O'BrienEngineering, Inc.
Hydraulics · Hydrology · Civil Engineering

TECHNICAL MEMORANDUM

To: Mr. Bob Cox
Cox Design Associates, Inc.
5121 Bee Cave Rd, #203
Austin, TX 8746

From: Jim O'Brien, PE, CFM, F.SAME
President

Date: June 16, 2016
Revised October 24, 2016

WISCONSIN
NORMAN JAMES
O'BRIEN
E-44908
COPPELL
TEXAS
PROFESSIONAL ENGINEER
October 27, 2016

RE: Water Quality Compliance for Four CLC Green Homes
Tomah VAMC, Tomah, Wisconsin

This Technical Memorandum is designed to provide information on the stormwater requirements for the site development, and how the planned development will meet those requirements. This memo is to be used in support of a Water Resources Application for Project Permits (WRAPP) and to document compliance with various federal requirements, as discussed below.

Development Introduction

The site is approximately 3.63 acres situated on the southeast corner of G Street and 4th Street (see **Exhibit 1** for the subject area). The pre-development condition consisted of short grass with scattered brush. The site was originally developed by the VA as a mowed grass open space used for a baseball field, which later became part of a golf course.

The existing condition includes two CLCs that replaced the baseball field that were built on the northern edge of the site, a parking lot extension on the southwest portion of the site, and three small interconnected stormwater ponds.

The post-development condition will include the two existing CLCs, the parking lot extension, two additional CLCs, and one dry detention pond to service all stormwater onsite. The drainage area of the site is approximately 5.64 acres, as shown on **Exhibit 1**, which also shows the proposed grading. The soil on site is classified by the NRCS as Hydrologic Soil Group A. The attached geotechnical report by Terracon Consultants, Inc., generally confirms the soil survey, with the exception of pockets of clay through the site. The nine borings throughout the site also indicated groundwater ranging from 1.5 to 6 feet below grade. Note, no design or permit documents were available that detail the function of the existing ponds.

The proposed project includes a dry detention pond that was designed to replace the smaller detention ponds that currently drain through a 12-inch storm sewer pipe to the southwest, as shown on the attached proposed site plan. The new pond will have a concrete apron endwall inlet structure with a 6-inch orifice and will tie into the existing 12-inch storm sewer. The pond will be located on the southeastern portion of the site and will be approximately 0.64 acres in area, 2 feet deep, and 1.08 acre-feet in volume with a 6:1 side slope.

Applicable State and Federal Stormwater Requirements

This VA project has to meet a number of state and federal requirements. One such regulation is the VA Site Development Design Manual for stormwater runoff, which references the Technical Guidance on Implementing Stormwater Runoff Requirements for Federal Projects under Section 438 of the Energy Independence and Security Act (EISA) of 2007. The EISA requires “the sponsor of any development or redevelopment project involving a Federal facility with a footprint that exceeds 5,000 square feet shall use site planning, design, construction, and maintenance strategies for the property to maintain or restore, to the maximum extent technically feasible, the predevelopment hydrology of the property with regard to the temperature, rate, volume, and duration of the flow.” This can be accomplished by one of two options: Retention of the 95th percentile rainfall event (Option 1), or through a site-specific hydrologic analysis (Option 2). Option 2 was chosen for this project, as discussed below.

The new institutional development post-construction standards of the Wisconsin DNR require detention of the 1-year and 2-year 24-hour storms. Also required for new development are the reduction of total suspended solids (TSS) by more than 80% and infiltration of more than 10% of post-development rainfall from the 2-year 24-hour storm. Redevelopment standards require only 40% TSS removal and does not require detention or infiltration, as outlined in the Wisconsin Administrative Code, Chapter NR 151. This site is considered redevelopment, which refers to “areas where development is replacing older development” as defined in NR 151.002.This means that only the 40% TSS removal applies to this site, although modeling was performed for detention and infiltration as well, as discussed below.

Site Development Stormwater Compliance

To comply with the various stormwater requirements mentioned above, two primary stormwater controls were utilized. First, about 53% of the site impervious area is indirectly connected. The proposed site plan has 2.03 acres of impervious area; 0.96 acres is directly connected, while 1.07 acres is indirectly connected. This means that runoff from the indirectly connected areas will drain across grass before entering a storm sewer or waterway. By draining across grassed areas, the runoff has a chance to infiltrate and be filtered by the grass to remove TSS. The 53% disconnected impervious area was determined using Wisconsin DRN guidelines, as discussed below.

The second control is a dry detention pond. This pond allows infiltration during smaller runoff events, filters the runoff to remove TSS, and detains peak flows during larger runoff events. As shown in Exhibit 1, the detention pond will replace the existing ponds on site and serve the same facilities, in addition to the two new CLC Green Homes.

Federal Regulations

As previously mentioned, “Option 2: Site-Specific Hydrological Analysis” of the Section 438 technical guidance document was used to establish and meet the federal performance design objective. This included calculating the 95th percentile storm event using historical rainfall data and developing pre-project and post-development runoff volume and peak flow discharges at the site. Daily rainfall data were obtained from the National Oceanic and Atmospheric Administration

(NOAA) Atlas 14 weather station in Necedah, Wisconsin, from 1974 to 2004 and used to calculate the 95th percentile storm total of 1.46 inches. For modeling purposes, the pre-project condition refers to the site as an open grass space before CLCs were constructed and includes a small portion of roadway within the drainage area. The post-project condition refers to the pre-developed condition with the addition of four CLCs (two existing, two proposed), the parking lot extension at the southwest corner, and the driveway. A portion of the post-project condition drains off-site (north and east) and is assumed to drain directly into a storm sewer system without treatment, infiltration, or detention. This is a conservative assumption, which overestimates the amount of offsite drainage, to limit the extent of additional analysis. The other portion drains to the detention pond through either vegetated swales and/or a storm sewer system.

The pond will detain the 50-year 24-hour storm while maintaining 1 foot of freeboard, as required in the design criteria for extended detention ponds Best Management Practice (BMP) found in Appendix B of the VA Site Development Design Manual. Detention for the 50-year 24-hour storm was modeled with the US Army Corps of Engineers (USACE) hydrologic modeling software HEC-HMS (Version 4.1) using the Natural Resource Conservation Service Technical Release 55 (TR-55) method to compare pre-project and post-project conditions. Composite Curve Numbers (CN) with disconnected impervious areas were calculated for the pre-project and post-project conditions using the definition of disconnection of rooftops and other impervious areas described in the Wisconsin Bureau of Watershed Management Program Guidance document titled "Modeling Post-Construction Storm Water Management Treatment", dated May 2015. **Table 1** shows the HEC-HMS hydrologic parameters. The Lag Time was shortened from 9 minutes in the pre-project condition to 6 minutes in the post-development condition. The Lag Time calculations are shown in **Table 2** and the pre-project and post-project flow paths are shown on **Exhibit 1**. The pre-project peak discharge is 2.3 cfs and post-development peak discharge would be approximately 2.3 cfs with a peak pond depth of 0.66 feet, allowing for 1.34 feet of freeboard in the 50 year runoff event without increasing the peak flow from the site, as shown in **Table 3**.

Water quality and infiltration were modeled using P8 (Version 3.5), which is approved by the Wisconsin Department of Natural Resources (DNR) and is designed to model water quality and infiltration, whereas HEC-HMS (used for the detention analysis) is not designed to model water quality and infiltration. The P8 software accounts for a variety of Best Management Practices, including indirectly connected impervious areas, vegetated swales, dry detention ponds, etc. The 95th percentile runoff volumes for pre-project and post-project conditions were modeled. Pre-project runoff would produce a volume of 0.03 acre-feet. Using a combination of the dry pond and 1.07 acres of indirectly connected impervious area, the post-development condition would produce a runoff volume of 0.03 acre-feet, this not increasing the runoff volume. Portions of directly connected and indirectly connected drain both off-site and to the detention pond, as shown in **Exhibit 1**. Input for the 95th percentile storm in P8 are shown in **Table 4**. The output for the 95th percentile storm event are shown in **Table 5**. The pond will allow the site to retain 100 percent of the post-development runoff volume based on the calculated 95th percentile storm event (1.46 inches) over the footprint of the project, as outlined in the above-mentioned guidance document for EISA Section 438.

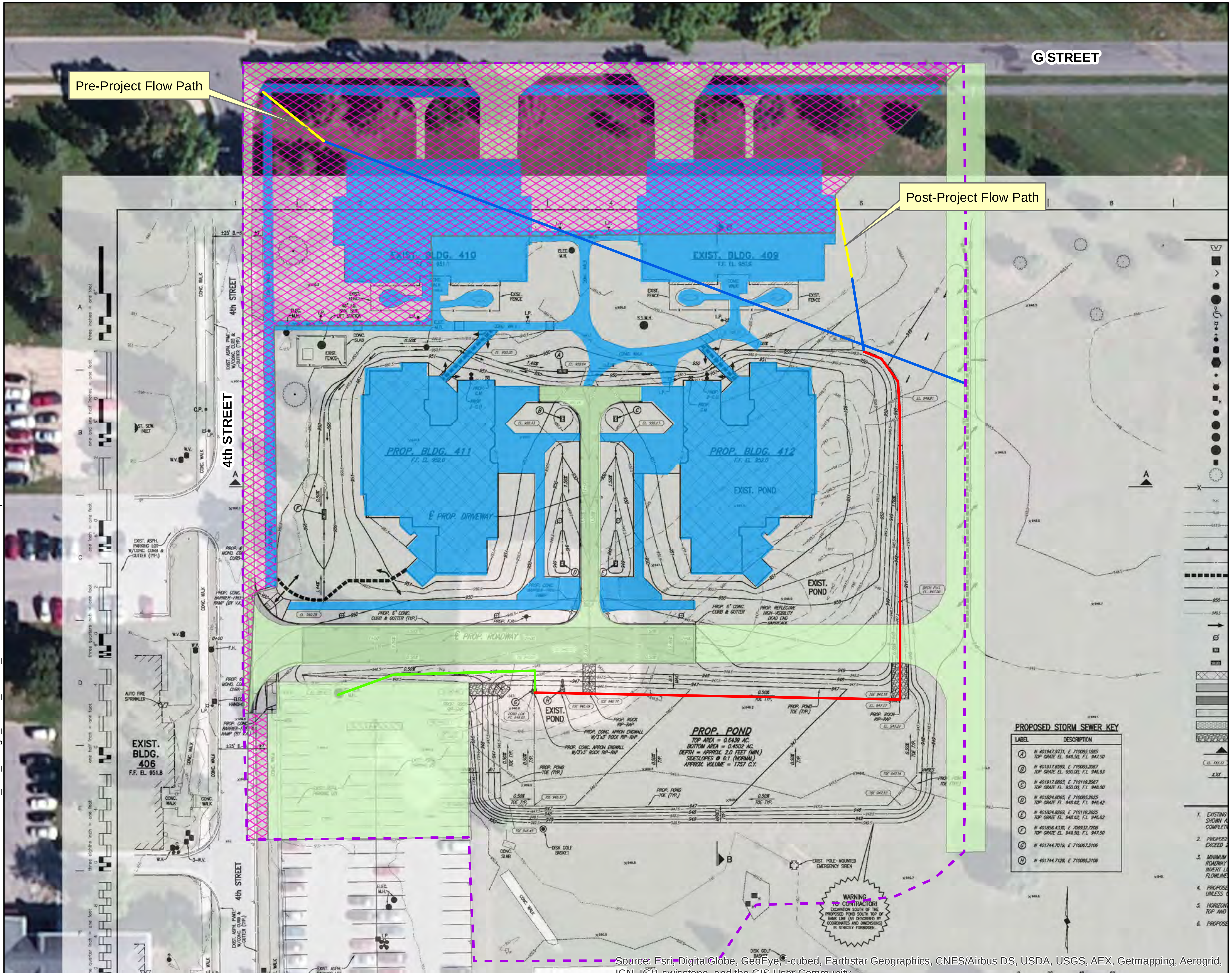
State Regulations

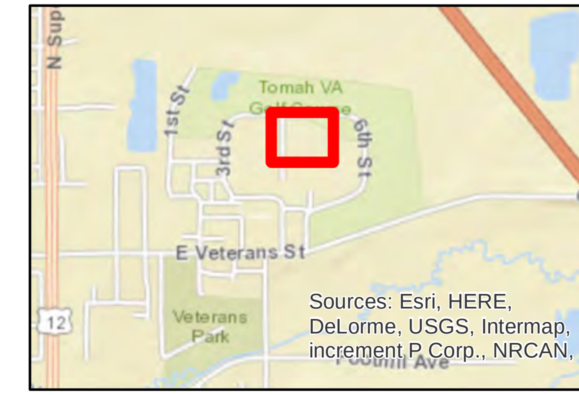
Rainfall for the 1-year and 2-year 24-hour design storms was obtained from the NOAA Atlas 14 station in Tomah, Wisconsin. Modeling for the Wisconsin DNR standards was performed using the state-approved modeling software P8. The 1-year peak discharge flows into the storm sewer would be 0.8 cfs and 1.0 cfs for pre-project and post-project conditions, respectively. The 2-year peak discharge flows would be 1.2 cfs for both the pre-project and post-project conditions. The detention pond would reduce TSS by 53% and 56% for the 1-year and 2-year storms, respectively. The post-development condition would infiltrate approximately 47% of the 2-year storm runoff. Hydrologic input parameters for the 1-year and 2-year storms are shown in **Table 6** and **Table 7**, respectively. The output for the 1-year and 2-year storms are shown in **Table 8** and **Table 9**, respectively.

Conclusions

In addition to the detention and infiltration exclusion because the site is considered redevelopment, the site would also be excluded from infiltration requirements due to high groundwater (NR 151.12(5)(c)5). According to the attached geotechnical report performed by Terracon Consultants, Inc., nine borings throughout the site indicated groundwater ranging from 1.5 to 6 feet below grade. While the shallow groundwater allows for an infiltration exclusion by Wisconsin DNR standards, the state and federal infiltration requirements would be met with a dry detention pond at this site. The site would also meet the DNR standards for institutional redevelopment, as detailed above. In summary, the combination of disconnected impervious area and dry detention pond included in the planned project meet both VA and Wisconsin DNR stormwater runoff requirements.

If you have any questions or require further information, please feel free to contact us. We may be reached at (972) 233-2288.





VICINITY MAP
NO SCALE

Legend

- Drainage Area

Flow Type

- Sheet Flow
- Shallow Concentrated
- Channel
- Pipe
- Off-Site Drainage
- Indirectly Connected Impervious Area
- Directly Connected Impervious Area

0 30 60 120 Feet

N

EXHIBIT 1

O'Brien Engineering, Inc.
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p: 972.233.2288 f: 972.233.2818 www.OBrienEng.com
Texas Registered Engineering Firm F-3758

COX DESIGN ASSOCIATES

DRAINAGE AREA MAP

TOMAH, MONROE COUNTY, WI

Date: 6/16/2016 OEI JOB #: 453.001

Document Path: P:\Current Jobs\453.001_Cox_Design_VAMC_Tomah_Wisconsin\GIS\VATomah Basemap.mxd

Table 1

HEC-HMS Hydrologic Parameters						
Hydrologic Element	Pre-Project			Post-Project		
	Drainage Area (mi^2)	CN	T_L (min)	Drainage Area (mi^2)	CN	T_L (min)
Subbasin-1	0.0088	42	9	0.0069	55	6
Off-Site Drainage	-	-	-	0.0019	51	6

Table 2

Lag Time Calculations														
Basin	Flow Type	U/S Elev [ft]	D/S Elev [ft]	L [ft]	S [ft/ft]	Surface n	Channel n	A [ft^2]	P_w [ft]	Velocity [ft/s]	T_c [hr]	T_c [min]	T_L [hr]	T_L [min]
Pre-Project Site	**Sheet Flow**	950.3	949.8	50.0	0.0100	0.15	-	-	-	0.12	0.117	7	0.070	4
	Shallow Concentrated	949.8	948.4	437.0	0.0032	Unpaved	-	-	-	0.9	0.133	8	0.080	5
	Total			**487**						**0.5**	**0.250**	**15**	**0.150**	**9**
Post-Project Site	**Sheet Flow**	950.5	950.1	50.0	0.0080	0.15	-	-	-	0.11	0.128	8	0.077	5
	Shallow Concentrated	950.1	948.8	49.0	0.0265	Unpaved	-	-	-	2.6	0.005	0	0.003	0
	Channel	948.8	946.5	462.0	0.005	-	0.045	22	19	**4.7**	0.027	2	0.016	1
	Storm Sewer	946.5	945	141.0	0.011	-	0.015			4.6	0.009	1	0.005	0
	Total			**702**						**1.2**	**0.169**	**10**	**0.101**	**6**

Table 3

HEC-HMS Hydrologic Analysis Results - 50-YR Peak Discharge (cfs)			
Comment	Hydrologic Element	Pre-Project	Post-Project
	Subbasin-1	2.3	8.9
Drains directly into storm drain	Off-Site Drainage	-	1.8
Pond Peak Elevation would be 0.66 feet	Pond	-	0.6
Storm Drain Outlet	Reservoir-2	2.3	2.3

Table 4

P8 Hydrologic Parameters - 95th Percentile Storm Event		
Input Parameter	Pre-Project	Post-Project
SCS Storm Type	II	II
Daily Air Temperature Station	Madison	Madison
Rainfall Amount (in.)	1.46	1.46
Watershed 1 (drains to pond in Post-Dev.)		
Total Area (acres)	5.64	4.34
Pervious Area Curve Number	39	39
Indirectly Connected Impervious Fraction	0	0.15
Connected Impervious Fraction	0.05	0.17
Depression Storage (inches)	0.025	0.025
Impervious Runoff Coefficient	0.882	0.882
Off-Site Drainage		
Total Area (acres)	-	1.30
Pervious Area Curve Number	-	39
Indirectly Connected Impervious Fraction	-	0.32
Connected Impervious Fraction	-	0.17
Depression Storage (inches)	-	0.025
Impervious Runoff Coefficient	-	0.882
Dry Pond		
Bottom Elevation (ft)	-	0
Bottom Area (acres)	-	0.4502
Permanent Pool Area (acres)	-	0
Permanent Pool Volume (ac-ft)	-	0
Permanent Pool Infiltration Rate (inches/hour)	-	0
Flood Pool Area (acres)	-	0.6439
Flood Pool Volume (ac-ft)	-	1.089
Flood Pool Infiltration Rate (inches/hour)	-	0.5
Orifice Diameter (inches)	-	7
Orifice Discharge Coefficient	-	0.6

Table 5

P8 Hydrologic Analysis Results - 95th Percentile Storm Event Runoff Volume (ac-ft)		
Term	Pre-Project	Post-Project
Watershed Inflows	0.03	0.11
Total Infiltration	-	0.08
Overall Surface Outflow	0.03	0.03

Table 6

P8 Hydrologic Parameters for 1-Year 24-Hour Storm		
Input Parameter	Pre-Project	Post-Project
SCS Storm Type	II	II
Daily Air Temperature Station	Madison	Madison
Rainfall Amount (in.)	2.49	2.49
Watershed 1 (drains to pond in Post-Dev.)		
Total Area (acres)	5.64	4.34
Pervious Area Curve Number	39	39
Indirectly Connected Impervious Fraction	0	0.15
Connected Impervious Fraction	0.05	0.17
Depression Storage (inches)	0.025	0.025
Impervious Runoff Coefficient	0.882	0.882
Off-Site Drainage		
Total Area (acres)	-	1.30
Pervious Area Curve Number	-	39
Indirectly Connected Impervious Fraction	-	0.32
Connected Impervious Fraction	-	0.17
Depression Storage (inches)	-	0.025
Impervious Runoff Coefficient	-	0.882
Dry Pond		
Bottom Elevation (ft)	-	0
Bottom Area (acres)	-	0.4502
Permanent Pool Area (acres)	-	0
Permanent Pool Volume (ac-ft)	-	0
Permanent Pool Infiltration Rate (inches/hour)	-	0
Flood Pool Area (acres)	-	0.6439
Flood Pool Volume (ac-ft)	-	1.089
Flood Pool Infiltration Rate (inches/hour)	-	0.5
Orifice Diameter (inches)	-	7
Orifice Discharge Coefficient	-	0.6

Table 7

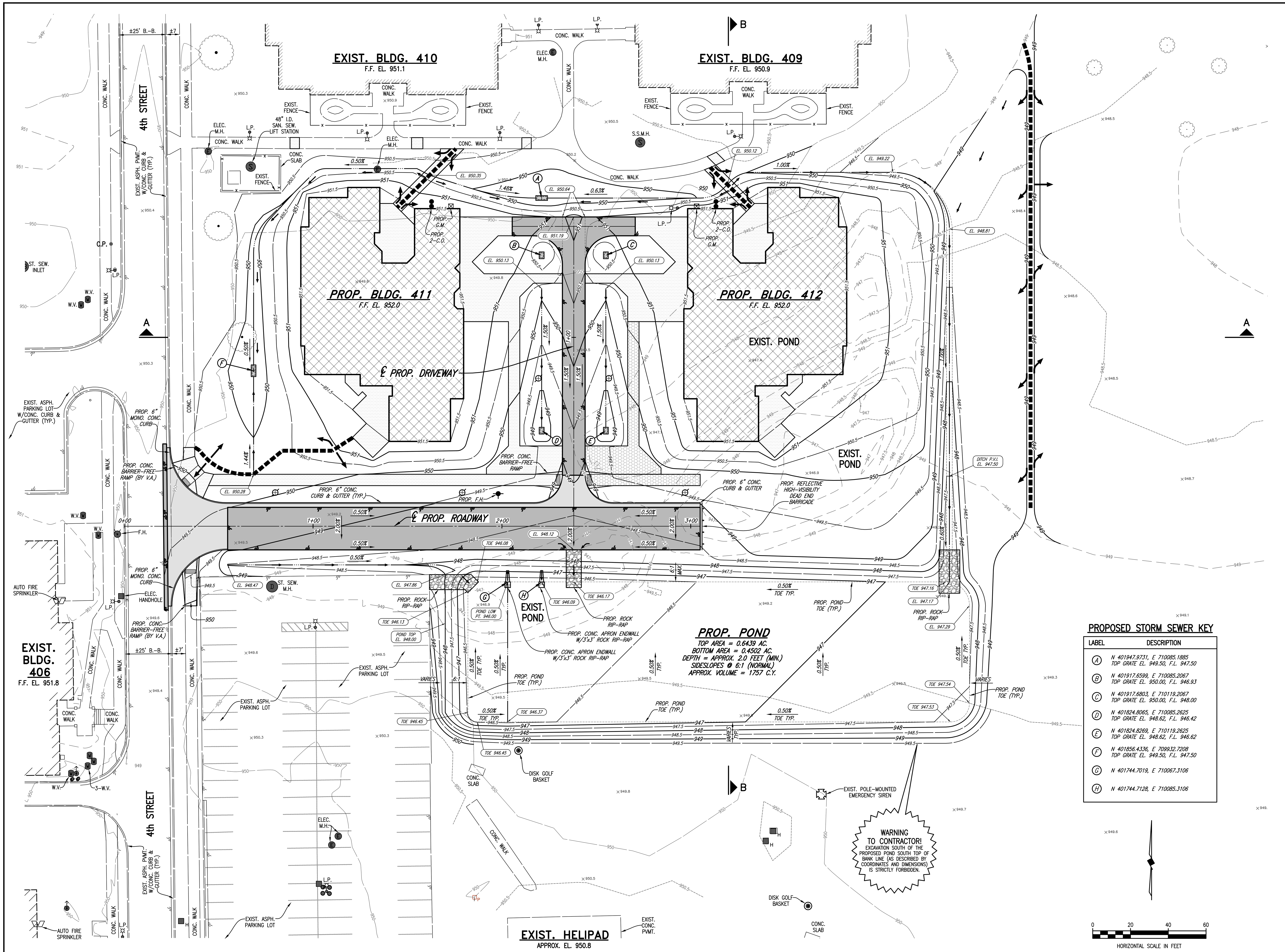
P8 Hydrologic Parameters for 2-Year 24-Hour Storm		
Input Parameter	Pre-Project	Post-Project
SCS Storm Type	II	II
Daily Air Temperature Station	Madison	Madison
Rainfall Amount (in.)	2.82	2.82
Watershed 1 (drains to pond in Post-Dev.)		
Total Area (acres)	5.64	4.34
Pervious Area Curve Number	39	39
Indirectly Connected Impervious Fraction	0	0.15
Connected Impervious Fraction	0.05	0.17
Depression Storage (inches)	0.025	0.025
Impervious Runoff Coefficient	0.882	0.882
Off-Site Drainage		
Total Area (acres)	-	1.30
Pervious Area Curve Number	-	39
Indirectly Connected Impervious Fraction	-	0.32
Connected Impervious Fraction	-	0.17
Depression Storage (inches)	-	0.025
Impervious Runoff Coefficient	-	0.882
Dry Pond		
Bottom Elevation (ft)	-	0
Bottom Area (acres)	-	0.4502
Permanent Pool Area (acres)	-	0
Permanent Pool Volume (ac-ft)	-	0
Permanent Pool Infiltration Rate (inches/hour)	-	0
Flood Pool Area (acres)	-	0.6439
Flood Pool Volume (ac-ft)	-	1.089
Flood Pool Infiltration Rate (inches/hour)	-	0.5
Orifice Diameter (inches)	-	7
Orifice Discharge Coefficient	-	0.6

Table 8

P8 Hydrologic Analysis Results for 1-Year 24-Hour Storm		
Term	Pre-Project	Post-Project
Infiltration of Post-Development Rainfall (%)	-	52
TSS Reduction (%)	-	53
Storm Drain Peak Outflow (cfs)	0.8	1.0

Table 9

P8 Hydrologic Analysis Results for 2-Year 24-Hour Storm		
Term	Pre-Project	Post-Project
Infiltration of Post-Development Rainfall (%)	-	47
TSS Reduction (%)	-	56
Storm Drain Peak Outflow (cfs)	1.2	1.2



LEGEND

- BLDG. AUTO FIRE SPRINKLER
- AIR CONDITIONER
- CULVERT
- CLEAN OUT
- STORM SEWER INLET
- HANDICAP PARKING
- LIGHT POLE
- POST INDICATOR VALVE
- GAS VALVE
- GAS METER
- GUARD POST/BOLLARD
- HYDRANT
- ELECTRIC HANDHOLE
- ELECTRIC MANHOLE
- SANITARY SEWER MANHOLE
- MISCELLANEOUS MANHOLES
- STORM SEWER MANHOLE
- WATER VALVE
- TREE
- EXISTING FENCE
- EXISTING MAJOR CONTOUR (1.0 FT.)
- EXISTING MINOR CONTOUR (1.0 FT.)
- EXISTING MINOR CONTOUR (0.5 FT.)
- EDGE OF EXIST. ASPHALT PVMT.
- EDGE OF PROP. ASPHALT PVMT.
- PROP. PAVING CENTERLINE
- PROP. DRAINAGE AREA DIVIDE LINE
- PROP. SWALE CENTERLINE
- PROP. CONTOUR (1.0 FT.)
- PROP. CONTOUR (0.5 FT.)
- PROP. DRAINAGE DIRECTION
- PROP. LIGHT POLE
- PROP. 1-GRATE ST. SEW. INLET
- PROP. 2-GRATE ST. SEW. INLET
- PROP. BUILDING
- PROP. CONCRETE PAVING OR CURB
- PROP. ASPHALT PAVING
- PROP. CONCRETE WALK
- PROP. CONCRETE WALK (ALT. BID)
- PROP. ROCK RIP-RAP
- PROP. SITE SECTION ALIGNMENT
- EL. XXX.XX PROP. FINISHED GRADE ELEVATION
- X.XX PROP. FINISHED GRADE SLOPE

PROPOSED STORM SEWER KEY

LABEL	DESCRIPTION
A	N 401947.9731, E 710085.1885 TOP GRATE EL. 949.50, F.L. 947.50
B	N 401917.6599, E 710085.2067 TOP GRATE EL. 950.00, F.L. 946.93
C	N 401917.6803, E 710119.2067 TOP GRATE EL. 950.00, F.L. 948.00
D	N 401824.8065, E 710085.2625 TOP GRATE EL. 948.62, F.L. 946.42
E	N 401824.8269, E 710119.2625 TOP GRATE EL. 948.62, F.L. 946.62
F	N 401856.4336, E 709932.7208 TOP GRATE EL. 949.50, F.L. 947.50
G	N 401744.7019, E 710067.3106
H	N 401744.7128, E 710085.3106

NOTES

1. EXISTING TOPO FEATURES AND UTILITIES ARE SHOWN AS THEY WOULD APPEAR AFTER COMPLETION OF DEMOLITION PHASE.
2. PROPOSED SIDEWALK CROSS-SLOPES DO NOT EXCEED 2.00%.
3. MINIMUM SLOPE FOR DRAINAGE (ALONG PROPOSED ROADWAY GUTTER LINES, PROPOSED DRIVEWAY INVERT LINE AND PROPOSED DRAINAGE SWALE FLOWLINES) IS 0.50%.
4. PROPOSED ROADWAY CROSS-SLOPE IS 2.00% UNLESS OTHERWISE NOTED.
5. HORIZONTAL DISTANCE BETWEEN PROPOSED POND TOP AND TOE IS 12'-0" (CONSTANT).
6. PROPOSED CONSTRUCTION FENCE NOT SHOWN.

100% CD

Revisions: | Date

Wisconsin Temporary Permit #2798
For Construction 6/8/2016

STATE OF TEXAS
JIM O'BRIEN
55861
LICENSED PROFESSIONAL ENGINEER

CONSULTANTS:

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Hydraulics · Hydrology · Civil Engineering

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Experience you can build on.™

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713.864.2900

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bcox@coxdesignassociates.com

Approved: Chief of MH	Approved: Chief of FMS
Date:	Date:
Approved: Director	Approved: VA Energy Engineer
Date:	Date:

Drawing Title
SITE LAYOUT/PAVING: PROPOSED GENERAL GRADING PLAN

Project Name
CONSTRUCT TWO CLC HOMES

Project Number
676-324

Date
06/08/2016

Location:
TOMAH VAMC
500 E. VETERANS STREET
TOMAH, WI. 54660

Building Number | Checked: OEI | Drawn: OEI

Drawing Number
1-CG-101
Dwg. of

Office of Construction and Facilities Management

Department of Veterans Affairs

VA FORM 08-6231

REVISED: 6/8/16 - GDAVIS P:\Current Jobs\453.001_Cox_Design_VAMC_Tomah_Wisconsin\Dwg\Sheets_As_Bid\Civil\08-676-324-CG-101_Proposed_General_Grading_Plan.dwg PLOT SCALE: 1:1 PLOT STYLE: 22x34_DWG-DWF_Grayscale.ctb PLOTTED BY: GARY DAVIS ON 6/8/2016

Geotechnical Engineering Report

New Tomah VA CLC Green Homes
Tomah, Wisconsin

September 14, 2015

Terracon Project No. MR155155

Prepared for:

Mr. Bob Cox
Evanston, Illinois

Prepared by:

Terracon Consultants, Inc.
Waunakee, Wisconsin

TABLE OF CONTENTS

Page

EXECUTIVE SUMMARY i

1.0 INTRODUCTION 1

2.0 PROJECT INFORMATION 1

2.1 Project Description 1

2.2 Site Location and Description 2

3.0 SUBSURFACE CONDITIONS 2

3.1 Typical Profile 2

3.2 Water Level Observations 3

4.0 RECOMMENDATIONS FOR DESIGN AND CONSTRUCTION 4

4.1 Geotechnical Considerations 4

4.2 Earthwork 5

4.2.1 Site Preparation 5

4.2.2 Engineered Soil Fill Material Requirements 5

4.2.3 Fill Placement and Compaction Requirements 5

4.2.4 Earthwork Construction Considerations 6

4.2.5 Grading and Drainage 7

4.2.6 Dewatering and Excavation Construction Considerations 7

4.3 Foundations 8

4.3.1 Shallow Spread Foundation Design Recommendations 8

4.3.2 Foundation Construction Considerations 8

4.4 Floor Slab 9

4.4.1 Floor Slab Design Recommendations 9

4.4.2 Floor Slab Construction Considerations 11

4.5 Pavements 11

4.5.1 Subgrade Preparation 11

4.5.2 Design Considerations 11

4.5.3 Estimates of Minimum Pavement Thickness 12

4.6.4 Pavement Drainage 13

4.6.5 Pavement Performance and Maintenance 14

4.6 Seismic Site Class 14

5.0 GENERAL COMMENTS 15

APPENDIX A – FIELD EXPLORATION

Exhibit A-1 Field Exploration Description

Exhibit A-2 Site Location Diagram

Exhibit A-3 Boring Location Diagram

Exhibit A-4 to A-12 Boring Logs

APPENDIX B – LABORATORY TESTING

Exhibit B-1 Laboratory Testing

APPENDIX C – SUPPORTING DOCUMENTS

Exhibit C-1 General Notes

Exhibit C-2 Unified Soil Classification

September 14, 2015

Mr. Bob Cox
Cox Design Associates, Inc.
820 Davis Street, Suite 432
Evanston, Illinois 60621

Re: Geotechnical Engineering Report
New Tomah VA CLC Green Homes
Tomah, Wisconsin
Terracon Project No. MR155155

Dear Mr. Cox:

Terracon Consultants, Inc. (Terracon) has completed the geotechnical engineering services for the above referenced project. These services were performed in general accordance with our proposal number PMR150256 dated August 6, 2015. This geotechnical engineering report presents the results of the subsurface exploration and provides recommendations regarding earthwork and the design and construction of foundations, floor slabs and pavements for the proposed project.

We appreciate the opportunity to be of service to you on this project. If you have any questions concerning this report, or if we may be of further service to you, please contact us.

Sincerely,
TERRACON CONSULTANTS, INC.

Justin Warner, P.E
Wisconsin No. E42425-6
Renews 07/31/2016

Paul Tarvin, P.E.
Wisconsin No. E25612-6
Renews 07/31/2016

Distribution: Addressee, PDF document

EXECUTIVE SUMMARY

Terracon Consultants, Inc. (Terracon) has completed the subsurface exploration for the proposed Tomah VA CLC Green Homes to be constructed at the Tomah VA Affairs Medical Center in Tomah, Wisconsin. Nine (9) borings extending to depths of 10 to 20 feet below existing grades were performed for the project site. This report describes the subsurface conditions encountered at the boring locations, presents the test data, and provides recommendations regarding the design and construction of foundations, floor slabs and pavements for the proposed project.

Based on the information obtained from our subsurface exploration, it is our opinion that the site can be developed for the proposed project. The following geotechnical considerations were identified:

- The soil borings generally encountered a thin veneer of topsoil underlain by fill soils to depths up to 3 feet. The fill was typically underlain by native medium dense to dense sand to the boring termination depths. An isolated layer of medium stiff lean clay was encountered to a depth of 5½ feet in Boring B-1, after which native medium dense to dense sand was encountered to the termination depth. The water table was encountered at depths ranging from 1½ to 6 feet below grade. Some excavation dewatering may likely be required because of the shallow groundwater conditions. Based on the conditions encountered at the boring locations, it is our opinion that the CLC Green Homes can be supported on conventional shallow spread foundations. Footings should bear at typical frost depths on the native medium dense to dense sand encountered below the topsoil and fill, or on lean concrete fill or engineered soil fill extending to suitable native soils. Shallow spread footings supported on the aforementioned materials can be proportioned for a maximum net allowable soil bearing pressure of 3,000 pounds per square foot. The net allowable soil bearing pressure is the pressure in excess of the minimum surrounding overburden pressure at the footing base elevation.

- The floor slabs for the new CLC Green Homes can be supported at or below grade on the existing fill soils, and/or native sands or on newly placed engineered soil fill used to raise site grades. We recommend that a minimum 6-inch thick granular leveling course be placed directly below the slab to provide uniform support. The existing fill soils should be prepared, observed and tested as recommended in this report to confirm that they are suitable for floor slab support.

- Pavements for the new parking and drive areas can be supported at grade on the existing fill soils or on newly placed engineered soil fill used to raise site grades. The existing fill soils should be prepared, observed and tested as recommended in this report to confirm that they are suitable for support of new pavements.

- The on-site fill soils and native soils typically appear suitable for use as engineered soil fill, provided they are placed with controlled density and moisture content as recommended in this report.

- Close monitoring of the construction operations discussed herein will be critical in achieving the design subgrade support. We therefore recommend that Terracon be retained to provide observation/testing during this portion of the work.

This summary should be used in conjunction with the entire report for design purposes. It should be recognized that details were not included or fully developed in this section, and the report must be read in its entirety for a comprehensive understanding of the items contained herein. The section titled **GENERAL COMMENTS** should be read for an understanding of the report limitations.

GEOTECHNICAL ENGINEERING REPORT
TOMAH VA CLC GREEN HOMES
TOMAH, WISCONSIN

Terracon Project No. MR155155
September 14, 2015

1.0 INTRODUCTION

Terracon Consultants, Inc. (Terracon) has completed the subsurface exploration for the proposed Tomah VA CLC Green Homes to be constructed at the Tomah VA Affairs Medical Center in Tomah, Wisconsin. Nine (9) borings extending to depths of 10 to 20 feet below existing grades were performed for the project site. Boring logs, a Site Location Diagram and a Boring Location Diagram are included in Appendix A. This report describes the subsurface conditions encountered at the boring locations, presents the test data, and provides geotechnical engineering recommendations regarding the following items:

- site preparation and earthwork
- construction dewatering
- design and construction of shallow spread foundations
- floor slab subgrade preparation
- pavement subgrade preparation and estimated minimum pavement sections
- seismic site class

2.0 PROJECT INFORMATION

2.1 Project Description

Item	Description
Site layout	See Appendix A, Exhibit A-2 Boring Location Diagram
Proposed Structures	Two (2) CLC Green Homes are proposed for the site. The homes will have individual footprints of 7,500 to 9,000 square feet +/- and are planned as slab-on-grade, single story structures. The final location of the new homes is not yet determined; however, we understand that they will be located within an approximately 30,000 square foot area to the south of two existing homes at the north boundary of the VA Medical Center.
Finished floor elevation	The finished floor elevations for the new nursing homes are expected to match the existing buildings first floor elevations at or near elevation 951 feet +/-.

Item	Description
Maximum loads	Structural loads were not provided. The following values were assumed: Columns: 75 to 150 kips Walls: 1½ to 3 kips per lineal foot Slabs: 100 to 150 pounds per square foot (psf)
Grading	Based on our understanding of current site grades, minimal grading will be needed to establish final site grades directly south of the existing facilities. It is anticipated that the existing dry stormwater ponds will need to be filled in and existing utilities relocated to facilitate construction of the new nursing homes. Based on existing site grades, approximately 3 to 4 feet of fill will be needed to fill the stormwater ponds.
Pavements	A new entrance drive and roadway will be constructed along the east and south sides of the new nursing homes.
Below Grade Walls	None anticipated.

2.2 Site Location and Description

ITEM	DESCRIPTION
Location	Near the north boundary of the existing VA Medical Facility at 500 E. Veterans Street, Tomah, Wisconsin
Existing improvements	The site consists of two-existing slab on grade housing facilities with approximate footprints of 7,500 to 9,000 square feet.
Existing topography	Based on the record drawing provided by Cox Design Associates, the site is generally level at elevation 950 feet +/- in the area of the proposed new housing facilities. Two (2) dry stormwater ponds are located in the southeast corner of the site. The bottom elevation of the dry stormwater ponds is 947 feet.

3.0 SUBSURFACE CONDITIONS

3.1 Typical Profile

Subsurface conditions at each boring location are described on the individual boring logs in Appendix A. The stratification boundaries shown on the boring logs represent the approximate depths where changes in material types occur. In-situ, transitions between material types can be more gradual in both the vertical and horizontal directions. Based on the results of the borings, subsurface conditions on the project site can be generalized as follows:

Description	Approximate Depth to Bottom of Stratum	Material Encountered	Consistency/Density
Surface	2 to 10 inches	Topsoil	Not applicable
Stratum 1 [1]	1½ to 3 feet	Fill soils: Poorly graded (SP) to silty and/or clayey sands (SC, SM) with isolated deposits of lean clay (CL)	Granular soils: typically loose to medium dense Cohesive soils: stiff
Stratum 2 [2]	Termination depths of 10 to 20 feet	Native soils: brown to orangeish brown sand, typically poorly graded (SP), fine to medium grained with occasional layers of silty sand (SM)	Typically medium dense to dense

1. Fill soils were not encountered in Boring B-5.
2. An isolated layer of native medium stiff lean clay was encountered in Boring B-1 from 3 to 5½ feet.

3.2 Water Level Observations

The borings were observed during drilling for the presence and level of water prior to the addition of drilling fluids into the borehole. The borings were advanced using mud rotary methods below the water table to minimize sample disturbance in the native sands. Thus, post drilling water levels were not obtained as these measurements would likely have been inaccurate due to the addition of drilling fluids. The water levels observed during drilling are presented on the boring logs and are summarized in the following table.

Boring Number	Groundwater Depth While Drilling [1,2] (Ft)	Groundwater Elevation While Drilling [2] (Ft)
B-1	6	944
B-2	5	945
B-3	5	945
B-4	6	944
B-5	1½ [3]	948
B-6	5	942
T-1	5	944½
T-2	6	943½
T-3	4½	945

1. Below grade
2. Measurements have been rounded down to the nearest ½ foot
3. May be indicative of perched water conditions

Groundwater was typically encountered in the native granular soils. Due to the predominantly granular nature of the site soils, it is our opinion that the groundwater observations in the open boreholes are a relatively accurate measurement of the long-term groundwater table at the time of our exploration.

Water levels may fluctuate due to seasonal variations in the amount of rainfall, runoff and other factors not evident at the time the borings were performed. Trapped or "perched" water can occur above lower permeability soil layers. The possibility of water level fluctuations should be considered when developing design and construction plans for the project. Groundwater levels during construction or at other times in the life of the structure may be higher or lower than the levels indicated in this report.

4.0 RECOMMENDATIONS FOR DESIGN AND CONSTRUCTION

4.1 Geotechnical Considerations

Based on the conditions encountered at the boring locations, it is our opinion that the new CLC Green Homes can be supported on conventional shallow spread foundations. Footings should bear at typical frost depths on the native medium dense to dense sand encountered below the topsoil and fill layers, or on lean concrete fill or engineered soil fill extending to suitable native soils. Detailed foundation recommendations are provided in Section 4.3.

Because of the shallow groundwater conditions, some excavation dewatering may likely be required to construct the building foundations.

We anticipate that the floor slabs for the new CLC Green Homes can be supported at or below grade on the existing fill soils and/or native sands, or on newly placed structural soil fill used to raise site grades. Detailed floor slab recommendations are provided in Section 4.4.

The on-site native inorganic soils typically appear suitable for use as engineered soil fill, provided they are placed with controlled density and moisture content as recommended in this report.

Additional recommendations for earthwork, fill placement and compaction, seismic site classification and other geotechnical design and construction considerations for the proposed structure are presented in the following sections.

4.2 Earthwork

Recommendations for site preparation, excavation, subgrade preparation and placement of engineered soil fill for the project are provided in the following subsections.

4.2.1 Site Preparation

All existing topsoil and organic matter should be removed from within the proposed building and pavement areas. The stripped topsoil could be stockpiled for later reuse in green areas. The exposed subgrade should then be proofrolled to delineate any remaining soft areas. Proofrolling can be accomplished using a vibratory drum roller with a gross weight of at least 12 tons, or similarly loaded equipment. Areas that display deflections greater than 1 inch, pumping or rutting should be improved by scarification and compaction or by removal and replacement with engineered soil fill as described below.

4.2.2 Engineered Soil Fill Material Requirements

Engineered soil fill should meet the following material property requirements:

Fill Type [1]	USCS Classification	Acceptable Location for Placement
Granular	GW, GP, GM, GC SW, SP, SM, SC	Below/adjacent to foundations and slabs
Cohesive	CL, CL-ML	Below/adjacent to foundations and slabs
Unsuitable	CH, MH, ML, OL, OH, PT	Non-structural locations

1. Engineered soil fill should consist of approved materials that are free of organic matter and debris. Granular fill soils should have between 5 and 15% passing the No. 200 sieve. Cohesive (clay) soils used as fill for this project should have liquid limit less than 45 and a plasticity index less than 20; cohesive soils that do not meet these criteria should be considered "unsuitable." Frozen material should not be used, and fill should not be placed on a frozen subgrade.
2. Based on visual and tactile examination of recovered soil samples, the existing granular fill and native granular soils encountered in the borings would likely meet the criteria for engineered soil fill. Any organic materials, rock fragments larger than 3 inches, and other unsuitable materials should be removed prior to use of the existing fill materials in new fill sections.

4.2.3 Fill Placement and Compaction Requirements

Item	Description
Fill Lift Thickness	9 inches or less in loose thickness when heavy, self-propelled compaction equipment is used. 4 to 6 inches in loose thickness when hand-guided equipment (i.e. jumping jack or plate compactor) is used.

Item	Description
Compaction of Granular Material and Cohesive Soil [1, 2]	Fill placed in the upper 12 inches below slabs should be compacted to at least 95% of the material's modified Proctor maximum dry density (ASTM D1557). This level of compaction should extend beyond the edges of the footings at least 8 inches for every foot of fill placed below the foundation base elevation. Fill placed more than 12 inches below final grade for support of floor slabs should be compacted to at least 92% of the material's modified Proctor maximum dry density.
Moisture Content of Cohesive Soil	Within 2% below to 4% above the modified Proctor optimum moisture content at the time of placement and compaction.
Moisture Content of Granular Material [3]	Workable moisture levels.

1. We recommend that engineered soil fill be tested for moisture content and compaction during placement. Should the results of the in-place density tests indicate the specified moisture or compaction limits have not been met, the area represented by the test should be reworked and retested as required until the specified moisture and compaction requirements are achieved.
2. If the granular material is a coarse sand or gravel, is of a uniform size, or has a low fines content, compaction comparison to relative density (ASTM D4253 and D4254) may be more appropriate. In this case, granular materials should be compacted to at least 60% of the material's maximum relative density.
3. The gradation of a granular material affects its stability and the moisture content required for proper compaction. Moisture levels should be maintained to achieve compaction without bulking or pumping during placement or when proofrolled.

4.2.4 Earthwork Construction Considerations

We recommend that a Terracon geotechnical engineer or qualified representative be retained during the construction phase of the project to observe earthwork and to perform necessary tests and observations during stripping of topsoil, subgrade preparation, placement and compaction of controlled compacted fills, backfilling of excavations, and just prior to construction of building floor slabs.

Care should be taken to avoid disturbance of prepared subgrades. Unstable subgrade conditions could develop during general construction operations, particularly if the soils are wetted and/or subjected to repetitive construction traffic. New fill compacted above optimum moisture content or that accumulates water during construction can also become disturbed under construction equipment. Construction traffic over the exposed subgrade should be avoided to the extent practical. If the subgrade becomes saturated, desiccated, or disturbed, the affected materials should either be scarified and compacted or be removed and replaced.

As a minimum, excavations should be performed in accordance with OSHA 29 CFR, Part 1926, Subpart P, "Excavations" and its appendices, and in accordance with any applicable local, state, and federal safety regulations. The contractor should be aware that slope height, slope inclination, and excavation depth should in no instance exceed those specified by these safety regulations. Based on the soil boring results, we anticipate that the majority of shallow excavations will encounter granular fill soils and then native granular soils in the upper 5 feet. These materials are classified as Type C in accordance with OSHA regulations. Therefore, we recommend that shallow excavations be planned at a preliminary 1.5 horizontal to 1.0 vertical (1.5H:1V) inclination for Type C soils. Flatter slopes than those dictated by these regulations may be required depending upon the soil conditions encountered and other external factors. These regulations are strictly enforced and if they are not followed, the owner, contractor, and/or earthwork and utility subcontractor could be liable and subject to substantial penalties. Under no circumstances should the information provided in this report be interpreted to mean that Terracon is responsible for construction site safety or the contractor's activities. Construction site safety is the sole responsibility of the contractor who shall also be solely responsible for the means, methods, and sequencing of the construction operations.

4.2.5 Grading and Drainage

During construction, grades should be developed to direct surface water flow away from or around the site. Exposed subgrades should be sloped to provide positive drainage so that saturation of subgrades is avoided. Surface water should not be permitted to accumulate on the site.

Final grades should slope away from the structures to promote rapid surface drainage. Accumulation of water adjacent to the structures could contribute to significant moisture increases in the subgrade soils and subsequent softening/settlement.

4.2.6 Dewatering and Excavation Construction Considerations

Groundwater was encountered at an average depth of about 5 feet below grade (El. ±944½ ft). The anticipated bottom of foundation elevation is anticipated to range from about elevation 944 to 947 based on the thickness of unsuitable fill. Thus, shallow excavations to construct the building foundations could intercept the local groundwater table and the Contractor should be prepared to dewater the excavations as necessary. If the groundwater table at the time of construction is at or below the levels observed in the borings, then the excavation depth below the water table should be less than about 1 to 2 feet. However, higher groundwater levels may be possible depending on the season and amount of precipitation in the weeks leading up to and during construction. For this reason, we recommend that construction occur in the drier later summer or fall months as opposed to early spring, if possible.

It is critical for successful performance of the foundations that excavations be adequately dewatered; otherwise, a quick condition may develop at the base of the excavations below the water table wherein the bearing soils will be excessively disturbed and lose strength.

Groundwater control is generally the responsibility of the Contractor; however, we expect that dewatering for shallow excavations above the water table and within 1 to 2 feet below can be accomplished with a typical sump pit and pump system, though the number of sumps will depend on the amount of water entering the excavation. The pumps should be adequately filtered to prevent pumping of fines. The groundwater level should be lowered to a depth of at least 2 feet below the bottom of foundation elevation at the time of construction. If the excavations extend deeper than 1 to 2 feet below the water table, then a more robust dewatering system (e.g., well points, etc.) may be required.

4.3 Foundations

In our opinion, the proposed CLC Green Homes can be supported on shallow spread foundations bearing on the native medium dense to dense granular soils, or on newly placed engineered soil fill or lean concrete fill that extends to suitable native soil. Design recommendations for footing foundations to support the proposed apartment building are presented below.

4.3.1 Shallow Spread Foundation Design Recommendations

DESCRIPTION	VALUE
Maximum net allowable soil bearing pressure [1]	3,000 psf
Minimum embedment below finished grade for frost protection	4 feet for heated structures
Approximate total settlement [2]	Less than 1 inch
Approximate differential settlement [2]	1/2 to 2/3 of the total settlement

1. The recommended net allowable bearing pressure is the pressure in excess of the minimum surrounding overburden pressure at the footing base elevation. This pressure assumes that any lower strength soils or otherwise unsuitable materials, if encountered, will be undercut and supported at that lower elevation, or replaced with properly placed and compacted engineered soil fill or lean concrete.
2. The foundation settlement will depend upon variations within the subsurface soil profile, the structural loading conditions, the embedment depth of the footing, and if applicable, the thickness of engineered soil fill, and the quality of earthwork operations.

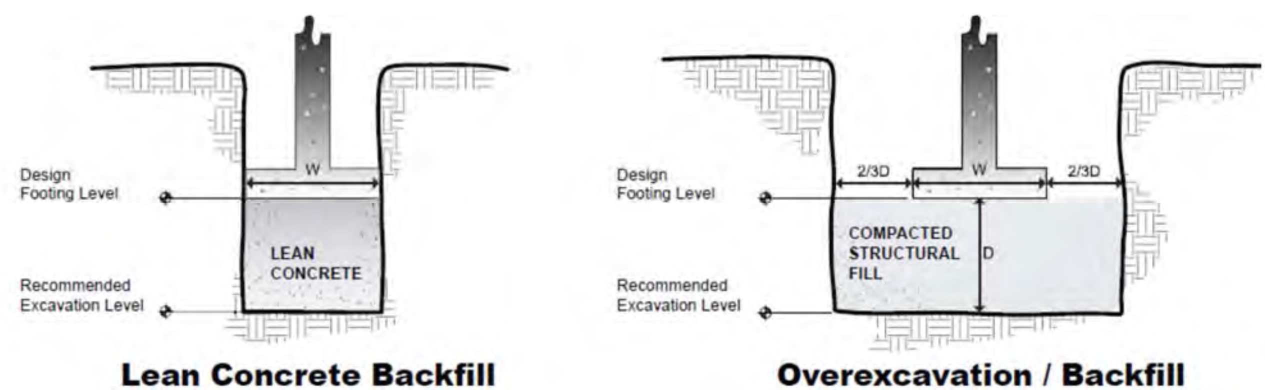
The minimum width of rectangular footings should be 30 inches and the minimum width of continuous footings should be 18 inches to avoid disproportionately small footings sizes.

4.3.2 Foundation Construction Considerations

The soils at the base of the foundation excavation should be observed and tested to evaluate whether they meet the requirements for suitable bearing soils as defined in this report. The excavation should be probed or otherwise sampled at regular intervals.

The base of the foundation excavation should be free of water and loose sands prior to placing concrete. As previously indicated, groundwater may be encountered during foundation excavations. Concrete should still be placed as soon after excavating as possible to reduce bearing soil disturbance. If the soils at bearing level become excessively dry, disturbed, saturated, or frozen, the affected soil should be removed prior to placing concrete. Placement of a lean concrete mud-mat over the bearing soils should be considered if the excavations must remain open overnight or for an extended period of time.

Footings should bear directly on tested and approved medium dense to dense sand or on new engineered soil fill or lean concrete that extends to approved native soils. If unsuitable bearing materials are encountered at the base of a footing excavation, the excavation should be extended deeper to suitable native soils. The footing could then bear at this lower elevation or the excavation could be backfilled to the original design footing elevation with engineered soil fill or lean concrete backfill. If engineered soil fill is used as backfill, then the base of the excavation should be 8 inches wider than the footing for each vertical foot of over-excavation, not accounting for sloping or benching. If lean concrete backfill (minimum 28-day compressive strength of 1,500 psi) is used, the excavation should be widened at least 6 inches on all sides of the footing. Because of the shallow groundwater conditions, it may be advantageous to use lean concrete to backfill over excavations rather than soil fill. The recommended extents of the over excavation and backfill procedure are illustrated in the following figure. Note that the sidewalls in this figure are shown vertical for ease of dimensioning. Since the upper site soils consist of granular soils (OSHA Type C), the excavation sidewalls will need to be properly sloped to prevent caving.



Note: Excavations in sketches shown vertical for convenience. Excavations should be sloped as necessary for safety.

4.4 Floor Slab

4.4.1 Floor Slab Design Recommendations

The floor slab for the new CLC Green Homes can be supported at or below grade on the loose to medium granular fill, native granular soils or on newly placed engineered soil fill used to raise site grades. We recommend that that a minimum 6-inch thick granular leveling course be placed directly below the slab to provide uniform support. Additional floor slab recommendations are provided below. Additional floor slab recommendations are provided below.

ITEM	DESCRIPTION
Floor slab support	Approved in-place fill, native soil or new engineered soil fill that has been prepared and tested in accordance with section 4.2.
Granular leveling course [1]	Minimum 6 inches of well-graded granular material with less than 5% passing the No. 200 sieve placed directly below the floor slab.
Modulus of subgrade reaction [2]	125 pounds per cubic inch (pci) for a soil subgrade prepared as recommended in this report

1. The floor slab should be placed on a leveling course comprised of well-graded granular material containing less than 5% fines (e.g., Wisconsin Department of Transportation (WisDOT) Open Graded Base) compacted to at least 95% of the material's modified Proctor maximum dry density (ASTM D1557).
2. The recommended modulus value is based on a 12-inch square plate. The modulus value used in design should be adjusted based on the actual size of the floor slab according to the Naval Facilities Engineering Design Manual 7.2 Table 4 equation: $K_b = K_v \frac{(b+1)^2}{2b}$ where K_v is the modulus value based on a 12-inch square plate, b is the width of the slab and K_b is the design modulus value.

Joints should be constructed at regular intervals as recommended by the American Concrete Institute (ACI) to help control the location of cracking. It should be understood that differential settlement between the floor slabs and foundations could occur. Thus, floor slabs should be structurally independent of building footings and walls supported on the footings to reduce the potential for floor slab cracking caused by differential movements between the slab and foundation.

The use of a vapor retarder or barrier should be considered beneath concrete slabs on grade that will be covered with wood, tile, carpet, or other moisture sensitive or impervious coverings, or when the slab will support equipment sensitive to moisture. When conditions warrant the use of a vapor retarder/barrier, the slab designer and slab contractor should refer to ACI 302 and ACI 360 for procedures and cautions regarding the use and placement of a vapor retarder/barrier.

We anticipate that the total settlement of floor slabs with a base pressure equal to or less than 150 psf and designed in accordance with the preceding recommendations will be roughly ½ inch or less.

4.4.2 Floor Slab Construction Considerations

On most project sites, the site grading is generally accomplished early in the construction phase. However as construction proceeds, the subgrade may be disturbed by utility excavations, construction traffic, desiccation, rainfall, etc. As a result, corrective action may be required prior to placement of the granular leveling course and concrete.

The condition of the floor slab subgrades should be reviewed and tested immediately prior to placement of the geotextile fabric, structural fill, granular leveling course and construction of the slabs. Particular attention should be paid to high traffic areas that were rutted and disturbed earlier and to areas where backfilled trenches are located. Areas where unsuitable conditions are located should be repaired by removing the affected material and replacing it with engineered soil fill.

4.5 Pavements

4.5.1 Subgrade Preparation

On most project sites, the site grading is accomplished relatively early in the construction phase. Fills are placed and compacted in a uniform manner. However, as construction proceeds, excavations are made into these areas, rainfall and surface water saturates some areas, heavy traffic from concrete trucks and other delivery vehicles disturbs the subgrade and many surface irregularities are filled in with loose soils to improve trafficability temporarily. As a result, the pavement subgrades, initially prepared early in the project, should be carefully evaluated as the time for pavement construction approaches.

We recommend the moisture content and density of the top 9 inches of the subgrade be evaluated and the pavement subgrades be proofrolled within two days prior to commencement of actual paving operations. Areas not in compliance with the required ranges of moisture or density should be moisture conditioned and re-compacted. Particular attention should be paid to high traffic areas that were rutted and disturbed earlier and to areas where backfilled trenches are located. Areas where unsuitable conditions are located should be repaired by removing and replacing the materials with properly compacted fills.

After proofrolling and repairing deep subgrade deficiencies, the entire subgrade should be scarified and developed as recommended in **Section 4.2** of this report to provide a uniform subgrade for pavement construction. Areas that appear severely desiccated following site stripping may require further undercutting and moisture conditioning. If a significant precipitation event occurs after the evaluation or if the surface becomes disturbed, the subgrade should be reviewed by qualified personnel immediately prior to paving. The subgrade should be in its finished form at the time of the final review.

4.5.2 Design Considerations

We anticipate that the subgrade in pavement areas will likely consist of the existing granular fill, native granular soils or newly placed engineered fill used to raise site grades. The existing fill and native granular soils are generally classified as SP or SM per the Unified Soil Classification System. Based on a review of the Natural Resource Conservation Service Web Soil Survey, the primary pedological units in this area of Tomah are generally expected to consist of the Bilmod sandy loam (466A). The existing granular fill and native granular soils encountered in the soil borings compare favorably with the primary pedological units mapped in the project area and are considered suitable for support of pavements, provided they do not contain appreciable amounts of organic matter and are prepared as recommended in this report. The following table provides design parameters for use in the design of both bituminous and Portland cement concrete pavements supported on the existing granular fill, native granular soils or engineered soil fill used to raise site grades.

Design Parameter [1]	Value
California Bearing Ratio (CBR)	5
AASHTO Classification	A-2-5
Design Group Index	0
Soil Support Value	6.5
Frost Group Index	F-2
Modulus of Subgrade Reaction	125 pci

1. The design parameters were developed from published values provided in the WisDOT Geotechnical Bulletin No. 1 for the primary pedological units mapped in the Tomah area. The design parameters may be used if the following criteria are met during pavement construction:
   - Subgrade is inspected properly.
   - Subgrade has uniform and adequate compaction.
   - Wet or soft soil zones are treated or removed.
   - Subgrade soil is a homogeneous mixture.
   - Adequate drainage is provided.

4.5.3 Estimates of Minimum Pavement Thickness

All pavements should be designed for the types and volumes of traffic, subgrade and drainage conditions that are anticipated. Traffic patterns and anticipated loading conditions were not available at the time that this report was prepared. However, we anticipate that traffic loads will be produced primarily by automobile traffic and occasional delivery and trash removal trucks. Based upon the design parameters provided above, we have developed recommended minimum pavement sections for both bituminous and Portland cement concrete, where the subgrade appears firm under proofrolling at the time of construction. The recommended minimum pavement sections are provided in the following table. The minimum thicknesses provided are based on the assumption of 20,000 total 18-kip Equivalent Single Axle Load Applications (W_{18}) for parking areas and 50,000 W_{18} for truck and drive areas over a 20 year design life. Greater pavement and/or base course thicknesses may be required for greater expected traffic loads and volumes, or if poorer subgrade conditions are encountered. The thickness of pavements subjected to heavy truck traffic should be determined using expected traffic volumes, vehicle types, and vehicle loads and should be in accordance with local, city or county ordinances.

Pavement Area	Type	Pavement Thickness (in)	Base Course Thickness [1] (in)
Parking Areas	Rigid (Concrete) Pavement	4.0	4.0
	Flexible (Bituminous) Pavement	3.0	5.0
Truck and Drive Areas	Rigid (Concrete) Pavement	5.0	4.0
	Flexible (Bituminous) Pavement	4.0	6.0

1. The base course aggregate beneath the new pavement should conform to the ¾-inch or 1-1/4-inch Dense Graded Base listed in Section 305 of the WisDOT Standard Specifications (current edition). The base course material should be compacted to a minimum of 95% of the modified Proctor density (ASTM D1557) within -2 to +4% of the optimum moisture content.

The American Association of State and Highway Transportation Officials (AASHTO) Guide for Design of Pavement Structures 1993 procedure was used to calculate the recommended minimum bituminous and Portland cement concrete thicknesses. The AASHTO design procedure allows the designer to select design inputs based on the pavement functional classification. In particular, these include reliability and terminal serviceability rating.

The level of reliability is a degree of certainty incorporated into the design to ensure the pavement will perform as intended over the design period. The AASHTO procedure includes recommended reliability for pavement functional classification (i.e. interstate, principal arterials, collectors, and local roads). A higher reliability number will result in a thicker design pavement section. A reliability number of 90% was used to develop the design sections recommended above.

Serviceability is defined by AASHTO as the ability of a pavement to serve the type of traffic that uses a particular facility. The terminal serviceability rating is the lowest rating allowed prior to pavement rehabilitation. The AASHTO Guide suggests a terminal serviceability rating of 2.5 for design of major highways and 2.0 for highways of lesser traffic volumes. A higher terminal serviceability rating will result in a thicker design pavement section. A terminal serviceability rating of 2.5 was used to develop the design sections recommended above.

4.5.4 Pavement Drainage

Pavements should be sloped to provide rapid drainage of surface water. Water allowed to pond on or adjacent to the pavements could saturate the subgrade and contribute to premature pavement deterioration. In addition, the pavement subgrade should be graded to provide positive drainage within the granular base section.

4.5.5 Pavement Performance and Maintenance

The pavement sections provided in this report represent minimum recommended thicknesses and, as such, periodic maintenance should be anticipated. Therefore preventive maintenance should be planned and provided through an on-going pavement management program. Maintenance activities are intended to slow the rate of pavement deterioration, and to preserve the pavement investment. Maintenance consists of both localized maintenance (e.g., crack and joint sealing and patching) and global maintenance (e.g., surface sealing). Preventive maintenance is usually the first priority when implementing a pavement maintenance program. Additional engineering observation is recommended to determine the type and extent of a cost effective program. Even with periodic maintenance, some movements and related cracking may still occur and repairs may be required.

Pavement performance is affected by its surroundings. In addition to providing preventive maintenance as described above, the civil engineer should consider the following recommendations in the design and layout of pavements:

- Final grade adjacent to parking lots and drives should slope down from pavement edges at a minimum 2% ;
- The subgrade and the pavement surface should have a minimum ¼ inch per foot slope to promote proper surface drainage;
- Install joint sealant and seal cracks immediately;
- Seal all landscaped areas in, or adjacent to, pavements to reduce moisture migration to subgrade soils;
- Place compacted, low permeability backfill against the exterior side of curb and gutter.

4.6 Seismic Site Class

Code	Site Class
2009 International Building Code (IBC)[1]	D

1. In general accordance with Table 1613.5.2 of the 2009 IBC.
2. The 2009 IBC requires a site soil profile determination extending a depth of 100 feet for seismic site classification. The maximum depth explored during our subsurface exploration was about 20 feet. IBC Section 1613.5.2 states that "When the soil properties are not known in sufficient detail to determine the site class, Site Class D shall be used unless the building official or geotechnical data determines that Site Class E or F soil is likely to be present at the site." Based on this section of the IBC and the conditions encountered at the boring locations, Site Class D can be used for design of the proposed project. Additional deeper borings and/or a site-specific seismic evaluation using geophysical methods would be required to further define, and potentially improve, the seismic site class.

5.0 GENERAL COMMENTS

Terracon should be retained to review the final design plans and specifications so comments can be made regarding interpretation and implementation of our geotechnical recommendations in the design and specifications. A qualified geotechnical engineering firm should be retained to provide observation and testing services during grading, excavation, foundation construction and other earth-related construction phases of the project.

The analysis and recommendations presented in this report are based upon the data obtained from the borings performed at the indicated locations and from other information discussed in this report. This report does not reflect variations that may occur between borings, across the site, or due to the modifying effects of construction or weather. The nature and extent of such variations may not become evident until during or after construction. If variations appear, we should be immediately notified so that further evaluation and supplemental recommendations can be provided.

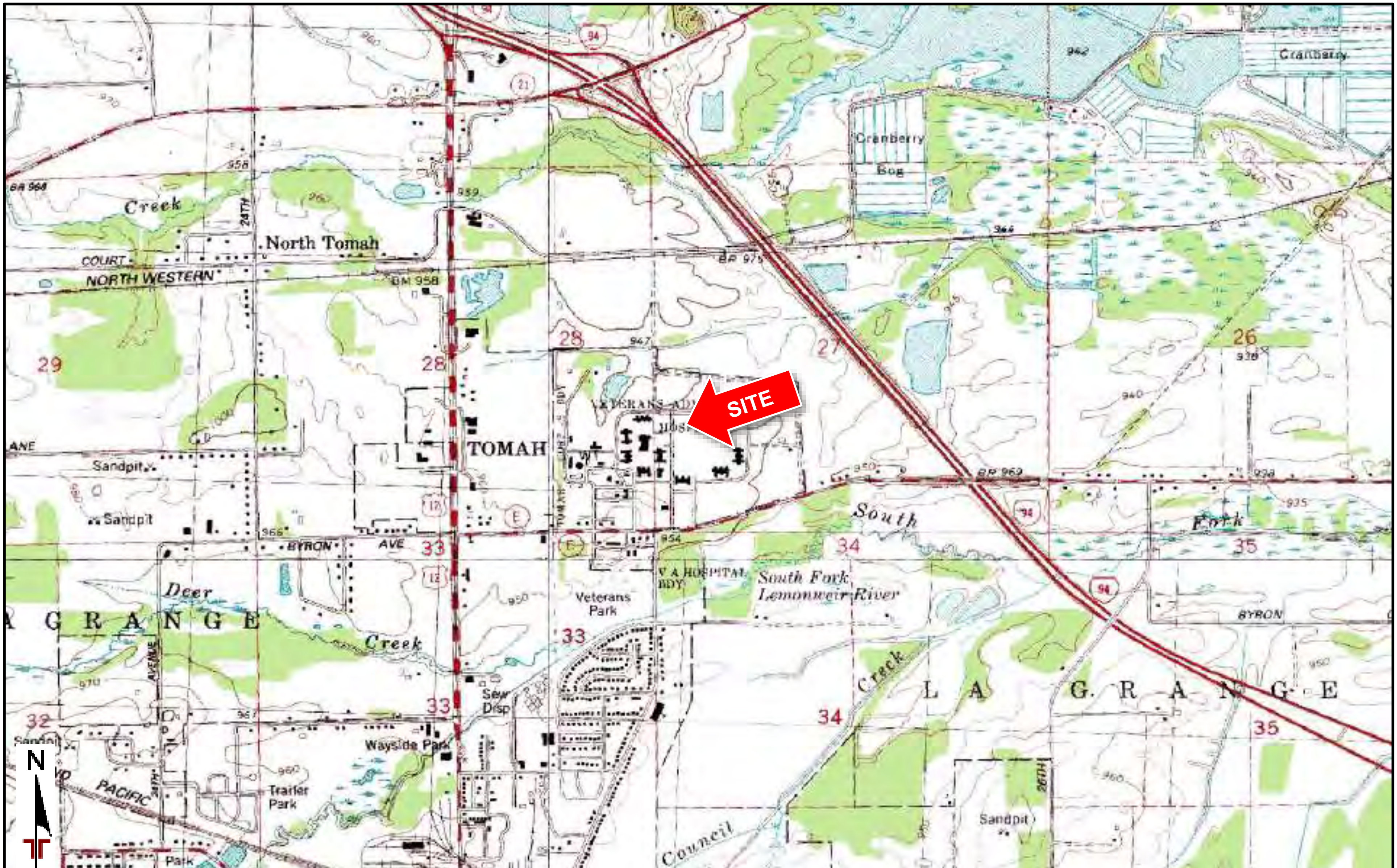
Support of floor slabs and pavements on/above existing fill is discussed in this report. Even with the construction observation/testing recommended in this report, a risk remains for the owner that unsuitable materials within or buried by the fill will not be discovered. This may result in larger than normal settlement and damage to foundations, floor slabs and pavements supported above existing fill, requiring additional maintenance. This risk cannot be eliminated without removing the existing fill from below the foundations, floor slab and pavement areas, but can be reduced by thorough observation and testing as discussed herein.

The scope of services for this project does not include either specifically or by implication any environmental or biological (e.g., mold, fungi, bacteria) assessment of the site or identification or prevention of pollutants, hazardous materials or conditions. If the owner is concerned about the potential for such contamination or pollution, other studies should be undertaken.

This report has been prepared for the exclusive use of our client for specific application to the project discussed and has been prepared in accordance with generally accepted geotechnical engineering practices. No warranties, either express or implied, are intended or made. Site safety, excavation support, and dewatering requirements are the responsibility of others. In the event that changes in the nature, design, or location of the project as outlined in this report are planned, the conclusions and recommendations contained in this report shall not be considered valid unless Terracon reviews the changes and either verifies or modifies the conclusions of this report in writing.

APPENDIX A

FIELD EXPLORATION



TOPOGRAPHIC MAP IMAGE COURTESY OF THE U.S. GEOLOGICAL SURVEY QUADRANGLES INCLUDE: TUNNEL CITY, WI (1/1/1983), WYEVILLE, WI (1/1/1981), TOMAH, WI (1/1/1983) and OAKDALE, WI (1/1/1983).

DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

Project Manager: JDW	Project No. MR155155
Drawn by: JDW	Scale: 1"=24,000 SF
Checked by: PAT	File Name:
Approved by: PAT	Date: 09/2015

Terracon
204 Moravian Valley Rd. STE. G
Waunakee, WI 53597

SITE LOCATION

Tomah VA CLC Green Homes
500 E. Veterans Street
Tomah, WI

Exhibit
A-1

AERIAL PHOTOGRAPHY PROVIDED BY MICROSOFT BING MAPS

DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

Project Manager: JDW	Project No. MR155155
Drawn by: JDW	Scale: NTS
Checked by: PAT	File Name:
Approved by: PAT	Date: 09/2015

Terracon
204 Moravian Valley Rd. STE. G
Waunakee, WI 53597

EXPLORATION PLAN

Tomah VA CLC Green Homes
500 E. Veterans Street
Tomah, WI

Exhibit
A-2

Field Exploration Description

The borings were drilled at the approximate locations indicated on the attached Boring Location Diagram (Exhibit A-3). Boring locations were selected by Terracon and located in the field by the drill crew using a measuring tape in conjunction with a hand held Global Positioning System (GPS) device. Ground surface elevations (rounded to the nearest 0.1 foot) indicated on the boring logs were measured using a surveyor's level and rod by referencing a temporary benchmark. The temporary benchmark was the finished floor elevation of the existing home to the northeast. The elevation of this benchmark was reported to be +951 feet. The locations and elevations of the borings should be considered accurate only to the degree implied by the means and methods used to define them.

The borings were drilled with a truck-mounted, rotary drill rig. The borings were generally advanced using hollow stem augers above the water table and mud rotary methods below to minimize sample disturbance in the native sands. Samples were generally obtained using split-barrel sampling procedures, in which a standard 2-inch (outside diameter) split-barrel sampling spoon is driven into the ground with a 140-pound automatic hammer falling a distance of 30 inches. The number of blows required to advance the sampling spoon the last 12 inches of a normal 18-inch penetration is recorded as the Standard Penetration Test (SPT) resistance value. These values, also referred to as SPT N-values, are an indication of soil strength/relative density and are provided on the boring logs at the depths of occurrence. The samples were tagged for identification, sealed to reduce moisture loss, and taken to our laboratory for further examination, testing, and classification.

The drill crew prepared a field log of each boring. These logs included visual classifications of the materials encountered during drilling and the driller's interpretation of the subsurface conditions between samples. The boring logs included with this report represent the engineer's interpretation of the field logs and include modifications based on laboratory observation and tests of the samples. Information provided on the boring logs attached to this report includes soil descriptions, consistency evaluations, boring depths, sampling intervals, and groundwater conditions. The borings were backfilled with cement bentonite grout prior to the drill crew leaving the site.

BORING LOG NO. B-1

PROJECT: VA Affairs CLC Green Homes

CLIENT: Cox Design Associates
Evanston, Illinois

SITE: 500 E. Veterans Street
Tomah, Wisconsin

LOCATION See Exhibit A-2

Surface Elev.: 949.8 (Ft.)

DEPTH	Description	ELEVATION (Ft.)
0.7	**TOPSOIL**, approximately 8.5 inches	949
3.0	**FILL - LEAN CLAY (CL)**, trace sand and gravel, brown, stiff	947
5.5	**LEAN CLAY (CL)**, trace sand, fine to medium grained, brown and gray (mottled), medium stiff	944.5
20.0	**POORLY GRADED SAND (SP)**, trace silt, fine to medium grained, orangeish brown, medium dense, wet	930
	Boring Terminated at 20 Feet	

DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS	HAND PENETROMETER (tsf)	SAMPLE NUMBER	WATER CONTENT (%)
1–2.5		X	12	2-3-4 N=7	1.25	1	16
3.5–5		X	12	1-2-2 N=4	0.75	2	26
6	▽						
6–7.5		X	16	6-6-8 N=14		3	
8.5–10		X	14	6-10-18 N=28		4	
13.5–15		X	18	6-10-13 N=23		5	
18.5–20		X	18	8-12-16 N=28		6	

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic Hammer

Advancement Method:
0 to 10' - Hollow Stem Auger
10 to 20' - Mud Rotary

Abandonment Method:
Boring backfilled with bentonite chips upon completion.

See Exhibit A-3 for description of field procedures.
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

▽ *6' while drilling*

Terracon
204 Moravian Valley Road, Suite G
Waunakee, Wisconsin

Boring Started: 8/27/2015	Boring Completed: 8/27/2015
Drill Rig: CME-750	Driller: BSD
Project No.: MR155155	Exhibit: A-4

BORING LOG NO. B-2

PROJECT: VA Affairs CLC Green Homes

**CLIENT: Cox Design Associates
Evanston, Illinois**

**SITE: 500 E. Veterans Street
Tomah, Wisconsin**

LOCATION See Exhibit A-2

Surface Elev.: 950.1 (Ft.)

DEPTH	Description	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS	HAND PENETROMETER (tsf)	SAMPLE NUMBER	WATER CONTENT (%)
0.8	**TOPSOIL**, approximately 9 inches	949.5								
3.0	**FILL - POORLY GRADED SAND WITH GRAVEL (SP)**, trace silt, fine to coarse grained, dark brown and gray, loose	947			X	6	3-4-4 N=8		1	
5.5	**CLAYEY SAND (SC)**, trace silt and gravel, fine to medium grained, brown and gray (mottled), medium dense, moist to wet	944.5	5	▽	X	12	5-5-6 N=11		2	
20.0	**POORLY GRADED SAND (SP)**, trace silt, fine to medium grained, orangeish brown, medium dense to dense, wet	930			X	12	7-8-12 N=20		3	
			10		X	16	8-14-24 N=38		4	
			15		X	18	12-14-22 N=36		5	
			20		X	18	10-16-24 N=40		6	
	Boring Terminated at 20 Feet									

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic Hammer

Advancement Method:
0 to 10' - Hollow Stem Auger
10 to 20' - Mud Rotary

Abandonment Method:
Boring backfilled with bentonite chips upon completion.

See Exhibit A-3 for description of field procedures.
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

▽ *5' while drilling*

Terracon
204 Moravian Valley Road, Suite G
Waunakee, Wisconsin

Boring Started: 8/27/2015	Boring Completed: 8/27/2015
Drill Rig: CME-750	Driller: BSD
Project No.: MR155155	Exhibit: A-5

BORING LOG NO. B-3

PROJECT: VA Affairs CLC Green Homes

CLIENT: Cox Design Associates Evanston, Illinois

SITE: 500 E. Veterans Street Tomah, Wisconsin

LOCATION See Exhibit A-2

Surface Elev.: 950 (Ft.)

DEPTH	MATERIAL DESCRIPTION	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS	HAND PENETROMETER (tsf)	SAMPLE NUMBER	WATER CONTENT (%)
0.7	**TOPSOIL**, approximately 8 inches	949.5								
	FILL - SILTY CLAYEY SAND (SC-SM), trace gravel, fine to medium grained, dark brown and gray, loose, moist				X	14	2-3-3 N=6		1	10
3.0		947								
	POORLY GRADED SAND WITH GRAVEL (SP), trace silt, fine to coarse grained, brown, medium dense, moist to wet			▽	X	18	6-6-7 N=13		2	
5.5		944.5	5							
	POORLY GRADED SAND (SP), trace silt, fine to medium grained, orangeish brown, medium dense, wet				X	14	4-5-8 N=13		3	
					X	18	6-10-16 N=26		4	
			10							
					X	12	6-12-14 N=26		5	
			15							
					X	4	6-12-12 N=24		6	
20.0		930	20							
	Boring Terminated at 20 Feet									

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic Hammer

Advancement Method:
0 to 10' - Hollow Stem Auger
10 to 20' - Mud Rotary

Abandonment Method:
Boring backfilled with bentonite chips upon completion.

See Exhibit A-3 for description of field procedures.

See Appendix B for description of laboratory procedures and additional data (if any).

See Appendix C for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

▽ *5' while drilling*

Terracon
204 Moravian Valley Road, Suite G
Waunakee, Wisconsin

Boring Started: 8/27/2015	Boring Completed: 8/27/2015
Drill Rig: CME-750	Driller: BSD
Project No.: MR155155	Exhibit: A-6

BORING LOG NO. B-4

PROJECT: VA Affairs CLC Green Homes

CLIENT: Cox Design Associates
Evanston, Illinois

SITE: 500 E. Veterans Street
Tomah, Wisconsin

LOCATION See Exhibit A-2

Surface Elev.: 950.1 (Ft.)

GRAPHIC LOG / DEPTH	DESCRIPTION	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS	HAND PENETROMETER (tsf)	SAMPLE NUMBER	WATER CONTENT (%)
0.8	**TOPSOIL**, approximately 10 inches	949.5								
3.0	**FILL - POORLY GRADED SAND (SP)**, trace silt, gravel and organics, fine to medium grained, brown and gray (mottled), medium dense, moist	947			X	18	6-6-7 N=13		1	
20.0	**POORLY GRADED SAND (SP)**, trace silt, fine to medium grained, light brown to orangeish brown, medium dense to dense, moist to wet	930			X	16	6-6-7 N=13		2	
			5	▽ (6')	X	10	4-6-9 N=15		3	
					X	18	4-7-17 N=24		4	
			10							
					X	6	12-13-21 N=34		5	
			15							
					X	4	10-14-18 N=32		6	
			20							
	Boring Terminated at 20 Feet									

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic Hammer

Advancement Method:
0 to 10' - Hollow Stem Auger
10 to 20' - Mud Rotary

Abandonment Method:
Boring backfilled with bentonite chips upon completion.

See Exhibit A-3 for description of field procedures.
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

▽ *6' while drilling*

Terracon
204 Moravian Valley Road, Suite G
Waunakee, Wisconsin

Boring Started: 8/27/2015	Boring Completed: 8/27/2015
Drill Rig: CME-750	Driller: BSD
Project No.: MR155155	Exhibit: A-7

BORING LOG NO. B-5

PROJECT: VA Affairs CLC Green Homes

**CLIENT: Cox Design Associates
Evanston, Illinois**

**SITE: 500 E. Veterans Street
Tomah, Wisconsin**

LOCATION See Exhibit A-2

Surface Elev.: 949.8 (Ft.)

DEPTH	Description	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS	HAND PENETROMETER (tsf)	SAMPLE NUMBER	WATER CONTENT (%)
0.2	**TOPSOIL**, approximately 2 inches	949.5								
	POORLY GRADED SAND (SP), trace silt, fine to medium grained, orangeish brown, loose to medium dense, wet			▽ (1.5')	X	16	3-4-5 N=9		1	
			5		X	14	3-5-8 N=13		2	
					X	16	8-10-12 N=22		3	
			10		X	10	10-11-14 N=25		4	
			15		X	14	7-9-12 N=21		5	
20.0		930	20		X	4	10-14-13 N=27		6	
	Boring Terminated at 20 Feet									

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic Hammer

Advancement Method:
0 to 10' - Hollow Stem Auger
10 to 20' - Mud Rotary

Abandonment Method:
Boring backfilled with bentonite chips upon completion.

See Exhibit A-3 for description of field procedures.
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

▽ *1.5' while drilling*

Terracon
204 Moravian Valley Road, Suite G
Waunakee, Wisconsin

Boring Started: 8/27/2015	Boring Completed: 8/27/2015
Drill Rig: CME-750	Driller: BSD
Project No.: MR155155	Exhibit: A-8

BORING LOG NO. B-6

PROJECT: VA Affairs CLC Green Homes

CLIENT: Cox Design Associates
Evanston, Illinois

SITE: 500 E. Veterans Street
Tomah, Wisconsin

LOCATION See Exhibit A-2

Surface Elev.: 947.3 (Ft.)

DEPTH	MATERIAL DESCRIPTION	ELEVATION (Ft.)
0.5	**TOPSOIL**, approximately 6 inches	947
3.0	**FILL - SILTY SAND (SM)**, trace gravel, fine to medium grained, dark brown, loose, moist	944.5
5.5	**SILTY SAND (SM)**, trace gravel, fine to medium grained, brown, medium dense, moist to wet	942
20.0	**POORLY GRADED SAND (SP)**, trace silt, fine to medium grained, orangeish brown, medium dense, wet	927.5

Boring Terminated at 20 Feet

DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS	HAND PENETROMETER (tsf)	SAMPLE NUMBER	WATER CONTENT (%)
1-2.5		X	14	3-3-4 N=7		1	
3.5-5	▽ (5)	X	16	4-5-5 N=10		2	
6-7.5		X	16	5-8-10 N=18		3	
8.5-10		X	18	7-10-14 N=24		4	
13.5-15		X	10	8-12-14 N=26		5	
18.5-20		X	10	10-13-15 N=28		6	

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic Hammer

Advancement Method:
0 to 10' - Hollow Stem Auger
10 to 20' - Mud Rotary

Abandonment Method:
Boring backfilled with bentonite chips upon completion.

See Exhibit A-3 for description of field procedures.
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

▽ *5' while drilling*

Terracon
204 Moravian Valley Road, Suite G
Waunakee, Wisconsin

Boring Started: 8/27/2015	Boring Completed: 8/27/2015
Drill Rig: CME-750	Driller: BSD
Project No.: MR155155	Exhibit: A-9

BORING LOG NO. T-1

PROJECT: VA Affairs CLC Green Homes

**CLIENT: Cox Design Associates
Evanston, Illinois**

**SITE: 500 E. Veterans Street
Tomah, Wisconsin**

LOCATION See Exhibit A-2

Surface Elev.: 949.6 (Ft.)

DEPTH	Description	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS	HAND PENETROMETER (tsf)	SAMPLE NUMBER	WATER CONTENT (%)
0.4	**TOPSOIL**, approximately 5 inches	949								
1.5	**FILL - LEAN CLAY (CL)**, trace sand, dark brown	948			X	10	3-4-5 N=9		1	
5.5	**SILTY SAND (SM)**, trace clay, fine to medium grained, brown, medium dense, moist to wet	944	5	▽	X	14	4-5-6 N=11		2	15
10.0	**POORLY GRADED SAND (SP)**, trace silt, fine to medium grained, orangeish brown, medium dense, wet	939.5			X	18	4-6-8 N=14		3	
			10		X	16	3-7-12 N=19		4	

Boring Terminated at 10 Feet

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic Hammer

Advancement Method:
Hollow Stem Auger

Abandonment Method:
Boring backfilled with bentonite chips upon completion.

See Exhibit A-3 for description of field procedures.
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

▽ *5' while drilling*

Terracon
204 Moravian Valley Road, Suite G
Waunakee, Wisconsin

Boring Started: 8/27/2015	Boring Completed: 8/27/2015
Drill Rig: CME-750	Driller: BSD
Project No.: MR155155	Exhibit: A-10

BORING LOG NO. T-2

PROJECT: VA Affairs CLC Green Homes

CLIENT: Cox Design Associates
Evanston, Illinois

SITE: 500 E. Veterans Street
Tomah, Wisconsin

LOCATION See Exhibit A-2

Surface Elev.: 949.8 (Ft.)

DEPTH	DESCRIPTION	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS	HAND PENETROMETER (tsf)	SAMPLE NUMBER	WATER CONTENT (%)
0.5	**TOPSOIL**, approximately 6 inches	949.5								
1.5	**FILL - LEAN CLAY (CL)**, trace sand, dark brown	948.5			X	14	4-6-8 N=14		1	
	POORLY GRADED SAND (SP), trace silt, fine to medium grained, orangeish brown, medium dense, moist to wet				X	12	3-5-7 N=12		2	
			5	▽ (6')	X	14	4-6-7 N=13		3	
10.0		940	10		X	14	8-10-11 N=21		4	

Boring Terminated at 10 Feet

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic Hammer

Advancement Method:
Hollow Stem Auger

Abandonment Method:
Boring backfilled with bentonite chips upon completion.

See Exhibit A-3 for description of field procedures.
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

▽ *6' while drilling*

Terracon
204 Moravian Valley Road, Suite G
Waunakee, Wisconsin

Boring Started: 8/27/2015	Boring Completed: 8/27/2015
Drill Rig: CME-750	Driller: BSD
Project No.: MR155155	Exhibit: A-11

BORING LOG NO. T-3

PROJECT: VA Affairs CLC Green Homes

CLIENT: Cox Design Associates
Evanston, Illinois

SITE: 500 E. Veterans Street
Tomah, Wisconsin

LOCATION See Exhibit A-2

Surface Elev.: 949.8 (Ft.)

DEPTH	DESCRIPTION	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS	HAND PENETROMETER (tsf)	SAMPLE NUMBER	WATER CONTENT (%)
0.5	**TOPSOIL**, approximately 6.5 inches	949.5								
	FILL - POORLY GRADED SAND (SP), trace silt, brown, medium dense, moist				X	16	5-5-5 N=10		1	
3.0		947								
	POORLY GRADED SAND (SP), trace silt, fine to medium grained, orangeish brown, medium dense, moist to wet			∇	X	14	8-9-9 N=18		2	
			5							
					X	16	3-6-9 N=15		3	
					X	18	6-8-12 N=20		4	
10.0		940	10							

Boring Terminated at 10 Feet

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic Hammer

Advancement Method:
Hollow Stem Auger

Abandonment Method:
Boring backfilled with bentonite chips upon completion.

See Exhibit A-3 for description of field procedures.
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

∇ *4.5' while drilling*

Terracon
204 Moravian Valley Road, Suite G
Waunakee, Wisconsin

Boring Started: 8/27/2015	Boring Completed: 8/27/2015
Drill Rig: CME-750	Driller: BSD
Project No.: MR155155	Exhibit: A-12

APPENDIX B

LABORATORY PROCEDURES

Laboratory Testing

Hand penetrometer tests were performed on cohesive samples to estimate the unconfined compressive strength. Moisture content tests were performed on all samples recovered using the spilt-barrel sampling procedure. The results of all tests performed are shown on the boring logs included in Appendix A.

The soil samples were classified in the laboratory based on visual observation, texture, plasticity, and the limited laboratory testing described above. The soil descriptions presented on the boring logs for native soils are in accordance with the enclosed General Notes and Unified Soil Classification System (USCS). The estimated USCS group symbols for native soils are shown on the boring logs, and a brief description of the USCS is included in this report in Appendix C.

Procedural standards noted above are for reference to methodology in general. In some cases, variations to methods are applied as a result of local practice or professional judgment.

APPENDIX C
SUPPORTING DOCUMENTS

GENERAL NOTES

DESCRIPTION OF SYMBOLS AND ABBREVIATIONS

SAMPLING

Auger	Split Spoon
Shelby Tube	Macro Core
Ring Sampler	Rock Core
Grab Sample	No Recovery

WATER LEVEL

- **Water Initially Encountered**
- **Water Level After a Specified Period of Time**
- **Water Level After a Specified Period of Time**

Water levels indicated on the soil boring logs are the levels measured in the borehole at the times indicated. Groundwater level variations will occur over time. In low permeability soils, accurate determination of groundwater levels is not possible with short term water level observations.

FIELD TESTS

(HP)	**Hand Penetrometer**
(T)	**Torvane**
(b/f)	**Standard Penetration Test (blows per foot)**
(PID)	**Photo-Ionization Detector**
(OVA)	**Organic Vapor Analyzer**

DESCRIPTIVE SOIL CLASSIFICATION

Soil classification is based on the Unified Soil Classification System. Coarse Grained Soils have more than 50% of their dry weight retained on a #200 sieve; their principal descriptors are: boulders, cobbles, gravel or sand. Fine Grained Soils have less than 50% of their dry weight retained on a #200 sieve; they are principally described as clays if they are plastic, and silts if they are slightly plastic or non-plastic. Major constituents may be added as modifiers and minor constituents may be added according to the relative proportions based on grain size. In addition to gradation, coarse-grained soils are defined on the basis of their in-place relative density and fine-grained soils on the basis of their consistency.

LOCATION AND ELEVATION NOTES

Unless otherwise noted, Latitude and Longitude are approximately determined using a hand-held GPS device. The accuracy of such devices is variable. Surface elevation data annotated with +/- indicates that no actual topographical survey was conducted to confirm the surface elevation. Instead, the surface elevation was approximately determined from topographic maps of the area.

STRENGTH TERMS

RELATIVE DENSITY OF COARSE-GRAINED SOILS (More than 50% retained on No. 200 sieve.) Density determined by Standard Penetration Resistance Includes gravels, sands and silts.			**CONSISTENCY OF FINE-GRAINED SOILS** (50% or more passing the No. 200 sieve.) Consistency determined by laboratory shear strength testing, field visual-manual procedures or standard penetration resistance				**BEDROCK**		
Descriptive Term (Density)	**Standard Penetration or N-Value Blows/Ft.**	**Ring Sampler Blows/Ft.**	**Descriptive Term (Consistency)**	**Unconfined Compressive Strength, Qu, psf**	**Standard Penetration or N-Value Blows/Ft.**	**Ring Sampler Blows/Ft.**	**Ring Sampler Blows/Ft.**	**Standard Penetration or N-Value Blows/Ft.**	**Descriptive Term (Consistency)**
Very Loose	0 - 3	0 - 6	Very Soft	less than 500	0 - 1	< 3	< 30	< 20	Weathered
Loose	4 - 9	7 - 18	Soft	500 to 1,000	2 - 4	3 - 4	30 - 49	20 - 29	Firm
Medium Dense	10 - 29	19 - 58	Medium-Stiff	1,000 to 2,000	4 - 8	5 - 9	50 - 89	30 - 49	Medium Hard
Dense	30 - 50	59 - 98	Stiff	2,000 to 4,000	8 - 15	10 - 18	90 - 119	50 - 79	Hard
Very Dense	> 50	≥ 99	Very Stiff	4,000 to 8,000	15 - 30	19 - 42	> 119	>79	Very Hard
			Hard	> 8,000	> 30	> 42			

RELATIVE PROPORTIONS OF SAND AND GRAVEL

Descriptive Term(s) of other constituents	Percent of Dry Weight
Trace	< 15
With	15 - 29
Modifier	> 30

GRAIN SIZE TERMINOLOGY

Major Component of Sample	Particle Size
Boulders	Over 12 in. (300 mm)
Cobbles	12 in. to 3 in. (300mm to 75mm)
Gravel	3 in. to #4 sieve (75mm to 4.75 mm)
Sand	#4 to #200 sieve (4.75mm to 0.075mm
Silt or Clay	Passing #200 sieve (0.075mm)

RELATIVE PROPORTIONS OF FINES

Descriptive Term(s) of other constituents	Percent of Dry Weight
Trace	< 5
With	5 - 12
Modifier	> 12

PLASTICITY DESCRIPTION

Term	Plasticity Index
Non-plastic	0
Low	1 - 10
Medium	11 - 30
High	> 30

UNIFIED SOIL CLASSIFICATION SYSTEM

Criteria for Assigning Group Symbols and Group Names Using Laboratory Tests [A]					Soil Classification	
					Group Symbol	Group Name [B]
Coarse Grained Soils: More than 50% retained on No. 200 sieve	**Gravels:** More than 50% of coarse fraction retained on No. 4 sieve	**Clean Gravels:** Less than 5% fines [C]	$Cu \geq 4$ and $1 \leq Cc \leq 3$ [E]		GW	Well-graded gravel [F]
			$Cu < 4$ and/or $1 > Cc > 3$ [E]		GP	Poorly graded gravel [F]
		Gravels with Fines: More than 12% fines [C]	Fines classify as ML or MH		GM	Silty gravel [F,G,H]
			Fines classify as CL or CH		GC	Clayey gravel [F,G,H]
	Sands: 50% or more of coarse fraction passes No. 4 sieve	**Clean Sands:** Less than 5% fines [D]	$Cu \geq 6$ and $1 \leq Cc \leq 3$ [E]		SW	Well-graded sand [I]
			$Cu < 6$ and/or $1 > Cc > 3$ [E]		SP	Poorly graded sand [I]
		Sands with Fines: More than 12% fines [D]	Fines classify as ML or MH		SM	Silty sand [G,H,I]
			Fines classify as CL or CH		SC	Clayey sand [G,H,I]
Fine-Grained Soils: 50% or more passes the No. 200 sieve	**Silts and Clays:** Liquid limit less than 50	**Inorganic:**	$PI > 7$ and plots on or above "A" line [J]		CL	Lean clay [K,L,M]
			$PI < 4$ or plots below "A" line [J]		ML	Silt [K,L,M]
		Organic:	Liquid limit - oven dried	< 0.75	OL	Organic clay [K,L,M,N]
			Liquid limit - not dried			Organic silt [K,L,M,O]
	Silts and Clays: Liquid limit 50 or more	**Inorganic:**	PI plots on or above "A" line		CH	Fat clay [K,L,M]
			PI plots below "A" line		MH	Elastic Silt [K,L,M]
		Organic:	Liquid limit - oven dried	< 0.75	OH	Organic clay [K,L,M,P]
			Liquid limit - not dried			Organic silt [K,L,M,Q]
Highly organic soils:	Primarily organic matter, dark in color, and organic odor				PT	Peat

[A] Based on the material passing the 3-inch (75-mm) sieve

[B] If field sample contained cobbles or boulders, or both, add "with cobbles or boulders, or both" to group name.

[C] Gravels with 5 to 12% fines require dual symbols: GW-GM well-graded gravel with silt, GW-GC well-graded gravel with clay, GP-GM poorly graded gravel with silt, GP-GC poorly graded gravel with clay.

[D] Sands with 5 to 12% fines require dual symbols: SW-SM well-graded sand with silt, SW-SC well-graded sand with clay, SP-SM poorly graded sand with silt, SP-SC poorly graded sand with clay

[E] $Cu = D_{60}/D_{10}$ $\quad Cc = \dfrac{(D_{30})^2}{D_{10} \times D_{60}}$

[F] If soil contains ≥ 15% sand, add "with sand" to group name.

[G] If fines classify as CL-ML, use dual symbol GC-GM, or SC-SM.

[H] If fines are organic, add "with organic fines" to group name.

[I] If soil contains ≥ 15% gravel, add "with gravel" to group name.

[J] If Atterberg limits plot in shaded area, soil is a CL-ML, silty clay.

[K] If soil contains 15 to 29% plus No. 200, add "with sand" or "with gravel," whichever is predominant.

[L] If soil contains ≥ 30% plus No. 200 predominantly sand, add "sandy" to group name.

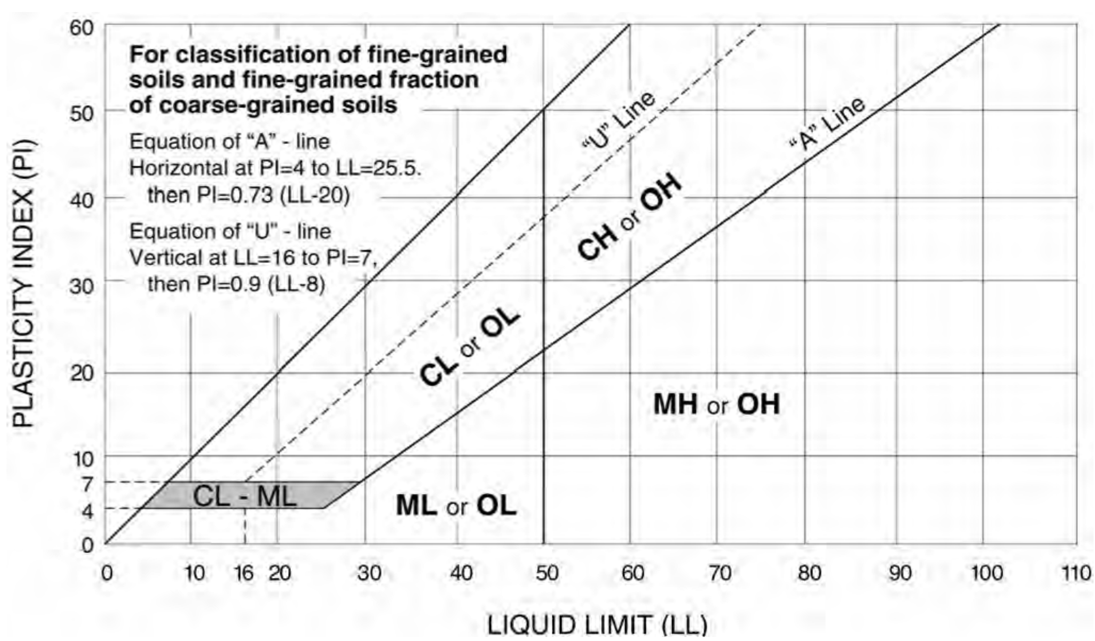
[M] If soil contains ≥ 30% plus No. 200, predominantly gravel, add "gravelly" to group name.

[N] PI ≥ 4 and plots on or above "A" line.

[O] PI < 4 or plots below "A" line.

[P] PI plots on or above "A" line.

[Q] PI plots below "A" line.



Terracon