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## **REPORT**

### **Geotechnical Exploration**

VA Research Office Building  
Oakland Campus  
Pittsburgh, Pennsylvania

**GAI Project Number: C060465.00.002**  
**December 2006**

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. . . transforming ideas into reality

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## Introduction

This report presents the results of a geotechnical exploration to develop criteria for design of foundations and earth retaining structures for a proposed research office building to be constructed at the Veterans Administration (VA) Hospital site in Pittsburgh, Pennsylvania.

### Site

The proposed building is to be located in the predominately urban Oakland section of Pittsburgh, Pennsylvania, as shown on Figure 1. The VA Hospital site is situated on a hilltop above the University of Pittsburgh campus and is generally surrounded by university facilities. The new research office building will be west of the existing hospital in the approximate area shown in Figure 2. Much of the area of the new construction is currently occupied by existing buildings and parking lots. The current ground in the immediate vicinity of the new building is at approximate elevation of 1160 feet (USGS datum).

### Proposed Facilities

GAI understands that the new building will have three to four stories above grade and a small partial basement for utilities extending one-story below grade. No significant regrading is planned around the new building. However, excavation and demolition of the existing buildings will be required to construct the new structure.

### Other Background Data

The existing hospital building adjacent to the proposed research office building is to remain during the construction of the new facility and will need to be protected from damage during and after construction activities.

### Scope of Work

The scope of GAI's geotechnical engineering services for this exploration included:

- Review of background literature for subsurface information;
- Retain a qualified drilling contractor to perform the drilling and sampling;
- Establish boring locations and monitor the subsurface exploration;
- Prepare field classification sheets of the borings;
- Select samples and perform laboratory tests; and
- Prepare a report that includes a plan of borings, the logs of the borings, the results of laboratory tests, and recommendations for the design of foundations and basement retaining walls for the proposed structure.

The scope did not include any assessment of the site for potential environmental hazards.

### Authorization

Astorino of Pittsburgh, PA is the architect for the proposed parking facility. The Department of Veteran Affairs of Washington, D.C. is the owner. This exploration was authorized by Astorino.

## Geology and Mining

### Geology

The site is located in the Pittsburgh Low Plateau Section of the Appalachian Plateau Physiographic Province. This region is characterized by nearly flat-lying sedimentary strata with structural features of this province predominately in a series of northeast-southwest trending gentle ridges and valleys. The study area has been dissected and eroded by many small branching streams, resulting in rugged, steep hillsides with valleys containing alluvial material.

Rock at the project site is of Pennsylvanian age, belonging to the lower Pittsburgh Formation of the Monongahela Group. Figure 3 presents a generalized geologic section of Allegheny County. The Pittsburgh formation, consisting of cyclic sequences of sandstone, shale, siltstone, limestone and coal,

extends from the base of the Uniontown coal seam to the base of the Pittsburgh coal. The strata are commonly interbedded and change lithologically over short lateral distances. Structurally, the site is located just east of the McMurray synclinal axis with a local rock strata dip to the southwest at approximately 10 feet per mile.

## Mining

Previous deep mining activities are indicated by the Coal Resources of Allegheny County (Dodge, 1985). The mining method was most likely room and pillar method based on the mining technique in the early 1900's, although no specific mining dates are known. Review of available mining references and information obtained during GAI's subsurface investigations at other areas of the VA property indicates that the site is undermined in the Pittsburgh coal. The depth below existing grade to the base elevation of the Pittsburgh coal at about 1060 feet is about 100 feet. The thickness of the seam is estimated to be 10 feet.

A former mine fire was northwest of the project site within the mine according to the Map of Coal Mining Features, Allegheny County, Pennsylvania (Davies, Pomeroy, Kohl, 1976). Information on the University of Pittsburgh's original campus concept indicated that a part of the mining operation was on fire, and other literature indicated that smoke was emitting from the hillside during construction in the early 1900's.

The original VA hospital constructed in the early 1950's included grouting at the mine interval to prevent mine subsidence. It was indicated to GAI by VA personnel that grouting was also performed for the building addition placed adjacent to the south side of the original building in the 1990's. The 1990's grouting program did not require much grout, most likely due to the lateral extent of the grouting program for the original building. Grouting was also done for the parking garage currently under construction south of the proposed mental health building, and is planned for the site of the proposed mental health building east of the main hospital building.

## Seismicity

The site is located in an area anticipated to have a 1.0 second spectral response acceleration of 0.05 G and a 0.2 second spectral response acceleration of 0.13 G, according to the 2006 International Building Code prepared by the International Code Council. The new building will be founded in an area with a shallow depth to rock. Therefore, the class definition is Class B, and the corresponding site coefficients of  $F_s$  and  $F_v$  are both 1.0. Thus, the adjusted 1.0 second spectral response acceleration is 0.05 G, and the adjusted 0.2 second spectral response acceleration is 0.13 G, for this site. No currently active faults are known to be present in the Southwestern region of Pennsylvania.

## Subsurface Exploration

### Equipment and Methods

Pennsylvania Drilling Company of McKees Rocks, Pennsylvania drilled a total of nine borings between November 6, 2006 and November 15, 2006 under subcontract to GAI. The locations of the borings are shown on the attached GAI Drawing D-E002. The drilling and sampling was conducted with a CME 45 drill rig. Soil sampling was conducted using standard penetration tests (ASTM Designation: D 1586) in conjunction with split barrel sampling at three-foot intervals. Hollow stem augers were used to maintain an open hole between soil samples. Soil sampling was conducted until rock was encountered, when sampling resistance exceeded 50 blows per 6 inches. The borings were then advanced into rock with NQ-II wire line coring tools which produce core samples approximately 2 inches in diameter (ASTM Designation: D 2113). The samples were visually identified, cores measured, and percentage of core recovery and Rock Quality Designation (RQD) values were calculated. The field classification sheets for the borings prepared by GAI are presented in Appendix A, and data from the borings is summarized in Table 1.

### Soils

The surface at the locations of borings was an asphalt pavement at about half the boring locations and landscaped areas at the others. Backfill of silty clay and/or sandy silt with rock fragments was

encountered in some of the borings. Beneath this was natural soils ranging from silty clay and sandy silt with rock fragments and/or decomposed sandy shale or sandstone. The total soil thickness varied from 4 to 19 feet, and the soil ranged from soft to very stiff or very loose to dense. The very stiff decomposed rock was sampled without coring, yet it retained the structure and texture characteristics of the parent material.

## Rock

The depth to the top of rock ranged from 4 to 19 feet at the borings. The rock generally consisted of medium soft to medium hard sandstone and shale overlying an approximate 10-foot to 15-foot thick soft claystone below approximate elevations 1138 to 1135 feet at this building location. Soft to medium soft sandy shale is below the claystone. Much of the rock encountered was very broken to blocky with numerous weathered horizontal to low angle fractures.

## Ground Water

Groundwater level measurements are recorded at the tops of the Field Classification sheets in Appendix A and are summarized in Table 1. Based on the measurements, there appears to be a perched water zone in the sandstone strata directly overlying the soft claystone.

Water level measurements have been made in the borings at the times and under the conditions indicated herein. It should be noted, however, that ground water levels may fluctuate due to variations in rainfall, temperature, site grading or other factors not evident at the times these measurements were made. Those preparing design drawings, specifications and construction plans should assume that variations will occur.

Following completion of the drilling program all borings were backfilled with cement grout. The boring locations within the bituminous asphalt parking areas were then topped with asphalt. The soil and rock core samples are being temporarily stored by GAI in Monroeville, PA.

## Laboratory Testing

Rock core samples from borings R-3, -4, -5, -6 and -7 were tested to determine rock strength. The results of the testing are summarized in Table 2. The actual test results are presented in Appendix B.

Ten rock samples were tested for unconfined compressive strength. The strength testing was performed by Geotechnics of East Pittsburgh, PA. Five of the rock core samples were tested according to ASTM D2938. Due to the smaller size of core available, three of the rock samples were tested using a Point Load tester (ASTM D5731). Due to the soft nature of two of the claystone samples, they were tested in general accordance with ASTM D2166, Unconfined Compressive Strength of Cohesive Soil. The results indicate the medium soft to medium hard sandstone or sandy shale have unconfined compressive strengths ranging from 500 to 14,000 psi, with the lower values being associated with more weathered rock. The soft claystone had unconfined compressive strengths ranging from 9 to 1225 psi. Previous testing for the parking garage indicated the medium soft and harder shale and other rocks below the claystone unit to have an unconfined compressive strength between 700 and 3,000 psi.

## Conclusions and Recommendations

### Subsurface Stabilization

The presence of abandoned mines in the Pittsburgh coal below the location of the proposed structure poses a risk of future subsidence damage to the new structure. GAI is not aware of available records that would document the complete previous grouting of the area below the proposed building. If such documentation is available from hospital site records, they should be provided to GAI for evaluation. Assuming there are none, GAI recommends that the coal seam and any fractured rock above be filled with cement grout in advance of foundation construction to substantially reduce the risk of future coal-mine induced subsidence. The subsurface stabilization program should be aimed at detecting the presence of any significant voids in the rock and filling them with cement grout. If voids are not found, the program will serve to verify that there are no significant voids present that would result in subsidence damage. GAI should prepare the plans and specifications for stabilization of the mined seam within the zone of influence of the new structure.

## Spread Footings

Spread footing foundations should be feasible for support of the new structure after the foundations of the existing structures have been removed and the recommended subsurface stabilization has been completed. The new foundations should bear on very stiff natural soils, decomposed rock, or rock. The foundations should be designed for a maximum allowable gross bearing pressure of 2 tons per square foot (TSF) when bearing on very stiff natural soil, decomposed rock, or rock. The very stiff natural soil or decomposed rock was found at depths of 3 feet to 6 feet in most borings, 9 feet in boring R-9, and at 18 feet in boring R-1 (see Table 1).

If additional capacity is needed, the allowable bearing pressure can be increased to 3 TSF where foundations bear directly on rock above elevation 1143 feet (see Table 1 for top of rock elevations). If a spread footing bears on rock below elevation 1143 feet, the design bearing pressure will be governed by the soft claystone layer present across the site, and should be limited to 2 TSF.

The recommended allowable design gross bearing pressures are for the combined effects of dead and frequently applied live loads. The values may be increased by 33 percent of the combined effects of infrequent events. The minimum footing width should be 18 inches. All footings should bear a minimum of three feet below finished grade to limit the effects of frost action. Footings so designed are estimated to settle on the order of ½ to 1 inch. Differential settlements should be gradual and tolerable.

The bases of all footing excavations should be examined by GAI and should be free of loose or soft material, frozen soil, organic materials, or other unsuitable materials and water prior to placing concrete. A concrete mud mat should be considered to protect the subgrade from deterioration, if the concrete for spread footings cannot be placed the same day that the excavation is completed.

Portions of the existing buildings may extend below the anticipated level of the new spread footing foundations. If that occurs, those portions of the existing buildings should be removed to very stiff natural soils or rock and should be replaced with backfill compacted as recommended later in this report.

## Drilled Shaft (Caisson) Foundations

It may be determined that drilled shaft foundations are more cost effective to support columns in portions of this structure with lower spread footing elevations (because of the reduced allowable design bearing pressures of footings within the zone of influence of the soft claystone layer, or to reduce excavation bracing costs). Drilled pier foundations socketed into the medium soft rock below about elevation 1124 are recommended. Drilled shaft foundations should be a minimum of 30 inches in diameter to permit entry for cleaning and verification of appropriate rock in the socket. The minimum rock socket depth should be one diameter below the base of the soft claystone layer (which has a base elevation of about 1124 feet). An allowable design bearing pressure of 8 TSF may be used. In addition, an allowable design rock socket side shear bond capacity of 25 PSI (pounds per square inch) may be assigned for medium soft rock and 50 PSI may be assigned for medium hard or harder rock. The relatively low side shear capacity of the soft claystone should be neglected. For example, a 5-foot diameter shaft extending 10 feet into medium soft rock would have a design capacity of 565 kips in side shear and 314 kips in end bearing, for a total capacity of 879 kips. The design concrete slump for dry excavations should be 5 to 7 inches. Drilled shaft foundations should be designed and constructed according to the current version of the ACI committee report "Design and Construction of Drilled Piers," ACI 336.3R.

## Floor Slabs

After the remnants of the existing buildings have been removed and replaced with well compacted backfill to finished subgrade for the floor slabs, the floor slabs in the base of the building should be underlain by at least six inches of inert, durable, hard PennDOT Type A aggregate and a vapor barrier. If it is desirable to maintain a dry floor to the extent practical, then the aggregate should have an AASHTO No. 57 gradation and supplemental perforated drain pipes should be provided in low areas for drainage of any water that accumulates below the slab. The underdrain system should be provided with a gravity drain or other means of removal of water from the area. (Note that a moisture barrier will not totally prevent slab moisture or possible mold.)

## Excavations and Retaining Walls

A portion of the new building will have a basement extending one story below the finished first floor elevation. The design of the basement retaining walls should be based on the following criteria. The basement walls will be a non-yielding and should therefore be based on the "at rest" lateral earth pressure coefficient,  $K_0$ . The backfill around the walls may be assigned a  $K_0 = 0.5$ . Natural soil may be assigned a moist unit weight = 135 PCF. If AASHTO #57 aggregate is used for backfill in the entire active zone in soil and below the top of rock, then the design soil unit weight may be reduced to 100 PCF. The effects of surcharges must be included in design. Passive resistance at the toe of the wall may be computed based on a passive earth pressure coefficient,  $K_p = 2.5$ , where the material below the wall will remain permanently. Sliding resistance along the base of the wall footing may be designed based on a coefficient of friction of 0.4, if the concrete bears on very stiff cohesive soil or rock. Sufficient drainage capacity should be provided around the basement walls to prevent the rise of ground water following precipitation events.

Existing buildings north and east of the proposed building will remain during construction of the new buildings. The design of the excavations adjacent to the existing buildings must prevent excessive movement of the supporting materials and foundations below the existing building. Similar comments apply where excavations may be adjacent to existing roadways that must be maintained in an active condition during construction.

The excavation for the basement may penetrate a medium soft to medium hard sandstone or shale layer over a soft claystone layer. The results of unconfined compression tests of samples of the rock are presented in Table 1 and Appendix B. The prospective contractors should view the core samples before determining means and methods of excavating these materials to limit construction vibrations to tolerable values. Blasting should not be used to assist in excavation. Pre- and post-construction surveys of surrounding facilities should be performed to determine if construction related damage occurs.

If temporary excavation bracing is needed in site soils with horizontal ground above and below the bracing, it should be designed based on an active lateral earth pressure coefficient of 0.4, a passive lateral earth pressure coefficient of 2.5 and a soil moist unit weight of 135 PCF. The effects of surcharges must be included in the design.

Side slopes of temporary open cut excavations should be in accordance with OSHA criteria.

## Backfill Compaction

Backfill may be placed below the lowest floor slab, around basement walls or under pavements. The remnants of the existing buildings and their ancillary facilities should be removed to very stiff natural soils or better support materials, before placing backfill to support new facilities. Unsuitable materials, water, frozen soil, loose soil, soft soil, organic materials, slag, coal, and pyritic strata should be removed prior to placing fill or backfill. The entire subgrade should be proof-rolled where space permits with five passes of a 10-ton rubber-tired roller. Any soft or loose soils encountered should be overexcavated and replaced with well-compacted backfill.

Cohesive soils (where acceptable) should be placed and compacted in loose lifts no greater than 8 inches in thickness. Compaction should be accomplished using a segmented wheeled or a sheepfoot roller. Where smaller compaction equipment must be used, the lift thicknesses should be reduced as needed to achieve the recommended degree of compaction. Cohesive backfill should not be placed within the zone of influence of retaining walls. Granular soils should be placed in loose lift thicknesses not exceeding 8 inches and compacted with a vibratory roller or plate compactor.

The maximum particle size for each material type should not exceed 2/3 the loose lift thickness. Cohesive backfill should be compacted to 100 percent of the maximum dry density according to ASTM Test Designation D698. Granular backfill that does not exhibit a moisture-density relationship should be compacted to 60% relative density according to ASTM Test Designations D4253 and D4254.

The unit weight and water content of soils should be corrected for soils containing oversized particles according to ASTM Test Designation D4718. Slag or pyritic materials which are potentially expansive should not be used as fill or backfill. Heavy compaction equipment should not be run beside retaining

walls during backfilling because they may apply unacceptably high lateral earth pressures on the wall due to soil compaction.

## Design Review

This report has been prepared to aid Astorino in the geotechnical design for this project. Its scope is limited to the specific project and location described herein and represents our understanding of the significant aspects relative to soil and foundation considerations. If there are differences in the locations of the proposed facilities and/or design features from those described herein, GAI should be informed so we may, if necessary, modify or revise our recommendations and determine if additional exploration, testing and analyses are warranted prior to final design of the facilities. GAI should be permitted to review and provide inputs to retaining wall, and foundation construction plans and specifications before they are final. GAI should prepare the subsurface stabilization plan and specifications. GAI should monitor at the site any additional exploration, subgrade preparation, subsurface stabilization, earthwork construction, retaining wall construction, and foundation construction so that these aspects of the project are constructed according to the intent of our recommendations and so that any unanticipated foundation conditions might be recognized and properly reconciled.

Respectfully submitted,  
GAI Consultants, Inc.

Handwritten signature of Samuel G. Mazzella in black ink, followed by the initials FBN.

Samuel G. Mazzella, PE  
Project Engineer

Handwritten signature of F. Barry Newman in black ink.

F. Barry Newman, PE  
Project Manager

SGM/FBN/eac



## Tables

GAI CONSULTANTS, INC.

TABLE 1

SUMMARY OF DATA from the TEST BORING PROGRAM

Proposed Research Office Building

Veterans Administration Hospital: Oakland Campus, Pittsburgh

Boring Number	Ground Surface Elevation (MSL) (Feet)	Soil Depth (Feet)	Top of Rock Elev. (Feet)	Depth to Very Stiff Nat Soil (Feet)	Elevation Top of Very Stiff Nat Soil (Feet)	Top of Sandstone Elevation (Feet)	Bot. of SS & Top of CS Elevation (Feet)	Bot. of CS Layer Elevation (Feet)	0 hr GWL (Feet)	0 hr Groundwater Elevation (Feet)	24 hr+ Groundwater Elevation (Feet)
R-1	1159.7	19.2	1140.5	18	1141.7	1140.5	1134.7	1124.7	22.9	1136.8	#N/A
R-2	1159.7	9.1	1150.6	6	1153.7	1150.6	1134.7	#N/A	15.0	1144.7	1151.7
R-3	1159.6	6.3	1153.3	6	1153.6	1145.4	1138.2	1124.1	3.7	1155.9	1150.2
R-4	1159.0	4.3	1154.7	3	1156.0	1140.0	1136.0	#N/A	9.1	1149.9	1140.9
R-5	1160.1	6.8	1153.3	3	1157.1	1148.1	1135.1	#N/A	4.4	1155.7	1139.7
R-6	1160.2	9.6	1150.6	3	1157.2	1140.2	1134.3	#N/A	9.3	1150.9	1144.9
R-7	1160.1	6.4	1153.7	3	1157.1	1146.2	1135.7	#N/A	4.6	1155.5	1139.8
R-8	1158.8	15.8	1143.0	3	1155.8	1138.8	1135.3	#N/A	13.6	1145.2	1133.6
R-9	1160.0	15.5	1144.5	9	1151.0	1144.5	1138.0	1127.6	22.2	1137.8	#N/A

**TABLE 2**  
**SUMMARY OF ROCK UNCONFINED COMPRESSIVE STRENGTH TEST RESULTS**  
Proposed Research Office Building  
Veterans Administration Hospital: Oakland Campus, Pittsburgh

Boring	Depth (ft)	Visual Classification of Rock Samples	Rock Unconfined Compression Strength (psi)	Unit Wet Weight (PCF)	ASTM Test Method
R-3	16.0-16.4	M. hard brown SANDSTONE	6,820		D 2938
R-3	18.4-18.8	M. hard brown SANDSTONE	9,360		D 2938
R-4	6.3-6.5	M. soft brown SANDY SHALE	2,768 <sup>1</sup>		D 5731
R-4	13.9-14.2	M. soft brown SANDY SHALE	1,768 <sup>1</sup>		D 5731
R-5	8.7-9.5	M. soft brown SANDY SHALE	480		D 2938
R-5	14.2-14.7	M. soft to m. hard brown-gray SANDSTONE	5,830		D 2938
R-5	30.2-30.7	Soft gray CLAYSTONE	9	136	D 2166
R-6	25.4-25.9	M. hard gray SANDSTONE	14,010		D 2938
R-6	28.0-28.6	Soft gray CLAYSTONE	16	138	D 2166
R-7	38.4-38.8	M. soft CLAYSTONE	1,225 <sup>1</sup>		D 5731

## Notes:

<sup>1</sup> Estimated based on point load test<sup>2</sup> Testing Conducted by Geotechnics

## Figures

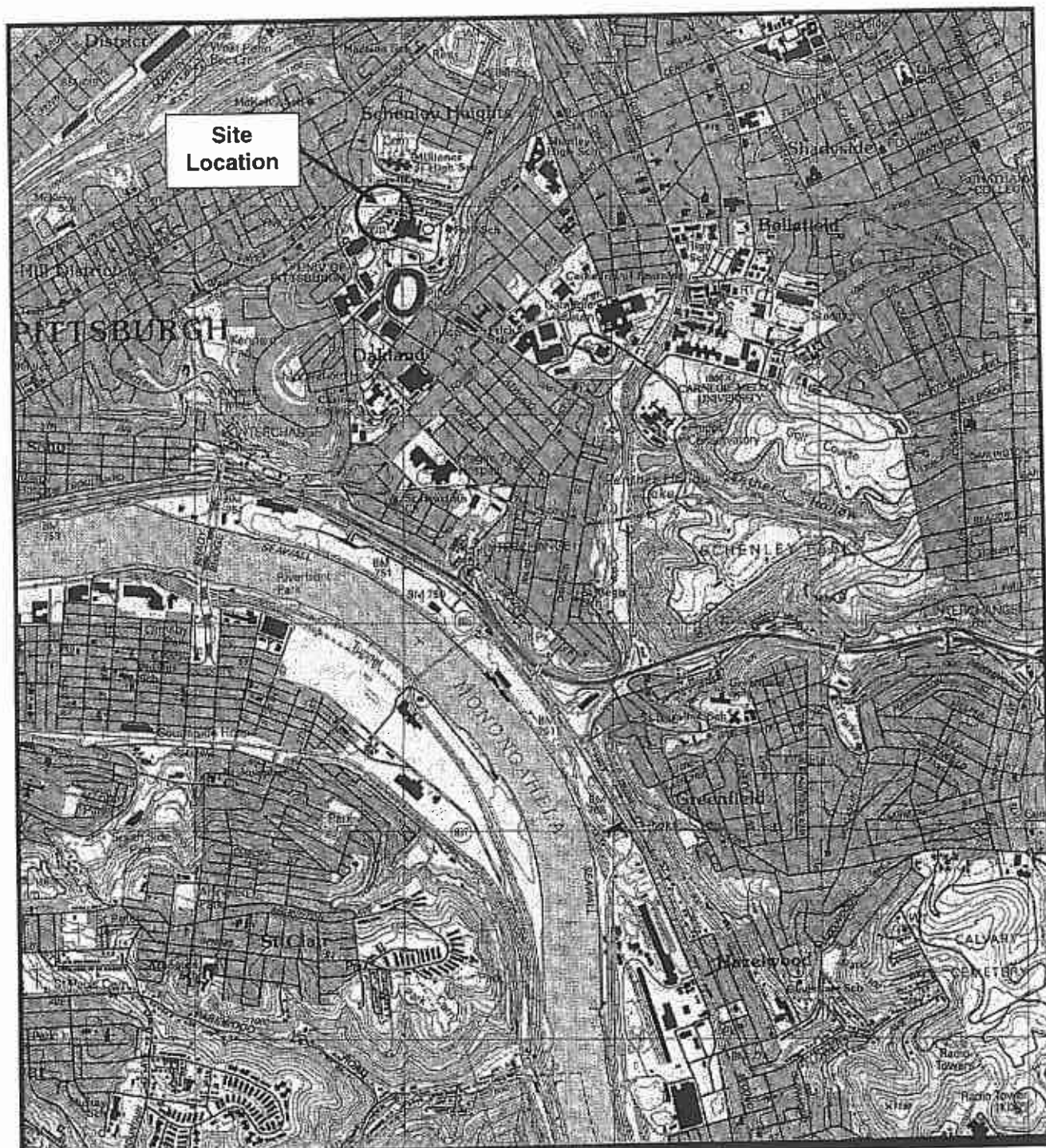


FIGURE 1

SITE LOCATION MAP

Veterans Administration Hospital  
Proposed Research Office Building  
Oakland Campus, Pittsburgh

GAI Consultants, Inc.  
C060465  
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Google  
Maps

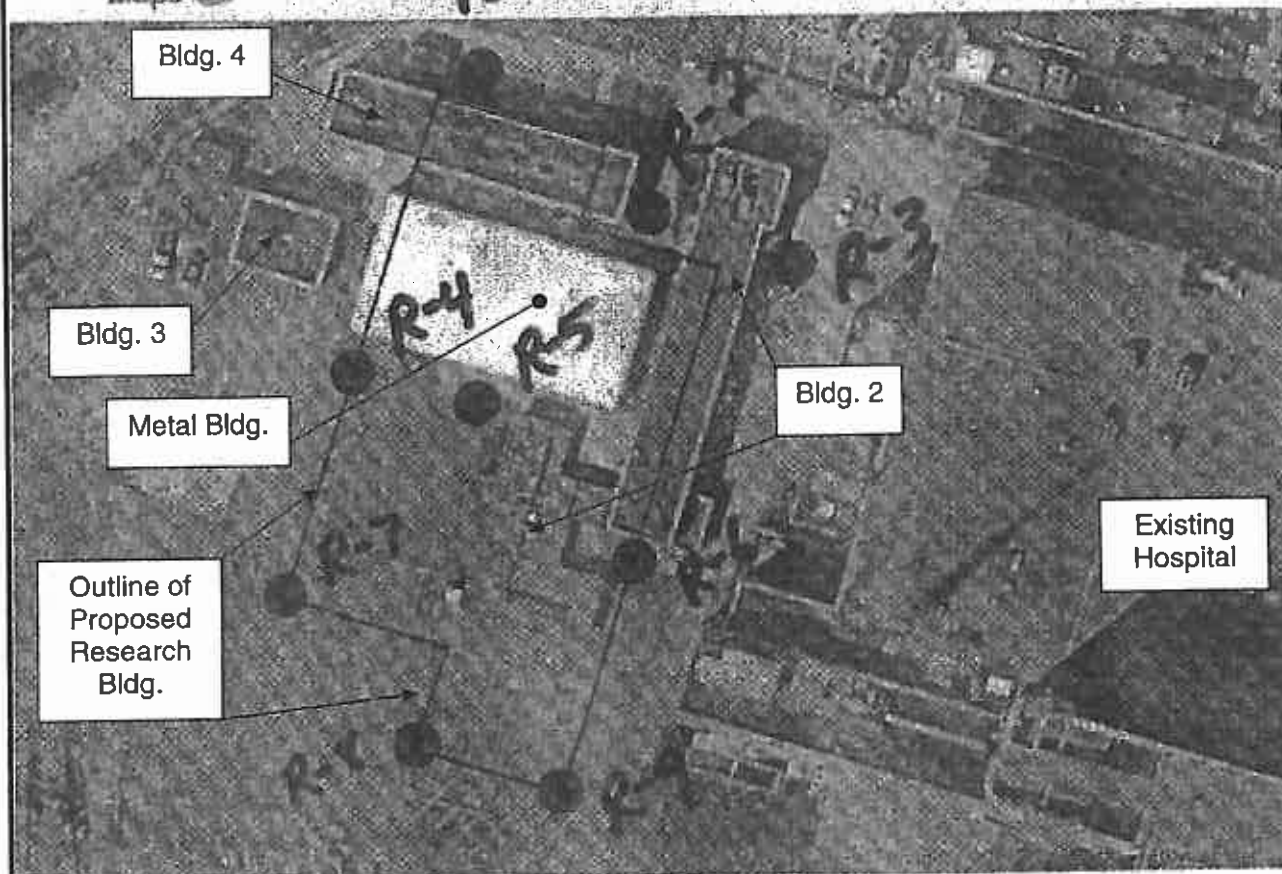
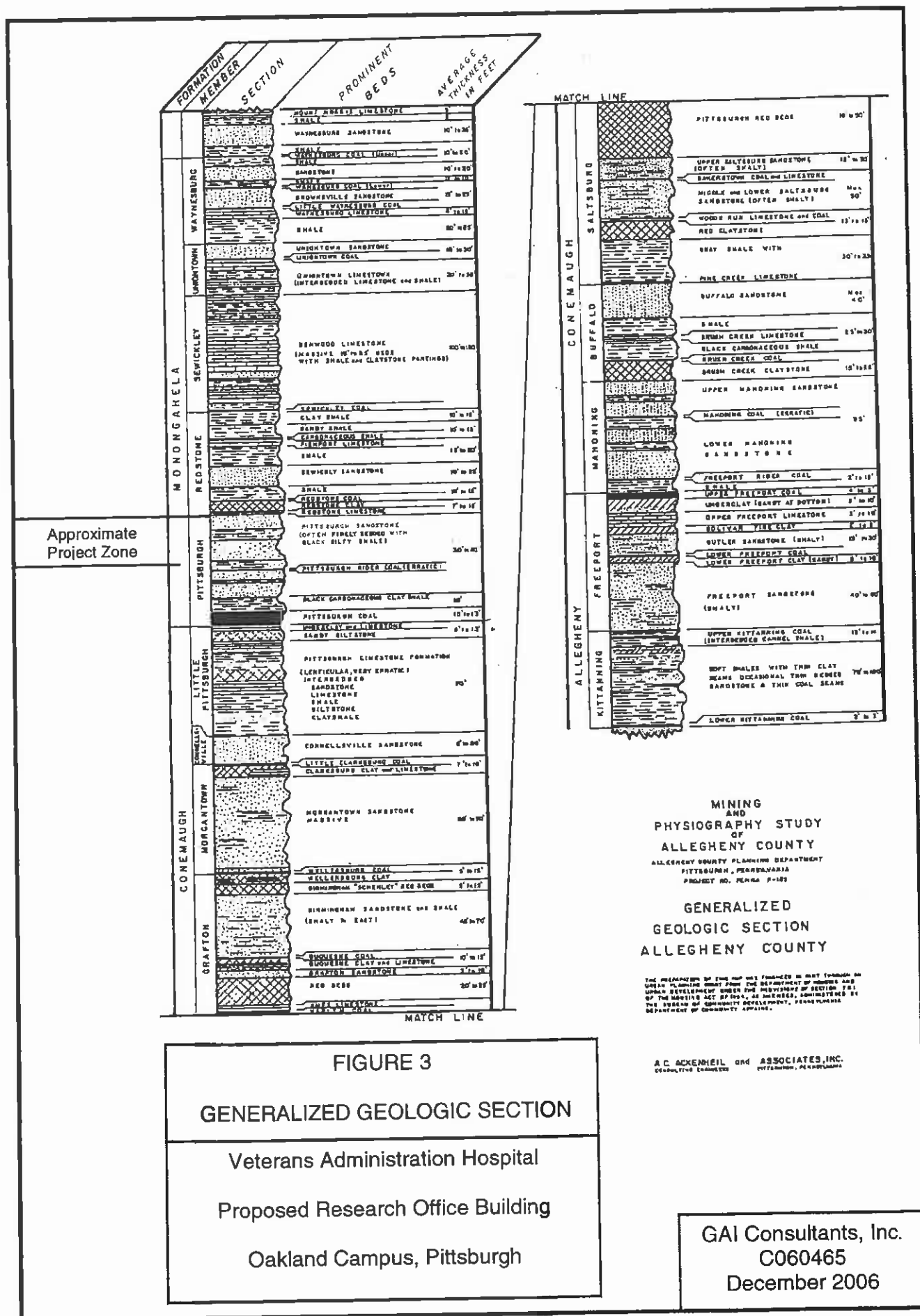


FIGURE 2

APPROXIMATE LOCATION OF  
NEW BUILDING

Veterans Administration Hospital  
Proposed Research Office Building  
Oakland Campus, Pittsburgh

GAI Consultants, Inc.  
C060465  
December 2006



**Appendix A**  
**Field Classification Sheets of Borings**



## SOILS

### DENSITY OF GRANULAR SOILS BASED ON STANDARD PENETRATION RESISTANCE

DESIGNATION	STANDARD PENETRATION RESISTANCE (BLOWS/FOOT)
VERY LOOSE	0 - 4
LOOSE	5 - 10
MEDIUM DENSE	11 - 30
DENSE	31 - 60
VERY DENSE	OVER 50

### CONSISTENCY OF COHESIVE SOILS IS BASED ON FIELD AND/OR LABORATORY TESTS

CONSISTENCY	UNC COMPRESSIVE STR. (TONS PER SQUARE FOOT)	FIELD IDENTIFICATION
VERY SOFT	LESS THAN 0.25	EASILY PENETRATED SEVERAL INCHES BY FIST
SOFT	0.25 TO 0.50	EASILY PENETRATED SEVERAL INCHES BY THUMB
MEDIUM STIFF	0.50 TO 1.0	CAN BE PENETRATED SEVERAL INCHES BY THUMB WITH MODERATE EFFORT
STIFF	1.0 TO 2.0	READILY INDENTED BY THUMB BUT PENETRATED ONLY WITH GREAT EFFORT
VERY STIFF	2.0 TO 4.0	READILY INDENTED BY THUMBNAIL
HARD	MORE THAN 4.0	INDENTED WITH DIFFICULT BY THUMBNAIL

### ADDITIONAL TERMS USED IN THE DESCRIPTION OF SOILS:

AND	INDICATES APPROXIMATELY EQUAL AMOUNTS OF MATERIALS, SUCH AS A SAND AND GRAVEL MIXTURE. IF THE MATERIALS OCCUR IN THIN SEPARATE SEAMS, IT IS NOTED IN THE DETAILED WORD CLASSIFICATION. THE THICKNESS IS GIVEN WHERE POSSIBLE.
SOME	INDICATES A SIGNIFICANT AMOUNT OF THE ACCESSORY MATERIAL. EXAMPLE: MEDIUM DENSE SILTY SAND - SOME GRAVEL
TRACE	INDICATES A MINOR AMOUNT OF THE ACCESSORY MATERIAL. EXAMPLE: LOOSE SILTY SAND - TRACE OF GRAVEL
INTERBEDDED	USED TO DESCRIBE THIN ALTERNATING SEAMS. THICKNESS IS GIVEN WHERE POSSIBLE EXAMPLE: HARD INTERBEDDED SILT AND CLAY (APPROXIMATELY 1/16" THICK)

## ROCK

TERM	DEFINITION
SEAM	THIN (12 INCHES OR LESS) PROBABLY CONTINUOUS LAYER
SOME	INDICATES SIGNIFICANT (15 TO 40 PERCENT) AMOUNTS OF THE ACCESSORY MATERIAL EXAMPLE: ROCK COMPOSED OF SANDSTONE (70%) AND SEAMS OF SHALE (30%) WOULD BE: SANDSTONE - SOME SHALE SEAMS
FEW	INDICATES MINOR (0-15 PERCENT) AMOUNTS OF THE ACCESSORY MATERIAL EXAMPLE: ROCK COMPOSED OF SANDSTONE (90%) AND SEAMS OF SHALE (10%) WOULD BE: SANDSTONE - FEW SHALE SEAMS
INTERBEDDED	USED TO INDICATE THIN OR VERY THIN ALTERNATING SEAMS OF MATERIAL OCCURRING IN APPROXIMATELY EQUAL AMOUNTS EXAMPLE: ROCK COMPOSED OF SANDSTONE (50%) AND SHALE (50%) SEAMS WOULD BE INTERBEDDED SANDSTONE AND SHALE.

THE DEGREE OF BROKENNESS OF THE ROCK IS DESCRIBED BY ONE OF THE FOLLOWING TERMS:
























DESCRIPTIVE TERMS	ABBREVIATION	SPACING
VERY BROKEN	(V. BR.)	LESS THAN 2 INCHES
BROKEN	(BR.)	2 INCHES - 1 FOOT
BLOCKY	(BL.)	1 FOOT - 3 FEET
MASSIVE	(M.)	3 FEET - 10 FEET

ROCK-ROCK QUALITY DESIGNATION IS CUMULATIVE LENGTH OF PIECES OF CORE EQUAL TO OR GREATER THAN FOUR INCHES IN LENGTH DIVIDED BY THE TOTAL LENGTH OF CORE RUN, EXPRESSED AS A PERCENTAGE.

### THE FOLLOWING BASIC NAMES ARE APPLIED TO SEDIMENTARY ROCK:

ROCK TYPE	CHARACTERISTICS
SANDSTONE	MADE UP PREDOMINANTLY OF GRANULAR MATERIALS RANGING BETWEEN 1/16 AND 2MM IN DIAMETER
SILTSTONE	MADE UP OF GRANULAR MATERIALS LESS THAN 1/16 MM IN DIAMETER. FRACTURES IRREGULARLY, MEDIUM THICK TO THICK BEDDED
CLAYSTONE	VERY FINE GRAINED ROCK MADE UP OF CLAY MATERIALS. FRACTURES IRREGULARLY, VERY SMOOTH TO TOUCH. GENERALLY HAS IRREGULARLY SPACED PITTING ON SURFACE OF DRILLED CORES.
SHALE	A FISSILE VERY FINE GRAINED ROCK. FRACTURES ALONG BEDDING PLANES
LIMESTONE	ROCK MADE UP PREDOMINANTLY OF CALCITES (CA CO <sub>3</sub> ) EFFERVESCES UPON THE APPLICATION OF HYDROCHLORIC ACID
COAL	ROCK CONSISTING MAINLY OF ORGANIC REMAINS

## LEGEND

 RESIDUAL SOIL	 CLAYSTONE	 2" O.D. SPLIT BARREL SAMPLE
 GRAVEL	 LIMESTONE	 CASING SAMPLE
 SAND OR ALLUVIUM	 SILTSTONE	 SAMPLE NUMBER 3" DIA. UNDISTURBED SAMPLE
 SILT	 SANDSTONE	 LENGTH OF CORE RECOVERED LENGTH OF DRILL RUN
 CLAY	 SHALE	 GROUND WATER LEVEL AND DATE OF OBSERVATION
 ORGANIC MATERIAL	 CONCRETE	 INDICATES 50 BLOWS REQUIRED FOR SPLIT BARREL TO PENETRATE 0.3 FEET
 SLAG	 COAL	 APPROXIMATE TOP OF ROCK
 FILL	 VOID	

PROJECT VA Research Office Building

ELEVATION 1159.7 GWL 0 HRS 22.9

DATE 11/6/06

CLASSIFIED BY LA Newman

BORING NO. R-1

PROJECT NO. 1060465

PAGE 1 of 2

DEPTH (FT.)	BLOWS PER SIX INCHES OR CORE RECOVERY/RUN	SAMPLE NO., TYPE & RECOVERY OR % ROCK RECOVERY	RQD (%) OR TORVANE	DESCRIPTION				USCS OR ROCK BROKENNESS	REMARKS*
				PROFILE	SOIL DENSITY - CONSISTENCY OR ROCK HARDNESS	COLOR	MATERIAL CLASSIFICATION		
1	2	3	4	5	6	7	8	9	10
	2 3 4	S-1			loose	BRN	clay and rock fragments (Fill)	GC	dry (sandstone)
3.0	2 3 3	S-2			soft	BRN	sandy clay, some rock fragments, trace slag (Fill)	GC	moist #0.5 TSF
6.0	2 2 3	S-3			Loose	BRN	sandstone boulder (Fill)		poor recovery, pushed through boulder
9.0	3 2 2	S-4			m. stiff	BRN	sandy clay, some rock fragments	GC	#0.5 - 0.75 TSF dry
12.0	2 2 3	S-5			stiff				#1.0 - 2.0 TSF
15.0	3 3 4	S-6							
18.0	3 5.0 7.0	S-7		18.0	v. stiff	BRN	Decomposed sandstone		Top of rock @ 19.2'
20.0	4.4 5.0	R-1 88 14		19.2	m. hard	BRN	sandstone, trace sandy shale seams	VBR BR	horizontal to low angle fractures
25.0	5.0 5.0	R-2 100 72		25.0	soft	gray	claystone	VBR PL	low to high angle fractures
30.0									

REMARKS\*\* LME 45 drill rig, NQ11 Coring tools, 3/4" 10 h.s.a. automatic hammer  
PA Drill Co. Driller - Bill Minor Helper - Craig Hicks

BORING R-1

\* POCKET PENETROMETER READINGS

\*\* METHOD OF ADVANCING AND CLEANING BORING



PROJECT VA Hospital Research Office Building

BORING NO. R-2

ELEVATION 1159.7 GWL 0 HRS 15.0

PROJECT NO C060465

DATE 11/7/06 24 HRS 8.0

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PAGE 1 of 1

DATE 11/1/77

DEPTH (FT.)	BLOWS PER SIX INCHES OR CORE RECOVERY/RUN	CORE RECOVERY/RUN SAMPLE NO., TYPE & RECOVERY OR % ROCK RECOVERY	RQD (%) OR TORVANE	DESCRIPTION				USCS OR ROCK BROKENNESS	REMARKS*
				PROFILE	SOIL DENSITY - CONSISTENCY OR ROCK HARDNESS	COLOR	MATERIAL CLASSIFICATION		
1	2	3	4	5	6	7	8	9	10
	45	S-1			m dense	BRN	sandy clay some rock fragments	GC	#20 TSE, dry
3.0	30 22 12	S-2			dense				
6.0	9 14 30	S-3		6.0	VSTH	BRN	decomposed sandstone		no water table coring
9.0	50 6.1			9.1			Top of rock @ 9.1'		
10.0	4.8 5.0	R-1	96	0	m. soft m. hard	BRN Lt Gray	sand stone, some sandy shale seams	VBR	Horizontal in some angle fractures
15.0	5.0 5.0	R-2	100	18					
20.0	3.0 5.0	R-3	60	30					
25.0	2.1 2.5	R-4	84	20	soft m. soft	Gray	claystone	VOR BR	Low to high angle fractures
27.5	1.5 2.5	R-5	60	0					
30.0							Bottom of boring @ 30.0'		

REMARKS\*\* CME 45 drill rig, NQ 11 coring tools, 3 1/4" ID h.s.a., automatic hammer  
PA Drill Co. Driller- Bill Minor, Helper- Craig Hicks

BORING R-2

\* POCKET PENETROMETER READINGS

\*\* METHOD OF ADVANCING AND CLEANING BORING

PROJECT VA Research Office Building

BORING NO. R-3

ELEVATION 1159.6 GWL 0 HRS 3.7

PROJECT NO. 060465

DATE 11/8/06 24 HRS 9.4

PAGE 1 of 2

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DEPTH (FT.)	BLOWS PER SIX INCHES OR CORE RECOVERY/RUN	CORE NO., TYPE & RECOVERY OR % ROCK RECOVERY	RQD (%) OR TORVANE	DESCRIPTION				USCS OR ROCK BROKENNESS	REMARKS*
				PROFILE	SOIL DENSITY - CONSISTENCY OR ROCK HARDNESS	COLOR	MATERIAL CLASSIFICATION		
1	2	3	4	5	6	7	8	9	10
	3 5	S-1			loose	BRN	sandy clay, some rock fragments, trace slag (Fill)	GC	moist
3.0	19 12	S-2			mdense				dry
6.0				6.0					Top of rock @ 6.3'
6.3	50/03	S-3		6.3	v dense	BRN	silty clay, some rock fragments	GC	
	42	R-1	100	21	m soft	BRN	interbedded sandy shale and sandstone	VBR to BR	Horizontal to low angle fractures
10.5	5.0	R-2	100	6					
	5.0								
14.2				14.2	m hard	BRN	sandstone, trace m soft sandy shale seams	VBR to BR	Horizontal to low angle fractures
15.5	5.0	R-3	100	42					
	5.0								
20.5	4.5	R-4	90	32					
	5.0			21.4	soft	Gray	Limestone seam @ 20.5-20.7 Claystone	VBR to BR	Low to high angle fractures
23.5	5.0	R-5	100	20					
	5.0								

REMARKS\*\* CME 415 drill rig, NG11 coring tools, 3 1/4" ID h.s.a., automatic hammer, PA Drill Co. Driller - Bill Minor, Helper - Craig Hicks

BORING R-3

\* POCKET PENETROMETER READINGS

\*\* METHOD OF ADVANCING AND CLEANING BORING



PROJECT VA Research Office Building

ELEVATION 1159.0 GWL 0 HRS 9.1

DATE 11/9/06 24 HRS 18.1

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BORING NO. R-4

PROJECT NO. CO60465

PAGE 1 of 1

DEPTH (FT.)	BLOWS PER SIX INCHES OR CORE RECOVERY/RUN	CORE RECOVERY/TYPE & RECOVERY OR % ROCK RECOVERY	RQD (%) OR TORVANE	DESCRIPTION				USCS OR ROCK BROSNESS	REMARKS*
				PROFILE	SOIL DENSITY - CONSISTENCY OR ROCK HARDNESS	COLOR	MATERIAL CLASSIFICATION		
1	2	3	4	5	6	7	8	9	10
1.0							Asphalt surface		
3.0	3 12 26	S-1		3.0	vs stiff	Gray	Sandy clay, some rock fragments	GC	#2.0-3.0 SF dry
	4 30 76	S-2		4.3	vs stiff	BRN	Decomposed sandy shale		dry
5.5							Top of rock @ 4.3'		
	5.0 5.0	R-1	100 0		msat	BRN	Sandy shale	VBR to BR	horizontal to low angle fractures
10.5	5.0 5.0	R-2	100 0						
15.5	5.0 5.0	R-3	100 12						
				19.0	m. hard	BRN	sandstone	VBR to BR	low to high angle fractures
20.5	2.7 25	R-4	88 32						
23.0	2.5 2.5	R-5	100 32	23.0	soft	Gray	claystone	VBR to BR	low to high angle fractures
25.5	4.0 4.5	R-6	97 53						
30.0							Bottom of boring @ 30.0'		

REMARKS: CME 45 drill rig, NQ 11 coring tools, 3/4" 10 h.s.a. automatic hammer,  
PA Drill Co. Driller - Bill Minor, Helper - Craig Hicks

BORING R-4

\* POCKET PENETROMETER READINGS

\*\* METHOD OF ADVANCING AND CLEANING BORING

PROJECT VA Research Office Building

BORING NO. R-5  
PROJECT NO. C060465

ELEVATION 1160.1 GWL 0 HRS 4.4

DATE 11/9/06-11/19/06 CLASSIFIED BY LA Newman

PAGE 1 of 2

DEPTH (FT.)	BLOWS PER SIX INCHES OR CORE RECOVERY/RUN	SAMPLE NO., TYPE & RECOVERY OR % ROCK RECOVERY	RQD (%) OR TORVANE	DESCRIPTION				USCS OR ROCK BROKENNESS	REMARKS*
				PROFILE	SOIL DENSITY - CONSISTENCY OR ROCK HARDNESS	COLOR	MATERIAL CLASSIFICATION		
1	2	3	4	5	6	7	8	9	10
1.0	56	S-1			vstiff	BRN	Asphalt surface		
3.0	22						Decomposed sandy shale		dry
	28, 34	S-2							
	41								
6.0									
6.8	42, 50, 63	S-3		6.8			Top of rock @ 6.8'		
	3, 3	R-1	100	33	m soft	BRN	sandy shale	VDR to BR	Horizontal to low angle fractures
10.0									
	5.0	R-2	100	20					
	5.0			12.0					
					m soft to m hard	BRN to Gray	sandstone, some m. soft shale seams	BR	Horizontal to low angle fractures
15.0									
	4.9	R-3	98	0				VDR to BR	
	5.0								
20.0									
	5.0	R-4	100	20					
	5.0			22.3					
					m soft	Gray	sandy shale	BR	Horizontal to low angle fractures
25.0									
	1.6, 2.5	R-5	64	0	soft	Gray	claystone	VDR to BR	Low to high angle fractures
27.5									
	2.0, 2.5	R-6	80	0					
30.0									

REMARKS\*\* CME 45 drilling, NQ 11 coring tool, 3 1/4" ID h.s.a., automatic hammer, PA Drill Co. Driller - Bill Minor, Helper - Craig Hicks

BORING R-5

\* POCKET PENETROMETER READINGS

\*\* METHOD OF ADVANCING AND CLEANING BORING



PROJECT VA Research Office Building  
ELEVATION 1160.1 GWL 0 HRS 4.4  
DATE 11/10/06 72 HRS 20.4 CLASSIFIED BY LA Newman  
BORING NO R-5  
PROJECT NO 060465  
PAGE 2 of 2

DEPTH (FT.)	BLOWS PER SIX INCHES OR CORE RECOVERY/RUN	SAMPLE NO., TYPE & RECOVERY OR % ROCK RECOVERY	RQD (%) OR TORVANE	DESCRIPTION				USCS OR ROCK BROKENNESS	REMARKS*
				PROFILE	SOIL DENSITY - CONSISTENCY OR ROCK HARDNESS	COLOR	MATERIAL CLASSIFICATION		
1	2	3	4	5	6	7	8	9	10
	4.9 /5.0	R-7/98	68		soft	gray	claystone (cont.)	VB + BL	low to high angle fractures
35.0	4.9 /5.6	R-8/98	54						
40.0				400			Bottom of boring @ 40.0'		

REMARKS\*\* CME 45 drill rig, NQ 11 coring tools, 3/4" ID h.s.g., automatic hammer,  
PA Drill Co. Driller-Bill Minor Helper-Craig Hicks

\* POCKET PENETROMETER READINGS  
\*\* METHOD OF ADVANCING AND CLEANING BORING

PROJECT VA Research Office Building

BORING NO. R-6

ELEVATION 1160.2 GWL 0 HRS 9.3

PROJECT NO. C060465

DATE 11/10/06-11/13/06 24 HRS 15.3

CLASSIFIED BY LA Newman

PAGE 1 of 1

DEPTH (FT.)	BLOWS PER SIX INCHES OR CORE RECOVERY/RUN	CORE RECOVERY/TYPE & SAMPLE NO., TYPE & RECOVERY OR % ROCK RECOVERY	RQD (%) OR TORVANE	DESCRIPTION				USCS OR ROCK BROKENNESS	REMARKS*	
				PROFILE	SOIL DENSITY - CONSISTENCY OR ROCK HARDNESS	COLOR	MATERIAL CLASSIFICATION			
1	2	3	4	5	6	7	8	9	10	
	2 3	S-1		6.0	vstiff	BRN	sandy clay, some rock fragments	GC	moist *2.5-3.0 TSF	
3.0	4 5	S-2			↓	↓	↓	↓	*2.5-3.0 TSF	
	5								dry	
6.0	6 7	S-3		9.6	vstiff	BRN	decomposed sandy shale		dry	
9.0	11 39	S-4			↓	↓	↓	↓	↓	
10.0	5.0	R1 100 32			m soft to	BRN to	inter bedded sandstone and sandy shale	VAR to BR	Horizontal to low angle fractures	
	5.0				m hard	Gray				
15.0	4.8	R2 96 0		20.0	↓	↓	↓	↓	↓	
	5.0									
20.0	4.6	R3 92 34		25.9	m hard	Gray	sandstone	VAR to BR	Horizontal to low angle fractures	
	5.0				↓	↓	↓	↓	↓	↓
25.0	5.0	R4 100 44		30.0	soft	gray	claystone	VAR to BR	Low to high angle fractures	
	5.0				↓	↓	↓	↓	↓	↓
30.0					↓	↓	Bottom of Boring @ 30.0'	↓	↓	

REMARKS\*\* CME 45 drill rig, NG 11 coring tools, 3 1/4" ID h.s.a., automatic hammer  
PA Drill Co. Driller - Bill Minor, Helper - Craig Hicks

BORING R-6

\* POCKET PENETROMETER READINGS

\*\* METHOD OF ADVANCING AND CLEANING BORING

PROJECT VA Research Office Building

BORING NO. R-7

ELEVATION 1160.1 GWL 0 HRS 4.6

PROJECT NO. C06046

DATE 11/13/06 24 HRS 20.3

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PAGE 1 of 2

DEPTH (FT.)	BLOWS PER SIX INCHES OR CORE RECOVERY/RUN	SAMPLE NO., TYPE & RECOVERY OR % ROCK RECOVERY	RQD (%) OR TORVANE	DESCRIPTION				USCS OR ROCK BROKENNESS	REMARKS*
				PROFILE	SOIL DENSITY - CONSISTENCY OR ROCK HARDNESS	COLOR	MATERIAL CLASSIFICATION		
1	2	3	4	5	6	7	8	9	10
1.0	10	39 S-1			vstiff	BRN	Asphalt surface		
3.0	50				↓	↓	Decomposed sandy shale		dry
	21.50/64	S-2		3.9	vstiff	BRN	Highly weathered sandy shale		↓
6.0					↓	↓			T.O.R @ 6.4'
6.4	50/64	S-3		6.4	m.soft	BRN	sandy shale	VBR to BR	horizontal to low angle fractures
10.0	4.0/4.6	R-1	87						
	5.0/5.0	R-2	100						
				13.9					
15.0	5.0/5.0	R-3	100	8	m hard	BRN-Gray	sandstone, some m. soft sandy shale seams	VBR to BR	horizontal to low angle fractures
20.0	5.0/5.0	R-4	100	52					
				24.4					
25.0	5.0/5.0	R-5	100	76	soft	Gray	claystone	VBR to BR	low to high angle fractures
30.0									

REMARKS: CME 45 drill rig, NQ 11 coring tools, 3 1/4" IP h.s.a. automatic hammer  
PA Drill Co. Driller-Bill Minor Helper-Craig Hicks

BORING R-7

\* POCKET PENETROMETER READINGS

\*\* METHOD OF ADVANCING AND CLEANING BORING

PROJECT VA Research Office Building

BORING NO. R-7

ELEVATION 1160.1 GWL 0 HRS 4.6

PROJECT NO. 060465

DATE 11/13/06 24 HRS 20.3

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PAGE 2 of 2

DEPTH (FT.)	BLOWS PER SIX INCHES OR CORE RECOVERY/RUN	CORE RECOVERY/RUN SAMPLE NO., TYPE & RECOVERY OR % ROCK RECOVERY	ROD (%) OR TORVANE	DESCRIPTION				USCS OR ROCK BROKENNESS	REMARKS*	
				PROFILE	SOIL DENSITY - CONSISTENCY OR ROCK HARDNESS	COLOR	MATERIAL CLASSIFICATION			
1	2	3	4	5	6	7	8	9	10	
	4.2 5.0	R-678430			modt	Gray	Claystone (cont)	VBR to BR	low to high angle structures	
35.0	4.2 5.0	R-79434								
40.0		1			490	✓	✓	Bottom of boring @ 40.0'	✓	✓

REMARKS\*\* CME 45 drill rig, NQ11 coring tools, 3/4" I.P.h.s.a., automatic hammer  
PA Drill Co. Driller - Bill Minor Helper - Craig Hicks

BORING R-7

\* POCKET PENETROMETER READINGS

\*\* METHOD OF ADVANCING AND CLEANING BORING

PROJECT VA Research Office Building

BORING NO. R-8

ELEVATION 1158.8 GWL 0 HRS 13.6

PROJECT NO. C060465

DATE 11/14/06 24 HRS 25.2

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PAGE 1 of 1

DEPTH (FT.)	BLOWS PER SIX INCHES OR CORE RECOVERY/RUN	CORE RECOVERY/TYPE & SAMPLE NO., TYPE & RECOVERY OR % ROCK RECOVERY	RQD (%) OR TORVANE	DESCRIPTION				USCS OR ROCK BROKENNESS	REMARKS*
				PROFILE	SOIL DENSITY - CONSISTENCY OR ROCK HARDNESS	COLOR	MATERIAL CLASSIFICATION		
1	2	3	4	5	6	7	8	9	10
1.0	24	S-1		22	v. stiff	GRN	Asphalt surface		
3.0	79	S-2			v. stiff	GRN	silty clay trace rock fragments	GC	*25-30% moisture
	14						decomposed sandy shale		dry
6.0	10	S-3							
	15								
9.0	25	S-4							
	10								
12.0	15	S-5							
	48								
15.0	99	S-6		158	↓	↓	Top of rock @ 15.8'	↓	↓
15.8	3.5	R-1	12		m. soft	GRN	interbedded sandstone	v. DR	low to high angle
	4.2				m. hard	Gray	and sandy shale	DR	fractures
20.0	5.9	R-2	10056	200	↓	↓	sandstone	↓	↓
	15.0				m. hard	Gray		v. DR	low to high angle
								DR	fractures
25.0	4.9	R-3	9848	335	↓	↓	claystone	↓	↓
	15.0				soft	Gray		v. DR	low to high angle
								DR	fractures
30.0				300	↓	↓	Bottom of boring @ 30.0	↓	↓

REMARKS\*\* LME 45 drill rig, 3 1/4" ID h.s.a., NQ-11 coring tools, automatic hammer,  
PA Drill Co. Driller- Bill Minor, Helper- Craig Hicks

\* POCKET PENETROMETER READINGS

\*\* METHOD OF ADVANCING AND CLEANING BORING

BORING R-8

PROJECT VA Research Office Building

BORING NO. R-9

ELEVATION 1160.0 GWL 0 HRS 22, 2

PROJECT NO LOG0465

DATE 11/15/06

HRS                       
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PAGE 1 of 2

DEPTH (FT.)	BLOWS PER SIX INCHES OR CORE RECOVERY/RUN	SAMPLE NO., TYPE & RECOVERY OR % ROCK RECOVERY	RQD (%) OR TORVANE	DESCRIPTION				USCS OR ROCK BROKENNESS	REMARKS*
				PROFILE	SOIL DENSITY - CONSISTENCY OR ROCK HARDNESS	COLOR	MATERIAL CLASSIFICATION		
1	2	3	4	5	6	7	8	9	10
1.0							Asphalt surface		
	4	S-1			v loose	Blk			wet
3.0	2								
	2	S-2			v stiff	BRN	sandy clay some rock fragments	GC	dry *3.0-3.5TSF
	3								
6.0									
	1	S-3			m stiff	BRN	stlty clay, trace rock fragments	GC	wet *0.5-1.0TSF
	2								
9.0									
	7	S-4			v stiff	BRN	Decomposed sandy shale		dry
	13								
	14								
12.0									
	6	S-5							
	31								
	50								
15.0							Top of rock @ 15.5'		
15.5	50	S-6							
	4	R-1	90	22	m hard	Gray	sandstone, some m soft	VBR	Horizontal to high
	1.5					BRN	sandy shale seams	BR	angle fractures
20.0									
	2.5	R-2	100	36					
	2.5			22.0					
22.5					soft	Gray	claystone	VBR	low to high angle
	2.2	R-3	88	100				BL	fractures
	2.5								
25.0									
	4.8	R-4	96	22					
	5.0								
30.0									

REMARKS \*\* CME 45 drill rig, NG-11 coring tools, 3 1/4" ID h.s.g., automatic hammer,  
PA Drill Co. Driller-Bill Minor Helper-Graig Hicks

BORING R-9

\* POCKET PENETROMETER READINGS

\*\* METHOD OF ADVANCING AND CLEANING BORING

PROJECT VA Research Office Building

BORING NO. R-9

ELEVATION 1160.0 GWL 0 HRS 22.2

PROJECT NO. 1060465

DATE 1/15/06

HRS \_\_\_\_\_ CLASSIFIED BY LA Newman

PAGE 2 of 2

DEPTH (FT.)	BLOWS PER SIX INCHES OR	CORE RECOVERY/RUN SAMPLE NO., TYPE & RECOVERY OR % ROCK RECOVERY	RQD (%) OR TORVANE	DESCRIPTION				USCS OR ROCK BROKENNESS	REMARKS*
				PROFILE	SOIL DENSITY - CONSISTENCY OR ROCK HARDNESS	COLOR	MATERIAL CLASSIFICATION		
1	2	3	4	5	6	7	8	9	10
	5.0 5.0	R5Y100	52		soft	Gray	claystone (cont)	VBR	horizontal to low angle fractures
				32.4	↓	↓	↓	BR	
					m soft	Gray	sandy shale, trace m hard sandstone seams	VBR	horizontal to low angle fractures
					↓	↓	↓	BR	
35.0	5.0 5.0	R6Y100	42						
					↓	↓	↓		
40.0				42.0	↓	↓	Bottom of boring @ 400'	↓	

REMARKS \*\* CPE 45 drill rig, NQ 11 coring tools, 3 1/4" ID h.s.a., automatic hammer, PA Drill Co. Driller - Bill Minor, Helper - Craig Hicks

\* POCKET PENETROMETER READINGS  
\*\* METHOD OF ADVANCING AND CLEANING BORING

BORING R-9

**Appendix B**  
**Unconfined Compressive Strength Test Results**



# UNCONFINED COMPRESSIVE STRENGTH TEST RESULTS

ASTM D 2938-95

CLIENT: GAI CONSULTANTS, INC.  
CLIENT PROJ: VA RESEARCH OFFICE BLDG. C060465.00  
PROJECT NO.: 2006-435-01  
LAB ID NO.: 2006-435-01-01

BORING I.D.: R-3  
DEPTH(ft): 16.0 - 16.4  
SAMPLE ID: NA

DESCRIPTION: 2" ROCK CORE

SPECIMEN DIAMETER(In.):

READING 1: 1.98  
READING 2: 1.98  
AVERAGE: **1.98**  
AREA(in<sup>2</sup>): 3.08  
L/D: 2.06

SPECIMEN LENGTH (in.)

BEFORE CAPPING

READING 1: 4.04  
READING 2: 4.04  
READING 3: 4.05  
AVERAGE: **4.04**

TOTAL LOAD(lbs) 20,990  
**COMPRESSIVE STRENGTH (PSI): 6,820**

SPECIMEN LENGTH (in.)

AFTER CAPPING

READING 1: 4.06  
READING 2: 4.07  
READING 3: 4.07  
AVERAGE: **4.07**

FRACTURE TYPE: **CONE & SHEAR**

RATE OF LOADING(lbs/sec): 99  
TIME TO BREAK(min:sec:100<sup>th</sup>): 3:33:09  
DEVIATION FROM STRAIGHTNESS<sup>4</sup>:

AXIAL: Pass

TOP: Pass

BOTTOM: Pass

NOTES:

- 2) Moisture conditions at time of test are as received.
  - 3) Specimens capped with cement/plaster paste.
  - 4) Deviation from straightness, Procedure A of ASTM D 4543.
- Pass/Fail criteria: gap < 0.02 = Pass, gap > 0.02 = Fail



Tested By: CK

Date: 12/1/06

Checked By: TM Date: 12-1-06

# UNCONFINED COMPRESSIVE STRENGTH TEST RESULTS

ASTM D 2938-86

CLIENT: GAI CONSULTANTS, INC.  
CLIENT PROJ: VA RESEARCH OFFICE BLDG. C060465.00  
PROJECT NO.: 2006-435-01  
LAB ID NO.: 2006-435-01-02

BORING I.D.: R-3  
DEPTH(ft): 18.4 - 18.8  
SAMPLE ID: NA

DESCRIPTION: 2" ROCK CORE

SPECIMEN DIAMETER(in.):

READING 1: 1.97  
READING 2: 1.98  
AVERAGE: **1.98**  
AREA(in<sup>2</sup>): 3.07  
L/D: 1.84

SPECIMEN LENGTH (in.)

BEFORE CAPPING

READING 1: 3.62  
READING 2: 3.61  
READING 3: 3.62  
AVERAGE: **3.62**

TOTAL LOAD(lbs) 28,755  
**COMPRESSIVE STRENGTH (PSI): 9,360**  
CORRECTION (PSI)<sup>1</sup>: 9,270  
FRACTURE TYPE: **CONE**

SPECIMEN LENGTH (in.)

AFTER CAPPING

READING 1: 3.64  
READING 2: 3.65  
READING 3: 3.65  
AVERAGE: **3.64**

RATE OF LOADING(lbs/sec): 110  
TIME TO BREAK(min:sec:100<sup>th</sup>): 4:20:79  
DEVIATION FROM STRAIGHTNESS<sup>4</sup>:

AXIAL: *Pass* TOP: *Pass* BOTTOM: *Pass*

- NOTES: 1) Corrected PSI value for L/D, as per ASTM D 2938-86.  
2) Moisture conditions at time of test are as received.  
3) Specimens capped with cement/plaster paste.  
4) Deviation from straightness, Procedure A of ASTM D 4543.  
Pass/Fail criteria: gap < 0.02 = Pass, gap > 0.02 = Fail



Tested By: **CK**

Date: **12/1/06**

Checked By **TW** Date **12-1-06**

**POINT LOAD TEST**  
ASTM D5731-02 (SOP S-46)

Client GAI Consultants, Inc.  
Client Reference VA Research Office Bldg C060465.00  
Project No. 2006-435-01  
Lab ID 2006-435-01-03

Boring No. R-4  
Depth (ft) 6.3-6.5  
Sample No. NA  
Description 2" BROWN ROCK CORE

**Sample Dimensions**

Sample Height Measurements, (D)  
Height, 1(in.) 1.624  
Height, 2(in.) 1.577  
Height, 3(in.) (Test Contact Point) 1.457  
Average Height, (in.) 1.553  
D<sub>av</sub> D<sub>e</sub> Ave. Equiv. Core Diam., (mm) 39.44

**Moisture Content**

Tare No. 3549  
Wt. of Tare + Wet Rock (gm.) 126.10  
Wt. of Tare + Dry Rock (gm.) 119.86  
Wt of Tare (gm.) 6.78  
Moisture Content 5.5

Sample Length Measurements, (W)  
Length, 1 (in.) 2.001  
Length, 2 (in.) 1.991  
Length, 3 (in.) 2.010  
Average Length, (in.) 2.001  
Length/Diameter Ratio (D/W) 0.776

Sample Length Measurements, (L)  
Length, 1 (in.) 1.000  
Length, 2 (in.) 1.000  
Length, 3 (in.) 1.000  
Average Length, (in.) 1.000  
Length/Diameter Ratio(L/D) 0.644

**Test Data**

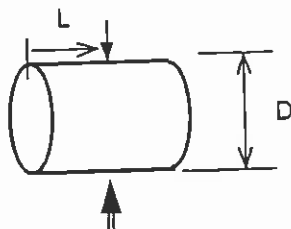
**Index & Strength Computations**

Piston Area (in<sup>2</sup>) 2.236  
P - Gauge Pressure @ Failure (lbf) 580  
I<sub>S</sub> - Point Load Index (psi) 146.7  
I<sub>S(50)</sub> - Corrected Point Load Index (psi) 131.8  
C - Index To Strength Conversion Factor 21.0  
δ<sub>ox</sub> - Est. Unconfined Compressive Strength (psi) 2,768

**Recommended Sample Dimensions for Each Test Type**

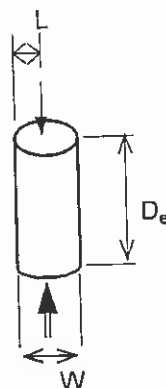
Orientation of bedding planes or planes of weakness.

L/D > 1.00  
L > 0.5D



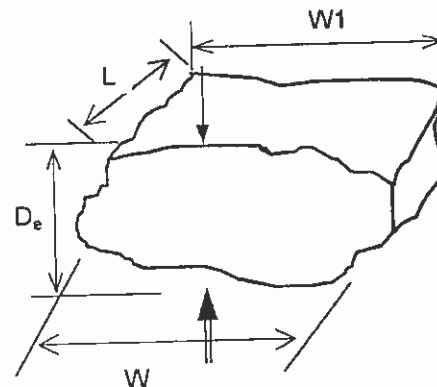
Diametral Test

D/W = 0.33 to 1.00  
L > 0.5D - Block



Axial or Block Test

D ≈ 50 mm (~2 in)  
D/W = 0.33 to 1.00  
L > 0.5D



Lump Test

Tested By DDA

Date 12/1/06

Checked By

Date 12-4-06

**POINT LOAD TEST**  
ASTM D5731-02 ( SOP S-46 )

Client GAI Consultants, Inc.  
Client Reference VA Research Office Bldg C060465.00  
Project No. 2006-435-01  
Lab ID 2006-435-01-04

Boring No. R-4  
Depth (ft) 13.9-14.2  
Sample No. NA  
Description 2" BROWN ROCK CORE

Sample Dimensions		Moisture Content	
Sample Height Measurements, (D)		Tare No.	3578
Height, 1(in.)	1.916	Wt. of Tare + Wet Rock (gm.)	198.44
Height, 2(in.)	2.012	Wt. of Tare +Dry Rock (gm.)	191.08
Height, 3(in.) ( <i>Test Contact Point</i> )	1.850	Wt of Tare (gm.)	6.71
Average Height, (in.)	1.926	Moisture Content	4.0
D <sub>av</sub> D <sub>e</sub> Ave. Equiv. Core Diam., (mm)	48.92		
Sample Length Measurements, (W)		Sample Length Measurements, (L)	
Length, 1 (in.)	2.028	Length, 1 (in.)	1.010
Length, 2 (in.)	2.023	Length, 2 (in.)	1.010
Length, 3 (in.)	2.010	Length, 3 (in.)	1.010
Average Length, (in.)	2.020	Average Length, (in.)	1.010
Length/Diameter Ratio (D/W)	0.953	Length/Diameter Ratio(L/D)	0.524

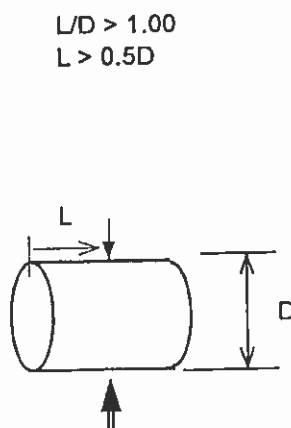
**Test Data**

**Index & Strength Computations**

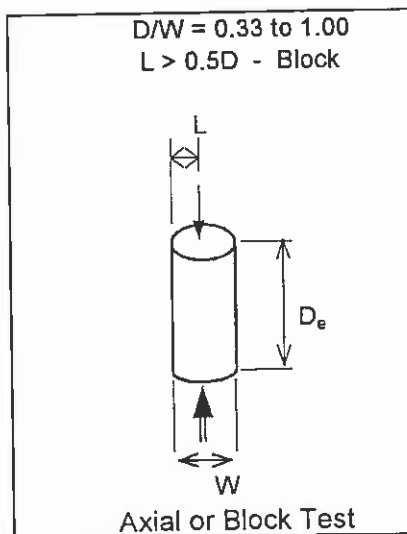
Piston Area (in <sup>2</sup> )		I <sub>s</sub> - Point Load Index (psi)	78.7
		I <sub>s(50)</sub> - Corrected Point Load Index (psi)	77.9
		C - Index To Strength Conversion Factor	22.7
P - Gauge Pressure @ Failure (lbf)	390	δ <sub>ux</sub> - Est.Unconfined Compressive Strength (psi)	1,768

**Recommended Sample Dimensions for Each Test Type**

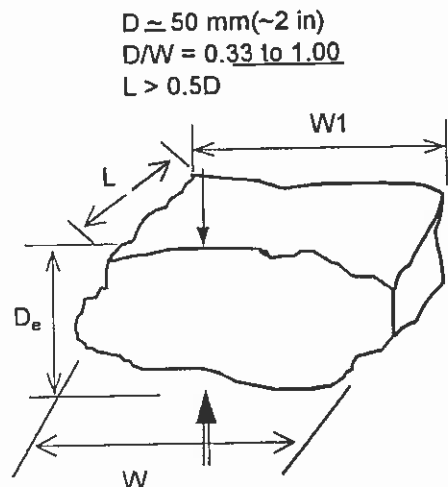
Orientation of bedding planes or planes of weakness.



Diametral Test



Axial or Block Test



Lump Test

Tested By DDA

Date 12/1/06

Checked By *KR*

Date 12-4-06

**UNCONFINED COMPRESSIVE STRENGTH TEST RESULTS**  
ASTM D 2938-95

CLIENT: GAI CONSULTANTS, INC.  
CLIENT PROJ: VA RESEARCH OFFICE BLDG. C060465.00  
PROJECT NO.: 2006-435-01  
LAB ID NO.: 2006-435-01-05

BORING I.D.: R-5  
DEPTH(ft): 8.7 - 9.5  
SAMPLE ID: NA

DESCRIPTION: 2" ROCK CORE

SPECIMEN LENGTH (in.)

BEFORE CAPPING

READING 1: 4.07  
READING 2: 4.07  
READING 3: 4.05  
AVERAGE: 4.06

SPECIMEN LENGTH (in.)

AFTER CAPPING

READING 1: 4.15  
READING 2: 4.15  
READING 3: 4.14  
AVERAGE: 4.14

SPECIMEN DIAMETER(in.):

READING 1: 1.98  
READING 2: 1.96  
AVERAGE: 1.97  
AREA(in<sup>2</sup>): 3.06  
L/D: 2.10

TOTAL LOAD(lbs) 1,460  
COMPRESSIVE STRENGTH (PSI): 480

FRACTURE TYPE: CRUMBLIED

RATE OF LOADING(lbs/sec): 19  
TIME TO BREAK(min:sec:100<sup>th</sup>): 1:17:52  
DEVIATION FROM STRAIGHTNESS<sup>1</sup>:

AXIAL: Fail TOP: Pass BOTTOM: Pass

NOTES:

- 2) Moisture conditions at time of test are as received.
  - 3) Specimens capped with cement/plaster paste.
  - 4) Deviation from straightness, Procedure A of ASTM D 4543.
- Pass/Fail criteria: gap < 0.02 = Pass, gap > 0.02 = Fail

NO PHOTO

SAMPLE  
CRUMBLIED

Tested By: CK

Date: 12/1/06

Checked By: TM Date: 12-1-06

# UNCONFINED COMPRESSIVE STRENGTH TEST RESULTS

ASTM D 2938-95

CLIENT: GAI CONSULTANTS, INC.  
CLIENT PROJ: VA RESEARCH OFFICE BLDG. C060465.00  
PROJECT NO.: 2006-435-01  
LAB ID NO.: 2006-435-01-06

BORING I.D.: R-5  
DEPTH(ft): 14.2 - 14.7  
SAMPLE ID: NA

DESCRIPTION: 2" ROCK CORE

SPECIMEN DIAMETER(in.):

READING 1: 1.98  
READING 2: 1.98  
AVERAGE: 1.98  
AREA(in<sup>2</sup>): 3.08  
L/D: 2.07

SPECIMEN LENGTH (in.)

BEFORE CAPPING

READING 1: 4.05  
READING 2: 4.03  
READING 3: 4.06  
AVERAGE: 4.04

TOTAL LOAD(lbs) 17,935  
**COMPRESSIVE STRENGTH (PSI): 5,830**

SPECIMEN LENGTH (in.)

AFTER CAPPING

READING 1: 4.09  
READING 2: 4.10  
READING 3: 4.10  
AVERAGE: 4.10

FRACTURE TYPE: **SHEAR**

RATE OF LOADING(lbs/sec): 113  
TIME TO BREAK(min:sec:100<sup>th</sup>): 2:38:10  
DEVIATION FROM STRAIGHTNESS<sup>4</sup>:

AXIAL: Pass TOP: Pass BOTTOM: Pass

NOTES:

- 2) Moisture conditions at time of test are as received.
  - 3) Specimens capped with cement/plaster paste.
  - 4) Deviation from straightness, Procedure A of ASTM D 4543.
- Pass/Fail criteria: gap < 0.02 = Pass, gap > 0.02 = Fail



Tested By: CK

Date: 12/1/06

Checked By: TM Date: 12-1-06



# UNCONFINED COMPRESSIVE STRENGTH

ASTM D2166-00 / AASHTO T208-96 (Modified-Peak Load Only) (SOP S-30)

Client	GAI Consultants, Inc.	Boring No.	R-5
Client Reference	VA Research Office Bldg C060465	Depth (ft.)	30.2-30.7
Project No.	2006-435-01	Sample No.	NA
Lab ID	2006-435-01-07	Visual Description:	2" DARK GRAY ROCK CORE

## INITIAL SAMPLE DIMENSIONS

Length 1(in)	4.228	Top Dia. (in)	2.054
Length 2(in)	4.217	Mid. Dia. (in)	2.043
Length 3(in)	4.156	Bot. Dia. (in)	2.061
Avg.Length(in)	4.200	Area (in.^2)	3.309

## WATER CONTENT AFTER TEST

Tare No.	1000
Wt. Tare + WS.(gms)	419.11
Wt. Tare + DS.(gms)	367.84
Wt. of Tare(gms)	6.64
% Moisture	14.19

## UNIT WEIGHT

Wt. Tube & WS.(gms.)	495.3	Sample Volume(cc.)	227.8
Wt. Of Tube(gms.)	0.00	Unit Wet Wt.(gms/cc)	2.17
Wt. Of WS.(gms.)	495.3	Unit Wet Wt.(pcf.)	135.69
Diameter (in.)	2.05	Moisture Content, %	14.19
Length (in.)	4.20	Unit Dry Wt.(pcf.)	118.82
Length (cm.)	10.67		

LOAD (lbs)

STRESS (psi)

29

8.76

Tested By CK

Date 12/1/06

Input Checked By *HR*

Date 12-4-06

# UNCONFINED COMPRESSIVE STRENGTH TEST RESULTS

ASTM D 2938-95

CLIENT: GAI CONSULTANTS, INC.  
CLIENT PROJ: VA RESEARCH OFFICE BLDG. C060465.00  
PROJECT NO.: 2006-435-01  
LAB ID NO.: 2006-435-01-08

BORING I.D.: R-6  
DEPTH(ft): 25.4 - 25.9  
SAMPLE ID: NA

DESCRIPTION: 2" ROCK CORE

SPECIMEN DIAMETER(in.):

READING 1: 1.99  
READING 2: 1.99  
AVERAGE: 1.99  
AREA(in<sup>2</sup>): 3.09  
L/D: 2.10

SPECIMEN LENGTH (in.)

BEFORE CAPPING

READING 1: 4.12  
READING 2: 4.13  
READING 3: 4.13  
AVERAGE: 4.13

TOTAL LOAD(lbs) 43,355  
COMPRESSIVE STRENGTH (PSI): 14,010

SPECIMEN LENGTH (in.)

AFTER CAPPING

READING 1: 4.16  
READING 2: 4.18  
READING 3: 4.17  
AVERAGE: 4.17

FRACTURE TYPE: CONE & SHEAR

RATE OF LOADING(lbs/sec): 117  
TIME TO BREAK(min:sec:100<sup>th</sup>): 6:12:09  
DEVIATION FROM STRAIGHTNESS<sup>4</sup>:

AXIAL: Pass TOP: Pass BOTTOM: Pass

NOTES:

- 2) Moisture conditions at time of test are as received.
  - 3) Specimens capped with cement/plaster paste.
  - 4) Deviation from straightness, Procedure A of ASTM D 4543.
- Pass/Fail criteria: gap < 0.02 = Pass, gap > 0.02 = Fail



Tested By: CK

Date: 12/1/06

Checked By: TM Date: 12-1-06





**UNCONFINED COMPRESSIVE STRENGTH**  
ASTM D2166-00 / AASHTO T208-96 (Modified-Peak Load Only) (SOP S-30)

Client	GAI Consultants, Inc.	Boring No.	R-6
Client Reference	VA Research Office Bldg C060465	Depth (ft.)	28.0-28.6
Project No.	2006-435-01	Sample No.	NA
Lab ID	2006-435-01-09	Visual Description:	2" DARK GRAY ROCK CORE

INITIAL SAMPLE DIMENSIONS			
Length 1(in)	3.903	Top Dia. (in)	2.059
Length 2(in)	3.905	Mid. Dia. (in)	2.050
Length 3(in)	3.922	Bot. Dia. (in)	2.057
Avg.Length(in)	3.910	Area (in.^2)	3.318

WATER CONTENT AFTER TEST	
Tare No.	3567
Wt. Tare + WS.(gms)	476.33
Wt. Tare + DS.(gms)	423.20
Wt. of Tare(gms)	6.88
% Moisture	12.76

UNIT WEIGHT			
Wt. Tube & WS.(gms.)	469.5	Sample Volume(cc.)	212.6
Wt. Of Tube(gms.)	0.00	Unit Wet Wt.(gms/cc)	2.21
Wt. Of WS.(gms.)	469.5	Unit Wet Wt.(pcf.)	137.81
Diameter (in.)	2.06	Moisture Content, %	12.76
Length (in.)	3.91	Unit Dry Wt.(pcf.)	122.22
Length (cm.)	9.93		

LOAD (lbs)

STRESS (psi)

52

15.67

Tested By CK

Date 12/1/06

Input Checked By *KB*

Date *12-4-06*

**POINT LOAD TEST**  
ASTM D5731-02 ( SOP S-46 )

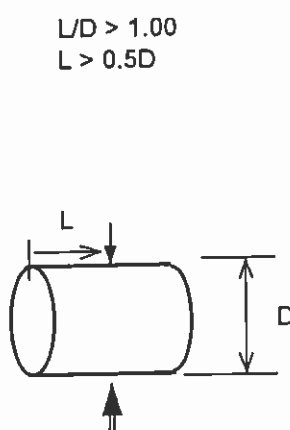
Client	GAI Consultants, Inc.	Boring No.	R-7
Client Reference	VA Research Office Bldg C060465.00	Depth (ft)	38.4-38.8
Project No.	2006-435-01	Sample No.	NA
Lab ID	2006-435-01-10	Description	2" BROWN ROCK CORE

Sample Dimensions		Moisture Content
Sample Height Measurements, (D)		
Height, 1(in.)	1.593	Tare No.
Height, 2(in.)	1.454	Wt. of Tare + Wet Rock (gm.)
Height, 3(in.) (Test Contact Point)	1.417	Wt. of Tare + Dry Rock (gm.)
Average Height, (in.)	1.488	Wt of Tare (gm.)
D <sub>av</sub> D <sub>e</sub> Ave. Equiv. Core Diam., (mm)	37.80	Moisture Content
Sample Length Measurements, (W)		Sample Length Measurements, (L)
Length, 1 (in.)	1.957	Length, 1 (in.)
Length, 2 (in.)	1.975	Length, 2 (in.)
Length, 3 (in.)	1.969	Length, 3 (in.)
Average Length, (in.)	1.967	Average Length, (in.)
Length/Diameter Ratio (D/W)	0.757	Length/Diameter Ratio(L/D)

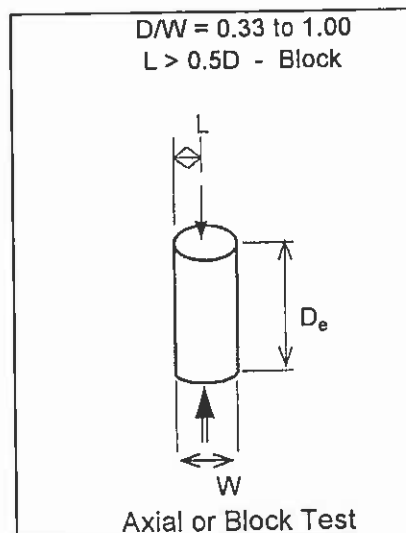
Test Data	Index & Strength Computations
	I <sub>S</sub> - Point Load Index (psi)
	I <sub>S(50)</sub> - Corrected Point Load Index (psi)
Piston Area (in <sup>2</sup> )	C - Index To Strength Conversion Factor
P - Gauge Pressure @ Failure (lbf)	δ <sub>ux</sub> - Est.Unconfined Compressive Strength (psi)

**Recommended Sample Dimensions for Each Test Type**

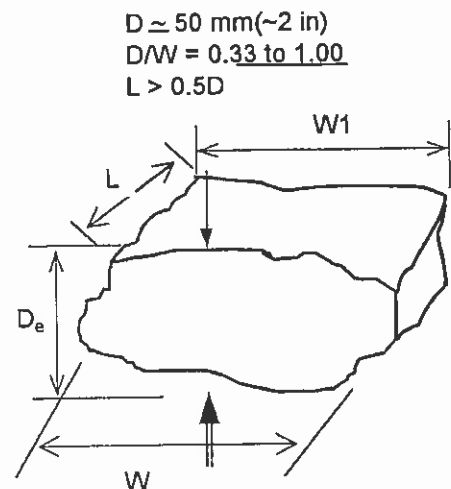
Orientation of bedding planes or planes of weakness.



Diametral Test



Axial or Block Test



Lump Test

Tested By DDA Date 12/1/06 Checked By KJB Date 12-4-06

## **DRAWINGS**

2

ASTORINO

Age Group	Percentage
18-29	65
30-49	75
50-69	85
70+	100



—  
END OF  
PAGE

**REMARKS:**

- LEGEND:
- |    |                      |
|----|----------------------|
| 01 | PROBATION            |
| 02 | HOUSE OF CORRECTIONS |
| 03 | DETENTION            |
| 04 | CHANGELING           |
| 05 | DEBILITATED          |
| 06 | CONFINED             |
| 07 | ALIEN                |
| 08 | WITNESS              |
| 09 | RECEIVED             |
| 10 | RECEIVED             |
| 11 | RECEIVED             |
| 12 | RECEIVED             |
| 13 | RECEIVED             |
| 14 | RECEIVED             |
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