Geotechnical Engineering Report

Proposed Street Reconstruction
Bomber Boulevard
Minot Air Force Base, North Dakota

February 26, 2014
MTL/Terracon Project No. M6135013

Prepared for:
FourFront Design
Rapid City, South Dakota

Prepared by:
Midwest Testing Laboratory
Grand Forks, North Dakota

Midwest Testing LABORATORY, INC.
A Terracon COMPANY

February 26, 2014

FourFront Design
517 7th Street
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Attn: Mr. Dirk Jablonski
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Re: Geotechnical Engineering Report
Proposed Street Reconstruction – Bomber Boulevard
Minot Air Force Base, North Dakota
MTL/Terracon Project Number: M6135013

Dear Mr. Jablonski:

Midwest Testing Laboratory (A Terracon Company) has completed the geotechnical engineering services for the above referenced project. This study was performed in general accordance with our proposal number PM6130090 dated October 31, 2013. This report presents the findings of the subsurface exploration and provides geotechnical recommendations concerning earthwork and the design and construction of the proposed street reconstruction.

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, please contact us.

Sincerely,
Midwest Testing Laboratory, A Terracon Company

David N. Ackert, EI
Staff Engineer

Steven S. Smith, PE
Senior Associate

William R. Olson, PE
Geotechnical Engineer

REGISTERED PROFESSIONAL ENGINEER
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NORTH DAKOTA

Enclosures
cc: 2 – Client
1 – File

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EXECUTIVE SUMMARY

Geotechnical engineering services have been completed for the proposed street reconstruction at the Minot Air Force Base, North Dakota. Twenty-six (26) soil test borings were drilled to a depth of 11 feet below existing grade.

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

- Our borings encountered asphalt pavement to a depth of approximately 4 to 7 inches underlain by approximately 12 to 18 inches of aggregate base. Natural, inorganic lean clays were typically encountered extending to the final depth of the borings.

- In our opinion, use of the existing subgrade soils for support of the proposed pavement is feasible.

- The natural clayey soils encountered in our borings are extremely susceptible to frost heaving. The pavement will be susceptible to cracking and heaving.

- Close monitoring of the construction operations discussed herein will be critical in achieving the design subgrade support. We therefore recommend that the MTL/Terracon be retained to monitor 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
PROPOSED STREET RECONSTRUCTION
BOMBER BOULEVARD
MINOT AIR FORCE BASE, NORTH DAKOTA

MTL/Terracon Project No. M6135013
February 26, 2014

1.0 INTRODUCTION

Geotechnical engineering services have been completed for the proposed street reconstruction at the Minot Air Force Base, North Dakota. Twenty-six (26) soil test borings were drilled to a depth of 11 feet below existing grade. Logs of the borings along with a site location map, and boring location plan are included in Appendix A of this report.

The purpose of these services is to provide information and geotechnical engineering recommendations relative to:

- subsurface soil conditions
- groundwater conditions
- earthwork
- pavement design and construction

2.0 PROJECT INFORMATION

2.1 Project Description

Item	Description
Site layout	See Appendix A, Exhibit A-2 and A-3: Boring Location Plan
Proposed Improvements	The project will include reconstruction/repair of the bituminous pavement along Bomber Boulevard. Complete reconstruction is proposed for a majority of the roadway, with the exception of the section between Peacekeeper Place and Minuteman Drive, where a mill and overlay is proposed.
Grading	We anticipate minor changes to the existing roadway grades.

2.2 Site Location and Description

Item	Description
Location	The project includes approximately 3 miles of roadway along Bomber Boulevard at the Minot Air Force Base, North Dakota. See Appendix A, Exhibit A-1: Site Location Map
Current ground cover	Grassed area/asphalt pavement
Existing topography	Relatively level project site

Item	Description
Existing Improvements	The existing bituminous pavement is experiencing some distress due to age and some drainage problems. The existing bituminous pavement is in poor to fair condition with the exception of the section between Peacekeeper Place and Minuteman Drive which is in good condition with some transverse cracks.

3.0 SUBSURFACE CONDITIONS

3.1 Typical Profile

Based on the results of the borings, subsurface conditions on the project site can be generalized as follows:

Stratum	Approximate Depth to Bottom of Stratum (feet)	Material Description	Consistency/ Density
1	0.4[1]	Asphalt pavement	N/A
2	2[1]	Existing fill consisting of silty sands with gravel	Frozen
3	4	Sandy lean clays and lean clays	Frozen to 3½' then medium stiff to stiff
4	Undetermined[2]	Sandy lean clay, lean clay, and poorly graded sand with silt	Stiff to very stiff and medium dense

1. The near surface soils were frozen, therefore only disturbed auger samples could be obtained in the upper portion of the borings. The thickness and depth of the fill should be considered approximate.
2. Borings were terminated in this stratum at the planned maximum depth of 11 feet.

Conditions at each boring location are indicated on the attached individual boring logs. Stratification boundaries on the boring logs represent the approximate location of changes in soil types; in situ, the transition between materials may be gradual. Details for each of the borings can be found on the boring logs in Appendix A of this report. A discussion of the field sampling is included in Appendix A.

3.2 Groundwater

Groundwater was not observed in in the borings during or upon completion of the drilling. However, this does not necessarily mean the borings were terminated above the groundwater. Due to the low permeability of the soils encountered in the borings, a relatively long period of time may be necessary for a groundwater level to develop and stabilize in a borehole in these materials. Long term observations in piezometers or observation wells sealed from the influence of surface water are often required to define groundwater levels in materials of this type.

Groundwater level fluctuations occur due to seasonal variations in the amount of rainfall, runoff and other factors not evident at the time the borings were performed. Therefore, groundwater levels during construction or at other times in the life of the structure may be higher or lower than the levels indicated on the boring logs. The possibility of groundwater level fluctuations should be considered when developing the design and construction plans for the project.

4.0 RECOMMENDATIONS FOR DESIGN AND CONSTRUCTION

4.1 Pavements

In our opinion, use of the existing subgrade soils for support of the proposed pavement is feasible. The natural clayey soils encountered in our borings are extremely susceptible to frost heaving. These soils experience frost heaving during winter months and a subsequent loss of strength during spring thaw. Therefore seasonal pavement movement and cracking should be expected due to the extreme temperature changes that will occur. For long term pavement performance, the pavement should have good surface drainage to catch basins. A maintenance program consisting of filling and maintaining the cracks that develop is needed for long term pavement performance.

4.1.1 Subgrade Preparation

We recommend the subgrade soils be scarified and recompacted to a minimum of 98 percent of the Standard Proctor maximum density. The moisture content at the time of compaction should range from optimum to 4 percent below optimum. Some moisture conditioning may be needed to obtain the recommended level of compaction.

We recommend the moisture content and density of the top 12 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 recompacted. Areas where unsuitable conditions are located should be repaired by removing and replacing the materials with properly compacted fills.

4.1.2 Design Considerations

Estimates of minimum thicknesses for new pavement sections for this project have been based on the procedures outlined in the 1993 Guideline for Design of Pavement Structures by the American Association of State Highway and Transportation Officials (AASHTO-1993).

Traffic loading information used in our analysis was provided by FourFront Design. Our analysis is based on approximately 1000 light passenger cars and trucks and 15 semi-trucks per day over a 20 year design life. For the section between ALCM Pass and Deterence Drive, we have included MHU-196 trailer and tow vehicle traffic. Our analysis is based on 75 trips per week for 4 weeks per year over a 20 year design life. Design parameters used in our analysis are provided in the following table:

PAVEMENT DESIGN INPUT		
Input Parameter	**All areas – excluding section between ALCM Pass and Deterence Drive**	**ALCM Pass and Deterence Drive**
Reliability (%)	85	85
Standard Deviation	0.45	0.45
Initial Serviceability	4.2	4.2
Terminal Serviceability	2.0	2.0
Design Serviceability Loss	2.2	2.2
Design ESAL Value	275,000	615,000

4.1.3 Asphalt Cement Concrete Thickness Design Recommendations

Location	Asphalt Pavement
All areas – excluding the section between ALCM Pass and Deterence Drive	6" ACC Pavement[1]
	12" Aggregate Base Course[2]
Section between ALCM Pass and Deterence Drive	7" ACC Pavement[1]
	12" Aggregate Base Course[2]

1. For the asphalt pavement, we recommend a mix meeting the requirements of North Dakota DOT Section 410; FAA 43.
2. The base course should meet the requirements of North Dakota 816.03 Class 5. As an alternative, a recycled concrete aggregate meeting the requirements of North Dakota 817 may be used. The aggregate base course should have a minimum CBR of 40. We recommend the aggregate base course be placed in loose lift thicknesses of six inches or less and compacted to a minimum of 95 percent of the Standard Proctor maximum density.

4.1.4 Mill and Overlay

We understand a mill and overlay alternative is proposed for the section between Peacekeeper Place and Cruise Missile Lane. The existing pavement in these areas in is relatively good condition. The borings performed in these areas indicate the existing pavement section consists of approximately 4 to 4 ½ inches of asphalt pavement underlain by 12 to 18 inches of aggregate base. In our opinion, a mill and overlay could be used to extend the life pavement. Based on the design parameters and using a 2 inch milling depth, we recommend a minimum 3 inch overlay. With this option, we recommend removal of any existing pavement that is experiencing alligator cracking or is in relatively poor condition.

4.1.5 Full Depth Reclamation

We understand consideration is being given to full depth reclamation for the sections between US Highway 83 and Deterence Drive, and Minuteman Drive and Demo Drive. Based on the soil conditions encountered at our boring locations, it is our opinion this option would be feasible. Based on a reclamation depth of 12 inches, we estimate a minimum asphalt cement pavement section on the order of 4 to 5 inches would be needed. Please contact us if you would like us to investigate this option further.

4.1.6 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. Appropriate sub-drainage or connection to a suitable daylight outlet should be provided to remove water from the granular subbase.

4.1.7 Pavement 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 for through an on-going pavement management program. Preventive maintenance activities are intended to slow the rate of pavement deterioration, and to preserve the pavement investment. Preventive 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 planned pavement maintenance program and provides the highest return on investment for pavements. Prior to implementing any maintenance, additional engineering observation is recommended to determine the type and extent of preventive maintenance. Even with periodic maintenance, some movements and related cracking may still occur and repairs may be required.

5.0 GENERAL COMMENTS

MTL/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. MTL/Terracon also should be retained to provide observation and testing services during grading, 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.

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 MTL/Terracon reviews the changes and either verifies or modifies the conclusions of this report in writing.

APPENDIX A
FIELD EXPLORATION

Field Exploration Description

Twenty-six (26) soil test borings were completed on December 16 and 17, 2013. The borings were advanced at the approximate locations indicated on Exhibit A-2 and A-3. The boring locations were laid out in the field by a MTL/Terracon representative using a site plan provided by the client. This foundation was assumed to be at elevation 100.0. The locations 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 using 2 ¼ hollow stem to advance the boreholes. Since the upper portion of the soils was frozen a the time of our field activities, auger samples were obtained in the upper 2 to 3 feet. Soil samples were then obtained using split-barrel sampling procedures. In the split-barrel sampling procedure the number of blows required to advance a standard 2-inch O.D., 1-3/8-inch I.D spilt-barrel sampler from 6 to 18 inches of penetration by means of a 140-pound hammer with a free fall of 30 inches is used to obtain the Standard Penetration Test (SPT) or N-value. The SPT is used to estimate the in-situ relative density of cohesionless soils and the consistency of cohesive soils.

An automatic SPT hammer was used to advance the split-barrel sampler in the borings performed at this site. A greater efficiency is typically achieved with the automatic hammer compared to the conventional safety hammer operated with a cathead and rope. Published correlations between the SPT values and soil properties are based on the lower efficiency cathead and rope method. This higher efficiency affects the standard penetration resistance blow count (N) value by increasing the penetration per hammer blow over what would be obtained using the cathead and rope method. The effect of the automatic hammer's efficiency has been considered in the interpretation and analysis of the subsurface information for this report.

The samples were tagged for identification, sealed to reduce moisture loss, and taken to our laboratory for further examination, testing, and classification. Information provided on the boring logs attached to this report includes soil descriptions, consistency evaluations, boring depths, sampling intervals, and groundwater conditions.

A field log of each boring was prepared by the drill crew. These logs included visual classifications of the materials encountered during drilling as well as the driller’s interpretation of the subsurface conditions between samples. Final 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.