

INFILTRATION ANALYSIS

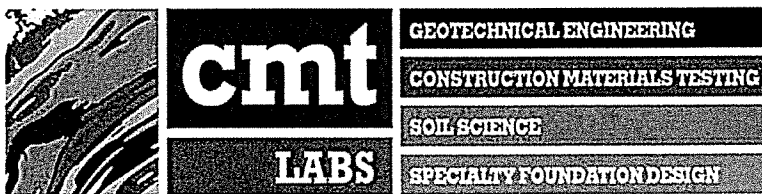
**Campus Living
Ferguson Township, Centre County, PA**

CMT Laboratories File No. 1313800

Prepared for:

**PennTerra Engineering, Inc.
3075 Enterprise Drive
State College, PA 16801**

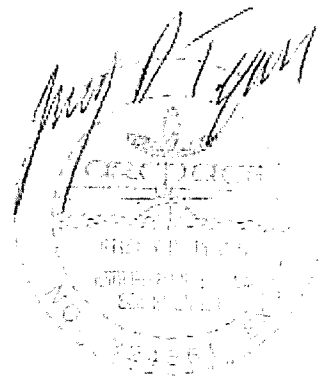
Prepared by:



The groundwork for success.

**CMT Laboratories, Inc.
2701 Carolean Industrial Drive
State College, PA 16801**

May 28, 2013



INDEX

	<u>Page</u>
INTRODUCTION	1
SOIL MAPPING.....	1
GEOLOGIC INFORMATION	2
Sinkhole Potential	2
TEST PITS.....	2
General.....	2
Topsoil	2
Subsoils.....	3
Bedrock.....	3
Groundwater/Redoximorphic Features.....	3
INFILTRATION TESTS	4
General.....	4
Conventional Infiltration Testing.....	4
Non-Conventional Infiltration Testing	5
TEST RESULTS.....	6
CONCLUSIONS.....	7
RECOMMENDATIONS	8
COMMENTS	10
APPENDIX:	
A. Test Pit Location Plan	
B. Test Pit Logs	
C. Infiltration Test Results	

INFILTRATION ANALYSIS

Campus Living

May 28, 2013

INTRODUCTION

Our scope of services included observing test pits within 5 proposed stormwater management areas identified by the Client, and conducting conventional infiltration tests at each of the test pit locations. Due to the subsurface conditions encountered during the work, our scope was modified to include non-conventional infiltration tests in lieu of, or in addition to, conventional infiltration tests at many of the test pit locations. The infiltration test locations, depths and methods were discussed with the Client prior to and during our investigation. The locations of the test pits are shown on a plan provided by the Client in Appendix A.

It should be noted that we have not considered any potential impact that an infiltration Best Management Practice (BMP) may have on adjacent structures (existing and/or proposed). These types of issues, if applicable, should be addressed by the appropriate professionals.

SOIL MAPPING

The Natural Resource Conservation Service (NRCS) soil mapping indicates that Hagerstown and Opequon-Hagerstown Complex series soils exist at the site.

In general, Opequon and Hagerstown series soils are similar. Both series consists of well-drained residual soils derived from limestone or dolomite bedrock; however, Opequon soils are shallow (20 inches or less to bedrock) and Hagerstown soils are deep or very deep (depth to bedrock of 40 inches or more). Typically, areas mapped as Opequon-Hagerstown have a depth to bedrock too variable to separate the two series.

GEOLOGIC INFORMATION

According to the NRCS mapping, the rock formation at the site is the Nittany Formation. The dominant rock type is dolomite.

Sinkhole Potential

Although no clear evidence of sinkhole activity was observed in the test pits, the presence of carbonate bedrock in itself renders the site susceptible to sinkhole development during or after construction. In addition, altering a site's grading and drainage characteristics can result in sinkholes developing in areas where test pit data reflect little or no potential.

TEST PITS

General

A total of 13 test pits were excavated in the presence of a CMT representative, with a backhoe provided and operated by a subcontractor. The soils observed in the test pits are consistent with the Hagerstown and Opequon series soils discussed in the soil mapping paragraph of this report.

After our observations were recorded, the test pits were backfilled with excavated materials.

Topsoil

The topsoil at the site consists of dark brown clayey silt with sand and organic matter, and is identified as an Ap-horizon on the test pit logs. The topsoil exhibits excellent soil structure and macropore (i.e., root channels, earthworm burrows, etc) abundance, which is typically favorable for infiltration.

Subsoils

The topsoil is underlain by residual silt and/or clay soils with variable amounts of sand and gravel. Most of the subsoil layers are identified as Bt-horizons; although some of the subsoil layers containing high amounts of weathered rock are identified as BR or CR-Horizons.

Soil structure and macropore abundance within the subsoil layers is moderate to good, and generally decreases slightly with depth.

Bedrock

Dolomite bedrock was observed in all but one of the test pits (TP-12). Most of rock observed appeared weathered with soil-filled fractures. Harder dolomite with fewer fractures was encountered in a few of the test pits.

With the exception of test pit TP13, the rock encountered in the test pits was able to be excavated several feet below the proposed maximum BMP bottom depths provided by the client. At test pit TP13, excavation refusal occurred above this depth; however, deeper excavation may have been possible with larger equipment and/or a larger excavation. In general, the rock observed in the test pits did not appear more restrictive than the overlying subsoils.

Groundwater/Redoximorphic Features

No groundwater or redoximorphic features were observed through the excavation termination depths.

INFILTRATION TESTS

General

Based on the proposed maximum BMP bottom depths at each location, the majority of the BMP bottoms may be situated within, or in close proximity above, bedrock. At the Client's request, conventional infiltration tests were conducted in the subsoils and non-conventional infiltration tests were conducted in the bedrock.

Conventional Infiltration Testing

A total of 18 conventional infiltration tests, including 16 double-ring infiltrometer and 2 uncased-hole tests, were conducted. The uncased-hole tests were conducted in general accordance with the Percolation Test procedures outlined in the December 2006 PADEP Stormwater BMP Manual. The double-ring infiltrometer tests were also conducted in accordance with the BMP manual. The uncased-hole tests were conducted in materials too coarse for the proper seating of infiltrometer tests.

The infiltration rate obtained using the uncased-hole method is calculated using the Reduction Factor specified in the BMP Manual for use with percolation tests. The reduction factor accounts for the exfiltration occurring through the sides of the percolation hole and assumes that the infiltration rate is affected by the depth of the water in the hole.

The infiltration rate obtained using the double-ring infiltrometer method is generally taken to be either the average rate of all measurements or the final measurement reported in in/hr. We recommend the use of the lower of the two rates.

The maximum design infiltration rates shown in this report were calculated using what we believe are reasonable minimum safety factors. The design engineer should determine if higher safety factors are appropriate.

Non-Conventional Infiltration Testing

A total of 10 non-conventional infiltration tests were conducted. The following procedure was used to estimate the rock's permeability:

1. A small area (i.e., test hole) was prepared at the pit bottom to contain a maximum of 6 inches of water. The dimensions of the test hole were recorded and are shown on the infiltration log.
2. Using a large container of known volume, water was added to the test hole and the time required for the water to drain completely was recorded.
3. The apparent infiltration rate (no safety factor applied) was calculated, and is shown on the infiltration log.

After the infiltration tests were completed, the holes were backfilled with excavated materials.

TEST RESULTS

The following table summarizes the infiltration test results.

Location	Test Type	Test Depth (ft)	Materials Tested	Apparent Infiltration Rate (in/hr)	Min. Safety Factor	Maximum Design Infiltration Rate (in/hr)
Subsoils						
IT1A	Infiltrometer	3.0	Strong Brown Sandy Clay, Little Gravel	1.32	2	0.66
IT1B	Infiltrometer	3.0	Strong Brown Sandy Clay, Little Gravel	1.92	2	0.96
IT2A	Infiltrometer	2.5	Strong Brown Silty Clay with Sand, Trace Gravel	2.10	2	1.05
IT2B	Infiltrometer	2.5	Strong Brown Silty Clay with Sand, Trace Gravel	3.90	2	1.95
IT4A	Infiltrometer	4.0	Yellowish Red Silty Clay with Sand, Trace Gravel	0.66	2	0.33
IT4B	Infiltrometer	4.0	Yellowish Red Silty Clay with Sand, Trace Gravel	0.78	2	0.39
IT5A	Infiltrometer	2.0	Strong Brown Silty Clay with Sand, Trace Gravel	5.52	2	2.76
IT5B	Infiltrometer	2.0	Strong Brown Silty Clay with Sand, Trace Gravel	3.60	2	1.80
IT6A	Infiltrometer	4.0	Yellowish Red Silty Clay with Sand, Trace Gravel	1.20	2	0.60
IT6B	Infiltrometer	4.0	Yellowish Red Silty Clay with Sand, Trace Gravel	1.20	2	0.60
IT8A	Infiltrometer	1.5	Yellowish Red Silty Clay with Sand and Gravel	3.36	2	1.68
IT8B	Infiltrometer	1.5	Yellowish Red Silty Clay with Sand and Gravel	0.96	2	0.48
IT9A	Infiltrometer	4.0	Yellowish Red Sandy Clay, Trace Gravel	4.80	2	2.40
IT9B	Infiltrometer	4.0	Yellowish Red Sandy Clay, Trace Gravel	3.12	2	1.56
IT11A	Infiltrometer	3.0	Brown Silty Clay with Sand, Trace Gravel	1.92	2	0.96
IT11B	Infiltrometer	3.0	Brown Silty Clay with Sand, Trace Gravel	4.32	2	2.16
IT12A	Uncased-Hole	4.5	Brown Clayey Sand with Gravel	0.91	2.5	0.37
IT12B	Uncased-Hole	4.5	Brown Clayey Sand with Gravel	2.06	2.5	0.82
Bedrock						
IT1C	Non-Conventional	10.0	Gray Weathered Dolomite with Clay	2.24	*	*
IT2C	Non-Conventional	9.5	Gray Weathered Dolomite with Clay	108.29	*	*
IT3A	Non-Conventional	7.5	Gray Weathered Dolomite with Clay	10.93	*	*
IT4C	Non-Conventional	7.5	Gray Dolomite; Few Fractures	7.79	*	*
IT5C	Non-Conventional	8.0	Gray Weathered Dolomite with Clay	16.35	*	*
IT6C	Non-Conventional	8.5	Gray Weathered Dolomite, Trace Clay	21.95	*	*
IT7A	Non-Conventional	5.0	Gray Weathered Dolomite, Trace Clay	46.20	*	*
IT10A	Non-Conventional	7.0	Gray Weathered Dolomite, Trace Clay	8.75	*	*
IT11C	Non-Conventional	6.5	Gray Weathered Dolomite and Clay	10.55	*	*
IT13A	Non-Conventional	5.5	Gray Weathered Dolomite, Trace Clay	18.33	*	*

*See Recommendations

CONCLUSIONS

The conventional (infiltrometer and uncased-hole) test results shown in the table above are considered reasonable for design purposes, assuming that the existing soil structure and macropore abundance is able to be maintained during and after construction. **Particular attention is called to the discussions regarding compaction during construction, sediment accumulation and soil restoration, which are included in the “Recommendations” section of this report.**

The conventional test results indicate that the subsoils at the site are permeable. We believe that the high infiltration rates obtained in some of the clay subsoils at this site are due to their high sand content and excellent soil structure/macropore abundance. The close proximity of the tested subsoils to permeable bedrock may have also contributed to the high infiltration rates at some locations.

The non-conventional test results indicate that the bedrock at the site is permeable. The result obtained from test pit TP-1 (i.e., IT1C) appears somewhat restrictive compared to other locations.

Since permeable bedrock exists at the site, the potential for erodible materials being lost into rock fractures also exists. Depending on the amount/thickness of erodible materials above the rock fractures, significant subsidence and sinkhole activity could occur. Removing the erodible materials from the proposed BMPs may decrease the risk and/or severity of sinkhole activity.

The governing municipality may require stormwater to pass through a filtration medium (i.e., a topsoil layer or other suitable medium) prior to entering the rock. A separation fabric may be needed to minimize loss of the filtration medium into the weathered rock; however, separation fabrics are prone to clogging over time, and may require long term maintenance. These issues should be discussed with appropriate municipal officials.

RECOMMENDATIONS

It is recommended that the civil engineer apply an appropriate factor of safety when establishing the design infiltration rates to account for inconsistencies in the test results, non-homogeneity of the soils, and long-term variations in the soils' infiltration characteristics due to seasonal changes and other factors. We believe that minimum safety factors of 2 and 2.5 should be applied to the infiltrometer and uncased-hole test results, respectively, for this purpose, and have applied these safety factors to the results shown in this report.

We believe the non-conventional infiltration test method is useful in demonstrating the general permeability and infiltration characteristics of the materials tested; however, we do not believe that the test results should be used without applying reasonable safety factors. Since the minimum safety factor for most conventional test methods ranges from 2 to 3, we recommend the designer consider applying a safety factor greater than 3 to the non-conventional test results.

Materials within planned infiltration areas must not be compacted during construction since it is believed that even minimal compaction will result in a loss of infiltration capability. All heavy equipment should be prohibited from operating and traveling over the infiltration areas, and all other traffic should be minimized. It is also recommended that planned infiltration areas be clearly marked on the site prior to the commencement of earthwork activities, and construction traffic be prohibited from entering the infiltration areas.

The infiltration capacity of an area may decrease over time due to sediment accumulation. We believe infiltration areas that are protected from sediment accumulation will maintain their infiltration capacity longer than those which are not protected. We recommend that infiltration areas not be used as temporary sediment traps during site construction. If the use of an infiltration area as a temporary sediment trap is unavoidable, measures to prevent sediment from reaching the planned infiltration surface may be effective in preserving the infiltration capacity. In our experience, these measures typically involve leaving some thickness of soil above the infiltration surface for the sediment trap, and then removing it when the sediment trap is converted to an infiltration area. Soils at the infiltration elevation are extremely susceptible to

compaction or smearing during the conversion process, even from small tracked equipment. Any compaction or smearing would result in a loss of infiltration capacity.

Construction of the proposed BMP(s) may involve the removal or disturbance of the existing topsoil layer. Although the topsoil may be replaced after construction, the new topsoil will likely exhibit soil structure and organism habitat that are less conducive to infiltration. The loss/reduction of soil organisms will likely affect infiltration rates in the tested subsoil layers as well. If the topsoil at the site is to be removed and replaced, the designer should consider applying a higher safety factor to the test results in this report, and/or include provisions to improve the new topsoil, as outlined below:

1. The addition of lime and/or stabilized compost to the topsoil may help maintain/restore soil structure and fertility. Mixing sand with the original topsoil may increase the infiltration rate to desirable levels while the soil re-establishes soil structure; however, too much sand may decrease soil fertility.
2. Restoring an adequate thickness of topsoil to the infiltration areas is important. In general, replacing topsoil to a thickness similar to (or thicker than) the original thickness is desirable for maintaining subsoil infiltration rates similar to those shown in this report.
3. The topsoil/subsoil interface may be enhanced by blending the new topsoil with several inches of the existing subsoil, being careful not to compact the soils. Alternatively, a similar effect could be accomplished by scarifying the existing subsoils just prior to the topsoil's placement.
4. Select a plant mixture that is moisture tolerant and does not require frequent mowing. Frequent mowing typically results in shallower root penetration and compaction from the mowing equipment, both reduce infiltration capacity.
5. Allow the new vegetation to fully establish itself prior to the introduction of any stormwater. Established vegetation stabilizes the BMP's surface, prevents the separation of materials (which is particularly important in soil mixtures), enhances soil structure, and creates habitat for organisms. If water is added to the BMP bottom prior to a stable vegetated surface, the resulting separation and/or sedimentation of silts and clays would likely result in a loss of infiltration capacity.

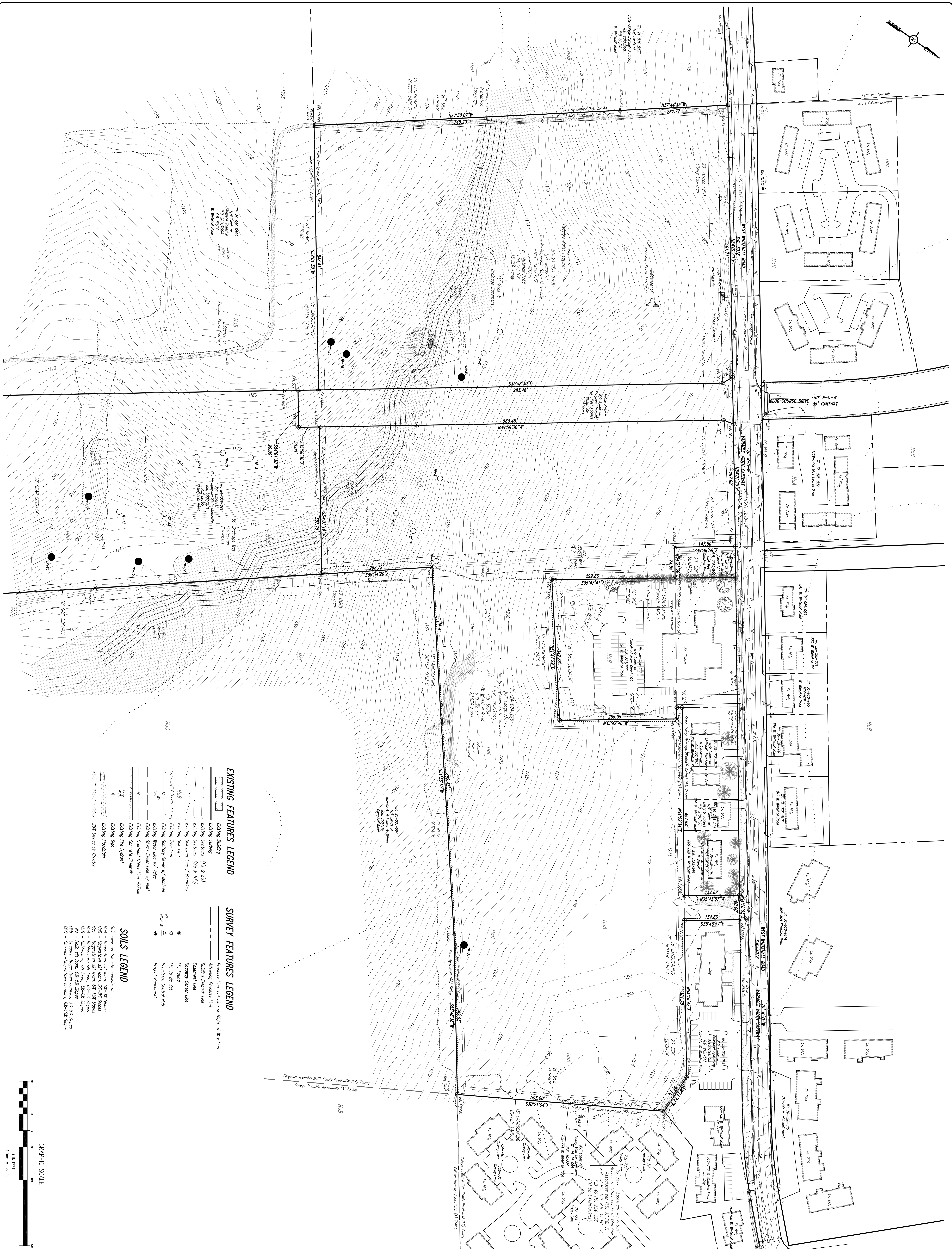
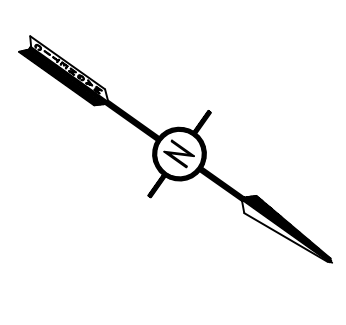
It is recommended that construction oversight (quality assurance) during construction be provided by the designer or owner. Oversight should include observation during earthwork activities, and evaluation of proposed fill materials (including topsoil).

COMMENTS

We request that this office be consulted if, during design or construction, conditions are encountered which differ from those contained herein, thereby warranting a review of our recommendations. This report has been prepared for the exclusive use of PennTerra Engineering, Inc.

APPENDIX A

Test Pit Location Plan



EXISTING FEATURES LEGEND

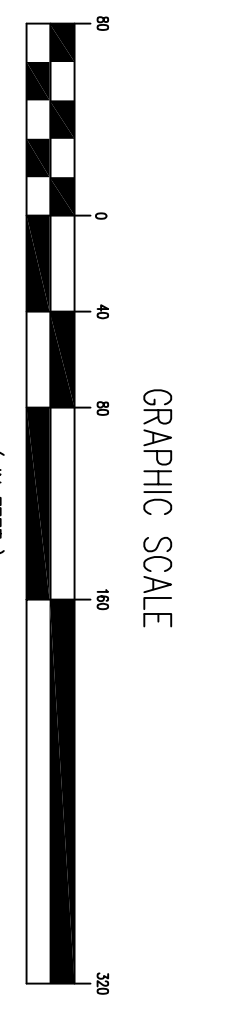
- Existing Building
- Existing Contours (1:3 & 2:3)
- Existing Contours (3:3 & 10:3)
- Existing Soil Limit Line / Boundary
- Existing Soil Type
- Existing Tree Line
- Existing Sanitary Sewer w/ Manhole
- Existing Water Line w/ Valve
- Existing Storm Sewer Line w/ Inlet
- Existing Overhead Utility Line w/ Pole
- Existing Concrete Sump
- Existing Fire Hydrant
- Existing Sign
- Existing Slope of Greater than 20%

SURVEY FEATURES LEGEND

- Property Line, Lot Line or Right of Way Line
- Adjoining Property Line
- Building Setback Line
- Easement Line
- Roadway Center Line
- 1/2" Found
- 1/2" To Be Set
- Penn Iron Control Hub
- Project Benchmark

SOILS LEGEND

- Soil cover on the site consists of:
- H4a - Highwater silt loam, 0% - 3% Slopes
 - H4b - Highwater silt loam, 3% - 8% Slopes
 - H4c - Highwater silt loam, 8% - 15% Slopes
 - H4d - Highwater silt loam, 15% - 25% Slopes
 - H4e - Highwater silt loam, 25% - 35% Slopes
 - H4f - Highwater silt loam, 35% - 45% Slopes
 - H4g - Highwater silt loam, 45% - 55% Slopes
 - H4h - Highwater silt loam, 55% - 65% Slopes
 - H4i - Highwater silt loam, 65% - 75% Slopes
 - H4j - Highwater silt loam, 75% - 85% Slopes
 - H4k - Highwater silt loam, 85% - 95% Slopes
 - H4l - Highwater silt loam, 95% - 100% Slopes
 - D1c - Depressor-highwater complex, 0% - 15% Slopes



<p>PROJECT NO. 12337</p> <p>DATE DECEMBER 19, 2014</p> <p>SCALE 1" = 30'</p> <p>SHEET NO. 1 of 1</p>	<p>SOIL TEST PIT LOCATIONS</p>	<p>TENTATIVE PLANNED RESIDENTIAL DEVELOPMENT PLAN</p>	<p>CAMPUS LIVING by TOLL BROTHERS</p> <p>FERGUSON TOWNSHIP CENTRE COUNTY PENNSYLVANIA</p>	<p>REVISIONS</p> <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th>No.</th> <th>Description</th> </tr> </thead> <tbody> <tr> <td> </td> <td> </td> </tr> </tbody> </table>	No.	Description			<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td>Designer</td> <td>MMK</td> </tr> <tr> <td>Draftsman</td> <td>MMK</td> </tr> <tr> <td>Checker</td> <td>MMK</td> </tr> <tr> <td>Surveyor</td> <td>MMK</td> </tr> <tr> <td>Professional Seal</td> <td> </td> </tr> <tr> <td>Board</td> <td> </td> </tr> <tr> <td>Approved</td> <td> </td> </tr> </table>	Designer	MMK	Draftsman	MMK	Checker	MMK	Surveyor	MMK	Professional Seal		Board		Approved		<p>Copyright 2014 by the Engineer. All rights reserved. No part of this document may be reproduced or transmitted in any form or by any means, electronic, mechanical, photocopying, recording, or by any information storage and retrieval system, without the prior written permission of the Engineer. This document is the property of the Engineer and is to be used only for the project and site identified herein. The Engineer is not responsible for any errors or omissions in this document.</p> <p>www.pentterra.com</p>	<p>Pentterra ENGINEERING INC.</p> <p>CENTRAL OFFICE REGION OFFICE STATE COLLEGE, PA 16801 PH: 814-231-5235 FAX: 814-231-2308</p> <p>LANCASTER OFFICE 3904 B ABEL DRIVE COLLUMBER, PA 17512 PH: 717-522-5551 FAX: 717-522-5549</p>
No.	Description																								
Designer	MMK																								
Draftsman	MMK																								
Checker	MMK																								
Surveyor	MMK																								
Professional Seal																									
Board																									
Approved																									

1831 BRUE COURSE DRIVE
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999.350.3427

SENSE BRUSH

Underground Basin

- TP-3 (4-MAX)
- TP-4 (4-MAX)
- TP-5 (4-MAX)

● TP-6 (5)

● TP-7 (2)

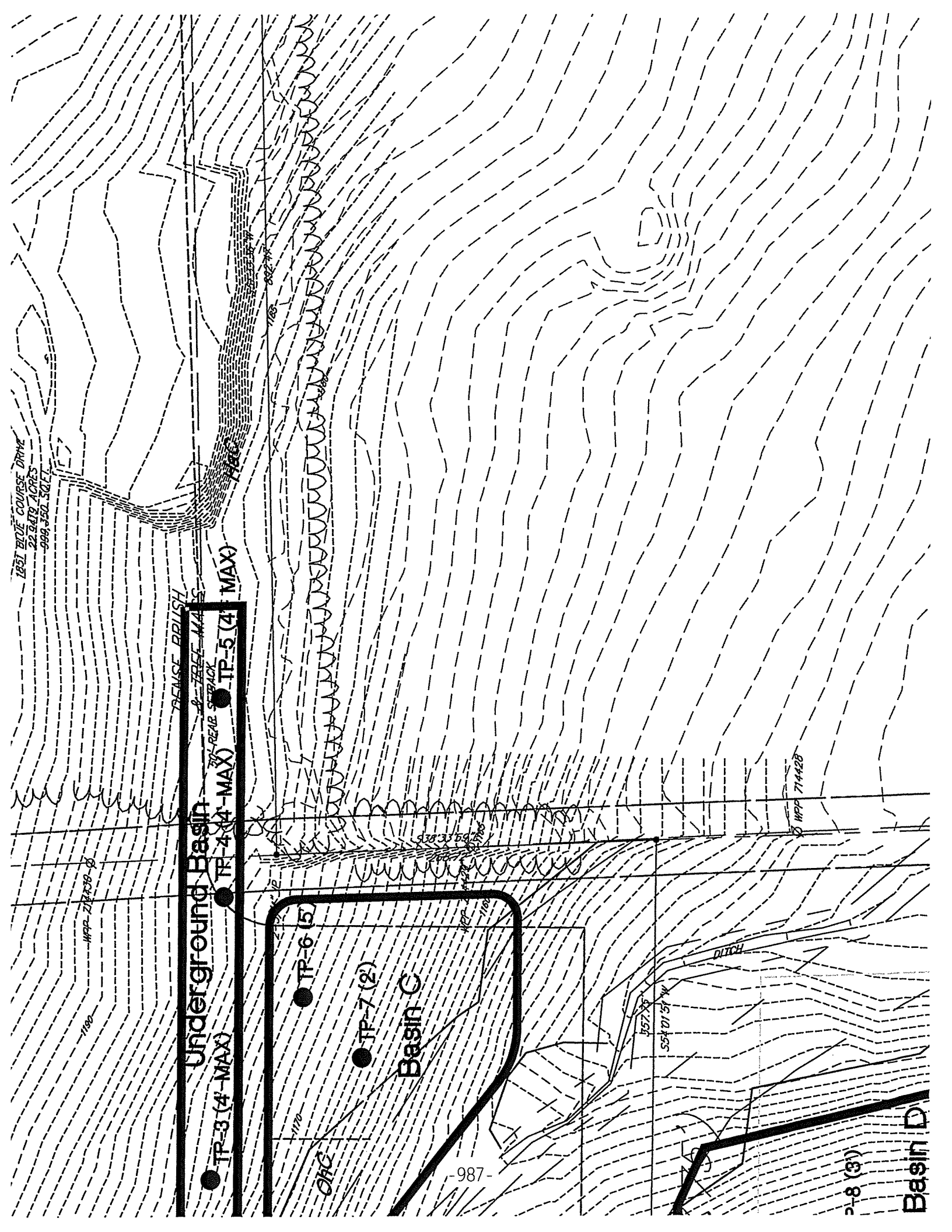
Basin C

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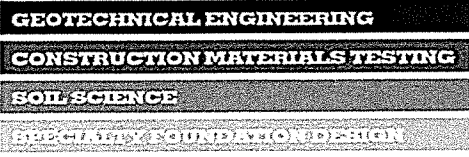
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Basin D



APPENDIX B

Test Pit Logs



The groundwork for success.

Test Pit Log

Project: Campus Living

Date Performed: 5/16/2013

Location: Ferguson Township, Centre County, PA

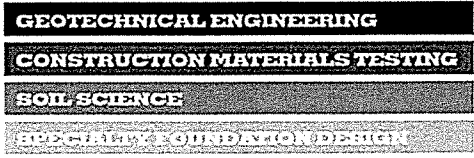
CMT File Number: 1313800

Client: PennTerra Engineering, Inc.

Location: TP-1

Excavation Equipment: Backhoe

Description	Depth (Feet)	Remarks
Ap - (0 to 11") TOPSOIL: Dark Brown Clayey SILT with Sand and Organic Matter: Granular Structure, Many Macropores, Damp	1	3.0': Infiltration Tests IT1A & IT1B
Bt₁ - (11" to 2.0') Strong Brown Silty CLAY, Little Sand and Gravel, Few Cobbles; Fine Sub-Angular Blocky Structure, Common Macropores, Damp	2	
Bt₂ - (2.0' to 4.4') Strong Brown Sandy CLAY, Little Gravel; Medium to Coarse Sub-Angular Blocky Structure, Few Manganese Coatings, Few Macropores, Moist	3	
-	4	
R - (4.4' to 10.0') Gray Weathered DOLOMITE with Clay-Filled Fractures; Broken, Damp	5	
-	6	
-	7	
-	8	
-	9	
-	10	
Bottom of Pit - 10.0'	10	10.0': Infiltration Test IT1C
-	11	Groundwater Not Encountered
-	12	
-	13	



The groundwork for success.

Test Pit Log

Project: Campus Living

Date Performed: 5/16/2013

Location: Ferguson Township, Centre County, PA

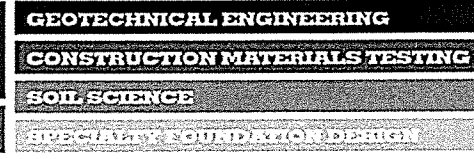
CMT File Number: 1313800

Client: PennTerra Engineering, Inc.

Location: TP-2

Excavation Equipment: Backhoe

Description	Depth (Feet)	Remarks
Ap - (0 to 12") TOPSOIL: Dark Brown Clayey SILT with Sand and Organic Matter; Granular Structure, Many Macropores, Damp	1	2.5': Infiltration Tests IT2A & IT2B
Bt₁ - (12" to 2.1') Strong Brown Silty CLAY, Trace Sand and Gravel; Fine Sub-Angular Blocky Structure, Common Macropores, Damp	2	
Bt₂ - (2.1' to 3.6') Strong Brown Silty CLAY with Sand, Trace Gravel; Medium to Coarse Sub-Angular Blocky Structure, Common Manganese Coatings, Few Macropores, Damp	3	
R - (3.6' to 9.5') Gray Weathered DOLOMITE with Clay-Filled Fractures; Broken, Moist	4	
	5	9.5': Infiltration Test IT2C
	6	
	7	
	8	
	9	
Bottom of Pit - 9.5'	10	Groundwater Not Encountered
	11	
	12	
	13	



The groundwork for success.

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Location: Ferguson Township, Centre County, PA

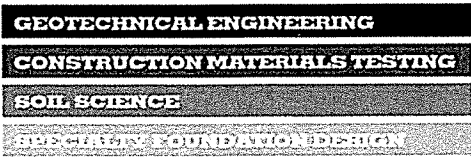
CMT File Number: 1313800

Client: PennTerra Engineering, Inc.

Location: TP3

Excavation Equipment: Backhoe

Description	Depth (Feet)	Remarks
Ap - (0 to 8") TOPSOIL: Dark Brown Clayey SILT with Sand and Organic Matter; Granular Structure, Many Macropores, Damp	1	
Bt ₁ - (8" to 1.5') Strong Brown Silty CLAY with Sand, Trace Gravel; Fine Sub-Angular Blocky Structure, Common Macropores, Damp	2	
Bt ₂ - (1.5' to 3.3') Strong Brown Silty CLAY with Sand, Some Cobbles; Medium Sub-Angular Blocky Structure, Few Macropores, Damp	3	
R - (3.3' to 7.5') Gray Weathered DOLOMITE with Clay-Filled Fractures; Broken, Moist	4	
	5	
	6	
	7	
	7.5'	Infiltration Test IT3A
Bottom of Pit - 7.5'	8	
	9	
	10	
	11	
	12	
	13	



The groundwork for success.

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Date Performed: 5/16/2013

Location: Ferguson Township, Centre County, PA

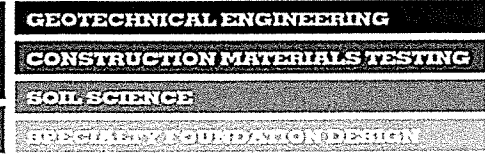
CMT File Number: 1313800

Client: PennTerra Engineering, Inc.

Location: TP-4

Excavation Equipment: Backhoe

Description	Depth (Feet)	Remarks
Ap - (0 to 10") TOPSOIL: Dark Brown Clayey SILT with Sand and Organic Matter; Granular Structure, Many Macropores, Damp	1	4.0': Infiltration Tests IT4A & IT4B
Bt₁ - (10" to 2.0') Yellowish Brown Clayey SILT with Sand and Gravel; Fine Sub-Angular Blocky Structure, Common Macropores, Damp	2	
Bt₂ - (2.0' to 4.0') Yellowish Red Silty CLAY with Sand, Trace Gravel; Medium to Coarse Sub-Angular Blocky Structure, Few Macropores, Damp	3	
Bt₃ - (4.0' to 7.0') Yellowish Red Silty CLAY with Sand, Trace Gravel; Massive Structure, Few Manganese Coatings, Few Macropores, Damp	4	
	5	7.5': Infiltration Test IT4C
	6	
	7	
R - (7.0' to 7.5') Gray DOLOMITE; Few Fractures, Damp	7	Groundwater Not Encountered
Bottom of Pit - 7.5'	8	
	9	
	10	
	11	
	12	
	13	



The groundwork for success.

Test Pit Log

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Location: Ferguson Township, Centre County, PA

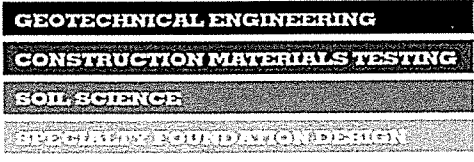
CMT File Number: 1313800

Client: PennTerra Engineering, Inc.

Location: TP-5

Excavation Equipment: Backhoe

Description	Depth (Feet)	Remarks
Ap - (0 to 12") TOPSOIL: Dark Brown Clayey SILT with Sand and Organic Matter; Granular Structure, Many Macropores, Damp	1	2.0': Infiltration Tests IT5A & IT5B
Bt ₁ - (12" to 1.7') Yellowish Brown Clayey SILT with Sand; Fine Sub-Angular Blocky Structure, Common Macropores, Damp	2	
Bt ₂ - (1.7' to 3.0') Strong Brown Silty CLAY with Sand, Trace Gravel; Medium Sub-Angular Blocky Structure, Common Macropores, Damp	3	
BR - (3.0' to 5.0') Gray Weathered DOLOMITE and CLAY (Cobbles and Boulders in Clay Matrix); Medium Sub-Angular Blocky Structure (Clay), Damp	4	
R - (5.0' to 8.0') Gray Weathered DOLOMITE with Clay-Filled Fractures; Slightly Broken, Damp	5	8.0': Infiltration Test IT5C
	6	
Bottom of Pit - 8.0'	7	
	8	Groundwater Not Encountered
	9	
	10	
	11	
	12	
	13	



The groundwork for success.

Test Pit Log

Project: Campus Living

Date Performed: 5/16/2013

Location: Ferguson Township, Centre County, PA

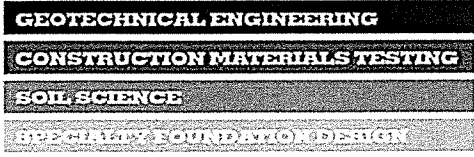
CMT File Number: 1313800

Client: PennTerra Engineering, Inc.

Location: TP-6

Excavation Equipment: Backhoe

Description	Depth (Feet)	Remarks
Ap - (0 to 10") TOPSOIL: Dark Brown Clayey SILT with Sand and Organic Matter; Granular Structure, Many Macropores, Damp	1	4.0': Infiltration Tests IT6A & IT6B 8.5': Infiltration Test IT6C Groundwater Not Encountered
Bt₁ - (10" to 2.4') Strong Brown Sandy CLAY, Trace Gravel; Fine to Medium Sub-Angular Blocky Structure, Common Macropores, Damp	2	
Bt₂ - (2.4' to 3.8') Strong Brown Sandy CLAY, Trace Gravel; Medium to Coarse Sub-Angular Blocky Structure, Few Manganese Coatings, Few Macropores, Damp	3	
Bt₃ - (3.8' to 6.0') Yellowish Red Silty CLAY with Sand, Trace Gravel, Few Cobbles and Thin Layers of Yellowish Brown Clayey SILT; Massive Structure, Few Macropores, Moist	4	
R - (6.0' to 8.5') Gray Weathered DOLOMITE, Trace Clay; Broken, Damp	5	
	6	
	7	
	8	
Bottom of Pit - 8.5'	9	
	10	
	11	
	12	
	13	



The groundwork for success.

Test Pit Log

Project: Campus Living

Date Performed: 5/16/2013

Location: Ferguson Township, Centre County, PA

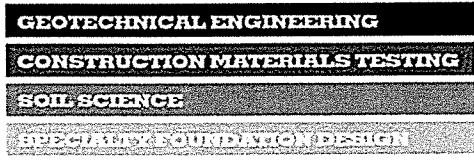
CMT File Number: 1313800

Client: PennTerra Engineering, Inc.

Location: TP-7

Excavation Equipment: Backhoe

Description	Depth (Feet)	Remarks
Ap - (0 to 6") TOPSOIL: Dark Brown Clayey SILT with Sand and Organic Matter; Granular Structure, Many Macropores, Damp	1	5.0': Infiltration Test IT7A Groundwater Not Encountered
BR - (6" to 1.5') Gray Weathered DOLOMITE and CLAY (Cobbles and Boulders in Clay Matrix); Medium Sub-Angular Blocky Structure (Clay), Damp	2	
R - (1.5' to 5.0') Gray Weathered DOLOMITE, Trace Clay; Broken, Damp	3	
	4	
	5	
Bottom of Pit - 5.0'	6	
	7	
	8	
	9	
	10	
	11	
	12	
	13	



The groundwork for success.

Test Pit Log

Project: Campus Living

Date Performed: 5/16/2013

Location: Ferguson Township, Centre County, PA

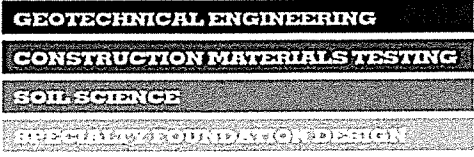
CMT File Number: 1313800

Client: PennTerra Engineering, Inc.

Location: TP-8

Excavation Equipment: Backhoe

Description	Depth (Feet)	Remarks
Ap - (0 to 10") TOPSOIL: Dark Brown Clayey SILT with Sand and Organic Matter; Granular Structure, Many Macropores, Damp	1	1.5': Infiltration Tests IT8A & IT8B
Bt₁ - (10" to 1.5') Yellowish Red Silty CLAY with Sand, Trace Gravel; Fine Sub-Angular Blocky Structure, Common Macropores, Damp	2	
Bt₂ - (1.5' to 3.5') Yellowish Red Silty CLAY with Sand, Gravel and Weathered Dolomite Cobbles; Medium to Coarse Sub-Angular Blocky Structure, Few Macropores, Damp	3	
R - (3.5' to 6.5') Gray Weathered DOLOMITE, Trace Clay; Slightly Broken, Hard, Damp	4	
	5	
	6	
Bottom of Pit - 6.5'	7	Groundwater Not Encountered
	8	
	9	
	10	
	11	
	12	
	13	



The groundwork for success.

Test Pit Log

Project: Campus Living

Date Performed: 5/16/2013

Location: Ferguson Township, Centre County, PA

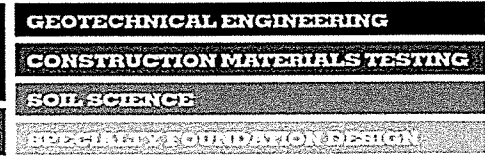
CMT File Number: 1313800

Client: PennTerra Engineering, Inc.

Location: TP-9

Excavation Equipment: Backhoe

Description	Depth (Feet)	Remarks
Ap - (0 to 8") TOPSOIL: Dark Brown Clayey SILT with Sand and Organic Matter; Granular Structure, Many Macropores, Damp	1	4.0': Infiltration Tests IT9A & IT9B
Bt₁ - (8" to 2.2') Yellowish Red Silty CLAY, Trace Sand and Gravel; Fine Sub-Angular Blocky Structure, Common Macropores, Damp	2	
Bt₂ - (2.2' to 4.0') Yellowish Red Silty CLAY with Sand, Trace Gravel; Medium to Coarse Sub-Angular Blocky Structure, Common Manganese Coatings, Few Macropores, Damp	3	
Bt₃ - (4.0' to 5.5') Yellowish Red/Yellowish Brown Sandy CLAY, Trace Gravel; Massive/Single-Grain Structure, Damp	4	
CR - (5.5' to 8.0') Yellowish Brown Clayey SILT with Sand and Weathered DOLOMITE; Massive/Single-Grain Structure, Moist	5	
	6	
	7	
Bottom of Pit - 8.0'	8	Groundwater Not Encountered
	9	
	10	
	11	
	12	
	13	



The groundwork for success.

Test Pit Log

Project: Campus Living

Date Performed: 5/16/2013

Location: Ferguson Township, Centre County, PA

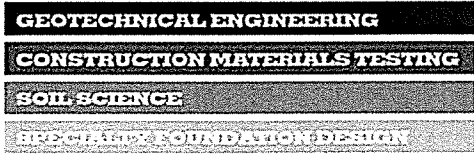
CMT File Number: 1313800

Client: PennTerra Engineering, Inc.

Location: TP-10

Excavation Equipment: Backhoe

Description	Depth (Feet)	Remarks
Ap - (0 to 8") TOPSOIL: Dark Brown Clayey SILT with Sand and Organic Matter; Granular Structure, Many Macropores, Damp	1	
Bt₁ - (8" to 1.9') Yellowish Red Silty CLAY, Trace Sand and Gravel; Fine Sub-Angular Blocky Structure, Common Macropores, Damp	2	
Bt₂ - (1.9' to 3.0') Yellowish Red Silty CLAY with Sand, Trace Gravel; Few Cobbles, Medium Sub-Angular Blocky Structure, Common Macropores, Damp	3	
R₁ - (3.0' to 5.0') Gray Weathered DOLOMITE with Clay-Filled Fractures; Broken, Moist	4	
R₂ - (5.0' to 7.0') Gray Weathered DOLOMITE, Trace Clay; Slightly Broken, Hard, Damp	5	
	6	
	7	
Bottom of Pit - 7.0'	7	7.0': Infiltration Test IT10A
	8	Groundwater Not Encountered
	9	
	10	
	11	
	12	
	13	



The groundwork for success.

Test Pit Log

Project: Campus Living

Date Performed: 5/16/2013

Location: Ferguson Township, Centre County, PA

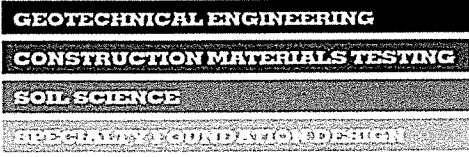
CMT File Number: 1313800

Client: PennTerra Engineering, Inc.

Location: TP-11

Excavation Equipment: Backhoe

Description	Depth (Feet)	Remarks
Ap - (0 to 15") TOPSOIL: Dark Brown Clayey SILT with Sand and Organic Matter; Granular Structure, Many Macropores, Damp	1	3.0': Infiltration Tests IT11A & IT11B
BE - (15" to 1.7') Yellowish Brown Clayey SILT with Sand, Trace Gravel; Fine Sub-Angular Blocky Structure, Common Macropores, Damp	2	
Bt - (1.7' to 4.5') Brown Silty CLAY with Sand, Trace Gravel; Coarse Sub-Angular Blocky Structure, Few Macropores, Moist	3	
—	4	
BR - (4.5' to 6.5') Gray Weathered DOLOMITE and CLAY (Cobbles and Boulders in Clay Matrix); Medium Sub-Angular Blocky Structure (Clay), Damp	5	6.5': Infiltration Test IT11C
—	6	
Bottom of Pit - 6.5'	7	Groundwater Not Encountered
	8	
	9	
	10	
	11	
	12	
	13	



The groundwork for success.

Test Pit Log

Project: Campus Living

Date Performed: 5/16/2013

Location: Ferguson Township, Centre County, PA

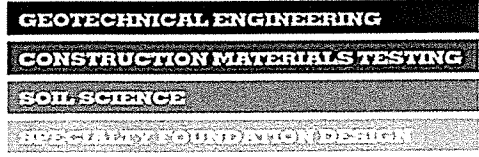
CMT File Number: 1313800

Client: PennTerra Engineering, Inc.

Location: TP-12

Excavation Equipment: Backhoe

Description	Depth (Feet)	Remarks
Ap - (0 to 11") TOPSOIL: Dark Brown Clayey SILT with Sand and Organic Matter: Granular Structure, Many Macropores, Damp	1	
BE - (11" to 1.5') Yellowish Brown Clayey SILT with Sand, Trace Gravel; Fine to Medium Sub-Angular Blocky Structure, Common Macropores, Damp	2	
Bt₁ - (1.5' to 4.5') Brown Sandy CLAY, Trace Gravel; Coarse Sub-Angular Blocky Structure, Few Macropores, Moist	3	
	4	
Bt₂ - (4.5' to 7.0') Brown Clayey SAND with Gravel; Dense, Massive/Single-Grain Structure, Common Manganese Coatings, Moist	5	4.5': Infiltration Tests IT12A & IT12B
	6	
Bottom of Pit - 7.0'	7	Groundwater Not Encountered
	8	
	9	
	10	
	11	
	12	
	13	



The groundwork for success.

Test Pit Log

Project: Campus Living

Date Performed: 5/16/2013

Location: Ferguson Township, Centre County, PA

CMT File Number: 1313800

Client: PennTerra Engineering, Inc.

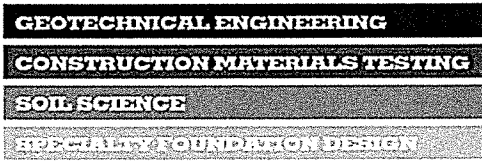
Location: TP-13

Excavation Equipment: Backhoe

Description	Depth (Feet)	Remarks
Ap - (0 to 3") TOPSOIL: Dark Brown Clayey SILT with Sand and Organic Matter; Granular Structure, Many Macropores, Damp	1	Surface: Rock outcrops in area.
BR - (3" to 3.0') Gray Weathered DOLOMITE and CLAY (Cobbles and Boulders in Clay Matrix); Fine to Medium Sub-Angular Blocky Structure (Clay), Damp	2	
R - (3.0' to 5.5') Gray Weathered DOLOMITE, Trace Clay; Slightly Broken, Hard, Damp	3	
	4	
	5	
Bottom of Pit - 5.5'	6	5.5': Excavation Refusal 5.5': Infiltration Test IT13A
	7	Groundwater Not Encountered
	8	
	9	
	10	
	11	
	12	
	13	

APPENDIX C

Infiltration Test Results



The groundwork for success.

Infiltration Test (Double-Ring Infiltrometer)

Project: Campus Living **Date:** 5/16/2013
Location: Ferguson Township, Centre County, PA **CMT File No.:** 1313800
Client: PennTerra Engineering, Inc.

Test Location: IT1A (Test Pit TP-1)

Test Apparatus Data						
Inner Ring Diameter: 6 in						
Outer Ring Diameter: 12 in						
Test Depth: 3.0 ft						
Soil Tested: Strong Brown Sandy Clay, Little Gravel						

Date	Time	Time Interval (min)	Initial Water Height (ft)	Measured Water Drop (ft)	Final Water Height (ft)	Infiltration Rate for Time Interval (in/hr)
5/16/2013	1:20 PM	Start				
	1:50 PM	30	0.43	0.05	0.38	1.20
	2:20 PM	30	0.43	0.05	0.38	1.20
	2:50 PM	30	0.43	0.06	0.37	1.44
	3:20 PM	30	0.43	0.06	0.37	1.44
Average:						1.32
Minimum Safety Factor:						2
Recommended Maximum Design Infiltration Rate (in/hr):						0.66

Note: Test was conducted in accordance with the Double-Ring Infiltrometer Test procedures outlined in the December 2006 PADEP Stormwater BMP Manual.



cmt
LABS

GEOTECHNICAL ENGINEERING

CONSTRUCTION MATERIALS TESTING

SOIL SCIENCE

SPECIALTY FOUNDATION DESIGN

The groundwork for success.

Infiltration Test (Double-Ring Infiltrometer)

Project: Campus Living
Location: Ferguson Township, Centre County, PA
Client: PennTerra Engineering, Inc.

Date: 5/16/2013
CMT File No.: 1313800

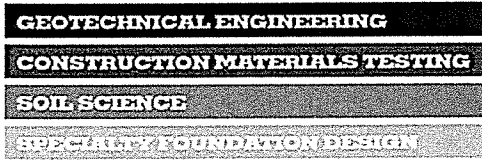
Test Location: IT1B (Test Pit TP-1)

Test Apparatus Data

Inner Ring Diameter: 6 in
Outer Ring Diameter: 12 in
Test Depth: 3.0 ft
Soil Tested: Strong Brown Sandy Clay, Little Gravel

Date	Time	Time Interval (min)	Initial Water Height (ft)	Measured Water Drop (ft)	Final Water Height (ft)	Infiltration Rate for Time Interval (in/hr)
5/16/2013	1:21 PM	Start				
	1:51 PM	30	0.40	0.13	0.27	3.12
	2:21 PM	30	0.40	0.08	0.32	1.92
	2:51 PM	30	0.40	0.08	0.32	1.92
	3:21 PM	30	0.40	0.06	0.34	1.44
	3:51 PM	30	0.40	0.08	0.32	1.92
Average:						2.06
Minimum Safety Factor:						2
Recommended Maximum Design Infiltration Rate (in/hr):						0.96

Note: Test was conducted in accordance with the Double-Ring Infiltrometer Test procedures outlined in the December 2006 PADEP Stormwater BMP Manual.



The groundwork for success.

Infiltration Test (Non-Conventional Method)

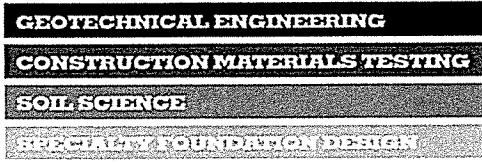
Project: Campus Living **Date:** 5/16/2013
Location: Ferguson Township, Centre County, PA **CMT File No.:** 1313800
Client: PennTerra Engineering, Inc.

Test Location: IT1C (Test Pit TP-1)

Test Data	
Test Hole Length (ft):	3.0
Test Hole Width (ft):	2.0
Test Hole Height (in):	4
Test Depth:	10.0 ft
Material tested:	Gray Weathered Dolomite with Clay

Date	Time Water Added	Volume of Water Added (gal)	Time Water Drained	Time Interval (min)	Apparent Infiltration Rate for Time Interval (in/hr)
5/16/2013	12:45 PM	25	3:44 PM	179	2.24
Safety Factor					See Note

Note: We believe the above infiltration test method is useful in demonstrating the general permeability of the material tested. However, we do not believe the results should be used without applying reasonable safety factors.



The groundwork for success.

Infiltration Test (Double-Ring Infiltrometer)

Project: Campus Living
Location: Ferguson Township, Centre County, PA
Client: PennTerra Engineering, Inc.

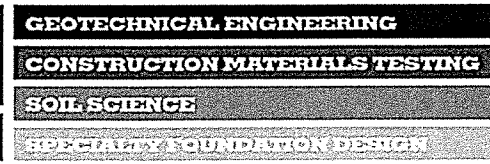
Date: 5/16/2013
CMT File No.: 1313800

Test Location: IT2A (Test Pit TP-2)

Test Apparatus Data	
Inner Ring Diameter:	6 in
Outer Ring Diameter:	12 in
Test Depth:	2.5 ft
Soil Tested:	Strong Brown Silty Clay with Sand, Trace Gravel

Date	Time	Time Interval (min)	Initial Water Height (ft)	Measured Water Drop (ft)	Final Water Height (ft)	Infiltration Rate for Time Interval (in/hr)
5/16/2013	1:22 PM	Start				
	1:52 PM	30	0.38	0.08	0.30	1.92
	2:22 PM	30	0.38	0.10	0.28	2.40
	2:52 PM	30	0.38	0.08	0.30	1.92
	3:22 PM	30	0.38	0.09	0.29	2.16
Average:						2.10
Minimum Safety Factor:						2
Recommended Maximum Design Infiltration Rate (in/hr):						1.05

Note: Test was conducted in accordance with the Double-Ring Infiltrometer Test procedures outlined in the December 2006 PADEP Stormwater BMP Manual.



The groundwork for success.

Infiltration Test (Double-Ring Infiltrometer)

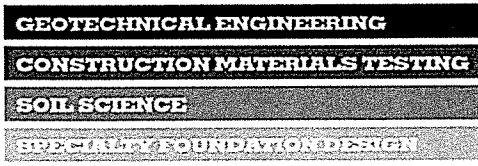
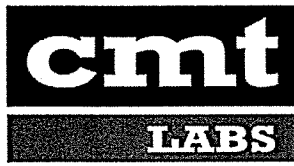
Project: Campus Living **Date:** 5/16/2013
Location: Ferguson Township, Centre County, PA **CMT File No.:** 1313800
Client: PennTerra Engineering, Inc.

Test Location: IT2B (Test Pit TP-2)

Test Apparatus Data	
Inner Ring Diameter:	6 in
Outer Ring Diameter:	12 in
Test Depth:	2.5 ft
Soil Tested:	Strong Brown Silty Clay with Sand, Trace Gravel

Date	Time	Time Interval (min)	Initial Water Height (ft)	Measured Water Drop (ft)	Final Water Height (ft)	Infiltration Rate for Time Interval (in/hr)
5/16/2013	1:23 PM	Start				
	1:53 PM	30	0.42	0.17	0.25	4.08
	2:23 PM	30	0.42	0.16	0.26	3.84
	2:53 PM	30	0.42	0.15	0.27	3.60
	3:23 PM	30	0.42	0.17	0.25	4.08
Average:						3.90
Minimum Safety Factor:						2
Recommended Maximum Design Infiltration Rate (in/hr):						1.95

Note: Test was conducted in accordance with the Double-Ring Infiltrometer Test procedures outlined in the December 2006 PADEP Stormwater BMP Manual.



The groundwork for success.

Infiltration Test (Non-Conventional Method)

Project: Campus Living
Location: Ferguson Township, Centre County, PA
Client: PennTerra Engineering, Inc.

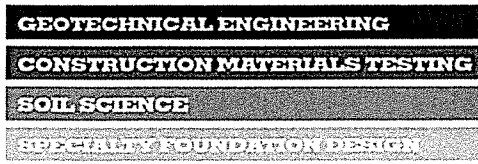
Date: 5/17/2013
CMT File No.: 1313800

Test Location: IT2C (Test Pit TP-2)

Test Data	
Test Hole Length (ft):	2.0
Test Hole Width (ft):	2.5
Test Hole Height (in):	5
Test Depth:	9.5 ft
Material tested:	Gray Weathered Dolomite with Clay

Date	Time Water Added	Volume of Water Added (gal)	Time Water Drained	Time Interval (min)	Apparent Infiltration Rate for Time Interval (in/hr)
5/17/2013	9:50 AM	112.5	10:10 AM	20	108.29
Safety Factor					See Note

Note: We believe the above infiltration test method is useful in demonstrating the general permeability of the material tested. However, we do not believe the results should be used without applying reasonable safety factors.



The groundwork for success.

Infiltration Test (Non-Conventional Method)

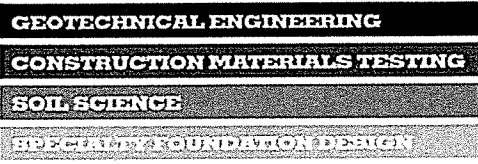
Project: Campus Living **Date:** 5/17/2013
Location: Ferguson Township, Centre County, PA **CMT File No.:** 1313800
Client: PennTerra Engineering, Inc.

Test Location: IT3A (Test Pit TP-3)

Test Data	
Test Hole Length (ft):	4.8
Test Hole Width (ft):	2.4
Test Hole Height (in):	6
Test Depth:	7.5 ft
Material tested:	Gray Weathered Dolomite with Clay

Date	Time Water Added	Volume of Water Added (gal)	Time Water Drained	Time Interval (min)	Apparent Infiltration Rate for Time Interval (in/hr)
5/17/2013	10:12 AM	112.5	11:38 AM	86	10.93
Safety Factor					See Note

Note: We believe the above infiltration test method is useful in demonstrating the general permeability of the material tested. However, we do not believe the results should be used without applying reasonable safety factors.



The groundwork for success.

Infiltration Test (Double-Ring Infiltrometer)

Project: Campus Living
Location: Ferguson Township, Centre County, PA
Client: PennTerra Engineering, Inc.

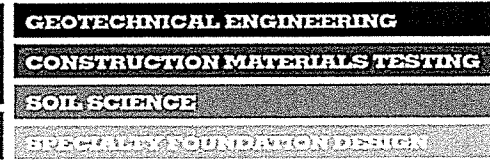
Date: 5/16/2013
CMT File No.: 1313800

Test Location: IT4A (Test Pit TP-4)

<u>Test Apparatus Data</u>	
Inner Ring Diameter:	6 in
Outer Ring Diameter:	12 in
Test Depth:	4.0 ft
Soil Tested:	Yellowish Red Silty Clay with Sand, Trace Gravel

Date	Time	Time Interval (min)	Initial Water Height (ft)	Measured Water Drop (ft)	Final Water Height (ft)	Infiltration Rate for Time Interval (in/hr)
5/16/2013	1:28 PM	Start				
	1:58 PM	30	0.43	0.03	0.40	0.72
	2:28 PM	30	0.43	0.02	0.41	0.48
	2:58 PM	30	0.43	0.03	0.40	0.72
	3:28 PM	30	0.43	0.03	0.40	0.72
Average:						0.66
Minimum Safety Factor:						2
Recommended Maximum Design Infiltration Rate (in/hr):						0.33

Note: Test was conducted in accordance with the Double-Ring Infiltrometer Test procedures outlined in the December 2006 PADEP Stormwater BMP Manual.



The groundwork for success.

Infiltration Test (Double-Ring Infiltrometer)

Project: Campus Living
Location: Ferguson Township, Centre County, PA
Client: PennTerra Engineering, Inc.

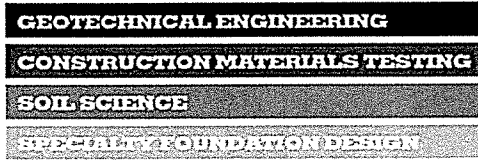
Date: 5/16/2013
CMT File No.: 1313800

Test Location: IT4B (Test Pit TP-4)

<u>Test Apparatus Data</u>	
Inner Ring Diameter:	6 in
Outer Ring Diameter:	12 in
Test Depth:	4.0 ft
Soil Tested:	Yellowish Red Silty Clay with Sand, Trace Gravel

Date	Time	Time Interval (min)	Initial Water Height (ft)	Measured Water Drop (ft)	Final Water Height (ft)	Infiltration Rate for Time Interval (in/hr)
5/16/2013	1:29 PM	Start				
	1:59 PM	30	0.40	0.02	0.38	0.48
	2:29 PM	30	0.40	0.03	0.37	0.72
	2:59 PM	30	0.40	0.04	0.36	0.96
	3:29 PM	30	0.40	0.04	0.36	0.96
Average:						0.78
Minimum Safety Factor:						2
Recommended Maximum Design Infiltration Rate (in/hr):						0.39

Note: Test was conducted in accordance with the Double-Ring Infiltrometer Test procedures outlined in the December 2006 PADEP Stormwater BMP Manual.



The groundwork for success.

Infiltration Test (Non-Conventional Method)

Project: Campus Living
Location: Ferguson Township, Centre County, PA
Client: PennTerra Engineering, Inc.

Date: 5/17/2013
CMT File No.: 1313800

Test Location: IT4C (Test Pit TP-4)

Test Data	
Test Hole Length (ft):	3.0
Test Hole Width (ft):	2.0
Test Hole Height (in):	6
Test Depth:	7.5 ft
Material tested:	Gray Dolomite; Few Fractures

Date	Time Water Added	Volume of Water Added (gal)	Time Water Drained	Time Interval (min)	Apparent Infiltration Rate for Time Interval (in/hr)
5/17/2013	6:50 AM	50	8:33 AM	103	7.79
Safety Factor					See Note

Note: We believe the above infiltration test method is useful in demonstrating the general permeability of the material tested. However, we do not believe the results should be used without applying reasonable safety factors.



GEOTECHNICAL ENGINEERING
CONSTRUCTION MATERIALS TESTING
SOIL SCIENCE
SUBSURFACE FOUNDATION DESIGN

The groundwork for success.

Infiltration Test (Double-Ring Infiltrometer)

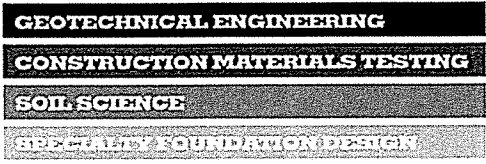
Project: Campus Living **Date:** 5/16/2013
Location: Ferguson Township, Centre County, PA **CMT File No.:** 1313800
Client: PennTerra Engineering, Inc.

Test Location: IT5A (Test Pit TP-5)

<u>Test Apparatus Data</u>
Inner Ring Diameter: 6 in
Outer Ring Diameter: 12 in
Test Depth: 2.0 ft
Soil Tested: Strong Brown Silty Clay with Sand, Trace Gravel

Date	Time	Time Interval (min)	Initial Water Height (ft)	Measured Water Drop (ft)	Final Water Height (ft)	Infiltration Rate for Time Interval (in/hr)
5/16/2013	1:31 PM	Start				
	2:01 PM	30	0.39	0.32	0.07	7.68
	2:31 PM	30	0.39	0.24	0.15	5.76
	3:01 PM	30	0.39	0.24	0.15	5.76
	3:31 PM	30	0.39	0.23	0.16	5.52
	4:01 PM	30	0.39	0.23	0.16	5.52
Average:						6.05
Minimum Safety Factor:						2
Recommended Maximum Design Infiltration Rate (in/hr):						2.76

Note: Test was conducted in accordance with the Double-Ring Infiltrometer Test procedures outlined in the December 2006 PADEP Stormwater BMP Manual.



The groundwork for success.

Infiltration Test (Double-Ring Infiltrometer)

Project: Campus Living
Location: Ferguson Township, Centre County, PA
Client: PennTerra Engineering, Inc.

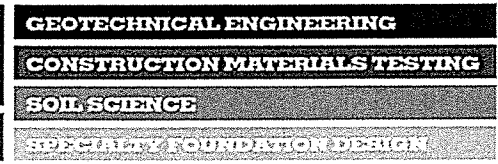
Date: 5/16/2013
CMT File No.: 1313800

Test Location: IT5B (Test Pit TP-5)

Test Apparatus Data	
Inner Ring Diameter:	6 in
Outer Ring Diameter:	12 in
Test Depth:	2.0 ft
Soil Tested:	Strong Brown Silty Clay with Sand, Trace Gravel

Date	Time	Time Interval (min)	Initial Water Height (ft)	Measured Water Drop (ft)	Final Water Height (ft)	Infiltration Rate for Time Interval (in/hr)
5/16/2013	1:32 PM	Start				
	2:02 PM	30	0.41	0.16	0.25	3.84
	2:32 PM	30	0.41	0.14	0.27	3.36
	3:02 PM	30	0.41	0.14	0.27	3.36
	3:32 PM	30	0.41	0.16	0.25	3.84
Average:						3.60
Minimum Safety Factor:						2
Recommended Maximum Design Infiltration Rate (in/hr):						1.80

Note: Test was conducted in accordance with the Double-Ring Infiltrometer Test procedures outlined in the December 2006 PADEP Stormwater BMP Manual.



The groundwork for success.

Infiltration Test (Non-Conventional Method)

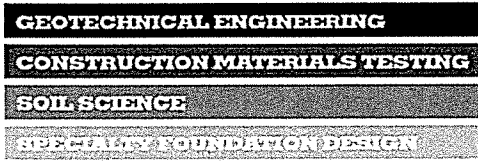
Project: Campus Living Date: 5/17/2013
 Location: Ferguson Township, Centre County, PA CMT File No.: 1313800
 Client: PennTerra Engineering, Inc.

Test Location: IT5C (Test Pit TP-5)

Test Data	
Test Hole Length (ft):	3.5
Test Hole Width (ft):	2.2
Test Hole Height (in):	4
Test Depth:	8.0 ft
Material tested:	Gray Weathered Dolomite with Clay

Date	Time Water Added	Volume of Water Added (gal)	Time Water Drained	Time Interval (min)	Apparent Infiltration Rate for Time Interval (in/hr)
5/17/2013	12:38 PM	85	1:43 PM	65	16.35
Safety Factor					See Note

Note: We believe the above infiltration test method is useful in demonstrating the general permeability of the material tested. However, we do not believe the results should be used without applying reasonable safety factors.



The groundwork for success.

Infiltration Test (Double-Ring Infiltrometer)

Project: Campus Living
Location: Ferguson Township, Centre County, PA
Client: PennTerra Engineering, Inc.

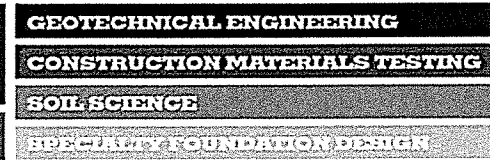
Date: 5/16/2013
CMT File No.: 1313800

Test Location: IT6A (Test Pit TP-6)

Test Apparatus Data	
Inner Ring Diameter:	6 in
Outer Ring Diameter:	12 in
Test Depth:	4.0 ft
Soil Tested:	Yellowish Red Silty Clay with Sand, Trace Gravel

Date	Time	Time Interval (min)	Initial Water Height (ft)	Measured Water Drop (ft)	Final Water Height (ft)	Infiltration Rate for Time Interval (in/hr)
5/16/2013	1:25 PM	Start				
	1:55 PM	30	0.38	0.08	0.30	1.92
	2:25 PM	30	0.38	0.04	0.34	0.96
	2:55 PM	30	0.38	0.03	0.35	0.72
	3:25 PM	30	0.38	0.05	0.33	1.20
	3:55 PM	30	0.38	0.05	0.33	1.20
Average:						1.20
Minimum Safety Factor:						2
Recommended Maximum Design Infiltration Rate (in/hr):						0.60

Note: Test was conducted in accordance with the Double-Ring Infiltrometer Test procedures outlined in the December 2006 PADEP Stormwater BMP Manual.



The groundwork for success.

Infiltration Test (Double-Ring Infiltrometer)

Project: Campus Living
Location: Ferguson Township, Centre County, PA
Client: PennTerra Engineering, Inc.

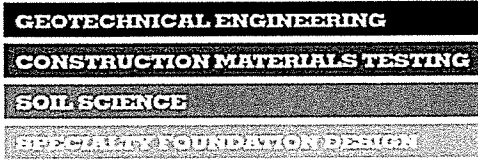
Date: 5/16/2013
CMT File No.: 1313800

Test Location: IT6B (Test Pit TP-6)

Test Apparatus Data	
Inner Ring Diameter:	6 in
Outer Ring Diameter:	12 in
Test Depth:	4.0 ft
Soil Tested:	Yellowish Red Silty Clay with Sand, Trace Gravel

Date	Time	Time Interval (min)	Initial Water Height (ft)	Measured Water Drop (ft)	Final Water Height (ft)	Infiltration Rate for Time Interval (in/hr)
5/16/2013	1:26 PM	Start				
	1:56 PM	30	0.43	0.07	0.36	1.68
	2:26 PM	30	0.43	0.06	0.37	1.44
	2:56 PM	30	0.43	0.05	0.38	1.20
	3:26 PM	30	0.43	0.05	0.38	1.20
Average:						1.38
Minimum Safety Factor:						2
Recommended Maximum Design Infiltration Rate (in/hr):						0.60

Note: Test was conducted in accordance with the Double-Ring Infiltrometer Test procedures outlined in the December 2006 PADEP Stormwater BMP Manual.



The groundwork for success.

Infiltration Test (Non-Conventional Method)

Project: Campus Living
Location: Ferguson Township, Centre County, PA
Client: PennTerra Engineering, Inc.

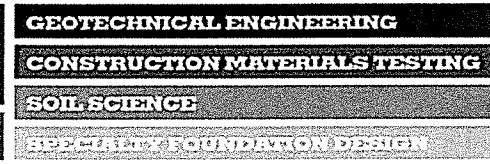
Date: 5/17/2013
CMT File No.: 1313800

Test Location: IT6C (Test Pit TP-6)

Test Data	
Test Hole Length (ft):	3.0
Test Hole Width (ft):	2.5
Test Hole Height (in):	4
Test Depth:	8.5 ft
Material tested:	Gray Weathered Dolomite, Trace Clay

Date	Time Water Added	Volume of Water Added (gal)	Time Water Drained	Time Interval (min)	Apparent Infiltration Rate for Time Interval (in/hr)
5/17/2013	12:07 PM	65	12:45 PM	38	21.95
Safety Factor					See Note

Note: We believe the above infiltration test method is useful in demonstrating the general permeability of the material tested. However, we do not believe the results should be used without applying reasonable safety factors.



The groundwork for success.

Infiltration Test (Non-Conventional Method)

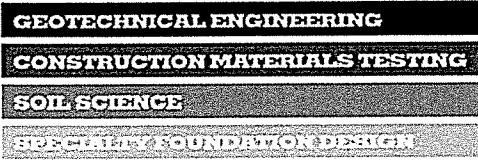
Project: Campus Living **Date:** 5/17/2013
Location: Ferguson Township, Centre County, PA **CMT File No.:** 1313800
Client: PennTerra Engineering, Inc.

Test Location: IT7A (Test Pit TP-7)

Test Data	
Test Hole Length (ft):	2.5
Test Hole Width (ft):	2.5
Test Hole Height (in):	4
Test Depth:	5.0 ft
Material tested:	Gray Weathered Dolomite, Trace Clay

Date	Time Water Added	Volume of Water Added (gal)	Time Water Drained	Time Interval (min)	Apparent Infiltration Rate for Time Interval (in/hr)
5/17/2013	11:40 AM	75	12:05 PM	25	46.20
				Safety Factor	See Note

Note: We believe the above infiltration test method is useful in demonstrating the general permeability of the material tested. However, we do not believe the results should be used without applying reasonable safety factors.



The groundwork for success.

Infiltration Test (Double-Ring Infiltrometer)

Project: Campus Living
Location: Ferguson Township, Centre County, PA
Client: PennTerra Engineering, Inc.

Date: 5/16/2013
CMT File No.: 1313800

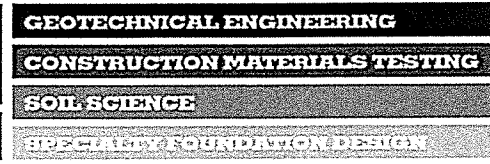
Test Location: IT8A (Test Pit TP-8)

Test Apparatus Data

Inner Ring Diameter: 6 in
Outer Ring Diameter: 12 in
Test Depth: 1.5 ft
Soil Tested: Yellowish Red Silty Clay with Sand and Gravel

Date	Time	Time Interval (min)	Initial Water Height (ft)	Measured Water Drop (ft)	Final Water Height (ft)	Infiltration Rate for Time Interval (in/hr)
5/16/2013	1:41 PM	Start				
	2:11 PM	30	0.37	0.23	0.14	5.52
	2:41 PM	30	0.37	0.16	0.21	3.84
	3:11 PM	30	0.37	0.15	0.22	3.60
	3:41 PM	30	0.37	0.15	0.22	3.60
	4:11 PM	30	0.37	0.14	0.23	3.36
Average:						3.98
Minimum Safety Factor:						2
Recommended Maximum Design Infiltration Rate (in/hr):						1.68

Note: Test was conducted in accordance with the Double-Ring Infiltrometer Test procedures outlined in the December 2006 PADEP Stormwater BMP Manual.



The groundwork for success.

Infiltration Test (Double-Ring Infiltrometer)

Project: Campus Living
Location: Ferguson Township, Centre County, PA
Client: PennTerra Engineering, Inc.

Date: 5/16/2013
CMT File No.: 1313800

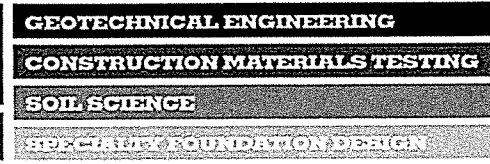
Test Location: IT8B (Test Pit TP-8)

Test Apparatus Data

Inner Ring Diameter: 6 in
Outer Ring Diameter: 12 in
Test Depth: 1.5 ft
Soil Tested: Yellowish Red Silty Clay with Sand and Gravel

Date	Time	Time Interval (min)	Initial Water Height (ft)	Measured Water Drop (ft)	Final Water Height (ft)	Infiltration Rate for Time Interval (in/hr)
5/16/2013	1:42 PM	Start				
	2:12 PM	30	0.39	0.09	0.30	2.16
	2:42 PM	30	0.39	0.04	0.35	0.96
	3:12 PM	30	0.39	0.05	0.34	1.20
	3:42 PM	30	0.39	0.05	0.34	1.20
	4:12 PM	30	0.39	0.04	0.35	0.96
Average:						1.30
Minimum Safety Factor:						2
Recommended Maximum Design Infiltration Rate (in/hr):						0.48

Note: Test was conducted in accordance with the Double-Ring Infiltrometer Test procedures outlined in the December 2006 PADEP Stormwater BMP Manual.



The groundwork for success.

Infiltration Test (Double-Ring Infiltrometer)

Project: Campus Living
Location: Ferguson Township, Centre County, PA
Client: PennTerra Engineering, Inc.

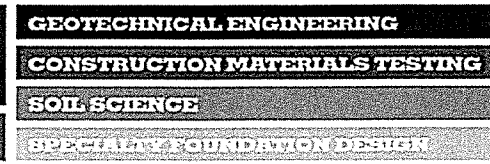
Date: 5/16/2013
CMT File No.: 1313800

Test Location: IT9A (Test Pit TP-9)

Test Apparatus Data	
Inner Ring Diameter:	6 in
Outer Ring Diameter:	12 in
Test Depth:	4.0 ft
Soil Tested:	Yellowish Red Sandy Clay, Trace Gravel

Date	Time	Time Interval (min)	Initial Water Height (ft)	Measured Water Drop (ft)	Final Water Height (ft)	Infiltration Rate for Time Interval (in/hr)
5/16/2013	1:39 PM	Start				
	2:09 PM	30	0.43	0.34	0.09	8.16
	2:39 PM	30	0.43	0.21	0.22	5.04
	3:09 PM	30	0.43	0.22	0.21	5.28
	3:39 PM	30	0.43	0.20	0.23	4.80
	4:09 PM	30	0.43	0.20	0.23	4.80
Average:						5.62
Minimum Safety Factor:						2
Recommended Maximum Design Infiltration Rate (in/hr):						2.40

Note: Test was conducted in accordance with the Double-Ring Infiltrometer Test procedures outlined in the December 2006 PADEP Stormwater BMP Manual.



The groundwork for success.

Infiltration Test (Double-Ring Infiltrometer)

Project: Campus Living
Location: Ferguson Township, Centre County, PA
Client: PennTerra Engineering, Inc.

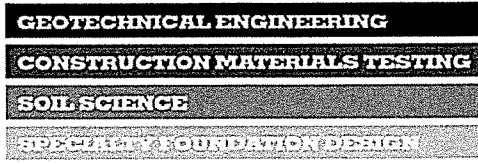
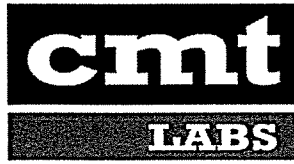
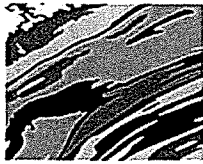
Date: 5/16/2013
CMT File No.: 1313800

Test Location: IT9B (Test Pit TP-9)

Test Apparatus Data	
Inner Ring Diameter:	6 in
Outer Ring Diameter:	12 in
Test Depth:	4.0 ft
Soil Tested:	Yellowish Red Sandy Clay, Trace Gravel

Date	Time	Time Interval (min)	Initial Water Height (ft)	Measured Water Drop (ft)	Final Water Height (ft)	Infiltration Rate for Time Interval (in/hr)
5/16/2013	1:40 PM	Start				
	2:10 PM	30	0.40	0.24	0.16	5.76
	2:40 PM	30	0.40	0.15	0.25	3.60
	3:10 PM	30	0.40	0.14	0.26	3.36
	3:40 PM	30	0.40	0.13	0.27	3.12
	4:10 PM	30	0.40	0.13	0.27	3.12
Average:						3.79
Minimum Safety Factor:						2
Recommended Maximum Design Infiltration Rate (in/hr):						1.56

Note: Test was conducted in accordance with the Double-Ring Infiltrometer Test procedures outlined in the December 2006 PADEP Stormwater BMP Manual.



The groundwork for success.

Infiltration Test (Non-Conventional Method)

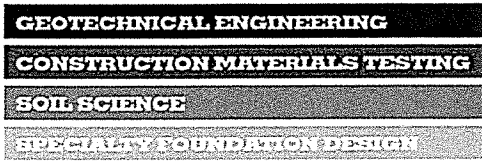
Project: Campus Living **Date:** 5/17/2013
Location: Ferguson Township, Centre County, PA **CMT File No.:** 1313800
Client: PennTerra Engineering, Inc.

Test Location: IT10A (Test Pit TP-10)

Test Data	
Test Hole Length (ft):	2.5
Test Hole Width (ft):	2.5
Test Hole Height (in):	6
Test Depth:	7.0 ft
Material tested:	Gray Weathered Dolomite, Trace Clay

Date	Time Water Added	Volume of Water Added (gal)	Time Water Drained	Time Interval (min)	Apparent Infiltration Rate for Time Interval (in/hr)
5/17/2013	7:00 AM	50	8:28 AM	88	8.75
Safety Factor					See Note

Note: We believe the above infiltration test method is useful in demonstrating the general permeability of the material tested. However, we do not believe the results should be used without applying reasonable safety factors.



The groundwork for success.

Infiltration Test (Double-Ring Infiltrometer)

Project: Campus Living
Location: Ferguson Township, Centre County, PA
Client: PennTerra Engineering, Inc.

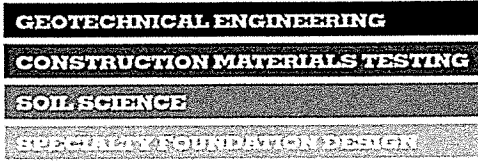
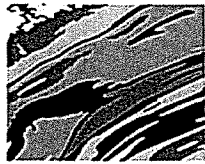
Date: 5/16/2013
CMT File No.: 1313800

Test Location: IT11A (Test Pit TP-11)

Test Apparatus Data	
Inner Ring Diameter:	6 in
Outer Ring Diameter:	12 in
Test Depth:	3.0 ft
Soil Tested:	Brown Silty Clay with Sand, Trace Gravel

Date	Time	Time Interval (min)	Initial Water Height (ft)	Measured Water Drop (ft)	Final Water Height (ft)	Infiltration Rate for Time Interval (in/hr)
5/16/2013	1:34 PM	Start				
	2:04 PM	30	0.44	0.10	0.34	2.40
	2:34 PM	30	0.44	0.08	0.36	1.92
	3:04 PM	30	0.44	0.09	0.35	2.16
	3:34 PM	30	0.44	0.08	0.36	1.92
Average:						2.10
Minimum Safety Factor:						2
Recommended Maximum Design Infiltration Rate (in/hr):						0.96

Note: Test was conducted in accordance with the Double-Ring Infiltrometer Test procedures outlined in the December 2006 PADEP Stormwater BMP Manual.



The groundwork for success.

Infiltration Test (Double-Ring Infiltrometer)

Project: Campus Living
Location: Ferguson Township, Centre County, PA
Client: PennTerra Engineering, Inc.

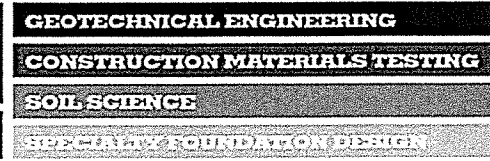
Date: 5/16/2013
CMT File No.: 1313800

Test Location: IT11B (Test Pit TP-11)

Test Apparatus Data	
Inner Ring Diameter:	6 in
Outer Ring Diameter:	12 in
Test Depth:	3.0 ft
Soil Tested:	Brown Silty Clay with Sand, Trace Gravel

Date	Time	Time Interval (min)	Initial Water Height (ft)	Measured Water Drop (ft)	Final Water Height (ft)	Infiltration Rate for Time Interval (in/hr)
5/16/2013	1:35 PM	Start				
	2:05 PM	30	0.42	0.22	0.20	5.28
	2:35 PM	30	0.42	0.20	0.22	4.80
	3:05 PM	30	0.42	0.20	0.22	4.80
	3:35 PM	30	0.42	0.19	0.23	4.56
	4:05 PM	30	0.42	0.18	0.24	4.32
Average:						4.75
Minimum Safety Factor:						2
Recommended Maximum Design Infiltration Rate (in/hr):						2.16

Note: Test was conducted in accordance with the Double-Ring Infiltrometer Test procedures outlined in the December 2006 PADEP Stormwater BMP Manual.



The groundwork for success.

Infiltration Test (Non-Conventional Method)

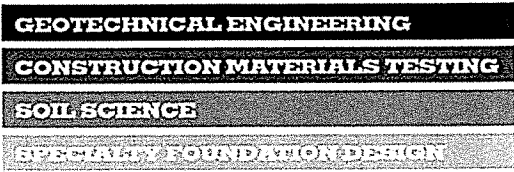
Project: Campus Living Date: 5/17/2013
 Location: Ferguson Township, Centre County, PA CMT File No.: 1313800
 Client: PennTerra Engineering, Inc.

Test Location: IT11C (Test Pit TP-11)

<u>Test Data</u>	
Test Hole Length (ft):	2.5
Test Hole Width (ft):	2.5
Test Hole Height (in):	6
Test Depth:	6.5 ft
Material tested:	Gray Weathered Dolomite and Clay

Date	Time Water Added	Volume of Water Added (gal)	Time Water Drained	Time Interval (min)	Apparent Infiltration Rate for Time Interval (in/hr)
5/17/2013	7:05 AM	50	8:18 AM	73	10.55
				Safety Factor	See Note

Note: We believe the above infiltration test method is useful in demonstrating the general permeability of the material tested. However, we do not believe the results should be used without applying reasonable safety factors.



The groundwork for success.

Infiltration Test (Uncased Hole)

Project: Campus Living
Location: Ferguson Township, Centre County, PA
Client: PennTerra Engineering, Inc.

Date: 5/16/2013
CMT File No.: 1313800

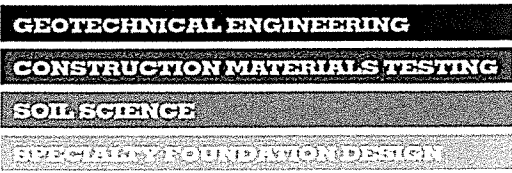
Test Location: IT12A (Test Pit TP-12)

Test Apparatus Data

Avg. Hole Diameter (in): 8.0
Test Depth: 4.5 ft
Soil Tested: Brown Clayey Sand with Gravel

Date	Time	Time Interval (min)	Initial Water Height (ft)	Measured Water Drop (ft)	Percolation Rate (in/hr)	Reduction Factor	Infiltration Rate (in/hr)	Min. Safety Factor	Recommended Max. Design Infiltration Rate (in/hr)
5/16/2013	1:36 PM	Start							
	2:06 PM	30	0.50	0.10					
	2:36 PM	30	0.50	0.09					
	3:06 PM	30	0.50	0.08					
	3:36 PM	30	0.50	0.09	2.16	2.37	0.91	2.5	0.37

Note: Test was conducted, and reduction factor/infiltration rate were calculated in accordance with the Percolation Test procedures outlined in the December 2006 PADEP Stormwater BMP Manual.



The groundwork for success.

Infiltration Test (Uncased Hole)

Project: Campus Living
Location: Ferguson Township, Centre County, PA
Client: PennTerra Engineering, Inc.

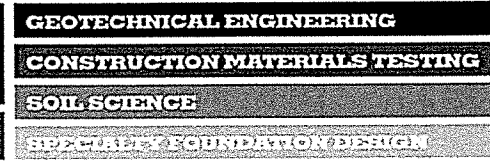
Date: 5/16/2013
CMT File No.: 1313800

Test Location: IT12B (Test Pit TP-12)

Test Apparatus Data									
Avg. Hole Diameter (in): 8.0									
Test Depth: 4.5 ft									
Soil Tested: Brown Clayey Sand with Gravel									

Date	Time	Time Interval (min)	Initial Water Height (ft)	Measured Water Drop (ft)	Percolation Rate (in/hr)	Reduction Factor	Infiltration Rate (in/hr)	Min. Safety Factor	Recommended Max. Design Infiltration Rate (in/hr)
5/16/2013	1:37 PM	Start							
	2:07 PM	30	0.50	0.18					
	2:37 PM	30	0.50	0.19					
	3:07 PM	30	0.50	0.18					
	3:37 PM	30	0.50	0.19	4.56	2.22	2.06	2.5	0.82

Note: Test was conducted, and reduction factor/infiltration rate were calculated in accordance with the Percolation Test procedures outlined in the December 2006 PADEP Stormwater BMP Manual.



The groundwork for success.

Infiltration Test (Non-Conventional Method)

Project: Campus Living
Location: Ferguson Township, Centre County, PA
Client: PennTerra Engineering, Inc.

Date: 5/17/2013
CMT File No.: 1313800

Test Location: IT13A (Test Pit TP-13)

Test Data	
Test Hole Length (ft):	2.5
Test Hole Width (ft):	2.5
Test Hole Height (in):	6
Test Depth:	5.5 ft
Material tested:	Gray Weathered Dolomite, Trace Clay

Date	Time Water Added	Volume of Water Added (gal)	Time Water Drained	Time Interval (min)	Apparent Infiltration Rate for Time Interval (in/hr)
5/17/2013	7:10 AM	75	8:13 AM	63	18.33
				Safety Factor	See Note

Note: We believe the above infiltration test method is useful in demonstrating the general permeability of the material tested. However, we do not believe the results should be used without applying reasonable safety factors.