APPENDIX I
EA GEOTECHNICAL INVESTIGATION

Geotechnical Investigation
St. Vrain Creek Breaches Restoration
Highway 36 to Hygiene Road
Boulder County, Colorado

Prepared for:

Boulder County Parks and Open Space
2025 14th Street
Boulder, Colorado 80302

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Project No. 110666

July 1, 2016

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1.0 INTRODUCTION

Engineering Analytics, Inc. (EA) is pleased to present this report for the St. Vrain Breaches Restoration project in Boulder County, Colorado. This report presents the results of the geotechnical investigation, laboratory testing, and recommendations.

1.1 Scope of Work

The scope of work for this project included the following:

1. Advancement of 8 borings to explore subsurface soil and bedrock conditions at the site and to obtain soil samples.
2. Laboratory testing of select soil samples.
3. Recommendations for on-site material re-use and/or import fill material

1.2 Site Description

The project site is located in the foothills of the Rocky Mountains, approximately 0.25 miles east of the intersection of US Highway 36 East/N Foothills Highway and State Highway 66/Ute Highway in Boulder County, Colorado. The project area includes nine breaches along the St. Vrain Creek between US Highway 36 to Hygiene Road that occurred in the September 2013 flooding. Emergency, temporary repairs were installed at some of the breach locations.

Breach 1 occurred along the south stream bank over a length of approximately 1200 feet. A temporary breach repair berm was installed in the area of Breach 1. According to the information provided by Boulder County, we understand this berm consists of fill material derived from native on-site flood-deposited sand and cobbles capped with 12 inches of imported clay across the top, along the front slope, and extending 20 feet toward the stream channel from the toe of the slope. The front slope is dressed with type M and H sandstone riprap. The elevation ranges from approximately Elevation (El.) 5257 to 5251 feet above sea level along the length of the berm.

Breach 2 occurred along the south stream bank over a length of approximately 100 feet. A temporary breach repair berm was installed in the area of Breach 2. According to the information provided by Boulder County, we understand the berm at Breach 2 consists of a mix of about 60% fill material derived from native on-site sand and cobble materials with about 40% clay/loam materials, mixed and compacted in lifts, and the slope face dressed with sandstone rip-rap. An additional 2 to 3 feet of on-site material was added to the height of the breach repair in 2014, and was dressed with imported granite riprap and spillway. The elevation ranges from approximately El. 5203 to 5202 feet above sea level along the length of the berm.

Breach 3 is more accurately defined as the area where overland flow of water from Breach 2 returned to the creek channel. Restoration of Breach 3 will be addressed through ongoing restoration planning with the surrounding property's mineral-rights owner.

The combined southeastward flow of water from Breach 1 and Breach 2 returned to the creek immediately downstream of the 63rd Street bridge at Breach 4. Breach 4 resulted in destruction of 61st Street, and the restoration of this Breach area is being addressed through separate projects.

A small amount of spatially varied flow from Breaches 1 and 2 continued overland south of the pre-flood channel and returned to the creek at Breach 5 through Ramey Pond. Breach 6 occurred along the south stream bank into Hepp #1 Reservoir. Return flow of the floodwater from Breach 6 to the pre-flood creek channel occurred through Breach 8. Additionally, a man-made cut, Breach 9, was excavated to enable water to return more directly to St. Vrain Creek. The current stream channel now passes through Breach 6 and Hepp #1 Reservoir, and returns to the pre-flood channel at Breaches 8 and 9.

Breach 7a occurred along the north stream bank into Hepp #2 Reservoir, where the floodwaters continued through Breach 7b to Hepp #3 Reservoir, and spatially varied overland flow occurred eastward. A temporary breach repair berm was installed in the area of Breach 7a. According to the information provided by Boulder County, we understand this berm consists of fill material derived from native on-site flood-deposited sand and cobbles capped with 12 inches of imported clay across the top, along the front slope, and extending 20 feet toward the stream channel from the toe of the slope. The front slope is dressed with type M and H sandstone riprap. The elevation ranges from approximately El. 5128 to 5125 feet above sea level along the length of the berm.

1.3 Report Layout

The purpose of this report is to present field observations, classification of the on-site soils, a summary of the laboratory testing, conclusions and recommendations. Figure 1 depicts the site location and the approximate locations of the borings explored by EA. The boring logs are included in Appendix A and show detailed descriptions of the subsurface conditions encountered. Appendix B contains the laboratory test results.

2.0 FIELD INVESTIGATION

The field investigation included the advancement and sampling of eight borings. The exploratory borings (B-1 through B-8) were drilled on June 8 and 9, 2016. The borings were advanced to depths ranging from about 18 to 23½ feet. EA logged the in-situ soil conditions, collected soil samples, and recorded groundwater conditions. The locations of the borings are described further in Section 2.2 below, and are shown on Figure 1. Logs of the borings are presented in Appendix A.

2.1 Exploration Procedures

Elite Drilling Services of Denver, Colorado performed the drilling, and the borings were advanced using a CME550 buggy rig with a 3 ¼” hollow-stem auger. EA personnel supervised the drilling and logged the materials in the boreholes.

EA collected samples using a Standard Penetration Test (SPT) sampler that consists of a 2-inch outside diameter split-barrel. The sampler was driven into the soil by a 140-pound manual (or rope)

hammer falling 30 inches, and the number of blows required to drive the sampler 24 inches was recorded in four consecutive intervals of 6 inches.

SPT samples were collected at the ground surface and at approximately 5-foot intervals thereafter in each of the borings. Bulk samples of the auger cuttings were collected from two of the borings. The sampling depths and descriptions of the materials encountered in the borings are presented on the boring logs in Appendix A.

Select field samples were sent to the laboratory for analysis and field verification.

2.2 Subsurface Conditions

The following summarizes the soil conditions encountered during the field investigation. All depths are relative to the ground surface at the time of the investigation. The boring logs in Appendix A provide a more detailed description of the materials encountered during the field investigation.

2.2.1 Breach 1

Borings B-1 and B-2 were drilled along the crest of the Breach 1 repair berm.

Sandy Clay/Clayey Sand: A layer of sandy clay to clayey sand was encountered at the ground surface of borings B-1 and B-2 to depths of approximately 5 inches and 2 feet below grade, respectively. This layer was comprised of brown clay and sand. This clayey layer is likely representative of the "clay cap" that was installed for the breach repair section.

Alluvial Soil: Native alluvial soil was encountered immediately below the surface materials listed above. and fill comprised of native alluvial materials Due to the nature of the fill materials being comprised of native alluvial materials, it was difficult to discern a boundary between fill materials and native materials with the samples collected in the borings. Alluvial materials were encountered through the extent of borings B-1 and B-2. These alluvial materials generally consisted of loose to dense sand and gravel with varying fractions of silt and clay.

2.2.2 Breach 2

Boring B-3 was drilled adjacent to the breach repair section in a location that did not appear to be disturbed or modified during the 2013 flood. Boring B-4 was drilled along the crest of the Breach 2 repair berm.

Topsoil: Topsoil material was encountered at the surface of boring B-3 to about 1 foot below existing ground surface.

Alluvial Soil: Native alluvial soil was encountered immediately below the topsoil in B-3. Fill material comprised of native alluvial materials was encountered at the ground surface of boring B-4. Due to the nature of the fill materials being comprised of native alluvial materials, it was

difficult to discern a boundary between fill materials and native materials with the samples collected in the borings. The alluvial materials were encountered to depths of approximately 8 feet and 13½ feet in borings B-3 and B-4, respectively. These alluvial materials generally consisted of loose to medium dense sand, gravel, and silty sand.

Bedrock: Shale bedrock was encountered in borings B-3 and B-4 at depths of approximately 8 and 13½ feet, respectively, through the extent of the borings. The shale was very dark gray to black and weak. The shale below 13 feet in boring B-3 exhibited a hydrocarbon odor.

2.2.3 Breach 5/Breach 6

Boring B-5 was drilled south of Breaches 5 and 6 in a location that did not appear to be disturbed or modified as a result of the 2013 flood.

Topsoil: Topsoil material was encountered at the surface of boring B-5 to about 3 feet below existing ground surface. This boring was drilled

Alluvial Soil: Native alluvial soil was encountered immediately below the topsoil layer through the extent of boring B-5. These alluvial materials generally consisted of stiff sandy clay, and very dense sand with varying fractions of gravel and clay.

2.2.4 Breach 7a

Borings B-6 and B-7 were drilled along the crest of the Breach 7a repair berm.

Sandy Clay/Clayey Sand: A layer of sandy clay was encountered at the ground surface of borings B-6 and B-7 to depths of approximately 4 inches. This layer was comprised of light brownish gray to olive-brown clay and sand. This clayey layer is likely representative of the "clay cap" that was installed for the breach repair section.

Alluvial Soil: Native alluvial soil and fill comprised of native alluvial materials was encountered immediately below the surface materials listed above. Due to the nature of the fill materials being comprised of native alluvial materials, it was difficult to discern a boundary between fill materials and native materials with the samples collected in the borings. The alluvial materials were encountered to a depth of approximately 23 feet below grade in boring B-6, and through the extent of boring B-7. These alluvial materials generally consisted of medium dense to very dense sand and gravel with varying fractions of clay.

Bedrock: Shale bedrock was encountered in boring B-6 at approximately 23 feet through the extent of the boring. The shale was dark gray to black and weak.

2.2.5 Breach 7b

Boring B-8 was drilled adjacent to Breach 7b in a location that did not appear to be disturbed or modified as a result of the 2013 flood.

Alluvial Soil: Native alluvial soil was encountered at the ground surface through the extent of boring B-8. These alluvial materials generally consisted of dense to very dense sand and gravel with varying fractions of clay.

2.2.6 Groundwater

Water was encountered during drilling at depths ranging from approximately 4 feet to 18 feet below grade in the borings, with the exception of boring B-3 where no water was encountered during drilling. Groundwater levels are known to fluctuate due to local and regional factors such as seasonal changes and storm events.

3.0 LABORATORY TESTING

Laboratory testing was conducted on selected samples obtained from the borings to determine engineering properties of the fill and native soils. The laboratory testing program included moisture content and dry density determination and grain size analyses. Smith Geotechnical Engineering Consultants (Smith) of Fort Collins, Colorado performed the laboratory testing. The laboratory results are summarized below and presented in Appendix B.

Moisture Content: Moisture content of select SPT samples was measured in accordance with test method ASTM D2216. The moisture contents of the samples ranged from 2.4% to 21.8%.

Grain Size Distribution: The grain size distribution was determined in accordance with ASTM D 422 and ASTM D 1140 for selected SPT samples. The percent passing the #200 sieve ranged from 3.6% to 70.1%.

4.0 CONCLUSIONS

We understand that the breach repairs that are currently in place at the project site were installed as part of FEMA emergency, temporary flood mitigation work during the winter of 2013/2014. We also understand that these temporary repairs need to be replaced with permanent solutions, and as such, may need to be re-constructed. Based on our understanding of the materials used for the temporary breach repairs, the conditions observed at the existing repair sections, and the materials encountered in our explorations, we anticipate that the existing on-site materials are generally suitable for re-use as fill for the permanent breach repairs. Additionally, the rip rap installed along the faces of the temporary breach repairs is generally in good condition and can be re-used for the permanent repairs.

5.0 RECOMMENDATIONS

5.1 Re-use of on-site material

Topsoil or surface materials containing rootlets or other deleterious materials should be removed within construction limits during site preparation. The native alluvial soils and fill comprised of

native alluvial materials encountered on site are suitable for reuse as structural fill and general fill. The existing sandstone and granite rip rap is suitable for reuse. We recommend the on-site materials intended for reuse be sorted to remove oversized and/or deleterious materials. Specific recommendations for fill materials will be dependent on the final breach repair design selected for construction.

5.2 Anticipated need for import material

The material encountered in our explorations primarily consisted of coarse-grained sands and gravels, with minor amounts of silts and clays. For construction of the breach repairs and dams on site, we understand that additional clay soil may be required. We recommend allocating for the import of clay soil for use as select fill material in the breach repairs and/or dams. Quantities of import material will be dependent on the final breach repair design selected for construction.

6.0 STANDARD OF CARE

The information contained in this report represents our findings at the time and location as indicated in this report. The methods utilized are in accordance with currently accepted engineering and testing procedures and other than this, no warranty, either expressed or implied, is intended.

FIGURES

A

B

OVERALL PLAN

C

LEGEND:

B-7 ● APPROXIMATE BORING LOCATION

Project No. 110666

June 2016

Engineering Analytics, Inc.

FIGURE 1
EXPLORATION LOCATION PLAN
ST. VRAIN CREEK BREACHES RESTORATION
US 36 TO HYGIENE ROAD

APPENDIX A
BORING LOGS

Engineering Analytics, Inc.

BOREHOLE LOG

PAGE: 1 OF 2

DATE: 6/8/2016

BOREHOLE NO.: B-1

PROJECT INFORMATION

PROJECT: ST VRAIN BREACHES

PROJECT NO.: 110666

CLIENT: BOULDER COUNTY PARKS AND OPEN SPACE

OWNER: BOULDER COUNTY PARKS AND OPEN SPACE

LOCATION: BOULDER COUNTY

BOREHOLE LOCATION

SEE FIGURE 1

FIELD INFORMATION

DATE & TIME ARRIVED: 6/8/2016 8:00 AM

BOREHOLE LOGGED BY: NRS

VISITORS: N/A

WEATHER: SUNNY, 80°s

DRILLING INFORMATION

DRILLING COMPANY: ELITE

START TIME: 9:05 AM

BORING DEPTH: 18'-5" BORING DIA.: 3 ¼" I.D.

DRILLING METHOD: HOLLOW STEM AUGER

SAMPLING METHOD: SPT

TIME DRILLING COMPLETE: 10:00 AM

BOREHOLE COMPLETION / ABANDONMENT INFORMATION

START TIME: 9:05 AM COMPLETE TIME: 10:00 AM

INSTRUMENTATION: N/A BACKFILL: CUTTINGS

ELEVATION - TOP OF BORING: APPROX. 5,255' NORTHING / WESTING: 40°12'39.7"N / 105°14'38.7"W

GROUNDWATER CONDITIONS

WATER WAS ENCOUNTERED AT APPROX. 8' BGS DURING DRILLING

FOLLOWING FIELD WORK

TIME OF CLEAN-UP COMPLETE: 11:45 AM TIME LEFT SITE: 12:00 PM

NOTES:

Engineering Analytics, Inc.

BOREHOLE LOG

PROJECT: ST VRAIN BREACHES **PAGE:** 2 OF 2

PROJECT NO.: 110666 **DATE:** 6/8/2016

BOREHOLE NO.: **B-1**

DEPTH (FT)	CORE RECOV.	DRIVE SAMPLES: SAMPLE TYPE	DRIVE SAMPLES: BLOWS (PER 6")	DRIVE SAMPLES: RECOV.	ADD'L SAMPLES	LITHOLOGY GRAPHIC	SOIL DESCRIPTION
0					S1A		**CLAYEY SAND (0-APPROX. 5")** SLIGHTLY MOIST, BROWN (10YR 4/3), LOOSE CLAYEY SAND
1		SPT	4 24 14 6	12"	S1B		**GRAVEL WITH SAND (APPROX. 5"-APPROX. 3')** DRY, PINKISH GRAY (7.5YR 6/2), DENSE POORLY GRADED GRAVEL WITH SAND, POSSIBLE FILL
2							
3		SPT	21 11 11 9	8"	S2		**SAND WITH GRAVEL (APPROX. 3'-APPROX. 8')** SLIGHTLY MOIST, REDDISH GRAY (5YR 5/2) TO GRAY (5YR 5/1), MEDIUM DENSE WELL GRADED SAND WITH GRAVEL, POSSIBLE FILL
4							
5							**- (APPROX. 5'- APPROX. 7')** DRILLER REPORTED AUGER GRINDING, POSSIBLE GRAVEL / COBBLES
6							
7							▼ **(APPROX. 8')** WATER ENCOUNTERED DURING DRILLING
8		SPT	8 11 20 20	18"	S3		**GRAVEL WITH SAND (APPROX. 8'-APPROX. 13')** WET, BROWN (7.5YR 4/2), DENSE POORLY GRADED GRAVEL WITH SAND, FINE TO COARSE SAND, FINE TO COARSE GRAVEL, POSSIBLE FILL
9							
10							
11							
12							
13		SPT	18 31 50/5"	16"	S4		**SAND WITH SILT AND GRAVEL (APPROX. 13'-APPROX. 18')** WET, LIGHT BROWNISH GRAY (10YR 6/2), VERY DENSE WELL GRADED SAND WITH SILT AND GRAVEL
14							
15							
16							
17							**GRAVEL WITH SILT AND SAND (APPROX. 18'-E.O.B.)** WET, GRAYISH BROWN (2.5YR 5/2), VERY DENSE WELL GRADED GRAVEL WITH SILT AND SAND
18		SPT	50/5"	3"	S5		
							E.O.B. = 18'-5"
19							
20							

Engineering Analytics, Inc.

BOREHOLE LOG

PAGE: 1 OF 2

DATE: 6/8/2016

BOREHOLE NO.: B-2

PROJECT INFORMATION

PROJECT: ST VRAIN BREACHES

PROJECT NO.: 110666

CLIENT: BOULDER COUNTY PARKS AND OPEN SPACE

OWNER: BOULDER COUNTY PARKS AND OPEN SPACE

LOCATION: BOULDER COUNTY

BOREHOLE LOCATION

SEE FIGURE 1

FIELD INFORMATION

DATE & TIME ARRIVED: 6/8/2016 8:00 AM

BOREHOLE LOGGED BY: NRS

VISITORS: N/A

WEATHER: SUNNY, 80°s

DRILLING INFORMATION

DRILLING COMPANY: ELITE

START TIME: 10:30 AM

BORING DEPTH: 19'-3" BORING DIA.: 3 ¼" I.D.

DRILLING METHOD: HOLLOW STEM AUGER

SAMPLING METHOD: SPT

TIME DRILLING COMPLETE: 11:30 AM

BOREHOLE COMPLETION / ABANDONMENT INFORMATION

START TIME: 10:30 AM COMPLETE TIME: 11:30 AM

INSTRUMENTATION: N/A BACKFILL: CUTTINGS

ELEVATION - TOP OF BORING: APPROX. 5,252' NORTHING / WESTING: 40°12'39.3"N / 105°14'34.5"W

GROUNDWATER CONDITIONS

WATER WAS ENCOUNTERED AT APPROX. 4' BGS DURING DRILLING

FOLLOWING FIELD WORK

TIME OF CLEAN-UP COMPLETE: 11:45 AM TIME LEFT SITE: 12:00 PM

NOTES:

Engineering Analytics, Inc.

BOREHOLE LOG

PROJECT: ST VRAIN BREACHES **PAGE:** 2 OF 2

PROJECT NO.: 110666 **DATE:** 6/8/2016

BOREHOLE NO.: **B-2**

DEPTH (FT)	CORE RECOV.	DRIVE SAMPLES: SAMPLE TYPE	DRIVE SAMPLES: BLOWS (PER 6")	DRIVE SAMPLES: RECOV.	ADD'L SAMPLES	LITHOLOGY GRAPHIC	SOIL DESCRIPTION
0							
1		SPT	3 6 11 17	12"	S1		**SANDY CLAY (0-APPROX. 2')** SLIGHTLY MOIST, BROWN (2.5YR 5/2), VERY STIFF SANDY CLAY WITH TRACE GRAVEL, POSSIBLE FILL
2							**SAND WITH GRAVEL (APPROX. 2'-APPROX. 9')** MOIST TO WET, DARK REDDISH GRAY (5YR 4/2), MEDIUM DENSE WELL GRADED SAND WITH GRAVEL, POSSIBLE FILL
3		SPT	17 14 15 12	8"	S2		**- (APPROX. 2.5')** DRILLER REPORTED AUGER GRINDING
4							▼ **(APPROX. 4')** WATER ENCOUNTERED DURING DRILLING
5							
6							
7							
8		SPT	5 6 12 20	20"	S3A		**- (APPROX. 8')** WET, REDDISH BROWN (5YR 5/2), MEDIUM DENSE WELL GRADED SAND WITH GRAVEL, FINE GRAVEL
9					S3B		**GRAVEL WITH SILT AND SAND (APPROX. 9'-APPROX. 18')** WET, REDDISH BROWN (5YR 5/4), MEDIUM DENSE WELL GRADED GRAVEL WITH SILT AND SAND, FINE TO COARSE GRAVEL, POSSIBLE FILL
10							
11							
12							
13		SPT	50/4"	4"	S4		**- (APPROX. 13')** WET, LIGHT OLIVE BROWNISH (2.5YR 5/3), VERY DENSE WELL GRADED GRAVEL WITH SILT AND SAND
14							
15							
16							
17							
18		SPT	23 26 50/3"	15"	S5		**SAND WITH CLAY AND GRAVEL (APPROX. 18'-E.O.B.)** WET, LIGHT YELLOWISH BROWN (2.5YR 6/3), VERY DENSE WELL GRADED SAND WITH CLAY AND GRAVEL, MEDIUM TO COARSE SAND
19							E.O.B. = 19'-3"
20							

Engineering Analytics, Inc.

BOREHOLE LOG

PAGE: 1 OF 2

DATE: 6/8/2016

BOREHOLE NO.: B-3

PROJECT INFORMATION

PROJECT: ST VRAIN BREACHES

PROJECT NO.: 110666

CLIENT: BOULDER COUNTY PARKS AND OPEN SPACE

OWNER: BOULDER COUNTY PARKS AND OPEN SPACE

LOCATION: BOULDER COUNTY

BOREHOLE LOCATION

SEE FIGURE 1

FIELD INFORMATION

DATE & TIME ARRIVED: 6/8/2016 12:30 PM

BOREHOLE LOGGED BY: NRS

VISITORS: N/A

WEATHER: SUNNY, 80°s

DRILLING INFORMATION

DRILLING COMPANY: ELITE

START TIME: 12:40 PM

BORING DEPTH: 18'-2" BORING DIA.: 3 ¼" I.D.

DRILLING METHOD: HOLLOW STEM AUGER

SAMPLING METHOD: SPT

TIME DRILLING COMPLETE: 1:30 PM

BOREHOLE COMPLETION / ABANDONMENT INFORMATION

START TIME: 12:40 PM COMPLETE TIME: 1:30 PM

INSTRUMENTATION: N/A BACKFILL: CUTTINGS

ELEVATION - TOP OF BORING: APPROX. 5,203' NORTHING / WESTING: 40°12'23.0"N / 105°13'30.9"W

GROUNDWATER CONDITIONS

NO WATER WAS ENCOUNTERED DURING DRILLING

FOLLOWING FIELD WORK

TIME OF CLEAN-UP COMPLETE: 3:00 PM TIME LEFT SITE: 3:30 PM

NOTES:

Engineering Analytics, Inc.

BOREHOLE LOG

PROJECT: ST VRAIN BREACHES **PAGE:** 2 OF 2

PROJECT NO.: 110666 **DATE:** 6/8/2016

BOREHOLE NO.: **B-3**

DEPTH (FT)	CORE RECOV.	DRIVE SAMPLES: SAMPLE TYPE	BLOWS (PER 6")	RECOV.	ADD'L SAMPLES	LITHOLOGY GRAPHIC	SOIL DESCRIPTION
0							
1		SPT	5 6 7 7	22"	S1A		**TOPSOIL (0-APPROX. 1')** SLIGHTLY MOIST, BROWN (7.5YR 4/3), MEDIUM DENSE TOPSOIL, POORLY GRADED SAND WITH ROOTLETS, FINE SAND
					S1B		**SAND (APPROX. 1'-APPROX. 8')** SLIGHTLY MOIST, REDDISH BROWN (5YR 5/3), MEDIUM DENSE POORLY GRADED SAND, FINE SAND WITH TRACE ROOTLETS
2							
3		SPT	7 10 17 17	12"	S2		**- (APPROX. 3')** DRY, DARK YELLOWISH BROWN (10YR 4/4), MEDIUM DENSE POORLY GRADED SAND WITH GRAVEL
4							
5				BAG 1			**- (0-APPROX. 8')** BAG 1 CUTTING SAMPLE
6							
7							
8		SPT	14 38 50/5"	17"	S3		**SILTY SAND WITH GRAVEL (APPROX. 8'-APPROX. 8'-3")** MOIST, VERY DARK GRAYISH BROWN (10YR 3/2), SILTY SAND WITH GRAVEL
9							**SHALE (APPROX. 8'-3"-APPROX. E.O.B.')** MOIST, VERY DARK GRAY (2.5YR 3/1), VERY DENSE SHALE
10							
11							
12							
13		SPT	50/2"	2"	S5		**- (APPROX. 13')** MOIST, BLACK (10YR 2/1), VERY DENSE WEAK SHALE, HYDROCARBON ODOR
14							
15							
16							
17							
18		SPT	50/2"	2"	S5		E.O.B. = 18'-2"
19							
20							

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BOREHOLE LOG

PAGE: 1 OF 2

DATE: 6/8/2016

BOREHOLE NO.: B-4

PROJECT INFORMATION

PROJECT: ST VRAIN BREACHES

PROJECT NO.: 110666

CLIENT: BOULDER COUNTY PARKS AND OPEN SPACE

OWNER: BOULDER COUNTY PARKS AND OPEN SPACE

LOCATION: BOULDER COUNTY

BOREHOLE LOCATION

SEE FIGURE 1

FIELD INFORMATION

DATE & TIME ARRIVED: 6/8/2016 12:30 PM

BOREHOLE LOGGED BY: NRS

VISITORS: N/A

WEATHER: SUNNY, 80°s

DRILLING INFORMATION

DRILLING COMPANY: ELITE

START TIME: 1:45 PM

BORING DEPTH: 18'-1" BORING DIA.: 3 ¼" I.D.

DRILLING METHOD: HOLLOW STEM AUGER

SAMPLING METHOD: SPT

TIME DRILLING COMPLETE: 2:45 PM

BOREHOLE COMPLETION / ABANDONMENT INFORMATION

START TIME: 1:45 PM COMPLETE TIME: 2:45 PM

INSTRUMENTATION: N/A BACKFILL: CUTTINGS

ELEVATION - TOP OF BORING: APPROX. 5,202' NORTHING / WESTING: 40°12'23.0"N / 105°13'30.0"W

GROUNDWATER CONDITIONS

WATER WAS ENCOUNTERED AT APPROX. 13' BGS DURING DRILLING

FOLLOWING FIELD WORK

TIME OF CLEAN-UP COMPLETE: 3:00 PM TIME LEFT SITE: 3:30 PM

NOTES:

Engineering Analytics, Inc.

BOREHOLE LOG

PROJECT: ST VRAIN BREACHES **PAGE:** 2 OF 2

PROJECT NO.: 110666 **DATE:** 6/8/2016

BOREHOLE NO.: B-4

DEPTH (FT)	CORE RECOV.	DRIVE SAMPLES: SAMPLE TYPE	BLOWS (PER 6")	RECOV.	ADD'L SAMPLES	LITHOLOGY GRAPHIC	SOIL DESCRIPTION
0							
1		SPT	8 10 18 13	20"	S1		**GRAVEL WITH SAND (0-APPROX. 3')** DRY, GRAYISH BROWN (10YR 5/2), MEDIUM DENSE WELL GRADED GRAVEL WITH SAND, POSSIBLE FILL
2							
3							
4		SPT	5 5 3 2	18"	S2		**SILTY SAND WITH GRAVEL (APPROX. 3'-APPROX. 9')** MOIST, VERY DARK GRAYISH BROWN (10YR 3/2), LOOSE SILTY SAND WITH GRAVEL, TRACE ROOTLETS, MICACEOUS, POSSIBLE FILL
5							
6							
7							
8							**- (APPROX. 8')** MOIST, VERY DARK GRAY (10YR 3/1), MEDIUM DENSE SILTY SAND WITH GRAVEL
9		SPT	17 11 7 3	14"	S3		
10							**GRAVEL WITH SAND (APPROX. 9'-APPROX. 13')** MOIST, GRAY (10YR 5/1), MEDIUM DENSE POORLY GRADED GRAVEL WITH SAND SAND
11							
12							
13		SPT	50/6"	6"	S4		▼ **(APPROX. 13')** WATER ENCOUNTERED DURING DRILLING **SAND WITH GRAVEL (APPROX. 13'-APPROX. 13'-6")** WET, BROWN (7.5YR 4/2), VERY DENSE WELL GRADED SAND WITH GRAVEL
14							**SHALE (APPROX. 13'-6"-APPROX. E.O.B.)** WET, VERY DARK GRAY (7.5YR 3/1), VERY DENSE WEAK SHALE
15							
16							
17							
18		SPT	50/1"	1"	S5		**- (APPROX. 18')** WET, BLACK (10YR 2/1), VERY DENSE WEAK SHALE
							E.O.B. = 18'-1"
19							
20							

Engineering Analytics, Inc.

BOREHOLE LOG

PAGE: 1 OF 2

DATE: 6/9/2016

BOREHOLE NO.: B-5

PROJECT INFORMATION

PROJECT: ST VRAIN BREACHES

PROJECT NO.: 110666

CLIENT: BOULDER COUNTY PARKS AND OPEN SPACE

OWNER: BOULDER COUNTY PARKS AND OPEN SPACE

LOCATION: BOULDER COUNTY

BOREHOLE LOCATION

SEE FIGURE 1

FIELD INFORMATION

DATE & TIME ARRIVED: 6/9/2016 12:15 PM

BOREHOLE LOGGED BY: NRS

VISITORS: N/A

WEATHER: SUNNY, 90°s

DRILLING INFORMATION

DRILLING COMPANY: ELITE

START TIME: 12:30 PM

BORING DEPTH: 20' BORING DIA.: 3 ¼" I.D.

DRILLING METHOD: HOLLOW STEM AUGER

SAMPLING METHOD: SPT

TIME DRILLING COMPLETE: 1:15 PM

BOREHOLE COMPLETION / ABANDONMENT INFORMATION

START TIME: 12:30 PM COMPLETE TIME: 1:15 PM

INSTRUMENTATION: N/A BACKFILL: CUTTINGS

ELEVATION - TOP OF BORING: APPROX. 5,134' NORTHING / WESTING: 40°11'27.5"N / 105°12'07.2W

GROUNDWATER CONDITIONS

WATER WAS ENCOUNTERED AT APPROX. 13' BGS DURING DRILLING

FOLLOWING FIELD WORK

TIME OF CLEAN-UP COMPLETE: 1:45 PM TIME LEFT SITE: 2:00 PM

NOTES:

Engineering Analytics, Inc.

BOREHOLE LOG

PROJECT: ST VRAIN BREACHES **PAGE:** 2 OF 2

PROJECT NO.: 110666 **DATE:** 6/9/2016

BOREHOLE NO.: **B-5**

DEPTH (FT)	CORE RECOV.	DRIVE SAMPLES: SAMPLE TYPE	DRIVE SAMPLES: BLOWS (PER 6")	DRIVE SAMPLES: RECOV.	ADD'L SAMPLES	LITHOLOGY GRAPHIC	SOIL DESCRIPTION
0							
1		SPT	3 3 2 2	18"	S1		**TOPSOIL (0-APPROX. 3'-3")** MOIST, DARK REDDISH BROWN (5YR 3/2), LOOSE TOPSOIL, SILTY SAND WITH ROOTLETS
2							
3		SPT	4 4 5 7	24"	S2		**SANDY CLAY (APPROX. 3'-3"-APPROX. 13')** MOIST, DARK YELLOWISH BROWN (10YR 4/6) TO DARK GRAYISH BROWN (10YR 4/2), STIFF SANDY CLAY, FINE GRAINED SAND, MOTTLED, MICACEOUS
4							
5							
6							
7							
8		SPT	20 50/6"	12"	S3		**SAND WITH GRAVEL (APPROX. --'-APPROX. --')** SLIGHTLY MOIST, GRAY (7.5YR 5/1), VERY DENSE WELL GRADED SAND WITH GRAVEL, FINE TO COARSE SAND, FINE TO COARSE GRAVEL
9							
10							
11							**- (APPROX. 11')** DRILLER REPORTED AUGER GRINDING, POSSIBLE GRAVEL / COBBLES / BOULDERS
12							
13							▼ **(APPROX. 13')** WATER ENCOUNTERED DURING DRILLING
14		SPT	13 17 50/5"	17"	S4		**SAND WITH CLAY AND GRAVEL (APPROX. 13'-E.O.B.)** WET, OLIVE GRAY (5Y 5/2), VERY DENSE POORLY GRADED SAND WITH CLAY AND GRAVEL
15							
16							
17							
18							**- (APPROX. 18')** WET, DARK GRAYISH BROWN (10YR 4/2), VERY DENSE POORLY GRADED SAND WITH CLAY AND GRAVEL
19		SPT	15 30 38 25	20"	S5		
20							E.O.B. = 20'

Engineering Analytics, Inc.

BOREHOLE LOG

PAGE: 1 OF 3

DATE: 6/9/2016

BOREHOLE NO.: B-6

PROJECT INFORMATION

PROJECT: ST VRAIN BREACHES

PROJECT NO.: 110666

CLIENT: BOULDER COUNTY PARKS AND OPEN SPACE

OWNER: BOULDER COUNTY PARKS AND OPEN SPACE

LOCATION: BOULDER COUNTY

BOREHOLE LOCATION

SEE FIGURE 1

FIELD INFORMATION

DATE & TIME ARRIVED: 6/9/2016 8:00 AM

BOREHOLE LOGGED BY: NRS

VISITORS: N/A

WEATHER: SUNNY, 90°s

DRILLING INFORMATION

DRILLING COMPANY: ELITE

START TIME: 9:45 AM

BORING DEPTH: 23'-6" BORING DIA.: 3 ¼" I.D.

DRILLING METHOD: HOLLOW STEM AUGER

SAMPLING METHOD: SPT

TIME DRILLING COMPLETE: 10:45 AM

BOREHOLE COMPLETION / ABANDONMENT INFORMATION

START TIME: 9:45 AM COMPLETE TIME: 10:45 AM

INSTRUMENTATION: N/A BACKFILL: CUTTINGS

ELEVATION - TOP OF BORING: APPROX. 5,127' NORTHING / WESTING: 40°11'30.3"N / 105°12'01.3W

GROUNDWATER CONDITIONS

WATER WAS ENCOUNTERED AT APPROX. 13' BGS DURING DRILLING

FOLLOWING FIELD WORK

TIME OF CLEAN-UP COMPLETE: 12:00 PM TIME LEFT SITE: 12:00 PM

NOTES:

Engineering Analytics, Inc.

BOREHOLE LOG

PROJECT: ST VRAIN BREACHES **PAGE:** 2 OF 3

PROJECT NO.: 110666 **DATE:** 6/9/2016

BOREHOLE NO.: **B-6**

DEPTH (FT)	CORE RECOV.	DRIVE SAMPLES: SAMPLE TYPE	BLOWS (PER 6")	RECOV.	ADD'L SAMPLES	LITHOLOGY GRAPHIC	SOIL DESCRIPTION
0					S1a		**SANDY CLAY (0-APPROX. 4")** DRY, LIGHT BROWNISH GRAY (2.5YR 6/2), STIFF SANDY CLAY, WITH ROOTLETS
1		SPT	7 7 8 7	18"	S1b		**SAND WITH GRAVEL (APPROX. 4"-APPROX. 13')** SLIGHTLY MOIST, BROWN (7.5YR 4/2), MEDIUM DENSE WELL GRADED SAND WITH GRAVEL, POSSIBLE FILL
2							
3		SPT	6 11 11 7	10"	S2		
4							
5							**- (APPROX. 5.5')** DRILLER REPORTED AUGER GRINDING, ROUNDED GRAVEL, COBBLES IN CUTTINGS
6							
7							
8		SPT	11 17 16 16	16"	S3		
9							**- (APPROX. 5.5')** DRY, LIGHT BROWNISH GRAY (10YR 6/2), DENSE POORLY GRADED SAND WITH GRAVEL, COARSE GRAVEL
10							
11							
12							▼ **(APPROX. 13')** WATER ENCOUNTERED DURING DRILLING
13		SPT	5 6 6 5	1"	S4		**GRAVEL WITH SAND (APPROX. 13'-APPROX. 18'-6")** WET, BROWN (10Y 4/3), MEDIUM DENSE WELL GRADED GRAVEL WITH SAND, FINE TO COARSE SAND, FINE TO COARSE GRAVEL
14							
15							
16							
17							
18		SPT	25 25 50/6"	22"	S5A		**(APPROX. 18')** WET, DARK GRAYISH BROWN (10YR 4/2), VERY WELL GRADED GRAVEL WITH SAND
19					S5B		**CLAYEY GRAVEL WITH SAND (APPROX. 18'-6"-APPROX. 23')** WET, GRAYISH BROWN (2.5Y 5/2), VERY DENSE CLAYEY GRAVEL WITH SAND, FINE TO COARSE SAND, FINE TO COARSE GRAVEL
20							

Engineering Analytics, Inc.

BOREHOLE LOG

PROJECT: ST VRAIN BREACHES **PAGE:** 3 OF 3

PROJECT NO.: 110666 **DATE:** 6/9/2016

BOREHOLE NO.: **B-6**

DEPTH (FT)	CORE RECOV.	DRIVE SAMPLES: SAMPLE TYPE	DRIVE SAMPLES: BLOWS (PER 6")	DRIVE SAMPLES: RECOV.	ADD'L SAMPLES	LITHOLOGY GRAPHIC	SOIL DESCRIPTION
20							**CLAYEY GRAVEL WITH SAND (APPROX. 18'-6"-APPROX. 23')** (SEE DESCRIPTION ON PREVIOUS PAGE)
21							
22							
23		SPT	50/6"	6"	S6		**SHALE (APPROX. 23'-E.O.B.)** MOIST, DARK GRAY (7.5Y 4/1) TO BLACK (7.5Y 2.5/1), VERY DENSE WEAK SHALE
							E.O.B. = 23'-6"
24							
25							
26							
27							
28							
29							
30							
31							
32							
33							
34							
35							
36							
37							
38							
39							
40							

Engineering Analytics, Inc.

BOREHOLE LOG

PAGE: 1 OF 2

DATE: 6/9/2016

BOREHOLE NO.: B-7

PROJECT INFORMATION

PROJECT: ST VRAIN BREACHES

PROJECT NO.: 110666

CLIENT: BOULDER COUNTY PARKS AND OPEN SPACE

OWNER: BOULDER COUNTY PARKS AND OPEN SPACE

LOCATION: BOULDER COUNTY

BOREHOLE LOCATION

SEE FIGURE 1

FIELD INFORMATION

DATE & TIME ARRIVED: 6/9/2016 8:00 AM

BOREHOLE LOGGED BY: NRS

VISITORS: N/A

WEATHER: SUNNY, 90°s

DRILLING INFORMATION

DRILLING COMPANY: ELITE

START TIME: 11:00 AM

BORING DEPTH: 20' BORING DIA.: 3 ¼" I.D.

DRILLING METHOD: HOLLOW STEM AUGER

SAMPLING METHOD: SPT

TIME DRILLING COMPLETE: 11:45 AM

BOREHOLE COMPLETION / ABANDONMENT INFORMATION

START TIME: 11:00 AM COMPLETE TIME: 11:45 AM

INSTRUMENTATION: N/A BACKFILL: CUTTINGS

ELEVATION - TOP OF BORING: APPROX. 5,125' NORTHING / WESTING: 40°11'28.3"N / 105°11'56.8W

GROUNDWATER CONDITIONS

WATER WAS ENCOUNTERED AT APPROX. 9.5' BGS DURING DRILLING

FOLLOWING FIELD WORK

TIME OF CLEAN-UP COMPLETE: 12:00 PM TIME LEFT SITE: 12:00 PM

NOTES:

Engineering Analytics, Inc.

BOREHOLE LOG

PROJECT: ST VRAIN BREACHES **PAGE:** 2 OF 2

PROJECT NO.: 110666 **DATE:** 6/9/2016

BOREHOLE NO.: B-7

DEPTH (FT)	CORE RECOV.	DRIVE SAMPLES: SAMPLE TYPE	BLOWS (PER 6")	RECOV.	ADD'L SAMPLES	LITHOLOGY GRAPHIC	SOIL DESCRIPTION
0							
1		SPT	11 6 11 16	20"	S1a S1b		**SANDY CLAY WITH GRAVEL (0-APPROX. 4")** MOIST, OLIVE-BROWN (2.5YR 4/4), STIFF SANDY CLAY WITH GRAVEL, WITH ROOTLETS
2							**SAND WITH GRAVEL (APPROX. 4"-APPROX. 8')** SLIGHTLY MOIST, BROWN (10YR 5/3), MEDIUM DENSE WELL GRADED SAND WITH GRAVEL
3							
4		SPT	5 7 5 5	6"	S2		
5							
6							**- (APPROX. 6')** DRILLER REPORTED AUGER GRINDING, ROUNDED TO SUB-ANGULAR GRAVEL AND COBBLES IN CUTTINGS
7							
8							
9		SPT	14 28 24 19	17"	S3		**GRAVEL WITH SAND (APPROX. 8'-APPROX. 13')** MOIST TO WET, DARK YELLOWISH BROWN (10YR 4/4), VERY DENSE POORLY GRADED GRAVEL WITH SAND ▼ **(APPROX. 9.5')** WATER ENCOUNTERED DURING DRILLING
10							
11							**- (APPROX. 11.5')** DRILLER REPORTED AUGER GRINDING
12							
13		SPT	50/6"	6"	S4		**SAND WITH CLAY AND GRAVEL (APPROX. 13'-APPROX. 18')** WET, LIGHT BROWNISH GRAY (2.5Y 6/2) TO LIGHT OLIVE BROWN (2.5Y 5/3), VERY DENSE POORLY GRADED SAND WITH CLAY AND GRAVEL
14							
15							
16							**- (APPROX. 16.5')** ROUNDED COBBLES AND GRAVEL IN CUTTINGS
17							
18							
19		SPT	20 28 35 21	18"	S5		**CLAYEY GRAVEL WITH SAND (APPROX. 18'-E.O.B.)** WET, PALE BROWN (10YR 6/3) TO LIGHT BROWNISH GRAY (10YR 6/3), VERY DENSE CLAYEY GRAVEL WITH SAND, MEDIUM TO COURSE SAND, FINE TO COARSE GRAVEL
20							E.O.B. = 20'

Engineering Analytics, Inc.

BOREHOLE LOG

PAGE: 1 OF 2

DATE: 6/9/2016

BOREHOLE NO.: B-8

PROJECT INFORMATION

PROJECT: ST VRAIN BREACHES

PROJECT NO.: 110666

CLIENT: BOULDER COUNTY PARKS AND OPEN SPACE

OWNER: BOULDER COUNTY PARKS AND OPEN SPACE

LOCATION: BOULDER COUNTY

BOREHOLE LOCATION

SEE FIGURE 1

FIELD INFORMATION

DATE & TIME ARRIVED: 6/9/2016 8:00 AM

BOREHOLE LOGGED BY: NRS

VISITORS: N/A

WEATHER: SUNNY, 90°s

DRILLING INFORMATION

DRILLING COMPANY: ELITE

START TIME: 8:30 AM

BORING DEPTH: 19'-4" BORING DIA.: 3 ¼" I.D.

DRILLING METHOD: HOLLOW STEM AUGER

SAMPLING METHOD: SPT

TIME DRILLING COMPLETE: 9:30 AM

BOREHOLE COMPLETION / ABANDONMENT INFORMATION

START TIME: 8:30 AM COMPLETE TIME: 9:30 AM

INSTRUMENTATION: N/A BACKFILL: CUTTINGS

ELEVATION - TOP OF BORING: APPROX. 5,127' NORTHING / WESTING: 40°11'30.3"N / 105°11'45.7W

GROUNDWATER CONDITIONS

WATER WAS ENCOUNTERED AT APPROX. 18' BGS DURING DRILLING

FOLLOWING FIELD WORK

TIME OF CLEAN-UP COMPLETE: 12:00 PM TIME LEFT SITE: 12:00 PM

NOTES:

Engineering Analytics, Inc.

BOREHOLE LOG

PROJECT: ST VRAIN BREACHES **PAGE:** 2 OF 2

PROJECT NO.: 110666 **DATE:** 6/9/2016

BOREHOLE NO.: **B-8**

DEPTH (FT)	CORE RECOV.	DRIVE SAMPLES: SAMPLE TYPE	BLOWS (PER 6")	RECOV.	ADD'L SAMPLES	LITHOLOGY GRAPHIC	SOIL DESCRIPTION
0							
1		SPT	12 16 14 16	15"	S1		**SAND WITH CLAY AND GRAVEL (0-APPROX. 3')** DRY, BROWN (10YR 5/3), DENSE POORLY GRADED SAND WITH CLAY AND GRAVEL, FINE TO MEDIUM SAND, FINE TO COARSE GRAVEL, ROOTLETS IN UPPER 4"
2							
3		SPT	25 25 33 40	16"	S2		**SAND WITH GRAVEL (APPROX. 3'-APPROX. 9')** DRY, GRAY (5YR 6/1) TO LIGHT BROWNISH GRAY (10YR 6/2), VERY DENSE POORLY GRADED SAND WITH GRAVEL, FINE TO MEDIUM SAND, FINE TO COARSE GRAVEL
4							**- (APPROX. 5')** DRILLER REPORTED AUGER GRINDING, POSSIBLE GRAVEL / COBBLES
5							
6							
7							
8		SPT	17 30 50/5"	14"	S3		**- (APPROX. 8')** SLIGHTLY MOIST, LIGHT OLIVE BROWN (2.5Y 5/3), VERY DENSE POORLY GRADED SAND, MEDIUM SAND
9							
10							**GRAVEL WITH SAND (APPROX. 9'-APPROX. 18')** DRY, GRAYISH BROWN (2.5Y 5/2), VERY DENSE POORLY GRADED GRAVEL WITH SAND
11					BAG 1		**- (APPROX. 10'- APPROX. 12')** BAG 1 CUTTINGS
12							
13		SPT	50/5"	5"	S4		
14							**- (APPROX. 14')** DRY, LIGHT BROWNISH GRAY (2.5Y 6/2), VERY DENSE POORLY GRADED GRAVEL WITH SAND
15							
16							
17							
18							▼ **(APPROX. 18')** WATER ENCOUNTERED DURING DRILLING
19		SPT	20 25 50/4"	18"	S5		**SAND WITH CLAY AND GRAVEL (APPROX. 18'-E.O.B.)** WET, LIGHT OLIVE BROWN (2.5YR 5/4), VERY DENSE WELL GRADED SAND WITH CLAY AND GRAVEL
							E.O.B. = 19'-4"
20							

APPENDIX B
LABORATORY TEST RESULTS

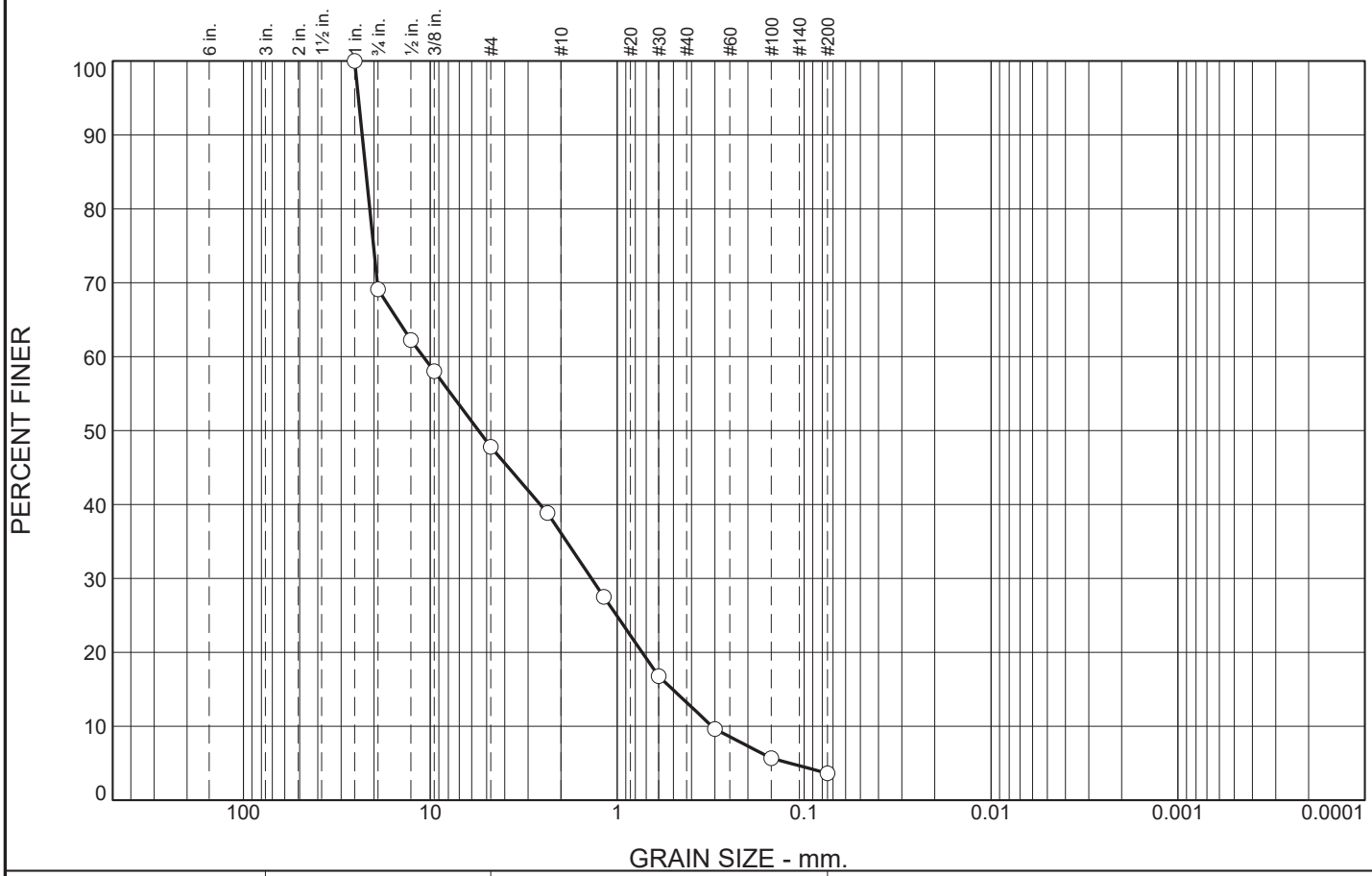
SUMMARY OF LABORATORY TEST RESULTS

JOB NAME: EA-110666-St. Vrain Breaches JOB NUMBER: 16.037T Date: June-2016

Depth (ft)	Sample Type	Moisture (%)	Dry Density (pcf)	Atterberg Limits LL / PL / PI *	% Passing 200 Sieve (Wash)	Grain Size Analysis	Hydrometer	Standard Proctor Max γ (pcf) / Opt. w (%)
B-1								
8-10	Bag	8.9			3.6	(1)		
B-2								
0-2	Bag	12.7			65.8	(1)		
B-2								
18-19.25	Bag	15.5			8.5	(1)		
B-3								
3-5	Bag	2.4			5.3	(1)		
B-4								
8-10	Bag	12.4			24.8	(1)		
B-5								
3-5	Bag	21.8			53.5	(1)		
B-5								
13-14.42	Bag	20.1			7.3	(1)		
B-6								
0-4	Bag	11.8			70.1	(1)		
B-6								
18.5-19.5	Bag	13.0			20.2	(1)		
B-7								
8-10	Bag	5.3			5.6	(1)		
B-7								
13-13.5	Bag	15.1			8.6	(1)		
B-8								
18-19.33	Bag	13.5			7.3	(1)		

*LL = Liquid Limit PL = Plastic Limit PI = Plasticity Index N.P. = Non Plastic (1) See Attached

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	30.9	21.3	11.7	22.9	9.6	3.6	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1	100.0		
.75	69.1		
.5	62.3		
.375	58.0		
#4	47.8		
#8	38.9		
#16	27.5		
#30	16.8		
#50	9.6		
#100	5.7		
#200	3.6		

* (no specification provided)

Material Description

Poorly graded gravel with sand

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 23.1416 D_{85}= 22.0888 D_{60}= 10.8948
D_{50}= 5.5167 D_{30}= 1.3736 D_{15}= 0.5053
D_{10}= 0.3111 C_u= 35.02 C_c= 0.56

Classification

USCS= GP AASHTO=

Remarks

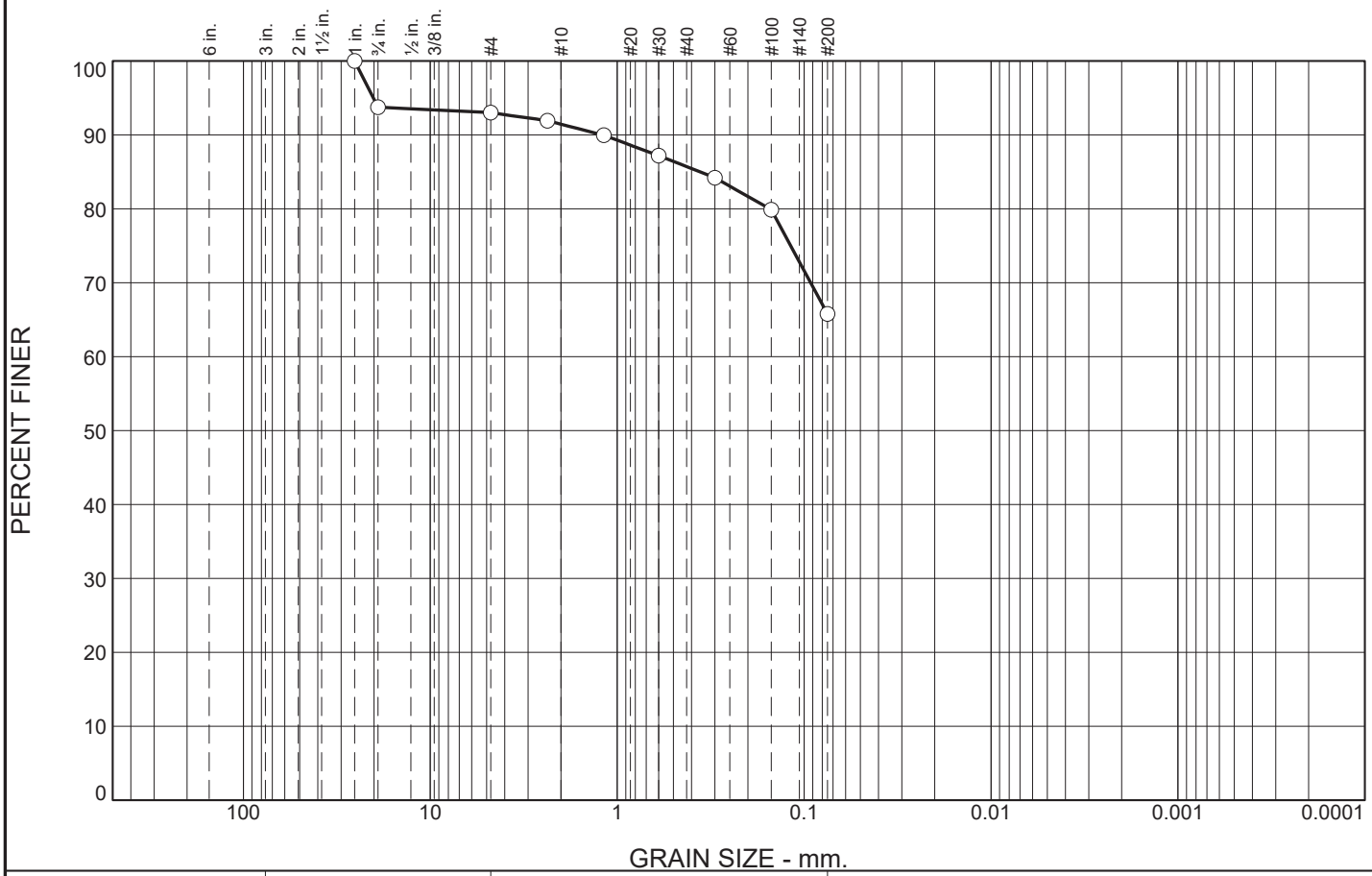
M%= 8.9

Source of Sample: B-1 **Depth:** 8'-10'
Sample Number: S3 **Date:** 6/21/2016

SMITH GEOTECHNICAL

Client: Engineering Analytics, Inc.
Project: EA-110666-St. Vrain Breaches
Project No: 16.037T **Figure**

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	6.2	0.8	1.5	5.8	19.9	65.8	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1	100.0		
.75	93.8		
#4	93.0		
#8	91.9		
#16	90.0		
#30	87.2		
#50	84.2		
#100	79.9		
#200	65.8		

* (no specification provided)

Material Description

Sandy clay

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 1.1963 D_{85}= 0.3602 D_{60}=
D_{50}= D_{30}= D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= CL AASHTO=

Remarks

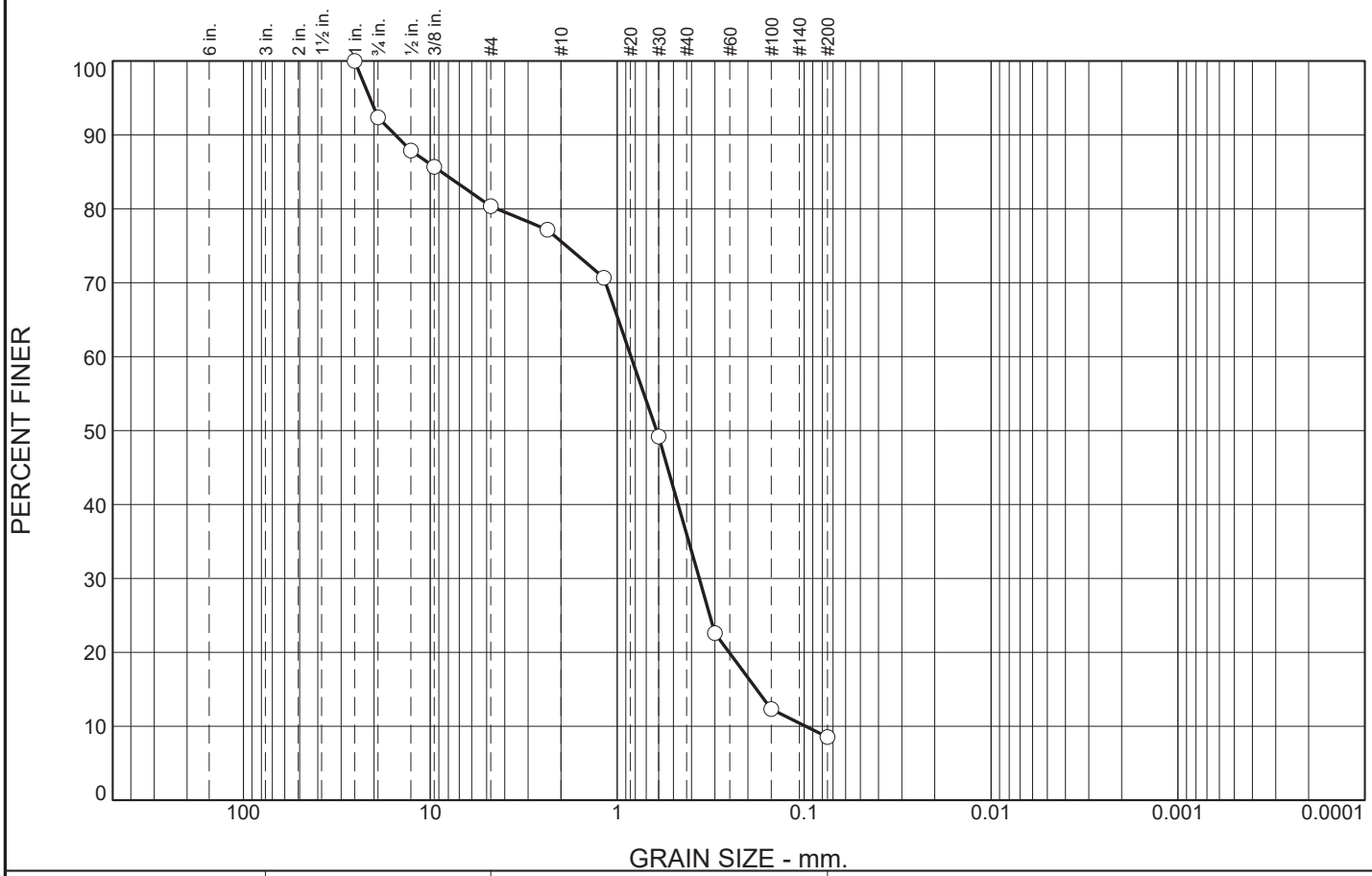
M%= 12.7

Source of Sample: B-2 **Depth:** 0'-2'
Sample Number: S1 **Date:** 6/21/2016

SMITH GEOTECHNICAL

Client: Engineering Analytics, Inc.
Project: EA-110666-St. Vrain Breaches
Project No: 16.037T **Figure**

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	7.6	12.0	4.8	39.6	27.5	8.5	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1	100.0		
.75	92.4		
.5	87.9		
.375	85.7		
#4	80.4		
#8	77.2		
#16	70.7		
#30	49.2		
#50	22.6		
#100	12.3		
#200	8.5		

* (no specification provided)

Material Description

Well graded sand with clay and gravel

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 15.3720 D_{85}= 8.7162 D_{60}= 0.8431
D_{50}= 0.6154 D_{30}= 0.3638 D_{15}= 0.1797
D_{10}= 0.0980 C_u= 8.60 C_c= 1.60

Classification

USCS= SW-SC AASHTO=

Remarks

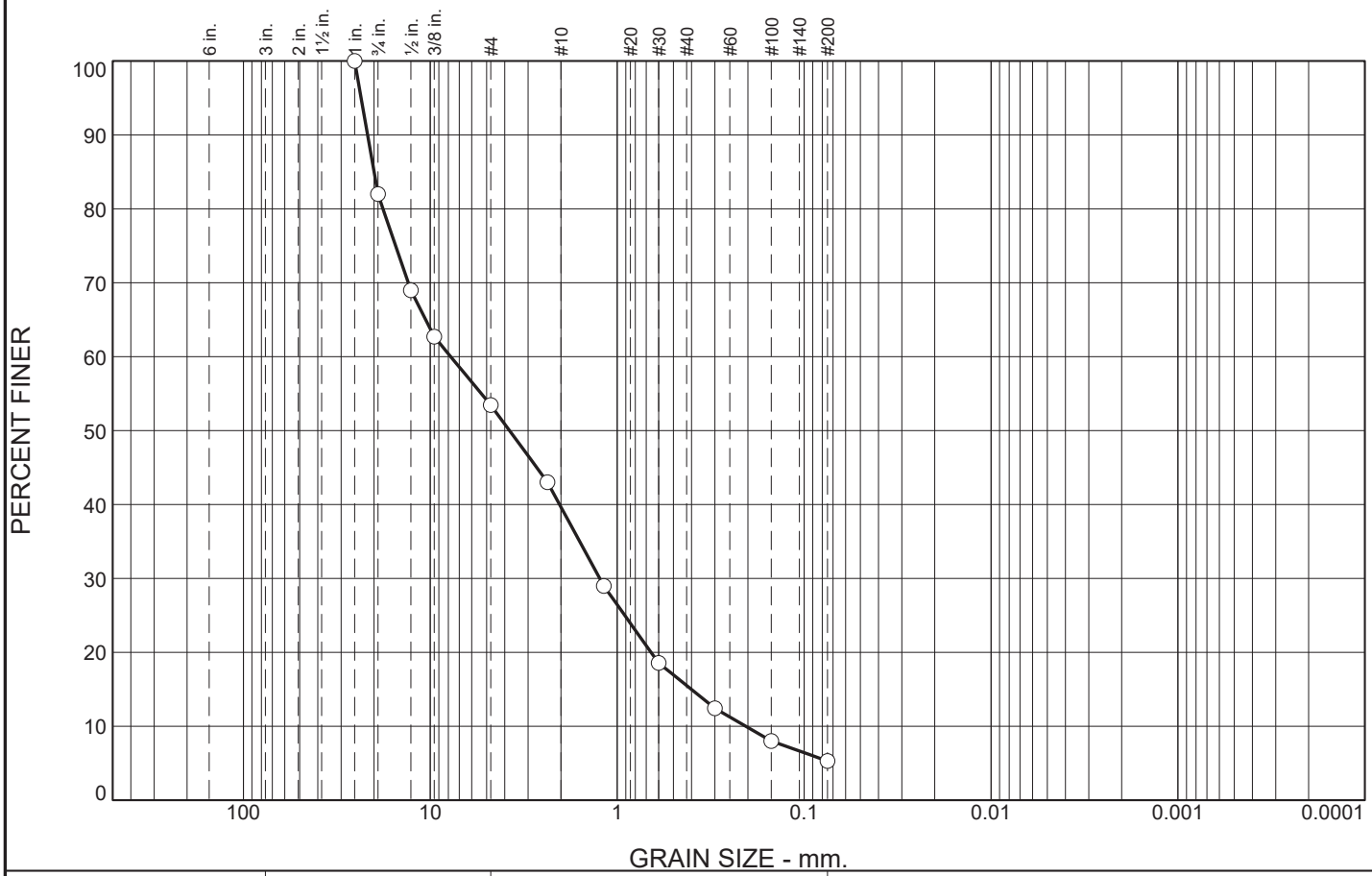
M%= 15.5

Source of Sample: B-2 **Depth:** 18'-19.25'
Sample Number: S5 **Date:** 6/21/2016

SMITH GEOTECHNICAL

Client: Engineering Analytics, Inc.
Project: EA-110666-St. Vrain Breaches
Project No: 16.037T **Figure**

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	18.0	28.5	13.8	24.2	10.2	5.3	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1	100.0		
.75	82.0		
.5	69.0		
.375	62.7		
#4	53.5		
#8	43.0		
#16	29.0		
#30	18.6		
#50	12.4		
#100	8.0		
#200	5.3		

* (no specification provided)

Material Description

Poorly graded sand with gravel

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 21.6497 D_{85}= 19.9876 D_{60}= 7.7679
D_{50}= 3.7674 D_{30}= 1.2405 D_{15}= 0.4012
D_{10}= 0.2050 C_u= 37.88 C_c= 0.97

Classification

USCS= SP AASHTO=

Remarks

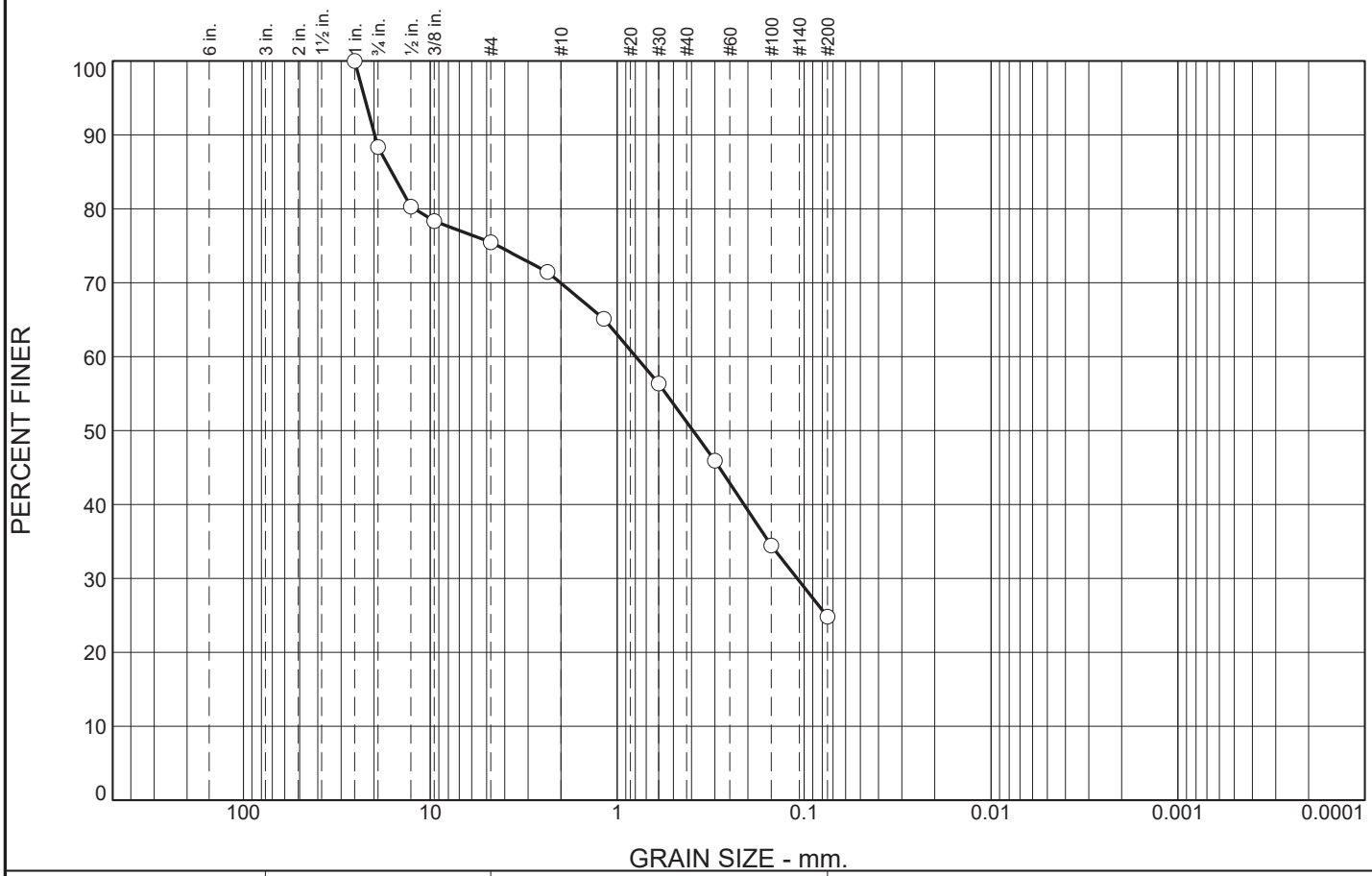
M%= 2.4

Source of Sample: B-3 **Depth:** 3'-5'
Sample Number: S2 **Date:** 6/21/2016

SMITH GEOTECHNICAL

Client: Engineering Analytics, Inc.
Project: EA-110666-St. Vrain Breaches
Project No: 16.037T **Figure**

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	11.6	12.9	5.5	18.8	26.4	24.8	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1	100.0		
.75	88.4		
.5	80.3		
.375	78.3		
#4	75.5		
#8	71.5		
#16	65.1		
#30	56.4		
#50	45.9		
#100	34.5		
#200	24.8		

* (no specification provided)

Material Description

Silty sand with gravel

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 19.8323 D_{85}= 16.0790 D_{60}= 0.7947
D_{50}= 0.3933 D_{30}= 0.1089 D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= SM AASHTO=

Remarks

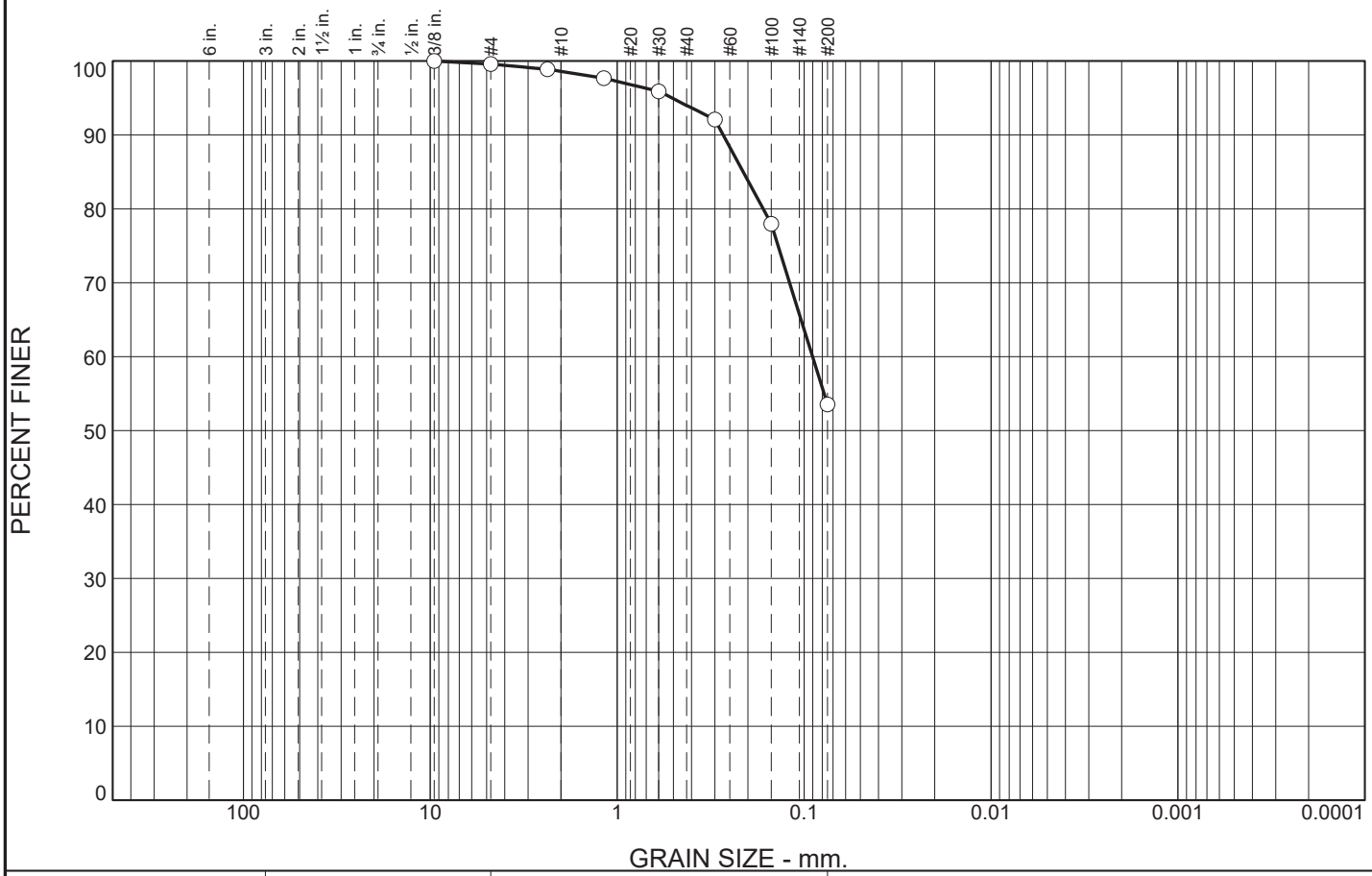
M%= 12.4

Source of Sample: B-4 **Depth:** 8'-10'
Sample Number: S3 **Date:** 6/21/2016

SMITH GEOTECHNICAL

Client: Engineering Analytics, Inc.
Project: EA-110666-St. Vrain Breaches
Project No: 16.037T **Figure**

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.4	1.0	4.6	40.5	53.5	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.375	100.0		
#4	99.6		
#8	98.9		
#16	97.7		
#30	95.9		
#50	92.1		
#100	78.0		
#200	53.5		

* (no specification provided)

Material Description

Sandy clay

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 0.2708 D_{85}= 0.2118 D_{60}= 0.0901
D_{50}= D_{30}= D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= CL AASHTO=

Remarks

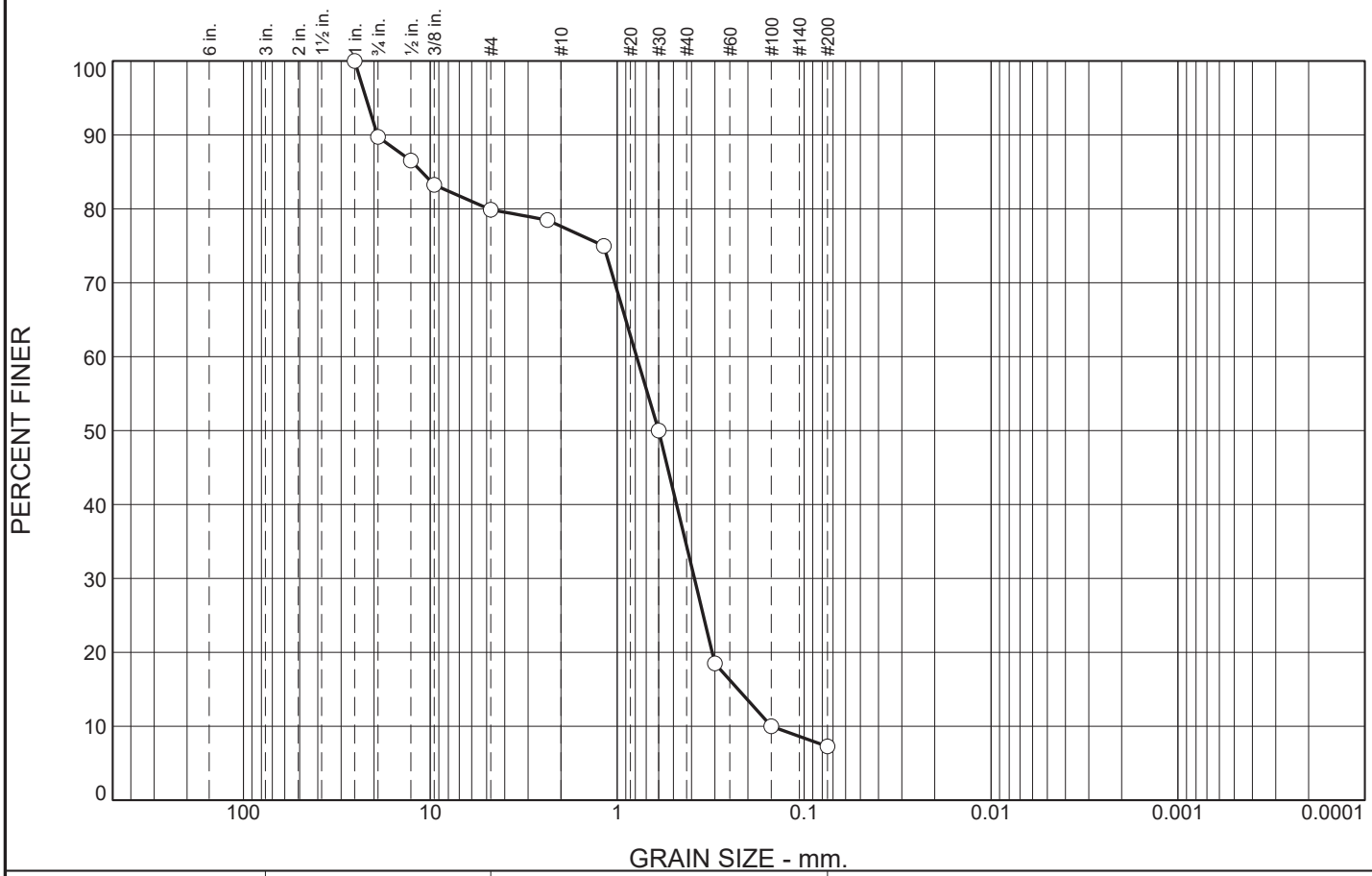
M%= 21.8

Source of Sample: B-5 **Depth:** 3'-5'
Sample Number: S2 **Date:** 6/21/2016

SMITH GEOTECHNICAL

Client: Engineering Analytics, Inc.
Project: EA-110666-St. Vrain Breaches
Project No: 16.037T **Figure**

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	10.3	9.8	2.2	43.4	27.0	7.3	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1	100.0		
.75	89.7		
.5	86.5		
.375	83.2		
#4	79.9		
#8	78.5		
#16	75.0		
#30	50.0		
#50	18.5		
#100	10.0		
#200	7.3		

* (no specification provided)

Material Description

Poorly graded sand with clay and gravel

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 19.1893 D_{85}= 11.1109 D_{60}= 0.7865
D_{50}= 0.6000 D_{30}= 0.3864 D_{15}= 0.2254
D_{10}= 0.1498 C_u= 5.25 C_c= 1.27

Classification

USCS= SP-SC AASHTO=

Remarks

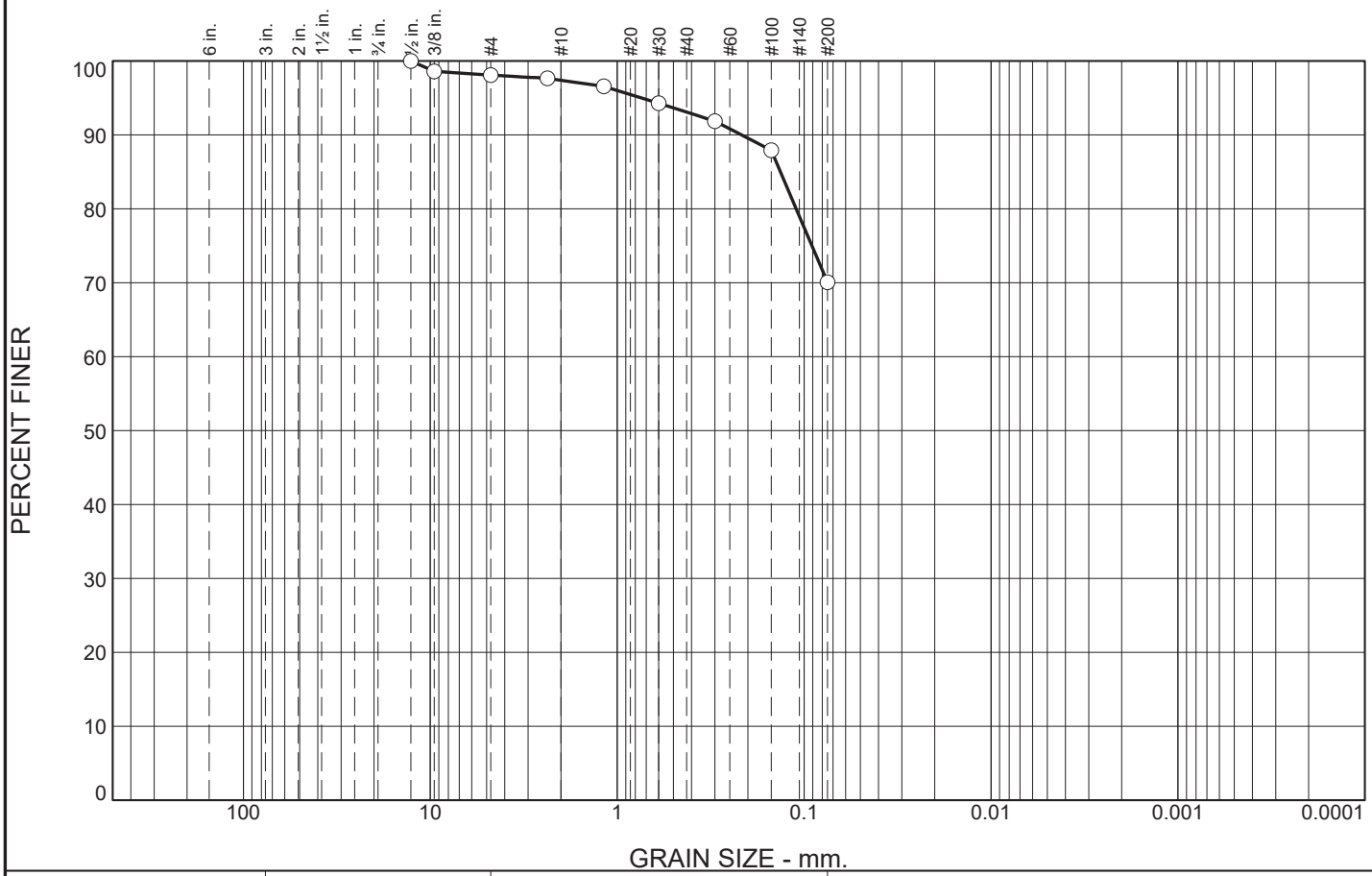
M%= 20.1

Source of Sample: B-5 **Depth:** 13'-14.42
Sample Number: S4 **Date:** 6/21/2016

SMITH GEOTECHNICAL

Client: Engineering Analytics, Inc.
Project: EA-110666-St. Vrain Breaches
Project No: 16.037T **Figure**

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	1.9	0.7	4.3	23.0	70.1	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.5	100.0		
.375	98.6		
#4	98.1		
#8	97.6		
#16	96.6		
#30	94.3		
#50	91.9		
#100	87.9		
#200	70.1		

* (no specification provided)

Material Description

Sandy clay

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 0.2160 D_{85}= 0.1339 D_{60}=
D_{50}= D_{30}= D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= CL AASHTO=

Remarks

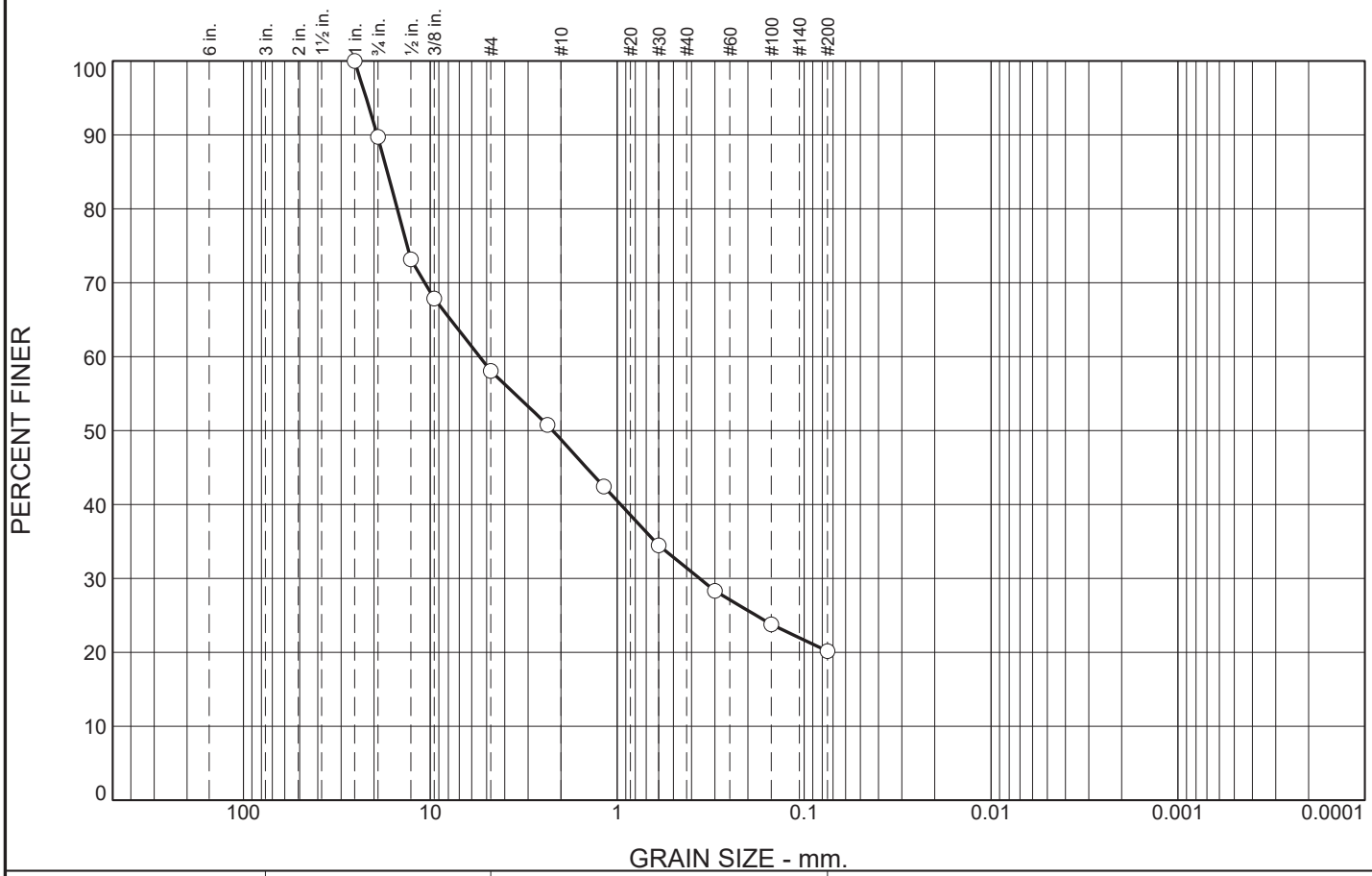
M%= 11.8

Source of Sample: B-6 **Depth:** 0'-4"
Sample Number: S1a **Date:** 6/21/2016

SMITH GEOTECHNICAL

Client: Engineering Analytics, Inc.
Project: EA-110666-St. Vrain Breaches
Project No: 16.037T **Figure**

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	10.3	31.6	9.3	17.4	11.2	20.2	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1	100.0		
.75	89.7		
.5	73.2		
.375	67.9		
#4	58.1		
#8	50.8		
#16	42.4		
#30	34.5		
#50	28.3		
#100	23.8		
#200	20.2		

* (no specification provided)

Material Description

Clayey gravel with sand

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 19.1927 D_{85}= 16.9667 D_{60}= 5.4470
D_{50}= 2.2115 D_{30}= 0.3626 D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= GC AASHTO=

Remarks

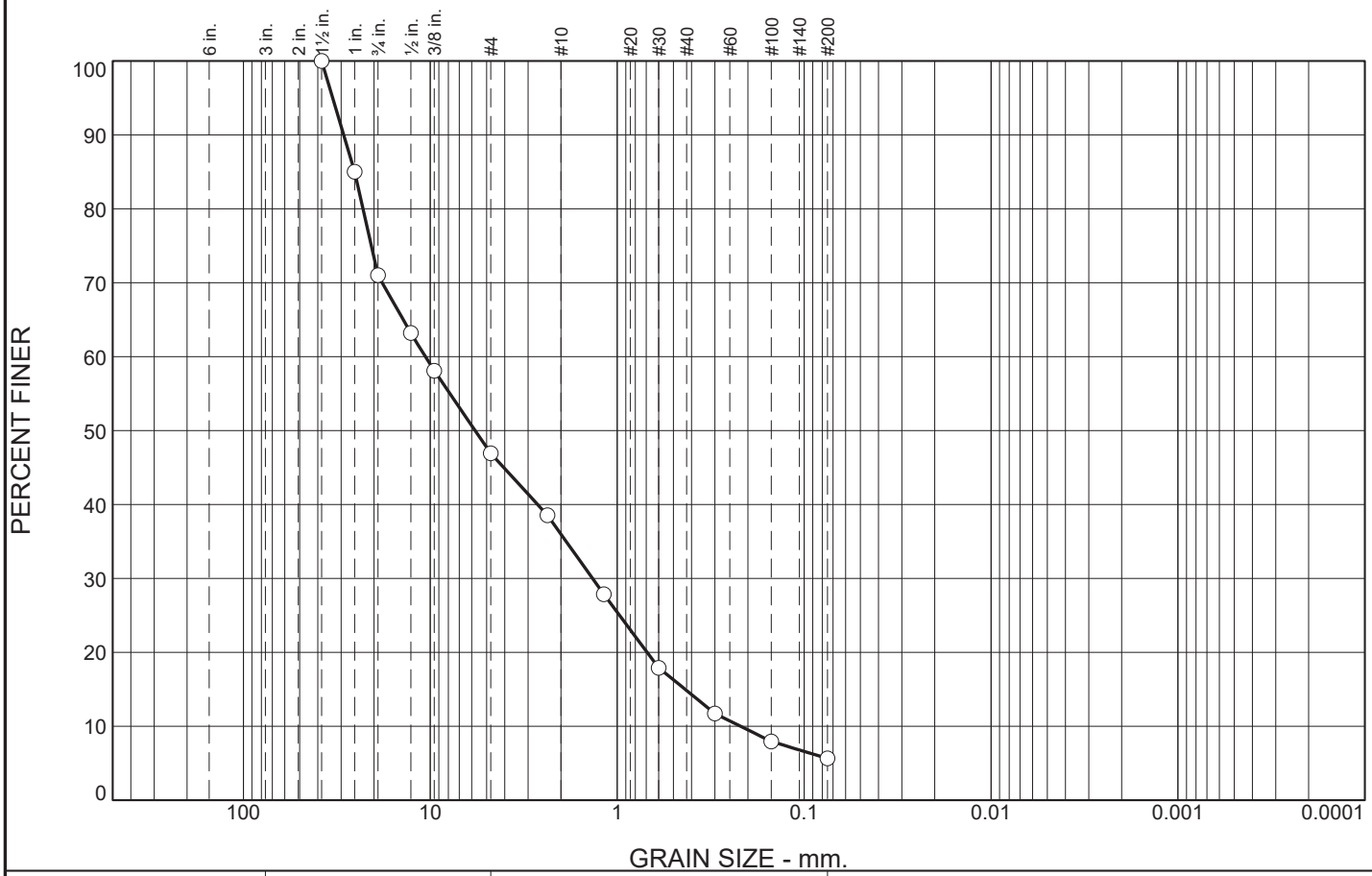
M%= 13.0

Source of Sample: B-6 **Depth:** 18.5'-19.5'
Sample Number: S5b **Date:** 6/21/2016

SMITH GEOTECHNICAL

Client: Engineering Analytics, Inc.
Project: EA-110666-St. Vrain Breaches
Project No: 16.037T **Figure**

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	29.0	24.1	10.9	21.2	9.2	5.6	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1.5	100.0		
1	85.0		
.75	71.0		
.5	63.2		
.375	58.1		
#4	46.9		
#8	38.5		
#16	27.9		
#30	17.9		
#50	11.7		
#100	7.9		
#200	5.6		

* (no specification provided)

Material Description

Poorly graded gravel with sand

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 29.0638 D_{85}= 25.3881 D_{60}= 10.6080
D_{50}= 5.7550 D_{30}= 1.3552 D_{15}= 0.4332
D_{10}= 0.2187 C_u= 48.51 C_c= 0.79

Classification

USCS= GP AASHTO=

Remarks

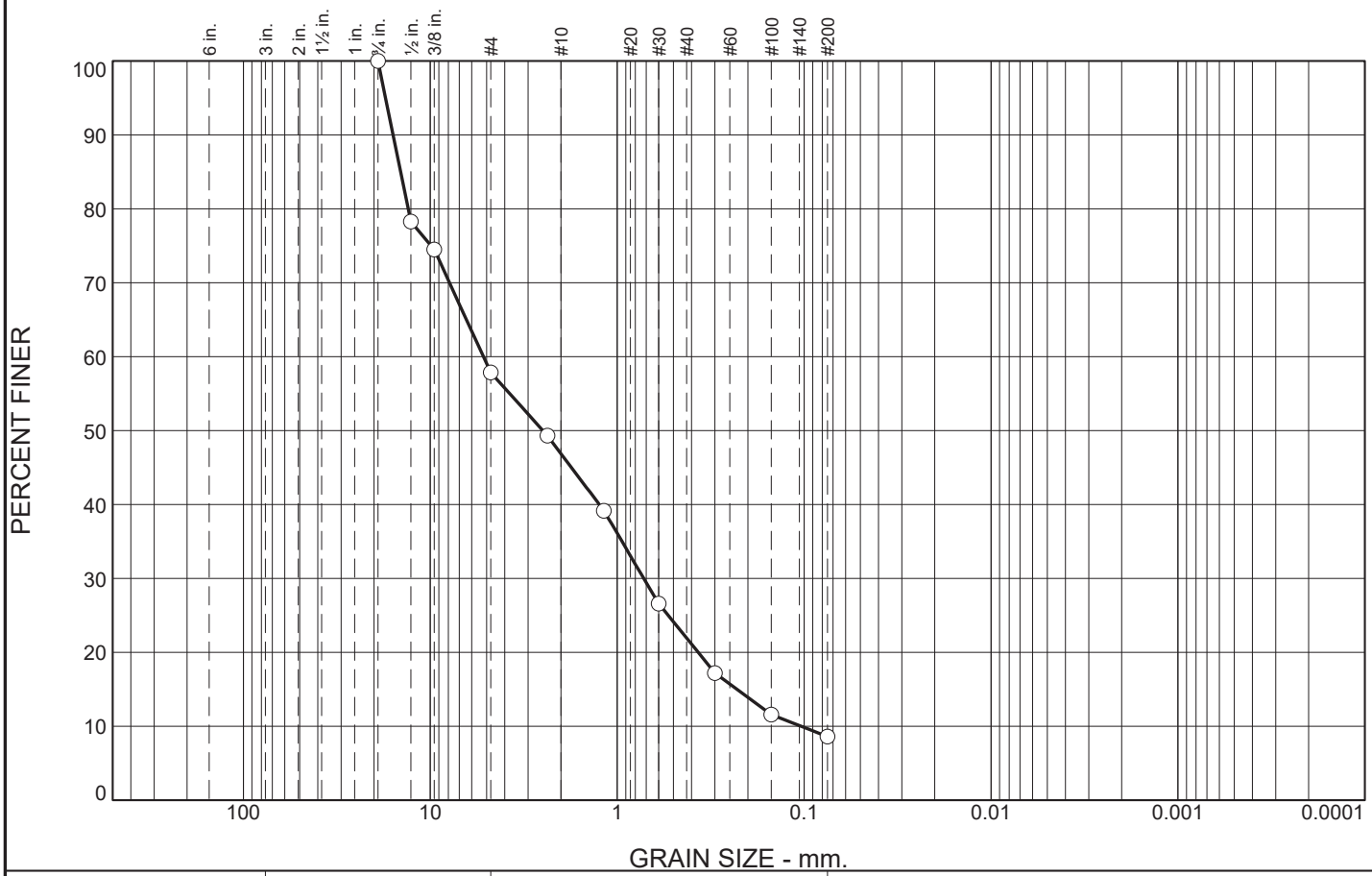
M%= 5.3

Source of Sample: B-7 **Depth:** 8'-10'
Sample Number: S3 **Date:** 6/21/2016

SMITH GEOTECHNICAL

Client: Engineering Analytics, Inc.
Project: EA-110666-St. Vrain Breaches
Project No: 16.037T **Figure**

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	42.1	11.0	25.0	13.3	8.6	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
0.75	100.0		
.5	78.3		
.375	74.5		
#4	57.9		
#8	49.3		
#16	39.1		
#30	26.6		
#50	17.2		
#100	11.6		
#200	8.6		

* (no specification provided)

Material Description

Poorly graded sand with clay and gravel

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 15.8063 D_{85}= 14.3979 D_{60}= 5.1948
D_{50}= 2.4963 D_{30}= 0.7206 D_{15}= 0.2287
D_{10}= 0.1037 C_u= 50.10 C_c= 0.96

Classification

USCS= SP-SC AASHTO=

Remarks

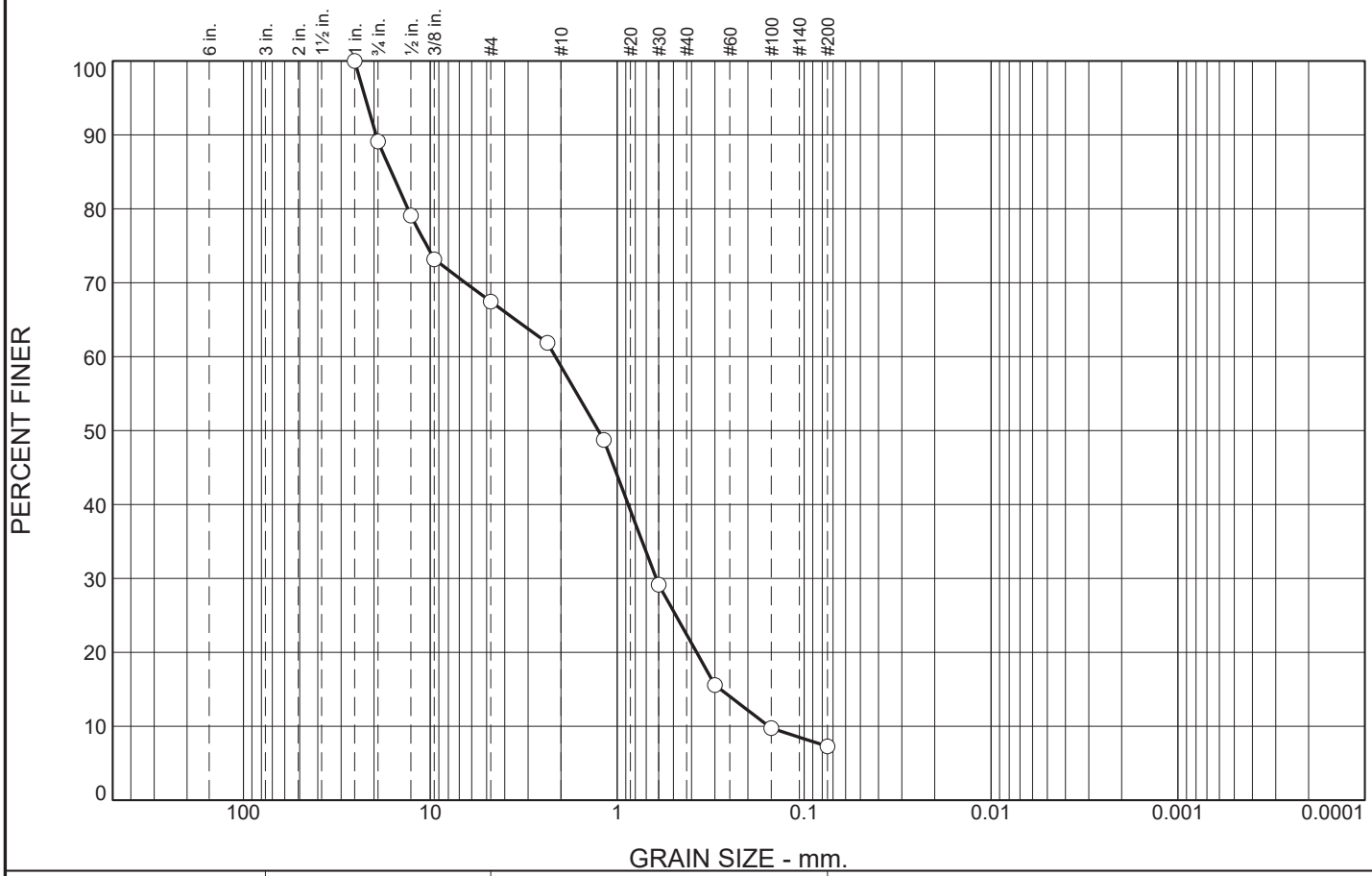
M%= 15.1

Source of Sample: B-7 **Depth:** 13'-13.5'
Sample Number: S4 **Date:** 6/21/2016

SMITH GEOTECHNICAL

Client: Engineering Analytics, Inc.
Project: EA-110666-St. Vrain Breaches
Project No: 16.037T **Figure**

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	10.9	21.7	8.7	36.3	15.1	7.3	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1	100.0		
.75	89.1		
.5	79.1		
.375	73.2		
#4	67.4		
#8	61.9		
#16	48.7		
#30	29.1		
#50	15.6		
#100	9.7		
#200	7.3		

* (no specification provided)

Material Description

Well graded sand with clay and gravel

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 19.5055 D_{85}= 16.1328 D_{60}= 2.1385
D_{50}= 1.2617 D_{30}= 0.6180 D_{15}= 0.2801
D_{10}= 0.1546 C_u= 13.83 C_c= 1.16

Classification

USCS= SW-SC AASHTO=

Remarks

M%= 13.5

Source of Sample: B-8 **Depth:** 18'-19.333
Sample Number: S5 **Date:** 6/21/2016

SMITH GEOTECHNICAL

Client: Engineering Analytics, Inc.
Project: EA-110666-St. Vrain Breaches
Project No: 16.037T **Figure**