GEOTECHNICAL ENGINEERING

RECOMMENDATIONS
For the

Edgemont Highlands Metro District Water Storage

PROJECT SITE

Prepared For:

Mr. Richard Cortese
Edgemont Metro District
Project Number: 51172GE
November 13, 2007

PN: 51172GE
October 30, 2007

1.0 REPORT INTRODUCTION

This report presents our geotechnical engineering recommendations for the proposed Edgemont Highlands Metro District Water Storage Ponds Project. This report was requested by Mr. Richard Cortese. The field study was completed on September 17, 2007. The laboratory study was completed on October 5, 2007.

Geotechnical engineering is a discipline which provides insight into natural conditions and site characteristics such as; subsurface soil and water conditions, soil strength, swell (expansion) potential, consolidation (settlement) potential, and often slope stability considerations. Typically the information provided by the geotechnical engineer is utilized by many people including the project owner, architect or designer, structural engineer, civil engineer, the project builder and others. The information is used to help develop a design and subsequently implement construction strategies that are appropriate for the subsurface soil and water conditions, and slope stability considerations. It is important that the geotechnical engineer be consulted throughout the design and construction process to verify the implementation of the geotechnical engineering recommendations provided in this report. Generally the recommendations and technical aspects of this report are intended for design and construction personnel who are familiar construction concepts and techniques, and understand the terminology presented below. We should be contacted if any questions or comments arise as a result of the information presented below.

Sections 1.0 and 2.0 provide an introduction and an establishment of our scope of service. Sections 3.0 through 8.0 of this report present our geotechnical engineering field and laboratory studies (Sections 3.0 and 4.0) followed by our recommendations (Sections 5.0 through 8.0) which are based on our engineering analysis of the data obtained.

Section 9.0 provides a brief discussion of construction sequencing and strategies which may influence the geotechnical engineering characteristics of the site. The discussion and construction recommendations presented in Section 9.0 are intended to help develop site soil conditions that are consistent with the geotechnical engineering recommendations presented previously in the report. Ancillary information such as some background information regarding soil corrosion and radon considerations is presented as general reference. The construction considerations section is not intended to address all of the construction planning and needs for the project site, but is intended to provide an overview to aid the owner, design team, and contractor in understanding some construction concepts that may influence some of the geotechnical engineering aspects of the site and proposed development.

The data used to generate our recommendations are presented throughout this report and in the attached figures.

1.1 *Scope of Project*

We understand that the project will consist of constructing an additional water storage pond adjacent to the existing water storage facility. The proposed pond will be constructed with earthen embankment material and will likely be lined with an impermeable liner material.

2.0 GEOTECHNICAL ENGINIEERING STUDY

This section of this report presents the results of our field and laboratory study and our geotechnical engineering recommendations based on the data obtained.

Our services include a geotechnical engineering study of the subsurface soil and water conditions for development of this site for the intended use.

2.1 *Geotechnical Engineering Study Scope of Service*

The outline of our study which was delineated in our proposal for services and the order of presentation of the information presented in this report is presented in this report is presented below.

Field Study

- We advanced eleven (11) test borings at the project within the areas we understand are planned for construction of the proposed water pond. Standpipe piezometers were installed in six (6) of the test borings advanced.

- Select driven sleeve and bulk soil samples were obtained from the test borings and returned to our laboratory for testing.

Laboratory Study

- The laboratory testing and analysis of the samples obtained included;

    - Moisture content and dry density,
    - Direct shear strength tests, to help establish a basis for development of soil bearing capacity and lateral earth pressure values,
    - Swell/consolidation tests to help assess the expansion and consolidation potential of the support soils on this site to help estimate potential uplift associated with expansive soils and to help estimate settlement of the foundation system,
    - Plastic and liquid limit tests to determine the Plasticity Index of the soil, and,

  - Sieve analysis tests

Geotechnical Engineering Recommendations

- This report addresses the geotechnical engineering aspects of the site and provides recommendations including;

  Geotechnical Engineering Section(s)

  - Subsurface soil and water conditions that may influence the project design and construction considerations
  - Geotechnical engineering design parameters including;

    - ✓ Recommendations regarding the geometry and post construction stability of the proposed pond embankment slopes, and,
    - ✓ Anticipated post construction settlement of the pond embankments

  Construction Consideration Section

  - Fill placement considerations including cursory comments regarding site preparation and grubbing operations,
  - Considerations for excavation cut slopes,
  - Natural soil preparation considerations for use as backfill on the site, and,
  - Compaction recommendations for various types of backfill proposed at the site.

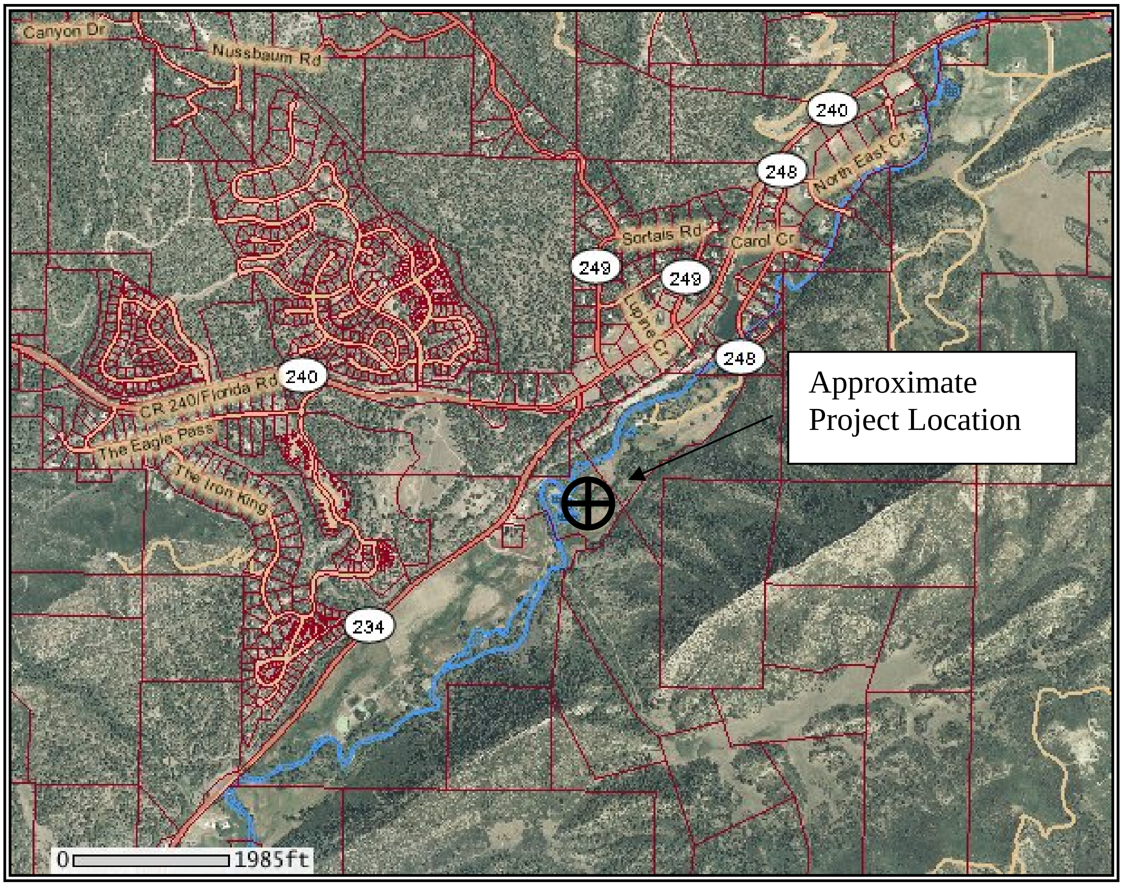
- This report provides design parameters, but does not provide foundation design or design of structure components. The project designer, structural engineer or builder may be contacted to provide a design based on the information presented in this report.

- Our subsurface exploration, laboratory study and engineering analysis do not address environmental or geologic hazard issues

3.0 FIELD STUDY

3.1 *Project location*

The project site is located at the existing Edgemont Metro District Water Storage Facility located adjacent to the southeast side of County Road 234, approximately one-quarter mile south of the intersection of County Road 240 and 234. The project site is located in La Plata County. The approximately location of the project site is shown below.



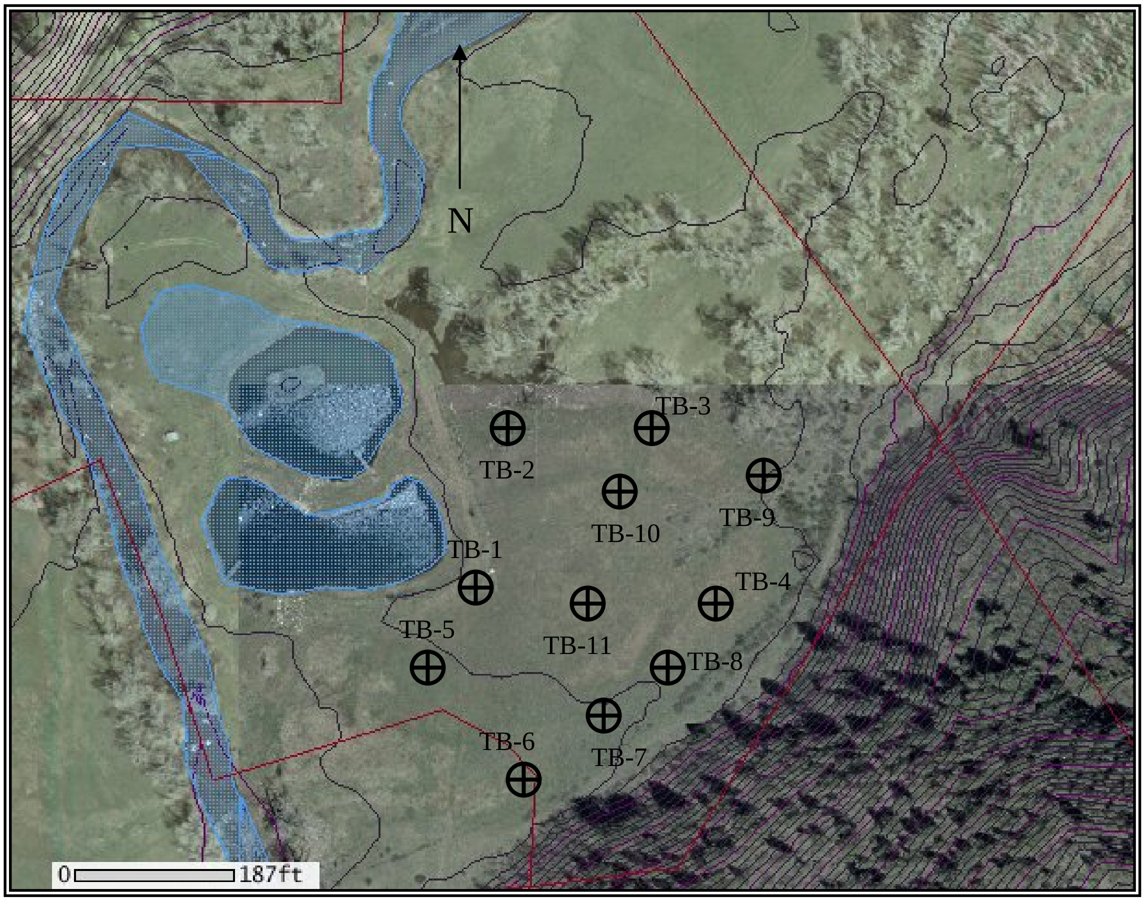
3.2 *Site Description and Geomorphology*

The proposed pond area is located adjacent to the east side of the existing water storage ponds and the Florida River, in an open and relatively flat meadow area. A steeply sloping hillside is situated above and to the southeast of the project site with slope inclinations of approximately two to one (2;1, horizontal to vertical) down to the northwest.

The subsurface soil and rock material typically encountered adjacent to the Florida River area consists of variable amounts of gravel and cobbles with a sandy silt soil matrix. The subsurface water elevation is typically located near the water elevation in the adjacent river. Formational shale material is often encountered at the approximate flow-line elevation of the adjacent river.

3.3 *Subsurface Soil and Water Conditions*

We advanced eleven test borings in the vicinity of the proposed pond location. Six (6) standpipe piezometers were installed in select test borings. The approximate location of the test borings are shown below. The logs of the soils encountered in our test borings are presented in Appendix A.



The approximate test boring locations shown above were prepared using notes taken during the field work and are intended to show the approximate test boring locations for reference purposes only. The test borings are marked in the field. We recommend that the test borings locations be surveyed if the exact locations of the test borings relative to the topography are needed.

We encountered a mixture of gravel and cobbles with a sandy clay soil matrix from the ground surface to the bottom of the test borings. The sandy clay soil matrix material encountered and tested exhibits a relatively low swell potential.

The density of the gravel and cobbles generally increased with depth. Several of our test borings were refused on cobbles at depths ranging from six (6) to thirteen (13) feet below the ground surface. We encountered the Mancos Shale Formation at a depth ranging from ten (10) to thirteen (13) feet below the ground surface in several of our test borings.

We encountered subsurface free water at depths ranging from approximately four (4) to eight (8) feet below the existing ground surface elevation. We anticipate that the subsurface free water elevation will vary directly with the water elevation in the adjacent Florida River and existing water storage ponds. We installed six (6) standpipe piezometers in select test borings in order to make future observations of the subsurface free water elevation at the project site.. Auger refusal on cobbles/boulders in some of the test borings advanced prevented us from defining the subsurface water elevation in all of the test borings.

The table below presents the elevations measured in the test borings completed during September 10 through 17, 2007. As noted in the table below, piezometers were installed in Test Borings One, Five, Six, Eight, Ten, and Elevem. We recorded the water elevation in the piezometers on September 21, 2007 and October 29, 2007. The water elevation recorded in the piezometers remained relatively constant to the elvations recorded during our original field study. We feel that the subsurface free water is located at a relatively uniform elevation. We anticipate that the difference in depth to the free water surface in our test borings is due to changes in the ground surface elevations.

Test Boring Designation	**Depth of Water During Field Study, September 10-17, 2007**	**Depth of Water as recorded on October 29, 2007**
TB-1	5½’	5½’
TB-2	7’	No piezometer
TB-3	No water to refusal @ 6’	No piezometer
TB-4	No water to refusal @ 7’	No piezometer
TB-5	4’	4’
TB-6	4½’	4’
TB-7	6’	No piezometer
TB-8	4’	4’
TB-9	No water to refusal @ 7’	No piezometer
TB-10	8’	8’
TB-11	6½’	6½’

The logs of the subsurface conditions presented in Appendix A and presented above are based on our interpretation of the subsurface conditions exposed in the test holes at the time of our field work. Subsurface soil and water conditions are often variable across relatively short distances. It is likely that variable subsurface soil and water conditions will be encountered during construction.

4.0 LABORATORY STUDY

The laboratory study included tests to estimate the strength, swell and consolidation potential of the soils tested. We performed the following tests on select samples obtained from the test borings.

Moisture content and dry density; the moisture content and in-situ dry density of some of the soil samples were assessed in general accordance with ASTM D2216

Atterberg Limits; the plastic limit, liquid limit and plasticity index of some of the soil samples was determined in general accordance with ASTM D4318

Direct Shear Strength tests; Direct shear strength tests were performed on select soil samples to estimate the soil strength characteristics in general accordance with ASTM D3080. We used an angle of internal friction (phi) of 30 degrees and a cohesion of about 50 pounds per square foot in our analysis.

Swell-Consolidation Tests; the one dimensional swell-consolidation potential of some of the soil samples obtained was determined in general accordance with ASTM D2435. The soil sample tested is exposed to varying loads and usually the addition of water. The one-dimensional swell-consolidation response of the soil sample to the loads and/or water is represented graphically on Figures 4.1 through 4.3.

A synopsis of some of our laboratory data for some of the samples tested is tabulated below.

Sample Designation	Moisture Content (percent)	Dry Density (PCF)	Swell Pressure (PSF)	Swell Potential (% under 100 psf load)
TB-1 @ 4 feet	14.6	119.3	Consolidate	--
TB-9 0-4 feet	7.2	93.5 remold	1,430	2.2
TB-11 0-4 feet	4.3	100.6 remold	1,320	0.5

5.0 POND EMBANKMENT BERM RECOMMENDATIONS

We understand that the proposed pond berms will be constructed from earthen fill material and will be lined with a water impervious liner on the interior of the ponds. We anticipate that the berms will be constructed from the native site soil materials, and that the berms will range in height from approximately five (5) to ten (10) feet. We recommend that a maximum slope inclination of two and one-half to one (2½:1, horizontal to vertical) be used, and that a minimum berm width of ten (10) feet at the upper portion or top of the be used in the project design. We recommend a maximum berm inclination of two and one-half to one (2½:1, h:v) or flatter in order to limit erosion of the berms and to help establish vegetation on the exposed surfaces of the berms.

5.1 Stability Analysis of the Pond Embankment

We performed a cursory analysis of the stability conditions of a hypothetical pond embankment using the above geometrical conditions. We used an interior bottom of pond elevation of approximately five (5) feet below the existing ground surface, the approximate subsurface free water elevation at the project site. The basic geometrical layout in the stability analyses presented below includes a ten (10) foot high exterior embankment surface with a two and one-half to one (2½:1, h:v) slope, a ten (10) foot wide flat embankment width at the top of the berm, and a fifteen (15) foot high interior embankment surface with an inclination of two and one-half to one (2½:1, h;v). We performed our analysis for both the unfilled pond condition and liquid filled pond condition. We utilized an angle of internal friction of thirty (30) degrees and a cohesion of fifty (50) pounds per square foot in our analysis. These values are based on laboratory testing performed on the native materials generally consisting of gravel with a sandy and clay soil matrix. Our study included observations of the topography and geomorphology of the project site and adjacent areas. We should be contacted to re-assess the stability if the above geometrical parameters are changed.

There are numerous methods and techniques available for slope stability analysis. Most methods include an evaluation of;

- the strength of the soil materials within the slope,
- anisotropies within the slope materials, such as formational material bedding planes, and anomalous soil contacts,
- the subsurface water and soil moisture conditions, and,
- the pre-construction and post-construction geometry of the slope areas where development and construction is proposed.

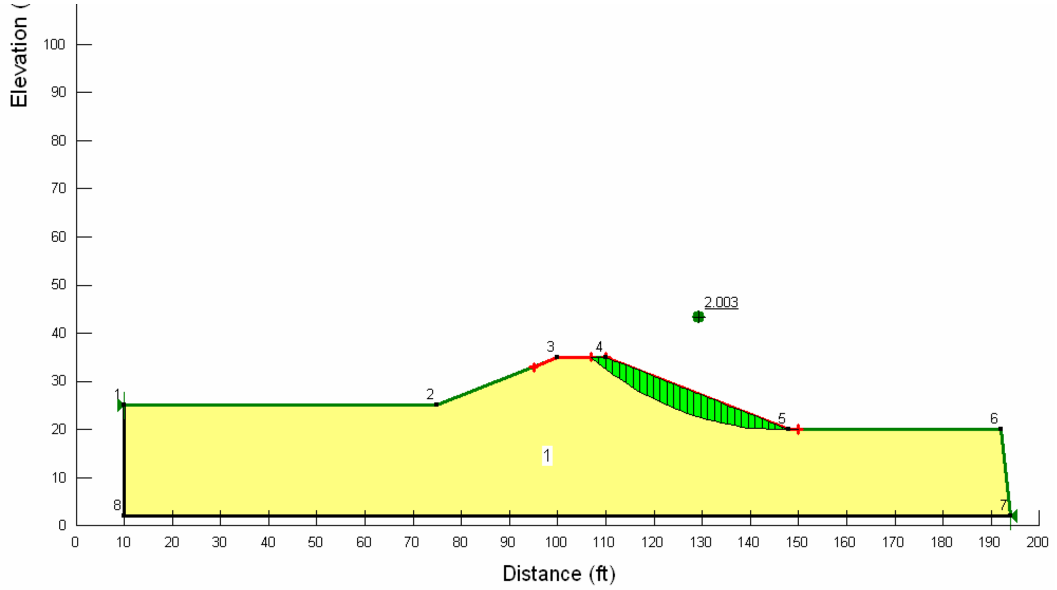
The data developed during the analysis is condensed and used to estimate the forces within a soil mass that tend to drive movement and the forces that tend to resist movement. The ratio of resisting forces to driving forces is often referred to as the “theoretical slope factor of safety” (FOS) which is a somewhat misleading term to describe this ratio. The ratio is not a true factor of safety, but is a useful mathematical characterization of the forces within a soil mass and the associated stability condition of the slope being analyzed.

A ratio of less than one (1) indicates that the driving forces within a soil mass are greater than the resisting forces; therefore movement of the slope is occurring. A ratio of one (1) indicates that the driving forces are equal to the resisting forces, which indicates that movement within the soil can be triggered by only slight increases in the driving forces or slight reductions in the resisting forces. A ratio of greater than one (1) is an indication that the driving forces are less than the resisting forces and the slope is not moving. Since there are numerous variables and incongruities within most soil masses, a slope is generally not considered as stable until the ratio is 1.5 or greater.

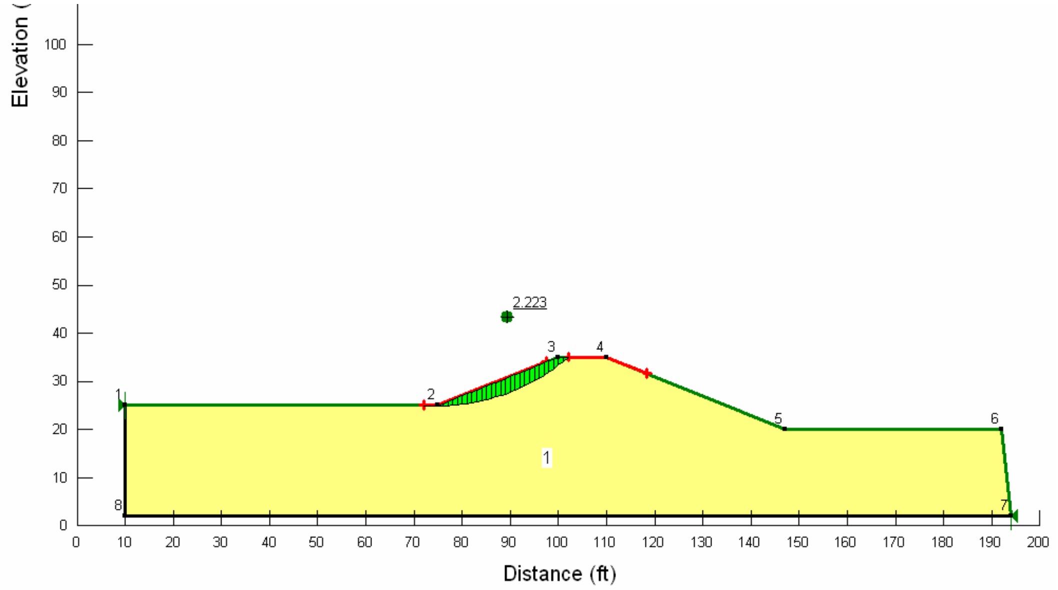
We used SLOPE-W slope stability software to evaluate the stability of computer modeled slope cross sections of select portions of this site. We primarily used the Modified Bishop’s Method of slices to analyze the computer modeled slopes. We further evaluated the stability of the slopes on this site using infinite slope stability analysis techniques. The Modified Bishop’s Method of Slices evaluates both the resisting and driving forces within slices of the sloped soil mass along a theoretical semi-circular failure plane. The semicircular failure plane with the lowest theoretical factor of safety is labeled the critical circle.

We analyzed the theoretical stability of a two and one-half to one (2½:1,h:v) exterior and interior embankment slope with an exterior height of ten (10) feet and an interior height of fifteen (15) feet. The unfilled condition of the pond is simulated in the analyses shown below.

2½:1,H:V Unfilled Pond Condition; Interior Embankment Stability



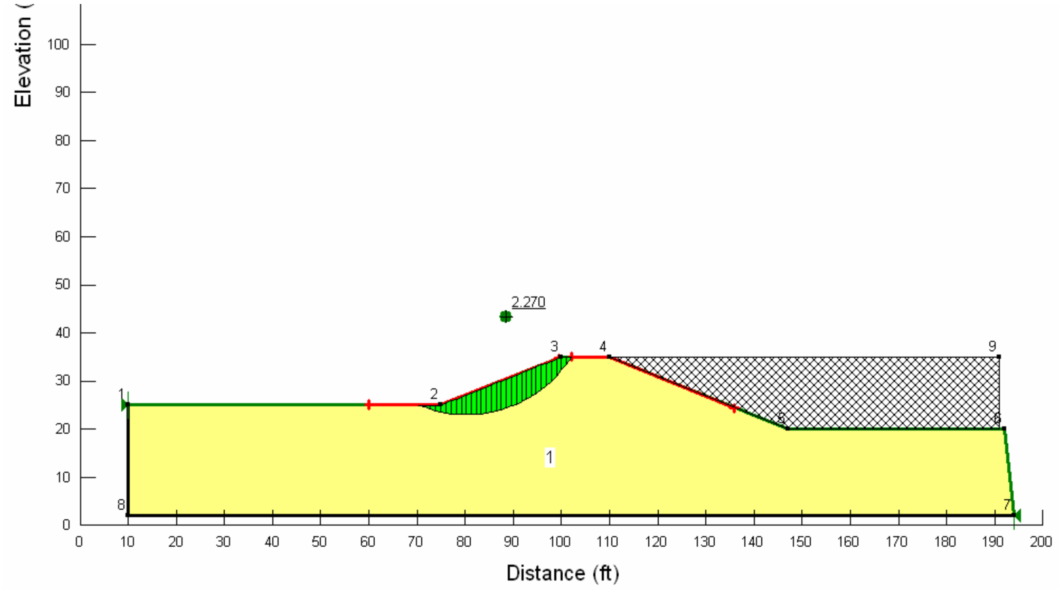
2½:1, H:V Unfilled Pond Condition; Exterior Slope Stability



The analyses shown above indicate that the theoretical factor of safety of two and one-half to one (2½:1, h:v) pond embankment slopes with a height ranging from ten (10) to fifteen (15) feet, and constructed with the on-site soil materials ranges from approximately 2.0 to 2.2. This theoretical factor of safety indicates that the proposed lined pond slope geometry parameters given above may be considered as being stable.

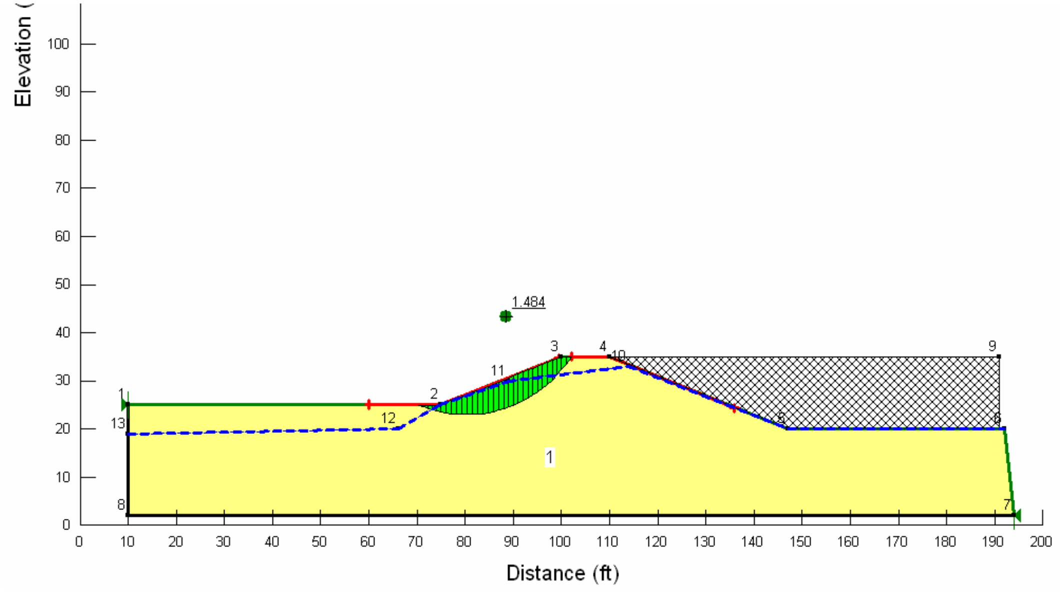
We analyzed the stability of the exterior pond berm surface with the addition of fifteen vertical feet of impounded water within the pond structure. This analysis is shown below.

2½:1,H:V Filled Pond Condition; Exterior Slopes



As shown, the theoretical factor of safety of the exterior slope remains at approximately 2.2 with the addition of fluid pressures towards the exterior slope side of the berm. The stability of the geometry shown above may be considered as stable for the proposed lined pond.

The above analyses represent the stability of the embankment slope under normal soil moisture conditions. The stability of the embankment slope will be reduced if a phreatic water elevation is allowed to develop in any of the proposed embankment berms. The stability analysis shown below represents the theoretical factor of safety of the exterior pond slope with a hypothetical subsurface phreatic water surface within the embankment materials. The top of the hypothetical phreatic water surface is approximately five (5) feet below the top of the dike and exits at the toe of the embankment slope. This analysis is shown below.



As shown in the analysis above, the theoretical factor of safety of the exterior pond slope is reduced from approximately 2.2 to approximately 1.5. This situation may still be considered as stable, however if a phreatic water surface does develop above the elevation represented above, the theoretical factor of safety may decrease to an unacceptable level. Potential sources for subsurface water to develop within the pond bank may be from precipitation or potentially from a leak within the liner structure. We recommend that a subsurface drain system be considered to reduce the potential for subsurface water to accumulate in the pond dike, particularly in the taller areas of the proposed embankment berms. The subsurface drain system concept is discussed below.

We should be contacted to analyze the final design pond berm geometry in relation to the proposed interior water elevation when this information becomes available.

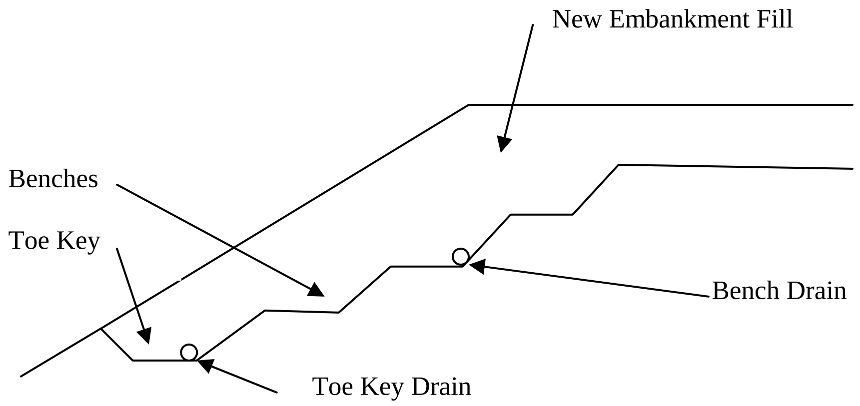
5.1.1 Erosion Protection Considerations

We do not typically provide erosion protection design recommendations. However, we anticipate that erosion of the pond embankments may occur. The slopes should be protected with either well established vegetation or a commercial rock product, geotextile material, or a combination of these products. We are available to provide geotechnical engineering parameters such as grain size distribution of the soils and imported rock products as needed.

5.2 Pond Dike Construction Recommendations

The native clayey sand soil material may be used to construct the pond dikes. The material should be moisture conditioned to plus or minus two (2) percent of the optimum moisture content as established by ASTM D1557, “Laboratory Compaction Characteristics of Soil Using Modified Effort” (Modified Proctor Test). The fill material should be placed and compacted in lift depths not to exceed twelve (12) inches. The material should be compacted to a dry density of at least ninety (90) percent of the maximum dry density as defined by ASTM D1557, Modified Proctor Test.

As mentioned above, it may be prudent to construct a subsurface drain system in the pond dike, particularly in the more extensive dike areas. This concept is shown below.



Toe Key and Bench Concept

No Scale

The width of the toe key should be at least one-fourth (1/4) of the height of the fill. The elevation difference between each bench, width, and geometry of each bench is not critical, but generally the elevation difference between each lift should not exceed about three (3) to four (4) feet. The benches should be of sufficient width to allow for placement of horizontal lifts of fill material, therefore the size of the compaction equipment used will influence the bench widths.

The toe key and bench drains shown above should be placed to reduce the potential for water accumulation in the embankment fill and in the soils adjacent to the embankment fill. The placement of these drains is more critical on larger fill areas, areas where subsurface water exists and in areas where the slopes are marginally stable. We generally suggest that toe drains be considered for fill areas where the vertical height exceeds about 8 feet and bench drains be considered with toe drains for total fill heights of greater than about (16) feet. The need for these drain systems should be determined by the project civil engineer. We are available to provide additional information, if needed.

The toe key and bench drains may consist of a perforated pipe which is surrounded by a free draining material which is wrapped by a geotextile filter fabric. The pipe should be surrounded by four (4) to six (6) cubic feet of free draining material per lineal foot of drain pipe.

5.3 Post Construction Settlement Considerations of the Pond

We analyzed the anticipate post construction settlement of the pond dike fill material. We anticipate that pond dike heights in the range of five (5) to ten (10) feet will have a total settlement ranging from approximately two (1) to three (3) inches in the central portion of the fill mass. Due to the granular nature of the soil, we estimate that about fifty (50) percent of the settlement will occur during the construction process.

Due to the variable height of the proposed embankment berms and the variable thickness of support soil between the berms and the underlying formational material we suspect that some differemntial settlement of the berms may occur. It is not possible to realistically calculate the total differential settlement, but will likely be in the range of about one (1) to two (2) inches. The proposed pond liner must be constructed to permit some amount of differential settlement of the pond structure.

6.0 CONSTRUCTION CONSIDERATIONS

The section of the report provides comments, considerations and recommendations for aspects of the site construction which may influence, or be influenced by the geotechnical engineering considerations discussed above. The information presented below is not intended to discuss all aspects of the site construction conditions and considerations that may be encountered as the project progresses. If any questions arise as a result of our recommendations presented above, or if unexpected subsurface conditions are encountered during construction we should be contacted immediately.

6.1 *Fill Placement Recommendations*

There are several references throughout this report regarding natural soil fill recommendations. The recommendations presented below are appropriate for the fill placement considerations discussed throughout the report above.

All areas to receive fill, structural components (if any), or other site improvements should be properly prepared and grubbed at the initiation of the project construction. The grubbing operations should include scarification and removal of organic material and soil. No fill material or concrete should be placed in areas where existing vegetation or fill material exist.

6.1.1 *Natural Soil Fill*

Any natural soil used for any fill purpose should be free of all deleterious material, such as organic material and construction debris. Natural soil fill includes excavated and replaced material or in-place scarified material.

The natural soils should be moisture conditioned, either by addition of water to dry soils, or by processing to allow drying of wet soils. The proposed fill materials should be moisture conditioned to between about optimum and about two (2) percent above optimum soil moisture content. This moisture content can be estimated in the field by squeezing a sample of the soil in the palm of the hand. If the material easily makes a cast of soil which remains in-tact, and a minor amount of surface moisture develops on the cast, the material is close to the desired moisture content. Material testing during construction is the best means to assess the soil moisture content.

Moisture conditioning of clay or silt soils may require many hours of processing. If possible, water should be added and thoroughly mixed into fine grained soil such as clay or silt the day prior to use of the material. This technique will allow for development of a more uniform moisture content and will allow for better compaction of the moisture conditioned materials.

The moisture conditioned soil should be placed in lifts that do not exceed the capabilities of the compaction equipment used and compacted to at least ninety (90) percent of maximum dry density as defined by ASTM D1557, modified Proctor test. We typically recommend a maximum fill lift thickness of six (6) inches for hand operated equipment and eight (8) to ten (10) inches for larger equipment. Care should be exercised in placement of utility trench backfill so that the compaction operations do not damage the underlying utilities.

6.1.2 *Granular Compacted Structural Fill*

We do not anticipate that much granular structural fill will be constructed as part of this site development. However, if ancillary structures are planned the recommendations presented in this section of our report should be considered.. Granular compacted structural fill should be constructed using an imported commercially produced rock product such as aggregate road base. Many products other than road base, such as clean aggregate or select crusher fines may be suitable, depending on the intended use. If a specification is needed by the design professional for development of project specifications, a material conforming to the Colorado Department of Transportation “Class 6” aggregate road base material can be specified. This specification can include an option for testing and approval in the event the contractor’s desired material does not conform to the Class 6 aggregate specifications.

All compacted structural fill should be moisture conditioned and compacted to at least ninety (90) percent of maximum dry density as defined by ASTM D1557, modified Proctor test. Areas where the structural fill will support traffic loads under concrete slabs or asphalt concrete should be compacted to at least ninety-five (95) percent of maximum dry density as defined by ASTM D1557, modified Proctor test.

6.2 *Excavation Considerations*

Unless a specific classification is performed, the site soils should be considered as an Occupational Safety and Health Administration (OSHA) Type C soil and should be sloped and/or benched according to the current OSHA regulations. Excavations should be sloped and benched to prevent wall collapse. Daily observations of the excavations should be conducted by OSHA competent site personnel to assess safety considerations.

If possible excavations should be constructed to allow for water flow from the excavation the event of precipitation during construction. If this is not possible it may be necessary to remove water from snowmelt or precipitation from the foundation excavations to help reduce the influence of this water on the soil support conditions and the site construction characteristics.

We encountered formational material in our test borings. We suspect that it may be difficult to excavate this material using conventional techniques. If blasting is planned it must be conducted strategically to reduce the affect of the blasting on the support characteristics of the site materials and the stability of adjacent slopes.

6.2.1 *Excavation Cut Slopes*

We anticipate that some permanent excavation cut slopes may be included in the site development. Temporary cut slopes should not exceed five (5) feet in height and should not be steeper than about one to one (1:1, horizontal to vertical) for most soils. Permanent cut slopes of greater than five (5) feet or steeper than two and one-half to one (2½:1, h:v) must be analyzed on a site specific basis.

We did not observe evidence of existing unstable slope areas influencing the site, but due to the steepness and extent of the slopes in the area we suggest that the magnitude of the proposed excavation slopes be minimized and/or supported by retaining structures.

6.4 *Exterior Grading and Drainage Comments*

The ground surface adjacent to the structure should be sloped to promote water flow away from the structure. The project civil engineering consultant or builder should develop a drainage scheme for the site. We typically suggest a minimum fall of about eight (8) to ten (10) percent away from the structure, in the absence of design criteria from others. Care should be taken to not direct water onto adjacent property or to areas that would negatively influence existing structures or improvements.

7.0 CONSTRUCTION MONITORING AND TESTING

Construction monitoring including engineering observations and materials testing during construction is a critical aspect of the geotechnical engineering contribution to any project. Unexpected subsurface conditions are often encountered during construction. The site structure excavation should be observed by the geotechnical engineer or a representative during the early stages of the site construction to verify that the actual subsurface soil and water conditions were properly characterized as part of field exploration, laboratory testing and engineering analysis. If the subsurface conditions encountered during construction are different than those that were the basis of the geotechnical engineering report then modifications to the design may be implemented prior to placement of fill materials or foundation concrete.

Compaction testing of fill material should be performed throughout the project construction so that the engineer and contractor may monitor the quality of the fill placement techniques being used at the site. Generally we recommend that compaction testing be performed for any fill material that is placed as part of the site development. Compaction tests should be performed on each lift of material placed in areas proposed for support of structural components.

In addition to compaction testing we recommend that the grain size distribution, clay content and swell potential be evaluated for any imported materials that are planned for use on the site.

We are available to develop a testing program for soil, aggregate materials, concrete and asphaltic concrete for this project.

8.0 CONCLUSIONS AND CONSIDERATIONS

We feel that it is feasible to develop this site for the proposed industrial use. The information presented in this report is based on our understanding of the proposed construction that was provided to us and on the data obtained from our field and laboratory studies. We recommend that we be contacted during the design and construction phase of this project to aid in the implementation of our recommendations. Please contact us immediately if you have any questions, or if any of the information presented above is not appropriate for the proposed site construction.

The recommendations presented above are intended to be used only for this project site and the proposed construction which was provided to us. The recommendations presented above are not suitable for adjacent project sites, or for proposed construction that is different than that outlined for this study.

Our recommendations are based on limited field and laboratory sampling and testing. Unexpected subsurface conditions encountered during construction may alter our recommendations. We should be contacted during construction to observe the exposed subsurface soil conditions to provide comments and verification of our recommendations. We are available to review and tailor our recommendations as the project progresses and additional information which may influence our recommendations becomes available.

Please contact us if you have any questions, or if we may be of additional service.

Respectfully submitted,
TRAUTNER GEOTECH

Jonathan P. Butler, P.E.
Staff Geotechnical Engineer

TRAUTNER GEOTECH
A DIVISION OF TRIGON EPC

Field Engineer : B. Bunker
Hole Diameter : 4" solid
Drilling Method : Continuous Flight Auger
Sampling Method : Mod. California Sampler
Date Drilled : 9/10/2007
Total Depth : 19'
Location : See Figure #1

LOG OF BORING TB1

Edgemont Highlands Metro District
Water Storage Ponds
Mr. Richard Cortese

Project #51172GE

Sample Type
- ☒ Mod. California Sampler
- ▨ Bag Sample
- ■ Standard Split Spoon

Water Level
- ▼ Water Level During Drilling
- ▽ Water Level After Drilling

Depth in Feet	DESCRIPTION	USCS	GRAPHIC	Samples	Blow Count	Water Level	REMARKS
0	CLAY, silty, stiff, slightly moist, brown	CL		▨			Stand-pipe piezometer set down to 13 feet
3	SAND, silty, medium stiff, very moist, brown	SM		▨			
4				☒	3/6 2/6		
5	SAND and GRAVEL, few cobbles, medium dense, wet, brown	GP					
6						▼	
13	Formational Material, Mancos Shale, very hard, slightly moist, dark gray	SH					
19	Bottom of test boring at 19 feet						

10-04-2007 T:\Current GE\51162GE, S&S Chemical Facility, Bloomfield\Logs of Test Borings\S&S Chemical TB-1.bor

TRAUTNER GEOTECH
A DIVISION OF TRIGON EPC

Field Engineer : B. Bunker
Hole Diameter : 4" solid
Drilling Method : Continuous Flight Auger
Sampling Method : Bag Sample
Date Drilled : 9/14/2007
Total Depth : 13.5'
Location : See Figure #1

LOG OF BORING TB2

Edgemont Highlands Metro District
Water Storage Ponds
Mr. Richard Cortese

Project #51172GE

Sample Type
- ☒ Mod. California Sampler
- ▨ Bag Sample
- ■ Standard Split Spoon

Water Level
- ▼ Water Level During Drilling
- ▽ Water Level After Drilling

Depth in Feet	DESCRIPTION	USCS	GRAPHIC	Samples	Blow Count	Water Level	REMARKS
0	CLAY, silty, few gravels, stiff, slightly moist, brown	CL	▨	▨			
3	GRAVEL and COBBLES, clayey, dense, slightly moist, brown	GP	░				
4				▨			
7	GRAVEL and COBBLES, clayey, dense, wet, brown	GP	░			▼	
9							
13.5	Auger refusal on cobbles at 13.5 feet						

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TRAUTNER GEOTECH
A DIVISION OF TRIGON EPC

Field Engineer : B. Bunker
Hole Diameter : 4" solid
Drilling Method : Continuous Flight Auger
Sampling Method : Mod. California Sampler
Date Drilled : 9/14/2007
Total Depth : 6'
Location : See Figure #1

LOG OF BORING TB3

Edgemont Highlands Metro District
Water Storage Ponds
Mr. Richard Cortese

Project #51172GE

Sample Type
- ☒ Mod. California Sampler
- ▨ Bag Sample
- ■ Standard Split Spoon

Water Level
- ▼ Water Level During Drilling
- ▽ Water Level After Drilling

Depth in Feet	DESCRIPTION	USCS	GRAPHIC	Samples	Blow Count	Water Level	REMARKS
0	CLAY, silty, few gravels, stiff, slightly moist, brown	CL	▨	▨			
2	GRAVEL and CLAY, sandy, medium dense, slightly moist, brown	GC	░	▨			
4			░	☒	6/6 3/6		
5			░				
6	Auger refusal on boulders at 6 feet						
7							

TRAUTNER GEOTECH
A DIVISION OF TRIGON EPC

Field Engineer : B. Bunker
Hole Diameter : 4" solid
Drilling Method : Continuous Flight Auger
Sampling Method : Bag Sample
Date Drilled : 9/14/2007
Total Depth : 7'
Location : See Figure #1

LOG OF BORING TB4

Edgemont Highlands Metro District
Water Storage Ponds
Mr. Richard Cortese

Project #51172GE

Sample Type
- ☒ Mod. California Sampler
- ▨ Bag Sample
- ■ Standard Split Spoon

Water Level
- ▼ Water Level During Drilling
- ▽ Water Level After Drilling

Depth in Feet	DESCRIPTION	USCS	GRAPHIC	Samples	Blow Count	Water Level	REMARKS
0	GRAVEL and CLAY, sandy, few gravels, dense, slightly moist, brown	GC	▨	▨			
1							
2	GRAVEL and COBBLES, clayey, few boulders, very dense, moist, brown	GP	░				
3							
4							
5							
6							
7	Auger refusal on boulders at 7 feet						
8							

TRAUTNER GEOTECH
A DIVISION OF TRIGON EPC

Field Engineer : B. Bunker
Hole Diameter : 4" solid
Drilling Method : Continuous Flight Auger
Sampling Method : No Sample
Date Drilled : 9/17/2007
Total Depth : 14'
Location : See Figure #1

LOG OF BORING TB5

Edgemont Highlands Metro District
Water Storage Ponds
Mr. Richard Cortese

Project #51172GE

Sample Type
- ☒ Mod. California Sampler
- ▨ Bag Sample
- ■ Standard Split Spoon

Water Level
- ▼ Water Level During Drilling
- ▽ Water Level After Drilling

Depth in Feet	DESCRIPTION	USCS	GRAPHIC	Samples	Blow Count	Water Level	REMARKS
0	CLAY, sandy, few gravels, stiff, moist, brown	CL	▨				Stand-pipe piezometer set down to 11 feet
2	GRAVEL and COBBLES, clayey, very dense, moist to very moist, brown	GP	░				
4						▼	
6	GRAVEL and COBBLES, clayey, dense, wet, brown	GP	░				
12	Formational Material, Mancos Shale, very hard, dry, gray	SH	☰				
14	Bottom of test boring at 14 feet						
15							

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TRAUTNER GEOTECH
A DIVISION OF TRIGON EPC

Field Engineer : B. Bunker
Hole Diameter : 4" solid
Drilling Method : Continuous Flight Auger
Sampling Method : Mod. California Sampler
Date Drilled : 9/17/2007
Total Depth : 6'
Location : See Figure #1

LOG OF BORING TB6

Edgemont Highlands Metro District
Water Storage Ponds
Mr. Richard Cortese

Project #51172GE

Sample Type
- ☒ Mod. California Sampler
- ▨ Bag Sample
- ■ Standard Split Spoon

Water Level
- ▼ Water Level During Drilling
- ▽ Water Level After Drilling

Depth in Feet	DESCRIPTION	USCS	GRAPHIC	Samples	Blow Count	Water Level	REMARKS
0	GRAVEL and SILT, sandy, dense, slightly moist, brown	GM		▨			Stand-pipe piezometer set down to 6 feet
1	SILT, clayey, few gravels, soft, wet, gray	ML		▨			
2							
3							
4				☒	4/12	▼	
5							
6	Auger refusal on boulders at 6 feet						
7							

LOG OF BORING TB7

Field Engineer : B. Bunker
Hole Diameter : 4" solid
Drilling Method : Continuous Flight Auger
Sampling Method : Bag Sample
Date Drilled : 9/17/2007
Total Depth : 14'
Location : See Figure #1

Edgemont Highlands Metro District
Water Storage Ponds
Mr. Richard Cortese

Project #51172GE

Sample Type
- ☒ Mod. California Sampler
- ▨ Bag Sample
- ■ Standard Split Spoon

Water Level
- ▼ Water Level During Drilling
- ▽ Water Level After Drilling

Depth in Feet	DESCRIPTION	USCS	GRAPHIC	Samples	Blow Count	Water Level	REMARKS
0	CLAY, silty, few gravels, medium stiff, moist to very moist, brown	CL	▨	▨			
4	GRAVEL, COBBLES, clayey, dense, wet, brown	GP				▼	
	FORMATIONAL MATERIAL, MANCOS SHALE, wet, hard, dark grey	SH					
14	Bottom of test boring at 14 feet						

TRAUTNER GEOTECH
A DIVISION OF TRIGON EPC

Field Engineer : B. Bunker
Hole Diameter : 4" solid
Drilling Method : Continuous Flight Auger
Sampling Method : Bag Sample
Date Drilled : 9/17/2007
Total Depth : 7'
Location : See Figure #1

LOG OF BORING TB8

Edgemont Highlands Metro District
Water Storage Ponds
Mr. Richard Cortese

Project #51172GE

Sample Type
- ☒ Mod. California Sampler
- ▨ Bag Sample
- ■ Standard Split Spoon

Water Level
- ▼ Water Level During Drilling
- ▽ Water Level After Drilling

Depth in Feet	DESCRIPTION	USCS	GRAPHIC	Samples	Blow Count	Water Level	REMARKS
0	GRAVEL, CLAY, sandy, few cobbles, dense, moist, brown	GC		▨			Stand-pipe piezometer set down to 6 feet
4	GRAVEL, COBBLES, clayey, few boulders, very dense, moist to very moist, brown	GP				▼	
7	Auger refusal on boulder at 7 feet						
8							

TRAUTNER GEOTECH
A DIVISION OF TRIGON EPC

Field Engineer : B. Bunker
Hole Diameter : 4" solid
Drilling Method : Continuous Flight Auger
Sampling Method : Bag Sample
Date Drilled : 9/17/2007
Total Depth : 7'
Location : See Figure #1

LOG OF BORING TB9

Edgemont Highlands Metro District
Water Storage Ponds
Mr. Richard Cortese

Project #51172GE

Sample Type
- ☒ Mod. California Sampler
- ▨ Bag Sample
- ■ Standard Split Spoon

Water Level
- ▼ Water Level During Drilling
- ▽ Water Level After Drilling

Depth in Feet	DESCRIPTION	USCS	GRAPHIC	Samples	Blow Count	Water Level	REMARKS
0	GRAVEL, CLAY, sandy, few cobbles, dense, slightly moist, brown	GC	▨	▨ (0–4)			
3	GRAVEL, COBBLES, clayey, few boulders, dense, slightly moist, brown	GP	░				
7	Auger refusal on boulder at 7 feet						

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TRAUTNER GEOTECH
A DIVISION OF TRIGON EPC

Field Engineer : B. Bunker
Hole Diameter : 4" solid
Drilling Method : Continuous Flight Auger
Sampling Method : Bag Sample
Date Drilled : 9/17/2007
Total Depth : 10'
Location : See Figure #1

LOG OF BORING TB10

Edgemont Highlands Metro District
Water Storage Ponds
Mr. Richard Cortese

Project #51172GE

Sample Type
- ☒ Mod. California Sampler
- ▨ Bag Sample
- ■ Standard Split Spoon

Water Level
- ▼ Water Level During Drilling
- ▽ Water Level After Drilling

Depth in Feet	DESCRIPTION	USCS	GRAPHIC	Samples	Blow Count	Water Level	REMARKS
0	CLAY, sandy, few gravels, stiff, slightly moist, brown	CL	▨	▨			Stand-pipe piezometer set down to 10 feet
1							
2							
3	GRAVEL, COBBLES, clayey, few boulders, dense, moist, brown	GP	░				
4							
5							
6							
7							
8							
9							
10	Auger refusal on boulder at 10 feet						
11							

TRAUTNER GEOTECH
A DIVISION OF TRIGON EPC

Field Engineer : B. Bunker
Hole Diameter : 4" solid
Drilling Method : Continuous Flight Auger
Sampling Method : Standard Split Spoon
Date Drilled : 9/17/2007
Total Depth : 11'
Location : See Figure #1

LOG OF BORING TB11

Edgemont Highlands Metro District
Water Storage Ponds
Mr. Richard Cortese

Project #51172GE

Sample Type
- ☒ Mod. California Sampler
- ▨ Bag Sample
- ■ Standard Split Spoon

Water Level
- ▼ Water Level During Drilling
- ▽ Water Level After Drilling

Depth in Feet	DESCRIPTION	USCS	GRAPHIC	Samples	Blow Count	Water Level	REMARKS
0	CLAY, sandy, few gravels, stiff, slightly moist, brown	CL	▨	▨			Stand-pipe piezometer set down to 10 feet
3	GRAVEL, COBBLES, clayey, dense, moist to very moist, brown	GP	░	▨			
4			░	■	38/6 30/6 50/5		
6			░			▼	
11	Auger refusal on boulder at 11 feet						
12							

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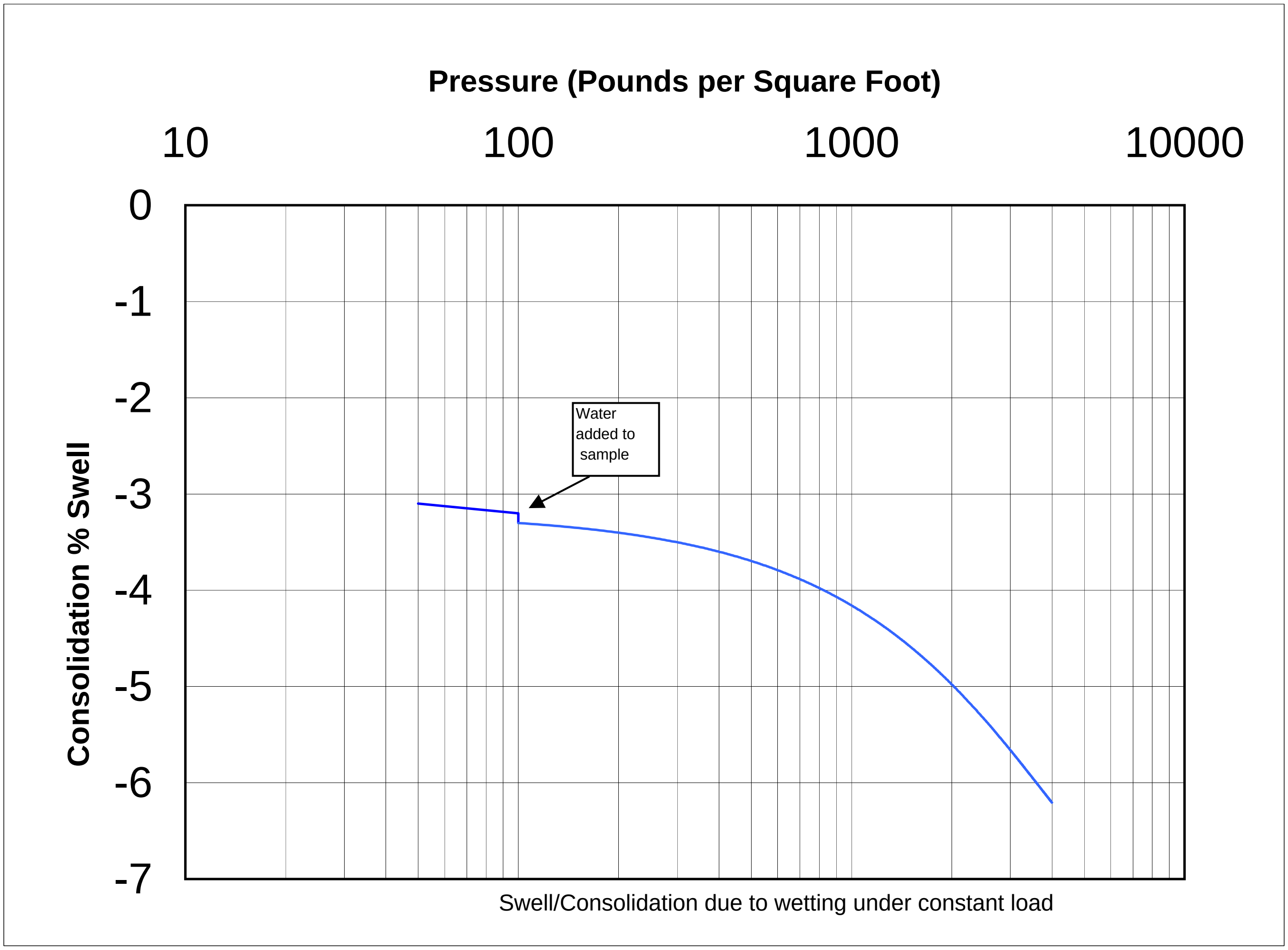
SWELL - CONSOLIDATION TEST

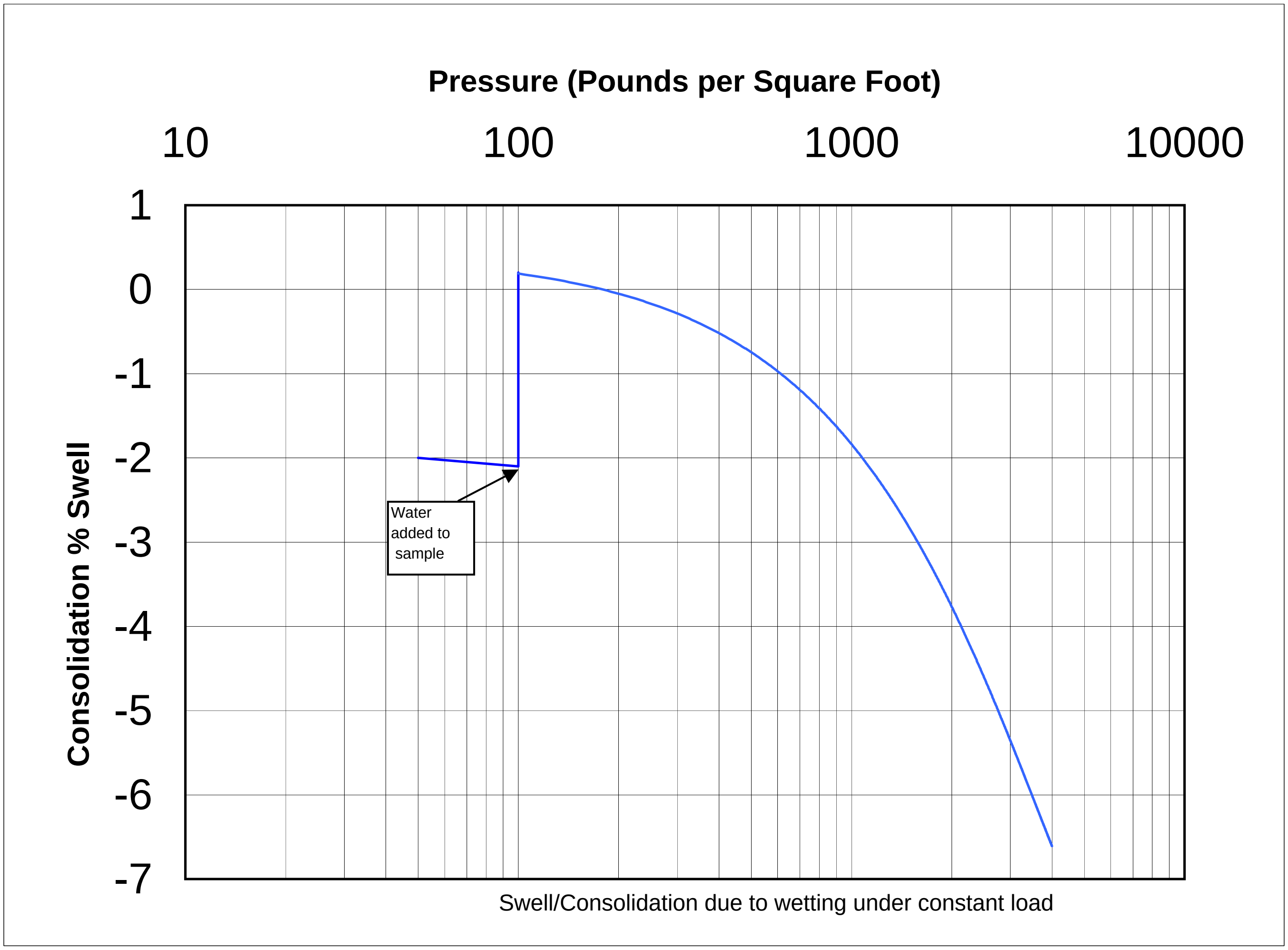


SUMMARY OF TEST RESULTS		
Sample Source	TB 1 @ 4'	
Soil Description	Silty Sand (SM)	
Swell Pressure (P.S.F)	CONSOLIDATION	
	Initial	Final
Moisture Content (%)	14.6	13.6
Dry Density (P.C.F)	119.3	125.8
Height (in.)	1.000	0.938
Diameter (in.)	1.94	1.94

Remold

Project Number	51172GE
Date	September 19, 2007
Figure	4.1

SWELL - CONSOLIDATION TEST

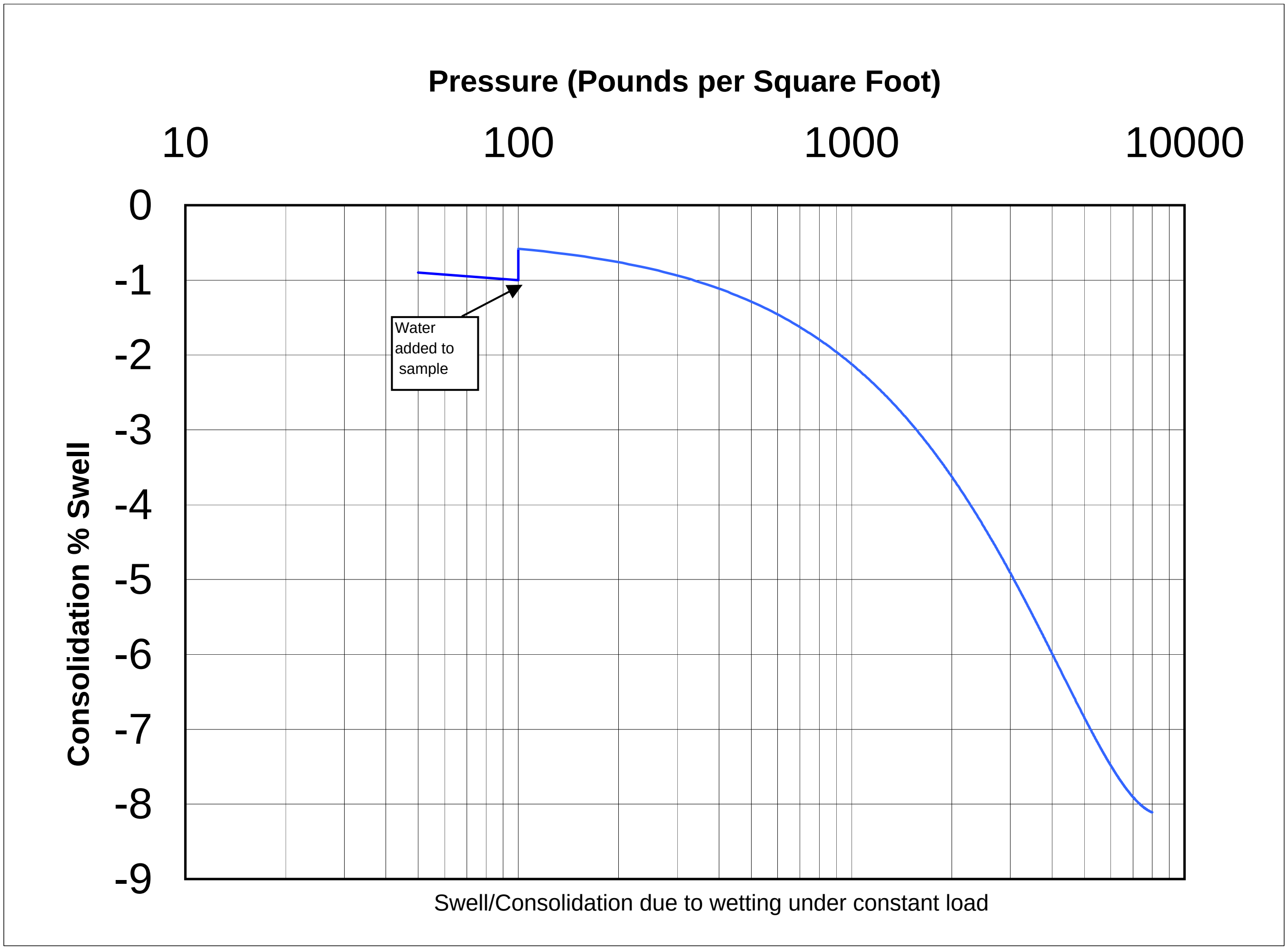


SUMMARY OF TEST RESULTS		
Sample Source	TB 9 @ 0'-4'	
Soil Description	Sandy Clay (CL)	
Swell Pressure (P.S.F)	1,430	
	Initial	Final
Moisture Content (%)	7.2	23.5
Dry Density (P.C.F)	93.5	99.4
Height (in.)	1.000	0.934
Diameter (in.)	1.94	1.94

REMOLD

Project Number	51172GE
Date	September 19, 2007
Figure	4.2

SWELL - CONSOLIDATION TEST



Swell/Consolidation due to wetting under constant load

SUMMARY OF TEST RESULTS		
Sample Source	TB 11 @ 0'-4'	
Soil Description	Sandy Clay (CL)	
Swell Pressure (P.S.F)	1,320	
	Initial	Final
Moisture Content (%)	4.3	17.9
Dry Density (P.C.F)	100.6	108.5
Height (in.)	1.000	0.919
Diameter (in.)	1.94	1.94

Project Number	51172GE
Date	9/19 07
Figure	4.3

Direct Shear Test Results

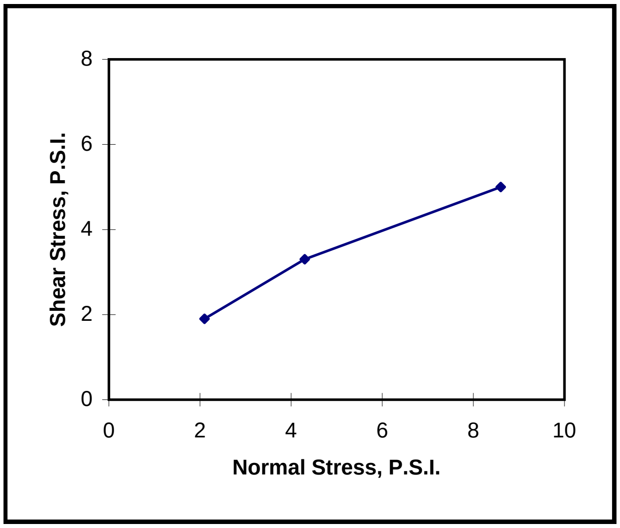
ASTM D3080-90

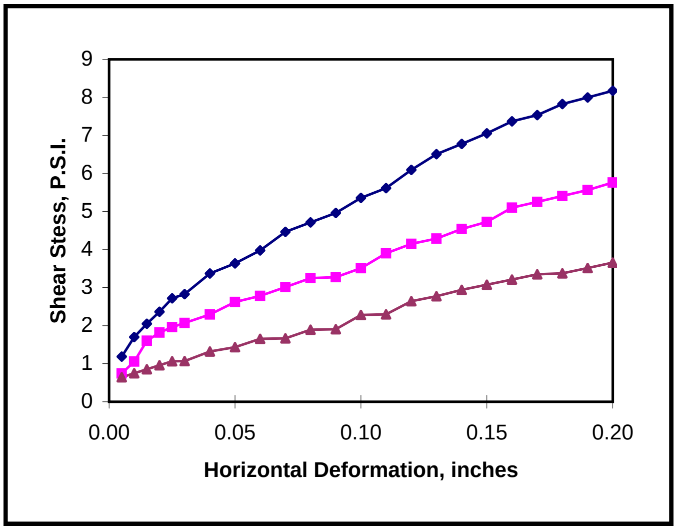
Project: Edgemont H2O Ponds
Project Number: 51172GE
Laboratory Number: 10526-M
DATE: 10/1/2007
Project Technician: Rz

Visual Soil Description: Clayey Silt (ML)
Type of Specimen: Remolded
Diameter 1.946 in.
Thickness 2.0 in
Sample Source: TB 8 @ 0'-4'

Summary of Sample Data:	
Initial Moisture Content (%)	7.3
Intial Dry Density (P.C.F)	100.7
Final Moisture Content (%)	20.4
Final Dry Density (P.C.F)	98.2

Residual Direct Shear Test Results:			
Normal Stress (P.S.I)	2.1	4.3	8.6
Max. Shear Stress (P.S.I)	1.9	3.3	5





ESTIMATED STRENGTH PARAMETERS	
Angle of Internal Friction, phi	27
Cohesion, P.S.F.	62