SECTION 15064

POLYVINYL CHLORIDE (PVC) PRESSURE PIPE

PART 1 – GENERAL

1.01 DESCRIPTION

A. Scope of Work: Furnish all labor, materials, equipment, and incidentals required and install in the locations as shown on the Drawings, the polyvinyl chloride (PVC) pipe and appurtenances as specified herein.

B. Related Work:
   1. Excavating, Trenching and Backfilling: Section 02202.
   2. Wastewater Transmission System: Section 02680.

1.02 QUALITY ASSURANCE

A. Standards:
   1. Polyvinyl Chloride (PVC) Pressure Pipe, 4-in. through 12-in.: AWWA C900, latest edition.
   2. Polyvinyl Chloride (PVC) Pressure Pipe, 14-in. through 48-in.: AWWA C905, latest edition.

B. Qualifications:
   1. All plastic pressure pipe and appurtenances shall be furnished by a single manufacturer who is fully experienced, reputable, and qualified in the manufacture of the items to be furnished. The equipment shall be designed, constructed, and installed in accordance with the best practices and methods and shall comply with these Specifications.
   2. The Contractor shall, at no additional cost to the Owner, arrange for a pipe supplier's field representative to be on-site to provide instruction to each crew working on the installation of pipe. The supplier's field representative shall certify that the installations observed were satisfactorily completed and all pipe installation crews were familiar with the proper methods and procedures for the pipeline installations.

C. Special tools, solvents, lubricants, and caulking compounds required for normal installation shall be furnished with the pipe by the manufacturer.

D. Acceptable Manufacturers: Refer to Appedix D for the Orange County Utilities "List of Approved Products".

1.03 SHOP DRAWINGS AND SUBMITTALS

A. Shop Drawings and submittals shall be submitted to the Engineer for review and acceptance prior to construction in accordance with the General Conditions and specifications Section 01300 “Submittals” for the following:
   1. Certified dimensional drawings of all pipe, specials, fittings, and supports.
   2. Laying schedule, line layout and marking diagrams which indicate the specific number of each pipe and fitting.

B. Manufacturer’s Certification:
   1. Submit Sworn certification of factory tests and their results.

C. All expenses incurred in making samples for certification of tests shall be borne by the Contractor.

1.04 HANDLING AND STORAGE

A. Delivery and Storage: Delivery and storage of the materials shall be in accordance with the manufacturer's recommendations. PVC pipe shall be covered with black plastic with a minimum thickness of 15-mil. Joint gaskets shall be stored in a clean, dark and dry location until use.

B. Handling: Care shall be taken in loading, transporting and unloading to prevent damage to the pipe or fittings and their respective coatings. Pipe or fittings shall not be rolled off the carrier or dropped. Pipe shall be unloaded by lifting with a forklift or crane. All pipe or fittings shall be examined before installation and no piece shall be installed which is found to be defective. Pipe shall be handled to prevent damage to the pipe or coating. Accidental damage to pipe or coating shall be repaired to the satisfaction of County or it shall be removed from the job. When not being handled, the pipe shall be supported on timber cradles or on level ground, graded to eliminate all rock points and to provide uniform support along the full pipe length. When being transported, the pipe shall be supported at all times in a manner to prevent distortion or damage to the lining or coating. Any unit of pipe that, in the opinion of the County, is damaged beyond repair by the Contractor shall be removed from the site.

C. The Contractor shall be responsible for all materials furnished and stored until the date of project completion. The Contractor shall replace, at his expense, all materials found to be defective or damaged in handling or storage. The Contractor shall, if requested by the County, furnish certificates, affidavits of compliance, test reports, samples or check analysis for any of the materials specified herein. All pipe delivered to project site for installation is subject to random testing for compliance with the designated specifications.

PART 2 – PRODUCTS

2.01 GENERAL

A. All material supplied shall be one of the products specified in Appendix D "List of Approved Products" appended to these technical specifications.

2.02 MATERIALS

A. Polyvinyl Chloride (PVC) Pipe
   1. Standards: AWWA C900/C905 and ASTM D1784/D3034/F679 (Gravity Sewer)
   2. Compounds: Class 12454-A or Class 12454-B
   3. PVC Pressure Pipe and Fittings: All PVC pipe of nominal diameter 4 to 12-inches shall be manufactured in accordance with AWWA Standard C900 and greater than 12-inches shall be manufactured in accordance with AWWA Standard C905. The PVC pipe shall have a minimum working pressure rating of 100-psi and shall have a maximum dimension ratio of 18. Pipe shall be the same outside diameter as ductile iron pipe.
   4. Dimension Ratio/Thickness: (unless otherwise shown on the Drawings)
      a. Raw Wastewater:
         (1) Pressure Systems: DR 18
      b. Treated Wastewater: DR 18
      c. Reclaimed Water: DR 18
      d. Raw Water: DR 18
      e. Potable Water: DR 18
      f. Irrigation Piping: Schedule 40 or SDR 21
   5. Joints:
      a. Push-on integral bell elastomeric gasket joints:
         (1) Standards: ASTM D3212/D3139/F477 and UNI-B-1
         (2) Gaskets:
            (a) Potable and Reclaimed Water Service: Styrene Butadiene Rubber (SBR) rieber type.
         (3) Pipe Markings: Pipes shall have a manufacturer's home-mark on the spigot. On field cut pipe, the Contractor shall provide home-mark on the spigot in accordance with manufacturer's recommendations.
      b. Solvent weld (nominal diameter less than 4-inches):
         (1) Standards: ASTM D2466/D2564
         (2) Type: Slip Fitting Socket (tapered)
         (3) Exclusions: Plastic saddle and flange joints will not be used.
      c. Restrained Joints:
         (1) Restrained joint devices shall be made specifically for PVC pipe and meet or exceed the requirements in ASTM F-1674.
         (2) Manufacturers: Uni-flange mechanical joint restraints and bell restraints (for all sizes); Meg-a-lug system as manufactured by EBBA Iron (sizes 12-inches or less), or acceptable equal.

(3) Design pressure rating equal to or above test pressure as specified herein.

d. Pipe Length:
   (1) Pressure systems: 20-feet maximum nominal length

B. All fittings for use with PVC pipe four (4) inches and larger shall be ductile iron fittings as specified in Section 15062: Ductile Iron Pipe and Fittings.

C. Fittings - Pressure Systems (nominal diameter less than 4-inches)
   1. Material: Polyvinyl Chloride (PVC)
   2. Joints: Slip fitting tapered socket with solvent weld
   3. Solvent: Sure Guard 12 or acceptable equal.
   4. Exclusions: Plastic saddle and flange joint fittings shall not be used.

2.03 RESTRAINED JOINTS FOR PVC PIPE

A. Restrained joint devices shall be made specifically for PVC pipe and meet or exceed the requirements in ASTM F-1674.

B. Design pressure-rating equal to or above test pressure as specified herein.

2.04 LOCATION MARKERS, LOCATION WIRE AND IDENTIFICATION MARKINGS

A. Electronic Markers and Locator System (for reclaimed water and wastewater ONLY)
   1. Markers: Markers shall consist of a passive device capable of reflecting a specifically designated repulse frequency tuned to the utility (service) being installed. Markers shall be color coded in accordance with the American Public Works Association's "Utility Locating and Coordinating Council Standards". Color shall be: Wastewater #1404 Green. Markers shall be full range. Markers shall be installed directly above the centerline of the respective pipeline at intervals not to exceed 100', at each fitting (tees, wyes, crosses, reducers, plugs, caps and bends) or change in horizontal direction and at each valve along the pipeline. Markers shall be hand backfilled to one (1) foot above the pad and have a finished depth of burial of not less than two (2) feet or more than six (6) feet. No separate payment shall be made for furnishing and installing the respective frequency and color-coded electronic pad type marker.
   2. Locator System: Marker locator set shall be the 3M Dynatel 1420 or 3M Dynatel 1420E Electronic Marker System Marker Locator, or acceptable equal. The Contractor shall furnish one locator set for each type of service piping installed on the Project (i.e.: reclaimed water, wastewater.) to the County. Each unit shall incorporate the following features and accessories:
      a. Unit(s) shall be tuned to the proper frequency for each type (service) of piping.
      b. Field strength meter that provides visual indication of the return signal.
      c. Function switch for selection of operation mode.
      d. Sensitivity control to adjust the receiver gain.
      e. Audio speaker for signal response.
      f. Battery access panel containing condensed operating instructions.

g. Auxiliary headset and heads set jack.
h. Permanently attached shoulder straps.
i. Rugged shockproof and weatherproof storage/carrying case.

3. Manufacturer: System shall be Scotch Mark Locator System, or acceptable equal.

B. Location Detection Wire

1. Materials: Continuous, insulated 10-gauge single strand solid core copper wire (color to match pipe identification).
2. Installation: Directly above (1-inch maximum) centerline of pipe terminating at top of each valve box collar and be capable of extending 18-inches above top of box (stored inside the 2-inch brass pipe through the valve box collar) in a manner so as not to interfere with valve operation. For direction drilling installations, a minimum of two (2) 10-gauge wires shall be pulled along with the pipe.

C. Identification Markings:

1. Pipe furnished in solid color or white with color lettering as indicated below.
   a. Lettering along top 90^{o} of pipe, minimum ¾-inch in height with appropriate wording appearing one or more times every 21-inches along the entire length of the pipeline.
      (1) Raw Wastewater: Safety Green
      (2) Reclaimed Water: Purple (Pantone 522C)
      (3) Potable Water: Safety Blue

PART 3 – EXECUTION

3.01 INSPECTION AND TESTING

A. All pipe and appurtenances are subject to inspection by the Owner and Engineer at the point of delivery. Material found to be defective due to manufacture or damage in shipping shall be marked as rejected and immediately removed from the job site.

B. The Owner shall have the right to have any or all piping, fittings or special castings inspected and tested by an independent testing agency at the foundry or elsewhere. Such inspection and testing will be at the Owner's expense.

3.02 INSTALLATION

A. Standards: AWWA C900/C905/UNI-B3 and 4

B. Underground Polyvinyl Chloride (PVC) Pipe and Fittings

1. Bedding: Firm, dry and even bearing of suitable material. Blocking under the pipe will not be permitted.
2. Placement/Alignment:
   a. Installation shall be in accordance with lines and grades shown on the Drawings. For pressure systems, deflection of joints shall not exceed 75% of that recommended by the manufacturer.

b. All pipe and fittings shall be inspected prior to lowering into trench to insure no cracked, broken or otherwise defective materials are being used. All homing marks shall be checked for the proper length so as to not allow a separation or over homing of connected pipe. Homing marks incorrectly marked on pipe shall result in rejection of pipe and removal from site. The Contractor shall clean ends of pipe thoroughly and remove foreign matter and dirt from inside of pipe and keep clean during and after installation.

c. Proper implements, tools and facilities shall be used for the safe and proper protection of the Work. Pipe shall be lowered into the trench in such a manner as to avoid any physical damage to the pipe. Pipe shall not be dropped or dumped into trenches under any circumstances.

d. Trench Dewatering and Drainage Control: Contractor shall prevent water from entering trench during excavation and pipe laying operations to the extent required to properly grade the bottom of the trench and allow for proper compaction of the backfill. Pipe shall not be laid in water.

e. Pipe Laying in Trench: Dirt or other foreign material shall be prevented from entering the pipe or pipe joint during handling or laying operations and any pipe or fitting that has been installed with dirt or foreign material in it shall be removed, cleaned and re-laid. Pigging of pipe may be used to remove foreign materials in lieu of flushing. At times when pipe installation is not in progress, the open ends of the pipe shall be closed by a watertight plug or by other means approved by the County to ensure absolute cleanliness inside the pipe. The color stripe and pipe text shall be viewed from the top of pipe when installed. When installing PVC pipe, no additional joints will be installed until the preceding pipe joint has been completed and the pipe carefully embedded and secured in place.

f. Locating Wire: Locating wire, for electronically locating pipe after it is buried, or installed by trenchless technology shall be attached along the length of and installed with the pipe. This is applicable to all sizes and types of pressure mains. At a minimum, the tracing wire is to be attached to the pipe with nylon wire ties. The wire itself shall be 10-gauge single strand solid core copper wire with non-metallic insulation. The insulation shall be color coded for the type of pipe being installed. Continuous continuity must be maintained in the wire along the entire length of the pipe run. Permanent splices must be made in the length of the wire using wire connectors approved for underground applications as listed in the uniform electric code handbook. The coiled wire shall extend to a minimum of 12-inches above the surface and be connected to a test station box at valve locations.

g. PVC Pressure Pipe Installation and Training: PVC pipe shall be installed in accordance with standards set forth in the UNI-BELL "Handbook of PVC Pipe", AWWA C605, and AWWA Manual M-23. The pipe shall be laid by inserting the spigot end into the bell flush with the insertion line or as recommended by the manufacturer. At no time shall the bell spigot end be allowed to go past the "insertion line" or "homing mark" for pressure pipe applications and homing mark shall be visible.

h. Field Cutting: PVC pipe can be cut with a handsaw or power driven abrasive disc making a square cut. The end shall be beveled with a beveling tool, wood rasp or power sander to the same angle as provided on the factory-finished pipe. The insertion line on the spigot shall be remarked to the same dimensions as the factory-marked spigot.

i. All Contractor pipe crews utilizing PVC pressure pipe shall be trained on an annual basis by Uni-Bell in coordination with the County and attended by the manufacturer's representative of the respective approved Manufacturers in Appendix D "List of Approved Products." The Uni-Bell PVC training session will consist of proper handling, storage, installation, and compaction as well as County requirements regarding PVC pipe and deflection. Every person handling, installing or backfilling PVC pipe shall not be permitted to install County owned and / or maintained pipe without training.

j. Approved manufacturers representatives (Appendix D "List of Approved Products"), not present at the hosted Uni-Bell training session or individuals of pipe crews not in attendance shall be trained on every project site. On-site project training shall be for each manufacturer of pipe utilized on-site, per crew and per project. Specifically each crewmember shall be trained on every project by every pipe manufactures representative regardless of previous on-site training. Every person handling, installing or backfilling PVC pipe shall not be permitted to install County owned and / or maintained pipe without training.

k. PVC Gravity Pipe Installation: Gravity sewer pipe shall be installed to the homing mark, no tolerance. Any noticeable separation shall be removed and reinstalled. The homing mark may be disregarded to meet the maximum of 1-inch separation between bell and spigot requirement. Joints:

l. Joint Placement:

(1) Push on joints: Pipe shall be laid with the bell ends facing upstream. The gasket shall be inserted and the joint surfaces cleaned and lubricated prior to placement of the pipe. After joining the pipe, a metal feeler shall be used to verify that the gasket is correctly located.

(2) Mechanical Joints: Pipe and fittings shall be installed in accordance with the "Notes on Method of Installation" under ANSI A21.11/AWWA C111. The gasket shall be inserted and the joint surfaces cleaned and lubricated with soapy water before tightening the bolts to the specified torque.

C. Thrust Restraint

1. Thrust restraint shall be accomplished by the use of mechanical restraining devices unless specifically identified otherwise on the Drawings or herein.
2. Length of restrained joints shall be in accordance with the lengths listed in the table as shown on the Drawings.

D. Installation of Pipes on Curves:

1. No joint deflection or pipe bending is allowed in PVC pipe. The maximum allowable tolerance in the joint due to variances in installation is 0.75° (degrees) (3-inches per joint per 20-foot stick of pipe). No bending tolerance in the pipe barrel shall be acceptable. Alignment change shall be made only with sleeves and fittings.

3.03 CLEANING AND FIELD TESTING

A. At the concludion of the Work, the Contractor shall provide all associated cleaning and field testing as specified in associated sections of these specifications.

END OF SECTION

SECTION 15066

HIGH-DENSITY POLYETHYLENE (HDPE) PIPE AND FITTINGS

PART 1 - GENERAL

1.01 DESCRIPTION

Scope of Work: Provide and install high-density polyethylene (HDPE) pipe and fittings of the sizes and in the locations shown on the Drawings and as specified for use in directional drilling.

1.02 STANDARDS

A. Pipe 1/2-inches (13-mm) through 3-inches (76-mm) shall conform to AWWA C901 and the Specifications.

B. Pipe and fittings 4-inches (102-mm) through 60-inches (1,524-mm) shall conform to AWWA C906 and the Specifications.

1.03 SHOP DRAWINGS AND SUBMITTALS

A. Submittals shall be submitted to the County for review and acceptance prior to construction in accordance with the General Conditions and Section 01300 "Submittals."

B. Submit manufacturers recommended method for butt-fusing joints.

C. The polyethylene pipe manufacturer shall provide certification that stress regression testing has been performed on the specific product. Certification shall include a stress life curve per ASTM D2837.

D. Provide certification that the material is listed by the Plastic Pipe Institute in PPI TR-3 with a hydrostatic design basis of 1,600-psi (11 MPa) at 73°F. The PPI listing shall be in the name of the pipe manufacturer and shall be based on ASTM D2837 and PPI TR-3 testing and validation of samples of the pipe manufacturer's production pipe.

E. The manufacturer's certification shall state that the pipe was manufactured from 1 specific resin in compliance with these Specifications. The certificate shall state the specific resin used, its source, and list its compliance to these specifications.

F. Submit certified lab data to verify specified physical properties. Certify that tests are representative of pipe supplied for this project.

G. Submit affidavit of compliance with referenced standards (e.g., AWWA C901, C906, etc.).

H. Submit qualification certificates for operators of heat fusion equipment.

I. Submit schedule for placement of and removal of test bulkheads.

J. Submit certification that materials intended to contact potable water are listed under NSF 61.

1.04 INSPECTION

All materials and installation furnished under this specification are subject to inspection by the County.

1.05 QUALITY AND WORKMANSHIP

A. The pipe and fitting manufacturer's production facilities shall be open for inspection by the County or his designated agents. During inspection, the manufacturer shall demonstrate that the facilities are capable of manufacturing the pipe and fittings required by this specification, that a quality control program meeting the minimum requirements of ASTM D3035 and ASTM F714 is in use, and that facilities for performing the tests required by this specification are in use.

1.06 QUALIFICATION OF FUSION OPERATORS

A. Each operator performing fusion joining shall be qualified in the use of the manufacturer's recommended fusion procedure(s) by the following:

Appropriate training or experience in the use of the fusion procedure.

1. Making a sample joint according to the procedure that passes the following inspections and tests:
   a. The joint shall be visually examined during and after joining and found to have the same appearance as a photograph or sample of an acceptable joint that was joined in accordance with the procedure; and
   b. The joint shall be tested or examined by 1 of the following methods:
      (1) Pressure and tensile test as described in 49 CFR 192.283
      (2) Ultrasonic inspection and found to be free of flaws that would cause failure
      (3) Cut into at least 3 longitudinal straps, each of which is:
         (a) Visually examined and found to be free of voids or unbonded areas on the cut surface of the joint, and
         (b) Deformed bending, torque, or impact and if failure occurs, it must not initiate in the joint area.
2. Each operator shall be re-qualified under the procedure if during any 12-month period:
   a. Operator has not made any joints under the procedure; or
   b. Operator has 3 joints or 3% of the joints made, whichever is greater, that are found unacceptable by testing according to 49 CFR 192.513.

1.07 DELIVERY, STORAGE, AND HANDLING

A. On site pipe storage shall meet all manufacturers' requirements.

B. Transport individual pipe lengths to the job site on padded bunks with nylon tie-down straps or padded bonding to protect the pipe. Coiled HDPE pipe shall be stored in a manner to ensure safety. Protect the pipe from sharp objects. Anchor pipe securely to prevent slippage.

C. Store individual pipe lengths on earth berms or timber cradles in the numerical order of installation. Stack the heaviest series of pipe at the bottom. Do not stack pipe in excess of 20-rows high.

D. Protect the pipe from stones and sharp objects.

E. Store fittings in their original cartons.

F. Lift pipes with handling beams or wide belt slings near the middle of joints as recommended by the pipe manufacturer. Do not use cable slings, chains, or hooks.

G. Before installation, check pipe and fittings for cuts, scratches, gouges, buckling, kinking, or splitting. Remove any pipe section containing defects by cutting out the damaged section in a complete cylinder.

PART 2 - PRODUCTS

2.01 GENERAL

A. All material supplied shall be one of the products specified in Appendix D "List of Approved Products" appended to these technical specifications.

2.02 PIPE

A. Pipe shall have a nominal IPS (iron pipe size) or ductile iron pipe size OD. The dimension ratio shall be verified by the Contractor based on the pipe pull strength and the pressure rating of the pipe supplied shall be (DR 9) pressure class 160 for water main and reclaimed water main, and (DR 11) 100 for wastewater force main, in accordance with Table 5 of AWWA C906. The pipe shall be homogenous throughout and free of visible cracks, holes, voids, foreign inclusions, or other deleterious defects and shall be identical in color, density, melt index, and other physical properties throughout.

B. Pipe shall have a minimum hydrostatic design basis (HDB) of 1,600-psi (11 MPa), as determined in accordance with ASTM D2837.

C. Pipe Material
   1. Pipes shall be marked in accordance with AWWA requirements (C901 Section 2.4 or C906 Section 3.1, as appropriate).
   2. AWWA C901 pipe (1/2-inch (13-mm) through 3-inches (76-mm)) shall be PE 3408 DR 9, colored blue for water, purple (Pantone 522C lavender) for reclaimed water, and green for wastewater. AWWA C901 pipe shall be as manufactured by Endot Endopure or equal.

3. AWWA C906 pipe [(4-inches (102-mm) through 60-inches (1,524-mm)] shall be color coded as above with 4 co-extruded equally spaced stripes of the same material as the pipe. Stripes printed on the pipe outside surface shall not be acceptable.
4. Materials used for the manufacture of polyethylene pipe and fittings shall be very high molecular weight, high-density ethylene/hexene copolymer PE 3408 polyethylene resin meeting the requirements of Table 15066-1.

Table 15066-1
Physical Property and Pipe Performance Requirements

Property	Specification	Units	Minimum Values
Material Designation	PPI/ASTM	---	PE3408
Material Classification	ASTM D1248	---	III C 5 P34
Cell Classification	ASTM D3350	---	345434C
Hardness	ASTM D2240	Shore D	64
Compressive Strength (Yield)	ASTM D695	psi	1,600
Tensile Strength @ Yield (Type IV Spec.)	ASTM D638 (2%/min)	psi	3,200
Elongation @ Yield	ASTM D638	%, min	8
Tensile Strength @ Break (Type IV Spec.)	ASTM D638	psi	3,500
Elongation @ Break	ASTM D638	%, min.	600
Modulus of Elasticity	ASTM D638	psi	110,000
ESCR:			
(Cond A, B, C: Mold. Slab)	ASTM D1693	Fo, Hrs	Fo>5,000
(Compressed Ring)	ASTM F1248	F50, Hrs	F50>1,000
Slow Crack Growth	Battelle		Fo>32
	Method	Days to Failure	Minimum Values
Impact Strength			
(IZOD) (0.125-inch thick)	ASTM D256	in-lb/in	
	(Method A)	Notch	42
Linear Thermal			
Expansion Coef	ASTM D696	in/in/°F	1.2 x 10-4
Thermal Conductivity	ASTM C177	BTU, in/	2.7
		Ft2/hrs/°F	
Brittleness Temp	ASTM D746	°F	<-180
Vicat Soft. Temp	ASTM D1525	°F	+257
NSF Listing	Standard 61	---	Listed

Note: * Standard deviation 0.01.

5. The pipe shall be extruded from pre-compounded resin. In-plant blending of resin is unacceptable.

2.03 NIPPLES AND FLANGED STUB ENDS

Short nipples and stub ends shall be of the same material as the HDPE pipe.

2.04 FITTINGS

A. Fittings shall be made from material meeting the same requirements as the pipe. Fittings shall be fabricated by the manufacturer of the pipe.

B. Fittings shall meet the appropriate AWWA standard for the size involved (C901 or C906) and shall be Pressure Class 160 for water main and reclaimed water main and Pressure Class 100 for wastewater force main.

C. Molded fittings shall be manufactured in accordance with ASTM D3261 and shall be so marked.

D. Mechanical fittings, when used, shall be specifically designed for, or tested and found to be acceptable for use with HDPE pipe.

E. Fittings used to connect with dissimilar pipe materials shall be provided as per Section 15062 "Ductile Iron Pipe and Fittings."

2.05 JOINTS

A. Sections of polyethylene pipe shall be joined into continuous lengths on the job site above ground. The joining method shall be the butt fusion method and shall be performed in strict accordance with the pipe manufacturer's recommendations. The butt fusion equipment used in the joining procedures shall be capable of meeting all conditions recommended by the pipe manufacturer.

B. Butt fusion joining shall result in joint weld strength equal to or greater than the tensile strength of the pipe. Socket fusion shall not be used. Extrusion welding or hot gas welding of HDPE shall not be used. Flanges, unions, grooved-couplers, transition fittings, and some mechanical couplers may be used to connect HDPE pipe mechanically without butt-fusion only where shown in the Drawings.

C. Ductile Iron to HDPE Connections
   1. Flanged connections between ductile iron pipe or fittings and HDPE pipe or fittings shall meet all requirements of Section 15062 "Ductile Iron Pipe and Fittings."
   2. Mechanical joint connections between ductile iron pipe or fittings and HDPE pipe or fittings shall use ductile iron mechanical joint glands conforming to AWWA C111 and AWWA C153. Mechanical joints shall be fully thrust restrained. Gaskets, bolts, and hexagonal nuts shall be standard rubber gaskets conforming to AWWA C111. Follower gland shall match class 350 compact fittings.
   3. HDPE pipe stiffeners shall be constructed of stainless steel and shall be flanged on one end to prevent over-insertion into the receiving pipe.

2.06 LOCATION DETECTION WIRES

A. Materials: Two continuous, insulated 10-gauge copper wires.

B. Installation: Wires shall be attached to the centerline of the HDPE pipe every 5-feet. Wires shall terminate at top of each valve box and be capable of extending 12-inches (305-mm) above the top of the box in a manner so as not to interfere with valve operation.

PART 3 - EXECUTION

3.01 HEAT FUSION

A. Use fusion equipment specially designed for heat fusion of HDPE. The equipment utilized shall be regulated for the different melt strength materials. Compatibility fusion techniques shall be used when polyethylene of different melt indexes are fused together.

B. Use the following procedure to butt fused HDPE pipe. If a procedure noted below contradicts manufacturer's recommendations, follow the manufacturer's recommendation.
   1. Maintain the proper temperature of the heater plate as recommended by the pipe manufacturer. Check it with a tempilstik or pyrometer for correct surface temperature.
   2. Clean pipe ends inside and outside with a clean cotton cloth to remove dirt, water, grease, and other foreign materials.
   3. Square (face) the pipe ends using the facing tools on the fusion machine. Remove all burrs, chips, and fillings before joining pipe or fittings.
   4. Check the line-up of pipe ends in the fusion machine to see that pipe ends meet squarely and completely over the entire surface to be fused. The clamps shall be tight so that the pipe does not slip during the fusion process.
   5. Insert the clean heater plate between the aligned ends and bring the ends firmly in contact with the plate but do not apply pressure while achieving the melt pattern. Allow the pipe ends to heat and soften. Softening depths shall be per the manufacturer's recommendation.
   6. Carefully move the pipe ends away from the heater plate and remove the plate (if the softened material sticks to the heater plate, discontinue the joint, clean heater plate, square pipe ends, and start over).
   7. The melted ends shall be connected rapidly but not slammed together. Apply enough pressure to form a double rollback bead to the body of the pipe around the entire circumference of the pipe about 1/8-inch (3.175-mm) to 3/16-inch (4.763-mm) wide. Pressure is necessary to cause the heated material to flow together.
   8. Allow the joint to cool and solidify properly. Remove the pipe from the clamps and inspect the joint appearance.

3.02 OPERATIONS INCIDENTAL TO JOINT COMPLETION

A. Plan joint completion to accommodate temporary test bulkheads for hydrostatic testing on the day of installation.

3.03 ASSEMBLING JOINTS

A. Flanged Joints
   1. Flange adapters shall be pressure rated the same as the pipe. Flange adapters shall be heat fused to the pipe as outlined in the heat fusion section.
   2. Gaskets shall be used between the polyethylene flange adapters when recommended by the HDPE pipe manufacturer. Sufficient torque shall be applied evenly to the bolts to prevent leaks. After initial installation and tightening of flanged connections, allow the connections to set for a few hours then conduct a final tightening of the bolts.
   3. Lubricate nuts and bolts with oil or graphite prior to installation.
   4. Check operation of valves connected to molded stub end flange adapters. Insert polyethylene spacer if recommended by pipe manufacturer for clearance.

B. Mechanical Joints
   1. Wipe the socket and the plain end clean. Lubrication and additional cleaning should be provided by brushing both the gasket and plain end with an approved pipe lubricant just prior to slipping the gasket onto the plain end for joint assembly. Place the gland on the plain end with the lip extension toward the plain end, followed by the gasket with the narrow edge of the gasket toward the plain end.
   2. Insert the pipe into the socket and press the gasket firmly and evenly into the gasket recess. Keep the joint straight during assembly.
   3. Push the gland toward the socket and center it around the pipe with the gland lip against the gasket. Insert bolts and hand tighten nuts. Make deflection after assembly but before tightening bolts.
   4. Tighten the bolts to the normal range of bolt torque as indicated in AWWA C-600 while maintaining approximately the same distance between the gland and the face of the flange at all points around the socket.
   5. When connection is being made to HDPE pipe or fittings use a welded flange to connect to fittings.

3.04 INSTALLATION

A. Installation of High-Density Polyethylene Pipe
   1. All high-density polyethylene (HDPE) pipe shall be handled, stored, assembled, and installed in accordance with AWWA C906, manufacturer's recommendations, and these Specifications.
   2. HDPE pipe shall be installed using directional drilling method of construction in accordance with Section 02665 "Horizontal Directional Drilling of Pressure Mains."

B. Installation of HDPE Service Connections
   1. HDPE AWWA C901 (1/2-inch through 3-inch) water and reclaimed water service connections crossing roads shall be installed in a PVC casing pipe. PVC casing pipe may be installed by push/pull (reaming) methods as approved by the County. PVC casing pipe shall be Schedule 40 and meet the requirements of ASTM D1785. PVC fittings shall be Schedule 40 and shall meet the requirements of ASTM D2466. Casing pipe/carrier pipe size shall be as follows:

Carrier Pipe (Nominal Dia.)	Casing Pipe (Nominal Dia.)			
	Size	O.D	Wall	I.D
1-inch	2-1/2-inches	2.875	0.203	2.469
1-1/4-inch	3-inches	3.50	0.216	3.068
1-1/2-inch	3-1/2-inches	4.00	0.226	3.548
2-inch	4-inches	4.5	0.237	4.026

2. Casing pipe shall be air pressure tested for leaks immediately upon completion of each crossing at a minimum test pressure of 20-psi (.138 MPa).
3. Following installation of carrier pipe within casing, install a plug in each open end of casing. Plugs shall be suitable for restraining against external earth load.

3.05 DISINFECTION OF PIPE

A. Flush and disinfect potable water pipe in accordance with Section 02660 "Potable Water System."

3.06 HYDROSTATIC TESTING

A. Perform hydrostatic testing for leakage prior to installation and following installation in accordance with manufacturer's written recommendations.

B. All pressure piping shall be hydrostatically tested at a pressure equivalent to 1-1/2 times the working pressure, but not less than 150-psi (1.034 MPa), unless otherwise noted. No high-density polyethylene pipe section under test will be accepted if the make-up water amount is greater than that specified in applicable specification Section 02660 "Potable Water System", Section 02661 "Wastewater Force Mains", and Section 02662 "Reclaimed Water System."

3.07 MANDREL TESTING

A. Perform mandrel testing through the entire length of the installed HDPE pipe. The mandrel size shall be 90% of the inside diameter of the pipe.

END OF SECTION

SECTION 15100

ANCILLARY EQUIPMENT

PART 1 – GENERAL

1.01 DESCRIPTION

A. Scope of Work: Provide all valves and appurtenances, ready for operation, as shown on the Drawings and as specified herein.

1.02 QUALITY ASSURANCE

A. All valves, appurtenances, and ancillary equipment shall be products of well-established reputable firms who are fully experienced, reputable and qualified in the manufacture of the particular equipment to be furnished. The equipment shall be designed, constructed, and installed in accordance with the best practices and methods and shall comply with these Specifications.

1.03 SHOP DRAWINGS AND SUBMITTALS

A. Submittals shall be submitted to the County for review and acceptance prior to construction in accordance with the General Conditions and specifications Section 01300 “Submittals”.

PART 2 – PRODUCTS

2.01 GENERAL

A. All valves, appurtenances, and ancillary equipment shall be of the sizes shown on the Drawings and specified herein.

B. All valves and appurtenances shall have the name of the maker and the working pressure for which they are designed cast in raised letters upon some appropriate part of the body.

C. All valves, appurtenances, and ancillary equipment shall be as specified in Appendix D “List of Approved Products” appended to these technical specifications.

2.02 AIR RELEASE VALVES

A. For Water Service and Reclaimed Water Service:
   1. General: Water mains shall be equipped with combination air release valves located as shown on the Drawings. Valves shall be made to remove air at high points where elevation changes exceed five feet. Automatic air release valves shall be located at high points for pipe systems greater than 12 inches in diameter.
   2. Water and Reclaimed Water Combination Air Release Valves: The valve body shall be 316 stainless steel, 316 stainless steel float, bronze water diffuser Buna-N or Viton seat and stainless steel trim.
   3. Fittings from the main to the air release valve shall be threaded and made of brass.

B. For Wastewater Service:
   1. General: Wastewater force mains shall be equipped with combination air release valves located as shown on the Drawings. Valves shall be made to remove air at high points where elevation changes is two feet or greater, located in an enclosure as detailed on the Drawings.
   2. Wastewater Combination Air Release Valves: The valve body shall be conical in shape and shall be 316 stainless steel with a funnel shape lower body to drain sewage automatically back into the system. All internal parts shall be corrosion resistant 316 stainless steel or non-metallic plastic materials.
   3. On flanged connections 316 stainless steel bolts, nuts and washers are to be used along with the proper sized gasket.

C. Air release valves shall be installed in an enclosure.

2.03 TAPPING SLEEVES AND VALVES

A. General: Tapping sleeves shall be mechanical joint sleeves.

B. Mechanical Joint Sleeves: Sleeves shall be cast of gray-iron or ductile-iron and have an outlet flange with the dimensions of the Class 125 flanges shown in ANSI B16.1 and properly recessed for tapping valve. Glands shall be gray-iron or ductile iron. Gaskets shall be vulcanized natural or synthetic rubber. Bolts and nuts shall be stainless steel and comply with ANSI/AWWA C111/ANSI A21.11. Sleeves shall be capable of withstanding a 200 psi working pressure.

C. Fabricated Mechanical Joint Tapping Sleeves: Sleeves shall be of split mechanical joint design with separate end and side gaskets. Sleeves shall be fabricated of high strength steel, meeting ASTM A283 Grade C or ASTM A-36. Outlet flange shall meet AWWA C-207, Class “D” ANSI l50 pound drilling and be properly recessed for the tapping valve. Bolts and nuts shall be stainless steel. Gasket shall be vulcanized natural or synthetic rubber. Sleeve shall have manufacturer applied fusion bonded epoxy coating, minimum l2 mil thickness.

D. Tapping Valves: Tapping valves shall be resilient seated gate valves flange by mechanical joint ends. Valves shall be compatible with tapping sleeves as specified above and specifically designed for pressure connection operations.
   1. Tapping valves with alignment lip shall be placed vertical where possible for Water and Reclaimed Water.
   2. Tapping Valves 12-inch and smaller shall be AWWA C509 resilient seated only.
   3. Tapping Valves 16-inch and larger shall be AWWA C515 resilient seated only (16-inch and 24-inch no gearing required) above 24-inch shall be installed vertically with a spur gear actuator. When tapping existing mains, valves 24-inch and above shall be furnished with NPT pipe plugs for flushing the tracks.
   4. On wastewater force main, tapping valves shall be horizontally installed and abandoned in the open position followed by a plug valve.

2.04 VALVE BOXES FOR BURIED VALVES

A. Standard Two-piece Cast Iron Valve Box: Are required for mains less than six feet below finished grade and less than or equal to 12-inches in diameter.
   1. Valve boxes shall be provided with suitable heavy bonnets and shall extend to such elevation at or slightly above the finished grade surface as directed by the Owner's Representative.
   2. The barrel shall be two-piece, screw type only, having 5-1/4-inch shaft. The upper section shall have a flange at the bottom having sufficient bearing area to prevent settling and shall be complete with locking cast iron covers. Coat buried cast iron pieces with coal tar epoxy.

B. Valve Box Assembly: Valve box assemblies with operating nut extension is required for any size main that is six feet or greater below finished grade or if mains are greater than 12-inches in diameter.
   1. Valve boxes shall be one complete assembled unit composed of the valve box and extension stem that attaches and locks to the two-inch wrench nut. The extension shall be high strength, corrosion resistant steel construction, and permanently attached to the operating nut.
   2. The operating nut extension insert shall be one complete assembled unit with a self-adjusting extension stem system that fits inside a standard valve box that will accommodate variable trench depths six-feet and greater as shown in the Drawings. All moving parts of the extension stem shall be enclosed in a housing to prevent contact with the soil.
   3. A valve box centering device designed to eliminate the shifting of the valve box against the operating nut of the valve shall be used. Valve box assembly shall be adjustable to accommodate variable trench depths six-foot and greater as shown in the Drawings.

C. The stem assembly shall be of a telescoping design that allows for variable adjustment length. The material shall be at minimum galvanized square steel tubing. The stem assembly shall have a built-in device that prevents the stem assembly from disengaging at its fully extended length. The extension stem must be capable of surviving a torque test to 1,000 ft-lb without failure.

D. Valve boxes shall have locking cast iron covers utilizing a five-sided nut with a special wrench needed to open. Covers shall have “WATER”, “SEWER”, or “RECLAIMED WATER” cast into the top, as applicable

E. Concrete Collar: Each valve installed in an unimproved area (outside of pavement, driveways or sidewalks) shall require a 24" x 24" x 6" concrete pad or collar as shown in the Drawings.

F. Identification Disc: Each 16" or larger valve (unless otherwise shown on the Drawings) installed shall be identified by a 3" diameter bronze disc anchored in the concrete pad or collar in unimproved areas and/or anchored on a 4" x 4" x 18" long concrete post set flush with the pavement surface in improved areas. The disc shall be stamped with the following information as shown on the Drawings:
   1. Owner
   2. Manufacturer and Size of the valve.
   3. Type of valve.
   4. Service.
   5. Direction and number of turns to open.
   6. Year

G. Valve markers are to be made of schedule 80 PVC and have decal applied containing information as shown on the Drawings. The marker shall be the same color as the pipe being marked.

2.05 LINE STOPPING ASSEMBLIES

A. Sleeves used to line-stop existing mains shall be provided and installed at locations as shown on the Drawings. Line-stopping sleeve shall be steel fusion epoxy coated body with stainless steel straps, bolts, nuts, and washers. Contractor shall determine the outside diameter of the existing main prior to ordering sleeve.

B. The line-stopping equipment shall consist of a resilient sealing element, which shall be attached to and transported by a plug inserter perpendicularly into the pipe. The linear actuator shall extend and retract the Line-Stopper into and out of the pipe. When retracted from the pipe, the element and inserter shall be contained within the stopper housing.

C. The hollow cylindrical sealing element shall be molded of natural rubber. The lower interior chamber of the element shall be enlarged into a hemispherical cavity to allow symmetrical deformation into sealing conformity with the bore of the pipe.

D. The linear actuator shall be hydraulic and shall have a self-contained hand operated pump. The actuator shall exert a force sufficient to deform perpendicularly the cylindrical element into axially symmetrical sealing contact with the bore of the pipe. Design of actuator shall provide adequate stroke and means to continually align the line-stop bullet stopping assemblies in sizes 14-inch through 20-inch with pressure rating to 250 psig.

E. Equalization of pressure across the sealed element shall not be required to retract the element from the pipe. No equalization fittings shall be required downstream of the line-stopper.

F. The line-stopping equipment shall be accurately aligned on the 4-inch through 8-inch fittings by locating in the external threads of the fitting nozzle. With sizes 10-inch and 12-inch, the location shall be made on the centering groove of the fitting flange.

G. Line-stopping equipment must be capable of function and acceptance of multiple stopper heads and shall be compatible with existing system fittings.

2.06 SERVICE SADDLES

A. Stainless Steel Service Saddles: Shall be epoxy or nylon coated ductile iron body with stainless steel, 18-8 type 304 straps, AWWA tapered threads for 1-inch and 2-inch to be iron pipe threads. Controlled OD saddles to be used on C905 PVC pipe, double straps to be 2-inch minimum width each, single strap to be minimum of three inches wide.

B. PVC Pipe Service Saddle:
   1. One-inch and two-inch services utilize brass body saddle with controlled OD for 12-inches and smaller pipe.
   2. One-inch and two-inch taps on existing pies larger than 12-inches shall use controlled OD epoxy or nylon coated ductile iron body with stainless steel 18-8 type 304 straps.
   3. Four-inch or larger services shall be mechanical tapping sleeves.

C. Ductile Iron Pipe Service Saddle:
   1. One–inch services shall be direct tapped.
   2. Two-inch service shall use a controlled OD service tapping saddle with stainless steel straps and a ductile iron body that is either nylon or epoxy coated
   3. Four-inch or larger services shall be mechanical tapping sleeves.

D. HDPE Pipe Service Saddle:
   1. One-inch and two-inch shall utilize controlled O.D. tapping saddle with epoxy or nylon coated stainless steel 18-8 type 304 double straps.
   2. Four-inch or larger, shall use wide body tapping sleeves with a broad cross section gasket set in a retaining groove that increases sealing capability as pressure increases.

E. Concrete Pressure Pipe Service Saddle:
   1. Tapped concrete pressure pipe shall be in accordance with AWWA M-9, using a strap-type saddle made specifically for concrete cylinder pressure pipe.

F. Steel Pipe Service Saddle:
   1. Welded-on steel sleeves shall be used for all sizes and applications.

2.07 CORPORATION STOPS AND CURB STOPS

A. Corporation Stops: Shall be brass body reduced port type compatible with the polyethylene tubing and threaded in accordance with AWWA C800, AWWA C901, and shall comply with NSF-61.

B. Curb Stops: Shall be brass body reduced port type compatible with the polyethylene tubing and threaded in accordance with AWWA C800, AWWA C901, and shall comply with NSF-61.

2.08 PRESSURE GAUGES

A. Pressure gauges shall be installed on each pump station discharge pipe as indicated on the Drawings.

B. Pressure gauge shall be direct mounted, diaphragm (type) gauge, stainless steel case, stainless steel sensing element, liquid filled, with a 4-1/2-inch diameter dial and furnished with a clear glass crystal window, ¼-inch shut-off (isolation) valve. Gauges shall be weatherproof.

C. The pressure gauge face dial shall be white finished aluminum with jet-black graduations and figures and shall indicate the units of pressure measured in psi. Gauges shall be provided with pressure at normal operation at the mid range of the gauge.

D. As wastewater flows through the housing, the cylinder shall transmit pressure through the sensing liquid. Gauge outlet in the spool or ring shall be threaded, ¼ inch, per ANSI B2.1.

E. Nipples for connecting gauges to piping shall be Schedule 80S, Grade TP 316 seamless stainless steel, conforming to ASTM A 312. Fittings shall conform to ASTM A 403, Class WP316. Threads shall conform to ANSI B2.1. Size of pipe nipple shall match the gauge connection size.

2.19 TIE RODS

A. Steel for tie rods and tie bolts shall conform to the requirements of ASTM Designation A 242, and rods shall be galvanized in conformance with requirements of ASTM Designation A 123.

2.10 FLANGED COUPLING ADAPTERS

A. All adapters shall be harnessed with the bolts across the joint (flange to flange or flange to lug) designed for the pipe test pressure.

B. Adapter Size: Conform in size and bolt hole placement to ANSI standards for steel and/or cast iron flanges 125 or 150 pound standard unless otherwise required for connections.

C. Exposed Sleeve Type:
   1. Material: Steel
   2. Coating: Enamel
   3. Bolting: Carbon steel
   4. Acceptable Manufacturers: Dresser Manufacturing Co. - Style 128 for cast iron ductile iron and steel pipes with diameters of 2 inches through 96 inches, or equal.

D. Buried Sleeve Type:
   1. Material: Cast iron
   2. Bolting: Type 304 stainless steel conforming to ASTM A 193, Grade B8 for bolts, and ATM A 194, Grade 8 for nuts and washers. Bolts and nuts greater than 1-1/8-inches shall be carbon steel, ASTM A 307, Grade B, with cadmium plating, ASTM A 165, Type NS.
   3. Acceptable manufacturers: Dresser Manufacturing Co. - Style 127 locking type for cast iron, ductile, iron, asbestos cement and steel pipes with diameters of 3 inches through 12 inches, or equal.

E. Split Type:
   1. Material: Malleable or ductile iron.
   2. Design: For use with grooved or shouldered end pipe.
   3. Coating: Enamel
   4. Acceptable Manufacturers: Victaulic Company of America - Style 741 for pipe diameters of 2 inches through 12 inches, Victaulic Company of America - Style 742 for pipe diameters of 14 inches through 16 inches, or equal.

PART 3 – EXECUTION

3.01 INSTALLATION

A. All ancillary equipment shall be installed in the locations shown, true to alignment and rigidly supported. Any damage to the above items shall be repaired to the satisfaction of the Engineer before installation.

B. After installation, all ancillary equipment shall be tested as specified for adjacent piping. If any joint or equipment proves to be defective, it shall be repaired and retested to the satisfaction of the Engineer.

C. Install all floor boxes, brackets, extension rods, guides, the various types of operators and appurtenances as shown on the Drawings that are in masonry floors or walls, and install concrete inserts for hangers and supports as soon as forms are erected and before concrete is poured. Before setting these items, the Contractor shall check all plans and figures, which have a direct bearing on the location and shall be responsible for the proper location of these valves and appurtenances during the construction of the structures.

D. Notification and Connections to Existing Mains:
   1. The Contractor shall submit a completed "System Connection" form (obtain form from Owner) to Owner to schedule the connection. The request shall be made a minimum of five (5) working days prior to the proposed tie-in to the existing main for pressure connections and ten (10) working days prior to the proposed tie-in to the existing main for non-pressure connections. In this request, the Contractor shall provide the following information.
      a. Points of connection, fittings to be used and method of flushing and disinfection if applicable.
      b. Estimated construction time for said connections.
      c. Identify pressure and non-pressure connections
   2. Connections shall only be made on the agreed upon date and time. If the Contractor does not perform the work in the agreed upon manner or schedule, the Contractor shall be required to reschedule the connection by following the procedure outlined above.

E. Pressure Connections: Sufficient length of main shall be exposed to allow for installation of the tapping sleeve and valve and the operation of the tapping machinery. The main shall be supported on concrete pedestals or bedding rock at sufficient intervals to properly carry its own weight, plus the weight of the tapping sleeve, valve and machinery. Any damage to the main due to improper or insufficient supports will be repaired at the Contractor's expense.
   1. Prior to the tap, the Contractor shall assemble all materials, tools, equipment, labor, and supervision necessary to make the connection.
   2. The Contractor shall excavate a dry and safe working area pit of sufficient size to enable the necessary Work.
   3. The inside of the tapping sleeve and valve, the outside of the main and the tapping machine shall be cleaned and swabbed or sprayed with one percent liquid chlorine solution prior to beginning installation for water system pressure connections and must comply with AWWA C-651-99 or most current version.
   4. After the tapping sleeve has been mounted on the main, the tapping valve shall be bolted to the outlet flange, making a pressure tight connection. Prior to beginning the tapping operation, the sleeve and valve shall be pressure tested under the observation of Owner personnel to 150 psi for 30-minute duration to ensure that no leakage will occur.

5. For pressure connections 4-inch through 20-inch installations, the minimum diameter cut shall be 1/2 inch less than the nominal diameter of the pipe to be attached. For larger taps, the allowable minimum diameter shall be two to three inches less than the nominal diameter of the pipe being attached. After the tapping procedure is complete, the Contractor shall submit the coupon to Owner.
6. The tapping valve shall be placed horizontally for pressure connections to wastewater force mains. A plug valve shall be attached to the tapping valve after the tapping procedure is complete. The tapping valve shall be left in the open position prior to backfilling.
7. Adequate restrained joint fittings shall be provided to prevent movement of the installation when test pressure is applied.
8. The Contractor shall be responsible for properly backfilling the work area pit after the Work is completed.

F. Non-Pressure Dry Connections:
1. For water service connections, no customer shall be without service for more than six hours. For wastewater connections, provide bypass operations per Section 01516 Collection System Bypass. This accommodation to customers may include scheduling after Normal Working Hours.
2. The Contractor shall be ready to proceed by pre-assembling as much material as possible at the site to minimize the length of service interruption.
3. Needed pipe restraints must be installed prior to the initiation of the shutdown.
4. The excavation shall be opened and needed site preparations must be completed before the initiation of the connection work.
5. Owner shall postpone a service cut-off if the Contractor is not ready to proceed at the scheduled time.
6. Only Owner personnel shall operate the valves needed to perform the shutdown on the existing system.

3.02 PAINTING

A. All exterior surfaces of iron body valves shall be clean, dry, and free from rust and grease before coating.

B. For valves installed underground or in valve vaults, all exterior ferrous parts of valve and actuator shall be coated at the factory with a thermally bonded epoxy coating in accordance with AWWA C550, latest revision.

C. For aboveground service, the exterior ferrous parts of all valves shall be coated in weatherproof paint. The color of the finish coats shall be in accordance with the Orange County Utilities Standards.

END OF SECTION

THIS PAGE LEFT BLANK INTENTIONALLY

SECTION 15111
GATE VALVES

PART 1 - GENERAL

1.01 DESCRIPTION

A. Scope of Work: Furnish and install gate valves of the type and size and in the locations as shown on the Drawings and/or specified herein.

B. General Design
   1. Resilient seat non-rising stem (NRS) gates valves shall be used for underground service and for aboveground service where shown on the Drawings.
   2. Resilient seat Outside Stem and Yoke (OS&Y) gate valves shall be used for aboveground service only where shown on the Drawings.

1.02 QUALITY ASSURANCE

A. All gate valves of same type and style shall be manufactured by one (1) manufacturer.

1.03 SHOP DRAWINGS AND SUBMITTALS

A. Submittals shall be submitted to the County/Professional for review and acceptance prior to construction in accordance with the General Conditions and specifications Section 01300 "Submittals."

B. Shop Drawings and submittals shall be submitted to the County/Professional Engineer for review and acceptance prior to construction for the following:
   1. Certified Shop Drawings showing details of construction, dimensions (including laying length), and weight.
   2. Descriptive literature, bulletins, and/or catalogs showing all valve parts and describing material of construction by material and specification, e.g., AISI.
   3. Valve coatings and linings, if any.
   4. A complete bill of materials for all equipment.
   5. See individual sections for additional requirements.

1.04 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Shipping
   1. All parts shall be properly protected so that no damage or deterioration will occur during a prolonged delay from the time of shipment until installation is completed.
   2. Factory assembled parts and components shall be dismantled for shipment unless permission is received in writing from the County/Professional Engineer.

3. Finished surfaces of all exposed openings shall be protected by wooden blanks, strongly built and securely bolted thereto.
4. Finished iron or steel surfaces not painted shall be properly protected to prevent rust and corrosion.
5. After hydrostatic or other tests, all entrapped water shall be drained prior to shipment, and proper care shall be taken to protect parts from the entrance of water during shipment, storage, and handling.
6. Each box or package shall be properly marked to show its net weight in addition to its contents.

B. Storage
1. Store valves and accessories in an area on the construction site protected from weather, moisture, or possible damage.
2. Do not store valves or accessories directly on the ground.

C. Handling
1. Handle valves and accessories to prevent damage of any nature.
2. Carefully inspect all materials for:
a. Defects in workmanship and materials.
b. Removal of debris and foreign material in valve openings and seats.
c. Proper functioning of all operating mechanisms.
d. Tightness of all nuts and bolts.

1.05 WARRANTY AND GUARANTEES

A. The manufacturer's warranty period shall be concurrent with the Contractor's for 1-year, unless otherwise specified, commencing at the time of final acceptance by the County.

B. The Contractor shall be responsible for obtaining certificates for equipment warranty for all equipment which lists for more than $500.00 (major equipment). The County reserves the right to request warranties for equipment not classified as "major". The Contractor shall still warrant equipment not considered to be "major" in the Contractor's 1-year warranty period even though certificates of warranty may not be required.

C. In the event that the equipment manufacturer or supplier is unwilling to provide a 1-year warranty commencing at the date of substantial completion, the Contractor shall obtain from the manufacturer a 2-year warranty commencing at the time of equipment delivery to the job site. This 2-year warranty from the manufacturer shall not relieve the Contractor of the 1-year warranty starting at the time of County acceptance of the equipment.

D. The County shall incur no labor or equipment cost during the guarantee period.

E. Guarantee shall cover all necessary labor, equipment, and replacement parts resulting from faulty or inadequate design, improper assembly or erection, defective workmanship and materials, leakage, breakage, or other failure of equipment or components furnished by the manufacturer.

PART 2 - PRODUCTS

2.01 GENERAL

A. All material supplied shall be one of the products specified in Appendix D "List of Approved Products" appended to these technical specifications.

2.02 MATERIALS

A. Gate valves shall be resilient seat gate valves, manufactured to meet or exceed the requirements of AWWA C509/C515, latest revision, and these Specifications. All valves are to be tested in strict accordance with AWWA C509/C515.

B. Valves shall have an unobstructed waterway equal to or greater than the full nominal diameter of the valve.

C. The minimum design working water pressure shall be minimum 250-psig.

D. Gate valves shall be installed vertically per the Drawings and with minimum depth of cover per Table 15111-1.

Table 15111-1
Minimum Pipe Cover Required for Valves

Pipe Diameter (Inches)	Vertical Gate Valve Cover	
	LOCAL Roadway	Non-LOCAL Roadway*
4-inch – 8-inch	30-inch	36-inch
12-inch	36-inch	36-inch
16-inch	44-inch	48-inch
20-inch	-	50-inch
24-inch	-	54-inch
* Additional 12-inches of cover is required for all vertical valves 16-inches and greater located in the pavement		

E. Valves 16-inches and larger shall be AWWA C515 resilient seated only (16-inches through 24-inches no gearing required).

F. The valve body, bonnet, and bonnet cover shall be cast iron ASTM A126, Class B for C509 valves and ductile iron ASTM A536 for C515 valves. All ferrous surfaces inside and outside shall have a fusion-bonded epoxy coating in accordance with AWWA C 550.

G. A 2-inch wrench nut shall be provided for operating the valve. Valves 30-inches and larger shall be provide with spur gear actuators. Side actuated gate valves are not acceptable. All valves shall open left or counter clockwise.

H. The valves shall have non-rising stems with the stem made of cast, forged, or rolled bronze as specified in AWWA C509. Two (2) stem seals shall be provided and shall be of the O-ring type. The stem nut must be independent of the gate.

I. The resilient sealing mechanism shall provide zero leakage at test and normal working pressure when installed with the flow from either direction.

J. Tapping valves shall be placed vertical where possible for Water and Reclaimed Water. When tapping existing mains, valves 24-inches and above shall be furnished with NPT pipe plugs for flushing the tracks.

PART 3 - EXECUTION

3.01 PREPARATION

A. All valves shall be inspected upon delivery in the field to insure proper working order before installation. Valves shall be set and jointed to the pipe in the manner as set forth in the AWWA Standards for the type of connection ends furnished. All buried gate valves shall be connected using restrained joints. All valves and appurtenances shall be installed true to alignment and rigidly supported. Any damage to the above items shall be repaired to the satisfaction of the County before installation.

3.02 INSTALLATION

A. Install valves and accessories in strict accordance with manufacturer's instruction and recommendations as shown on the Drawings and as directed by the County.

B. Carefully erect all valves and support them in their respective positions free from distortion and strain.

C. Bolt holes of flanged valves shall straddle the horizontal and vertical centerlines of the pipe run to which the valves are attached. Clean flanges by wire brushing before installing flanged valves. Clean flange bolts and nuts by wire brushing, lubricate threads with oil and graphite, and tighten nuts uniformly and progressively. Clean threaded joints by wire brushing or swabbing. Apply Teflon joint compound or Teflon tape to pipe threads before installing threaded valves. Joints shall be watertight.

D. Support all valves connected to pumps and equipment and in piping systems that cannot support valves.

E. Repair any scratches, marks and other types of surface damage with original coating as supplied by the factory.

F. Valves shall be carefully inspected, opened wide and then tightly closed and the nuts and bolts shall be tested for tightness. Special care shall be taken to prevent any foreign matter from becoming lodged in the valve seat. Any valve that does not operate correctly shall be removed and replaced.

3.03 INSPECTION AND TESTING

A. Check and adjust all valves and accessories for smooth operation.

B. Test valves for leakage at the same time that connecting pipelines are tested. See Section 02662 "Reclaimed Water Transmission System" for pressure testing requirements. Protect or isolate any parts of valves, operators, or control and instrument systems whose pressure rating is less than the pressure tests.

END OF SECTION

THIS PAGE LEFT BLANK INTENTIONALLY

APPENDIX A

GEOTECHNICAL REPORT

Dated March 19, 2015

The attached Geotechnical Engineering Investigation and dewatering ground water sampling was accomplished for the utilization of the Design Engineer during the design phases of this project. The criteria and recommendations stated herein are not to be construed as direction from the Design Engineer to the Contractor and are hereby provided only as general information, furnished as a courtesy to the Contractor.

THIS PAGE LEFT BLANK INTENTIONALLY

GEOTECHNICAL INVESTIGATION REPORT
JOHN YOUNG PARKWAY
RECLAIMED WATER MAIN IMPROVEMENTS
ORANGE COUNTY, FLORIDA

AEA PROJECT No. 201319

Antillian Engineering Associates, Inc.
3331 Bartlett Boulevard
Orlando, Florida 32811
(407) 422-1441

ANTILLIAN
ENGINEERING ASSOCIATES, INC.

March 19, 2015

BFA Environmental, Inc.
1230 Hillcrest Street
Orlando, Florida 32803

Attention: Geoff Hennessy, P.E.

Reference: Geotechnical Investigation Report
John Young Parkway Reclaimed Water Main Improvements
Orange County, Florida
AEA Project No. 201319

Dear Mr. Hennessy:

Antillian Engineering Associates, Inc. has completed a geotechnical engineering investigation for a proposed reclaimed water main along John Young Parkway in Orange County, Florida. The work on this project was done in general accordance with the scope of services presented in our proposal dated November 16, 2012. This report contains the results of our investigations, recommendations for design and installation of the reclaimed water main, and other concerns as appropriate.

It has been our pleasure to serve BFA and Orange County Utilities on this project. Please let us know if you have any questions or if you need additional information.

Respectfully submitted,
ANTILLIAN ENGINEERING ASSOCIATES, INC.
State of Florida Authorization No. EB 6685

PETER GREGORY SUAH
No 46910
STATE OF
03.19.2015
PROFESSIONAL ENGINEER

Peter G. Suah, P.E.
Principal Engineer
Florida P.E. No. 46910

Attachments: Figures
Appendix A: Field and Laboratory Investigations
Appendix B: Important Information About Your Geotechnical Engineering Report
Appendix C: Constraints and Restrictions

TABLE OF CONTENTS

201319
John Young Parkway
Reclaimed Water Main Improvements
March 19, 2015

PROJECT DESCRIPTION

Orange County Utilities Department ("OCU") is planning to install a new reclaimed water main along John Young Parkway from the intersection with Town Center Boulevard in Hunters Creek to connect with an existing main about 1,800 feet north of State Road 528 ("SR 528"). The overall length of the pipe route is about 22,000 feet. Its approximate location is shown on Figure 1.

It is our understanding that the pipe for the reclaimed water main will be installed in the John Young Parkway right-of-way, typically in the unpaved areas beyond the edge of the roadway shoulder. Most of the pipe along the route will be installed within ten feet of the existing ground surface, using conventional trenching and backfilling ("cut-and-cover") construction methods. Pipe crossings beneath major roadways and two drainage channels will be accomplished at depths greater than ten feet below the ground surface, using methods that do not require trenching ("trenchless") construction methods. BFA Environmental, Inc. ("BFA") was selected by OCU to design this project. The geotechnical investigation was assigned to Antillian Engineering Associates, Inc. as the geotechnical consultant on the BFA team.

AVAILABLE INFORMATION

The United States Geological Survey (USGS) quadrangle topographic map for the area and the Natural Resource Conservation Service (NRCS) Soil Survey of Orange County were examined for general information about the project area. Preliminary project plan sheets prepared by BFA ("the preliminary BFA plans") were examined for information pertinent to the project.

The USGS map showed the project area as a broad, nearly level to gently sloping plain on the eastern bank of Shingle Creek. Broad areas of marsh and wetlands, some up to several hundred feet wide, were shown between the creek and the broad, nearly level to gently sloping plain to the east. State Road 528 (identified as "Bee Line Expressway") and SR 500/United States Highway 17/92/441 were shown but John Young Parkway and the Hunters Creek area were not. Ground surface elevations in the area where John Young Parkway is currently situated were mapped between the Elevation 75 feet NGVD (El. 75) and El. 80 contours. A copy of the USGS map is reproduced as Figure 1.

The NRCS Soil Survey showed near-surface soils along the alignment that are commonly found on the broad, low plains of central Orange County. The predominant soil unit was Smyrna fine sand. Small areas of Pomello fine sand were shown in areas that were mapped at slightly higher elevations on the USGS map. These two soil units were described as nearly level and poorly drained. Seasonal high groundwater levels were reported within a foot of the natural ground surface in Smyrna fine sand and within two feet of the ground surface in Pomello fine sand. Isolated areas of Basinger fine sand depressional were mapped in a few localized low areas shown on the USGS map. This soil unit was reported to be very poorly drained and submerged for most of the year.

The preliminary BFA plans showed the route for the reclaimed water main ("the pipe route") in the John Young Parkway right-of-way beyond the edge of the roadway shoulder. Survey stationing was

shown at 100-foot intervals along the centerline of John Young Parkway. The beginning of the project was shown near Sta. 103+00, on the eastern side of the roadway less than 300 feet north of the intersection with Town Center Boulevard. The pipe route crossed John Young Parkway from east to west near Sta. 146+80, and crossed back at the end of the project near Sta. 328+40.

Twelve locations for trenchless construction were shown. Seven roadway crossings will utilize the "jack-and-bore" method, three additional roadway crossings will use horizontal directional drilling ("HDD") and two drainage channel crossings with adjoining segments of the route with difficult access for conventional construction equipment will also use HDD. A summary of the 12 locations where trenchless construction methods are planned is presented below in Table 1.

TABLE 1
SUMMARY OF SEGMENTS FOR TRENCHLESS CONSTRUCTION

SIDE OF ROAD	APPROX. STATION		DESCRIPTION	INSTALLATION METHOD
	BEGIN	END		
East	129+00	137+20	SR 417 NB on-ramp to SR 417 SB off-ramp	Jack-and-bore
	144+00	145+80	Substation Road crossing	Jack-and-bore
- - -	146+80	146+80	John Young Pkwy road crossing east to west	Jack-and-bore
West	161+00	166+00	Battles Drive road crossing	HDD
	196+00	206+00	Peppermill Canal crossing	HDD
	266+00	271+00	Central Florida Parkway road crossing	HDD
	277+50	286+50	Canal II approach and crossing	HDD
	291+00	294+50	Taft-Vineland Road crossing	Jack-and-bore
	306+00	307+60	SR 528 EB off-ramp crossing	Jack-and-bore
	310+80	314+50	SR 528 Mainline crossing	HDD
	321+00	322+10	SR 528 WB on-ramp crossing	Jack-and-bore
- - -	328+40	328+40	John Young Pkwy crossing west to east	Jack-and-bore

The reclaimed water main was labeled "24" DIP RECLAIMED WATER MAIN" or "24" HDPE". Additional notes on the drawing revealed two existing 12-inch diameter reclaimed water mains on the west side of John Young Parkway that will be removed or abandoned as part of this project. Other utilities shown on the west side of John Young Parkway included a 24-inch diameter gravity sewer and a 24-inch diameter potable water main. A copy of the preliminary BFA plan is reproduced as Figure 2 through Figure 5.

FIELD INVESTIGATION

Several field visits were conducted in November, 2014 to observe surface conditions along the proposed pipeline route and prepare for the drilling program. Test boring locations were established along the route at intervals not exceeding 500 feet approximately, using the preliminary BFA plans and visible landmarks as references. The boring locations were staked and painted for underground utility location and marking as required by Florida statutes and to facilitate subsequent identification by the drilling crew.

The borings were designated to match their approximate stationing along John Young Parkway. For example, boring "135+70" was situated near Sta. 135+70. The suffix "E" or "W" was added to the boring designations at roadway crossings (where stationing would be identical) to indicate the side of the roadway on which the boring was located. For example, boring "146+80W" was located on the western side of the road crossing at Sta. 146+80.

Fifty-eight test borings were drilled between December 1, 2014 and December 18, 2014 along the pipe route. Thirty borings were drilled to a depth of ten feet each along the segments of the pipe route where cut-and-cover construction is planned. Twenty-eight borings (the" deeper borings") were drilled to a depth of 25 feet in the segments of the route where trenchless methods are planned. Five borings between Sta. 255+00 and Sta. 271+00 could not be drilled because utility locating services were unable to detect a 24-inch potable water main shown on the preliminary BFA plans. Approximate boring locations are shown on Figure 2 through Figure 5.

Boreholes were advanced by continuous split-spoon sampling and mud-rotary drilling. The Standard Penetration Test (SPT) was conducted with the split-spoon sampling in general accordance with ASTM D 1586. Testing and sampling were conducted continuously from one foot below the ground surface to a depth of ten feet. The deeper borings were tested and sampled at five-foot intervals from ten feet to 25 feet. Sampler penetration resistance expressed in hammer blows per foot (the "SPT N-value"), the soils recovered in each sampler and other notable observations were logged by the field crew. Representative samples were sealed in clean, airtight containers for transportation to our Orlando office. The depth to groundwater in each borehole was measured and recorded on the field logs. At the completion of testing, the shallow boreholes were backfilled with soil. The deeper boreholes were grouted with a cement-bentonite slurry.

LABORATORY TESTING

The recovered soil samples were examined in our office by a geotechnical engineer who confirmed the descriptions on the field logs, classified the soils visually in accordance with ASTM D 2488 and developed a representation of the soil stratigraphy at each boring location. Soil samples were selected for laboratory testing, which consisted of 68 single-sieve gradation analyses (ASTM D 1140), four Atterberg limits test series (ASTM D 4318) and four natural moisture content tests (ASTM D 2216). Test results are presented on the boring logs and the Summary of Laboratory Test Results sheets in Appendix A.

SURFACE CONDITIONS

John Young Parkway was a four-lane, divided roadway in a suburban area. For most of its length, the roadway was on a low earth embankment estimated to between two feet and six feet above the natural ground surface, depending on location. Most of the pipe route was in or near drainage swales at the bottom of the embankment side slope. Standing water from recent rainfall was observed in the swales on several occasions after rainfall events.

John Young Parkway intersected with local streets at grade but SR 417 and SR 528 were conveyed over the roadway on dual bridges at grade-separated interchanges. Approach embankments between 20 feet and 25 feet high were situated immediately east and west of the overpass bridge abutments. Broad, unlined drainage channels crossed beneath John Young Parkway at two locations in the northern portion of the route. The water surface in both channels was estimated to be between six feet and eight feet below the roadway surface, but the water depth could not be estimated. The proposed pipe route crossed beneath all the features discussed above.

Vegetation along the route was mostly well-maintained grass turf and a few moderately-sized, landscaped trees. Plastic flags and paint markings along the route indicated the presence of water mains, valves, sanitary sewer force mains and other underground utilities.

SUBSURFACE CONDITIONS

The stratigraphy, soil types and groundwater levels described below are based on the results of the test borings and the laboratory testing. SPT N-values were used as empirical indications of soil condition. The stratigraphy is general and describes the major soil types that were encountered. Detailed subsurface characteristics at each boring location are shown on the boring logs and on the Summary of Laboratory Test Results sheet in Appendix A.

The uppermost materials encountered in the majority of the borings were mostly grayish brown to very dark grayish brown, brown to very dark brown, light yellowish brown to dark yellowish brown, light gray to very dark gray, and occasionally pale yellow to yellow and very pale brown fine sands that contained varying amounts of silt. Small fragments of crushed rock were occasionally recovered in some soil samples. Encountered thicknesses ranged from less than a foot to ten feet. Actual thicknesses could not be confirmed in the borings that had been terminated before fully penetrating these materials. SPT N-values ranged from 2 blows per foot (bpf) to 32 bpf, with most values lower than 30 bpf, indicating loose to dense but generally loose to medium dense conditions. Single-sieve soil gradation analysis of 16 samples indicated fines contents (fraction by dry weight passing the U.S. Standard No. 200 sieve) that ranged from 4 percent to 16 percent. Based on the visual classification and laboratory test results, these soils were given the Unified Soil Classification System (USCS) designations “SP” for poorly graded sand, “SP-SM” for sand with silt and “SM” for silty sand. Because of the observed variations in composition and color, and the fact that the borings were near marked utilities within the side slope of the road embankment, these soils were characterized as “possible backfill” and “possible fill”.

Beneath the possible backfill and possible fill in a few borings south of Taft-Vineland Road, and uppermost in several borings near the Peppermill Canal and the SR 528 exit ramps was mostly dark grayish brown, grayish brown, dark yellowish brown, gray fine sand that contained silt. Encountered thicknesses ranged from one foot to about 13 feet. SPT N-values ranged from 2 bpf to 50 blows for three inches (50/3") with most values between 5 bpf and 30 bpf, indicating very loose to very dense but mostly loose to medium dense conditions. Single-sieve soil gradation analysis of eight samples indicated fines contents that ranged from 6 percent to 11 percent. Based on the visual classification and laboratory test results, these soils were given the USCS designation "SP-SM" for sand with silt.

Beneath the possible backfill and possible fill in some borings, and the sand with silt in others, was mostly grayish brown to dark grayish brown, light brownish gray, brown, dark brown and dark yellowish brown fine sands that contained silt. Encountered thicknesses ranged from less than two feet to 26 feet. Actual thicknesses could not be verified in borings that had been terminated before fully penetrating this material. SPT N-values ranged from 2 bpf to 71bpf with most values between 5 bpf and 30 bpf, indicating very loose to very dense but generally loose to medium dense conditions. Single-sieve soil gradation analysis of 37 samples indicated fines contents that ranged from 13 percent to 33 percent. Based on the visual classification and laboratory test results, these soils were given the USCS designation "SM" for silty sand.

Interbedded within the silty sand in a few borings was a layer of brown, very pale brown, light gray, pale yellow, light yellowish brown, gray and grayish brown fine sand. Encountered thicknesses ranged from less than two feet to 14 feet. SPT N-values ranged from 10 bpf to 32 bpf with most values lower than 30 bpf, indicating generally medium dense conditions. Single-sieve soil gradation analysis of three samples indicated fines contents that ranged from 4 percent to 11 percent. Based on the visual classification and laboratory test results, the soils were given the USCS designations "SP" for poorly graded sand, and "SP-SM".

Beneath the silty sand at isolated locations along the pipe route was gray, grayish brown and dark gray fine sand that contained clay. Encountered thicknesses ranged from less than two feet to about eight feet. Actual thicknesses could not be verified in the borings that had been terminated before fully penetrating this material. SPT N-values ranged from 2 bpf to 15 bpf with most values higher than 5 bpf, indicating very loose to medium dense conditions or stiff consistency. Single-sieve soil gradation analysis of five samples indicated fines contents that ranged from 47 percent to 91 percent. Additional testing of four samples indicated natural moisture contents that ranged from 20 percent to 38 percent, liquid limit values that ranged from 38 to 91 and plasticity index values that ranged from 18 to 71. Based on visual classification the laboratory test results, these soils were given USCS designations "SC" for clayey sand, "CL" for low-plasticity clay and "CH" for high-plasticity clay.

Beneath the sandy clay in boring 201+00 was pale yellow sand that contained silt. Its encountered thickness was less than two feet. The actual thickness could not be verified because the boring had been terminated before fully penetrating this material. The only SPT N-value recorded in this material was 14 bpf, indicating medium dense conditions. Single-sieve soil gradation analysis of one sample indicated a fines content of 16 percent. Based on visual classification and the laboratory test results, this soil was given the USCS designation"SM".

Groundwater was encountered in the boreholes at depths between a foot and about nine feet below the existing ground surface.

[END OF SECTION]

GENERAL COMMENTS ON RECOMMENDATIONS

The following recommendations are based upon a review of the available information, the field and laboratory test results, our understanding of the proposed construction and our experience with similar projects and subsurface conditions. If plans for the proposed construction change from those discussed in this report, we request the opportunity to review our recommendations and amend them as needed to accommodate those changes. The project plans and specifications should be reviewed by this office before being submitted to the owner to confirm that the geotechnical recommendations and concerns expressed in this report have been appropriately conveyed to those documents. If subsurface conditions encountered during construction differ significantly from those encountered in the boreholes, those conditions should be reported to us for our observation and comment.

GENERAL ASSESSMENT OF ENCOUNTERED SOILS

As discussed in the SUBSURFACE CONDITIONS section of this report, the uppermost soils encountered during this investigation were mostly loose to medium dense fine sands that contained varying amounts of silt. These soils were characterized as possible backfill, possible fill or sand with silt. In many borings, these soils were underlain by silty sands that were mostly loose to medium dense. Interbedded zones of loose to medium dense sands were encountered within the silty sands at some locations. Clayey sands, sandy clays and clays were occasionally encountered beneath the silty sands in the deeper borings. Isolated zones of very dense, possibly cemented sands were encountered within ten feet of the existing ground surface at a few locations.

Because of the natural variability in soils and the broad horizontal spacing between boring locations, the distribution of soil characteristics developed from the test boring information should not be expected to be consistent everywhere along the proposed pipe route. Higher occurrences of very loose and dense to very dense soils, clayey soils, organic soils and roots, as well as crushed rock and other anomalous inclusions are all possible and should be expected. This is particularly true in the section of the route between Sta. 255+00 and Sta. 271+00 (about 1,600 feet south of Central Florida Parkway) which was not explored because of possible conflicts with the water main that the utility locating services could not detect even though it was shown on the preliminary plans.

In our opinion, the soils encountered within the limits defined by the locations and depths of the test borings should be suitable for installation of the reclaimed water main along the proposed route, provided the recommendations presented later in this report are followed. Difficult earthwork is likely in the dense to very dense sands, and should be expected.

DESIGN HIGH WATER LEVEL

During the rainy season in Florida (normally between June and September), groundwater levels are generally higher than those observed at other times of the year. The extent of the variation depends on several factors, including the terrain, the intensity and duration of rainfall, the hydrogeologic properties of the soils and the presence and proximity of artificial drainage facilities.

Because of the urbanized nature of the project area and our observations of standing water in the roadside swales following rainfall events, it is our opinion that the natural, seasonal variation in groundwater level should not be used to estimate high groundwater levels. Instead, we recommend setting the water level at the ground surface for design of the pipe and any buried structures, as well as any temporary excavation support systems and dewatering systems that will be needed.

DESIGN OF PIPES AND BURIED STRUCTURES

Pipes, manholes and other buried structures should be designed to resist the vertical and lateral loads imposed by the soils, as well as possible hydrostatic pressures, surcharge loads and traffic loads. For calculating soil loading on buried structures, we recommend using a saturated soil unit weight of 125 pounds per cubic foot (pcf) and a lateral earth pressure coefficient of 0.5. That same coefficient should be applied to loads imposed on the ground surface by construction equipment and other vehicular traffic near the excavations. In the absence of more detailed information, typical traffic loads should be represented by a uniformly distributed surcharge of 250 pounds per square foot (psf).

PIPELINE DESIGN

For the purpose of pipeline design, a minimum modulus of soil reaction (E') value of 1,000 pounds per square inch (psi) may be used, provided the earthwork, compaction and subgrade preparation recommendations described in the EARTHWORK FOR BELOW-GRADE CONSTRUCTION section below are implemented.

FOUNDATION SUPPORT

Manholes, thrust blocks, anchor blocks and other underground structures should be supported on compacted natural soil or compacted backfill prepared as recommended in the EARTHWORK FOR CUT-AND-OVER CONSTRUCTION section presented later in this report. Soils compacted as recommended should support bearing pressures up to 1,500 pounds per square foot (psf) with total settlement of less than one inch. Even when full, installed pipe weighs less than the soil it displaced, which means it imposes little if any additional vertical stress on the underlying soil. Under those conditions, settlement of the pipe is not anticipated.

UPLIFT RESISTANCE

Groundwater levels can rise and submerge parts of some structures, resulting in uplift forces from buoyancy. Uplift forces are resisted by the self-weight of the affected structure (divided by an appropriate factor of safety) and the buoyant weight of backfill directly above any parts of the base of the structure that project beyond its walls. Soil shear along vertical planes extending upward from the edges of the base of the structure should not be included in uplift resistance calculations.

SOIL RESISTANCE TO HORIZONTAL PIPELINE FORCES

Changing fluid pressure inside a pipeline can induce horizontal forces at junctions with buried structures and in locations where the pipe changes direction. Those forces can cause the pipe to move uncontrollably and eventually lead to distress, so anchor blocks or thrust blocks are typically provided to restrain the pipe. Those blocks resist horizontal forces by virtue of their mass as well as the ability to mobilize the shear resistance of the soil beneath their bases and the passive resistance of the soil in contact with their vertical faces.

In order to resist the anticipated pipeline forces, soil needs to be in a medium dense to dense condition. Naturally loose soils (and all fill or backfill materials) should be compacted to achieve an in-place dry density not less than 95 percent of the maximum obtained by the Modified Proctor method (ASTM D 1557). This condition should extend at least two feet below the base of any block or structure and at least five feet beyond the vertical face in contact with the soil. The soils should be continuous with no voids or other discontinuities.

Shear resistance beneath the base of any block or structure may be estimated using the following expression:

$$S = \frac{(W + \gamma_s H_t A - U) \tan (0.67\phi)}{FS_b}$$

where

S = allowable shear resistance, in pounds
W = total weight of the block, in pounds
γ_s = unit weight of the soil above the block, in pounds/ft^3
H_t = depth from ground surface to the top of the block, in feet
A = base area of the block, in ft^2
U = total uplift force, in pounds
ϕ = soil friction angle (30 degrees typically assumed)
FS_b = desired factor of safety for base shear (1.5 typically assumed)

For design of thrust blocks or anchor blocks, the unit weight for moist, compacted soil in central Florida is often estimated at about 110 pounds per cubic foot (pcf). Saturated soils are estimated at about 120 pcf. Passive soil resistance against the face of any block or structure may be calculated conventionally using the estimated soil properties and the desired factor of safety for passive resistance. Surcharges, wheel loads and the weight of construction equipment should not be considered in these analyses.

EXCAVATION SAFETY

The sides of all excavations more than four feet deep must be inclined or supported to withstand lateral forces exerted by the existing soils in accordance with the latest regulations promulgated by the Occupational Safety and Health Administration (OSHA). The design of temporary excavation support systems should be conducted in conjunction with the design of the dewatering systems. As discussed earlier in this report, groundwater should be maintained at least two feet below the bottoms of all excavations. If a dewatering system fails, groundwater can return to its pre-construction level and possibly fill the excavation. Uncontrolled pumping of water from a flooded excavation could create a "rapid drawdown" condition which can reduce soil strength to its minimum. This condition should be analyzed with the groundwater level set at the ground surface.

GROUNDWATER CONTROL

Based on the encountered depth to groundwater, the estimated design high groundwater level and the anticipated depths of installation of the new reclaimed water main, groundwater is expected to influence construction. As a result, the Contractor should be prepared to lower and maintain the groundwater at least two feet below the bottoms of all excavations in order to facilitate excavations and enable the proper working of the subgrade soils and backfill as recommended in this report. The contract documents should require the Contractor to verify the groundwater level before starting construction, and to be responsible for all dewatering, regardless of the groundwater level during construction.

To prevent instability, groundwater should be drawn down before starting work. Dewatering should be conducted in accordance with applicable state and local regulations and should be maintained for the duration of all below-grade activity. Water from dewatering pumps should be discharged as far as practically possible away from the work areas, to prevent return flow or erosion. The Contractor should have submersible pumps ready to intercept and remove any localized inflows.

EARTHWORK FOR CUT-AND-COVER CONSTRUCTION

Pavement materials, grass and other vegetation, topsoil, roots or any other materials unsuitable for earthwork within the limits of the proposed construction should be removed and either discarded or stockpiled away from the immediate work areas for reuse as appropriate. Any organic materials encountered during trench excavation should be treated in a similar fashion.

Conventional construction equipment should be able to excavate the soils that were encountered during this investigation, but the Contractor should consider selecting equipment that can continue to operate efficiently even if less-favorable conditions are encountered while excavating. For example, abandoned utilities and large roots may exist along the route, even in locations where trees do not exist, as large trees and their stumps may have been removed in the past.

Excavations should be dug to the required depths and to the width needed to provide working room for proper installation of pipes, buried structures and any excavation support that may be needed. This work should be supervised by a suitably qualified member of the Contractor's staff. All below-grade construction activity should be conducted in accordance with the recommendations for excavation safety and groundwater control presented earlier in this report.

Pipes and buried structures should be bedded on firm, stable soil compacted to exceed the minimum criteria selected by OCU for this project, to a depth of at least one foot below the bedding surface for pipes and two feet below the bearing surface for structures. Soils should be tested for adequate compaction as required by OCU before placing any pipes or structures. Soils that cannot be improved should be removed and replaced with compacted backfill.

Backfill material should be free from mud, muck, stumps, roots and other vegetable matter, debris, rubbish or other materials that might decompose or otherwise cause excessive settlement. It should consist of sand with fines content lower than 12 percent.

Backfill should be placed in loose, level, uniform lifts approximately one foot thick. It should be placed uniformly and equally on both sides of the pipe and around all sides of buried structures before initiating compaction.

Each lift of backfill should be compacted to exceed the minimum criteria selected by OCU for this project. Special care should be taken to ensure that backfill beneath the pipe haunches is properly compacted. Although in-place dry density not less than 95 percent of the maximum obtained by the Modified Proctor method (ASTM D 1557) is widely accepted throughout the industry, some agencies have more stringent requirements for utilities installed near and beneath streets. As a result, standard specifications from other agencies should not be adopted for this project without consulting with OCU. Backfill should be tested for adequate compaction at the frequency required by OCU or at a maximum spacing of one test per vertical foot per 300-foot run of pipe.

Typical vibratory equipment used to compact trench backfill should not affect adjacent structures. However, some vibratory equipment can cause loose to very loose soils to settle. If any disturbance, or other undesirable effects are noted on more than an isolated or random basis, compaction should be halted immediately. If necessary, procedures should be modified so that satisfactory compaction can still be achieved at no additional cost to OCU.

[END OF SECTION]

REUSE OF EXCAVATED MATERIALS

Based on the soils discussed earlier in the "SUBSURFACE CONDITIONS" section of this report, some excavated soils may be suitable for reuse as backfill. However, most soils are likely to be too wet for immediate reuse and are expected to require significant moisture conditioning in order to achieve the recommended level of compaction. Materials with fines contents up to 20 percent may be used, but will require more stringent moisture control and attention to compaction to achieve satisfactory densification. A general discussion of the suitability of the soil types that may be encountered during excavation is presented below.

Poorly Graded Sands (SP)

These soils had fines contents of 5 percent or less. They are highly desirable for use as fill because they drain freely, which allows these soils to be placed and compacted readily, even when excavated from below the groundwater level. Satisfactory densification can be achieved using a wide variety of compaction equipment and across a relatively broad range of moisture contents. Because of the relatively small size, sub-rounded shape and near-uniform distribution of the soil particles, some instability or "pumping" can be expected if efforts are made to compact these sands near saturation.

Sands with Silt or Clay (SP-SM, SP-SC)

These soils consisted of sands with fines contents between 5 percent and 12 percent. Although these sands drain less freely than poorly graded sands, they are still suitable for use as fill. If excavated from below the groundwater surface, they may have to be stockpiled and allowed to drain (or spread to dry) before being placed as fill. Satisfactory densification can be achieved using a variety of compaction equipment and across a moderate to wide range of moisture contents, but efforts should be made to maintain the moisture content during compaction below the optimum moisture content. As with the poorly graded sands, some instability or "pumping" can be expected when trying to compact these soils near and above saturation.

Silty Sands (SM), Clayey Sands(SC) and Clays (CL, CH)

Because of the tendency of these soils to hold moisture and the likelihood that they will be excavated from below the groundwater surface, we do not recommend using them as backfill.

HORIZONTAL DIRECTIONAL DRILLING OVERVIEW

As discussed earlier in this report, the pipes beneath some street crossings may be installed by horizontal directional drilling ("HDD"). The method utilizes a rotary drill rig with its axis inclined at a shallow angle to the horizontal. The operator uses a specialized cutting tool at the end of the rods to change the inclination and direction of the borehole while drilling. A pilot hole is initiated by drilling into the ground at a shallow angle and advanced incrementally by adding drill rods at the rig. The cutting tool inclination is decreased slightly as each rod is added to create a curved borehole that becomes horizontally oriented at the intended drilling depth. The cutting tool is then advanced horizontally to an interim target location, where the inclination is increased incrementally until the tool emerges from the ground at the far end.

The cutting tool is removed and replaced with a reaming tool, which is drawn back through the pilot hole while rotating with the drilling rods to increase the hole diameter ("ream and pullback"). As the rods are being retracted, a continuous polymer casing connected behind the reaming tool with a swivel is pulled into the enlarged borehole to become the conduit for the utility line to be installed.

During drilling, specially formulated drilling fluid (usually a bentonite-water slurry) is pumped through the hollow drill rods to the face of the cutting tool. The fluid flushes soil cuttings away from the tool face, lubricates the rods and stabilizes the borehole as it returns to the rig in the annular space between the rods and the borehole wall. At the rig, the fluid passes through a series of screens to remove the suspended cuttings before being reconditioned as needed and pumped back through the rods into the hole. In the drilling industry, this process is known as "circulation".

MINIMUM DRILLING FLUID PRESSURE

In order to establish and maintain circulation in the borehole, the drilling fluid pump on the rig must develop a certain minimum pressure to overcome the shear resistance of the fluid inside the drill rods and in the annulus plus the static head between the drilling tool and the rig. Additional pressure is needed to circulate the drilling fluid fast enough to return the cuttings to the rig for screening. Otherwise, they can fall out of suspension and accumulate in the borehole, possibly obstructing it.

Minimum pump pressure is a function of the borehole length (which increases as drilling progresses) the shearing resistance of the drilling fluid (a function of dynamic fluid viscosity, borehole wall characteristics and circulation rate) and the difference in elevation between the drill tool and the rig. None of those variables is known at this time, so minimum fluid pressure cannot be estimated. However, most of the variables affecting minimum drilling pressure can be selected by the HDD contractor and some can be adjusted during drilling.

MAXIMUM DRILLING FLUID PRESSURE

Under certain conditions (including obstruction of the borehole or unanticipated reduction in soil strength) drilling fluid pressure in the borehole can exceed the ability of the soil to contain it. The resulting rupture of the soil is known as a "hydraulic fracture" during which drilling fluid usually escapes from the borehole. Escaping fluid can invade and damage nearby underground facilities, cause ground subsidence, erupt at the surface, create a nuisance and incur additional costs and delays for cleanup. Lost circulation can also cause an otherwise serviceable borehole to become obstructed, which can complicate drilling operations even further.

DRILLING FLUID PRESSURE ANALYSIS

The contract documents should require the contractor to conduct minimum and maximum fluid pressure analyses based on the anticipated hole geometry (length and depth of each run), properties of the encountered soils and the intended drilling fluid, anticipated circulation rates and operating fluid pressures for the drill rig that will be used. Those analyses should be submitted for review at least two weeks before the anticipated start of construction. The Contractor should be required to submit additional analyses before changing any of those variables during installation.

As mentioned earlier in this report, minimum fluid pressure increases with increasing borehole length. Maximum fluid pressure should be compared with the anticipated variation of minimum fluid pressure along the borehole length to ensure that each hole can be drilled efficiently without causing hydraulic fracture. If not, borehole lengths should be decreased, hole depth should be increased or the hole should be routed through more resistant soils.

During drilling - and especially during the initial stages of each borehole attempt - fluid pressures and drill rig performance should be monitored closely to ensure that the operating pressures established by the analyses are not exceeded. Since the limiting drilling fluid pressures are estimates, the contractor may adjust them during drilling to improve performance provided he understands clearly that his responsibility for maintaining the integrity of the borehole will not be relaxed. The contractor should be reminded that drilling fluid can also be lost through natural and man-made discontinuities in the soil, and that favorable pressure analyses should not be considered as assurance of problem-free drilling. Regardless of the circumstances, the contractor should be responsible for containing and recovering all fluid losses promptly and at no additional expense to the owner.

[END OF SECTION]

JACK-AND-BORE OVERVIEW

As discussed earlier in this report, some pipe crossings beneath cross-streets will be installed using the jack-and-bore method. The process is initiated by excavating temporary, below-grade work areas ("shafts" or "pits") at opposite ends of each crossing. Construction proceeds from the "launching" (or "jacking") shaft to the "exit" (or "receiving") shaft by forcing consecutive sections of steel casing into the soil in a near-horizontal orientation using an apparatus with powerful hydraulic jacks. As each section of casing is advanced, the soil within is removed using a horizontal auger slightly smaller than the casing bore before adding the next section.

Jack-and-bore crossings should be installed in accordance with Section 556 of the current FDOT Standard Specifications for Road and Bridge Construction (the "FDOT Specifications") or other criteria acceptable to OCU. Most contractors capable of doing this work should be familiar with the FDOT Specifications. In addition to the requirements in the FDOT Specifications, we recommend construction monitoring to ensure that facilities are safeguarded not only during construction but also for the anticipated design life of the reclaimed water main.

As discussed earlier in this report, medium dense clayey sands and medium dense to dense sands were encountered in the test borings. Higher jacking loads and reduced operating efficiency should be expected in these conditions. Even if the Contractor is experienced with jack-and-bore operations in similar subsurface conditions, he should still select equipment with care to avoid delays from less-favorable subsurface conditions. Earthwork for the jacking and receiving shafts, and incidental activity were discussed in the EARTHWORK, GROUNDWATER CONTROL and EXCAVATION SAFETY sections of this report.

LAUNCHING AND EXIT SHAFTS

Launching and exit shafts should be sized to accommodate not only the jacking equipment but also provide adequate room to work around it. Actual shaft size will depend on the Contractor's equipment and methods. The shafts should extend to a depth at least two feet below the proposed pipe invert. Because the shafts are likely to be excavated to depths below the groundwater level, dewatering of those excavations will be required. A concrete mud-mat can be poured on the bottom of the shaft excavations to provide a working surface. A drainage layer of open-graded, crushed stone may be placed beneath the concrete mud-mat to help maintain a dry and stable excavation subgrade. The stone should be separated from the underlying soils using a geotextile ("filter fabric") to minimize the migration of the soil into the pore space within the crushed stone.

Because of the anticipated depths of the shafts, temporary excavation support will be needed. Steel sheet piling is typically used for that purpose. Temporary excavation support systems for the shafts are the responsibility of the Contractor, and should be designed for the Contractor by a professional engineer who is experienced in excavation support design and registered in the State of Florida. Sheet piles should be designed to resist the full earth, water, surcharge and traffic loads acting on them. Thrust loads from the jacking operations also must be considered in the design of the support

system for the launching shaft. Other loads may be required based on the Contractor's planned construction methods.

JACKING LOADS AND THRUST BLOCKS

The Contractor is responsible for the design of the thrust block for the launching shaft. The thrust block must be capable of resisting the anticipated maximum jacking load at the launching shaft with an adequate reserve. Jacking loads should be estimated and the thrust block should be designed based on estimated friction resistance between the jacking casing and the surrounding soil. The thrust block should be designed by a professional engineer who is experienced with jack-and-bore operations and registered in the State of Florida. If jacking becomes more difficult than anticipated, a lubricant may be used to reduce friction. Typical lubricants consist of bentonite-water slurry, although commercial products are available. Polymer-based slurries should not be used.

STEEL CASING AND CARRIER PIPE

Jacking should be conducted using steel jacking casing; carrier pipe should not be jacked directly into position. Jacking casing should meet the requirements of Section 556-2 of the FDOT Specifications. Its bore should be at least six inches larger than the outside diameter of the intended carrier pipe. As discussed earlier in this report, medium dense to dense sands and sands with silt are anticipated along the jack-and-bore alignment. Some difficulties should be expected during jacking through those soils. The completed jacking casing should be watertight. Once the soil in the casing has been removed, the carrier pipe can be installed, aligned as needed and then grouted into place. Corrugated pipe should not be used as jacking casing, nor as carrier pipe.

WORKING FACE STABILITY

Soil inside the jacking casing should be carefully removed to ensure that a soil plug or continuous pressure is maintained to counteract the soil and groundwater pressures and promote stability of the working face. The auger should not be advanced ahead of the casing as this may cause instability at the working face and potential subsidence of the ground surface above. Lowering the groundwater to a depth of at least two feet below the invert of the jack-and-bore installation should help to promote a stable excavation face.

TEMPORARY GROUND SUPPORT

The jacking casing will support the ground above the pipe crossings, so it should be designed for the Contractor by a professional engineer who is experienced with jack-and-bore methods and registered in the State of Florida. The casing should be designed to resist the full earth, water, surcharge, traffic and jacking loads acting on it. Because of the anticipated depth of soil cover over the pipe, some ground surface settlement is possible along the jacking alignment and should be expected. As long as the Contractor conducts jack-and-bore operations in accordance with the standard of care for the industry, ground surface settlements should not exceed one inch.

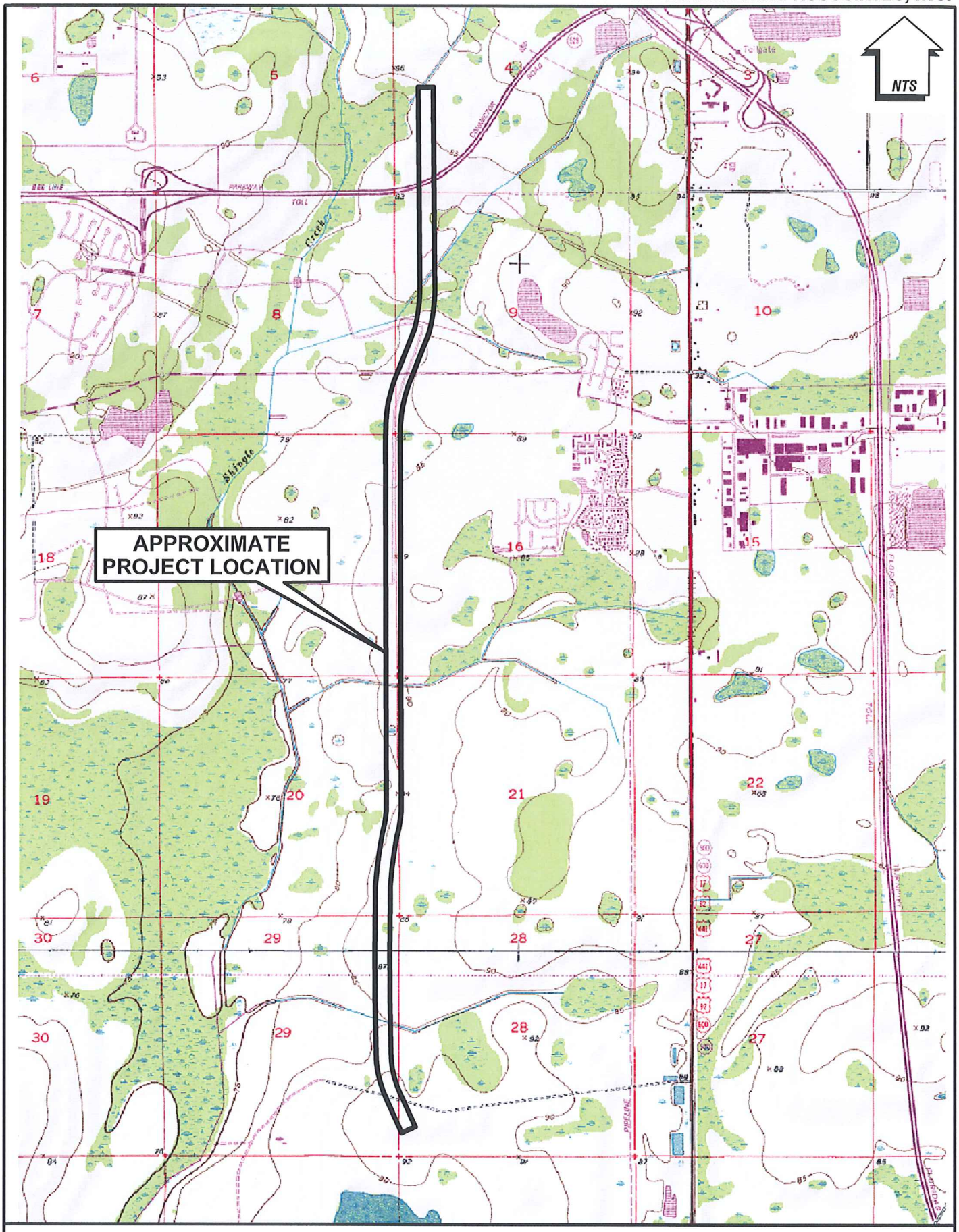
LIMITATIONS

This report presents an evaluation of the subsurface conditions on the basis of accepted geotechnical procedures for site characterization. The recovered soil samples were not examined or tested in any way for chemical composition or environmental hazards. The investigation was confined to the zone of soil which is likely to be affected by the proposed construction, and did not address the potential of surface expression of deep geologic activity such as sinkholes. This type of evaluation requires a more extensive range of services than those performed for this study.

Soils are natural materials, so variations in composition and other physical characteristics are normal and should be expected. Because of those natural variations, the broad spacing between the boring locations and the fact that portions of the pipe route were beyond the limits defined by the boring locations and depths, materials other than those encountered by the test borings, (including materials that are less favorable for underground utility construction) may exist along the pipe route, and although not encountered during this investigation, should still be anticipated. If encountered during construction they should be treated as directed by OCU representative, at no additional cost to OCU.

Because of the natural limitations inherent in working with the subsurface, a geotechnical engineer cannot predict and address all possible problems. During construction, geotechnical issues not addressed in this report may arise. The bulletin “Important Information About Your Geotechnical Engineering Report” published by the Geoprofessional Business Association (GBA) is presented in Appendix B to help explain the nature of geotechnical issues. Additional information is presented in Appendix C to discuss the potential concerns and the basic limitations of a typical geotechnical investigation report.

FIGURES



SITE LOCATION MAP

201319	JOHN YOUNG PARKWAY RECLAIMED WATER MAIN IMPROVEMENTS	FIG. 1

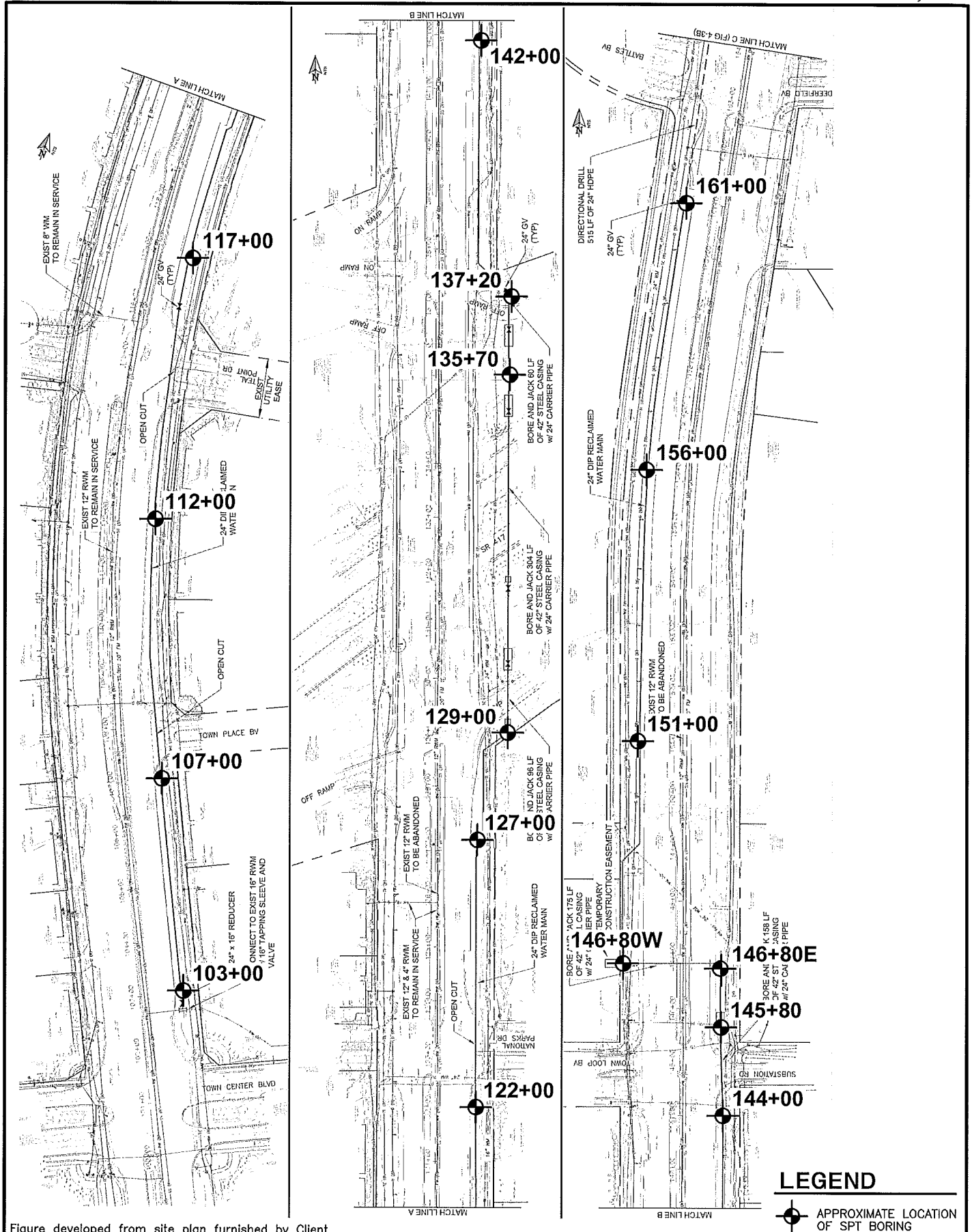
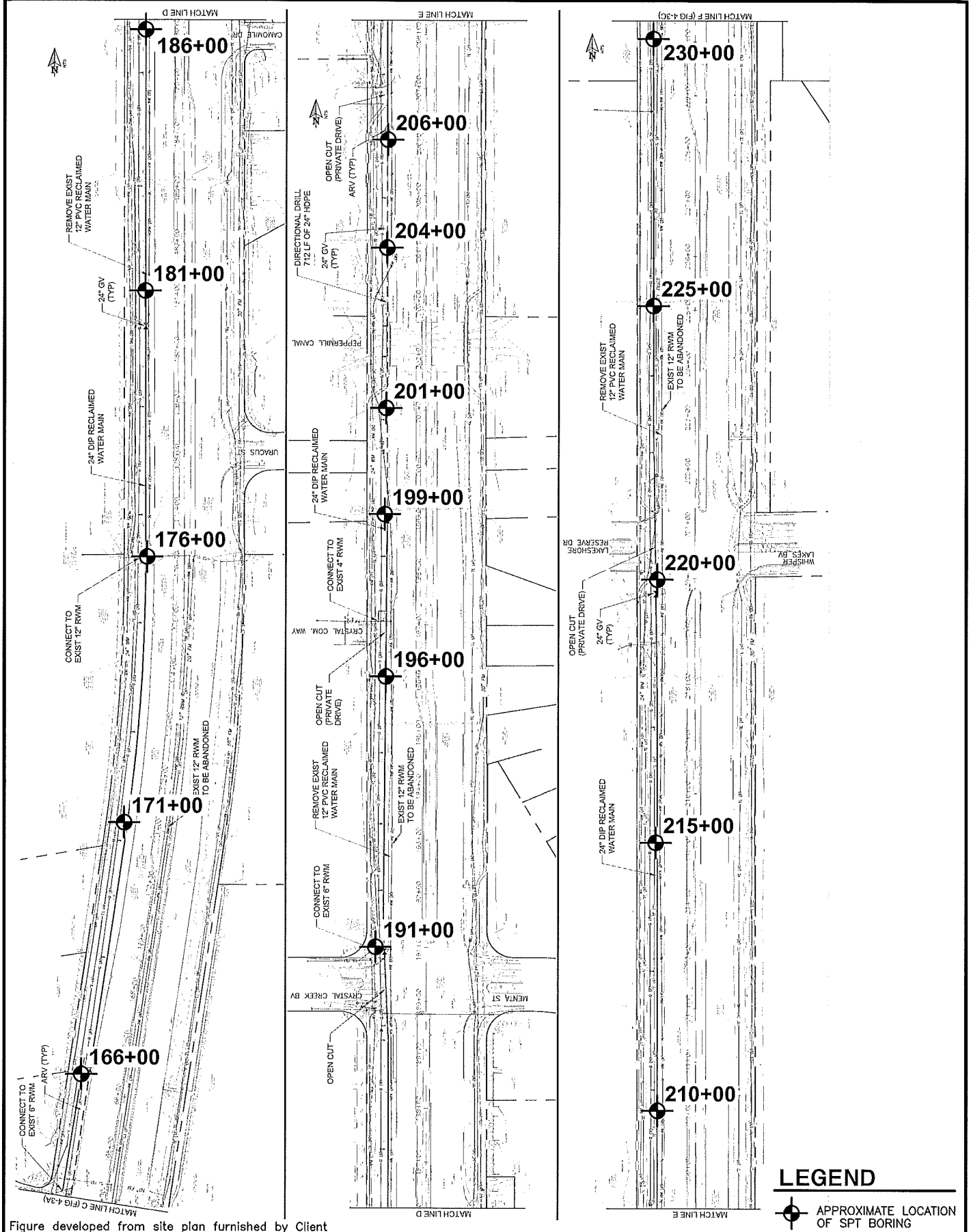


Figure developed from site plan furnished by Client

BORING LOCATION PLAN

201319	JOHN YOUNG PARKWAY RECLAIMED WATER MAIN IMPROVEMENTS	FIG. 2



LEGEND

APPROXIMATE LOCATION OF SPT BORING

Figure developed from site plan furnished by Client

BORING LOCATION PLAN

201319	JOHN YOUNG PARKWAY RECLAIMED WATER MAIN IMPROVEMENTS	FIG. 3

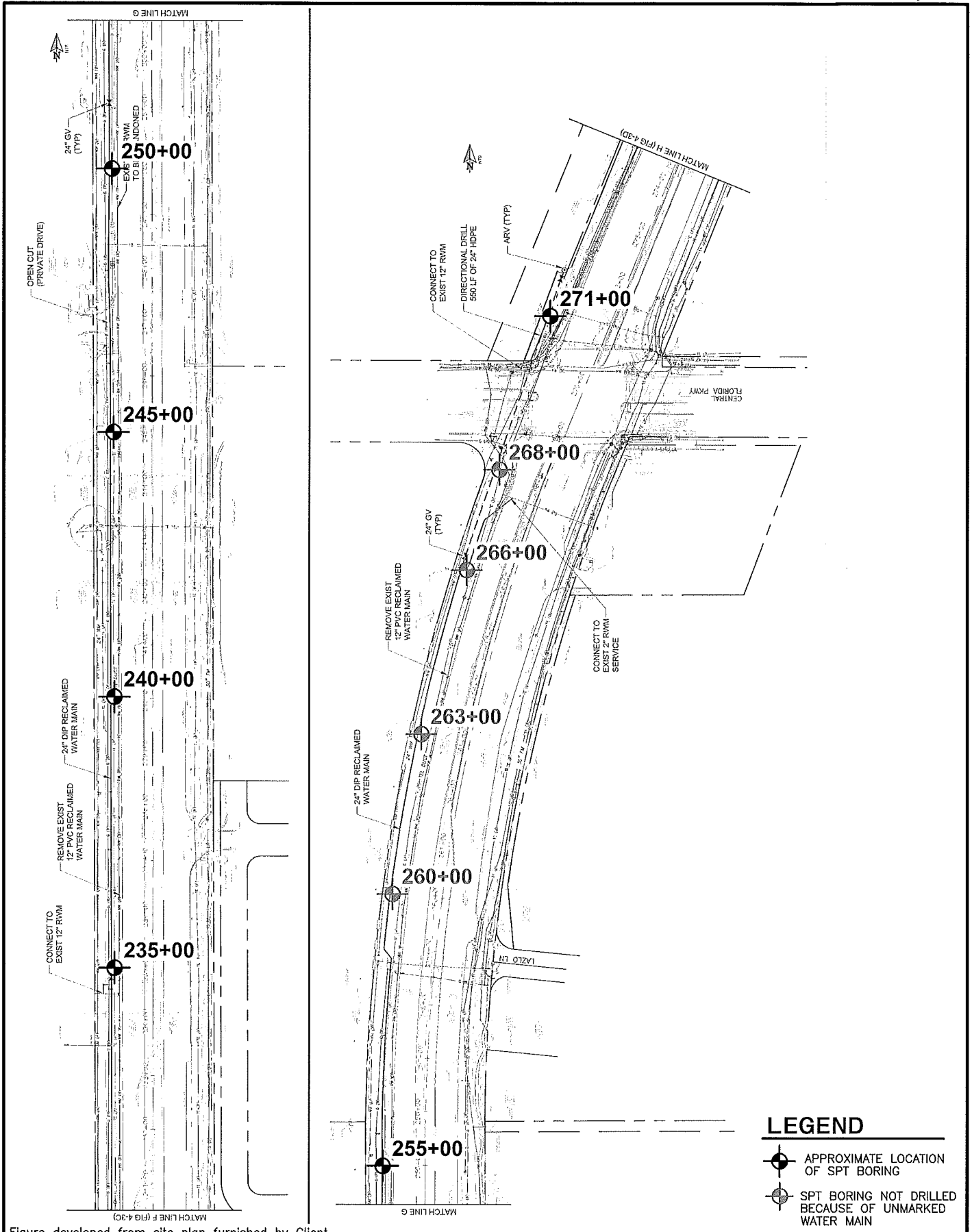


Figure developed from site plan furnished by Client

BORING LOCATION PLAN

201319	JOHN YOUNG PARKWAY RECLAIMED WATER MAIN IMPROVEMENTS	FIG. 4

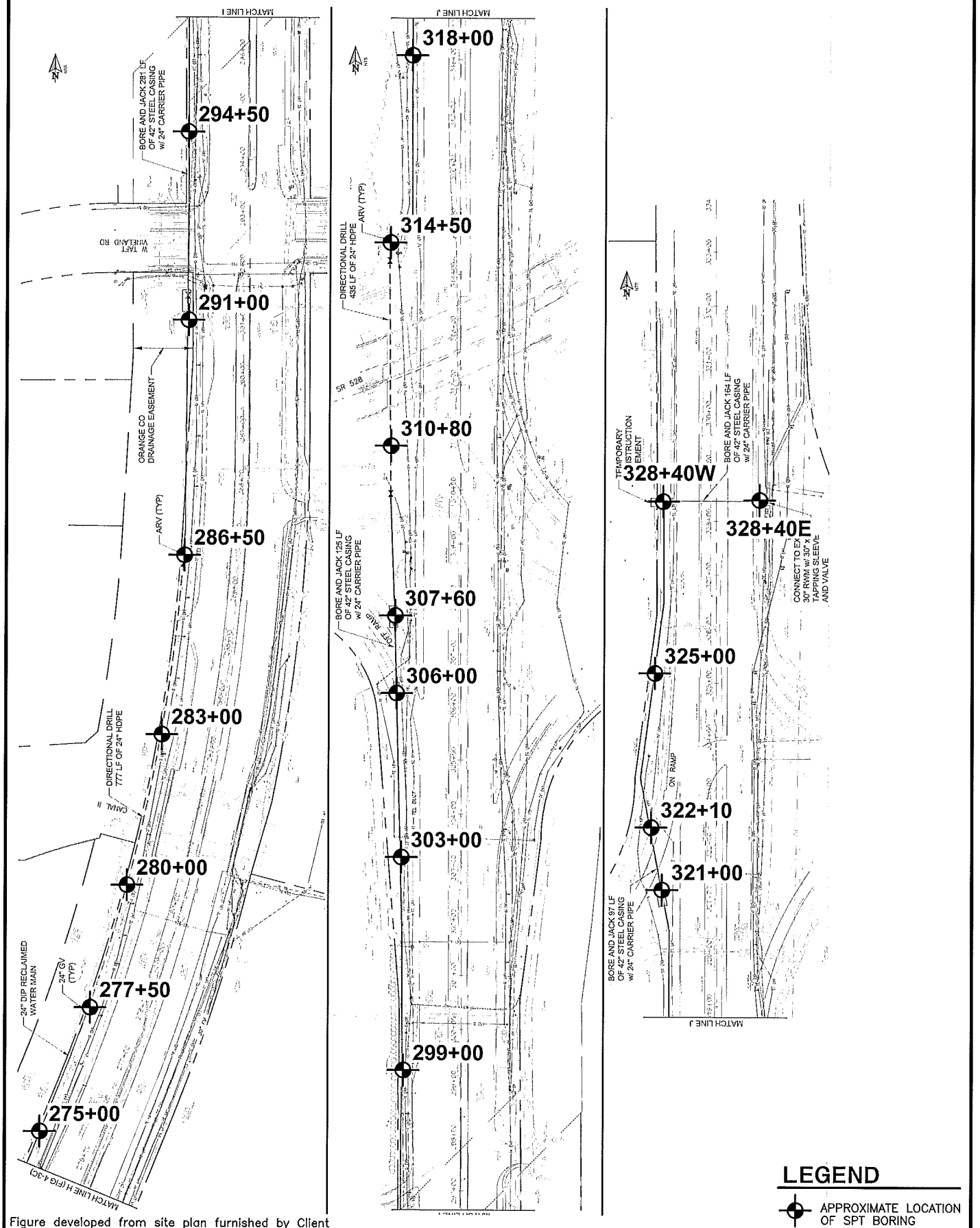


Figure developed from site plan furnished by Client

LEGEND

APPROXIMATE LOCATION OF SPT BORING

BORING LOCATION PLAN

201319	JOHN YOUNG PARKWAY RECLAIMED WATER MAIN IMPROVEMENTS	FIG. 5

APPENDIX A

ANTILLIAN ENGINEERING ASSOCIATES, INC.
3331 Bartlett Boulevard Orlando, Florida 32811
Tel (407) 422-1441 Fax (407) 422-2226

KEY TO BORING LOGS

SYMBOLS

10	SPT N-Value (number of blows a 140-lb weight falling 30 inches required to drive a Standard Split-Spoon sampler one foot into otherwise undisturbed soil)
WR	Penetration of sampler under weight of drill rods
WH	Penetration of sampler under weight of drill rods and hammer
SS	Split Spoon sample
ST	Undisturbed thin-walled Shelby Tube sample
	Observed change in soil type
	Unobserved change in soil type
▽	Estimated seasonal high groundwater level
▼	Encountered groundwater level

SOIL CONSISTENCY

(Based on empirical correlation with SPT N-Value)

GRANULAR SOILS

Very Loose - Less Than 4 blows/ft.
Loose - 4 to 10 blows/ft.
Medium Dense - 10 to 30 blows/ft.
Dense - 30 to 50 blows/ft.
Very Dense - More Than 50 blows/ft.

FINE-GRAINED SOILS

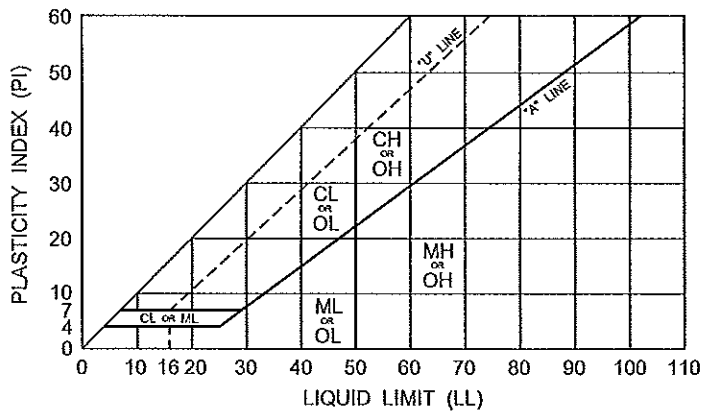
Very Soft - Less Than 2 blows/ft.
Soft - 2 to 4 blows/ft.
Firm - 4 to 8 blows/ft.
Stiff - 8 to 15 blows/ft.
Very Stiff - 15 to 30 blows/ft.
Hard - More Than 30 blows/ft.

UNIFIED SOILS CLASSIFICATION SYSTEM ASTM D 2487

(Based on material passing the 3-inch (75-mm) sieve)

MAJOR DIVISIONS			GROUP SYMBOLS	TYPICAL NAMES
COARSE-GRAINED SOILS More than 50% retained on No. 200 sieve	GRAVELS 50% or more of coarse fraction retained on No. 4 sieve	CLEAN GRAVELS	GW	Well-graded gravels and gravel-sand mixtures, little or no fines
			GP	Poorly graded gravels and gravel-sand mixtures, little or no fines
		GRAVELS WITH FINES	GM	Silty gravels, gravel-sand-silt mixtures
			GC	Clayey gravels, gravel-sand-clay mixtures
	SANDS More than 50% of coarse fraction passes No. 4 sieve	CLEAN SANDS	SW	Well-graded sands and gravelly sands, little or no fines
			SP	Poorly graded sands and gravelly sands, little or no fines
		SANDS WITH FINES	SM	Silty sands, sand-silt mixtures
			SC	Clayey sands, sand-clay mixtures
FINE-GRAINED SOILS More than 50% passing No. 200 sieve	SILTS AND CLAYS Liquid limit 50% or less		ML	Inorganic silts, very fine sands, rock flour, silty or clayey fine sands
			CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays
			OL	Organic silts and organic silty clays of low plasticity
	SILTS AND CLAYS Liquid limit greater than 50%		MH	Inorganic silts, micaceous or diatomaceous fine sands or silts, elastic silts
			CH	Inorganic clays or high plasticity, fat clays
			OH	Organic clays of medium to high plasticity
HIGHLY ORGANIC SOILS			Pt	Peat, muck and other highly organic soils

PLASTICITY CHART



ANTILLIAN ENGINEERING ASSOCIATES, INC.

LOG OF BORING 103+00

SHEET 1 OF 1

PROJECT NO:	**201319**	SURFACE ELEVATION:	**Unknown**
PROJECT:	**John Young Parkway Reclaimed Water Imps.**	GROUNDWATER DEPTH:	**3.5**
DATE:	**12/5/14**	COMPLETION DEPTH:	**10.0**
LOCATION:	**See Figure 2**	DRILLING METHOD:	**Hand auger and split-spoon**

DEPTH, ft.	SAMPLES	SPT N-VALUE (bpf)	SAMPLE TYPE	DESCRIPTION	STRATUM EL / DEPTH	SYMBOL	- 200	MC %	LL	PI	OC %
0			HA	Very dark gray fine SAND (SP)							
				- pale yellow	▼						
5		3	SS	- very loose, dark yellowish brown fine SAND with silt (SP-SM)							
		10	SS	- loose, dark brown			10				
		14	SS	- medium dense, light yellowish brown, less silt							
10		32	SS	- dense, dark brown (POSSIBLE BACKFILL)	10.0						

ANTILLIAN ENGINEERING ASSOCIATES, INC.

LOG OF BORING 107+00

SHEET 1 OF 1

PROJECT NO:	**201319**	SURFACE ELEVATION:	**Unknown**
PROJECT:	**John Young Parkway Reclaimed Water Imps.**	GROUNDWATER DEPTH:	**0.8**
DATE:	**12/4/14**	COMPLETION DEPTH:	**10.0**
LOCATION:	**See Figure 2**	DRILLING METHOD:	**Hand auger and split-spoon**

DEPTH, ft.	SAMPLES	SPT N-VALUE (bpf)	SAMPLE TYPE	DESCRIPTION	STRATUM EL / DEPTH	SYMBOL	- 200	MC %	LL	PI	OC %
0			HA	Gray fine SAND (SP)							
				Dark grayish brown fine SAND with silt (SP-SM)							
				- dark yellowish brown							
		14	SS	- medium dense			10				
5				(POSSIBLE BACKFILL)							
		10	SS	Loose, very pale brown fine SAND with silt (SP-SM)	5.5						
		7	SS	- light gray							
		20	SS	- medium dense, very pale brown			10				
10					10.0						

ANTILLIAN ENGINEERING ASSOCIATES, INC.

LOG OF BORING 112+00

SHEET 1 OF 1

PROJECT NO:	**201319**	SURFACE ELEVATION:	**Unknown**
PROJECT:	**John Young Parkway Reclaimed Water Imps.**	GROUNDWATER DEPTH:	**2.7**
DATE:	**12/5/14**	COMPLETION DEPTH:	**10.0**
LOCATION:	**See Figure 2**	DRILLING METHOD:	**Hand auger and split-spoon**

DEPTH, ft.	SAMPLES	SPT N-VALUE (bpf)	SAMPLE TYPE	DESCRIPTION	STRATUM EL / DEPTH	SYMBOL	- 200	MC %	LL	PI	OC %
0			HA	Dark grayish brown fine SAND (SP)							
				- light gray							
				Very dark brown fine SAND with silt (SP-SM)	▼						
		16	SS	- medium dense, yellowish brown			6				
5		9	SS	- loose							
		12	SS	- medium dense, light yellowish brown (POSSIBLE BACKFILL)							
		22	SS	Medium dense, light gray silty fine SAND (SM)	8.5						
10					10.0						

ANTILLIAN ENGINEERING ASSOCIATES, INC.

LOG OF BORING 117+00

SHEET 1 OF 1

PROJECT NO:	**201319**	SURFACE ELEVATION:	**Unknown**
PROJECT:	**John Young Parkway Reclaimed Water Imps.**	GROUNDWATER DEPTH:	**3.5**
DATE:	**12/5/14**	COMPLETION DEPTH:	**10.0**
LOCATION:	**See Figure 2**	DRILLING METHOD:	**Hand auger and split-spoon**

DEPTH, ft.	SAMPLES	SPT N-VALUE (bpf)	SAMPLE TYPE	DESCRIPTION	STRATUM EL / DEPTH	SYMBOL	- 200	MC %	LL	PI	OC %
0			HA	Dark grayish brown fine SAND (SP)							
				- light yellowish brown							
				- pale yellow	▼						
5		15	SS	- medium dense, light brownish gray							
		15	SS	- pale yellow							
		17	SS								
				(POSSIBLE BACKFILL)							
		24	SS	Medium dense, pale yellow silty fine SAND (SM)	8.5		21				
10					10.0						

ANTILLIAN ENGINEERING ASSOCIATES, INC.

LOG OF BORING 122+00

SHEET 1 OF 1

PROJECT NO:	**201319**	SURFACE ELEVATION:	**Unknown**
PROJECT:	**John Young Parkway Reclaimed Water Imps.**	GROUNDWATER DEPTH:	**3.5**
DATE:	**12/5/14**	COMPLETION DEPTH:	**10.0**
LOCATION:	**See Figure 2**	DRILLING METHOD:	**Hand auger and split-spoon**

DEPTH, ft.	SAMPLES	SPT N-VALUE (bpf)	SAMPLE TYPE	DESCRIPTION	STRATUM EL / DEPTH	SYMBOL	- 200	MC %	LL	PI	OC %
0			HA	Grayish brown fine SAND with silt (SP-SM)							
				- light olive brown	▼						
5		4	SS	Loose, light olive brown silty fine SAND (SM							
		5	SS	- pale yellow			14				
		16	SS	Medium dense, yellow fine SAND (SP) (POSSIBLE BACKFILL)							
10		14	SS	Medium dense, light yellowish brown silty fine SAND (SM)	8.5		20				
					10.0						

ANTILLIAN ENGINEERING ASSOCIATES, INC.

LOG OF BORING 127+00

SHEET 1 OF 1

PROJECT NO:	**201319**	SURFACE ELEVATION:	**Unknown**
PROJECT:	**John Young Parkway Reclaimed Water Imps.**	GROUNDWATER DEPTH:	**3.0**
DATE:	**12/4/14**	COMPLETION DEPTH:	**10.0**
LOCATION:	**See Figure 2**	DRILLING METHOD:	**Hand auger and split-spoon**

DEPTH, ft.	SAMPLES	SPT N-VALUE (bpf)	SAMPLE TYPE	DESCRIPTION	STRATUM EL / DEPTH	SYMBOL	- 200	MC %	LL	PI	OC %
0			HA	Dark brown fine SAND (SP)							
				- gray							
				Yellowish brown fine SAND with silt (SP-SM)	▼						
		14	SS	Medium dense, light olive brown silty fine SAND (SM)			16				
5		8	SS	- loose, light yellowish brown							
		32	SS	Dense, dark yellowish brown fine SAND with silt (SP-SM)							
		26	SS	- medium dense, brown (POSSIBLE BACKFILL)							
10					10.0						

ANTILLIAN ENGINEERING ASSOCIATES, INC.

LOG OF BORING 129+00

SHEET 1 OF 1

PROJECT NO:	**201319**	SURFACE ELEVATION:	**Unknown**
PROJECT:	**John Young Parkway Reclaimed Water Imps.**	GROUNDWATER DEPTH:	**4.5**
DATE:	**12/4/14**	COMPLETION DEPTH:	**25.0**
LOCATION:	**See Figure 2**	DRILLING METHOD:	**Mud-rotary**

DEPTH, ft.	SAMPLES	SPT N-VALUE (bpf)	SAMPLE TYPE	DESCRIPTION	STRATUM EL / DEPTH	SYMBOL	- 200	MC %	LL	PI	OC %
0			HA	Brown fine SAND (SP)							
				Light yellowish brown fine SAND with silt (SP-SM)							
				- dark yellowish brown							
		11	SS	- medium dense	▼						
5		2	SS	(POSSIBLE FILL)							
				Very loose, very dark brown silty fine SAND (SM)	6.0						
		5	SS	- loose, dark brown, a few roots							
		6	SS	- very dark brown, no roots			13				
10											
		6	SS	- light brownish gray, less silty							
15											
		4	SS	- more silty							
20											
		5	SS	- grayish brown, more silty			31				
25					25.0						

ANTILLIAN ENGINEERING ASSOCIATES, INC.

LOG OF BORING 135+70

SHEET 1 OF 1

PROJECT NO:	**201319**	SURFACE ELEVATION:	**Unknown**
PROJECT:	**John Young Parkway Reclaimed Water Imps.**	GROUNDWATER DEPTH:	**4.0**
DATE:	**12/5/14**	COMPLETION DEPTH:	**25.0**
LOCATION:	**See Figure 2**	DRILLING METHOD:	**Mud-rotary**

DEPTH, ft.	SAMPLES	SPT N-VALUE (bpf)	SAMPLE TYPE	DESCRIPTION	STRATUM EL / DEPTH	SYMBOL	- 200	MC %	LL	PI	OC %
0			HA	Dark brown fine SAND with silt (SP-SM)							
				- grayish brown							
				Dark yellowish brown fine SAND (POSSIBLE BACKFILL)							
		2	SS	Very loose, very dark brown silty fine SAND (SM)	4.0 ▼						
5		6	SS	- loose							
		12	SS	- medium dense, yellowish brown							
		13	SS								
10											
		14	SS	- light gray			13				
15											
					18.0						
		9	SS	Stiff, gray sandy CLAY (CH)							
20											
		11	SS				54	24	52	35	
25					25.0						

ANTILLIAN ENGINEERING ASSOCIATES, INC.

LOG OF BORING 137+20

SHEET 1 OF 1

PROJECT NO:	**201319**	SURFACE ELEVATION:	**Unknown**
PROJECT:	**John Young Parkway Reclaimed Water Imps.**	GROUNDWATER DEPTH:	**6.5**
DATE:	**12/5/14**	COMPLETION DEPTH:	**25.0**
LOCATION:	**See Figure 2**	DRILLING METHOD:	**Mud-rotary**

DEPTH, ft.	SAMPLES	SPT N-VALUE (bpf)	SAMPLE TYPE	DESCRIPTION	STRATUM EL / DEPTH	SYMBOL	- 200	MC %	LL	PI	OC %
0			HA	Grayish brown fine SAND with silt (SP-SM)							
				Yellow fine SAND (SP)							
		5	SS	- loose, light olive brown (POSSIBLE BACKFILL)							
5		4	SS	Loose, very dark brown silty fine SAND (SM)	5.5 ▼						
		6	SS	- dark brown							
		11	SS	Medium dense, brown fine SAND with silt (SP-SM)	8.5						
10											
		16	SS	- very pale brown							
15											
		12	SS	Medium dense, light gray silty fine SAND (SM)	18.0		20				
20											
		13	SS	Stiff, gray CLAY (CH)	23.0		91	38	91	71	
25					25.0						

ANTILLIAN ENGINEERING ASSOCIATES, INC.

LOG OF BORING 142+00

SHEET 1 OF 1

PROJECT NO:	**201319**	SURFACE ELEVATION:	**Unknown**
PROJECT:	**John Young Parkway Reclaimed Water Imps.**	GROUNDWATER DEPTH:	**3.5**
DATE:	**12/5/14**	COMPLETION DEPTH:	**10.0**
LOCATION:	**See Figure 2**	DRILLING METHOD:	**Hand auger and split-spoon**

DEPTH, ft.	SAMPLES	SPT N-VALUE (bpf)	SAMPLE TYPE	DESCRIPTION	STRATUM EL / DEPTH	SYMBOL	- 200	MC %	LL	PI	OC %
0			HA	Gray fine SAND (SP)							
				- yellowish brown (POSSIBLE FILL)	▼						
		4	SS	Very loose, dark yellowish brown fine SAND with silt (SP-SM)	4.0						
5		6	SS	- loose, dark grayish brown			6				
		6	SS								
		23	SS	- medium dense							
10					10.0						

ANTILLIAN ENGINEERING ASSOCIATES, INC.

LOG OF BORING 144+00

SHEET 1 OF 1

PROJECT NO:	**201319**	SURFACE ELEVATION:	**Unknown**
PROJECT:	**John Young Parkway Reclaimed Water Imps.**	GROUNDWATER DEPTH:	**4.5**
DATE:	**12/4/14**	COMPLETION DEPTH:	**25.0**
LOCATION:	**See Figure 2**	DRILLING METHOD:	**Mud-rotary**

DEPTH, ft.	SAMPLES	SPT N-VALUE (bpf)	SAMPLE TYPE	DESCRIPTION	STRATUM EL / DEPTH	SYMBOL	- 200	MC %	LL	PI	OC %
0			HA	Very dark grayish brown fine SAND with silt (SP-SM)							
				- light yellowish brown (POSSIBLE BACKFILL)							
		3	SS	Very loose, very dark grayish brown silty fine SAND (SM)	4.0 ▼						
5		4	SS	- dark brown							
		4	SS	- grayish brown							
		6	SS	- loose, dark grayish brown							
10											
		7	SS	- grayish brown, more silty			22				
15											
		20	SS	- medium dense							
20											
		10	SS	- dark grayish brown			23				
25					25.0						

ANTILLIAN ENGINEERING ASSOCIATES, INC.

LOG OF BORING 145+80

SHEET 1 OF 1

PROJECT NO:	**201319**	SURFACE ELEVATION:	**Unknown**
PROJECT:	**John Young Parkway Reclaimed Water Imps.**	GROUNDWATER DEPTH:	**2.8**
DATE:	**12/5/14**	COMPLETION DEPTH:	**25.0**
LOCATION:	**See Figure 2**	DRILLING METHOD:	**Mud-rotary**

DEPTH, ft.	SAMPLES	SPT N-VALUE (bpf)	SAMPLE TYPE	DESCRIPTION	STRATUM EL / DEPTH	SYMBOL	- 200	MC %	LL	PI	OC %
0			HA	Dark brown fine SAND with silt (SP-SM)							
				- dark gray							
				Gray fine SAND (SP)	▼						
		12	SS	- medium dense, light olive brown (POSSIBLE BACKFILL)							
5		8	SS	Loose, dark grayish brown fine SAND with silt (SP-SM)	5.5						
		2	SS	- very loose							
		11	SS	- medium dense							
10											
		12	SS	- brown			11				
15											
		8	SS	Loose, grayish brown silty fine SAND (SM)	18.0						
20											
		10	SS	Stiff, gray sandy CLAY (CL)	23.0		65	23	40	25	
25					25.0						

ANTILLIAN ENGINEERING ASSOCIATES, INC.

LOG OF BORING 146+80E

SHEET 1 OF 1

PROJECT NO:	**201319**	SURFACE ELEVATION:	**Unknown**
PROJECT:	**John Young Parkway Reclaimed Water Imps.**	GROUNDWATER DEPTH:	**3.2**
DATE:	**12/8/14**	COMPLETION DEPTH:	**25.0**
LOCATION:	**See Figure 2**	DRILLING METHOD:	**Mud-rotary**

DEPTH, ft.	SAMPLES	SPT N-VALUE (bpf)	SAMPLE TYPE	DESCRIPTION	STRATUM EL / DEPTH	SYMBOL	- 200	MC %	LL	PI	OC %
0			HA	Dark yellowish brown fine SAND with silt (SP-SM)							
				Gray fine SAND (SP)	▼						
5		10	SS	Medium dense, dark brown fine SAND with silt (SP-SM) (POSSIBLE BACKFILL)			11				
		8	SS	Loose, dark yellowish brown, silty fine sand (SM)	5.5		14				
		12	SS	- medium dense							
10		11	SS								
		10	SS	Medium dense, light gray fine SAND with silt (SP-SM)	13.0						
15											
		10	SS	Medium dense, gray silty fine SAND (SM)	18.0		22				
20											
		12	SS	Stiff, dark gray sandy CLAY (CL)	23.0						
25					25.0						

ANTILLIAN ENGINEERING ASSOCIATES, INC.

LOG OF BORING 146+80W

SHEET 1 OF 1

PROJECT NO:	**201319**	SURFACE ELEVATION:	**Unknown**
PROJECT:	**John Young Parkway Reclaimed Water Imps.**	GROUNDWATER DEPTH:	**5.0**
DATE:	**12/18/14**	COMPLETION DEPTH:	**25.0**
LOCATION:	**See Figure 2**	DRILLING METHOD:	**Mud-rotary**

DEPTH, ft.	SAMPLES	SPT N-VALUE (bpf)	SAMPLE TYPE	DESCRIPTION	STRATUM EL / DEPTH	SYMBOL	- 200	MC %	LL	PI	OC %
0			HA	Brown fine SAND (SP)							
				- dark grayish brown							
				- brown							
		12	SS	Medium dense, dark grayish brown fine SAND with silt (SP-SM)							
5		16	SS	Medium dense, dark yellowish brown fine SAND (SP) (POSSIBLE BACKFILL)							
		12	SS	Medium dense, dark brown silty fine SAND (SM)	7.0						
		12	SS								
10											
		11	SS	- light yellowish brown							
15											
		5	SS	- loose, pale brown							
20											
		8	SS				23				
25					25.0						

ANTILLIAN ENGINEERING ASSOCIATES, INC.

LOG OF BORING 151+00

SHEET 1 OF 1

PROJECT NO:	**201319**	SURFACE ELEVATION:	**Unknown**
PROJECT:	**John Young Parkway Reclaimed Water Imps.**	GROUNDWATER DEPTH:	**4.0**
DATE:	**12/9/14**	COMPLETION DEPTH:	**10.0**
LOCATION:	**See Figure 2**	DRILLING METHOD:	**Hand auger and split-spoon**

DEPTH, ft.	SAMPLES	SPT N-VALUE (bpf)	SAMPLE TYPE	DESCRIPTION	STRATUM EL / DEPTH	SYMBOL	- 200	MC %	LL	PI	OC %
0			HA	Dark yellowish brown fine SAND with silt (SP-SM)							
				- light yellow (POSSIBLE BACKFILL)							
		9	SS	Loose, very dark brown silty fine SAND (SM)	4.0						
5		14	SS	- medium dense							
		13	SS	- brown			19				
		15	SS	- light brownish gray							
10					10.0						

ANTILLIAN ENGINEERING ASSOCIATES, INC.

LOG OF BORING 156+00

SHEET 1 OF 1

PROJECT NO:	**201319**	SURFACE ELEVATION:	**Unknown**
PROJECT:	**John Young Parkway Reclaimed Water Imps.**	GROUNDWATER DEPTH:	**4.3**
DATE:	**12/9/14**	COMPLETION DEPTH:	**10.0**
LOCATION:	**See Figure 2**	DRILLING METHOD:	**Hand auger and split-spoon**

DEPTH, ft.	SAMPLES	SPT N-VALUE (bpf)	SAMPLE TYPE	DESCRIPTION	STRATUM EL / DEPTH	SYMBOL	- 200	MC %	LL	PI	OC %
0			HA	Dark yellowish brown fine SAND with silt (SP-SM)							
				- brown (POSSIBLE BACKFILL)							
		2	SS	Very loose, dark grayish brown silty fine SAND (SM)	4.0 ▼						
5		13	SS	- medium dense, dark yellowish brown							
		9	SS	- loose							
		11	SS	- medium dense							
10					10.0						

ANTILLIAN ENGINEERING ASSOCIATES, INC.

LOG OF BORING 161+00

SHEET 1 OF 1

PROJECT NO:	**201319**	SURFACE ELEVATION:	**Unknown**
PROJECT:	**John Young Parkway Reclaimed Water Imps.**	GROUNDWATER DEPTH:	**3.0**
DATE:	**12/9/14**	COMPLETION DEPTH:	**25.0**
LOCATION:	**See Figure 2**	DRILLING METHOD:	**Mud-rotary**

DEPTH, ft.	SAMPLES	SPT N-VALUE (bpf)	SAMPLE TYPE	DESCRIPTION	STRATUM EL / DEPTH	SYMBOL	- 200	MC %	LL	PI	OC %
0			HA	Light gray fine SAND (SP)							
				- brown	▼						
				(POSSIBLE BACKFILL)							
		7	SS	Loose, olive yellow silty fine SAND (SM)	4.0						
5		4	SS	- very loose							
		17	SS	- medium dense, pale yellow							
		18	SS	Medium dense, pale yellow fine SAND with silt (SP-SM)	8.5						
10											
					13.0						
		13	SS	Medium dense, light brownish gray silty fine SAND (SM)							
15											
		10	SS	- loose, grayish brown							
20											
		9	SS	- light olive brown			30				
25					25.0						

ANTILLIAN ENGINEERING ASSOCIATES, INC.

LOG OF BORING 166+00

SHEET 1 OF 1

PROJECT NO:	**201319**	SURFACE ELEVATION:	**Unknown**
PROJECT:	**John Young Parkway Reclaimed Water Imps.**	GROUNDWATER DEPTH:	**3.6**
DATE:	**12/18/14**	COMPLETION DEPTH:	**25.0**
LOCATION:	**See Figure 3**	DRILLING METHOD:	**Mud-rotary**

DEPTH, ft.	SAMPLES	SPT N-VALUE (bpf)	SAMPLE TYPE	DESCRIPTION	STRATUM EL / DEPTH	SYMBOL	- 200	MC %	LL	PI	OC %
0			HA	Dark brown fine SAND (SP)							
				- gray							
				Yellowish brown fine SAND with silt (SP-SM) (POSSIBLE BACKFILL)							
		3	SS	Very loose, very dark grayish brown silty fine SAND with roots (SM)	4.0						
5		7	SS	- loose, no roots							
		4	SS	- very loose							
		10	SS	- loose							
10											
		11	SS	- medium dense, light gray							
15											
		7	SS	- loose			19				
20											
		9	SS	Loose, gray clayey fine SAND (SC)	23.0						
25					25.0						

ANTILLIAN ENGINEERING ASSOCIATES, INC.

LOG OF BORING 171+00

SHEET 1 OF 1

PROJECT NO:	**201319**	SURFACE ELEVATION:	**Unknown**
PROJECT:	**John Young Parkway Reclaimed Water Imps.**	GROUNDWATER DEPTH:	**3.8**
DATE:	**12/4/14**	COMPLETION DEPTH:	**10.0**
LOCATION:	**See Figure 3**	DRILLING METHOD:	**Hand auger and split-spoon**

DEPTH, ft.	SAMPLES	SPT N-VALUE (bpf)	SAMPLE TYPE	DESCRIPTION	STRATUM EL / DEPTH	SYMBOL	- 200	MC %	LL	PI	OC %
0			HA	Dark grayish brown fine SAND with silt (SP-SM)							
				- light olive brown							
		3	SS	- very loose, very dark brown							
5		11	SS	- medium dense			9				
		5	SS	- loose, dark brown							
		10	SS								
				(POSSIBLE BACKFILL)							
10					10.0						

ANTILLIAN ENGINEERING ASSOCIATES, INC.

LOG OF BORING 176+00

SHEET 1 OF 1

PROJECT NO:	**201319**	SURFACE ELEVATION:	**Unknown**
PROJECT:	**John Young Parkway Reclaimed Water Imps.**	GROUNDWATER DEPTH:	**6.0**
DATE:	**12/4/14**	COMPLETION DEPTH:	**10.0**
LOCATION:	**See Figure 3**	DRILLING METHOD:	**Hand auger and split-spoon**

DEPTH, ft.	SAMPLES	SPT N-VALUE (bpf)	SAMPLE TYPE	DESCRIPTION	STRATUM EL / DEPTH	SYMBOL	- 200	MC %	LL	PI	OC %
0			HA	Dark grayish brown fine SAND with silt (SP-SM)							
				- dark gray							
		3	SS	- very loose							
5				(POSSIBLE BACKFILL)							
		11	SS	Medium dense, light brownish gray silty fine SAND (SM)	5.5 ▼						
		9	SS	- loose, light yellowish brown							
		8	SS	- light brownish gray			18				
10					10.0						

ANTILLIAN ENGINEERING ASSOCIATES, INC.

LOG OF BORING 181+00

SHEET 1 OF 1

PROJECT NO:	**201319**	SURFACE ELEVATION:	**Unknown**
PROJECT:	**John Young Parkway Reclaimed Water Imps.**	GROUNDWATER DEPTH:	**4.0**
DATE:	**12/4/14**	COMPLETION DEPTH:	**10.0**
LOCATION:	**See Figure 3**	DRILLING METHOD:	**Hand auger and split-spoon**

DEPTH, ft.	SAMPLES	SPT N-VALUE (bpf)	SAMPLE TYPE	DESCRIPTION	STRATUM EL / DEPTH	SYMBOL	- 200	MC %	LL	PI	OC %
0			HA	Dark brownish gray fine SAND (SP)							
				Light yellowish brown fine SAND with silt (SP-SM)							
		8	SS	- loose, yellow			10				
5		9	SS	- light brownish gray							
		16	SS	Medium dense, light gray fine SAND (SP) (POSSIBLE BACKFILL)							
		17	SS	Medium dense, light brownish gray silty fine SAND, slightly plastic (SM)	8.5						
10					10.0						

ANTILLIAN ENGINEERING ASSOCIATES, INC.

LOG OF BORING 186+00

SHEET 1 OF 1

PROJECT NO:	**201319**	SURFACE ELEVATION:	**Unknown**
PROJECT:	**John Young Parkway Reclaimed Water Imps.**	GROUNDWATER DEPTH:	**4.0**
DATE:	**12/4/14**	COMPLETION DEPTH:	**10.0**
LOCATION:	**See Figure 3**	DRILLING METHOD:	**Hand auger and split-spoon**

DEPTH, ft.	SAMPLES	SPT N-VALUE (bpf)	SAMPLE TYPE	DESCRIPTION	STRATUM EL / DEPTH	SYMBOL	- 200	MC %	LL	PI	OC %
0			HA	Dark brown fine SAND (SP)							
				- dark gray							
				- light yellowish brown							
		8	SS	Loose, grayish brown fine SAND with silt (SP-SM)							
5		5	SS	- pale brown			7				
		14	SS	- medium dense (POSSIBLE BACKFILL)							
		17	SS	Medium dense, light brownish gray silty fine SAND, slightly plastic (SM)	8.5						
10					10.0						

ANTILLIAN ENGINEERING ASSOCIATES, INC.

LOG OF BORING 191+00

SHEET 1 OF 1

PROJECT NO:	**201319**	SURFACE ELEVATION:	**Unknown**
PROJECT:	**John Young Parkway Reclaimed Water Imps.**	GROUNDWATER DEPTH:	**6.5**
DATE:	**12/4/14**	COMPLETION DEPTH:	**10.0**
LOCATION:	**See Figure 3**	DRILLING METHOD:	**Hand auger and split-spoon**

DEPTH, ft.	SAMPLES	SPT N-VALUE (bpf)	SAMPLE TYPE	DESCRIPTION	STRATUM EL / DEPTH	SYMBOL	- 200	MC %	LL	PI	OC %
0			HA	Gray fine SAND with silt (SP-SM)							
				- very dark gray							
5		27	SS	- medium dense							
		19	SS	- dark grayish brown	▼						
		8	SS	- loose, very dark gray							
		4	SS	- very loose, very dark brown (POSSIBLE BACKFILL)			11				
10					10.0						

ANTILLIAN ENGINEERING ASSOCIATES, INC.

LOG OF BORING 196+00

SHEET 1 OF 1

PROJECT NO:	**201319**	SURFACE ELEVATION:	**Unknown**
PROJECT:	**John Young Parkway Reclaimed Water Imps.**	GROUNDWATER DEPTH:	**3.5**
DATE:	**12/3/14**	COMPLETION DEPTH:	**10.0**
LOCATION:	**See Figure 3**	DRILLING METHOD:	**Hand auger and split-spoon**

DEPTH, ft.	SAMPLES	SPT N-VALUE (bpf)	SAMPLE TYPE	DESCRIPTION	STRATUM EL / DEPTH	SYMBOL	- 200	MC %	LL	PI	OC %
0			HA	Brown fine SAND with silt (SP-SM)							
				Grayish brown fine SAND (SP)							
				Dark brown fine SAND with silt (SP-SM) (POSSIBLE BACKFILL)	▼						
		5	SS	Loose, very dark brown silty fine SAND (SM)	4.0						
5		7	SS								
		10	SS								
		11	SS	- medium dense							
10					10.0						

ANTILLIAN ENGINEERING ASSOCIATES, INC.

LOG OF BORING 199+00

SHEET 1 OF 1

PROJECT NO:	**201319**	SURFACE ELEVATION:	**Unknown**
PROJECT:	**John Young Parkway Reclaimed Water Imps.**	GROUNDWATER DEPTH:	**4.2**
DATE:	**12/9/14**	COMPLETION DEPTH:	**25.0**
LOCATION:	**See Figure 3**	DRILLING METHOD:	**Mud-rotary**

DEPTH, ft.	SAMPLES	SPT N-VALUE (bpf)	SAMPLE TYPE	DESCRIPTION	STRATUM EL / DEPTH	SYMBOL	- 200	MC %	LL	PI	OC %
0			HA	Light olive brown fine SAND with silt (SP-SM)							
				Grayish brown fine SAND (SP)							
		3	SS	Very loose, very dark brown fine SAND with silt (SP-SM)							
5		14	SS	- medium dense, brown							
		11	SS	Very pale brown fine SAND (SP) (POSSIBLE BACKFILL)							
		5	SS	Loose, light brownish gray silty fine SAND (SM)	8.5						
10											
		5	SS								
15											
		7	SS	- slightly plastic			32				
20											
		6	SS								
25					25.0						

ANTILLIAN ENGINEERING ASSOCIATES, INC.

LOG OF BORING 201+00

SHEET 1 OF 1

PROJECT NO:	**201319**	SURFACE ELEVATION:	**Unknown**
PROJECT:	**John Young Parkway Reclaimed Water Imps.**	GROUNDWATER DEPTH:	**6.5**
DATE:	**12/3/14**	COMPLETION DEPTH:	**25.0**
LOCATION:	**See Figure 3**	DRILLING METHOD:	**Mud-rotary**

DEPTH, ft.	SAMPLES	SPT N-VALUE (bpf)	SAMPLE TYPE	DESCRIPTION	STRATUM EL / DEPTH	SYMBOL	- 200	MC %	LL	PI	OC %
0			HA	Dark grayish brown fine SAND with silt (SP-SM)							
				- dark yellowish brown			10				
5		16	SS	- medium dense							
		25	SS	- dark reddish brown	▼						
		10	SS	- very dark brown							
10		11	SS								
					13.0						
15		8	SS	Loose, light brownish gray silty fine SAND (SM)							
					18.0						
20		14	SS	Stiff, grayish brown, sandy clay (CL)			56				
					23.0						
25		5	SS	Loose, pale yellow silty fine SAND (SM)			16				
					25.0						

ANTILLIAN ENGINEERING ASSOCIATES, INC.

LOG OF BORING 204+00

PROJECT NO:	**201319**	SURFACE ELEVATION:	**Unknown**
PROJECT:	**John Young Parkway Reclaimed Water Imps.**	GROUNDWATER DEPTH:	**5.0**
DATE:	**12/3/14**	COMPLETION DEPTH:	**25.0**
LOCATION:	**See Figure 3**	DRILLING METHOD:	**Mud-rotary**

DEPTH, ft.	SAMPLES	SPT N-VALUE (bpf)	SAMPLE TYPE	DESCRIPTION	STRATUM EL / DEPTH	SYMBOL	- 200	MC %	LL	PI	OC %
0			HA	Dark brown fine SAND with silt (SP-SM)							
				- brown			8				
5		10	SS	- medium dense, very dark brown	▼						
		28	SS	- dark yellowish brown							
		15	SS	Medium dense, dark yellowish brown silty fine SAND (SM)	7.0		19				
		16	SS	- very dark grayish brown							
10											
		5	SS	- loose, light brownish gray			21				
15											
		7	SS	- light gray							
20											
		4	SS	- light brownish gray							
25					25.0						

ANTILLIAN ENGINEERING ASSOCIATES, INC.

LOG OF BORING 206+00

SHEET 1 OF 1

PROJECT NO:	**201319**	SURFACE ELEVATION:	**Unknown**
PROJECT:	**John Young Parkway Reclaimed Water Imps.**	GROUNDWATER DEPTH:	**4.0**
DATE:	**12/3/14**	COMPLETION DEPTH:	**25.0**
LOCATION:	**See Figure 3**	DRILLING METHOD:	**Mud-rotary**

DEPTH, ft.	SAMPLES	SPT N-VALUE (bpf)	SAMPLE TYPE	DESCRIPTION	STRATUM EL / DEPTH	SYMBOL	- 200	MC %	LL	PI	OC %
0			HA	Brown fine SAND with silt (SP-SM)							
				- brown							
				- dark grayish brown	▼						
5		15	SS	- medium dense, dark yellowish brown							
		17	SS	- very dark brown							
		16	SS	- dark brown							
		17	SS	Medium dense, very dark brown silty fine SAND (SM)	8.5		15				
10											
		7	SS	- loose, pale brown							
15											
		6	SS	- light brownish gray							
20											
		6	SS	- light yellowish brown			14				
25					25.0						

ANTILLIAN ENGINEERING ASSOCIATES, INC.

LOG OF BORING 210+00

SHEET 1 OF 1

PROJECT NO:	**201319**	SURFACE ELEVATION:	**Unknown**
PROJECT:	**John Young Parkway Reclaimed Water Imps.**	GROUNDWATER DEPTH:	**0.0**
DATE:	**12/3/14**	COMPLETION DEPTH:	**10.0**
LOCATION:	**See Figure 3**	DRILLING METHOD:	**Hand auger and split-spoon**

DEPTH, ft.	SAMPLES	SPT N-VALUE (bpf)	SAMPLE TYPE	DESCRIPTION	STRATUM EL / DEPTH	SYMBOL	- 200	MC %	LL	PI	OC %
0			HA	Brown silty fine SAND (SM) - very dark grayish brown with a few rock fragments (POSSIBLE BACKFILL)							
		10	SS	Medium dense, dark yellowish brown fine SAND with silt (SP-SM)	4.0						
5		22	SS	- dark grayish brown							
		23	SS	- dark olive brown							
		24	SS	Medium dense, dark brown silty fine SAND (SM)	8.5						
10					10.0						

ANTILLIAN ENGINEERING ASSOCIATES, INC.

LOG OF BORING 215+00

SHEET 1 OF 1

PROJECT NO:	**201319**	SURFACE ELEVATION:	**Unknown**
PROJECT:	**John Young Parkway Reclaimed Water Imps.**	GROUNDWATER DEPTH:	**4.0**
DATE:	**12/3/14**	COMPLETION DEPTH:	**10.0**
LOCATION:	**See Figure 3**	DRILLING METHOD:	**Hand auger and split-spoon**

DEPTH, ft.	SAMPLES	SPT N-VALUE (bpf)	SAMPLE TYPE	DESCRIPTION	STRATUM EL / DEPTH	SYMBOL	- 200	MC %	LL	PI	OC %
0			HA	Gray fine SAND with silt (SP-SM)							
				- dark grayish brown							
				- dark yellowish brown, with less silt			5				
		16	SS	- medium dense							
5		7	SS	- loose, very dark brown, with more silt			9				
		50/3	SS	- very dense							
				(POSSIBLE FILL)							
		71	SS	Very dense, dark brown silty fine SAND (SM)	8.5						
10					10.0						

ANTILLIAN ENGINEERING ASSOCIATES, INC.

LOG OF BORING 220+00

SHEET 1 OF 1

PROJECT NO:	**201319**	SURFACE ELEVATION:	**Unknown**
PROJECT:	**John Young Parkway Reclaimed Water Imps.**	GROUNDWATER DEPTH:	**5.5**
DATE:	**12/3/14**	COMPLETION DEPTH:	**10.0**
LOCATION:	**See Figure 3**	DRILLING METHOD:	**Hand auger and split-spoon**

DEPTH, ft.	SAMPLES	SPT N-VALUE (bpf)	SAMPLE TYPE	DESCRIPTION	STRATUM EL / DEPTH	SYMBOL	- 200	MC %	LL	PI	OC %
0			HA	Brown fine SAND with silt (SP-SM) - dark brown							
				Dark yellowish brown silty fine SAND (SM)	2.5		13				
		8	SS	- loose, very dark gray							
5					▼						
		33	SS	- dense, dark yellowish brown			16				
		36	SS								
		30	SS								
10					10.0						

ANTILLIAN ENGINEERING ASSOCIATES, INC.

LOG OF BORING 225+00

SHEET 1 OF 1

PROJECT NO:	**201319**	SURFACE ELEVATION:	**Unknown**
PROJECT:	**John Young Parkway Reclaimed Water Imps.**	GROUNDWATER DEPTH:	**2.5**
DATE:	**12/3/14**	COMPLETION DEPTH:	**10.0**
LOCATION:	**See Figure 3**	DRILLING METHOD:	**Hand auger and split-spoon**

DEPTH, ft.	SAMPLES	SPT N-VALUE (bpf)	SAMPLE TYPE	DESCRIPTION	STRATUM EL / DEPTH	SYMBOL	- 200	MC %	LL	PI	OC %
0			HA	Very dark grayish brown silty fine SAND (SM)							
				- very dark gray							
		22	SS	- medium dense, very dark brown fine SAND with silt (SP-SM)			7				
5		12	SS	- dark yellowish brown silty fine SAND (SM) (POSSIBLE BACKFILL)							
		12	SS	Medium dense, dark brown silty fine SAND (SM)	7.0						
		8	SS	- loose							
10					10.0						

ANTILLIAN ENGINEERING ASSOCIATES, INC.

LOG OF BORING 230+00

SHEET 1 OF 1

PROJECT NO:	**201319**	SURFACE ELEVATION:	**Unknown**
PROJECT:	**John Young Parkway Reclaimed Water Imps.**	GROUNDWATER DEPTH:	**4.0**
DATE:	**12/3/14**	COMPLETION DEPTH:	**10.0**
LOCATION:	**See Figure 3**	DRILLING METHOD:	**Hand auger and split-spoon**

DEPTH, ft.	SAMPLES	SPT N-VALUE (bpf)	SAMPLE TYPE	DESCRIPTION	STRATUM EL / DEPTH	SYMBOL	- 200	MC %	LL	PI	OC %
0			HA	Brown fine SAND with silt (SP-SM)							
				- very dark gray							
				- pale yellow, with less silt							
		11	SS	- medium dense, light olive brown	▼						
5		8	SS	Loose, very dark brown silty fine SAND (SM)	5.5						
		12	SS	- medium dense, brown							
		11	SS								
10					10.0						

ANTILLIAN ENGINEERING ASSOCIATES, INC.

LOG OF BORING 235+00

SHEET 1 OF 1

PROJECT NO:	**201319**	SURFACE ELEVATION:	**Unknown**
PROJECT:	**John Young Parkway Reclaimed Water Imps.**	GROUNDWATER DEPTH:	**4.0**
DATE:	**12/3/14**	COMPLETION DEPTH:	**10.0**
LOCATION:	**See Figure 4**	DRILLING METHOD:	**Hand auger and split-spoon**

DEPTH, ft.	SAMPLES	SPT N-VALUE (bpf)	SAMPLE TYPE	DESCRIPTION	STRATUM EL / DEPTH	SYMBOL	- 200	MC %	LL	PI	OC %
0			HA	Very dark gray fine SAND with silt (SP-SM)							
				Light yellowish brown fine SAND (SP)			4				
		11	SS	- medium dense							
5		15	SS	Medium dense, dark brown fine SAND with silt (SP-SM)							
		27	SS	- dark yellowish brown							
		24	SS	- very dark brown (POSSIBLE BACKFILL)							
10					10.0						

ANTILLIAN ENGINEERING ASSOCIATES, INC.

LOG OF BORING 240+00

SHEET 1 OF 1

PROJECT NO:	**201319**	SURFACE ELEVATION:	**Unknown**
PROJECT:	**John Young Parkway Reclaimed Water Imps.**	GROUNDWATER DEPTH:	**0.0**
DATE:	**12/3/14**	COMPLETION DEPTH:	**10.0**
LOCATION:	**See Figure 4**	DRILLING METHOD:	**Hand auger and split-spoon**

DEPTH, ft.	SAMPLES	SPT N-VALUE (bpf)	SAMPLE TYPE	DESCRIPTION	STRATUM EL / DEPTH	SYMBOL	- 200	MC %	LL	PI	OC %
0			HA	Dark brown fine SAND with silt (SP-SM)							
				- very dark brown							
		16	SS	- medium dense, dark yellowish brown							
5		12	SS								
		20	SS	- very dark brown							
		20	SS	- dark grayish brown (POSSIBLE BACKFILL)							
10					10.0						

ANTILLIAN ENGINEERING ASSOCIATES, INC.

LOG OF BORING 245+00

SHEET 1 OF 1

PROJECT NO:	**201319**	SURFACE ELEVATION:	**Unknown**
PROJECT:	**John Young Parkway Reclaimed Water Imps.**	GROUNDWATER DEPTH:	**3.0**
DATE:	**12/4/14**	COMPLETION DEPTH:	**10.0**
LOCATION:	**See Figure 4**	DRILLING METHOD:	**Hand auger and split-spoon**

DEPTH, ft.	SAMPLES	SPT N-VALUE (bpf)	SAMPLE TYPE	DESCRIPTION	STRATUM EL / DEPTH	SYMBOL	- 200	MC %	LL	PI	OC %
0			HA	Dark yellowish brown fine SAND with silt (SP-SM)							
					▼						
		30	SS	- dense, very dark grayish brown			6				
5		17	SS	- medium dense, dark yellowish brown							
		26	SS								
		21	SS								
10					10.0						

ANTILLIAN ENGINEERING ASSOCIATES, INC.

LOG OF BORING 250+00

SHEET 1 OF 1

PROJECT NO:	**201319**	SURFACE ELEVATION:	**Unknown**
PROJECT:	**John Young Parkway Reclaimed Water Imps.**	GROUNDWATER DEPTH:	**0.0**
DATE:	**12/2/14**	COMPLETION DEPTH:	**10.0**
LOCATION:	**See Figure 4**	DRILLING METHOD:	**Hand auger and split-spoon**

DEPTH, ft.	SAMPLES	SPT N-VALUE (bpf)	SAMPLE TYPE	DESCRIPTION	STRATUM EL / DEPTH	SYMBOL	- 200	MC %	LL	PI	OC %
0			HA	Dark grayish brown fine SAND with silt and shell fragments (SP-SM)							
				Very dark brown silty fine SAND (SM) (POSSIBLE BACKFILL)							
		25	SS	Medium dense, dark brownish gray fine SAND with silt (SP-SM)	4.0						
5		37	SS	- dense, gray							
		25	SS	Medium dense, grayish brown silty fine SAND (SM)	7.0						
		15	SS								
10					10.0						

ANTILLIAN
ENGINEERING ASSOCIATES, INC.

LOG OF BORING 255+00

SHEET 1 OF 1

PROJECT NO:	**201319**	SURFACE ELEVATION:	**Unknown**
PROJECT:	**John Young Parkway Reclaimed Water Imps.**	GROUNDWATER DEPTH:	**0.0**
DATE:	**12/2/14**	COMPLETION DEPTH:	**10.0**
LOCATION:	**See Figure 4**	DRILLING METHOD:	**Hand auger and split-spoon**

DEPTH, ft.	SAMPLES	SPT N-VALUE (bpf)	SAMPLE TYPE	DESCRIPTION	STRATUM EL / DEPTH	SYMBOL	- 200	MC %	LL	PI	OC %
0			HA	Very dark grayish brown silty fine SAND (SM)							
		24	SS	- medium dense, dark grayish brown							
5		27	SS	- light yellowish brown fine SAND (SP) (POSSIBLE FILL)							
		14	SS	Medium dense, dark grayish brown fine SAND with silt (SP-SM)	7.0		8				
		15	SS	- light brownish gray							
10					10.0						

ANTILLIAN ENGINEERING ASSOCIATES, INC.

LOG OF BORING 271+00

SHEET 1 OF 1

PROJECT NO:	**201319**	SURFACE ELEVATION:	**Unknown**
PROJECT:	**John Young Parkway Reclaimed Water Imps.**	GROUNDWATER DEPTH:	**3.0**
DATE:	**12/2/14**	COMPLETION DEPTH:	**25.0**
LOCATION:	**See Figure 4**	DRILLING METHOD:	**Mud-rotary**

DEPTH, ft.	SAMPLES	SPT N-VALUE (bpf)	SAMPLE TYPE	DESCRIPTION	STRATUM EL / DEPTH	SYMBOL	- 200	MC %	LL	PI	OC %
0			HA	Brown fine SAND with silt (SP-SM)							
				- dark grayish brown							
				- dark brown	▼						
5		7	SS	- loose							
		14	SS	- medium dense, very dark grayish brown							
		7	SS	- loose							
		11	SS	Medium dense, brown silty fine SAND (SM)	8.5						
10											
		9	SS	- loose, grayish brown							
15											
		8	SS								
20											
		8	SS				21				
25					25.0						

ANTILLIAN ENGINEERING ASSOCIATES, INC.

LOG OF BORING 275+00

SHEET 1 OF 1

PROJECT NO:	**201319**	SURFACE ELEVATION:	**Unknown**
PROJECT:	**John Young Parkway Reclaimed Water Imps.**	GROUNDWATER DEPTH:	**3.5**
DATE:	**12/2/14**	COMPLETION DEPTH:	**10.0**
LOCATION:	**See Figure 5**	DRILLING METHOD:	**Hand auger and split-spoon**

DEPTH, ft.	SAMPLES	SPT N-VALUE (bpf)	SAMPLE TYPE	DESCRIPTION	STRATUM EL / DEPTH	SYMBOL	- 200	MC %	LL	PI	OC %
0			HA	Brown fine SAND (SP)							
				- brown silty fine SAND (SM)							
				- dark yellowish brown	▼						
		13	SS	Medium dense, light yellowish brown fine SAND (SP) (POSSIBLE FILL)							
5		7	SS	Loose, very dark brown silty fine SAND (SM)	5.5		12				
		10	SS								
		14	SS	- medium dense							
10					10.0						

ANTILLIAN ENGINEERING ASSOCIATES, INC.

LOG OF BORING 277+50

SHEET 1 OF 1

PROJECT NO:	**201319**	SURFACE ELEVATION:	**Unknown**
PROJECT:	**John Young Parkway Reclaimed Water Imps.**	GROUNDWATER DEPTH:	**6.0**
DATE:	**12/2/14**	COMPLETION DEPTH:	**25.0**
LOCATION:	**See Figure 5**	DRILLING METHOD:	**Mud-rotary**

DEPTH, ft.	SAMPLES	SPT N-VALUE (bpf)	SAMPLE TYPE	DESCRIPTION	STRATUM EL / DEPTH	SYMBOL	- 200	MC %	LL	PI	OC %
0			HA	Brownish yellow fine SAND (SP)							
				(POSSIBLE FILL)							
				Very dark brown fine SAND with silt (SP-SM)	2.5						
5		30	SS	- dense, light yellowish brown							
		17	SS	- medium dense, dark yellowish brown	▼						
		10	SS	- loose							
10		22	SS	- medium dense, brown							
					13.0						
		9	SS	Loose, light brownish gray silty fine SAND (SM)							
15											
		8	SS				24				
20											
		7	SS	- grayish brown							
25					25.0						

ANTILLIAN ENGINEERING ASSOCIATES, INC.

LOG OF BORING 280+00

SHEET 1 OF 1

PROJECT NO:	**201319**	SURFACE ELEVATION:	**Unknown**
PROJECT:	**John Young Parkway Reclaimed Water Imps.**	GROUNDWATER DEPTH:	**5.0**
DATE:	**12/2/14**	COMPLETION DEPTH:	**25.0**
LOCATION:	**See Figure 5**	DRILLING METHOD:	**Mud-rotary**

DEPTH, ft.	SAMPLES	SPT N-VALUE (bpf)	SAMPLE TYPE	DESCRIPTION	STRATUM EL / DEPTH	SYMBOL	- 200	MC %	LL	PI	OC %
0			HA	Dark brown fine SAND with silt (SP-SM) (POSSIBLE FILL)							
				Dark gray fine SAND with silt (SP-SM)	2.5						
5		28	SS	- medium dense, gray							
		15	SS	Medium dense, very dark grayish brown silty fine SAND (SM)	5.5						
		11	SS				22				
		6	SS	- loose							
10											
		15	SS	- medium dense			20				
15											
		9	SS	- loose, light brownish gray			22				
20											
		9	SS	- grayish brown							
25					25.0						

ANTILLIAN ENGINEERING ASSOCIATES, INC.

LOG OF BORING 283+00

SHEET 1 OF 1

PROJECT NO:	**201319**	SURFACE ELEVATION:	**Unknown**
PROJECT:	**John Young Parkway Reclaimed Water Imps.**	GROUNDWATER DEPTH:	**4.0**
DATE:	**12/11/14**	COMPLETION DEPTH:	**25.0**
LOCATION:	**See Figure 5**	DRILLING METHOD:	**Mud-rotary**

DEPTH, ft.	SAMPLES	SPT N-VALUE (bpf)	SAMPLE TYPE	DESCRIPTION	STRATUM EL / DEPTH	SYMBOL	- 200	MC %	LL	PI	OC %
0			HA	Brown fine SAND (SP)							
				Dark brown fine SAND with silt (SP-SM) (POSSIBLE FILL)							
				Dark gray fine SAND (SP)	2.5						
5		15	SS	- medium dense, brown							
		9	SS	- loose							
		9	SS	Loose, gray silty fine SAND (SM)	7.0						
		11	SS	- medium dense, grayish brown							
10											
		14	SS	- medium dense							
15											
		9	SS	- loose, gray							
20											
		7	SS	- more silty			33				
25					25.0						

ANTILLIAN ENGINEERING ASSOCIATES, INC.

LOG OF BORING 286+50

SHEET 1 OF 1

PROJECT NO: **201319**
PROJECT: **John Young Parkway Reclaimed Water Imps.**
DATE: **12/1/14**
LOCATION: **See Figure 5**

SURFACE ELEVATION: **Unknown**
GROUNDWATER DEPTH:
COMPLETION DEPTH: **25.0**
DRILLING METHOD: **Mud-rotary**

DEPTH, ft.	SAMPLES	SPT N-VALUE (bpf)	SAMPLE TYPE	DESCRIPTION	STRATUM EL / DEPTH	SYMBOL	- 200	MC %	LL	PI	OC %
0			HA	Dark yellowish brown fine SAND with silt (SP-SM)							
		3	SS	- very loose, dark brown							
5		11	SS	- medium dense, grayish brown							
		12	SS	- dark grayish brown							
		14	SS	Medium dense, grayish brown silty fine SAND (SM)	8.5		24				
10											
		12	SS								
15											
		15	SS								
20											
		13	SS								
25					25.0						

ANTILLIAN ENGINEERING ASSOCIATES, INC.

LOG OF BORING 291+00

SHEET 1 OF 1

PROJECT NO:	**201319**	SURFACE ELEVATION:	**Unknown**
PROJECT:	**John Young Parkway Reclaimed Water Imps.**	GROUNDWATER DEPTH:	**3.0**
DATE:	**12/1/14**	COMPLETION DEPTH:	**25.0**
LOCATION:	**See Figure 5**	DRILLING METHOD:	**Mud-rotary**

DEPTH, ft.	SAMPLES	SPT N-VALUE (bpf)	SAMPLE TYPE	DESCRIPTION	STRATUM EL / DEPTH	SYMBOL	- 200	MC %	LL	PI	OC %
0			HA	Grayish brown fine SAND (SP)							
				Grayish brown silty fine SAND	1.0 ▼						
5		11	SS	Medium dense, dark grayish brown fine SAND with silt (SP-SM)	4.0						
		8	SS	- loose, grayish brown, with less silt							
		24	SS	- medium dense							
10		25	SS								
15		23	SS	- dark grayish brown							
					18.0						
20		10	SS	Loose, gray silty fine SAND (SM)			26				
25		8	SS		25.0						

ANTILLIAN ENGINEERING ASSOCIATES, INC.

LOG OF BORING 294+50

SHEET 1 OF 1

PROJECT NO:	**201319**	SURFACE ELEVATION:	**Unknown**
PROJECT:	**John Young Parkway Reclaimed Water Imps.**	GROUNDWATER DEPTH:	**5.5**
DATE:	**12/9/14**	COMPLETION DEPTH:	**25.0**
LOCATION:	**See Figure 5**	DRILLING METHOD:	**Mud-rotary**

DEPTH, ft.	SAMPLES	SPT N-VALUE (bpf)	SAMPLE TYPE	DESCRIPTION	STRATUM EL / DEPTH	SYMBOL	- 200	MC %	LL	PI	OC %
0			HA	Olive brown fine SAND with silt (SP-SM)							
				- dark grayish brown							
5		7	SS	- loose, grayish brown							
		2	SS	Very loose, grayish brown silty fine SAND (SM)	5.5						
		11	SS	- medium dense, light brownish gray							
10		14	SS								
		18	SS	Medium dense, light gray fine SAND (SP)	13.0		4				
15											
		11	SS	Medium dense, grayish brown silty fine SAND (SM)	18.0						
20											
		10	SS	- brown							
25					25.0						

ANTILLIAN ENGINEERING ASSOCIATES, INC.

LOG OF BORING 299+00

SHEET 1 OF 1

PROJECT NO:	**201319**	SURFACE ELEVATION:	**Unknown**
PROJECT:	**John Young Parkway Reclaimed Water Imps.**	GROUNDWATER DEPTH:	**3.1**
DATE:	**12/1/14**	COMPLETION DEPTH:	**10.0**
LOCATION:	**See Figure 5**	DRILLING METHOD:	**Hand auger and split-spoon**

DEPTH, ft.	SAMPLES	SPT N-VALUE (bpf)	SAMPLE TYPE	DESCRIPTION	STRATUM EL / DEPTH	SYMBOL	- 200	MC %	LL	PI	OC %
0			HA	Very dark brown fine SAND with silt (SP-SM)							
				- gray ▼							
		2	SS	Very loose, very dark brown silty fine SAND (SM)	4.0						
5		2	SS				14				
		10	SS	- loose, very dark grayish brown							
		16	SS	- medium dense, grayish brown, more silty							
10					10.0						

ANTILLIAN ENGINEERING ASSOCIATES, INC.

LOG OF BORING 303+00

SHEET 1 OF 1

PROJECT NO:	**201319**	SURFACE ELEVATION:	**Unknown**
PROJECT:	**John Young Parkway Reclaimed Water Imps.**	GROUNDWATER DEPTH:	**5.5**
DATE:	**12/1/14**	COMPLETION DEPTH:	**10.0**
LOCATION:	**See Figure 5**	DRILLING METHOD:	**Hand auger and split-spoon**

DEPTH, ft.	SAMPLES	SPT N-VALUE (bpf)	SAMPLE TYPE	DESCRIPTION	STRATUM EL / DEPTH	SYMBOL	- 200	MC %	LL	PI	OC %
0			HA	Very dark grayish brown fine SAND with silt (SP-SM)							
				Dark grayish brown silty fine SAND (SM)	2.5						
5		3	SS	- very loose, dark brown							
		5	SS	- loose, olive brown							
		9	SS	- grayish brown							
		15	SS	Medium dense, gray fine SAND with silt (SP-SM)	8.5						
10					10.0						

ANTILLIAN ENGINEERING ASSOCIATES, INC.

LOG OF BORING 306+00

SHEET 1 OF 1

PROJECT NO:	**201319**	SURFACE ELEVATION:	**Unknown**
PROJECT:	**John Young Parkway Reclaimed Water Imps.**	GROUNDWATER DEPTH:	**3.2**
DATE:	**12/1/14**	COMPLETION DEPTH:	**25.0**
LOCATION:	**See Figure 5**	DRILLING METHOD:	**Mud-rotary**

DEPTH, ft.	SAMPLES	SPT N-VALUE (bpf)	SAMPLE TYPE	DESCRIPTION	STRATUM EL / DEPTH	SYMBOL	- 200	MC %	LL	PI	OC %
0			HA	Dark brown fine SAND with silt (SP-SM) - yellowish brown							
				Brownish yellow silty fine SAND (SM)	2.5 ▼						
5		8	SS	- loose, gray			31				
		25	SS	- medium dense							
		32	SS	Dense, light yellowish brown fine SAND (SP)	7.0						
		17	SS	Medium dense, gray silty fine SAND (SM)	8.5		26				
10											
		14	SS	- more silty			30				
15											
		20	SS	- dark gray							
20											
		11	SS	- grayish brown, less silty			18				
25					25.0						

ANTILLIAN ENGINEERING ASSOCIATES, INC.

LOG OF BORING 307+60

SHEET 1 OF 1

PROJECT NO:	**201319**	SURFACE ELEVATION:	**Unknown**
PROJECT:	**John Young Parkway Reclaimed Water Imps.**	GROUNDWATER DEPTH:	**3.5**
DATE:	**12/1/14**	COMPLETION DEPTH:	**25.0**
LOCATION:	**See Figure 5**	DRILLING METHOD:	**Mud-rotary**

DEPTH, ft.	SAMPLES	SPT N-VALUE (bpf)	SAMPLE TYPE	DESCRIPTION	STRATUM EL / DEPTH	SYMBOL	- 200	MC %	LL	PI	OC %
0			HA	Dark grayish brown fine SAND with silt (SP-SM)							
				- dark yellowish brown							
				- light yellowish brown, with less silt	▼						
		13	SS	Medium dense, dark yellowish brown silty fine SAND (SM)	4.0						
5		7	SS	- loose							
		13	SS	- medium dense, dark grayish brown, more silty, plastic							
		15	SS								
10											
		13	SS	- less silty							
15											
		12	SS	- grayish brown							
20											
		11	SS								
25					25.0						

ANTILLIAN ENGINEERING ASSOCIATES, INC.

LOG OF BORING 310+80

SHEET 1 OF 1

PROJECT NO:	**201319**	SURFACE ELEVATION:	**Unknown**
PROJECT:	**John Young Parkway Reclaimed Water Imps.**	GROUNDWATER DEPTH:	**6.0**
DATE:	**12/1/14**	COMPLETION DEPTH:	**25.0**
LOCATION:	**See Figure 5**	DRILLING METHOD:	**Mud-rotary**

DEPTH, ft.	SAMPLES	SPT N-VALUE (bpf)	SAMPLE TYPE	DESCRIPTION	STRATUM EL / DEPTH	SYMBOL	- 200	MC %	LL	PI	OC %
0			HA	Grayish brown fine SAND (SP)							
				Very dark grayish brown fine SAND with silt (SP-SM)							
				Dark grayish brown fine SAND (SP)							
		8	SS	Loose, dark grayish brown fine SAND with silt (SP-SM) (POSSIBLE BACKFILL)							
5		7	SS	Loose, dark grayish brown fine SAND with silt (SP-SM)	5.5 ▼						
		10	SS	- medium dense, grayish brown			11				
		3	SS	- very loose, dark grayish brown							
10											
					13.0						
		14	SS	Medium dense, brown, silty fine sand (SM)			18				
15											
		14	SS	- light yellowish brown							
20											
					23.0						
		15	SS	Medium dense, dark gray clayey fine SAND (SC)			47	20	38	18	
25					25.0						

ANTILLIAN ENGINEERING ASSOCIATES, INC.

LOG OF BORING 314+50

SHEET 1 OF 1

PROJECT NO:	**201319**	SURFACE ELEVATION:	**Unknown**
PROJECT:	**John Young Parkway Reclaimed Water Imps.**	GROUNDWATER DEPTH:	**6.0**
DATE:	**12/1/14**	COMPLETION DEPTH:	**25.0**
LOCATION:	**See Figure 5**	DRILLING METHOD:	**Mud-rotary**

DEPTH, ft.	SAMPLES	SPT N-VALUE (bpf)	SAMPLE TYPE	DESCRIPTION	STRATUM EL / DEPTH	SYMBOL	- 200	MC %	LL	PI	OC %
0			HA	Dark gray fine SAND with rock fragments (SP)							
				Dark yellowish brown fine SAND with silt (SP-SM)							
				Dark grayish brown silty fine SAND with wood (SM)							
		16	SS	Medium dense, gray fine SAND (SP)							
5				(POSSIBLE BACKFILL)							
		14	SS	Medium dense, dark yellowish brown silty fine SAND (SM)	5.5 ▼						
		17	SS	- dark brown							
		13	SS	- grayish brown							
10											
		14	SS								
15											
		7	SS	- loose, light brownish gray							
20											
					23.0						
		4	SS	Loose, grayish brown clayey fine SAND (SC)							
25					25.0						

ANTILLIAN ENGINEERING ASSOCIATES, INC.

LOG OF BORING 318+00

SHEET 1 OF 1

PROJECT NO:	**201319**	SURFACE ELEVATION:	**Unknown**
PROJECT:	**John Young Parkway Reclaimed Water Imps.**	GROUNDWATER DEPTH:	**6.0**
DATE:	**12/1/14**	COMPLETION DEPTH:	**10.0**
LOCATION:	**See Figure 5**	DRILLING METHOD:	**Hand auger and split-spoon**

DEPTH, ft.	SAMPLES	SPT N-VALUE (bpf)	SAMPLE TYPE	DESCRIPTION	STRATUM EL / DEPTH	SYMBOL	- 200	MC %	LL	PI	OC %
0			HA	Brown fine SAND (SP)							
				Dark grayish brown fine SAND with silt (SP-SM)							
				- very dark grayish brown, with wood							
		7	SS	- loose							
5		5	SS		▼		9				
		18	SS	- medium dense, light brownish gray							
		18	SS	Medium dense, light gray fine SAND (SP) (POSSIBLE BACKFILL)							
10					10.0						

ANTILLIAN ENGINEERING ASSOCIATES, INC.

LOG OF BORING 321+00

SHEET 1 OF 1

PROJECT NO:	**201319**	SURFACE ELEVATION:	**Unknown**
PROJECT:	**John Young Parkway Reclaimed Water Imps.**	GROUNDWATER DEPTH:	**5.0**
DATE:	**12/1/14**	COMPLETION DEPTH:	**25.0**
LOCATION:	**See Figure 5**	DRILLING METHOD:	**Mud-rotary**

DEPTH, ft.	SAMPLES	SPT N-VALUE (bpf)	SAMPLE TYPE	DESCRIPTION	STRATUM EL / DEPTH	SYMBOL	- 200	MC %	LL	PI	OC %
0			HA	Grayish brown fine SAND with silt (SP-SM)							
				- very dark gray							
		16	SS	- medium dense, dark brown to dark yellowish brown	▼						
5		18	SS								
		11	SS	Medium dense, light brownish gray silty fine SAND (SM)	7.0						
		6	SS	- loose, gray							
10											
		14	SS	- medium dense, brown							
15											
		11	SS	- dark grayish brown							
20											
		9	SS	- loose, grayish brown							
25					25.0						

ANTILLIAN ENGINEERING ASSOCIATES, INC.

LOG OF BORING 322+10

SHEET 1 OF 1

PROJECT NO:	**201319**	SURFACE ELEVATION:	**Unknown**
PROJECT:	**John Young Parkway Reclaimed Water Imps.**	GROUNDWATER DEPTH:	**3.6**
DATE:	**12/1/14**	COMPLETION DEPTH:	**25.0**
LOCATION:	**See Figure 5**	DRILLING METHOD:	**Mud-rotary**

DEPTH, ft.	SAMPLES	SPT N-VALUE (bpf)	SAMPLE TYPE	DESCRIPTION	STRATUM EL / DEPTH	SYMBOL	- 200	MC %	LL	PI	OC %
0			HA	Grayish brown fine SAND with silt (SP-SM)							
				- dark grayish brown							
				- dark gray	▼						
		24	SS	Medium dense, very dark brown silty fine SAND (SM)	4.0						
5		24	SS	- dark yellowish brown							
		29	SS	- light yellowish brown							
		14	SS	- brownish gray							
10											
		10	SS	- loose, brown							
15											
		8	SS	- pale brown			15				
20											
		8	SS	- dark grayish brown							
25					25.0						

ANTILLIAN ENGINEERING ASSOCIATES, INC.

LOG OF BORING 325+00

SHEET 1 OF 1

PROJECT NO:	**201319**	SURFACE ELEVATION:	**Unknown**
PROJECT:	**John Young Parkway Reclaimed Water Imps.**	GROUNDWATER DEPTH:	**9.4**
DATE:	**12/12/14**	COMPLETION DEPTH:	**10.0**
LOCATION:	**See Figure 5**	DRILLING METHOD:	**Hand auger and split-spoon**

DEPTH, ft.	SAMPLES	SPT N-VALUE (bpf)	SAMPLE TYPE	DESCRIPTION	STRATUM EL / DEPTH	SYMBOL	- 200	MC %	LL	PI	OC %
0			HA	Grayish brown fine SAND with silt (SP-SM) - brown, a few rock fragments - dark gray (POSSIBLE FILL)							
		29	SS	Medium dense, gray fine SAND with silt (SP-SM)	4.0						
5		44	SS	- dense, light gray							
		63	SS	- very dense, gray							
		69	SS	Very dense, grayish brown silty fine SAND (SM)	8.5 ▼						
10					10.0						

ANTILLIAN ENGINEERING ASSOCIATES, INC.

LOG OF BORING 328+40W

SHEET 1 OF 1

PROJECT NO:	**201319**	SURFACE ELEVATION:	**Unknown**
PROJECT:	**John Young Parkway Reclaimed Water Imps.**	GROUNDWATER DEPTH:	**9.0**
DATE:	**12/12/14**	COMPLETION DEPTH:	**25.0**
LOCATION:	**See Figure 5**	DRILLING METHOD:	**Mud-rotary**

DEPTH, ft.	SAMPLES	SPT N-VALUE (bpf)	SAMPLE TYPE	DESCRIPTION	STRATUM EL / DEPTH	SYMBOL	- 200	MC %	LL	PI	OC %
0			HA	Grayish brown fine SAND with silt and rock fragments (SP-SM)							
				- light brownish gray							
5		24	SS	- medium dense, dark gray, with more silt (POSSIBLE BACKFILL)							
		47	SS	Dense, gray fine SAND with silt (SP-SM)	5.5						
		73	SS	- very dense, grayish brown							
		26	SS	- medium dense	▼						
10											
					12.0						
		15	SS	Medium dense, yellowish brown silty fine SAND (SM)							
15											
		16	SS	- light brownish gray							
20											
		16	SS								
25					25.0						

ANTILLIAN ENGINEERING ASSOCIATES, INC.

LOG OF BORING 328+40E

SHEET 1 OF 1

PROJECT NO:	**201319**	SURFACE ELEVATION:	**Unknown**
PROJECT:	**John Young Parkway Reclaimed Water Imps.**	GROUNDWATER DEPTH:	**3.0**
DATE:	**12/12/14**	COMPLETION DEPTH:	**25.0**
LOCATION:	**See Figure 5**	DRILLING METHOD:	**Mud-rotary**

DEPTH, ft.	SAMPLES	SPT N-VALUE (bpf)	SAMPLE TYPE	DESCRIPTION	STRATUM EL / DEPTH	SYMBOL	- 200	MC %	LL	PI	OC %
0			HA	Grayish brown fine SAND with silt (SP-SM)							
		17	SS	Medium dense, dark grayish brown fine SAND (SP) (POSSIBLE BACKFILL)							
5		12	SS	Medium dense, dark grayish brown silty fine SAND (SM)	5.5						
		14	SS	- light olive brown							
		11	SS	- grayish brown							
10											
		11	SS								
15											
		8	SS	- loose, light brownish gray							
20											
		13	SS	- medium dense							
25					25.0						