Cardno ATC

Shaping the Future

REPORT OF KARST FEATURE SURVEY

PROPOSED BALL HOMES DEVELOPMENT
ST. JOSEPH ORPHANAGE SITE
FACTORY LANE
LOUISVILLE, JEFFERSON COUNTY, KENTUCKY

CARDNO ATC PROJECT NO. Z027000112

JUNE 4, 2015

PREPARED FOR:

MR. BRIAN STEPHENS
BALL HOMES
3609 WALDEN DRIVE
LEXINGTON, KY 40517

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July 4, 2015

Ball Homes
3609 Walden Drive
Lexington, KY 40517
Phone: 859-268-1191

Attention: Brian Stephens

Subject: **Proposed Ball Homes Development**
St. Joseph Orphanage Site
Louisville, Jefferson County, Kentucky
Cardno Project No. Z027000112

Dear Mr. Stephens:

Cardno ATC has completed a karst reconnaissance at the proposed Ball Homes St. Joseph Orphanage Site in Louisville, Jefferson County, Kentucky. These services were provided in accordance with Cardno Proposal Number 020146420 dated April 1, 2015.

The attached report presents a review of the project information provided to us, a description of the site and geologic conditions, a summary of the karst features found on the site, and a brief discussion of the impact of the observed solution features on the proposed site development.

Cardno appreciates the opportunity to provide these services and we look forward to serving as your geotechnical consultant throughout this project. If there are any questions, or if additional information is required, please call.

Sincerely,

ATC Associates, Inc.

Travis J. Andres, P.E.
Senior Geotechnical Engineer
Licensed Kentucky 29429

Mark Edmonson, P.E.
Branch Manager

Attachment: Report of Karst Feature Survey

TABLE OF CONTENTS

1. PROJECT INFORMATION

The site consists of approximately 122-acres of undeveloped property located at 13605 and 13615 Factory Lane, in northeast Jefferson County, Louisville, Kentucky. The site was undeveloped and covered with a combination of harvested agricultural land, grassland, and wooded areas at the time of our site reconnaissance. We understand a residential development is planned for the site and potential karstic features and steep slopes along with management/remediation of such may influence future site development.

This Karst Evaluation was performed in part to satisfy Chapter 4, Parts 7 and 9of the Land Development Code for Louisville Metro, Jefferson County, Kentucky.

2. SURFACE CONDITIONS

Our field reconnaissance activities were performed by Travis Andres, P.E. and Dylan Durbin of Cardno ATC on April 13 and 23 of 2015. The purpose of the reconnaissance was to observe and document surface conditions at the site. The information gathered was used to help us interpret the geologic data and to detect conditions which could affect our recommendations.

In general the site drains from two highpoints on the north end of the property (595 feet MSL) to southwest property corner (586 MSL) adjacent to I-264. A broad, very gently sloping swale separates the topographic highpoints and traverses the site from northeast to southwest at a 0.3 percent slope. The remainder of the site is flat lying with slopes of less than 0.5 percent over most of the site.

The majority of the site included harvested agricultural land and heavily vegetated brush and wooded areas with some grassland. The thick vegetation obscured the ground surface throughout many areas of the site. Our reconnaissance was based in part on visual observations of karst features. We anticipate some additional features were obscured by vegetation during our site walkover and may be discovered during site clearing and earthwork.

3. DATA REVIEW

3.1 SOIL SURVEY

The United States Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) Custom Soil Resource Report for Jefferson County, Kentucky was assembled and referenced. The following near-surface soil types are mapped at the site:

Soil Survey Soil Types

Map Symbol	Soil Type	Slopes	% of Site, approx.
CaD2	Caneyville Silt Loam	12-15%	38.8
NnB	Bedford Silt Loam	2-6%	31.5
Bo	Boonewood Silt Loam	Occasionally Flooded	7.8
CaC2	Caneyville Silt Loam	6-12%	3.2
CrB	Crider Silt Loam	2-6%	2.4
SaB	Sandview Silt Loam	2-6%	1.5
BeC	Beasley Silt Loam	6-12%	0.5

The Caneyville Series consists of well drained soils formed in clay residuum weathered from limestone. Typical landforms in this series include ridges, shoulders, hills, back slopes and sideslopes. The series develops a fragipan at a depth of about 16 inches.

The Bedford Series consists of moderately well drained soils formed in loess over loamy loess over clay residuum, typically in hills and sideslopes.

The Boonewood Series consists of well drained soils formed in alluvium over limestone residuum. These soils typically are present in flood plains.

The Crider Series consists of deep, well drained soils formed in loess over clayey residuum weathered from limestone and dolomite, typically in ridges and interfluve.

The Sandview Series consists of well drained soils formed in loess over clayey residuum weathered from limestone and dolomite, typically in ridges and interfluve.

The Beasley Series consists of well drained soils formed in clay residuum weathered from calcareous shale and siltstone. These soils typically are present as ridges and side slopes.

3.2 SITE GEOLOGY

The site lies in the Outer Bluegrass Physiographic region of Kentucky which is characterized by the presence of late Ordovician aged limestone rock that is frequently interbedded with layers of shale. The bedding planes in the underlying rock units are nearly horizontal, dipping gradually in elevation to the north and to the west at a rate of about 1 foot vertically per 200 to 300 feet horizontally.

A review of the *Geologic Map of the Crestwood Quadrangle, Kentucky* by Roy C. Kepferle, 1976 (a portion of which is provided as Figure 1) published by the United States Geological Survey (USGS), indicates the site is underlain by the Louisville Limestone formation (Slv). The Louisville Limestone is mapped below the Jeffersonville Limestone and is described as dolomitic limestone and dolomite, which is gray to light olive gray in color, is fossiliferous and thin to very thin bedded in the upper part, and thick bedded near the base. The upper few feet of the formation contains chert in thin discontinuous layers. The limestone formation is susceptible to differential weathering sometimes resulting in rock pinnacles and soil-filled slots, sinks, and possible formation of springs.

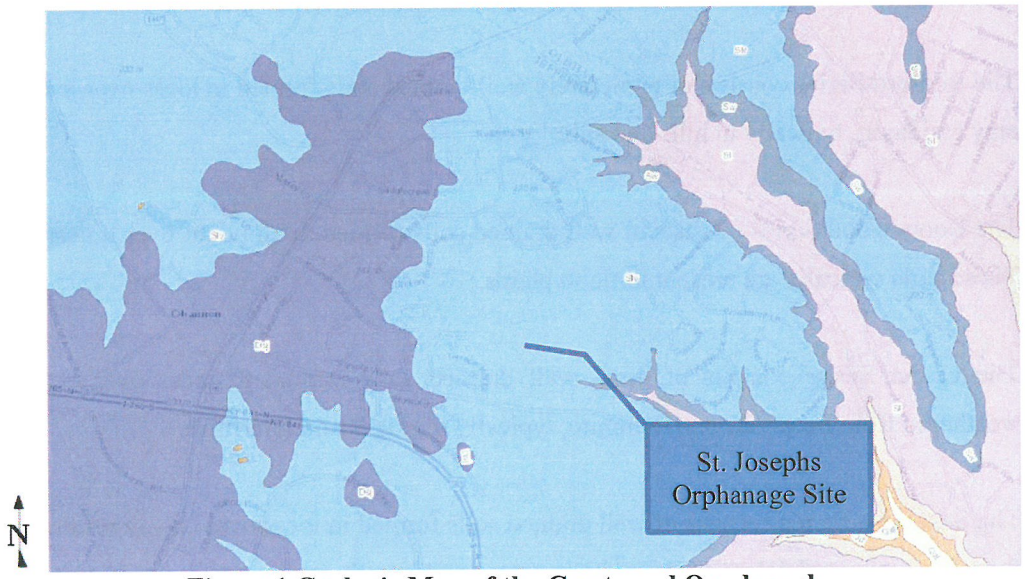


Figure 1 Geologic Map of the Crestwood Quadrangle

The Waldron Shale formation is present below the Louisville Limestone in the southeastern corner of the site and is described as clay shale, greenish gray, silty, dolomitic, pyritic, thin to very thin bedded, and weathers to yellowish gray clay. Site topography in areas underlain by Waldron Shale

are generally gentle slopes on broad benches of Laurel Dolomite. The unit is marked by low permeability soils and rock where farm ponds and low marshy areas are common.

4. KARST POTENTIAL

The proposed development site is underlain by limestone rock deposits (described above) which are locally known for the potential to develop Karstic features such as sinkholes. Figure 2 shows a map of eastern Jefferson County prepared by the Kentucky Geologic Survey. The map displays the areas of known karstic activity near the proposed development site and indicates the project area as having a medium potential for karstic activity. The nearest known karstic activity is mapped about 1 mile to the southwest of the south site. However it is not uncommon for karstic features to exist and not be displayed by this map. Based on our experience and the presence of the limestone rock formations underlying the site there is a potential for Karstic activity to be present at this site.

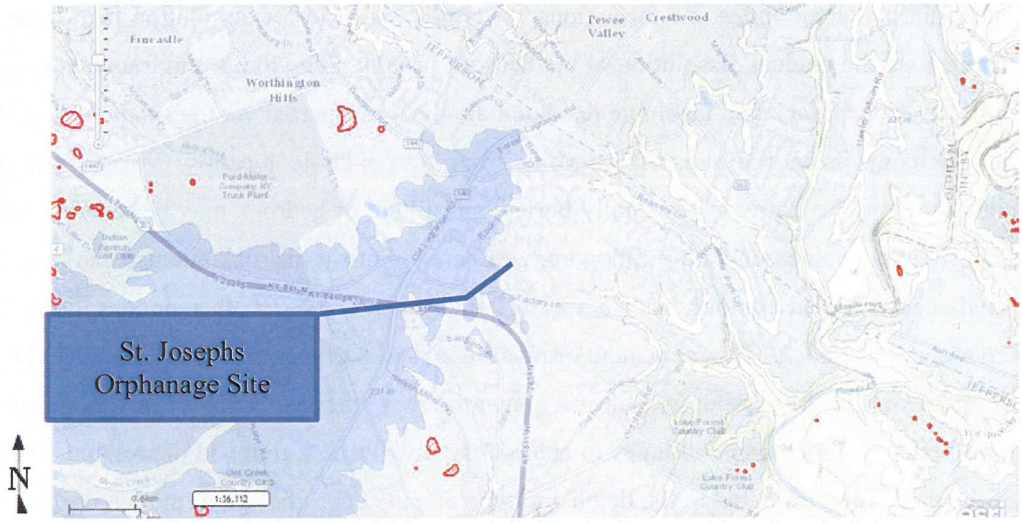


Figure 2, Karst Potential Map (red indicates known Karst activity)

4.1 SINKHOLE DEVELOPMENT

Solution activity in areas underlain by limestone generally results from a gradual process of dissolving underlying limestone rock units by slightly acidic rain water. This process takes hundreds to thousands of years to develop but may result in the formation of caves in the subsurface and sinkholes at the ground surface. Sinkholes are defined by the Jefferson County Land Development Code (LDC) as follows: *Any closed depression in soil or bedrock formed by the erosion and transport of earth material from below the land surface, which is circumscribed by a closed topographic contour and drains to the sub-surface.*

Sinkholes at the ground surface are caused from either a general raveling of the overlying soil into voids in the underlying rock or by a cover collapse, both of which are described below in further detail. Either phenomena typically results in depressions at the ground surface, which if large enough, can be identified on topographic maps. In addition to the natural causes of sinkhole development, sinkholes may also form as a result from fluids leaking from subsurface piping and drainage systems such as buried water and sewer pipes, septic lateral fields, and roof drains beneath the building and floor slabs. The attached *Karst Diagram of the Inner Bluegrass* illustrates features which are common to Karstic areas.

4.1.1 Dissolution Feature

Dissolution features are the most common ground subsidence phenomena associated with areas underlain by karstic limestone formations. A typical scenario for dissolution feature development begins with the gradual dissolution of the bedrock usually along joints and fractures in the bedrock units. Dissolved rock and insoluble residuum are then transported via the *sinkhole throat* and *karst aquifer* conduits in the subsurface, away from the sinkhole location. Variants of dissolution sinkholes may be expressed as totally buried, soil filled, or bedrock may be totally exposed. The features may be linear in nature following weathered joints in the rock but also can have the classic bowl-shaped closed contour, with a variable thickness of soil or other unconsolidated residuum covering the bedrock. The movement or raveling of soil particles over time results in the formation of open voids in the overburden soil just above the rock surface. Surface erosion, generally over a long period of time, then continues to enlarge the dropout to a rounded depression. The diameter of the depression is related to the depth and type of soil cover, the age of the feature, the size of the opening in the subsurface, its ability to receive water and soil as well as the size of the watershed surrounding and feeding water into the feature. Over long periods of time, the migration of water may result in additional solution weathering of the limestone rock. However, this dissolutioning process generally requires hundreds or thousands of years to occur. The natural acidity in water migrating through the rock reacts with the calcium-based limestone rock. This chemical reaction dissolves the rock, resulting in the formation of voids and cavities in the rock unit. The open voids and cavities in the rock act as a conduit for movement of water and suspended solids.

4.1.2 Cover Collapse

The second type of subsidence is due to rock or soil cover collapse. The development of caves within limestone rock is the result of prolonged, concentrated solution activity. Voids are created through the introduction of surface water into the subsurface, as described above. The voids thus

created are then enlarged by continued flow of water through the area. As the voids become larger and eventually interconnect, the quantity of water flowing through the area increases and results in more rapid solution weathering. When the strength of the underlying rock/soil support is compromised and cannot support the weight of the overburden, then the rock roof can collapse, resulting in a surface depression (i.e., a cover collapse sinkhole). This type of sinkhole formation is generally rare in Jefferson County.

5. SURFACE CONDITIONS

5.1 GROUND WATER CONDITIONS

Karst areas are often characterized by the lack of well-defined streams or creeks since surface water runoff is directed to closed topographic depressions and sinkholes. These features collect and direct the water into cracks, crevices, joints, porous zones, and caves in the underlying limestone rock. An unnamed perennial stream is present on the site flowing from the northwest corner of the property to the south and southeast across the western and southern extents to the southeast corner of the property. Two large and two small gently sloping drainage swales exist on this site as apparent on topographic mapping presented in Figure 3 below. All of which are considered ephemeral.

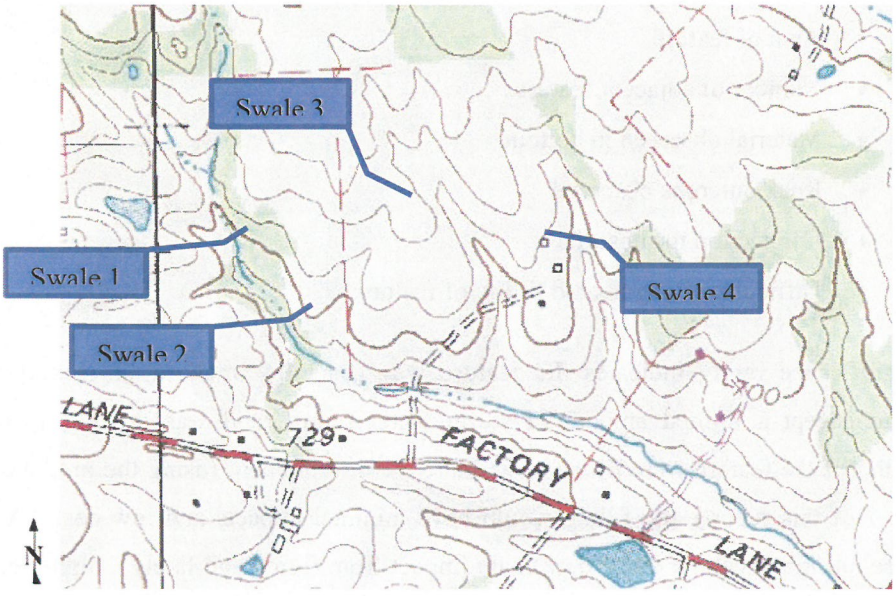


Figure 3, Topographic Map of the Crestwood Quadrangle, 1981

5.2 SITE RECONNAISSANCE

Our site reconnaissance activities were conducted in April of 2015. As part of our reconnaissance the site terrain was traversed in an effort to identify, locate and document the topographical features at the site that may be related to solution activity (closed topographic depressions and sinkholes) in the underlying limestone rock. Topographical features observed during our reconnaissance were located in the field using a handheld GPS (Global Positioning System) unit. The approximate location of the twenty features noted, are shown on the Geologic Feature Reconnaissance Table and Feature Location Plan in the Appendix to this report. The field locations shown are approximate.

The features observed were photographed for documentation purposes. Representative photographs of the features are attached to this report. All of the features observed were given a qualitative significance rating which is also shown on the table. The significance rating is somewhat subjective but was based on the following criteria:

- Drainage area
- Topographic Location
- Depth of bottom
- Area of feature
- Number of adjacent features
- Material observed in bottom
- Rock outcrops observed
- Connection to subsurface
- Difficulty of engineered filling of feature

A **low** significance rating indicates the feature was generally small in horizontal dimension, appeared to accept a limited amount of storm water runoff, and was thought to represent a condition that if the feature were filled to facilitate the development (using the methods described in Section 7 of this report), the filling would have minimal impacts and low cost. A **moderate** significance rating indicates a more significant impact from filling and likely a higher construction cost to fill the feature. A **high** rating indicates a likely impact from filling and a significant construction cost to fill the feature.

Several common indicators of Karst activity such as springs, sinking streams, sinkholes, closed contour depressions, and vuggy rock outcrops were observed during our site reconnaissance. These features appeared concentrated near and along the alignments of the two small drainage swales and perennial stream noted above, on the west and southern halves of the property. Additional features were noted near and along the alignment of the large drainage swales noted previously, on the east half of the property. None of these swales were observed to have flowing water and may be associated with Karstic features in the underlying rock units. Subsurface conditions in the area of observed karst features likely have a ground water table influenced by an internal "plumbing" system in the rock. Surface water collected by closed depressions and sinkholes is often routed internally through discontinuities in the underlying limestone toward seeps and springs. Springs and seeps are common and typically flow when perched water sources daylight in drainage swales, creek corridors, and tributaries. Flow may be intermittent depending on the weather. Observed features were generally of small horizontal dimension and depth. Several features appear to have been addressed either by the previous owner or farmer in an effort to control further erosion by the addition of large gravel to the feature. These features are designated as Feature numbers 1 to 20 in the Geologic Feature Reconnaissance Table and Karst Feature Location Map provided in the Appendix.

In our opinion the observed features noted during our study likely represent dissolution features, the most common ground subsidence phenomena associated with areas underlain by karstic limestone formations as described in Section 4.1.1. The mapped features appear to be linear in nature, likely following weathered joints in the rock. Only small distinct bowl like features were observed and is characteristic of karstic areas with shallow unconsolidated residuum covering bedrock. Over long periods of time, the migration of water may result in additional solution weathering of the limestone rock. However, this dissolutioning process generally requires hundreds or thousands of years to occur.

A sinking stream and groundwater spring as indicated by the respective feature designations of SS-14 and GS-19 appear located outside of the proposed development area and within the proposed conservation area near the unnamed perennial stream along the southern portion of the site. The shale present in the Waldron Shale formation located at the base of the Louisville Limestone formation is generally more resistant to dissolution and likely represents a lower boundary or limit to Karst activity in the rock units underlying the site. Therefore, these features are not expected to require additional consideration during planning and development.

6. DEVELOPMENT SCHEME EVALUATION

We understand this report will be utilized in preparation of the development scheme for the property. The significance of each feature we observed during our reconnaissance was subjectively assessed from a development cost and environmental standpoint using the criteria in Section 5.2. Although the site is underlain by limestone rock formations which are susceptible to Karstic activity we did not observe site features which appear to require special consideration during planning and development. The proximity of the underlying rock surface has likely limited the depth and areal extent of surface features. None of the features identified within the proposed development area by this study are in our opinion large enough or possess attributes which warrant preservation.

The thick site vegetative ground cover made the observation of karstic features in some areas difficult. We recommend once the site is cleared of surface vegetation a reevaluation of the site be made to determine whether additional features (previously obscured by vegetation) are present. There is the possibility that some features may have gone unnoticed during our field reconnaissance. During grading and construction activities all identified and any newly exposed solution features should be observed by Cardno so that specific recommendations can be made dependent on the characteristics of the feature and the area usage. If springs are encountered in construction areas, Cardno will make recommendations for the installation of spring boxes and underdrains (French drains), if necessary. All feature remediation and filling should be performed according to the procedures described in Section 7 of this report. These treatment schemes have been successfully used on many similar developments in karst terrain.

7. FEATURE TREATMENT RECOMMENDATIONS

We recommend all solution features noted on the property in this report or discovered during site earthwork operations be located by surveying methods and flagged in the field. Features with a defined throat should be repaired individually as described below. The features with no discernible throat should be stripped of topsoil and vegetation. The exposed subgrade in the closed depression should then be proofrolled in the presence of the geotechnical engineer to locate areas of soft, wet soil or incipient dropouts. Proofrolling should be performed using a loaded dump truck, or similar equipment judged acceptable by the geotechnical engineer, after a suitable period of dry weather to avoid degrading the subgrade. Normally, two to four passes over each section with the proofrolling equipment is required.

After stripping and proofrolling the exposed subgrade material should be observed for evidence of sinkhole throats. The throats are typically indicated by zones of wet soil, of darker soil containing a higher percentage of organic material, or by cherty more granular material. When sinkhole throats are well defined, they should be cleaned of all soil and extraneous material to expose competent limestone rock on all sides and in the bottom. The filling of the excavated feature should then proceed according to one of the following procedures.

7.1.1 Sinkhole Treatment Method A

When the throat is less than 2 feet in diameter and no evidence of flowing water is present a concrete plug may be utilized. The plug should be constructed of low slump concrete and be 1½ to 2 times as tall or long as it is wide to facilitate the filling of voids and crevices. It is essential that a good concrete to rock bond be created by the plug, and the plug increase in diameter with elevation. After the concrete plug has set up, we recommend the resulting excavation be lined with a geotextile filter fabric and backfilled with engineered fill material compacted to at least 95 percent of the soil's standard Proctor maximum dry density (ASTM D698).

7.1.2 Sinkhole Treatment Method B

When the throat is greater than 2 feet in diameter or evidence of flowing water is observed, an inverted filter should be constructed; however smaller features may also be filled in this manner. To plug the throat, a zone of shot-rock, rip-rap or durable limestone boulders such as KYTC Class IV Channel Lining should be placed and wedged into the throat. Using the large stone pieces as a base, place an 18-inch-thick layer of Kentucky Transportation Cabinet (KYTC) gradation No. 3 and/or No. 57 crushed limestone over the larger stone and tamp into place with hand tampers. Next, construct a 12-inch-thick layer of dense-graded aggregate (DGA) tamped into place with hand tampers. The entire throat area and a minimum of 10 feet of the surrounding area should be covered with a geotextile filter fabric. The resulting excavation may then be properly backfilled with engineered fill material compacted to at least 95 percent of the soil's standard Proctor maximum dry density (ASTM D698).

7.1.3 Sinkhole Treatment Method C

If well-defined sinkhole throats are not identifiable after stripping the surficial soils from the sinkholes to expose the residual soils, shallow test pits should be excavated to check for voids present below the ground surface as a result of solution activity. The pits should be excavated at

the lowest elevations of the depression. If no throat is found, then the excavation and depression should be properly backfilled using engineered fill material from the borrow areas on site. The fill material should be compacted the same as in Methods A and B.

8. QUALIFICATIONS TO REPORT

It is not possible to remove all of the risk associated with construction in steeply sloped areas or over known sinkholes or in sinkhole-prone, karst areas. Our experience in other portions of Jefferson County indicates the limestone formations mapped underlying the site are prone to solution activity and sinkhole formation. The natural rising and lowering of the ground water table and surface water migration downward through the subsurface soils can create the risk of continued soil migration into solution voids in the underlying limestone. In addition, current of future anthropogenic sources of subsurface water such as drains, septic leach fields, leaking water utilities, etc. may contribute to development of karst features. However we believe the risks of construction at this site are no greater than similar sites located in this portion of Jefferson County.

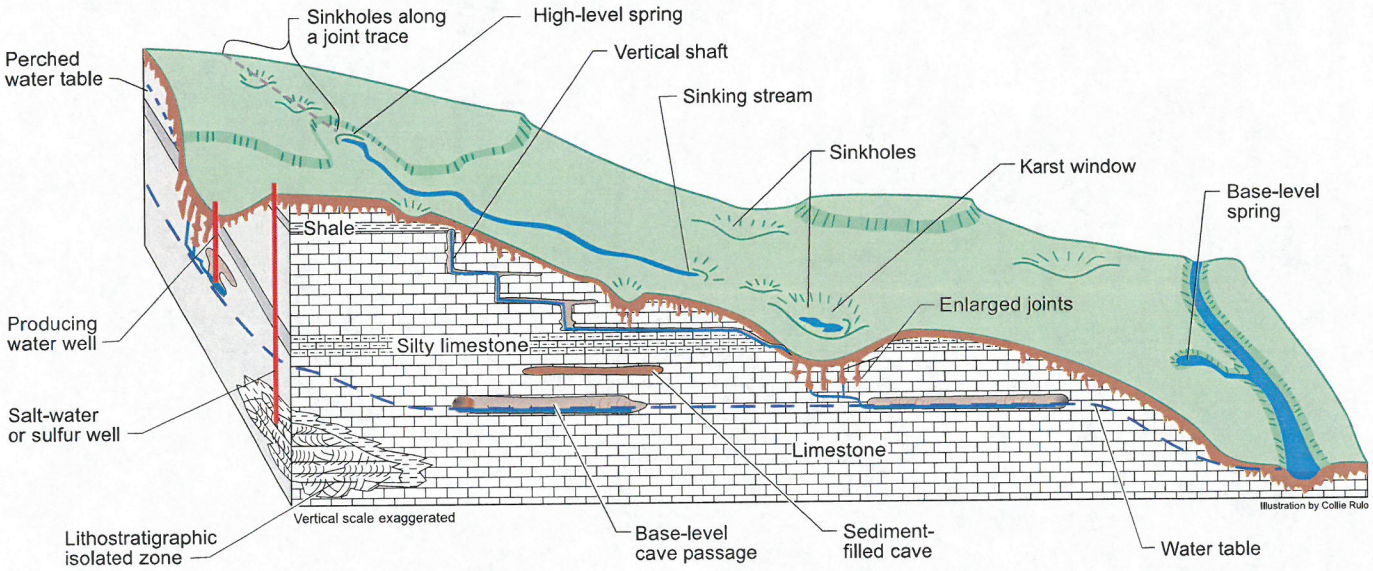
Proper observations during sinkhole repair and during construction by a qualified geotechnical engineer can reduce but not eliminate the level of risk. To further reduce the risk of unidentified sinkholes at the site would require the implementation of more sophisticated geotechnical exploration methods including borings on a tightly spaced grid or geophysical methods. In our opinion these exploration methods are not warranted at this time.

Kentucky Geological Survey
James C. Cobb, State Geologist and Director
UNIVERSITY OF KENTUCKY, LEXINGTON

MAP AND CHART 15
Series XII, 2001

Generalized Block Diagram of the Inner Bluegrass Karst

James C. Currens



Inner Bluegrass karst:

Karst occurs where limestone or other soluble bedrock is near the earth's surface, and fractures in the rock become enlarged when the rock dissolves. Sinkholes and sinking streams are two surface features that indicate karst development. In karst areas most rainfall sinks underground, resulting in fewer streams flowing on the surface than in non-karst settings. Instead of flowing on the surface, the water flows underground through caves, sometimes reemerging at karst windows, then sinks again to eventually discharge at a base-level spring along a major stream or at the top of an impermeable strata. The development of karst features is influenced by the type of soluble rock and how it has been broken or folded by geologic forces. There are four major karst regions in Kentucky: the Inner Bluegrass, Western Pennyroyal, Eastern Pennyroyal, and Pine Mountain. This diagram depicts the Inner Bluegrass karst.

In the Inner Bluegrass, insoluble impurities within the limestone, such as shale, result in a perched or isolated water table that discharges ground water at high-level springs or may locally isolate pockets of saltwater or sulfur water. In some locations, vertical fractures in the rock, called joints, may increase the rate of water flowing toward base level. The joints and impurities also influence the location and development of vertical shafts and caves. As erosion on the surface continues over geologic time, the major stream draining a karst terrane cuts its channel deeper. In response, deeper conduits increase their flow to the major stream, and new springs develop at lower elevations along the stream's banks. Older, higher flow routes are left as dry cave passages, some of which become sediment filled. To produce significant amounts of water, wells drilled into karst aquifers must intersect a set of enlarged fractures, a dissolution conduit, or a cave passage with an underground stream.

For information on obtaining copies of this chart and other Kentucky Geological Survey maps and publications call:
Publication Sales
(859) 257-3896
View the KGS World Wide Web site at:
www.uky.edu/kgs

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Cardno ATC
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KARST FEATURE LOCATION PLAN

St. Joseph Orphanage Site
Ball Homes
Factory Lane
Louisville, Kentucky

PROJECT NO: Z027000112		
DESIGNED BY: TA		REVIEWED BY: TA
DRAWN BY: DD	DATE: 6/1/15	FIGURE: 1

Ball Homes - St. Josephs Orphanage Site

Karst Feature Reconnaissance Table

Project Name: St. Josephs Orphanage Site
ATC Project Number: Z027000112
Field Reconaissance Dates: April 13, 23, 2015

Item ID		Physical Setting													Feature Characteristics														Assessment						
Feature Des.		Location			Estimated Drainage Area				Topography						Estimated Dimensions				Surrounding Features			Bottom Material				Rock Outcrops			Connection to Subsurface			Significance ***			
Feature Location No.	Feature Type *	Geologic Formation **	GPS Point	Photo No.	Less than 1 acre	Less than 10 acres	Less than 50 acres	More than 50 acres	Top of Hill	Hillside	Valley Floor	Near Vertical Wall	Drainage Swale	In 100-Year Flood Plain	Depth (feet)	Diameter (feet)	Estimated Length (ft.)	Estimated Width (ft.)	Low, less than 1 per acre	Moderate, 1 to 10 per acre	High, more than 10 per Ac.	None, Open Throat	Sand, Gravel, or Cobbles	Silt or Clay	Domestic Debris	Throat	Rim	Adjacent Areas	Open Throat	Water Inflow	Water Outflow	None, Easily Plugged	L: Cleanout and Plug	M: Irregular, Mult. Throats	H: Leave Intact
SH1	RS	Slv	A	1		x							x		1	1	1	1		x				x		na			x			x			
SH2	RS	Slv	B	2	x					x					1	-	5	5	x				x	x		na				x			x		
SH3	RS	Slv	C	3		x				x					1	-	10	5		x			x	x		na				x			x		
SH4	RS	Slv	D	4		x				x					1	-	100	10		x			x	x		na				x			x		
SH5	SH	Slv	E	5		x							x		1	2	50	10		x			x	x		na				x			x		
SH6	RS	Slv	F	6		x							x		1	-	10	5		x				x		na				x		x			
CD7	RS	Slv	G	7			x						x		1	-	30	15		x				x		na				x		x			
SH8	CD	Slv	H	8			x						x		1	-	3	3		x				x		na				x			x		
SH9	RS	Slv	I	9		x							x		1	-	100	3		x				x		na				x			x		
SH10	RS	Slv	J	10		x							x		2	1	3	1		x				x		na				x			x		
SH11	CD	Slv	K	11		x							x		1	1	2	2		x				x		na				x			x		
SH12	CD	Slv	L	12	x					x					1	-	20	20		x				x		na				x			x		
VR13	VR	Slv	M	13	-					x					0	-	50	30		x		na						x				x			

* **Feature Type:** CD = Closed Depression; RS = Enlarged Slot in Rock; SH = Sinkhole; C = Cave; KW = Karst Window; GS = Groundwater Spring; SS = Sinking Stream
FR = Fractured Rock Outcrop; VR = Vuggy Rock Outcrop; MM = Man-Made;

** **Geologic Formation: Slv = Louisville Limestone; Sw = Waldron Shale**

*** **Significance Rating:** **L - Low**, featue easily plugged or filled; **M - Moderate,** Irregular shape, multiple throats, candidate for preservation;
H - High, Large or deep feature, difficult to plug, preservation recommended.

Abbreviations: na - not applicable, no - not observed

Notes:
1 Off Site
2 On property line
3 Likely from road construction
4 irregular shaped
5 Connected to another Feature
6 Heavily Vegetated, View Obscured
7 Animal Burrow
8 Depression likely from tree removal

Ball Homes - St. Josephs Orphanage Site

Karst Feature Reconnaissance Table

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ATC Project Number: Z027000112
Field Reconnaissance Dates: April 13, 23, 2015

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SS14	RS	Slv	N	14			x							x	1	1	50	2	x			x				x					x			x
CD15	RS	Slv	O	15		x							x		1	-	100	15		x				x		na				x		x			
VR16	RS	Slv	P	16	-					x					0	-	30	3	x				x					x	na			x			
SH17	RS	Slv	Q	17		x							x		2	-	10	15		x				x		na				x			x		
VR18	SH	Slv	R	18	-					x					0	-	50	20		x			x					x	na			x			
GS19	RS	Slv	S	19				x						x	1	1	10	3	x					x		na				x				x
SH20	RS	Slv	T	20	x					x					1	-	10	10	x					x		na				x				

* **Feature Type:** CD = Closed Depression; RS = Enlarged Slot in Rock; SH = Sinkhole; C = Cave; KW = Karst Window; GS = Groundwater Spring; SS = Sinking Stream
FR = Fractured Rock Outcrop; VR = Vuggy Rock Outcrop; MM = Man-Made;

** **Geologic Formation: Slv = Louisville Limestone; Sw = Waldron Shale**

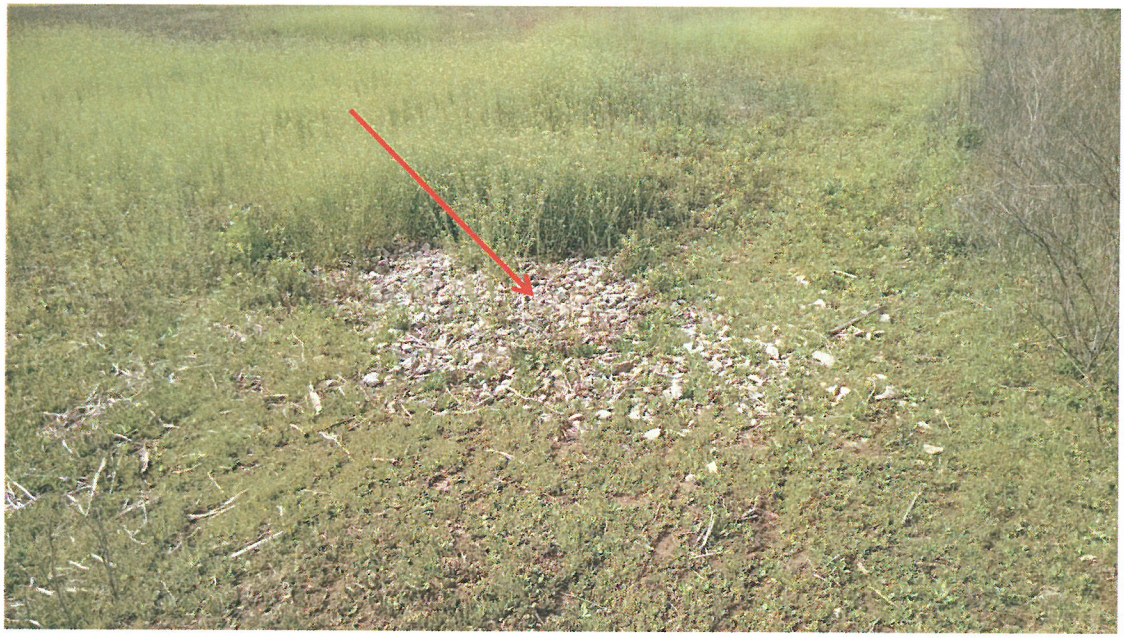
*** **Significance Rating:** **L - Low,** featue easily plugged or filled; **M - Moderate,** Irregular shape, multiple throats, candidate for preservation;
H - High, Large or deep feature, difficult to plug, preservation recommended.

Abbreviations: na - not applicable, no - not observed

Notes:
1 Off Site
2 On property line
3 Likely from road construction
4 irregular shaped
5 Connected to another Feature
6 Heavily Vegetated, View Obscured
7 Animal Burrow
8 Depression likely from tree removal

Photograph No. 1: Feature SH-1 Photo taken facing southwest along swale.

Photograph No. 2: Feature SH-2: Photo taken facing west.



Photograph No. 3: Feature SH-3: Photo taken facing north

Photograph No. 4: Features SH-4: Photo taken facing southeast

Photograph No. 5 Feature SH-5: Photo taken facing south along swale

Photograph No. 6: Feature SH-6: Photo taken facing northeast along swale

Photograph No. 7: Feature CD-7: Photo taken facing northeast along swale

Photograph No. 8: Feature SH-8: Photo taken facing northeast along swale

Photograph No. 9: Feature SH-9: Photo taken facing southeast along swale

Photograph No. 10: Feature SH-10: Photo taken facing north

Photograph No. 11: Feature SH-12: Photo taken facing south

Photograph No. 12: Feature VR-13: Photo taken facing north

Photograph No. 13: Feature SS-14: Photo taken facing north

Photograph No. 14: Feature CD-15: Photo taken facing southwest along swale

Photograph No. 15: Feature VR-16: Photo taken facing northeast

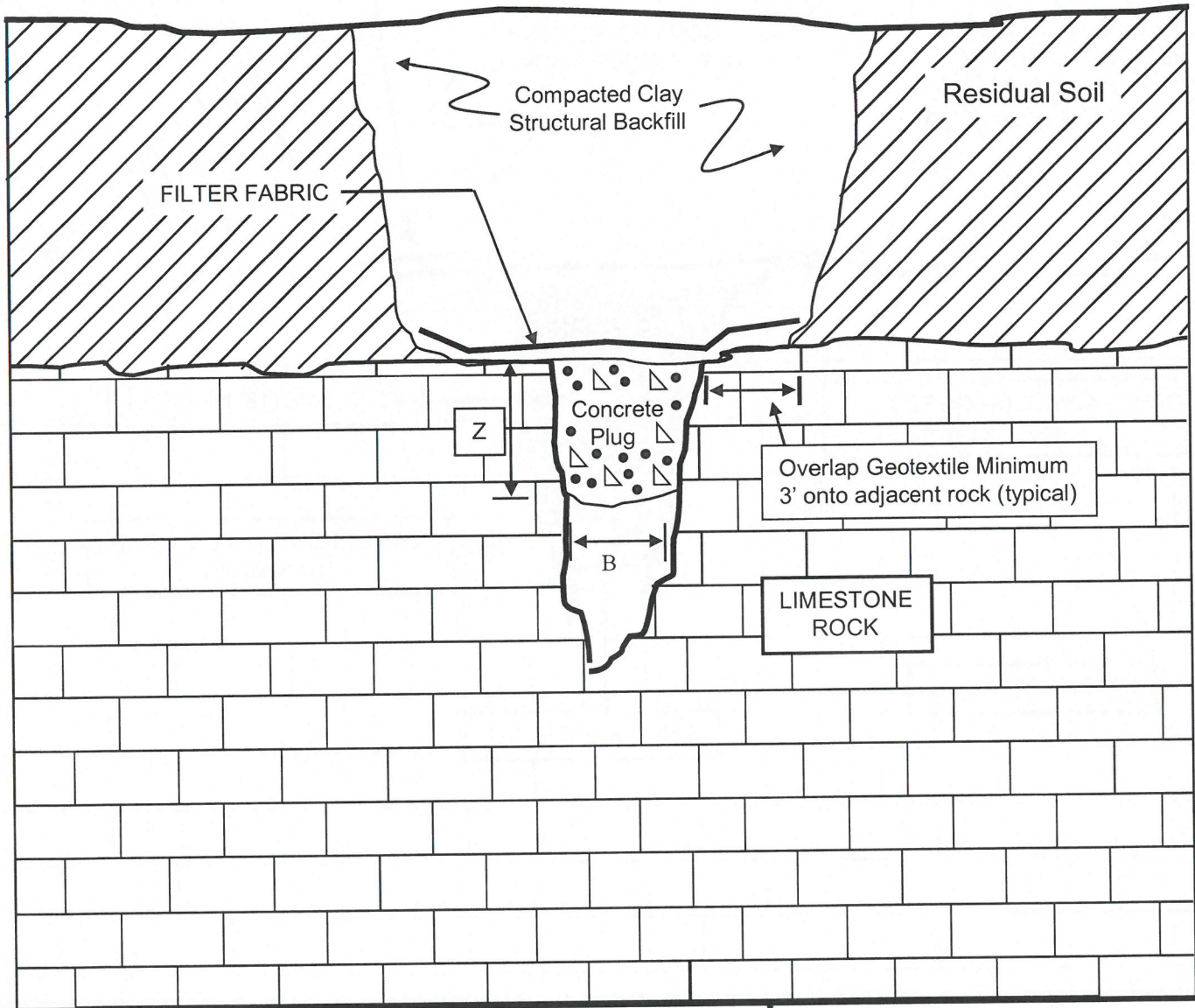
Photograph No. 16: Feature SH-17: Photo taken facing southwest

Photograph No. 17: Feature VR-18: Photo taken facing east

Photograph No. 18: Feature GS-19: Photo taken facing north

Photograph No. 19: Feature CD-7: Photo taken facing northwest

NOTE: Good concrete to rock bond is essential (Z = 1.5 to 2 times B)



CLIENT:

Ball Homes

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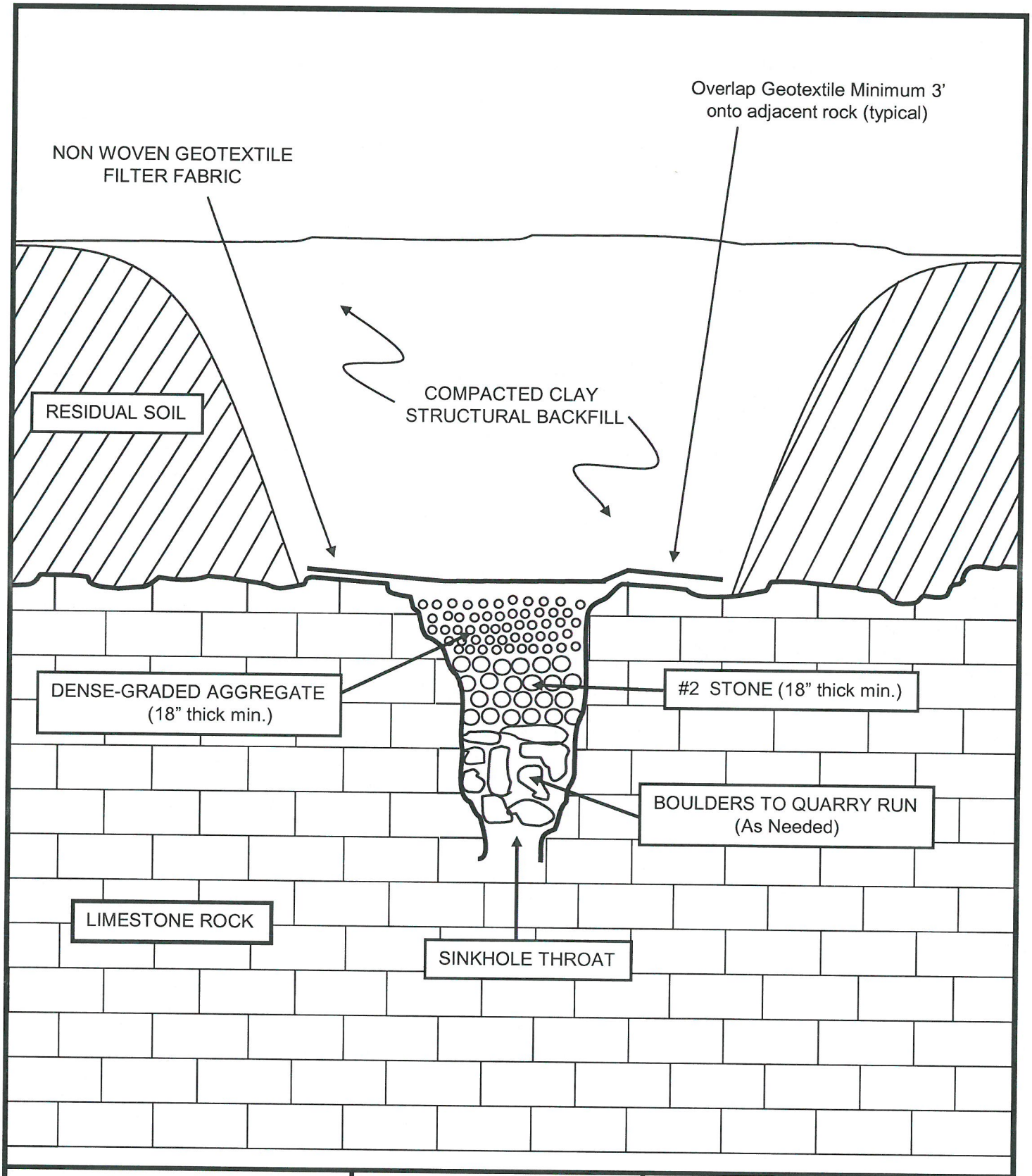
Louisville, KY 40299
Phone: (502) 722-1401
Fax: (502) 267-4072

DENTAL FILLING OF SMALL SOLUTION CAVITY

St. Josephs Orphanage Site
Louisville, Jefferson County, Kentucky

PROJECT NO: Z027000112



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Phone: (502) 722-1401
Fax: (502) 267-4072

GRADED FILTER FOR SOLUTION CAVITY

St. Josephs Orphanage Site
Louisville, Jefferson County, Kentucky

PROJECT NO: Z027000112