

MEMORANDUM

TO: Roger Weigel
Design Division

ATTN: Wayne Zacher
Design Division

FROM: /s/Ron Horner
Materials and Research Engineer
/s/Matt Kurle
Geotechnical Section

DATE: February 1, 2012

SUBJECT: Soils Report and Recommendation for Project SS-3-020(106)129

Attached is the Soils Report and Recommendation for project SS-3-020(106)129. If you have any questions please call me at 328-6924 or Jeff Jirava at 328-6908.

c: Office of Project Development
Devils Lake District
Construction Services
FHWA
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LINEAR SOIL REPORT AND RECOMMENDATION

Project: SS-3-020(106)129

Project Description: N Jct 17 to E Jct 5 - Clyde

PCN: 18865

Project Length: 20.8 Miles

Project Limits: RP 129.463 to RP 150.270

Date: February 1, 2012

This document was originally issued and sealed by Jeff Jirava, Registration Number PE-5950, on 2/1/2012 and the original document is stored at the North Dakota Department of Transportation.

Introduction: The proposed improvements for this project are a HBP overlay, culvert rehabilitation, selective subcut, and slope flattening. The samples were taken at maintenance problem areas within the project limits on 9/29/2010. The offset of the borings varied from 8 feet right to 8 feet left of the existing roadway centerline. The borings extended to depths of up to 10.0 feet below the existing pavement surface. A total of 24 samples were taken from 22 borings from the following locations:

SOIL CLASSIFICATION AND COMMENTS

Quantity	AASHTO Classification	In-Place Moisture Range (%)	In-Place Moisture Average (%)	T-180 Optimum Moisture Average (%)	Plastic Limit Range (%)	Plastic Limit Average (%)
19	A-6	17.2-29.7	23.5	12.8	15-21	19
5	A-7-6	22.5-33.9	26.1	14.5	23-24	23

AASHTO Classification	Plasticity Index Range (%)	Plasticity Index Average (%)	Liquid Limit Range (%)	Liquid Limit Average (%)
A-6	12-22	17	27-41	36
A-7-6	17-21	19	41-43	42

Note: Moisture Contents provided in this report have been obtained from samples taken on 9/29/2010.

The Plasticity Index values ranged from 12 to 22 with an average of 18. The swell potential, based on the Plasticity Index (PI) results, is shown below:

Swell Potential		
Low (PI<25)	Marginal (25≤PI≤35)	High (PI>35)
100%	None	None

Comparisons of In-Place Moisture Contents to Plastic Limits for the 2 to 10 foot depths are shown below:

Depth	Quantity	Below Plastic Limit	Plastic Limit to 5% Above	More than 5% Above Plastic Limit
2 Foot	22	27%	59%	14%
3 Foot	22	18%	36%	46%
4 Foot	22	5%	45%	50%
5 Foot	22	18%	41%	41%
6 Foot	1	None	100%	None
7 Foot	1	None	100%	None
8 Foot	1	None	100%	None
9 Foot	1	100%	None	None
10 Foot	1	100%	None	None

SOIL CLASSIFICATION AND COMMENTS (Cont.)

In-Place Moisture vs. Optimum Moisture						
<u>Quantity</u>	<u>AASHTO Class.</u>	<u>Below Optimum</u>	<u>Optimum to Moderate</u> (0 to 6% over optimum)	<u>Moderate to High</u> (6 to 10% over optimum)	<u>High</u> (10 to 16% over optimum)	<u>Very High</u> (> 16% over optimum)
19	A-6	N/A	11%	26%	63%	N/A
5	A-7-6	N/A	N/A	40%	40%	20%

Note: Moisture Contents provided in this report have been obtained from samples taken on 9/29/2010.

Moisture samples were taken at all boring locations. The results are as follows:

<u>Depth</u>	<u>Quantity</u>	<u>In-Place Moisture Range (%)</u>	<u>In-Place Moisture Average (%)</u>
2 Foot	22	13.0-31.9	21.9
3 Foot	22	12.5-43.9	24.3
4 Foot	22	18.6-29.9	25.1
5 Foot	22	17.3-33.6	23.9
6 Foot	1	N/A	20.6
7 Foot	1	N/A	24.9
8 Foot	1	N/A	21.5
9 Foot	1	N/A	19.4
10 Foot	1	N/A	17.8

Note: Moisture Contents provided in this report have been obtained from samples taken on 9/29/2010.

Frost Susceptibility:

Two of the samples were classified as an F4 soil. The F4 designation indicates that under the right conditions these soils have a higher probability of heaving during freeze/thaw cycles. These samples were located in distress area 1 and distress area 2

Group Index:

All of the samples were classified as an A-6 or A-7-6. The Group Indexes from the samples ranged from a low of 3 to a high of 12 with an average of 9. A group index of 20 or greater indicates a “very poor” subgrade material.

SOIL CLASSIFICATION AND COMMENTS (Cont.)

Summary of Findings:

A detailed spreadsheet of the samples has been attached to the report.

- All of the samples had a group index of less than 13.
- The samples were, on average, 10.9% above the T-180 optimum moisture contents.

SOIL DESCRIPTIONS

Silt-Clay Soils:

The **A-6** soils typically consist of plastic clays. They usually have high volume change between wet and dry states. These soils have dry strength but lose much of this strength upon absorbing water. The A-6 soils will compress when wet and shrink and swell with changes in moisture content. They do not drain readily and may absorb water by capillarity with resulting loss in strength. These soils can also be highly frost susceptible although they will perform well when moisture is kept near the optimum value.

The **A-7-6** soils possess many of the A-6 characteristics except that they have high liquid limits and may be elastic as well as subject to extremely high volume change. The plasticity index in these soils is high in relation to liquid limit.

EXISTING SECTION

The following table shows the history of the roadway through the project limits:

RP 129.463 to RP 141.195					
Year	Component	Depth (in)	Left Shoulder width (ft)	Roadway width (ft)	Right Shoulder Width (ft)
1959	Reshaped			32.0	
1959	Aggregate Base	7.0		28.0	
1959	Hot Bit Pavement	2.0		24.0	
1994	Contract Chip Seal			24.0	
1997	Structural Items				
2002	District Chip Seal			24.0	
Roadway widths are both lanes combined					

RP 141.195 to RP 150.270					
Year	Component	Depth (in)	Left Shoulder width (ft)	Roadway width (ft)	Right Shoulder Width (ft)
1961	Reshaped			32.0	
1961	Aggregate Base	3.5		32.0	
1961	Emulsified Base	3.5		28.0	
1961	Hot Bit Pavement	2.0		24.0	
1968	Contract Chip Seal			24.0	
1974	Contract Chip Seal			24.0	
1994	Contract Chip Seal			24.0	
2002	District Chip Seal			24.0	
Roadway widths are both lanes combined					

EXISTING PAVEMENT SECTION

The soil borings were performed on 9/29/2010 using a 6 inch solid flight auger. The asphalt thickness varied from 0.5 to 0.9 feet with an average of 0.7 feet. The thickness of the base varied from 0.2 to 0.6 feet with an average of 0.4 feet. The following table represents the pavement section as reported in the field log at the boring locations. All measurements are in feet.

RP+Feet	Offset	Asphalt	Agg. Base
137+3137	Rt 7 NB	0.8	0.4
137+3605	Rt 7 NB	0.6	0.4
137+3693	Rt 7 NB	0.9	0.2
137+3752	Rt 7 NB	0.7	0.2
137+3816	Rt 8 NB	0.5	0.5
138+4125	Rt 8 NB	0.7	0.4
138+4200	Rt 8 NB	0.7	0.4
138+4253	Rt 8 NB	0.6	0.3
141+1114	Rt 8 NB	0.7	0.4
141+1245	Rt 8 NB	0.8	N/A
141+1346	Rt 8 NB	0.8	0.3
141+1446	Rt 8 NB	0.6	0.5
141+1555	Rt 8 NB	0.8	0.3
141+1847	Rt 8 NB	0.7	0.2
141+2290	Rt 8 NB	0.7	0.3
145+4057	Lt 8 SB	0.7	0.3
145+4116	Lt 8 SB	0.7	0.3
145+4213	Lt 8 SB	0.7	0.3
145+4266	Lt 8 SB	0.8	0.3
150+0325	Lt 8 SB	0.6	0.6
150+0431	Lt 8 SB	0.8	0.5
150+0552	Lt 8 SB	0.7	0.4

Average asphalt thickness = 0.7 feet

Average base thickness = 0.4 feet

MAINTENANCE

On 09/29/2010, drill crew chief Jamie Naumann met with Colin Fetsch, Langdon Maintenance, and with Ronald Ebensteiner, Starkweather Maintenance, to review the distress in the pavement. The following table lists the areas that were discussed

Distress Area	Location (RP + Feet)	No. of Samples	Severity	Description of Distress
1	137+3699	5	High	Frost Heave
2	138+4200	3	High	Frost Heave
3	141+1120 to 141+1825	8	High	Blade Patch, Slough Area on left/right side
4	145+4141 to 145+4166	4	High	Frost Heave
5	150+0336 to 150+0509	4	Medium	Blade Patch, Rutting

Rutting and bleeding of the HBP surface was apparent in the following locations. These areas were not drilled due to Maintenance personnel not describing them as problem areas.

RP+feet to RP+feet
148+4942 to 148+5045
149+0280 to 149+0420
149+3550 to 149+3580
149+3650 to 149+3715
149+3825 to 149+3940

The following pages are a synopsis of the distress areas drilled. Specific soil information is given at each location, and we have provided a detailed explanation of the recommendation for each area.

Distress Area 1 RP+Feet 137+3699 (Frost Heave)

The distress at this area is described as being a high severity, seasonal, and signed frost heave. There is no slough area or culvert at this location. The group indices and plastic indices were low for all five borings taken at this location. The soils found in this location had moisture contents that were, on average, 11.0 percent over their optimum moistures. F4 soils were present in this location. The Geotechnical Section recommends a subcut at this area.



MAINTENANCE (Cont.)

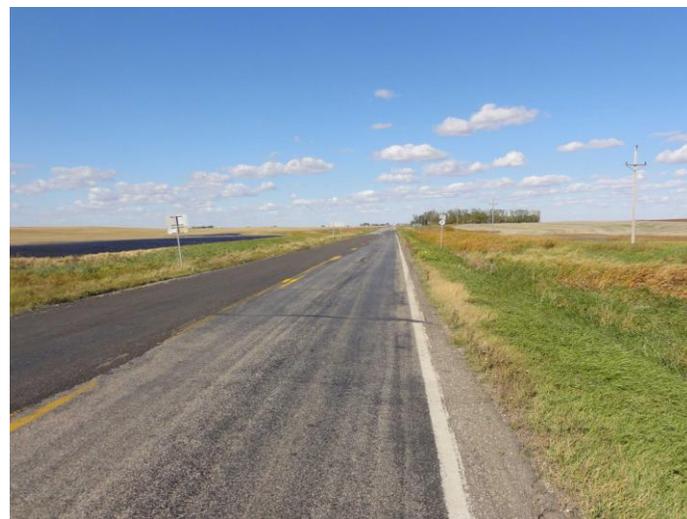
Distress Area 2 RP+Feet 138+4200 (Frost Heave)

The distress at this area is described as being a high severity, seasonal, and signed frost heave. There is no slough area or culvert at this location. The group indices and plastic indices were low for all five borings taken at this location. The soils found in this location had moisture contents that were, on average, 6.4 percent over their optimum moistures. F4 soils were present in this location. The Geotechnical Section recommends a subcut at this area.



Distress Area 3 RP+Feet 141+1120 to RP+Feet 141+1825 (Blade Patch)

The distress at this area can be described as a high severity blade patch with a slough area on both sides of the road. The group indices and plastic indices were low for all eight borings taken at this location. The soils found in this location had moisture contents that were, on average, 11.3 percent over their optimum moistures. The Geotechnical Section recommends a subcut at this area due to the nature of distress exhibited in the roadway



MAINTENANCE (Cont.)

Distress Area 4 RP+Feet 145+4141 to RP 145+4166 (Frost Heave)

The distress at this area is described as being a high severity, seasonal, and signed frost heave. The group indices and plastic indices were low for all five borings taken at this location. The soils found in this location had moisture contents that were, on average, 12.2 percent over their optimum moistures. The Geotechnical Section recommends a subcut at this area due to the severity of the distress in this location



Distress Area 5 RP+Feet 150+0336 to RP+Feet 150+0509 (Blade Patch)

The distress at this area is described as a rutting, bleeding, and high maintenance area. Colin Fetsch stated that this area needed to be patched bi-annually. The group indices and plastic indices were low for all five borings taken at this location. The soils found in this location had moisture contents that were, on average, 12.4 percent over their optimum moistures. The Geotechnical Section recommends a subcut at this area due to the severity of the distress in this location



DESIGN RECOMMENDATIONS

The Geotechnical section recommends that an additional 500 feet of 18” subcut be provided for use at areas the project engineer deems necessary. Below is the list of the subcut areas as described in the maintenance section of this report.

18 Inch Subcut Recommendation:

<u>RP + Feet</u>	<u>to</u>	<u>RP + Feet</u>	<u>Remarks</u>
141+1050		141+1875	Subcut to a depth of 18” below the top of the subgrade (bottom of existing base) at full width of the roadway embankment. Place reinforcement fabric (R1) at the bottom of the subcut excavation and backfill with Class 3 or Class 5 aggregate. Place 6 inches of aggregate on the fabric prior to compacting. Do not scarify the bottom of the subcut. Compaction of aggregate shall comply with 90% of the maximum dry density as determined by AASHTO T-180.
150+0250		150+0575	

Discretionary Subcut length = **500 feet**
Total Subcut 18” Length = **1650 feet**

30 Inch Subcut Recommendation:

<u>RP + Feet</u>	<u>to</u>	<u>RP + Feet</u>	<u>Remarks</u>
137+3600		137+3800	Subcut to a depth of 30” below the top of the subgrade (bottom of existing base) at full width of the roadway embankment. Place reinforcement fabric (R1) at the bottom of the subcut excavation and backfill with Class 3 or Class 5 aggregate. Place 6 inches of aggregate on the fabric prior to compacting. Do not scarify the bottom of the subcut. Compaction of aggregate shall comply with 90% of the maximum dry density as determined by AASHTO T-180.
138+4100		138+4300	
145+4050		145+4250	

Total Subcut 30” Length = **600 feet**

The recommendations in this report are based on the hot bituminous pavement overlay, culvert rehabilitation, selective subcut, and slope flattening option. If the vertical profile, horizontal alignment, or project limits are changed, in either the conceptual phase or the design phase, Materials and Research must be notified as soon as possible to ensure that there is adequate geotechnical information addressing these areas.

Please contact me at 328-6924 or Jeff Jirava at 328-6908 if there are any questions or modifications to the plans for rehabilitation of this roadway.

