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GEOTECHNICAL EXPLORATION, PAVEMENT TESTING, ENGINEERING ANALYSIS AND REVIEW

Frac Sand Haul Road Project

Pepin County, Wisconsin

AET Project No. 28-00500

Date:

April 25, 2012

Prepared for:

Pepin County Highway Department
312 10th Ave. East
Durand, WI 54736

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EXHIBIT D

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April 25, 2012

Pepin County Highway Department
312 10th Ave. East
Durand, WI 54736

Attn: Mr. Steve Schofield, Highway Commissioner

RE: Geotechnical and Pavement Testing, Analysis and Review
Frac Sand Haul Roads Project
Pepin County, Wisconsin
Report No. 28-00500

Dear Mr. Schofield:

American Engineering Testing, Inc. (AET) is pleased to present the results of our geotechnical exploration, pavement testing, engineering analysis and review for your Frac Sand Haul Road project in Pepin County, Wisconsin. These services were performed according to our proposal to you dated August 18, 2011 and your addendum dated on March 7, 2012.

Per your request we are submitting this report to you electronically.

Please contact me if you have any questions about the report. I can also be contacted for arranging construction observation and testing services during the earthwork phase.

Sincerely,
American Engineering Testing, Inc.

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1.0 INTRODUCTION

Pepin County Highway Department (County) is preparing for haul route pavement evaluation and possible future improvements along selected haul routes for the "Frac Sand" mine and aggregate quarry that are located in Pepin County, Wisconsin. To assist in the planning and design, County has authorized American Engineering Testing, Inc. (AET) to conduct a subsurface exploration, perform nondestructive pavement testing at the site, and prepare a geotechnical and pavement engineering analysis of the project. This report presents the results of the above services, and provides our engineering recommendations based on this data.

2.0 SCOPE OF SERVICES

AET's scope of services initially included Digital Video Log (DVL), Ground Penetrating Radar (GPR), and Falling Weight Deflectometer (FWD) testing, as well as performing soil borings on approximately 8.5 miles of county highways. The scope consisted of the following:

1. Perform DVL testing on the selected haul routes, in two traveling directions, using a digital video camera. The total length of Highway to be tested was approximately 17 lane miles. The digital video log shows pavement surface condition as well as geographic benchmarks such as bridges and road signs which assisted in determining the location of the video log.

2. Perform GPR testing on main haul routes, at 1 foot intervals and in two traveling directions, to measure pavement thickness and to identify thin pavement locations. The total length of Highway to be tested was approximately 17 lane miles.

3. Perform FWD testing in one traveling direction, to determine the moduli of pavement layers and subgrade soils. The length of Highway to be tested was approximately 8.5

miles. We performed this testing using 0.1-mile spacing, and back calculated an effective subgrade modulus from the test data. From the back calculated effective subgrade modulus we provide an estimated effective subgrade CBR and existing structural number (SN) for pavement design.

As an enhancement to our work the GPR and FWD data collection systems are tied to GPS coordinates.

4. Following completion of GPR and FWD analysis work we performed 18 soil borings. Based on the analysis of GPR and FWD test data, we provided coordinates for recommended soil boring locations for your consideration. The locations of borings were spaced at approximately 0.5 miles with additional borings in specific areas where the initial GPR analysis was unclear.

5. At identified soil boring locations we cleared public utilities with the Wisconsin Digger's Hotline System, cored the pavement surface and obtained a sample of the aggregate base by augering. Soil borings were then advanced to a depth of approximately 4 feet below the surface of the pavement. The borings were performed to identify pavement and base thickness and for identification of soil type classification which will be classified by the ASTM Soil Classification Systems.

   The boreholes were backfilled with soil cuttings and the surface at each boring location was patched with asphalt patching material. Drilling-related debris was removed from the Highway after each soil boring was completed.

6. Prepare 1) engineering report discussing axle load capacity, general Highway and pavement condition, specific potential problem areas identified by the video, pavement condition ratings (0-100 scale modified from the ASTM standard because of the use of video) and other issues related to suitability of the Highways to withstand truck traffic from the sand mining and 2) single page summary sheets recommending Highway improvements to the haul routes once traffic volumes have been established for each mile and/or per each section.

These services are intended for geotechnical purposes. The scope is not intended to explore for the presence or extent of environmental contamination in the soil or ground water.

3.0 PROJECT INFORMATION

The "Frac Sand" Haul Road Project ("Project") is located in the West side of Pepin County, Wisconsin, including one mine and one quarry located in Dad Lake Island as shown in Figure 1.

The fracturing sand mine plans to run 10-11 months out of the year, under spring load restrictions, with an annual sand production or hauling tonnage of 500,000 tons and located to the south an existing quarry has an average of 8,000 tons of aggregate removed each year with about 85% of that using this same haul route.

With quad axle trucks (22 tons of payload) being the primary hauling trucks, the mine and quarry will introduce approximately 69 (11 months of hauling) to 75 (10-months of hauling) quad axle trucks daily to adjacent county highways, resulting in additional 138-150 of HCADT to the impacted county highways (two-way traffic).

The primary transportation arteries through the project area include U.S Highways 10, and County Highways (CTH) P, N, SS and D. According to Wisconsin Department of Transportation (WisDOT), the 2009 AADT for U.S. Highway 10, ranges from 2,700 to 10,000 vehicles per day. The average annual daily traffic (AADT) for the county highways ranges from 50 to 970 vehicles per day in 2009.

Ten (10) percent of the AADT was assumed to be the current proportion of truck traffic. This estimated truck volume was used to forecast the future (10 and 20 year) traffic by assuming a projection factor of 1.5. The equivalent single axle load (ESAL) for the existing traffic was calculated by using the truck ESAL factor of the quad truck with a 22 ton payload and two supporting axles contacting the pavement. The projected daily ESAL's generated by the frac sand hauling trucks was calculated by using the forecast trips per day of quad axle trucks with 22 ton loads. The haul ESALs accumulated for 10 or 20 years were estimated by assuming a zero growth rate. The current ESALs were added to haul ESALs to get the total ESALs for analysis.

The project will require the use of county highways to transport the Frac Sand to the processing plants. A significant amount of wear and tear on the roads will occur as a result of the transport of heavy materials and additional hauling will consume the structural life of the pavement structures that were designed for much less traffic loading.

The above stated information represents our understanding of the proposed construction. This information is an integral part of our engineering review. It is important that you contact us if there are changes from that described so that we can evaluate whether modifications to our recommendations are appropriate.

4.0 SUBSURFACE EXPLORATION AND PAVEMENT TESTING

4.1 Field Exploration and Pavement Testing Program

The field exploration program conducted for the project consisted of 18 soil borings, while the pavement testing program consisted of Digital Video Log (DVL) recording, Ground Penetrating Radar (GPR) testing, and Falling Weight Deflectometer (FWD) testing.

As shown in Table 4.0, 8.5 miles of the selected haul routes are bituminous surfaced and have gravel base and sand subbase if the subgrade soils were not suitable.

Table 4.0 Pavement Sections

Section	Highway	Termini		Length	Type*	2012 AADT	Haul AADT
		From	To	(mile)			
1	CTH P	US 10	660' W	0.1	AG	955	127
2	CTH P	660' W	CTH O	1.7	AG	955	127
3	CTH P	CTH O	CTH N	1.5	AG	957	127
4	CTH N	CTH P	CTH SS	2.1	AG	1029	127
5	CTH SS	CTH N	0.8 mi W	0.8	AG	225	127
6	CTH SS	0.8 mi W	CTH D	0.9	AG	270	127
7	CTH D	CTH SS	Klein Ln	1.4	AG	56	127
1				8.5			

*AG = Asphalt Concrete Over Gravel.

4.1.1 Subsurface Exploration

The subsurface exploration program consisted of 18 soil borings. The logs of the coring/borings and details of the methods used appear in Appendix A. The logs contain information concerning soil layering and classification, geologic description and moisture condition.

The borings were marked and cleared on March 26, 2012, and drilled and sampled from March 30, 2012. The boring locations are shown on Figure 2.

The borings were located in the field by AET personnel by measuring from nearby site features and GPR images. Surface elevations in WGS 84 were measured in the field by AET personnel using a GPS unit.

4.1.2 Pavement Condition Survey

The pavement condition survey program conducted for the project consisted of the use of digital video cameras mounted on a moving vehicle to capture pavement images for evaluating the pavement surface distress. The distress identification procedure used to determine the surfacing rating is done by technicians using a video player, which allows the operators to continuously view and evaluate the digital images captured by the test vehicle. The video was synched with GPS coordinates to aid in determining the location of the video on the roadway.

The pavement condition survey includes identification and classification of various types and severities of surface cracks (longitudinal, transverse, alligator, block, and edge cracks), patching and potholes, and determination of surface deformation and defects, such as rutting, polished aggregate, and raveling, are also made in the evaluation program.

The modified ASTM pavement condition index (PCI) system was used (a rating from 0 to 100) to rate the paved highway. A new bituminous pavement would rate 100 and a road in need of total reconstruction would rate less than 25. The past PASER ratings from WisDOT were reviewed and compared with the current PCI rating.

4.1.3 Pavement Thickness Testing

The pavement thickness testing program conducted for the project consisted of a high speed GPR antenna collecting the pavement thickness data at one scan per foot. The data was collected using a 2 GHz antenna, which allows material layer measurements at depths of 18 to 20 inches with a resolution less than about ½ inch. The details of the methods used appear in Appendix C.

The GPR data was collected on March 26, 2012 on 17 lane miles of roads. Figure 2 shows the GPR scanning routes. Scans of the pavement were collected according to SIR-20 processor settings established by GSSI Roadscan system, approximately in the middle of the traveling lane and in two directions of travel. A calibration file, required for data post-processing, was collected prior to testing.

The GPR interface identification was accomplished using RADAN 6.0, a proprietary software package included with the GSSI RoadScan system. The software includes tools to aid in delineating pavement layer transitions, and automatically calculates their depths from the pavement surface using the calibration file(s) collected prior to testing. The identified layer was also compared to the core data to validate the accuracy of the layer thicknesses.

The total depth of pavement is not always explicitly clear. Where gaps in clear identification of pavement and base layer thicknesses are encountered, they are reported as a percent of the picking rate of the layer interface. A picking rate of 100 percent indicates the layer interfaces were visible in 100 percent of the scanned points. Factors influencing definition of radar scans include ambient electromagnetic interference, the presence of moisture, the presence of voids and the similarity of material layer type between layers (gravel vs. gravelly sand).

4.1.4 Pavement Defection Testing

The pavement deflection testing program conducted for the project consisted of FWD testing on 8.5 miles of county highways at net 0.1-mile spacing in one traveling direction. After seating drops, data for four impulse loads (two at 6,000 lbs nominal load and two at 9,000 lbs nominal load) were collected at each test point. The test data and details of the methods used appear in Appendix B of this report.

The Falling Weight Deflectometer testing was performed on March 30, 2012 using a Dynatest 9000 falling weight deflectometer (FWD). Figure 2 shows the FWD testing points where four sets of data (load and deflections) were collected at each testing location.

4.2 Analysis Procedures

For deflection data were analyzed using the American Association of State Highway and Transportation Officials (AASHTO) method for determining the in-place (effective) subgrade and pavement strength, as well as allowable spring axle loads for a Highway (*AASHTO Guide for Design of Pavement Structures*, 1993).

The effective subgrade modulus (Esg) and structural number (SN) were estimated from the deflection relationship equation. The required structural number was calculated using the effective Esg, forecasted traffic loadings, and spring load restriction. The required overlay thickness was calculated from the difference between the effective and required structural number and WisDOT standard layer coefficient for standard asphalt concrete (0.44).

The pavement load carrying capacity and required overlay without weight limits were calculated using the MnDOT TONN method as described in the MnDOT publication "Estimated Spring Load-Carrying Capacity (according to TONN)." MnDOT's TONN method is a maximum deflection approach based on the concept that structural overlays are required to strengthen weak pavement systems to reduce pavement deflections to tolerable limits based on projected future traffic applications.

5.0 RESULTS

5.1 Pavement Surface Condition

In general, the roads selected for analysis were in fair to excellent condition with an isolated area that was in poor condition. Predominantly transverse and longitudinal cracks were in light to medium severity, and were sealed. There are edge cracks, longitudinal cracks in wheel path or alligator cracks in low severity, and bleaching.

The overall surface ratings of all the sections are listed by road name in Table 5.1.

Table 5.1 Pavement Surface Condition

Section	Highway	Termini		Length (miles)	Rating	
		From	To			
1	CTH P	US 10	660' W	0.1	99	Excellent
2	CTH P	660' W	CTH O	1.7	95	Excellent
3	CTH P	CTH O	CTH N	1.5	95	Excellent
4	CTH N	CTH P	CTH SS	2.1	89	Excellent
5	CTH SS	CTH N	0.8 mi W	0.8	60	Fair
6	CTH SS	0.8 mi W	CTH D	0.9	82	Good
7	CTH D	CTH SS	Klein Ln	1.4	59	Fair

5.2 Subsurface Soils/Geology

Eighteen borings were drilled for subsurface exploration. The average thickness of asphalt surface ranged from 2.5 to 3.8 inches and the thickness of gravel base ranged from 5.0 to 10.75 inches, as shown in Table 5.2.

Table 5.2 Average Thickness of Pavement Layers from Soil Borings

Section	Highway	Termini		Type*	Average (inches)			Soil Type
		From	To		Surface	Base	Subbase	
1	CTH P	US 10	660' W	AG	No Boring			
2	CTH P	660' W	CTH O	AG	3.29	10.75		A-3
3	CTH P	CTH O	CTH N	AG	3.33	10.33		A-3
4	CTH N	CTH P	CTH SS	AG	3.81	8.63		A-3
5	CTH SS	CTH N	0.8 mi W	AG	2.63	6.25		A-3
6	CTH SS	0.8 mi W	CTH D	AG	2.50	6.00	11.50	A-6
7	CTH D	CTH SS	Klein Ln	AG	3.00	5.00	8.75	A-6

*AG = Asphalt Concrete Over Gravel.

The predominant natural geology beneath the site includes water-deposited (alluvial) soils. . The alluvium is both coarse grained (e.g., sand) and fine grained (e.g. lean clay).

The upper portion of the subgrade (which represents the soil affecting CBR and subgrade frost/drainage properties) is sand, sand with silt, or silty sand. The primary soils within the upper subgrade zone affecting the design CBR are the non-plastic soils meeting the A-3 AASHTO soil category or the plastic soils meeting A-6 AASHTO soil category, as shown in Table 5.2.

Our descriptions of the crushed stone base-like layer, directly beneath some of the paved layers, are based on samples obtained and classified from the soil samples. Additional measurements, where thin layers were observed, were taken from the side of the clear plastic sample tube.

5.3 Ground Water

No ground water was observed within the depth of borings. Ground water levels fluctuate due to varying seasonal and annual rainfall and snow melt amounts, runoff, and infiltration.

5.4 Pavement Thicknesses

The GPR data show clear interfaces between bituminous and reclaimed base with 100% picking rate (meaning all layers were clearly identified). The interface between reclaimed base and subgrade soil was also picked at a rate of 100%. The data sheets and plots of the layer thicknesses are included in Appendix C.

Table 5.4 shows the average thickness results of the GPR data for each section. The results include both the asphalt surface and the pulverized asphalt and granular base layer that were identified beneath the pavement surface. The pavement thickness is shown in Figure 3.

Table 5.4 GPR Results

Section	Highway	Termini		Type*	Average (inches)		
		From	To		Surface	Base	Subbase
1	CTH P	US 10	660' W	AG	4.4	1.4	
2	CTH P	660' W	CTH O	AG	3.2	9.8	
3	CTH P	CTH O	CTH N	AG	3.3	8.0	
4	CTH N	CTH P	CTH SS	AG	3.6	8.8	
5	CTH SS	CTH N	0.8 mi W	AG	3.1	3.7	
6	CTH SS	0.8 mi W	CTH D	AG	2.5	10.4	ND*
7	CTH D	CTH SS	Klein Ln	AG	2.9	6.3	7.8

* AG = Asphalt Concrete Over Gravel.
* ND = Layer thickness could not be determined due to thickness greater than GPR measurement depth

As shown in Table 5.4, the average thickness of the bituminous surface ranges from 2.5 to 4.4 inches while the average thickness of the gravel base ranges from 1.4 to 10.4 inches. The average thickness of the subbase is 7.8 inches where the interface between subbase and subgrade is within the depth of investigation of GPR.

5.5 Pavement Strength

Table 5.5A shows the FWD testing results evaluated under the current traffic conditions (without hauling) and Table 5.5B for the results when using the total traffic conditions (with hauling). Averaged layer thicknesses used in our analysis were from GPR data in the same direction.

As shown in Table 5.5A, the average subgrade CBR in spring for each segment ranges from 3.6% to 7.5%, with 85% of the subgrade of each section being from 2.4% to 6.3%, indicating a subgrade with moderate to high strength in spring. The soil support values (SSV) converted from the median modulus ranges from 4.85 to 5.45 and design group index (DGI) ranges from 1 to 8, indicating the frost indices of F-2 and F-3.

Table 5.5A Summary of Analysis Results – Current Traffic Conditions

Section	Highway	From	To	Effective CBR			Effective SN			Load Capacity (tons)		
				Avg	CV	15th	Avg	CV	15th	Avg	CV	15th
1	CTH P	US 10	660' W	4.6	0%	4.6	3.1	1%	3.1	20.9	1%	20.8
2	CTH P	660' W	CTH O	4.9	20%	3.9	3.0	5%	2.9	16.2	8%	14.8
3	CTH P	CTH O	CTH N	6.7	19%	5.1	2.5	6%	2.3	15.2	10%	13.6
4	CTH N	CTH P	CTH SS	7.5	12%	6.3	2.3	6%	2.2	13.3	7%	12.4
5	CTH SS	CTH N	0.8 mi W	4.8	16%	4.4	1.5	23%	1.2	15.3	21%	12.2
6	CTH SS	0.8 mi W	CTH D	5.6	71%	2.4	3.0	17%	2.4	21.2	36%	12.1
7	CTH D	CTH SS	Klein Ln	3.6	24%	2.8	2.4	4%	2.3	14.6	13%	12.4

Note: Avg – Average; CV – Coefficient of Variation; 15th – 15th Percentile.

The average effective SN calculated for all the sections ranges from 1.5 to 3.1, with 85% of each section being from 1.2 to 3.1. The results for the current traffic conditions indicated that the tested roads currently have a spring load capacity greater than 10 tons per axle, as shown in Table 5.5A.

Table 5.5B Summary of Analysis Results – Current Traffic Conditions

Section	Highway	From	To	Effective CBR			Effective SN			Load Capacity (tons)		
				Avg	CV	15th	Avg	CV	15th	Avg	CV	15th
1	CTH P	US 10	660' W	4.6	0%	4.6	3.1	1%	3.1	14.6	1%	14.5
2	CTH P	660' W	CTH O	4.9	20%	3.9	3.0	5%	2.9	11.3	8%	10.4
3	CTH P	CTH O	CTH N	6.7	19%	5.1	2.5	6%	2.3	10.6	10%	9.5
4	CTH N	CTH P	CTH SS	7.5	12%	6.3	2.3	6%	2.2	9.3	7%	8.7
5	CTH SS	CTH N	0.8 mi W	4.8	16%	4.4	1.5	23%	1.2	9.4	21%	7.5
6	CTH SS	0.8 mi W	CTH D	5.6	71%	2.4	3.0	17%	2.4	12.7	36%	7.2
7	CTH D	CTH SS	Klein Ln	3.6	24%	2.8	2.4	4%	2.3	9.2	10%	7.8

Note: Avg – Average; CV – Coefficient of Variation; 15th – 15th Percentile.

The results of our analysis for the sand hauling conditions indicated that the spring load capacity of the haul roads we tested ranges from 7.2 to 14.5 tons per axle, as shown in Table 5.5B. The added traffic from the haul trucks reduces the current spring load capacity significantly for all the sections.

Since spring load restrictions are to be applied, the additional structure needs for hauling trucks will be governed by the repetitive truck loadings restricted to the non-spring thaw period and accumulated over the design periods (10 or 20 years).

As shown in Tables 5.5C, the roads with non-spring thaw hauling can be improved to withstand the next 10-year and 20 year traffic loading with a bituminous overlay of less than 2 and 2.5 inches, respectively, except for CTH SS. The required overlay thicknesses for CTH SS are 3.5 and 4.1 inches the next 10-year and 20 year traffic loading, respectively.

Table 5.5C Overlay Thicknesses Required (inches)

Section	Highway	From	To	10 Year		20 Year	
				Without Haul	With Haul	Without Haul	With Haul
1	CTH P	US 10	660' W	0.0	0.0	0.0	0.2
2	CTH P	660' W	CTH O	0.0	0.2	0.2	0.7
3	CTH P	CTH O	CTH N	0.0	0.7	0.7	1.4
4	CTH N	CTH P	CTH SS	0.0	0.7	0.7	1.5
5	CTH SS	CTH N	0.8 mi W	1.8	3.4	2.4	4.1
6	CTH SS	0.8 mi W	CTH D	0.2	1.4	1.0	2.1
7	CTH D	CTH SS	Klein Ln	0.0	1.7	0.0	2.4

Figures 4 and 5 show the overlay thickness required for the next 10 year and 20 year traffic at each testing location for the current traffic, and current traffic with sand hauling, respectively. Overall, the impact of hauling indicates additional 0.2-2.4 inches of asphalt overlay.

6.0 CONCLUSIONS

The conclusions made in the report are based on our understanding of the project as described above.

6.1 Pavement Structural Strength

The geotechnical exploration indicated sandy silt and sandy lean clay is the primary subgrade types for the selected roads. The analysis of the subgrade using the FWD data confirmed that subgrade soils for all the roads have moderate to high strength (average effective CBR = 3.6% to 7.5%) in spring.

We have reviewed the in-place effective CBR back calculated from FWD data within the upper subgrade zone and have made judgments of the required soil strength for constructability.

FWD testing represents a single point on a 500-foot section of Highway. Because there may be varying subgrade and pavement conditions at the time of construction the condition of each road section should be evaluated at the time any improvements are made.

The pavement evaluation indicated the existing asphalt pavements have structural strength adequate to support the current traffic (average effective SN=1.5 to 3.1) with thin or functional overlays except for CTH SS from CTH N to 0.8 miles west where a structural overlay is needed.

Sand hauling will have a significant impact on the existing pavements of CTHs SS and D. The sand hauling traffic loading on CTHs SS and D is 5.3 to 21 times the current traffic loading while that of CTHs P and N is 1.3 to 1.4 times the current traffic loading. .

6.2 Structural Improvements

Based on our review of the site and analysis of the subgrade and pavement strength data, we recommend that the tested pavements, if used for hauling, receive a functional or structural bituminous overlay to support heavy truck loading.

Our analysis shows that the tested county highways need 1.5 to 2 inches and 1.5 to 2.5 inches of bituminous overlay to withstand the next 10 and 20 years of sand hauling traffic, respectively, except for CTH SS (3.5 and 4 inches). If the overlay thicknesses required only for the current traffic are subtracted from the total overlay thicknesses for the current and sand hauling traffic, the overlay thicknesses attributed to sand hauling ranges from 0 to 1.7 inches for 10 year and 0.2 to 2.4 inches for 20 years.

Our review of the site and analysis of subgrade and pavement strength data were based on the existing traffic volume and estimated hauling truck volume over the next 10 and 20 years. More accurately estimated or actual counts of hauling trucks may be different from what has been used in this report, and if different may change the analysis results.

6.3 Recommendations

We recommend the functional or structural improvements of the tested sections occur prior to the start of regular hauling. The recommended overlay thickness for the impacted sections is shown in Table 6.3. For 10 year hauling, we recommend 1.5 to 3.5 inch overlay and for 20 year hauling, we recommend 1.5 to 4 inch overlay. Typical pre-overlay pavement surface preparation (sweeping and tack coat) will be required prior to the placement of the overlay. We also recommend the use of a PG58-34 binder for the overlay mixes.

Table 6.3 Recommended Overlay Thicknesses (inches)

Highway	Termini		Length		Overlay (inches)	
	From	To	(mile)	Quarry	10 Year	20 Year
CTH P	CTH O	CTH N	1.5	Bechel/Anderson	1.5	1.5
CTH N	CTH P	CTH SS	2.1	Bechel/Anderson	1.5	1.5
CTH SS	CTH N	0.8 mi W	0.8	Bechel/Anderson	3.5	4.0
CTH SS	0.8 mi W	CTH D	0.9	Bechel/Anderson	1.5	2.0
CTH D	CTH SS	Klein Ln	1.4	Bechel/Anderson	2.0	2.5

We recommend staging overlays (2.5-inch in the first year of hauling and 1.5-inch in the 5th year of hauling) for CTH SS from CTH N to 0.8 miles west with localized repairs or patching where the overlay becomes ineffective due to the reflective cracking or underlying deterioration from the poor pavement. We recommend performing full depth patches (permanent patches) in the areas showing significant deterioration (alligator cracking) prior to the placement of the overlay.

For the addition of turn lanes at intersections we recommend constructing the new pavement with a structure identical to the existing adjacent pavement (asphalt and aggregate base), including the overlay thickness, and the aggregate base.

7.0 LIMITATIONS

Within the limitations of scope, budget, and schedule, our services have been conducted according to generally accepted geotechnical engineering practices at this time and location. Other than this, no warranty, express or implied, is intended.

Important information regarding risk management and proper use of this report is given in Appendix D entitled "Geotechnical Report Limitations and Guidelines for Use".