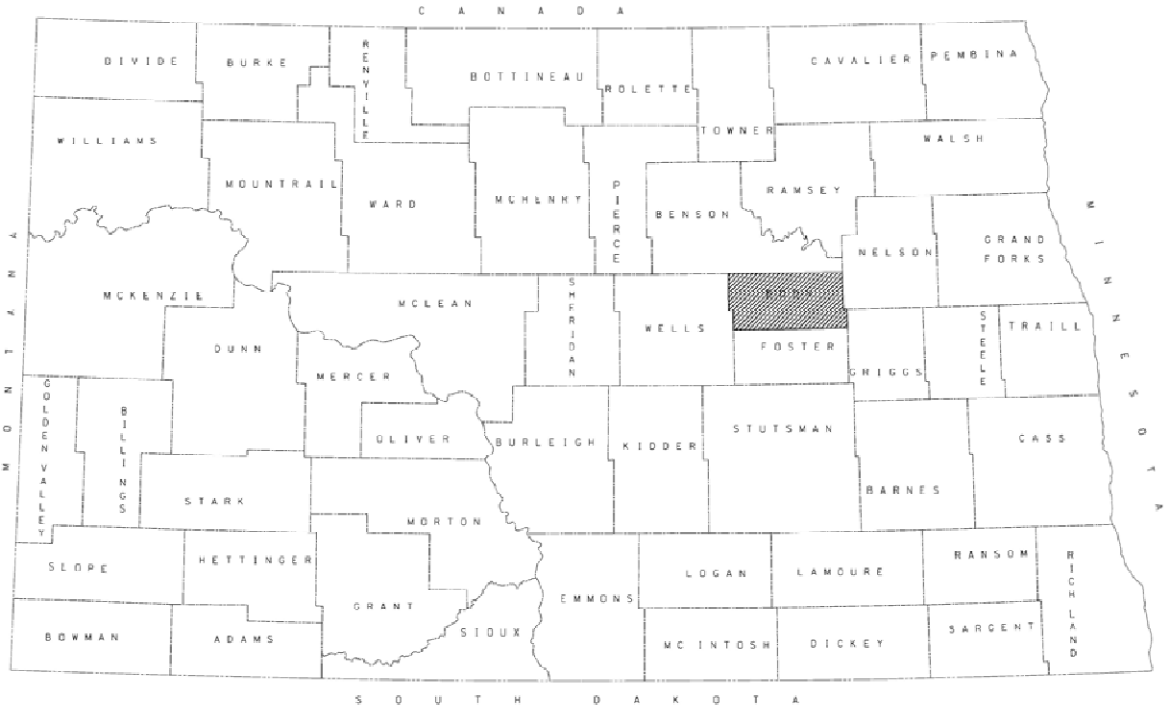
LINEAR SOILS SURVEY AND RECOMMENDATIONS

PROJECT NO. SS-3-020(122)061

PCN 17765

COUNTY Eddy

Highway 20 from RP 61.198 to RP 69.313



PREPARED BY: Jordan M. Nehls, P.E.

NORTH DAKOTA DEPARTMENT OF TRANSPORTATION
MATERIALS AND RESEARCH DIVISION

SEPTEMBER 2014

SS-3-020(122)061

Highway 20 From South Junction ND 15 To North Junction ND 15

CERTIFICATION

I hereby certify that this report was prepared by me or under my direct supervision and that I am a duly registered professional engineer under the laws of the State of North Dakota. This document was originally issued and sealed by Jordan M. Nehls, Registration number PE-8782 on 9/17/14 and the original document is stored at the North Dakota Department of Transportation.

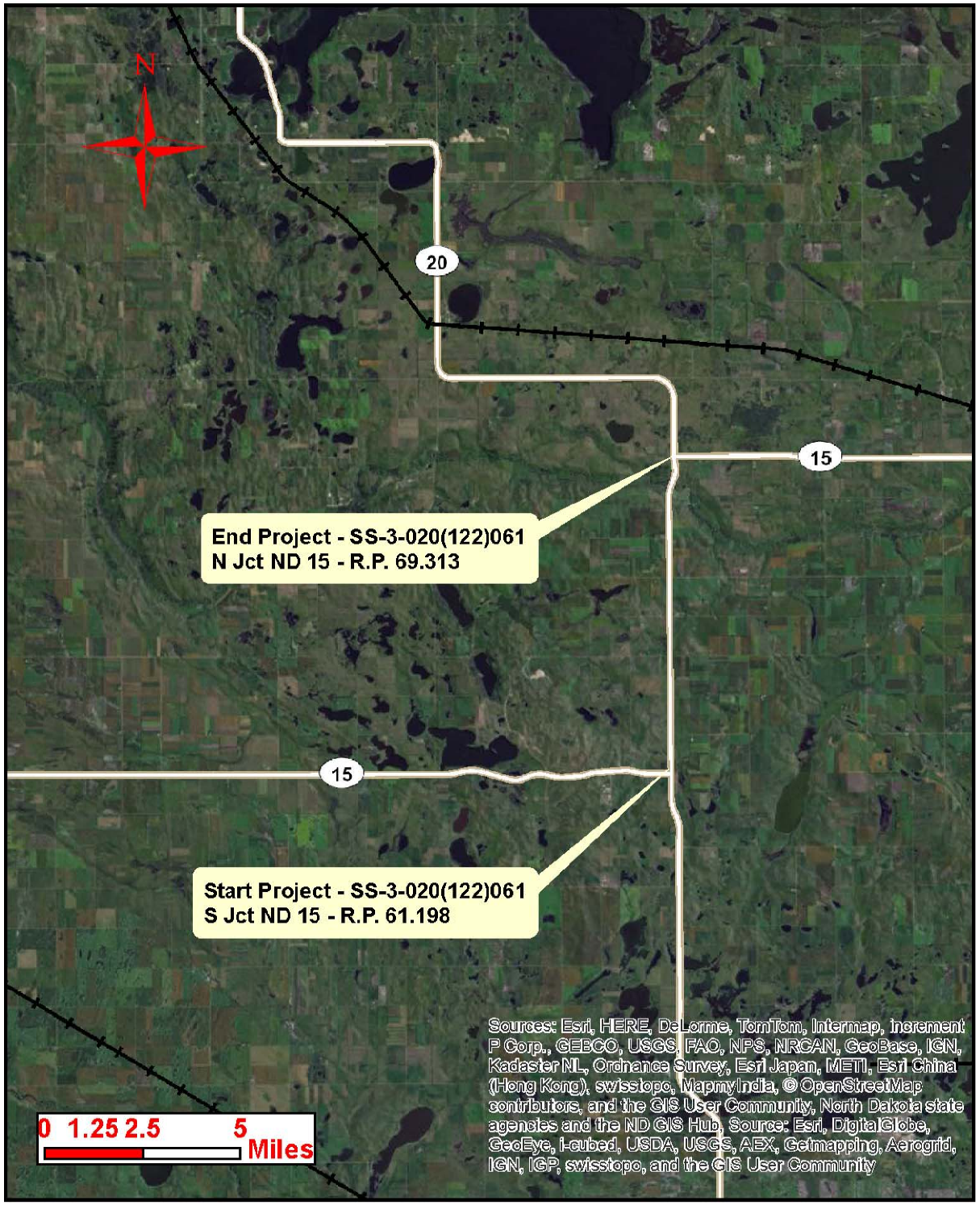
REGISTERED PROFESSIONAL ENGINEER
JORDAN M. NEHLS
Jordan M. Nehls
PE-8782
DATE 9/17/14
NORTH DAKOTA

Jordan M. Nehls
Jordan M. Nehls, P.E.

9/17/14
Date

Linear Soils Report and Recommendation

Project: SS-3-020(122)061
PCN: 17765
Scope: Thin Lift Overlay, Subcuts, Culvert Rehabilitation
Length: 8.11 Miles
Location: Highway 20 From South Junction ND 15 to North Junction ND 15



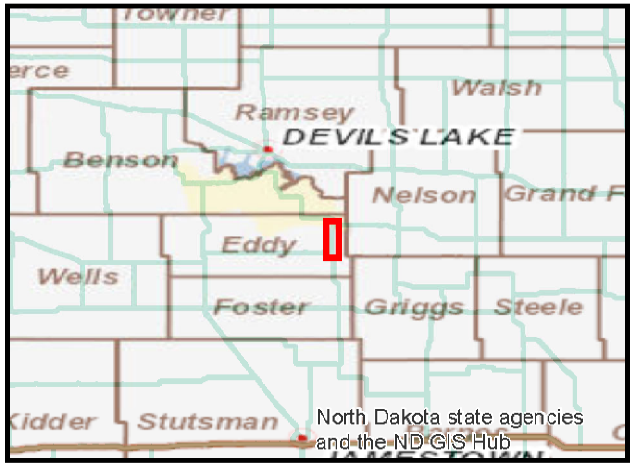


Table of Contents

Existing Roadway Section 1
Construction History 1
Existing Roadway Condition 2
Distress Data 2
Ride Data 2
Maintenance Review 3
Soil Sample Distribution 4
Moisture 4
Atterberg Limits 5
Swell Potential 5
Frost Susceptibility 6
Group Index 6
Existing Surface and Base Section at the Boring Locations 7
Design Recommendations 8
Design Information 9
Plan Notes 10

List of Figures

Figure 1 - Soil Sample Distribution 4
Figure 2 - Frost Susceptibility Distribution 6

List of Tables

Table 1 - Construction History R.P. 61.198 to R.P. 68.567 1
Table 2 - Construction History R.P. 68.567 to R.P. 68.816 1
Table 3 - Construction History R.P. 68.816 to R.P. 69.313 1
Table 4 – 2012 Distress Data 2
Table 5 – 2012 Ride Data 2
Table 6 - Identified Maintenance Areas 3
Table 7 - Summary of In-Place and Optimum Moisture Contents 4
Table 8 - Summary of In-Place versus Optimum Moisture Content 5
Table 9 - Summary of Atterberg Limits 5
Table 10 - Swell Potential 5
Table 11 - Group Indices 6
Table 12 - Surface and Base Section at the Boring Locations 7
Table 13 – Design Recommendations 8
Table 14 – Subcut Recommendations 9

Appendices

Appendix A – Soil Classification and Frost Susceptibility
Appendix B – Pavement Evaluation Log and Photos
Appendix C – Boring Locations
Appendix D – Summary of Soils Analysis
Appendix E – Lab Results

Introduction

Location: Highway 20 From South Junction ND 15 To North Junction ND 15
Reference Points: 61.198 to 69.313
Project Length: 8.11 Miles
Proposed Project Scope: Thin Lift Overlay, Subcut, Culvert Rehabilitation
Investigation Scope: Identified Areas Only

Existing Roadway Section

Construction History

Table 1 - Construction History R.P. 61.198 to R.P. 68.567

Construction History				
Year	**Construction**	**Depth (in)**	**Width (ft)**	**Oil**
1962	Grade	---	38.0	---
1962	Traffic Service Gravel	1.0	37.0	---
1965	Aggregate Base	5.0	35.0	
1965	Hot Bit Pavement	2.0	24.0	120-150
1995	Contract Chip Seal	---	24.0	MC-3000
2000	Hot Bit Pavement	1.5	24.0	PG 58-28
2003	District Chip Seal	---	24.0	MC-3000

Table 2 - Construction History R.P. 68.567 to R.P. 68.816

Construction History				
Year	**Construction**	**Depth (in)**	**Width (ft)**	**Oil**
1989	Grade	---	48.0	---
1989	Aggregate Base	8.0	36.0	---
1989	Hot Bit Pavement	4.0	36.0	120-150
1995	Contract Chip Seal	---	27.0	MC-3000
2000	Hot Bit Pavement	1.5	24.0	PG 58-28
2003	District Chip Seal	---	24.0	MC-3000

Table 3 - Construction History R.P. 68.816 to R.P. 69.313

Construction History				
Year	**Construction**	**Depth (in)**	**Width (ft)**	**Oil**
1962	Grade	---	38.0	---
1962	Traffic Service Gravel	1.0	37.0	---
1965	Aggregate Base	5.0	35.0	
1965	Hot Bit Pavement	2.0	24.0	120-150
1995	Contract Chip Seal	---	24.0	MC-3000
2000	Hot Bit Pavement	1.5	24.0	PG 58-28
2003	District Chip Seal	---	24.0	MC-3000

Existing Roadway Condition

Distress Data

Table 4 – 2012 Distress Data

Reference Point	Alligator Cracking	Longitudinal Cracking	Transverse Cracking	Block Cracking	Bituminous Patching	Rutting
	(0-18)	(0-9)	(0-9)	(0-9)	(0-18)	(0-12)
61	0	4	7	0	6	0
62	3	1	4	0	6	0
63	3	4	5	1	6	0
64	3	4	4	0	6	0
65	3	4	7	1	6	0
66	0	1	4	0	6	0
67	3	1	4	0	6	0
68	3	1	5	2	6	0
69	3	4	5	2	6	0
Average	**2**	**3**	**5**	**1**	**6**	**0**

Ride Data

Table 5 – 2012 Ride Data

Reference Point	Distress Score		Rut (inches)		International Roughness Index (inches/mile)	
	Excellent	**≥ 98**	**Excellent**	**< 0.25**	**Excellent**	**< 61**
	Good	**88 - 97**	**Good**	**0.25 - 0.375**	**Good**	**61 - 99**
	Fair	**77 - 87**	**Fair**	**0.376 - 0.50**	**Fair**	**100 - 145**
	Poor	**≤ 76**	**Poor**	**> 0.50**	**Poor**	**>145**
61	82		0.14		123	
62	85		0.13		94	
63	80		0.11		74	
64	82		0.13		91	
65	78		0.10		95	
66	88		0.10		91	
67	85		0.10		91	
68	82		0.12		95	
69	79		0.08		55	
Average	**82**		**0.11**		**90**	

Maintenance Review

Date of Maintenance Review: 7/8/2014
Materials and Research Person Conducting the Review: Jamie Naumann
District Maintenance Person Conducting Review: George Kobel, Transportation Service Supervisor, Pekin Section

The summary of the identified maintenance areas are shown in the following table. The evaluation log and photos can be found in Appendix B.

Table 6 - Identified Maintenance Areas

Location RP + Feet	Distress Identified	Drilling Required (Yes or No)
61+1145 To 69+1652	Transverse Cracking	No
61+2360 To 61+3000	Bituminous Patch	Yes
61+3100 To 61+3240	Bituminous Patch	Yes
61+5080 To 62+0050	Bituminous Patch	Yes
62+0340 To 62+0410	Bituminous Patch	No
62+0700 To 62+0800	Bituminous Patch - Pipe	No
63+1180 To 63+1360	Bituminous Patch - Pipe	No
63+3240	Raveling & Weather – Pipe	No
64+1800 To 64+2000	Bituminous Patch	Yes
64+4050 To 64+4240	Bituminous Patch	Yes
67+1280 To 67+1440	Bituminous Patch – Cattle Pass	No
68+1130 To 68+1400	Transverse Cracks - Frost Heave	Yes

Summary of Soil Analysis

Soil Sample Distribution

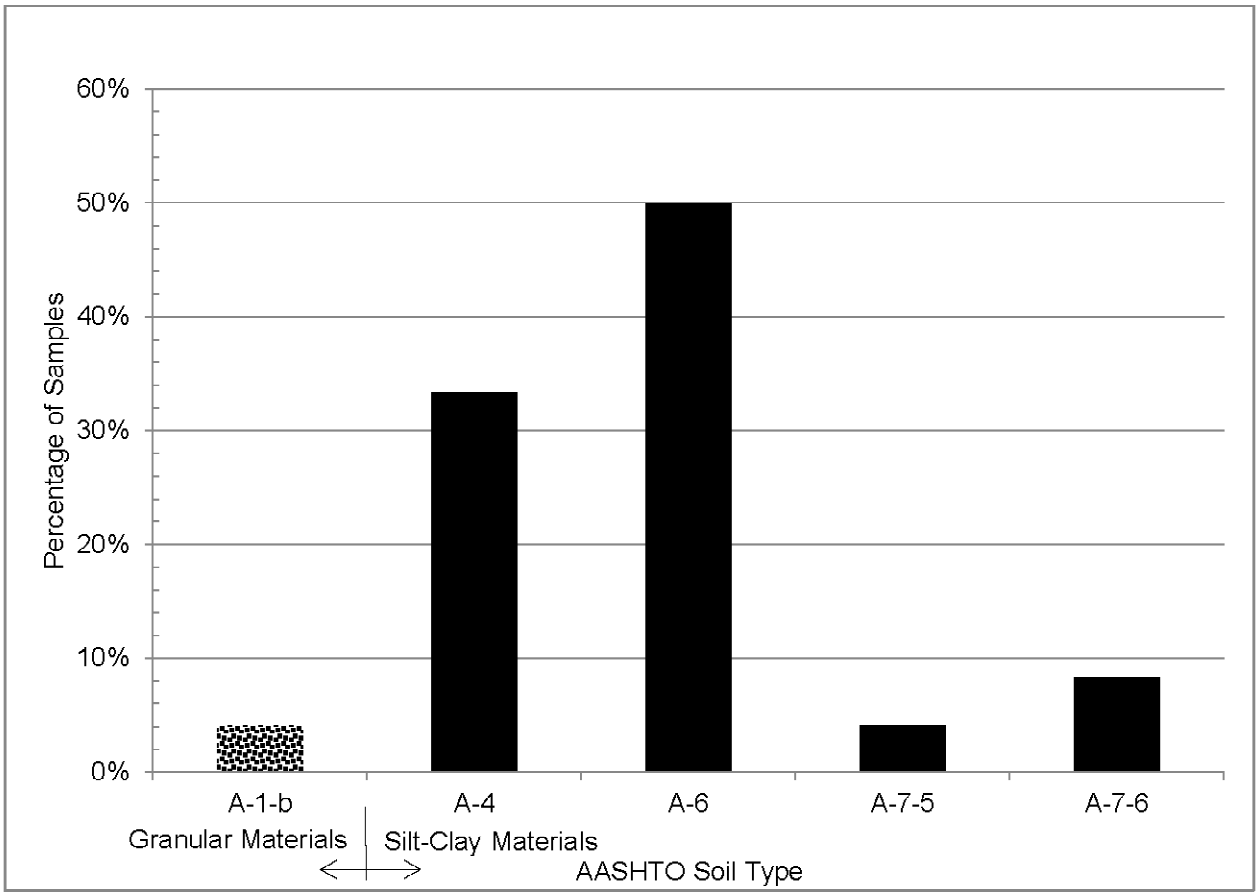


Figure 1 - Soil Sample Distribution

Moisture

The moisture contents provided in this report and summarized below have been obtained from samples taken on 7/8/14.

Table 7 - Summary of In-Place and Optimum Moisture Contents

Quantity	AASHTO Classification	In-Place Moisture Range (%)	In-Place Moisture Average (%)	Optimum Moisture Average (%)	Difference Between Average In-Place and Optimum Moistures (%)
1	A-1-b	-	10.2	10.8	-0.6
8	A-4	17.7-23.5	20.2	12	8.2
12	A-6	18.2-26.8	23	13.4	9.6
1	A-7-5	-	22.6	20.5	2.1
2	A-7-6	17.7-21.5	19.6	14.4	5.2

Table 8 - Summary of In-Place versus Optimum Moisture Content

Quantity	**AASHTO Classification**	**Below Optimum**	**Optimum to Moderate** (0 to 6% over optimum)	**Moderate to High** (6 to 10% over optimum)	**High** (10 to 16% over optimum)	**Very High** (> 16% over optimum)
1	A-1-b	100%	0%	0%	0%	0%
8	A-4	0%	13%	50%	38%	0%
12	A-6	0%	17%	17%	67%	0%
1	A-7-5	0%	100%	0%	0%	0%
2	A-7-6	0%	50%	50%	0%	0%

Atterberg Limits

Table 9 - Summary of Atterberg Limits

AASHTO Classification	**Liquid Limit Range (%)**	**Liquid Limit Average (%)**	**Plastic Limit Range (%)**	**Plastic Limit Average (%)**	**Plasticity Index Range (%)**	**Plasticity Index Average (%)**
A-1-b	-	0	-	0	-	0
A-4	0-29	24	NP-21	17	NP-10	7
A-6	32-40	36	18-22	20	13-20	16
A-7-5	-	53	-	31	-	22
A-7-6	44-46	45	20-23	22	23-24	23

Swell Potential

The swell potential, which is based on the Plasticity Index (PI), is shown in the following table.

Table 10 - Swell Potential

Low (Plasticity Index < 25)	**Marginal** (25 ≤ Plasticity Index ≤ 35)	**High** (Plasticity Index > 35)
100%	0%	0%

Frost Susceptibility

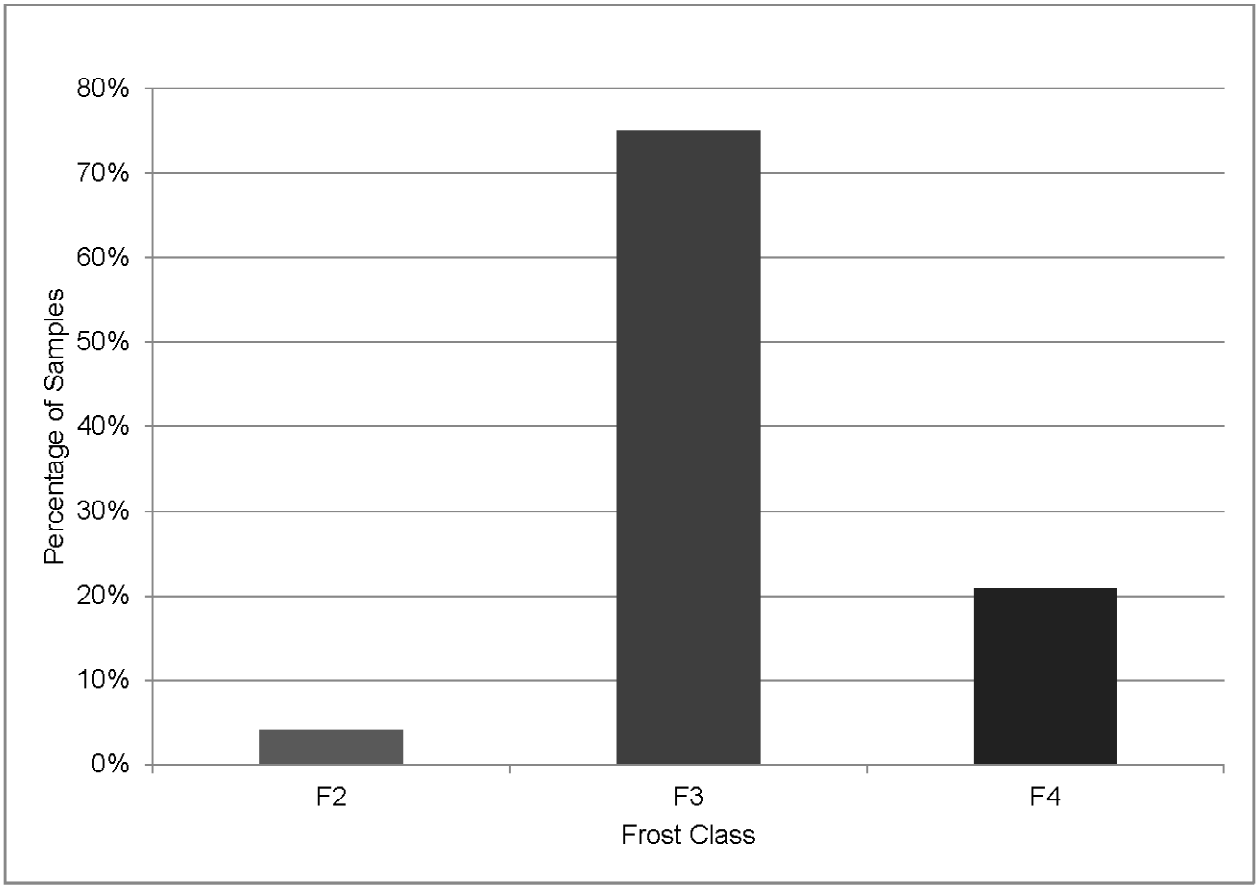


Figure 2 - Frost Susceptibility Distribution

Group Index

The Group Index is a parameter used to evaluate the quality of a soil as a subgrade material. The group index is always zero for A-1, A-2 and A-3 soils (Granular Soils). A group index of 20 or greater indicates a "very poor" subgrade material. The group indices are summarized in the following table.

Table 11 - Group Indices

AASHTO Classification	Group Index Range	Group Index Average
A-1-b	1-1	1
A-4	0-4	2
A-6	3-15	8
A-7-5	9-9	9
A-7-6	6-20	13

Existing Surface and Base Section at the Boring Locations

The soil borings were performed on 7/8/14 using a 6 inch solid flight auger. The following table represents the pavement section as reported in the field log at the boring locations.

Table 12 - Surface and Base Section at the Boring Locations

RP + Feet	Offset	Surfacing Thickness (ft)	Base Thickness (ft)
61+2300	Rt 8 NB	0.4	0.5
61+2411	Rt 8 NB	1.0	0.3
61+2505	Rt 8 NB	1.0	0.3
61+2622	Rt 8 NB	1.2	0.4
61+2737	Rt 6 NB	1.0	0.4
61+2839	Rt 6 NB	0.6	1.5
61+2938	Rt 8 NB	0.8	0.5
61+3055	Rt 8 NB	0.6	0.5
61+5040	Rt 9 NB	0.7	0.7
61+5094	Rt 9 NB	1.2	0.5
61+5181	Rt 5 NB	1.0	0.6
62+0052	Rt 8 NB	0.7	0.6
64+1750	Rt 8 NB	0.7	0.5
64+1840	Rt 8 NB	0.5	1.0
64+1930	Rt 8 NB	0.4	1.0
64+2043	Rt 8 NB	0.4	1.0
64+4020	Rt 8 NB	0.8	0.6
64+4120	Rt 8 NB	0.9	0.5
64+4222	Rt 8 NB	0.6	1.7
64+4318	Rt 9 NB	0.6	0.7
68+1036	Rt 8 NB	0.6	1.9
68+1156	Rt 9 NB	0.7	0.7
68+1255	Rt 9 NB	0.9	0.7
68+1347	Rt 9 NB	0.9	0.5
Average		**0.8**	**0.7**

Design Recommendations

Table 13 – Design Recommendations

Location RP + Feet	Distress Identified	Recommendation*	Justification
61+1145 To 69+1652	Transverse Cracking	Do Nothing	• The transverse cracking is a pavement distress that is not related to the subgrade • No subgrade work required
61+2360 To 61+3000	Bituminous Patch	Subcut	• Numerous patches in the area • Elevated moistures and frost susceptible soils present • Subcut to 2/3 of extreme frost depth below top of pavement (Extreme Frost Depth = 6.5' per USGS) • Subcut depth = 36" below top of existing subgrade (Pavement Section - on average = 16" per measured pavement and base)
61+3100 To 61+3240	Bituminous Patch	Subcut	• Numerous patches in the area • Elevated moistures and frost susceptible soils present • Subcut to 2/3 of extreme frost depth below top of pavement (Extreme Frost Depth = 6.5' per USGS) • Subcut depth = 36" top of existing subgrade (Pavement Section - on average = 16" per measured pavement and base)
61+5080 To 62+0050	Bituminous Patch	Subcut	• Patch • Elevated moistures and frost susceptible soils present • Subcut to 2/3 of extreme frost depth below top of pavement (Extreme Frost Depth = 6.5' per USGS) • Subcut depth = 36" below top of existing subgrade (Pavement Section - on average = 18" per measured pavement and base)
62+0340 To 62+0410	Bituminous Patch	Do Nothing	• Based on the maintenance review this area is not of concern • Based on scope of the project this area will be remediated with overlay work • No subgrade work required
62+0700 To 62+0800	Bituminous Patch - Pipe	Place riprap at end sections	• Area around the end sections has been scoured out from high flows and needs to be armored with rip rap
63+1180 To 63+1360	Bituminous Patch - Pipe	Remove and Replace Pipe(s)	• Separation and Siltation • Void in road over pipe • Yearly patch • Designer should consult with Materials and Research about proper pipe backfill detail to use
63+3240	Raveling & Weather – Pipe	Remove and Replace Pipe	• Separation and Siltation • Void in road over pipe

Location RP + Feet	Distress Identified	Recommendation*	Justification
			• Designer should consult with Materials and Research about proper pipe backfill detail to use
64+1800 To 64+2000	Bituminous Patch	Subcut	• Soft spot in NB lane with patch • Subcut to 18" below top of subgrade to increase the strength of the pavement section through this area
64+4050 To 64+4240	Bituminous Patch	Subcut	• Soft spot with patch • Subcut to 18" below top of subgrade to increase the strength of the pavement
67+1280 To 67+1440	Bituminous Patch – Cattle Pass	Remove Cattle Pass (If possible)	• Very minimal water flow • Does not appear to be used as a cattle pass anymore • Soft spots over the cattle pass causing maintenance to patch area
68+1130 To 68+1400	Transverse Cracks - Frost Heave	Subcut	• Annual problem area in the winter • Elevated moistures and frost susceptible soils present • Subcut to 2/3 of extreme frost depth below top of pavement (Extreme Frost Depth = 6.5' per USGS) • Subcut depth = 36" below top of existing subgrade (Pavement Section - on average = 18" per measured pavement and base)

*See Design Information Below

Design Information

Compaction Method: T-180

Subgrade Prep: None

Subcut:

Table 14 – Subcut Recommendations

Location RP + Feet	Length	Depth
61+2200 To 61+3250	1050'	36"
61+4950 To 62+0100	430'	36"
64+1550 To 64+2100	550'	18"
64+3800 To 64+4250	450'	18"
68+0800 To 68+1750	950'	36"

Subcut:
This subcut quantity shall be calculated based on the lengths and depths as shown in Table 14 above and adhere to the guidelines stated below.

Remarks:
Subcut XX" below the top of the existing subgrade. Place reinforcement fabric (R1) at the bottom of all subcut excavations and backfill with Class 3 or Class 5 aggregate. Place 12" of aggregate on the fabric prior to compacting. Do not scarify the bottom of the subcut.

Drainage: None

Plan Notes

None

The recommendations in this report are based on the scope specified in the Introduction. If the scope of work, vertical profile or horizontal alignment is changed, in either the conceptual phase or the design phase, the Geotechnical Engineer must be notified as soon as possible to ensure that there is adequate geotechnical information addressing these areas.

APPENDIX A

SOIL CLASSIFICATION AND FROST SUSCEPTIBILITY

AASHTO Soil Classification System

Table 5.1. AASHTO Classification System

General Classification	*Granular materials (35% or less passing No. 200 Sieve (0.075 mm)*							*Silt-clay Materials More than 35% passing No. 200 Sieve (0.075 mm)*			
Group Classification	*A—1*		*A—3*	*A—2*				*A—4*	*A—5*	*A—6*	*A—7*
	A—1—a	*A—1—b*		*A—2—4*	*A—2—5*	*A—2—6*	*A—2—7*				*A—7—5* *A—7—6*
(*a*) Sieve Analysis: Percent Passing											
(*i*) 2.00 mm (No. 10)	50 max										
(*ii*) 0.425 mm (No. 40)	30 max	50 max	51 min								
(*iii*) 0.075 mm (No. 200)	15 max	25 max	10 max	35 max	35 max	35 max	35 max	36 min	36 min	36 min	36 min
(*b*) Characteristics of fraction passing 0.425 mm (No. 40)											
(*i*) Liquid limit				40 max	41 min	40 max	41 min	40 max	41 min	40 max	41 min
(*ii*) Plasticity index	6 max		N.P.	10 max	10 max	11 min	11 min	10 max	10 max	11 min	11 min*
(*c*) Usual types of significant Constituent materials	Stone Fragments Gravel and sand		Fine Sand	Silty or Clayey Gravel Sand				Silty Soils		Clayey Soils	
(*d*) General rating as subgrade.	Excellent to Good							Fair to Poor			

* If plasticity index is equal to or less than (liquid Limit—30), the soil is A—7—5 (*i.e.* PL > 30%)
If plasticity index is greater than (Liquid Limit—30), the soil is A—7—6 (*i.e.* PL < 30%)

Frost Susceptibility Index (Bases on US Army Corps of Engineers)

Frost Class	Frost Susceptibility	Soil Type	Percent Finer than 0.02 mm by weight %
F1	Negligible to Low	• Gravely Soils	3 – 10
F2	Low to Medium	• Gravely Soils • Sands	10 – 20 3 – 15
F3	High	• Gravelly Soils • Sands, except very fine silty sands • Clays, PI > 12	Greater than 20 Greater than 15 ---
F4	Very High	• All Silts • Very Fine Silty Sands • Clays, PI > 12 • Varved Clays and other fine-grained banded sediments	--- Greater than 15 --- ---

APPENDIX B

PAVEMENT EVALUATION AND PHOTOS

PAVEMENT EVALUATION LOG FOR LINEAR SOIL SURVEY

North Dakota Department of Transportation, Materials & Research
SFN 60472 (9-2013)

Project Number	PCN	Date of Survey
SS-3-020(122)061	17765	7/8/2014
Section Maintenance Contact: George Kobel		Completed By: Jamie Naumann
Highway Reference Points: 61+1145 to 69+1652	Surface Type: Asphalt	

Location	Pavement Distress	Description	Maintenance Comment	Picture Number	Drilling Required
61+1145 to 69+1652	Transv. Cracks	Depressed transversed cracks throughout project ~30' Crack Spacing.	Last crack seal 2012		No
61+2360 to 61+3000	Bituminous Patch	Multiple bituminous patches throughout this location. Rutting ~0.6' deep	MBP yearly	1	Yes
61+3100 to 61+3240	Bituminous Patch	Rutting 0.6' deep	MBP yearly	1	Yes
61+5080 to 62+0050	Bituminous Patch	Alligator cracking found within the bituminous patch Rutting 0.6' deep	MBP yearly	2	Yes
62+0340 to 62+0410	Bituminous Patch	Rutting/Shoving of the pavement Rutting 0.6' deep	soft spot	3	No
62+0700 to 62+0800	Bituminous Patch	Pipe Location Dual 5' corrugated pipes Recommend rip rap be placed at the end sections	middle lower, MHP yearly	4-6	No
63+1180 to 63+1360	Bituminous Patch	Pipe Location Triple pipes Untied sections, losing material	End separation, ditch erosion,void in road over pipe-MHP yearly	7-9	No
63+3240	Raveling & Weather	Culvert separation	Voids filled MHP 2014	10-11	No
64+1800 to 64+2000	Bituminous Patch	NB Lane Only Rutting 0.6' deep	soft spot, MBP	12	Yes

Comments

PAVEMENT EVALUATION LOG FOR LINEAR SOIL SURVEY

North Dakota Department of Transportation, Materials & Research
SFN 60472 (9-2013)

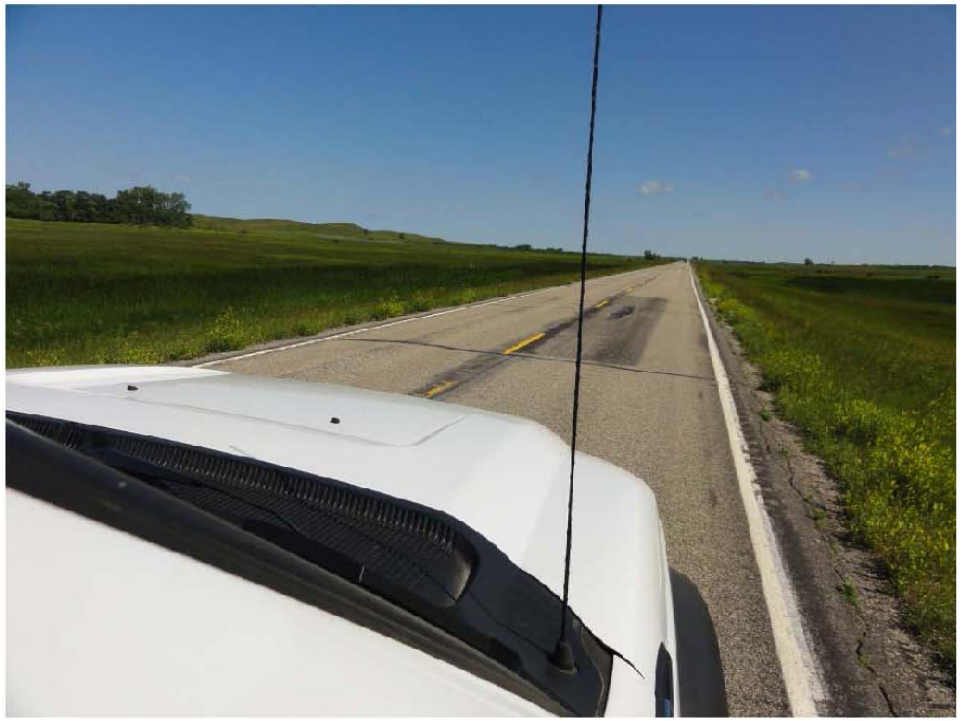
Project Number	PCN	Date of Survey
SS-3-020(122)061	17765	7/8/2014
Section Maintenance Contact: George Kobel		Completed By: Jamie Naumann
Highway Reference Points: 61+1045 to 69+1652	Surface Type: Asphalt	

Location	Pavement Distress	Description	Maintenance Comment	Picture Number	Drilling Required
64+4050 to 64+4240	Bituminous Patch	Rutting 0.6' deep	soft spot, MBP	13	Yes
67+1280 to 67+1440	Bituminous Patch	6' cattle pass location Doesn't seem to be used as a cattle pass anymore. Not much water flow.	soft spots over culvert	14	No
68+1130 to 68+1400	Transv. Cracks	Frost Heave	Reduced speed-spring time,signed year round	15-16	Yes
	Select One				Select One
	Select One				Select One
	Select One				Select One
	Select One				Select One
	Select One				Select One
	Select One				Select One

Comments

1

2



3

4

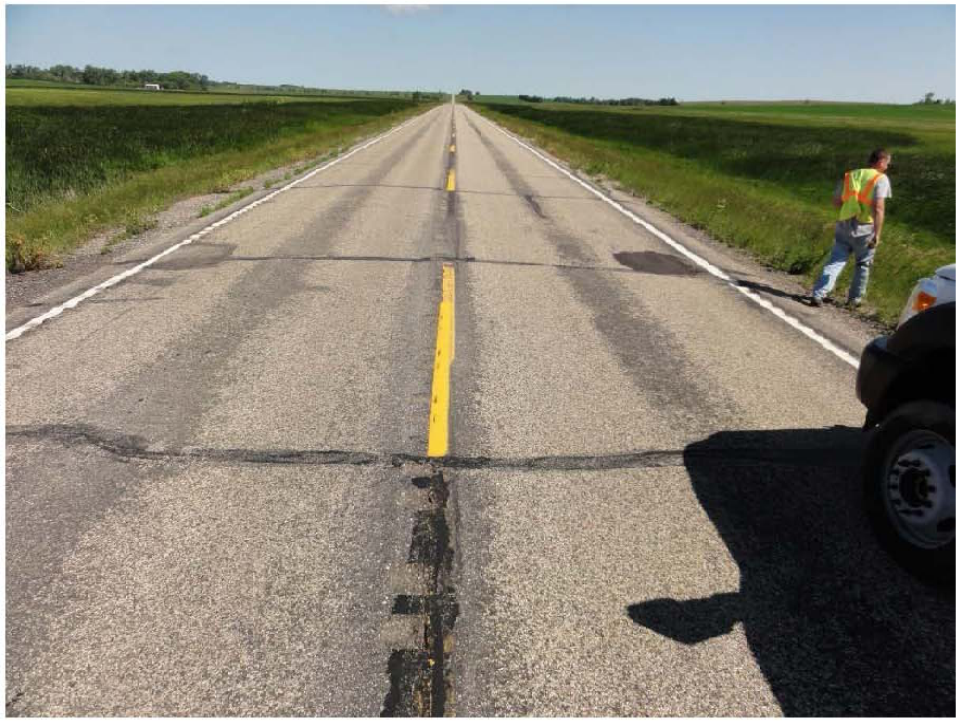
5

6

7

8

9



10

11

12

13

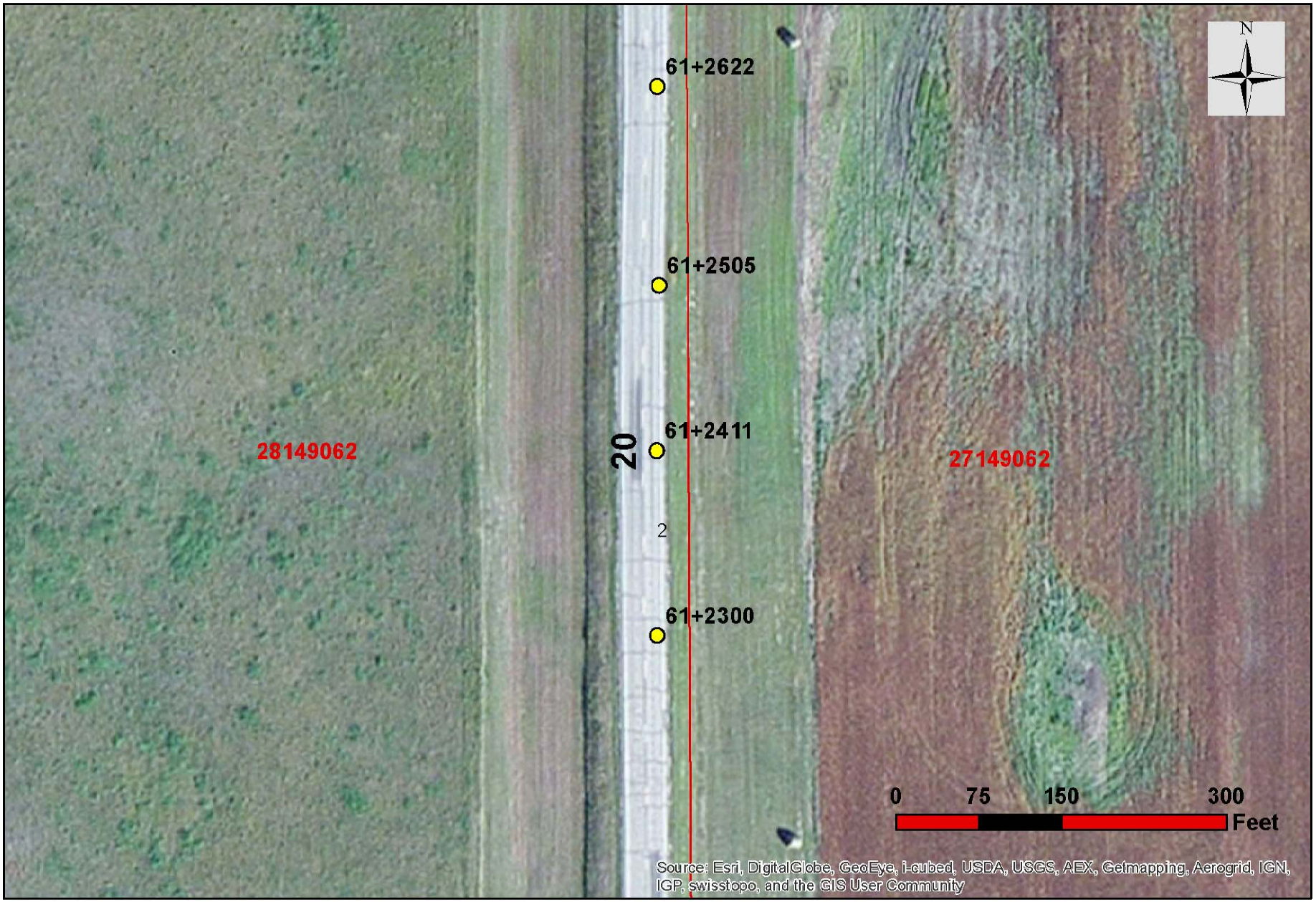
14

15

16

APPENDIX C

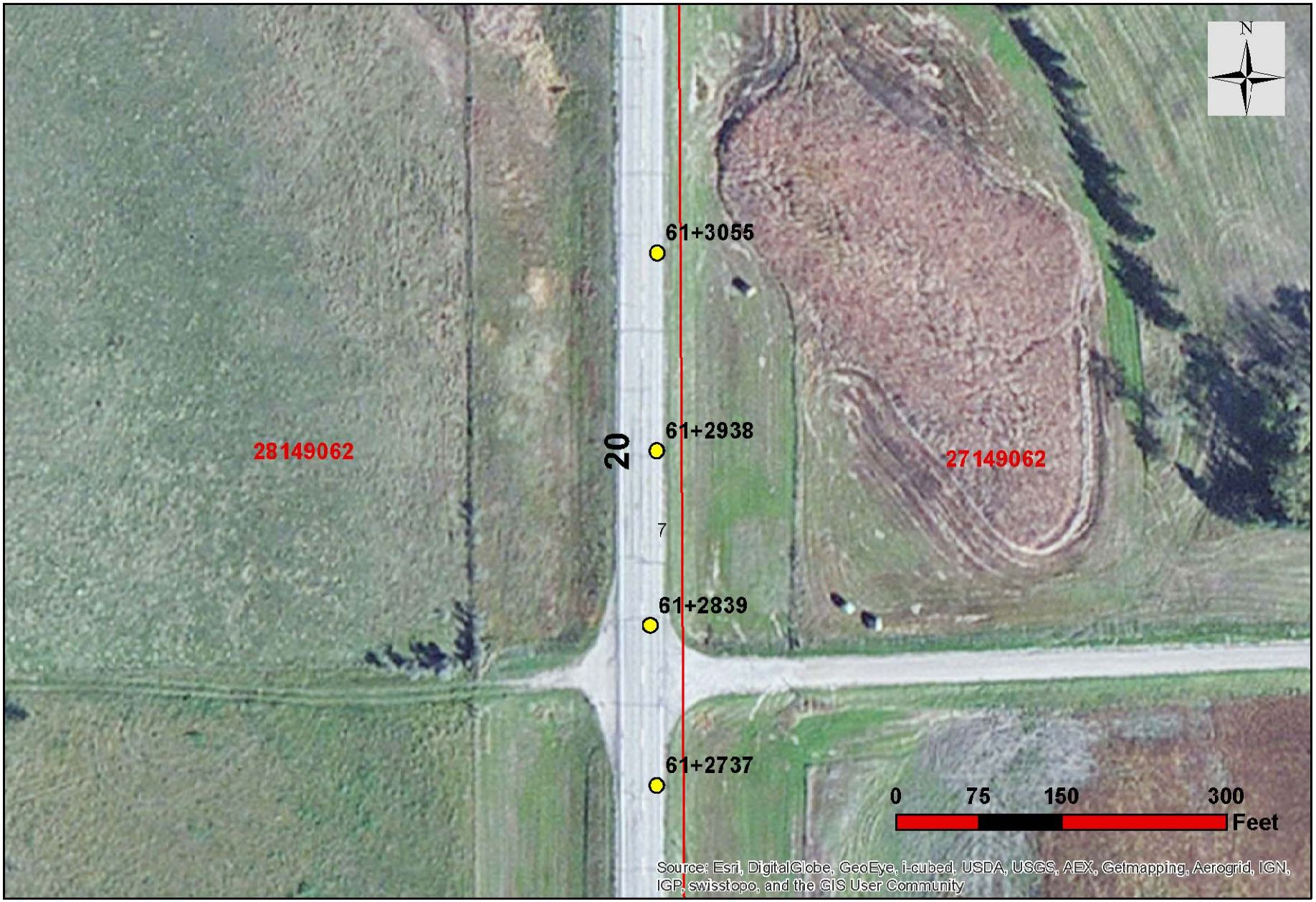
BORING LOCATIONS



Legend

- Reference Point
- SECTWPRGE
- LinearSoils

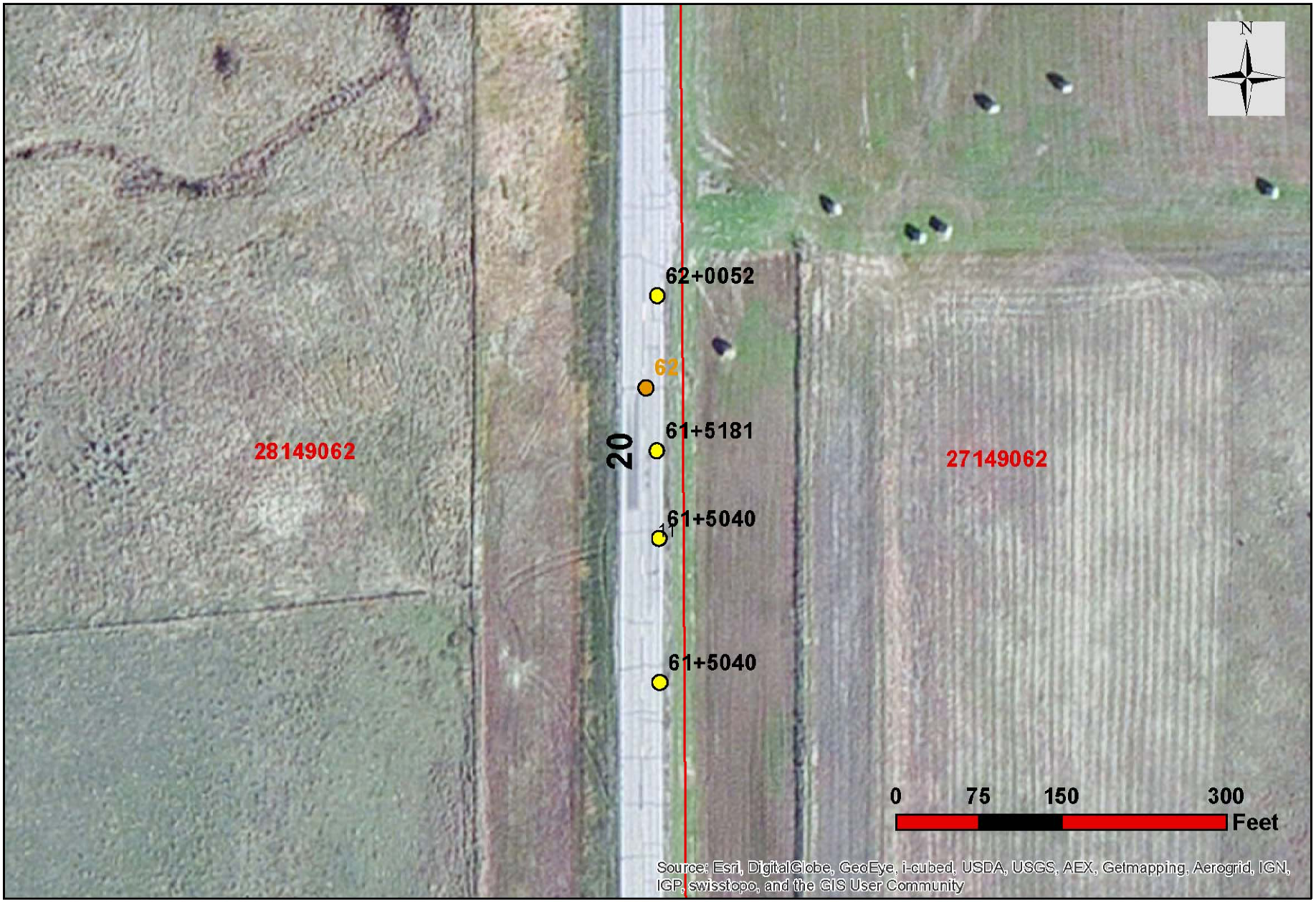
Project Number: SS-3-020(122)061



Legend

- Reference Point
- SECTWPRGE
- LinearSoils

Project Number: SS-3-020(122)061



Legend

- Reference Point
- SECTWPRGE
- LinearSoils

Project Number: SS-3-020(122)061

Legend

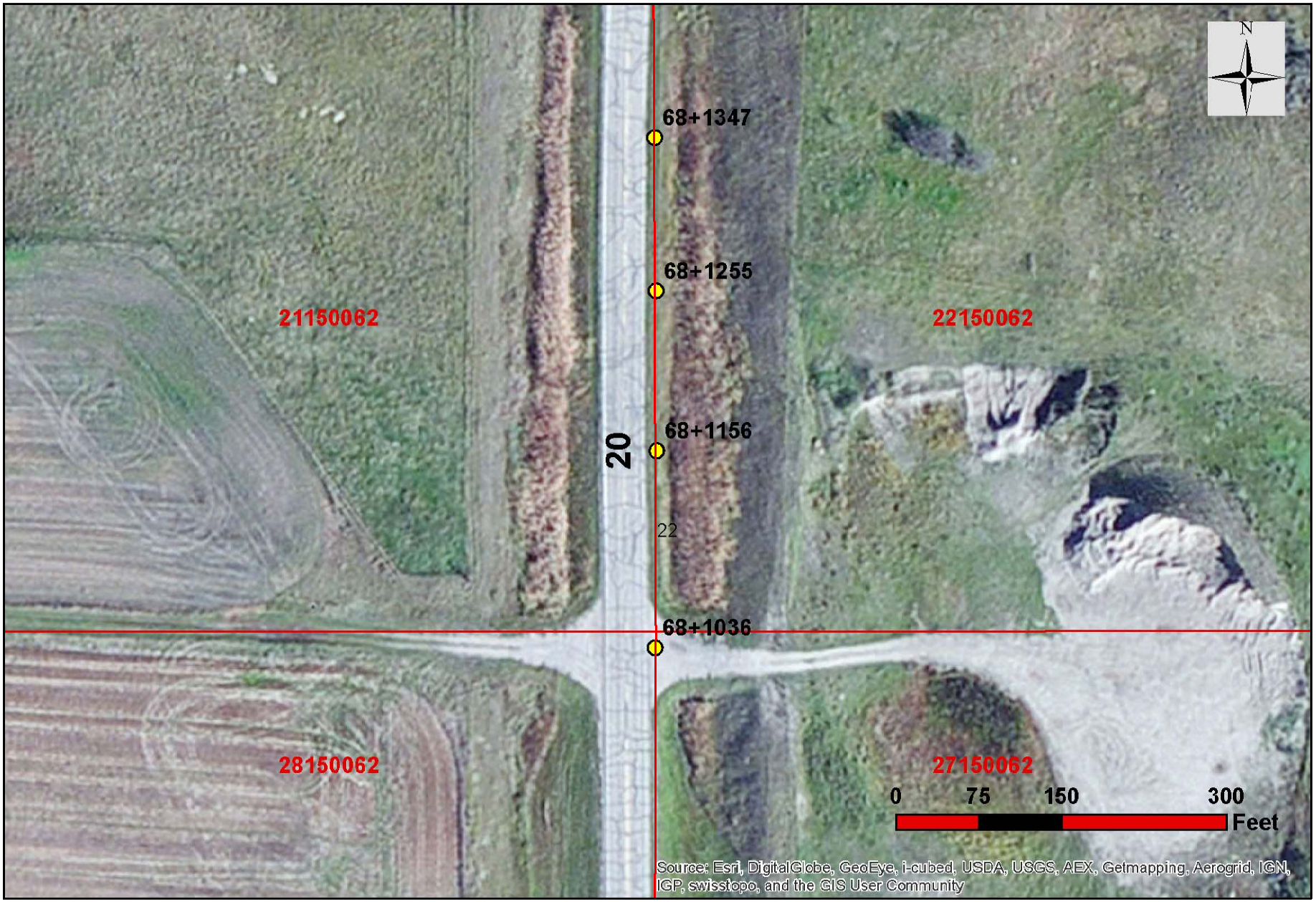
- Reference Point
- SECTWPRGE
- LinearSoils

Project Number: SS-3-020(122)061

Legend

- Reference Point
- SECTWPRGE
- LinearSoils

Project Number: SS-3-020(122)061



Legend

- Reference Point
- SECTWPRGE
- LinearSoils

Project Number: SS-3-020(122)061

APPENDIX D

SUMMARY OF SOILS ANALYSIS

Project No.: SS-3-020(077)061

PCN: 17765

Color Key

Swell Potential:	Low	Marginal	High	
Moisture Content:	Below PL	0-5% Over PL	>5% Over PL	
Group Index:	GI≤20	GI>20		
Ave. In-Place: Moisture Content	MC < Opt.	0 ≤ MC < 6% Over opt.	6 ≤ MC < 10% Over opt.	10 ≤ MC < 16% Over opt.	MC >16% Over opt.

Lab No.	STA	Offset	Depth of Sample (ft)	Plastic Limit (PL)	AASHTO Class	Group Index	Optimum Moisture	Swell Potential (PI)	Ave. In-Place Moisture	Moisture Content @ Depth (ft) 2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	Frost Class
266	61+2300	Rt 8 NB	0.4-4.5	18.4	A-6(5)	5	12.0	14	25.0	21.6	15.5	28.7	39.1																					F3
267	61+2411	Rt 8 NB	1-5	18.5	A-4(4)	4	11.9	9	23.5	23.4	28.7	19.2	27.6																					F4
268	61+2505	Rt 8 NB	1-4	20.1	A-6(7)	7	13.2	13	23.4	24.6	23.2	24.8	21.0																					F3
269	61+2622	Rt 8 NB	1.2-5	21.7	A-6(15)	15	14.3	18	25.4	14.7	28.4	31.1	27.5																					F3
270	61+2737	Rt 6 NB	1-5	21.9	A-6(14)	14	14.8	17	26.8	20.3	29.2	27.4	30.2																					F3
271	61+2839	Rt 6 NB	0.6-5	21.1	A-4(2)	2	12.1	8	19.2	10.3	23.1	22.0	21.6																					F4
272	61+2938	Rt 8 NB	0.8-5	20.3	A-6(8)	8	13.8	14	21.2	20.6	23.2	21.9	19.3																					F3
273	61+3055	Rt 8 NB	0.6-5	20.8	A-4(2)	2	12.3	7	23.0	23.8	21.5	22.1	24.5																					F4
274	61+5040	Rt 9 NB	0.7-5	18.9	A-6(4)	4	12.7	13	22.9	21.6	21.3	25.8	22.9																					F3
275	61+5094	Rt 9 NB	1.2-5	19.5	A-4(3)	3	11.3	10	17.7	6.8	24.5	21.1	18.2																					F4
276	61+5181	Rt 5 NB	1-5	19.3	A-4(0)	0	11.6	7	18.7	17.5	19.6	18.0	19.7																					F3
277	62+0052	Rt 8 NB	0.7-5	18.9	A-4(0)	0	11.4	7	22.5	24.5	22.0	23.5	20.1																					F3
278	64+1750	Rt 8 NB	0.7-5	20.2	A-6(10)	10	12.7	20	22.7	19.5	20.7	25.7	24.7																					F3

Project No.: SS-3-020(077)061

PCN: 17765

Color Key

Swell Potential:	Low	Marginal	High	
Moisture Content:	Below PL	0-5% Over PL	>5% Over PL	
Group Index:	GI≤20	GI>20		
Ave. In-Place: Moisture Content	MC < Opt.	0 ≤ MC < 6% Over opt.	6 ≤ MC < 10% Over opt.	10 ≤ MC < 16% Over opt.	MC >16% Over opt.

Lab No.	STA	Offset	Depth of Sample (ft)	Plastic Limit (PL)	AASHTO Class	Group Index	Optimum Moisture	Swell Potential (PI)	Ave. In-Place Moisture	Moisture Content @ Depth (ft) 2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	Frost Class
279	64+1840	Rt 8 NB	0.5-5	19.1	A-6(13)	13	13.5	20	24.2	18.5	28.3	25.0	25.1																					F3
280	64+1930	Rt 8 NB	0.4-5	18.7	A-6(11)	11	12.9	19	24.4	25.7	23.6	23.3	25.0																					F3
281	64+2043	Rt 8 NB	0.4-5	19.9	A-7-6(20)	20	13.6	24	21.5	13.8	25.1	24.3	22.6																					F3
282	64+4020	Rt 8 NB	0.8-5	19.0	A-6(7)	7	13.1	15	18.2	16.4	16.2	17.1	22.9																					F3
283	64+4120	Rt 8 NB	0.9-5	19.1	A-6(5)	5	13.7	14	23.4	19.2	14.1	18.2	42.1																					F3
284	64+4222	Rt 8 NB	0.6-5	16.6	A-4(1)	1	11.1	9	18.6	6.8	14.1	28.8	25.0																					F3
285	64+4318	Rt 9 NB	0.6-5	0.0	A-4(0)	0	14.3	0	18.3	17.8	17.8	18.3	19.2																					F3
286	68+1036	Rt 8 NB	0.6-5	0.0	A-1-b(1)	1	10.8	0	10.2	4.6	7.7	6.1	22.4																					F2
287	68+1156	Rt 9 NB	0.7-5	20.0	A-6(3)	3	13.5	13	18.3	23.7	16.5	11.4	21.5																					F3
288	68+1255	Rt 9 NB	0.9-3.5	23.2	A-7-6(6)	6	15.2	23	17.7	13.9	23.1	4.7	29.0																					F3
289	68+1347	Rt 9 NB	0.9-5	30.8	A-7-5(9)	9	20.5	22	22.6	13.5	18.3	29.1	29.6																					F4

APPENDIX E

LAB RESULTS

Linear Laboratory Analysis

Department of Transportation, Materials and Research Division
300 Airport Road, Bismarck ND 58504 (701) 328-6900

Report Number	SS-12-2014	**Date Reported**	7/28/2014	**District**	Devils Lake
County	EDDY	**Submitted By**	Naumann	**Project Number**	SS-3-020(077)061
		AASHTO Test Method	T-180	**PCN**	17765

Comments

Lab Number	266	267	268	269
Reference Pt + Feet	61+2300	61+2411	61−2505	61+2622
Distance From CenterLine (Ft.)	Rt 8 NB	Rt 8 NB	Rt 8 NB	Rt 8 NB
Depth, Ft.	0.4 - 4.5	1.0 - 5.0	1.0 - 4.0	1.2 - 5.0
Field Sample No.	266	267	268	269
% Pass. 3/8" Sieve	100	100	100	100
% Pass. No. 4 Sieve	98	99	99	100
% Pass. No. 10 Sieve	92	97	96	99
% Coarse Sand (-No. 10 + No. 40)	10	6	6	2
% Fine Sand (-No. 40 + No. 200)	26	28	23	15
% Silt (0.074 - 0.005 mm)	31	42	43	48
% Clay (-0.005 mm)	24	21	25	33
Liquid Limit (-No. 40)	32	28	33	40
Plasticity Index (-No. 40)	14	9	13	19
Plastic Limit	18	19	20	22
Soil Color	BRN	BRN/GRY/BLK	BRN/GRY/BLK	BRN/GRY/BLK
Textural Class	CLY LM	CLY LM	CLY LM	CLY
Soil Class (AASHTO M-145)	A-6(5)	A-4(4)	A-6(7)	A-6(15)
Frost Class	F3	F4	F3	F3
Optimum Moisture (%)	12.0	11.9	13.2	14.3
Maximum Dry Density (pcf)	120.6	121.1	117.7	115.2
% Organic Content				
Depth (Ft.) | Moisture (%)	2 | 21.6	2 | 23.4	2 | 24.6	2 | 14.7
	3 | 15.5	3 | 23.7	3 | 23.2	3 | 28.4
	4 | 23.7	4 | 19.2	4 | 24.8	4 | 31.1
	5 | 39.1	5 | 27.6	5 | 21.0	5 | 27.5
Avg. Moisture of Sample Depth	20.2	23.5	24.2	25.5

Scott W. Wutzke, Testing Lab Supervisor
Date Printed: 8/25/2014

Linear Laboratory Analysis

Department of Transportation, Materials and Research Division
300 Airport Road, Bismarck ND 58504 (701) 328-6900

Report Number	SS-12-2014	**Date Reported**	7/28/2014	**District**	Devils Lake
County	EDDY	**Submitted By**	Naumann	**Project Number**	SS-3-020(077)061
		AASHTO Test Method	T-180	**PCN**	17765

Comments

Lab Number	270	271	272	273
Reference Pt + Feet	61+2737	61+2839	61−2938	61+3055
Distance From CenterLine (Ft.)	Rt 6 NB	Rt 6 NB	Rt 8 NB	Rt 8 NB
Depth, Ft.	1.0 - 5.0	0.6 - 5.0	0.8 - 5.0	0.6 - 5.0
Field Sample No.	270	271	272	273
% Pass. 3/8" Sieve	100	100	100	100
% Pass. No. 4 Sieve	100	99	100	100
% Pass. No. 10 Sieve	99	96	99	98
% Coarse Sand (-No. 10 + No. 40)	2	5	2	2
% Fine Sand (-No. 40 + No. 200)	16	34	27	39
% Silt (0.074 - 0.005 mm)	46	38	46	38
% Clay (-0.005 mm)	35	19	24	19
Liquid Limit (-No. 40)	39	29	34	28
Plasticity Index (-No. 40)	17	8	14	7
Plastic Limit	22	21	20	21
Soil Color	BRN/GRY/BLK	BRN/GRY/BLK	BRN/GRY/BLK	BRN/GRY/BLK
Textural Class	CLY	LM	CLY LM	LM
Soil Class (AASHTO M-145)	A-6(14)	A-4(2)	A-6(8)	A-4(2)
Frost Class	F3	F4	F3	F4
Optimum Moisture (%)	14.8	12.1	13.8	12.3
Maximum Dry Density (pcf)	114.6	119.8	118.2	119.2
% Organic Content				
Depth (Ft.) | Moisture (%)	2 | 20.3	2 | 10.3	2 | 20.6	2 | 23.8
	3 | 29.2	3 | 23.1	3 | 23.2	3 | 21.5
	4 | 27.4	4 | 22.0	4 | 21.9	4 | 22.1
	5 | 30.2	5 | 21.6	5 | 19.3	5 | 24.5
Avg. Moisture of Sample Depth	26.8	19.3	21.2	22.9

Scott W. Wutzke, Testing Lab Supervisor
Date Printed: 8/25/2014

Linear Laboratory Analysis

Department of Transportation, Materials and Research Division
300 Airport Road, Bismarck ND 58504 (701) 328-6900

Report Number	SS-12-2014	**Date Reported**	7/28/2014	**District**	Devils Lake
County	EDDY	**Submitted By**	Naumann	**Project Number**	SS-3-020(077)061
		AASHTO Test Method	T-180	**PCN**	17765

Comments

Lab Number	274	275	276	277
Reference Pt + Feet	61+5040	61+5094	61−5181	62+0052
Distance From CenterLine (Ft.)	Rt 9 NB	Rt 9 NB	Rt 5 NB	Rt 8 NB
Depth, Ft.	0.7 - 5.0	1.2 - 5.0	1.0 - 5.0	0.7 - 5.0
Field Sample No.	274	275	276	277
% Pass. 3/8" Sieve	100	99	100	100
% Pass. No. 4 Sieve	100	97	100	100
% Pass. No. 10 Sieve	99	91	98	98
% Coarse Sand (-No. 10 + No. 40)	5	9	5	6
% Fine Sand (-No. 40 + No. 200)	41	28	49	47
% Silt (0.074 - 0.005 mm)	31	36	30	27
% Clay (-0.005 mm)	21	19	15	19
Liquid Limit (-No. 40)	32	29	26	26
Plasticity Index (-No. 40)	13	10	7	7
Plastic Limit	19	20	19	19
Soil Color	BRN/GRY/BLK	BRN/GRY/BLK	BRN/GRY/BLK	BRN/GRY/BLK
Textural Class	CLY LM	LM	SNDY LM	SNDY LM
Soil Class (AASHTO M-145)	A-6(4)	A-4(3)	A-4(0)	A-4(0)
Frost Class	F3	F4	F3	F3
Optimum Moisture (%)	12.7	11.3	11.6	11.4
Maximum Dry Density (pcf)	118.0	122.4	120.0	121.2
% Organic Content				
Depth (Ft.) | Moisture (%)	2 | 21.6	2 | 6.8	2 | 17.5	2 | 24.5
	3 | 21.3	3 | 24.5	3 | 19.6	3 | 22.0
	4 | 25.8	4 | 21.1	4 | 18.0	4 | 23.5
	5 | 22.9	5 | 18.2	5 | 19.7	5 | 20.1
Avg. Moisture of Sample Depth	22.9	17.6	18.7	22.5

Scott W. Wutzke, Testing Lab Supervisor
Date Printed: 8/25/2014

Linear Laboratory Analysis

Department of Transportation, Materials and Research Division
300 Airport Road, Bismarck ND 58504 (701) 328-6900

Report Number	SS-12-2014	**Date Reported**	7/28/2014	**District**	Devils Lake
County	EDDY	**Submitted By**	Naumann	**Project Number**	SS-3-020(077)061
		AASHTO Test Method	T-180	**PCN**	17765

Comments

Lab Number	278	279	280	281
Reference Pt + Feet	64+1750	64+1840	64−1930	64+2043
Distance From CenterLine (Ft.)	Rt 8 NB	Rt 8 NB	Rt 8 NB	Rt 8 NB
Depth, Ft.	0.7 - 5.0	0.5 - 5.0	0.4 - 5.0	0.4 - 5.0
Field Sample No.	278	279	280	281
% Pass. 3/8" Sieve	99	100	100	100
% Pass. No. 4 Sieve	93	99	99	100
% Pass. No. 10 Sieve	90	97	98	99
% Coarse Sand (-No. 10 + No. 40)	7	6	5	3
% Fine Sand (-No. 40 + No. 200)	21	18	24	14
% Silt (0.074 - 0.005 mm)	31	57	36	42
% Clay (-0.005 mm)	31	17	34	41
Liquid Limit (-No. 40)	40	39	37	44
Plasticity Index (-No. 40)	20	20	19	24
Plastic Limit	20	19	19	20
Soil Color	BRN/GRY/BLK	BRN/GRY/BLK	BRN/GRY/BLK	BRN/GRY/BLK
Textural Class	CLY	SLTY LM	CLY	CLY
Soil Class (AASHTO M-145)	A-6(10)	A-6(13)	A-6(11)	A-7-6(20)
Frost Class	F3	F3	F3	F3
Optimum Moisture (%)	12.7	13.5	12.9	13.6
Maximum Dry Density (pcf)	119.3	118.8	119.8	118.7
% Organic Content				
Depth (Ft.) | Moisture (%)	2 | 19.5	2 | 18.5	2 | 25.7	2 | 13.8
	3 | 20.7	3 | 28.3	3 | 23.6	3 | 25.1
	4 | 25.7	4 | 25.0	4 | 23.3	4 | 24.3
	5 | 24.7	5 | 25.1	5 | 25.0	5 | 22.6
Avg. Moisture of Sample Depth	22.7	24.2	24.4	21.4

Scott W. Wutzke, Testing Lab Supervisor
Date Printed: 8/25/2014

Linear Laboratory Analysis

Department of Transportation, Materials and Research Division
300 Airport Road, Bismarck ND 58504 (701) 328-6900

Report Number	SS-12-2014	**Date Reported**	7/28/2014	**District**	Devils Lake
County	EDDY	**Submitted By**	Naumann	**Project Number**	SS-3-020(077)061
		AASHTO Test Method	T-180	**PCN**	17765

Comments

Lab Number	282	283	284	285
Reference Pt + Feet	64+4020	64+4120	64−4222	64+4318
Distance From CenterLine (Ft.)	Rt 8 NB	Rt 8 NB	Rt 8 NB	Rt 9 NB
Depth, Ft.	0.8 - 5.0	0.9 - 5.0	0.6 - 5.0	0.6 - 5.0
Field Sample No.	282	283	284	285
% Pass. 3/8" Sieve	100	100	100	100
% Pass. No. 4 Sieve	100	100	98	100
% Pass. No. 10 Sieve	99	99	94	100
% Coarse Sand (-No. 10 + No. 40)	4	4	6	0
% Fine Sand (-No. 40 + No. 200)	32	38	45	52
% Silt (0.074 - 0.005 mm)	35	28	22	35
% Clay (-0.005 mm)	28	30	22	13
Liquid Limit (-No. 40)	34	33	26	0
Plasticity Index (-No. 40)	15	14	9	NP
Plastic Limit	19	19	17	0
Soil Color	BLK/GRY	GRY/BLK	DRK BRN	BRN
Textural Class	CLY LM	CLY LM	SNDY CLY LM	SNDY LM
Soil Class (AASHTO M-145)	A-6(7)	A-6(5)	A-4(1)	A-4(0)
Frost Class	F3	F3	F3	F3
Optimum Moisture (%)	13.1	13.7	11.1	14.3
Maximum Dry Density (pcf)	117.8	116.8	125.0	115.1
% Organic Content				
Depth (Ft.) | Moisture (%)	2 | 16.4	2 | 19.2	2 | 6.8	2 | 17.8
	3 | 16.2	3 | 14.1	3 | 14.1	3 | 17.8
	4 | 17.1	4 | 18.2	4 | 28.3	4 | 18.3
	5 | 22.9	5 | 42.1	5 | 25.0	5 | 19.2
Avg. Moisture of Sample Depth	18.2	23.4	18.6	18.3

Scott W. Wutzke, Testing Lab Supervisor
Date Printed: 8/25/2014

Linear Laboratory Analysis

Department of Transportation, Materials and Research Division
300 Airport Road, Bismarck ND 58504 (701) 328-6900

Report Number	SS-12-2014	**Date Reported**	7/28/2014	**District**	Devils Lake
County	EDDY	**Submitted By**	Naumann	**Project Number**	SS-3-020(077)061
		AASHTO Test Method	T-180	**PCN**	17765

Comments

Lab Number	286	287	288	289
Reference Pt + Feet	68+1036	68+1156	68−1255	68+1347
Distance From CenterLine (Ft.)	Rt 8 NB	Rt 9 NB	Rt 9 NB	Rt 9 NB
Depth, Ft.	0.6 - 5.0	0.7 - 5.0	0.9 - 3.5	0.9 - 5.0
Field Sample No.	286	287	288	289
% Pass. 3/8" Sieve	90	100	99	100
% Pass. No. 4 Sieve	84	96	94	98
% Pass. No. 10 Sieve	76	88	85	95
% Coarse Sand (-No. 10 + No. 40)	54	20	20	22
% Fine Sand (-No. 40 + No. 200)	16	23	21	21
% Silt (0.074 - 0.005 mm)	2	25	17	28
% Clay (-0.005 mm)	4	20	27	25
Liquid Limit (-No. 40)	0	33	46	53
Plasticity Index (-No. 40)	NP	13	23	22
Plastic Limit	0	20	23	31
Soil Color	BRN	BRN	BRN	GRY
Textural Class	SND	SNDY CLY LM	SNDY CLY LM	CLY LM
Soil Class (AASHTO M-145)	A-1-b(1)	A-6(3)	A-7-6(6)	A-7-5(9)
Frost Class	F2	F3	F3	F4
Optimum Moisture (%)	10.8	13.5	15.2	20.5
Maximum Dry Density (pcf)	119.9	117.9	113.2	100.9
% Organic Content				
Depth (Ft.) | Moisture (%)	2 | 4.6	2 | 23.7	2 | 13.9	2 | 13.5
	3 | 7.7	3 | 16.5	3 | 23.1	3 | 18.3
	4 | 6.1	4 | 11.4	4 | 4.7	4 | 29.1
	5 | 22.4	5 | 21.5	5 | 29.0	5 | 29.6
Avg. Moisture of Sample Depth	10.2	18.3	18.5	22.6

Scott W. Wutzke, Testing Lab Supervisor
Date Printed: 8/25/2014