MEMORANDUM

Missouri Department of Transportation
Construction & Materials
Central Office

TO: Bret Davidson-nw/cm

FROM: Lydia Brownell
Geotechnical Engineer

DATE: September 10, 2018

SUBJECT: Slide Investigation
Slide No S2498
Job No. R35G
Hwy 59, Holt County

In response to a request from Bret Davidson, the Geotechnical Section has conducted an investigation to determine the cause of and corrective measures for two slides that have occurred on the north and south sides of Highway 59 in Holt County. These slides are located approximately ½ mile east of Oregon, MO. The slide along the northern slope extends from Sta 1526+50 to 1531+50, for an approximate length of 500 feet. The slide along the southern slope extends from Sta 1526+75 to Sta 1533+50, for a length of 675 feet.

Coordinates and elevations were provided by Northwest District survey. Cross-sections were not provided for our analysis. The top of slope and bottom of slope elevations, along with project plans along the route, were utilized to create a general profile to perform an analysis. Attached are typicals for repair options, an aerial photo of boring locations, logs of borings, photos of the northern and southern slope and aerial photos from 2008 to 2014.

History

These slides have been a problem for many years. Maintenance has tried to remove the material from the toe and push it back up slope several times over the years. According to maintenance, the ditch lines along this section are perpetually wet.

Aerial maps from Google Earth Pro are attached showing a history of movement. The earliest map that could be obtained was dated April 2008. In this aerial, you can see movement along the south slope, but not as much along the northern slope. The August 2010 aerial shows additional movement along the southern slope and vegetation loss across the northern slope, which is most likely signs of movement. The September 2012 and October 2014 aerials show little or no change on either slope.

There have been a few significant precipitation events since our exploration and little or no movement has occurred following these events.

Existing Conditions

Five borings were performed across the site. Two were completed along the southern slope and three along the northern slope. See attached aerial for boring locations.

Along the northern slope, the back fill height is about 42.5 feet at the highest point, with the back fill cut on a slope of about 2.5H to 3H:1V. The northern slope consists of silt, overlying lean clay on top

of sand and shale, which is visible in the ditch. The silt and lean clay classify as ML, ML-CL, and CL material by ASTM classification methods. Along the southern slope, the back fill height is about 47 feet at the highest point, with the back fill cut on a slope of about 2H to 2.5H:1V. The southern slope consists of silt, overlying lean clay on top of shale which is visible in the ditch. The silt and lean clay classify as ML, ML-CL, and CL material by ASTM classification methods. The ditches along both sides of the roadway are filled with cattails, a wetland plant that thrives in a wet environment.

Present guidelines in the EPG 321.1 would require slopes no steeper than 2.5H:1V for this material and old plan sheets show a 3H:1V slope was designed for this location. Both of these slides appear to be caused by water seepage into the silt material, most likely caused by sparse vegetation along the slope in addition to a water table that appears to be either perched in the silt or slowly draining at the toe of the slope. This drainage is creating a permanently saturated condition at the toe of the slope.

Rock Blanket Repair Recommendations for the Northern Slope (Sta 1526+50 to 1531+50)

Beginning at least 195 feet left of C/L (at the center of the area showing movement), excavate and bench the existing slope on a 1.5H:1V to 3 feet below the toe of the slope to remove the disturbed material. Any additional disturbed material remaining below the 1.5:1 slope should be removed. The excavation should be backfilled with rock fill meeting Specification 214 to reconstruct a slope no steeper than 2H:1V or flatter. The minimum thickness or the rock blanket shall be 6 feet. Geotextile shall be placed against the excavation slope to keep fines from infiltrating the rock fill. See Figure 1. The repair should extend a minimum of 10 feet outside of the sliding area.

Attention should be brought to the continued drainage of this excavation which may require additional excavation to allow for gravity drainage at the toe of this repair. If gravity drainage is not possible, it may be necessary to install a geotextile wrapped perforated drainage pipe placed at the back edge of the rock fill key. The perforated pipe should be connected to a non-perforated drainage pipe placed every 50 feet along the excavation area to outlet the water. It is also recommended to line the ditch along the slide location and beyond to promote gravity drainage away from the slide location.

Rock Blanket Repair Recommendations for the Southern Slope (Sta 1526+75 to 1533+50)

Beginning at least 205 feet right of C/L(at the center of the area showing movement), excavate and bench the existing slope on a 1.5H:1V to 3 feet below the toe of the slope to remove the disturbed material. Any additional disturbed material remaining below the 1.5:1 slope should be removed. The excavation should be backfilled with rock fill meeting Specification 214 to reconstruct a slope no steeper than 2H:1V or flatter. The minimum thickness or the rock blanket shall be 6 feet. Geotextile shall be placed against the excavation slope to keep fines from infiltrating the rock fill. See Figure 1. The repair should extend a minimum of 10 feet outside of the sliding area.

Attention should be brought to the continued drainage of this excavation which may require additional excavation to allow for gravity drainage at the toe of this repair. If gravity drainage is not possible, it may be necessary to install a geotextile wrapped perforated drainage pipe placed at the back edge of the rock fill key. The perforated pipe should be connected to a non-perforated drainage pipe placed every 50 feet along the excavation area to outlet the water. It is also recommended to line the ditch along the slide location and beyond to promote gravity drainage away from the slide location.

General Requirements

The Geotechnical Engineering Section recommends that the removal of the existing disturbed material be done in the shortest practical increments with rapid reconstruction to reduce the possibility of additional sliding beyond the temporary excavation. It is recommended to have rock on site during excavation to expedite placement. During the repair, any temporary construction surfaces shall be sloped and sealed as appropriate to prevent ponding and minimize infiltration of precipitation and runoff.

Drainage Repair Only

Both of these slides are very large, both horizontally and vertically, which makes a rock blanket repair very costly. After reviewing the aerial photos from April 2008 to October 2014, the additional movement within this slope has been minimal, but the ditch line has been a problem for maintenance and is wet year round. Another option would be to simply address drainage within the slope by installing aggregate drains. This repair may not be a permanent fix, but will reduce the water within the slope which can increase the strength of the soil. This may reduce or even prevent additional movement within the slope.

Aggregate Drains (See page 14-17 of Slide Repair Guidebook)

The top of the drain should extend a minimum of 5 feet past the slide scarp, although 10 feet past is preferable (at least 195 feet left of C/L for the northern slope and 205 feet right of C/L for the southern slope). The drains should extend a minimum of 10 feet below existing grade and slope towards the bottom of the slope, regardless of where the slide ends. The drains should be constructed approximately 30-inches wide and be installed on 20 to 40-foot centers within the slide area. See Figure 2.

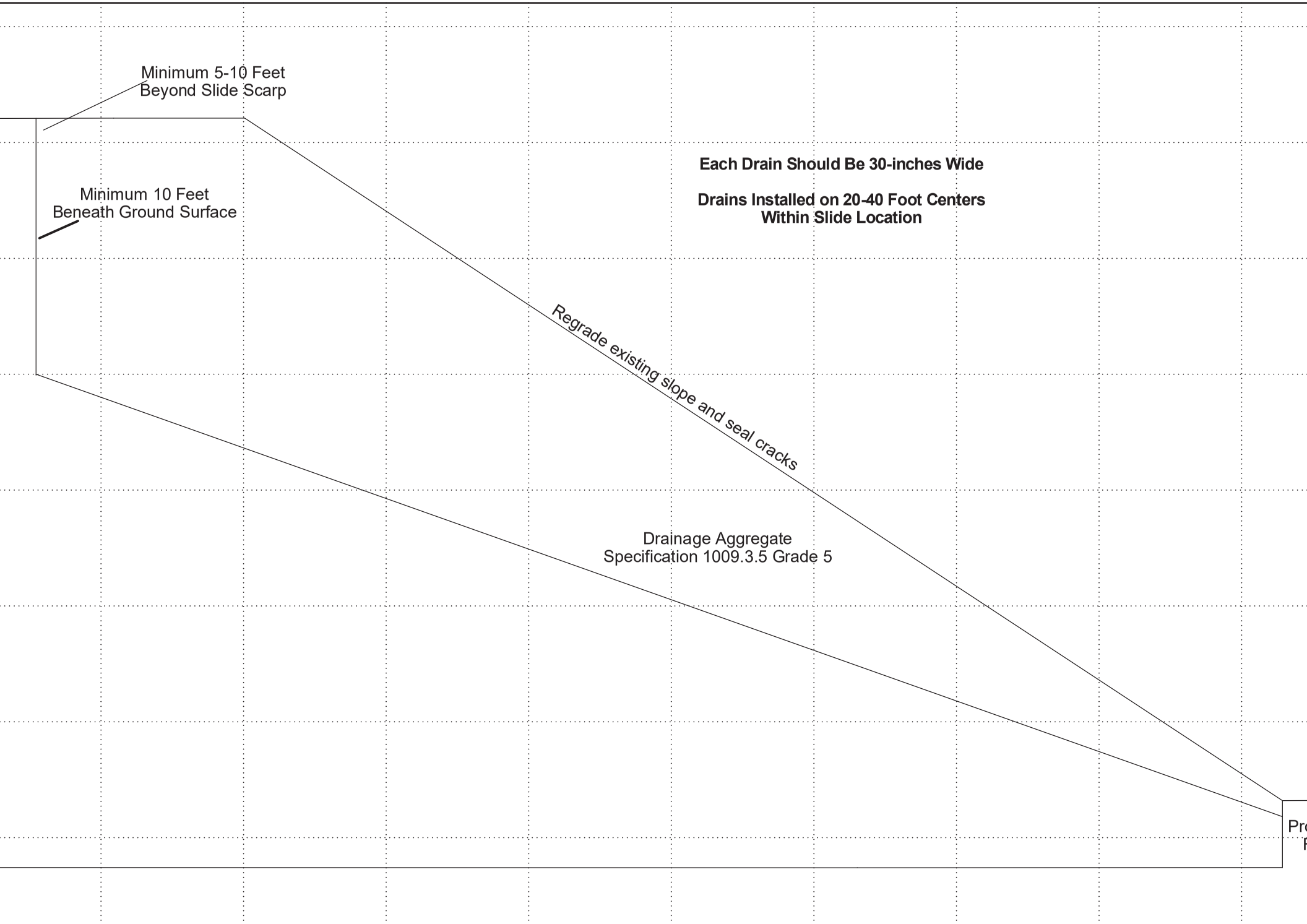
Drain material should consist of MoDOT Aggregate for Drainage in accordance with 1009.3.5 Grade 5. Pipes and separation fabric are not required in the drains. Once the drains are installed, the slope should be re-graded and any cracks in the ground surface, above the slide, should be sealed to prevent surface water from entering the slide. This can be accomplished by blading and tracking over cracks with a small dozer. Vegetation should be established as quickly as possible. The use of coconut fabric is recommended to promote vegetation growth.

Attention should be brought to the continued drainage of this excavation which may require additional excavation to allow for gravity drainage at the toe of this repair. It is also recommended to line the ditch along the slide location and beyond to promote gravity drainage away from the slide location.

lbb/kb
Attachments

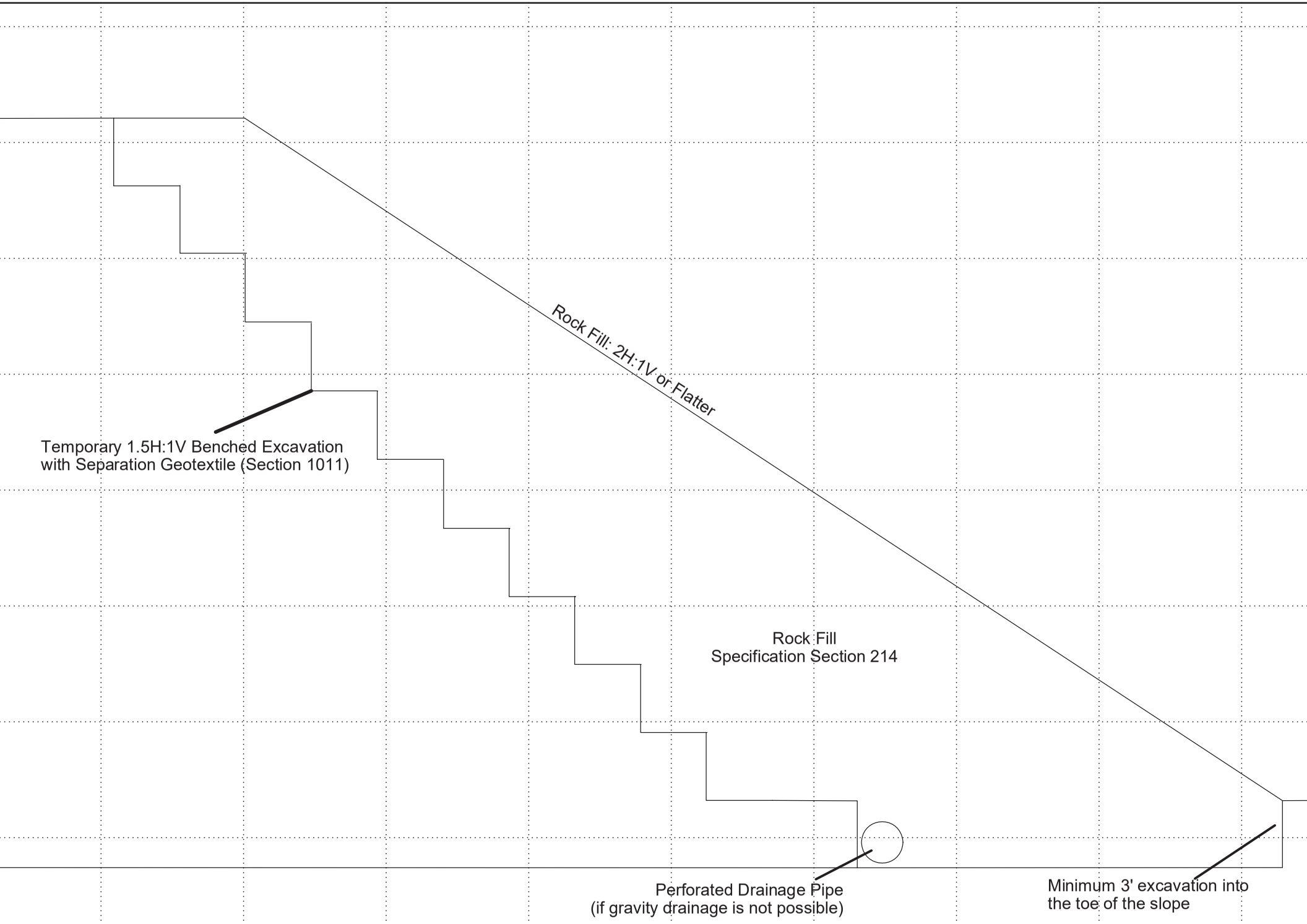
CLIENT

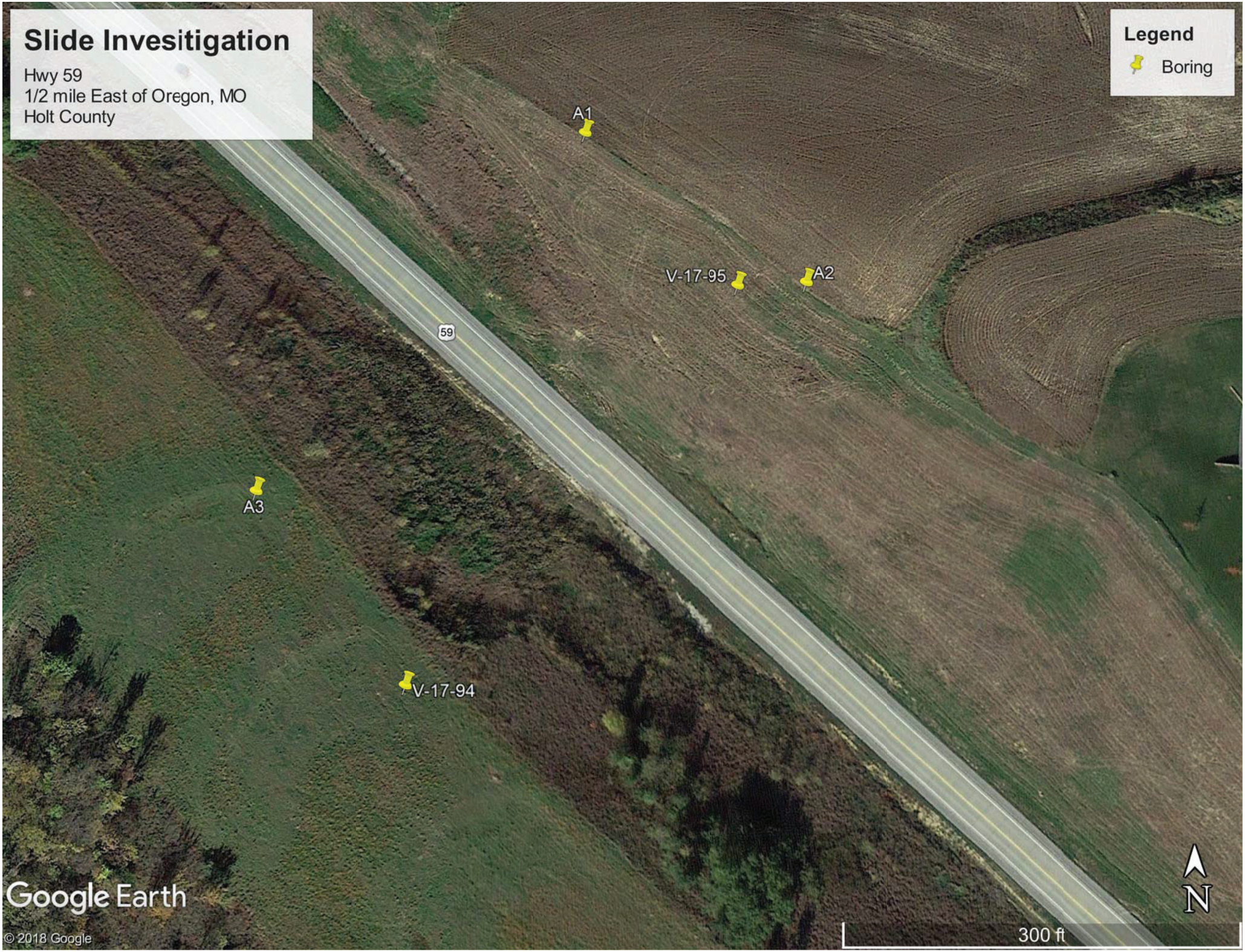
PROJECT NUMBER S2498



CLIENT

PROJECT NUMBER S2498




Slide Invesitigation
Hwy 59
1/2 mile East of Oregon, MO
Holt County
Legend
Boring
A1
V-17-95
A2
59
A3
V-17-94
Google Earth
© 2018 Google
N
300 ft

Missouri Department of Transportation
Construction and Materials

Job No.: S2498 **County:** Holt **Route:** 59
Design: S2498 **Skew:** **Location:** Holt County
Bent: **Logged By:** Lydia Brownell **Operator:** Kenny Mathews
Station: 1528+00 **Northing:** 1389681.658 **Date of Work:** 09/07/17-09/07/17
Offset: 170 L **Easting:** 2614423.289 **Depth to Water:** 15.7
Elevation: 1014.5 **Requested Northing:** **Depth Hole Open:** 15.7
Requested Station: **Requested Easting:** **Time Change:** 0 hours
Requested Offset: **Equipment:** Acker Renegade ,
Requested Elevation: **Location Note:**
Drill No.: G-9667 **Hammer Efficiency:** 76% **Drilling Method:** Continuous Flight Auger

Depth (ft)	Graphic	Description	Elevation (ft)	Sample Type	REC % (RQD %)	Blow Counts (N_{60})	Shear Data	Field Tests	Index Tests
0		0.0-7.5' Brown and tan, CLAYEY SILT, medium stiff, dry	1010						
10		7.5-23.0' Tan and gray, SILTY LEAN CLAY, very soft, moist, PAWT	1000						
20		23.0-28.0' Tan and gray, SILTY LEAN CLAY, medium stiff, moist	990						
30		28.0-37.6' Tan and gray, SANDY SILT, stiff to very stiff, moist to wet	980						
		37.6-38.0' Hard Rock Bottom of borehole at 38.0 feet.							

N_{60} = (Em/60)Nm N_{60} - Corrected N value for standard 60% SPT efficiency; Em - Measured hammer efficiency in percent; Nm - Observed N-value
(1) = Assumed, (2) = Actual

Coordinate System: Modified U.S. State Plane 1983 **Coordinate Zone:** Missouri West **Coordinate Proj. Factor:** 1.0000754
Coordinate Datum: NAD 83 (CONUS) **Coordinate Units:** U.S. Survey Feet

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Missouri Department of Transportation
Construction and Materials

BORING NO. A3

Job No.: S2498 **County:** Holt **Route:** 59
Design: S2498 **Skew:** **Location:** Holt County
Bent: **Logged By:** Lydia Brownell **Operator:** Kenny Mathews
Station: 1528+00 **Northing:** 1389416.377 **Date of Work:** 09/07/17-09/07/17
Offset: 195 R **Easting:** 2614172.397 **Depth to Water:** 26.5
Elevation: 1015.9 **Requested Northing:** **Depth Hole Open:** 26.5
Requested Station: **Requested Easting:** **Time Change:** 0 hours
Requested Offset: **Equipment:** Acker Renegade ,
Requested Elevation: **Location Note:**
Drill No.: G-9667 **Hammer Efficiency:** 76% **Drilling Method:** Continuous Flight Auger

Depth (ft)	Graphic	Description	Elevation (ft)	Sample Type	REC % (RQD %)	Blow Counts (N_{60})	Shear Data	Field Tests	Index Tests
0		0.0-5.0' Tan and brown, SILTY LEAN CLAY, medium stiff to stiff, dry							
		5.0-17.0' Brown and gray, SILTY LEAN CLAY, stiff, moist	1010						
10									
			1000						
		17.0-24.0' Gray to dark gray, SILT, stiff, moist, organic odor							
20									
		24.0-31.0' Tan, LEAN CLAY some sand, medium stiff, moist to wet	990						
30									
		31.0-40.0' Tan, SANDY LEAN CLAY scattered gravel, medium stiff, moist to wet	980						
40		Bottom of borehole at 40.0 feet.							

N_{60} = (Em/60)Nm N_{60} - Corrected N value for standard 60% SPT efficiency; Em - Measured hammer efficiency in percent; Nm - Observed N-value
(1) = Assumed, (2) = Actual

Coordinate System: Modified U.S. State Plane 1983 **Coordinate Zone:** Missouri West **Coordinate Proj. Factor:** 1.0000754
Coordinate Datum: NAD 83 (CONUS) **Coordinate Units:** U.S. Survey Feet

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Missouri Department of Transportation
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Job No.: S2498 **County:** Holt **Route:** 59
Design: S2498 **Skew:** **Location:** Holt County
Bent: **Logged By:** Lydia Brownell **Operator:** Kenny Mathews
Station: 1529+50 **Northing:** 1389562.146 **Date of Work:** 09/06/17-09/07/17
Offset: 140 L **Easting:** 2614535.539 **Depth to Water:**
Elevation: 1022.9 **Requested Northing:** **Depth Hole Open:** 11.2
Requested Station: **Requested Easting:** **Time Change:** End of Drilling
Requested Offset: **Equipment:** Acker Renegade ,Split-Spoon Sampler, Shelby Tube
Requested Elevation: **Location Note:**
Drill No.: G-9667 **Hammer Efficiency:** 76% **Drilling Method:** Hollow Stem Auger

Depth (ft)	Graphic	Description	Elevation (ft)	Sample Type	REC % (RQD %)	Blow Counts (N_{60})	Shear Data	Field Tests	Index Tests
0		0.0-7.5' Light gray and orange, CLAYEY SILT, stiff, dry to moist	1020						
					100			PP = 8.00 tsf	MC = 13.8% γ_{sat} = 139 pcf(1) LL = 34 PL = 21 Sieve Analysis Sieve # % Passing #10 100.0 #40 99.2 #200 98.8
5					64			PP = 1.50 tsf Torvane = 2.25 tsf	
		7.5-20.5' Brown and orange, SILTY LEAN CLAY, medium stiff to stiff, moist	1015			3-3-3		PP = 1.50 tsf	MC = 20.9% γ_{sat} = 129 pcf(1) LL = 34 PL = 26 Sieve Analysis Sieve # % Passing #10 100.0 #40 99.7 #200 99.0
10					48			PP = 1.25 tsf	MC = 23.7% γ_{sat} = 126 pcf(1)
			1010			3-2-4		PP = 0.75 tsf	MC = 24.5% γ_{sat} = 125 pcf(1) LL = 34 PL = 24 Sieve Analysis Sieve # % Passing #40 100.0 #200 99.7
15					76			PP = 1.00 tsf Torvane = 3.00 tsf	MC = 26.1% γ_{sat} = 124 pcf(1)
			1005			2-2-3		PP = 1.00 tsf	MC = 25.9% γ_{sat} = 124 pcf(1) LL = 35 PL = 22 Sieve Analysis Sieve # % Passing #10 100.0 #40 99.8 #200 98.7
20		20.5-22.5' Brown and orange, LEAN CLAY, medium stiff, moist			68			PP = 1.00 tsf Torvane = 2.50 tsf	MC = 26.5% γ_{sat} = 124 pcf(1)
		22.5-30.0' Brown and orange, LEAN CLAY scattered fine gravel, medium stiff to stiff, moist	1000			2-3-4		PP = 1.50 tsf	MC = 25.6% γ_{sat} = 124 pcf(1) LL = 43 PL = 21 Sieve Analysis Sieve # % Passing #10 100.0 #40 98.2 #200 92.3
25					48			PP = 1.75 tsf Torvane = 8.50 tsf	
			995			3-3-5		PP = 1.00 tsf	MC = 22.2% γ_{sat} = 128 pcf(1) MC = 23.2% γ_{sat} = 127 pcf(1) LL = 42
30									

N_{60} = (Em/60)Nm N_{60} - Corrected N value for standard 60% SPT efficiency; Em - Measured hammer efficiency in percent; Nm - Observed N-value
(1) = Assumed, (2) = Actual

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Coordinate Datum: NAD 83 (CONUS) **Coordinate Units:** U.S. Survey Feet

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Bent: **Logged By:** Lydia Brownell **Operator:** Kenny Mathews
Station: 1529+50 **Northing:** 1389562.146 **Date of Work:** 09/06/17-09/07/17
Offset: 140 L **Easting:** 2614535.539 **Depth to Water:**
Elevation: 1022.9 **Requested Northing:** **Depth Hole Open:** 11.2
Requested Station: **Requested Easting:** **Time Change:** End of Drilling
Requested Offset: **Equipment:** Acker Renegade ,Split-Spoon Sampler, Shelby Tube
Requested Elevation: **Location Note:**
Drill No.: G-9667 **Hammer Efficiency:** 76% **Drilling Method:** Hollow Stem Auger

Depth (ft)	Graphic	Description	Elevation (ft)	Sample Type	REC % (RQD %)	Blow Counts (N_{60})	Shear Data	Field Tests	Index Tests
30									
		30.0-35.0' Tannish brown and gray, SILTY SAND, medium stiff, moist to wet, fine grained			88			PP = 1.50 tsf	PL = 18 Sieve Analysis Sieve # % Passing 3/8" 100.0 #4 99.1 #10 98.9 #40 93.0 #200 73.1
		▽ 31.7-31.7' Water encountered.	990			5-4-6		PP = 0.50 tsf	
35									MC = 23.2% γ_{sat} = 127 pcf(1) LL = NP Sieve Analysis Sieve # % Passing 3/8" 100.0 #4 99.9 #10 99.8 #40 91.3 #200 71.3
		35.0-40.0' Tannish brown and gray, LEAN CLAY scattered fine gravel, very stiff, moist			72			PP = 4.25 tsf	
		37.0-38.5' sand seam	985			6-8-6		PP = 2.00 tsf	
40									MC = 27.5% γ_{sat} = 123 pcf(1)
		40.0-41.5' Tan and gray, LEAN CLAY with shale, hard, moist				3-5-7		PP = 4.50 tsf	MC = 18.2% γ_{sat} = 133 pcf(1) LL = 31 PL = 16 Sieve Analysis Sieve # % Passing 3/8" 100.0 #4 99.6 #10 99.0 #40 97.4 #200 71.0
		Bottom of borehole at 41.5 feet.							MC = 23.9% γ_{sat} = 126 pcf(1)

N_{60} = (Em/60)Nm N_{60} - Corrected N value for standard 60% SPT efficiency; Em - Measured hammer efficiency in percent; Nm - Observed N-value
(1) = Assumed, (2) = Actual

Coordinate System: Modified U.S. State Plane 1983 **Coordinate Zone:** Missouri West **Coordinate Proj. Factor:** 1.0000754
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LETTER BOREHOLE - MODOT 20150728.GDT - 9/7/18 15:54 - Z:\SG\GINT\PROJECT FILES\S2498_HWY59_HOLT.GPJ

Missouri Department of Transportation
Construction and Materials

Job No.: S2498 **County:** Holt **Route:** 59
Design: S2498 **Skew:** **Location:** Holt County
Bent: **Logged By:** Lydia Brownell **Operator:** Kenny Mathews
Station: 1529+88 **Northing:** 1389272.085 **Date of Work:** 09/06/17-09/06/17
Offset: 240 R **Easting:** 2614284.665 **Depth to Water:**
Elevation: 1027.6 **Requested Northing:** **Depth Hole Open:** 3.2
Requested Station: **Requested Easting:** **Time Change:** 8 hours
Requested Offset: **Equipment:** Acker Renegade ,Split-Spoon Sampler, Shelby Tube
Requested Elevation: **Location Note:**
Drill No.: G-9667 **Hammer Efficiency:** 76% **Drilling Method:** Hollow Stem Auger

Depth (ft)	Graphic	Description	Elevation (ft)	Sample Type	REC % (RQD %)	Blow Counts (N_{60})	Shear Data	Field Tests	Index Tests
0		0.0-7.5' Light brown, LEAN CLAY, stiff, dry to moist	1025						
					76			PP = 9.00 tsf	MC = 14.9% γ_{sat} = 137 pcf(1) LL = 34 PL = 22 Sieve Analysis Sieve # % Passing #40 100.0 #200 99.7
5					76			PP = 1.25 tsf	
		7.5-14.0' Light brown and orange, CLAYEY SILT, very stiff, moist	1020			4-4-4		PP = 2.25 tsf	MC = 25.6% γ_{sat} = 124 pcf(1) LL = 34 PL = 25 Sieve Analysis Sieve # % Passing #10 100.0 #40 99.9 #200 99.6
10					40			PP = 3.50 tsf Torvane = 5.00 tsf	MC = 21.7% γ_{sat} = 128 pcf(1)
			1015			2-3-4		PP = 4.00 tsf	MC = 24.4% γ_{sat} = 126 pcf(1) LL = 36 PL = 25 Sieve Analysis Sieve # % Passing #40 100.0 #200 99.7
15		14.0-16.5' Gray, SILT, stiff, moist			84			PP = 3.50 tsf Torvane = 4.00 tsf	MC = 22.4% γ_{sat} = 128 pcf(1)
		16.5-22.5' Dark brown and gray, SILT with organics, stiff, moist, (tree pieces and roots and an organic odor)	1010			3-4-6		PP = 1.50 tsf	MC = 24.6% γ_{sat} = 125 pcf(1) LL = 36 PL = 26 Sieve Analysis Sieve # % Passing #40 100.0 #200 99.8
20					64			PP = 1.75 tsf Torvane = 5.00 tsf	MC = 26.1% γ_{sat} = 124 pcf(1)
			1005			3-4-4		PP = 0.50 tsf	MC = 25.5% γ_{sat} = 124 pcf(1) LL = 31 PL = 24 Sieve Analysis Sieve # % Passing #10 100.0 #40 99.9 #200 99.6
25		22.5-25.0' Tan and orange, SILTY LEAN CLAY trace organics, medium stiff, moist							
		25.0-35.0' Tan and orange, SILTY LEAN CLAY, medium stiff to soft, moist to wet, Water @ 30'. Water poured out of top of shelby tube @ 35'			60			PP = 0.75 tsf Torvane = 4.25 tsf	MC = 25.6% γ_{sat} = 124 pcf(1)
			1000			0-1-2		PP = 0.25 tsf	MC = 27.6% γ_{sat} = 122 pcf(1) LL = 39 PL = 22 Sieve Analysis
30		▽							

N_{60} = (Em/60)Nm N_{60} - Corrected N value for standard 60% SPT efficiency; Em - Measured hammer efficiency in percent; Nm - Observed N-value
(1) = Assumed, (2) = Actual

Coordinate System: Modified U.S. State Plane 1983 **Coordinate Zone:** Missouri West **Coordinate Proj. Factor:** 1.0000754
Coordinate Datum: NAD 83 (CONUS) **Coordinate Units:** U.S. Survey Feet

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Missouri Department of Transportation
Construction and Materials

Job No.: S2498 **County:** Holt **Route:** 59
Design: S2498 **Skew:** **Location:** Holt County
Bent: **Logged By:** Lydia Brownell **Operator:** Kenny Mathews
Station: 1529+88 **Northing:** 1389272.085 **Date of Work:** 09/06/17-09/06/17
Offset: 240 R **Easting:** 2614284.665 **Depth to Water:**
Elevation: 1027.6 **Requested Northing:** **Depth Hole Open:** 3.2
Requested Station: **Requested Easting:** **Time Change:** 8 hours
Requested Offset: **Equipment:** Acker Renegade ,Split-Spoon Sampler, Shelby Tube
Requested Elevation: **Location Note:**
Drill No.: G-9667 **Hammer Efficiency:** 76% **Drilling Method:** Hollow Stem Auger

Depth (ft)	Graphic	Description	Elevation (ft)	Sample Type	REC % (RQD %)	Blow Counts (N_{60})	Shear Data	Field Tests	Index Tests
30		25.0-35.0' Tan and orange, SILTY LEAN CLAY, medium stiff to soft, moist to wet, Water @ 30'. Water poured out of top of shelby tube @ 35' *(continued)* 30.0' Groundwater encountered.	995		88			PP = 0.50 tsf Torvane = 3.25 tsf	Sieve # % Passing #40 100.0 #200 99.7 MC = 28.1% γ_{sat} = 122 pcf(1)
						2-3-4		PP = 0.75 tsf	MC = 28.3% γ_{sat} = 122 pcf(1) LL = 33 PL = 23 Sieve Analysis
35		35.0-40.0' Tannish brown and orange, LEAN CLAY scattered fine gravel, trace sand, stiff, moist 35.0-37.5' Water poured out of top of shelby tube.	990		64			PP = 2.00 tsf Torvane = 7.00 tsf	Sieve # % Passing #10 100.0 #40 99.7 #200 97.7 MC = 26.0% γ_{sat} = 124 pcf(1)
						2-3-5		PP = 1.50 tsf	MC = 25.5% γ_{sat} = 125 pcf(1) LL = 42 PL = 20 Sieve Analysis
40		40.0-45.0' Shale, tan and gray, soft	985		84			PP = 2.50 tsf Torvane = 9.00 tsf	Sieve # % Passing 3/8" 100.0 #4 99.7 #10 99.7 #40 96.4 #200 87.7
						6-8-12		PP = 8.50 tsf	MC = 21.9% γ_{sat} = 128 pcf(1)
45		45.0-46.5' Orangish tan and gray, SANDY LEAN CLAY scattered fine gravel, very stiff, moist Bottom of borehole at 46.5 feet.				5-8-13		PP = 4.00 tsf	MC = 27.7% γ_{sat} = 122 pcf(1) LL = 57 PL = 24 Sieve Analysis Sieve # % Passing #4 100.0 #10 99.9 #40 98.9 #200 90.3

N_{60} = (Em/60)Nm N_{60} - Corrected N value for standard 60% SPT efficiency; Em - Measured hammer efficiency in percent; Nm - Observed N-value
(1) = Assumed, (2) = Actual

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Coordinate Datum: NAD 83 (CONUS) **Coordinate Units:** U.S. Survey Feet

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Missouri Department of Transportation
Construction and Materials

BORING NO. A2

Job No.: S2498 **County:** Holt **Route:** 59
Design: S2498 **Skew:** **Location:** Holt County
Bent: **Logged By:** Lydia Brownell **Operator:** Kenny Mathews
Station: 1530+00 **Northing:** 1389562.146 **Date of Work:** 09/07/17-09/07/17
Offset: 195 L **Easting:** 2614585.539 **Depth to Water:** 8.4
Elevation: 1027.9 **Requested Northing:** **Depth Hole Open:** 8.4
Requested Station: **Requested Easting:** **Time Change:** 0 hours
Requested Offset: **Equipment:** Acker Renegade ,
Requested Elevation: **Location Note:**
Drill No.: G-9667 **Hammer Efficiency:** 76% **Drilling Method:** Continuous Flight Auger

Depth (ft)	Graphic	Description	Elevation (ft)	Sample Type	REC % (RQD %)	Blow Counts (N_{60})	Shear Data	Field Tests	Index Tests
0		0.0-5.0' Tan and gray, CLAYEY SILT, stiff to medium stiff, dry							
		5.0-12.0' Tan and gray, SILTY LEAN CLAY, medium stiff to soft, moist	1020						
10		12.0-22.5' Tan and gray, SILTY LEAN CLAY, very soft, moist							
			1010						
20		22.5-30.0' Tan and gray, LEAN CLAY, medium stiff to stiff, moist							
			1000						
30		30.0-36.5' Tan and gray, SANDY SILT, stiff, moist to wet							
		36.5-43.0' Tan and gray, SANDY SILT, stiff to very stiff, moist to wet	990						
40		Bottom of borehole at 43.0 feet.							

N_{60} = (Em/60)Nm N_{60} - Corrected N value for standard 60% SPT efficiency; Em - Measured hammer efficiency in percent; Nm - Observed N-value
(1) = Assumed, (2) = Actual

Coordinate System: Modified U.S. State Plane 1983 **Coordinate Zone:** Missouri West **Coordinate Proj. Factor:** 1.0000754
Coordinate Datum: NAD 83 (CONUS) **Coordinate Units:** U.S. Survey Feet

* Persons using this information are cautioned that the materials shown are determined by the equipment noted and accuracy of the "log of materials" is limited thereby and by judgement of the operator. THIS INFORMATION IS FOR DESIGN PURPOSES ONLY.

LETTER BOREHOLE - MODOT 20150728.GDT - 9/7/18 15:53 - Z:\SG\GINT\PROJECT FILES\S2498_HWY59_HOLT.GPJ

Photos of Northern Slope

Northern slope looking north.

Northern slope looking northeast.

Sparse vegetation along northern slope.

Photos of Southern Slope (September 2017)

Southern Slope

Cattails in southern ditch line.

Southern Slope

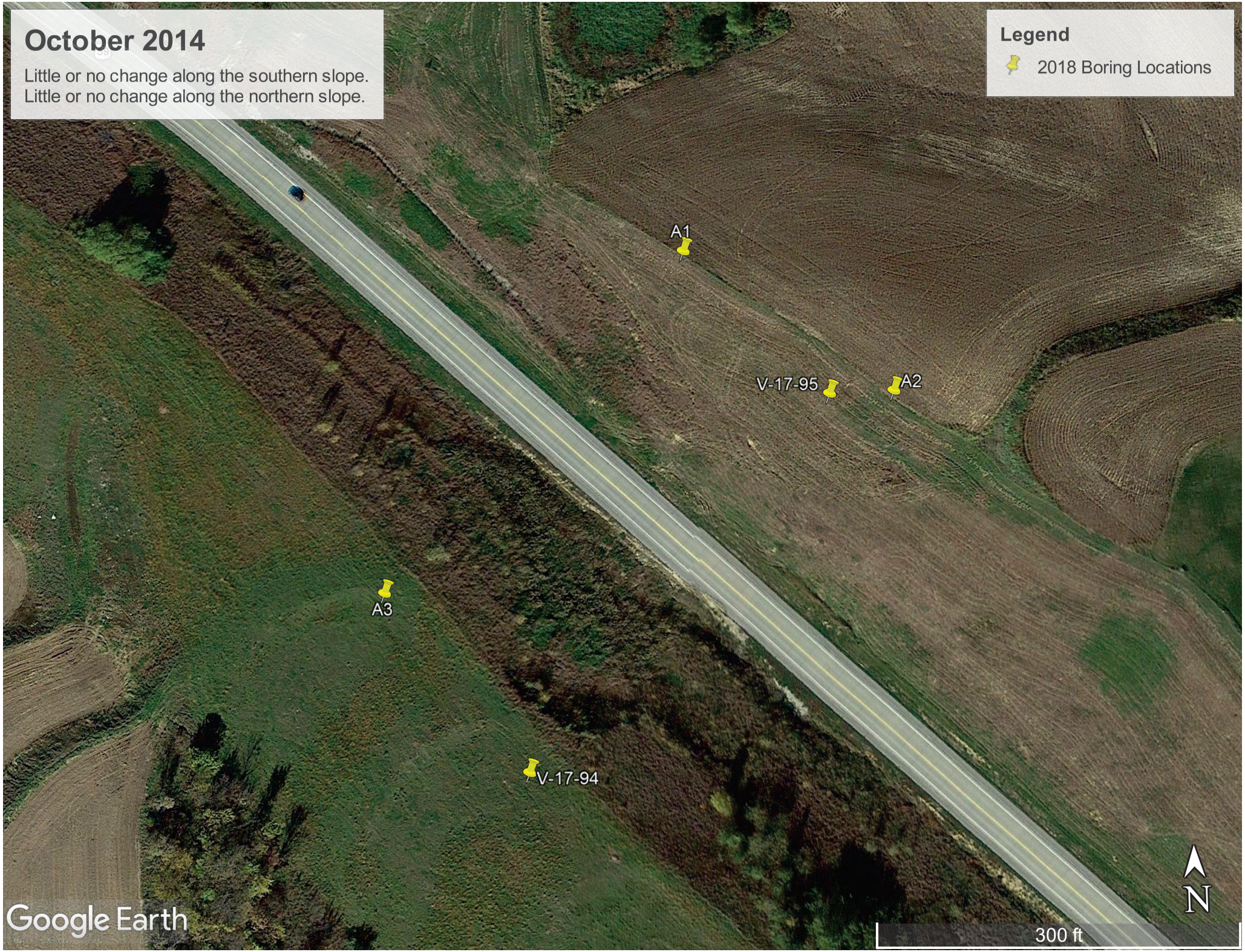
Filled ditch beneath southern slope.

Cracks along upper surface of southern slope.


April 2008
Evidence of failure along the southern slope.
Legend
2018 Boring Locations
A1
V-17-95
A2
A3
V-17-94
Google Earth
Image U.S. Geological Survey
N
300 ft


August 2010
Additional movement along the southern slope
Vegetation loss along the northern slope that could be due to failure.
Legend
2018 Boring Locations
A1
V-17-95
A2
A3
V-17-94
N
300 ft
Google Earth


September 2012
Little or no change along the southern slope.
Little or no change along the northern slope.
Legend
2018 Boring Locations
A1
V-17-95
A2
A3
V-17-94
Google Earth
N
300 ft


October 2014
Little or no change along the southern slope.
Little or no change along the northern slope.
Legend
2018 Boring Locations
A1
V-17-95
A2
A3
V-17-94
N
300 ft
Google Earth

KEY TO SYMBOLS

MoDOT - Geotechnical Section
1617 Missouri Boulevard
Jefferson City, Missouri 65109

CLIENT _____ **PROJECT NAME** Holt County Slide

PROJECT NUMBER S2498 **PROJECT LOCATION** Holt County

LITHOLOGIC SYMBOLS
(Unified Soil Classification System)

- Bedrock
- USCS High Plasticity Clay
- USCS Low Plasticity Clay
- USCS Low Plasticity Gravelly Clay
- USCS Low Plasticity Silty Clay
- USCS Low Plasticity Sandy Clay
- USCS Silt
- USCS Gravelly Silt
- USCS Sandy Silt
- Shale
- USCS Silty Sand

SAMPLER SYMBOLS

- Split-Spoon Sampler
- Shelby Tube

WELL CONSTRUCTION SYMBOLS

ABBREVIATIONS

LL - LIQUID LIMIT (%)
PI - PLASTIC INDEX (%)
W - MOISTURE CONTENT (%)
DD - DRY DENSITY (PCF)
NP - NON PLASTIC
-200 - PERCENT PASSING NO. 200 SIEVE
PP - POCKET PENETROMETER (TSF)
Qu - UNCONFINED COMPRESSIVE STRENGTH (PSF)

TV - TORVANE
PID - PHOTOIONIZATION DETECTOR
UC - UNCONFINED COMPRESSION
ppm - PARTS PER MILLION

▽ Water Level at Time of Drilling

▼ Water Level at End of Drilling

▼ Water Level after Drilling