

at which the soil can be rolled into 1/8-inch diameter threads without crumbling. The plasticity index (PI) is the difference between the liquid limit and the plastic limit, and is the range of moisture content over which a soil deforms as a plastic material.

Pocket Penetrometer

The pocket penetrometer is a hand-held, spring-loaded rod that measures the penetration resistance of soil. It is used to gauge the approximate unconfined compressive strength of cohesive soils. The strength is measured by applying pressure to the end of the penetrometer thereby pushing the rod tip a prescribed distance into the soil. The unconfined compressive strength is read directly from a scale or gauge on the device.

Laboratory Procedures

General

Laboratory tests are generally conducted to satisfy one or more of the following objectives: (1) confirmation of visual-manual soil identification; (2) determination of index values used to estimate soil engineering properties (i.e., strength, compressibility and permeability); or (3) direct measurement of specific soil properties. The tests selected for a given project are dependent on the subsurface conditions encountered, as well as specific project requirements, such as structural loads and planned grade changes. The results of the laboratory tests conducted for this project are listed on the **Boring Records**, Laboratory Test Data Summary, or laboratory data curves in the **Appendix**. Brief descriptions of the test procedures are provided below.

Description and Identification of Soils (Visual-Manual Procedure) (ASTM D 2488)

The Visual-Manual Procedure provides a general guide to the engineering properties of soils and enables the engineer to apply past experience to current situations. Samples obtained during the field exploration are examined and visually described and identified by a geotechnical engineer or geologist. The soils are typically identified according to predominant particle size (clay, silt, sand, etc.), consistency (based on apparent stiffness and the number of blows from standard penetration tests), color, moisture and group symbol (CL, CH, SP, SC, etc.). Unless otherwise indicated, the soil descriptions in this report are based on the Visual-Manual Procedure.

Classification of Soils for Engineering Purposes (Unified Soil Classification System) (ASTM D 2487)

The Visual-Manual Procedure described above is primarily qualitative. The Unified Soil Classification System (USCS) is used when precise soil classification is required. The USCS is based on laboratory determination of particle-size characteristics, liquid limit, and plasticity index. Using these test results, the soil can be classified according to the Unified Classification System, which provides an index for estimating soil behavior.

Water (Moisture) Content of Soil (ASTM D 2216)

Moisture content is one of the most important index properties used in establishing a correlation between soil behavior and soil properties such as strength and compressibility. The moisture content, along with the liquid and plastic limits, are used to express the relative consistency or liquidity index of a soil. Increasing moisture contents typically reflect lower strengths for a given soil. The soil moisture content is the ratio, expressed as a percentage, of the mass of "pore" or "free" water in a given mass of soil to the mass of the solid soil. Moisture content samples are taken from the sealed container obtained during the field exploration phase of a project. Each sample is weighed, and then placed in an oven set to $110^{\circ}\text{C} \pm 5^{\circ}\text{C}$. Each sample remains in the oven until the free moisture evaporates. Each dried sample is removed from the oven, allowed to cool, and then weighed. The moisture content is computed by dividing the weight of evaporated water by the weight of the dry sample.

Liquid Limit, Plastic Limit, and Plasticity Index of Soils (ASTM D 4318)

Depending upon the relative moisture content, a fine-grained soil may occur in a liquid, plastic, or solid state. In current usage, the liquid limit (LL) and plastic limit (PL) of a soil are referred to as the "Atterberg Limits", which establish the approximate moisture contents at which the soil changes state. This test method is an integral part of several engineering classification systems to characterize the fine grained fractions of soils. It is also used with other soil properties to correlate with engineering behavior such as compressibility, permeability, compactability, shrink-swell, and shear strength. The liquid limit is the moisture content at which a soil becomes sufficiently "wet" to behave as a heavy viscous fluid (i.e., transition from plastic to liquid state). It is defined as the moisture content at which the soil, when placed in a standard brass bowl, makes a 1/2-inch closure in a groove cut through the soil after the bowl is dropped 25 times at a specified height and rate. The plastic limit is the moisture content at which the soil begins to lose its plasticity (i.e., transition from plastic to semi-solid state). It is defined as the lowest moisture content

Field Procedures

General

ECS conducts field sampling and testing procedures in general accordance with methods of the American Society for Testing Materials (ASTM) and widely accepted geotechnical engineering standards. A brief description of the procedures we utilize is provided in the following paragraphs.

Boring Locations and Elevations

Boring locations typically are selected by our project manager. The project manager establishes the boring locations in the field by pacing or measuring distances and estimating angles relative to existing site landmarks. When topographic plans of the site are provided, the project manager estimates the surface elevation of the boring locations using available information. Surveying to determine the locations and elevations of the borings is beyond the scope of typical geotechnical studies; therefore, the boring locations and elevations should be considered approximate.

Dynamic Cone Penetrometer Tests (ASTM STP-399)

The Dynamic Cone Penetrometer (DCP) uses a 15 lb (6.8 kg) steel mass falling 20 in (50.8 cm) that strikes an anvil to cause penetration of a 1.5 in (3.8 cm) diameter cone (45° vertex angle) that has been seated in the bottom of a hand augered hole. The blows required to drive the embedded cone a depth of 1-3/4 in have been correlated to N values derived from the Standard Penetration Test (SPT). Experience has shown that the DCP can be used effectively in augered holes to depths of 15 to 20 ft. (4.6 to 6.1 m).

Boring Records

Our interpretation of the conditions encountered at each location is indicated on the **Boring Records**, which are prepared from the observations of the ECS field engineer or geologist during drilling or excavation, our engineering review of the soil samples obtained, the results of laboratory testing on selected samples, and our experience with similar subsurface conditions. Soil descriptions are made using the Unified Soil Classification System and/or ASTM D-2488 as guides. The depths designating strata changes are estimations and only representative of depths at that specific boring location. In many geologic settings, the transition between strata is gradual. A **Boring Legend**, which defines the symbols and other pertinent information presented on the **Boring Records**, is provided with this report. The subsurface conditions indicated on our **Boring Records** represent only the conditions encountered at the specific boring location at the time of our exploration. The groundwater observations were made at the time of drilling and may vary with changes in the season and weather.

Refusal

Refusal is the term applied to material that cannot be penetrated with augers or has a standard penetration resistance exceeding 50 blows per 6-inch increment. Refusal may be encountered on continuous bedrock, discontinuous floaters, cemented soil, weathered rock, debris, buried structures, or other hard subsurface materials. Refusal materials can be evaluated only by obtaining a core of the material. This limitation must be considered when evaluating refusal depths where coring is not conducted.



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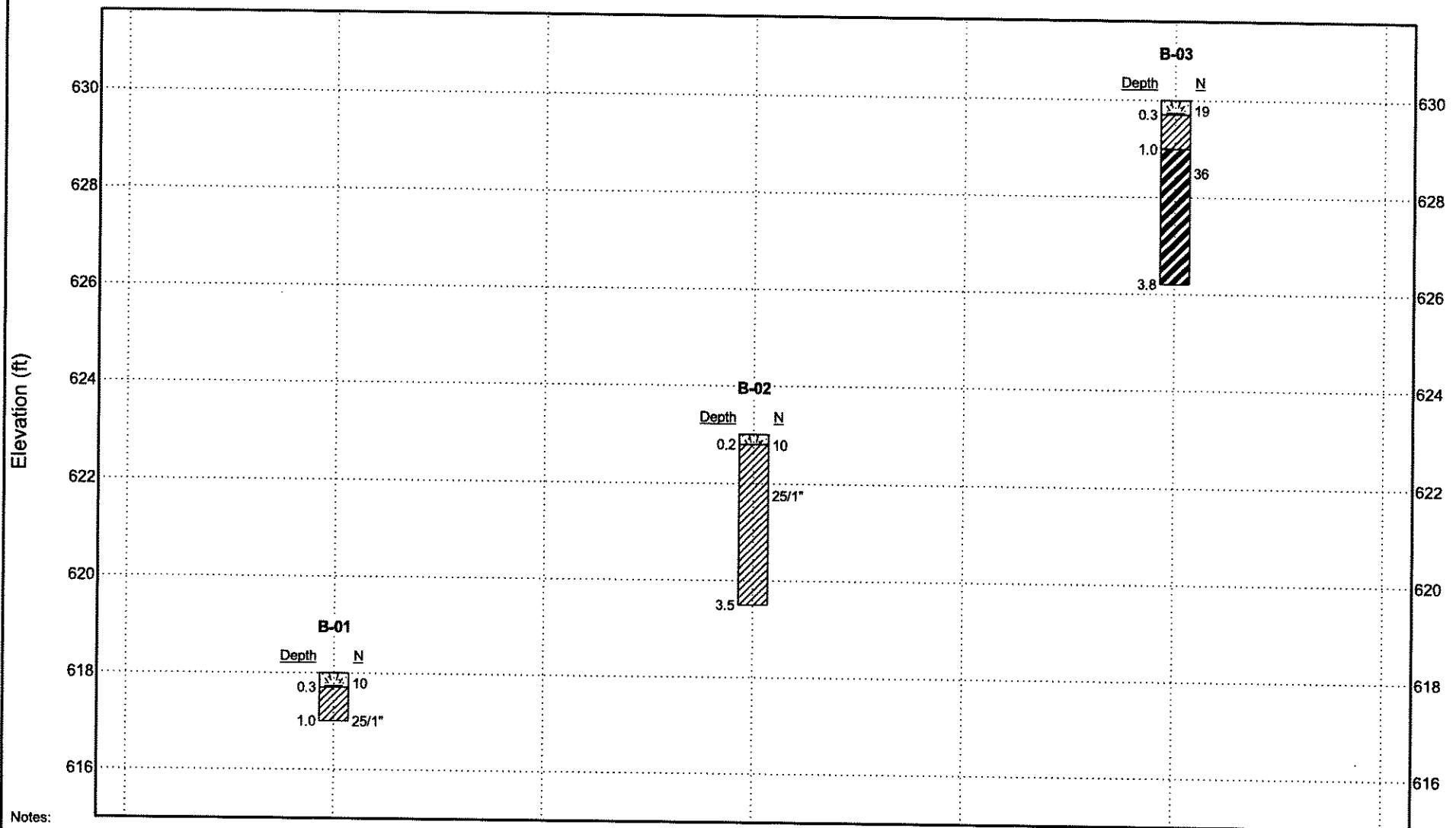
CLIENT Long Run Creek Properties, LLC

PROJECT NUMBER 61-2863RI

BORING COMPOSITE - Revision I

PROJECT NAME Slope Evaluation and Karst Survey - 2405 Echo Trail

PROJECT LOCATION 2405 Echo Trail, Louisville, KY 40425



Notes:

Ground surface elevations interpolated to ± 1.0 feet based on a drawing "22-ZONEPA-0110 - 22-09-12 (FILED)", provided by Allison Hicks of Mindel Scott, dated September 9, 2022.

Location of borings along the horizontal axis are not indicative of actual spacing

Received Feb. 27. 2023

Planning & Design

22-ZONE-0131



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1762 Watterson Trail
Louisville, KY 40299

BORING RECORD

Project Name **Slope Evaluation and Karst Survey - 2405 Echo Trail**
 Location **2405 Echo Trail, Louisville, KY 40425**
 Client **Long Run Creek Properties, LLC**
 Driller **B. Emery/B. Kabbes** Rig Type **DCP**
 Drill Method **Hand Auger** Hammer Type **Manual**
 Groundwater **Not Encountered ATD**

Boring No. **B-03**
 Project No. **61-2863R1**
 Elevation **630 (a)**
 Started **11/03/2022**
 Completed **11/03/2022**
 Logged By **B. Kabbes**
 Weather **60s, Sunny**

Scale, ft.	Elevation, ft.	Soil Symbol	Material Description and Classification	Depth, ft.	Sample Type	Sample Depth, ft.	Recovery, %	DCP Penetration Test Blows	Ne Value	Water Content, %	Uc, tsf	Comments
			TOPSOIL (4 inches)									
				0.3		0.0 - 0.4		6-8-11	9			Two borings were extended at approximately 1 foot spacing. DCP testing was performed in one boring while an undisturbed sample was collected in the adjacent boring. A drive rod was offset an additional 1 foot and driven to refusal.
			CLAY, silty, yellow to medium brown, low plasticity, stiff, dry, (CL), with few root fibers									
1	629			1.0								Undisturbed sample was obtained from approximately 1.0 to 2.0 feet below existing grade.
			CLAY, silty, orange to medium brown, moderate to high plasticity, hard, dry to slightly moist, (CH), with few root fibers and weathered rock fragments			1.0 - 2.0	88	10-15-21	18	23.1		Hand Auger Refusal was encountered at approximately 1.8 to 1.9 feet below existing grades.
2	628											Liquid Limit: 76 Plastic Limit: 27 Plasticity Index: 49
			- mostly weathered rock fragments below 1.8 feet									
3	627											
				3.8								
4	626		Boring Terminated at Drive Rod Refusal									

Remarks: (a) Ground surface elevations interpolated to ± 1.0 feet based on a drawing "22-ZONEPA-0110 - 22-09-12 (FILED)", provided by Allison Hicks of Mindel Scott, dated September 9, 2022.

Sheet 1 of 1

**ECS Southeast, LLP**1762 Watterson Trail
Louisville, KY 40299**BORING RECORD**

Project Name **Slope Evaluation and Karst Survey - 2405 Echo Trail**
 Location **2405 Echo Trail, Louisville, KY 40425**
 Client **Long Run Creek Properties, LLC**
 Driller **B. Emery/B. Kabbes** Rig Type **DCP**
 Drill Method **Hand Auger** Hammer Type **Manual**
 Groundwater **Not Encountered ATD**

Boring No. **B-02**
 Project No. **61-2863R1**
 Elevation **623 (a)**
 Started **11/03/2022**
 Completed **11/03/2022**
 Logged By **B. Kabbes**
 Weather **60s, Sunny**

Scale, ft.	Elevation, ft.	Soil Symbol	Material Description and Classification	Depth, ft.	Sample Type	Sample Depth, ft.	Recovery, %	DCP Penetration Test Blows	Ne Value	Water Content, %	Uc, tsf	Comments
			TOPSOIL (2 inches)	0.2		0.0 - 0.4		7-4-6	5			Two borings were extended at approximately 1 foot spacing. DCP testing was performed in one boring while an undisturbed sample was collected in the adjacent boring. A drive rod was offset an additional 1 foot and driven to refusal.
1	622		CLAY, silty, yellow to medium brown, low plasticity, firm, dry, (CL), with few root fibers									
						1.0 - 1.5	66	10-25/1"	25/1"	14.6		DCP Refusal was encountered at approximately 1.2 feet below existing grade.
			- mostly weathered rock fragments below 1.6 feet									Undisturbed sample was obtained from approximately 1.0 to 1.5 feet below existing grade.
2	621											Hand Auger Refusal was encountered at approximately 1.5 feet below existing grade.
												Liquid Limit: 46 Plastic Limit: 20 Plasticity Index: 26
3	620											
				3.5								Boring Terminated at Drive Rod Refusal
4	619											

Remarks: (a) Ground surface elevations interpolated to ± 1.0 feet based on a drawing "22-ZONEPA-0110 - 22-09-12 (FILED)", provided by Allison Hicks of Mindel Scott, dated September 9, 2022.

Sheet 1 of 1

**ECS Southeast, LLP**1762 Watterson Trail
Louisville, KY 40299**BORING RECORD**

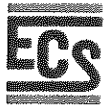
Project Name **Slope Evaluation and Karst Survey - 2405 Echo Trail**
 Location **2405 Echo Trail, Louisville, KY 40425**
 Client **Long Run Creek Properties, LLC**
 Driller **B. Emery/B. Kabbes** Rig Type **DCP**
 Drill Method **Hand Auger** Hammer Type **Manual**
 Groundwater **Not Encountered ATD**

Boring No. **B-01**
 Project No. **61-2863RI**
 Elevation **618 (a)**
 Started **11/03/2022**
 Completed **11/03/2022**
 Logged By **B. Kabbes**
 Weather **60s, Sunny**

Scale, ft.	Elevation, ft.	Soil Symbol	Material Description and Classification	Depth, ft.	Sample Type	Sample Depth, ft.	Recovery, %	DCP Penetration Test Blows	N _e Value	Water Content, %	Uc, tsf	Comments
			TOPSOIL (4 inches), with trace rock fragments									
				0.3		0.0 - 0.4		4-6	5			
			CLAY, silty, sandy, orange to medium brown, low plasticity, firm, very moist to wet, (CL), with trace root fibers									
			- mostly rock fragments below 0.8 feet									
1	617			1.0		1.0 - 1.0		25/1"	25/1"			Hand Auger Refusal encountered approximately 0.8 feet below existing grade.
			Boring Terminated at Drive Rod Refusal									
2	616											
3	615											
4	614											

Remarks: (a) Ground surface elevations interpolated to ± 1.0 feet based on a drawing "22-ZONEPA-0110 - 22-09-12 (FILED)", provided by Allison Hicks of Mindel Scott, dated September 9, 2022.

Sheet 1 of 1



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1762 Watterson Trail
Louisville, KY 40299

BORING RECORD LEGEND

Scale, ft.	Elevation, ft.	Soil Symbol	Material Description and Classification	Depth, ft.	Sample Type	Sample Depth, ft.	Recovery, %	DCP Penetration Test Blows	Ne Value	Water Content, %	Uc, tsf	Comments
			TOPSOIL									<p>Scale - Proportional distance below the surface.</p> <p>Elevation - Vertical distance above or below a benchmark.</p> <p>Soil Symbol - Graphic representation of subsurface material.</p> <p>Material Description - Account of encountered materials based on ASTM D-2488.</p> <p>Depth - Distance below the surface to a strata as measured in the field.</p> <p>Sample Type - Method for collecting soil or rock specimens.</p> <p>Sample Depth - Collected specimen interval.</p> <p>Recovery - Percentage of recovered sample material.</p> <p>DCP Penetration Test Blows - Number of blows to drive a dynamic cone penetrometer three 1.75" increments with a 15-lb. hammer falling 20".</p> <p>Ne Value - Number of blows to drive the dynamic cone penetrometer the final foot. These blow counts have not been corrected for hammer efficiency or other applicable factors. The manual hammer, if used, has an estimated efficiency of 60%. The automatic hammer, if used, has an estimated efficiency of 96%.</p> <p>Water Content - The weight of water divided by the weight of oven dried soil, expressed as a percentage.</p> <p>Uc - Unconfined compressive strength, as determined by a pocket penetrometer.</p> <p>Comments - Pertinent comments about the conditions encountered.</p>
			Low Plasticity Clay (CL)	1.0								
			Moderate to High Plasticity Clay (CH)	2.0								
2.5												
				3.0								
			<p><u>Abbreviations</u> ATD - At the Time of Drilling HA - Hand Auger DCP - Dynamic Cone Penetrometer</p> <p><u>Notes</u> Dashed lines indicate an estimated or gradual strata change. Solid lines indicate a more precise, measured depth value.</p>									
5.0			Dynamic Cone Penetrometer			5.5 - 6.5						
7.5			Shelby Tube			7.0 - 8.0						

Remarks: Additional information about the surface, subsurface, or other conditions that could impact the exploration results.

Sheet 1 of 1



SOIL CLASSIFICATION

MAJOR DIVISIONS			SYMBOLS	TYPICAL DESCRIPTIONS
COARSE GRAINED SOILS MORE THAN 50% OF MATERIAL IS LARGER THAN NO. 200 SIEVE	GRAVEL AND GRAVELLY SOILS	Clean Gravels	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	GM	Silty gravels, gravel-sand-silt mixtures
			GC	Clayey gravels, gravel-sand-clay mixtures
	SAND AND SANDY SOILS	Clean Sands	SW	Well graded sands, gravelly sands, little or no fines
			SP	Poorly graded sands, gravelly sand, little or no fines
		Sands with fines	SM	Silty sands, sand-silt mixtures
			SC	Clayey sands, sand-clay mixtures
FINE GRAINED SOILS MORE THAN 50% OF MATERIAL IS SMALLER THAN NO. 200 SIEVE	SILTS AND CLAYS	Liquid Limit less than 50	ML	Inorganic silts, silty or clayey fine sands or clayey silts with slight plasticity
			CL	Inorganic clays of low to moderate 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 moderate to high plasticity, organic silts
			HIGHLY ORGANIC SOILS	

SOIL CONSISTENCY SPT N: Standard Penetration Test N-Value N¹ – Manual Hammer (Rope & Pulley - 60% Efficiency) N² – Automatic Hammer (Free-Fall - 96% Efficiency)

COARSE GRAINED SOILS		
SPT N ¹	SPT N ²	Relative Density
0-4	0-3	Very loose
4-10	3-6	Loose
10-30	6-19	Medium dense
30-50	19-31	Dense
> 50	> 31	Very dense

FINE GRAINED SOILS		
SPT N ¹	SPT N ²	Field Identification
0-2	0-1	Very soft – Easily penetrated several inches by fist
3-4	2-3	Soft – Easily penetrated several inches by thumb
5-7	3-4	Firm – Can be penetrated several inches by thumb with moderate effort
8-15	5-9	Stiff – Readily indented by thumb but penetrated only with great effort
16-30	10-19	Very stiff – Readily indented by thumbnail
> 30	> 19	Hard – Indented with difficulty by thumbnail

SOIL PARTICLE SIZES

Description	Size Limits	Familiar Example
Boulder	12 inches or more	Larger than basketball
Cobble	3 - 12 inches	Orange to basketball
Coarse gravel	¾ - 3 inches	Grape to orange
Fine gravel	4.75 mm (No. 4 sieve) - ¾ inch	Pea to grape
Coarse sand	2-4.75 mm (No. 10 to 4 sieve)	Rock Salt
Medium sand	0.42-2 mm (No. 40 to 10 sieve)	Table Salt
Fine sand	0.075-0.42 mm (No. 200 to 40 sieve)	Powdered sugar
Silt/Clay/Fines	Less than 0.075 mm (No. 200)	Not visible to naked eye

RELATIVE PROPORTIONS

Description	Percent
Trace	1-5
Few	5-15
Little	15-30
Some	30-50
Mostly	50-100

ROCK CONTINUITY

Description	Core Recovery (%)
Incompetent	0-40
Competent	40-70
Fairly Continuous	70-90
Continuous	90-100

ROCK QUALITY DESIGNATION

Description	RQD (%)
Very Poor	0-25
Poor	25-50
Fair	50-75
Good	75-90
Excellent	90-100

ROCK BEDDING

Description	Thickness (in)
Parting	< 0.3
Band	0.3-2.5
Thin Bed	2.5-6.0
Medium bed	6.0-12.0
Thick bed	12.0-36.0
Massive	> 36.0

ROCK HARDNESS (Descriptions for rock core samples)

Description	Definition
Very soft	Can be broken with fingers
Soft	Can be scratched with fingernail; only edges can be broken with fingers
Moderately hard	Can be easily scratched with knife; cannot be scratched with fingernail
Hard	Difficult to scratch with knife; hard hammer blow to break specimen
Very hard	Cannot be scratched with knife; several hard hammer blows to break specimen

ROCK WEATHERING (Descriptions for rock core samples)

Description	Definition
Completely	Rock decomposed to soil; rock fabric and structure completely destroyed
Highly	Most minerals are decomposed; texture indistinct but fabric preserved; strength greatly reduced
Moderately	Discoloration throughout and weaker minerals decomposed; texture preserved but strength less than unweathered rock
Slightly	Discoloration around open fractures; strength preserved
Unweathered	No sign of decomposition

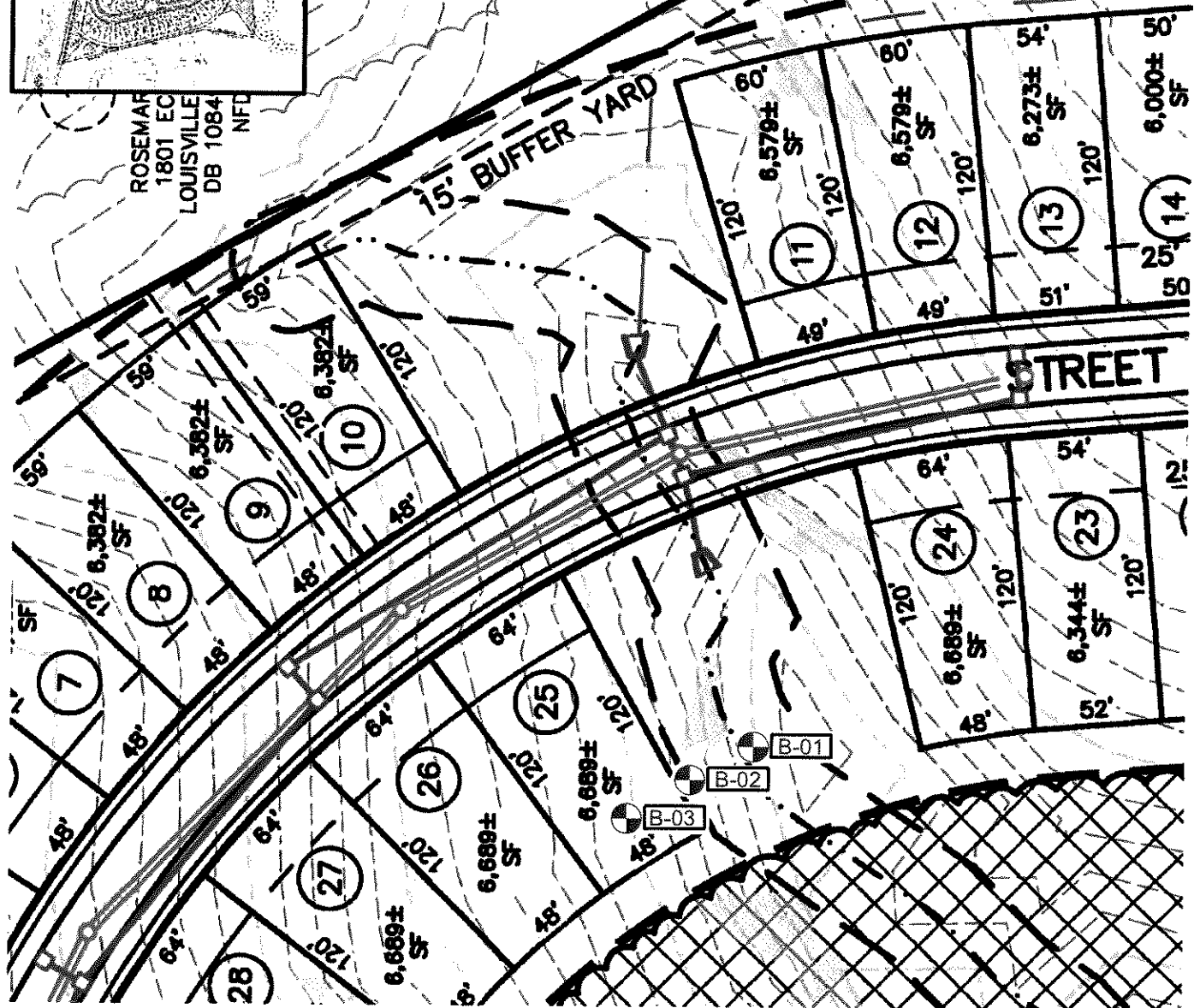
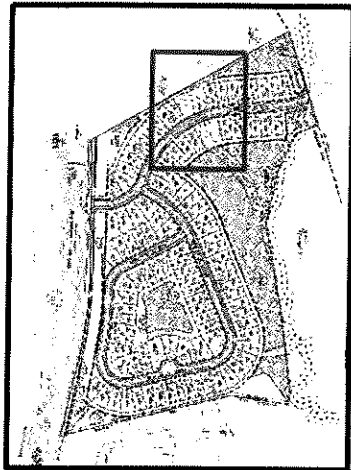
LEGEND

 Soil Test Boring Location

 Slope Areas > 30%

 Slope Areas > 20 - 30%

Note: Locations are approximate.



Based on a drawing "22-ZONEPA-0110 - 22-09-12 (FILED)", provided by Allison Hicks of Mindel Scott, dated September 9, 2022.

0 100 Feet
Graphic Scale



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Louisville, Kentucky 40299
Tel. (502) 493-7100

Boring Location Diagram

Preliminary Slope Evaluation and Karst Survey - 2405 Echo Trail

2405 Echo Trail
Louisville, Jefferson County, Kentucky 40245

DRAWN BY

BEK

APPROVED BY

FEN

PROJECT NO.

61-2863

DATE

11-14-2022

Received Feb. 27, 2023

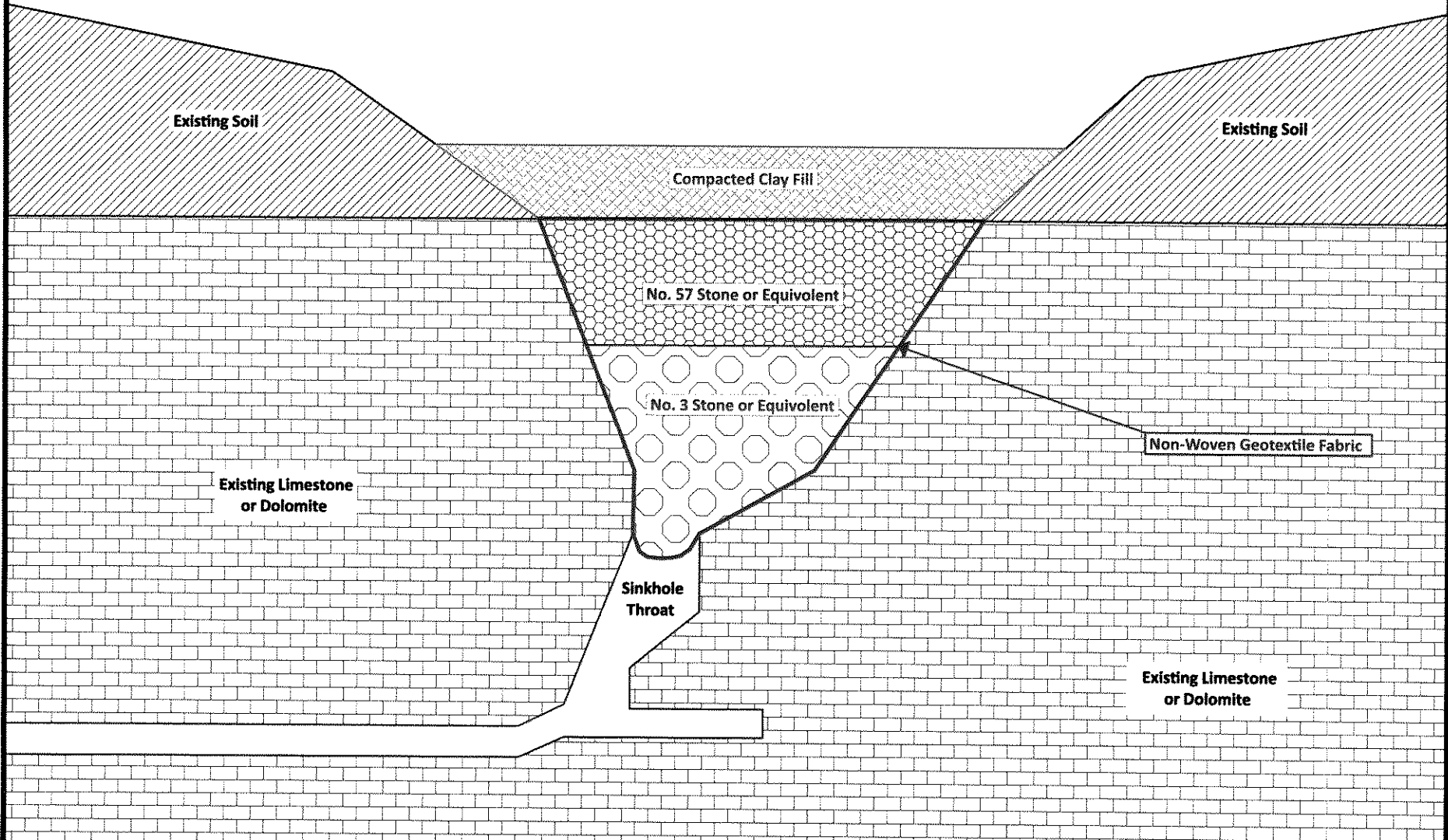
Planning & Design

22-ZONEPA-0110

APPENDIX C – Slope Exploration

Boring Location Diagram
Soil & Rock Classification
Boring Legend
Boring Records
Boring Composite
Field Procedures
Laboratory Procedures

Note: Not for construction - specific remediation for each sinkhole must be recommended by ECS Southeast, LLP at the time of remediation. See "Sinkhole Remediation Guidelines" in the report.



Typical Sinkhole Remediation Diagram Slope Evaluation and Karst Survey - 2405 Echo Trail Louisville, Jefferson County Kentucky 40425	
Project No.: 61-2863 Drawing No.: 2863 BLP Date: 11/21/2022	Drawn By: BEK Checked By: FEN Scale: As Shown
ECS Southeast, LLP 1762 Watterson Trail Louisville, Kentucky 4025 Tel. (502) 493-7100	

Site Photos

*Preliminary Slope Exploration and Karst Survey – 2405 Echo Trail
ECS Project No.: 61-2863*

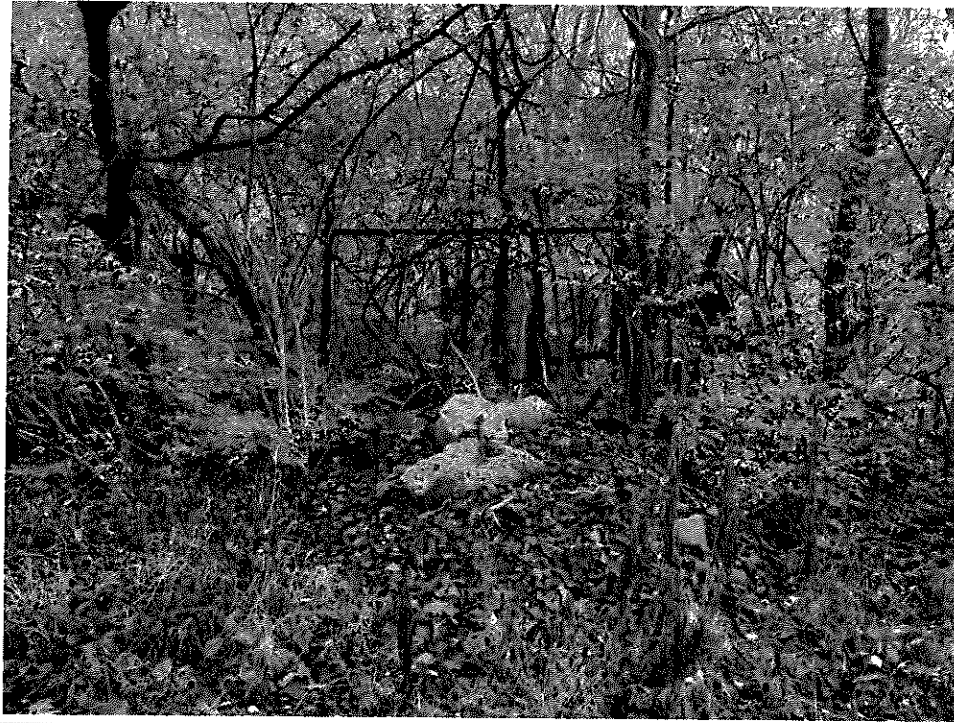


Photo 35: View of debris piles typically encountered in the southern portion of the site, near the existing cleared access paths.



Photo 36: View of dense brush encountered throughout the site that could obscure potential karst features or indications of slope instability from view.

Site Photos

Preliminary Slope Exploration and Karst Survey – 2405 Echo Trail

ECS Project No.: 61-2863



Photo 33: View of a drainage swale typically encountered throughout the southern portion of the site, directed towards the central stream directed south.

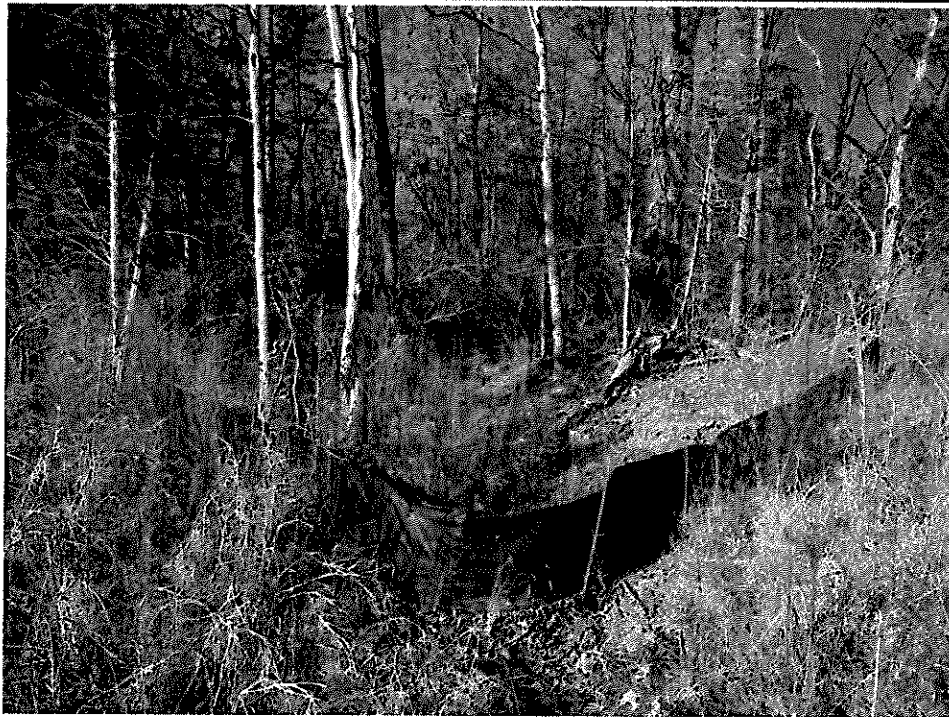


Photo 34: View of the central stream from the southern property boundary.

Site Photos

Preliminary Slope Exploration and Karst Survey – 2405 Echo Trail

ECS Project No.: 61-2863



Photo 31: View of slope downslope of slope failure area SF-02.



Photo 32: View of a shallow drainage swale typically encountered throughout the northeastern and eastern portions of the site, directed towards the eastern creek.



Photo 29: View of drainage swale directed downslope of slope failure area SF-01.



Photo 30: View of fan-shaped slope failure area SF-02.



Photo 27: View of large fan-shaped slope failure area SF-01.

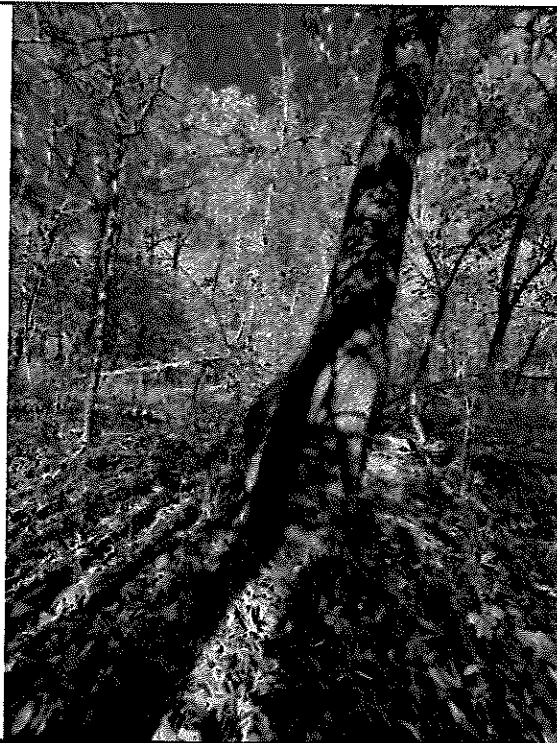


Photo 28: View of bowed trees and mounded soil encountered in SF-01.



Photo 25: View of probe rod extended in partially closed throat located in F-29.



Photo 26: View of F-31.



Photo 23: View of F-26.



Photo 24: View of probe rod extended in partially closed throat located in F-28.



Photo 21: View of F-25.



Photo 22: View of possible human disturbance and partially closed throat located in F-25.



Photo 19: View of probe rod extended in partially closed throat located in F-22.



Photo 20: View of probe rod extended in partially closed throat located in F-23.

Site Photos

Preliminary Slope Exploration and Karst Survey – 2405 Echo Trail

ECS Project No.: 61-2863



Photo 17: View of stream sidewalls located in northeastern portion of the site.



Photo 18: View of F-21.



Photo 15: View of probe rod extended in partially closed throat located in F-18.



Photo 16: View of stream located in northeastern portion of the site.



Photo 13: View of probe rod extended in partially closed throat located in F-15.



Photo 14: View of probe rod extended in partially closed throat located in F-17.



Photo 11: View of probe rod extended in partially closed throat located in F-11.



Photo 12: View of probe rod extended in partially closed throat located in F-12.



Photo 9: View of multiple partially closed throats located in F-08.



Photo 10: View of multiple closed depressions located in F-09.



Photo 7: View of F-06 containing rusted debris and a partially closed throat.



Photo 8: View of probe rod in partially closed throat in F-07.

Site Photos

Preliminary Slope Exploration and Karst Survey – 2405 Echo Trail

ECS Project No.: 61-2863



Photo 5: View of F-04.



Photo 6: View of F-05.



Photo 3: View of one of several throats located in F-03.



Photo 4: View of F-03.

Site Photos

Preliminary Slope Exploration and Karst Survey – 2405 Echo Trail

ECS Project No.: 61-2863



Photo 1: View of remnant shed located adjacent to F-01.



Photo 2: View of F-02.

LEGEND

SF-XX

Minor Slope Failures

Existing Stream

Drainage Swale

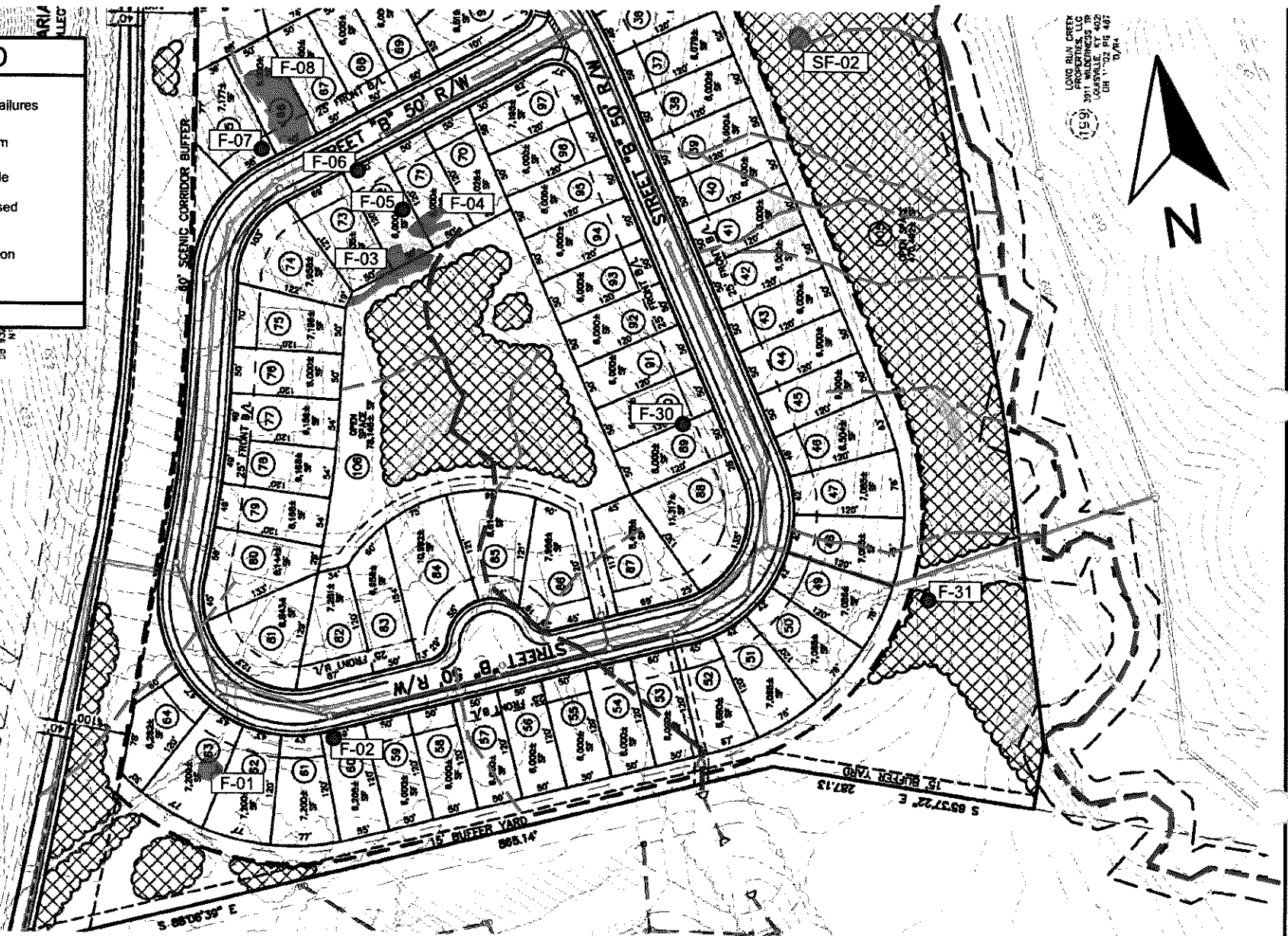
F-XX

Observed Closed Depressions

F-XX

Feature Location (defined area)

Note: Locations are approximate.

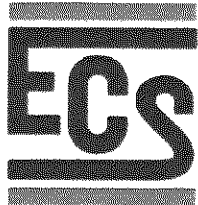


Based on a drawing "22-ZONEPA-0110 - 22-09-12 (FILED)", provided by Allison Hicks of Mindel Scott, dated September 9, 2022.

0 200 400 Feet
Graphic Scale

Site Reconnaissance Plan - South Area
Slope Evaluation and Karst Survey - 2405 Echo Trail
2405 Echo Trail
Louisville, Jefferson County, Kentucky 40245

DRAWN BY	BEK
APPROVED BY	FEN
PROJECT NO.	61-2863
DATE	11-14-2022








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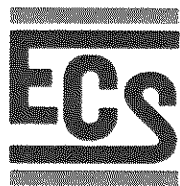
22-ZONEPA-0110

LEGEND

	Minor Slope Failures
	Existing Stream
	Drainage Swale
	Observed Closed Depressions
	Feature Location (defined area)

Note: Locations are approximate.

Note: Locations are approximate.



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1762 Watterson Trail
Louisville, Kentucky 40299
Tel. (502) 493-7100

Slope Evaluation and Karst Survey - 2405 Echo Trail

2405 Echo Trail
Louisville, Jefferson County, Kentucky 40245

DRAWN BY
BEK

APPROVED BY
FEN

PROJECT NO.
61-2863






DATE
11-14-2022

22-201F-0131

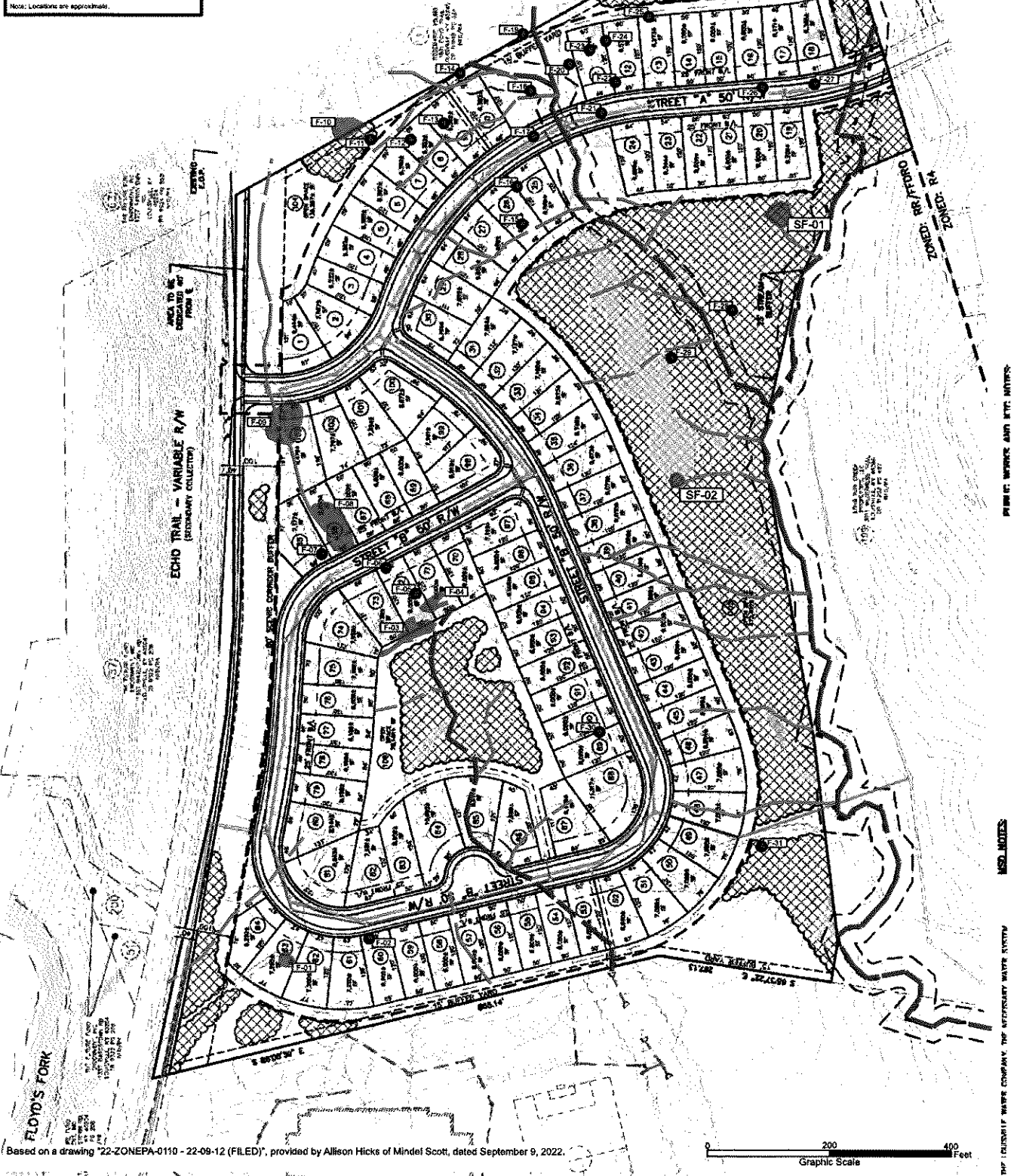
Received Feb. 27, 2023

Planning & Design

LEGEND

-  Minor Slope Failures
-  Existing Stream
-  Drainage Swale
-  Observed Closed Depressions
-  Feature Location (defined area)

Note: Locations are approximate.



Based on a drawing "22-ZONEPA-0110 - 22-09-12 (FILED)", provided by Allison Hicks of Mindel Scott, dated September 9, 2022.



ECS Southeast, LLP
1762 Watterson Trail
Louisville, Kentucky 40299
Tel. (502) 493-7100

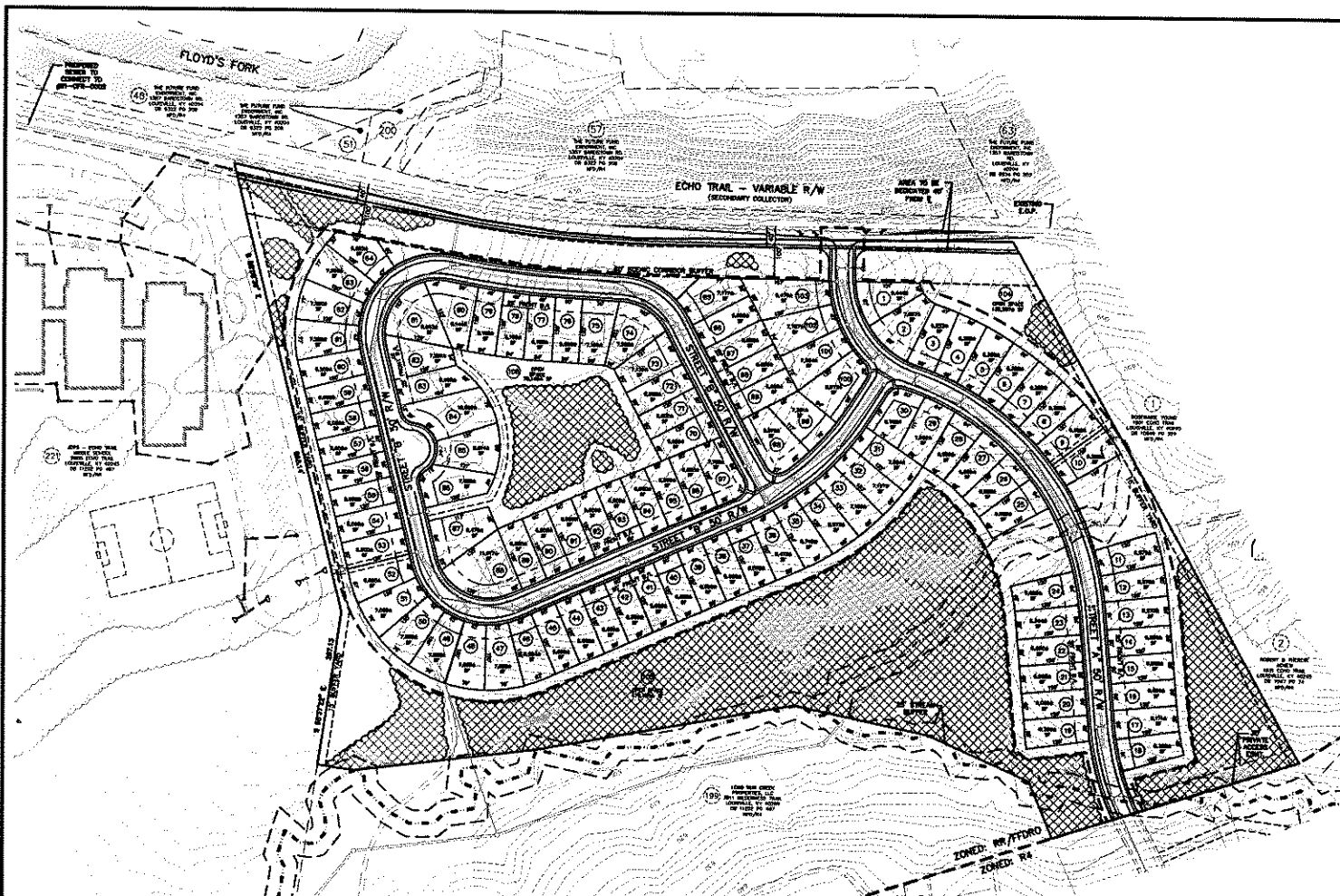
Site Reconnaissance Plan Slope Evaluation and Karst Survey - 2405 Echo Trail

2405 Echo Trail
Louisville, Jefferson County, Kentucky 40245

DRAWN BY
BEK
APPROVED BY
FEN
PROJECT NO.
61-2863
DATE
11-14-2022

APPENDIX B – Site Reconnaissance

Site Reconnaissance Plans
Site Photos
Typical Sinkhole Remediation Diagram



SITE DATA

EXISTING ZONING: R-1
 PROPOSED ZONING: R-1
 PROPOSED LAND USE: SINGLE-FAMILY RESIDENTIAL
 NET LAND AREA: 38.676 AC (1,687,331 SF)
 BUILDABLE AREA: 31,744 AC (1,384,432 SF)
 BUILDABLE LOTS: 103
 GROSS DENSITY: 2.61 D.U./AC
 NET DENSITY: 2.20 D.U./AC
 OPEN SPACE PROVIDED: 684,825 SF (14%)

DEVELOPMENTAL STANDARDS

FRONT/STREET SIDE YARDS: 15' (25' W/ GARAGE)
 SIDE YARD: 10' (10' W/ GARAGE)
 REAR YARD: 10' (10' W/ GARAGE)
 MINIMUM LOT WIDTH: 30'

TREE CANOPY DATA:

EXISTING SITE AREA: 38.676 AC (1,687,331 SF)
 EX. TREE CANOPY: 1,000,000 SF (60%)
 EX. TREE CANOPY TO BE PRESERVED: 1,000,000 SF (60%)
 TOTAL TREE CANOPY REQUIRED: 1,000,000 SF (60%)

TREE CANOPY DEPICTED ON PLAN PER MTD LOGIC MAPPING, AERIAL PHOTO OR FIELD SURVEY. TREE CANOPY CALCULATIONS BASED UPON TREE AREAS SHOWN.

MAXIMUM BALANCE TRANSFER LOT CALCULATION

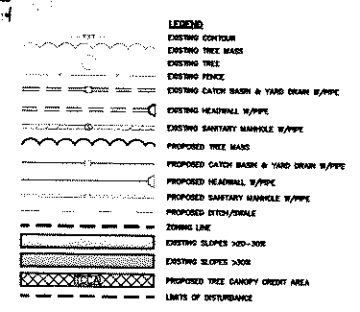
MRP - MAXIMUM LOTS PERMITTED: 103
 TA - TOTAL LAND AREA (38.676 AC)
 OR - STEEP SLOPES AREA (SLOPES GREATER THAN 10%): 1.00 AC
 M - INFRASTRUCTURE AREA (4.87 AC)
 MR = $[(TA - OR - M) \times 0.84] + 0.5 \times 0.84$
 MR = $[(38.676 - 1.00 - 4.87) \times 0.84] + 0.5 \times 0.84$
 MR = $[(32.806 \times 0.84)] + 0.42$
 MR = 27.56

NOTE: ONLY THE AREAS OF STEEP SLOPES WITHIN OPEN SPACE LOTS ARE USED FOR THE BALANCE TRANSFER AREA CALCULATION.

- GENERAL NOTES:**
1. DOMESTIC WATER SUPPLY: SUBJECT SITE CAN BE SERVED BY THE LOUISVILLE WATER COMPANY. THE NECESSARY WATER SYSTEM IMPROVEMENTS REQUIRED TO SERVICE THE DEVELOPMENT SHALL BE AT THE OWNER/DEVELOPER'S EXPENSE.
 2. TREE PRESERVATION: A TREE PRESERVATION PLAN SHALL BE PROVIDED TO THE PLANNING COMMISSION'S STAFF LANDSCAPE ARCHITECT FOR APPROVAL PRIOR TO BEGINNING ANY CONSTRUCTION ACTIVITIES ON THE SITE. CONSTRUCTION PERSONNEL SHALL BE TRAINED TO IDENTIFY AND PRESERVE TREES TO BE PRESERVED. THE EXISTING CANOPY SHALL BE MAINTAINED THROUGHOUT THE CONSTRUCTION PERIOD. THE EXISTING CANOPY SHALL BE MAINTAINED THROUGHOUT THE CONSTRUCTION PERIOD. THE EXISTING CANOPY SHALL BE MAINTAINED THROUGHOUT THE CONSTRUCTION PERIOD.
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- LAND NOTES:**
1. CONSTRUCTION PLANS AND DOCUMENTS SHALL COMPLY WITH LOUISVILLE AND SPOTSWOOD COUNTY METROPOLITAN SEWER DISTRICT'S DESIGN MANUAL AND STANDARD SPECIFICATIONS.
 2. SEWERAGE: SEWERAGE SHALL BE PROVIDED TO THE FLOYD FORK WASTEWATER TREATMENT PLANT BY LATERAL EXTENSION ADJACENT, SUBJECT TO FEES, SEWERAGE SEWER CAPACITY TO BE APPROVED BY METROPOLITAN SEWER DISTRICT.
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- PUBLIC WORKS AND SITE NOTES:**
1. NO LANDSCAPING AND CONSTRUCTION SHALL BE PERMITTED BY METRO SEWER DISTRICT.
 2. RIGHT-OF-WAY: RIGHT-OF-WAY SHALL BE MAINTAINED BY METRO SEWER DISTRICT.
 3. CONSTRUCTION: CONSTRUCTION SHALL BE PERMITTED BY METRO SEWER DISTRICT.
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CASE # 22-ZONEPA-0110
 RELATED PROJECTS: #18SUBDIV1023,
 #21-CFR-0002
 MSD WM # 9674

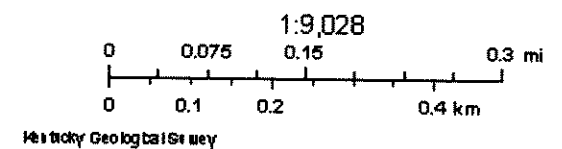
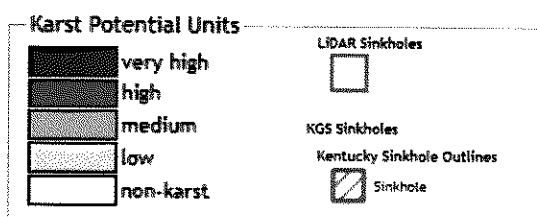
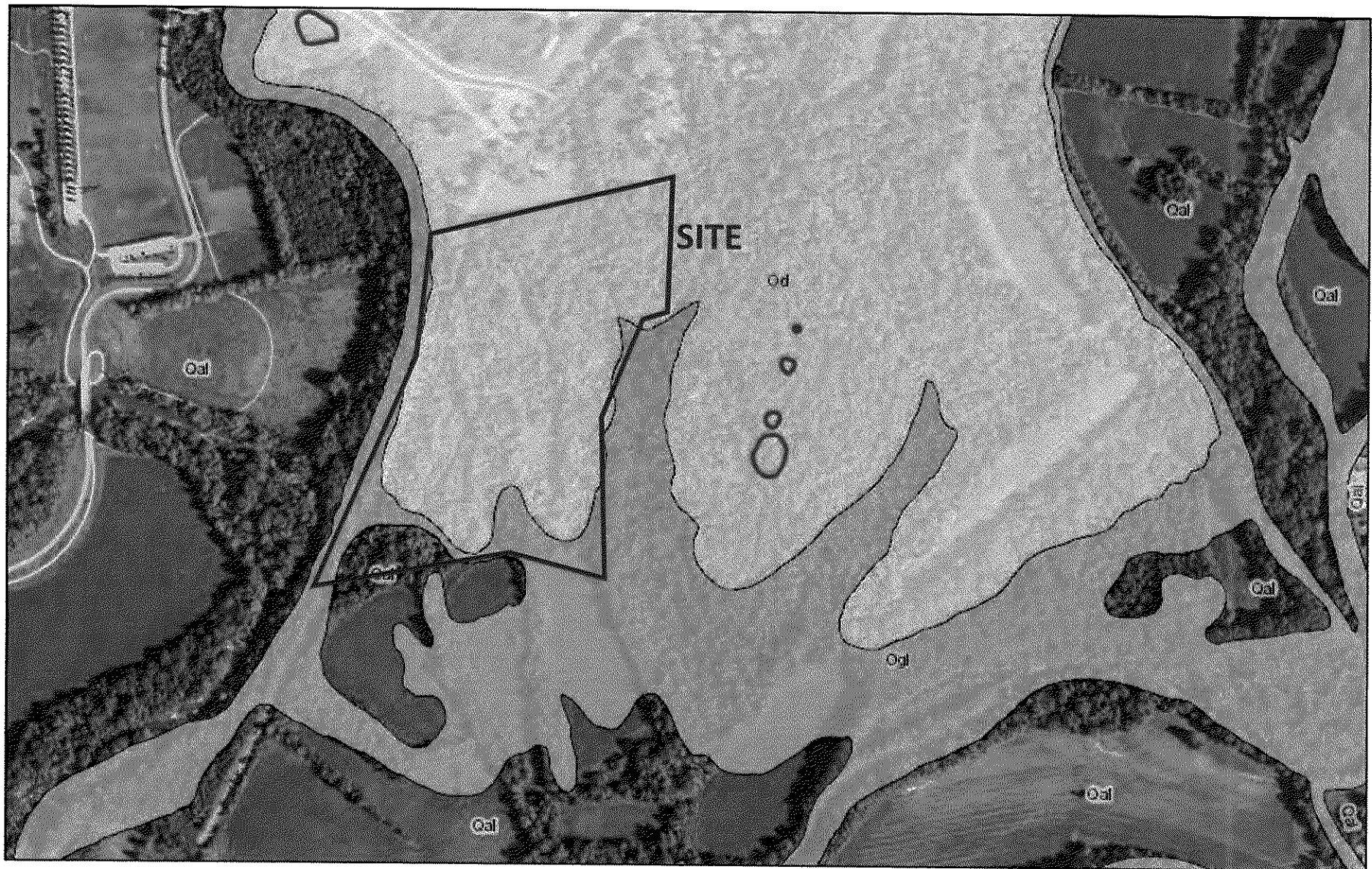
MINDEL SCOTT
 ENGINEERS • 151 Jefferson Blvd., Louisville, KY 40203
 502-485-1008 • info@mindelscott.com

OWNER/DEVELOPER
 LONG CREEK PROPERTIES, LLC
 3911 WILDERNESS LN
 LOUISVILLE, KY

CHANGE OF ZONING PLAN
ECHO TRAIL RESIDENTIAL
 DEVELOPMENT POTENTIAL TRANSFER
 (FLOYD FORK DRD)
 ECHO TRAIL, LOUISVILLE, KY 40245
 BLOCK 0041, LOT 0199
 DEED BOOK 0041, PAGE 341

Vertical Scale: N/A
 Horizontal Scale: 1"=100'
 Date: 09/12/2022
 Job Number: 3334-002
 Sheet: 1
 of 1

Kentucky Geologic Map Information Service – Karst Potential Map

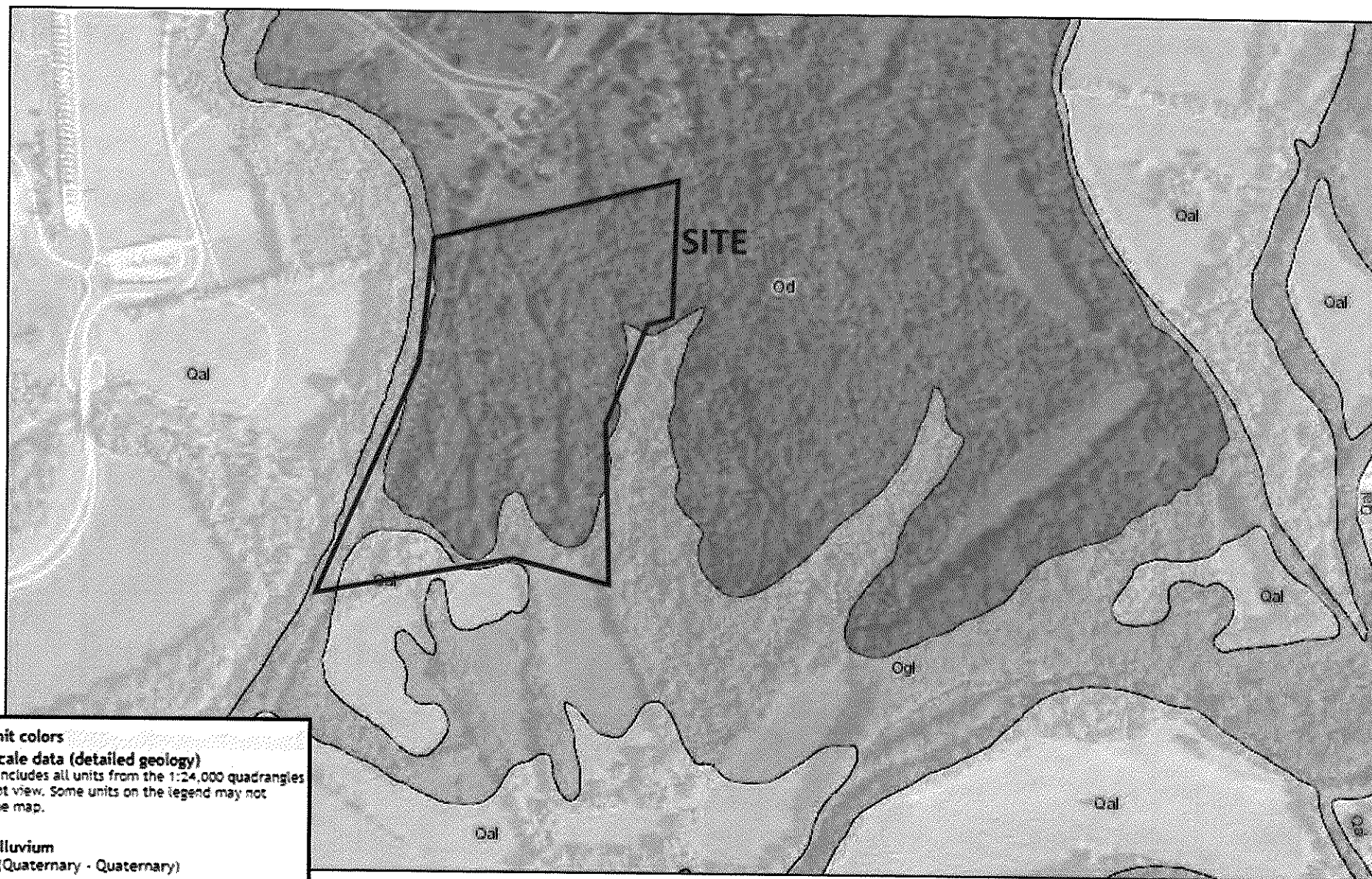


Received Feb. 27, 2023

Planning & Design

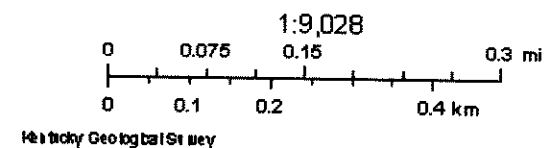
author: Kentucky Geological Survey
copyright Kentucky Geological Survey
22-70NF-0131

Kentucky Geologic Map Information Service – Geology Location Diagram



map unit colors
24,000 scale data (detailed geology)
this legend includes all units from the 1:24,000 quadrangles
in the current view. Some units on the legend may not
appear on the map.

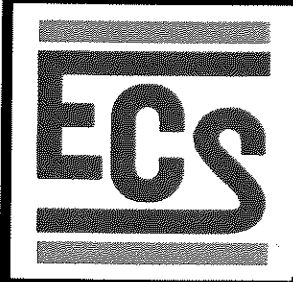
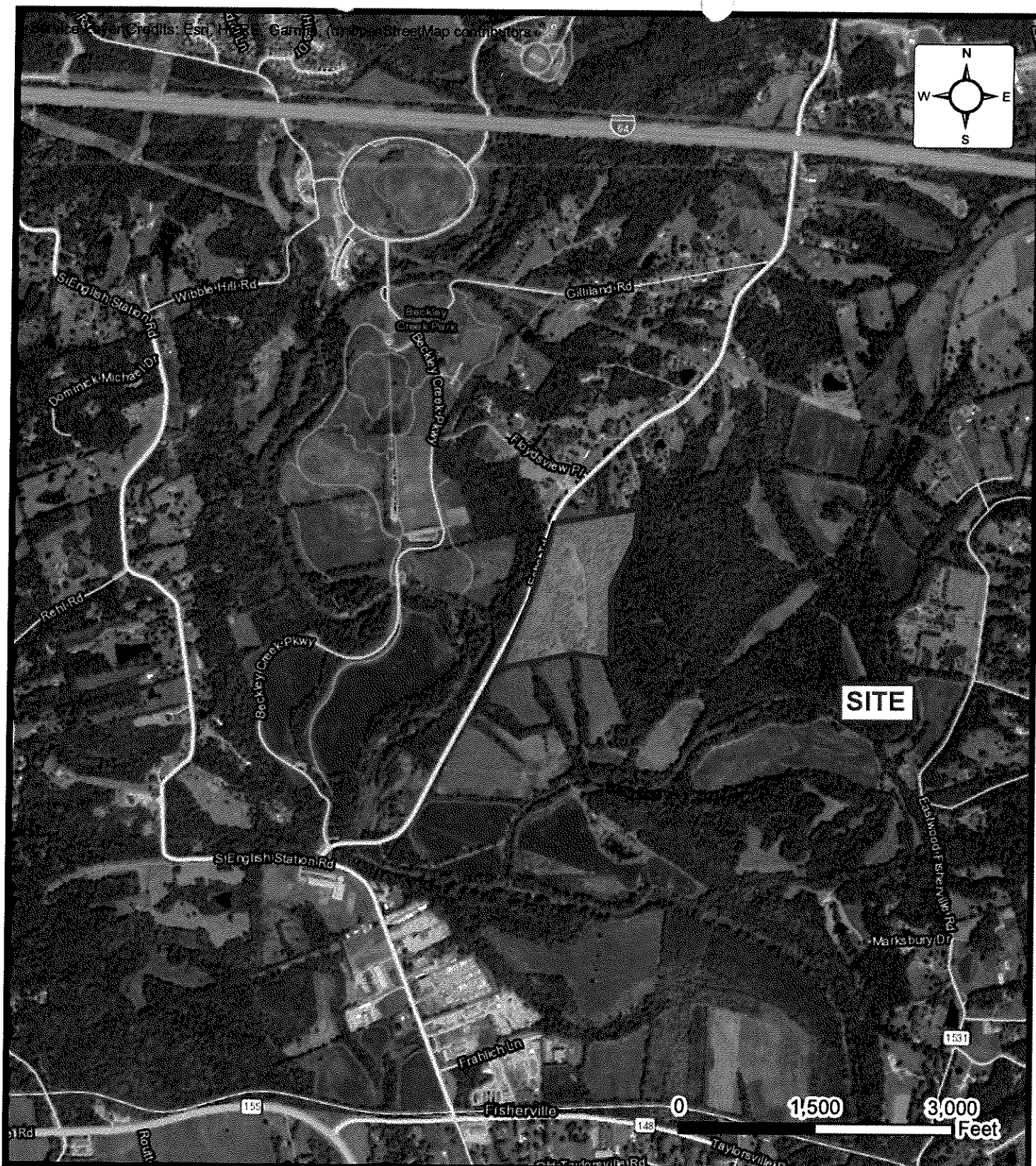
Qal	Alluvium (Quaternary - Quaternary)
Od	Drakes Formation (Upper Ordovician - Upper Ordovician)
Ogl	Grant Lake Limestone (Upper Ordovician - Upper Ordovician)



Received Feb. 27, 2023

Planning & Design

author: Kentucky Geological Survey
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22-ZONE-0131



SITE LOCATION DIAGRAM

PRELIMINARY SLOPE EVALUATION AND KARST
SURVEY - 2405 ECHO TRAIL

2405 ECHO TRAIL, LOUISVILLE, KENTUCKY 40245
LONG RUN CREEK PROPERTIES

ENGINEER BEK
SCALE AS NOTED
PROJECT NO. 61-2863
FIGURE 1 OF 1
DATE 11/10/2022

APPENDIX A – Drawings

Site Location Diagram

Geology Location Diagram

Karst Potential Diagram

Provided Drawing: 22- ZONEPA-0110 – 22-09-12 (FILED)

- Construct embankments with controlled fill compacted to at least 98 percent of the Standard Proctor maximum dry density and within 2 percent of the optimum moisture content.
- Maximum fill embankment height of 5 feet.
- Horizontally bench new fill into existing slopes in maximum one-foot vertical steps.
- Maintain the following limits for new cuts in soil without additional geotechnical exploration and analysis:
 - 3:1 (horizontal: vertical) or flatter slopes.
 - Maximum cut height of 5 feet.
- Provide adequate erosion and surface water drainage control during construction and over the life of the subdivision.
- Establish permanent vegetative cover as soon as practical.

Closing

We appreciate the opportunity to serve as your geotechnical consultants for this project. We look forward to future association with you on this and other projects.

Respectfully submitted,
ECS Southeast, LLP


Bryn Kabbes, E.I.T
Project Engineer
bkabbes@ecslimited.com



Liz Blandford Newcomb, P.E.
Principal Engineer
lnewcomb@ecslimited.com

APPENDICES

Appendix A – Drawings

- Site Location Diagram
- Geology Location Map
- Karst Potential Map
- Provided Drawing : 22-ZONEPA-0110 – 22-09-12 (FILED)

Appendix B – Site Reconnaissance

- Site Reconnaissance Plans – 3 pages
- Site Photos – 18 pages
- Typical Sinkhole Remediation Diagram

Appendix C – Slope Exploration

- Boring Location Diagram
- Soil & Rock Classification
- Boring Legend
- Boring Records
- Boring Composite
- Field and Laboratory Procedures

Laboratory Test Summary

STRATUM	MOISTURE CONTENT	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	UNCONFINED COMPRESSIVE STRENGTH (ksf)	UNDRAINED SHEAR STRENGTH (psf)	UNIFIED SOIL CLASSIFICATION
II	14.6	46	20	26	3.0 – 9.0	1,500 – 4,500	CL
III	23.1	76	27	49	2.0 – 8.0	1,000 – 4,000	CH

Notes:

- (1) A more detailed summary of the laboratory test results is included on the **Boring Records** and **Laboratory Reports** in the **Appendix**. Detailed descriptions of the laboratory test methods are listed in the **Laboratory Procedures** section of the **Appendix**.
- (2) Atterberg Limits test results were not complete at the time the report was issued. Once completed, an updated report will be issued.

Findings

Based on our review of the above referenced observations and information, and on our past experience with site development for similar conditions in Jefferson County, our opinion is that most of the on-site slopes (excluding small, localized erosion features along swales) in the observed areas were generally stable at the time of our site reconnaissance. Evidence of minor instability was observed in isolated areas in the northeast and east portions of the site (identified as SF-01 and SF-02 in this report).

The current, on-site localized slope instability observed likely is related to the following factors:

- Relatively thin depths of soil in slope areas
- Cohesive (clayey) soil matrix
- Rocky soil texture
- Limestone, dolomite, and or shale bedrock
- Numerous trees and other vegetation
- Groundwater seepage from shallow bedrock

Based on the conditions observed, our opinion is that additional geotechnical exploration/analyses including soil/rock test borings/coring, shear strength tests of soils, etc. are not required for most of the evaluated on-site slopes, provided that the planned subdivision is designed and constructed utilizing the guidelines included in this report.

The northeast and east portions of the site, particularly in areas identified as “existing slopes > 20-30%” and “existing slopes >30%” as shown on the provided drawing, and including the shaded “Minor Failure Areas”, where minor instability was observed should be further evaluated during the construction phase of the project once the location and planned elevation of the proposed structures and related improvements are known.

The following guidelines should be used to help maintain the stability of the existing and planned slopes during the design and construction of the new subdivision, and over the life of the new homes. These guidelines include:

- All foundations should bear entirely on competent rock (sound and continuous).
- Groundwater seepage should be anticipated. Plan to install foundation and sub-floor drainage systems for structures bearing entirely on rock or near the soil/rock interface.
- Plan grading to minimize changes to existing topography along slopes.
- Minimize disturbance to slopes and vegetation outside new construction areas.
- Avoid significant transverse cuts along face or at the toe of existing slopes.
- Avoid significant embankments on the face, or along or at the crest of existing slopes.
- Avoid placing new construction at or within 10 feet of the crest of existing slopes.
- Maintain the following limits for new embankments without additional geotechnical exploration and analysis:
 - 3:1 (horizontal: vertical) or flatter slopes.
 - Properly strip all vegetation, topsoil, etc. where fill will be placed.

Standard Proctor maximum dry density, within 2% of the optimum moisture content. Placement and compaction of the fill in limited horizontal lifts will reduce porosity and surface water infiltration. Periodic observations and compaction testing are recommended to confirm the character and continuity of the clay caps. Grading the site to promote surface drainage in all areas and avoiding ponding water is also important in reducing future subsidence of existing karst features (including sinkholes) and reducing the development of additional karst features.

Existing buildings, debris, and brush piles located on the property potentially could have obscured indications of slope instability and/or karst features at the time of this evaluation. Additionally, fallen leaves and trees due to the seasonal transition can also obscure such observations.

Subsurface Summary

Three (3) borings were extended on November 3, 2022, using a hand auger and Dynamic Cone Penetrometer (DCP). The approximate boring locations were established with a consumer-grade GPS device. A drive rod was extended in each boring, below the encountered hand auger refusal, to determine approximate refusal depths at each location. Refusal was encountered approximately 1.0 to 3.8 feet below existing grades. Materials encountered at each location were documented. Brief descriptions are provided in the following **Boring Summary**. Refer to the **Boring Location Diagram** for the approximate boring locations, and the **Boring Records** for the depths of materials encountered at each location.

Boring Summary

APPROXIMATE DEPTH (FT)	STRATUM	DESCRIPTION	N-VALUES BLOWS PER FOOT (BPF) ⁽²⁾
0.0 – 0.3	I	TOPSOIL – Approximately 2 to 4 inches of topsoil encountered at the surface materials in all borings. Rock fragments were encountered within topsoil in Boring B-01.	NA
0.3 – 3.5	II	CLAY (CL) – Orange brown to brown, low to moderate plasticity, firm to stiff, dry to slightly moist, silty clay (CL), with trace black oxide nodules and root fibers. Encountered below Stratum I in all borings. Weathered rock fragments and cobbles were encountered within silty clay in Borings B-01 and B-02 from approximately 0.8 to 1.6 feet to drive rod refusal.	5 – 25/1"
1.0 – 3.8	III	CLAY (CH) – Orange brown to medium brown, moderate to high plasticity, hard, dry to slightly moist, silty clay (CL), with few root fibers. Encountered below Stratum II in Boring B-03. Weathered rock fragments and cobbles were encountered within silty clay from approximately 1.8 feet to drive rod refusal.	18
REFUSAL⁽³⁾	Refusal was encountered approximately 1.0 to 3.8 feet below existing grades.		
GROUNDWATER	Groundwater was not encountered at the time of boring. However, groundwater seepage at the soil/rock interface and within the underlying bedrock onsite is common and should be anticipated.		

Notes:

- (1) This summary is generalized and does not describe the actual conditions in each boring. These zones also may not occur at each location. Depths are approximate. Detailed descriptions of the encountered materials are listed on the **Boring Records** in the **Appendix**.
- (2) Number of blows to drive the dynamic cone penetrometer 1.75 inches has been empirically correlated to the Standard Penetration Test value "N" in blows per foot.
- (3) Refusal is the term applied to material that cannot be penetrated with augers or has a Dynamic Penetration resistance exceeding 25 blows per 1.75-inch increment. Refusal may be encountered on continuous bedrock, discontinuous floaters, cemented soil, weathered rock, debris, buried structures, or other hard subsurface materials.

Feature	Description	Approximate Dimensions	Approximate Depth
F-26	Closed depression with soil sidewalls.	4' Wide 6' Long	1'
F-27	Small opening with soil/rock sidewalls. Probe rod extended approximately 1-2 feet below the feature.	1'	2-3'
F-28	Oval-shaped closed depression with soil sidewalls and a partially closed throat at the bottom of the depression.	6-7' Long 3-4' Wide	2'
F-29	Oblong shaped closed depression with soil sidewalls and a partially closed throat at the bottom of the depression. Probe rod extended to apparent rock approximately 3 feet below the feature.	6-7' Long 4-5' Wide	1-3'
F-30	Bowl shaped closed depression with soil sidewalls.	10' Long 5' Wide	1'
F-31	Oval shaped closed depression with soil sidewalls. The southern wall of the closed depression was approximately 3 feet above the northern wall of the closed depression.	10' Long 4-6' Wide	1-2'

The observed closed depressions may have been caused by removal of a tree rootball, previous land use, or could be indicative of the presence of a karst feature. No other karst features were identified during the site reconnaissance. However, the existing remnant structures, debris, and man-made fill piles and berms located on the property potentially could have obscured indications of karst features at the time of this site reconnaissance. Additionally, fallen leaves and trees due to seasonal transition, especially in densely wooded areas, can also obscure such observations. Refer to the attached **Site Reconnaissance Plans** for the approximate locations of each possible karst-feature and the **Site Photos** for conditions observed.

Karst Feature Remediation Guidelines

Typically, karst features in this vicinity and similar to those identified in this survey can be stabilized for development, as needed, for the planned future use of the site. Remediation methods vary based on planned use of the specific area where a karst feature is located and the characteristics of each feature. Treatment methods may vary for features where buildings or other improvements are located, in contrast to features in non-sensitive areas. For this project the typical objective of the treatment of a feature will be to reduce the risk of future subsidence and to decrease surface water infiltration in and around the active karst feature(s).

An experienced and qualified geotechnical engineer or geologist should be present during remediation to evaluate the characteristics as the feature is excavated, and to recommend specific treatment methods for each feature. Remediation of most karst features identified is anticipated to consist of excavation of the closed depression or slot-features to identify the active feature(s) and determine the appropriate stabilization method. Once the active karst throat or weathered apparent rock area is stabilized, an inverted filter (see attached **Typical Sinkhole Remediation Diagram**) should be constructed within and over the feature(s).

The filter will reduce future loss of soil into the feature, reducing the risk of subsidence. The area can then be backfilled with clay, with the fill mounded above adjacent grade to reduce surface water infiltration. Clay fill placed in above the filter constructed in the karst features should meet the requirements for "CL" or "CH" according to the Unified Soil Classification System. The fill should be placed in one-foot lifts and compacted to at least 95% of the

Feature	Description	Approximate Dimensions	Approximate Depth
F-13	Shallow, clover-shaped closed depression with soil sidewalls and large trees growing around the perimeter.	5' Long 6' Wide	6"
F-14	Clover-shaped closed depression with soil sidewalls.	3-4' Long 2-4' Wide	2-6'
F-15	Bowl-shaped closed depression with soil sidewalls and a partially closed throat encountered at the bottom of the depression.	5' Diameter	2'
F-16	Oblong-shaped closed depression with soil sidewalls.	3-5' Long 3-4' Wide	1'
F-17	Shallow, oval-shaped closed depression with soil sidewalls and a 3 inch partially closed opening at the bottom of the depression. Probe rod extended 3.5' below the feature.	2' Long 3' Wide	1'
F-18	Bowl-shaped closed depression with soil/rock sidewalls and a partially closed throat at the bottom of the depression. Probe rod extended 2 feet below the feature to an apparent rock bottom.	4' Diameter	1'
F-19	Bowl-shaped closed depression with soil/rock sidewalls.	3' Diameter	1-3'
F-20	Oval-shaped closed depression with soil sidewalls near bed of creek.	6' Long 4' Wide	0.5'
F-21	Bowl-shaped closed depression with soil sidewalls.	4' Diameter	2.5'
F-22	Bowl-shaped closed depression with soil sidewalls and a partially closed throat encountered at the bottom of the depression. Probe rod extended 1 foot below the feature to an apparent rock bottom.	7' Diameter	2-3'
F-23	Bowl-shaped closed depression with soil/rock sidewalls and a partially closed throat at the bottom of the depression. Probe rod extended 1 feet below the feature.	3' Diameter	1'
F-24	Bowl-shaped closed depression with soil sidewalls. Probe rod extended 2' below the bottom of the feature to an apparent rock bottom.	1' Diameter	0.5'
F-25	Bowl-shaped closed depression. Evidence of apparent human disturbance with sidewalls lined with boulders. A large tree is located at the center of the depression.	10' Diameter	1-3'

Feature	Description		Approximate Dimensions	Approximate Depth
F-07	Oval-shaped closed depression with soil/rock sidewalls and a partially closed throat at the bottom of the depression. Probe rod extended 3 feet below the feature to an apparent rock bottom.		6' Long 5' Wide	4'
F-08	Large-closed depression with soil/rock sidewalls and contained slot shaped features, closed depressions, and several small openings.		80' Diameter	4'
	A	Bowl-shaped closed depression with soil sidewalls.	5' Diameter	2'
	B	Bowl-shaped closed depression with soil/rock sidewalls and a partially closed throat at the bottom of the depression.	8' Diameter	2-3'
	C	Slot-shaped feature with soil/rock sidewalls.	20' Long 3-4' Wide	2-4'
	D	Oval-shaped closed depression with soil sidewalls.	5' Long 3-4' Wide	2-3'
F-09	Large, closed depression with soil/rock sidewalls and contained four (4) smaller closed depressions.		30' Long 20' Wide	4'
	A	Oblong-shaped closed depression with soil sidewalls.	2-3' Long 1-2' Wide	1'
	B	Bowl-shaped closed depression with soil sidewalls.	4' Diameter	3'
	C	Bowl-shaped closed depression with soil sidewalls.	3' Diameter	2'
	D	Bowl-shaped closed depression with soil/rock sidewalls.	6' Diameter	4'
F-10	Large, closed depression with soil sidewalls and contained two (2) smaller closed depressions separated by a large tree.		20' Diameter	3'
	A	Oval-shaped closed depression with soil sidewalls.	10' Long 5' Wide	1'
	B	Bowl-shaped closed depression with several partially closed throats (approximately 2-4 inches in diameter) encountered at the bottom of the depression. Probe rod extended 2 feet below the feature.	5' Diameter	2-3'
F-11	Clover-shaped closed depression with soil sidewalls and a partially closed throat at the bottom of the depression. Probe rod extended 2 feet below the base of the feature.		15-20' Long 5-10' Wide	1'
F-12	Bowl-shaped closed depression with soil sidewalls.		4' Diameter	1'

and/or features with multiple designations (A, B, C, etc.) represent a series of features which appeared to be related to a common joint or similar lineation.

Feature	Description		Approximate Dimensions	Approximate Depth
F-01	Large, shallow closed depression with soil sidewalls and contained three (3) smaller closed depressions. Observed near remnant storage shed which could have obscured additional closed depressions from view.		20' Diameter	1'
	A	Bowl-shaped closed depression with soil sidewalls.	2' Diameter	1'
	B	Oblong-shaped closed depression with soil sidewalls.	2' Long 1' Wide	0.5'
	C	Bowl-shaped closed depression with soil sidewalls.	1' Diameter	0.5'
F-02	Oblong-shaped closed depression with soil sidewalls.		6-7' Long 2-5' Wide	1'
F-03	Large closed depression with soil/rock sidewalls and contained slot-shaped features, closed depressions, and several small openings.		50' Long 50' Wide	6'
	A	Bowl-shaped closed depression with soil sidewalls. Probe rod extended 2' below the bottom of the feature.	5' Diameter	2'
	B	Slot-shaped feature with soil/rock sidewalls. May tie in to existing creek. Probe rod extended 2-3' below slot feature in two small openings at the bottom of the feature.	15-20' Long 3-5' Wide	3-6'
	C	Bowl-shaped closed depression with soil/rock sidewalls.	10' Diameter	4'
F-04	Large, closed depression with soil sidewalls and contained two (2) oval shaped closed depressions.		50' Long 30' Wide	3'
	A	Closed depression with soil sidewalls.	20' Long 3-4' Wide	1-2'
	B	Closed depression with soil sidewalls.	20' Long 4-5' Wide	2-3'
F-05	Crescent-shaped closed depression. Evidence of apparent human disturbance with sidewalls lined with boulders and debris.		12-14' Long 10-12' Wide	1-3'
F-06	Oval-shaped closed depression with soil/rock sidewalls and a partially closed throat at the bottom of the depression. Evidence of apparent human disturbance with sidewalls lined with boulders and rusted metal debris.		10' Long 5-7' Wide	1-3'

Site Reconnaissance

A site reconnaissance was conducted over several days beginning November 3, 2022 through November 9, 2022 by Bryn Kabbes, E.I.T. of ECS. The purpose of the site reconnaissance was to observe and record site conditions for karst geologic features defined in the LDC as well as observe indicated steeper slope areas that would be disturbed by new construction.

Several remnant structures were observed in the southwestern portion of the site, including a small wooden storage building, a silo, and several isolated piles of rubble and debris. Remnant structures were observed in close proximity to one another along the southern boundary of the site and were typically encountered along existing cleared access paths. Several fill mounds and man-made berms, typically 1-3' in height were observed around the remnant structures and cleared access paths, and generally consisted of crushed pavement and stone.

In general, the surface drainage appeared to be directed from the northern portion of the property and away from Echo Trail towards the eastern and southern portions of the property. Two (2) existing streams were observed in the northeastern portion of the site, which conjoin in the northern portion of proposed open space Lot 105. A third existing stream was observed in the southern central portion of the site, in proposed open space Lot 106, which extended southward towards an existing drainage inlet on the southern property boundary. All three existing streams observed extend southward through the property towards Long Run Creek, located approximately 1,300 feet south of the southern property boundary. Drainage swales and associated shallow tributaries were observed throughout the site typically extending downslope towards the existing streams on the site. Swales ranged from 10 to 100 feet long, 1 to 10 feet wide, and 0.5 to 4 feet deep. Evidence of erosion was primarily observed along the drainage swales and typically consisted of areas of bare or loose soil, exposed tree roots, and displaced rock fragments (gravel, cobbles, and/or boulders). No apparent springs or rock outcroppings typical of karst terrain were observed at the time of the site reconnaissance.

Steeper slopes, as identified on the provided drawing, were generally observed adjacent to drainage swales and the existing streams. Steep slopes with numerous displaced gravel, cobbles, and/or boulder-sized rock, eroded/mounded soil, and various indications of minor slope instability and soil creep were observed in the northern and eastern portions of the site and typically became prevalent within 100 feet of the existing streams. Gentle slopes were encountered throughout most of the southern and western portions of the site, typically within the dense wooded areas. The central portion of the site consisting of open space was relatively flat and slope instability was not observed in the area. No indications of large, wide-scale or deep seated slope movements were noted. However, minor slope movements (wedge, bowl, or fan shaped failures) were observed in isolated areas (typically near slope areas approaching 20%), and specifically in failure areas SF-01 and SF-02, which are noted on the attached **Site Reconnaissance Plans**. For the remainder of the site, the slopes appeared to be relatively stable (excluding stream and drainage swale banks).

Two (2) minor slope failure areas were observed in isolated areas on the eastern portion of the site. Both failure areas were fan-shaped which narrowed to form drainage swales directed towards the existing stream located in the eastern portion of the property. Evidence of soil instability in these areas included bowed and fallen trees, erosion, mounded soil, and exposed tree roots. SF-01, located in the northeastern portion of proposed open space Lot 105, was approximately 50 feet long, 40 feet wide, and 3 to 5 feet deep which narrowed to a drainage swale approximately 2 to 5 feet wide and 0.5 feet deep. SF-02, located in the eastern portion of proposed open space Lot 105, was approximately 10 to 20 feet long, 8 to 10 feet wide, and 1 to 3 feet deep which narrowed to a drainage swale approximately 0.5 to 1.0 feet wide and 0.5 feet deep. Photos of each area observed are included in this letter. See the attached **Site Reconnaissance Plans** for the approximate locations, and **Site Photos** for conditions observed.

Thirty-one (31) possible karst-related features were identified onsite during the site reconnaissance. Refer to the attached **Site Reconnaissance Plans** and **Site Photos** for the approximate location of observed site features and pictures of selected features. Brief descriptions of the features are provided in the table on the following page. Areas

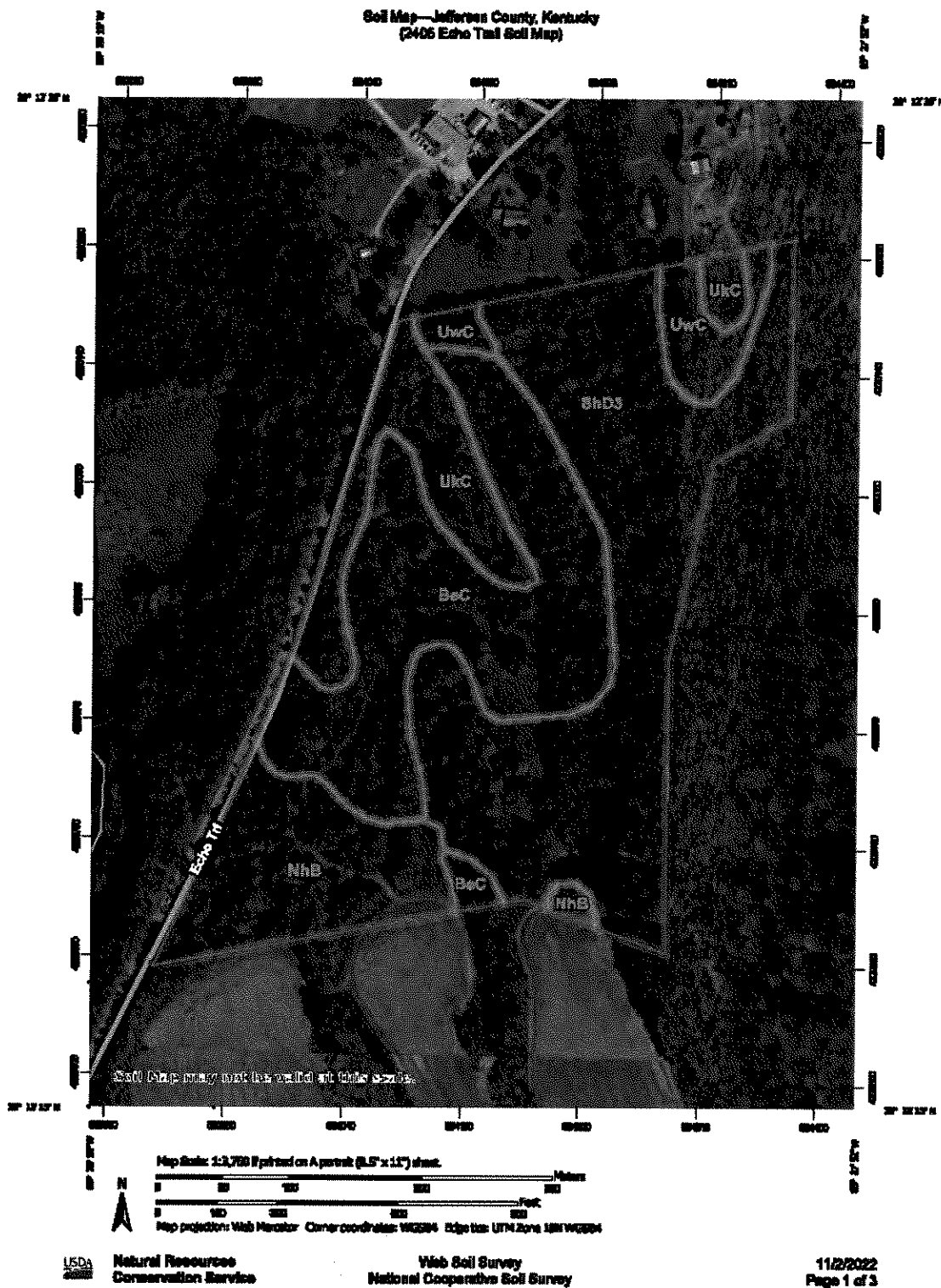


Figure 2: Reported Soil Data

NRCS CUSTOM SOIL RESOURCE REPORT				
Map Unit Symbol	Map Unit Name	Parent Material	Acres in AOI (Approximate)	Percent of AOI (Approximate)
BeC	Beasley silt loam, 6 to 12 percent slopes.	Clayey residuum weathered from calcareous shale and/or calcareous siltstone.	11.3	29.7%
NhB	Nicholson silt loam, 2 to 6 percent slopes	Fine-silty noncalcareous loess over clayey residuum weathered from limestone.	5.3	13.9%
ShD3	Shrouts silt loam, 12 to 25 percent slopes, severely eroded, very rocky	Clayey residuum weathered from calcareous shale and/or siltstone	15.6	41.3%
UkC	Urban land-Alfic Udarents-Beasley complex, 0 to 12 percent slopes	Clayey residuum weathered from calcareous shale and/or calcareous siltstone.	4.0	10.6%
UwC	Urban land-Alfic Udarents-Shrouts complex, 0 to 12 percent slopes	Clayey residuum weathered from calcareous shale and/or siltstone.	1.8	4.6 %

with alluvial gravel along east side of Floyds Fork between the mouths of Pope Lick and Cane Run 45 to 60 feet below top of unit. Least abundant limestone type is medium gray, micro-grained to medium grained, well-sorted, planar laminated calcarenite to calcisiltite in smooth surfaced, even, continuous inter-beds 0.1 to 0.4 foot thick; fossils not conspicuous; this limestone type presents only in upper part of unit. Inter-beds of planar-laminated calcisiltite and shale were well exposed at the time of mapping. Shale is olive gray to dark greenish gray, weathers light olive gray and dusky yellow; calcareous; in partings and beds 0.1 to 1.2 feet thick, commonly less than 0.6 foot thick; sparsely fossiliferous. Base of unit not exposed.

Alluvium

Total Reported Thickness: 0 - 20 feet

Karst Potential: Non-Karst

Primary Lithology: Silt, clay, sand, and gravel

Alluvium consists of silt, clay, sand, and gravel. Along Floyds Fork, silty clay, olive gray in root zone, grades downward to moderate brown to grayish brown clayey silt with blocky structure, then to moderate brown, calcareous, sandy, silty clay containing thin-shelled pelecypods, in turn underlain by as much as 3.5 feet of limestone gravel containing abundant cobbles and pebbles. In smaller stream valleys alluvium is brown to dark grayish brown silty clay and clayey silt, sand, and gravel. Gravel ranges in size from granules to boulders. Most granules and sand are limonite derived from soil; pebbles, cobbles, and slabs are from local bedrock. Older alluvium on limestone bench 30 to 45 feet above Floyds Fork is 15 to 20 feet thick; alluvium beneath modern floodplain is 8 to 10 feet thick. Basal gravel in older alluvium contains pebbles as much as 0.2 foot long; consists of brown chert, quartz geodes, silicified corals, and limonite cemented siltstone; overlain by grayish orange to moderate yellowish orange silty clay. Locally completely removed by stream erosion.

Karst Potential

According to the KGS Karst Potential Classification definitions, formations designated with a "Medium" karst potential are "Limestone units and coarse-grained, or siliciclastic units with limestone interbeds. Limestone units may contain a high percentage of insoluble minerals. Siliciclastic units will only be karst-prone where limestone beds occur in the near surface. Development of karst features in this category is variable and dependent on site-specific conditions." Formations designated with a "Low" karst potential are where the development of karst features are poorly developed or absent with the formations described as "siliciclastic units with minor limestone beds or units primarily composed of dolomite". Formations designated with a "Non-Karst" karst potential are described as "Consolidated or unconsolidated siliclastic units. Karst features are rare or absent." The karst potential is based on the tendency for the site to develop or have karst features as shown on the Kentucky Geologic Map Information Service and is not necessarily indicative of the actual presence or absence of karst activity at the site.

No sinkholes were mapped on the site by the Kentucky Geologic Map Information Service. However, several karst features were reported approximately 500 to 1,000 feet east and northwest of the site. Refer to attached **Karst Potential Map** for approximate location of mapped features.

Soil Conservation Service Soil Survey

The USDA Natural Resources Conservation Service "Web Soil Survey" website indicated 5 general soil types at the site as shown in **Figure 2**. Descriptions of these soil types are summarized below.

Drakes Formation

Total Reported Thickness: \pm 140 feet

Karst Potential: Low

Primary Lithology: Dolomite and Limestone

Members: Hitz Limestone Bed; Saluda Dolomite Member; Bardstown Member; and Rowland Member.

Hitz Limestone Bed: Primarily limestone, dolomite, and shale. Limestone and dolomite are dark gray to olive gray, weathers light gray to grayish orange, locally with a reddish brown cast; very fine to medium grained, silty; laminated in part; hackly to blocky fracture; inter-bedded and inter-tongued. Shale is grayish black to dusky brown, carbonaceous, calcareous, and strongly fissile, commonly appears in two beds, one about 0.5 feet thick near base and one 0.2 foot thick near the top.

Saluda Dolomite Member: Primarily dolomite, dolomitic mudstone, shale, and limestone. Dolomite is greenish gray, light to medium gray, grayish yellowish green, and light olive gray in distinct color bands, weathers same to yellowish gray and grayish orange. Dolomite in the upper three fourths of the unit is laminated. Weathers blocky in steep ravines, shaly to flaggy on weathered slopes. Lower one-fourth of the unit is dolomitic mudstone and lacks prominent lamination, weathers shaly or to blocky prisms. Limestone is bluish gray, weathers olive gray to brownish gray; dense, micritic; conchoidal fracture; commonly as one or two beds 0.1 to 0.6 feet thick in lower part of laminated dolomite sequence. Shale is light gray to olive black, locally carbonaceous; as persistent parting 0.1 to about 1 foot thick in lower part of laminated dolomite.

Bardstown Member: Primarily limestone, mudstone, and shale. Limestone is of three main types: Most common limestone is medium to dark gray, weathers yellowish brown, micritic to fine grained in very thin beds, laminated and continuous with fossils common. Second type is medium light gray to olive gray, weathers light gray to dark yellowish orange, micritic to coarse grained in very thin and/or discontinuous beds, with abundant whole fossils. Third type is muddy limestone, blueish to olive gray, weathers greenish gray to yellowish green, and resembles limestone of underlying Rowland Member (see below). Mudstone and shale appear as inter-beds in limestone, are olive gray, somewhat calcareous, light olive gray to light gray; locally grayish to brownish black, weathers medium gray. All shale is fossiliferous.

Rowland Member: Primarily limestone and shale. Dominant limestone is medium and greenish gray to medium bluish gray calcisiltite; weathers pale olive to yellowish gray; dolomitic and argillaceous; streaked with irregular burrows filled with dusky yellowish-green glauconitic material which weathers out readily to form holes and pitted bed surfaces; thin to thick bedded in continuous but poorly defined planar beds. Dominant shale is olive gray, light olive gray, greenish gray, and dark greenish gray; weathers yellowish gray to light gray; clayey and calcareous; prominent in two persistent beds 5 to 7 feet thick near upper and basal contacts. Small ponds for livestock and recreation are common in areas underlain by the Waldron Shale and by shale of the Osgood Formation and the Bardstown and Rowland Members of the Drakes Formation.

Grant Lake Limestone

Total Reported Thickness: + 100 feet

Karst Potential: Medium

Primary Lithology: Limestone and Shale

Grant Lake Limestone is of three main types. Dominant limestone type is medium gray, contains abundant coarse fossil fragments and whole fossils in a greenish gray calcareous mudstone or a medium to very coarse grained calcarenite cemented by sparry calcite; beds uneven to nodular, some continuous, commonly less than 0.2 foot thick. Less abundant limestone type is medium gray, fossil fragmental, poorly sorted calcarenite with sparry cement; weathers with abundant brown specks; in crossbeds 0.1 to 1.3 feet thick with smooth to undulating surfaces. Cross-bedded limestone common about 10 feet below top of unit; forms 15 foot thick sequence underlying bench capped

The existing topography generally sloped down from north to south, with areas of steeper slopes generally occurring within the eastern portions of the site and sloped towards the existing streams.

Geology

The following geologic information is based on the review of: the Fisherville, 24K Quadrangle, Geologic Map, Kentucky, published by the United States Geological Survey (USGS); information (aerial photos, geologic maps, and topographic maps, etc.) obtained from the Kentucky Geological Survey (KGS) Geologic Information Service website; and Google Earth satellite imaging.

The Kentucky Geologic Map Information Service website indicated that the majority of the proposed development area (roughly above ~EL 605 to ~EL 620) was underlain by the Drakes Formation. Lower elevation areas roughly between ~EL 600 to ~EL 620 were underlain by Grant Lake Limestone. The southeastern-most portion of the proposed development area between elevations of roughly ~EL 605 to ~EL 610 were underlain by Alluvium.

Above ~EL 605 – 620	Drakes Formation
~EL 600 – 620	Grant Lake Limestone
Below ~EL 605 – 610	Alluvium

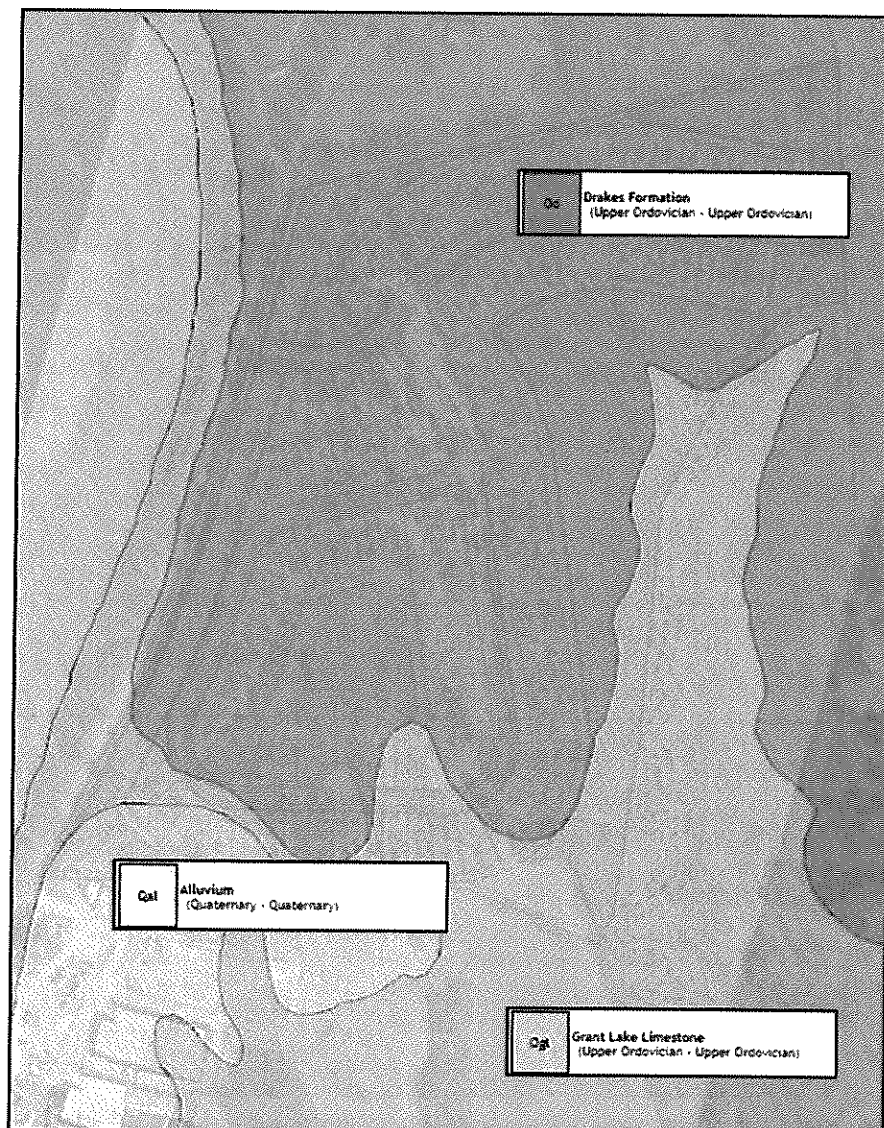
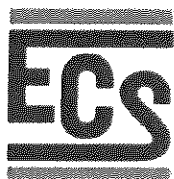


Figure 1: Reported Site Geology



ECS SOUTHEAST, LLP

Geotechnical • Construction Materials • Environmental • Facilities

"One Firm. One Mission."

February 14, 2023

Mr. S. Bradford Rives
Long Run Creek Properties, LLC
3911 Wilderness Trail
Louisville, Kentucky 40299

c/o Mr. David Mindel
Mindel Scott
5151 Jefferson Boulevard
Louisville, Kentucky 40219

Reference: **Slope Evaluation and Karst Survey – 2405 Echo Trail – Revision I**
2405 Echo Trail
Louisville, Jefferson County, Kentucky 40245
ECS Project No. 61-2863RI

Dear Mr. Rives:

ECS Southeast, LLP (ECS) conducted a combined evaluation, consisting of a limited subsurface exploration and site reconnaissance, for the referenced site in accordance with ECS Proposal No. 61-P2890, dated October 10, 2022. This evaluation included the following elements: a review of provided drawings; a review of soil survey information; a review of geologic maps; a review of topographic maps; a review of current and historical aerial photographs; a visual reconnaissance of site conditions for the karst geologic features defined in the Metro Louisville Land Development Code (LDC); a visual reconnaissance of indicated steeper slope areas that would be disturbed by new construction; a limited subsurface evaluation to explore the materials along slopes greater than 30% that will be disturbed during construction; and evaluate the reviewed information and prepare a report of our findings and recommendation.

Purpose

The purpose of the subsurface evaluation was to explore the materials along slopes greater than 30% that will be disturbed during construction, the depth to bedrock and the shear strength of the soils in these areas are required to be analyzed by a geotechnical engineer per the county development code (Section 4.7.4 of the LDC). A visual reconnaissance of the site was completed concurrently with the subsurface evaluation to identify potential karst geologic features and document the condition of steeper slope areas not evaluated during the subsurface evaluation, per the LDC (Section 4.9.3).

The drawing "22-ZONEPA-0110 – 22-09-12 (FILED)" provided by Allison Hicks of Mindel Scott via email, dated September 12, 2022, was used as a reference during the subsurface evaluation and site reconnaissance and for creation of the attached maps and diagrams. A reduced copy of this drawing is attached to this report. Slopes identified as greater than 30%, and slopes between 20% and 30%, were reported on this drawing, as well as the location of planned construction.

Project Information

The proposed development on-site includes 103 single-family residential lots and associated roadways. The site undulates across the proposed development footprint with approximately 75 feet of fall across the entire site, with up to approximately 20 feet of fall across a single proposed residential development lot. The site includes approximately 36.67 acres of rolling hills which are mostly wooded, with isolated open areas. Two existing streams are located in the northeastern portion of the site. A third stream was observed in the southern portion of the site in the proposed open space located in Lot 106, which extended towards the southern property boundary of the site.

at which the soil can be rolled into 1/8-inch diameter threads without crumbling. The plasticity index (PI) is the difference between the liquid limit and the plastic limit, and is the range of moisture content over which a soil deforms as a plastic material.

Pocket Penetrometer

The pocket penetrometer is a hand-held, spring-loaded rod that measures the penetration resistance of soil. It is used to gauge the approximate unconfined compressive strength of cohesive soils. The strength is measured by applying pressure to the end of the penetrometer thereby pushing the rod tip a prescribed distance into the soil. The unconfined compressive strength is read directly from a scale or gauge on the device.

Laboratory Procedures

General

Laboratory tests are generally conducted to satisfy one or more of the following objectives: (1) confirmation of visual-manual soil identification; (2) determination of index values used to estimate soil engineering properties (i.e., strength, compressibility and permeability); or (3) direct measurement of specific soil properties. The tests selected for a given project are dependent on the subsurface conditions encountered, as well as specific project requirements, such as structural loads and planned grade changes. The results of the laboratory tests conducted for this project are listed on the **Boring Records**, Laboratory Test Data Summary, or laboratory data curves in the **Appendix**. Brief descriptions of the test procedures are provided below.

Description and Identification of Soils (Visual-Manual Procedure) (ASTM D 2488)

The Visual-Manual Procedure provides a general guide to the engineering properties of soils and enables the engineer to apply past experience to current situations. Samples obtained during the field exploration are examined and visually described and identified by a geotechnical engineer or geologist. The soils are typically identified according to predominant particle size (clay, silt, sand, etc.), consistency (based on apparent stiffness and the number of blows from standard penetration tests), color, moisture and group symbol (CL, CH, SP, SC, etc.). Unless otherwise indicated, the soil descriptions in this report are based on the Visual-Manual Procedure.

Classification of Soils for Engineering Purposes (Unified Soil Classification System) (ASTM D 2487)

The Visual-Manual Procedure described above is primarily qualitative. The Unified Soil Classification System (USCS) is used when precise soil classification is required. The USCS is based on laboratory determination of particle-size characteristics, liquid limit, and plasticity index. Using these test results, the soil can be classified according to the Unified Classification System, which provides an index for estimating soil behavior.

Water (Moisture) Content of Soil (ASTM D 2216)

Moisture content is one of the most important index properties used in establishing a correlation between soil behavior and soil properties such as strength and compressibility. The moisture content, along with the liquid and plastic limits, are used to express the relative consistency or liquidity index of a soil. Increasing moisture contents typically reflect lower strengths for a given soil. The soil moisture content is the ratio, expressed as a percentage, of the mass of "pore" or "free" water in a given mass of soil to the mass of the solid soil. Moisture content samples are taken from the sealed container obtained during the field exploration phase of a project. Each sample is weighed, and then placed in an oven set to $110^{\circ}\text{C} \pm 5^{\circ}\text{C}$. Each sample remains in the oven until the free moisture evaporates. Each dried sample is removed from the oven, allowed to cool, and then weighed. The moisture content is computed by dividing the weight of evaporated water by the weight of the dry sample.

Liquid Limit, Plastic Limit, and Plasticity Index of Soils (ASTM D 4318)

Depending upon the relative moisture content, a fine-grained soil may occur in a liquid, plastic, or solid state. In current usage, the liquid limit (LL) and plastic limit (PL) of a soil are referred to as the "Atterberg Limits", which establish the approximate moisture contents at which the soil changes state. This test method is an integral part of several engineering classification systems to characterize the fine grained fractions of soils. It is also used with other soil properties to correlate with engineering behavior such as compressibility, permeability, compactability, shrink-swell, and shear strength. The liquid limit is the moisture content at which a soil becomes sufficiently "wet" to behave as a heavy viscous fluid (i.e., transition from plastic to liquid state). It is defined as the moisture content at which the soil, when placed in a standard brass bowl, makes a 1/2-inch closure in a groove cut through the soil after the bowl is dropped 25 times at a specified height and rate. The plastic limit is the moisture content at which the soil begins to lose its plasticity (i.e., transition from plastic to semi-solid state). It is defined as the lowest moisture content

Field Procedures

General

ECS conducts field sampling and testing procedures in general accordance with methods of the American Society for Testing Materials (ASTM) and widely accepted geotechnical engineering standards. A brief description of the procedures we utilize is provided in the following paragraphs.

Boring Locations and Elevations

Boring locations typically are selected by our project manager. The project manager establishes the boring locations in the field by pacing or measuring distances and estimating angles relative to existing site landmarks. When topographic plans of the site are provided, the project manager estimates the surface elevation of the boring locations using available information. Surveying to determine the locations and elevations of the borings is beyond the scope of typical geotechnical studies; therefore, the boring locations and elevations should be considered approximate.

Dynamic Cone Penetrometer Tests (ASTM STP-399)

The Dynamic Cone Penetrometer (DCP) uses a 15 lb (6.8 kg) steel mass falling 20 in (50.8 cm) that strikes an anvil to cause penetration of a 1.5 in (3.8 cm) diameter cone (45° vertex angle) that has been seated in the bottom of a hand augered hole. The blows required to drive the embedded cone a depth of 1-3/4 in have been correlated to N values derived from the Standard Penetration Test (SPT). Experience has shown that the DCP can be used effectively in augered holes to depths of 15 to 20 ft. (4.6 to 6.1 m).

Boring Records

Our interpretation of the conditions encountered at each location is indicated on the **Boring Records**, which are prepared from the observations of the ECS field engineer or geologist during drilling or excavation, our engineering review of the soil samples obtained, the results of laboratory testing on selected samples, and our experience with similar subsurface conditions. Soil descriptions are made using the Unified Soil Classification System and/or ASTM D-2488 as guides. The depths designating strata changes are estimations and only representative of depths at that specific boring location. In many geologic settings, the transition between strata is gradual. A **Boring Legend**, which defines the symbols and other pertinent information presented on the **Boring Records**, is provided with this report. The subsurface conditions indicated on our **Boring Records** represent only the conditions encountered at the specific boring location at the time of our exploration. The groundwater observations were made at the time of drilling and may vary with changes in the season and weather.

Refusal

Refusal is the term applied to material that cannot be penetrated with augers or has a standard penetration resistance exceeding 50 blows per 6-inch increment. Refusal may be encountered on continuous bedrock, discontinuous floaters, cemented soil, weathered rock, debris, buried structures, or other hard subsurface materials. Refusal materials can be evaluated only by obtaining a core of the material. This limitation must be considered when evaluating refusal depths where coring is not conducted.



ECS Southeast, LLP

1762 Watterson Trail
Louisville, KY 40299

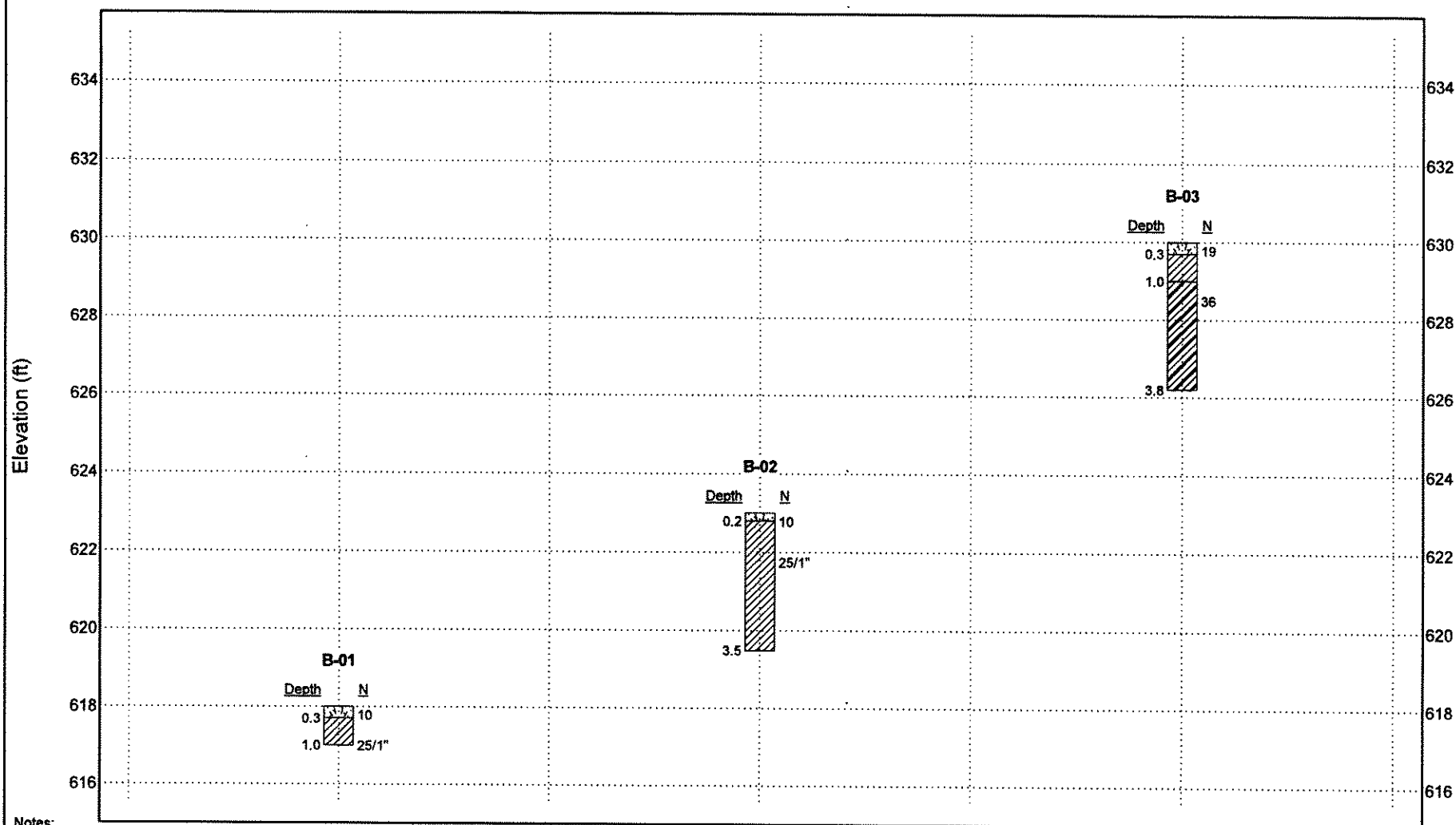
CLIENT Long Run Creek Properties, LLC

PROJECT NUMBER 61-2863

BORING COMPOSITE

PROJECT NAME Slope Evaluation and Karst Survey - 2405 Echo Trail

PROJECT LOCATION 2405 Echo Trail, Louisville, KY 40425



Notes:

Ground surface elevations interpolated to ± 1.0 feet based on a drawing "22-ZONEPA-0110 - 22-09-12 (FILED)", provided by Allison Hicks of Mindel Scott, dated September 9, 2022.

Location of borings along the horizontal axis are not indicative of actual spacing

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22-ZONE-0131

**ECS Southeast, LLP**1762 Watterson Trail
Louisville, KY 40299**BORING RECORD**

Project Name **Slope Evaluation and Karst Survey - 2405 Echo Trail**
 Location **2405 Echo Trail, Louisville, KY 40425**
 Client **Long Run Creek Properties, LLC**
 Driller **B. Emery/B. Kabbes** Rig Type **DCP**
 Drill Method **Hand Auger** Hammer Type **Manual**
 Groundwater **Not Encountered ATD**

Boring No. **B-03**
 Project No. **61-2863**
 Elevation **630 (a)**
 Started **11/03/2022**
 Completed **11/03/2022**
 Logged By **B. Kabbes**
 Weather **60s, Sunny**

Scale, ft.	Elevation, ft.	Soil Symbol	Material Description and Classification	Depth, ft.	Sample Type	Sample Depth, ft.	Recovery, %	DCP Penetration Test Blows	N _e Value	Water Content, %	U _c , tsf	Comments
			TOPSOIL (4 inches)									
				0.3		0.0 - 0.4		6-8-11	9			Two borings were extended at approximately 1 foot spacing. DCP testing was performed in one boring while an undisturbed sample was collected in the adjacent boring. A drive rod was offset an additional 1 foot and driven to refusal.
			CLAY, silty, yellow to medium brown, low plasticity, stiff, dry, (CL), with few root fibers									
1	629			1.0								Undisturbed sample was obtained from approximately 1.0 to 2.0 feet below existing grade.
			CLAY, silty, orange to medium brown, low to moderate plasticity, hard, dry to slightly moist, (CL), with few root fibers and weathered rock fragments			1.0 - 2.0	88	10-15-21	18	23.1		Hand Auger Refusal was encountered at approximately 1.8 to 1.9 feet below existing grades.
2	628											
			- mostly weathered rock fragments below 1.8 feet									
3	627											
				3.8								
4	626		Boring Terminated at Drive Rod Refusal									

Remarks: (a) Ground surface elevations interpolated to ± 1.0 feet based on a drawing "22-ZONEPA-0110 - 22-09-12 (FILED)", provided by Allison Hicks of Mindel Scott, dated September 9, 2022.

Sheet 1 of 1

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**ECS Southeast, LLP**1762 Watterson Trail
Louisville, KY 40299**BORING RECORD**

Project Name **Slope Evaluation and Karst Survey - 2405 Echo Trail**
 Location **2405 Echo Trail, Louisville, KY 40425**
 Client **Long Run Creek Properties, LLC**
 Driller **B. Emery/B. Kabbes** Rig Type **DCP**
 Drill Method **Hand Auger** Hammer Type **Manual**
 Groundwater **Not Encountered ATD**

Boring No. **B-02**
 Project No. **61-2863**
 Elevation **623 (a)**
 Started **11/03/2022**
 Completed **11/03/2022**
 Logged By **B. Kabbes**
 Weather **60s, Sunny**

Scale, ft.	Elevation, ft.	Soil Symbol	Material Description and Classification	Depth, ft.	Sample Type	Sample Depth, ft.	Recovery, %	DCP Penetration Test Blows	N _e Value	Water Content, %	U _c , tsf	Comments
			TOPSOIL (2 inches)	0.2		0.0 - 0.4		7-4-6	5			Two borings were extended at approximately 1 foot spacing. DCP testing was performed in one boring while an undisturbed sample was collected in the adjacent boring. A drive rod was offset an additional 1 foot and driven to refusal.
			CLAY, silty, yellow to medium brown, low plasticity, firm, dry, (CL), with few root fibers									
1	622											
						1.0 - 1.5	66	10-25/1"	25/1"	14.6		DCP Refusal was encountered at approximately 1.2 feet below existing grade.
			- mostly weathered rock fragments below 1.6 feet									Undisturbed sample was obtained from approximately 1.0 to 1.5 feet below existing grade.
2	621											Hand Auger Refusal was encountered at approximately 1.5 feet below existing grade.
3	620											
				3.5								Boring Terminated at Drive Rod Refusal
4	619											

Remarks: (a) Ground surface elevations interpolated to ± 1.0 feet based on a drawing "22-ZONEPA-0110 - 22-09-12 (FILED)", provided by Allison Hicks of Mindel Scott, dated September 9, 2022.

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22-ZONE-0131

**ECS Southeast, LLP**1762 Watterson Trail
Louisville, KY 40299**BORING RECORD**

Project Name **Slope Evaluation and Karst Survey - 2405 Echo Trail**
 Location **2405 Echo Trail, Louisville, KY 40425**
 Client **Long Run Creek Properties, LLC**
 Driller **B. Emery/B. Kabbes** Rig Type **DCP**
 Drill Method **Hand Auger** Hammer Type **Manual**
 Groundwater **Not Encountered ATD**

Boring No. **B-01**
 Project No. **61-2863**
 Elevation **618 (a)**
 Started **11/03/2022**
 Completed **11/03/2022**
 Logged By **B. Kabbes**
 Weather **60s, Sunny**

Scale, ft.	Elevation, ft.	Soil Symbol	Material Description and Classification	Depth, ft.	Sample Type	Sample Depth, ft.	Recovery, %	DCP Penetration Test Blows	Ne Value	Water Content, %	Uc, tsf	Comments
			TOPSOIL (4 inches), with trace rock fragments									
				0.3		0.0 - 0.4		4-4-6	5			
			CLAY, silty, sandy, orange to medium brown, low plasticity, firm, very moist to wet, (CL), with trace root fibers									
			- mostly rock fragments below 0.8 feet	1.0		1.0 - 1.0		25/1"	25/1"			Hand Auger Refusal encountered approximately 0.8 feet below existing grade.
			Boring Terminated at Drive Rod Refusal									
1	617											
2	616											
3	615											
4	614											

Remarks: (a) Ground surface elevations interpolated to ± 1.0 feet based on a drawing "22-ZONEPA-0110 - 22-09-12 (FILED)", provided by Allison Hicks of Mindel Scott, dated September 9, 2022.

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22-ZONE-0131



SOIL CLASSIFICATION

MAJOR DIVISIONS			SYMBOLS	TYPICAL DESCRIPTIONS
COARSE GRAINED SOILS MORE THAN 50% OF MATERIAL IS LARGER THAN NO. 200 SIEVE	GRAVEL AND GRAVELLY SOILS	Clean Gravels	GW	Well graded gravels, gravel-sand mixtures, little or no fines
		Gravels with fines	GP	Poorly graded gravels, gravel-sand mixtures, little or no fines
			GM	Silty gravels, gravel-sand-silt mixtures
	SAND AND SANDY SOILS	Clean Sands	GC	Clayey gravels, gravel-sand-clay mixtures
			SW	Well graded sands, gravelly sands, little or no fines
		Sands with fines	SP	Poorly graded sands, gravelly sand, little or no fines
SM			Silty sands, sand-silt mixtures	
FINE GRAINED SOILS MORE THAN 50% OF MATERIAL IS SMALLER THAN NO. 200 SIEVE	SILTS AND CLAYS	Liquid Limit less than 50	SC	Clayey sands, sand-clay mixtures
			ML	Inorganic silts, silty or clayey fine sands or clayey silts with slight plasticity
			CL	Inorganic clays of low to moderate plasticity, gravelly clays, sandy clays, silty clays, lean clays
	SILTS AND CLAYS	Liquid Limit greater Than 50	OL	Organic silts and organic silty clays of low plasticity
			MH	Inorganic silts, micaeaceous or diatomaceous fine sand or silty soils
			CH	Inorganic clays of high plasticity
HIGHLY ORGANIC SOILS			OH	Organic clays of moderate to high plasticity, organic silts
			PT	Peat, humus, swamp soils with high organic contents

SOIL CONSISTENCY SPT N: Standard Penetration Test N-Value N¹ - Manual Hammer (Rope & Pulley - 60% Efficiency) N² - Automatic Hammer (Free-Fall - 96% Efficiency)

COARSE GRAINED SOILS		
SPT N ¹	SPT N ²	Relative Density
0-4	0-3	Very loose
4-10	3-6	Loose
10-30	6-19	Medium dense
30-50	19-31	Dense
> 50	> 31	Very dense

FINE GRAINED SOILS		
SPT N ¹	SPT N ²	Field Identification
0-2	0-1	Very soft - Easily penetrated several inches by fist
3-4	2-3	Soft - Easily penetrated several inches by thumb
5-7	3-4	Firm - Can be penetrated several inches by thumb with moderate effort
8-15	5-9	Stiff - Readily indented by thumb but penetrated only with great effort
16-30	10-19	Very stiff - Readily indented by thumbnail
> 30	> 19	Hard - Indented with difficulty by thumbnail

SOIL PARTICLE SIZES

Description	Size Limits	Familiar Example
Boulder	12 inches or more	Larger than basketball
Cobble	3 - 12 inches	Orange to basketball
Coarse gravel	¾ - 3 inches	Grape to orange
Fine gravel	4.75 mm (No. 4 sieve) - ¾ inch	Pea to grape
Coarse sand	2-4.75 mm (No. 10 to 4 sieve)	Rock Salt
Medium sand	0.42-2 mm (No. 40 to 10 sieve)	Table Salt
Fine sand	0.075-0.42 mm (No. 200 to 40 sieve)	Powdered sugar
Silt/Clay/Fines	Less than 0.075 mm (No. 200)	Not visible to naked eye

RELATIVE PROPORTIONS

Description	Percent
Trace	1-5
Few	5-15
Little	15-30
Some	30-50
Mostly	50-100

ROCK CONTINUITY

Description	Core Recovery (%)
Incompetent	0-40
Competent	40-70
Fairly Continuous	70-90
Continuous	90-100

ROCK QUALITY DESIGNATION

Description	RQD (%)
Very Poor	0-25
Poor	25-50
Fair	50-75
Good	75-90
Excellent	90-100

ROCK BEDDING

Description	Thickness (in)
Parting	< 0.3
Band	0.3-2.5
Thin Bed	2.5-6.0
Medium bed	6.0-12.0
Thick bed	12.0-36.0
Massive	> 36.0




ROCK HARDNESS (Descriptions for rock core samples)

Description	Definition
Very soft	Can be broken with fingers
Soft	Can be scratched with fingernail; only edges can be broken with fingers
Moderately hard	Can be easily scratched with knife; cannot be scratched with fingernail
Hard	Difficult to scratch with knife; hard hammer blow to break specimen
Very hard	Cannot be scratched with knife; several hard hammer blows to break specimen

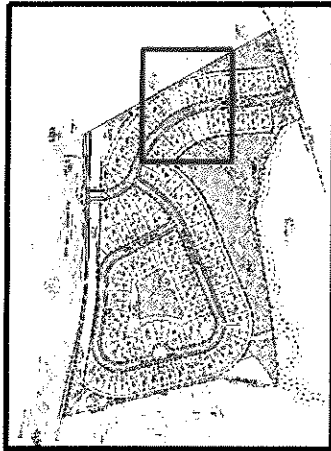
ROCK WEATHERING (Descriptions for rock core samples)

Description	Definition
Completely	Rock decomposed to soil; rock fabric and structure completely destroyed
Highly	Most minerals are decomposed; texture indistinct but fabric preserved; strength greatly reduced
Moderately	Discoloration throughout and weaker minerals decomposed; texture preserved but strength less than unweathered rock
Slightly	Discoloration around open fractures; strength preserved
Unweathered	No sign of decomposition

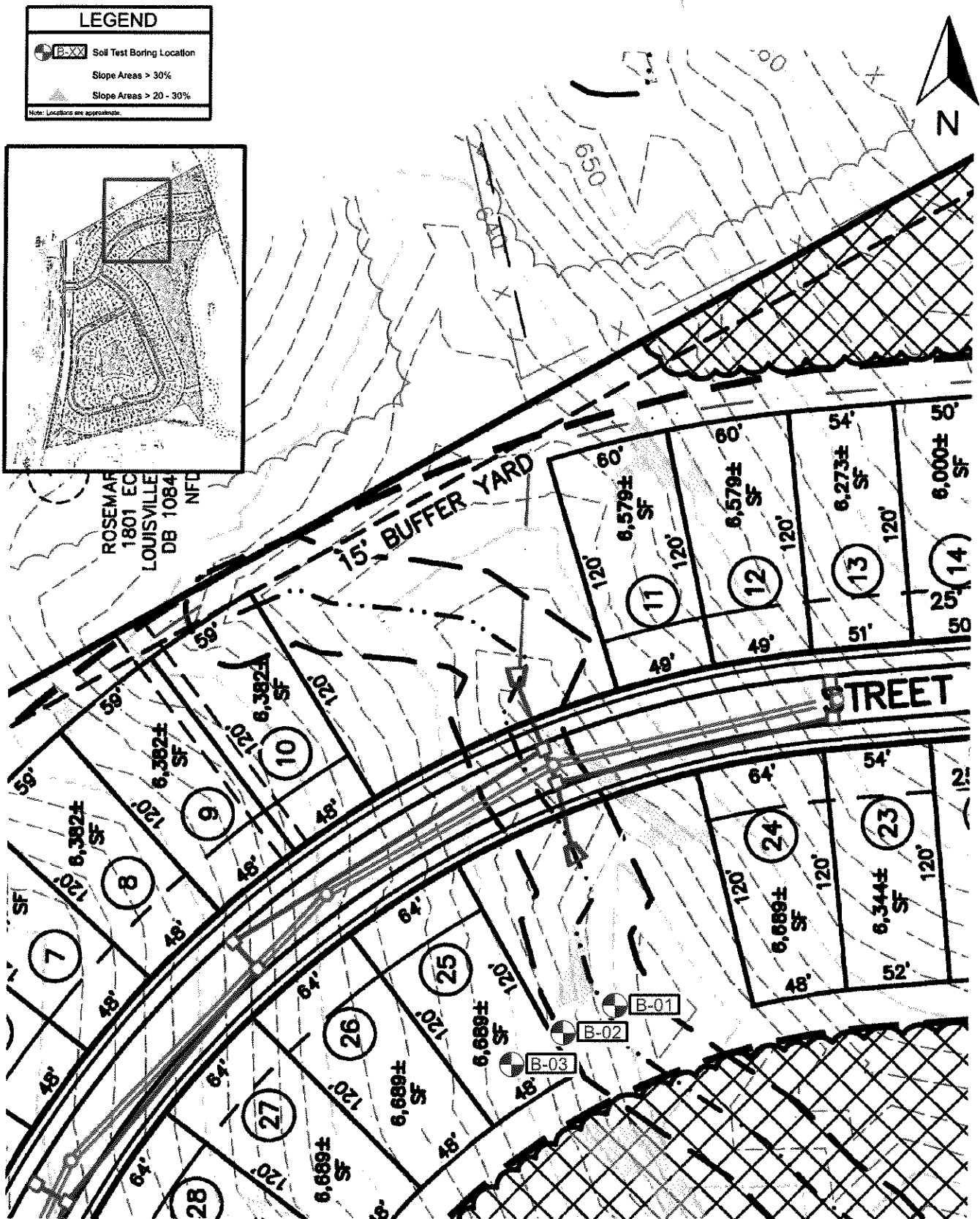
LEGEND

-  B-XX Soil Test Boring Location
-  Slope Areas > 30%
-  Slope Areas > 20 - 30%

Note: Locations are approximate.



ROSEMAR
1801 EC
LOUISVILLE
DB 1084
NFD



Based on a drawing "22-ZONEPA-0110 - 22-09-12 (FILED)", provided by Allison Hicks of Mindel Scott, dated September 9, 2022.

0 100
Feet
Graphic Scale



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1762 Watterson Trail
Louisville, Kentucky 40299
Tel. (502) 493-7100

received Nov. 29, 2022

Boring Location Diagram

Preliminary Slope Evaluation and Karst Survey - 2405 Echo Trail

2405 Echo Trail
Louisville, Jefferson County, Kentucky 40245

DRAWN BY
BEK

APPROVED BY
FEN

PROJECT NO.
61-2863

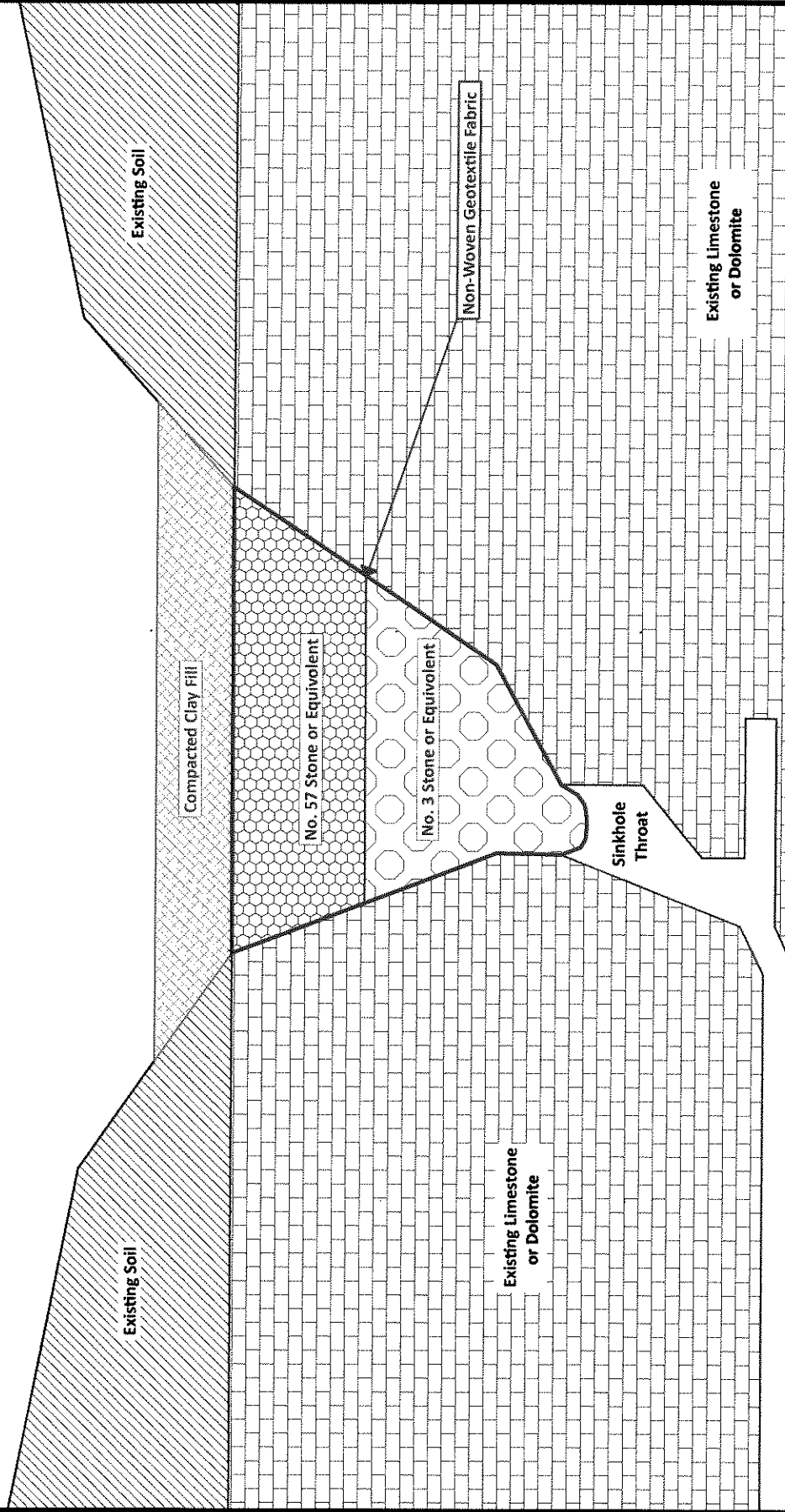
DATE
11-14-2022

22-ZONE

APPENDIX C – Slope Exploration

Boring Location Diagram
Soil & Rock Classification
Boring Legend
Boring Records
Boring Composite
Field Procedures
Laboratory Procedures

Note: Not for construction - specific remediation for each sinkhole must be recommended by ECS Southeast, LLP at the time of remediation. See "Sinkhole Remediation Guidelines" in the report.



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02-ZONE-0

ECS

ECS Southeast, LLP
1762 Watterson Trail
Louisville, Kentucky 40299
Tel: (502) 493-7100

Project No.: 61-2863
Drawing No.: 2863 BLP
Date: 11/21/2022

Drawn By: BEK
Checked By: FEN
Scale: As Shown

Typical Sinkhole Remediation Diagram
Slope Evaluation and Karst Survey - 2405 Echo Trail
Louisville, Jefferson County Kentucky 40425

Site Photos

Preliminary Slope Exploration and Karst Survey – 2405 Echo Trail

ECS Project No.: 61-2863



Photo 35: View of debris piles typically encountered in the southern portion of the site, near the existing cleared access paths.



Photo 36: View of dense brush encountered throughout the site that could obscure potential karst features or indications of slope instability from view.

Site Photos

*Preliminary Slope Exploration and Karst Survey – 2405 Echo Trail
ECS Project No.: 61-2863*



Photo 33: View of a drainage swale typically encountered throughout the southern portion of the site, directed towards the central stream directed south.



Photo 34: View of the central stream from the southern property boundary.

Site Photos

*Preliminary Slope Exploration and Karst Survey – 2405 Echo Trail
ECS Project No.: 61-2863*



Photo 31: View of slope downslope of slope failure area SF-02.



Photo 32: View of a shallow drainage swale typically encountered throughout the northeastern and eastern portions of the site, directed towards the eastern creek.

Site Photos

*Preliminary Slope Exploration and Karst Survey – 2405 Echo Trail
ECS Project No.: 61-2863*



Photo 29: View of drainage swale directed downslope of slope failure area SF-01.



Photo 30: View of fan-shaped slope failure area SF-02.

Site Photos

*Preliminary Slope Exploration and Karst Survey – 2405 Echo Trail
ECS Project No.: 61-2863*



Photo 27: View of large fan-shaped slope failure area SF-01.

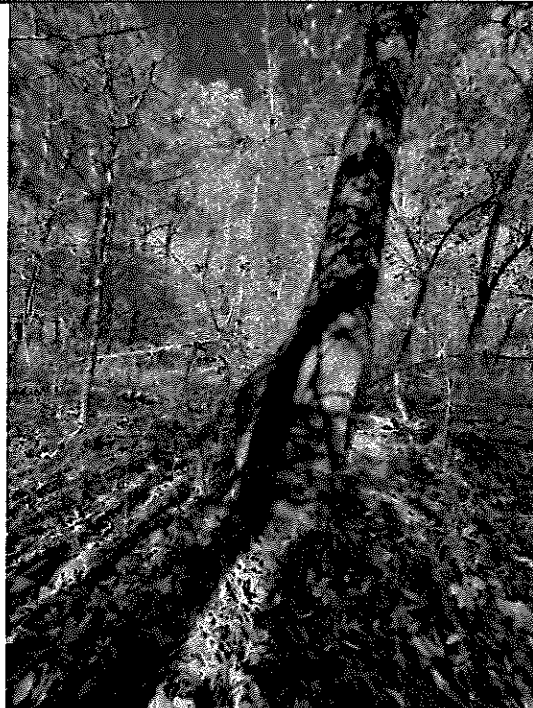


Photo 28: View of bowed trees and mounded soil encountered in SF-01.

Site Photos

*Preliminary Slope Exploration and Karst Survey – 2405 Echo Trail
ECS Project No.: 61-2863*



Photo 25: View of probe rod extended in partially closed throat located in F-29.



Photo 26: View of F-31.

Site Photos

*Preliminary Slope Exploration and Karst Survey – 2405 Echo Trail
ECS Project No.: 61-2863*



Photo 23: View of F-26.



Photo 24: View of probe rod extended in partially closed throat located in F-28.

Site Photos

*Preliminary Slope Exploration and Karst Survey – 2405 Echo Trail
ECS Project No.: 61-2863*



Photo 21: View of F-25.



Photo 22: View of possible human disturbance and partially closed throat located in F-25.

Site Photos

*Preliminary Slope Exploration and Karst Survey – 2405 Echo Trail
ECS Project No.: 61-2863*



Photo 19: View of probe rod extended in partially closed throat located in F-22.



Photo 20: View of probe rod extended in partially closed throat located in F-23.

Site Photos

*Preliminary Slope Exploration and Karst Survey – 2405 Echo Trail
ECS Project No.: 61-2863*



Photo 17: View of stream sidewalls located in northeastern portion of the site.



Photo 18: View of F-21.

Site Photos

*Preliminary Slope Exploration and Karst Survey – 2405 Echo Trail
ECS Project No.: 61-2863*



Photo 15: View of probe rod extended in partially closed throat located in F-18.



Photo 16: View of stream located in northeastern portion of the site.

Site Photos

Preliminary Slope Exploration and Karst Survey – 2405 Echo Trail

ECS Project No.: 61-2863



Photo 13: View of probe rod extended in partially closed throat located in F-15.



Photo 14: View of probe rod extended in partially closed throat located in F-17.

Site Photos

*Preliminary Slope Exploration and Karst Survey – 2405 Echo Trail
ECS Project No.: 61-2863*



Photo 11: View of probe rod extended in partially closed throat located in F-11.



Photo 12: View of probe rod extended in partially closed throat located in F-12.

Site Photos

*Preliminary Slope Exploration and Karst Survey – 2405 Echo Trail
ECS Project No.: 61-2863*



Photo 9: View of multiple partially closed throats located in F-08.



Photo 10: View of multiple closed depressions located in F-09.

Site Photos

Preliminary Slope Exploration & Karst Survey – 2405 Echo Trail

ECS Project No.: 61-2863



Photo 7: View of F-06 containing rusted debris and a partially closed throat.



Photo 8: View of probe rod in partially closed throat in F-07.

Site Photos

Preliminary Slope Exploration and Karst Survey – 2405 Echo Trail
ECS Project No.: 61-2863



Photo 5: View of F-04.



Photo 6: View of F-05.

Site Photos

*Preliminary Slope Exploration and Karst Survey – 2405 Echo Trail
ECS Project No.: 61-2863*



Photo 3: View of one of several throats located in F-03.



Photo 4: View of F-03.

Site Photos

Preliminary Slope Exploration and Karst Survey – 2405 Echo Trail

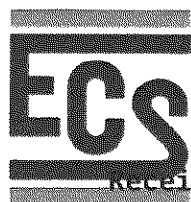
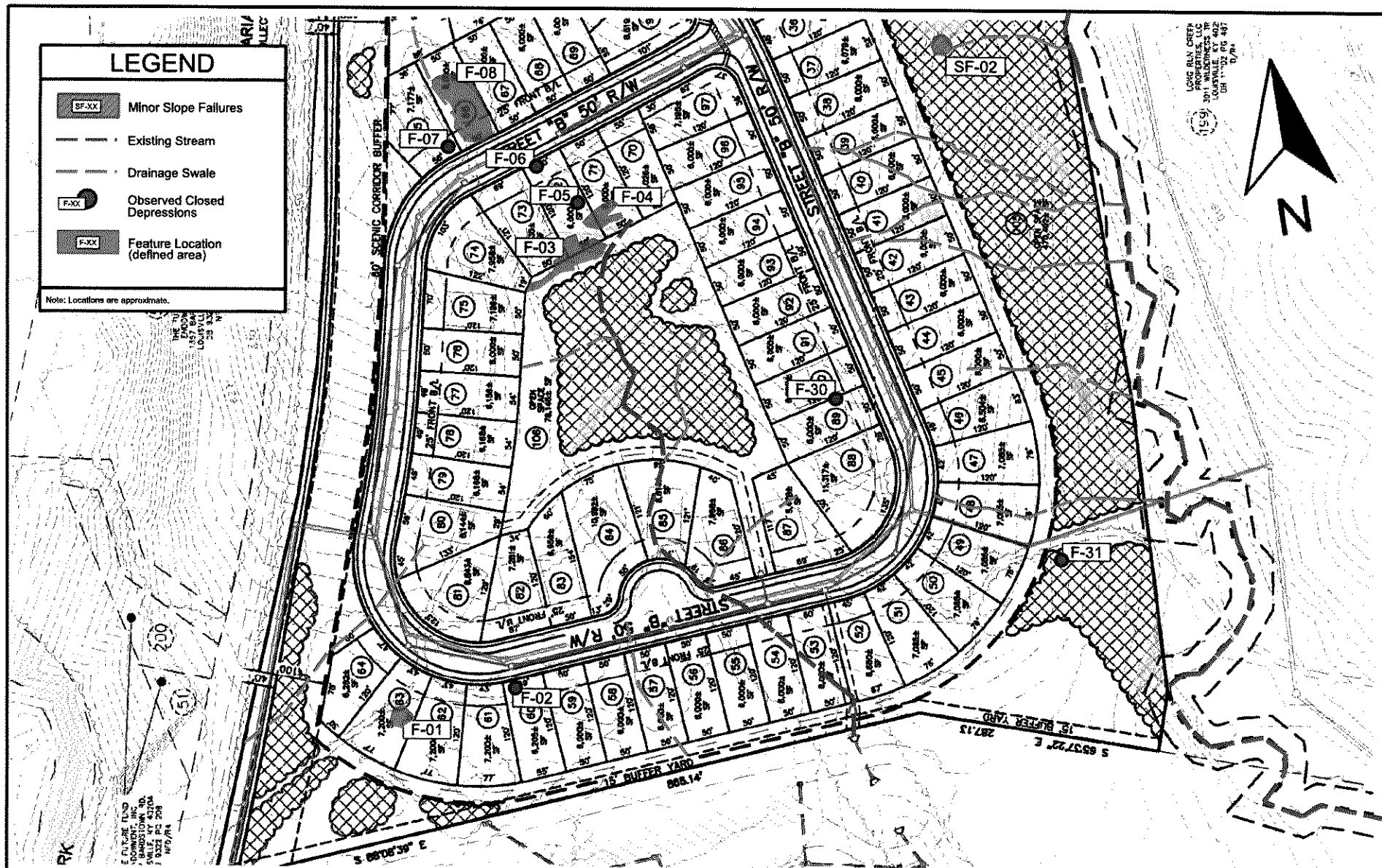
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Photo 1: View of remnant shed located adjacent to F-01.



Photo 2: View of F-02.



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Site Reconnaissance Plan - South Area

Slope Evaluation and Karst Survey - 2405 Echo Trail

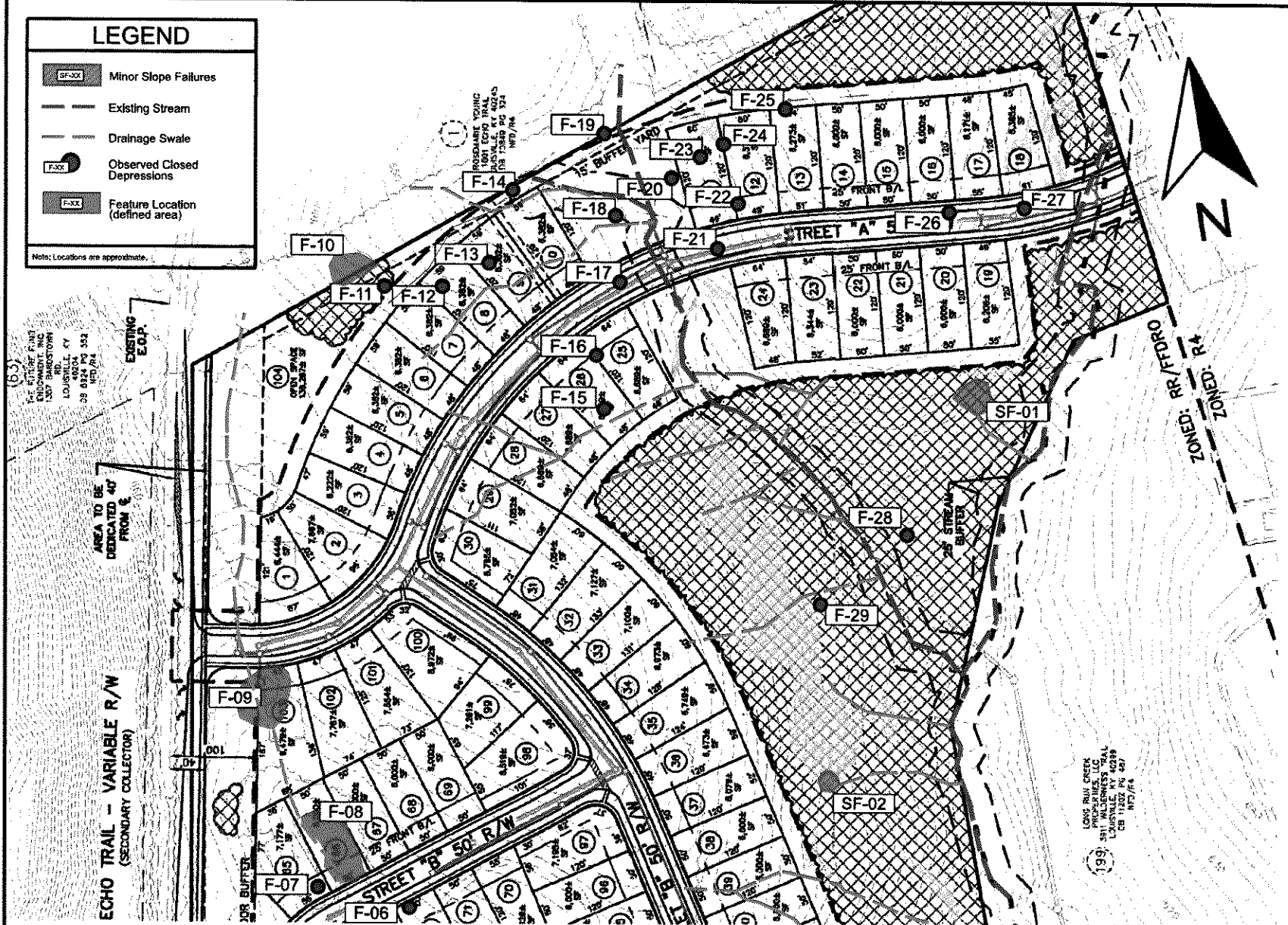
2405 Echo Trail
Louisville, Jefferson County, Kentucky 40245

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BEK
APPROVED BY
FEN
PROJECT NO.
61-2863
22-ZONEPA-0131
11-14-2022

LEGEND

- SF-XX Minor Slope Failures
- Existing Stream
- Drainage Swale
- F-XX Observed Closed Depressions
- F-XX Feature Location (defined area)

Note: Locations are approximate.



Based on a drawing "22-ZONEPA-0110 - 22-09-12 (FILED)", provided by Allison Hicks of Mindel Scott, dated September 9, 2022.








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Site Reconnaissance Plan - North Area Slope Evaluation and Karst Survey - 2405 Echo Trail

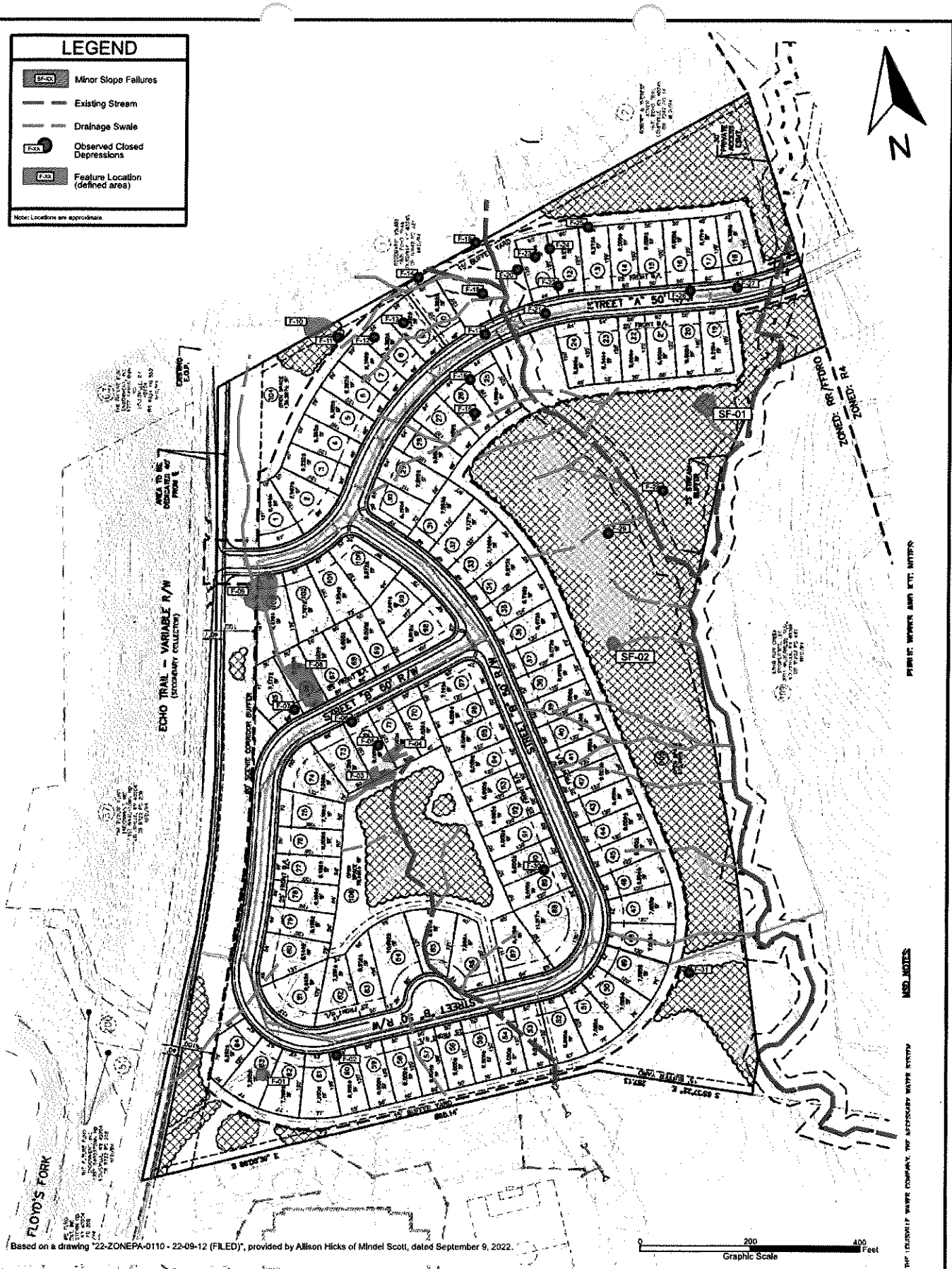
2405 Echo Trail
Louisville, Jefferson County, Kentucky 40245

DRAWN BY BEK
APPROVED BY FEN
PROJECT NO. 61-2863
DATE ZONE-0131 11-14-2022

LEGEND

-  Minor Slope Failures
-  Existing Stream
-  Drainage Swale
-  Observed Closed Depressions
-  Feature Location (defined area)

Note: Locations are approximate.



Based on a drawing "22-ZONEPA-0110 - 22-09-12 (FILED)", provided by Allison Hicks of Mindel Scott, dated September 9, 2022.

Graphic Scale 0 200 400 Feet



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1762 Watterson Trail
Louisville, Kentucky 40299
Tel. (502) 493-7100

Site Reconnaissance Plan Slope Evaluation and Karst Survey - 2405 Echo Trail

2405 Echo Trail
Louisville, Jefferson County, Kentucky 40245

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FEN
PROJECT NO.
61-2863
DATE
11-14-2022

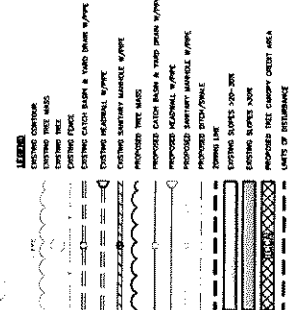
22-ZONE

APPENDIX B – Site Reconnaissance

Site Reconnaissance Plans
Site Photos
Typical Sinkhole Remediation Diagram

[illegible]

GRAPHIC SCALE 1"=100'

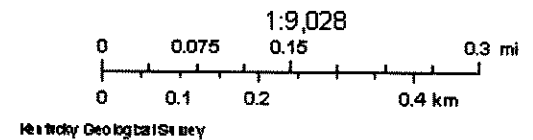
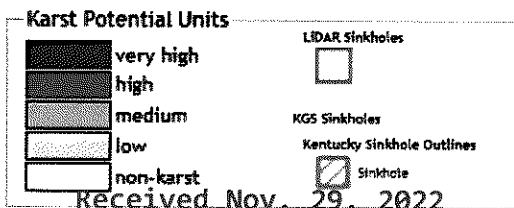
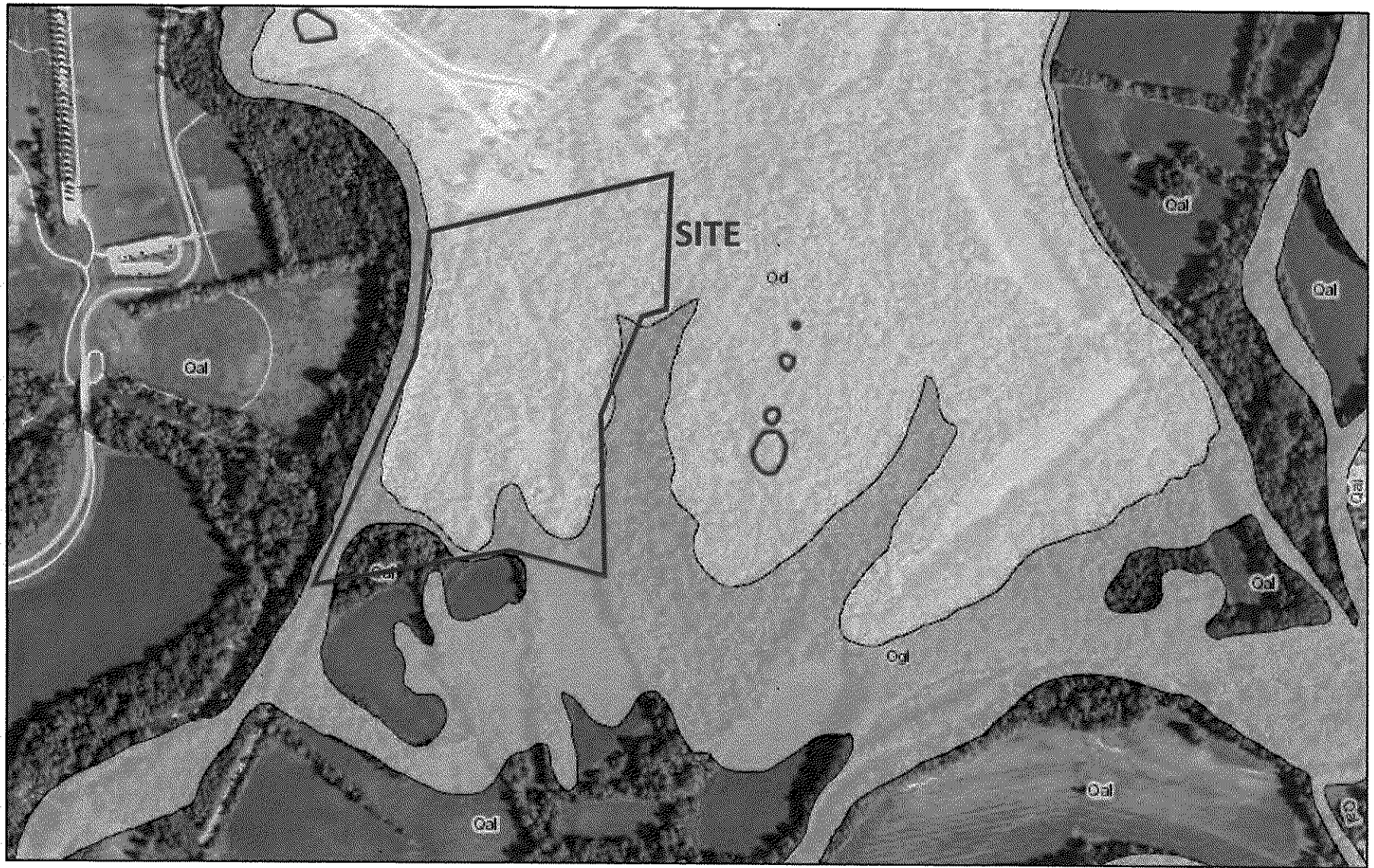


NOTE: ONLY THE AREAS OF STEEP SLOPE WITHIN OPEN SPACE
LOYS ARE USED FOR THE BALANCE TRANSFER AREA CALCULATION.

OWNER/DEVELOPER
LONG RUN CREEK PROPERTIES, LLC
3911 WILDERNESS TRAIL
LOUISVILLE, KY 40299

[illegible][illegible]

Kentucky Geologic Map Information Service – Karst Potential Map



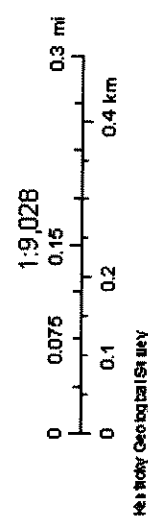
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Legend

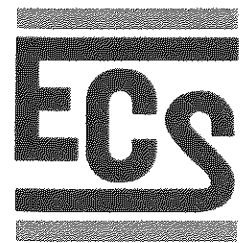
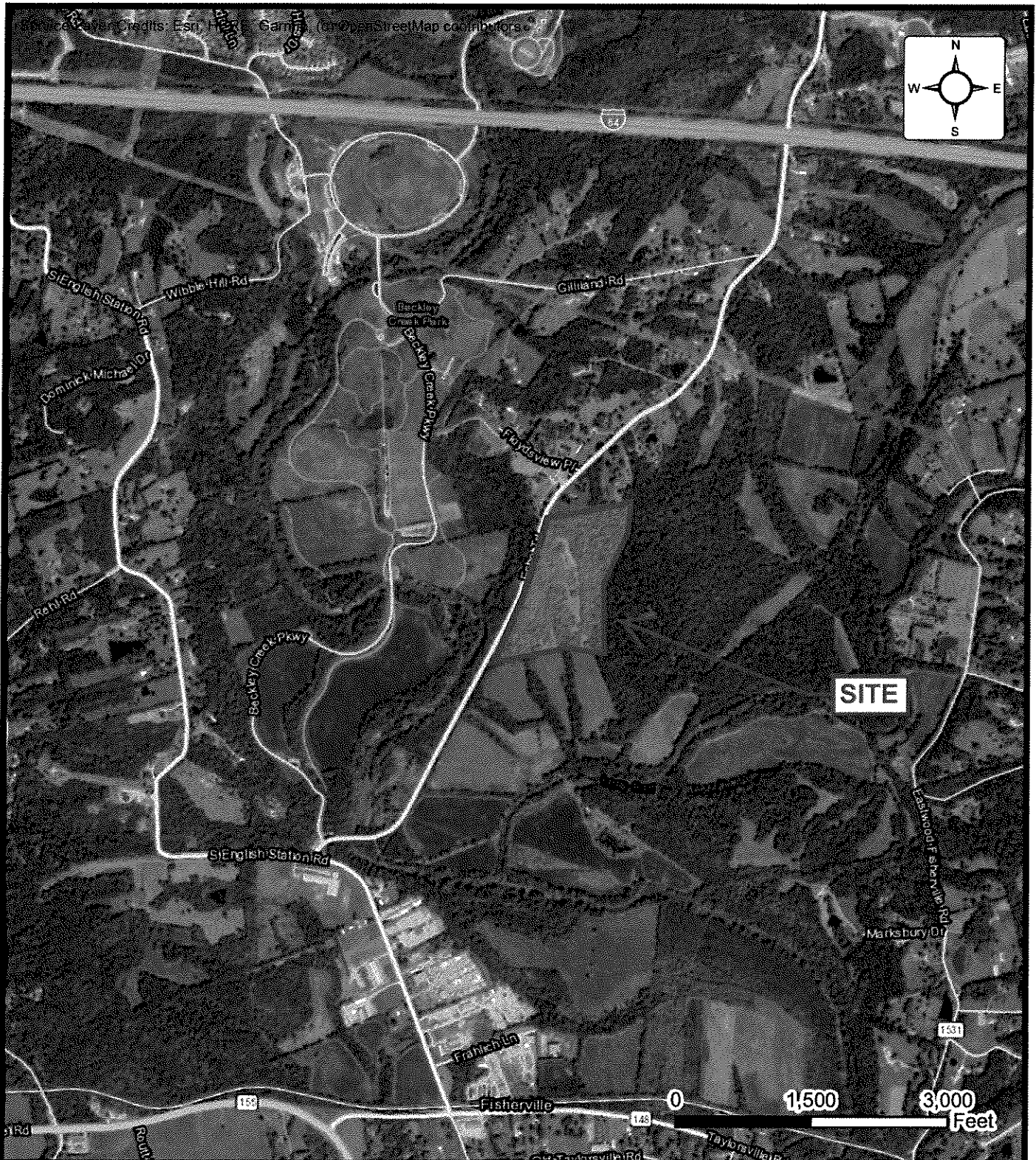
- Site** (indicated by a black outline)
- Geological units** (indicated by different colors and patterns):
 - Oal**: Oolitic limestone
 - Qal**: Quaternary alluvium
 - Qd**: Quaternary deposits

Scale: 1:24,000

Map: Includes all units from the 1:24,000 quadrangles in view. Some units on the legend may not be shown.



Planning & Design



SITE LOCATION DIAGRAM
PRELIMINARY SLOPE EVALUATION AND KARST
SURVEY - 2405 ECHO TRAIL

2405 ECHO TRAIL, LOUISVILLE, KENTUCKY 40245
LONG RUN CREEK PROPERTIES

ENGINEER BEK
SCALE AS NOTED
PROJECT NO. 61-2863
FIGURE 1 OF 1
DATE 11/10/2022

APPENDIX A – Drawings

Site Location Diagram

Geology Location Diagram

Karst Potential Diagram

Provided Drawing: 22- ZONEPA-0110 – 22-09-12 (FILED)

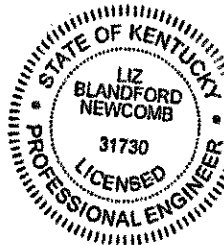
- Maximum fill embankment height of 5 feet.
- Horizontally bench new fill into existing slopes in maximum one-foot vertical steps.
- Maintain the following limits for new cuts in soil without additional geotechnical exploration and analysis:
 - 3:1 (horizontal: vertical) or flatter slopes.
 - Maximum cut height of 5 feet.
- Provide adequate erosion and surface water drainage control during construction and over the life of the subdivision.
- Establish permanent vegetative cover as soon as practical.


Closing

We appreciate the opportunity to serve as your geotechnical consultants for this project. We look forward to future association with you on this and other projects.

Respectfully submitted,
ECS Southeast, LLP


Bryn Kabbes, E.I.T.
Project Engineer
bkabbes@ecslimited.com




Liz Blandford Newcomb, P.E.
Principal Engineer
lnewcomb@ecslimited.com

APPENDICES

Appendix A – Drawings

- Site Location Diagram
- Geology Location Map
- Karst Potential Map
- Provided Drawing : 22-ZONEPA-0110 – 22-09-12 (FILED)

Appendix B – Site Reconnaissance

- Site Reconnaissance Plans – 3 pages
- Site Photos – 18 pages
- Typical Sinkhole Remediation Diagram

Appendix C – Slope Exploration

- Boring Location Diagram
- Soil & Rock Classification
- Boring Legend
- Boring Records
- Boring Composite
- Field and Laboratory Procedures

Laboratory Test Summary

STRATUM	MOISTURE CONTENT	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	UNCONFINED COMPRESSIVE STRENGTH (ksf)	UNDRAINED SHEAR STRENGTH (psf)	UNIFIED SOIL CLASSIFICATION
II	14.6 – 23.1	---(2)	---(2)	---(2)	2.0 – 9.0	1,000 – 4,500	CL-CH

Notes:

- (1) A more detailed summary of the laboratory test results is included on the Boring Records and Laboratory Reports in the Appendix. Detailed descriptions of the laboratory test methods are listed in the Laboratory Procedures section of the Appendix.
- (2) Atterberg Limits test results were not complete at the time the report was issued. Once completed, an updated report will be issued.

Findings

Based on our review of the above referenced observations and information, and on our past experience with site development for similar conditions in Jefferson County, our opinion is that most of the on-site slopes (excluding small, localized erosion features along swales) in the observed areas were generally stable at the time of our site reconnaissance. Evidence of minor instability was observed in isolated areas in the northeast and east portions of the site (identified as SF-01 and SF-02 in this report).

The current, on-site localized slope instability observed likely is related to the following factors:

- Relatively thin depths of soil in slope areas
- Cohesive (clayey) soil matrix
- Rocky soil texture
- Limestone, dolomite, and or shale bedrock
- Numerous trees and other vegetation
- Groundwater seepage from shallow bedrock

Based on the conditions observed, our opinion is that additional geotechnical exploration/analyses including soil/rock test borings/coring, shear strength tests of soils, etc. are not required for most of the evaluated on-site slopes, provided that the planned subdivision is designed and constructed utilizing the guidelines included in this report.

The northeast and east portions of the site, particularly in areas identified as “existing slopes > 20-30%” and “existing slopes >30%” as shown on the provided drawing, and including the shaded “Minor Failure Areas”, where minor instability was observed should be further evaluated during the construction phase of the project once the location and planned elevation of the proposed structures and related improvements are known.

The following guidelines should be used to help maintain the stability of the existing and planned slopes during the design and construction of the new subdivision, and over the life of the new homes. These guidelines include:

- All foundations should bear entirely on competent rock (sound and continuous).
- Groundwater seepage should be anticipated. Plan to install foundation and sub-floor drainage systems for structures bearing entirely on rock or near the soil/rock interface.
- Plan grading to minimize changes to existing topography along slopes.
- Minimize disturbance to slopes and vegetation outside new construction areas.
- Avoid significant transverse cuts along face or at the toe of existing slopes.
- Avoid significant embankments on the face, or along or at the crest of existing slopes.
- Avoid placing new construction at or within 10 feet of the crest of existing slopes.
- Maintain the following limits for new embankments without additional geotechnical exploration and analysis:
 - 3:1 (horizontal: vertical) or flatter slopes.
 - Properly strip all vegetation, topsoil, etc. where fill will be placed.
 - Construct embankments with controlled fill compacted to at least 98 percent of the Standard Proctor maximum dry density and within 2 percent of the optimum moisture content.

Standard Proctor maximum dry density, within 2% of the optimum moisture content. Placement and compaction of the fill in limited horizontal lifts will reduce porosity and surface water infiltration. Periodic observations and compaction testing are recommended to confirm the character and continuity of the clay caps. Grading the site to promote surface drainage in all areas and avoiding ponding water is also important in reducing future subsidence of existing karst features (including sinkholes) and reducing the development of additional karst features.

Existing buildings, debris, and brush piles located on the property potentially could have obscured indications of slope instability and/or karst features at the time of this evaluation. Additionally, fallen leaves and trees due to the seasonal transition can also obscure such observations.

Subsurface Summary

Three (3) borings were extended on November 3, 2022, using a hand auger and Dynamic Cone Penetrometer (DCP). The approximate boring locations were established with a consumer-grade GPS device. A drive rod was extended in each boring, below the encountered hand auger refusal, to determine approximate refusal depths at each location. Refusal was encountered approximately 1.0 to 3.8 feet below existing grades. Materials encountered at each location were documented. Brief descriptions are provided in the following **Boring Summary**. Refer to the **Boring Location Diagram** for the approximate boring locations, and the **Boring Records** for the depths of materials encountered at each location.

Boring Summary

APPROXIMATE DEPTH (FT)	STRATUM	DESCRIPTION	N-VALUES BLOWS PER FOOT (BPF) ⁽²⁾
0.0 – 0.3	I	TOPSOIL – Approximately 2 to 4 inches of topsoil encountered at the surface materials in all borings. Rock fragments were encountered within topsoil in Boring B-01.	NA
0.3 – 3.8	II	CLAY (CL) – Orange brown to brown, low to moderate plasticity, stiff to hard, dry to slightly moist, silty clay (CL), with trace black oxide nodules and root fibers. Encountered below Stratum I in all borings. Weathered rock fragments and cobbles were encountered within silty clay in Borings B-02 and B-03 from approximately 1.6 to 1.8 feet to drive rod refusal.	18 – 25/1"
REFUSAL⁽³⁾	Refusal was encountered approximately 1.0 to 3.8 feet below existing grades.		
GROUNDWATER	Groundwater was not encountered at the time of boring. However, groundwater seepage at the soil/rock interface and within the underlying bedrock onsite is common and should be anticipated.		

Notes:

- (1) This summary is generalized and does not describe the actual conditions in each boring. These zones also may not occur at each location. Depths are approximate. Detailed descriptions of the encountered materials are listed on the **Boring Records** in the **Appendix**.
- (2) Number of blows to drive the dynamic cone penetrometer 1.75 inches has been empirically correlated to the Standard Penetration Test value "N" in blows per foot.
- (3) Refusal is the term applied to material that cannot be penetrated with augers or has a Dynamic Penetration resistance exceeding 25 blows per 1.75-inch increment. Refusal may be encountered on continuous bedrock, discontinuous floaters, cemented soil, weathered rock, debris, buried structures, or other hard subsurface materials.

Feature	Description	Approximate Dimensions	Approximate Depth
F-26	Closed depression with soil sidewalls.	4' Wide 6' Long	1'
F-27	Small opening with soil/rock sidewalls. Probe rod extended approximately 1-2 feet below the feature.	1'	2-3'
F-28	Oval-shaped closed depression with soil sidewalls and a partially closed throat at the bottom of the depression.	6-7' Long 3-4' Wide	2'
F-29	Oblong shaped closed depression with soil sidewalls and a partially closed throat at the bottom of the depression. Probe rod extended to apparent rock approximately 3 feet below the feature.	6-7' Long 4-5' Wide	1-3'
F-30	Bowl shaped closed depression with soil sidewalls.	10' Long 5' Wide	1'
F-31	Oval shaped closed depression with soil sidewalls. The southern wall of the closed depression was approximately 3 feet above the northern wall of the closed depression.	10' Long 4-6' Wide	1-2'

The observed closed depressions may have been caused by removal of a tree rootball, previous land use, or could be indicative of the presence of a karst feature. No other karst features were identified during the site reconnaissance. However, the existing remnant structures, debris, and man-made fill piles and berms located on the property potentially could have obscured indications of karst features at the time of this site reconnaissance. Additionally, fallen leaves and trees due to seasonal transition, especially in densely wooded areas, can also obscure such observations. Refer to the attached **Site Reconnaissance Plans** for the approximate locations of each possible karst-feature and the **Site Photos** for conditions observed.

Karst Feature Remediation Guidelines

Typically, karst features in this vicinity and similar to those identified in this survey can be stabilized for development, as needed, for the planned future use of the site. Remediation methods vary based on planned use of the specific area where a karst feature is located and the characteristics of each feature. Treatment methods may vary for features where buildings or other improvements are located, in contrast to features in non-sensitive areas. For this project the typical objective of the treatment of a feature will be to reduce the risk of future subsidence and to decrease surface water infiltration in and around the active karst feature(s).

An experienced and qualified geotechnical engineer or geologist should be present during remediation to evaluate the characteristics as the feature is excavated; and to recommend specific treatment methods for each feature. Remediation of most karst features identified is anticipated to consist of excavation of the closed depression or slot-features to identify the active feature(s) and determine the appropriate stabilization method. Once the active karst throat or weathered apparent rock area is stabilized, an inverted filter (see attached **Typical Sinkhole Remediation Diagram**) should be constructed within and over the feature(s).

The filter will reduce future loss of soil into the feature, reducing the risk of subsidence. The area can then be backfilled with clay, with the fill mounded above adjacent grade to reduce surface water infiltration. Clay fill placed in above the filter constructed in the karst features should meet the requirements for "CL" or "CH" according to the Unified Soil Classification System. The fill should be placed in one-foot lifts and compacted to at least 95% of the

Feature	Description	Approximate Dimensions	Approximate Depth
F-13	Shallow, clover-shaped closed depression with soil sidewalls and large trees growing around the perimeter.	5' Long 6' Wide	6"
F-14	Clover-shaped closed depression with soil sidewalls.	3-4' Long 2-4' Wide	2-6'
F-15	Bowl-shaped closed depression with soil sidewalls and a partially closed throat encountered at the bottom of the depression.	5' Diameter	2'
F-16	Oblong-shaped closed depression with soil sidewalls.	3-5' Long 3-4' Wide	1'
F-17	Shallow, oval-shaped closed depression with soil sidewalls and a 3 inch partially closed opening at the bottom of the depression. Probe rod extended 3.5' below the feature.	2' Long 3' Wide	1'
F-18	Bowl-shaped closed depression with soil/rock sidewalls and a partially closed throat at the bottom of the depression. Probe rod extended 2 feet below the feature to an apparent rock bottom.	4' Diameter	1'
F-19	Bowl-shaped closed depression with soil/rock sidewalls.	3' Diameter	1-3'
F-20	Oval-shaped closed depression with soil sidewalls near bed of creek.	6' Long 4' Wide	0.5'
F-21	Bowl-shaped closed depression with soil sidewalls.	4' Diameter	2.5'
F-22	Bowl-shaped closed depression with soil sidewalls and a partially closed throat encountered at the bottom of the depression. Probe rod extended 1 foot below the feature to an apparent rock bottom.	7' Diameter	2-3'
F-23	Bowl-shaped closed depression with soil/rock sidewalls and a partially closed throat at the bottom of the depression. Probe rod extended 1 feet below the feature.	3' Diameter	1'
F-24	Bowl-shaped closed depression with soil sidewalls. Probe rod extended 2' below the bottom of the feature to an apparent rock bottom.	1' Diameter	0.5'
F-25	Bowl-shaped closed depression. Evidence of apparent human disturbance with sidewalls lined with boulders. A large tree is located at the center of the depression.	10' Diameter	1-3'

Feature	Description	Approximate Dimensions	Approximate Depth
F-07	Oval-shaped closed depression with soil/rock sidewalls and a partially closed throat at the bottom of the depression. Probe rod extended 3 feet below the feature to an apparent rock bottom.	6' Long 5' Wide	4'
F-08	Large-closed depression with soil/rock sidewalls and contained slot shaped features, closed depressions, and several small openings.	80' Diameter	4'
	A Bowl-shaped closed depression with soil sidewalls.	5' Diameter	2'
	B Bowl-shaped closed depression with soil/rock sidewalls and a partially closed throat at the bottom of the depression.	8' Diameter	2-3'
	C Slot-shaped feature with soil/rock sidewalls.	20' Long 3-4' Wide	2-4'
	D Oval-shaped closed depression with soil sidewalls.	5' Long 3-4' Wide	2-3'
F-09	Large, closed depression with soil/rock sidewalls and contained four (4) smaller closed depressions.	30' Long 20' Wide	4'
	A Oblong-shaped closed depression with soil sidewalls.	2-3' Long 1-2' Wide	1'
	B Bowl-shaped closed depression with soil sidewalls.	4' Diameter	3'
	C Bowl-shaped closed depression with soil sidewalls.	3' Diameter	2'
	D Bowl-shaped closed depression with soil/rock sidewalls.	6' Diameter	4'
F-10	Large, closed depression with soil sidewalls and contained two (2) smaller closed depressions separated by a large tree.	20' Diameter	3'
	A Oval-shaped closed depression with soil sidewalls.	10' Long 5' Wide	1'
	B Bowl-shaped closed depression with several partially closed throats (approximately 2-4 inches in diameter) encountered at the bottom of the depression. Probe rod extended 2 feet below the feature.	5' Diameter	2-3'
F-11	Clover-shaped closed depression with soil sidewalls and a partially closed throat at the bottom of the depression. Probe rod extended 2 feet below the base of the feature.	15-20' Long 5-10' Wide	1'
F-12	Bowl-shaped closed depression with soil sidewalls.	4' Diameter	1'

and/or features with multiple designations (A, B, C, etc.) represent a series of features which appeared to be related to a common joint or similar lineation.

Feature	Description		Approximate Dimensions	Approximate Depth
F-01	Large, shallow closed depression with soil sidewalls and contained three (3) smaller closed depressions. Observed near remnant storage shed which could have obscured additional closed depressions from view.		20' Diameter	1'
	A	Bowl-shaped closed depression with soil sidewalls.	2' Diameter	1'
	B	Oblong-shaped closed depression with soil sidewalls.	2' Long 1' Wide	0.5'
	C	Bowl-shaped closed depression with soil sidewalls.	1' Diameter	0.5'
F-02	Oblong-shaped closed depression with soil sidewalls.		6-7' Long 2-5' Wide	1'
F-03	Large closed depression with soil/rock sidewalls and contained slot-shaped features, closed depressions, and several small openings.		50' Long 50' Wide	6'
	A	Bowl-shaped closed depression with soil sidewalls. Probe rod extended 2' below the bottom of the feature.	5' Diameter	2'
	B	Slot-shaped feature with soil/rock sidewalls. May tie in to existing creek. Probe rod extended 2-3' below slot feature in two small openings at the bottom of the feature.	15-20' Long 3-5' Wide	3-6'
	C	Bowl-shaped closed depression with soil/rock sidewalls.	10' Diameter	4'
F-04	Large, closed depression with soil sidewalls and contained two (2) oval shaped closed depressions.		50' Long 30' Wide	3'
	A	Closed depression with soil sidewalls.	20' Long 3-4' Wide	1-2'
	B	Closed depression with soil sidewalls.	20' Long 4-5' Wide	2-3'
F-05	Crescent-shaped closed depression. Evidence of apparent human disturbance with sidewalls lined with boulders and debris.		12-14' Long 10-12' Wide	1-3'
F-06	Oval-shaped closed depression with soil/rock sidewalls and a partially closed throat at the bottom of the depression. Evidence of apparent human disturbance with sidewalls lined with boulders and rusted metal debris.		10' Long 5-7' Wide	1-3'

Site Reconnaissance

A site reconnaissance was conducted over several days beginning November 3, 2022 through November 9, 2022 by Bryn Kabbes, E.I.T. of ECS. The purpose of the site reconnaissance was to observe and record site conditions for karst geologic features defined in the LDC as well as observe indicated steeper slope areas that would be disturbed by new construction.

Several remnant structures were observed in the southwestern portion of the site, including a small wooden storage building, a silo, and several isolated piles of rubble and debris. Remnant structures were observed in close proximity to one another along the southern boundary of the site and were typically encountered along existing cleared access paths. Several fill mounds and man-made berms, typically 1-3' in height were observed around the remnant structures and cleared access paths, and generally consisted of crushed pavement and stone.

In general, the surface drainage appeared to be directed from the northern portion of the property and away from Echo Trail towards the eastern and southern portions of the property. Two (2) existing streams were observed in the northeastern portion of the site, which conjoin in the northern portion of proposed open space Lot 105. A third existing stream was observed in the southern central portion of the site, in proposed open space Lot 106, which extended southward towards an existing drainage inlet on the southern property boundary. All three existing streams observed extend southward through the property towards Long Run Creek, located approximately 1,300 feet south of the southern property boundary. Drainage swales and associated shallow tributaries were observed throughout the site typically extending downslope towards the existing streams on the site. Swales ranged from 10 to 100 feet long, 1 to 10 feet wide, and 0.5 to 4 feet deep. Evidence of erosion was primarily observed along the drainage swales and typically consisted of areas of bare or loose soil, exposed tree roots, and displaced rock fragments (gravel, cobbles, and/or boulders). No apparent springs or rock outcroppings typical of karst terrain were observed at the time of the site reconnaissance.

Steeper slopes, as identified on the provided drawing, were generally observed adjacent to drainage swales and the existing streams. Steep slopes with numerous displaced gravel, cobbles, and/or boulder-sized rock, eroded/mounded soil, and various indications of minor slope instability and soil creep were observed in the northern and eastern portions of the site and typically became prevalent within 100 feet of the existing streams. Gentle slopes were encountered throughout most of the southern and western portions of the site, typically within the dense wooded areas. The central portion of the site consisting of open space was relatively flat and slope instability was not observed in the area. No indications of large, wide-scale or deep seated slope movements were noted. However, minor slope movements (wedge, bowl, or fan shaped failures) were observed in isolated areas (typically near slope areas approaching 20%), and specifically in failure areas SF-01 and SF-02, which are noted on the attached **Site Reconnaissance Plans**. For the remainder of the site, the slopes appeared to be relatively stable (excluding stream and drainage swale banks).

Two (2) minor slope failure areas were observed in isolated areas on the eastern portion of the site. Both failure areas were fan-shaped which narrowed to form drainage swales directed towards the existing stream located in the eastern portion of the property. Evidence of soil instability in these areas included bowed and fallen trees, erosion, mounded soil, and exposed tree roots. SF-01, located in the northeastern portion of proposed open space Lot 105, was approximately 50 feet long, 40 feet wide, and 3 to 5 feet deep which narrowed to a drainage swale approximately 2 to 5 feet wide and 0.5 feet deep. SF-02, located in the eastern portion of proposed open space Lot 105, was approximately 10 to 20 feet long, 8 to 10 feet wide, and 1 to 3 feet deep which narrowed to a drainage swale approximately 0.5 to 1.0 feet wide and 0.5 feet deep. Photos of each area observed are included in this letter. See the attached **Site Reconnaissance Plans** for the approximate locations, and **Site Photos** for conditions observed.

Thirty-one (31) possible karst-related features were identified onsite during the site reconnaissance. Refer to the attached **Site Reconnaissance Plans** and **Site Photos** for the approximate location of observed site features and pictures of selected features. Brief descriptions of the features are provided in the table on the following page. Areas



Figure 2: Reported Soil Data

NRCS CUSTOM SOIL RESOURCE REPORT				
Map Unit Symbol	Map Unit Name	Parent Material	Acres in AOI (Approximate)	Percent of AOI (Approximate)
BeC	Beasley silt loam, 6 to 12 percent slopes.	Clayey residuum weathered from calcareous shale and/or calcareous siltstone.	11.3	29.7%
NhB	Nicholson silt loam, 2 to 6 percent slopes	Fine-silty noncalcareous loess over clayey residuum weathered from limestone.	5.3	13.9%
ShD3	Shrouts silt loam, 12 to 25 percent slopes, severely eroded, very rocky	Clayey residuum weathered from calcareous shale and/or siltstone	15.6	41.3%
UkC	Urban land-Alfic Udarents-Beasley complex, 0 to 12 percent slopes	Clayey residuum weathered from calcareous shale and/or calcareous siltstone.	4.0	10.6%
UwC	Urban land-Alfic Udarents-Shrouts complex, 0 to 12 percent slopes	Clayey residuum weathered from calcareous shale and/or siltstone.	1.8	4.6 %

with alluvial gravel along east side of Floyds Fork between the mouths of Pope Lick and Cane Run 45 to 60 feet below top of unit. Least abundant limestone type is medium gray, micro-grained to medium grained, well-sorted, planar laminated calcarenite to calcisiltite in smooth surfaced, even, continuous inter-beds 0.1 to 0.4 foot thick; fossils not conspicuous; this limestone type presents only in upper part of unit. Inter-beds of planar-laminated calcisiltite and shale were well exposed at the time of mapping. Shale is olive gray to dark greenish gray, weathers light olive gray and dusky yellow; calcareous; in partings and beds 0.1 to 1.2 feet thick, commonly less than 0.6 foot thick; sparsely fossiliferous. Base of unit not exposed.

Alluvium

Total Reported Thickness: 0 - 20 feet

Karst Potential: Non-Karst

Primary Lithology: Silt, clay, sand, and gravel

Alluvium consists of silt, clay, sand, and gravel. Along Floyds Fork, silty clay, olive gray in root zone, grades downward to moderate brown to grayish brown clayey silt with blocky structure, then to moderate brown, calcareous, sandy, silty clay containing thin-shelled pelecypods, in turn underlain by as much as 3.5 feet of limestone gravel containing abundant cobbles and pebbles. In smaller stream valleys alluvium is brown to dark grayish brown silty clay and clayey silt, sand, and gravel. Gravel ranges in size from granules to boulders. Most granules and sand are limonite derived from soil; pebbles, cobbles, and slabs are from local bedrock. Older alluvium on limestone bench 30 to 45 feet above Floyds Fork is 15 to 20 feet thick; alluvium beneath modern floodplain is 8 to 10 feet thick. Basal gravel in older alluvium contains pebbles as much as 0.2 foot long; consists of brown chert, quartz geodes, silicified corals, and limonite cemented siltstone; overlain by grayish orange to moderate yellowish orange silty clay. Locally completely removed by stream erosion.

Karst Potential

According to the KGS Karst Potential Classification definitions, formations designated with a "Medium" karst potential are "Limestone units and coarse-grained, or siliciclastic units with limestone interbeds. Limestone units may contain a high percentage of insoluble minerals. Siliciclastic units will only be karst-prone where limestone beds occur in the near surface. Development of karst features in this category is variable and dependent on site-specific conditions." Formations designated with a "Low" karst potential are where the development of karst features are poorly developed or absent with the formations described as "siliciclastic units with minor limestone beds or units primarily composed of dolomite". Formations designated with a "Non-Karst" karst potential are described as "Consolidated or unconsolidated siliclastic units. Karst features are rare or absent." The karst potential is based on the tendency for the site to develop or have karst features as shown on the Kentucky Geologic Map Information Service and is not necessarily indicative of the actual presence or absence of karst activity at the site.

No sinkholes were mapped on the site by the Kentucky Geologic Map Information Service. However, several karst features were reported approximately 500 to 1,000 feet east and northwest of the site. Refer to attached **Karst Potential Map** for approximate location of mapped features.

Soil Conservation Service Soil Survey

The USDA Natural Resources Conservation Service "Web Soil Survey" website indicated 5 general soil types at the site as shown in **Figure 2**. Descriptions of these soil types are summarized below.

Drakes Formation

Total Reported Thickness: \pm 140 feet

Karst Potential: Low

Primary Lithology: Dolomite and Limestone

Members: Hitz Limestone Bed; Saluda Dolomite Member; Bardstown Member; and Rowland Member.

Hitz Limestone Bed: Primarily limestone, dolomite, and shale. Limestone and dolomite are dark gray to olive gray, weathers light gray to grayish orange, locally with a reddish brown cast; very fine to medium grained, silty; laminated in part; hackly to blocky fracture; inter-bedded and inter-tongued. Shale is grayish black to dusky brown, carbonaceous, calcareous, and strongly fissile, commonly appears in two beds, one about 0.5 feet thick near base and one 0.2 foot thick near the top.

Saluda Dolomite Member: Primarily dolomite, dolomitic mudstone, shale, and limestone. Dolomite is greenish gray, light to medium gray, grayish yellowish green, and light olive gray in distinct color bands, weathers same to yellowish gray and grayish orange. Dolomite in the upper three fourths of the unit is laminated. Weathers blocky in steep ravines, shaly to flaggy on weathered slopes. Lower one-fourth of the unit is dolomitic mudstone and lacks prominent lamination, weathers shaly or to blocky prisms. Limestone is bluish gray, weathers olive gray to brownish gray; dense, micritic; conchoidal fracture; commonly as one or two beds 0.1 to 0.6 feet thick in lower part of laminated dolomite sequence. Shale is light gray to olive black, locally carbonaceous; as persistent parting 0.1 to about 1 foot thick in lower part of laminated dolomite.

Bardstown Member: Primarily limestone, mudstone, and shale. Limestone is of three main types: Most common limestone is medium to dark gray, weathers yellowish brown, micritic to fine grained in very thin beds, laminated and continuous with fossils common. Second type is medium light gray to olive gray, weathers light gray to dark yellowish orange, micritic to coarse grained in very thin and/or discontinuous beds, with abundant whole fossils. Third type is muddy limestone, blueish to olive gray, weathers greenish gray to yellowish green, and resembles limestone of underlying Rowland Member (see below). Mudstone and shale appear as inter-beds in limestone, are olive gray, somewhat calcareous, light olive gray to light gray; locally grayish to brownish black, weathers medium gray. All shale is fossiliferous.

Rowland Member: Primarily limestone and shale. Dominant limestone is medium and greenish gray to medium bluish gray calcisiltite; weathers pale olive to yellowish gray; dolomitic and argillaceous; streaked with irregular burrows filled with dusky yellowish-green glauconitic material which weathers out readily to form holes and pitted bed surfaces; thin to thick bedded in continuous but poorly defined planar beds. Dominant shale is olive gray, light olive gray, greenish gray, and dark greenish gray; weathers yellowish gray to light gray; clayey and calcareous; prominent in two persistent beds 5 to 7 feet thick near upper and basal contacts. Small ponds for livestock and recreation are common in areas underlain by the Waldron Shale and by shale of the Osgood Formation and the Bardstown and Rowland Members of the Drakes Formation.

Grant Lake Limestone

Total Reported Thickness: + 100 feet

Karst Potential: Medium

Primary Lithology: Limestone and Shale

Grant Lake Limestone is of three main types. Dominant limestone type is medium gray, contains abundant coarse fossil fragments and whole fossils in a greenish gray calcareous mudstone or a medium to very coarse grained calcarenite cemented by sparry calcite; beds uneven to nodular, some continuous, commonly less than 0.2 foot thick. Less abundant limestone type is medium gray, fossil fragmental, poorly sorted calcarenite with sparry cement; weathers with abundant brown specks; in crossbeds 0.1 to 1.3 feet thick with smooth to undulating surfaces. Cross-bedded limestone common about 10 feet below top of unit; forms 15 foot thick sequence underlying bench capped

The existing topography generally sloped down from north to south, with areas of steeper slopes generally occurring within the eastern portions of the site and sloped towards the existing streams.

Geology

The following geologic information is based on the review of: the Fisherville, 24K Quadrangle, Geologic Map, Kentucky, published by the United States Geological Survey (USGS); information (aerial photos, geologic maps, and topographic maps, etc.) obtained from the Kentucky Geological Survey (KGS) Geologic Information Service website; and Google Earth satellite imaging.

The Kentucky Geologic Map Information Service website indicated that the majority of the proposed development area (roughly above ~EL 605 to ~EL 620) was underlain by the Drakes Formation. Lower elevation areas roughly between ~EL 600 to ~EL 620 were underlain by Grant Lake Limestone. The southeastern-most portion of the proposed development area between elevations of roughly ~EL 605 to ~EL 610 were underlain by Alluvium.

Above ~EL 605 – 620	Drakes Formation
~EL 600 – 620	Grant Lake Limestone
Below ~EL 605 – 610	Alluvium



Figure 1: Reported Site Geology



ECS SOUTHEAST, LLP

Geotechnical • Construction Materials • Environmental • Facilities

"One Firm. One Mission."

November 28, 2022

Mr. S. Bradford Rives
Long Run Creek Properties, LLC
3911 Wilderness Trail
Louisville, Kentucky 40299

c/o Mr. David Mindel
Mindel Scott
5151 Jefferson Boulevard
Louisville, Kentucky 40219

Reference: **Slope Evaluation and Karst Survey – 2405 Echo Trail**
2405 Echo Trail
Louisville, Jefferson County, Kentucky 40245
ECS Project No. 61-2863

Dear Mr. Rives:

ECS Southeast, LLP (ECS) conducted a combined evaluation, consisting of a limited subsurface exploration and site reconnaissance, for the referenced site in accordance with ECS Proposal No. 61-P2890, dated October 10, 2022. This evaluation included the following elements: a review of provided drawings; a review of soil survey information; a review of geologic maps; a review of topographic maps; a review of current and historical aerial photographs; a visual reconnaissance of site conditions for the karst geologic features defined in the Metro Louisville Land Development Code (LDC); a visual reconnaissance of indicated steeper slope areas that would be disturbed by new construction; a limited subsurface evaluation to explore the materials along slopes greater than 30% that will be disturbed during construction; and evaluate the reviewed information and prepare a report of our findings and recommendation.

Purpose

The purpose of the subsurface evaluation was to explore the materials along slopes greater than 30% that will be disturbed during construction, the depth to bedrock and the shear strength of the soils in these areas are required to be analyzed by a geotechnical engineer per the county development code (Section 4.7.4 of the LDC). A visual reconnaissance of the site was completed concurrently with the subsurface evaluation to identify potential karst geologic features and document the condition of steeper slope areas not evaluated during the subsurface evaluation, per the LDC (Section 4.9.3).

The drawing "22-ZONEPA-0110 – 22-09-12 (FILED)" provided by Allison Hicks of Mindel Scott via email, dated September 12, 2022, was used as a reference during the subsurface evaluation and site reconnaissance and for creation of the attached maps and diagrams. A reduced copy of this drawing is attached to this report. Slopes identified as greater than 30%, and slopes between 20% and 30%, were reported on this drawing, as well as the location of planned construction.

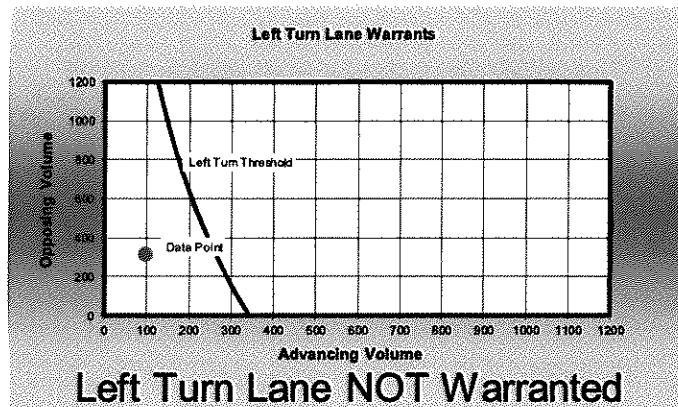
Project Information

The proposed development on-site includes 103 single-family residential lots and associated roadways. The site undulates across the proposed development footprint with approximately 75 feet of fall across the entire site, with up to approximately 20 feet of fall across a single proposed residential development lot. The site includes approximately 36.67 acres of rolling hills which are mostly wooded, with isolated open areas. Two existing streams are located in the northeastern portion of the site. A third stream was observed in the southern portion of the site in the proposed open space located in Lot 106, which extended towards the southern property boundary of the site.

Left Turn Lane Warrants

Input Fields

Left Turn Volume (vph)	<u>44</u>	Speed Limit (mph)	<u>35</u>
Advancing Volume (vph)	<u>99</u>	No. of through lanes	<u>1</u>
Opposing Volume (vph)	<u>307</u>	Percent Heavy Vehicles (decimal percent)	<u>0.01</u>



Note: This spreadsheet is intended to supplement the guidance provided in the Auxiliary Turn Lane policy outlined in the KYTC Highway Design Manual. This policy should be fully reviewed and understood prior to using this application.

Right Turn Lane Warrants

Input Fields

Right Turn Volume (vph)	<u>238</u>	Speed Limit (mph)	<u>35</u>
Advancing Volume (vph)	<u>307</u>		



Note: This spreadsheet is intended to supplement the guidance provided in the Auxiliary Turn Lane policy outlined in the KYTC Highway Design Manual. This policy should be fully reviewed and understood prior to using this application.

HCS Two-Way Stop-Control Report																
General Information								Site Information								
Analyst	DBZ							Intersection	Echo Trail at Street G							
Agency/Co.	Diane B. Zimmerman Traffic Engineering LLC							Jurisdiction								
Date Performed	1/5/2023							East/West Street	Echo Trail							
Analysis Year	2033							North/South Street	Street A							
Time Analyzed	PM Peak Build							Peak Hour Factor	0.85							
Intersection Orientation	North-South							Analysis Time Period (hrs)	0.25							
Project Description	Echo Trail															
Lanes																
<p style="text-align: center;">Major Street: North-South</p>																
Vehicle Volumes and Adjustments																
Approach	Eastbound				Westbound				Northbound				Southbound			
Movement	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Priority		10	11	12		7	8	9	1U	1	2	3	4U	4	5	6
Number of Lanes		0	0	0		0	1	0	0	0	1	0	0	0	1	0
Configuration							LR					TR		LT		
Volume (veh/h)						6		42			84	11		72	93	
Percent Heavy Vehicles (%)						1		1						1		
Proportion Time Blocked																
Percent Grade (%)					0											
Right Turn Channelized																
Median Type Storage	Undivided															
Critical and Follow-up Headways																
Base Critical Headway (sec)						7.1		6.2						4.1		
Critical Headway (sec)						6.41		6.21						4.11		
Base Follow-Up Headway (sec)						3.5		3.3						2.2		
Follow-Up Headway (sec)						3.51		3.31						2.21		
Delay, Queue Length, and Level of Service																
Flow Rate, v (veh/h)						56								85		
Capacity, c (veh/h)						882								1484		
v/c Ratio						0.06								0.06		
95% Queue Length, Q ₉₅ (veh)						0.2								0.2		
Control Delay (s/veh)						9.4								7.6	0.5	
Level of Service (LOS)						A								A	A	
Approach Delay (s/veh)					9.4								3.6			
Approach LOS					A								A			

HCS Two-Way Stop-Control Report																
General Information								Site Information								
Analyst	DBZ							Intersection	Echo Trail at Street G							
Agency/Co.	Diane B. Zimmerman Traffic Engineering LLC							Jurisdiction								
Date Performed	1/5/2023							East/West Street	Echo Trail							
Analysis Year	2033							North/South Street	Street A							
Time Analyzed	PM Peak No Build							Peak Hour Factor	0.85							
Intersection Orientation	North-South							Analysis Time Period (hrs)	0.25							
Project Description	Echo Trail															
Lanes																
<p style="margin-top: 10px;">Major Street: North-South</p>																
Vehicle Volumes and Adjustments																
Approach	Eastbound				Westbound				Northbound				Southbound			
Movement	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Priority		10	11	12		7	8	9	1U	1	2	3	4U	4	5	6
Number of Lanes		0	0	0		0	1	0	0	0	1	0	0	0	1	0
Configuration							LR					TR		LT		
Volume (veh/h)						6		42			69	11		72	67	
Percent Heavy Vehicles (%)						1		1						1		
Proportion Time Blocked																
Percent Grade (%)					0											
Right Turn Channelized																
Median Type Storage	Undivided															
Critical and Follow-up Headways																
Base Critical Headway (sec)						7.1		6.2						4.1		
Critical Headway (sec)						6.41		6.21						4.11		
Base Follow-Up Headway (sec)						3.5		3.3						2.2		
Follow-Up Headway (sec)						3.51		3.31						2.21		
Delay, Queue Length, and Level of Service																
Flow Rate, v (veh/h)						56								85		
Capacity, c (veh/h)						909								1506		
v/c Ratio						0.06								0.06		
95% Queue Length, Q ₉₅ (veh)						0.2								0.2		
Control Delay (s/veh)						9.2								7.5	0.4	
Level of Service (LOS)						A								A	A	
Approach Delay (s/veh)					9.2								4.1			
Approach LOS					A								A			

HCS Two-Way Stop-Control Report

General Information		Site Information	
Analyst	DBZ	Intersection	Echo Trail at Street G
Agency/Co.	Diane B. Zimmerman Traffic Engineering LLC	Jurisdiction	
Date Performed	1/5/2023	East/West Street	Echo Trail
Analysis Year	2033	North/South Street	Street A
Time Analyzed	AM Peak Build	Peak Hour Factor	0.85
Intersection Orientation	North-South	Analysis Time Period (hrs)	0.25
Project Description	Echo Trail		

Lanes

Major Street: North-South															

Vehicle Volumes and Adjustments

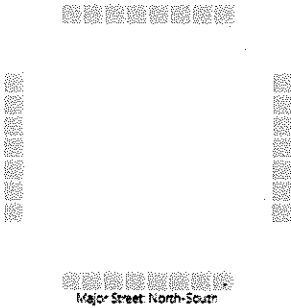
Approach	Eastbound				Westbound				Northbound				Southbound			
Movement	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Priority		10	11	12		7	8	9	1U	1	2	3	4U	4	5	6
Number of Lanes		0	0	0		0	1	0	0	0	1	0	0	0	1	0
Configuration							LR					TR		LT		
Volume (veh/h)						9		62				228	13		21	234
Percent Heavy Vehicles (%)						1		1						1		
Proportion Time Blocked																
Percent Grade (%)					0											
Right Turn Channelized																
Median Type Storage	Undivided															

Critical and Follow-up Headways

Base Critical Headway (sec)						7.1		6.2						4.1		
Critical Headway (sec)						6.41		6.21						4.11		
Base Follow-Up Headway (sec)						3.5		3.3						2.2		
Follow-Up Headway (sec)						3.51		3.31						2.21		

Delay, Queue Length, and Level of Service

Flow Rate, v (veh/h)						84								25		
Capacity, c (veh/h)						704								1285		
v/c Ratio						0.12								0.02		
95% Queue Length, Q_{95} (veh)						0.4								0.1		
Control Delay (s/veh)						10.8								7.9	0.2	
Level of Service (LOS)						B								A	A	
Approach Delay (s/veh)					10.8								0.8			
Approach LOS					B								A			

HCS Two-Way Stop-Control Report																
General Information								Site Information								
Analyst	DBZ							Intersection	Echo Trail at Street G							
Agency/Co.	Diane B. Zimmerman Traffic Engineering LLC							Jurisdiction								
Date Performed	1/5/2023							East/West Street	Echo Trail							
Analysis Year	2033							North/South Street	Street A							
Time Analyzed	AM Peak No Build							Peak Hour Factor	0.85							
Intersection Orientation	North-South							Analysis Time Period (hrs)	0.25							
Project Description	Echo Trail															
Lanes																
																
Vehicle Volumes and Adjustments																
Approach	Eastbound				Westbound				Northbound				Southbound			
Movement	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Priority		10	11	12		7	8	9	1U	1	2	3	4U	4	5	6
Number of Lanes		0	0	0		0	1	0	0	0	1	0	0	0	1	0
Configuration							LR					TR		LT		
Volume (veh/h)						9		62			205	13		21	226	
Percent Heavy Vehicles (%)						1		1						1		
Proportion Time Blocked																
Percent Grade (%)					0											
Right Turn Channelized																
Median Type Storage	Undivided															
Critical and Follow-up Headways																
Base Critical Headway (sec)						7.1		6.2						4.1		
Critical Headway (sec)						6.41		6.21						4.11		
Base Follow-Up Headway (sec)						3.5		3.3						2.2		
Follow-Up Headway (sec)						3.51		3.31						2.21		
Delay, Queue Length, and Level of Service																
Flow Rate, v (veh/h)						84								25		
Capacity, c (veh/h)						731								1314		
v/c Ratio						0.11								0.02		
95% Queue Length, Q ₉₅ (veh)						0.4								0.1		
Control Delay (s/veh)						10.6								7.8	0.2	
Level of Service (LOS)						B								A	A	
Approach Delay (s/veh)					10.6								0.8			
Approach LOS					B								A			

HCS Two-Way Stop-Control Report																
General Information								Site Information								
Analyst	DBZ							Intersection				Echo Trail at Street A				
Agency/Co.	Diane B. Zimmerman Traffic Engineering LLC							Jurisdiction								
Date Performed	1/5/2023							East/West Street				Echo Trail				
Analysis Year	2033							North/South Street				Street A				
Time Analyzed	PM Peak Build							Peak Hour Factor				0.85				
Intersection Orientation	North-South							Analysis Time Period (hrs)				0.25				
Project Description	Echo Trail															
Lanes																
Vehicle Volumes and Adjustments																
Approach	Eastbound				Westbound				Northbound				Southbound			
Movement	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Priority		10	11	12		7	8	9	1U	1	2	3	4U	4	5	6
Number of Lanes		0	0	0		0	1	0	0	0	1	0	0	0	1	0
Configuration							LR					TR		LT		
Volume (veh/h)						141		26			69	238		44	55	
Percent Heavy Vehicles (%)						1		1						1		
Proportion Time Blocked																
Percent Grade (%)					0											
Right Turn Channelized																
Median Type Storage	Undivided															
Critical and Follow-up Headways																
Base Critical Headway (sec)						7.1		6.2						4.1		
Critical Headway (sec)						6.41		6.21						4.11		
Base Follow-Up Headway (sec)						3.5		3.3						2.2		
Follow-Up Headway (sec)						3.51		3.31						2.21		
Delay, Queue Length, and Level of Service																
Flow Rate, v (veh/h)						196								52		
Capacity, c (veh/h)						616								1203		
v/c Ratio						0.32								0.04		
95% Queue Length, Q ₉₅ (veh)						1.4								0.1		
Control Delay (s/veh)						13.6								8.1	0.4	
Level of Service (LOS)						B								A	A	
Approach Delay (s/veh)					13.6								3.8			
Approach LOS					B								A			

HCS Two-Way Stop-Control Report																
General Information								Site Information								
Analyst	DBZ							Intersection				Echo Trail at Street A				
Agency/Co.	Diane B. Zimmerman Traffic Engineering LLC							Jurisdiction								
Date Performed	1/5/2023							East/West Street				Echo Trail				
Analysis Year	2033							North/South Street				Street A				
Time Analyzed	PM Peak No Build							Peak Hour Factor				0.85				
Intersection Orientation	North-South							Analysis Time Period (hrs)				0.25				
Project Description	Echo Trail															
Lanes																
Vehicle Volumes and Adjustments																
Approach	Eastbound				Westbound				Northbound				Southbound			
Movement	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Priority		10	11	12		7	8	9	1U	1	2	3	4U	4	5	6
Number of Lanes		0	0	0		0	1	0	0	0	1	0	0	0	1	0
Configuration							LR					TR		LT		
Volume (veh/h)						118		11			69	200		18	55	
Percent Heavy Vehicles (%)						1		1						1		
Proportion Time Blocked																
Percent Grade (%)					0											
Right Turn Channelized																
Median Type Storage	Undivided															
Critical and Follow-up Headways																
Base Critical Headway (sec)						7.1		6.2						4.1		
Critical Headway (sec)						6.41		6.21						4.11		
Base Follow-Up Headway (sec)						3.5		3.3						2.2		
Follow-Up Headway (sec)						3.51		3.31						2.21		
Delay, Queue Length, and Level of Service																
Flow Rate, v (veh/h)						152								21		
Capacity, c (veh/h)						688								1249		
v/c Ratio						0.22								0.02		
95% Queue Length, Q ₉₅ (veh)						0.8								0.1		
Control Delay (s/veh)						11.7								7.9	0.1	
Level of Service (LOS)						B								A	A	
Approach Delay (s/veh)					11.7								2.1			
Approach LOS					B								A			

HCS Two-Way Stop-Control Report																
General Information								Site Information								
Analyst	DBZ							Intersection				Echo Trail at Street A				
Agency/Co.	Diane B. Zimmerman Traffic Engineering LLC							Jurisdiction								
Date Performed	1/5/2023							East/West Street				Echo Trail				
Analysis Year	2033							North/South Street				Street A				
Time Analyzed	AM Peak Build							Peak Hour Factor				0.85				
Intersection Orientation	North-South							Analysis Time Period (hrs)				0.25				
Project Description	Echo Trail															
Lanes																
Vehicle Volumes and Adjustments																
Approach	Eastbound				Westbound				Northbound				Southbound			
Movement	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Priority		10	11	12		7	8	9	1U	1	2	3	4U	4	5	6
Number of Lanes		0	0	0		0	1	0	0	0	1	0	0	0	1	0
Configuration							LR					TR		LT		
Volume (veh/h)						205		38			193	67		13	230	
Percent Heavy Vehicles (%)						1		1						1		
Proportion Time Blocked																
Percent Grade (%)					0											
Right Turn Channelized																
Median Type Storage	Undivided															
Critical and Follow-up Headways																
Base Critical Headway (sec)						7.1		6.2						4.1		
Critical Headway (sec)						6.41		6.21						4.11		
Base Follow-Up Headway (sec)						3.5		3.3						2.2		
Follow-Up Headway (sec)						3.51		3.31						2.21		
Delay, Queue Length, and Level of Service																
Flow Rate, v (veh/h)						286								15		
Capacity, c (veh/h)						510								1261		
v/c Ratio						0.56								0.01		
95% Queue Length, Q ₉₅ (veh)						3.4								0.0		
Control Delay (s/veh)						20.7								7.9	0.1	
Level of Service (LOS)						C								A	A	
Approach Delay (s/veh)					20.7								0.5			
Approach LOS					C								A			

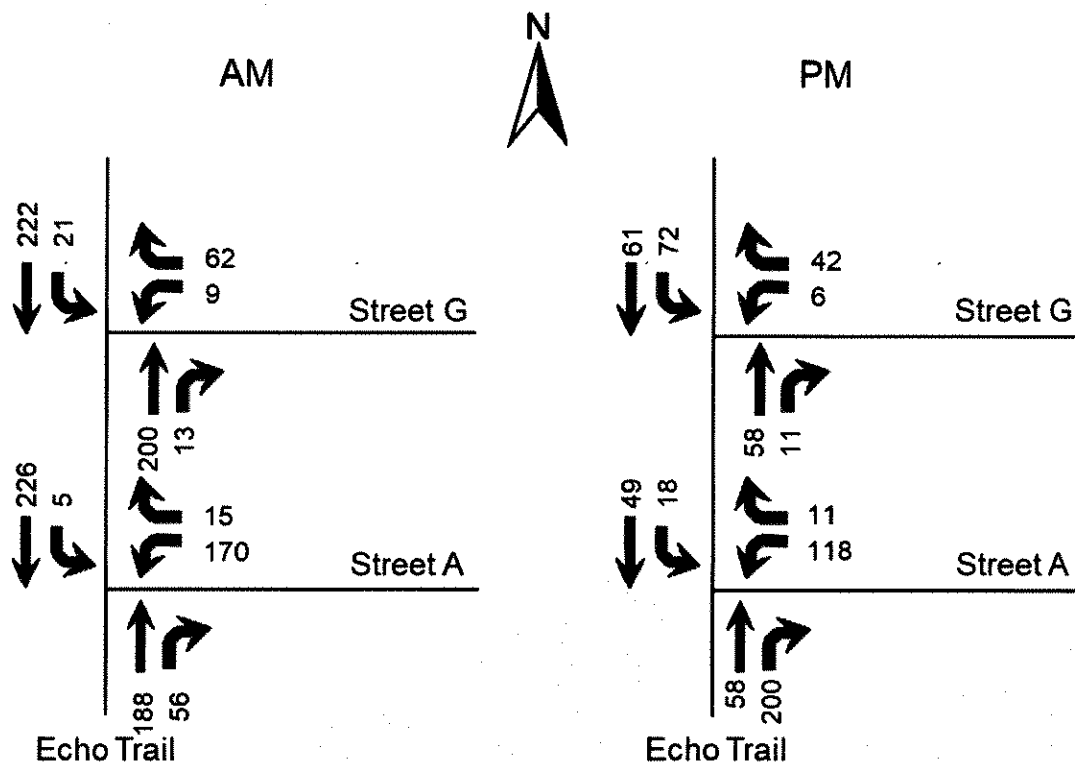
HCS Reports

HCS Two-Way Stop-Control Report																	
General Information									Site Information								
Analyst	DBZ								Intersection				Echo Trail at Street A				
Agency/Co.	Diane B. Zimmerman Traffic Engineering LLC								Jurisdiction								
Date Performed	1/5/2023								East/West Street				Echo Trail				
Analysis Year	2033								North/South Street				Street A				
Time Analyzed	AM Peak No Build								Peak Hour Factor				0.85				
Intersection Orientation	North-South								Analysis Time Period (hrs)				0.25				
Project Description	Echo Trail																
Lanes																	
<p>Major Street North-South</p>																	
Vehicle Volumes and Adjustments																	
Approach	Eastbound				Westbound				Northbound				Southbound				
Movement	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R	
Priority		10	11	12		7	8	9	1U	1	2	3	4U	4	5	6	
Number of Lanes		0	0	0		0	1	0	0	0	1	0	0	0	1	0	
Configuration							LR					TR		LT			
Volume (veh/h)						170		15			193	56		5	230		
Percent Heavy Vehicles (%)						1		1						1			
Proportion Time Blocked																	
Percent Grade (%)					0												
Right Turn Channelized																	
Median Type Storage	Undivided																
Critical and Follow-up Headways																	
Base Critical Headway (sec)						7.1		6.2						4.1			
Critical Headway (sec)						6.41		6.21						4.11			
Base Follow-Up Headway (sec)						3.5		3.3						2.2			
Follow-Up Headway (sec)						3.51		3.31						2.21			
Delay, Queue Length, and Level of Service																	
Flow Rate, v (veh/h)						218								6			
Capacity, c (veh/h)						515								1274			
v/c Ratio						0.42								0.00			
95% Queue Length, Q ₉₅ (veh)						2.1								0.0			
Control Delay (s/veh)						17.0								7.8	0.0		
Level of Service (LOS)						C								A	A		
Approach Delay (s/veh)					17.0								0.2				
Approach LOS					C								A				

TRIP GENERATION AND DISTRIBUTION FOR 577 LOTS AND MIDDLE SCHOOL

The Echo Trail Subdivision TIS assigned 30% to/from the north. For the middle school 60% to/from the north was used.

Land Use	A.M. Peak Hour			P.M. Peak Hour		
	Trips	In	Out	Trips	In	Out
Single-Family Detached (532 lots)	341	85	256	478	301	177
Middle School (1,000 student)	670	362	308	150	72	78



Echo Trail Subdivision
Traffic Impact Study

Traffic Counts

Classified Turn Movement Count || All vehicles



Louisville, KY

www.marrtraffic.com

Site 1 of 1

Echo Trail
Echo Trail Rd
Gilliland Rd
Driveway

Date

Wednesday, September 28, 2022

Weather

Fair
56°F

Lat/Long

38.217683°, -85.460465°

0700 - 0900 (Weekday 2h Session) (09-28-2022)

All vehicles

TIME	Northbound Echo Trail					Southbound Echo Trail Rd					Eastbound Gilliland Rd					Westbound Driveway					Int Total
	Left 1.1	Thru 1.2	Right 1.3	U-Turn 1.4	App Total	Left 1.5	Thru 1.6	Right 1.7	U-Turn 1.8	App Total	Left 1.9	Thru 1.10	Right 1.11	U-Turn 1.12	App Total	Left 1.13	Thru 1.14	Right 1.15	U-Turn 1.16	App Total	
0700 - 0715	0	1	0	0	1	0	1	0	0	1	2	0	0	0	2	0	0	0	0	0	4
0715 - 0730	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	1
0730 - 0745	0	1	0	0	1	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	2
0745 - 0800	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hourly Total	0	2	0	0	2	0	1	0	0	1	4	0	0	0	4	0	0	0	0	0	7
0800 - 0815	0	1	0	0	1	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	2
0815 - 0830	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	1
0830 - 0845	0	2	0	0	2	0	1	0	0	1	1	1	0	0	2	0	0	0	0	0	5
0845 - 0900	0	2	0	0	2	0	0	2	0	2	0	0	0	0	0	0	0	0	0	0	4
Hourly Total	0	5	0	0	5	0	3	2	0	5	1	1	0	0	2	0	0	0	0	0	12
Grand Total	0	7	0	0	7	0	4	2	0	6	5	1	0	0	6	0	0	0	0	0	19
Approach %	0.00	100.00	0.00	0.00	-	0.00	66.67	33.33	0.00	-	83.33	16.67	0.00	0.00	-	0.00	0.00	0.00	0.00	-	
Intersection %	0.00	36.84	0.00	0.00	36.84	0.00	21.05	10.53	0.00	31.58	26.32	5.26	0.00	0.00	31.58	0.00	0.00	0.00	0.00	0.00	
PHF	0.00	0.63	0.00	0.00	0.63	0.00	0.75	0.25	0.00	0.63	0.25	0.25	0.00	0.00	0.25	0.00	0.00	0.00	0.00	0.00	0.60

1600 - 1800 (Weekday 2h Session) (09-28-2022)

All vehicles

TIME	Northbound Echo Trail					Southbound Echo Trail Rd					Eastbound Gilliland Rd					Westbound Driveway					Int Total
	Left 1.1	Thru 1.2	Right 1.3	U-Turn 1.4	App Total	Left 1.5	Thru 1.6	Right 1.7	U-Turn 1.8	App Total	Left 1.9	Thru 1.10	Right 1.11	U-Turn 1.12	App Total	Left 1.13	Thru 1.14	Right 1.15	U-Turn 1.16	App Total	
1600 - 1615	0	0	1	0	1	0	0	2	0	2	0	0	0	0	0	0	0	0	0	0	3
1615 - 1630	0	0	0	0	0	1	2	1	0	4	0	0	0	0	0	0	0	0	0	0	4
1630 - 1645	0	1	0	0	1	0	0	2	1	3	0	0	0	0	0	0	0	0	0	0	4
1645 - 1700	0	0	0	0	0	1	4	1	0	6	0	0	0	0	0	0	0	0	0	0	6
Hourly Total	0	1	1	0	2	2	6	6	1	15	0	0	0	0	0	0	0	0	0	0	17
1700 - 1715	0	3	0	0	3	1	1	2	1	5	2	0	0	0	2	0	0	0	0	0	10
1715 - 1730	0	3	0	0	3	0	1	2	0	3	1	0	1	0	2	0	0	0	0	0	8
1730 - 1745	0	2	1	0	3	0	0	1	1	2	1	0	0	0	1	0	0	0	0	0	6
1745 - 1800	0	3	0	0	3	0	3	0	0	3	2	0	0	0	2	0	0	0	0	0	8
Hourly Total	0	11	1	0	12	1	5	5	2	13	6	0	1	0	7	0	0	0	0	0	32
Grand Total	0	12	2	0	14	3	11	11	3	28	6	0	1	0	7	0	0	0	0	0	49
Approach %	0.00	85.71	14.29	0.00	-	10.71	39.29	39.29	10.71	-	85.71	0.00	14.29	0.00	-	0.00	0.00	0.00	0.00	-	
Intersection %	0.00	24.49	4.08	0.00	28.57	6.12	22.45	22.45	6.12	57.14	12.24	0.00	2.04	0.00	14.29	0.00	0.00	0.00	0.00	0.00	
PHF	0.00	0.92	0.25	0.00	1.00	0.25	0.42	0.63	0.50	0.65	0.75	0.00	0.25	0.00	0.88	0.00	0.00	0.00	0.00	0.00	0.80

APPENDIX

Table 2. Peak Hour Level of Service

Approach	A.M.			P.M.		
	2022 Existing	2033 No Build	2033 Build	2022 Existing	2033 No Build	2033 Build
Echo Trail at Street A						
Street A Westbound		C 17.0	C 20.7		B 11.7	B 13.6
Echo Trail Southbound		A 7.8	A 7.9		A 7.9	A 8.1
Echo Trail at Street G						
Street G Westbound		B 10.6	B 10.8		A 9.2	A 9.4
Echo Trail Southbound		A 7.8	A 7.9		A 7.5	A 7.6

Key: Level of Service, Delay in seconds per vehicle

Both entrances were evaluated for turn lanes using the Kentucky Transportation Cabinet Highway Design Guidance Manual dated July, 2020. Using the volumes in Figure 6, no turn lanes will be required at either entrance. The development plan shows a stub to a residual tract south and east of the middle school, which potentially will provide a third street connection to Echo Trail. This will reduce the turning traffic at both Street A and G upon completion.

CONCLUSIONS

Based upon the volume of traffic generated by the development and the amount of traffic forecasted for the year 2033, there will be an impact to the existing highway network. No turn lanes will be required at the entrances.

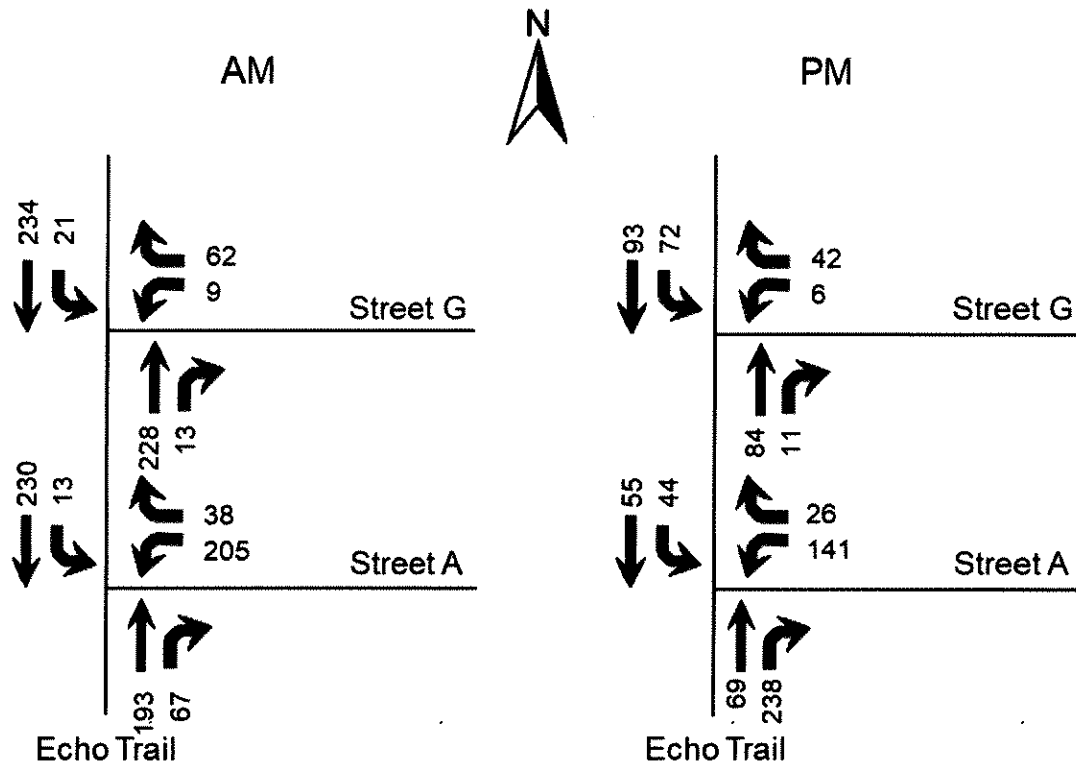


Figure 6. 2033 Build Peak Hour Volumes

ANALYSIS

The qualitative measure of operation for a roadway facility or intersection is evaluated by assigning a "Level of Service". Level of Service is a ranking scale from A through F, "A" is the best operating condition and "F" is the worst. Level of Service results depend upon the facility that is analyzed. In this case, the Level of Service is based upon the total delay experienced at an intersection.

To evaluate the impact of the proposed development, the vehicle delays at the intersections were determined using procedures detailed in the Highway Capacity Manual, 7th edition. Future delays and Level of Service were determined for the intersections using the HCS Streets (version 2023) software. The delays and Level of Service are summarized in **Table 2**.

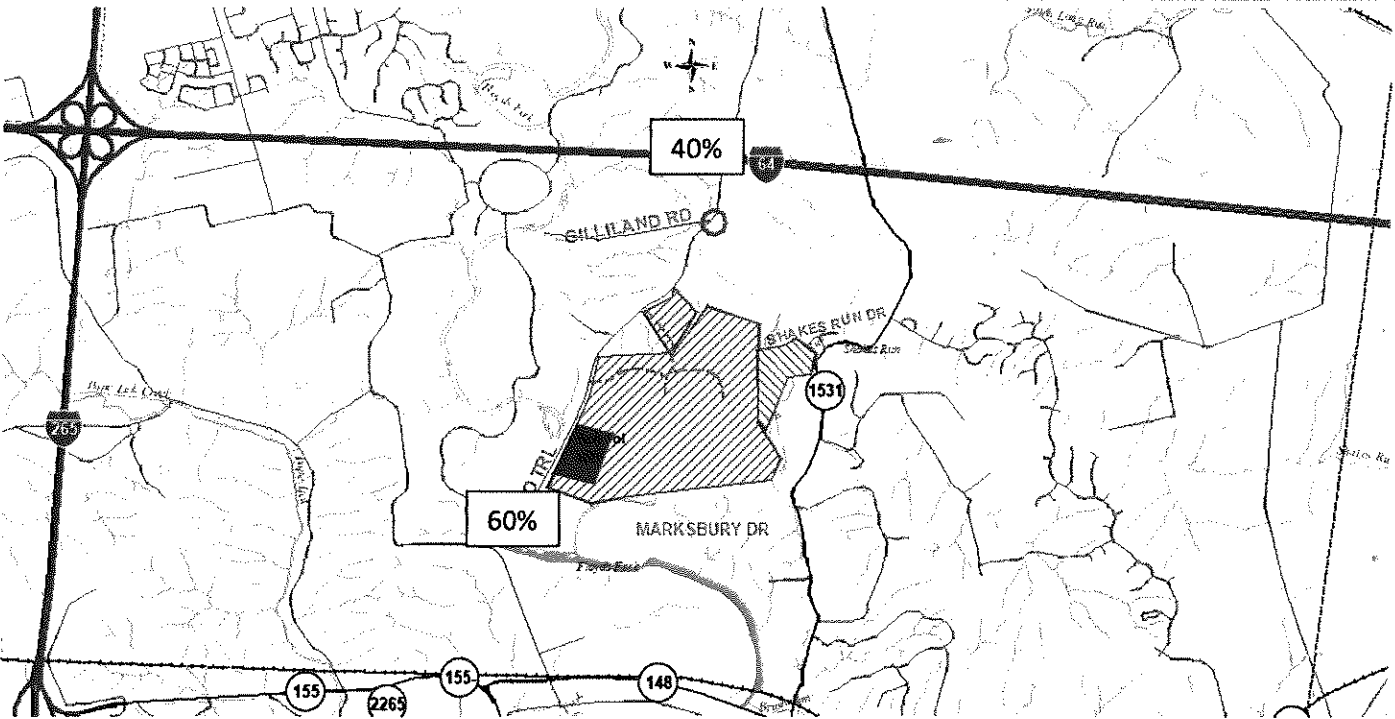


Figure 4: Trip Distribution Percentages

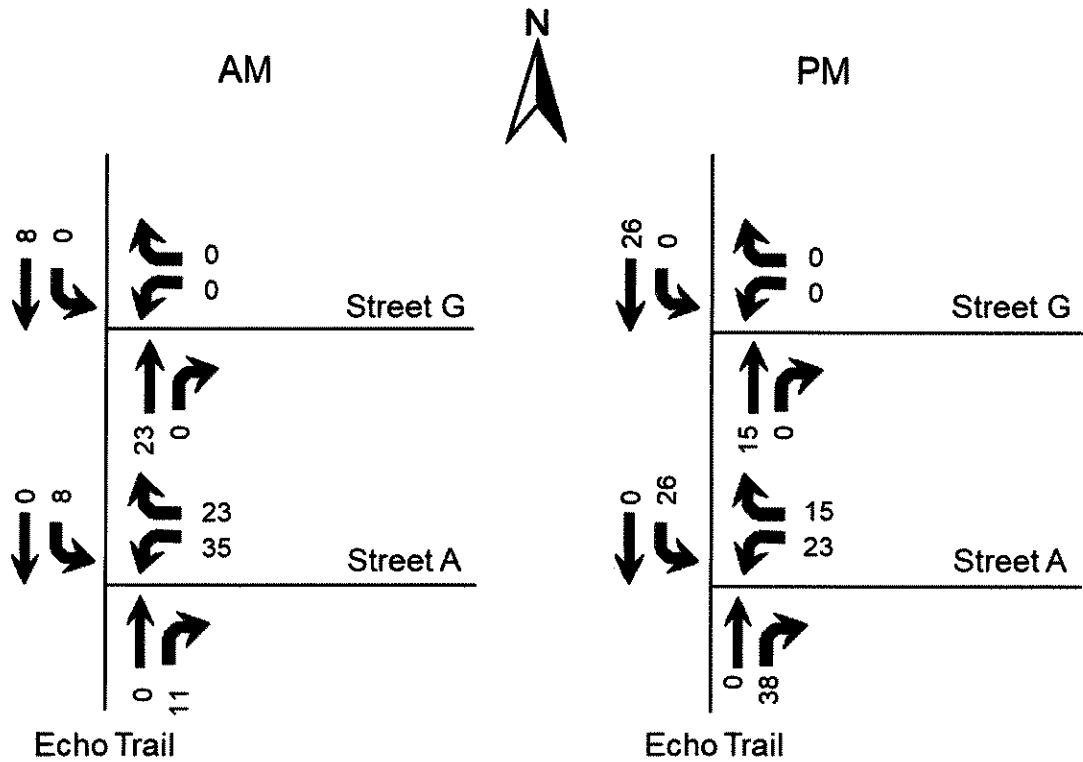


Figure 5. Peak Hour Trips Generated by Site

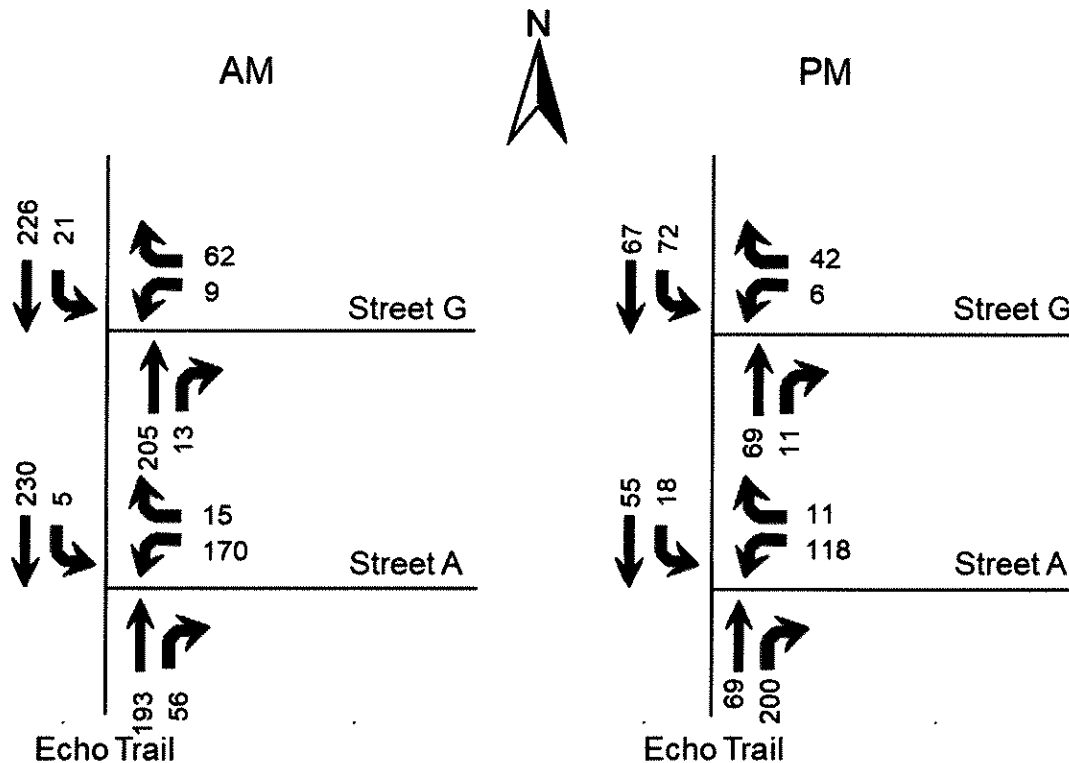


Figure 3. 2033 No Build Peak Hour Volumes

TRIP GENERATION

The Institute of Transportation Engineers Trip Generation Manual, 11th Edition contains trip generation rates for a wide range of developments. The land use of “Single Family Detached (210)” was reviewed and determined to be the best match. The trip generation results are listed in **Table 1**. The trips were assigned to the highway network with the percentages shown in **Figure 4**. **Figure 5** shows the trips generated by this development and distributed throughout the road network during the peak hours. **Figure 6** displays the individual turning movements for the peak hours when the development is completed.

Table 1. Peak Hour Trips Generated by Site

Land Use	A.M. Peak Hour			P.M. Peak Hour		
	Trips	In	Out	Trips	In	Out
Single-Family Detached (103 lots)	77	19	58	102	64	38

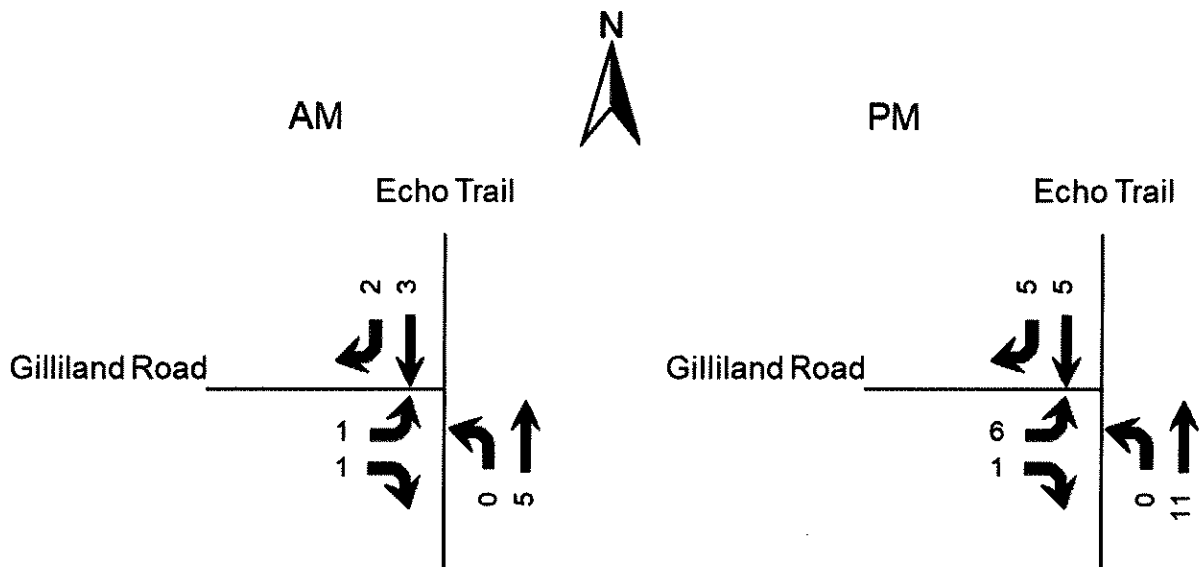


Figure 2. Existing Peak Hour Volumes

FUTURE CONDITIONS

The project completion date is 2033. Trip generation for the previously approved 577 lots with access to Echo Trail and middle school are included. The trip distribution for the previously approved lots is taken from the Echo Trail Subdivision Traffic Impact Study, October 22, 2018. **Figure 3** displays the 2033 No Build peak hour volumes.

INTRODUCTION

The development plan for a new section of a previously approved subdivision on Echo Trail in Louisville, KY shows 103 new single-family lots, which brings the total to 680 single-family lots. **Figure 1** displays a map of the site. Access to the subdivision will be from two entrances on Echo Trail and an entrance on Eastwood Fisherville Road. There will not be a bridge over Long Run Creek. This study focuses on 103 lots proposed at the southern entrance (Street A). The purpose of this study is to examine the traffic impacts of the development upon the adjacent highway system. For this study, the impact area was defined to be the intersections of Echo Trail with the two entrances.

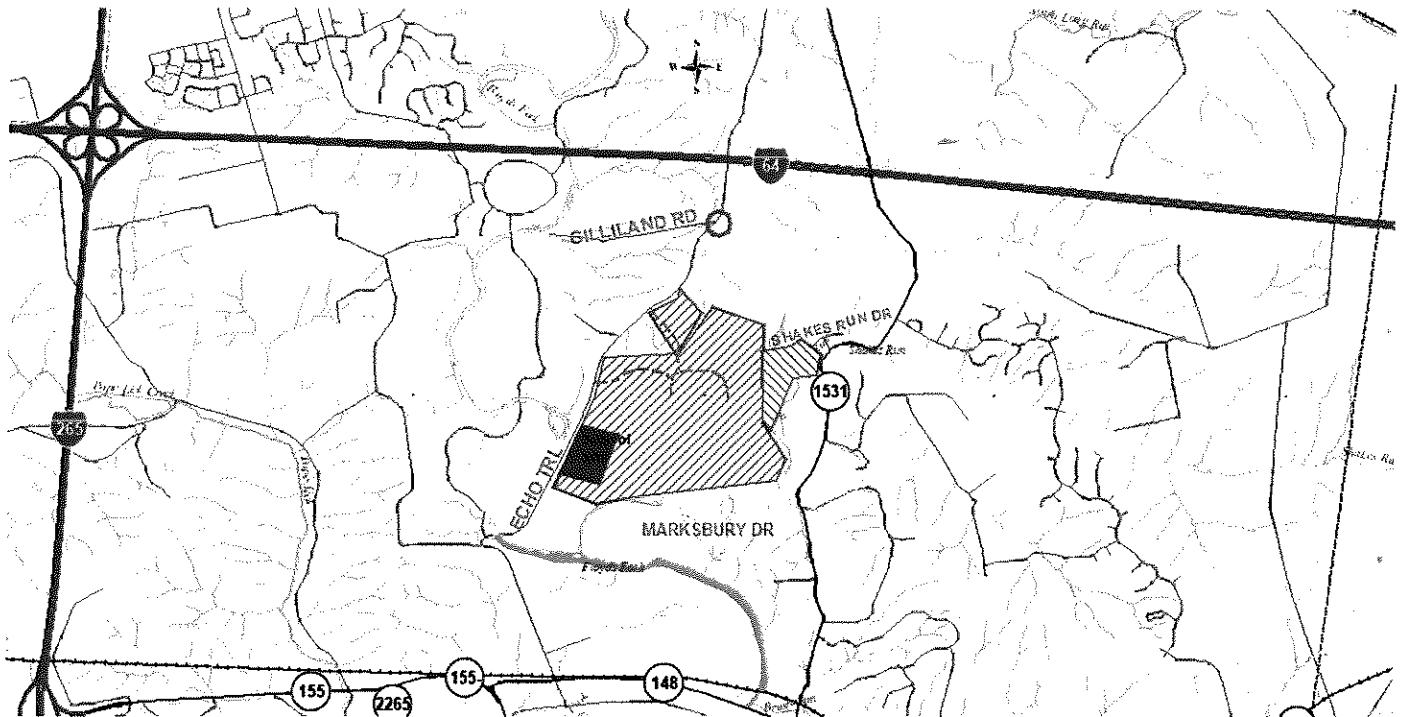


Figure 1. Site Map

EXISTING CONDITIONS

Echo Trail, is a Metro-maintained road with an estimated 2022 ADT of 1,000 vehicles per day between South English Station Road and Eastwood Cutoff Road, as estimated from the Kentucky Transportation Cabinet 2019 count at station 366. The road is a two-lane highway with nine-foot lanes with two-foot shoulders through the study area. The speed limit is 35 mph. There are no sidewalks. The intersection with South English Station Road, is controlled as an all-way stop. There are no turn lanes.

Peak hour traffic counts for the intersection of Gilliland Road and Echo Trail were obtained on September 28, 2022. The a.m. peak hour is 8:00 to 9:00 and the p.m. peak hour is 5:00 to 6:00. **Figure 2** illustrates the existing a.m. and p.m. peak hour traffic volumes. The Appendix contains the full count data for each intersection.

Table of Contents

INTRODUCTION	2
Figure 1. Site Map.....	2
EXISTING CONDITIONS	2
Figure 2. Existing Peak Hour Volumes	3
FUTURE CONDITIONS	3
Figure 3. 2033 No Build Peak Hour Volumes.....	4
TRIP GENERATION	4
Table 1. Peak Hour Trips Generated by Site.....	4
Figure 4. Trip Distribution Percentages	5
Figure 5. Peak Hour Trips Generated by Site.....	5
Figure 6. 2033 Build Peak Hour Volumes	6
ANALYSIS	6
Table 2. Peak Hour Level of Service.....	7
CONCLUSIONS	7
APPENDIX	8

final report

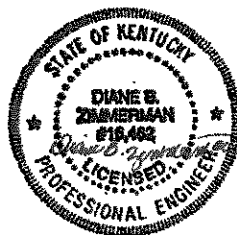
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Traffic Impact Study

Echo Trail Subdivision
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Louisville Metro Planning Commission



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