Appendix K –

Preliminary Geotechnical Engineering Report Discovery Ridge –

Certified Site Program Lots 2, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, and 18 (Terracon, 2011b)

Preliminary Geotechnical Engineering Report

Discovery Ridge – Certified Site Program
Lots 2, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17 and 18
Columbia, Missouri

February 17, 2011
Terracon Project No. 09105094.1

Prepared for:
Trabue, Hansen & Hinshaw, Inc.
Columbia, Missouri

Prepared by:
Terracon Consultants, Inc.
Columbia, Missouri

February 17, 2011

Terracon

Trabue, Hansen & Hinshaw, Inc.
1901 Pennsylvania
Columbia, Missouri 65202

Attn: Mr. John Huss, P.E.
P: [573] 814-1568
F: [573] 814-1128

Re: Preliminary Geotechnical Engineering Report
Discovery Ridge – Certified Site Program
Lots 2, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17 and 18
Columbia, Missouri
Terracon Project Number: 09105094.1

Dear Mr. Huss

Terracon Consultants, Inc. (Terracon) has completed the preliminary geotechnical engineering services for the above referenced project. This study was performed in general accordance with our proposal number D0910226 dated December 15, 2010 and our Supplemental Change Order dated February 2, 2011. This report presents the findings of the subsurface exploration and provides preliminary geotechnical recommendations concerning earthwork and the design and construction of foundations, floor slabs and pavements for the proposed project.

We appreciate the opportunity to be of service to you on this project. If you have any questions concerning this report, or if we may be of further service, please contact us.

Sincerely,
Terracon Consultants, Inc.

Jamie M. Klein, P.E.
Staff Geotechnical Engineer
Missouri: PE 2009001099

STATE OF MISSOURI
JAMIE M. KLEIN
NUMBER PE-2009001099
PROFESSIONAL ENGINEER
2-17-11

Eric H. Lidholm, P.E.
Senior Principal
Office Manager

Enclosures
cc: 3 – Client
1 – File

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EXECUTIVE SUMMARY

A preliminary geotechnical investigation has been performed for the proposed certified site which consists of Lots 2, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17 and 18 of the Discovery Ridge Research Park in southeastern Columbia, Missouri. Nine (9) borings, designated B-1 through B-9, were performed to depths of approximately 13 to 20 feet below the existing ground surface at the subject site.

Based on the information obtained from our subsurface exploration, the site can be developed for future construction. The following geotechnical considerations were identified:

- Typical lightly loaded commercial buildings may be supported on shallow footings bearing on stiff to very stiff native clay or on compacted structural fill.
- Assuming proper site preparation and any necessary subgrade repair, total and differential settlement should be within anticipated client/owner specifications.
- Existing fill was encountered in Borings B-3 and B-4, however we understand that this material was placed as part of mass grading during mid to late 2008. At that time, Terracon was onsite to observe and test the density and moisture during placement of engineered fill material.
- Based on the USGS map, it appears that a pond may have been located in the vicinity of lot 16 and that the existing pond located north of the Radil Facility previously extended west onto a portion of Lot 2. We recommend these areas be thoroughly investigated during the final geotechnical investigation for each respective lot.
- The near-surface soils are active and prone to volume change with variations in moisture content. For this reason, a low volume change zone (LVC) is typically constructed beneath at-grade, grade-supported floor slabs. Depending on final grading plans, construction of the LVC may require overexcavation within future building pads.
- On-site soils appear suitable for use as compacted structural fill; however, if they do not meet the low plasticity fill criteria, they should not be utilized for LVC material.
- The 2006/2009 International Building Code (IBC), Table 1613.5.2 seismic site classification for this site is C
- The Modified Mercalli Intensity Scale for seismic events for Boone County is VII.

EXECUTIVE SUMMARY (continued)

- Close monitoring of the construction operations discussed herein will be critical in achieving the design subgrade support. We recommend that Terracon be retained to monitor this portion of the work.

This summary should be used in conjunction with the entire report for design purposes. It should be recognized that details were not included or fully developed in this section, and the report must be read in its entirety for a comprehensive understanding of the items contained herein. The section titled **GENERAL COMMENTS** should be read for an understanding of the report limitations. Although this report discusses design parameters, these parameters are preliminary. This preliminary report is not intended to be relied upon for final design.

PRELIMINARY GEOTECHNICAL ENGINEERING REPORT
DISCOVERY RIDGE – CERTIFIED SITE PROGRAM
LOTS 2, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17 and 18
COLUMBIA, MISSOURI

Terracon Project No. 09105094.1
February 17, 2011

1.0 INTRODUCTION

A preliminary geotechnical engineering report has been completed for the proposed certified which consists of Lots 2, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17 and 18 of Discovery Ridge Research Park in Columbia, Missouri. Nine (9) borings, designated B-1 through B-9, were performed to depths of approximately 13 to 20 feet below the existing ground surface at the subject site. Logs of the borings along with a site location map, USGS map, geologic map and boring location diagram are included in Appendix A of this report.

The purpose of these services is to provide information and preliminary geotechnical engineering recommendations relative to:

- subsurface soil conditions
- groundwater conditions
- earthwork
- pavements
- foundation design and construction
- floor slab design and construction
- seismic considerations

It is important to note that this preliminary geotechnical engineering report is not meant to provide final design recommendations. Once final development plans are available, a final geotechnical investigation should be performed for site and structure-specific geotechnical recommendations.

2.0 PROJECT INFORMATION

2.1 Project Description

ITEM	DESCRIPTION
Site layout	See Appendix A, Exhibit A-4: Boring Location Diagram
Structures	The project will include future development of approximately 90 acres of vacant land. Finalized specific building or site layout details were unknown at the time this report was prepared.

ITEM	DESCRIPTION
Grading	Site grading information was not available at the time that this report was prepared. However for the purpose and scope of this report, we have assumed that local cuts and/or fills required for development will be limited to approximately 10 feet. Additionally, we understand that mass grading was performed in mid to late 2008 in the vicinity of the existing Radil Facility and ABC Laboratories building. At that time, Terracon was onsite to observe and test the placement of engineered fill material.
Cut and fill slopes	No steeper than 3H:1V (Horizontal to Vertical) (assumed)

2.2 Site Location and Description

ITEM	DESCRIPTION
Location	The proposed project site consists of Lots 2, 5, 6, 7 8, 9, 10, 11, 12, 13, 14, 15, 16, 17 and 18 of Discovery Ridge Research Park in Columbia, Missouri.
Existing improvements	The lots are vacant with the exception of Lot 5 which is developed with a storage building.
Current ground cover	Generally grass covered, however portions of the site in the vicinity of Lot 16 were cultivated fields.
Existing topography	In general, slightly to moderately sloped downward towards the south and west.

3.0 SUBSURFACE CONDITIONS

3.1 Geology

Most of the upland area is covered by a thin loess blanket and glacial drift. Highly plastic clays that exhibit volume change with variations in moisture are commonly encountered near the ground surface.

Based on the 2003 Geologic Map of Missouri, Missouri Department of Natural Resources, bedrock at this site consists primarily of the Pennsylvanian aged Cherokee Group (Pc), the Pennsylvanian aged Marmaton Group (Pm), and the Mississippian aged Burlington formation (Mo). The Cherokee Group is predominantly shale with minor amounts of carbonates and sandstone. This group contains most of the mineable coal beds in Missouri. The Marmaton Group consists of a succession of shale, limestone, clay, and coal beds.

The Burlington formation is characteristically a white to gray, medium to coarsely crystalline, medium to coarsely crinoidal, chert free to sparsely cherty limestone. Solution features, including caves and sinkholes, are commonly present in this formation. No caves or sinkholes are known to exist, or are published to exist, within approximately 1 mile of this project site. However several areas of known karst activity are present west and southwest of the project site.

It is difficult to predict future sinkhole activity. Sinkholes and caves in this area are in various stages of development and can appear at any time. Site grading and drainage may alter site conditions and could possibly cause sinkholes in areas that have no history of this activity.

3.2 Typical Profile

Based on the results of the borings, subsurface conditions on the project site can be generalized as follows:

Stratum	Approximate Depth to Bottom of Stratum (feet)	Material Description	Consistency/Density
Surface	0.2 to 0.5	Topsoil: brown, friable and contained significant organic matter	N/A
1	3 to 12 (Borings B-3 & B-4 only)	Existing Fill [1] consisting of lean clay and lean to fat clay with varying amounts of sand and gravel	Very stiff to hard
2	3 to 12	Lean clay, lean to fat clay and fat clay	Stiff to very stiff
3	Undetermined: Borings B-1 through B-5, B-8 and B-9 terminated within this stratum at the planned depth of approximately 20 feet	Lean to fat clay and fat clay with varying amounts of sand, gravel and possible cobbles (visually classified as glacial drift)	Stiff to hard
4	Undetermined: Borings B-6 and B-7 terminated within this stratum.	Limestone	Caused split spoon sampler refusal and auger refusal

Note 1: The existing fill material was placed in mid to late 2008. Terracon provided onsite observation and moisture/density testing during the placement of fill material.

The upper soil encountered in the borings generally consisted of lean to fat clay and fat clay which was of moderate to high plasticity, and had the following measured liquid limits, plastic limits, and plasticity indices:

Sample Location	Depth (feet)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)
Boring B-1	3 – 5	43	15	28
Boring B-3	1 – 3	41	16	25
Boring B-5	1 – 3	31	21	10
Boring B-9	1 – 3	44	21	23

Conditions encountered at each boring location are indicated on the individual boring logs. Stratification boundaries on the boring logs represent the approximate location of changes in soil types; in situ, the transition between materials may be gradual. Details for each of the borings can be found on the boring logs in Appendix A of this report.

3.3 Groundwater

The boreholes were observed while drilling and after completion for the presence and level of groundwater. Groundwater was observed at in Borings B-5 and B-6 at depths of approximately 12 to 18.5 feet. Groundwater was not observed in the remaining borings during drilling or for the short amount of time the borings were allowed to remain open following drilling completion. However, this does not necessarily mean that stable groundwater levels were observed in Borings B-5 and B-6, or that the remaining borings were terminated above groundwater.

Due to the low permeability of the soils encountered in the borings, a relatively long period of time may be necessary for a groundwater level to develop and stabilize in a borehole in these materials. Long term observations in piezometers or observation wells sealed from the influence of surface water are often required to define groundwater levels in materials of this type.

Pockets, lenses, and stringers of sand are sometimes encountered in the glacial soils found in the vicinity of the referenced project. These sand pockets are normally discontinuous and often contain water of variable quality and quantity. These sand pockets may be encountered during foundation excavation. This possibility should be considered when developing design and construction plans and specifications for the project.

Groundwater level fluctuations occur due to seasonal variations in the amount of rainfall, runoff, proximity to existing ponds, and other factors not evident at the time the borings were performed. In addition, perched water can develop over low permeability soil strata. Therefore, groundwater levels during construction or at other times in the life of the structure may be higher or lower than the levels indicated on the boring logs. The possibility of groundwater level fluctuations should be considered when developing the design and construction plans for the project.

4.0 SITE SUITABILITY AND PRELIMINARY FINDINGS AND RECOMMENDATIONS

4.1 Geotechnical Considerations

The borings performed for this project generally encountered native lean to fat clay and fat clay underlain by glacial drift. Existing fill was encountered in Borings B-3 and B-4 to depths of 3 to 12 feet, and limestone bedrock was encountered in Borings B-6 and B-7 at depths of approximately 17 and 12.5 feet, respectively. Depending on final site grading plans, we anticipate that either the native clay or compacted structural fill will form the subgrade for future building foundations and floor slabs.

Based on the USGS map, it appears that a pond may have been located in the vicinity of lot 16. Further, based on aerial photography the existing pond located north of the Radil Facility previously extended southwest onto a portion of Lot 2. We recommend these areas be thoroughly investigated during the final geotechnical investigation for each respective lot.

Performance of foundations depends on many factors including, but not limited to, the depth of footings, amounts of cuts or fill, bearing material, and foundation loads. Structural loads, final grades, and other design details should be provided when available. Although this report discusses design parameters, these parameters are preliminary. This preliminary report is not intended to be relied upon for final design. We recommend a more detailed study be performed when specific project details are known, and/or possibly following completion of general site grading.

Examination of the boring logs indicates a range of soil-moisture conditions are present at this site. At the time of drilling, some of the soils at various depths are at moisture levels above their measured plastic limit. Typically, soil with moisture levels above their measured plastic limit may be prone to rutting, pumping, and can develop into unstable subgrade conditions during general construction operations.

Moderately to highly plastic, lean to fat clay and fat clay soils were present on site. Such soils are commonly referred to as "expansive" or "swelling" soils because they expand or swell as their moisture contents increase. However, these soils also "contract" or "shrink" as their moisture levels decrease. Footings, floor slabs, and pavements supported on expansive soils will move upward and downward and such movements will result in distortion, possibly causing cracking or structural damage to structures. For this reason, a low volume change zone will likely be required beneath at-grade floor slabs. We recommend that additional laboratory testing be performed during the final geotechnical exploration to better evaluate the expansive nature of these soils.

We recommend that the exposed subgrade be thoroughly evaluated after stripping of any topsoil and creation of all cut areas, but prior to the start of any fill operations. We recommend that the geotechnical engineer be retained to evaluate the bearing material for the foundations and floor slab subgrade soils. Subsurface conditions, as identified by the field and laboratory testing programs, have been reviewed and evaluated with respect to the proposed development plans known to us at this time.

4.2 Earthwork

The widely spaced preliminary borings typically encountered stiff to hard lean to fat clay and fat clay. Shallow bedrock, karst features, or extensive pervious deposits of water-bearing sand that could impact site development did not appear to be present based on the preliminary site and subsurface information gathered at this time.

Based on the subsurface conditions encountered in the widely spaced borings, the site soils are suitable for future development. Additional borings should be completed so that each site can be adequately characterized and recommendations can be more fully developed to assist and guide future mass grading.

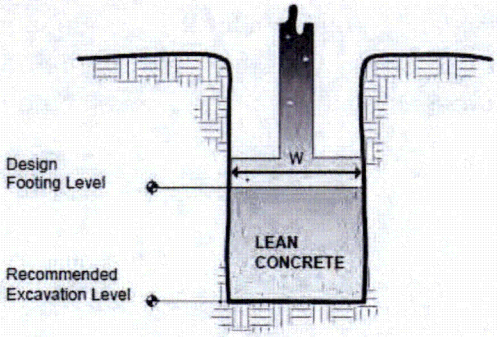
Recommendations will need to be developed for site preparation and proof-rolling operations as well as construction of cut and structural fill operations. In our opinion, full-time testing and observation should be employed during mass grading to evaluate compliance with project earthwork recommendations and requirements. If site grading results in relatively thick structural fills, settlement and cut/fill slope stability may need to be evaluated.

4.3 Foundations

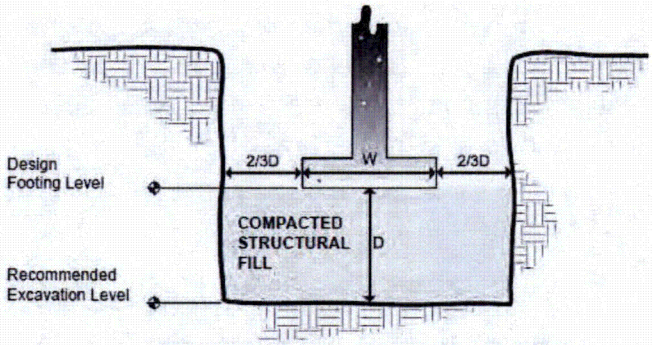
Shallow foundations could be used to support lightly loaded commercial structures provided the footings are supported by suitable material (stiff to hard native clay or compacted structural fill). Depending on the design footing elevation and bearing material (native clay or newly placed compacted structural fill), allowable bearing pressures would likely be in the range of 1,000 psf to 3,000 psf. Due to the presence of clay soils, shallow foundations are typically soil-formed in the general vicinity of this site. Further testing at the individual structure locations should be performed to determine the appropriate bearing capacity for structural support.

Heavier loads, which could cause excessive settlement, are normally supported by shallow foundations which are supported, in turn, by aggregate-pier intermediate foundations or by drilled piers. Pier drilling through the native soils is not expected to become difficult based upon the material encountered within the borings; however, the drilled pier contractor should be prepared should sandy zones or large boulders be encountered. These materials, although not

encountered in our borings, can sometimes be encountered in the glacial soils that are present in the vicinity of this site when drilling pier holes which are much larger in diameter than the bore holes.



Lean Concrete Backfill



Overexcavation / Backfill

NOTE: Excavations in sketches shown vertical for convenience. Excavations should be sloped as necessary for safety.

4.4 Seismic Considerations

Method Used	Site Classification
Modified Mercalli Intensity Scale [1]	VII [2]

1. Missouri State Emergency Management Agency; P.O. Box 116; Jefferson City, MO 65102
2. See Appendix C, Exhibit C-4 for Projected Earthquake Intensities (Modified Mercalli Scale)

Code Used	Site Classification
2006/2009 International Building Code (IBC) [1]	C [2]

1. In general accordance with the *2006/2009 International Building Code,* Table 1613.5.2.
2. The 2006/2009 International Building Code requires a site soil profile determination extending a depth of 100 feet for seismic site classification. The current scope requested does not include the required 100 foot soil profile determination. Borings for this report extended to a maximum depth of approximately 20 feet and this seismic site class assignment considers that shale or limestone bedrock is present within approximately 30 feet of the ground surface and continues below the maximum depth of the subsurface exploration. Additional exploration to greater depths could be considered to confirm the conditions below the current depth of exploration. Alternatively, a geophysical exploration could be utilized in order to attempt to justify a more favorable seismic site class.

4.5 Floor Slabs

Many of the clay soils in this locale have the potential to increase or decrease in volume with variations in moisture content. Soil having high plasticity characteristics (i.e., fat clay) generally has a greater potential for moisture related volume change than less plastic materials such as lean clay. In addition, swell potential is generally greater in material with a high dry unit weight and low initial moisture content. However, even low plasticity soils can swell significantly if their moisture levels are initially low.

Because of the moderate to high shrink-swell potential of the lean to fat clay and fat clay soil encountered in the borings, a low volume change layer will likely be required below at-grade floor slabs. This layer typically varies from 12 to 36 inches in thickness. The on-site lean to fat clay and fat clay soils encountered in the borings performed for this report are typically not suitable for use as low volume change material; however, on-site materials may exist which would meet the low volume change material criteria. Further testing at the individual structure locations should be performed to determine the required low volume change layer thickness.

4.6 Pavements

On most project sites, the site grading is accomplished relatively early in the construction phase. Fills are placed and compacted in a uniform manner. However, as construction proceeds, excavations are made into these areas, rainfall and surface water saturates some areas, heavy traffic from concrete trucks and other delivery vehicles disturbs the subgrade and many surface irregularities are filled in with loose soils to improve trafficability temporarily. As a result, the pavement subgrades, initially prepared early in the project, should be carefully evaluated as the time for pavement construction approaches.

Pavement thickness can be determined using AASHTO, Asphalt Institute and/or other methods if specific wheel loads, axle configurations, frequencies, and desired pavement life are provided. Pavement design methods are intended to provide structural sections with adequate thickness over a particular subgrade such that wheel loads are reduced to a level the subgrade can support. The support characteristics of the subgrade for pavement design do not account for shrink/swell movements of an expansive clay subgrade such as the soils encountered on this project. Thus, the pavement may be adequate from a structural standpoint, yet still experience cracking and deformation due to shrink/swell related movement of the subgrade.

Expansive soils are present at this site. It is important to minimize moisture changes in the subgrade both during construction and during the life of the pavement to reduce shrink/swell movements.

5.0 GENERAL COMMENTS

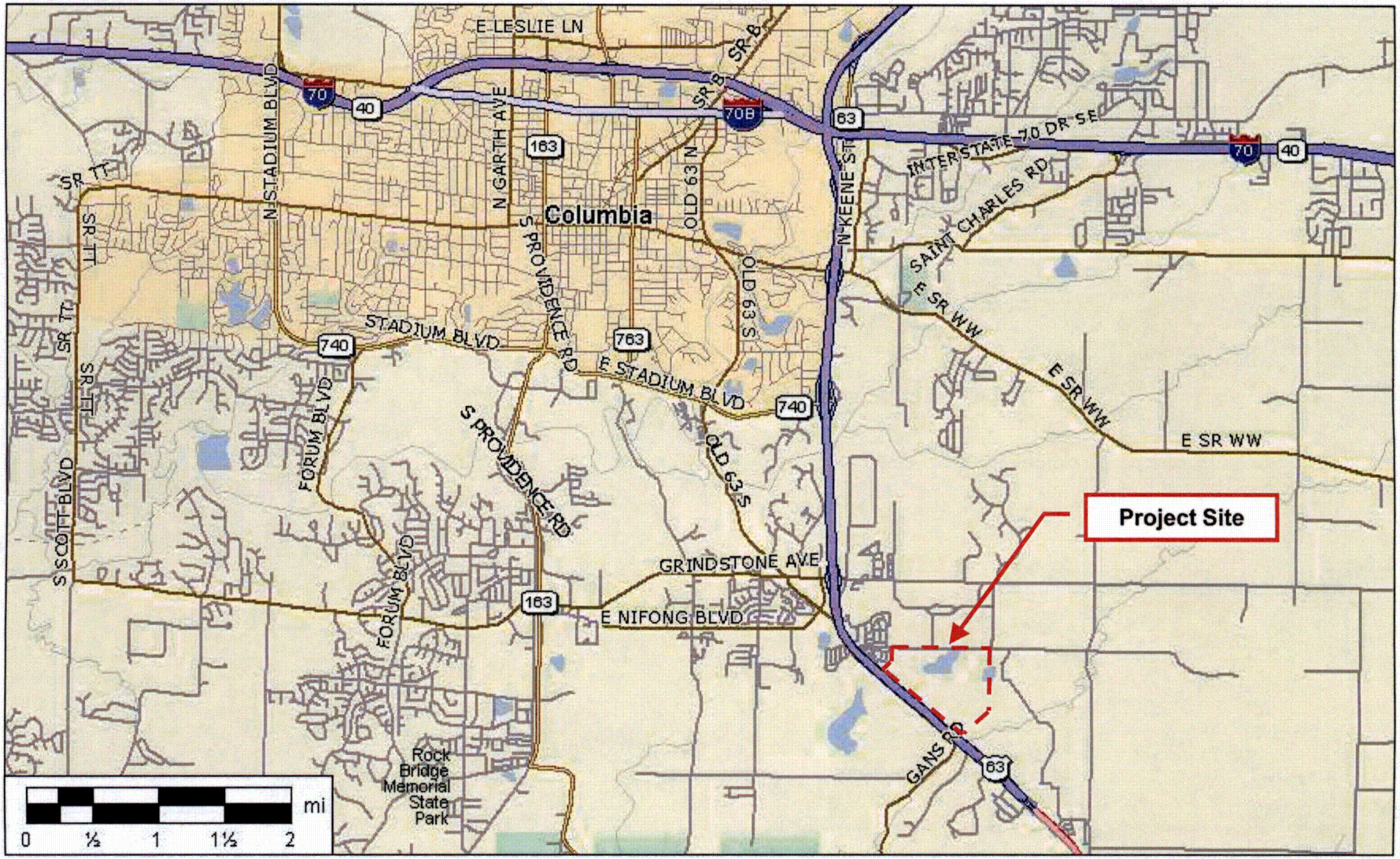
Terracon should be retained to review the final design plans and specifications so comments can be made regarding interpretation and implementation of our geotechnical recommendations in the design and specifications. Terracon also should be retained to provide observation and testing services during grading, excavation, foundation construction and other earth-related construction phases of the project.

The preliminary analysis and preliminary recommendations presented in this report are based upon the data obtained from the borings performed at the indicated locations and from other information discussed in this preliminary report. This preliminary report does not reflect variations that may occur between borings, across the site, or due to the modifying effects of construction or weather. The nature and extent of such variations may not become evident until during or after construction. If variations appear, we should be immediately notified so that further evaluation and supplemental recommendations can be provided.

The scope of services for this project does not include either specifically or by implication any environmental or biological (e.g., mold, fungi, bacteria) assessment of the site or identification or prevention of pollutants, hazardous materials or conditions. If the owner is concerned about the potential for such contamination or pollution, other studies should be undertaken.

This report has been prepared for the exclusive use of our client for specific application to the project discussed and has been prepared in accordance with generally accepted geotechnical engineering practices. No warranties, either express or implied, are intended or made. Site safety, excavation support, and dewatering requirements are the responsibility of others. In the event that changes in the nature, design, or location of the project as outlined in this report are planned, the conclusions and recommendations contained in this preliminary report shall not be considered valid unless Terracon reviews the changes and either verifies or modifies the conclusions of this report in writing.

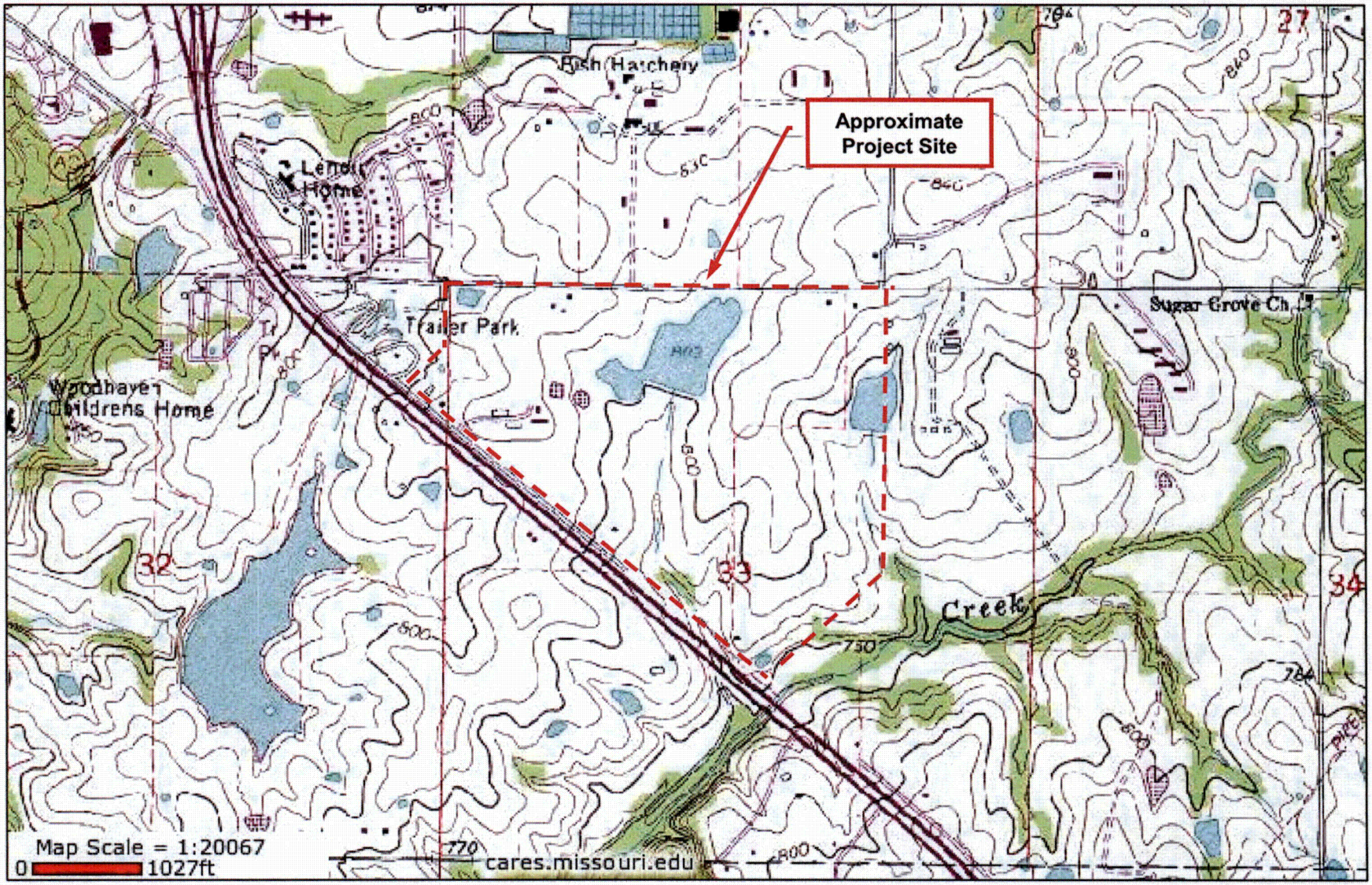
APPENDIX A
FIELD EXPLORATION



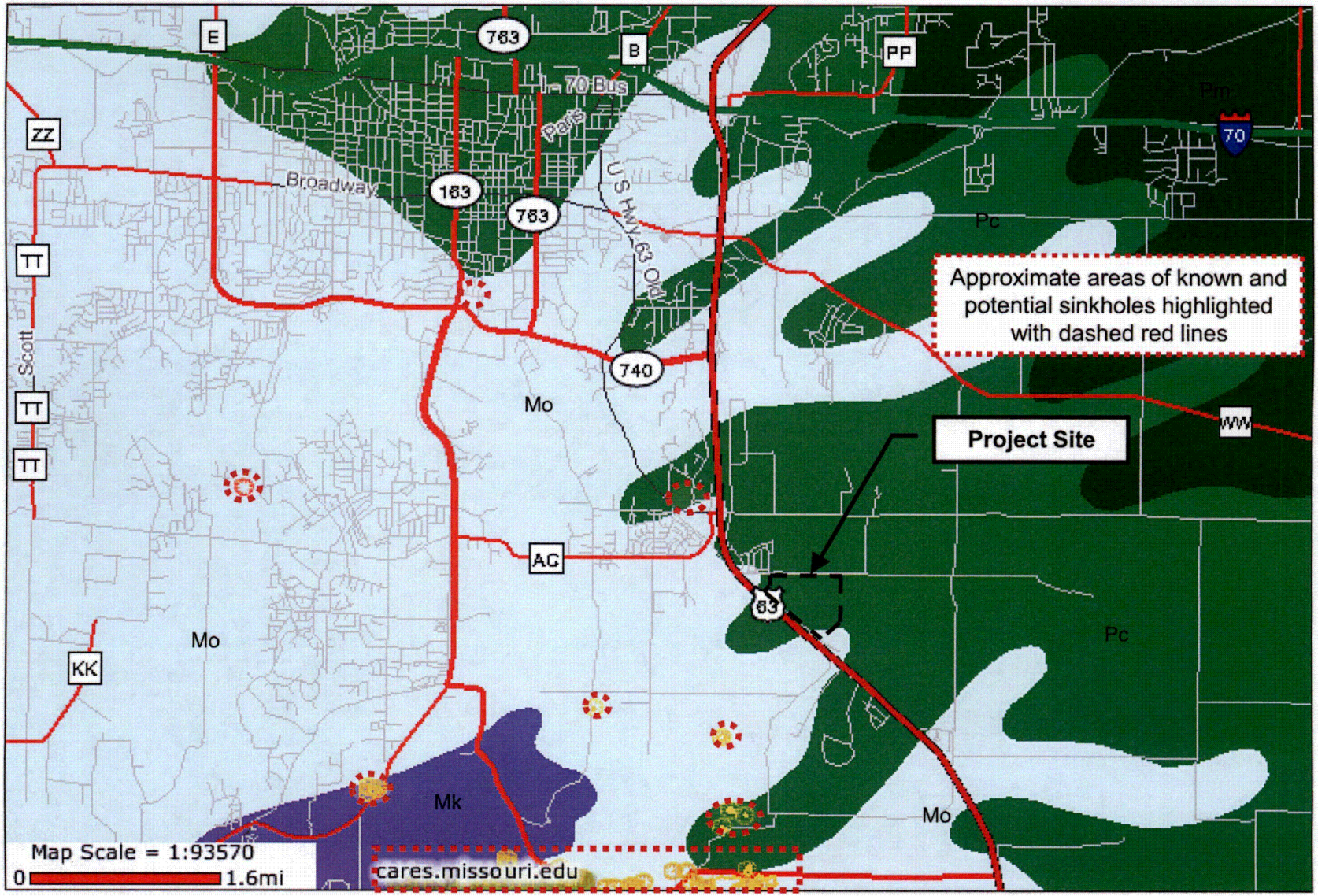
Project Manager: JMK	Project No. 09105094.1	Terracon Consulting Engineers & Scientists	SITE LOCATION MAP
Drawn by: JMK	Scale: GRAPHIC	3601 Mojave Court, Suite A Columbia, Missouri 65202	DISCOVERY RIDGE CERTIFIED SITE PROGRAM
Checked by: EHL	File Name: 09105094.1 SMAP	P [573] 214 2677 F [573] 214 2714	LOTS 2, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17 & 18
Approved by: EHL	Date: 2/17/2011		COLUMBIA, MISSOURI

Exhibit

A-1



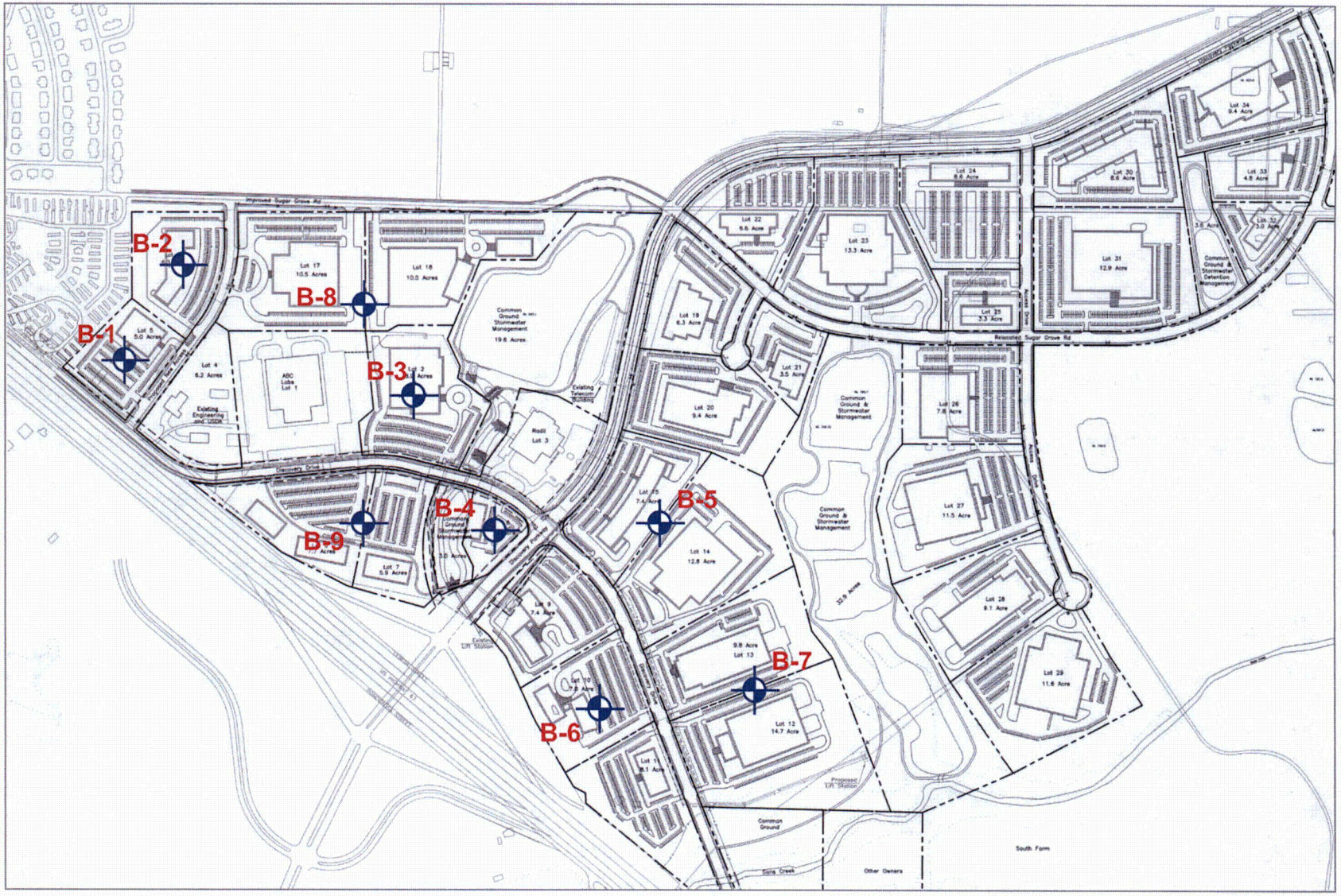
Project Manager: JMK	Project No. 09105094.1	Terracon Consulting Engineers & Scientists	USGS MAP
Drawn by: JMK	Scale: GRAPHIC	3601 Mojave Court, Suite A Columbia, Missouri 65202	DISCOVERY RIDGE CERTIFIED SITE PROGRAM
Checked by: EHL	File Name: 09105094.1 USGS MAP	P [573] 214 2677 F [573] 214 2714	LOTS 2, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17 & 18 COLUMBIA, MISSOURI
Approved by: EHL	Date: 2/17/2011		Exhibit A-2



N

Project Manager: JMK	Project No. 09105094.1	Terracon Consulting Engineers & Scientists	GEOLOGIC MAP
Drawn by: JMK	Scale: GRAPHIC	3601 Mojave Court, Suite A Columbia, Missouri 65202	DISCOVERY RIDGE CERTIFIED SITE PROGRAM
Checked by: EHL	File Name: 09105094.1 GMAP	P [573] 214 2677 F [573] 214 2714	LOTS 2, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17 & 18
Approved by: EHL	Date: 2/17/2011		COLUMBIA, MISSOURI

Exhibit A-3



Project Manager: JMK	Project No. 09105094.1	Terracon Consulting Engineers & Scientists	BORING LOCATION PLAN
Drawn by: JMK	Scale: GRAPHIC	3601 Mojave Court, Suite A Columbia, Missouri 65202	DISCOVERY RIDGE CERTIFIED SITE PROGRAM LOTS 2, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17 & 18 COLUMBIA, MISSOURI
Checked by: EHL	File Name: 09105094.1 BPLAN	P [573] 214 2677 F [573] 214 2714	Exhibit A-4
Approved by: EHL	Date: 2/17/2011		

BORING LOG NO. B-1

CLIENT: **Trabue Hansen & Hinshaw, Inc.**

ENGINEER: **Trabue Hansen & Hinshaw, Inc.**

SITE: **Discovery Ridge**
Columbia, Missouri

PROJECT: **Discovery Ridge - Certified Site Program**

Boring Location: Lot 16

Approximate Surface Elevation: 835 ft

GRAPHIC LOG	DESCRIPTION	DEPTH, ft.	USCS SYMBOL	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES RECOVERY, in.	SAMPLES SPT - N ** BLOWS / ft.	TESTS WATER CONTENT, %	TESTS DRY UNIT WT pcf	TESTS UNCONFINED STRENGTH, ksf	ATTERBERG LIMITS (LL,PL,PI)
	0.3 3" TOPSOIL: 834.7				PA						
	LEAN TO FAT CLAY: brown and gray, stiff to very stiff		CL CH	1	ST	24		25	93	4500*	
	-- reddish brown, trace gray		CL CH	2	ST	24		22	105	6000* 2580	43, 15, 28
		5			PA						
	8 827										
	FAT CLAY: light gray with reddish brown, trace black, trace sand and gravel, possible cobbles, very stiff (Glacial Drift)		CH	3	ST	24		24	102	6000*	
		10			PA						
	-- reddish brown, trace gray and black		CH	4	ST	24		28	97	6500*	
		15			PA						
	20 815		CH	5	ST	24		21	108	7000*	
	BOTTOM OF BORING AT 20 FEET	20									

The stratification lines represent the approximate boundary lines between soil and rock types: in-situ, the transition may be gradual.

*Calibrated Hand Penetrometer
**CME 140H SPT automatic hammer

WATER LEVEL OBSERVATIONS, ft				
WL	▽ None	WS	▽ None	AB
WL	▽		▽	

Exhibit A-5

Terracon

BORING STARTED	12-28-10		
BORING COMPLETED	12-28-10		
RIG	550X	FOREMAN	SB
APPROVED	JMK	JOB #	09105094

BOREHOLE W FIGURE NO 09105094.GPJ GINT 001.GDT 2/18/11

BORING LOG NO. B-2

CLIENT: **Trabue Hansen & Hinshaw, Inc.**

ENGINEER: **Trabue Hansen & Hinshaw, Inc.**

SITE: **Discovery Ridge, Columbia, Missouri**

PROJECT: **Discovery Ridge - Certified Site Program**

Boring Location: Lot 5

Approximate Surface Elevation: 840 ft

GRAPHIC LOG	DESCRIPTION	DEPTH, ft.	USCS SYMBOL	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES RECOVERY, in.	SAMPLES SPT - N ** BLOWS / ft.	TESTS WATER CONTENT, %	TESTS DRY UNIT WT pcf	TESTS UNCONFINED STRENGTH, ksf
	0.3 4" TOPSOIL: 839.7				PA					
	LEAN TO FAT CLAY: gray with brown, very stiff		CL CH	1	ST	24		17	98	7000*
			CL CH	2	ST	16		17	110	7000* 6700
		5			PA					
	8 832									
	FAT CLAY: reddish brown with light gray, trace sand and gravel, possible cobbles, hard (Glacial Drift)		CH	3	ST	24		19	109	9000*
		10			PA					
			CH	4	ST	20		17	115	9000+* 9740
		15			PA					
			CH	5	SS	14	18	18		9000+*
	20 820	20								
	BOTTOM OF BORING AT 20 FEET									

The stratification lines represent the approximate boundary lines between soil and rock types: in-situ, the transition may be gradual.

*Calibrated Hand Penetrometer
**CME 140H SPT automatic hammer

WATER LEVEL OBSERVATIONS, ft				
WL	▽ None	WS	▽ None	AB
WL	▽		▽	

Exhibit A-6

Terracon

BORING STARTED	12-28-10		
BORING COMPLETED	12-28-10		
RIG	550X	FOREMAN	SB
APPROVED	JMK	JOB #	09105094

BOREHOLE W FIGURE NO 09105094.GPJ GINT 001.GDT 2/18/11

BORING LOG NO. B-3

CLIENT
Trabue Hansen & Hinshaw, Inc.

ENGINEER
Trabue Hansen & Hinshaw, Inc.

SITE
Discovery Ridge
Columbia, Missouri

PROJECT
Discovery Ridge - Certified Site Program

Boring Location: Lot 2

GRAPHIC LOG	DESCRIPTION	DEPTH, ft.	USCS SYMBOL	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES RECOVERY, in.	SAMPLES SPT - N ** BLOWS / ft.	TESTS WATER CONTENT, %	TESTS DRY UNIT WT pcf	TESTS UNCONFINED STRENGTH, ksf	ATTERBERG LIMITS (LL,PL,PI)
	Approximate Surface Elevation: 805 ft										
	0.2 2" TOPSOIL: 804.8				PA						
	FILL: lean to fat clay, gray and reddish brown, trace sand and gravel, very stiff			1	ST	22		19	111	7000*	41, 16, 25
	3 802										
	LEAN TO FAT CLAY: brown with gray, very stiff		CL CH	2	ST	15		22	105	5500*	
		5			PA						
	-- light gray, with silt		CL CH	3	ST	22		18	111	6000*	
		10			PA						
	12 793										
	LEAN TO FAT CLAY: reddish brown and gray, trace sand and gravel, possible cobbles, very stiff (Glacial Drift)		CL CH	4	ST	19		18	108	8000* 7490	
		15			PA						
	-- sandy		CL CH	5	ST	24		21	110	6500*	
	20 785	20									
	BOTTOM OF BORING AT 20 FEET										

The stratification lines represent the approximate boundary lines between soil and rock types: in-situ, the transition may be gradual.

*Calibrated Hand Penetrometer
**CME 140H SPT automatic hammer

WATER LEVEL OBSERVATIONS, ft				
WL	▽ None	WS	▽ None	AB
WL	▽		▽	

Exhibit A-7

Terracon

BORING STARTED	12-28-10		
BORING COMPLETED	12-28-10		
RIG	550X	FOREMAN	SB
APPROVED	JMK	JOB #	09105094

BOREHOLE W FIGURE NO 09105094.GPJ GINT 001.GDT 2/18/11

BORING LOG NO. B-4

CLIENT: **Trabue Hansen & Hinshaw, Inc.**

ENGINEER: **Trabue Hansen & Hinshaw, Inc.**

SITE: **Discovery Ridge**
Columbia, Missouri

PROJECT: **Discovery Ridge - Certified Site Program**

Boring Location: Lot 8

Approximate Surface Elevation: 800 ft

GRAPHIC LOG	DESCRIPTION	DEPTH, ft.	USCS SYMBOL	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES RECOVERY, in.	SAMPLES SPT - N ** BLOWS / ft.	TESTS WATER CONTENT, %	TESTS DRY UNIT WT pcf	TESTS UNCONFINED STRENGTH, ksf
	0.2 2" TOPSOIL: 799.8				PA					
	FILL: lean clay and lean to fat clay, brown, trace gray and reddish brown, trace sand and gravel, very stiff to hard			1	ST	24		17	100	8000*
				2	ST	10		17	111	9000* 8900
		5			PA					
				3	ST	24		21	102	8000* 5740
		10			PA					
	12 788									
	LEAN TO FAT CLAY: brown and light gray, trace reddish brown, trace sand and gravel, possible cobbles, very stiff (Glacial Drift)		CL CH	4	ST	12		18	110	6000*
		15			PA					
			CL CH	5	ST	23		21	108	6500*
	20 780	20								
	BOTTOM OF BORING AT 20 FEET									

The stratification lines represent the approximate boundary lines between soil and rock types: in-situ, the transition may be gradual.

*Calibrated Hand Penetrometer
**CME 140H SPT automatic hammer

WATER LEVEL OBSERVATIONS, ft				
WL	▽ None	WS	▽ None	AB
WL	▽		▽	

Exhibit A-8

Terracon

BORING STARTED	12-28-10		
BORING COMPLETED	12-28-10		
RIG	550X	FOREMAN	SB
APPROVED	JMK	JOB #	09105094

BOREHOLE W FIGURE NO 09105094.GPJ GINT 001.GDT 2/18/11

BORING LOG NO. B-5

CLIENT: **Trabue Hansen & Hinshaw, Inc.**

ENGINEER: **Trabue Hansen & Hinshaw, Inc.**

SITE: **Discovery Ridge**
Columbia, Missouri

PROJECT: **Discovery Ridge - Certified Site Program**

Boring Location: Between Lot 14 & Lot 15

Approximate Surface Elevation: 805 ft

GRAPHIC LOG	DESCRIPTION	DEPTH, ft.	USCS SYMBOL	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES RECOVERY, in.	SAMPLES SPT - N ** BLOWS / ft.	TESTS WATER CONTENT, %	TESTS DRY UNIT WT pcf	TESTS UNCONFINED STRENGTH, ksf	ATTERBERG LIMITS (LL,PL,PI)
	0.3 4" TOPSOIL: 804.7				PA						
	LEAN CLAY: brown, trace gray, stiff		CL	1	ST	16		24	98	4000*	31, 21, 10
	3 802										
	FAT CLAY: gray with red, stiff		CH	2	ST	12		31	91	4000*	
		5			PA						
	8 797										
	FAT CLAY: reddish brown and light gray, trace sand and gravel, possible cobbles, very stiff (Glacial Drift)		CH	3	ST	21		16	119	7000*	
		10			PA						
	12 ▼ 793										
	SANDY LEAN TO FAT CLAY: reddish brown and light gray, trace gravel, possible cobbles, stiff (Glacial Drift)		CL CH	4	ST	19		21		4000*	
		15			PA						
	▽ 17 788										
	FAT CLAY: reddish brown and light gray, trace sand and gravel, possible cobbles, very stiff (Glacial Drift)		CH	5	SS	13	19	18		7500*	
	20 785	20									
	BOTTOM OF BORING AT 20 FEET										

The stratification lines represent the approximate boundary lines between soil and rock types: in-situ, the transition may be gradual.

*Calibrated Hand Penetrometer
**CME 140H SPT automatic hammer

WATER LEVEL OBSERVATIONS, ft				
WL	▽ 16.5	WS	▼ 12	AB
WL	▽		▼	

Exhibit A-9

Terracon

BORING STARTED	12-28-10		
BORING COMPLETED	12-28-10		
RIG	550X	FOREMAN	SB
APPROVED	JMK	JOB #	09105094

BOREHOLE W FIGURE NO 09105094.GPJ GINT 001.GDT 2/18/11

BORING LOG NO. B-6

CLIENT: **Trabue Hansen & Hinshaw, Inc.**

ENGINEER: **Trabue Hansen & Hinshaw, Inc.**

SITE: **Discovery Ridge**
Columbia, Missouri

PROJECT: **Discovery Ridge - Certified Site Program**

Boring Location: Lot 10

Approximate Surface Elevation: 780 ft

GRAPHIC LOG	DESCRIPTION	DEPTH, ft.	USCS SYMBOL	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES RECOVERY, in.	SAMPLES SPT - N ** BLOWS / ft.	TESTS WATER CONTENT, %	TESTS DRY UNIT WT pcf	TESTS UNCONFINED STRENGTH, ksf
	0.3 3" TOPSOIL: 779.7				PA					
	LEAN TO FAT CLAY: light gray and reddish brown, very stiff		CL CH	1	ST	22		21	109	6000*
	3 777									
	FAT CLAY: reddish brown and light gray, trace sand and gravel, possible cobbles, trace slickensides, very stiff (Glacial Drift)		CH	2	ST	24		22	106	5000*
		5			PA					
	-- shaley texture		CH	3	SS	14	21	12		8000*
		10			PA					
			CH	4	SS	11	41	17		8000*
		15			PA					
	17 763									
	LIMESTONE***: weathered ▼									
	18.9 761.1			5	ST	5	50/5"	21		7000*
	SPLIT SPOON SAMPLER REFUSAL AT 18.9 FEET									
	***Classifications and stratigraphic boundaries estimated from disturbed samples. Core samples and petrographic analysis may reveal other rock types and stratigraphic classifications.									

The stratification lines represent the approximate boundary lines between soil and rock types: in-situ, the transition may be gradual.

*Calibrated Hand Penetrometer
**CME 140H SPT automatic hammer

WATER LEVEL OBSERVATIONS, ft				
WL	▽ None	WS	▽ 18.5	AB
WL	▽		▽	

Exhibit A-10

Terracon

BORING STARTED	12-28-10		
BORING COMPLETED	12-28-10		
RIG	550X	FOREMAN	SB
APPROVED	JMK	JOB #	09105094

BOREHOLE W FIGURE NO 09105094.GPJ GINT 001.GDT 2/18/11

BORING LOG NO. B-7

CLIENT: **Trabue Hansen & Hinshaw, Inc.**

ENGINEER: **Trabue Hansen & Hinshaw, Inc.**

SITE: **Discovery Ridge**
Columbia, Missouri

PROJECT: **Discovery Ridge - Certified Site Program**

Boring Location: Between Lot 12 & Lot 13

Approximate Surface Elevation: 790 ft

GRAPHIC LOG	DESCRIPTION	DEPTH, ft.	USCS SYMBOL	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES RECOVERY, in.	SAMPLES SPT - N ** BLOWS / ft.	TESTS WATER CONTENT, %	TESTS DRY UNIT WT pcf	TESTS UNCONFINED STRENGTH, ksf
	0.3 4" TOPSOIL: 789.7				PA					
	LEAN TO FAT CLAY: brown, trace light gray, with silt, stiff to very stiff		CL CH	1	ST	24		19	106	7000*
			CL CH	2	ST	18		17	110	5000* 2510
		5			PA					
	8 782									
	FAT CLAY: light gray with reddish brown, trace sand and gravel, possible cobbles, very stiff (Glacial Drift)		CH	3	ST	24		22	107	6500*
		10			PA					
	12.5 777.5									
	13 LIMESTONE***: weathered 777									
	AUGER REFUSAL AT 13 FEET			4	SS	0	50/0"			

***Classifications and stratigraphic boundaries estimated from disturbed samples. Core samples and petrographic analysis may reveal other rock types and stratigraphic classifications.

The stratification lines represent the approximate boundary lines between soil and rock types: in-situ, the transition may be gradual.

*Calibrated Hand Penetrometer
**CME 140H SPT automatic hammer

WATER LEVEL OBSERVATIONS, ft				
WL	▽ None	WS	▼ None	AB
WL	▽		▼	

Exhibit A-11

Terracon

BORING STARTED	12-28-10		
BORING COMPLETED	12-28-10		
RIG	550X	FOREMAN	SB
APPROVED	JMK	JOB #	09105094

BOREHOLE W FIGURE NO 09105094.GPJ GINT 001.GDT 2/18/11

BORING LOG NO. B-8

CLIENT: **Trabue Hansen & Hinshaw, Inc.**

ENGINEER: **Trabue Hansen & Hinshaw, Inc.**

SITE: **Discovery Ridge**
Columbia, Missouri

PROJECT: **Discovery Ridge - Certified Site Program**

Boring Location: Between Lot 17 & Lot 18

Approximate Surface Elevation: 815 ft

GRAPHIC LOG	DESCRIPTION	DEPTH, ft.	USCS SYMBOL	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES RECOVERY, in.	SAMPLES SPT - N ** BLOWS / ft.	TESTS WATER CONTENT, %	TESTS DRY UNIT WT pcf	TESTS UNCONFINED STRENGTH, ksf
	0.5 6" TOPSOIL: 814.5				PA					
	LEAN TO FAT CLAY: brown and gray, trace reddish brown, trace root hairs, stiff		CL CH	1	ST	14		35	85	2000*
	-- light gray and reddish brown, with silt		CL CH	2	ST	15		24	101	4000* 3330
		5			PA					
	8 807									
	FAT CLAY: light gray and reddish brown, trace black, trace sand and gravel, possible cobbles, stiff to very stiff (Glacial Drift)		CH	3	ST	24		25	103	4000* 2880
		10			PA					
			CH	4	SS	18	15	19		5000*
		15			PA					
			CH	5	SS	18	15	18		5500*
	20 795	20								
	BOTTOM OF BORING AT 20 FEET									

The stratification lines represent the approximate boundary lines between soil and rock types: in-situ, the transition may be gradual.

*Calibrated Hand Penetrometer
**CME 140H SPT automatic hammer

WATER LEVEL OBSERVATIONS, ft				
WL	▽ None	WS	▼ None	AB
WL	▽		▼	

Exhibit A-12

Terracon

BORING STARTED	2-14-11		
BORING COMPLETED	2-14-11		
RIG	550X	FOREMAN	BW
APPROVED	JMK	JOB #	09105094

BOREHOLE W/ FIGURE NO 09105094.GPJ GINT 001.GDT 2/18/11

BORING LOG NO. B-9

CLIENT: **Trabue Hansen & Hinshaw, Inc.**

ENGINEER: **Trabue Hansen & Hinshaw, Inc.**

SITE: **Discovery Ridge**
Columbia, Missouri

PROJECT: **Discovery Ridge - Certified Site Program**

Boring Location: Between Lot 6 & Lot 7

Approximate Surface Elevation: 800 ft

GRAPHIC LOG	DESCRIPTION	DEPTH, ft.	USCS SYMBOL	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES RECOVERY, in.	SAMPLES SPT - N ** BLOWS / ft.	TESTS WATER CONTENT, %	TESTS DRY UNIT WT pcf	TESTS UNCONFINED STRENGTH, ksf	ATTERBERG LIMITS (LL,PL,PI)
	0.2 2" TOPSOIL: 799.8				PA						
	LEAN TO FAT CLAY: dark brown with gray, with silt, stiff		CL CH	1	ST	14		20	105	4000*	44, 21, 23
			CL CH	2	ST	10		24	96	3000* 2050	
		5			PA						
	8 792										
	FAT CLAY: light gray and brown, with sand, trace gravel, possible cobbles, very stiff (Glacial Drift)		CH	3	ST	24		19	112	6000* 6020	
		10			PA						
	-- gray and reddish brown		CH	4	SS	18	22	19		8000*	
		15			PA						
	-- reddish brown, trace gray		CH	5	SS	13	28	20		7500*	
	20 780	20									
	BOTTOM OF BORING AT 20 FEET										

The stratification lines represent the approximate boundary lines between soil and rock types: in-situ, the transition may be gradual.

*Calibrated Hand Penetrometer
**CME 140H SPT automatic hammer

WATER LEVEL OBSERVATIONS, ft				
WL	▽ None	WS	▽ None	AB
WL	▽		▽	

Exhibit A-13

Terracon

BORING STARTED	2-14-11		
BORING COMPLETED	2-14-11		
RIG	550X	FOREMAN	BW
APPROVED	JMK	JOB #	09105094

BOREHOLE W FIGURE NO 09105094.GPJ GINT 001.GDT 2/18/11

Field Exploration Description

The proposed boring locations were laid out in the field by a Terracon engineer using a scaled site plan provided by the client and measuring from existing site features. The ground surface elevations at the boring locations were interpolated from a topographic map provided by the client. The elevations included on the boring logs are approximate and have been rounded to the nearest 5-foot. The locations and elevations of the borings should be considered accurate only to the degree implied by the means and methods used to define them.

The borings were drilled with an ATV-mounted rotary drill rig using continuous flight solid-stem augers to advance the boreholes. Samples of the soil encountered in the borings were obtained using the split-barrel and thin-walled tube sampling procedures.

In the split-barrel sampling procedure, the number of blows required to advance a standard 2-inch O.D. split-barrel sampler the last 12 inches of the typical total 18-inch penetration by means of a 140-pound hammer with a free fall of 30 inches, is the standard penetration resistance value (SPT-N). This value is used to estimate the in-situ relative density of cohesionless soils and consistency of cohesive soils.

A CME automatic SPT hammer was used to advance the split-barrel sampler in the borings performed on this site. A significantly greater efficiency is achieved with the automatic hammer compared to the conventional safety hammer operated with a cathead and rope. This higher efficiency has an appreciable effect on the SPT-N value. The effect of the automatic hammer's efficiency has been considered in the interpretation and analysis of the subsurface information for this report.

In the thin-walled tube sampling procedure, a thin-walled, seamless steel tube with a sharp cutting edge is pushed hydraulically in to the soil to obtain a relatively undisturbed sample. The samples were tagged for identification, sealed to reduce moisture loss, and taken to our laboratory for further examination, testing, and classification. Information provided on the boring logs attached to this report includes soil descriptions, consistency evaluations, boring depths, sampling intervals, and groundwater conditions. The borings were backfilled with auger cuttings prior to the drill crew leaving the site.

A field log of each boring was prepared by the drill crew. These logs included visual classifications of the materials encountered during drilling as well as the driller's interpretation of the subsurface conditions between samples. Final boring logs included with this report represent the engineer's interpretation of the field logs and include modifications based on laboratory observation and tests of the samples.

APPENDIX B
LABORATORY TESTING

Laboratory Testing

Soil samples were tested in the laboratory to measure their dry unit weight and natural water content. Unconfined compression tests were performed on selected samples and a calibrated hand penetrometer was used to estimate the approximate unconfined compressive strength of some samples. The calibrated hand penetrometer has been correlated with unconfined compression tests and provides a better estimate of soil consistency than visual examination alone. The test results are provided on the boring logs included in Appendix A.

Descriptive classifications of the soils indicated on the boring logs are in accordance with the enclosed General Notes and the Unified Soil Classification System. Also shown are estimated Unified Soil Classification Symbols. A brief description of this classification system is attached to this report. All classification was by visual manual procedures. Selected samples were further classified using the results of Atterberg limit testing. The Atterberg limit test results are also provided on the boring logs.

APPENDIX C
SUPPORTING DOCUMENTS

GENERAL NOTES

DRILLING & SAMPLING SYMBOLS:

SS:	Split Spoon - 1-3/8" I.D., 2" O.D., unless otherwise noted	HS:	Hollow Stem Auger
ST:	Thin-Walled Tube – 2" O.D., 3" O.D., unless otherwise noted	PA:	Power Auger (Solid Stem)
RS:	Ring Sampler - 2.42" I.D., 3" O.D., unless otherwise noted	HA:	Hand Auger
DB:	Diamond Bit Coring - 4", N, B	RB:	Rock Bit
BS:	Bulk Sample or Auger Sample	WB	Wash Boring or Mud Rotary

The number of blows required to advance a standard 2-inch O.D. split-spoon sampler (SS) the last 12 inches of the total 18-inch penetration with a 140-pound hammer falling 30 inches is considered the "Standard Penetration" or "N-value".

WATER LEVEL MEASUREMENT SYMBOLS:

WL:	Water Level	WS:	While Sampling	BCR:	Before Casing Removal
WCI:	Wet Cave in	WD:	While Drilling	ACR:	After Casing Removal
DCI:	Dry Cave in	AB:	After Boring	N/E:	Not Encountered

Water levels indicated on the boring logs are the levels measured in the borings at the times indicated. Groundwater levels at other times and other locations across the site could vary. In pervious soils, the indicated levels may reflect the location of groundwater. In low permeability soils, the accurate determination of groundwater levels may not be possible with only short-term observations.

DESCRIPTIVE SOIL CLASSIFICATION: Soil classification is based on the Unified Soil Classification System. Coarse Grained Soils have more than 50% of their dry weight retained on a #200 sieve; their principal descriptors are: boulders, cobbles, gravel or sand. Fine Grained Soils have less than 50% of their dry weight retained on a #200 sieve; they are principally described as clays if they are plastic, and silts if they are slightly plastic or non-plastic. Major constituents may be added as modifiers and minor constituents may be added according to the relative proportions based on grain size. In addition to gradation, coarse-grained soils are defined on the basis of their in-place relative density and fine-grained soils on the basis of their consistency.

CONSISTENCY OF FINE-GRAINED SOILS

Unconfined Compressive Strength, Qu, psf	Standard Penetration or N-value (SS) Blows/Ft.	Consistency
< 500	0 - 1	Very Soft
500 – 1,000	2 - 4	Soft
1,000 – 2,000	4 - 8	Medium Stiff
2,000 – 4,000	8 - 15	Stiff
4,000 – 8,000	15 - 30	Very Stiff
8,000+	> 30	Hard

RELATIVE DENSITY OF COARSE-GRAINED SOILS

Standard Penetration or N-value (SS) Blows/Ft.	Relative Density
0 – 3	Very Loose
4 – 9	Loose
10 – 29	Medium Dense
30 – 50	Dense
> 50	Very Dense

RELATIVE PROPORTIONS OF SAND AND GRAVEL

Descriptive Term(s) of other constituents	Percent of Dry Weight
Trace	< 15
With	15 – 29
Modifier	≥ 30

GRAIN SIZE TERMINOLOGY

Major Component of Sample	Particle Size
Boulders	Over 12 in. (300mm)
Cobbles	12 in. to 3 in. (300mm to 75mm)
Gravel	3 in. to #4 sieve (75mm to 4.75mm)
Sand	#4 to #200 sieve (4.75 to 0.075mm)
Silt or Clay	Passing #200 Sieve (0.075mm)

RELATIVE PROPORTIONS OF FINES

Descriptive Term(s) of other constituents	Percent of Dry Weight
Trace	< 5
With	5 – 12
Modifier	> 12

PLASTICITY DESCRIPTION

Term	Plasticity Index
Non-plastic	0
Low	1-10
Medium	11-30
High	> 30

UNIFIED SOIL CLASSIFICATION SYSTEM

Criteria for Assigning Group Symbols and Group Names Using Laboratory Tests [A]					Soil Classification	
					Group Symbol	Group Name [B]
Coarse Grained Soils: More than 50% retained on No. 200 sieve	**Gravels:** More than 50% of coarse fraction retained on No. 4 sieve	**Clean Gravels:** Less than 5% fines [C]	$Cu \geq 4$ and $1 \leq Cc \leq 3$ [E]		GW	Well-graded gravel [F]
			$Cu < 4$ and/or $1 > Cc > 3$ [E]		GP	Poorly graded gravel [F]
		Gravels with Fines: More than 12% fines [C]	Fines classify as ML or MH		GM	Silty gravel [F,G,H]
			Fines classify as CL or CH		GC	Clayey gravel [F,G,H]
	Sands: 50% or more of coarse fraction passes No. 4 sieve	**Clean Sands:** Less than 5% fines [D]	$Cu \geq 6$ and $1 \leq Cc \leq 3$ [E]		SW	Well-graded sand [I]
			$Cu < 6$ and/or $1 > Cc > 3$ [E]		SP	Poorly graded sand [I]
		Sands with Fines: More than 12% fines [D]	Fines classify as ML or MH		SM	Silty sand [G,H,I]
			Fines classify as CL or CH		SC	Clayey sand [G,H,I]
Fine-Grained Soils: 50% or more passes the No. 200 sieve	**Silts and Clays:** Liquid limit less than 50	**Inorganic:**	PI > 7 and plots on or above "A" line [J]		CL	Lean clay [K,L,M]
			PI < 4 or plots below "A" line [J]		ML	Silt [K,L,M]
		Organic:	Liquid limit - oven dried / Liquid limit - not dried	< 0.75	OL	Organic clay [K,L,M,N] / Organic silt [K,L,M,O]
	Silts and Clays: Liquid limit 50 or more	**Inorganic:**	PI plots on or above "A" line		CH	Fat clay [K,L,M]
			PI plots below "A" line		MH	Elastic Silt [K,L,M]
		Organic:	Liquid limit - oven dried / Liquid limit - not dried	< 0.75	OH	Organic clay [K,L,M,P] / Organic silt [K,L,M,Q]
Highly organic soils:	Primarily organic matter, dark in color, and organic odor				PT	Peat

[A] Based on the material passing the 3-inch (75-mm) sieve

[B] If field sample contained cobbles or boulders, or both, add "with cobbles or boulders, or both" to group name.

[C] Gravels with 5 to 12% fines require dual symbols: GW-GM well-graded gravel with silt, GW-GC well-graded gravel with clay, GP-GM poorly graded gravel with silt, GP-GC poorly graded gravel with clay.

[D] Sands with 5 to 12% fines require dual symbols: SW-SM well-graded sand with silt, SW-SC well-graded sand with clay, SP-SM poorly graded sand with silt, SP-SC poorly graded sand with clay

[E] $Cu = D_{60}/D_{10}$ $\quad Cc = \dfrac{(D_{30})^2}{D_{10} \times D_{60}}$

[F] If soil contains ≥ 15% sand, add "with sand" to group name.

[G] If fines classify as CL-ML, use dual symbol GC-GM, or SC-SM.

[H] If fines are organic, add "with organic fines" to group name.

[I] If soil contains ≥ 15% gravel, add "with gravel" to group name.

[J] If Atterberg limits plot in shaded area, soil is a CL-ML, silty clay.

[K] If soil contains 15 to 29% plus No. 200, add "with sand" or "with gravel," whichever is predominant.

[L] If soil contains ≥ 30% plus No. 200 predominantly sand, add "sandy" to group name.

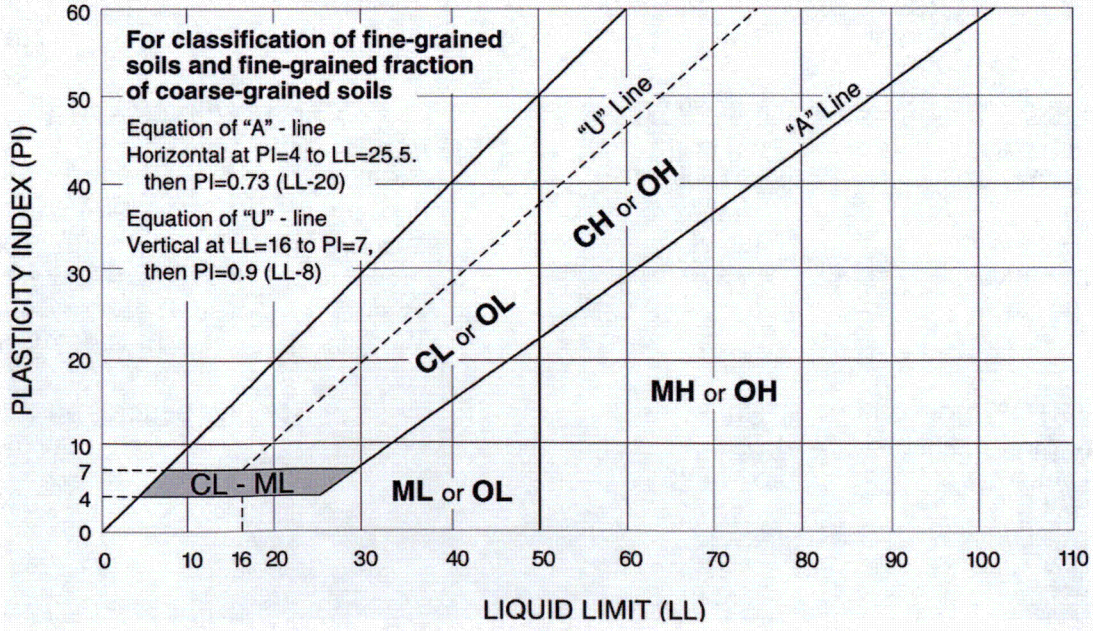
[M] If soil contains ≥ 30% plus No. 200, predominantly gravel, add "gravelly" to group name.

[N] PI ≥ 4 and plots on or above "A" line.

[O] PI < 4 or plots below "A" line.

[P] PI plots on or above "A" line.

[Q] PI plots below "A" line.



Terracon

Exhibit C-2

GENERAL NOTES

Description of Rock Properties

WEATHERING

Fresh	Rock fresh, crystals bright, few joints may show slight staining. Rock rings under hammer if crystalline.
Very slight	Rock generally fresh, joints stained, some joints may show thin clay coatings, crystals in broken face show bright. Rock rings under hammer if crystalline.
Slight	Rock generally fresh, joints stained, and discoloration extends into rock up to 1 in. Joints may contain clay. In granitoid rocks some occasional feldspar crystals are dull and discolored. Crystalline rocks ring under hammer.
Moderate	Significant portions of rock show discoloration and weathering effects. In granitoid rocks, most feldspars are dull and discolored; some show clayey. Rock has dull sound under hammer and shows significant loss of strength as compared with fresh rock.
Moderately severe	All rock except quartz discolored or stained. In granitoid rocks, all feldspars dull and discolored and majority show kaolinization. Rock shows severe loss of strength and can be excavated with geologist's pick.
Severe	All rock except quartz discolored or stained. Rock "fabric" clear and evident, but reduced in strength to strong soil. In granitoid rocks, all feldspars kaolinized to some extent. Some fragments of strong rock usually left.
Very severe	All rock except quartz discolored or stained. Rock "fabric" discernible, but mass effectively reduced to "soil" with only fragments of strong rock remaining.
Complete	Rock reduced to "soil". Rock "fabric" not discernible or discernible only in small, scattered locations. Quartz may be present as dikes or stringers.

HARDNESS (for engineering description of rock – not to be confused with Moh's scale for minerals)

Very hard	Cannot be scratched with knife or sharp pick. Breaking of hand specimens requires several hard blows of geologist's pick.
Hard	Can be scratched with knife or pick only with difficulty. Hard blow of hammer required to detach hand specimen.
Moderately hard	Can be scratched with knife or pick. Gouges or grooves to ¼ in. deep can be excavated by hard blow of point of a geologist's pick. Hand specimens can be detached by moderate blow.
Medium	Can be grooved or gouged 1/16 in. deep by firm pressure on knife or pick point. Can be excavated in small chips to pieces about 1-in. maximum size by hard blows of the point of a geologist's pick.
Soft	Can be gouged or grooved readily with knife or pick point. Can be excavated in chips to pieces several inches in size by moderate blows of a pick point. Small thin pieces can be broken by finger pressure.
Very soft	Can be carved with knife. Can be excavated readily with point of pick. Pieces 1-in. or more in thickness can be broken with finger pressure. Can be scratched readily by fingernail.

Joint, Bedding, and Foliation Spacing in Rock [a]		
Spacing	**Joints**	**Bedding/Foliation**
Less than 2 in.	Very close	Very thin
2 in. – 1 ft.	Close	Thin
1 ft. – 3 ft.	Moderately close	Medium
3 ft. – 10 ft.	Wide	Thick
More than 10 ft.	Very wide	Very thick

a. Spacing refers to the distance normal to the planes, of the described feature, which are parallel to each other or nearly so.

Rock Quality Designator (RQD) a	
RQD, as a percentage	**Diagnostic description**
Exceeding 90	Excellent
90 – 75	Good
75 – 50	Fair
50 – 25	Poor
Less than 25	Very poor

a. RQD (given as a percentage) = length of core in pieces 4 in. and longer/length of run.

Joint Openness Descriptors	
Openness	**Descriptor**
No Visible Separation	Tight
Less than 1/32 in.	Slightly Open
1/32 to 1/8 in.	Moderately Open
1/8 to 3/8 in.	Open
3/8 in. to 0.1 ft.	Moderately Wide
Greater than 0.1 ft.	Wide

References: American Society of Civil Engineers. Manuals and Reports on Engineering Practice - No. 56. Subsurface Investigation for Design and Construction of Foundations of Buildings. New York: American Society of Civil Engineers, 1976. U.S. Department of the Interior, Bureau of Reclamation, Engineering Geology Field Manual.

February 21, 2011

MISSOURI DEPARTMENT OF NATURAL RESOURCES
STATE HISTORIC PRESERVATION OFFICE
Attn: Section 106 Review
P.O. Box 176
Jefferson City, Missouri 65102-0176

RE: Request for **Additional** Review
MDNR SHPO project number: 015-BO-11
Section 106 Review
Discovery Ridge
Lots 2, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, and 18
Discovery Drive and Discovery Ridge Parkway
Columbia, Boone County, Missouri
T 48N N, R 12W, Sec 33, N ½
Terracon Project No.: 09117701

Terracon Consultants, Inc. (Terracon), on behalf of the Trabue, Hansen & Hinshaw, Inc and the University of Missouri Research Parks – University of Missouri Systems, is assisting with a preconstruction Phase 1 Environmental Site Assessment for a proposed expansion of the current scientific research park, Discovery Ridge, located on a portion of a historic University of Missouri research farm at Discovery Drive and Discovery Ridge Parkway, east of U.S. Highway 63 in the vicinity of the southern limits of Columbia, Missouri.

We are enclosing a Section 106 Project Information Form, A section of the topographic map which includes the subject site, a developmental phasing plan, and photographs of the on-site metal machine shed type buildings located on Lot 17 and the quacent hut building located on Lot 5. Additionally, photos have been included of structures located on properties adjacent to the site. Please review your records and files to determine if historic features are located on the site.

The site has historically been agricultural land associated with a University of Missouri research farm. Portions of the site, which are located within Phase I of the project, have been graded to construct vacant lots suitable for development. We would appreciate a response within 30 days following receipt of this information. If you have any questions or wish to discuss this submittal, please contact me.

Sincerely,
Terracon
Adam White
Adam J. White
Staff Environmental Scientist

Enclosure

MISSOURI DEPARTMENT OF NATURAL RESOURCES
STATE HISTORIC PRESERVATION OFFICE

SECTION 106 PROJECT INFORMATION FORM

Submission of a completed Project Information Form with adequate information and attachments constitutes a request for a review pursuant to Section 106 of the National Historic Preservation Act of 1966 (as amended). We reserve the right to request more information. **Please refer to the CHECKLIST on Page 2 to ensure that all basic information relevant to the project has been included.** For further information, refer to our website at: http://dnr.mo.gov/shpo and follow the links to Section 106 Review.

NOTE: Section 106 regulations provide for a 30-day response time by the Missouri State Historic Preservation Office from the date of receipt.

PROJECT NAME

Discovery Ridge Lots 2, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, and 18

FEDERAL AGENCY PROVIDING FUNDS, LICENSE, OR PERMIT

APPLICANT	TELEPHONE
Trabue, Hasen & Hinshaw, Inc. and the University of Missouri, Research Parks - UM Systems	
CONTACT PERSON	**TELEPHONE**
Terracon - Adam J. White	(573) 214-2677

ADDRESS FOR RESPONSE

Terracon
3601 Mojave Court, Suite A
Columbia, MO 65203

LOCATION OF PROJECT

COUNTY

Boone

STREET ADDRESS	CITY
Discovery Drive and Discovery Ridge Parkway (land associated with UM research farm)	Columbia

LEGAL DESCRIPTION OF PROJECT AREA (TOWNSHIP, RANGE, SECTION, ¼ SECTION)

USGS TOPOGRAPHIC MAP QUADRANGLE NAME (SEE MAP REQUIREMENTS ON PAGE 2)

Columbia, Missouri

YEAR	TOWNSHIP	RANGE	SECTION
1981	48 North	12 West	33

PROJECT DESCRIPTION

DESCRIBE THE OVERALL PROJECT IN DETAIL. IF IT INVOLVES EXCAVATION, INDICATE HOW WIDE, HOW DEEP, ETC. IF THE PROJECT INVOLVES DEMOLITION OF EXISTING BUILDINGS, MAKE THAT CLEAR. IF THE PROJECT INVOLVES REHABILITATION, DESCRIBE THE PROPOSED WORK IN DETAIL. USE ADDITIONAL PAGES IF NECESSARY.

The site consist of 15 lots. Eight of the lots (Lots 2, 5, 6, 7, 8, 9, 10, and 11) are located within Phase I of the research park development plan. Of the lots located within Phase I of the developmental plan, Lots 2, 6, 7, and 8 have been graded to construct vacant lots suitable for development, additional, Lot 9 is currently in the process of being graded to facility a lot suitable for development. Currently lot 5 is the location of a quacent hut type building. Seven of the lots that comprise the site (Lots 12, 13, 14, 15, 16, 17, and 18) are located within Phase II of the developmental plan and consist of vacant grass covered farm land utilized as grazing pasture for livestock and row crop research. Currently Lot 17 is the location of two small metal machine sheds and one large machine shed type buildings. Historically a residential structure, and four small metal machine sheds were located at the site starting between 1939-1968 with the residence being removed in 2001 and two of the machine sheds being removed in 2007. Historically the site has been utilized as farm land associated with a University of Missouri research farm (South Farms). Beginning in the early 2000s the area surrounding the site has been utilized as Discovery Ridge, a scientific research park . The applicant is investigating the site for expanded use as a scientific research park.

ARCHAEOLOGY (EARTHMOVING ACTIVITIES)

HAS THE GROUND INVOLVED BEEN GRADED, BUILT ON, BORROWED, OR OTHERWISE DISTURBED? PLEASE DESCRIBE IN DETAIL (USE ADDITIONAL PAGES, IF NECESSARY) PHOTOGRAPHS ARE HELPFUL:

The site has historically been farmed associated with a University of Missouri research farm. During the early 2000s portions of the lots that comprise Phase I of the site were graded to construct multiple vacant building lots suitable for development. Currently lots located within Phase II of the developmental plan are vacant grass covered land with portion utilized for row crop research.

WILL THE PROJECT REQUIRE FILL MATERIAL? ☐ YES ☐ NO
IF **YES**, INDICATE PROPOSED BORROW AREAS (SOURCE OF FILL MATERIAL) ON TOPOGRAPHIC MAP

ARE YOU AWARE OF ARCHAEOLOGICAL SITES ON OR ADJACENT TO PROJECT AREA? ☐ YES ☑ NO
IF **YES**, IDENTIFY THEM ON THE TOPOGRAPHIC MAP

STRUCTURES (REHABILITATION, DEMOLOTION, ADDITIONS TO, OR CONTRUCTION NEAR EXISTING STRUCTURES)

TO THE BEST OF YOUR KNOWLEDGE, IS THE STRUCTURE LOCATED IN ANY OF THE FOLLOWING?

☐ AN AREA PREVIOUSLY SURVEYED FOR HISTORIC PROPERTIES.	☐ A NATIONAL REGISTER DISTRICT	☐ A LOCAL HISTORIC DISTRICT
IF YES, PLEASE PROVIDE THE NAME OF THE SURVEY OR DISTRICT:	IF YES, PLEASE PROVIDE THE NAME OF THE SURVEY OR DISTRICT:	IF YES, PLEASE PROVIDE THE NAME OF THE SURVEY OR DISTRICT:

- PLEASE PROVIDE PHOTOGRAPHS OF ALL STRUCTURES, SEE PHOTOGRAPHY REQUIREMENTS
- **NOTE:** ALL PHOTOGRAPHS SHOULD BE LABELED AND KEYED TO ONE MAP OF THE PROJECT AREA
- PLEASE PROVIDE A BRIEF HISTORY OF THE BUILDING(S), INCLUDING CONSTRUCTION DATES AND BUILDING USES. (USE ADDITONAL PAGES, IF NECESSARY.)

ADDITIONAL REQUIREMENTS

Map Requirements: Attach a copy of the relevant portion (8 ½ x 11) of the current USGS 7.5 min. topographic map **and**, if necessary, a large scale project map. Please do not send an individual map with each structure or site. While an original map is preferable, a good copy is acceptable. For a list of sites from which to order, download or print the required USGS 7.5 min. topographic maps at little or no cost, consult http://dnr.mo.gov/shpo/sectionrev.htm .

Photography Requirements: Clear black and white or color photographs (minimum 3" x 5") are acceptable. Polariods, photocopies, emailed or faxed photographs are not acceptable. **Good quality photographs are important for expeditious project review.** Photographs of neighboring or nearby buildings are also helpful. All photographs should be labeled and keyed to one map of the project area.

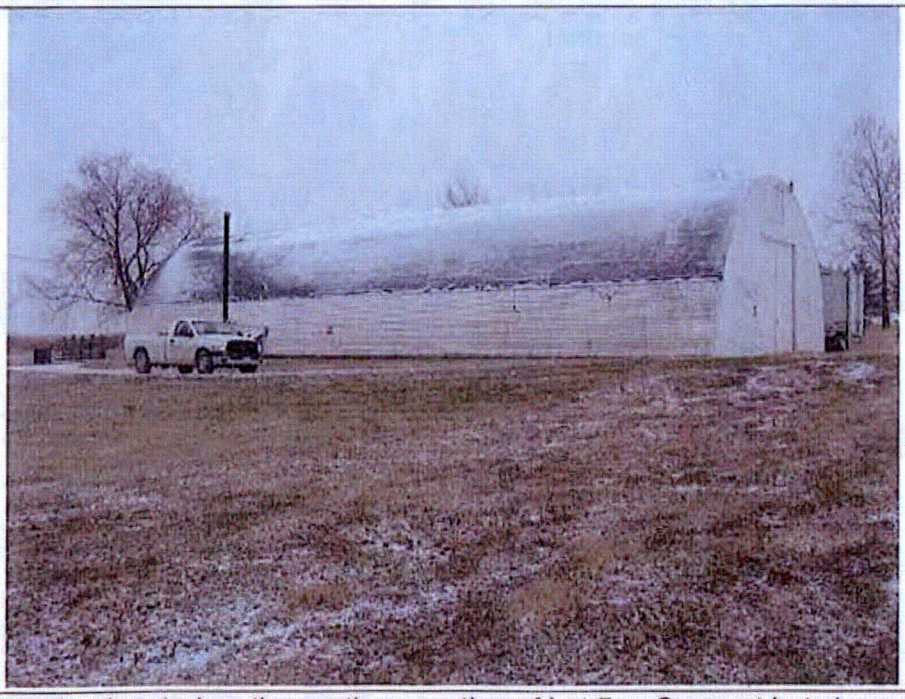
CHECKLIST-DID YOU PROVIDE THE FOLLOWING INFORMATION?

☑ Topographic map 7.5 min. (per project, not structure)	☑ Other supporting documents (If necessary to explain the project)
☐ Thorough description (all projects)	☐ For new construction, rehabilitations, etc., attach work write-ups, plans, drawings, etc.
☑ Photographs (all structures)	☑ Is topographic map identified by quadrangle and year?

Return this Form and Attachments to:

MISSOUR DEPARTMENT OF NATURAL RESOURCES
STATE HISTORIC PRESERVATION OFFICE
Attn: Section 106 Review
P.O. BOX 176
JEFFERSON CITY, MISSOURI 65102-0176

Quacent hut building located on the southern portion of Lot 5. Quacent hut viewed from the south adjoining property. Quacent hut constructed between 1980 and 1992.



Quacent hut building located on the southern portion of Lot 5. Quacent hut viewed from the west portion of Lot 5. Quacent hut constructed between 1980 and 1992.

Trailer park located west of Lots 5, and 16. Trailer park established between 1956 and 1968. Trailer park viewed from the western portion of Lot 5.

Trailer park located west of Lots 5, and 16. Trailer park established between 1956 and 1968. Trailer park viewed from the western portion of Lot 5.

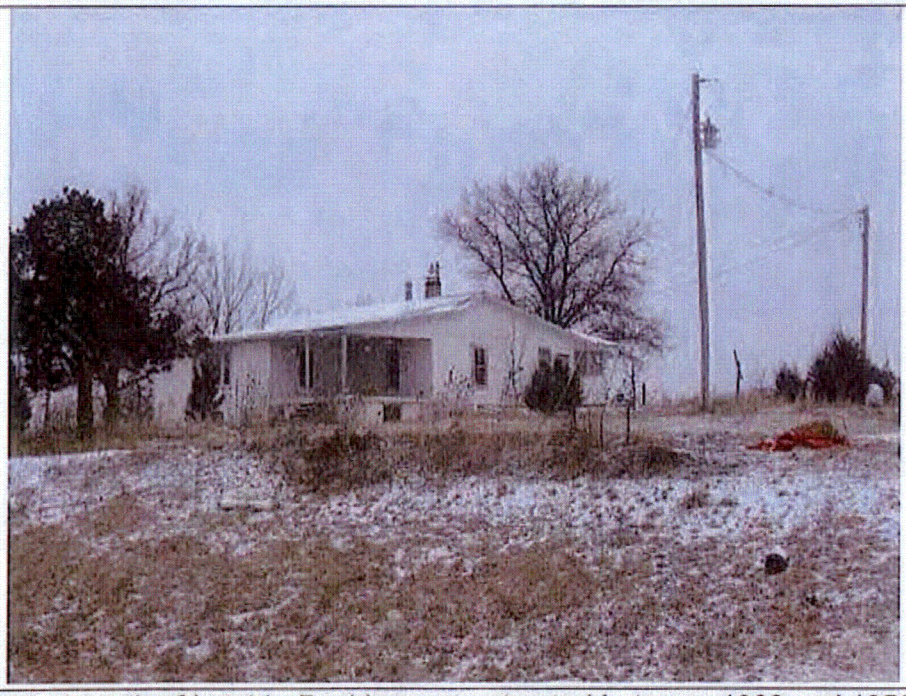
University of Missouri Civil Engineering research building located east of Lot 5. Building constructed between 1956 and 1968.

Metal sided USDA building located within the vicinity of the University of Missouri Civil Engineering research building and east of Lot 5. Building constructed between 1995 and 2002.

ABC Lab building located west of Lot 2. Building constructed between 2002 and 2007. Building viewed from Discovery Drive.

Radil building located east of Lot 2. Building constructed between 2002 and 2007. Building viewed from the intersection of Discovery Drive and Discovery Parkway.

Residence located south of Lot 11. Residence constructed between 1939 and 1956. Residence viewed from US Highway 63, southwest of the structure.



Residence located south of Lot 11. Residence constructed between 1939 and 1956. Residence viewed from US Highway 63, southwest of the structure.

Residence located south of Lot 11. Residence constructed between 1939 and 1956.
Residence viewed from Lot 11, north of the structure.

Barn located south of the residence south of Lot 11. Barn constructed between 1939 and 1956.
Barn viewed from US Highway 63, southwest of the structure.

Residence located south of Lot 11. Residence constructed between 1939 and 1956. Residence viewed from Lot 11 looking southwest.

Barn located south of Lot 11. Barn constructed between 1939 and 1956. Barn viewed from Lot 11 looking southwest.

Large metal machine shed structure located on Lot 17. Machine shed placed on-site in approximately 2007. Machine shed viewed from the north adjoining property.

Large metal machine shed structure located on Lot 17. Machine shed placed on-site in approximately 2007. Machine shed viewed from the north adjoining property.

Two small metal machine sheds located on Lot 17. Small metal machine sheds constructed between 1939 and 1968.

Eastern small metal machine sheds located on Lot 17. Machine shed constructed between 1939 and 1968.

Western small metal machine sheds located on Lot 17. Machine shed constructed between 1939 and 1968.