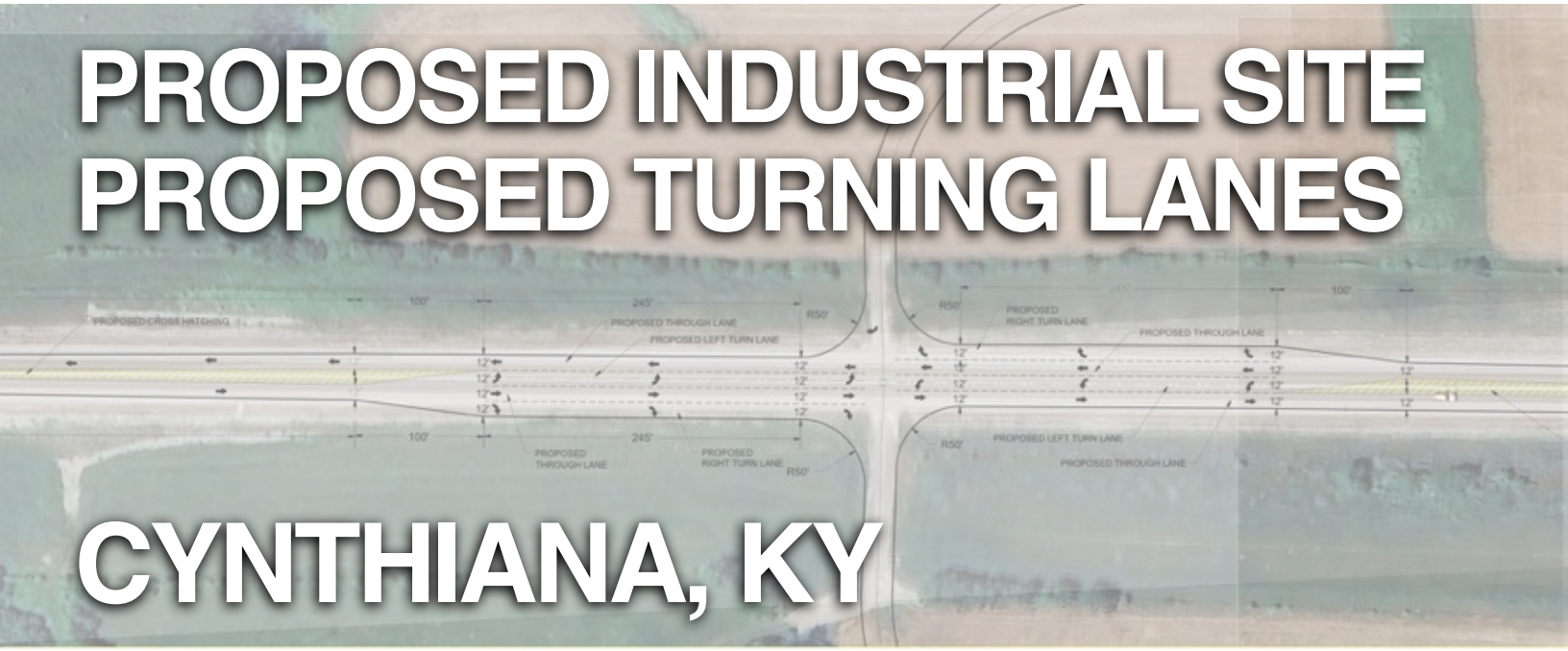
March 26, 2025

GEOTECHNICAL REPORT

PROPOSED INDUSTRIAL SITE
PROPOSED TURNING LANES



CYNTHIANA, KY

CETCO

Cooke Engineering and Testing Company

March 26, 2025

Mr. Garnett Furnish, Executive Director
Cynthiana-Harrison County Economic Development Authority
via email: gtfurnish@gmail.com

Subject: **Geotechnical Report**
Proposed Industrial Site Turning Lane Addition
Cynthiana, Harrison County, Kentucky
CETCO Project No. 4100-24-0102

Dear Garnett and the EDA Board:

CETCO appreciates the opportunity to provide our services to you and the Owner (Cynthiana - Harrison County Economic Development Authority). As follows, we are providing our geotechnical report. Our services were provided in general accordance with our proposal number CET 4100-24-0312, dated October 8, 2024. Also, please note the report appendix which contains many detailed findings as well as our standard of care for providing our services.

We appreciate the opportunity to provide our geotechnical services to you and the project team. Please do not hesitate to contact us for questions or comments about the information contained herein.

Cordially,

STATE OF KENTUCKY
JOSEPH S. COOKE
21244
LICENSED PROFESSIONAL ENGINEER

Hunter Hawkins, SI
Staff Geologist

Joseph S. Cooke, P.E.
Principal
Licensed KY 21244

Attachments: Geotechnical Report and Appendix

Cooke Engineering and Testing Company

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US-27 Turning Lane Addition

CYNTHIANA, KENTUCKY

GEOTECHNICAL REPORT SUMMARY

We provided our services in general accordance with our previous discussions and our proposal number 4110-24-0312, dated October 8, 2024 and approved by the your office on the same date. CETCO has consulted with your office and discussed the need for CETCO to provide geotechnical services including sampling and exploration with soil test borings, site field services by our office, lab testing and analysis and providing a geotechnical report. These services included providing our opinion of the conditions encountered for the purpose of design and development for turning lanes off of US-27 for a proposed industrial park site. The project plans are in the preliminary stage, and may change. CETCO should be advised on any changes from the information presented in our report. The site is located off of US-27 in Cynthiana, Kentucky. This introductory section, which has previously been discussed with your office, provides a brief summary for quick reference. The report that follows provides much greater details for design and construction purposes.

In general, we encountered the typical, “thin” mostly brown lean to fat clays found in Cynthiana. The borings located near the grass lined ditch were mostly gravel and clay fill. Groundwater was encountered in few of our borings near the bottom of the ditch. Limestone bedrock was encountered in all borings ranging from about 3 to 9 feet deep. The native clay soils were typically stiff.

The primary concerns for the addition are the “normal” Cynthiana, KY risks of: Shallow depth to bedrock and shrink-swell potential for the clay soils. Normal KyTC construction and planning practices of the Cynthiana area are expected. Details for these issues and recommendations for design and construction as well as our other recommendations are discussed in the report.

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1 PROJECT BACKGROUND

1.1 CETCO SCOPE OF SERVICES

Our scope of services included conducting an exploration of the subsurface conditions for the proposed new turning lane additions off of US-27. This including using 10 soil test borings, including two 10 foot rock cores, observing site and site area conditions and providing geotechnical analysis. We have completed our field work, analysis and we are issuing the geotechnical report as follows.

1.2 PROVIDED INFORMATION

We were provided information for the project as follows:

Provided Document	Source
Site drawings are in the “concept” stage. The provided sketch shows the potential turning lane additions for the 60 acre industrial entrance.	MSE
Site/property images showing the position of site location.	MSE

The following information summarizes our understanding of the project conditions.

Condition	Specifics
Industrial entrance Information	A north and south bound turning lane addition, with a modified entrance way, is proposed for a potential main entrance to 60 acres of potential industrial site in Cynthiana, Kentucky.
Pavement/Traffic Information	The paved new turning lanes would be part of US 27 and the entrance way roads would be part of a potential industrial property. In general, traffic loading/quantities would be assumed to be those required for a typical intersection along US 27, as well as potential industrial traffic. This would include assumed loading of 30 to 50 tractor trailers per day over the life of the pavement.
Site Grading	The initial concept includes a new entrance of 2 lanes (24 foot wide with asphalt shoulders) and new turning lanes with paved shoulders on both sides. There is a gravel/ grass lined ditch beyond the shoulders and embankment leading to the industrial sites beyond the ditch. It is anticipated that the proposed turning lanes will be where the existing shoulder and grass lined ditch is currently. The embankment will likely need to be “cut” to accommodate the new lanes and new ditch line areas. This could mean cuts of over 10 to 15 feet deep.

If any of the aforementioned information is incorrect or requires modification, please let CETCO know. Changes to our reporting, recommendations and opinions may be required.

1.3 PUBLISHED SITE AND AREA INFORMATION

We have reviewed the following published/public domain site information.

AREA TOPOGRAPHY AND PHYSIOGRAPHY

The site is located in the “Outer Bluegrass Region” of central Kentucky. These areas can have rolling to hilly upland of low to moderately high relief, which are often dissected by sinkholes, springs, entrenched rivers, intermittent and perennial streams. The region is mostly underlain by interbedded Upper Ordovician limestone and shale, which are more easily eroded than limestones of the inner bluegrass. The region has less karst features, with fewer sinkholes and rolling hills. The southern boundary of this physiographic region in Kentucky consists of knobs which consist of hundreds of steep sloping cone shaped hills. The valleys of the Licking River are commonly the lowest elevations, with ridge tops being the highest elevations. Elevations generally range from 550 to 1050 feet in the Cynthiana area, however the site vicinity ranged from 790 to 850 feet.

SITE GEOLOGY

The Kentucky Geologic Survey public information was reviewed including the USGS mapped geologic information for the site (the Cynthiana Geological Quadrangle). Available geologic mapping indicates the site vicinity is underlain by variable geologic units including the Clays Ferry Formation and several members of the Lexington Limestone (primarily the Tanglewood and Millersburg). All of these units contain primarily limestone bedrock with gray shades of coloring. Some gray shale interbedding is also mapped.

The primary issues we believe that affect the site include karst (sinkhole and similar) topography, relatively shallow top of bedrock conditions (thin soil overburden) and moderate plasticity clay soil overburden.

Geologic mapping is shown on the following page.

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GEOLOGIC MAPPING

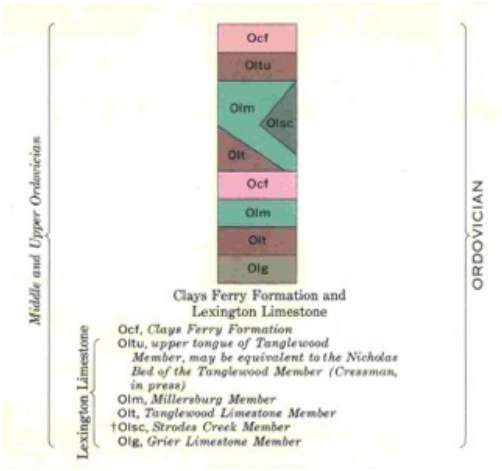


Image from the KGS website for geologic units: Site location is the black rectangle.

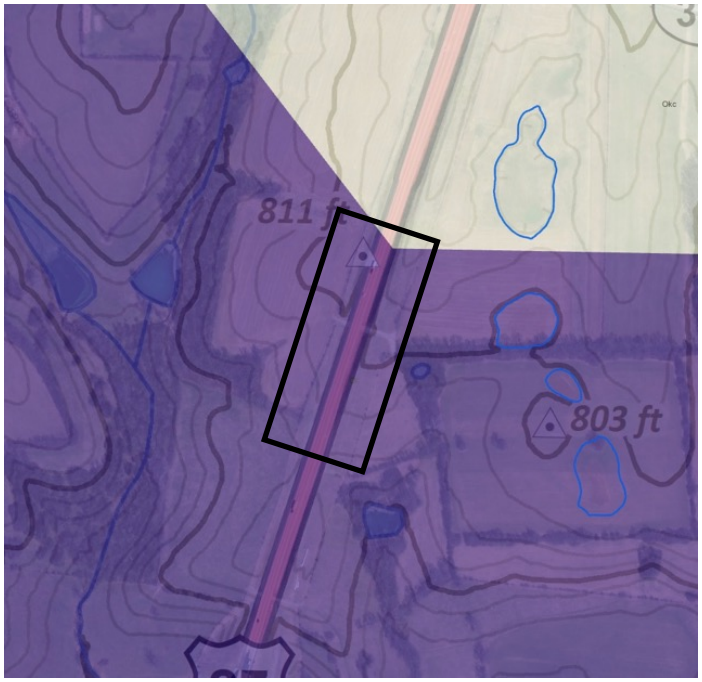
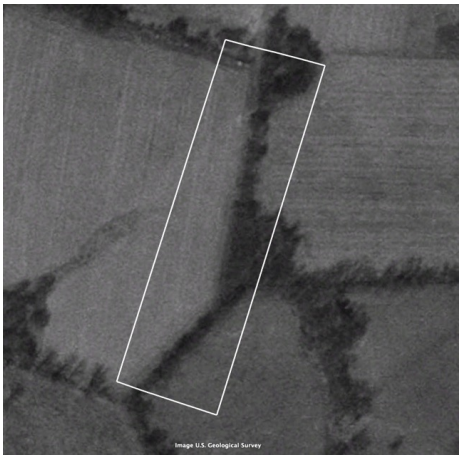


Image from the KGS website for Karst Potential: Site location is the black rectangle.

AERIAL MAPPING

Aerial information back as far as 1997 was readily available for the site. Images showing site progression. Photo on the left is the aerial from 1997, showing undeveloped farm land throughout the majority of the area. US-27 (called the US-27 bypass) was constructed between 2010 and 2014 and can been seen prior to being built in the 2010 aerial. The eastern entrance used to be a wooded area prior to when US-27 was constructed. Throughout the remaining aerials, the site conditions appear to be very similar to current day. Please reference the pictures below.



1997 : Aerial from Google Earth

2010 : Aerial from Google Earth

2023 : Aerial from Google Earth

SITE SOIL SURVEY MAPPING

The Soil Survey of the site area was also reviewed. Issues affecting the site development included: depth to bedrock, shrink/swell of soil, and slope construction. We are providing recommendations to address these issues. Also, the soil survey lists the some of the site as having “high risk” for corrosion of steel. The local roads and streets section of the Soil Survey listed Frost action and low strength as issues for roadway construction.

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2 CETCO FINDINGS

We provided a site and area reconnaissance, logged soil test borings and explored the site using those borings. The following sections discuss our findings. Geotechnical professionals provided our field services including a site reconnaissance and logging of the borings in the field, during the exploration on February 17-18, 2025. Mr. Joe Cooke, PE, was also on-site during drilling and also observed and logged recovered soil and bedrock samples.

2.1 CURRENT SITE SURFACE CONDITIONS AND OBSERVATIONS

The site is located off of US27 (also known as the US27 bypass). There are two asphalt entrances on either side of US27 leading to the proposed 60 acre industrial parcels. US27 is 24 feet wide with a 10 feet paved shoulder. A grass lined ditch runs north to south on both sides of US27, and is approximately 4 feet lower than the road elevation. The eastern portion is gently sloping south, with a grassy embankment east of the grass lined ditch. The bottom of the eastern ditch had a slight stream of water running through, likely due to the large amount of snow/rainfall in recent days. Some grass is growing closer to the bottom of the ditch. The western portion is also gently sloping south, with a steeper embankment leading to the western parcel. There is a fence-line at the top of the embankment. No moving water was observed in the bottom of the ditch. Some rock outcrops were observed throughout the hillside, especially the northern most section. Two, 24-inch culverts were observed in the ditch area underneath both of the asphalt entrances.

The ground surface appeared to be “firm” and did not appreciably rut under the weight of the drill rig during our drilling operations. The existing asphalt appears to have minimal to no cracking or other indications of instability/fatigue or failure.

The site appears to drain well, as the weather conditions prior to drilling and during drilling included rainy days, but no large-scale ponding of water due to the rain was observed and minimal muddy conditions were observed.

The following page shows photos of the area at the time of our field work.

Project Photos

Description	Photo
Showing example view of the paved entrances off of US-27. Facing southwest	
Example showing the eastern section grass lined ditch. Facing northwest.	

Description	Photo
Example view showing B-3 location on the eastern side of US-27. Also showing a slight stream at the bottom of the grass lined ditch. Facing south.	
Example view showing B-9 location on top of the eastern embankment. Facing south.	

Description	Photo
Example view of B-7 location on the western embankment near the entrance. Facing northwest.	
Example view showing US-27on the right side of the image with the western ditch and embankment on the left side of the image. Facing north.	

Description	Photo
Example view of B-5 drilled near the bottom of the ditch. Notice there is not any running water on the western side ditch. Facing north.	
Example view showing B-10 location on top of the western embankment. Facing south.	

2.2 SUBSURFACE INFORMATION SUMMARY

A total of 10 soil boring tests, including two 10 foot rock cores were utilized to explore the subsurface conditions at the site. The borings were drilled in locations to provide an indication of the site subsurface conditions with proximity to the proposed turning lane additions off of US-27. The boring location plan in the appendix shows the approximate drilling locations.

SUBSURFACE CONDITIONS: At our sampling locations, we encountered mostly gravel/clay fill at the existing sides of the existing US-27 and ditch area lower elevation borings. Native soils were observed in all four of the higher elevation embankment borings and were generally brown in coloring, overlying weathered limestone rock. Below is a table summarizing the soil conditions at the site. Detailed findings are in the Appendix boring logs and laboratory testing pages.

Strata	Thickness	Notes
Fill: Mostly gravel with some brownish gray clay, generally very moist to wet and “stiff”	3-6 feet	All lower elevation borings showed fill throughout the overburden.
Topsoil	1-5 inches	Minimal topsoil. Only present in the higher elevation embankment borings.
Native soils: mostly lean to fat clay, brown in coloring and generally “moist” and “firm to stiff”.	4-7 feet	Higher elevation embankment borings showed native soils in the entire overburden.
Bedrock: Weathered Limestone	N/A	All borings encountered limestone bedrock.

Auger refusal was encountered in all borings. Auger refusal is interpreted at the top of limestone bedrock. The table below shows depth to bedrock listed. (i.e., Auger Refusal listed as AR)

Boring Number	Depth to Auger Refusal (AR)
B-1	6.4
B-2	3.0
B-3	3.5
B-4	7.6
B-5	4.2

Boring Number	Depth to Auger Refusal (AR)
B-6	4.0
B-7	4.7
B-8	8.9
B-9	4.7
B-10	7.5

GROUNDWATER CONDITIONS: Free water or “wet” conditions were encountered in the grass eastern grass lined ditch borings. This could be due to the large amount of rainfall/snow from recent days. Most of this site area is “karst prone or intense”. This usually means that springs and wet conditions at or near the bedrock surface are possible. The types of areas can have pockets of water within the soil mass.

BEDROCK CONDITIONS: Bedrock depths from our borings throughout the bottom of ditch averaged approximately 4.8 feet deep. The higher elevation borings on top of the embankment averaged approximately 6.5 feet deep, however limestone outcrops were observed throughout the northwestern hillside. Bedrock elevations could be very shallow to rock in those areas. Two 10 foot cores were taken at B-9 and B-10. These cores consisted of gray limestone, fine to coarsely crystalline, with trace mud seams, and moderately hard. Detailed information on these cores can be found in the boring logs in the Appendix.

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3 OPINIONS AND DISCUSSION

SUMMARY: In general, the project site is suitable for the proposed new development and site improvements. This includes the use of shallow spread footings and conventional building slab-on-grade floors.

3.1 PRIMARY GEOTECHNICAL ISSUES

The following issues are our opinion of the primary geotechnical-related issues at the site. Other issues are likely present, but we believe the following represent the greatest impact to the project budget, schedule, design and construction. Our recommendations address these issues.

- Shallow depth to bedrock / Slope construction
- Soft “Silty” Soils (Low-lying areas)
- Karst potential
- Previous Roadway Construction
- Moderate to High Plasticity Clays

Shallow Depth to bedrock/Slope construction

Seven out of ten of the borings drilled showed shallow bedrock conditions (less than 7 feet to bedrock). The lower elevation borings drilled throughout the grass lined ditch appeared to be shallower to bedrock, with an average of 4.8 feet to bedrock, and as shallow as 3 feet. Limestone rock outcrops were observed throughout the western hillside embankment, which means it could be very shallow depth to bedrock in these areas. During construction, rock excavation techniques will likely be used in majority of these areas in order to reach proper depth to sub grade. This also means there could be exposed rock embankment or proper sloping will need to occur.

Slopes will consist of hard bedrock material overlain by normal Central Kentucky clay soils. Appropriate KyTC slope design and construction would be required. The bedrock cut slopes (less than 20 feet tall) in similar limestone are typically allowed to be as steep as 1H:20V. Soil slopes should be 3H:1V or flatter (for stability and mowing).

Silty Clays and Soft/Wet Soils (low-lying areas)

Most of the site soil conditions are stiff to very stiff, but low-lying areas of “soft” and/or “wet” soils are present. These low-lying areas were all soft and wet at the time of drilling. The lower elevations also had “thicker” vegetation, which is reflective of wetter soil conditions in the area. **Some undercutting of the low-lying areas should be expected.**

Karst (sinkholes and caves)

What is Karst? With regards to conditions that would affect the site development, it is simply a geologic condition that makes the site more prone to the formation of sinkholes, caves, erratic top of bedrock elevations and formations of “springs”. Kentucky (including most of Cynthiana) is underlain by various areas and degrees of “Karst Topography” conditions. The specific site is underlain by bedrock that has “intense” or “high” karst formation risk (see the geologic mapping on previous pages of the report). However, *this is the same risk as many areas of Cynthiana/Harrison County*. This risk is normal for many south-central Kentucky areas and sites. Karst includes sinkholes, caves, formations of springs, shallow or erratic top of bedrock profile, etc. Two sinkholes are mapped on the eastern industrial parcel site and obvious indications of a large surface depression were observed on these adjacent site. For the site, we are providing specific recommendations to minimize this risk of construction in karst terrain (see page 14 of the report). ***One means to lower risk of unknown or submerged sinkholes is to perform a heavy proof roll of the entire site after final grading has taken place.*** This can locate sinkholes that are just below the top of ground surface

Previous Roadway Construction

US-27 was constructed between 2010 and 2014. The land was also previously cultivated farmland and a wooded area. US-27 is a 24 feet wide two lane road with a 10 foot shoulder on both sides leading to grass lined ditches. The proposed road will be located along the shoulder and the grass lined ditches. The new grass lined ditches will be on the embankment slope, which could mean shallow depths to bedrock when excavating. Expect to have some level of undercutting of previously developed materials (old fill) as well as thicker topsoil in cultivated areas.

Moderate to High Plasticity Clay

The soils on-site are primarily lean to fat clay of moderate to high plasticity. Lab tests indicate soil plasticity indices (PI) from 27 to 51. Soils with a PI of 35 or greater are considered to be highly plastic with a moderate shrink-swell potential. This is especially the case for soils that are prone to high changes in moisture content (primarily shallow/surface soils). Means to limit the risks associated with shrink-swell include control of moisture content during construction/ placement and proper site drainage. Our report addresses these controls.

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4 RECOMMENDATIONS

The following recommendations are provided to assist in the planning, design and construction of the project.

Karst Region Recommendations

As discussed previously, the site is in a “karst prone area”. The notes that follow (prior to section 4.1) should be considered for the planning and construction of the entire site. Levels of risk associated with Karst are difficult to assess, especially with our limited scope. So the Owner must assume that there is always a level of risk of sinkholes or soil dropouts which could cause damage to completed structures or pavements in any limestone karst area. The use of suitable precautionary measures can reduce this risk. Some of these measures include:

- Typically the risk of sinkhole drop-out formation is reduced in filled areas and increased in cut areas.
- Water flow considerations (both surface and subsurface) are a key factor to try to reduce Karst associated risks when planning. CETCO should be retained to assess civil plans of water flow to provide guidance with regards to potential increases to Karst risks.
- A simple way to assess near surface potential dropouts is to conduct a ***heavy and strict proofroll of all construction areas after clearing and topsoil removal***. Cut areas should be re-proofrolled after planned subgrade is reached.
- If a sinkhole/dropout is encountered, the most effective repair method is usually to excavate to bedrock, and then construct a suitable concrete "plug" or rock-fill filter over the bedrock opening. However, the geotechnical engineer should be consulted before performing any repairs.
- For highway/road cut areas, the karst features (including sinkholes) are typically completely filled with engineered materials (usually large, limestone quarried gravel-KyTC channel liner or #2 stone).
- Specific procedure used to repair drop-outs will depend on the specific condition encountered. The project geotechnical engineer should be contacted if drop-outs form or suspect old drop-outs are encountered.

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4.1 SITE PREPARATION

We recommend that site grading should take place between about late April to early November. Earthwork taking place outside this time period will likely encounter wet conditions and weather conditions that will provide little to no assistance with drying the soils. Additionally, the following bulleted items are critical to prepare the site for earthwork and additional construction.

- Topsoil and organic materials should be removed (stripped) from the construction area and all structural fill areas. These materials should be wasted from the site or used as topsoil in landscape areas;
- Areas ready to receive new fill should be proofolled with a loaded dump truck or similar equipment judged acceptable by CETCO;
- Proofrolling should not be performed on wet subgrade. If possible, perform proof rolls after suitable dry weather periods of time;
- Previous on-site pavement materials should be undercut and removed. The existing old fill materials may remain in-place if the materials pass a proofroll test;
- **Some undercutting of low-lying areas, especially during wet periods of the year, should be expected. The area also likely has "thicker" topsoil**;
- CETCO should determine amounts of undercutting (if any) for any area which pumps or ruts. CETCO should also determine acceptable backfill materials and backfill methods. In general any backfill should be accomplished in general accordance with section 4.2;
- Remove deleterious materials or materials that are unsuitable for use in supporting the overlying new fill. The backfill should be consistent with the requirements listed in section 4.2;
- CETCO should observe the proofrolling operations and make recommendations for any unstable or unsuitable conditions encountered.

4.2 EARTHWORK

Before new fill construction, representative samples should be obtained of the proposed fill material to determine the moisture-density and overall classification of the material. The tests also would assist in determining if the material is suitable for use as structural fill.

The turning lane addition varies in elevation from the shoulder, to the bottom of the ditch as a lower elevation and highest elevations along the embankment. We are providing the following

recommendations for any mass earthwork/filling. After the subgrade has been approved to receive new fill, the fill may commence with the following procedures and guidelines recommended:

Mass Earthwork

- Based on our observations and laboratory testing, the on-site soils appear to be suitable for use as structural fill;
- Fill placement guidelines:
    - Structural fill should be placed in maximum 8-inch thick loose lifts;
    - Maximum particle size of the soil should be limited to 8 inches in any dimension;
    - Materials should have a plasticity index (PI) of less than 35.
    - Some of the soils tested on-site exceeded this limit. Therefore, it should be assumed that some of the on-site soils (especially those deeper than about 2 feet) may not meet the requirement.
- Quality control testing guidelines:
    - Density testing of newly placed clay soils should be performed. The rate of testing should be at least 3 per lift and at least one per 10,000 square feet of soil placement. Soil should be compacted to at least **95 percent** of standard Proctor (ASTM D698) maximum dry density. **Moisture content should be from minus 1 to plus 3 percent of optimum moisture content (range is such due to moderately high plasticity of the on-site clay soils)**;
    - Soil should never be placed “dry” (dusty). CETCO should observe fill placement to determine acceptable soil moisture;
- Observation of fill “stability” is critical. The roller and earthwork equipment traversing over the new fill should be observed to document minimal movement occurs. This includes sheepsfoot roller action observed to ensure the compactor is “walking out” of each lift;
- CETCO should observe and document fill placement and compaction operations.

Backfill Construction

These materials are placed in more confined areas than mass earthwork materials and therefore cannot be placed in full compliance with the previous recommendations. The following are general recommendations for backfill areas:

- Gravel/granular materials are recommended for confined fill areas;
- Fill lift thicknesses will vary dependent on compaction equipment available and material types, but in no case should exceed 8 inches;
- For crushed stone/aggregate backfills in trenches or wall backfill, the lift thickness should not exceed 4 inches;
- Observation of stability and moisture should be similar to those mentioned previously;
- CETCO should provide addition recommendations for backfill.

Again, we recommend that site grading be started in the period from about late April to about November in order to prevent additional undercutting due to wet conditions. Drying of the site soils during other portions of the year is typically difficult.

Slopes

We have been provided with initial information on the overall project configuration. The exact slope locations and planned slope angles were not provided. We have anticipated a combination of soil and bedrock cut slopes with minimal fill slopes.

In general, we are recommending the following maximum slope angles:

- Soil: fill or cut slopes should be no steeper than 3H:1V.
- Bedrock cut slopes: cut slopes in limestone bedrock can be as steep as 1H:20V for slope heights of up to 10 feet. Taller slopes should be flattened to a maximum of 1H:5V (or flatter).
- Based on the site observations and elevations, slopes of 20 feet or taller or not anticipated.
- All slopes should comply with KyTC guidelines.

Site Drainage

Site drainage (water flow into, along and from the site) is key to minimize damaging effects of water flow. Excess water ponding can destabilize soils. Excessive water flow can erode soils and destabilize soils, especially at or near slopes.

For shallow groundwater seepage (less than 5 feet deep or so), the water encroaching upon construction excavations can be removed by placing a sump near the source of seepage and

then pumping from the sump. Should heavy seepage occur, or should there be evidence of soil particle migration such as silting of the sump, then the geotechnical engineer should be contacted.

The following are general guidelines for site drainage.

- For all earthwork operations, positive surface drainage is prudent to keep water from ponding on the surface and to assist in maintaining surface stability;
- The surface should be sealed prior to expected wet weather. This can usually be accomplished with rubber-tired construction equipment or a steel-drum roller;
- During construction, water should not be allowed to pond in excavations or undercutting will likely be required;
- During the life of the project, slope the subgrade and other site features so that surface water flows away from the site structures;
- Diversion ditches should be used at the toe of all slopes to keep surface water from accumulating at or near site structures;
- For excavations during construction, most free water from the subsurface conditions could likely be removed via sump pumps and open channel flow (ditches) at or near the source of seepage. However, if normal dewatering measures prove insufficient, CETCO should be retained to provide recommendations on the issue;

4.3 PAVEMENT RECOMMENDATIONS

Pavement (including the soil sub grade) should meet KyTC requirements for materials and workmanship/placement. Adequate soil/subgrade support is critical for any pavement area. Please refer the Earthwork section of this report for subgrade preparation. Prior to stone base placement we recommend an additional proofroll of the subgrade should be performed to verify subgrade conditions. Recommendations for undercutting/repair of the subgrade can be made at that time by CETCO.

Laboratory testing indicates CBR values of about 2 to 4 for on-site clayey soils. We have also assumed a 15 year life and conventional industrial traffic for turning lanes and the main entrance lanes. This includes about 30 to 50 tractor trailers per day.

NOTE: The laboratory testing also revealed plasticity indices of greater than 27 for all soil tested. This can exceed some KyTC allowable limits. One means to lower the plasticity of in-place soils is lime treatment. CETCO can provide in-depth recommendations for lime

modifications, if desired. For the basis of planning, it is anticipated that at least 4% lime addition would be needed to lower the plasticity to acceptable levels (based on experience with similar clay soils. Also, this would include the upper 16 inches of site soils.

Adequate drainage and slope of the pavement subgrade and pavement section should be provided to promote adequate drainage. Edges of the pavement should be provided a means of water outlet by extending the aggregate base course through to side ditches or providing drain pipes and weep holes at catch basin walls.

The recommended pavement section includes:

- For the turning lanes and extending into the project site to the edge of the KyTC right of way, the total thickness shall be the thicker of the following:
    - The turn lanes shall match the existing pavement section (as a minimum thickness), including gravel base and asphalt, or;
    - 1.5 inches surface asphalt, over 6 inches base asphalt, over 12 inches compacted KyTC DGA aggregate.
    - If a thinner section is desired, the sub grade will require stabilization. CETCO can provide that alternative, as needed.
- For the remainder of the entrance road, the traffic will be limited to only industrial park type traffic (i.e., non-KyTC design limits). The total thickness shall be:
    - 1.5 inches of surface asphalt, over 4.5 inches of base asphalt, over 10 inches of compacted DGA.

4.4 POST-REPORT GEOTECHNICAL CONSULTING

CETCO services as “geotechnical engineer of record” include answering questions pertaining to the materials presented in this report and the appendix. However, if conditions arise during construction that are different than those encountered during our exploration or if additional recommendations are needed, CETCO should be retained to provide that guidance. Construction observation and testing are beyond the typical scope of the geotechnical engineer, but are essential to completing the geotechnical engineer’s anticipated completion of their recommendations. CETCO should always be contracted as the testing/inspection firm for any project that applies their geotechnical report information. This always saves time, risk and project costs.

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5 NOTES ON THE REPORT

The assessment of site environmental conditions or the presence of contaminants in the soil, rock, surface water or groundwater of the site was beyond the scope of this exploration.

The recommendations provided are based in part on project information provided to us and they only apply to the specific project and site discussed in this report. If the project information section in this report contains incorrect information or if additional information is available, you should convey the correct or additional information to us and retain us to review our recommendations. We can then modify our recommendations if they are inappropriate for the proposed project.

Regardless of the thoroughness of a geotechnical exploration, there is always a possibility that conditions between borings/test pits will be different from those at specific boring/test pit locations and that conditions will not be as anticipated by the designers or contractors. In addition, the construction process may itself alter soil conditions. Therefore, experienced geotechnical personnel should observe and document the construction procedures used and the conditions encountered. Unanticipated conditions and inadequate procedures should be reported to the design team along with timely recommendations to solve the problems created. We recommend that the owner retain CETCO to provide this service based upon our familiarity with the project, the subsurface conditions and the intent of the recommendations.

We recommend that this complete report be provided to the various design team members, the contractors and the project owner. Potential contractors should be informed of this report in the "instructions to bidders" section of the bid documents. The report should not be included or referenced in the actual contract documents.

We wish to remind you that our exploration services include storing the samples collected and making them available for inspection for 30 days. The samples are then discarded unless you request otherwise.

APPENDIX

SITE LOCATION PLAN
BORING LOCATION PLAN
TEST BORING LOGS
FIELD STANDARDS
LABORATORY TESTING
LABORATORY STANDARDS

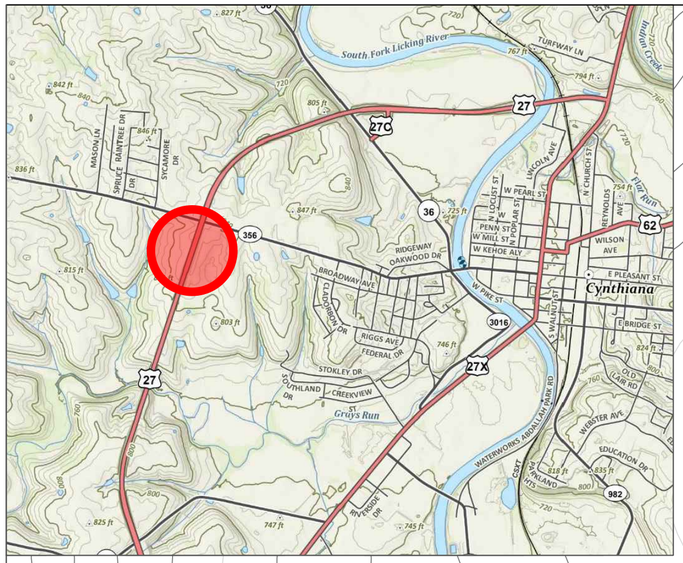

Photo adapted from KGS, with further adaptations from CETCO. The general site location is shown in the red circle

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Drawn By: Hunter Hawkins

Checked By: Joe Cooke, PE

Drawing No: 1 of 1

Project No: 4110-24-0102

Date: 02/26/25

Scale: Not to Scale

SITE PLAN

US-27 Turning Lane Additions
Cynthiana, Kentucky

G-2

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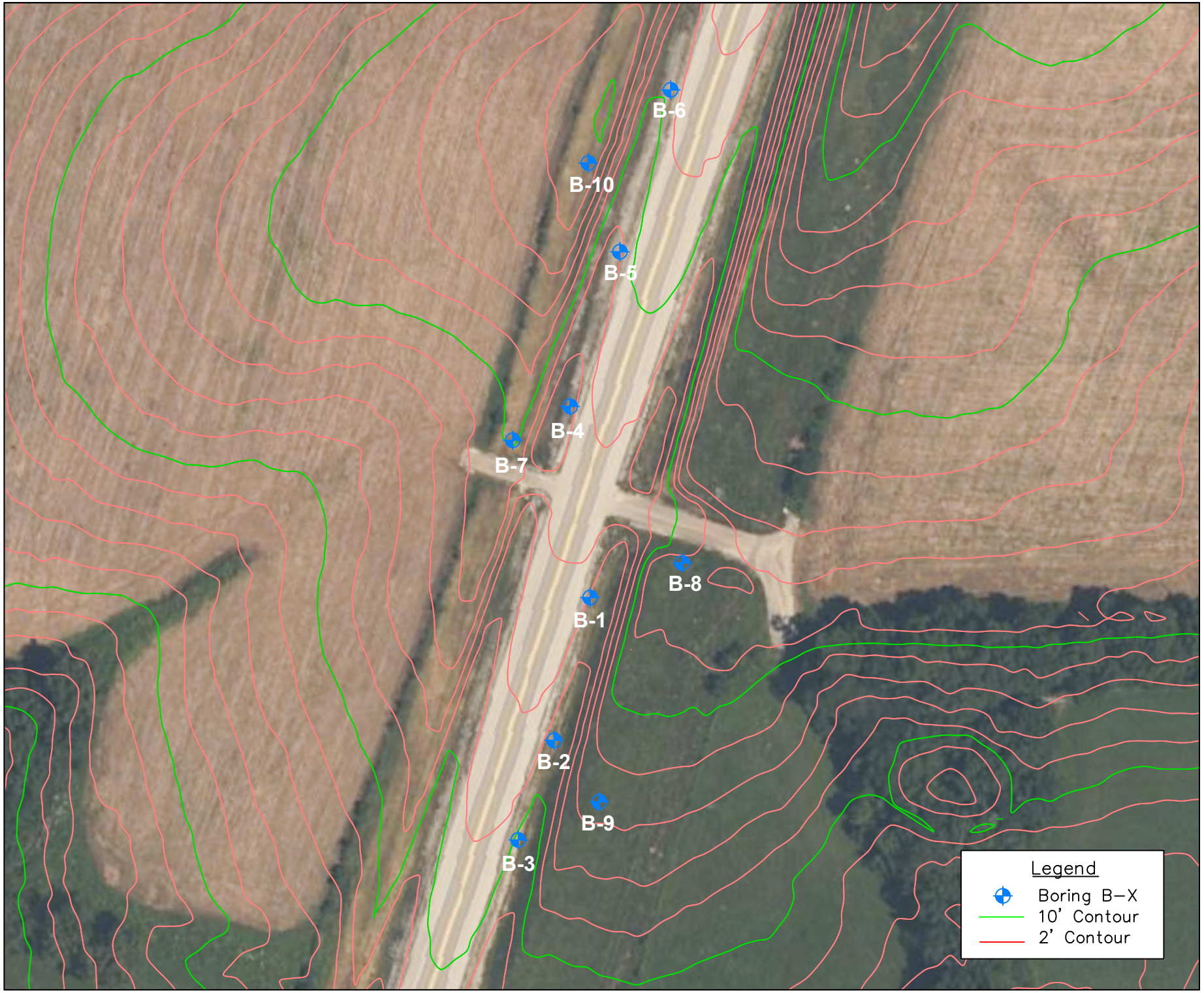

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Boring Location Plan

US-27 Turning Lane Addition
Cynthiana, KY

Project No: 4110-24-0102	Date: 02/28/25	Scale: NTS
Drawn By: Mason Ross	Checked By: Joe Cooke, PE	Drawing No: 1 of 1

G-1

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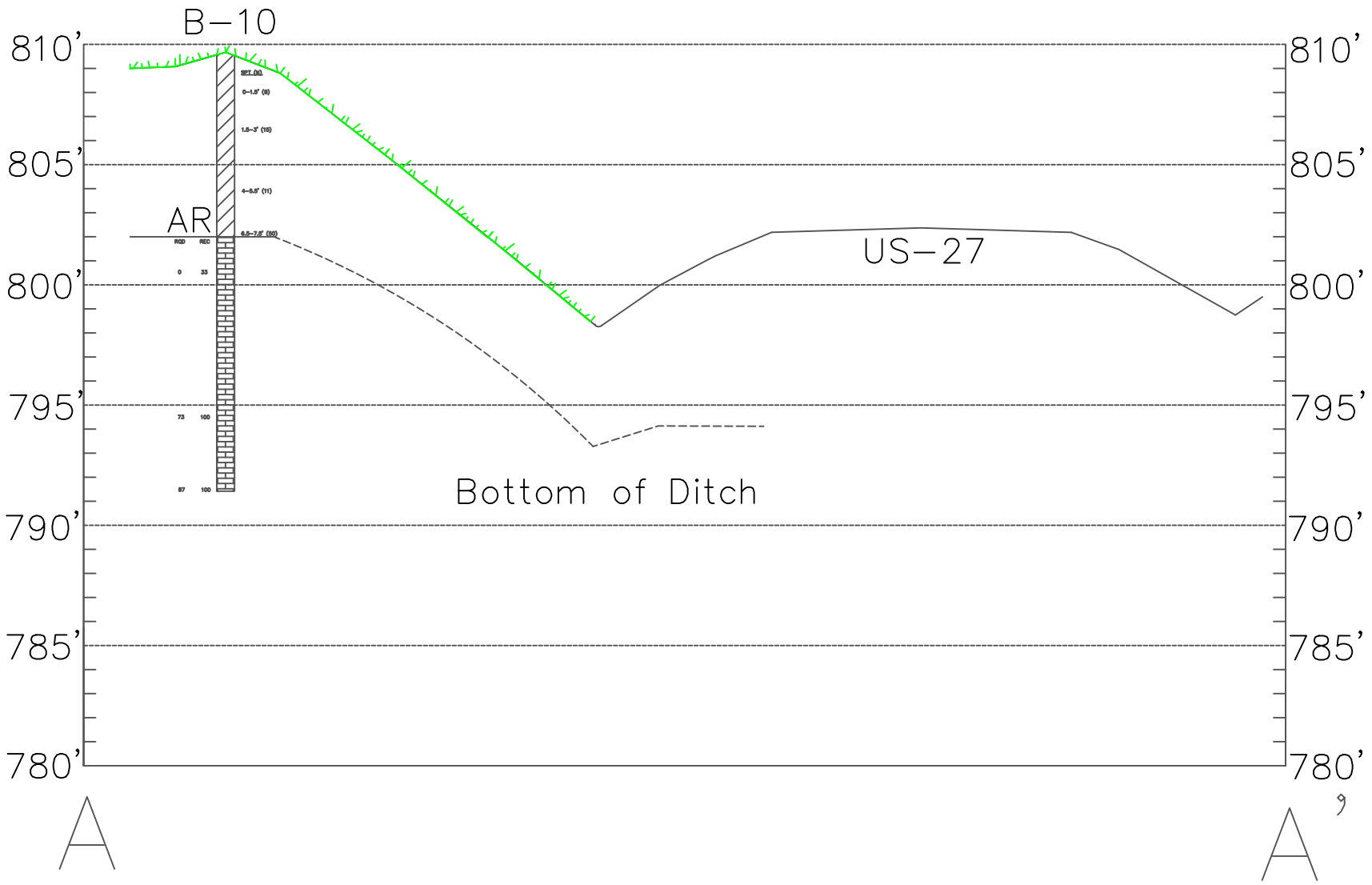

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Drawn By: Mason Ross
Checked By: Joe Cooke, PE
Drawing No: 1 of 1

Project No: 4110–24–0102
Date: 02/28/25
Verticle Scale: As Shown
Horizontal Scale:NTS

Slope Cross Sections: A–A’

US–27 Turning Lane Addition
Cynthiana, KY

G–3

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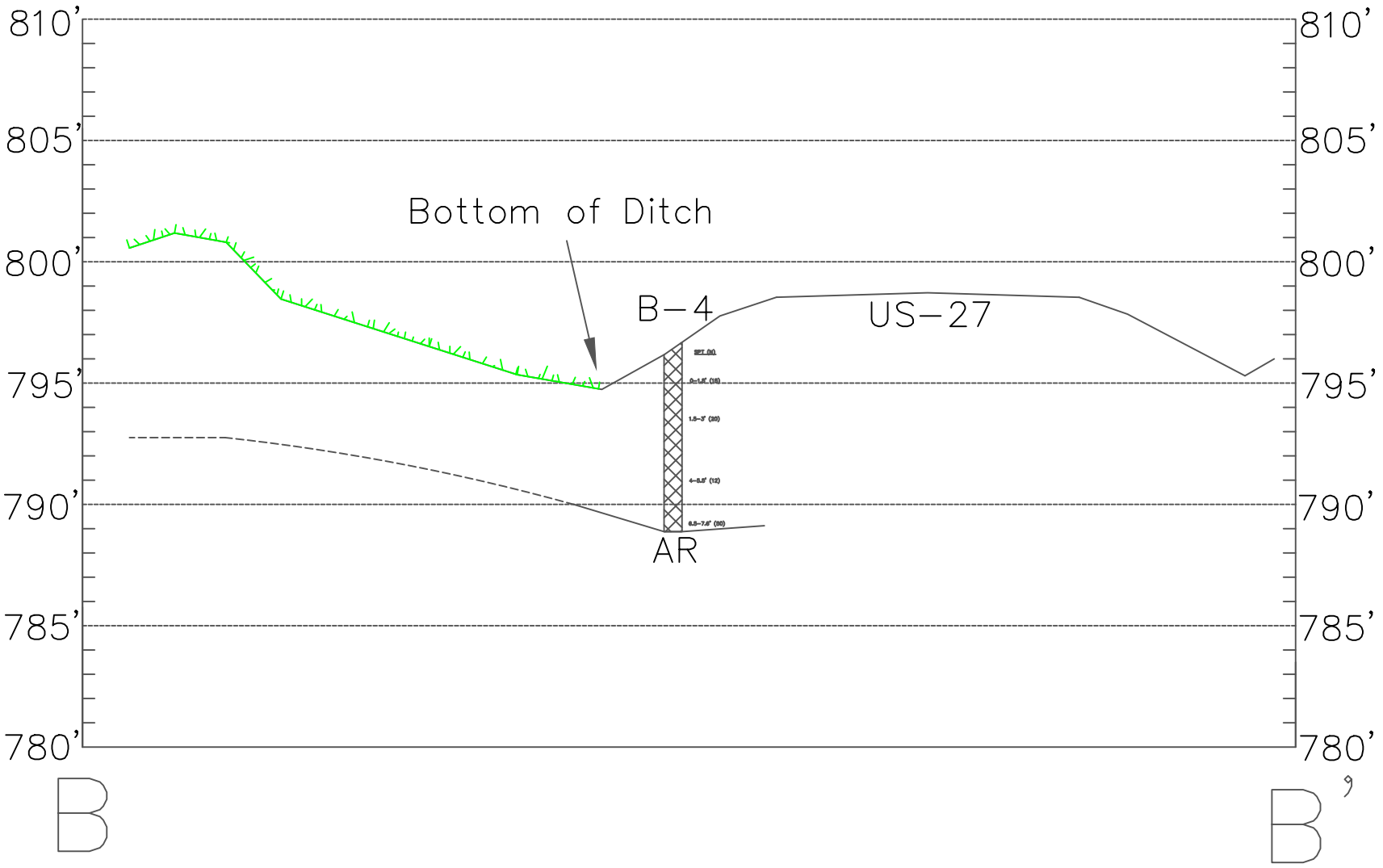

Legend

- Grass
- Residual Clay Overburden
- Fill Overburden
- Assumed Top of Bedrock Surface
- Limestone

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Drawn By: Mason Ross
Checked By: Joe Cooke, PE
Drawing No: 1 of 1

Project No: 4110–24–0102
Date: 02/28/25
Verticle Scale: As Shown
Horizontal Scale:NTS

Slope Cross Sections: B–B’

US–27 Turning Lane Addition
Cynthiana, KY

G–4

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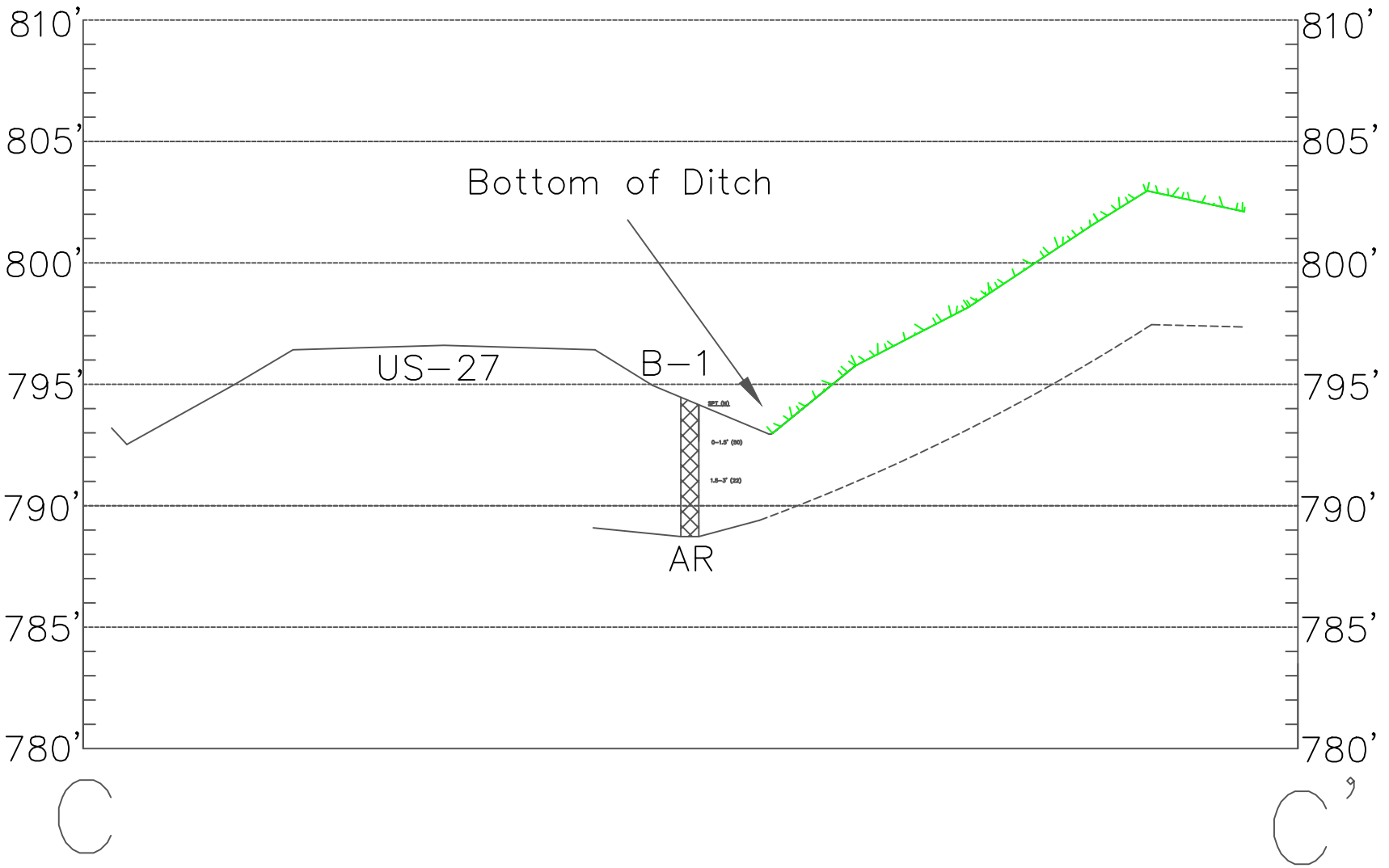

Legend

- Grass
- Residual Clay Overburden
- Fill Overburden
- Assumed Top of Bedrock Surface
- Limestone

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Drawing No: 1 of 1

Project No: 4110–24–0102
Date: 02/28/25
Verticle Scale: As Shown
Horizontal Scale:NTS

Slope Cross Sections: C–C’

US–27 Turning Lane Addition
Cynthiana, KY

G–5

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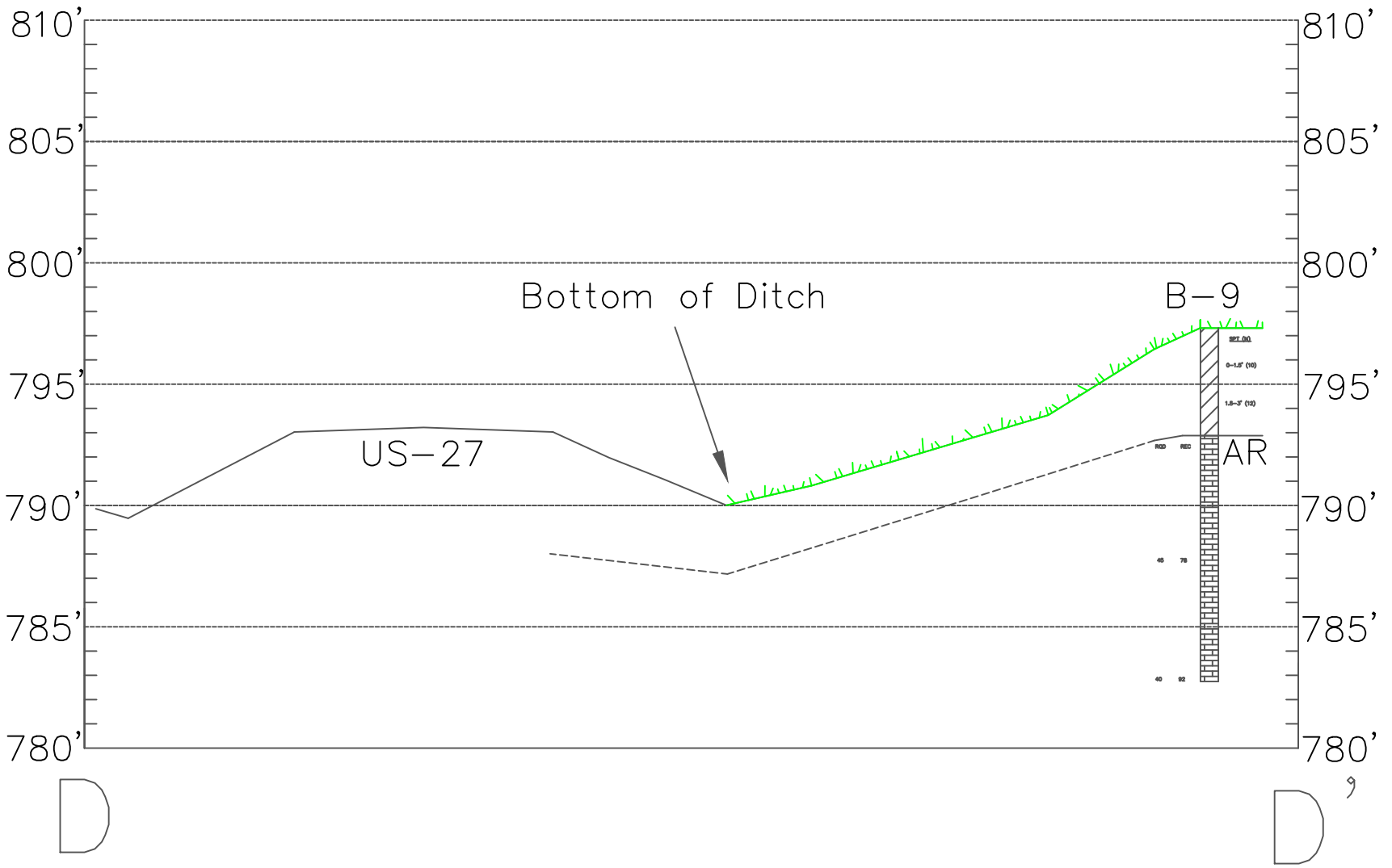

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Drawn By: Mason Ross
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Drawing No: 1 of 1

Project No: 4110-24-0102
Date: 02/28/25
Verticle Scale: As Shown
Horizontal Scale:NTS

Slope Cross Sections: D-D'

US-27 Turning Lane Addition
Cynthiana, KY

G-6

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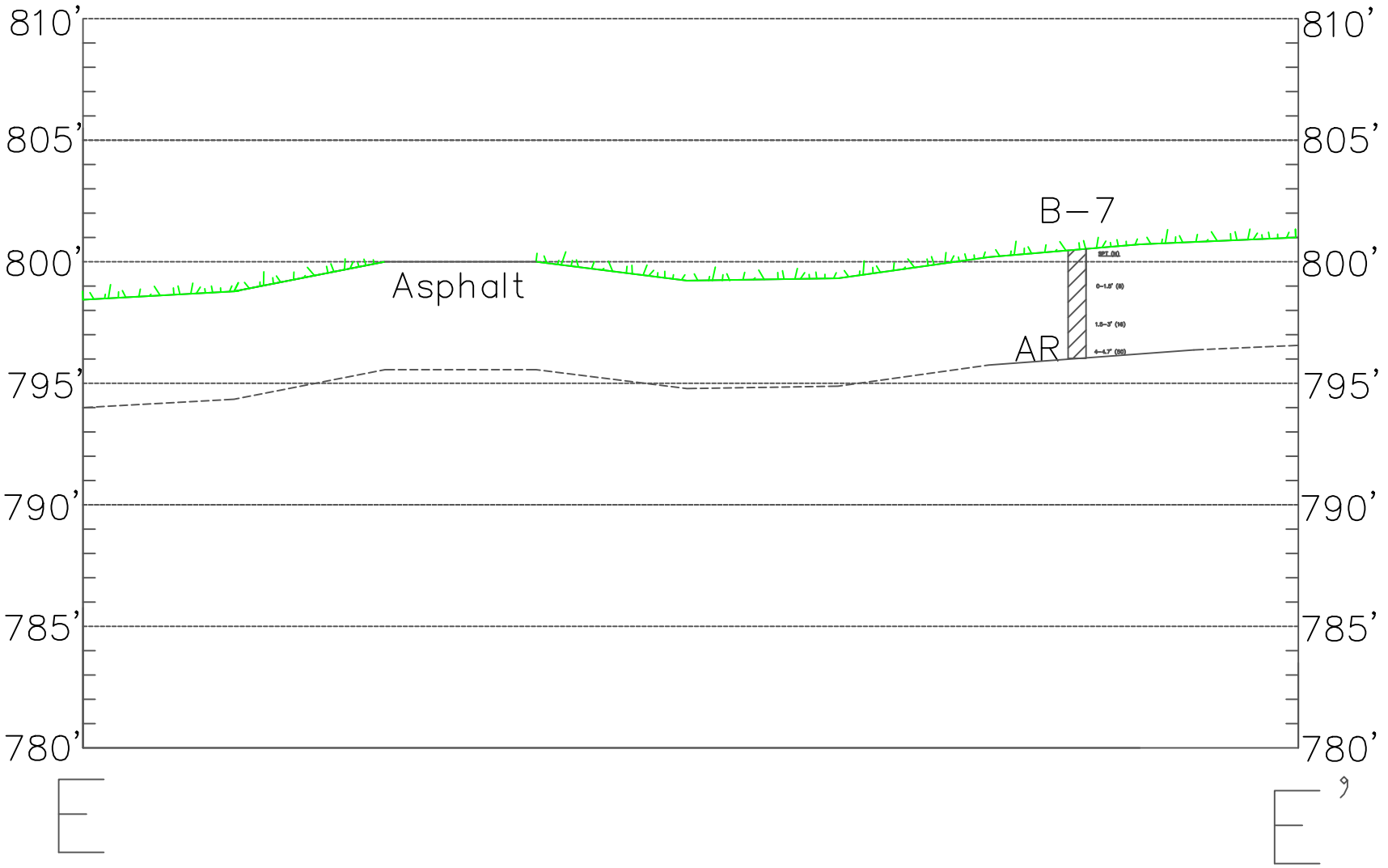

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Checked By: Joe Cooke, PE
Drawing No: 1 of 1

Project No: 4110–24–0102
Date: 02/28/25
Verticle Scale: As Shown
Horizontal Scale:NTS

Slope Cross Sections: E–E’

US–27 Turning Lane Addition
Cynthiana, KY

G–7

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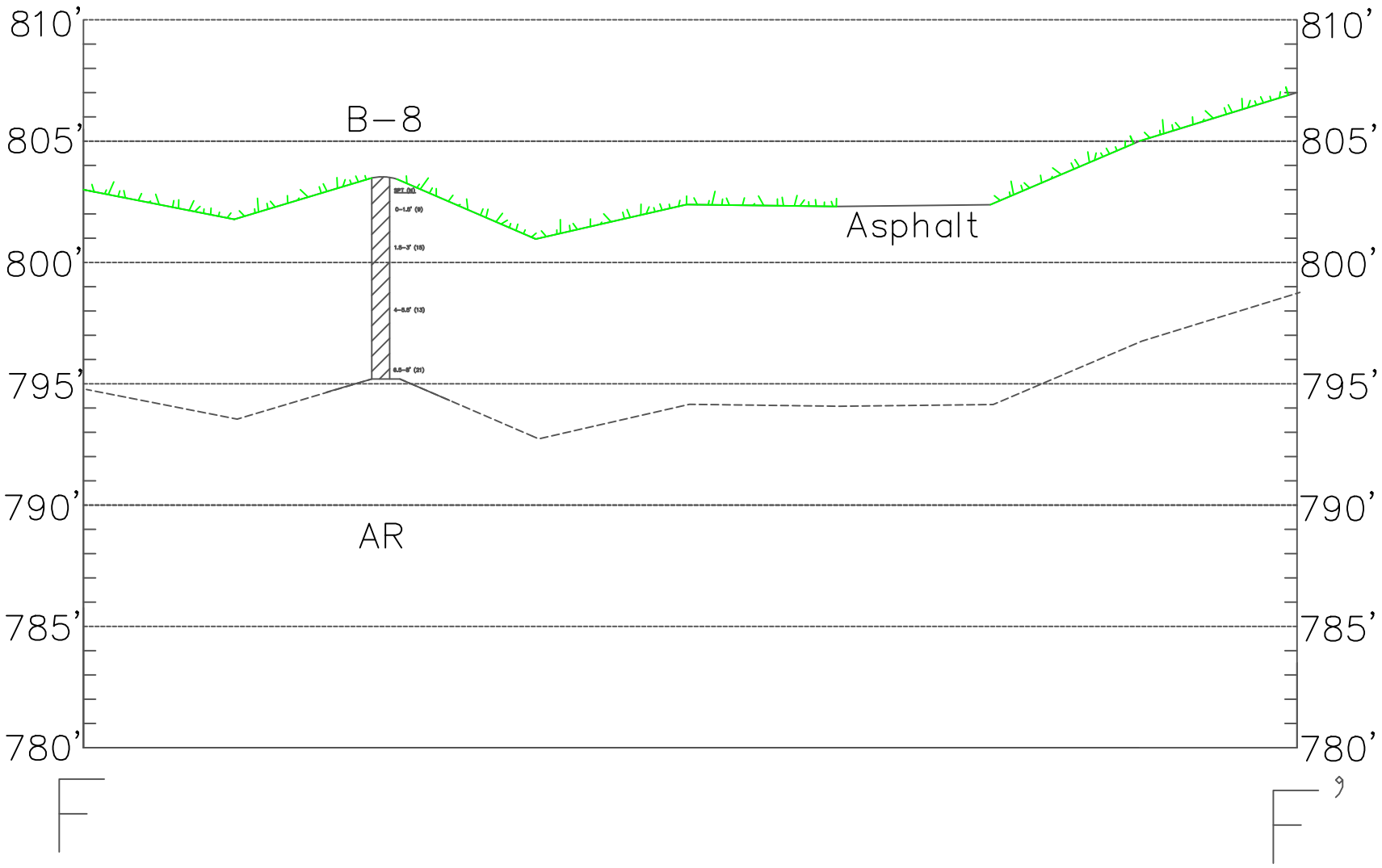

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Drawn By: Mason Ross
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Drawing No: 1 of 1

Project No: 4110–24–0102
Date: 02/28/25
Verticle Scale: As Shown
Horizontal Scale:NTS

Slope Cross Sections: F–F’

US–27 Turning Lane Addition
Cynthiana, KY

G–8

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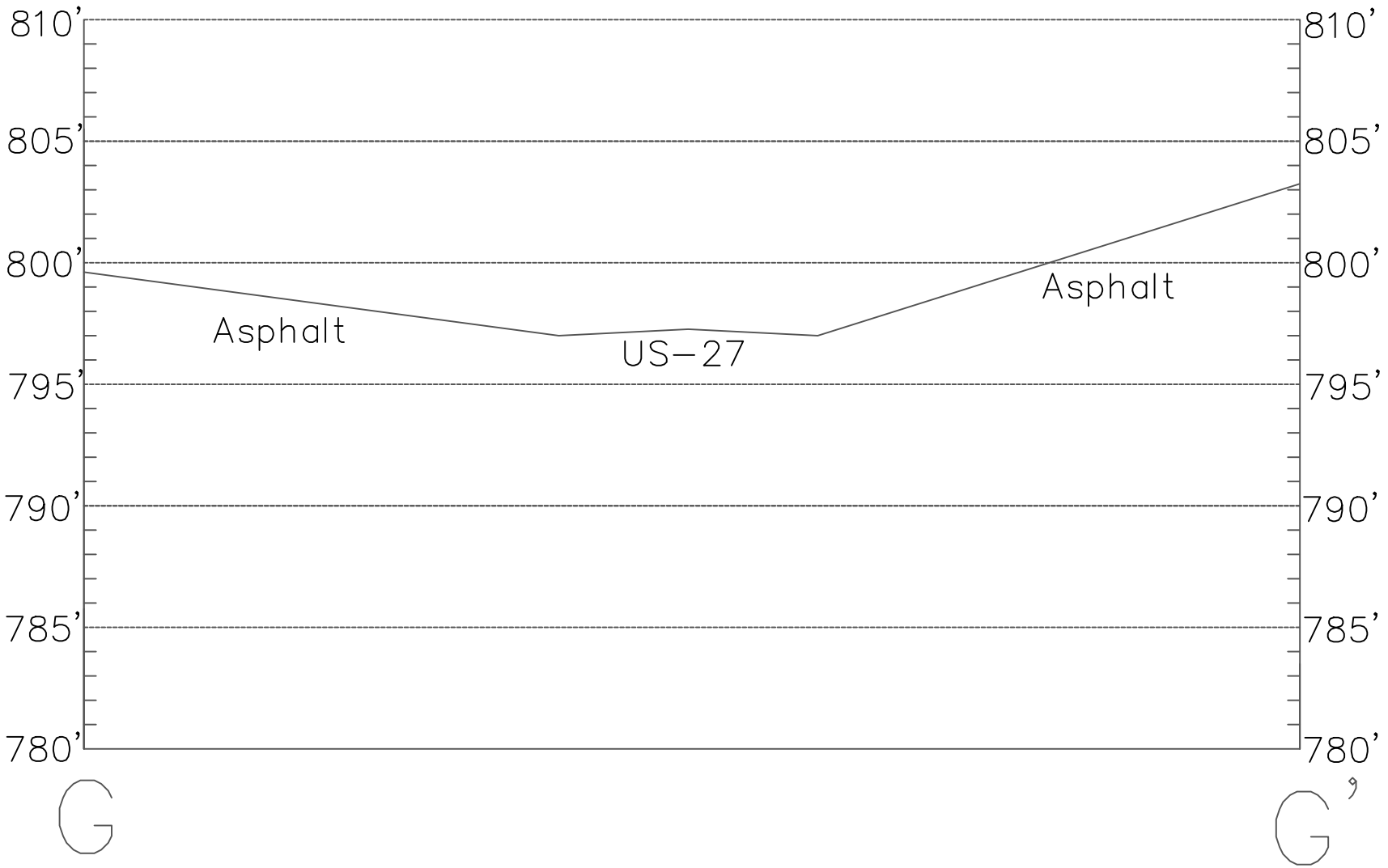

Legend

- Grass
- Residual Clay Overburden
- Fill Overburden
- Assumed Top of Bedrock Surface
- Limestone

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Drawn By: Mason Ross
Checked By: Joe Cooke, PE
Drawing No: 1 of 1

Project No: 4110–24–0102
Date: 02/28/25
Verticle Scale: As Shown
Horizontal Scale: NTS

Slope Cross Sections: G–G’

US–27 Turning Lane Addition
Cynthiana, KY

G–9

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Telephone: 859-475-3933

BORING NUMBER B-1

CLIENT Cynthiana - Harrison County EDA
PROJECT NAME Cynthiana 60 Acre Site
PROJECT NUMBER 4110-24-0102
PROJECT LOCATION Cynthiana, KY
DATE STARTED 2/17/25 **COMPLETED** 2/17/25
GROUND ELEVATION 795 ft **HOLE SIZE** 4"
DRILLING CONTRACTOR Strata Group
GROUND WATER LEVELS:
DRILLING METHOD Solid Flight Auger
AT TIME OF DRILLING ---
LOGGED BY Hunter Hawkins **CHECKED BY** Joe Cooke, PE
AT END OF DRILLING --- Dry upon completion of drilling
NOTES Sunny, 20's
AFTER DRILLING ---

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	▲ SPT N VALUE ▲ 20 40 60 80 / PL MC LL 20 40 60 80 / ☐ FINES CONTENT (%) ☐ 20 40 60 80
0.0		Previously Placed FILL: Mostly DGA with trace brown clay, moist to very moist, HARD	SPT S-1	64	5-11-50/2"			>>
2.5			SPT S-2	83	5-9-13 (22)			
		Previously Placed FILL: Grayish brown clay with some gravel, very moist to wet, VERY STIFF						
5.0		Rocky gravel zone						
		Weathered LIMESTONE						

Refusal at 6.4 feet.
Bottom of borehole at 6.4 feet.

GEOTECH BH PLOTS - GINT STD US.GDT - 3/6/25 11:51 - C:\USERS\PUBLIC\DOCUMENTS\BENTLEY\GINTCL\PROJECTS\CYNTHIANA TURNING LANE ADDITION.GPJ

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BORING NUMBER B-2

CLIENT Cynthiana - Harrison County EDA
PROJECT NAME Cynthiana 60 Acre Site
PROJECT NUMBER 4110-24-0102
PROJECT LOCATION Cynthiana, KY
DATE STARTED 2/17/25 **COMPLETED** 2/17/25
GROUND ELEVATION 791 ft **HOLE SIZE** 4"
DRILLING CONTRACTOR Strata Group
GROUND WATER LEVELS:
DRILLING METHOD Solid Flight Auger
AT TIME OF DRILLING ---
LOGGED BY Hunter Hawkins **CHECKED BY** Joe Cooke, PE
AT END OF DRILLING --- Dry upon completion of drilling
NOTES Sunny, 20's
AFTER DRILLING ---

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	▲ SPT N VALUE ▲ 20 40 60 80 / PL MC LL 20 40 60 80 / ☐ FINES CONTENT (%) ☐ 20 40 60 80
0.0		Previously Placed FILL: DGA with some brown clay, very moist, VERY STIFF	SPT S-1	67	4-7-9 (16)			▲
2.5		Rocky gravel zone	SPT S-2	17	5-50			
		Weathered LIMESTONE						

Refusal at 3.0 feet.
Bottom of borehole at 3.0 feet.

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BORING NUMBER B-3

CLIENT Cynthiana - Harrison County EDA
PROJECT NAME Cynthiana 60 Acre Site
PROJECT NUMBER 4110-24-0102
PROJECT LOCATION Cynthiana, KY
DATE STARTED 2/17/25 **COMPLETED** 2/17/25
GROUND ELEVATION 790 ft **HOLE SIZE** 4"
DRILLING CONTRACTOR Strata Group
GROUND WATER LEVELS:
DRILLING METHOD Solid Flight Auger
AT TIME OF DRILLING ---
LOGGED BY Hunter Hawkins **CHECKED BY** Joe Cooke, PE
AT END OF DRILLING --- Dry upon completion of drilling
NOTES Sunny, 20's
AFTER DRILLING ---

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	▲ SPT N VALUE ▲ 20 40 60 80 / PL MC LL 20 40 60 80 / ☐ FINES CONTENT (%) ☐ 20 40 60 80
0.0		Previously Placed FILL: Mostly DGA with some brown clay, moist, STIFF	SPT S-1	78	4-4-8 (12)			
2.5		Previously Placed FILL: Grayish brown clay with some gravel, very moist to wet, VERY STIFF	SPT S-2	67	3-6-9 (15)			
		Weathered LIMESTONE						

Refusal at 3.5 feet.
Bottom of borehole at 3.5 feet.

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BORING NUMBER B-4

CLIENT Cynthiana - Harrison County EDA
PROJECT NAME Cynthiana 60 Acre Site
PROJECT NUMBER 4110-24-0102
PROJECT LOCATION Cynthiana, KY
DATE STARTED 2/17/25 **COMPLETED** 2/17/25
GROUND ELEVATION 796 ft **HOLE SIZE** 4"
DRILLING CONTRACTOR Strata Group
GROUND WATER LEVELS:
DRILLING METHOD Solid Flight Auger
AT TIME OF DRILLING ---
LOGGED BY Hunter Hawkins **CHECKED BY** Joe Cooke, PE
AT END OF DRILLING --- Dry upon completion of drilling
NOTES Sunny, 20's
AFTER DRILLING ---

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)
0.0		Previously Placed FILL: Mostly DGA with trace brown clay, moist to very moist, HARD	SPT S-1	78	5-7-8 (15)		
			SPT S-2	89	5-9-11 (20)		
2.5		Previously Placed FILL: Grayish brown clay with some gravel, very moist to wet, VERY STIFF	SPT S-3	56	5-6-6 (12)		
5.0			SPT S-4	108	5-50		
7.5		Weathered LIMESTONE					

Refusal at 7.6 feet.
Bottom of borehole at 7.6 feet.

▲ SPT N VALUE ▲
20 40 60 80
PL MC LL
20 40 60 80
☐ FINES CONTENT (%) ☐
20 40 60 80

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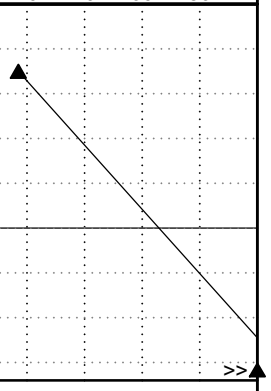
BORING NUMBER B-5

CLIENT Cynthiana - Harrison County EDA
PROJECT NAME Cynthiana 60 Acre Site
PROJECT NUMBER 4110-24-0102
PROJECT LOCATION Cynthiana, KY
DATE STARTED 2/17/25 **COMPLETED** 2/17/25
GROUND ELEVATION 799 ft **HOLE SIZE** 4"
DRILLING CONTRACTOR Strata Group
GROUND WATER LEVELS:
DRILLING METHOD Solid Flight Auger
AT TIME OF DRILLING ---
LOGGED BY Hunter Hawkins **CHECKED BY** Joe Cooke, PE
AT END OF DRILLING --- Dry upon completion of drilling
NOTES Sunny, 20's
AFTER DRILLING ---

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)
0.0		Previously Placed FILL: Mostly DGA with trace brown clay, moist to very moist, HARD	SPT S-1	78	4-8-9 (17)		
2.5		Weathered LIMESTONE	SPT S-3	100	50/2"		
		Refusal at 4.2 feet. Bottom of borehole at 4.2 feet.					

▲ SPT N VALUE ▲
20 40 60 80
PL MC LL
20 40 60 80
☐ FINES CONTENT (%) ☐
20 40 60 80



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BORING NUMBER B-6

CLIENT Cynthiana - Harrison County EDA
PROJECT NAME Cynthiana 60 Acre Site
PROJECT NUMBER 4110-24-0102
PROJECT LOCATION Cynthiana, KY
DATE STARTED 2/17/25 **COMPLETED** 2/17/25
GROUND ELEVATION 802 ft **HOLE SIZE** 4"
DRILLING CONTRACTOR Strata Group
GROUND WATER LEVELS:
DRILLING METHOD Solid Flight Auger
AT TIME OF DRILLING ---
LOGGED BY Hunter Hawkins **CHECKED BY** Joe Cooke, PE
AT END OF DRILLING --- Dry upon completion of drilling
NOTES Sunny, 20's
AFTER DRILLING ---

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)
0.0		Previously Placed FILL: Mostly DGA with trace brown clay, moist to very moist, HARD	SPT S-1	67	3-6-9 (15)		
			SPT S-2	79	11-13-50/2"		
2.5		Rocky gravel zone					
		Weathered LIMESTONE					

Refusal at 4.0 feet.
Bottom of borehole at 4.0 feet.

▲ SPT N VALUE ▲
20 40 60 80
PL MC LL
20 40 60 80
☐ FINES CONTENT (%) ☐
20 40 60 80

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BORING NUMBER B-7

CLIENT Cynthiana - Harrison County EDA
PROJECT NAME Cynthiana 60 Acre Site
PROJECT NUMBER 4110-24-0102
PROJECT LOCATION Cynthiana, KY
DATE STARTED 2/17/25 **COMPLETED** 2/17/25
GROUND ELEVATION 801 ft **HOLE SIZE** 4"
DRILLING CONTRACTOR Strata Group
GROUND WATER LEVELS:
DRILLING METHOD Solid Flight Auger
AT TIME OF DRILLING ---
LOGGED BY Hunter Hawkins **CHECKED BY** Joe Cooke, PE
AT END OF DRILLING --- Dry upon completion of drilling
NOTES Sunny, 20's
AFTER DRILLING ---

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)
0.0		TOPSOIL (3")					
		Brown LEAN CLAY (CL), with few black oxides and trace fine organics, moist, FIRM	SPT S-1	100	4-4-4 (8)		
		Dark brown LEAN to FAT CLAY (CL-CH), with few black oxides, moist, STIFF					
2.5		Brown FAT CLAY (CH), moist, VERY STIFF	SPT S-2	78	5-7-9 (16)		
		Weathered LIMESTONE	SPT S-3	100	50/3"		

▲ SPT N VALUE ▲
20 40 60 80
PL MC LL
20 40 60 80
☐ FINES CONTENT (%) ☐
20 40 60 80

Refusal at 4.7 feet.
Bottom of borehole at 4.7 feet.

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BORING NUMBER B-8

CLIENT Cynthiana - Harrison County EDA
PROJECT NAME Cynthiana 60 Acre Site
PROJECT NUMBER 4110-24-0102
PROJECT LOCATION Cynthiana, KY
DATE STARTED 2/17/25 **COMPLETED** 2/17/25
GROUND ELEVATION 804 ft **HOLE SIZE** 4"
DRILLING CONTRACTOR Strata Group
GROUND WATER LEVELS:
DRILLING METHOD Solid Flight Auger
AT TIME OF DRILLING ---
LOGGED BY Hunter Hawkins **CHECKED BY** Joe Cooke, PE
AT END OF DRILLING --- Dry upon completion of drilling
NOTES Sunny, 20's
AFTER DRILLING ---

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)
0.0		TOPSOIL (6")					
		Brown LEAN CLAY (CL), with few black oxides and some fine organics, moist, STIFF	SPT S-1	100	5-4-5 (9)		
2.5		Brown LEAN to FAT CLAY (CL-CH), with trace fine organics and few black oxides, moist, STIFF	SPT S-2	61	3-6-9 (15)		
5.0		Brown LEAN to FAT CLAY (CL-CH), with many black oxides, moist, STIFF	SPT S-3	100	5-6-7 (13)		
		Light brown to brown FAT CLAY (CH),with few black oxides and trace limestone gravel lenses, moist, VERY STIFF					
7.5			SPT S-4	100	5-9-12 (21)		
		Weathered LIMESTONE					

Refusal at 8.9 feet.
Bottom of borehole at 8.9 feet.

▲ SPT N VALUE ▲
20 40 60 80
PL MC LL
20 40 60 80
☐ FINES CONTENT (%) ☐
20 40 60 80

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BORING NUMBER B-9

CLIENT Cynthiana - Harrison County EDA
PROJECT NAME Cynthiana 60 Acre Site
PROJECT NUMBER 4110-24-0102
PROJECT LOCATION Cynthiana, KY
DATE STARTED 2/18/25 **COMPLETED** 2/18/25
GROUND ELEVATION 797 ft **HOLE SIZE** 4"
DRILLING CONTRACTOR Strata Group
GROUND WATER LEVELS:
DRILLING METHOD Solid Flight Auger
AT TIME OF DRILLING ---
LOGGED BY Hunter Hawkins **CHECKED BY** Joe Cooke, PE
AT END OF DRILLING --- Dry upon completion of drilling
NOTES Cloudy, Snow, 20's
AFTER DRILLING ---

DEPTH (ft)	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)
0.0	TOPSOIL (6")					
	Brown LEAN CLAY (CL), with few black oxides and fine organics, moist, STIFF	SPT S-1	83	3-4-6 (10)		
	Brown LEAN to FAT CLAY (CL-CH), with trace black oxides and fine organics, moist, STIFF	SPT S-2	89	3-5-7 (12)		
2.5	Rocky gravel zone					
	Weathered LIMESTONE					
5.0	Gray LIMESTONE, with few mudseams, coarsely crystalline, MODERATELY HARD	RC C-1	78 (45)			
7.5						
10.0		RC C-2	92 (40)			
12.5						

▲ SPT N VALUE ▲
20 40 60 80
PL MC LL
20 40 60 80
☐ FINES CONTENT (%) ☐
20 40 60 80

Refusal at 4.7 feet.
Bottom of borehole at 14.7 feet.

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CETCO
624 Wellington Way
Lexington, KY 40503
Telephone: 859-475-3933

BORING NUMBER B-10

CLIENT Cynthiana - Harrison County EDA
PROJECT NAME Cynthiana 60 Acre Site
PROJECT NUMBER 4110-24-0102
PROJECT LOCATION Cynthiana, KY
DATE STARTED 2/18/25 **COMPLETED** 2/18/25
GROUND ELEVATION 810 ft **HOLE SIZE** 4"
DRILLING CONTRACTOR Strata Group
GROUND WATER LEVELS:
DRILLING METHOD Solid Flight Auger
AT TIME OF DRILLING ---
LOGGED BY Hunter Hawkins **CHECKED BY** Joe Cooke, PE
AT END OF DRILLING --- Dry upon completion of drilling
NOTES Cloudy, Snow, 20's
AFTER DRILLING ---

DEPTH (ft)	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)
0.0	TOPSOIL (5")					
	Dark brown LEAN CLAY (CL), with few organics, moist, FIRM	SPT S-1	100	3-4-4 (8)		
	Brown LEAN to FAT CLAY (CL-CH), with some black oxides, moist, STIFF	SPT S-2	89	3-7-8 (15)		
2.5	Brown FAT CLAY (CH), with some black oxides, moist, STIFF					
	Light brown FAT CLAY (CH), with many black oxides, moist, VERY STIFF	SPT S-3	89	5-5-6 (11)		
5.0						
7.5	Weathered LIMESTONE	SPT S-4	75	10-50		
	Gray LIMESTONE, with few mudseams and trace quartz includsions, fine to coarsely crystalline, MODERATELY HARD	RC C-1	33 (0)			
10.0		RC C-2	100 (73)			
12.5						
15.0						

▲ SPT N VALUE ▲
20 40 60 80
PL MC LL
20 40 60 80
☐ FINES CONTENT (%) ☐
20 40 60 80

(Continued Next Page)

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CETCO
624 Wellington Way
Lexington, KY 40503
Telephone: 859-475-3933

BORING NUMBER B-10

CLIENT Cynthiana - Harrison County EDA **PROJECT NAME** Cynthiana 60 Acre Site

PROJECT NUMBER 4110-24-0102 **PROJECT LOCATION** Cynthiana, KY

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	▲ SPT N VALUE ▲ 20 40 60 80 / PL MC LL 20 40 60 80 / ☐ FINES CONTENT (%) ☐ 20 40 60 80
15.0								
		Gray LIMESTONE, with few mudseams and trace quartz includsions, fine to coarsely crystalline, MODERATELY HARD *(continued)*	RC C-3	100 (87)				
17.5								

Refusal at 7.5 feet.
Bottom of borehole at 17.9 feet.

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Cooke Engineering and Testing Company

Laboratory Testing Summary Table

Project Name:	Cynthiana-Harrison Co Turning Lanes	Date:	March 12, 2025
Project Location:	Cynthiana, Kentucky	Reviewed by:	Joe Cooke, PE
Client:	Cynthiana-Harrison Co EDA	CETCO Project Number:	4110-25-0102

Sample ID	Depth (ft)	Natural Moisture Content (%)	Liquid Limit	Plastic Limit	Percent Passing #200 (%)	CBR	Maximum Dry Density (pcf)	Optimum Moisture Content (%)
P-1	0.5-4.0	34.0	82	35	92.7	2.2	96.7	25.2
P-2	1.0-5.0	35.0	84	33	94.9	4.2	95.1	26.1
B-1	2.5-4.0	19.1						
B-2	0.0-1.5	19.4						
B-3	1.5-3.0	5.2*						
B-4	1.5-3.0	12.9*						
B-4	4.0-5.5	9.6*						
B-4	6.5-7.5	11.7*						
B-5	4.0-4.1	7.1*						
B-6	1.5-3.0	11.9*						
B-7	0.0-1.5	33.8						
B-7	1.5-3.0	31.8	68	29	94.4			
B-7	4.0-4.2	27.8						
B-8	0.0-1.5	25.2						
B-8	1.5-3.0	35.1						
B-8	4.0-5.5	29.4						
B-8	6.5-8.0	19.4	50	23	58.6			
B-10	1.5-3.0	28.8						
B-10	4.0-5.5	39.3						
B-10	6.5-7.5	36.0						

*Sample was mostly gravel/rock

Cooke Engineering and Testing Company

Atterberg Limits Chart

Project Name:	Cynthiana-Harrison Co. Turning Lanes	Date:	March 12, 2025
Project Location:	Cynthiana, Kentucky	Reviewed by:	Joe Cooke, PE
Client:	Cynthiana-Harrison Co EDA	CETCO Project Number:	4110-25-0102
		"Atterberg Limits", ASTM D4318	

Sample ID	Depth (ft)	Natural Moisture Content (%)	Liquid Limit	Plastic Limit	Plasticity Index	% Finer than #200 Sieve
P-1, 0.5'-4' ▲	0.5-4.0	34.0	82	35	47	92.7
P-2, 1'-5' ★	1.0-5.0	35.0	84	33	51	94.9
B-7, 1.5'-3' ◆	1.5-3.0	31.8	68	29	39	94.4
B-8, 6.5'-8' ▼	6.5-8.0	19.4	50	23	27	58.6

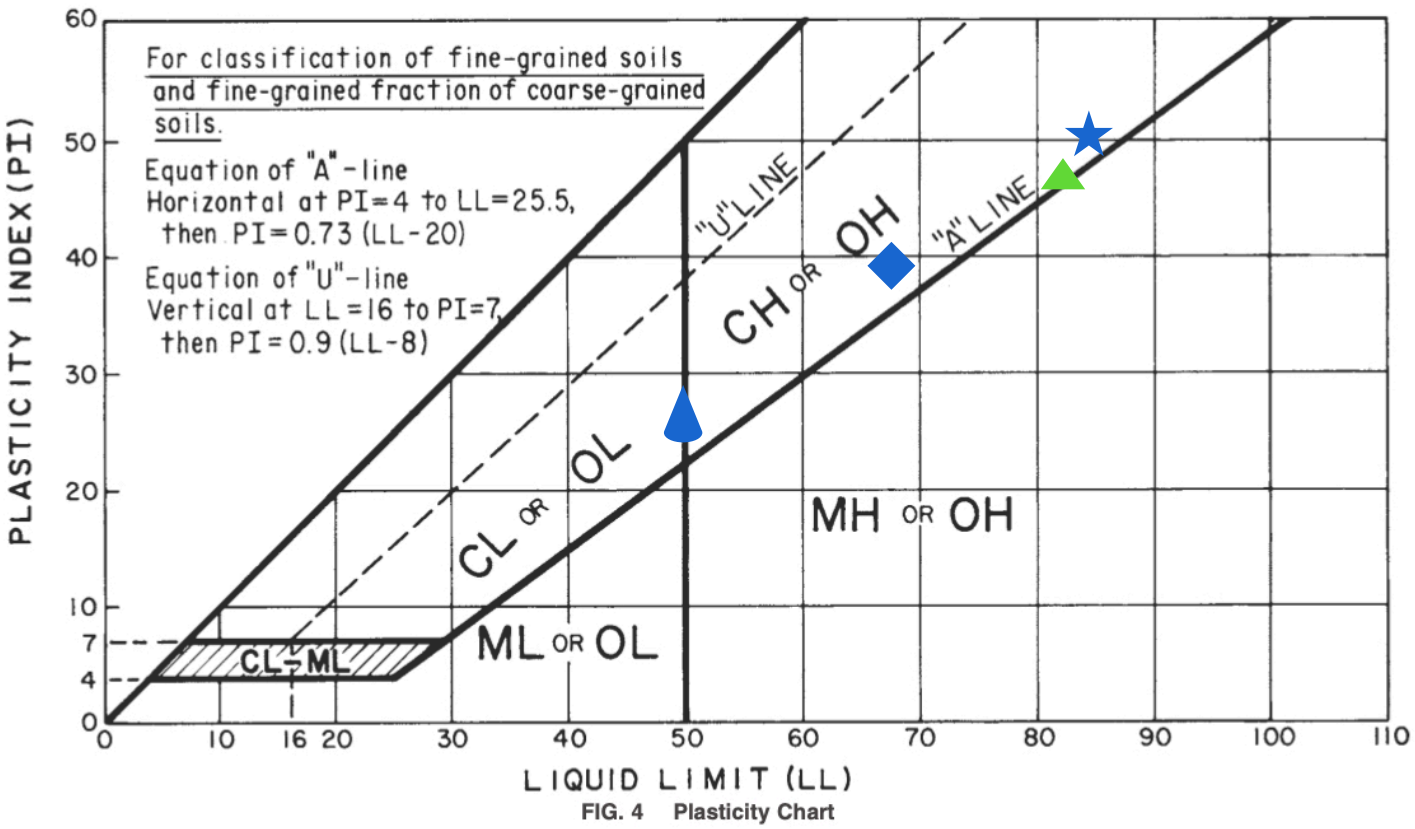


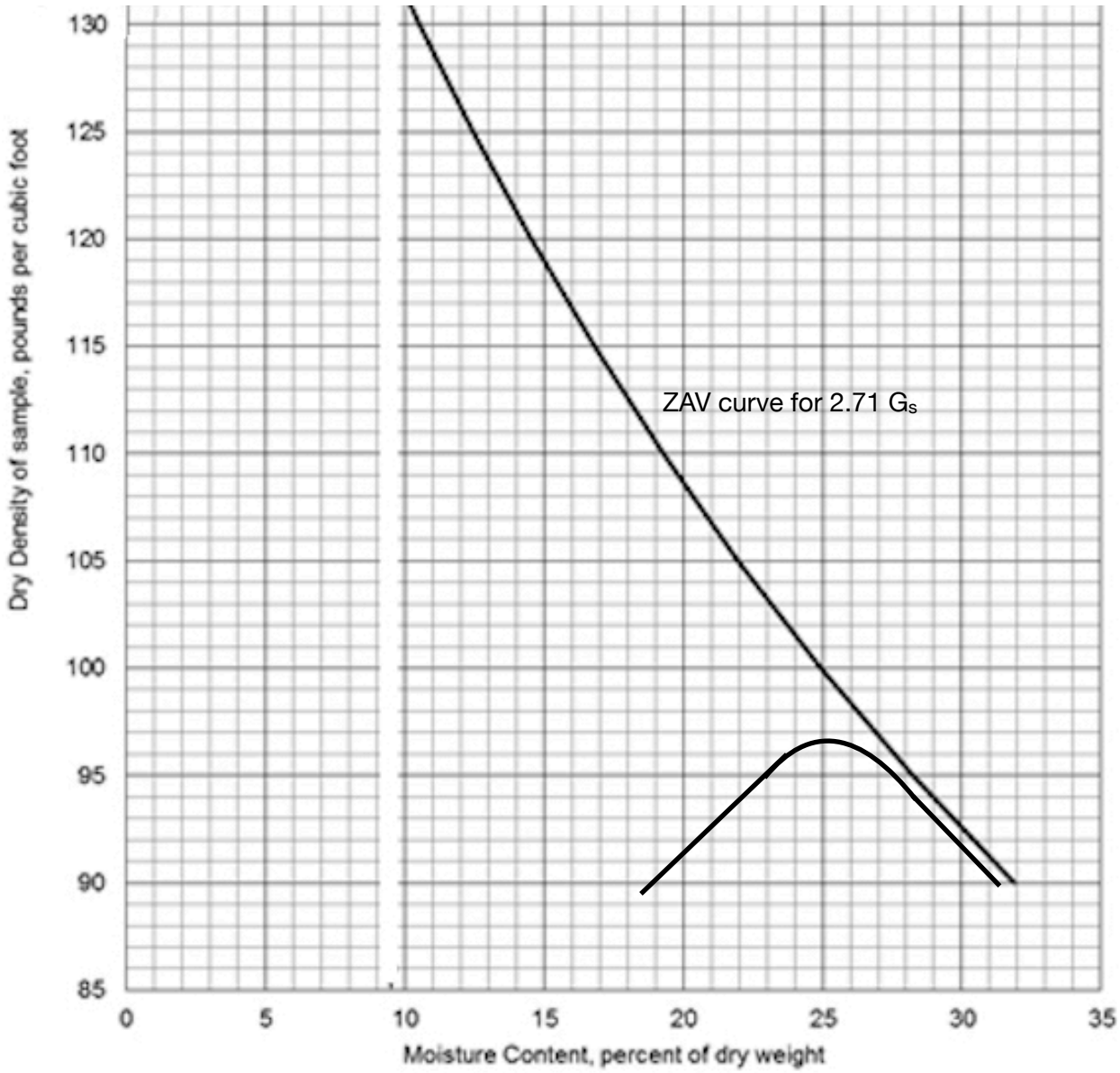
FIG. 4 Plasticity Chart

Cooke Engineering and Testing Company

Moisture-Density (“Proctor”) Sheet

Project Name:	Cynthiana-Harrison Co Turning Lanes	Date:	March 9, 2025
Project Location:	Cynthiana, Kentucky	Reviewed by:	Joe Cooke, PE
Client:	Cynthiana-Harrison Co EDA	CETCO Project Number: 4110-25-0102	
Light Brown Fat Clay		“Proctor”, ASTM D698-A	

Sample ID	Natural Moisture Content (%)	Liquid Limit (%)	Plasticity Index	Maximum Dry Density (pcf)	Optimum Moisture Content (%)	% Finer than #200 Sieve
P-1 (B-9), 0.5’-4.0’	34.0	82	47	96.7	25.2	92.7

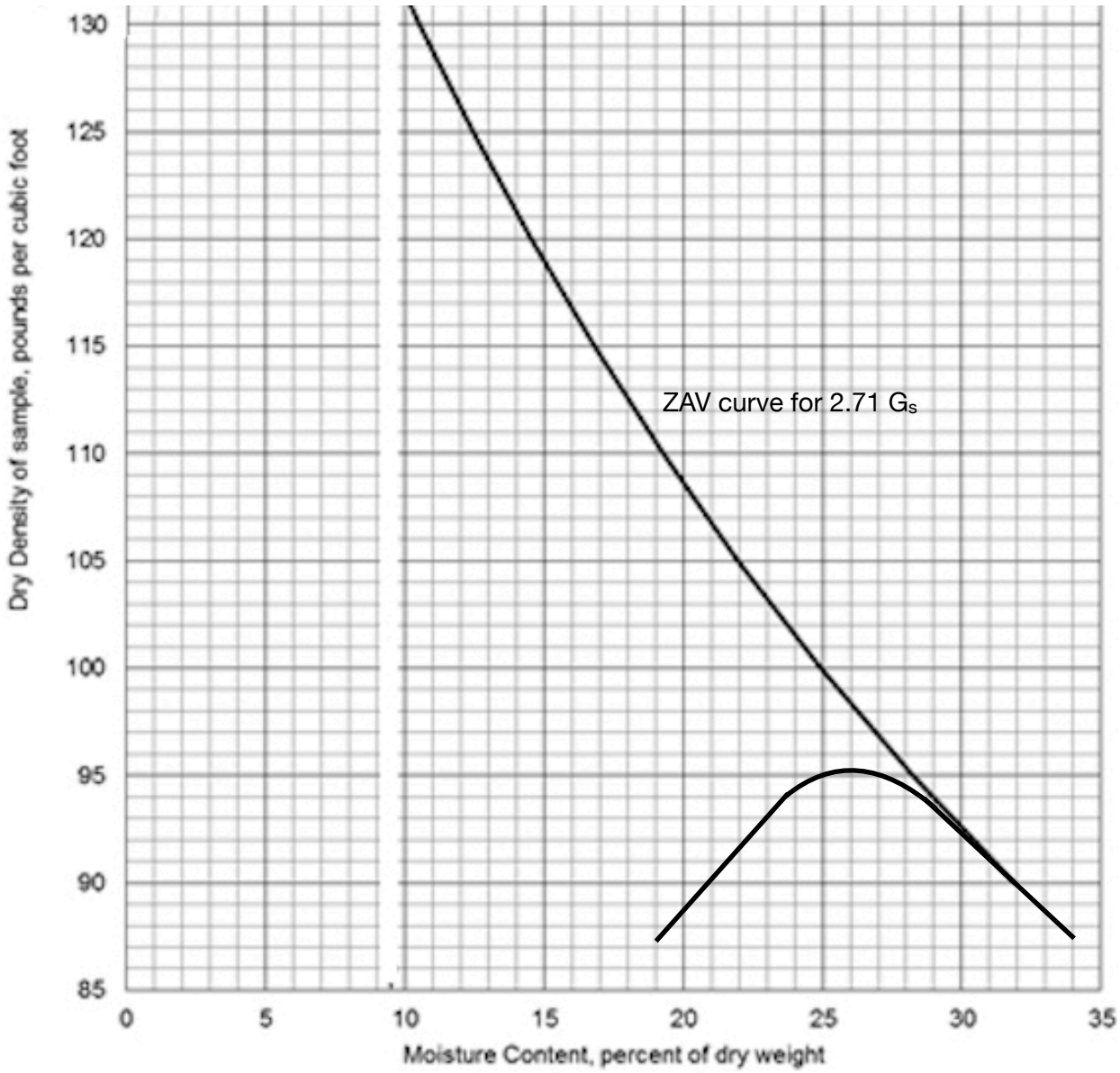


Cooke Engineering and Testing Company

Moisture-Density (“Proctor”) Sheet

Project Name:	Cynthiana-Harrison Co. Turning Lanes	Date:	March 9, 2025
Project Location:	Cynthiana, Kentucky	Reviewed by:	Joe Cooke, PE
Client:	Cynthiana-Harrison Co. EDA	CETCO Project Number:	4110-25-0102
Brown Fat Clay		“Proctor”, ASTM D698-A	

Sample ID	Natural Moisture Content (%)	Liquid Limit (%)	Plasticity Index	Maximum Dry Density (pcf)	Optimum Moisture Content (%)	% Finer than #200 Sieve
P-2 (B-10), 1.0’-5.0’	35.0	84	51	95.1	26.1	94.9



LABORATORY STANDARDS AND PROCEDURES

Soil Classification: Soil classifications provide a general guide to the engineering properties of various soil types and enable the engineer to apply past experience to current problems. In our investigations, samples obtained during drilling operations are examined in our laboratory and visually classified by an engineer. The soils are classified according to consistency (based on number of blows from standard penetration tests or “by hand” stiffness), color and texture. These classification descriptions are included on our "Boring Logs” or “Test Pit Logs”

The classification system discussed above is primarily qualitative and for detailed soil classification two laboratory tests are necessary: grain size tests and plasticity tests. Using these test results the soil can be classified according to the AASHTO or Unified Classification Systems (ASTM D2487). Each of these classification systems and the in-place physical soil properties provides an index for estimating the soil's behavior. The soil classification and physical properties obtained are presented in this report.

Atterberg Limits: Portions of the samples are taken for Atterberg Limits testing to determine the plasticity characteristics of the soil. The plasticity index (PI) is the range of moisture content over which the soil deforms as a plastic material. It is bracketed by the liquid limit (LL) and the plastic limit (PL). The liquid limit is the moisture content at which the soil becomes sufficiently "wet" to flow as a heavy viscous fluid. The plastic limit is the lowest moisture content at which the soil is sufficiently plastic to be manually rolled into tiny threads. The liquid limit and plastic limit are determined in accordance with ASTM D4318.

Moisture Content: The Moisture Content is determined according to ASTM D2216.

Percent Finer Than 200 Sieve: Selected samples of soils are washed through a number 200 sieve to determine the percentage of material less than 0.074 mm in diameter.

“Proctor” (Moisture-Density Test): Often called by it’s original author’s name, the “Proctor” test is a moisture-density relationship test to determine “maximum dry density” and “optimum moisture content” curves using a set amount of force of “compaction” at variable moisture contents in a pre-determined mold size. The test is typically ASTM D698, method A, for standard effort. For a “modified” effort (higher amount of force), ASTM D 1557, again method A, is usually used. Due to high amounts of clay as well as typical compaction construction equipment used, the standard Proctor (ASTM D698) is the most common method used. For materials with larger grain sizes, methods B, C and D of each ASTM method can be used.

CBR: California Bearing Ratio (CBR) testing is often performed on soils to assist in pavement design. The test involves compacting soil into an approximate “0.075 cubic foot” volume at specified density and moisture content and then soaking the compacted sample with a surcharge weight (for a time period of usually at least 96 hours). Then, the sample is “loaded” using a fixed strain penetration piston and the penetration resistance and stress is recorded (as stress in pounds per square inch-psi) at 0.1 inches and 0.2 inches penetration. The resistant stress is then compared (as a “ratio”) to the standard resistant stress, hence the value is reported as unit-less. The test is typically conducted in general accordance with ASTM D1883.

Rock Strength Tests: To obtain strength data for rock materials encountered, unconfined compression tests are performed on selected samples. In the unconfined compression test, a cylindrical portion of the rock core is subjected to increasing axial load until it fails. The pressure required to produce failure is recorded, corrected for the length to diameter ratio of the core and reported.

FIELD SERVICES STANDARDS AND PROCEDURES

Field Operations: The general field procedures employed by CETCO are summarized in ASTM D420 which is entitled "Investigating and Sampling Soils and Rocks for Engineering Purposes." This recommended practice lists recognized methods for determining soil and rock distribution and ground water conditions. These methods include geophysical, in situ methods and test pits as well as borings.

Borings are drilled to obtain subsurface samples using one of several alternate techniques depending upon the subsurface conditions. These techniques typically include:

a. Continuous 2-1/2 or 3-1/4 inch I.D. hollow stem augers;
b. Wash borings using roller cone or drag bits (mud or water);
c. Continuous flight augers (ASTM D 1425).

These drilling methods are not capable of penetrating through material designated as "refusal materials." Refusal, thus indicated, may result from hard cemented soil, soft weathered rock, coarse gravel or boulders, thin rock seams, or the upper surface of sound continuous rock. Core drilling procedures are required to determine the character and continuity of refusal materials.

The subsurface conditions encountered during drilling are reported on a field test boring record by our field personnel (typically engineers). The record contains information concerning the boring method, samples attempted and recovered, indications of the presence of various materials such as coarse gravel, cobbles, etc., and observations between samples. Therefore, these boring records contain both factual and interpretive information. The field boring records are on file in our office.

The soil and rock samples plus the field boring records are reviewed by a geotechnical engineer. The engineer classifies the soils in general accordance with the procedures outlined in ASTM D2488 and prepares the final boring records which are the basis for all evaluations and recommendations.

The final boring records represent our interpretation of the contents of the field records based on the results of the engineering examinations and tests of the field samples. These records depict subsurface conditions at the specific locations and at the particular time when drilled. Soil conditions at other locations may differ from conditions occurring at these boring locations. Also, the passage of time may result in a change in the subsurface soil and ground water conditions at these boring locations. The lines designating the interface between soil or refusal materials on the records and on profiles represent approximate boundaries. The transition between materials may be gradual. The final boring records are included with this report.

The detailed data collection methods using during this study are discussed on the following pages.

Soil Test Borings: Soil test borings were made at the site at locations shown on the attached Boring Plan. Soil sampling and penetration testing were performed in accordance with ASTM D1586.

The borings were made by mechanically twisting a hollow stem steel auger into the soil. At regular intervals, the drilling tools were removed and soil samples obtained with a standard 1.4 inch I.D., 2 inch O.D., split tube sampler. The sampler was first seated 6 inches to penetrate any loose cuttings, then driven an additional foot with blows of a 140-pound hammer falling 30 inches. The number of hammer blows required to drive the sampler the final foot was recorded and is designated the "penetration resistance". The penetration resistance, when properly evaluated, is an index to the soil strength and foundation supporting capability.

Representative portions of the soil samples, thus obtained, were placed in glass jars and transported to the laboratory. In the laboratory, the samples were examined to verify the driller's field classifications. Test Boring Records are attached which graphically show the soil descriptions and penetration resistances.

Core Drilling: Refusal materials are materials that cannot be penetrated with the soil drilling methods employed. Refusal, thus indicated, may result from hard cemented soil, soft weathered rock, coarse gravel or boulders, thin rock seams or the upper surface of sound continuous rock. Core drilling procedures are required to determine the character and continuity of refusal materials.

Prior to coring, casing is set in the drilled hole through the overburden soils, if necessary, to keep the hole from caving. Refusal materials are then cored according to ASTM D2113 using a diamond-studded bit fastened to the end of a hollow

double tube core barrel. This device is rotated at high speeds, and the cuttings are brought to the surface by circulating water. Core samples of the material penetrated are protected and retained in the swivel-mounted inner tube. Upon completion of each drill run, the core barrel is brought to the surface, the core recovered is measured, the samples are removed and the core is placed in boxes for storage.

The core samples are returned to our laboratory where the refusal material is identified and the percent core recovery and rock quality designation is determined by a soils engineer or geologist. the percent core recovery is the ratio of the sample length obtained to the depth drilled, expressed as a percent. The rock quality designation (RQD) is obtained by summing up the length of core recovered, including only the pieces of core which are four inches or longer, and dividing by the total length drilled. The percent core recovery and RQD are related to soundness and continuity of the refusal material. Refusal material descriptions, recoveries, and RQDs are shown on the "Test Boring Records".

Water Level Readings: Water table readings are normally taken in conjunction with borings and are recorded on the "Boring Logs". These readings indicate the approximate location of the hydrostatic water table at the time of our field investigation. Where impervious soils are encountered (clayey soils) the amount of water seepage into the boring is small, and it is generally not possible to establish the location of the hydrostatic water table through water level readings. The ground water table may also be dependent upon the amount of precipitation at the site during a particular period of time. Fluctuations in the water table should be expected with variations in precipitation, surface run-off, evaporation and other factors.

The time of boring water level reported on the boring records is determined by field crews as the drilling tools are advanced. The time of boring water level is detected by changes in the drilling rate, soil samples obtained, etc. Additional water table readings are generally obtained at least 24 hours after the borings are completed. The time lag of at least 24 hours is used to permit stabilization of the ground water table which has been disrupted by the drilling operations. The readings are taken by dropping a weighted line down the boring or using an electrical probe to detect the water level surface.

Occasionally the borings will cave-in, preventing water level readings from being obtained or trapping drilling water above the caved-in zone. The cave-in depth is also measured and recorded on the boring records.

Rock Classification: Rock classifications (if any) provide a general guide to the engineering properties of various rock types and enable the engineer to apply past experience to current situations. In our explorations, rock core samples obtained during drilling operations are examined in our laboratory and visually classified by an engineer. The rock cores are classified according to relative hardness and RQD (see Guide to Rock Classification Terminology), color, and texture. These classification descriptions are included on our Boring Records.

Test Pits: Occasionally, our field sampling includes the use of “test pits”. Similarly to soil test borings, our classifications on the materials observed and sampled are performed in general accordance with ASTM standards. These excavations are performed by excavators of various sizes and the width/length/depth of the excavations vary as well. Typically, only the soil or “loose” rock areas can be sampled or excavated. The samples taken are usually taken at highly variable depths and the engineer or field personnel have extreme discretion on the sample sizes and locations. These are typically sealed in “zip lock” type baggies and transported back to our office for lab testing and further classification. Visual descriptions of rock materials (sand, gravel, cobbles, boulders, etc.) are provided on both samples taken and observations of spoils removed and sides of excavations. Typically, photos of both the mass excavation and spoil pile are provide on the test pit logs in our reports. Groundwater levels are noted and can include water flow at the excavation bottom or at points of depth in the excavation sides. “Refusal” usually means that the excavator cannot remove additional materials at the excavation bottom. Some excavations may also have very large boulders than cannot be removed by the excavator used. Depths indicated on the logs are usually measured with steel tape or cloth tape. Final complete details of the test pit findings and opinions are provided in the “Test Pit Logs” in our reports. Lastly, test pit excavations have no set standards and are performed at our engineers discretion.

Field and Lab Procedures