GEOTECHNICAL ENGINEERING REPORT

JAMES RIVER WATER AUTHORITY WATER SUPPLY
PROPOSED PUMP STATION
FLUVANNA COUNTY, VIRGINIA

JOB NUMBER: 36790

PREPARED FOR:

FAULCONER CONSTRUCTION COMPANY, INC.
2496 OLD IVY ROAD
P.O. BOX 7706
CHARLOTTESVILLE, VIRGINIA 22906

August 24, 2016

TIMMONS GROUP

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EXECUTIVE SUMMARY

For your convenience, this report is summarized in outline form below. This brief summary should not be used for design or construction purposes without reviewing the more detailed conclusions and recommendations contained in this report.

1. The subsurface exploration included a visual site reconnaissance, performance of 5 test borings to depths of approximately 23 to 49 feet below the ground surface and quantitative laboratory testing.

2. The borings encountered approximately 1 to 3 inches of surficial topsoil. Beneath the topsoil, the borings encountered undisturbed alluvial soil deposits to depths up to 31 feet below the ground surface. These soils consisted of fine grained very soft to stiff silts and clays and very loose to dense sands. Weathered rock was encountered in all the borings at depths ranging from approximately 21 feet below the existing ground surface to boring termination depths.

3. At the time of exploration, water was encountered in several of the borings at depths ranging from 13 to 18 feet below the ground surface.

4. We recommend that site grading be conducted during the typically drier summer months.

5. Temporary shoring or sloping of excavation sidewalls will be required for the deep excavations at this site.

6. Pump station structures bearing near existing grade may be supported on shallow foundations designed using an allowable bearing pressure of 1,500 psf. The wet well foundation may be supported on rock materials.

7. Earth pressure parameters for various backfill types are present in this report. Earth pressures can be substantially reduced if off-site granular materials are used as backfill.

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August 24, 2016

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Attention: Mr. Ed Stelter

Re: **Geotechnical Engineering Report**
James River Water Authority Water Supply
Proposed Pump Station
Fluvanna County, Virginia
Timmons Group Project No. 36790

Mr. Stelter:

Timmons Group is pleased to submit this geotechnical engineering report for the referenced project. The objectives of our services were to explore subsurface conditions and provide our geotechnical recommendations for site grading and foundation support.

1. PROJECT INFORMATION

The site consists of partially wooded land located along the James River in Fluvanna County, Virginia. A Site Vicinity Map is shown on Figure 1.

The site currently consists of agricultural land near the intersection of the Rivanna River and James River. There are two stretches of mature woodland that run parallel with the James River on the property.

Proposed construction will consist of a new pump station with a wet well and an intake from the James River. The pump station will have a floor elevation near existing grade (approximate elevation 200 feet), and the bottom of the wet well is expected to bear on rock below approximate elevation 170 feet. Some foundations for the pump station building will bear at shallow depths below existing grade. We expect maximum column and wall loads for the pump station will be 10 kips and 2 kips per linear foot, respectively.

Site grades range from approximately elevation 200 feet near the pump station to elevation 170 at the location of the intake along the James River.

2. FIELD EXPLORATION

The field exploration included a visual site reconnaissance by a representative of Timmons Group and performance of five soil test borings (B-01 through B-05). Boring locations were selected by Timmons Group. A representative of Timmons Group established locations in the field using GPS equipment. Approximate boring locations are shown on Figure 2 in Appendix A.

Borings were performed to auger refusal with hollow stem drilling techniques. A Timmons Group representative was present on site to visually classify encountered subsurface conditions. Split-spoon samples of subsurface soils were taken within soil test borings at approximate 2-foot intervals above a depth of 10 feet and at 5 foot intervals below 10 feet. Two bulk samples of soil cuttings were also collected. Standard penetration tests were conducted in conjunction with split-spoon sampling in general accordance with ASTM D 1586-99. Within Boring B-04, materials refusing auger advancement were cored with an NQ core barrel, typically at 5-foot core intervals. Total core run was approximately 20 feet in this boring.

Water levels were measured in open boreholes at the time of drilling. Upon completion, boreholes were then backfilled up to the original ground surface with drill cuttings. Representative portions of split-spoon soil samples and the bulk samples were returned to our laboratory for quantitative testing and visual classification in general accordance with Unified Soil Classification System guidelines.

Boring logs and a generalized soil profile (Figure 3), which present specific information from the borings, are included in the Appendix. Stratification lines shown on the boring logs and profile are intended to represent approximate depths of changes in soil types. Naturally, transitional changes in soil types are often gradual and cannot be defined at particular depths. Ground surface elevations shown on these documents were interpolated from a GIS topographic plan and should be considered approximate.

3. LABORATORY TESTING

Laboratory testing was performed on representative split-spoon and bulk soil samples obtained from the borings. This testing consisted of natural moisture content, Atterberg limits, grain size analyses, and standard Proctor tests. Testing of rock core samples consisted of unconfined compression strength. Laboratory tests were performed in general accordance with applicable ASTM procedures. Individual laboratory test data sheets are provided in the Appendix. A summary of laboratory test data is provided in the tables below.

Natural Moisture and Classification Tests

Boring	Sample	Depth (Feet)	Natural Moisture Content (%)	Atterberg Limits			Grain Size Analysis		USCS Classification
				LL	PL	PI	% Sand	% Fines*	
B-01	S-5	8-10	23.1	56	18	38	13.3	86.7	CH
B-02	Bulk	0-10	21.7	53	24	29	2.2	97.8	CH
B-02	Bulk	10-20	23.5	50	24	26	28.3	71.7	CH
B-03	S-3	4-6	21.8	58	31	27	2.9	97.1	MH
B-03	S-6	13-15	27.5	51	20	31	30.6	69.4	CH
B-04	S-2	2-4	19.7	38	25	13	7.2	92.8	ML

*****Material passing No. 200 sieve (clay and silt)
******Visual Classification

Standard Proctor Testing

Boring	Depth (Feet)	Natural Moisture Content (%)	Standard Proctor		USCS Classification
			Optimum Moisture Content (%)	Maximum Dry Density (pcf)	
B-02	0-10	21.7	21.4	102.2	CH
B-02	10-20	23.5	19.2	103.7	CH

Unconfined Compression Testing of Rock Core Samples

Boring	Approximate Depth (Feet)	Unconfined Compressive Strength of Rock Core (psi)
B-04	29.5-30.1	6,581
B-04	39.0-39.56	8,580

Based on the Atterberg limits testing, soils are of low to high plasticity. Based on comparison of natural moisture contents to the optimum moisture contents of the bulk samples, near-surface soils appear near to wet of optimum moisture. Drying of some near-surface soils will likely be required prior to their re-use as fill. The time of year the grading occurs will likely have a significant impact on the moisture levels of near-surface soils.

4. SITE GEOLOGY

According to the 1993 Geologic Map of Virginia, the site is located in the Piedmont Physiographic Province of Virginia. The Piedmont is characterized by low, rounded hills composed of saprolitic soils overlying folded metamorphic and igneous bedrock. Locally, the site appears to be underlain by the Columbia pluton formation. Undisturbed soils in the Piedmont were formed from the chemical weathering of parent bedrock and are termed “residual” soils.

Based on the borings performed at this site, the majority of encountered soils appear to be alluvial in nature (i.e., deposited by the James River). The alluvial soils are underlain by a thin layer of weathered rock followed by intact bedrock.

5. SUBSURFACE CONDITIONS

The following is a summary of subsurface conditions encountered during the exploration.

5.1 Ground Surface Cover

The borings encountered approximately 1 to 3 inches of surficial topsoil.

5.2 Soils

Beneath the topsoil, the borings encountered alluvial soil deposits to depths up to 31 feet below the ground surface. These soils consisted of fine-grained very soft to stiff highly plastic clay (CH), elastic silt (MH), silt (ML) and lean clay (CL). The coarse soils were sampled as very loose and dense silty sand (SM) and clayey sand (SC). SPT N-values within the soil profile ranged from 1 to 38 blows per foot (bpf).

5.3 Weathered Rock

Weathered rock was encountered in all the borings at depths ranging from approximately 21 feet below the existing ground surface to boring termination depths. Weathered rock is residual material derived from the physical and chemical weathering of underlying parent rock. Weathered rock is defined as a residual soil having Standard Penetration Test N-values of 60 blows per foot or greater. Weathered rock was sampled primarily as silty sand (SM) and clayey sand (SC).

5.4 Auger Refusal Materials

Materials refusing auger advancement were encountered in all the borings at depths of 23.6 to 31 feet below the ground surface. Based on cores taken from Boring B-04, rock materials were sampled as granite bedrock.

5.5 Groundwater

At the time of exploration, water was encountered in all the borings at depths ranging from 13 to 18 feet below the ground surface. It is important to realize that groundwater levels will fluctuate with changes in rainfall, river water levels, and evaporation rates. In addition, perched groundwater could be encountered within near-surface soils, particularly after rainfall.

6. CONCLUSIONS AND RECOMMENDATIONS

The following conclusions and recommendations are based upon our borings, laboratory testing, engineering analysis, and past experience with similar projects and subsurface conditions

6.1 Site Preparation

6.1.1 General

Site grading will be difficult during periods of extended rainfall and low temperatures that generally occur during the winter months. If grading is conducted during a wet time period, soils will tend to rut and pump under rubber-tired traffic and provide poor subgrade support for pavements. Heavy rubber-tired construction equipment should not be allowed to operate on wet or unstable subgrades at this site due to the potential for rutting and other damage to the soils. To reduce potential earthwork problems, site preparation and grading should be scheduled during the typically drier summer months, if possible. We recommend that exposed subgrades be sloped and sealed at the end of each day to promote runoff and reduce infiltration from rainfall.

Site preparation should begin with clearing and grubbing of existing trees, stripping of topsoil, and removal of any other unsuitable materials. Approximately 1 to 3 inches of topsoil was encountered in the borings. However, stripping activities often mix topsoil with underlying “clean” soils and cause stripping depths to be greater than actual topsoil depths, particularly during wet periods of the year. Topsoil should be wasted from the site or permanently stockpiled outside the proposed construction limits.

6.1.2 Subgrade Evaluation

After stripping, exposed soil subgrades in areas to receive fill, and finished subgrades, should be evaluated by the Geotechnical Engineer or his representative. To aid the engineer during this evaluation, exposed soil subgrades should be proofrolled with a loaded tandem axle dump truck or equivalent. Proofrolling will help to reveal the presence of unstable or otherwise unsuitable surface materials. The following methods are typically used to repair soil subgrades that are observed to rut, pump, or deflect excessively during proofrolling:

- Undercut the unstable soils to firm soils and replace them with suitable, well compacted fill.
- In-place repair of near-surface soils by scarifying, drying and recompacting, when weather conditions are suitable.

6.2 Excavations

We expect that deep excavations on the order 30 to 40 feet will be required to construct the wet well and intake pipe. Excavations will extend through low to high consistency soils, weathered rock, and mass rock. A temporary shoring system or sloping of excavation sidewalls will be required for excavations. Excavation considerations are presented in the following sections.

6.2.1 Excavated Materials

Soils encountered above approximate elevation 173 feet consist of low to moderate consistency soils which can likely be excavated using conventional earthwork equipment. However, blasting of rock will be required below that elevation. Care must be used to avoid over-blasting materials beneath the planned bottom elevation of structures. Any over-blasted materials must be removed beneath structures because over-blasted materials could settle if left in place. We recommend that a preblast survey of any nearby structures be performed prior to blasting.

6.2.2 Shoring

Temporary shoring will be required to support lateral earth pressures from excavation sidewalls. Otherwise, excavation sidewalls should be properly sloped in accordance with OSHA guidelines. The temporary shoring or sloped excavation sidewalls should be designed by an engineer that is licensed in the state of Virginia who specializes in temporary excavation design and has experience with similar geologic conditions.

Water was encountered in the borings at depths ranging from approximately 13 to 18 feet below existing grades. The contractor should be prepared to control and remove groundwater seepage that occurs within excavations.

6.3 Structural Fill

Structural fill placed in building area should be free of debris, contain less than 5 percent organics, have plasticity index (PI) less than 25, and have a maximum particle size of 3 inches. These requirements apply to the re-use of on-site soils or imported soils. The near-surface, low-plasticity silts (ML) should be suitable for re-use in the building area, provided the moisture content can be properly controlled. Structural fill should be placed in maximum 8 to 10-inch loose lifts and compacted to at least 95 percent of the Standard Proctor maximum dry density

(ASTM D 698). The final 12 inches of structural fill relative to finished subgrade should be compacted to at least 98 percent of the Standard Proctor maximum dry density. Structural fill should be maintained within 3 percentage points of optimum moisture during placement and compaction.

Recommended backfill materials types for the wet well retaining walls are provided later in this report.

Site preparation, including fill placement and compaction, should be observed by a qualified soils technician working under the direction of the Geotechnical Engineer. During fill placement, a sufficient amount of in-place density tests should be conducted to confirm that compaction and fill moisture is in accordance with our recommendations.

6.4 Foundations

6.4.1 Pump Station Foundations

Based on the performed borings and assumed structural loads, the light pump station loads bearing near elevation 200 feet may be supported on shallow foundations designed using an allowable bearing pressure of 1,500 psf. Individual column and wall foundations should be at least 24 inches and 18 inches wide, respectively. This recommendation is made to prevent a localized or "punching" shear failure condition which can occur with very narrow footings. Because some near-surface soils are highly plastic, we recommend that the foundations bear at least 36 inches below finished exterior grade. This embedment depth should provide adequate frost protection for foundation bearing materials.

We expect total and differential settlements of the pump station structures will be one inch and ½ inches, respectively, provided the recommendations of this report are properly implemented.

Foundation excavations should be evaluated by the Geotechnical Engineer or his representative prior to reinforcing steel and concrete placement. The evaluation should involve probing of foundation bearing surfaces, advancing shallow hand auger borings, and dynamic cone penetrometer (DCP) testing. If soft foundation bearing soils are encountered, they should be overexcavated and replaced with VDOT No. 57 stone.

If groundwater or surface water runoff collects in any excavation, it should be removed promptly. Care should be exercised during construction of foundations in order not to disturb bearing soils and reduce their bearing strength. Concrete for the foundations should be placed as soon as practical following excavation. If concrete placement is delayed, placement of a concrete "mud mat" on exposed bearing soils should be considered.

6.4.2 Wet Well

The wet well will bear on mass rock. The wet well foundation is expected to consist of a structural mat supporting cast-in-place concrete walls. As previously mentioned, all overblasted rock must be removed beneath the wet well. We recommend that any overblasted rock material below the wet well bearing elevation be backfilled with VDOT No. 57 stone up to the design bearing elevation for the wet well. Wet well foundation bearing on rock can be designed using an allowable bearing pressure of 5,000 psf. Higher bearing pressures are available for the rock but are not expected to be needed. Settlement of the wet well foundation is expected to be ½ inches or less.

6.5 Seismic Site Classification

Based on our test borings and our past experience, it is our opinion the site should be considered Seismic Site Classification D in accordance with the 2012 International Building Code (IBC). Additional field testing (i.e., shear wave velocity testing) could be performed in an attempt to obtain a more favorable seismic site classification.

6.6 Uplift Considerations for Below-Grade Structures

During normal operations, the wet well will have both internal and external fluid pressures applied to the exterior walls. Water within the structure should balance or exceed hydrostatic forces applied to the outside of the walls from groundwater. However, if this structure will be emptied for maintenance purposes, hydrostatic pressure from groundwater will create uplift forces on the structures. The structures should be designed with an adequate factor of safety against uplift. A method to reduce uplift pressures on the structures during maintenance includes construction of pressure relief valves along the mat bottom.

6.7 Below Grade Walls

Cast-in-place concrete, below-grade walls will be constructed for the wet well. These walls must be designed to resist lateral earth pressures from the backfill. In addition to these lateral pressures, the walls may be subjected to surcharge loading from adjacent traffic and stockpiled materials. If present, these surcharge stresses should be resolved into appropriate lateral stress distributions and added to the earth pressures outlined below.

Backfill soils placed behind retaining walls should be compacted to at least 95 percent of the soil's standard Proctor maximum dry density (ASTM D 698) and within 3 percent points of optimum moisture. Operating heavy compaction equipment within 5 feet behind the retaining structures can create lateral earth pressures far in excess of those recommended for design. As such, we recommend that hand-operated equipment be used within 5 feet from walls.

On-site soils may be used as backfill behind the wet well walls. However, the earth pressures can be substantially reduced by backfilling with an off-site granular material, such as relatively clean sands (less than 10 percent fines), VDOT 21B stone, or VDOT No. 57 stone. To receive the benefit of reduced lateral earth pressure, the granular backfill must be located within an imaginary line extending at a 45-degree angle from the bottom of wall (e.g., for a 30-foot tall wall, the granular backfill must extend 15 feet behind the top of wall).

At-rest equivalent fluid unit weights are provided in the table below for various backfill types described above. The lateral earth pressure parameters presented below assume no wall friction between the wall and soil backfill (δ = 0 degrees) and are based on placement of properly compacted backfill and a level backfill surface.

Backfill Type	**At-Rest Equivalent Fluid Unit Weight (γ_{eq})**
On-Site Soils	75 pcf
Granular Backfill	40 pcf
VDOT 21B Stone or Relatively Clean Sand	50 pcf

We expect the wet well will maintain a water pool elevation above the groundwater table. For this case, internal and external hydrostatic pressures are expected to balance each other. If the wet well walls will not experience this balance, then the potential external hydrostatic lateral pressures on the wall must be considered in design.

7. LIMITATIONS OF REPORT

The recommendations contained in this report are made on the basis of the site information made available to us and the surface and subsurface conditions that existed at the time of the exploration. While this exploration has been conducted in accordance with generally accepted geotechnical engineering practices, there remains some potential for variation of the subsurface conditions in unexplored areas of the site. If the subsurface conditions encountered during construction vary significantly from those presented in this report, we should be notified to reevaluate our recommendations. No other warranty, expressed or implied, is made as to the professional advice included in this report.

8. CLOSURE

We appreciate this opportunity to be of service to you on this project. If you have any questions regarding this study or if we can be of further assistance, please contact us at (804) 200-6500.

Respectfully submitted,
TIMMONS GROUP

Julian M. Ruffin IV, P.E.
Geotechnical Engineer

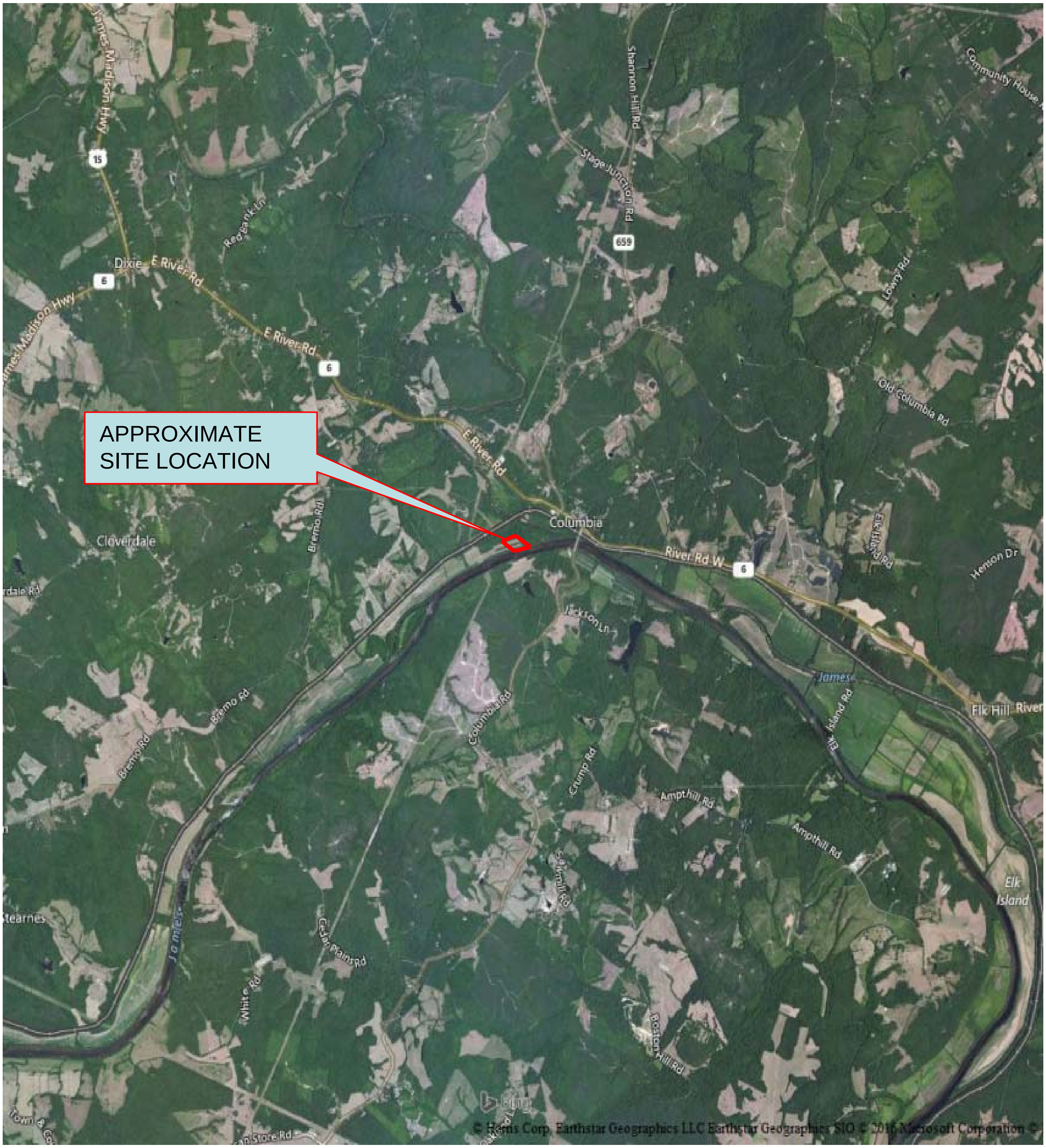
COMMONWEALTH OF VIRGINIA
JNR
8/24/16
J NATHAN REEVES
No. 049619
PROFESSIONAL ENGINEER

J. Nathan Reeves, P.E.
Geotechnical Engineer
VA Registration No. 049619

APPENDIX A

FIGURES

NORTH



Source: Bing Maps

SCALE:	NTS
CHECKED BY:	JNR
PLOTTED BY:	JMR
DATE:	4-18-2016

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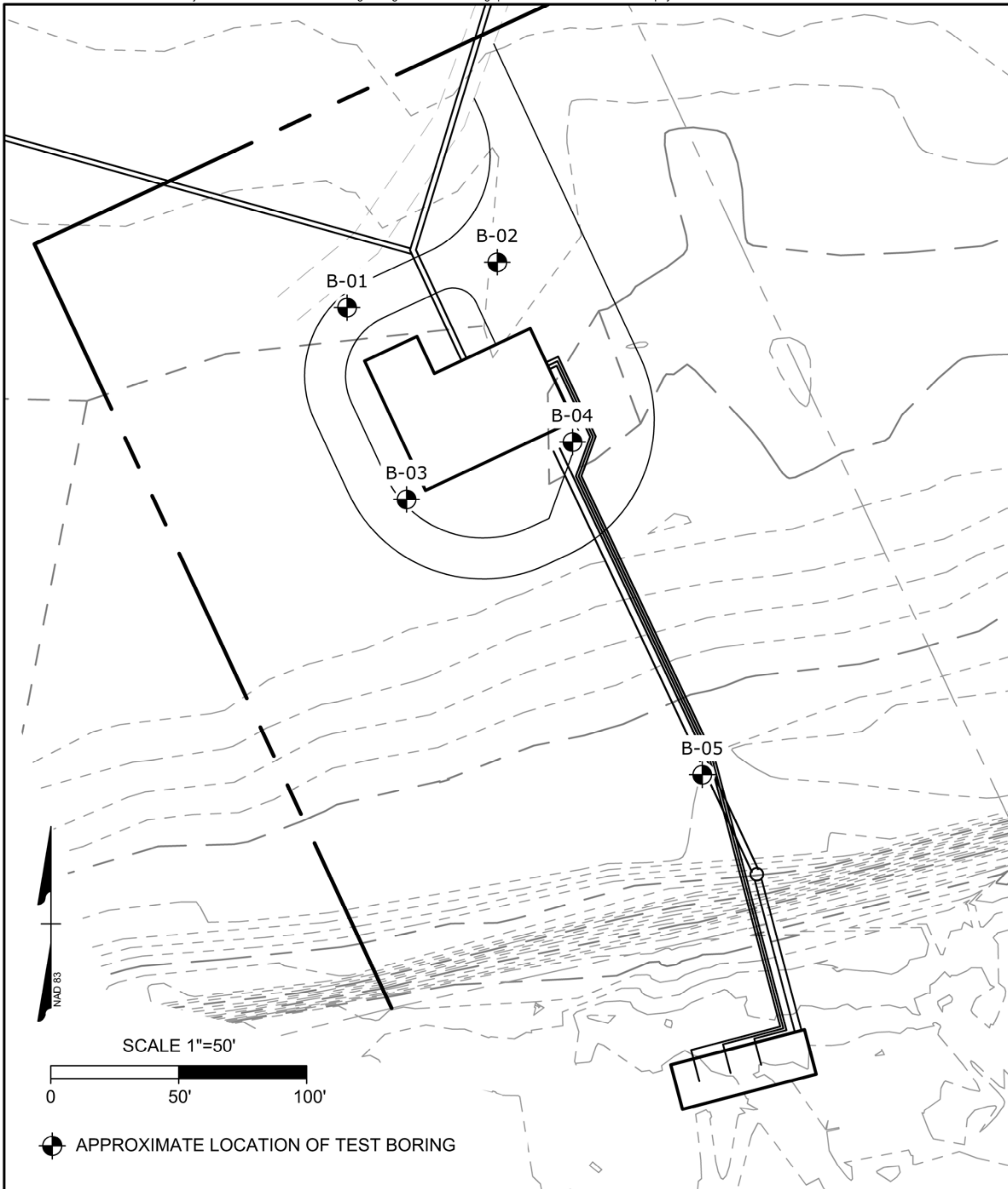
PROJECT NUMBER: 36790

SITE VICINITY MAP
JAMES RIVER WATER AUTHORITY
WATER SUPPLY
FLUVANNA COUNTY, VA

FIGURE
1



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THIS DRAWING PREPARED AT THE
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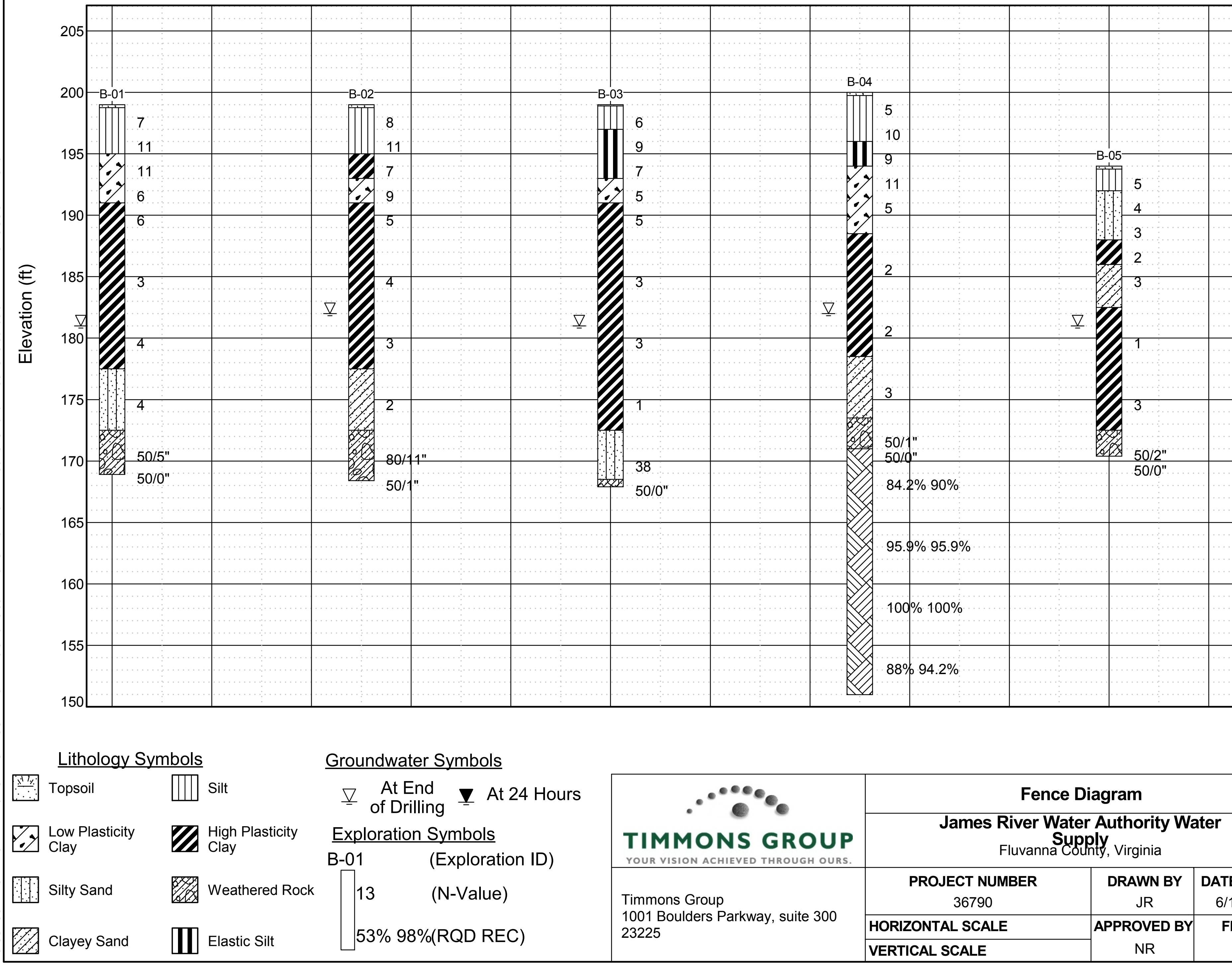
JAMES RIVER WATER AUTHORITY WATER SUPPLY

FLUVANNA COUNTY - VIRGINIA

BORING LOCATION PLAN

SHEET NO.	JOB NO.	SCALE	CHECKED BY	DESIGNED BY	DRAWN BY	DATE
2	36790	AS SHOWN	N. REEVES	N. REEVES	J. RUFFIN	4/25/2016

DATE	REVISION DESCRIPTION



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Timmons Group
1001 Boulders Parkway, suite 300
23225

Fence Diagram

James River Water Authority Water Supply
Fluvanna County, Virginia

PROJECT NUMBER	**DRAWN BY**	**DATE DRAWN**
36790	JR	6/13/2016
HORIZONTAL SCALE	**APPROVED BY**	**FIGURE**
VERTICAL SCALE	NR	3

APPENDIX B

BORING LOGS

SOIL CLASSIFICATION CHART

MAJOR DIVISIONS			SYMBOLS GRAPH	SYMBOLS LETTER	TYPICAL DESCRIPTIONS
COARSE GRAINED SOILS MORE THAN 50% OF MATERIAL IS LARGER THAN NO. 200 SIEVE SIZE	GRAVEL AND GRAVELLY SOILS MORE THAN 50% OF COARSE FRACTION RETAINED ON NO. 4 SIEVE	CLEAN GRAVELS (LITTLE OR NO FINES)		GW	WELL-GRADED GRAVELS, GRAVEL - SAND MIXTURES, LITTLE OR NO FINES
				GP	POORLY-GRADED GRAVELS, GRAVEL - SAND MIXTURES, LITTLE OR NO FINES
		GRAVELS WITH FINES (APPRECIABLE AMOUNT OF FINES)		GM	SILTY GRAVELS, GRAVEL - SAND - SILT MIXTURES
				GC	CLAYEY GRAVELS, GRAVEL - SAND - CLAY MIXTURES
	SAND AND SANDY SOILS MORE THAN 50% OF COARSE FRACTION PASSING ON NO. 4 SIEVE	CLEAN SANDS (LITTLE OR NO FINES)		SW	WELL-GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES
				SP	POORLY-GRADED SANDS, GRAVELLY SAND, LITTLE OR NO FINES
		SANDS WITH FINES (APPRECIABLE AMOUNT OF FINES)		SM	SILTY SANDS, SAND - SILT MIXTURES
				SC	CLAYEY SANDS, SAND - CLAY MIXTURES
FINE GRAINED SOILS MORE THAN 50% OF MATERIAL IS SMALLER THAN NO. 200 SIEVE SIZE	SILTS AND CLAYS	LIQUID LIMIT LESS THAN 50		ML	INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTY OR CLAYEY FINE SANDS OR CLAYEY SILTS WITH SLIGHT PLASTICITY
				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 SAND OR SILTY SOILS
				CH	INORGANIC CLAYS OF HIGH PLASTICITY
				OH	ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY, ORGANIC SILTS
HIGHLY ORGANIC SOILS				PT	PEAT, HUMUS, SWAMP SOILS WITH HIGH ORGANIC CONTENTS

NOTE: DUAL SYMBOLS ARE USED TO INDICATE BORDERLINE SOIL CLASSIFICATIONS

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KEY TO ROCK CORE TERMINOLOGY

Descriptive Sequence – Weathering, hardness, bedding (if present), color, ROCK TYPE, fracturing/joint condition, additional features observed.
Example Description – Unweathered, hard, thin foliation, slightly jointed, gray and green QUARTZ MUCOVITE SCHIST; foliation present with dip of 23 degrees, primary joint set at 72 degrees, joints typically infilled with quartz and slightly rough.

Degree of Weathering	
Unweathered	No evidence of any chemical or mechanical alteration
Slightly	Slight discoloration on surface, slight alteration along discontinuities, less than 10% of the rock volume altered
Moderately	Discoloring evident, surface pitted and altered, weathering “halos” evident. 10-50% of the rock altered.
Highly	Entire mass discolored, alteration for nearly all of the rock, pockets of slightly weathered rock, some minerals leached.
Decomposed	Rock reduced to a soil, relict rock structure remaining. Generally molded and crumbled by hand (friable).

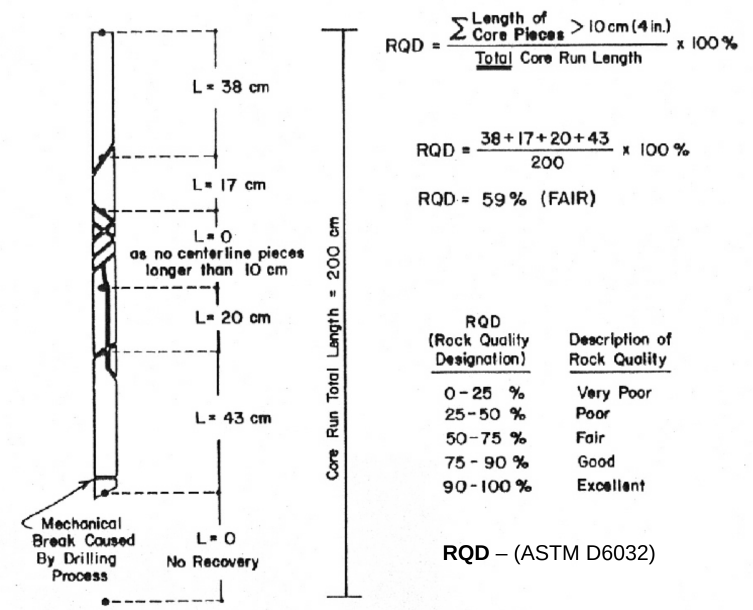
Hardness		**Bedding Thickness**		**Color**
Very soft	Deformed by hand.	Thin	< 0.3 ft	The color is to be described immediately after the core is extracted and also in the dry state using the Munsell Color Chart or simplified color terms.
Soft	Scratched with a fingernail.	Medium	0.3 ft to 1 ft	
Moderately Hard	Scratched easily with a knife.	Thick	1 ft to 3 ft	
Hard	Scratched with difficulty with a knife.	Massive	> 3 ft	
Very hard	Cannot be scratched with a knfe.			

Igneous Rocks			**Sedimentary Rocks**			**Metamorphic Rocks**		
Granite	Diorite	Diabase	Arkose	Breccia	Limestone	Gneiss	Schist	Greenstone
Basalt	Rhyolite	Pegmatite	Sandstone	Shale	Dolostone	Slate	Phyllite	Unakite
Tuff	Gabbro		Conglomerate	Coal	Siltstone	Quarzite	Marble	Soapstone
			Claystone	Mudstone				

Fracturing and Joint Conditions

Fracturing – Breaks in a core are nonparallel, nonsystematic, or cur across bedding or foliations.
Joints – Breaks in a core run are parallel or systematic.
Spacing – When possible, measure the actual spacing perpendicular to the surface. Note the mineralogy of infilling.

Spacing		**Separation of Planes**	**Surface Condition**	**Wall Rock** – Describe the condition of the parent rock on either side as Hard Wall Rock or Soft Wall Rock
Very widely	> 10 ft	No separation	Very rough	**Continuity** – Continuous/discontinuous; assume continuous if not discernable
Slightly	3 ft to 10 ft	Separation < 0.05 in	Slightly rough	
Moderately	1 ft to 3 ft	Gouge < 0.2 in	Slickensided	**Orientation** – Measure in degrees from a horizontal plane when possible. If not possible use High, Moderate, or Low-angle. Note if joints are conjugated.
Highly	2 in to 1 ft	Gouge > 0.2 in	Gouge	
Intensely	< 2 in	Joints open 0.05 to 0.2 in		
		Joints open > 0.2 in		



RQD – (ASTM D6032)

Timmons Group
1001 Boulders Parkway, suite 300
23225

BORING B-01

PROJECT NUMBER 36790
PROJECT NAME James River Water Authority Water Supply
CLIENT Faulconer Construction Company, Inc.
PROJECT LOCATION Fluvanna County, Virginia
DATE STARTED 4/25/2016 **COMPLETED** 4/25/2016
GROUND ELEVATION 199 ft **HOLE DEPTH** 30.1 feet
DRILLING CONTRACTOR Landmark Drilling, Inc.
BOREHOLE WATER LEVELS:
DRILLING METHOD Hollow Stem Auger
∇ **AT END OF DRILLING** 18.00 ft / Elev 181.00 ft
LOGGED BY Julian Ruffin **CHECKED BY**
▼ **AT 24 HOURS DRILLING** ---
NOTES
CAVE DEPTH

DEPTH (ft)	ELEVATION (ft)	MATERIAL DESCRIPTION	SYMBOL	SAMPLING BLOW COUNTS (N-VALUE)	POCKET PEN. (tsf)	LAB TESTS	REMARKS
0		TOPSOIL: (3 Inches)		S-1, SPT 1-4-3-3 (7)			
		SANDY SILT, (ML): brown, moist, medium stiff, contains roots					
		(ML): stiff		S-2, SPT 4-4-7-8 (11)			
	195						
5		LEAN CLAY WITH SAND, (CL): brown, moist, stiff		S-3, SPT 3-4-7-7 (11)			
		(CL): medium stiff		S-4, SPT 3-3-3-5 (6)			
	190	FAT CLAY WITH SAND, (CH): brown, moist, medium stiff		S-5, SPT 2-2-4-4 (6)			
10							
	185	(CH): soft		S-6, SPT 2-1-2-1 (3)			
15							
		∇					
	180			S-7, SPT 2-2-2-1 (4)			
20							
		SILTY SAND, (SM): gray, fine to medium grained, moist, loose, contains wood fragments					
	175			S-8, SPT 1-2-2-2 (4)			
25							
		SILTY SAND WITH GRAVEL, (SM): gray, fine to coarse grained, wet, very dense, weathered decomposed rock		S-9, SPT 50/5"			
	170						
30				S-10, SPT 50/0"			

Refusal at 30.1 feet.
Bottom of borehole at 30.1 feet.

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BORING B-02

PROJECT NUMBER 36790
PROJECT NAME James River Water Authority Water Supply
CLIENT Faulconer Construction Company, Inc.
PROJECT LOCATION Fluvanna County, Virginia
DATE STARTED 4/26/2016 **COMPLETED** 4/26/2016
GROUND ELEVATION 199 ft **HOLE DEPTH** 30.6 feet
DRILLING CONTRACTOR Landmark Drilling, Inc.
BOREHOLE WATER LEVELS:
DRILLING METHOD Hollow Stem Auger
∇ **AT END OF DRILLING** 17.00 ft / Elev 182.00 ft
LOGGED BY Julian Ruffin **CHECKED BY**
▼ **AT 24 HOURS DRILLING** ---
NOTES
CAVE DEPTH

DEPTH (ft)	ELEVATION (ft)	MATERIAL DESCRIPTION	SYMBOL	SAMPLING BLOW COUNTS (N-VALUE)	POCKET PEN. (tsf)	LAB TESTS	REMARKS
0		TOPSOIL: (3 Inches)		S-1, SPT 4-4-4-4 (8)			
		SANDY SILT, (ML): brown, moist, medium stiff, contains roots					
		(ML): stiff		S-2, SPT 4-5-6-7 (11)			
	195	FAT CLAY, (CH): brown, moist, medium stiff		S-3, SPT 4-3-4-7 (7)			
5							
		LEAN CLAY WITH SAND, (CL): brown, moist, stiff		S-4, SPT 4-4-5 (9)			
	190	FAT CLAY WITH SAND, (CH): brown, wet, medium stiff		S-5, SPT 3-2-3-3 (5)			
10							
	185	(CH): soft		S-6, SPT 2-2-2-2 (4)			
15							
		∇					
	180			S-7, SPT 2-1-2-2 (3)			
20							
		CLAYEY SAND, (SC): gray, fine to medium grained, wet, very loose, Contains wood fragments					
	175			S-8, SPT 2-1-1-1 (2)			
25							
		SILTY SAND, (SM): gray, fine to medium grained, moist, very dense, weathered decomposed rock					
	170			S-9, SPT 80/11"			
30							
		Refusal at 30.6 feet. Bottom of borehole at 30.6 feet.		S-10, SPT 50/1"			

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BORING B-03

PROJECT NUMBER 36790
PROJECT NAME James River Water Authority Water Supply
CLIENT Faulconer Construction Company, Inc.
PROJECT LOCATION Fluvanna County, Virginia
DATE STARTED 4/25/2016 **COMPLETED** 4/25/2016
GROUND ELEVATION 199 ft **HOLE DEPTH** 31.1 feet
DRILLING CONTRACTOR Landmark Drilling, Inc.
BOREHOLE WATER LEVELS:
DRILLING METHOD Hollow Stem Auger
∇ **AT END OF DRILLING** 18.00 ft / Elev 181.00 ft
LOGGED BY Julian Ruffin **CHECKED BY**
▼ **AT 24 HOURS DRILLING** ---
NOTES
CAVE DEPTH

DEPTH (ft)	ELEVATION (ft)	MATERIAL DESCRIPTION	SYMBOL	SAMPLING BLOW COUNTS (N-VALUE)	POCKET PEN. (tsf)	LAB TESTS	REMARKS
0		TOPSOIL: (1 Inch)					
		SANDY SILT, (ML): brown, moist, medium stiff		S-1, SPT 3-3-3-3 (6)			
		ELASTIC SILT, (MH): brown, moist, stiff		S-2, SPT 4-4-5-7 (9)			
5	195	(MH): medium stiff		S-3, SPT 3-3-4-6 (7)			
		LEAN CLAY WITH SAND, (CL): brown, moist, medium stiff		S-4, SPT 2-2-3-3 (5)			
10	190	FAT CLAY WITH SAND, (CH): brown, moist, medium stiff		S-5, SPT 2-3-2-4 (5)			
15	185	(CH): wet, soft		S-6, SPT 0-1-2-1 (3)			
20	180	∇		S-7, SPT 1-1-2-1 (3)			
25	175	(CH): gray, very soft		S-8, SPT 1-0-1-2 (1)			
		SILTY SAND WITH GRAVEL, (SM): gray, fine to coarse grained, wet, dense					
30	170			S-9, SPT 8-19-19-29 (38)			
		SILTY SAND, (SM): gray, fine to coarse grained, wet, very dense, contains rock fragments, weathered decomposed rock		S-10, SPT 50/0"			

Refusal at 31.1 feet.
Bottom of borehole at 31.1 feet.

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BORING B-04

PROJECT NUMBER 36790 **PROJECT NAME** James River Water Authority Water Supply
CLIENT Faulconer Construction Company, Inc. **PROJECT LOCATION** Fluvanna County, Virginia
DATE STARTED 4/25/2016 **COMPLETED** 4/25/2016 **GROUND ELEVATION** 200 ft **HOLE DEPTH** 49.01 feet
DRILLING CONTRACTOR Landmark Drilling, Inc. **BOREHOLE WATER LEVELS:**
DRILLING METHOD Hollow Stem Auger ∇ **AT END OF DRILLING** 18.00 ft / Elev 182.00 ft
LOGGED BY Julian Ruffin **CHECKED BY** ▼ **AT 24 HOURS DRILLING** ---
NOTES **CAVE DEPTH**

DEPTH (ft)	ELEVATION (ft)	MATERIAL DESCRIPTION	SYMBOL	SAMPLING BLOW COUNTS (N-VALUE)	POCKET PEN. (tsf)	LAB TESTS	REMARKS
0	200	TOPSOIL: (3 Inches)		S-1, SPT 3-3-2-3 (5)			
		SILT, (ML): brown, moist, medium stiff, contains roots					
		(ML): stiff		S-2, SPT 6-4-6-6 (10)			
5	195	ELASTIC SILT WITH SAND, (MH): brown, moist, stiff		S-3, SPT 3-4-5-6 (9)			
		SANDY LEAN CLAY, (CL): brown, moist, stiff		S-4, SPT 5-5-6-6 (11)			
		(CL): medium stiff		S-5, SPT 2-2-3-4 (5)			
10	190						
		SANDY FAT CLAY, (CH): brown, moist, soft					
15	185			S-6, SPT 1-1-1-2 (2)			
		∇		S-7, SPT 1-1-1-0 (2)			
20	180						
		CLAYEY SAND, (SC): gray, fine to medium grained, wet, very loose		S-8, SPT 1-2-1-3 (3)			
25	175						
		SILTY SAND WITH GRAVEL, (SM): gray, fine to coarse grained, wet, very dense, weathered decomposed rock		S-9, SPT 50/1"			
		GRANITE, slightly weathered, light gray, very hard		S-10, SPT 50/0"			
30	170			1, RC RQD=84.2% Rec=90%			
35	165						

(Continued Next Page)

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PROJECT NUMBER 36790
PROJECT NAME James River Water Authority Water Supply
CLIENT Faulconer Construction Company, Inc.
PROJECT LOCATION Fluvanna County, Virginia
DATE STARTED 4/25/2016 **COMPLETED** 4/25/2016
GROUND ELEVATION 200 ft **HOLE DEPTH** 49.01 feet
DRILLING CONTRACTOR Landmark Drilling, Inc.
BOREHOLE WATER LEVELS:
DRILLING METHOD Hollow Stem Auger
∇ **AT END OF DRILLING** 18.00 ft / Elev 182.00 ft
LOGGED BY Julian Ruffin **CHECKED BY**
▼ **AT 24 HOURS DRILLING** ---
NOTES
CAVE DEPTH

DEPTH (ft)	ELEVATION (ft)	MATERIAL DESCRIPTION	SYMBOL	SAMPLING BLOW COUNTS (N-VALUE)	POCKET PEN. (tsf)	LAB TESTS	REMARKS
35	165	GRANITE, slightly weathered, light gray, very hard *(continued)*		2, RC RQD=95.9% Rec=95.9%			
40	160			3, RC RQD=100% Rec=100%			
45	155			4, RC RQD=88% Rec=94.2%			

Refusal at 29.0 feet.
Bottom of borehole at 49.0 feet.

BORING B-05

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PROJECT NUMBER 36790
PROJECT NAME James River Water Authority Water Supply
CLIENT Faulconer Construction Company, Inc.
PROJECT LOCATION Fluvanna County, Virginia
DATE STARTED 4/25/2016 **COMPLETED** 4/25/2016
GROUND ELEVATION 194 ft **HOLE DEPTH** 23.6 feet
DRILLING CONTRACTOR Landmark Drilling, Inc.
BOREHOLE WATER LEVELS:
DRILLING METHOD Hollow Stem Auger
▽ **AT END OF DRILLING** 13.00 ft / Elev 181.00 ft
LOGGED BY Julian Ruffin **CHECKED BY**
▼ **AT 24 HOURS DRILLING** ---
NOTES
CAVE DEPTH

DEPTH (ft)	ELEVATION (ft)	MATERIAL DESCRIPTION	SYMBOL	SAMPLING BLOW COUNTS (N-VALUE)	POCKET PEN. (tsf)	LAB TESTS	REMARKS
0		TOPSOIL: (3 Inches)		S-1, SPT 1-3-2-3 (5)			
		SANDY SILT, (ML): brown, moist, medium stiff, contains roots					
		SILTY SAND, (SM): brown, fine to medium grained, moist, loose		S-2, SPT 2-2-2-2 (4)			
5	190	Very loose		S-3, SPT 1-1-2-1 (3)			
		SANDY FAT CLAY, (CH): brown, moist, soft		S-4, SPT 1-1-1-2 (2)			
10	185	CLAYEY SAND, (SC): brown, fine to medium grained, wet, very loose		S-5, SPT 1-1-2-1 (3)			
		SANDY FAT CLAY, (CH): gray, wet, very soft					
15	180	▽		S-6, SPT 1-0-1-1 (1)			
20	175	(CH): soft, trace organics		S-7, SPT 1-1-2-1 (3)			
		CLAYEY SAND, (SC): gray, fine to coarse grained, moist, very dense, weathered decomposed rock		S-8, SPT 50/2"			
				S-9, SPT 50/0"			

Refusal at 23.6 feet.
Bottom of borehole at 23.6 feet.

APPENDIX C

LABORATORY TEST RESULTS

TIMMONS GROUP
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UNCONFINED COMPRESSIVE STRENGTH OF INTACT ROCK CORE SPECIMENS

Project Name: James River Water Authority Water Supply
Project Number: 36790
Report Date: 5/9/2016

Sample Information

Date Sampled: 4/25/2016
Boring: B-04
Core Run (ft): 29 to 34

Specimen Information

Date Prepared: 5/9/2016
Length (in): 3.92
Diameter (in): 1.84
L/D Ratio: 2.13
Test Depth (ft): 29.54 to 30.1
Area (in^2): 2.66
Mass (g): 478.9
Unit Weight (pcf): 174.9

Test Information

Date Tested: 5/9/2016
Max Load (lb): 17500
Failure Time (sec): 78
Compressive Strength (psi): 6581
Load Rate (lb/sec): 224

Photos

Before

After

TIMMONS GROUP
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UNCONFINED COMPRESSIVE STRENGTH OF INTACT ROCK CORE SPECIMENS

Project Name: James River Water Authority Water Supply **Report Date:** 5/9/2016
Project Number: 36790

Sample Information

Date Sampled: 4/25/2016 **Boring:** B-04 **Core Run (ft):** 39 to 44

Specimen Information

Date Prepared:	5/9/2016	**Test Depth (ft):**	39 to 39.56
Length (in):	3.98	**Area (in^2):**	2.68
Diameter (in):	1.85	**Mass (g):**	487.5
L/D Ratio:	2.16	**Unit Weight (pcf):**	173.9

Test Information

Date Tested:	5/9/2016	**Compressive Strength (psi):**	8580
Max Load (lb):	23000	**Load Rate (lb/sec):**	288
Failure Time (sec):	80		

Photos

Before

After

TIMMONS GROUP

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GRAIN SIZE DISTRIBUTION TEST REPORT

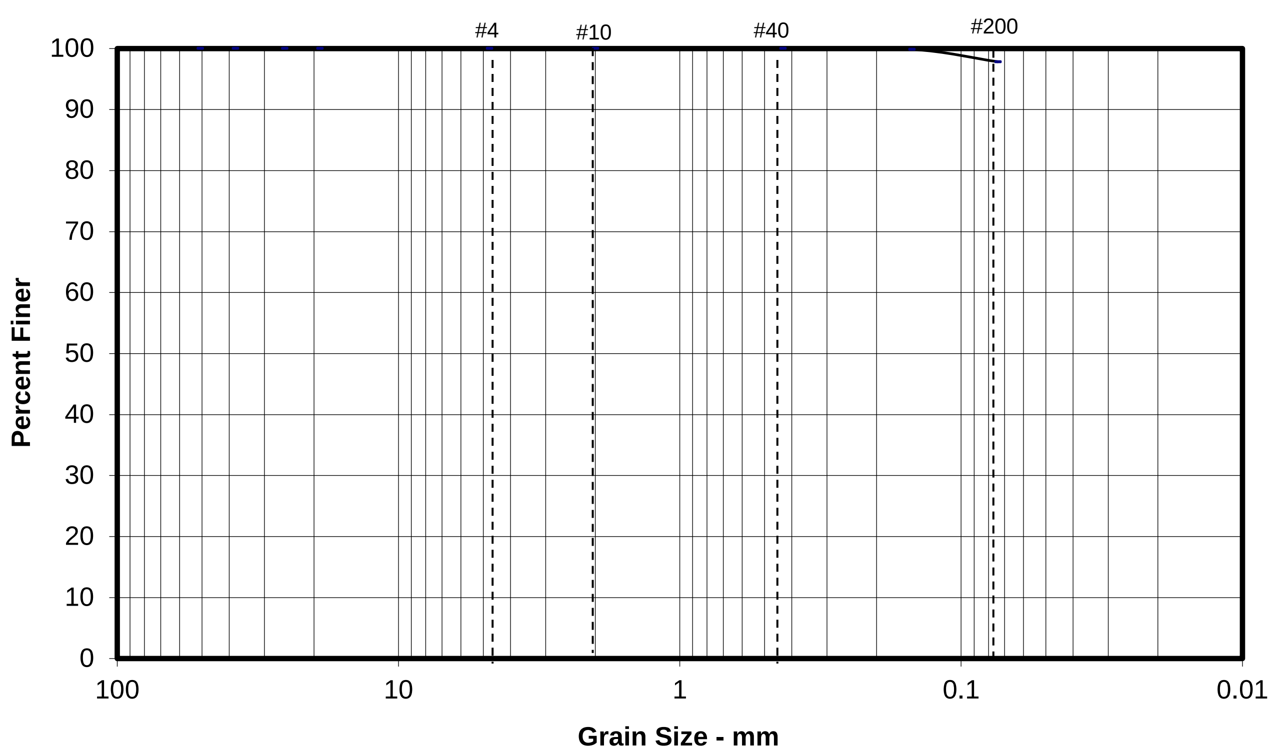
Project Number	36790
Project Name	James River Water Authority Water Supply
Location	B-02 Bulk/ 0-10

Liquid Limit	Plastic Index	USCS	AASHTO
53	**29**	**CH**	**A-7-6 (15.7)**

Percent Gravel	Percent Sand	Percent Silt and Clay
0.0%	**2.2%**	**97.8%**

Material Description	Fat CLAY
Natural Moisture	21.7%
SPT Blow Counts	N/A

Grain Size Distribution



DATE 6/8/16

FIGURE NUMBER GS4

TIMMONS GROUP
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PROCTOR TEST REPORT

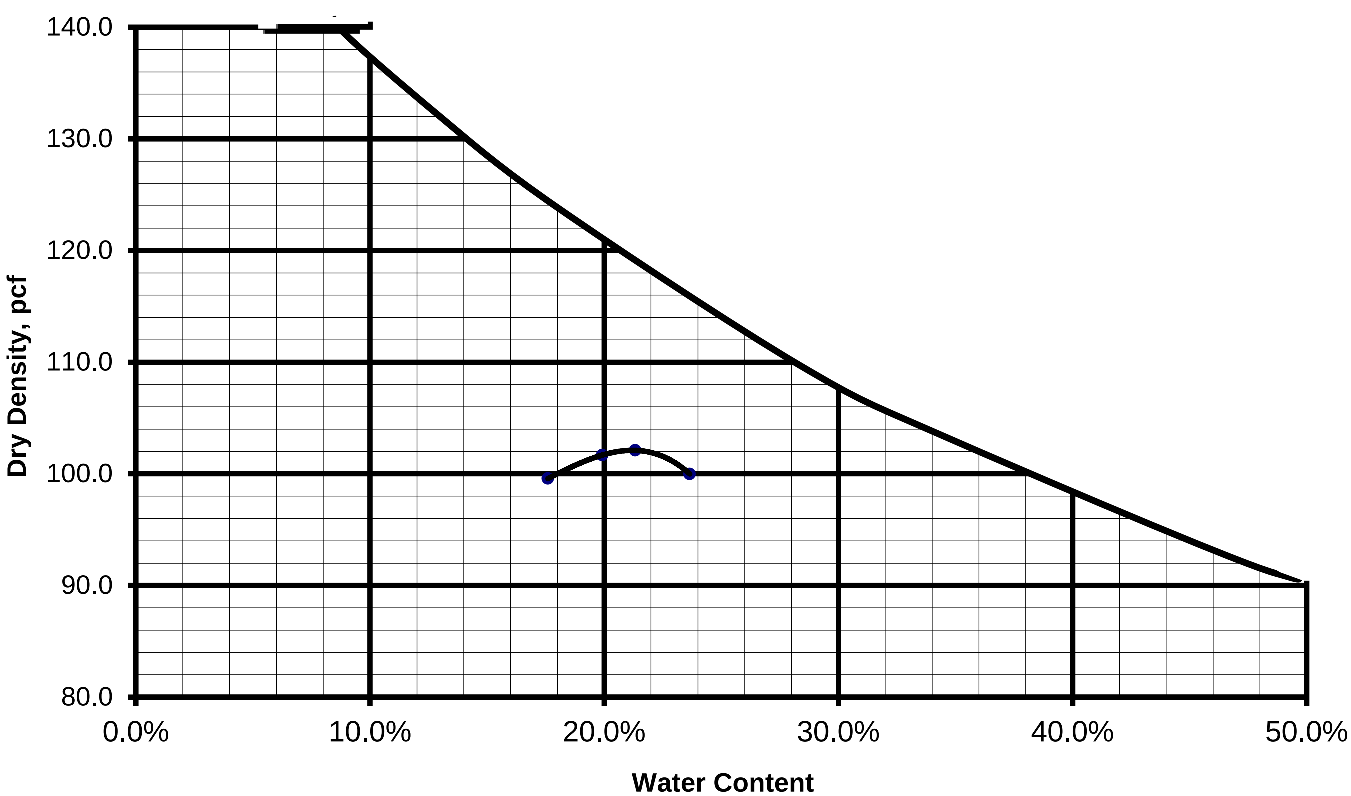
Project Number	36790
Project Name	James River Water Authority Water Supply
Location	B-02 Bulk/ 0-10

	Uncorrected	Rock Corrected Results
Maximum Dry Density, pcf	**102.2**	**102.2**
Optimum Moisture	**21.4**	**21.4**

Material Description	Fat CLAY

USCS	CH	AASHTO	A-7-6 (15.7)
Natural Moisture	21.7%	Percent Fines	97.8%
Liquid Limit	53	Plastic Index	29

Moisture-Density Curve



DATE 6/8/16

FIGURE NUMBER PR2

TIMMONS GROUP
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GRAIN SIZE DISTRIBUTION TEST REPORT

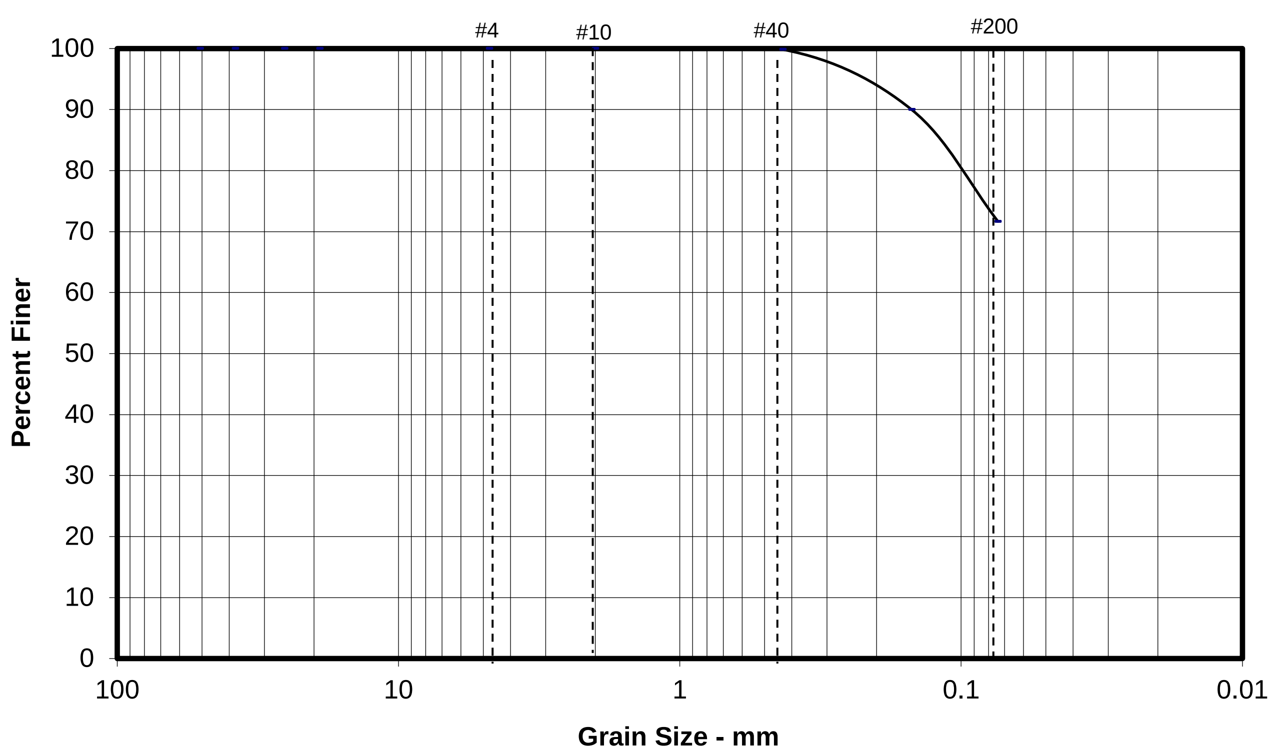
Project Number	36790
Project Name	James River Water Authority Water Supply
Location	B-02 Bulk/ 10-20

Liquid Limit	Plastic Index	USCS	AASHTO
50	**26**	**CH**	**A-7-6 (7.9)**

Percent Gravel	Percent Sand	Percent Silt and Clay
0.0%	**28.3%**	**71.7%**

Material Description	Fat CLAY with Sand
Natural Moisture	23.5%
SPT Blow Counts	N/A

Grain Size Distribution



DATE 6/8/16

FIGURE NUMBER GS4

TIMMONS GROUP
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PROCTOR TEST REPORT

Project Number	36790
Project Name	James River Water Authority Water Supply
Location	B-02 Bulk/ 10-20

	Uncorrected	Rock Corrected Results
Maximum Dry Density, pcf	**103.7**	**103.7**
Optimum Moisture	**19.2**	**19.2**

Material Description	Fat CLAY with Sand

USCS	CH	AASHTO	A-7-6 (7.9)
Natural Moisture	23.5%	Percent Fines	71.7%
Liquid Limit	50	Plastic Index	26

Moisture-Density Curve

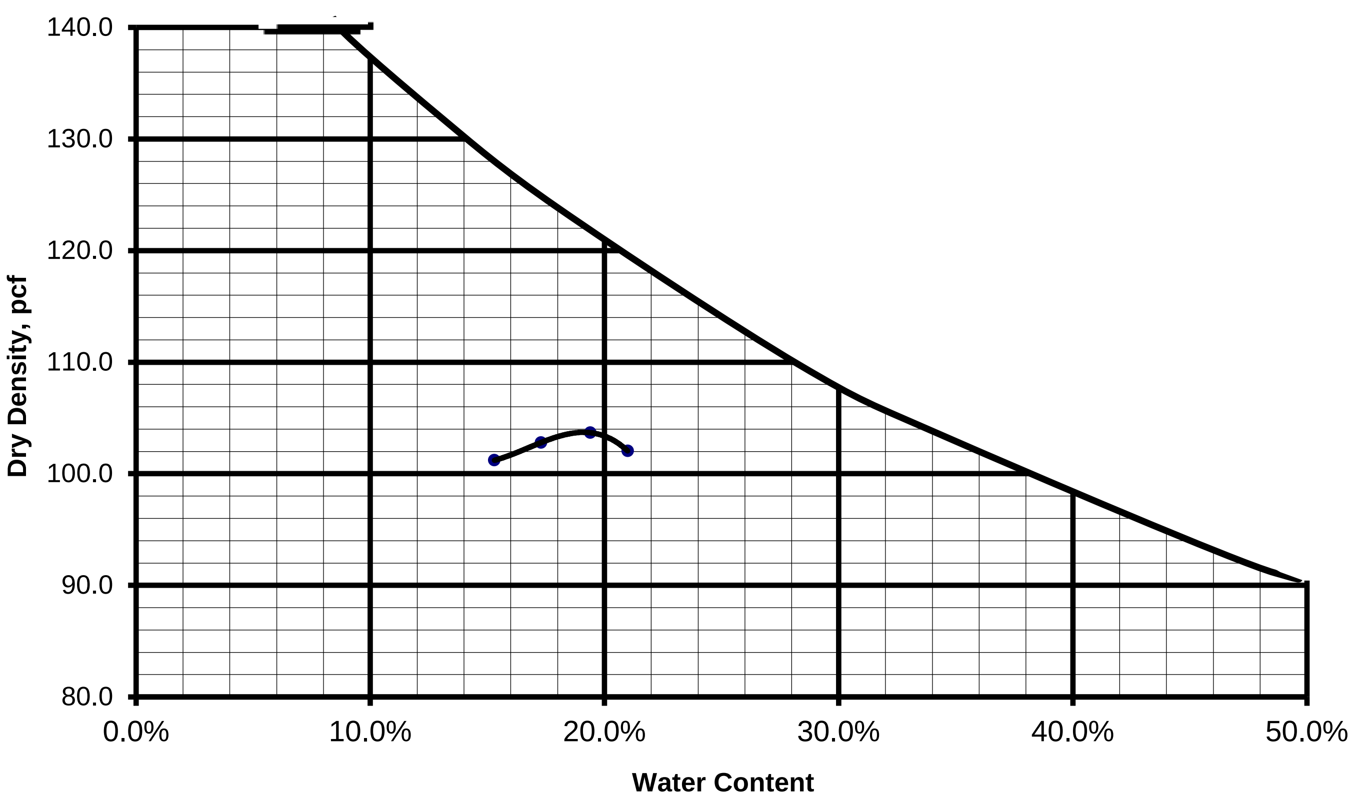

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FIGURE NUMBER PR2

TIMMONS GROUP

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GRAIN SIZE DISTRIBUTION TEST REPORT

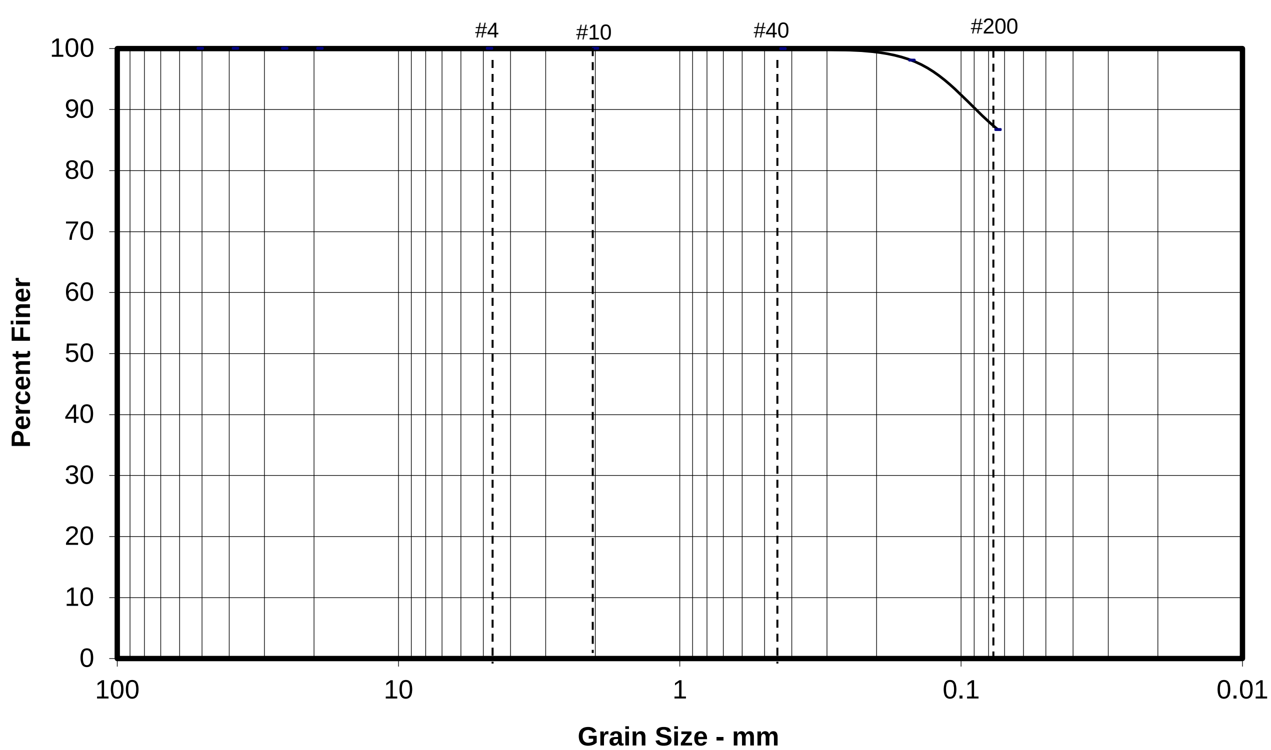
Project Number	36790
Project Name	James River Water Authority Water Supply
Location	B-01/ 8-10

Liquid Limit	Plastic Index	USCS	AASHTO
56	**38**	**CH**	**A-7-6 (20.1)**

Percent Gravel	Percent Sand	Percent Silt and Clay
0.0%	**13.3%**	**86.7%**

Material Description	Fat CLAY
Natural Moisture	23.1%
SPT Blow Counts	2-2-4-4

Grain Size Distribution



DATE 6/8/16

FIGURE NUMBER GS4

TIMMONS GROUP
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GRAIN SIZE DISTRIBUTION TEST REPORT

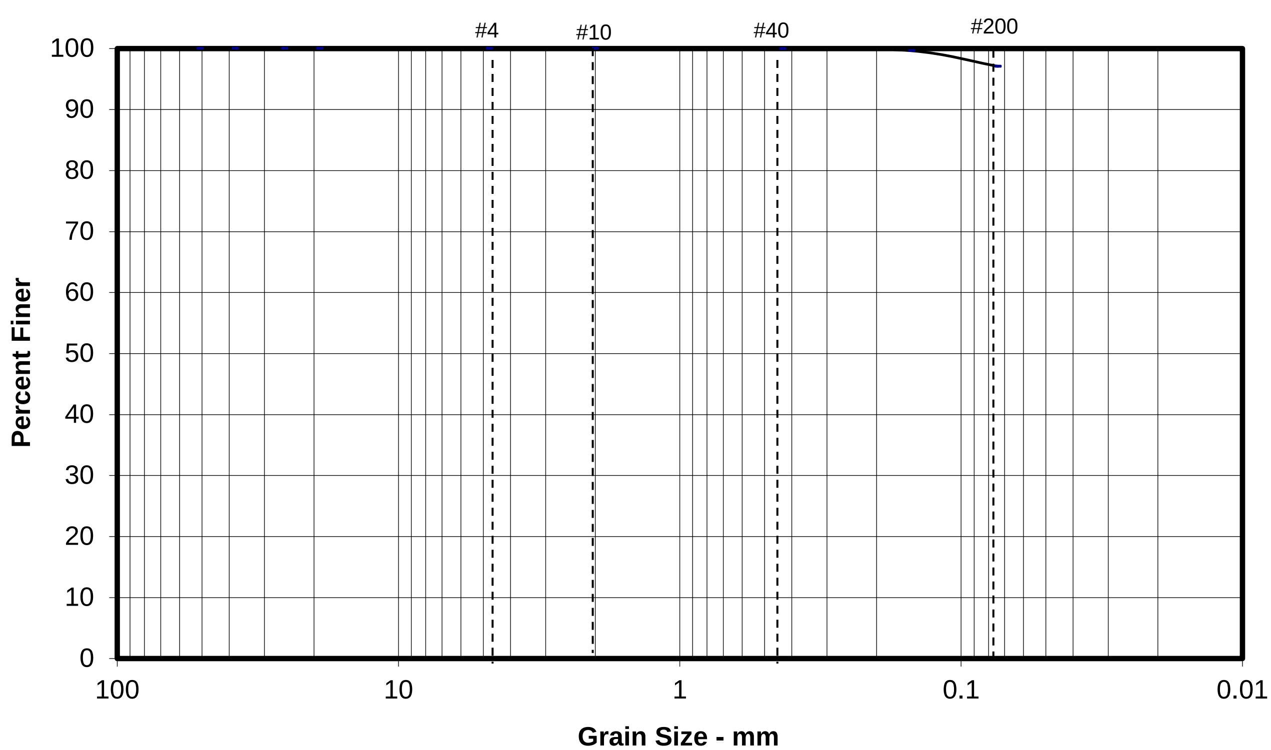
Project Number	36790
Project Name	James River Water Authority Water Supply
Location	B-03/ 4-6

Liquid Limit	Plastic Index	USCS	AASHTO
58	**27**	**MH**	**A-7-5 (14.0)**

Percent Gravel	Percent Sand	Percent Silt and Clay
0.0%	**2.9%**	**97.1%**

Material Description	Elastic SILT
Natural Moisture	21.8%
SPT Blow Counts	3-3-4-6

Grain Size Distribution



DATE 6/8/16

FIGURE NUMBER GS4

TIMMONS GROUP
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GRAIN SIZE DISTRIBUTION TEST REPORT

Project Number	36790
Project Name	James River Water Authority Water Supply
Location	B-03/ 13-15

Liquid Limit	Plastic Index	USCS	AASHTO
51	**31**	**CH**	**A-7-6 (11.4)**

Percent Gravel	Percent Sand	Percent Silt and Clay
0.0%	**30.6%**	**69.4%**

Material Description	Sandy Fat CLAY
Natural Moisture	27.5%
SPT Blow Counts	0-1-2-1

Grain Size Distribution

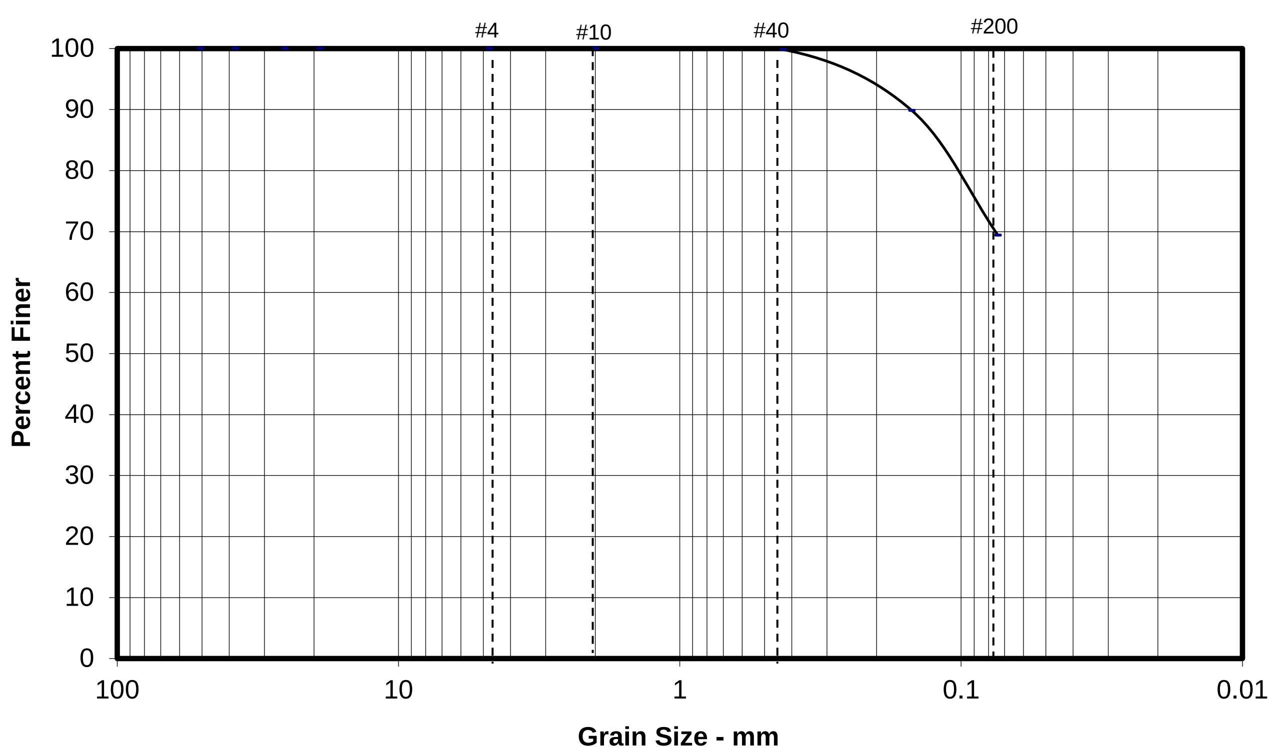

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FIGURE NUMBER GS4

TIMMONS GROUP
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GRAIN SIZE DISTRIBUTION TEST REPORT

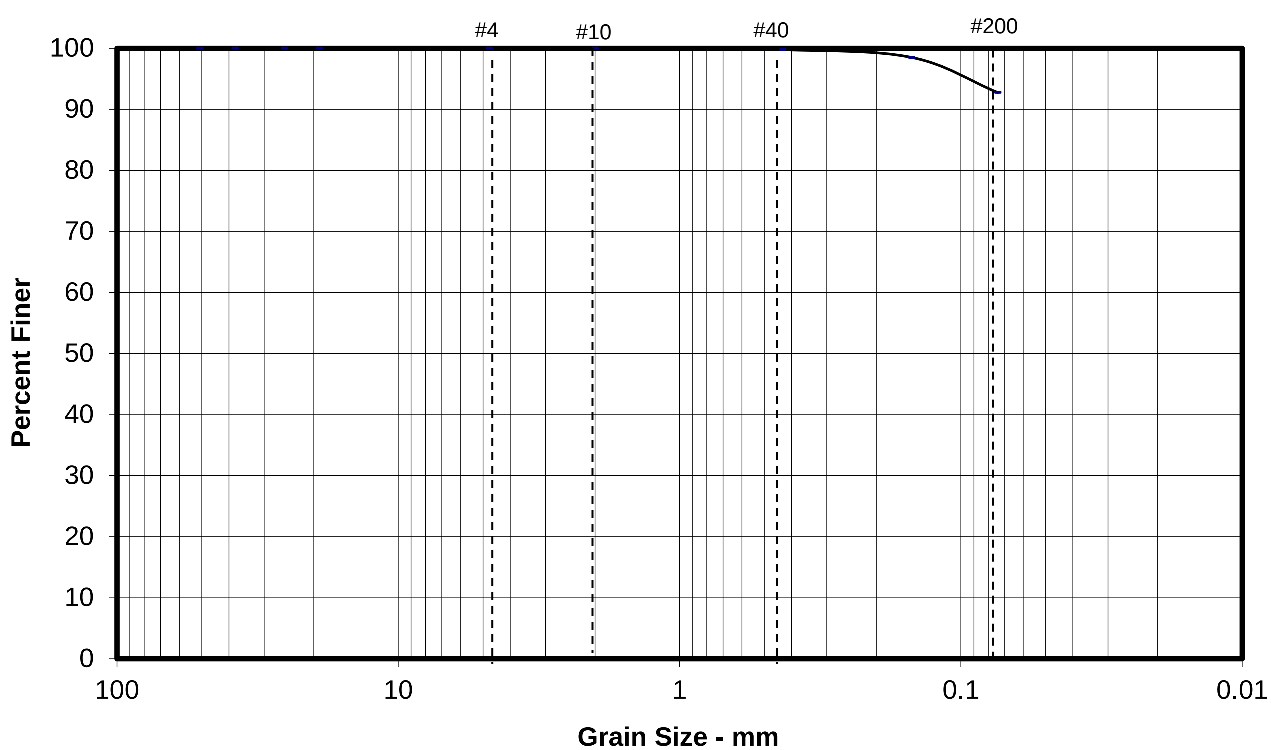
Project Number	36790
Project Name	James River Water Authority Water Supply
Location	B-04/ 2-4

Liquid Limit	Plastic Index	USCS	AASHTO
38	**13**	**ML**	**A-6 (2.3)**

Percent Gravel	Percent Sand	Percent Silt and Clay
0.0%	**7.2%**	**92.8%**

Material Description	Silt
Natural Moisture	19.7%
SPT Blow Counts	6-4-6-6

Grain Size Distribution



DATE 6/8/16

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