



TETRA TECH

**PRELIMINARY SITE INVESTIGATION AND  
GEOTECHNICAL ENGINEERING REPORT**

**EAGLE RIVER STATION  
EAGLE, COLORADO**

(Tetra Tech No. 7390406)

Submitted to: Mr. Skip Johnson  
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Submitted by: TERTA TECH, INC.

  
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Reviewed by:

  
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Senior Geotechnical Engineer  
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October 25, 2007



## **EXECUTIVE SUMMARY**

Tetra Tech, Inc. (Tt) has completed the preliminary subsurface exploration for the proposed development in Eagle, Colorado. Tetra Tech understands that the project will consist of a several single story structures, a water tank, and parking/drive areas.

In general, the subsurface conditions identified by the borings include topsoil over a sandy silty clayey soil. The clayey soils have several soft zones and generally have high moisture contents. The clayey soil grades into a gravelly sand with some cobble sized material. Groundwater was encountered in four borings at depths varying from 5 to 10 feet.

A grading plan was provided by John Golden with BHC Rhodes. The recommendations that follow are general for site development, and should result in acceptable building pads for the proposed structures.

**THE EXECUTIVE SUMMARY HAS BEEN PREPARED TO PROVIDE A GENERAL OVERVIEW AND SHOULD NOT BE RELIED UPON TO FOR ANY OTHER PURPOSE. ALL INFORMATION ABOUT FINDINGS, RECOMMENDATIONS, AND OTHER CONCERNS CAN ONLY BE FOUND IN THE FULL REPORT.**

## **FIELD AND LABORATORY INVESTIGATION**

The site subsurface conditions were explored with 12 borings, 10 in the proposed building areas (B-01 – B-10) and 2 in the water tank area (Tank 1 – Tank 2). The borings were drilled between September 5, 2007 and September 10, 2007 using a CME 55 truck mounted drill rig equipped with continuous flight augers and hollow stem augers. The building borings were drilled until the gravelly sand layer was penetrated. The water tank borings were drilled until cobbles were present. One of the water tank borings was continued with an additional 20 feet with conventional rock coring. Soil samples were routinely obtained during the drilling process using standard penetration test samplers (ASTM D 1586) and thin walled tube samplers (ASTM D 1587). Tetra Tech laid out the boring locations in the field. A sketch showing the approximate boring locations with respect to the proposed construction and existing site features is included in Appendix I.

A field log was prepared for each boring. These logs contain visual classifications of the materials encountered during drilling as well as an interpolation of the subsurface conditions between samples. Final logs included in Appendix I represent our interpretation of the field logs and may include modifications based on laboratory observations and tests of the field samples. The final logs describe the materials encountered, their thickness and the locations where samples were obtained. The borings were backfilled with auger cuttings upon completion.

The field investigation was undertaken to develop engineering information directed solely to meet the purposes as defined in "INTRODUCTION". The intent of the geotechnical investigation was not to uncover or identify any contaminated subsurface material that may contain hazardous or flammable substances. Identification of such substances requires specialized exploration techniques and analyses that were not employed in this investigation.

Field samples obtained from the borings were returned to our laboratory where they were visually classified and logged. Laboratory tests were performed in general accordance with ASTM procedures. The results of these tests are presented in detail in Appendix II of this report. Test results were utilized in the development of the geotechnical recommendations.

## **SITE AND SUBSURFACE CONDITIONS**

The proposed site is northeast of Eagle Colorado between Interstate 70 and Highway 6. The site surface is vegetated and at the time of our investigation irrigated. An aerial photo of the site can be seen below:

PROPERTY DESCRIPTION  SOIL STRATA TYPE	RANGE OF PROPERTY VALUES						
	Hand Penetrometer tsf	Standard Penetration N	Moisture Content %	Dry Unit Weight Pcf	Unconfined Compressive Strength, $Q_u$ psf	Liquid Limit %	Plastic Limit %
Clayey soil	0.5 – 1.75	0 – 12	5 – 27	100 – 105	2,500	29 – 35	15 – 21
Gravelly Sand	---	28 – 79	1 – 15	---	---	----	---

The above subsurface description and laboratory test results are of a generalized nature to highlight the major subsurface stratification features and material characteristics. The boring logs included in the Appendix I should be reviewed for specific information at individual boring locations. These records include soil descriptions, stratifications, penetration resistances, locations of the samples, and laboratory test data. The stratifications shown on the boring logs represent the conditions only at the actual boring locations. Variations may occur and should be expected between boring locations. The stratifications represent the approximate boundary between subsurface materials and the actual transition may be gradual.

#### GROUNDWATER

Groundwater was encountered during the investigation in borings B-01, B-02, B-03, and B-07 at 5, 5, 10, and 5 feet respectively. It is Tt's opinion that the groundwater level is not static at these locations. The groundwater could have been caused by the irrigation of the site. Some of the clayey soils appear to have very high moisture contents, and would likely drain into an open bore hole.

It should be understood that the level of groundwater might fluctuate during construction or at other times of the year depending upon climatic and rainfall conditions. Groundwater levels may be higher or lower during construction or at other times during the life of the project.

#### POTENTIAL CONSTRUCTION ISSUES

The following geotechnical related evaluations have been developed on the basis of the subsurface conditions encountered and our understanding of the proposed construction. Should changes in the project criteria occur, a review must be made by Tt to determine if modifications to our recommendations will be required.

There are four potential construction issues at this site that may affect the proposed construction's ability to provide 2,500 – 3,000 psf allowable bearing capacity building pads. The following summarizes these concerns:

The material on-site will likely have to be dried to meet the moisture content requirements for fill. If the native soils are too wet and cannot be dried to near-optimum moisture within the construction schedule, they can be dried with the addition of fly ash to provide a stable subgrade material.

The first layer of fill material should be placed in a relatively uniform horizontal lift and be adequately keyed into the stripped and compacted subgrade soils. Fill materials should be free of organic or other deleterious material, and have a maximum particle size less than 3 inches in any direction. On-site clayey soils are acceptable as a fill and select fill material satisfying a liquid limit less than 45 and a plasticity index less than 25. All fill material should be unfrozen and be approved by the geotechnical engineer. The geotechnical engineer should be notified at least 72 hours before fill is imported to the site, to sample and test the material. No imported material should be delivered to the site without proper sampling and testing.

The upper fine-grained soils encountered at this site are expected to be sensitive to disturbances caused by construction traffic and changes in moisture content. During wet weather periods, increases in the moisture content of the soil can cause significant reduction in the soil strength and support capabilities. In addition, soils that become wet may be slow to dry and thus significantly retard the progress of grading and compaction activities. It will, therefore, be advantageous to perform earthwork and foundation construction activities during dry weather.

Continuous observation by the geotechnical engineer of record or his designated representative should be maintained during placement of all fill and backfill material. Fill placement should be completed as soon as possible in order to give the compacted soil time to settle before footings are placed.

### Option 2

Based on the significant amount of soft clayey soil, it is Tt's opinion that utilization of Geopier™ is an effective and economical foundation option for this project. This system would be installed prior to the general contractor starting building construction and would require exact footing loads and locations. The slabs-on-grade may also require Geopier™ support at this site. This is a patented design-build system by Geopier™, however, Tt will be pleased to help coordinate the bidding of the system.

Geopiers™ are a subsurface stabilization technique, constructed by drilling a hole to create a cavity, removing a volume of compressible subsoil, then building a bottom bulb of clean, open-graded stone while vertically prestressing and prestraining subsoils underlying the bottom bulb. The Geopier™ shaft is built on top of the bottom bulb, using well-graded highway

**APPENDIX**

**I**

**BORING LOCATION DRAWING  
BORING LOGS**



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**BORING NO. BH-01**

Figure No.

Project No.: 7390406  
Project: Retail Center  
Location: Eagle Colorado

Drilling Method: Hollow-Stem Auger  
Hammer Type: CME Automatic  
Northing: 126906.2226  
Easting: 128273.6027

WATER LEVELS	
▽ While Drilling	5 ft
▽ At Completion	N/A ft
▽ 24 Hours	N/A ft

Depth, (feet)	Graphic Log	Sample Type	Sample No.	USCS Classification	MATERIAL DESCRIPTION	SPT Blows/N-Value	Dry Density (pcf)	Moisture, %	STANDARD PENETRATION TEST DATA		Additional Remarks
									N in blows/ft	Moisture	
Surface Elev.: 6696.5 feet											
0					TOPSOIL						
0-5					Sandy Clayey SILT; reddish brown; firm; moist	2-2-3 N=5		19		*	
5					Grading soft	WOH N=0		23		*	
5-10					Grading stiff	WOH N=0		25		□	LL = 30% PL = 18%
10-15					Grading firm	WOH N=0 3-4-6 N=10		26		*	
15-20					Grading soft	3-3-3 N=6		19		*	
20-25					Grading soft	3-1-2 N=3		18		*	
25					Gravelly SAND; brown; hard; with some silt and clay	12-24-50 N=74		6		*	
Boring terminated at 26 feet											

Completion Depth: 26.0 ft  
Boring Started: 9/5/07  
Boring Completed: 9/5/07  
Logged By: MS  
Logging Contractor: Tetra Tech

Sample Types:  
 Auger Cutting  
 Split-Spoon  
 Rock Core  
 Shelby Tube  
 Hand Auger  
 Liner Tube

Remarks:

Stratification lines represent approximate boundaries. The transition may be gradual.



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# BORING NO. BH-03

Figure No.

b No.: 7390406  
Object: Retail Center  
Location: Eagle Colorado

Drilling Method: Hollow Stem Auger  
Hammer Type: CME Automatic  
Northing: 126948.4092  
Easting: 127312.488

WATER LEVELS	
▽ While Drilling	10 ft
▽ At Completion	N/A ft
▽ 24 Hours	N/A ft

Depth (feet)	Graphic Log	Sample Type	Sample No.	USCS Classification	MATERIAL DESCRIPTION	SPT Blows/N-Value	Dry Density (pcf)	STANDARD PENETRATION TEST DATA		Additional Remarks
								N in blows/ft	Moisture, %	
Surface Elev.: 6699.1 feet										
0					TOPSOIL					
0-5					Sandy Clayey SILT; brown; stiff, dry	5-5-6 N=11		5	★	
5-10					Grading dark brown; firm	6-3-2 N=5		20	★	
10-11					Grading reddish brown; soft	1-1-2 N=3		21	★	
11-12						0-0-1 N=1				
12-15					Grading brown			25	★	
15-18						0-2-5 N=7		17	★	
18-24.5					Gravelly SAND; brown; very stiff	12-16-16 N=32		10	★	
Boring terminated at 24.5 feet										

Completion Depth: 23.0 ft  
Boring Started: 9/6/07  
Boring Completed: 9/6/07  
Logged By: MS  
Logging Contractor: Tetra Tech

Sample Types:  
 Auger Cutting  
 Split-Spoon  
 Rock Core  
 Shelby Tube  
 Hand Auger  
 Liner Tube

Remarks:

Stratification lines represent approximate boundaries. The transition may be gradual.



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# BORING NO. BH-05

Figure No.

No.: 7390406  
Project: Retail Center  
Location: Eagle Colorado

Drilling Method: Hollow Stem Auger  
Hammer Type: CME Automatic  
Northing: 126312.1857  
Easting: 126275.4001

WATER LEVELS	
▽ While Drilling	None ft
▽ At Completion	N/A ft
▽ 24 Hours	N/A ft

Depth, (feet)	Graphic Log	Sample Type	Sample No.	USCS Classification	MATERIAL DESCRIPTION	SPT Blows/N-Value	Dry Density (pcf)	Moisture, %	STANDARD PENETRATION TEST DATA		Additional Remarks
									N in blows/ft	N in blows/ft	
Surface Elev.: 6683.6 feet											
0					TOPSOIL						
0-4					Sandy Clayey SILT; reddish brown; firm; dry	3-3-4 N=7					
4-8					Grading moist; soft	2-1-2 N=3					
8-13											
13-15											
15-20					Grading stiff	2-2-1 N=3					
20-25											
25					Gravelly SAND; brown; hard; with broken rock	3-3-6 N=9					
25					Boring terminated at 26 feet	11-50					
										LL = 28% PL = 18%	

Completion Depth: 26.0 ft  
Boring Started: 9/7/07  
Boring Completed: 9/7/07  
Designed By: MS  
Drilling Contractor: Tetra Tech

Sample Types:

	Auger Cutting		Shelby Tube
	Split-Spoon		Hand Auger
	Rock Core		Liner Tube

Remarks:

stratification lines represent approximate boundaries. The transition may be gradual.



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# BORING NO. BH-09

Figure No.

b No.: 7390406  
Project: Retail Center  
Location: Eagle Colorado

Drilling Method: Hollow Stem Auger  
Hammer Type: CME Automatic  
Northing: 126687.2034  
Easting: 127575.6651

### WATER LEVELS

▽ While Drilling None ft  
▽ At Completion N/A ft  
▽ 24 Hours N/A ft

Depth, (feet)	Graphic Log	Sample Type	Sample No.	USCS Classification	MATERIAL DESCRIPTION	SPT Blows/N-Value	Dry Density (pcf)	Moisture, %	STANDARD PENETRATION TEST DATA		Additional Remarks
									N in blows/ft	Strength, tsf	
					Surface Elev.: 6689.5 feet			* Moisture    □ PL ● LL ▲ Qu    ● Qp			
0					TOPSOIL						
0-5					Sandy Clayey SILT; reddish brown; stiff, moist Grading soft	5-4-4 N=8		9			
5-10					Grading brown	4-1-2 N=3		14	*		
10-15					Grading firm		106	19	▲*		Qu = 2555 psf
15-20					Gravelly SAND; brown; very stiff, with some rock pieces and cobbles	3-3-3 N=6		17	*		
20					Boring terminated at 20.5 feet	7-14-14 N=28		15	*	●	

Completion Depth: 20.5 ft  
Boring Started: 9/8/07  
Boring Completed: 9/8/07  
Logged By: MS  
Logging Contractor: Tetra Tech

Sample Types:  
 Auger Cutting    Shelby Tube  
 Split-Spoon    Hand Auger  
 Rock Core    Liner Tube

Remarks:

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# BORING NO. Tank 1

Figure No.

No.: 7390406  
Project: Retail Center  
Location: Eagle Colorado

Drilling Method: Hollow Stem Auger  
Hammer Type: CME Automatic

Northing:  
Easting:

### WATER LEVELS

▽ While Drilling	N/A ft
▽ At Completion	N/A ft
▽ 24 Hours	N/A ft

Depth, (feet)	Graphic Log	Sample Type	Sample No.	USCS Classification	MATERIAL DESCRIPTION	SPT Blows/N-Value	Dry Density (pcf)	Moisture, %	STANDARD PENETRATION TEST DATA				Additional Remarks	
									N in blows/ft					
Surface Elev.:      feet														
0					TOPSOIL; with some rock	6-6-6								
					Gravelly Sandy SILT; tan; stiff; dry	N=12								
5					Grading hard	19-35-50								
						N=85								
10						18-34-37								
						N=71								
15						20-50/3"								
20					COBBLES; red and black; sandstone and basalt									
					Grading with white quartz									
25														
30					Grading to granite, white quartz, gneiss									
35														
Boring terminated at 37.5 feet														

Completion Depth: 37.5 ft  
Boring Started: 9/9/07  
Boring Completed: 9/9/07  
Logged By: MS  
Logging Contractor: Tetra Tech

Sample Types:  
 Auger Cutting  
 Split-Spoon  
 Rock Core  
 Shelby Tube  
 Hand Auger  
 Liner Tube

Remarks:

stratification lines represent approximate boundaries. The transition may be gradual.

# **APPENDIX**

## **II**

### **LABORATORY TEST RESULTS**

Borehole	Depth	Liquid Limit	Plastic Limit	Plasticity Index	Qu (psf)	%<#4 Sieve	%<#200 Sieve	Water Content (%)	Dry Density (pcf)	Remarks
BH-07	13.5	34	20	15		97	72	19.8		
BH-07	18.5							19.9		
BH-07	23.0							5.0		
BH-08	1.0							20.7		
BH-08	3.0	29	16	13		98	59	22.3	100.3	
BH-08	8.0							24.7		
BH-08	10.5							25.6		
BH-08	18.5							19.4		
BH-08	23.0							3.5		
BH-09	1.0							9.4		
BH-09	3.5							14.2		
BH-09	8.0				2555			18.9	105.5	
BH-09	13.5							16.9		
BH-09	18.5							14.6		
BH-10	1.0							9.8		
BH-10	3.5							10.6		
BH-10	8.5							21.8		
BH-10	13.5							20.4		
BH-10	18.5							15.4		
BH-10	23.5							4.2		



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**Summary of Laboratory Test Results**

Job No.: 7390406  
 Project: Retail Center  
 Location: Eagle Colorado

**APPENDIX  
III  
DEFINITIONS**

PERCHED GROUNDWATER

Water in a saturated zone underlain by an impervious stratum.

PERMEABILITY

The capacity of a material to transmit a fluid.

PUMPING

Phenomenon where the soil surface undulates under transient loads due to the applied stress being carried by the fluids in the voids in the soil mass. Severe cases result in rupture of the soil surface.

ROCK

A natural agglomerate of mineral grains connected by strong and permanent cohesive forces. Usually requires drilling, wedging, blasting or other methods of extraordinary force for excavation.

SCARIFY

To mechanically loosen soil or break down existing soil structure.

SELECT FILL

Controlled fill material that is classified as low-plasticity and has a liquid limit less than 45 and a plasticity index between 10 and 25.

SETTLEMENT

Downward movement.

SLAB ON GRADE

Plain, reinforced, or prestressed concrete that is continuously supported by ground and imparts less than 50 percent of the allowable bearing capacity.

SOIL

Any unconsolidated material composed of discrete solid particles, derived from the physical and/or chemical disintegration of vegetable or mineral matter, which can be separated by gentle mechanical means such as agitation in water.

STRIP

To remove from present location.

SUBBASE

A layer of specified material placed to form a layer between the subgrade and base course.

SUBBASE GRADE

Top of subbase.

SUBGRADE

Prepared soil surface.

VAPOR BARRIER

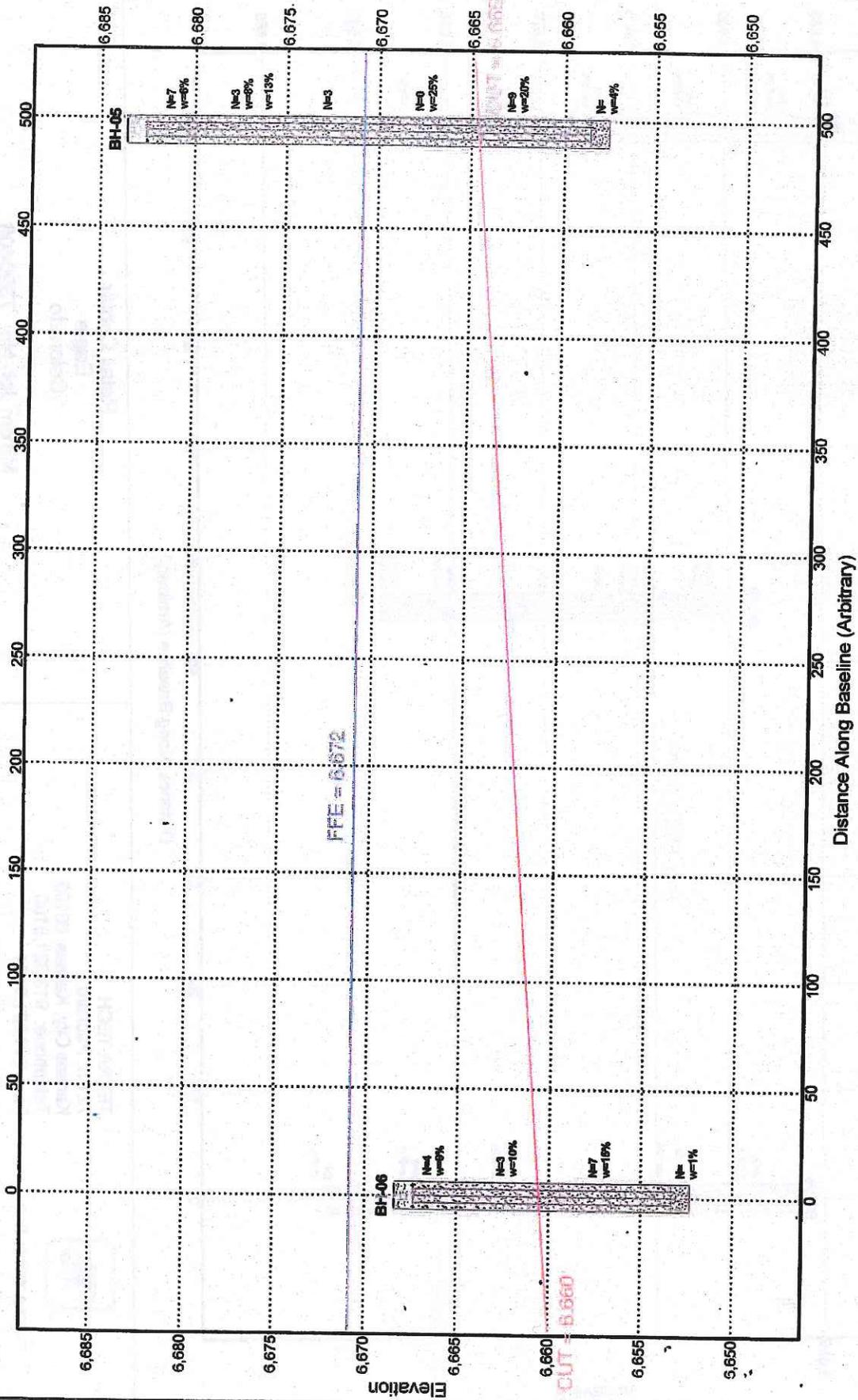
Polyethylene sheeting (typical) placed as a layer below concrete slab on grade to prevent upward migration of moisture.

VOID RATIO

The ratio of the volume of voids to the volume of solid particles in a soil mass.

WEATHERING

The physical and chemical disintegration and decomposition of rocks and minerals.

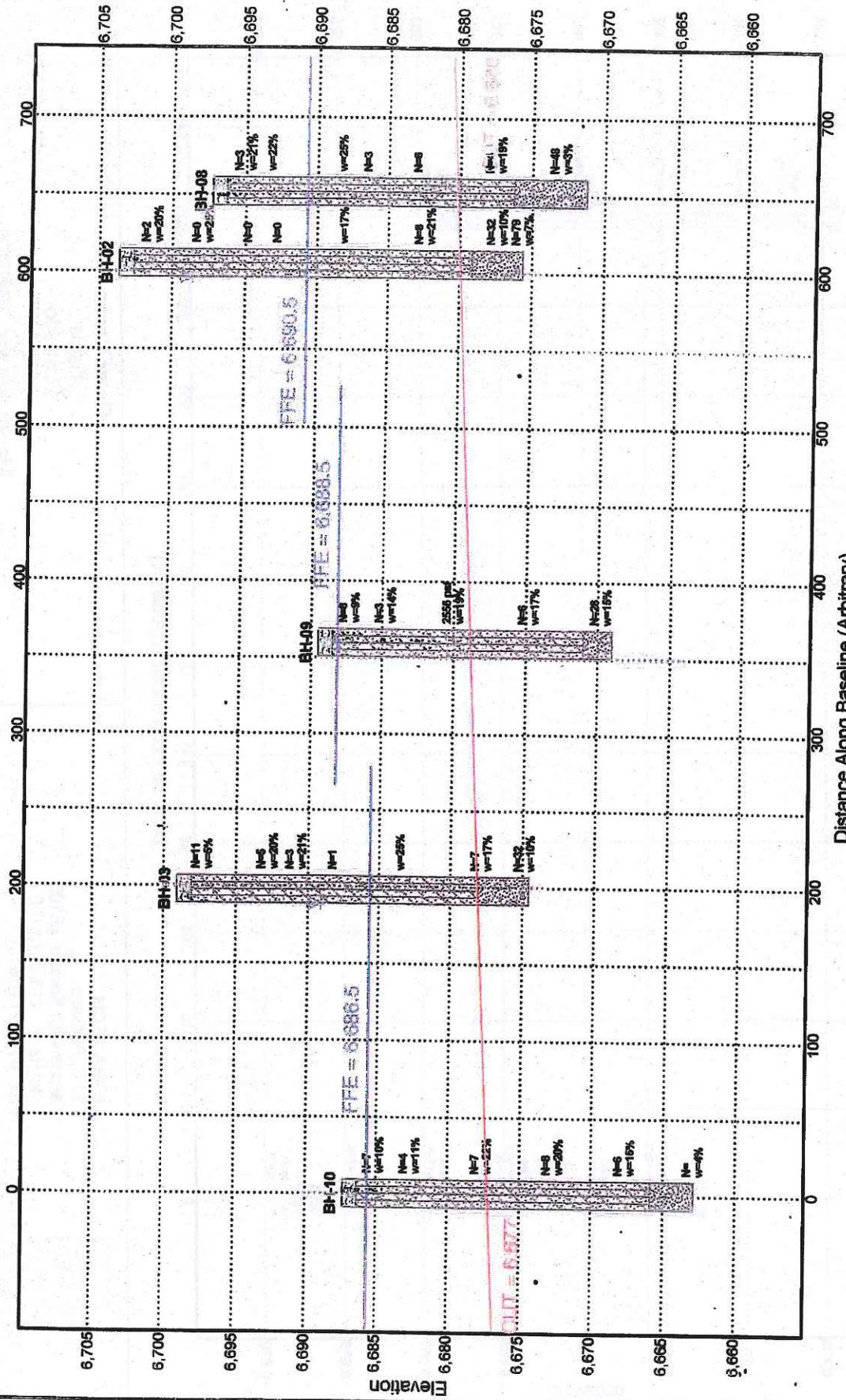


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Retail Center  
 Eagle  
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Maxim Job No: 7390406

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Distance Along Baseline (Arbitrary)



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**APPENDIX  
VI**

**TANK CROSS SECTIONS**