface levels which existed before work started. The site shall be thoroughly cleaned until approved by the ENGINEER. Failure to comply with these requirements shall give the authority of other contractors or workmen directed by the ENGINEER to enter upon the site and complete the clean up, grading, etc. The cost of this work shall be deducted from money due or to become due for construction of the wells.

END OF APPENDIX C