APPENDIX ONE

Geotechnical
Report

GSI

Report of Geotechnical Investigation for ED EXPANSION, BUILDING 4 Veterans Administration Medical Campus 3600 30th Street Des Moines, Iowa

GSI Project No. 106120

July 2, 2010

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LICENSED PROFESSIONAL ENGINEER MICHAEL T. LUSTIG 10059 IOWA	I hereby certify that this engineering document was prepared by me or under my direct personal supervision and that I am a duly licensed Professional Engineer under the laws of the State of Iowa. Michael T. Lustig — 7/2/2010 July 2, 2010 My license renewal date is December 31, 2010. Pages covered by this seal: 1 - 16, Appendices A, B, C, & D Date issued: July 2, 2010

Important Information about Your

Geotechnical Engineering Report

Subsurface problems are a principal cause of construction delays, cost overruns, claims, and disputes.

While you cannot eliminate all such risks, you can manage them. The following information is provided to help.

Geotechnical Services Are Performed for Specific Purposes, Persons, and Projects

Geotechnical engineers structure their services to meet the specific needs of their clients. A geotechnical engineering study conducted for a civil engineer may not fulfill the needs of a construction contractor or even another civil engineer. Because each geotechnical engineering study is unique, each geotechnical engineering report is unique, prepared *solely* for the client. No one except you should rely on your geotechnical engineering report without first conferring with the geotechnical engineer who prepared it. *And no one — not even you* — should apply the report for any purpose or project except the one originally contemplated.

Read the Full Report

Serious problems have occurred because those relying on a geotechnical engineering report did not read it all. Do not rely on an executive summary. Do not read selected elements only.

A Geotechnical Engineering Report Is Based on A Unique Set of Project-Specific Factors

Geotechnical engineers consider a number of unique, project-specific factors when establishing the scope of a study. Typical factors include: the client's goals, objectives, and risk management preferences; the general nature of the structure involved, its size, and configuration; the location of the structure on the site; and other planned or existing site improvements, such as access roads, parking lots, and underground utilities. Unless the geotechnical engineer who conducted the study specifically indicates otherwise, do not rely on a geotechnical engineering report that was:

- not prepared for you,
- not prepared for your project,
- not prepared for the specific site explored, or
- completed before important project changes were made.

Typical changes that can erode the reliability of an existing geotechnical engineering report include those that affect:

- the function of the proposed structure, as when it's changed from a parking garage to an office building, or from a light industrial plant to a refrigerated warehouse,
- elevation, configuration, location, orientation, or weight of the proposed structure,
- composition of the design team, or
- project ownership.

As a general rule, *always* inform your geotechnical engineer of project changes—even minor ones—and request an assessment of their impact. *Geotechnical engineers cannot accept responsibility or liability for problems that occur because their reports do not consider developments of which they were not informed.*

Subsurface Conditions Can Change

A geotechnical engineering report is based on conditions that existed at the time the study was performed. *Do not rely on a geotechnical engineering report* whose adequacy may have been affected by: the passage of time; by man-made events, such as construction on or adjacent to the site; or by natural events, such as floods, earthquakes, or groundwater fluctuations. *Always* contact the geotechnical engineer before applying the report to determine if it is still reliable. A minor amount of additional testing or analysis could prevent major problems.

Most Geotechnical Findings Are Professional Opinions

Site exploration identifies subsurface conditions only at those points where subsurface tests are conducted or samples are taken. Geotechnical engineers review field and laboratory data and then apply their professional judgment to render an opinion about subsurface conditions throughout the site. Actual subsurface conditions may differ—sometimes significantly—from those indicated in your report. Retaining the geotechnical engineer who developed your report to provide construction observation is the most effective method of managing the risks associated with unanticipated conditions.

A Report's Recommendations Are *Not* Final

Do not overrely on the construction recommendations included in your report. *Those recommendations are not final,* because geotechnical engineers develop them principally from judgment and opinion. Geotechnical engineers can finalize their recommendations only by observing actual subsurface conditions revealed during construction. *The geotechnical engineer who developed your report cannot assume responsibility or liability for the report's recommendations if that engineer does not perform construction observation.*

A Geotechnical Engineering Report Is Subject to Misinterpretation

Other design team members' misinterpretation of geotechnical engineering reports has resulted in costly problems. Lower that risk by having your geotechnical engineer confer with appropriate members of the design team after submitting the report. Also retain your geotechnical engineer to review pertinent elements of the design team's plans and specifications. Contractors can also misinterpret a geotechnical engineering report. Reduce that risk by having your geotechnical engineer participate in prebid and preconstruction conferences, and by providing construction observation.

Do Not Redraw the Engineer's Logs

Geotechnical engineers prepare final boring and testing logs based upon their interpretation of field logs and laboratory data. To prevent errors or omissions, the logs included in a geotechnical engineering report should *never* be redrawn for inclusion in architectural or other design drawings. Only photographic or electronic reproduction is acceptable, *but recognize that separating logs from the report can elevate risk.*

Give Contractors a Complete Report and Guidance

Some owners and design professionals mistakenly believe they can make contractors liable for unanticipated subsurface conditions by limiting what they provide for bid preparation. To help prevent costly problems, give contractors the complete geotechnical engineering report, *but* preface it with a clearly written letter of transmittal. In that letter, advise contractors that the report was not prepared for purposes of bid development and that the report's accuracy is limited; encourage them to confer with the geotechnical engineer who prepared the report (a modest fee may be required) and/or to conduct additional study to obtain the specific types of information they need or prefer. A prebid conference can also be valuable. *Be sure contractors have sufficient time* to perform additional study. Only then might you be in a position to give contractors the best information available to you, while requiring them to at least share some of the financial responsibilities stemming from unanticipated conditions.

Read Responsibility Provisions Closely

Some clients, design professionals, and contractors do not recognize that geotechnical engineering is far less exact than other engineering disciplines. This lack of understanding has created unrealistic expectations that have led to disappointments, claims, and disputes. To help reduce the risk of such outcomes, geotechnical engineers commonly include a variety of explanatory provisions in their reports. Sometimes labeled "limitations" many of these provisions indicate where geotechnical engineers' responsibilities begin and end, to help others recognize their own responsibilities and risks. *Read these provisions closely.* Ask questions. Your geotechnical engineer should respond fully and frankly.

Geoenvironmental Concerns Are Not Covered

The equipment, techniques, and personnel used to perform a *geoenvironmental* study differ significantly from those used to perform a *geotechnical* study. For that reason, a geotechnical engineering report does not usually relate any geoenvironmental findings, conclusions, or recommendations; e.g., about the likelihood of encountering underground storage tanks or regulated contaminants. *Unanticipated environmental problems have led to numerous project failures.* If you have not yet obtained your own geoenvironmental information, ask your geotechnical consultant for risk management guidance. *Do not rely on an environmental report prepared for someone else.*

Obtain Professional Assistance To Deal with Mold

Diverse strategies can be applied during building design, construction, operation, and maintenance to prevent significant amounts of mold from growing on indoor surfaces. To be effective, all such strategies should be devised for the *express purpose* of mold prevention, integrated into a comprehensive plan, and executed with diligent oversight by a professional mold prevention consultant. Because just a small amount of water or moisture can lead to the development of severe mold infestations, a number of mold prevention strategies focus on keeping building surfaces dry. While groundwater, water infiltration, and similar issues may have been addressed as part of the geotechnical engineering study whose findings are conveyed in this report, the geotechnical engineer in charge of this project is not a mold prevention consultant; ***none of the services performed in connection with the geotechnical engineer's study were designed or conducted for the purpose of mold prevention. Proper implementation of the recommendations conveyed in this report will not of itself be sufficient to prevent mold from growing in or on the structure involved.***

Rely, on Your ASFE-Member Geotechncial Engineer for Additional Assistance

Membership in ASFE/The Best People on Earth exposes geotechnical engineers to a wide array of risk management techniques that can be of genuine benefit for everyone involved with a construction project. Confer with your ASFE-member geotechnical engineer for more information.

ASFE
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TABLE OF CONTENTS

GSI

Geotechnical Investigation
ED EXPANSION, BUILDING 4
Veterans Administration Medical Campus
3600 30th Street
Des Moines, Iowa
July 2, 2010
GSI Project No. 106120

INTRODUCTION

This report presents the results of the geotechnical investigation performed by Geotechnical Services, Inc. (GSI) at the site of the Emergency Department expansion to Building 4 at the VA Medical Campus in Des Moines, Iowa. This exploration was authorized by Mr. John K. Gardner, AIA of Brooks Borg Skiles Architecture Engineering, LLP on June 24, 2010 and performed in general accordance with our proposal dated June 22, 2010.

The investigation for this project includes eleven test borings, laboratory testing, data analysis, and a report of our conclusions and recommendations as they affect foundation and sitework considerations.

The scope of this investigation did not include an environmental assessment for the presence of hazardous or toxic materials in the soil or ground water on or near this site. If contamination is suspected or is a concern, we recommend that the scope of this study be expanded to include an environmental assessment. Any statements in this report regarding odors, discoloration, or suspicious conditions are strictly for the information of our client.

GSI prepared this report under the supervision of a professional engineer licensed in the State of Iowa. Recommendations are based on the applicable standards of the profession within this geographic area at the time of this report. This report has been prepared for the exclusive use of Brooks Borg Skiles Architecture Engineering, LLP for design of the proposed project in accordance with generally accepted geotechnical engineering practices.

PROPOSED CONSTRUCTION

Our understanding of the project is based upon the preliminary information provided in an electronic mail message received June 18, 2010. The new addition will consist of one story above grade and partial mechanical basement below grade with a gross floor area of 7,000 ft^2. However, the structure may be expanded to include two stories over time. We assume the building will utilize a combination of structural steel, reinforced concrete, and reinforced masonry framing resulting in maximum wall loads of 8 to 10 kips per lineal foot and maximum column loads are expected to be on the order of 230 kips. The main level floor has been established at elevation of 144.25 feet and the mechanical basement at 132.25 feet. The utility crawl space under the first floor will be near 136.74 feet. The current road will be relocated east and south of the current alignment. Therefore, retaining walls with heights on the order of 12 feet may be required.

SITE CONDITIONS

The proposed Emergency Department expansion will be connected to the existing Building 4 at the VA campus in Des Moines, Iowa. Existing conditions in the footprint of the proposed addition consisted of paved driveway, parking area, sidewalks, and grass lawn areas. Utility locations performed for the field exploration indicate that various underground utility trenches and lines traverse the proposed addition footprint.

SUBSURFACE EXPLORATION

The field exploration was conducted between June 24 and 28, 2010. The exploratory program consisted of drilling eleven new test borings near the locations shown on the Subsurface Exploration Plan (Appendix A). The Subsurface Exploration Plan was provided by BBSAE. The subsurface testing locations were selected and laid out in the field by others. Subsurface elevations of the test borings were interpolated from contours of the Subsurface Exploration Plan. Locations and elevations of the borings should be considered accurate to the degree implied by the methods indicated.

Eleven test borings were completed for the proposed Emergency Department Expansion. Test borings were completed to depths between 15 and 50 feet below existing grade with either a truck-mounted Mobile B-57 drill rig using 2¼-inch hollow stem augers or a truck mounted Mobile B-47 drilling rig using 4-inch continuous flight augers.

Our drill crew obtained soil samples during drilling at the sampling intervals shown on the boring logs (Appendix C). Undisturbed samples, designated "U" samples, were obtained with thin-walled tube samplers, 3.0-inch outside diameter, hydraulically pushed in general accordance with ASTM D1587, "Thin Walled Tube Sampling of Soils". Split-barrel samples, designated "S" samples, were obtained while performing Standard Penetration Tests (SPT) with a thick walled sampler, 1.50-inch inside diameter, driven in general accordance with ASTM D1586, "Penetration Test and Split-Barrel Sampling of Soils." The N-value, reported in blows per foot, is the number of blows required to drive the sampler the final 12 inches of the 18-inch sample interval. Recovered undisturbed samples were protected during transport to the laboratory, extruded in the laboratory, sealed in plastic bags, and labeled prior to laboratory testing. Split-barrel samples were sealed in plastic bags after performing the field penetration tests and protected during transport to the laboratory.

The boring logs were prepared in general accordance with ASTM D2488, "Description of Soils (Visual-Manual Procedure)." Stratification lines shown on the boring logs represent approximate boundaries between soil types. It should be noted that in situ, soil transitions may be gradual. Our drill crew made ground water observations in the borings at the times and under conditions stated on the boring logs.

LABORATORY TESTING

The field boring logs were reviewed to outline the soil types and depths of the soil strata. A laboratory testing program was then established to evaluate the engineering properties of recovered samples. Water content tests were performed on split-barrel samples. Water content, dry unit weight, and unconfined compressive strength tests were conducted on representative samples of soil obtained from the thin wall tube samplers. All tests were conducted by a laboratory technician in general accordance with current ASTM test procedures. Laboratory test results are shown on the boring logs in Appendix C.

COAL MINE HISTORY

The potential for previous underground coal mining activity at the site was reviewed within the project area. According to mine maps published by the Geological Survey Bureau of the Iowa Department of Natural Resources, no known coal mining was conducted within the project vicinity. The nearest mines are nearly ¼ mile away and are of known location and known extent based on mine maps. Therefore, the possibility that the site will be impacted by previous coal mining activity is relatively low. A copy of the mine map is included in Appendix B.

SUBSURFACE CONDITIONS

REGIONAL GEOLOGY

The project site is located within a geomorphic region referred to as the "Des Moines Glacial Lobe" and is on an upland of the nearby Des Moines River. This landform region was formed by extensive glacial activity including erosion, reworking, and deposition. Typically, the predominant surficial sediment is glacial drift deposited by the Wisconsinan glacier. Glacial soils commonly encountered within 15± feet of ground surface are classified as supraglacial sediments. The supraglacial materials are generally variable and can be stratified in composition consisting of very silty sandy clay interbedded with silt and sand seams, layers, and extensive pockets throughout. In contrast, the underlying subglacial soils, which were deposited beneath the glacial ice as it advanced, tend to be a homogeneous composition of silty sandy clay materials.

Underlying this most recent glacial deposit are pre-glacial deposits consisting of windblown silts and clays, termed loess. The loess, having been transported from major stream valleys and distributed throughout a large portion of Iowa during Wisconsinan geological time, is of relatively uniform particle size with silt dominating the soil matrix.

Prior to loess deposition, the Pre-Illinoian glaciers advanced throughout Iowa depositing a well-graded mixture of clay, silt, and sand, having pebbles, cobbles, and occasional boulders intermixed throughout the soil matrix. In some areas of this geomorphic region, the upper portion of the Pre-Illinoian till was exposed to intensive weathering which altered the soil texture. In areas where this weathering process occurred, the upper portion of the Pre-Illinoian till deposit is typically a highly plastic clay, termed paleosol, altering to a less weathered sandy clay with depth, and finally to the unaltered silty sandy clay parent material.

SITE SOIL PROFILE

Either topsoil or man-made fill soils were encountered near the surface of all eleven test borings. These soils generally consisted of dark brown to brown moist sandy lean clay to very sandy lean clay. The consistency of these soils varied from soft to firm and the lower boundary varied from 1 foot to 8 feet across the site.

The near surface soils were underlain by Wisconsinan glacial till that consisted of light brown sandy lean clay. These moist cohesive soils exhibited soft to medium stiff consistency. The lower boundary of the upper glacial till varied from 3½ to 12 feet below existing grade.

Wisconsinan loess was encountered beneath the glacial till soils. The loess consisted of light brown gray mottled silty lean clay. These moist to very moist cohesive soils exhibited soft to stiff consistency. The loess in Test Borings B-8, B-9, and B-10 was desiccated with depth and soil water contents near the shrinkage limit. Therefore, it should be recognized that the medium stiff to stiff consistency measured by the Standard Penetration Test in these soils is artificially high due to the low water contents; if these soils experience an increase in water content, the consistency will decrease.

We encountered Pre-Illinoian glacial till beneath the loess in Test Borings B-1, B-2, B-3, B-4, B-5, and B-6. The lower glacial till consisted of maroon to brown sandy fat to lean clay trace gravel. These cohesive soils were moist to damp and consistencies ranged from stiff to hard, consistency increased with depth. These six borings terminated in the glacial till at depths of 25 and 50 feet below existing grades.

Field and laboratory testing of the site soils indicate the following ranges of in situ engineering properties:

Water Content (%)	11 - 29
Standard Penetration Number "N" (bpf)	1 - 32
Dry Unit Weight (psf)	105 - 110
Unconfined Compressive Strength (psf)	960 - 3930

GROUND WATER

Ground water observations were made during drilling and shortly after completion of drilling.

TABLE 1. GROUND WATER LEVEL OBSERVATIONS
EMERGENCY DEPARTMENT EXPANSION – VA MEDICAL CENTER

Depths Below Existing Ground Surface (feet)		
Test Boring	**Ground Water During Drilling**	**Ground Water at Completion of Drilling**
B-1	20	47
B-2	24	43
B-3	20	25
B-4	22	23
B-5	24	41
B-6	22	24
B-7	Dry	Dry
B-8	Dry	Dry
B-9	Dry	Dry
B-10	Dry	Dry
B-11	Dry	Dry

These ground water observations are not necessarily a true indication of the static ground water conditions. Observations over a long period of time are usually required to accurately determine the static ground water level and seasonal variations in water levels.

The free ground water surface or ground water table within unconfined aquifers is generally a subdued reflection of surface topography. Water generally flows downward from upland positions (recharge zones) to low lying areas or surface water bodies (discharge zones). Therefore, ground water levels and the level of any perched water at the project site will vary with climatic conditions, surface drainage, and landscaping irrigation practices.

CONCLUSIONS AND RECOMMENDATIONS

SITE CONSIDERATIONS

The proposed addition site is covered with grass/pavement and is underlain by several underground utility lines and may also be underlain by abandoned utility lines. Site preparation should include relocation or abandonment of existing buried utilities, demolition of parking areas and hard surfaced areas, and backfill of any excavations. We recommend that demolition include complete removal of all subsurface building components such as foundation walls, floor slabs, and footings. Abandoned underground utility lines should be either completely removed or capped and grouted full. All existing pavement sections, including asphaltic and Portland Cement concrete, should be completely removed to prevent water entrapment and expose voids which may otherwise go undetected.

Special care must be given to the risk of undermining the foundations of the adjoining existing buildings during excavation. Several alternatives for underpinning construction methods are provided in the UNDERPINNING EXISTING FOUNDATION section of this report.

FOUNDATION ANALYSIS

Based on the provided structural loads and the subsurface soil profile, it is our opinion that the proposed one-story (up to two-story) structure cannot be supported on shallow foundations alone due to soft consistency of the fill, upper glacial till, and loess soils which will result in excessive total and differential settlements. We recommend that the Emergency Department Expansion be supported by one of two alternatives: rammed aggregate piers or a drilled shaft deep foundation system. Our recommendations for foundation design and construction are stated in the following sections.

Building code requirements may include design for seismic forces associated with earthquake motions. The project site is classified as Site Class D according to Table 1613.5.2 in the 2006 International Building Code.

RAMMED AGGREGATE PIER SOIL IMPROVEMENT

In our opinion, one alternative for reliable foundation support would be to leave existing soils in place and install rammed aggregate piers to improve the foundation soils. Rammed aggregate piers (trade name Geopiers) are a method to improve bearing capacity and limit settlement for spread foundations and floors. Geopiers can provide owners with a cost-effective alternative to extensive over-excavation and recompacted backfill projects or deep foundations. The system is based on the theory of soil reinforcement utilizing highly compacted aggregate columns and prestressing the existing soils. High capacity side friction is developed at the interface of the aggregate and the existing soils. Individual piers can often develop capacities on the order of 50 kips or more. Rammed aggregate pier construction typically results in an allowable soil bearing pressure of 4,000 to 5,000 pounds per square foot that can be used for design of a shallow foundation system.

The construction of Geopiers consists of augering holes into the existing soils at the base of the foundation excavation, and then prestressing these soils by placing well-graded aggregate in several controlled lifts into these holes. This aggregate is densely compacted using high energy compaction equipment. The compaction literally pushes the aggregate laterally against the sidewalls, which significantly compresses, densifies, and strengthens the soils between the holes.

The Geopier soil improvement holes are generally 2.5 feet in diameter and variable in length, depending on structural loads and depth of soil improvement needed to control settlement to acceptable limits. Geopiers modify the existing soils so that differential settlement is significantly reduced compared to the existing condition for these soils.

Conventional foundation elements or floor slabs are constructed above the Geopier improved soils. If the existing loess soils encountered in the test borings are modified with Geopiers, we would expect that maximum net allowable bearing pressures on the order of 4,500 to 5,000 pounds per square foot could be developed by soil improvement. Actual design capacities are verified by a field modulus load test conducted at the time of Geopier installation, which is essentially a combination of procedures outlined in ASTM D1194 and ASTM D1143. The modulus test is not a pass or fail test, but rather provides load capacity and settlement data corresponding to the Geopier installation procedures used. These data are compared with estimated design values. If the estimated values are less than required, then either the installation procedures are made more stringent (and proven by an additional load test), or a greater Geopier footprint coverage is provided. Geopiers are constructed on a design-build basis, with the Geopier Foundation Company supporting the design aspects.

DRILLED SHAFT/AUGER CAST IN PLACE PILE DEEP FOUNDATION

In our opinion, the Emergency Department Expansion could be supported on deep foundations consisting of either straight drilled shafts or auger cast in place piles designed for both skin friction and end bearing. Either deep foundation should terminate in the Pre-Illinioan glacial till soils at a minimum depth of 40 feet or more below existing grade. Drilled shafts with bells are not recommended because of sand layers and seams within the glacial till soils that prevent construction of bells. Design of deep foundations should be based on the allowable parameters in Table 2.

The allowable end bearing pressure is expressed in terms of the net pressure transferred to the glacial till. We estimate that long term total settlement of a deep foundation system will be less than ½-inch and differential settlement will be negligible if deep foundation construction is based on the design parameters in Table 2.

The contractor should be aware of the soil and ground water conditions that may be encountered during excavation of the drilled shafts at this site. Soils encountered in the test borings include glacial till, which may have sand seams and pockets.

TABLE 2. DEEP FOUNDATION DESIGN PARAMETERS
EMERGENCY DEPARTMENT EXPANSION, DES MOINES, IOWA

Elevation [a] (feet)	Soil Type	ϕ Degrees	γ pcf	Allowable[b] Skin Friction psf	Allowable End Bearing ksf
144-140	Excavation Zone	n/a	n/a	n/a	n/a
140-132	Wisconsinan Glacial Till	20	125	400	n/a
132-116	Wisconsinan Loess	18	120	300	n/a
116-89	Pre-Illinoian Glacial Till	28	135	1200	12[c]

Notes:
a) Referenced to existing ground surface contours indicated in Site Plan.
b) Applicable for compression; use 75 percent of listed values for tension.
c) Applicable between elevations 100 and 90 feet.

Variations in the texture of the soils combined with water levels above the planned depth of excavation may cause caving and sloughing of the drilled shaft excavations. Therefore, either temporary casing or polymer/mineral drilling slurry should be used during drilled shaft construction to prevent the soils from sloughing into the excavations. Polymer or mineral drilling fluids can be used in excavations with sufficient head to stabilize the excavated drilled shaft walls. Polymer drilling fluid has been used successfully to maintain stability of excavated shaft walls below the ground water table and does not adversely affect the bond between concrete and reinforcing steel.

The actual depth of the drilled shafts may require adjustment in the field based on conditions encountered at the time of excavation. Drilling tools should be capable of removing soft, loose, or spalled material from the end bearing surface of the drilled shaft.

Concrete should be placed into the shaft excavation as quickly as possible after completion of the excavation to minimize sloughing of the excavation side walls. Concrete, placed in the shaft excavation by either pumping or tremie methods, should exhibit consistency (slump) in the 5 to 7 inch range.

RETAINING WALL FOUNDATIONS

Based on the test boring data, foundations for new retaining walls along the realigned roadway will bear in either the existing glacial till or loess soils. These soils exhibited variations in water content and consistency and in our opinion cannot provide reliable support for retaining walls with up to 12 feet of new backfill. Therefore, we recommend that retaining wall foundations bear on either soil improved by rammed aggregate piers or on a minimum of three (3) vertical feet of granular structural backfill compacted to a minimum of 98 percent of the material's maximum dry unit weight per the Standard Proctor test. The structural backfill should be installed in accordance with the OVER-EXCAVATION AND BACKFILL section of this report.

Retaining wall foundations, bearing on either rammed aggregate pier reinforced soil or a minimum of three vertical feet of granular structural backfill, may be proportioned for a net allowable soil bearing pressure of 3,500 pounds per square foot for continuous footings.

The allowable bearing pressure is expressed in terms of the net pressure transferred to the soil. It is advisable to place a 6-inch thick layer of either 3 inch minus crushed limestone or crusher run at the bottom of the excavation to serve as a working platform for foundation construction. We estimate maximum total settlement of one (1) inch and differential settlement on the order of ¾ of the total settlement within each proposed structure.

All exterior footings and footings in unheated areas should be placed a minimum of 3½ feet below final exterior grade to minimize the detrimental effects of seasonal moisture variations and frost penetration. Continuous foundations should be adequately reinforced to limit deflections over areas having non-uniform soil support characteristics.

Soils exposed in the bottoms of all satisfactory foundation excavations should be protected against detrimental changes in conditions such as disturbance, excessive drying, rain and freezing. Surface runoff should be drained away from excavations and not allowed to pond. Water should not be allowed to accumulate in footing excavations. This could result in softening or loosening of the soil and a reduction in the support characteristics of the foundation material.

Building code requirements may include design for seismic forces associated with earthquake motions. The project site is classified as Site Class D according to Table 1613.5.2 in the 2006 International Building Code.

OVER-EXCAVATION AND STRUCTURAL BACKFILL

We recommend that careful observations be performed by a geotechnical engineer at the time of construction for all foundations at this project site to determine that the soils at bearing level are capable of providing the recommended bearing pressure. If soft, loose, or otherwise unsuitable soils are encountered in the base of foundation excavations, an over-excavation and structural backfill procedure should be implemented. The over-excavation and structural backfill procedure should include the complete removal of the unsuitable soils, extending the excavation laterally 9 inches in all directions for each foot of over-excavation depth, and replacement with structural fill.

We recommend that granular soils used for structural backfill be free of rubble and/or organics and exhibit a Unified Soil Classification of SM or GM. Granular soils used as structural fill should contain a minimum of 15 percent fines. Our experience with similar projects indicates that IDOT Class A roadstone works well in this application. The granular structural backfill soils should be compacted in accordance with the minimum requirements in Table 2 in the EARTHWORK AND EXCAVATIONS section of this report.

EARTHWORK AND EXCAVATIONS

Pavements and vegetation should be stripped from the site prior to earthwork construction or placement of new pavements. In areas to accept new fill, an additional 12 inches of the ground surface should be scarified and compacted to eliminate a plane of weakness along the contact surface. The subgrade should be compacted to at least 95 percent of the maximum laboratory dry density (ASTM D698, Standard Proctor) at a soil water content between 0 and +4 percentage points of optimum water content before placement of new fill.

On-site or imported material should be clean, inorganic lean clay with a Liquid Limit less than 45 percent and a Plasticity Index less than 20. The fill soils at this site contained seams of fat clay and should not be used below structural elements, slabs, or pavements. New fill material should be placed in maximum loose lifts of 8 inches thick and compacted in accordance with the recommended minimum requirements in Table 3. Soil water content at the time of compaction should be controlled between 0 and +4 percentage points of optimum water content.

TABLE 3. RECOMMENDED GUIDELINES FOR DEGREE-OF-COMPACTION

Construction Application	Standard Proctor (ASTM D698) Cohesive Soil	Standard Proctor (ASTM D698) Cohesionless Soil	*Relative Density (D4253 & D4254) Cohesionless Soil
Building Foundation, Roadway Subgrades, and Critical Backfill Areas	95%	98%	70%
Backfill Adjacent to Structures Not Supporting Other Structures – Minor Subsidence Possible	90%	93%	45%
Backfill in Non-Critical Areas - Moderate Subsidence Possible	85%	88%	20%

*Use Relative Density technique (ASTM D4253 & D4254) where Standard Proctor technique (ASTM D698) does not result in a definable maximum dry density and optimum moisture content.

Vertical cuts and excavations should not be considered stable in any case. All excavations should be sloped back, shored, or shielded for protection of workers. Trenching and excavation activities should conform to federal, state and local regulations as a minimum. The soils encountered in the test borings at the time of our field exploration generally classify as Type C soils according to OSHA's Construction Standards for Excavations. In general, the maximum allowable slope for shallow excavations in Type C soils is 1½:1 (horizontal:vertical), although other provisions and restrictions may apply. Design and maintenance of all excavation slopes is the responsibility of the contractor.

SLAB-ON-GRADE SUPPORT

Two wings of the Emergency Department expansion are shown as slab-on-grade with the finish floor at 144.25 feet (Site Datum). Based on the test boring data, these two wings will require about 3 to 4 feet of new structural fill to achieve elevation. Therefore, we recommend that the new structural fill in these areas consist of clean, low plasticity cohesive soil exhibiting a minimum Standard Proctor maximum dry unit weight of 125 pounds per cubic foot. The new structural fill should be compacted to a minimum of 95 percent of the Standard Proctor maximum dry unit weight.

The loess soils will be encountered near the mechanical basement floor and are silty textured and prone to disturbance from construction operations. We recommend that the existing soils encountered at basement subgrade elevation be over-excavated a minimum of 18 vertical inches below final subgrade elevations and that the excavations be backfilled with granular structural backfill. The over-excavation and replacement procedure will provide reliable floor slab support and provide a working construction platform.

We recommend that granular soils for floor slab support be free of rubble and/or organics and exhibit a Unified Soil Classification of SP or GW in order to provide a free draining layer beneath the floor slab. After over-excavation and prior to placement of granular structural backfill, we recommend six to eight inches of three-inch minus crushed limestone be placed in the base of the excavation and compacted in order to mechanically stabilize the underlying loess soils. After the 3 inch minus material has been placed, the free draining (less than 5 percent passing the No. 200 Sieve) granular structural backfill should be placed and compacted in lifts to achieve final subgrade. Our experience with similar projects indicates that a well-graded crushed limestone similar to IDOT specifications 4131 works well in this application.

We recommend that granular floor subgrade soils be compacted to a minimum of 98 percent of maximum dry unit weight at 0 to 3 percent above the optimum water content according to the material's Standard Proctor (ASTM D698). We recommend that floor slabs, bearing on a well-prepared compacted subgrade as described above and in the EARTHWORK AND EXCAVATIONS section of this report, be designed for a modulus of subgrade reaction value of 100 pounds per cubic inch.

BASEMENT MOISTURE RESISTANCE

Fluctuations in ground water levels should be expected with variations in precipitation. During alternating wet and dry periods, minimizing the potential for hydrostatic uplift of the structure and moisture seepage into basements and other below-grade building structures may be achieved by implementing procedures for moisture resistance of the subsurface portions of the structure. This includes installation of moisture barriers and a subsurface perimeter interceptor system.

The architectural details of basements and other below-grade portions of the building should include moisture barriers and a subsurface interceptor drain system to minimize the potential for moisture seepage due to fluctuating ground water levels over the life of the structure. Moisture barriers may consist of bentonite panels or bituminous mastic sufficient to withstand the anticipated water head. The subsurface perimeter interceptor system should be installed in accordance with the recommendations in the LATERAL EARTH PRESSURES section of this report. In addition, subsurface drain lines should be installed in the granular structural backfill beneath the basement floor slab. The drain lines should be spaced 40 feet (center to center) and directed to a pumped sump capable of handling the discharge.

LATERAL EARTH PRESSURES

The mechanical basement walls and roadway retaining walls will retain soils and be subjected to lateral earth pressures. Estimated lateral earth pressures for cohesive and granular backfill are presented in the following Table 4. Granular backfill lateral earth pressure parameters may be used where granular backfill is installed behind the subsurface wall on a 2:1 (vertical to horizontal) slope or flatter. The area between the required minimum zone of granular material and the actual limits of excavation may be backfilled with either cohesive or granular soils.

TABLE 4. ESTIMATED LATERAL EARTH (EQUIVALENT FLUID) PRESSURES [a]

For Vertical Walls and Level Backfill

	COHESIVE SOIL	GRANULAR SOIL (Sand)
Approximate Total Density	130 pcf	120 pcf
Approximate Friction Angle	15° - 20°	30° - 35°
Active Pressure Coeff.: K_a	0.5	0.3
At-Rest Pressure Coeff.: K_o	0.7	0.5
Passive Pressure Coeff.: K_p	2.0	3.3
	Active Earth Pressure	
Drained	65 pcf	35 pcf
Undrained[b]	95 pcf	80 pcf
	At-Rest Earth Pressure	
Drained	90 pcf	60 pcf
Undrained[b]	110 pcf	90 pcf
	Passive Earth Pressure	
Drained	260 pcf	400 pcf
Undrained[c]	135 pcf	190 pcf

[a] Excluding Cohesion Shear Strength Sliding Friction Effects
[b] Combined Factored Soil Buoyant Unit Weight and Hydrostatic Water Head (62.4 pcf)
[c] Excluding Hydrostatic Water Head (62.4 pcf)

Active earth pressure design assumes the top of the wall can deflect. If the top of the wall is restrained, higher lateral earth pressures will develop against the wall and the at-rest pressure parameters should be used for design. Increased pressures can also develop from restricted soil drainage, surcharge loads adjacent to subsurface walls, and over-compaction of the backfill adjacent to exterior foundation walls.

Walls retaining fine-grained soils and subjected to seasonally depressed temperatures may be subject to long-term accumulative movement due to soil creep and freeze-thaw action. It is desired to use free draining granular backfill behind such walls to minimize this movement. We recommend that a triangular prism of clean granular material (less than 5 percent passing the No. 200 Sieve) be placed directly against the back of these walls and that the prism be connected to a drain system. An acceptable drain system may be constructed using perforated pipe encased in clean granular material and sloped to sumps or storm drains. The free-draining wall backfill material should be capped with a minimum of two vertical feet of compacted, cohesive soil. See Appendix D for a perimeter drainage schematic detail.

LATERALLY LOADED DEEP FOUNDATIONS

We understand that lateral loads may be transferred to the structure foundations. Several alternatives are available for providing resistance to lateral loads including grade beams and lateral load transfer to deep foundations. A grade beam system could provide resistance to lateral loads from the passive lateral resistance provided by compacted engineered fill placed adjacent to the outside edge of the grade beam. Compacted engineered fill for this purpose should extend a minimum of two (2) feet beyond the grade beam and be compacted to a minimum of 95 percent of the maximum dry unit weight as determined by the Modifed Proctor (ASTM D1557). Passive lateral resistance may be calculated using the lateral earth pressure parameters in Table 4.

An alternative to reconcile lateral loads is to estimate lateral resistance in deep foundation members acting against the adjacent soil. Several methods are available for the determination of lateral load resistance utilizing the lateral subgrade reaction modulus, k_s. The lateral subgrade modulus is analogous to the spring constant in the Winkler model of a beam on an elastic foundation. The modulus k_s is dependent upon soil type, elastic properties of the soil, and the foundation element geometry. The value of k_s can be estimated from correlations with published data and are used to estimate applicable values of the lateral subgrade modulus for the Pre-Illinoian glacial till. These values are provided in the following Table 5.

TABLE 5. ESTIMATED LATERAL MODULUS OF SUBGRADE REACTION

SHAFT DIAMETER (ft)	k_s (tons/ft^3)
2	15
3	12
4	10
5	8.5

UNDERPINNING EXISTING FOUNDATION

Underpinning of the existing building foundations will be required during excavation for construction of the new addition. In addition, temporary shoring or bracing of existing soils beneath the existing building will be necessary during construction of the proposed addition.

The underpinning of the existing foundations should be conducted in short lengths compatible with the structural bridging capacity of the existing foundations. Excavation beneath the existing foundations should be performed to minimize disturbance of both existing and new foundation soils. The underpinning pits or excavations should be shored and/or braced during construction in accordance with applicable OSHA regulations.

Upon completion of the underpinning pit to the desired foundation bearing level, concrete for the new foundations should be placed to within 3 inches of the bottom of the existing foundations and then concrete allowed to cure and attain sufficient strength. The remaining 3 inch space between the new foundations and the existing foundations should be thoroughly "dry packed" to provide intimate contact between the new and existing foundations and minimize the potential for settlement of the structure.

The "dry packing" should consist of a non-shrink grout with just enough water to make the mixture hold its shape when squeezed. The mixture is placed in small quantities into the space between the new and existing foundations and tamped with a short length of 2 x 4 lumber and an 8-pound hammer. The process is repeated until the space is completely filled and complete bearing is achieved.

An alternative for existing building foundation underpinning would consist of the use of micropiles installed either through or adjacent to the existing foundation and extended to an elevation below the proposed building addition foundations. Micropiles would derive support from the underlying Pre-Illinoian glacial till soils and could be designed for a combination of skin friction and end bearing. The feasibility of micropiles should be discussed with a geotechnical specialty contractor experienced in this application.

PAVEMENT SUBGRADE PREPARATION

We anticipate that the soil subgrade to support new pavement at this site will consist of either existing soils or compacted engineered fill required to provide the desired final grades. To provide satisfactory pavement performance, it is important that the subgrade support be relatively uniform with no abrupt changes in the degree of support. Non-uniform pavement support can result from variations in soil types and consistencies, particularly at transitions between cut-and-fill areas. Our recommendations for a properly prepared soil subgrade are presented in the following paragraphs.

It is difficult to place new fill and/or pavement on a soft and yielding subgrade. After completion of stripping, cutting, and/or over-excavation operations, and prior to the placement of any new fill, the exposed subgrades should be proof-rolled with heavy construction equipment. The proof-rolling process delineates shallow zones of soft soils, which may require additional compaction or removal. Where soft, organic, or otherwise unsuitable soils occur within the subgrade are, we recommend over-excavation to a minimum depth of 2 feet below finish subgrade elevation or until complete removal is achieved, whichever is shallower. Over-excavated areas should be filled with non-expansive cohesive compacted soil in 6 to 8 inch thick lifts.

As a minimum, we recommend that the upper 2 feet of pavement soil subgrade consist of compacted cohesive soils. This compacted zone can be prepared by reworking the existing soils or placing new fill. Reworking existing soils for subgrade would involve removal of the upper 12 inches or more below final subgrade, scarification of the lower 12 inches, soil moisture adjustment as required, and recompaction in lifts.

In areas to receive new fill, exposed subgrades should be scarified to a minimum depth of 12 inches, adjusted in moisture content as needed, and compacted prior to placement of the new fill. This will improve the density of near-surface soils, and develop a firm base on which new fill soils can be compacted against.

We recommend all fill used to develop design subgrades consist of non-expansive cohesive soils, free of organic matter and other deleterious material. Reworked existing soils and new fill should be placed in 6 to 8 inch thick lifts and compacted to a minimum of 95 percent of the material's maximum dry unit weight as determined by the Standard Proctor procedure (ASTM D-698). The moisture content of subgrade soils containing silts and clays should be within 0 to +4 percent of the soil's optimum water content at the time of compaction and should be maintained prior to final construction. We estimate that a California Bearing Ratio (CBR) of 3 could be used for the purpose of pavement design for a well-prepared and compacted cohesive soil subgrade.

PAVEMENT THICKNESS DESIGN

In our opinion, both basic types of pavement, flexible and rigid, are feasible for use on this site. Pavement design is influenced by anticipated traffic loads and volume, site subgrade conditions, pavement materials, and the desired design life. Our pavement thickness design is based upon a comparison of equivalent pavement sections based on recognized structural coefficients using locally available materials. In areas where heavy traffic loads are expected (such as buses or delivery trucks), additional pavement capacity can be gained by increasing pavement thickness, using a 6-inch layer of compacted Iowa DOT class A roadstone, or a combination of both options.

Table 6 summarizes the alternate pavement design thicknesses. The selected design should include appropriate factors of safety for the projected traffic volumes and types. It should be recognized that the design E-18's are not considered absolute, but rather provide a quantifiable means to compare the various pavement sections.

TABLE 6. PAVEMENT MINIMUM THICKNESS DESIGN

20-Year Design Life

	Mixed Semi-Trailer Truck	Semi-Trailer Truck	Straight & Semi-Trailer Truck	Mixed Auto & Straight Truck	Occasional Truck Traffic
Rigid: P.C. Concrete Thickness (inches)					
	9	8	7	6	6
Flexible: Full Depth A.C. Concrete Thickness (inches)					
Type A Surface	2.0	2.0	1.5	1.5	1.5
Type A Base	7.3	6.5	6.1	5.2	5.2
Section Capacity: E-18 Loads (in millions)					
	3.2	1.6	0.7	0.3	0.1

We recommend that joint design for Portland Cement concrete pavement be based on the P.C.C. Parking Manual published by the Iowa Concrete Paving Association and the Iowa Ready Mixed Concrete Association. We recommend that Portland Cement concrete pavement be used in areas subject to heavy stationary loads and/or tight turning radius areas.

GENERAL

In the event that any changes in the nature, design, or location of the structure are planned, the conclusions and recommendations contained in this report shall not be considered valid unless the changes are reviewed and conclusions of this report modified or verified in writing. Analyses and recommendations presented in this report are based in part upon the data obtained from the soil test borings. The nature and extent of variations across the site may not become evident until construction. If variations then appear, it will be necessary to reevaluate the recommendations of this report.

We require that GSI be provided the opportunity for a general review of the final design plans and specifications. This is to ensure that earthwork and foundation recommendations have been properly interpreted in the design and specifications. GSI will not be responsible for misrepresentation of this report resulting from partial reproduction or paraphrasing of its contents.

We also require that GSI be retained to provide continuous engineering services during construction of the foundation, excavation, and earthwork phases of the work. This is to observe compliance with the design concepts, specifications, and recommendations and to modify recommendations in the event that subsurface conditions differ from those anticipated. Please review the ASFE document *"Important Information About Your Geotechnical Engineering Report"* located ahead of the Table of Contents for additional information regarding this report.

Respectfully,

Geotechnical Services, Inc.

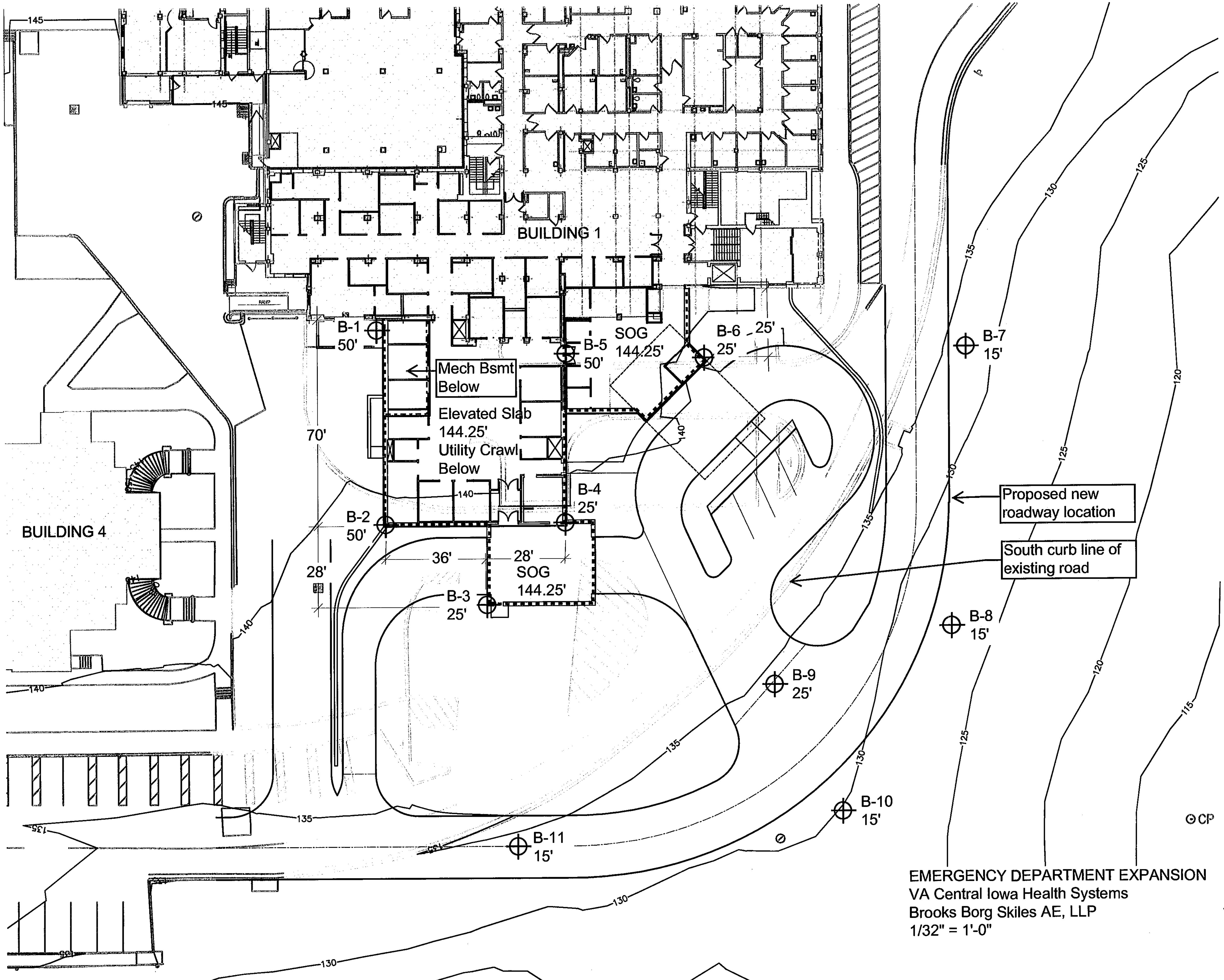
Stacia L. Zink

Stacia L. Zink, E.I.
Staff Engineer

Michael T. Lustig, P.E.
Principal Engineer

APPENDIX A

BORING LOCATION PLAN

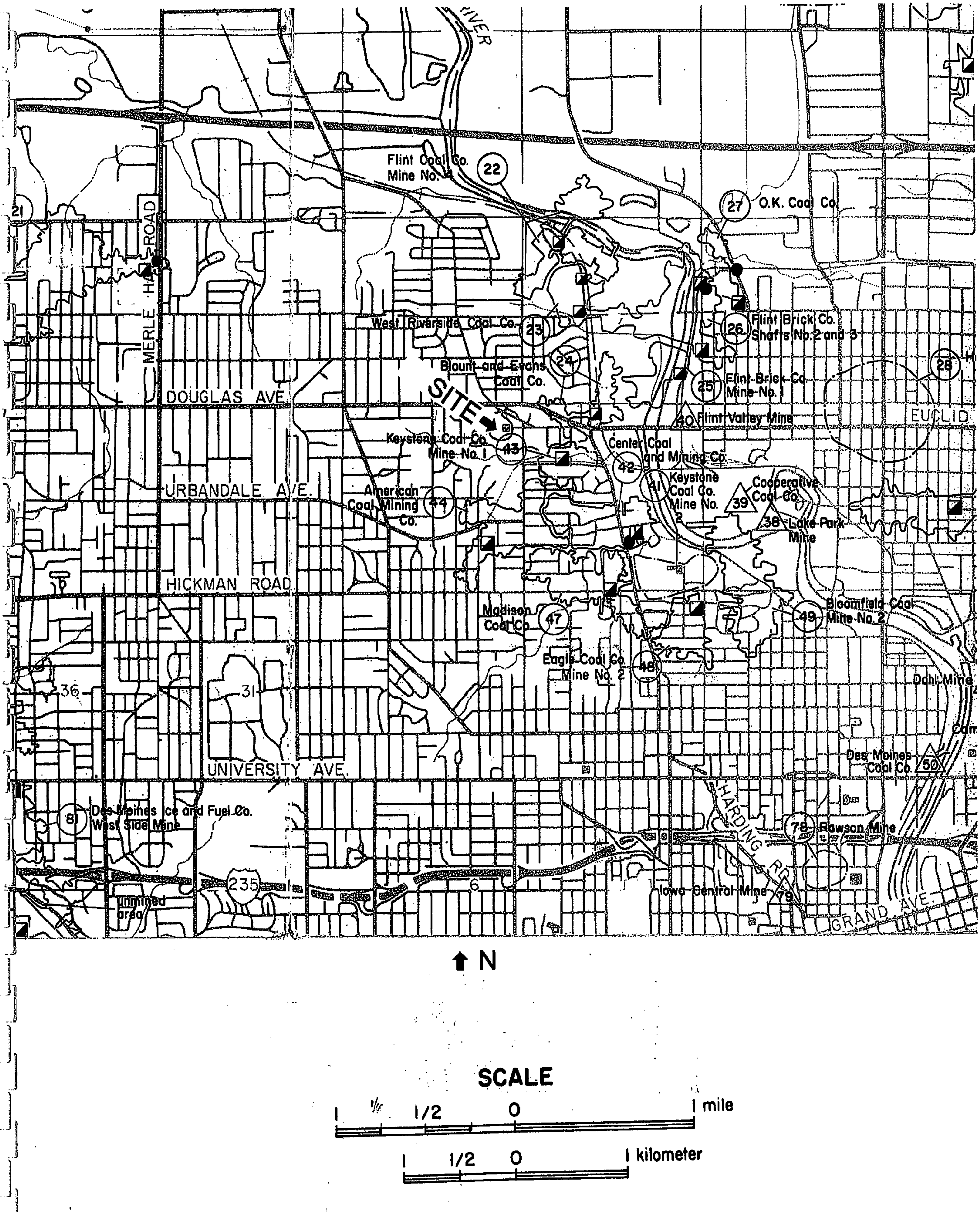


EMERGENCY DEPARTMENT EXPANSION
VA Central Iowa Health Systems
Brooks Borg Skiles AE, LLP
1/32" = 1'-0"

Des Moines, IA
11 JUN 10

APPENDIX B

COAL MINE LOCATION MAP


RIVER
Flint Coal Co. Mine No. 4
22
21
27
O.K. Coal Co.
MERLE HAY ROAD
West Riverside Coal Co.
23
26
Flint Brick Co. Shafts No. 2 and 3
24
Blount and Evans Coal Co.
28
25
Flint Brick Co. Mine No. 1
DOUGLAS AVE.
SITE
40
Flint Valley Mine
EUCLID
Keystone Coal Co. Mine No. 1
43
Center Coal and Mining Co.
42
41
Keystone Coal Co. Mine No. 2
Cooperative Coal Co.
39
URBANDALE AVE.
American Coal Mining Co.
44
38
Lake Park Mine
HICKMAN ROAD
Madison Coal Co.
47
Bloomfield Coal Mine No. 2
49
Eagle Coal Co. Mine No. 2
48
Dahl Mine
36
31
UNIVERSITY AVE.
Des Moines Coal Co.
50
HARDING RD.
81
Des Moines Ice and Fuel Co. West Side Mine
78
Rawson Mine
235
6
unmined area
Iowa Central Mine
79
GRAND AVE.
N
SCALE
1
1/2
0
1 mile
1
1/2
0
1 kilometer

APPENDIX C

BORING LOGS

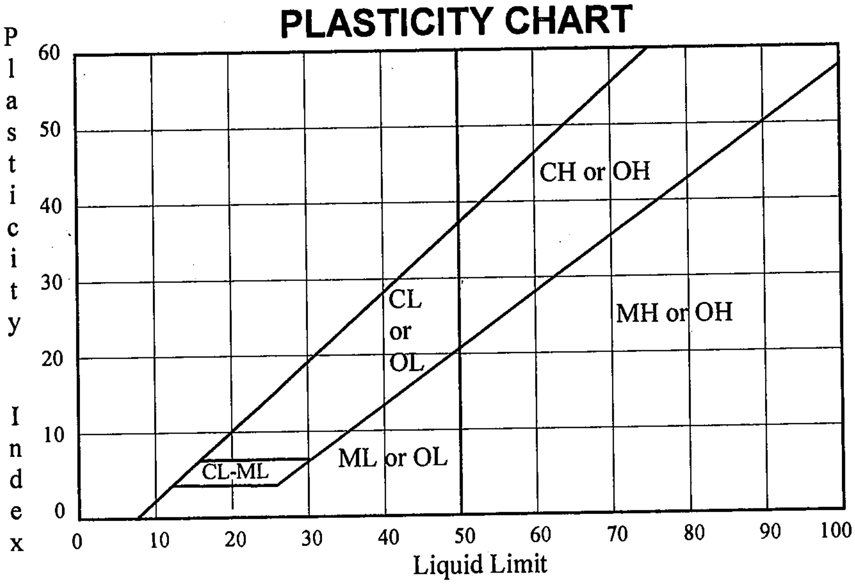
UNIFIED SOIL CLASSIFICATION SYSTEM

GROUP NAME	GROUP SYMBOL	SOIL DESCRIPTION	Comments
Peat	Pt	Highly organic soils	50% or more is smaller than No. 200 sieve
Fat Clay	CH	Clay - Liquid limit > 50% *	
Plastic Silt	MH	Silt - Liquid limit > 50% *	
Lean Clay	CL	Clay - Liquid limit < 50% *	
Silt	ML	Silt - Liquid limit < 50% *	
Silty Clay	CL-ML	Silty Clay *	
Clayey Sand	SC	Sands with 12 to 50 percent smaller than No. 200 sieve *	More than 50% is larger than No. 200 sieve and % sand > % gravel
Silty Sand	SM		
Poorly-graded Sand with Clay	SP-SC	Sands with 5 to 12 percent smaller than No. 200 sieve *	
Poorly-graded Sand with Silt	SP-SM		
Well-graded Sand with Clay **	SW-SC		
Well-graded Sand with Silt **	SW-SM		
Poorly-graded Sand	SP	Sands with less than 5 percent smaller than No. 200 sieve *	
Well-graded Sand **	SW		
Clayey Gravel	GC	Gravels with 12 to 50 percent smaller than No. 200 sieve *	More than 50% is larger than No. 200 sieve and % gravel > % sand
Silty Gravel	GM		
Poorly-graded Gravel with Clay	GP-GC	Gravels with 5 to 12 percent smaller than No. 200 sieve *	
Poorly-graded Gravel with Silt	GP-GM		
Well-graded Gravel with Clay **	GW-GC		
Well-graded Gravel with Silt **	GW-GM		
Poorly Graded Gravel	GP	Gravels with less than 5 percent smaller than No. 200 sieve *	
Well-graded Gravel **	GW		

* See Plasticity Chart for definition of silts and clays.

** See definition for well graded.

PLASTICITY CHART



LEGEND OF TERMS

SAMPLE IDENTIFICATION

U - Undisturbed (shelby tube)
S - Split barrel/SPT (disturbed)
C - California Sampler
L - Lasky continous sampler
A - Auger cuttings (sack sample)
B - Bulk sample (auger cuttings)
H - Head space sample

CONSISTENCY OF COHESIVE SOILS

Unconfined Comp.Strength, Qu, psf	
<500	Very Soft
500-1000	Soft
1000-2000	Medium stiff (Firm)
2000-4000	Stiff
4000-8000	Very stiff
>8000	Hard

RELATIVE DENSITY OF GRANULAR SOILS

N - blows per foot	
0-3	Very loose
4-9	Loose
10-29	Medium Dense
30-49	Dense
50-80	Very Dense

CLASSIFICATION CRITERIA FOR SANDS AND GRAVELS

Well graded sands (SW) $C_u = D_{60}/D_{10} \geq 6$ and $C_c = (D_{30})^2/(D_{10} \times D_{60}) \leq 3$ and ≥ 1

Well graded gravels (GW) $C_u = D_{60}/D_{10} \geq 4$ and $C_c = (D_{30})^2/(D_{10} \times D_{60}) \leq 3$ and ≥ 1

Boulders	Cobbles	Coarse Gravel	Fine Gravel	Coarse Sand	Medium Sand	Fine Sand	FINES (silt or clay)
Sieve sizes 10"	3"	3/4"	#4	#10	#40	#200	

GSI

BORING LOG No. B-1

BORING NO.	LOCATION OF BORING	ELEVATION	DATUM	DRILLER	LOGGER
B-1	See Boring Site Plan	140.5	Site Plan	DAH	CWM

WATER LEVEL OBSERVATIONS				TYPE OF SURFACE	DRILL RIG
WHILE DRILLING	END OF DRILLING	24 HOURS AFTER DRILLING		Grass	B-57
				DRILLING METHOD	TOTAL DEPTH
20 feet	47 feet			2 1/4 inch hollow stem auger	50 feet

DEP. FT.	SAMPLE NO. & TYPE	"N" BLOWS (FT)	% REC.	SOIL DESCRIPTION: COLOR, MOISTURE, CONSISTENCY / GEOLOGIC DESCRIPTION & OTHER REMARKS	USCS CLASS.	% MC	DRY DENS. pcf	Qu psf	DEP. FT.
				Dark brown, Moist, Firm, SANDY LEAN CLAY trace organics	FILL				
				TOPSOIL/MAN-MADE FILL —2.0'					
				Light brown rust mottled, Moist, Medium stiff, SANDY LEAN CLAY					
4	S-1	7	90		CL	20			4
8				WISCONSINAN GLACIAL TILL —8.0'					8
				Light brown gray mottled, Very moist, Soft to medium stiff, SILTY LEAN CLAY					
	S-2	5	90			27			
12									12
	S-3	5	95		CL	27			
16									16
	S-4	5	90			29			
20									▽ 20
				WISCONSINAN LOESS —22.5'					
				Maroon, Damp to moist, Medium stiff to stiff, SANDY FAT-LEAN CLAY					
24	S-5	20	95			21			24
28									28
	S-6	16	90		CL-CH	23			

GSI Geotechnical Services, Inc.
10607 Aurora Avenue, Urbandale, Iowa 50322
(515) 270-6542 FAX (515) 270-1911

PROJECT: Emergency Department Expansion
LOCATION: VA Medical Center, 3600 Douglas, Des Moines,
JOB NO.: 106120
DATE: 6-26-2010

BORING LOG No. B-1

BORING NO.	LOCATION OF BORING	ELEVATION	DATUM	DRILLER	LOGGER
B-1	See Boring Site Plan	140.5	Site Plan	DAH	CWM

WATER LEVEL OBSERVATIONS				TYPE OF SURFACE	DRILL RIG
WHILE DRILLING	END OF DRILLING	24 HOURS AFTER DRILLING		Grass	B-57
				DRILLING METHOD	TOTAL DEPTH
20 feet	47 feet			2 1/4 inch hollow stem auger	50 feet

DEP. FT.	SAMPLE NO. & TYPE	"N" BLOWS (FT)	% REC.	COLOR, MOISTURE, CONSISTENCY / GEOLOGIC DESCRIPTION & OTHER REMARKS	USCS CLASS.	% MC	DRY DENS. pcf	Qu psf	DEP. FT.
	S-7	18	95			16			
36				PRE-ILLINOIAN GLACIAL TILL —36.0'					36
				Brown gray mottled, Damp, Very stiff, SANDY LEAN CLAY trace gravel					
40	S-8	16	90			14			40
44	S-9	18	90		CL	15			44
48									48
	S-10	30	95	PRE-ILLINOIAN GLACIAL TILL —50.0'		18			
				Bottom of Boring @ 50'					
52									52
56									56
60									60

GSI Geotechnical Services, Inc.
10607 Aurora Avenue, Urbandale, Iowa 50322
(515) 270-6542 FAX (515) 270-1911

PROJECT: Emergency Department Expansion
LOCATION: VA Medical Center, 3600 Douglas, Des Moines,
JOB NO.: 106120
DATE: 6-26-2010

BORING LOG No. B-2

BORING NO.	LOCATION OF BORING	ELEVATION	DATUM	DRILLER	LOGGER
B-2	See Boring Site Plan	139.0	Site Plan	DAH	CWM

WATER LEVEL OBSERVATIONS				TYPE OF SURFACE	DRILL RIG
WHILE DRILLING	END OF DRILLING	24 HOURS AFTER DRILLING		Pavement	B-57
				DRILLING METHOD	TOTAL DEPTH
24 feet	43 feet			2 1/4 inch hollow stem auger	50 feet

DEP. FT.	SAMPLE DATA: SAMPLE NO. & TYPE	SAMPLE DATA: "N" BLOWS (FT)	SAMPLE DATA: % REC.	SOIL DESCRIPTION: COLOR, MOISTURE, CONSISTENCY / GEOLOGIC DESCRIPTION & OTHER REMARKS	USCS CLASS.	LABORATORY DATA: % MC	LABORATORY DATA: DRY DENS. pcf	LABORATORY DATA: Qu psf	DEP. FT.
				ASPHALTIC CEMENT CONCRETE — 0.4'					
				Dark brown and brown mixed, Dry, Firm, SANDY LEAN CLAY with crushed rock MAN-MADE FILL — 3.0'	FILL				
4	S-1	8	90	Light brown, Moist, Medium stiff, SANDY LEAN CLAY	CL	19			4
8				WISCONSINAN GLACIAL TILL — 8.0'					8
	S-2	8	90	Light brown gray mottled, Very moist, Medium stiff, SILTY LEAN CLAY		24			
12									12
	S-3	6	95		CL	28			
16									16
20	S-4	5	90			29			20
				WISCONSINAN LOESS — 22.0'					
				Brown gray mottled, Damp, Stiff to very stiff, SANDY LEAN CLAY trace gravel					
24	S-5	17	95			20			▽ 24
28									28
	S-6	14	90			24			

GSI Geotechnical Services, Inc.
10607 Aurora Avenue, Urbandale, Iowa 50322
(515) 270-6542 FAX (515) 270-1911

PROJECT: Emergency Department Expansion
LOCATION: VA Medical Center, 3600 Douglas, Des Moines,
JOB NO.: 106120
DATE: 6-25-2010

BORING LOG No. B-2

BORING NO.	LOCATION OF BORING	ELEVATION	DATUM	DRILLER	LOGGER
B-2	See Boring Site Plan	139.0	Site Plan	DAH	CWM

WATER LEVEL OBSERVATIONS				TYPE OF SURFACE	DRILL RIG
WHILE DRILLING	END OF DRILLING	24 HOURS AFTER DRILLING		Pavement	B-57
				DRILLING METHOD	TOTAL DEPTH
24 feet	43 feet			2 1/4 inch hollow stem auger	50 feet

DEP. FT.	SAMPLE DATA: SAMPLE NO. & TYPE	"N" BLOWS (FT)	% REC.	SOIL DESCRIPTION: COLOR, MOISTURE, CONSISTENCY / GEOLOGIC DESCRIPTION & OTHER REMARKS	USCS CLASS.	LABORATORY DATA: % MC	DRY DENS. pcf	Qu psf	DEP. FT.
	S-7	18	95			16			
36					CL				36
40	S-8	20	90			15			40
44	S-9	24	90	Maroon and increasing clay content below 43 feet		15			44
48									48
	S-10	23	95	PRE-ILLINOIAN GLACIAL TILL 50.0'		19			
				Bottom of Boring @ 50'					
52									52
56									56
60									60

GSI Geotechnical Services, Inc.
10607 Aurora Avenue, Urbandale, Iowa 60322
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PROJECT: Emergency Department Expansion
LOCATION: VA Medical Center, 3600 Douglas, Des Moines,
JOB NO.: 106120
DATE: 6-25-2010

BORING LOG No. B-3

BORING NO.	LOCATION OF BORING	ELEVATION	DATUM	DRILLER	LOGGER
B-3	See Boring Site Plan	138.0	Site Plan	DAH	CWM

WATER LEVEL OBSERVATIONS				TYPE OF SURFACE	DRILL RIG
WHILE DRILLING	END OF DRILLING	24 HOURS AFTER DRILLING		Pavement	B-47
				DRILLING METHOD	TOTAL DEPTH
20 feet	25 feet			4 inch continuous flight auger	25 feet

DEP. FT.	SAMPLE NO. & TYPE	"N" BLOWS (FT)	% REC.	SOIL DESCRIPTION: COLOR, MOISTURE, CONSISTENCY / GEOLOGIC DESCRIPTION & OTHER REMARKS	Depth	USCS CLASS.	% MC	DRY DENS. pcf	Qu psf	DEP. FT.
				ASPHALTIC CEMENT CONCRETE	0.4'					
				Brown and gray mixed, Moist, Soft to firm, VERY SANDY LEAN CLAY		FILL				
4	S-1	1	85				17			4
				MAN-MADE FILL	6.0'					
				Brown, Moist, Firm, SANDY LEAN CLAY		CL				
8	S-2	4	90				18			8
12				WISCOSINAN GLACIAL TILL	12.0'					12
				Light brown rust mottled, Very moist, Medium stiff, SILTY LEAN CLAY		CL				
	S-3	7	90				28			
16										16
20	S-4	6	95				26			▽ 20
				WISCONSINAN LOESS	22.0'					
				Maroon to brown, Moist to very moist, Stiff, SANDY FAT-LEAN CLAY		CL-CH				
24	S-5	26	90				19			24
				PRE-ILLINOIAN GLACIAL TILL	25.0'					▼
				Bottom of Boring @ 25'						
28										28

GSI Geotechnical Services, Inc.
10607 Aurora Avenue, Urbandale, Iowa 50322
(515) 270-6542 FAX (515) 270-1911

PROJECT: Emergency Department Expansion
LOCATION: VA Medical Center, 3600 Douglas, Des Moines,
JOB NO.: 106120
DATE: 6-24-2010

BORING LOG No. B-4

BORING NO.	LOCATION OF BORING	ELEVATION	DATUM	DRILLER	LOGGER
B-4	See Boring Site Plan	138.5	Site Plan	DAH	CWM

WATER LEVEL OBSERVATIONS				TYPE OF SURFACE	DRILL RIG
WHILE DRILLING	END OF DRILLING	24 HOURS AFTER DRILLING		Pavement	B-47
				DRILLING METHOD	TOTAL DEPTH
22 feet	23 feet			4 inch continuous flight auger	25 feet

DEP. FT.	SAMPLE DATA: SAMPLE NO. & TYPE	"N" BLOWS (FT)	% REC.	SOIL DESCRIPTION: COLOR, MOISTURE, CONSISTENCY / GEOLOGIC DESCRIPTION & OTHER REMARKS	USCS CLASS.	LABORATORY DATA: % MC	DRY DENS. pcf	Qu psf	DEP. FT.
				ASPHALTIC CEMENT CONCRETE — 0.4'					
				Reddish brown, Moist, Firm, CLAYEY SAND	FILL				
4	S-1	8	85			9			4
				MAN-MADE FILL — 6.0'					
				Light brown gray mottled, Moist to very moist, Medium stiff, SILTY LEAN CLAY					
8	S-2	7	90			25			8
12									12
	S-3	6	95		CL	29			
16									16
20	S-4	6	95			29			20
				WISCONSINAN LOESS — 22.0'					
				Maroon to brown, Dry, Stiff, SANDY FAT CLAY	CL-CH				
24	S-5	29	95			21			24
				PRE-ILLINOIAN GLACIAL TILL — 25.0'					
				Bottom of Boring @ 25'					
28									28

GSI Geotechnical Services, Inc.
10607 Aurora Avenue, Urbandale, Iowa 50322
(515) 270-6542 FAX (515) 270-1911

PROJECT: Emergency Department Expansion
LOCATION: VA Medical Center, 3600 Douglas, Des Moines,
JOB NO.: 106120
DATE: 6-24-2010

BORING LOG No. B-5

BORING NO.	LOCATION OF BORING	ELEVATION	DATUM	DRILLER	LOGGER
B-5	See Boring Site Plan	141.0	Site Plan	DAH	CWM

WATER LEVEL OBSERVATIONS				TYPE OF SURFACE	DRILL RIG
WHILE DRILLING	END OF DRILLING	24 HOURS AFTER DRILLING		Grass	B-57
				DRILLING METHOD	TOTAL DEPTH
24 feet	41 feet			2 1/4 inch hollow stem auger	50 feet

DEP. FT.	SAMPLE DATA: SAMPLE NO. & TYPE	"N" BLOWS (FT)	% REC.	SOIL DESCRIPTION: COLOR, MOISTURE, CONSISTENCY / GEOLOGIC DESCRIPTION & OTHER REMARKS	USCS CLASS.	LABORATORY DATA: % MC	DRY DENS. pcf	Qu psf	DEP. FT.
0				Dark brown, Moist, Firm, SILTY LEAN CLAY trace organics	FILL				
4	S-1	5	90			14			4
6.0'				**TOPSOIL / MAN-MADE FILL**					
				Light brown rust mottled, Moist, Firm, SANDY LEAN CLAY	CL				
8	S-2	5	95			19			8
12.0'				**WISCONSINAN GLACIAL TILL**					12
				Light brown gray mottled, Very moist, Medium stiff, SILTY LEAN CLAY	CL				
	S-3	5	95			27			
16									16
20	S-4	6	90			27			20
22.0'				**WISCONSINAN LOESS**					
				Maroon to brown, Moist, Stiff to very stiff, SANDY FAT-LEAN CLAY	CL-CH				
24	S-5	14	90			22			▽ 24
28	S-6	18	95			21			28

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10807 Aurora Avenue, Urbandale, Iowa 50322
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PROJECT: Emergency Department Expansion
LOCATION: VA Medical Center, 3600 Douglas, Des Moines,
JOB NO.: 106120
DATE: 6-25-2010

BORING LOG No. B-5

BORING NO.	LOCATION OF BORING	ELEVATION	DATUM	DRILLER	LOGGER
B-5	See Boring Site Plan	141.0	Site Plan	DAH	CWM

WATER LEVEL OBSERVATIONS				TYPE OF SURFACE	DRILL RIG
WHILE DRILLING	END OF DRILLING	24 HOURS AFTER DRILLING		Grass	B-57
				DRILLING METHOD	TOTAL DEPTH
24 feet	41 feet			2 1/4 inch hollow stem auger	50 feet

DEP. FT.	SAMPLE NO. & TYPE	"N" BLOWS (FT)	% REC.	SOIL DESCRIPTION: COLOR, MOISTURE, CONSISTENCY / GEOLOGIC DESCRIPTION & OTHER REMARKS	USCS CLASS.	% MC	DRY DENS. pcf	Qu psf	DEP. FT.
				PRE-ILLINOIAN GLACIAL TILL —32.0'					
				Brown gray mottled, Damp, Very stiff, SANDY LEAN CLAY trace gravel					
	S-7	24	95			15			
36									36
40	S-8	32	95			15			40
					CL				
44	S-9	23	95			16			44
48									48
	S-10	22	90			15			
				PRE-ILLINIOAN GLACIAL TILL —50.0'					
				Bottom of Boring @ 50'					
52									52
56									56
60									60

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PROJECT: Emergency Department Expansion
LOCATION: VA Medical Center, 3600 Douglas, Des Moines,
JOB NO.: 106120
DATE: 6-25-2010

BORING LOG No. B-6

BORING NO.	LOCATION OF BORING	ELEVATION	DATUM	DRILLER	LOGGER
B-6	See Boring Site Plan	140.0	Site Plan	DAH	CWM

WATER LEVEL OBSERVATIONS				TYPE OF SURFACE	DRILL RIG
WHILE DRILLING	END OF DRILLING	24 HOURS AFTER DRILLING		Grass	B-47
				DRILLING METHOD	TOTAL DEPTH
22 feet	24 feet			4 inch continuous flight auger	25 feet

DEP. FT.	SAMPLE DATA: SAMPLE NO. & TYPE	"N" BLOWS (FT)	% REC.	SOIL DESCRIPTION: COLOR, MOISTURE, CONSISTENCY / GEOLOGIC DESCRIPTION & OTHER REMARKS	USCS CLASS.	LABORATORY DATA: % MC	DRY DENS. pcf	Qu psf	DEP. FT.
				Dark brown, Moist, Firm, SILTY LEAN CLAY trace organics **TOPSOIL / MAN-MADE FILL** —1.0'	FILL				
				Light brown, Moist, Medium stiff, SANDY LEAN CLAY					
4	S-1	7	90		CL	19			4
				WISCONSINAN GLACIAL TILL —7.0'					
				Light brown rust mottled, Moist to very moist, Medium stiff, SILTY LEAN CLAY					
8									8
	S-2	9	95			25			
12									12
	S-3	7	95		CL	28			
16									16
	S-4	9	92			27			
20									20
				WISCONSINAN LOESS —22.0'					▽
				Maroon to brown, Damp, Very stiff, SANDY FAT-LEAN CLAY	CL-CH				
24	S-5	30	90			20			24 ▼
				PRE-ILLINOIAN GLACIAL TILL —25.0' Bottom of Boring @ 25'					
28									28

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PROJECT: Emergency Department Expansion
LOCATION: VA Medical Center, 3600 Douglas, Des Moines,
JOB NO.: 106120
DATE: 6-24-2010

BORING LOG No. B-7

BORING NO.	LOCATION OF BORING	ELEVATION	DATUM	DRILLER	LOGGER
B-7	See Boring Site Plan	133.0	Site Plan	DAH	CWM

WATER LEVEL OBSERVATIONS				TYPE OF SURFACE	DRILL RIG
WHILE DRILLING	END OF DRILLING	24 HOURS AFTER DRILLING		Grass	B-47
				DRILLING METHOD	TOTAL DEPTH
DRY	DRY			4 inch continuous flight auger	15 feet

DEP. FT.	SAMPLE DATA			SOIL DESCRIPTION		LABORATORY DATA			DEP. FT.
	SAMPLE NO. & TYPE	"N" BLOWS (FT)	% REC.	COLOR, MOISTURE, CONSISTENCY / GEOLOGIC DESCRIPTION & OTHER REMARKS	USCS CLASS.	% MC	DRY DENS. pcf	Qu psf	
				Dark brown, Moist, Firm, SILTY LEAN CLAY trace organics **TOPSOIL / MAN-MADE FILL** 1.0'	FILL				
				Light brown, Moist, Medium stiff, SANDY LEAN CLAY **WISCONSINAN GLACIAL TILL** 3.0'	CL				
				Light brown gray mottled, Moist to very moist, Medium stiff, SILTY LEAN CLAY	CL				
4	S-1	10	90			24			4
8	S-2	9	95			27			8
12	S-3	8	93	**WISCONSINAN LOESS** 15.0'		28			12
16				Bottom of Boring @ 15'					16
20									20
24									24
28									28

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PROJECT: Emergency Department Expansion
LOCATION: VA Medical Center, 3600 Douglas, Des Moines,
JOB NO.: 106120
DATE: 6-26-2010

BORING LOG No. B-8

BORING NO.	LOCATION OF BORING	ELEVATION	DATUM	DRILLER	LOGGER
B-8	See Boring Site Plan	127.0	Site Plan	DAH	CWM

WATER LEVEL OBSERVATIONS				TYPE OF SURFACE	DRILL RIG
WHILE DRILLING	END OF DRILLING	24 HOURS AFTER DRILLING		Grass	B-47
				DRILLING METHOD	TOTAL DEPTH
DRY	DRY			4 inch continuous flight auger	15 feet

DEP. FT.	SAMPLE NO. & TYPE	"N" BLOWS (FT)	% REC.	SOIL DESCRIPTION: COLOR, MOISTURE, CONSISTENCY / GEOLOGIC DESCRIPTION & OTHER REMARKS	USCS CLASS.	% MC	DRY DENS. pcf	Qu psf	DEP. FT.
				Dark brown, Moist, Firm, SILTY LEAN CLAY trace organics **TOPSOIL / MAN-MADE FILL** — 1.0'	FILL				
	U-1		92	Reddish brown, Moist, Medium stiff, VERY SANDY LEAN CLAY **WISCONSINAN GLACIAL TILL** — 3.5'	CL	16	110	960	
4	S-2	10	90	Light brown rust mottled, Moist to dry, Stiff, SILTY LEAN CLAY		26			4
8									8
	S-3	16	95		CL	21			
12									12
	S-4	23	93	Very dry below 13 feet **WISCONSINAN LOESS** — 15.0'		11			
16				Bottom of Boring @ 15'					16
20									20
24									24
28									28

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PROJECT: Emergency Department Expansion
LOCATION: VA Medical Center, 3600 Douglas, Des Moines,
JOB NO.: 106120
DATE: 6-24-2010

BORING LOG No. B-9

BORING NO.	LOCATION OF BORING	ELEVATION	DATUM	DRILLER	LOGGER
B-9	See Boring Site Plan	134.0	Site Plan	DAH	CWM

WATER LEVEL OBSERVATIONS				TYPE OF SURFACE	DRILL RIG
WHILE DRILLING	END OF DRILLING	24 HOURS AFTER DRILLING		Grass	B-47
DRY	DRY			**DRILLING METHOD**: 4 inch continuous flight auger	**TOTAL DEPTH**: 25 feet

DEP. FT.	SAMPLE NO. & TYPE	"N" BLOWS (FT)	% REC.	SOIL DESCRIPTION: COLOR, MOISTURE, CONSISTENCY / GEOLOGIC DESCRIPTION & OTHER REMARKS	USCS CLASS.	% MC	DRY DENS. pcf	Qu psf	DEP. FT.
				Dark brown, Moist, Firm, SILTY LEAN CLAY trace organics TOPSOIL / MAN-MADE FILL —1.0'	FILL				
	U-1		92	Reddish brown, Moist, Medium stiff, VERY SANDY LEAN CLAY		16	106	1260	
4	S-2	5	90		CL	19			4
				WISCONSINAN GLACIAL TILL —7.0'					
8				Light brown gray mottled, Moist, Stiff, SILTY LEAN CLAY					8
	S-3	8	95			26			
12									12
	S-4	24	90	Very dry between 12 feet and 21 feet		14			
16					CL				16
	S-5	21	92			12			
20									20
24	S-6	16	90			27			24
				WISCONSINAN LOESS —25.0' Bottom of Boring @ 25'					
28									28

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PROJECT: Emergency Department Expansion
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JOB NO.: 106120
DATE: 6-24-2010

BORING LOG No. B-10

BORING NO.	LOCATION OF BORING	ELEVATION	DATUM	DRILLER	LOGGER
B-10	See Boring Site Plan	130.0	Site Plan	DAH	CWM

WATER LEVEL OBSERVATIONS				TYPE OF SURFACE	DRILL RIG
WHILE DRILLING	END OF DRILLING	24 HOURS AFTER DRILLING		Grass	B-47
				DRILLING METHOD	TOTAL DEPTH
DRY	DRY			4 inch continuous flight auger	15 feet

DEP. FT.	SAMPLE NO. & TYPE	"N" BLOWS (FT)	% REC.	SOIL DESCRIPTION: COLOR, MOISTURE, CONSISTENCY / GEOLOGIC DESCRIPTION & OTHER REMARKS	USCS CLASS.	% MC	DRY DENS. pcf	Qu psf	DEP. FT.
				Dark brown, Moist, Firm, SILTY LEAN CLAY trace organics **TOPSOIL / MAN-MADE FILL** — 1.0'	FILL				
	U-1		93	Reddish brown, Moist, Medium stiff, SANDY LEAN CLAY **WISCONSINAN GLACIAL TILL** — 3.5'	CL	19	108	3930	
4	S-2	12	92	Light brown gray mottled, Moist to dry, Stiff, SILTY LEAN CLAY					4
8	S-3	18	95		CL	21			8
12	S-4	32	93	**WISCONSINAN LOESS** — 15.0'		13			12
16				Bottom of Boring @ 15'					16
20									20
24									24
28									28

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JOB NO.: 106120
DATE: 6-24-2010

BORING LOG No. B-11

BORING NO.	LOCATION OF BORING	ELEVATION	DATUM	DRILLER	LOGGER
B-11	See Boring Site Plan	134.0	Site Plan	DAH	CWM

WATER LEVEL OBSERVATIONS				TYPE OF SURFACE	DRILL RIG
WHILE DRILLING	END OF DRILLING	24 HOURS AFTER DRILLING		Grass	B-47
				DRILLING METHOD	TOTAL DEPTH
DRY	DRY			4 inch continuous flight auger	15 feet

DEP. FT.	SAMPLE DATA: SAMPLE NO. & TYPE	"N" BLOWS (FT)	% REC.	SOIL DESCRIPTION: COLOR, MOISTURE, CONSISTENCY / GEOLOGIC DESCRIPTION & OTHER REMARKS	USCS CLASS.	LABORATORY DATA: % MC	DRY DENS. pcf	Qu psf	DEP. FT.
				Dark brown, Moist, Firm, SILTY LEAN CLAY trace organics **TOPSOIL / MAN-MADE FILL** — 1.0'	FILL				
	U-1		93	Brown and gray, Moist, Medium stiff, SANDY LEAN CLAY		19	105	1330	
4	S-2	2	90		CL	23			4
				WISCONSINAN GLACIAL TILL — 7.0'					
8				Light brown gray mottled, Moist to very moist, Medium stiff, SILTY LEAN CLAY					8
	S-3	8	95			24			
12					CL				12
	S-4	8	92			27			
				WISCONSINAN LOESS — 15.0' Bottom of Boring @ 15'					
16									16
20									20
24									24
28									28

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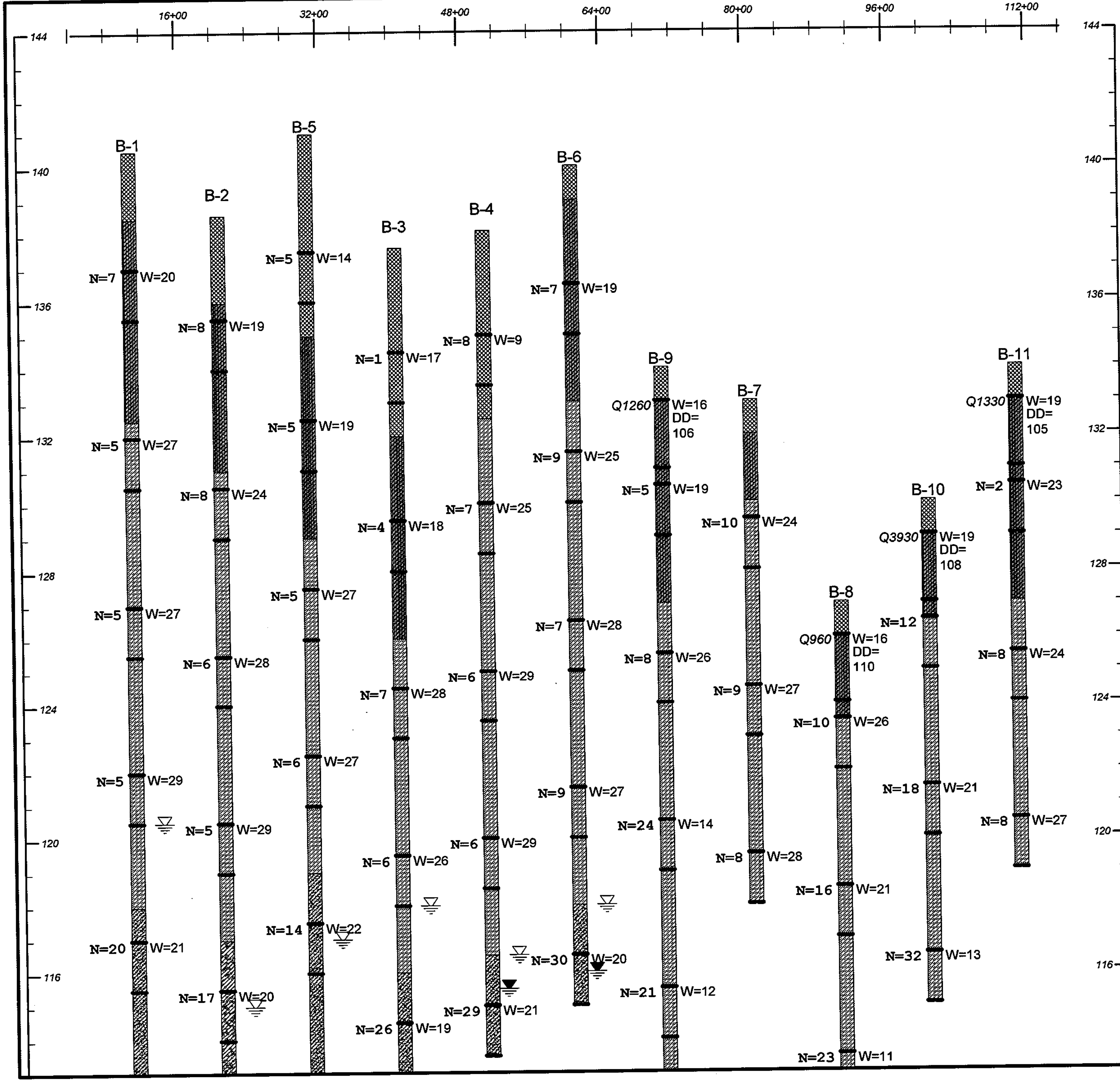
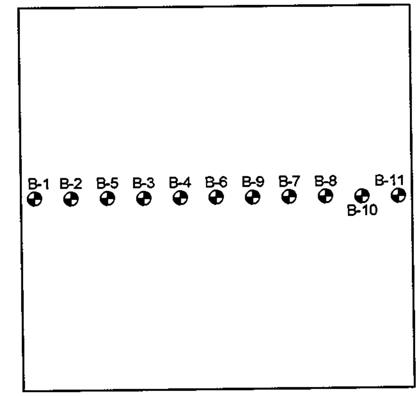
PROJECT: Emergency Department Expansion
LOCATION: VA Medical Center, 3600 Douglas, Des Moines,
JOB NO.: 106120
DATE: 6-24-2010



Plan View



GENERALIZED SOIL PROFILE

GSI

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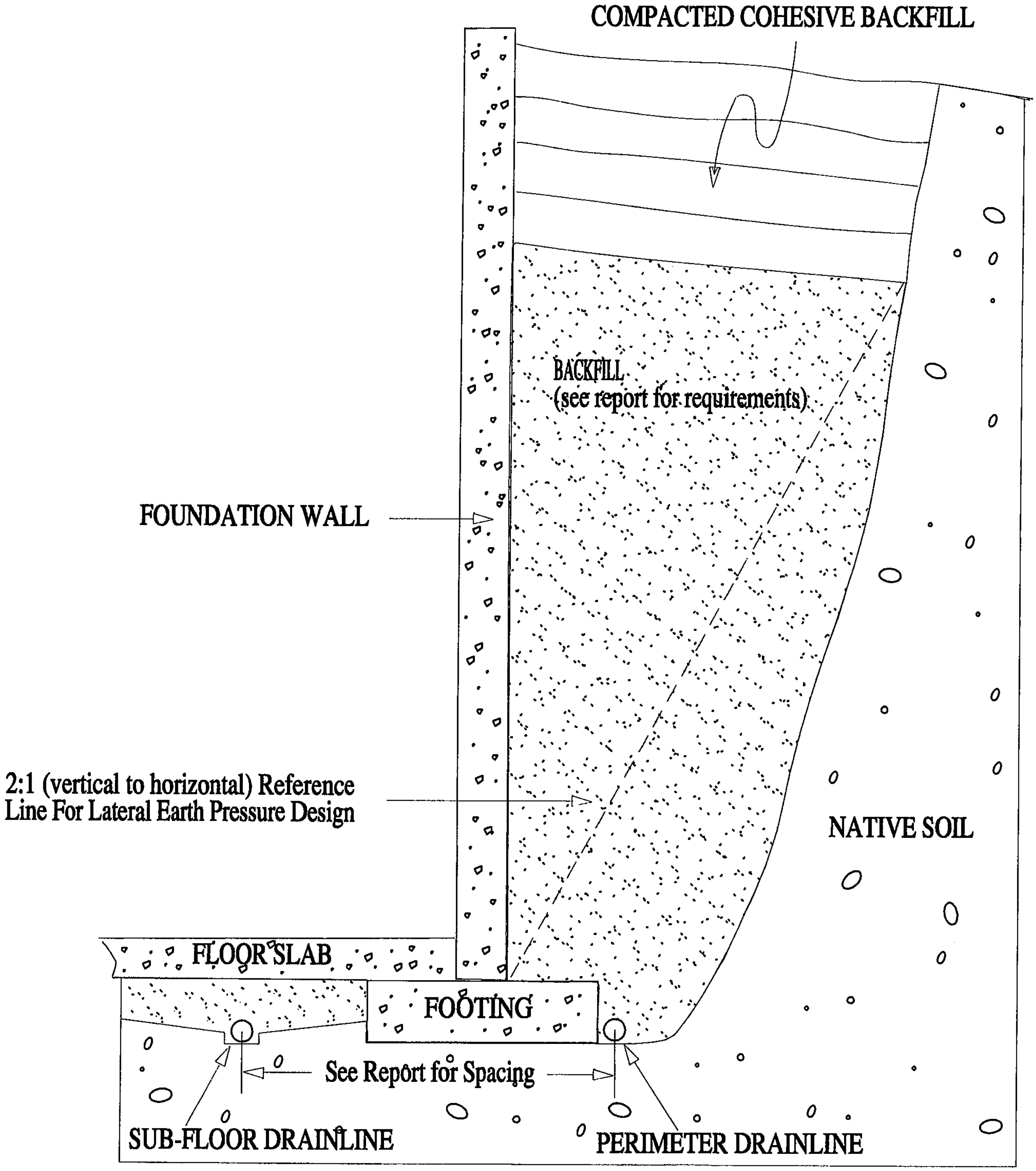
Emergency Department Expansion

FIGURE

APPENDIX D

FOUNDATION WALL BACKFILL AND DRAINAGE SCHEMATIC

FOUNDATION WALL BACKFILL & DRAINAGE



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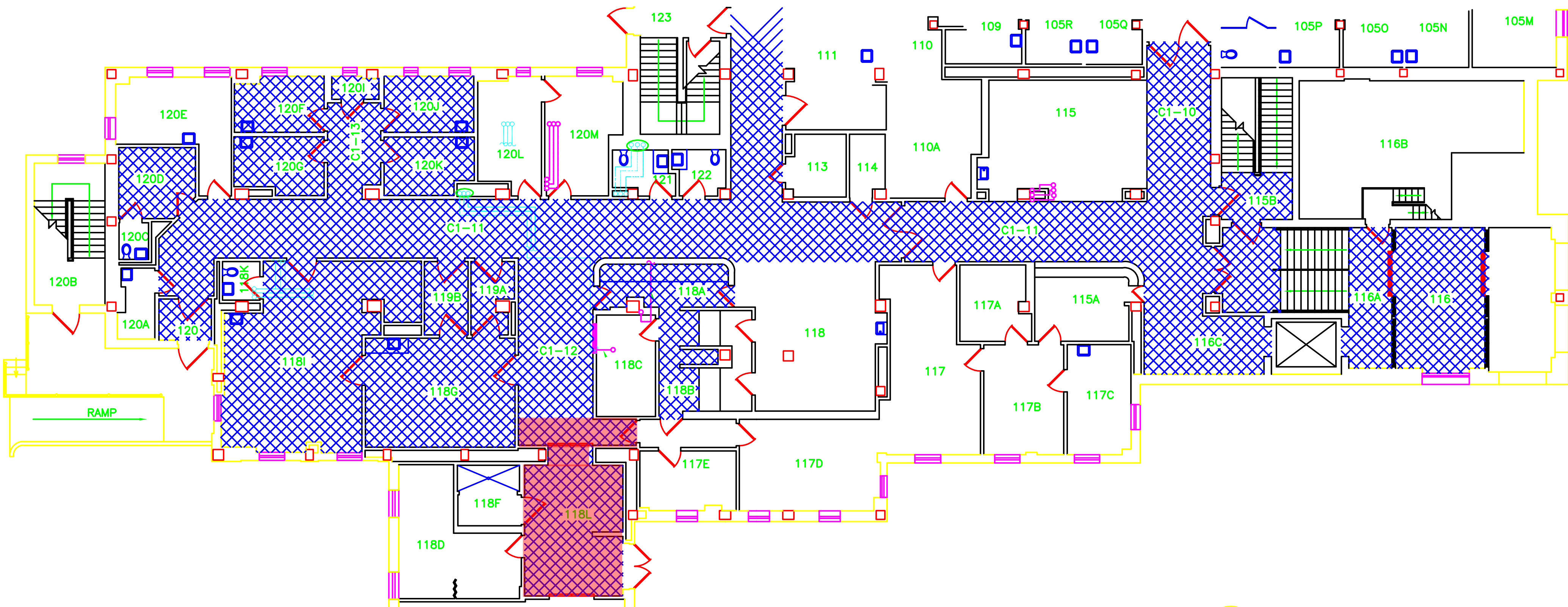
ATTACHMENT 5

VA EMERGENCY DEPARTMENT
EXPAND RENOVATE
ABATEMENT PLAN



BUILDING 1 – FIRST FLOOR PLAN – AREA B
SCALE: 1/8" = 1'-0"

ABATEMENT AREA