

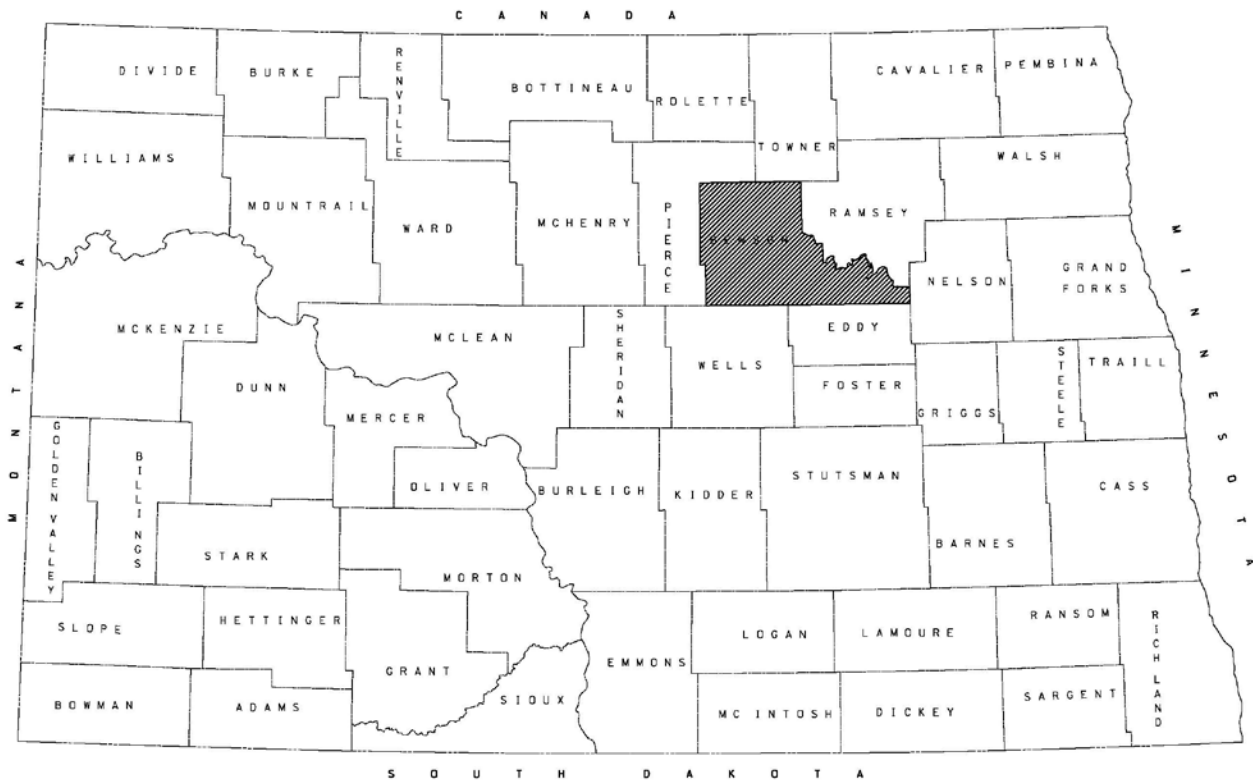
LINEAR SOILS SURVEY AND RECOMMENDATIONS

PROJECT NO. NH-3-281(130)148

PCN 21506

COUNTY Benson

Near Jct. Hwy 57 to New 281



PREPARED BY: Matthew C. Kurle, P.E.

NORTH DAKOTA DEPARTMENT OF TRANSPORTATION
MATERIALS AND RESEARCH DIVISION

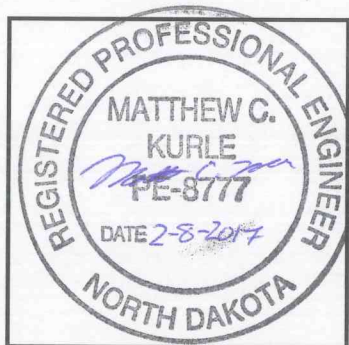
February 2017

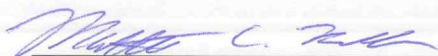
NH-3-281(130)148

Near Jct. 57 (RP 148.879) to New 281 (RP 154.817)

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 Matthew C. Kurle, Registration number PE-8777 on 2/8/2017 and the original document is stored at the North Dakota Department of Transportation.





Matthew C. Kurle, P.E.

8 FEB 2017

Date

Linear Soils Report and Recommendation

Project: NH-3-281(130)148

PCN: 21506

Scope: Full Depth Reclamation with Widening

Length: 5.938 Miles

Location: Near Jct. 57 to New 281

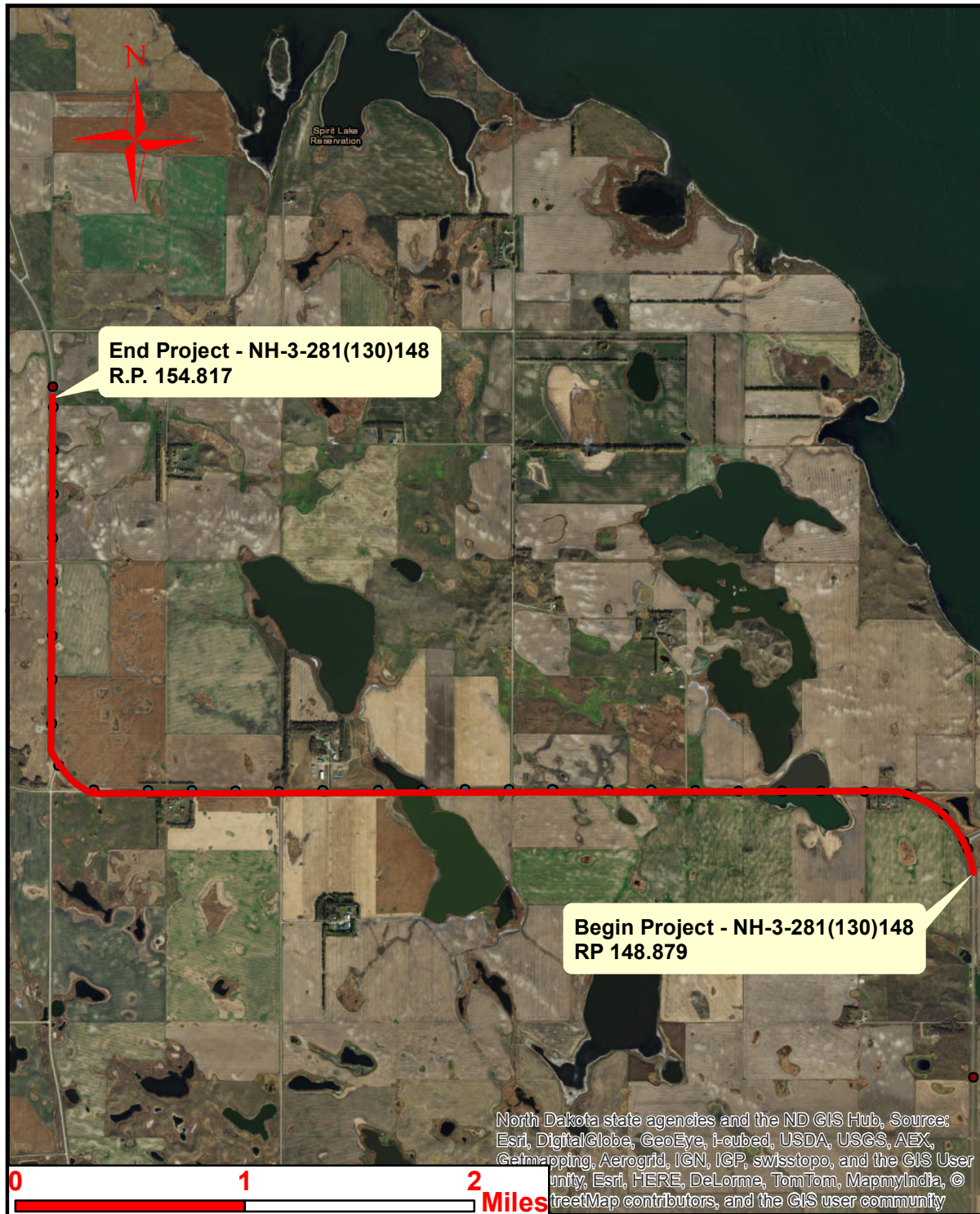


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Appendix C – Boring Locations
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Introduction

Location: Near Jct. 57 to New 281

Reference Points: 148.879 to 154.817

Project Length: 5.938 Miles

Proposed Project Scope: Major Rehabilitation Full Depth Reclamation, Widening, Curve Realignment, and Intersection Improvements.

Investigation Scope: 1000' Intervals

Existing Roadway Section

Construction History

Table 1 - Construction History – RP 148.879 to 149.583

Construction History				
Year	Construction	Depth(in)	Width (ft)	Oil
2004	Grade	-	65.0	-
2004	Salvaged Bit Base	15.0	43.0	-
2004	Hot Bit Pavement	2.0	9.0-24.0-9.0	PG 58-28
2005	Hot Bit Pavement	2.0	9.0-24.0-9.0	PG 58-28
2010	Slurry Seal	-	26.0	CRS-2

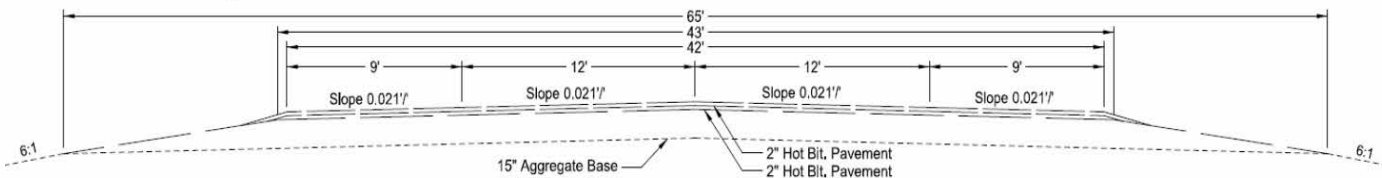


Figure 1 – Existing Typical Section RP 148.879 to 149.583

Table 2 - Construction History – RP 149.583 to RP 153.203

Construction History				
Year	Construction	Depth(in)	Width (ft)	Oil
1952	Grade	-	36.0	-
1952	Traffic Service Gravel	1.0	34.0	-
1955	Aggregate Base	5.0	34.0	-
1955	Stabilized Base	2.0	32.0	-
1955	Hot Bit Pavement	2.5	24.0	120-150
1991	Milling	-1.0	24.0	
1991	Hot Bit Pavement	2.5	24.0	120-150
1991	Salvaged Aggregate Base	-	-	-
1996	Contract Chip Seal	-	24.0	MC-3000
1997	Riprap	-	-	-
2010	Hot Bit Pavement	2.0	24.0	PG 58-28
2014	Microsurfacing	--	24.0	-

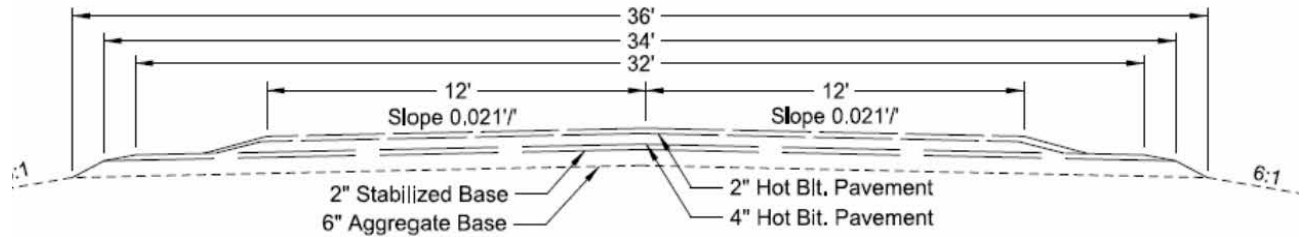


Figure 2 – Existing Typical Section RP 149.583 to 153.203

Table 3 - Construction History – RP 153.203 to 154.817

Construction History				
Year	Construction	Depth(in)	Width (ft)	Oil
1952	Grade	-	36.0	-
1952	Traffic Service Gravel	1.0	34.0	-
1955	Aggregate Base	5.0	34.0	-
1955	Stabilized Base	2.0	32.0	-
1955	Hot Bit Pavement	2.5	24.0	120-150
1991	Milling	-1.0	24.0	
1991	Hot Bit Pavement	2.5	24.0	120-150
1991	Salvaged Aggregate Base	-	-	-
1996	Contract Chip Seal	-	24.0	MC-3000
1997	Riprap	-	-	-
2014	Microsurfacing	--	24.0	-

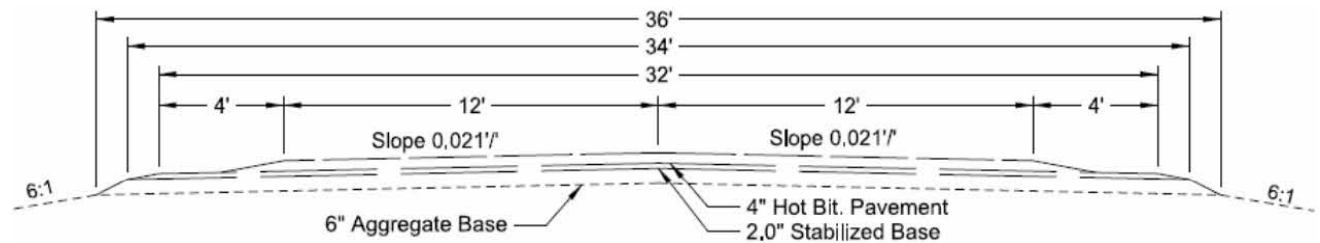


Figure 3 – Existing Typical Section RP 154.203 to 154.817

Existing Roadway Condition

Distress Data

Table 4 – 2015 Distress Data

Reference Point	Alligator Cracking	Longitudinal Cracking	Transverse Cracking	Bituminous Patching	Rutting
	(0-27)	(0-9)	(0-9)	(0-18)	(0-27)
148	3	0	1	0	0
149	3	1	7	2	0
150	0	0	7	2	0
151	3	1	4	2	0
152	3	0	4	0	0
153	3	0	7	2	0
154	3	0	7	4	0
Average	3	0	5	2	0

Ride Data

Table 5 – 2015 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
148	95		0.12		69	
149	86		0.14		99	
150	90		0.14		76	
151	89		0.13		85	
152	92		0.12		85	
153	87		0.12		97	
154	85		0.13		100	
Average	89		0.13		87	

Proposed Improvements

According to the decision document signed on 11/29/2016 the horizontal curve at RP 152.932 is to be reconfigured into the proposed layout shown in the figure below.



Figure 4 – Radial T Intersection and horizontal curve realignment

At the time of the soils investigation this option was not investigated. The soils information available in this report follows the current roadway alignment.

Maintenance Review

Date of Maintenance Review(s): 5/25/2016

Materials and Research Person Conducting the Review: Jamie Naumann

District Maintenance Person Conducting Review: Dave Abrahamson –
Maddock Section

The summary of the identified maintenance areas are shown in the following table. This table also includes areas indicated by district personnel that were not identified during the maintenance review. The pavement evaluation log can be found in Appendix B (Subsurface Investigation Scope).

Table 6 - Identified Maintenance Areas

Location RP + Feet	Distress Identified	Drilling Required (Yes or No)
148+4644 to 154+4316	Transverse Cracks	No
148+4644 to 149+2832	Blade Patches	No
149+3835	Transverse Cracks, Dip in EB Lane	No
151+3008	Transverse Cracks, Dip in EB Lane	No
154+2450 to 154+3237	Bit Patch, Rutting, Pumping Water	No
154+3750 to 154+4200	Bit Patch, Rutting, Pumping Water	No

Summary of Soil Analysis

Soil Sample Distribution

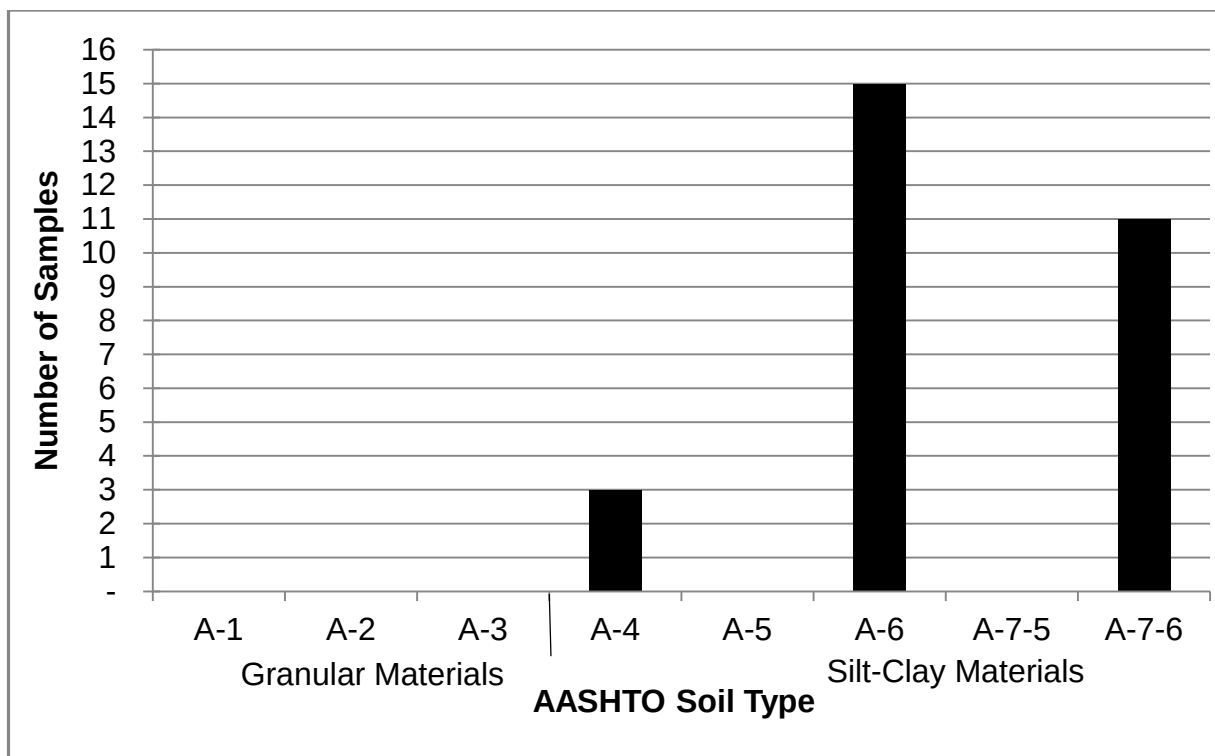


Figure 5 - Soil Sample Distribution

Moisture

The moisture contents provided in this report and summarized below have been obtained from samples taken between 8/22/16 & 8/25/16.

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 (%)
3	A-4	13-14.4	13.6	10.6	3
15	A-6	17.8-26.3	21	12.1	8.9
11	A-7-6	16.8-28.3	23.8	14.4	9.5

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)
3	A-4	0%	100%	0%	0%	0%
15	A-6	0%	0%	80%	20%	0%
11	A-7-6	0%	9%	55%	36%	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-4	24-26	25	17-20	18	6-9	7
A-6	29-40	37	16-22	19	11-22	18
A-7-6	41-46	43	20-26	22	18-24	21

Swell Potential

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

Table 10 - Summary of Atterberg Limits

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

Frost Susceptibility

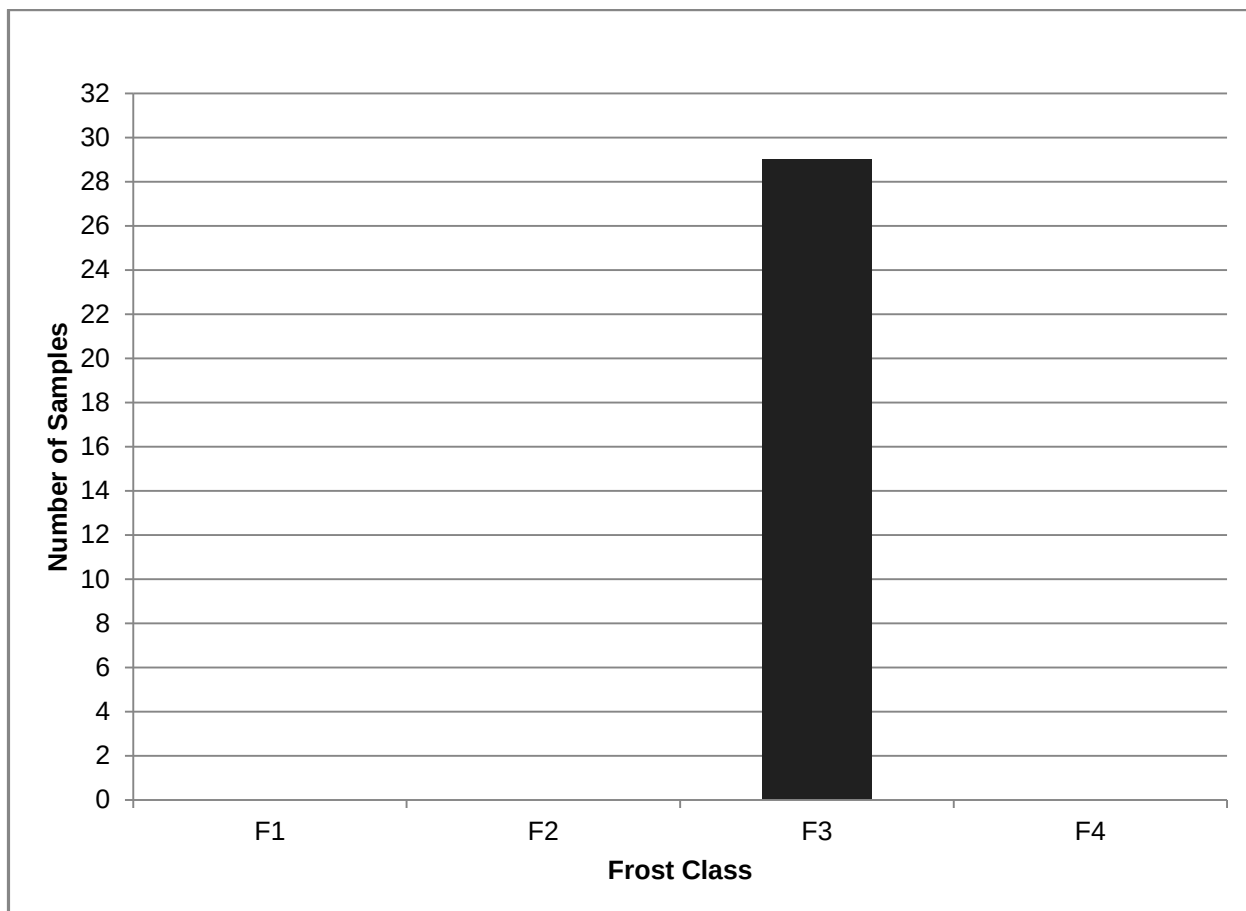


Figure 6 - Frost Susceptibility Distribution

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-4	0-0	0
A-6	0-13	8
A-7-6	10-19	14

Existing Surface and Base Section at the Boring Locations

The soil borings were performed between 8/22/16 & 8/25/16 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	Asphalt Thickness (ft)	Base Thickness (ft)	RP + Feet	Offset	Asphalt Thickness (ft)	Base Thickness (ft)
149+1060	Rt 8 NB	0.4	1.1	152+1000	Rt 8 NB	0.8	0.8
149+2000	Rt 8 NB	0.4	1.0	152+2000	Rt 8 NB	0.9	0.5
149+3000	Rt 8 NB	0.8	1.0	152+3000	Rt 8 NB	0.9	0.5
149+4000	Rt 8 NB	0.5	1.1	152+4000	Rt 8 NB	0.8	0.5
150+0000	Rt 8 NB	0.5	1.0	153+0000	Rt 8 NB	0.8	3.3 ¹
150+1000	Rt 8 NB	0.7	0.7	153+1000	Rt 8 NB	0.8	0.7
150+2000	Rt 8 NB	0.8	0.5	153+2000	Rt 8 NB	0.8	0.7
150+3000	Rt 8 NB	0.9	0.7	153+3000	Rt 8 NB	0.9	0.5
150+4000	Rt 8 NB	0.9	0.4	153+4000	Rt 8 NB	0.7	0.7
151+0000	Rt 8 NB	0.9	0.5	154+0000	Rt 8 NB	0.9	0.5
151+1000	Rt 8 NB	0.9	0.6	154+1000	Rt 8 NB	0.8	0.5
151+2000	Rt 8 NB	0.9	0.5	154+2000	Rt 8 NB	0.8	0.8
151+3000	Rt 8 NB	0.7	1.6	154+3000	Rt 8 NB	1.0	0.5
151+4000	Rt 8 NB	0.8	0.5	154+4000	Rt 8 NB	0.8	0.6
152+0000	Rt 8 NB	0.9	0.5				

¹Boring log indicated recycled concrete base.

Design Recommendations

Table 13 – Evaluation Table

Location RP + Feet	Distress Identified	Recommendation¹	Justification
148+4644 to 154+4316	Transverse Cracks	Do Nothing	• The transverse cracking is not indicative of any specific subgrade related issues. • Borings were performed at 1000' intervals through entire project.
148+4644 to 149+2832	Blade Patches	Do Nothing	• The soils in this area have low swell potential and group indices. The distress does not appear to be subgrade related.
149+3835	Transverse Cracks, Dip in EB Lane	Do Nothing	• The soils in this area have low swell potential and group indices. The distress does not appear to be subgrade related. • Inslope erosion appears to be a contributing factor. • The proposed widening of the roadway should remediate this issue
151+3008	Transverse Cracks, Dip in EB Lane	Do Nothing	• The soils in this area have low swell potential and group indices. The distress does not appear to be subgrade related. • Photos indicate that little to no vegetation is growing on the inslope causing a potential loss of embankment material. This may be contributing to the distress in this area • The proposed widening of the roadway should remediate this issue
154+2450 to 154+3237	Bit Patch, Rutting, Pumping Water	Do nothing	• The soils in this area have low swell potential and group indices. • The samples obtained indicated slightly elevated moisture contents in comparison to their optimum moisture. • The proposed Full Depth Reclamation should remediate this maintenance issue.
154+3750 to 154+4200	Bit Patch, Rutting, Pumping Water	Do nothing	• The soils in this area have low swell potential and group indices. • The samples obtained indicated slightly elevated moisture contents in comparison to their optimum moisture. • The proposed Full Depth Reclamation should remediate this maintenance issue.

¹See Design Information Below

Design Information

Compaction Method: T-180

Subgrade Prep: None

Subcut: None

Drainage: The scoping report states that a new centerline pipe may be needed near RP 150. If new centerline pipes are to be installed on this project it is recommended that they be installed using the detail attached in Appendix F

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	• Gravely 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

Subsurface Investigation Scope

LINEAR SOILS SURVEY FIELD INVESTIGATION SCOPE

TO:	File
FROM:	Jordan Nehls – Materials and Research (Geotechnical)
DATE:	8/10/2016
HIGHWAY:	281.148
PROJECT NUMBER:	NH-3-281(130)148
PCN:	21506
LOCATION:	Jct ND 57 to New US 281
IMPROVEMENT SCOPE:	Full Depth Reclamation, Widening, HBP Surfacing
SUBJECT:	Linear Soils Survey Subsurface Investigation Scope

We have completed the Maintenance Review of the roadway (attached to this memo) and have circulated it to the Devils Lake District for comments. The linear soils survey field investigation scope is based on the improvement strategy for the roadway as per Chapter 7 of the NDDOT Design Manual.

Improvement Strategy: Major Rehabilitation

Investigation Scope: U.S. Highway 281 From Junction of ND 57 to new US 281

The following table shows the proposed subsurface investigation scope.

Boring Location	Justification for Boring	Boring Depth	Location
148+5000 To 154+4000	Major Rehabilitation of Roadway	5 feet	Conduct 1 boring every 1000' along the existing roadway. A total number of approximately 30 borings.

The following are the associated tasks and dates for the completion of the Linear Soils Survey and Recommendations for this project.

Task	Completion (<i>Anticipated</i>) Date
Maintenance Review with District Maintenance Forces	5/25/2016
District Review of Findings from Previous Task	8/10/2016
Linear Soils Survey Field Work Complete	8/16/2016
Linear Soils Survey Lab Work	10/30/2016
Linear Soils Survey Report	1/1/2017*
*Milestone Task	

PAVEMENT EVALUATION LOG FOR LINEAR SOIL SURVEY

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

Sheet

1 of 1

Project Number NH-3-281(130)148	PCN 21506	Date of Survey 5/25/2016
Section Maintenance Contact Dave Abrahamson	Completed By Jamie Naumann	
Highway Reference Points 148+4644 to 154+4316	Surface Type Asphalt	

Location	Pavement Distress	Description	Maintenance Comment	Picture Number	Drilling Required
148+4644 to 154+4316	Transv. Cracks	Depressed			No
148+4644 to 149+2832	Bituminous Patch	Miscellaneous Blade Patch			No
149+3835	Transv. Cracks	Dip East Bound Lane Only	Miscellaneous Blade Patch in 2015, Material added to shoulders.	1,2,3	No
150+3008 151+3008	Transv. Cracks	Dip East Bound Lane Only	Slurry Seal in 2014	4,5,6	No
154+2450 to 154+3237	Bituminous Patch	Rutting	Water pumping		No
154+3750 to 154+4200	Bituminous Patch	Rutting	Water pumping		No
	Select One				Select One
	Select One				Select One
	Select One				Select One

Comments

Met with Dave Abrahamson and he indicated these problem ares. Cracks were approximately 50' apart. Rutting depth was approximately 0.5".



1



2



3



4



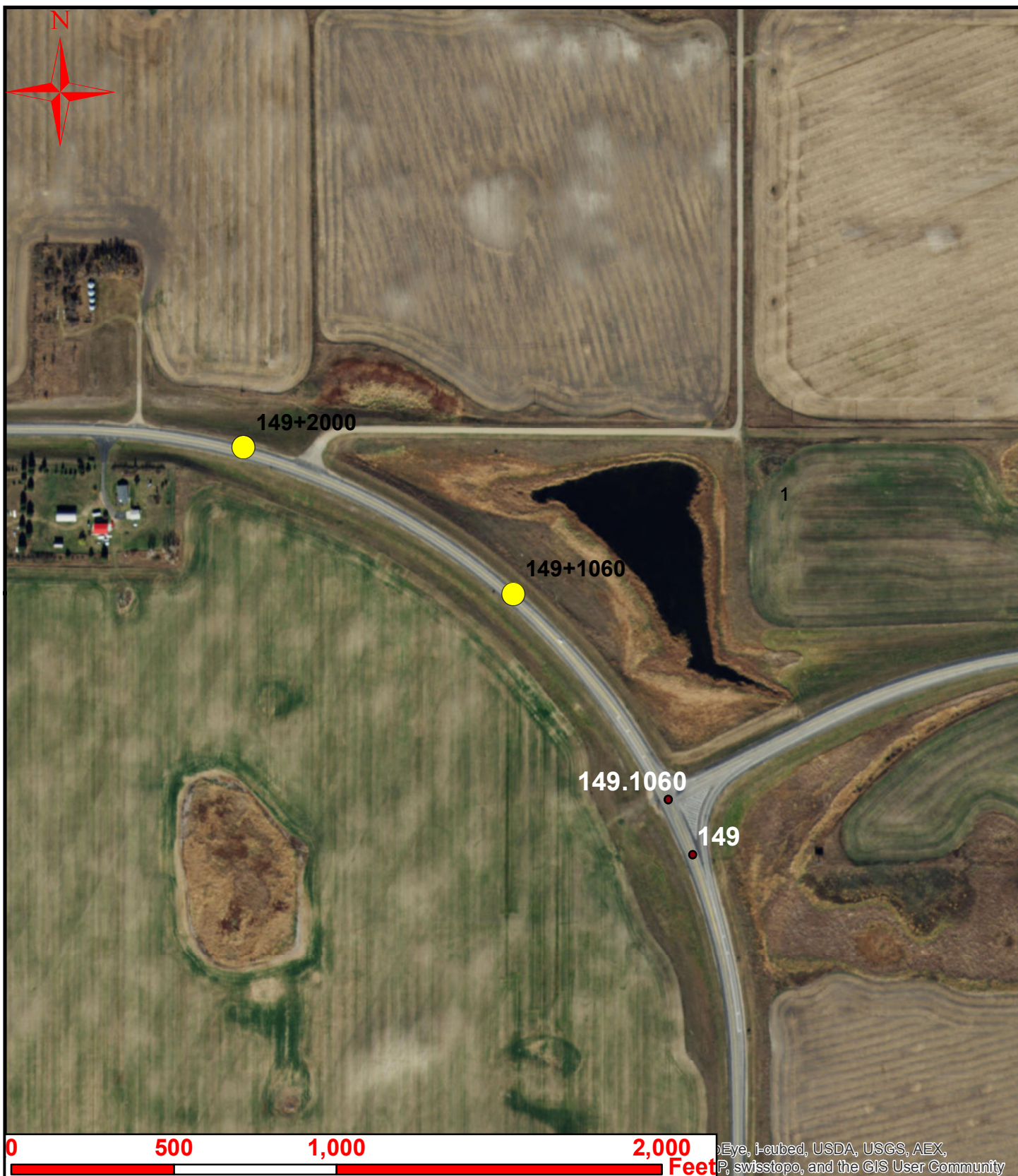
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APPENDIX C

Boring Locations



Legend

- Boring Locations
- Reference Points

NH-3-281(130)148



Legend

- Boring Locations
- Reference Points



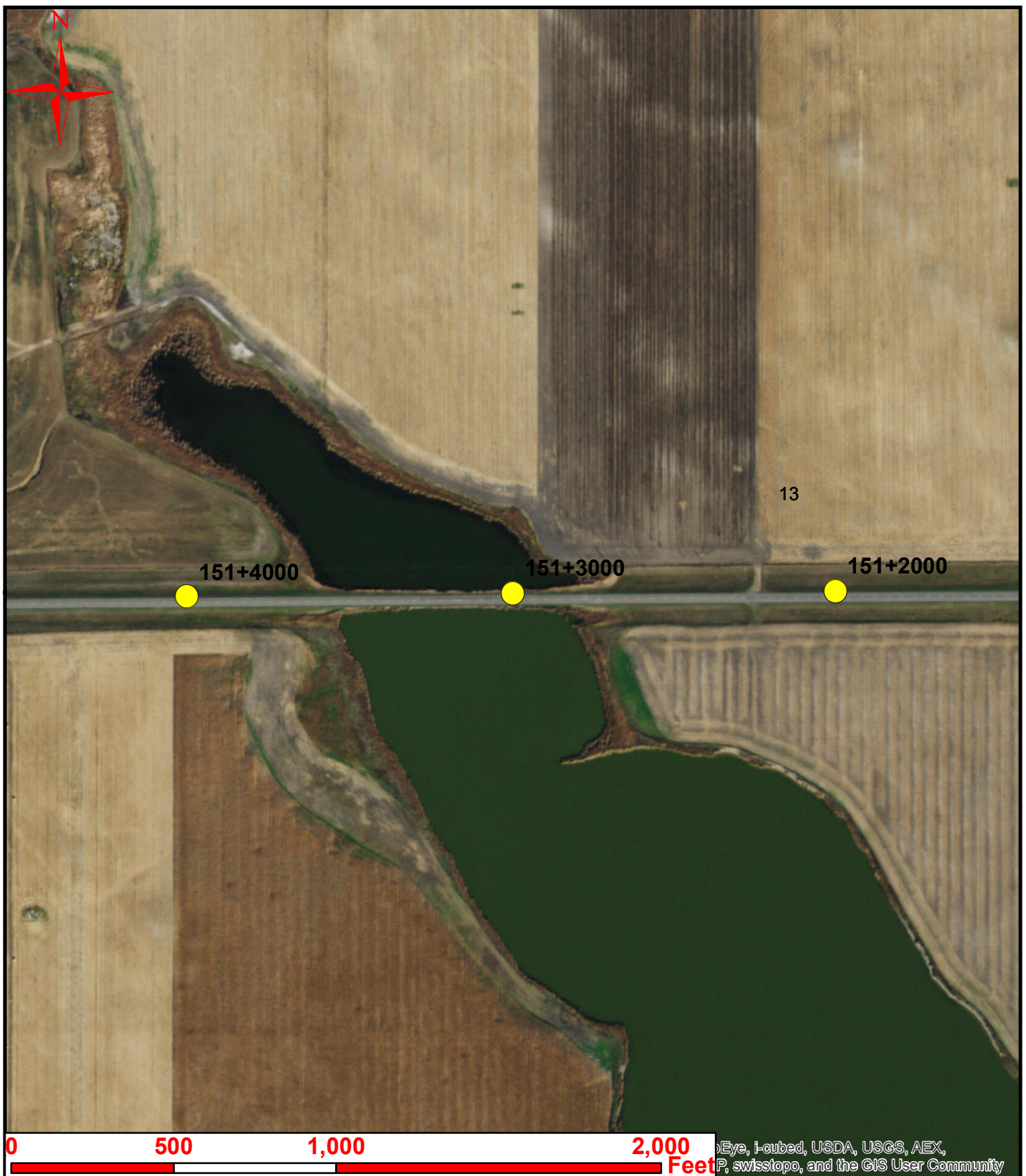
Legend

- Boring Locations
- Reference Points



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- Boring Locations
- Reference Points



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- Boring Locations
- Reference Points



Legend

- Boring Locations
- Reference Points



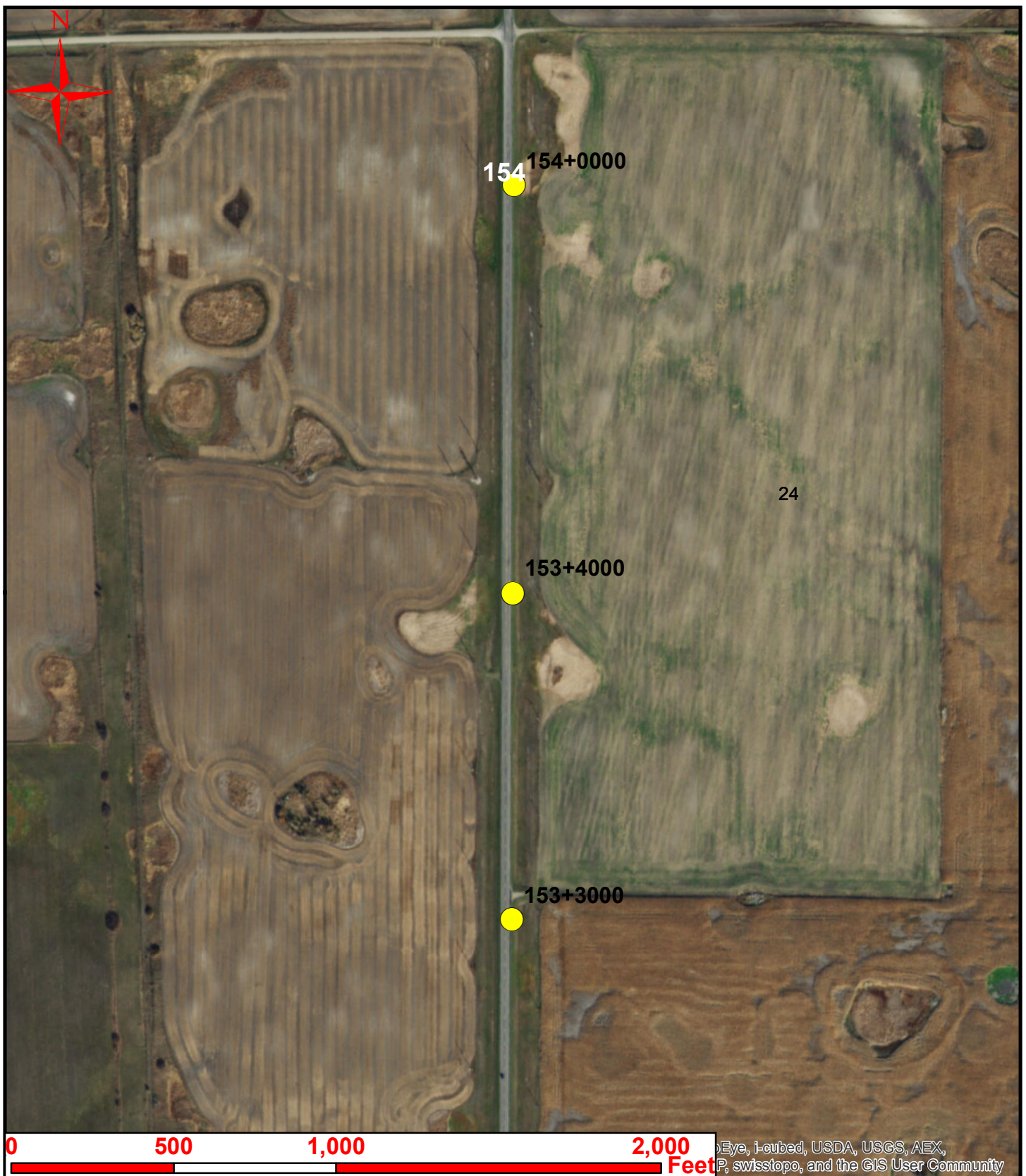
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- Reference Points



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- Boring Locations
- Reference Points



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- Boring Locations
- Reference Points



Legend

- Boring Locations
- Reference Points

APPENDIX D

SUMMARY OF SOILS ANALYSIS

Project No.: NH-3-281(130)148

PCN: 21506

Swell Potential: Low Marginal High

Moisture Content: Below PL 0-5% Over PL >5% Over PL

Color Key

Group Index: GI≤20 GI>20

Ave. In-Place: MC < 0 ≤ MC < 6% 6 ≤ MC < 10% 10 ≤ MC < 16% MC > 16%

Moisture Content Opt. Over opt. Over opt. Over opt. 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)																							Frost Class
										2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
942	149+1060	Rt 8 NB	0.4-5	20.0	A-7-6(10)	10	13.0	22	16.8	11.3	18.1	22.2	15.7																				F3
943	149+2000	Rt 8 NB	0.4-5	20.2	A-6(8)	8	12.6	20	19.8	18.4	16.6	21.4	22.7																				F3
944	149+3000	Rt 8 NB	0.8-5	19.8	A-7-6(18)	18	12.6	24	20.4	23.2	20.3	18.8	19.1																				F3
945	149+4000	Rt 8 NB	0.5-5	17.4	A-4(0)	0	9.6	9	14.4	13.5	16.2	12.2	15.7																				F3
946	150+0000	Rt 8 NB	0.5-5	17.6	A-4(0)	0	9.9	6	13.4	11.8	14.7	16.3	11.0																				F3
947	150+1000	Rt 8 NB	0.7-5	20.5	A-4(0)	0	12.3	6	13.0	12.4	12.6	14.2	12.6																				F3
948	150+2000	Rt 8 NB	0.8-5	17.7	A-6(0)	0	10.2	11	20.0	22.7	21.0	16.4	19.8																				F3
949	150+3000	Rt 8 NB	0.9-5	18.5	A-6(7)	7	11.3	19	17.8	9.6	17.4	23.9	20.2																				F3
950	150+4000	Rt 8 NB	0.9-5	21.6	A-6(7)	7	12.2	16	20.5	13.1	20.9	22.9	25.0																				F3
951	151+0000	Rt 8 NB	0.9-5	22.0	A-6(8)	8	13.2	16	26.3	22.1	30.3	29.1	23.8																				F3
952	151+1000	Rt 8 NB	0.9-5	21.4	A-6(10)	10	13.6	18	26.2	24.8	27.7	30.7	21.5																				F3
953	151+2000	Rt 8 NB	0.9-5	25.7	A-7-6(12)	12	15.5	18	27.8	26.0	33.0	26.5	25.9																				F3
954	151+3000	Rt 8 NB	0.7-5	20.0	A-6(9)	9	12.4	18	21.2	7.8	23.0	27.1	27.1																				F3

Project No.: NH-3-281(130)148

PCN: 21506

Swell Potential: Low Marginal High

Moisture Content: Below PL 0-5% Over PL >5% Over PL

Color Key

Group Index: GI≤20 GI>20

Ave. In-Place: MC < Opt. 0 ≤ MC < 6% 6 ≤ MC < 10% 10 ≤ MC < 16% MC > 16%
Moisture Content Over opt. Over opt. Over opt. 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)																							Frost Class
										2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
955	151+4000	Rt 8 NB	0.8-5	16.1	A-6(11)	11	10.6	18	18.5	14.6	19.0	22.1	18.2																				F3
956	152+0000	Rt 8 NB	0.7-5	22.1	A-7-6(10)	10	13.5	19	23.0	22.9	27.0	18.5	23.5																				F3
957	152+1000	Rt 8 NB	0.8-5	20.4	A-7-6(11)	11	14.2	20	22.4	18.2	26.3	21.1	23.9																				F3
958	152+2000	Rt 8 NB	0.9-5	23.3	A-7-6(14)	14	15.5	21	28.3	19.6	34.3	37.2	22.0																				F3
959	152+3000	Rt 8 NB	0.9-5	18.6	A-6(13)	13	12.8	22	20.3	17.6	16.3	28.6	18.8																				F3
960	152+4000	Rt 8 NB	0.8-5	21.1	A-7-6(14)	14	15.2	23	28.3	20.6	31.4	26.6	34.5																				F3
961	153+0000	Rt 8 NB	0.8-5	24.0	A-7-6(15)	15	15.8	22	21.8	12.4	17.7	30.7	26.3																				F3
962	153+1000	Rt 8 NB	0.8-5	18.3	A-6(12)	12	12.7	20	19.6	17.9	27.1	14.5	18.8																				F3
963	153+2000	Rt 8 NB	0.8-5	19.8	A-7-6(14)	14	14.7	21	23.4	16.3	17.3	28.1	31.9																				F3
964	153+3000	Rt 8 NB	0.9-5	17.6	A-6(8)	8	11.8	18	22.2	15.0	24.5	23.2	26.0																				F3
965	153+4000	Rt 8 NB	0.7-5	20.7	A-6(9)	9	12.9	18	22.5	10.2	24.7	27.9	27.2																				F3
966	154+0000	Rt 8 NB	0.9-5	19.6	A-6(7)	7	11.7	18	21.2	18.2	22.3	23.1	21.3																				F3
967	154+1000	Rt 8 NB	0.8-5	22.6	A-7-6(13)	13	14.3	20	22.1	12.0	12.6	44.3	19.6																				F3

Project No.: NH-3-281(130)148

PCN: 21506

Swell Potential: Low Marginal High

Moisture Content: Below PL 0-5% Over PL >5% Over PL

Color Key

Group Index: GI≤20 GI>20

Ave. In-Place: MC < 0 ≤ MC < 6% 6 ≤ MC < 10% 10 ≤ MC < 16% MC > 16%
Moisture Content Opt. Over opt. Over opt. Over opt. 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)																Frost Class						
										2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17		18	19	20	21	22	23
968	154+2000	Rt 8 NB	0.8-5	20.6	A-6(7)	7	12.1	15	20.0	6.6	25.8	21.1	26.5																			F3
969	154+3000	Rt 8 NB	1-5	17.5	A-6(6)	6	11.4	15	19.4	16.7	21.3	19.6	19.8																			F3
970	154+4000	Rt 8 NB	0.8-5	19.6	A-7-6(19)	19	13.7	24	27.9	20.1	32.0	27.0	32.5																			F3

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-43-2016	Date Reported	8/30/2016	District	Devils Lake
County	BENSON	Submitted By	Naumann	Project Number	NH-3-281(130)148
		AASHTO Test Method	T-180	PCN	21506

Comments

Lab Number	942	943	944	945
Reference Pt + Feet	149+1060	149+2000	149+3000	149+4000
Distance From CenterLine (Ft.)	Rt 8 NB	Rt 8 NB	Rt 8 NB	Rt 8 NB
Depth, Ft.	0.4 - 5.0	0.4 - 5.0	0.8 - 5.0	0.5 - 5.0
Field Sample No.	942	943	944	945
% Pass. 3/8" Sieve	98	98	100	98
% Pass. No. 4 Sieve	96	96	99	96
% Pass. No. 10 Sieve	87	90	95	91
% Coarse Sand (-No. 10 + No. 40)	11	17	5	13
% Fine Sand (-No. 40 + No. 200)	17	18	13	39
% Silt (0.074 - 0.005 mm)	30	28	43	25
% Clay (-0.005 mm)	30	27	34	14
Liquid Limit (-No. 40)	42	40	44	26
Plasticity Index (-No. 40)	22	20	24	9
Plastic Limit	20	20	20	17
Soil Color	BRN/BLK	BRN/GRY/BLK	BRN/GRY/BLK	BRN/GRY/BLK
Textural Class	CLY LM	CLY LM	CLY	SNDY LM
Soil Class (AASHTO M-145)	A-7-6(10)	A-6(8)	A-7-6(18)	A-4(0)
Frost Class	F3	F3	F3	F3
Optimum Moisture (%)	13.0	12.6	12.6	9.6
Maximum Dry Density (pcf)	117.8	119.2	120.5	127.1
% Organic Content				
Depth (Ft.) Moisture (%)	2 11.3	2 18.4	2 23.2	2 13.5
	3 18.1	3 16.6	3 20.3	3 16.2
	4 22.2	4 21.4	4 18.8	4 12.2
	5 15.7	5 22.7	5 19.1	5 15.7
Avg. Moisture of Sample Depth	16.8	19.8	20.4	14.4

Linear Laboratory Analysis

Department of Transportation, Materials and Research Division

300 Airport Road, Bismarck ND 58504 (701) 328-6900

Report Number	SS-43-2016	Date Reported	8/30/2016	District	Devils Lake
County	BENSON	Submitted By	Naumann	Project Number	NH-3-281(130)148
		AASHTO Test Method	T-180	PCN	21506

Comments

Lab Number	946	947	948	949
Reference Pt + Feet	150+0000	150+1000	150+2000	150+3000
Distance From CenterLine (Ft.)	Rt 8 NB	Rt 8 NB	Rt 8 NB	Rt 8 NB
Depth, Ft.	0.5 - 5.0	0.7 - 5.0	0.8 - 5.0	0.9 - 5.0
Field Sample No.	946	947	948	949
% Pass. 3/8" Sieve	96	97	99	96
% Pass. No. 4 Sieve	95	96	96	93
% Pass. No. 10 Sieve	93	95	90	87
% Coarse Sand (-No. 10 + No. 40)	10	4	17	12
% Fine Sand (-No. 40 + No. 200)	42	43	37	20
% Silt (0.074 - 0.005 mm)	26	33	24	33
% Clay (-0.005 mm)	14	15	12	23
Liquid Limit (-No. 40)	24	26	29	37
Plasticity Index (-No. 40)	6	6	11	19
Plastic Limit	18	21	18	19
Soil Color	BRN/GRY	BRN	BRN/BLK	BRN/GRY/BLK
Textural Class	SNDY LM	SNDY LM	SNDY LM	CLY LM
Soil Class (AASHTO M-145)	A-4(0)	A-4(0)	A-6(0)	A-6(7)
Frost Class	F3	F3	F3	F3
Optimum Moisture (%)	9.9	12.3	10.2	11.3
Maximum Dry Density (pcf)	127.3	124.1	123.2	122.9
% Organic Content				
Depth (Ft.) Moisture (%)	2 11.8	2 12.4	2 22.7	2 9.6
	3 14.7	3 12.6	3 21.0	3 17.4
	4 16.3	4 14.2	4 16.4	4 23.9
	5 11.0	5 12.6	5 19.8	5 20.2
Avg. Moisture of Sample Depth	13.4	13.0	20.0	17.8

Linear Laboratory Analysis

Department of Transportation, Materials and Research Division

300 Airport Road, Bismarck ND 58504 (701) 328-6900

Report Number	SS-43-2016	Date Reported	8/30/2016	District	Devils Lake
County	BENSON	Submitted By	Naumann	Project Number	NH-3-281(130)148
		AASHTO Test Method	T-180	PCN	21506

Comments

Lab Number	950	951	952	953
Reference Pt + Feet	150+4000	151+0000	151+1000	151+2000
Distance From CenterLine (Ft.)	Rt 8 NB	Rt 8 NB	Rt 8 NB	Rt 8 NB
Depth, Ft.	0.9 - 5.0	0.9 - 5.0	0.9 - 5.0	0.9 - 5.0
Field Sample No.	950	951	952	953
% Pass. 3/8" Sieve	99	98	99	98
% Pass. No. 4 Sieve	97	96	96	96
% Pass. No. 10 Sieve	91	91	92	94
% Coarse Sand (-No. 10 + No. 40)	13	13	11	8
% Fine Sand (-No. 40 + No. 200)	20	19	19	15
% Silt (0.074 - 0.005 mm)	31	35	39	43
% Clay (-0.005 mm)	27	25	24	28
Liquid Limit (-No. 40)	38	39	40	43
Plasticity Index (-No. 40)	16	17	18	18
Plastic Limit	22	22	21	26
Soil Color	BRN/GRY/BLK	BRN/GRY/BLK	BRN/GRY/BLK	BRN/GRY/BLK
Textural Class	CLY LM	CLY LM	CLY LM	CLY LM
Soil Class (AASHTO M-145)	A-6(7)	A-6(8)	A-6(10)	A-7-6(12)
Frost Class	F3	F3	F3	F3
Optimum Moisture (%)	12.2	13.2	13.6	15.5
Maximum Dry Density (pcf)	119.4	114.9	116.5	109.9
% Organic Content				
Depth (Ft.) Moisture (%)	2 -4.3	2 22.1	2 24.8	2 26.0
	3 20.9	3 30.3	3 27.7	3 135.4
	4 22.9	4 29.1	4 30.7	4 26.5
	5 25.0	5 23.8	5 21.5	5 25.9
Avg. Moisture of Sample Depth	20.5	26.3	26.2	53.4

Linear Laboratory Analysis

Department of Transportation, Materials and Research Division

300 Airport Road, Bismarck ND 58504 (701) 328-6900

Report Number	SS-43-2016	Date Reported	8/30/2016	District	Devils Lake
County	BENSON	Submitted By	Naumann	Project Number	NH-3-281(130)148
		AASHTO Test Method	T-180	PCN	21506

Comments

Lab Number	954	955	956	957
Reference Pt + Feet	151+3000	151+4000	152+0000	152+1000
Distance From CenterLine (Ft.)	Rt 8 NB	Rt 8 NB	Rt 8 NB	Rt 8 NB
Depth, Ft.	0.7 - 5.0	0.8 - 5.0	0.7 - 5.0	0.8 - 5.0
Field Sample No.	954	955	956	957
% Pass. 3/8" Sieve	96	96	96	92
% Pass. No. 4 Sieve	95	94	93	90
% Pass. No. 10 Sieve	91	90	88	87
% Coarse Sand (-No. 10 + No. 40)	10	7	10	8
% Fine Sand (-No. 40 + No. 200)	18	12	16	14
% Silt (0.074 - 0.005 mm)	36	44	37	37
% Clay (-0.005 mm)	27	28	26	28
Liquid Limit (-No. 40)	38	34	41	41
Plasticity Index (-No. 40)	18	18	19	21
Plastic Limit	20	16	22	20
Soil Color	BLK/GRY	BRN	BRN/GRY/BLK	BRN/GRY/BLK
Textural Class	CLY LM	CLY LM	CLY LM	CLY LM
Soil Class (AASHTO M-145)	A-6(9)	A-6(11)	A-7-6(10)	A-7-6(11)
Frost Class	F3	F3	F3	F3
Optimum Moisture (%)	12.4	10.6	13.5	14.2
Maximum Dry Density (pcf)	120.5	125.8	116.6	115.7
% Organic Content				
Depth (Ft.) Moisture (%)	2 7.8	2 14.6	2 22.9	2 18.2
	3 23.0	3 19.0	3 27.0	3 26.3
	4 27.1	4 22.1	4 18.5	4 21.1
	5 27.1	5 18.2	5 23.5	5 23.9
Avg. Moisture of Sample Depth	21.3	18.5	23.0	22.4

Linear Laboratory Analysis

Department of Transportation, Materials and Research Division

300 Airport Road, Bismarck ND 58504 (701) 328-6900

Report Number	SS-43-2016	Date Reported	8/30/2016	District	Devils Lake
County	BENSON	Submitted By	Naumann	Project Number	NH-3-281(130)148
		AASHTO Test Method	T-180	PCN	21506

Comments

Lab Number	958	959	960	961
Reference Pt + Feet	152+2000	152+3000	152+4000	153+0000
Distance From CenterLine (Ft.)	Rt 8 NB	Rt 8 NB	Rt 8 NB	Rt 8 NB
Depth, Ft.	0.9 - 5.0	0.9 - 5.0	0.8 - 5.0	0.8 - 5.0
Field Sample No.	958	959	960	961
% Pass. 3/8" Sieve	99	100	100	98
% Pass. No. 4 Sieve	96	98	98	96
% Pass. No. 10 Sieve	89	93	93	92
% Coarse Sand (-No. 10 + No. 40)	7	9	10	9
% Fine Sand (-No. 40 + No. 200)	12	18	15	13
% Silt (0.074 - 0.005 mm)	46	33	36	39
% Clay (-0.005 mm)	25	34	32	31
Liquid Limit (-No. 40)	44	41	44	46
Plasticity Index (-No. 40)	21	22	23	22
Plastic Limit	23	19	21	24
Soil Color	BRN/GRY/BLK	BRN/GRY/BLK	BRN/GRY/BLK	BRN
Textural Class	CLY LM	CLY	CLY	CLY
Soil Class (AASHTO M-145)	A-7-6(14)	A-6(13)	A-7-6(14)	A-7-6(15)
Frost Class	F3	F3	F3	F3
Optimum Moisture (%)	15.5	12.8	15.2	15.8
Maximum Dry Density (pcf)	112.4	120.7	110.8	112.5
% Organic Content				
Depth (Ft.) Moisture (%)	2 19.6	2 17.6	2 20.6	2 12.4
	3 34.3	3 16.3	3 31.4	3 17.7
	4 37.2	4 28.6	4 26.6	4 30.7
	5 22.0	5 18.8	5 34.5	5 26.3
Avg. Moisture of Sample Depth	28.3	20.4	28.3	21.7

Linear Laboratory Analysis

Department of Transportation, Materials and Research Division

300 Airport Road, Bismarck ND 58504 (701) 328-6900

Report Number	SS-43-2016	Date Reported	8/30/2016	District	Devils Lake
County	BENSON	Submitted By	Naumann	Project Number	NH-3-281(130)148
		AASHTO Test Method	T-180	PCN	21506

Comments

Lab Number	962	963	964	965
Reference Pt + Feet	153+1000	153+2000	153+3000	153+4000
Distance From CenterLine (Ft.)	Rt 8 NB	Rt 8 NB	Rt 8 NB	Rt 8 NB
Depth, Ft.	0.8 - 5.0	0.8 - 5.0	0.9 - 5.0	0.7 - 5.0
Field Sample No.	962	963	964	965
% Pass. 3/8" Sieve	95	99	96	97
% Pass. No. 4 Sieve	94	98	94	95
% Pass. No. 10 Sieve	91	94	90	87
% Coarse Sand (-No. 10 + No. 40)	7	7	10	8
% Fine Sand (-No. 40 + No. 200)	16	14	21	17
% Silt (0.074 - 0.005 mm)	37	40	34	36
% Clay (-0.005 mm)	31	33	25	26
Liquid Limit (-No. 40)	38	41	36	39
Plasticity Index (-No. 40)	20	21	19	18
Plastic Limit	18	20	18	21
Soil Color	BRN/GRY/BLK	BRN/GRY/BLK	BRN/GRY/BLK	BRN/GRY/BLK
Textural Class	CLY	CLY	CLY LM	CLY LM
Soil Class (AASHTO M-145)	A-6(12)	A-7-6(14)	A-6(8)	A-6(9)
Frost Class	F3	F3	F3	F3
Optimum Moisture (%)	12.7	14.7	11.8	12.9
Maximum Dry Density (pcf)	121.0	114.7	122.9	118.8
% Organic Content				
Depth (Ft.) Moisture (%)	2 17.9	2 16.3	2 15.0	2 10.2
	3 27.1	3 17.3	3 24.5	3 24.7
	4 14.5	4 28.1	4 23.2	4 27.9
	5 18.8	5 31.9	5 26.0	5 27.2
Avg. Moisture of Sample Depth	19.5	23.4	22.2	22.6

Linear Laboratory Analysis

Department of Transportation, Materials and Research Division

300 Airport Road, Bismarck ND 58504 (701) 328-6900

Report Number	SS-43-2016	Date Reported	8/30/2016	District	Devils Lake
County	BENSON	Submitted By	Naumann	Project Number	NH-3-281(130)148
		AASHTO Test Method	T-180	PCN	21506

Comments

Lab Number	966	967	968	969
Reference Pt + Feet	154+0000	154+1000	154+2000	154+3000
Distance From CenterLine (Ft.)	Rt 8 NB	Rt 8 NB	Rt 8 NB	Rt 8 NB
Depth, Ft.	0.9 - 5.0	0.8 - 5.0	0.8 - 5.0	1.0 - 5.0
Field Sample No.	966	967	968	969
% Pass. 3/8" Sieve	99	97	99	98
% Pass. No. 4 Sieve	96	96	98	97
% Pass. No. 10 Sieve	90	90	93	92
% Coarse Sand (-No. 10 + No. 40)	12	7	10	11
% Fine Sand (-No. 40 + No. 200)	23	15	22	20
% Silt (0.074 - 0.005 mm)	32	42	37	39
% Clay (-0.005 mm)	23	28	24	22
Liquid Limit (-No. 40)	37	42	36	32
Plasticity Index (-No. 40)	18	20	15	15
Plastic Limit	20	23	21	18
Soil Color	BRN/GRY/BLK	BRN/GRY/BLK	BRN	BRN
Textural Class	CLY LM	CLY LM	CLY LM	CLY LM
Soil Class (AASHTO M-145)	A-6(7)	A-7-6(13)	A-6(7)	A-6(6)
Frost Class	F3	F3	F3	F3
Optimum Moisture (%)	11.7	14.3	12.1	11.4
Maximum Dry Density (pcf)	122.3	114.1	119.9	123.1
% Organic Content				
Depth (Ft.) Moisture (%)	2 18.2	2 12.0	2 6.6	2 16.7
	3 22.3	3 12.6	3 25.8	3 21.3
	4 23.1	4 44.3	4 21.1	4 19.6
	5 21.3	5 19.6	5 26.5	5 19.8
Avg. Moisture of Sample Depth	21.2	22.1	20.0	19.4

Linear Laboratory Analysis

Department of Transportation, Materials and Research Division

300 Airport Road, Bismarck ND 58504 (701) 328-6900

Report Number	SS-43-2016	Date Reported	8/30/2016	District	Devils Lake
County	BENSON	Submitted By	Naumann	Project Number	NH-3-281(130)148
		AASHTO Test Method	T-180	PCN	21506

Comments

Lab Number	970		
Reference Pt + Feet	154+4000		
Distance From CenterLine (Ft.)	Rt 8 NB		
Depth, Ft.	0.8 - 5.0		
Field Sample No.	970		
% Pass. 3/8" Sieve	100		
% Pass. No. 4 Sieve	99		
% Pass. No. 10 Sieve	96		
% Coarse Sand (-No. 10 + No. 40)	5		
% Fine Sand (-No. 40 + No. 200)	12		
% Silt (0.074 - 0.005 mm)	43		
% Clay (-0.005 mm)	37		
Liquid Limit (-No. 40)	43		
Plasticity Index (-No. 40)	24		
Plastic Limit	20		
Soil Color	BRN/GRY/BLK		
Textural Class	CLY		
Soil Class (AASHTO M-145)	A-7-6(19)		
Frost Class	F3		
Optimum Moisture (%)	13.7		
Maximum Dry Density (pcf)	116.6		
% Organic Content			
Depth (Ft.) Moisture (%)	2		20.1
	3		32.0
	4		27.0
	5		32.5
Avg. Moisture of Sample Depth	27.9		

MOISTURE-DENSITY RELATIONS OF SOILS

North Dakota Department Of Transportation, Materials & Research Division

SFN 10063 (Rev. 03-2006)

Project No. NH-3-281(130)148	PCN	Station	Depth Below Grade
Offset From Centerline		Type of Soil	
AASHTO Designation T-180	Date 12/1/2016	942	

Density	Test Count	4				
Determination No.	1	2	3	4	5	6
A Volume of Mold cu. ft.	0.0333	0.0333	0.0333	0.0333	0.0333	0.0333
lbs.	8.57	8.76	8.86	8.87		
C Weight of Mold lbs.	4.41	4.41	4.41	4.41	4.41	4.41
D Weight of Compacted Soil = B - C lbs.	4.15	4.35	4.45	4.45		
E Wet Density = D / A lbs./cu.ft.	124.7	130.7	133.7	133.8		
F Dry Density = (E x 100) / (100 + L) lbs./cu.ft.	113.6	117.1	117.3	116.1	#VALUE!	#VALUE!

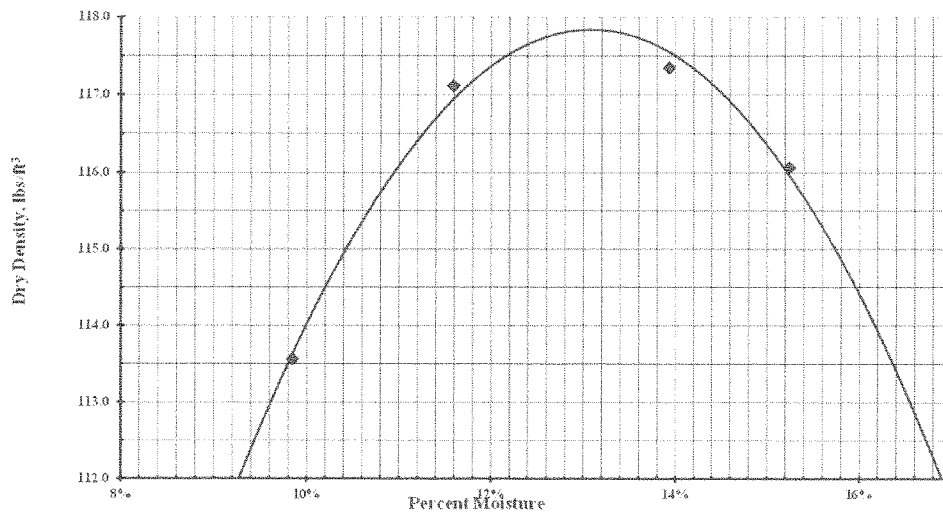
Moisture Content

AASHTO T99 or T180 Tested by:

Container No.	52	53	54	55		
G Wet Weight / Container grams	152.2	150.7	147.4	153.8		
H Dry Weight / Container grams	141.9	138.9	133.9	138.3		
I Moisture Loss = G - H grams	10.3	11.8	13.5	15.5		
J Tare Weight of Container grams	37.3	37.1	37.0	36.6		
K Dry Soil = H - J grams	104.6	101.8	96.9	101.7		
L %Moisture = (I / K) x 100	9.8%	11.6%	13.9%	15.2%		

ASTM D4643 AASHTO T217 or T265 Tested by: ss

Moisture Density Relationship



Max Dry Density

117.8 lbs./cu.ft.

Optimum Moisture

13.0%

MOISTURE-DENSITY RELATIONS OF SOILS

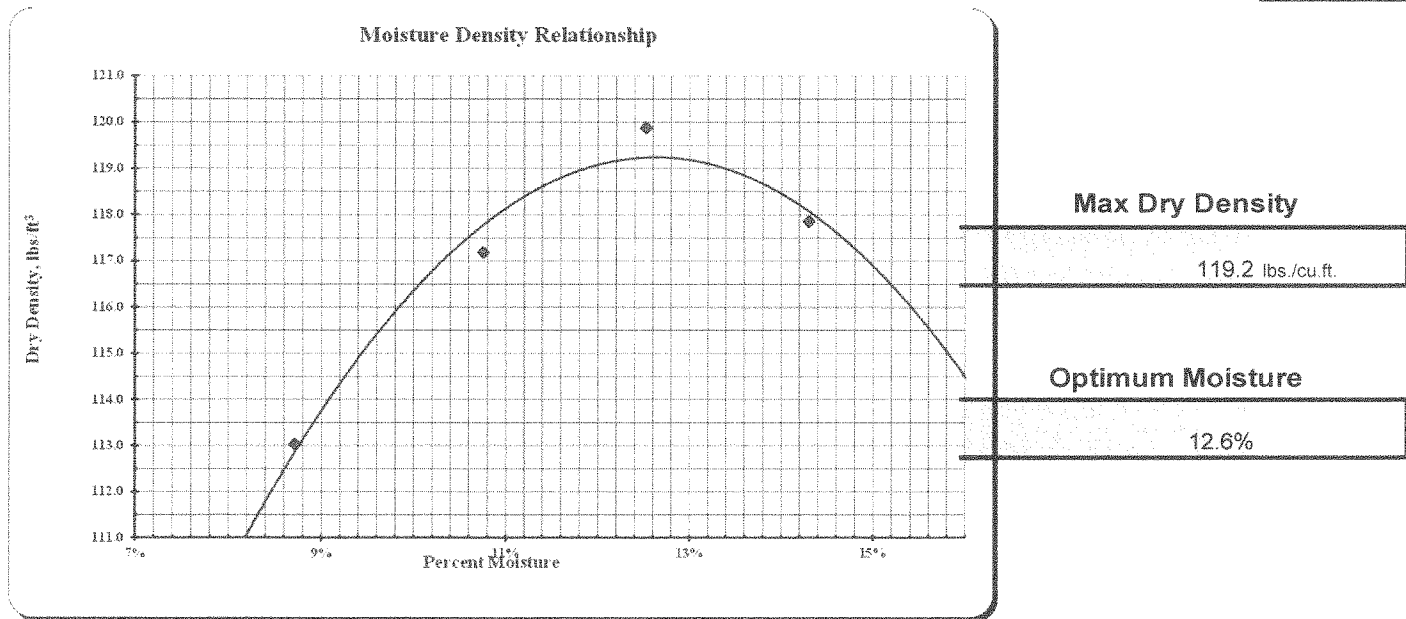
North Dakota Department Of Transportation, Materials & Research Division

SFN 10063 (Rev. 03-2006)

Project No. NH-3-281(130)148		PCN		Station		Depth Below Grade	
Offset From Centerline				Type of Soil			
AASHTO Designation T-180		Date 12/1/2016				943	
Density		Test Count		4			
Determination No.		1		2		3	
A Volume of Mold		cu. ft.		0.0333		0.0333	
		lbs.		8.50		8.73	
C Weight of Mold		lbs.		4.41		4.41	
D Weight of Compacted Soil = B - C		lbs.		4.09		4.32	
E Wet Density = D / A		lbs./cu.ft.		122.9		129.8	
F Dry Density = (E x 100) / (100 + L)		lbs./cu.ft.		113.0		117.2	

Moisture Content		AASHTO T99 or T180 Tested by:			
Container No.		56		57	
G Wet Weight / Container		grams		155.8	
H Dry Weight / Container		grams		146.3	
I Moisture Loss = G - H		grams		9.5	
J Tare Weight of Container		grams		37.3	
K Dry Soil = H - J		grams		109.0	
L %Moisture = (I / K) x 100		%		8.7%	

ASTM D4643 AASHTO T217 or T265 Tested by: ss



MOISTURE-DENSITY RELATIONS OF SOILS

North Dakota Department Of Transportation, Materials & Research Division

SFN 10063 (Rev. 03-2006)

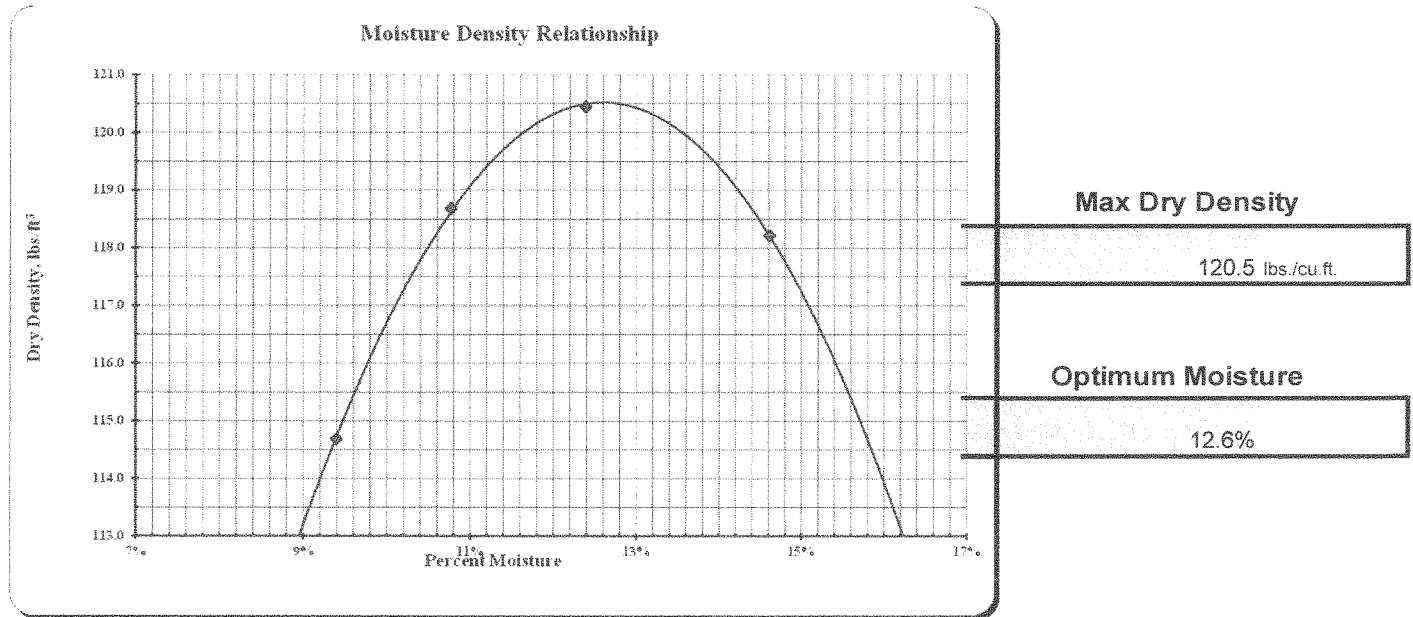
Project No. NH-3-281(130)148		PCN		Station		Depth Below Grade	
Offset From Centerline				Type of Soil			
AASHTO Designation T-180		Date 12/5/2016				944	
Density		Test Count		4			
Determination No.		1		2		3	
A Volume of Mold		cu. ft.		0.0333		0.0333	
		lbs.		8.59		8.79	
C Weight of Mold		lbs.		4.41		4.41	
D Weight of Compacted Soil = B - C		lbs.		4.18		4.38	
E Wet Density = D / A		lbs./cu.ft.		125.5		131.5	
F Dry Density = (E x 100) / (100 + L)		lbs./cu.ft.		114.7		118.7	

Moisture Content

AASHTO T99 or T180 Tested by:

Container No.		85	86	87	88		
G Wet Weight / Container	grams	149.6	148.7	151.8	147.6		
H Dry Weight / Container	grams	140.0	137.9	139.2	133.6		
I Moisture Loss = G - H	grams	9.6	10.8	12.6	14.0		
J Tare Weight of Container	grams	37.8	37.6	37.5	37.8		
K Dry Soil = H - J	grams	102.2	100.3	101.7	95.8		
L %Moisture = (I / K) x 100	%	9.4%	10.8%	12.4%	14.6%		

ASTM D4643 AASHTO T217 or T265 Tested by: ss



MOISTURE-DENSITY RELATIONS OF SOILS

North Dakota Department Of Transportation, Materials & Research Division

SFN 10063 (Rev. 03-2006)

Project No. NH-3-281(130)148	PCN	Station	Depth Below Grade
Offset From Centerline		Type of Soil	
AASHTO Designation T-180	Date 12/5/2016	945	

Density		Test Count					
		3					
Determination No.		1	2	3	4	5	6
A	Volume of Mold	cu. ft.	0.0333	0.0333	0.0333	0.0333	0.0333
		lbs.	8.78	9.02	9.05		
C	Weight of Mold	lbs.	4.41	4.41	4.41	4.41	4.41
D	Weight of Compacted Soil = B - C	lbs.	4.36	4.61	4.63		
E	Wet Density = D / A	lbs./cu.ft.	131.1	138.6	139.2		
F	Dry Density = (E x 100) / (100 + L)	lbs./cu.ft.	122.4	127.0	125.3	#VALUE!	#VALUE!

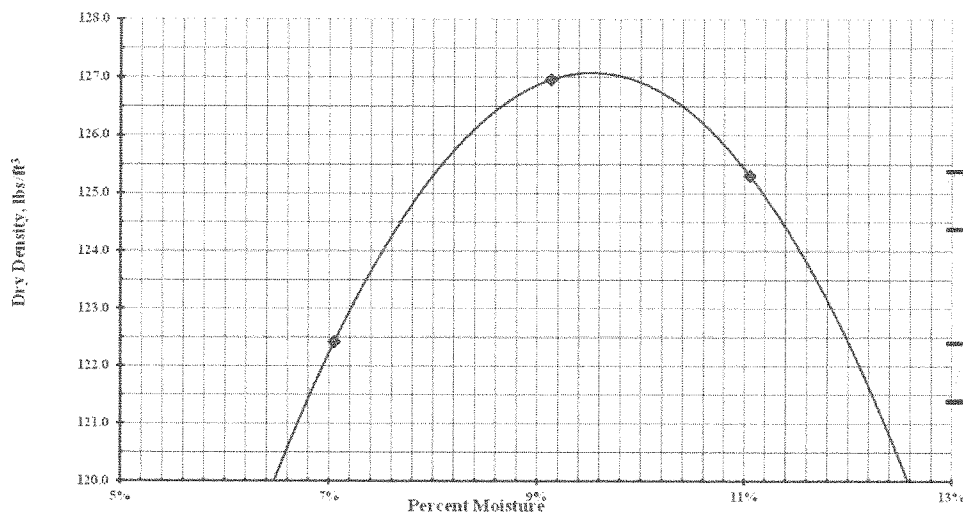
Moisture Content

AASHTO T99 or T180 Tested by:

Container No.		89	90	91			
G	Wet Weight / Container	grams	153.0	151.4	162.2		
H	Dry Weight / Container	grams	145.4	141.9	149.8		
I	Moisture Loss = G - H	grams	7.6	9.5	12.4		
J	Tare Weight of Container	grams	37.6	37.9	37.6		
K	Dry Soil = H - J	grams	107.8	104.0	112.2		
L	%Moisture = (I / K) x 100	%	7.1%	9.1%	11.1%		

ASTM D4643 AASHTO T217 or T265 Tested by: ss

Moisture Density Relationship



Max Dry Density

127.1 lbs./cu.ft.

Optimum Moisture

9.6%

MOISTURE-DENSITY RELATIONS OF SOILS

North Dakota Department Of Transportation, Materials & Research Division

SFN 10063 (Rev. 03-2006)

Project No. NH-3-281(130)148	PCN	Station	Depth Below Grade
Offset From Centerline		Type of Soil	
AASHTO Designation T-180	Date 12/5/2016	946	

Density		Test Count		4			
Determination No.		1	2	3	4	5	6
A	Volume of Mold	cu. ft.	0.0333	0.0333	0.0333	0.0333	0.0333
		lbs.	8.67	8.93	9.08	9.07	
C	Weight of Mold	lbs.	4.41	4.41	4.41	4.41	4.41
D	Weight of Compacted Soil = B - C	lbs.	4.26	4.52	4.67	4.66	
E	Wet Density = D / A	lbs./cu.ft.	127.9	135.9	140.2	139.9	
F	Dry Density = (E x 100) / (100 + L)	lbs./cu.ft.	120.4	125.6	127.4	124.9	#VALUE!

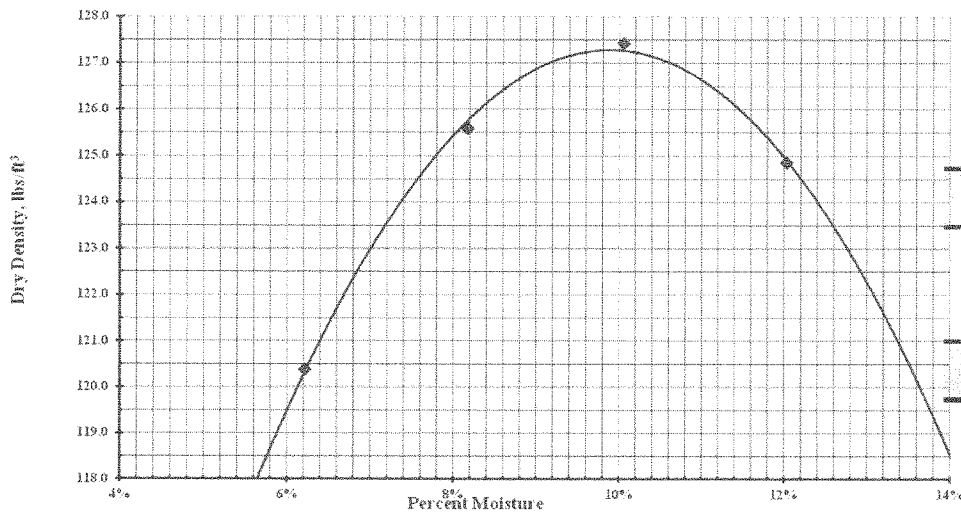
Moisture Content

AASHTO T99 or T180 Tested by:

Container No.		92	93	94	95		
G	Wet Weight / Container	grams	158.7	158.1	155.9	153.9	
H	Dry Weight / Container	grams	151.6	149.0	145.1	141.4	
I	Moisture Loss = G - H	grams	7.1	9.1	10.8	12.5	
J	Tare Weight of Container	grams	37.4	37.6	37.7	37.5	
K	Dry Soil = H - J	grams	114.2	111.4	107.4	103.9	
L	%Moisture = (I / K) x 100	%	6.2%	8.2%	10.1%	12.0%	

ASTM D4643 AASHTO T217 or T265 Tested by: ss

Moisture Density Relationship



Max Dry Density

127.3 lbs./cu.ft.

Optimum Moisture

9.9%

MOISTURE-DENSITY RELATIONS OF SOILS

North Dakota Department Of Transportation, Materials & Research Division

SFN 10063 (Rev. 03-2006)

Project No. NH-3-281(130)148	PCN	Station	Depth Below Grade
Offset From Centerline		Type of Soil	
AASHTO Designation T-180	Date 12/5/2016	947	

Density		Test Count					
		4					
Determination No.		1	2	3	4	5	6
A	Volume of Mold	cu. ft.	0.0333	0.0333	0.0333	0.0333	0.0333
		lbs.	8.44	8.65	8.90	9.01	
C	Weight of Mold	lbs.	4.41	4.41	4.41	4.41	4.41
D	Weight of Compacted Soil = B - C	lbs.	4.02	4.24	4.49	4.60	
E	Wet Density = D / A	lbs./cu.ft.	120.8	127.3	134.7	138.0	
F	Dry Density = (E x 100) / (100 + L)	lbs./cu.ft.	114.1	118.1	122.9	123.7	#VALUE!

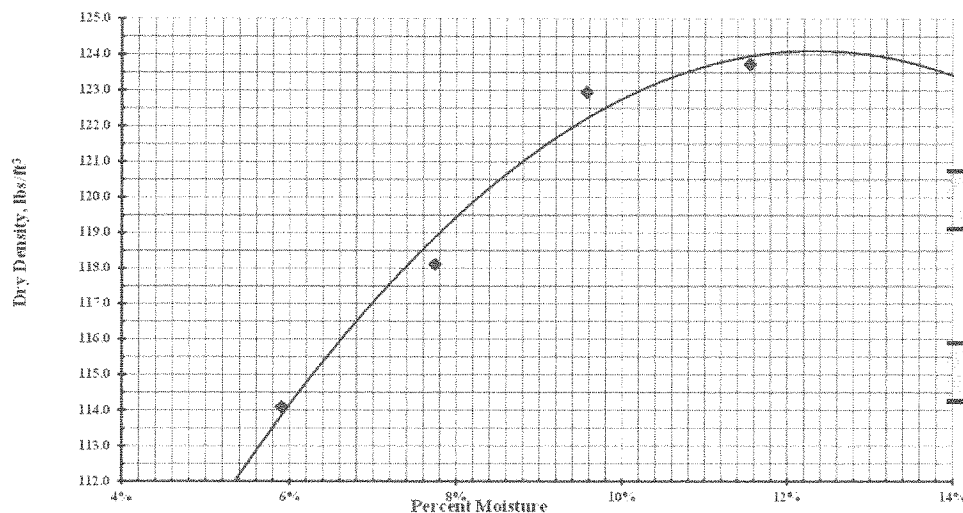
Moisture Content

AASHTO T99 or T180 Tested by:

Container No.		96	97	98	99		
G	Wet Weight / Container	grams	157.4	157.4	153.1	156.4	
H	Dry Weight / Container	grams	150.7	148.8	143.0	144.1	
I	Moisture Loss = G - H	grams	6.7	8.6	10.1	12.3	
J	Tare Weight of Container	grams	37.2	37.7	37.5	37.6	
K	Dry Soil = H - J	grams	113.5	111.1	105.5	106.5	
L	%Moisture = (I / K) x 100	%	5.9%	7.7%	9.6%	11.5%	

ASTM D4643 AASHTO T217 or T265 Tested by: ss

Moisture Density Relationship



Max Dry Density

124.1 lbs./cu.ft.

Optimum Moisture

12.3%

MOISTURE-DENSITY RELATIONS OF SOILS

North Dakota Department Of Transportation, Materials & Research Division

SFN 10063 (Rev. 03-2006)

Project No. NH-3-281(130)148	PCN	Station	Depth Below Grade
Offset From Centerline		Type of Soil	
AASHTO Designation T-180	Date 12/5/2016	948	

Density		Test Count					
		4					
Determination No.		1	2	3	4	5	6
A	Volume of Mold	cu. ft.	0.0333	0.0333	0.0333	0.0333	0.0333
		lbs.	8.54	8.75	8.96	8.92	
C	Weight of Mold	lbs.	4.41	4.41	4.41	4.41	4.41
D	Weight of Compacted Soil = B - C	lbs.	4.12	4.34	4.55	4.51	
E	Wet Density = D / A	lbs./cu.ft.	123.8	130.4	136.6	135.4	
F	Dry Density = (E x 100) / (100 + L)	lbs./cu.ft.	116.2	120.4	123.8	120.7	#VALUE!

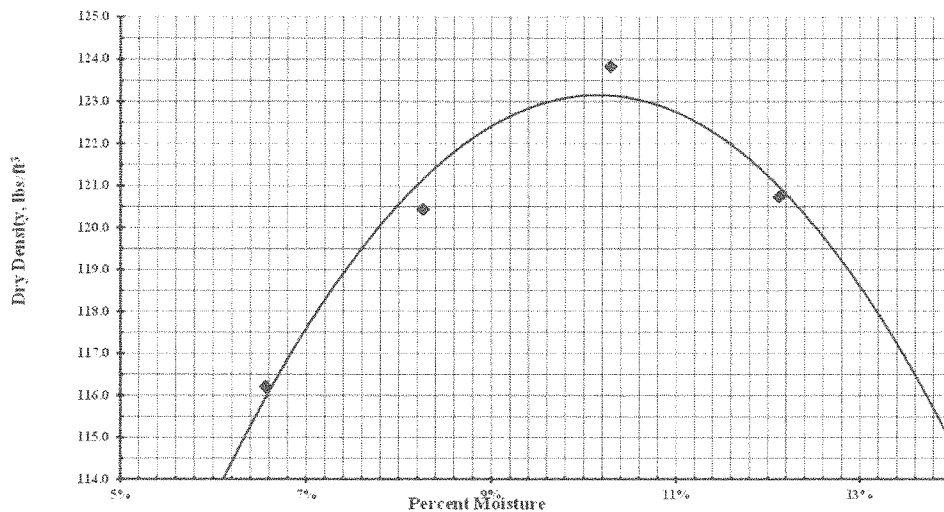
Moisture Content

AASHTO T99 or T180 Tested by:

Container No.		1	2	3	4		
G	Wet Weight / Container	grams	153.5	150.0	159.3	151.4	
H	Dry Weight / Container	grams	146.3	141.4	147.9	139.0	
I	Moisture Loss = G - H	grams	7.2	8.6	11.4	12.4	
J	Tare Weight of Container	grams	36.6	37.3	37.1	36.7	
K	Dry Soil = H - J	grams	109.7	104.1	110.8	102.3	
L	%Moisture = (I / K) x 100	%	6.6%	8.3%	10.3%	12.1%	

ASTM D4643 AASHTO T217 or T265 Tested by: ss

Moisture Density Relationship



Max Dry Density

123.2 lbs./cu.ft.

Optimum Moisture

10.2%

MOISTURE-DENSITY RELATIONS OF SOILS

North Dakota Department Of Transportation, Materials & Research Division

SFN 10063 (Rev. 03-2006)

Project No. NH-3-281(130)148	PCN	Station	Depth Below Grade			
Offset From Centerline		Type of Soil				
AASTHO Designation T-180	Date 12/5/2016			949		
Density	Test Count	4				
Determination No.	1	2	3	4	5	6
A Volume of Mold	cu. ft.	0.0333	0.0333	0.0333	0.0333	0.0333
	lbs.	8.67	8.90	9.00	8.88	
C Weight of Mold	lbs.	4.41	4.41	4.41	4.41	4.41
D Weight of Compacted Soil = B - C	lbs.	4.26	4.49	4.59	4.47	
E Wet Density = D / A	lbs./cu.ft.	127.8	134.8	137.7	134.2	
F Dry Density = (E x 100) / (100 + L)	lbs./cu.ft.	117.9	122.1	122.7	117.5	#VALUE!

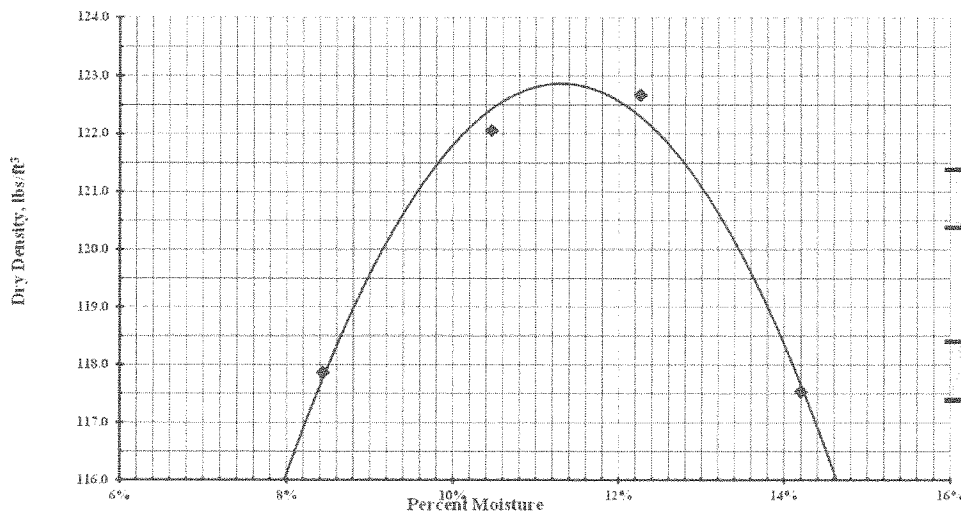
Moisture Content

AASHTO T99 or T180 Tested by:

Container No.	5	6	7	8		
G Wet Weight / Container	grams	155.4	149.0	149.8	152.0	
H Dry Weight / Container	grams	146.2	138.4	137.4	137.7	
I Moisture Loss = G - H	grams	9.2	10.6	12.4	14.3	
J Tare Weight of Container	grams	37.1	37.1	36.3	37.0	
K Dry Soil = H - J	grams	109.1	101.3	101.1	100.7	
L %Moisture = (I / K) x 100	%	8.4%	10.5%	12.3%	14.2%	

ASTM D4643 AASHTO T217 or T265 Tested by: ss

Moisture Density Relationship



Max Dry Density

122.9 lbs./cu.ft.

Optimum Moisture

11.3%

MOISTURE-DENSITY RELATIONS OF SOILS

North Dakota Department Of Transportation, Materials & Research Division

SFN 10063 (Rev. 03-2006)

Project No. NH-3-281(130)148		PCN		Station		Depth Below Grade	
Offset From Centerline				Type of Soil			
ASTHO Designation T-180		Date 12/5/2016				950	
Density		Test Count		4			
Determination No.		1		2		3	
A Volume of Mold		cu. ft.		0.0333		0.0333	
		lbs.		8.57		8.75	
C Weight of Mold		lbs.		4.41		4.41	
D Weight of Compacted Soil = B - C		lbs.		4.16		4.34	
E Wet Density = D / A		lbs./cu.ft.		125.0		130.5	
F Dry Density = (E x 100) / (100 + L)		lbs./cu.ft.		114.5		118.0	

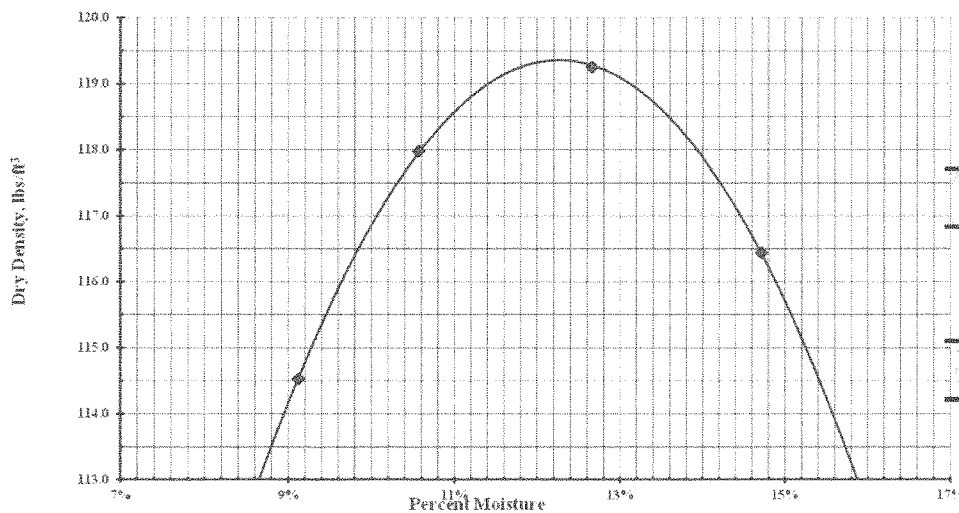
Moisture Content

AASHTO T99 or T180 Tested by:

Container No.		9	10	11	12		
G Wet Weight / Container	grams	158.0	156.0	151.1	152.3		
H Dry Weight / Container	grams	147.9	144.6	138.3	137.5		
I Moisture Loss = G - H	grams	10.1	11.4	12.8	14.8		
J Tare Weight of Container	grams	37.2	36.7	37.2	36.9		
K Dry Soil = H - J	grams	110.7	107.9	101.1	100.6		
L %Moisture = (I / K) x 100	%	9.1%	10.6%	12.7%	14.7%		

ASTM D4643 AASHTO T217 or T265 Tested by: ss

Moisture Density Relationship



Max Dry Density

119.4 lbs./cu.ft.

Optimum Moisture

12.2%

MOISTURE-DENSITY RELATIONS OF SOILS

North Dakota Department Of Transportation, Materials & Research Division

SFN 10063 (Rev. 03-2006)

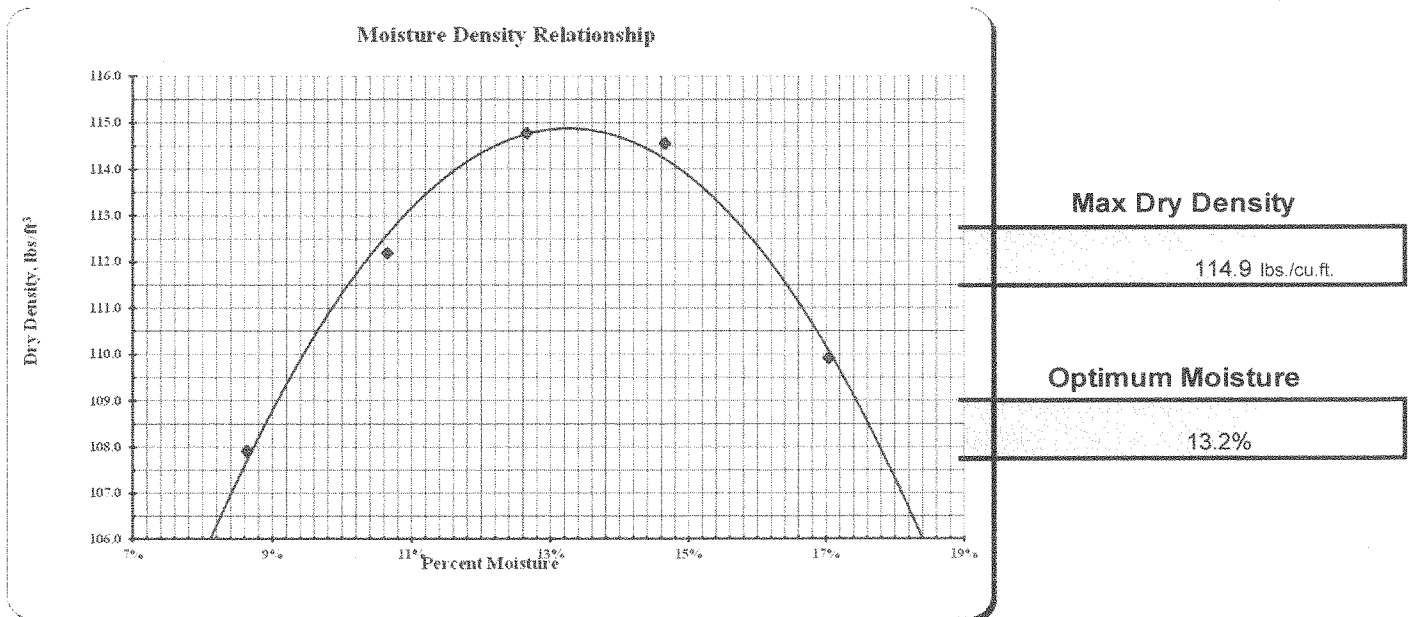
Project No. NH-3-281(130)148	PCN	Station	Depth Below Grade				
Offset From Centerline		Type of Soil					
AASHTO Designation T-180	Date 12/5/2016	951					
Density	Test Count	5					
Determination No.	1	2	3	4	5	6	
A Volume of Mold cu. ft.	0.0333	0.0333	0.0333	0.0333	0.0333	0.0333	
lbs.	8.32	8.54	8.72	8.79	8.70		
C Weight of Mold lbs.	4.41	4.41	4.41	4.41	4.41	4.41	
D Weight of Compacted Soil = B - C lbs.	3.90	4.13	4.31	4.37	4.28		
E Wet Density = D / A lbs./cu.ft.	117.2	124.1	129.3	131.4	128.6		
F Dry Density = (E x 100) / (100 + L) lbs./cu.ft.	107.9	112.2	114.8	114.6	109.9	#VALUE!	

Moisture Content

AASHTO T99 or T180 Tested by:

Container No.		13	14	15	16	17	
G Wet Weight / Container	grams	159.1	155.3	161.0	151.4	151.5	
H Dry Weight / Container	grams	149.4	144.0	147.1	136.8	134.8	
I Moisture Loss = G - H	grams	9.7	11.3	13.9	14.6	16.7	
J Tare Weight of Container	grams	37.1	37.9	37.3	37.2	36.8	
K Dry Soil = H - J	grams	112.3	106.1	109.8	99.6	98.0	
L %Moisture = (I / K) x 100	%	8.6%	10.7%	12.7%	14.7%	17.0%	

ASTM D4643 AASHTO T217 or T265 Tested by: ss



MOISTURE-DENSITY RELATIONS OF SOILS

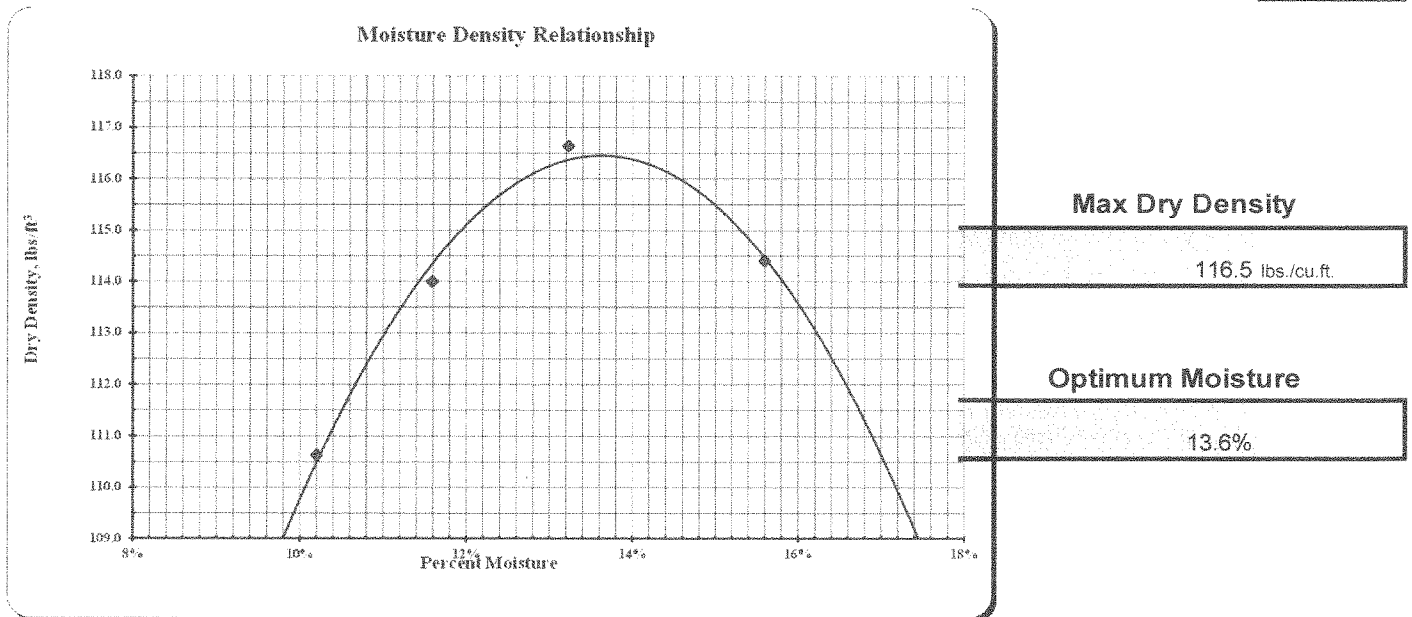
North Dakota Department Of Transportation, Materials & Research Division

SFN 10063 (Rev. 03-2006)

Project No. NH-3-281(130)148		PCN		Station		Depth Below Grade	
Offset From Centerline				Type of Soil			
AASHTO Designation T-180		Date 12/5/2016				952	
Density		Test Count		4			
Determination No.		1		2		3	
A Volume of Mold		cu. ft.		0.0333		0.0333	
		lbs.		8.47		8.65	
C Weight of Mold		lbs.		4.41		4.41	
D Weight of Compacted Soil = B - C		lbs.		4.06		4.24	
E Wet Density = D / A		lbs./cu.ft.		121.9		127.2	
F Dry Density = (E x 100) / (100 + L)		lbs./cu.ft.		110.6		114.0	

Moisture Content		AASHTO T99 or T180 Tested by:					
Container No.		18		47		48	
G Wet Weight / Container		grams		154.4		156.4	
H Dry Weight / Container		grams		143.5		144.0	
I Moisture Loss = G - H		grams		10.9		12.4	
J Tare Weight of Container		grams		37.1		37.0	
K Dry Soil = H - J		grams		106.4		107.0	
L %Moisture = (I / K) x 100		%		10.2%		11.6%	

ASTM D4643 AASHTO T217 or T265 Tested by: ss



MOISTURE-DENSITY RELATIONS OF SOILS

North Dakota Department Of Transportation, Materials & Research Division

SFN 10063 (Rev. 03-2006)

Project No. NH-3-281(130)148	PCN	Station	Depth Below Grade
Offset From Centerline		Type of Soil	
AASHTO Designation T-180	Date 12/8/2016	953	

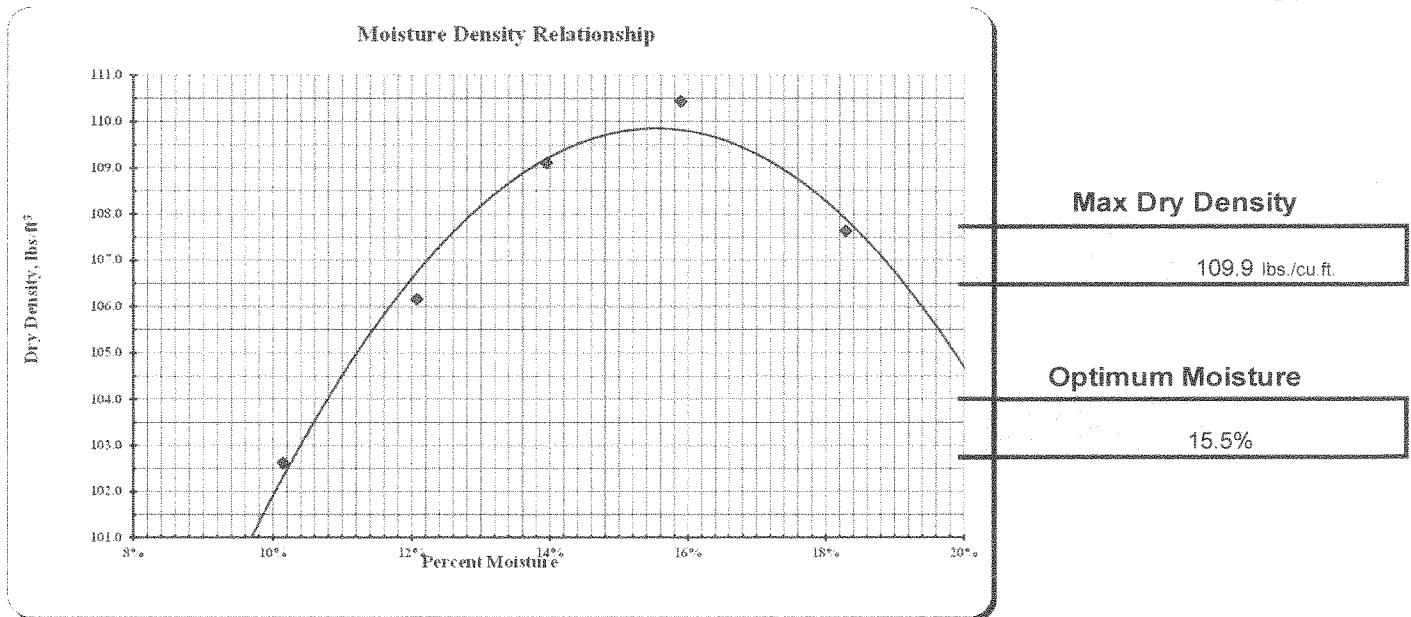
Density		Test Count					
		5					
Determination No.		1	2	3	4	5	6
A	Volume of Mold	cu. ft.	0.0333	0.0333	0.0333	0.0333	0.0333
		lbs.	8.17	8.37	8.55	8.67	8.65
C	Weight of Mold	lbs.	4.41	4.41	4.41	4.41	4.41
D	Weight of Compacted Soil = B - C	lbs.	3.76	3.96	4.14	4.26	4.24
E	Wet Density = D / A	lbs./cu.ft.	113.0	119.0	124.3	128.0	127.3
F	Dry Density = (E x 100) / (100 + L)	lbs./cu.ft.	102.6	106.2	109.1	110.4	107.6
							#VALUE!

Moisture Content

AASHTO T99 or T180 Tested by:

Container No.		50	51	52	53	54	
G	Wet Weight / Container	grams	152.1	155.1	153.3	154.5	147.6
H	Dry Weight / Container	grams	141.5	142.4	139.1	138.4	130.5
I	Moisture Loss = G - H	grams	10.6	12.7	14.2	16.1	17.1
J	Tare Weight of Container	grams	37.0	37.2	37.3	37.1	37.0
K	Dry Soil = H - J	grams	104.5	105.2	101.8	101.3	93.5
L	%Moisture = (I / K) x 100	%	10.1%	12.1%	13.9%	15.9%	18.3%

ASTM D4643 AASHTO T217 or T265 Tested by: ss



MOISTURE-DENSITY RELATIONS OF SOILS

North Dakota Department Of Transportation, Materials & Research Division

SFN 10063 (Rev. 03-2006)

Project No. NH-3-281(130)148	PCN	Station	Depth Below Grade
Offset From Centerline		Type of Soil	
AASHTO Designation T-180	Date 12/8/2016	954	

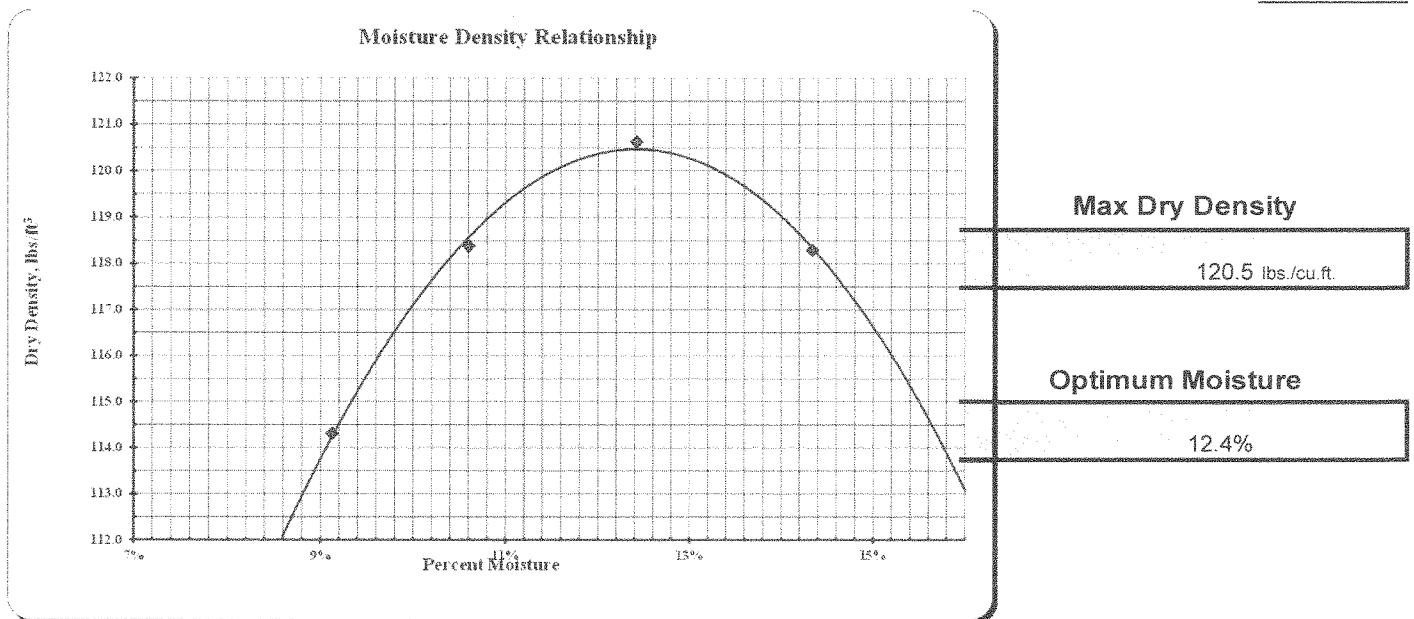
Density		Test Count					
		4					
Determination No.		1	2	3	4	5	6
A	Volume of Mold	cu. ft.	0.0333	0.0333	0.0333	0.0333	0.0333
		lbs.	8.56	8.77	8.93	8.91	
C	Weight of Mold	lbs.	4.41	4.41	4.41	4.41	4.41
D	Weight of Compacted Soil = B - C	lbs.	4.15	4.36	4.52	4.50	
E	Wet Density = D / A	lbs./cu.ft.	124.7	130.9	135.6	135.3	
F	Dry Density = (E x 100) / (100 + L)	lbs./cu.ft.	114.3	118.4	120.6	118.3	#VALUE!

Moisture Content

AASHTO T99 or T180 Tested by:

Container No.		55	56	57	58		
G	Wet Weight / Container	grams	150.2	147.9	147.7	158.0	
H	Dry Weight / Container	grams	140.7	137.3	135.5	142.8	
I	Moisture Loss = G - H	grams	9.5	10.6	12.2	15.2	
J	Tare Weight of Container	grams	36.6	37.3	37.3	36.8	
K	Dry Soil = H - J	grams	104.1	100.0	98.2	106.0	
L	%Moisture = (I / K) x 100	%	9.1%	10.6%	12.4%	14.3%	

ASTM D4643 AASHTO T217 or T265 Tested by: ss



MOISTURE-DENSITY RELATIONS OF SOILS

North Dakota Department Of Transportation, Materials & Research Division

SFN 10063 (Rev. 03-2006)

Project No. NH-3-281(130)148		PCN		Station		Depth Below Grade	
Offset From Centerline				Type of Soil			
AASHTO Designation T-180		Date 12/8/2016				955	
Density		Test Count		4			
Determination No.		1		2		3	
A Volume of Mold		cu. ft.		0.0333		0.0333	
		lbs.		8.77		8.99	
C Weight of Mold		lbs.		4.41		4.41	
D Weight of Compacted Soil = B - C		lbs.		4.36		4.58	
E Wet Density = D / A		lbs./cu.ft.		131.0		137.4	
F Dry Density = (E x 100) / (100 + L)		lbs./cu.ft.		121.7		125.1	

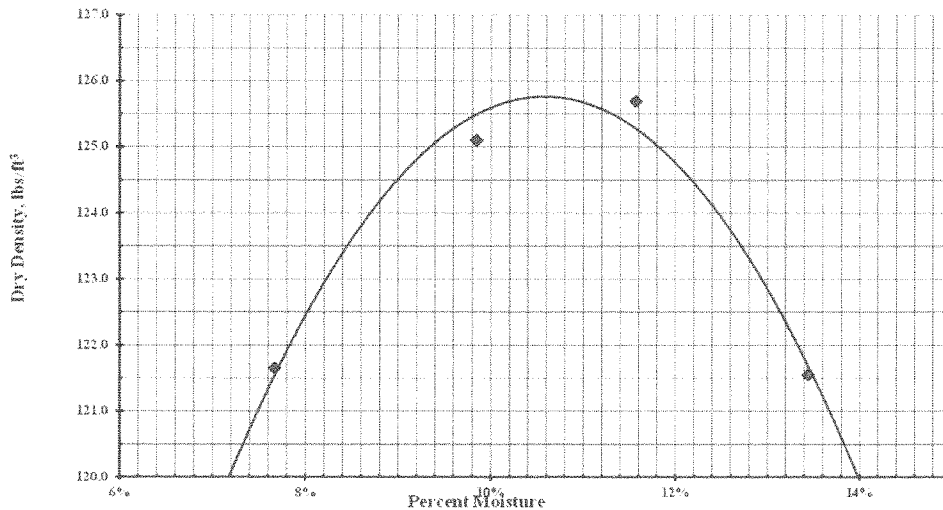
Moisture Content

AASHTO T99 or T180 Tested by:

Container No.	59	60	61	62		
G Wet Weight / Container	grams	157.9	156.8	155.9	154.9	
H Dry Weight / Container	grams	149.3	146.1	143.6	141.0	
I Moisture Loss = G - H	grams	8.6	10.7	12.3	13.9	
J Tare Weight of Container	grams	37.2	37.4	37.3	37.6	
K Dry Soil = H - J	grams	112.1	108.7	106.3	103.4	
L %Moisture = (I / K) x 100	%	7.7%	9.8%	11.6%	13.4%	

ASTM D4643 AASHTO T217 or T265 Tested by: ss

Moisture Density Relationship



Max Dry Density

125.8 lbs./cu.ft.

Optimum Moisture

10.6%

MOISTURE-DENSITY RELATIONS OF SOILS

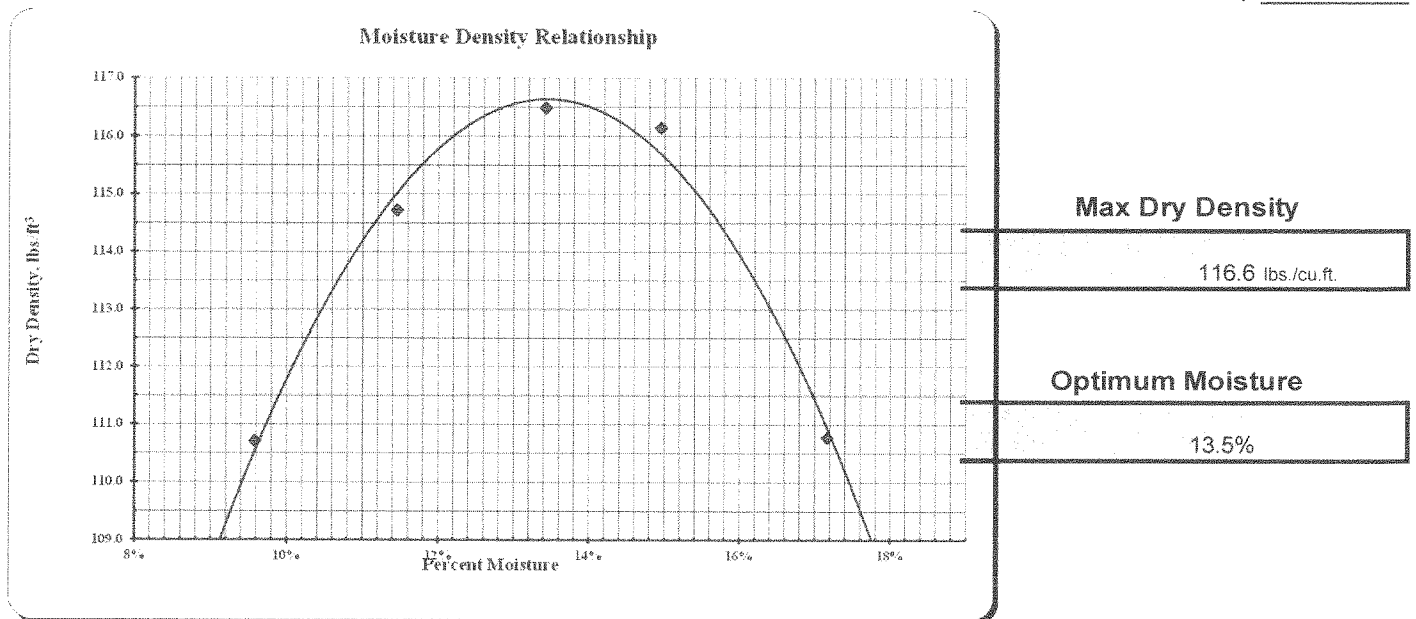
North Dakota Department Of Transportation, Materials & Research Division

SFN 10063 (Rev. 03-2006)

Project No. NH-3-281(130)148		PCN		Station		Depth Below Grade	
Offset From Centerline				Type of Soil			
ASTHO Designation T-180		Date 12/8/2016				956	
Density		Test Count		5			
Determination No.		1		2		3	
A Volume of Mold		cu. ft.		0.0333		0.0333	
		lbs.		8.45		8.67	
C Weight of Mold		lbs.		4.41		4.41	
D Weight of Compacted Soil = B - C		lbs.		4.04		4.26	
E Wet Density = D / A		lbs./cu.ft.		121.3		127.9	
F Dry Density = (E x 100) / (100 + L)		lbs./cu.ft.		110.7		114.7	

Moisture Content		AASHTO T99 or T180 Tested by:					
Container No.		63	64	65	66	67	
G Wet Weight / Container	grams	148.2	156.0	149.3	153.8	151.2	
H Dry Weight / Container	grams	138.5	143.8	136.1	138.7	134.5	
I Moisture Loss = G - H	grams	9.7	12.2	13.2	15.1	16.7	
J Tare Weight of Container	grams	37.3	37.3	37.8	37.7	37.2	
K Dry Soil = H - J	grams	101.2	106.5	98.3	101.0	97.3	
L %Moisture = (I / K) x 100	%	9.6%	11.5%	13.4%	15.0%	17.2%	

ASTM D4643 AASHTO T217 or T265 Tested by: ss



MOISTURE-DENSITY RELATIONS OF SOILS

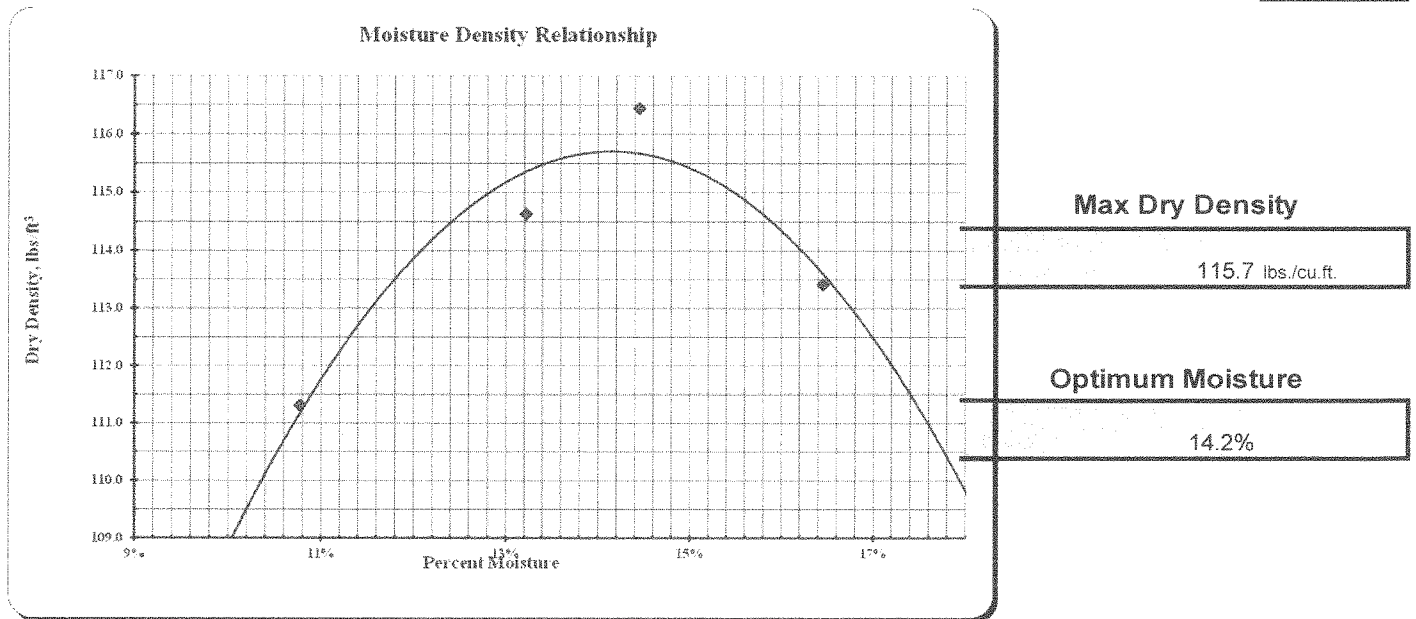
North Dakota Department Of Transportation, Materials & Research Division

SFN 10063 (Rev. 03-2006)

Project No. NH-3-281(130)148		PCN		Station		Depth Below Grade	
Offset From Centerline				Type of Soil			
AASHTO Designation T-180		Date 12/8/2016				957	
Density		Test Count		4			
Determination No.		1		2		3	
A Volume of Mold		cu. ft.		0.0333		0.0333	
		lbs.		8.52		8.73	
C Weight of Mold		lbs.		4.41		4.41	
D Weight of Compacted Soil = B - C		lbs.		4.11		4.32	
E Wet Density = D / A		lbs./cu.ft.		123.3		129.8	
F Dry Density = (E x 100) / (100 + L)		lbs./cu.ft.		111.3		114.6	

Moisture Content		AASHTO T99 or T180 Tested by:					
Container No.		68	69	70	71		
G Wet Weight / Container	grams	157.3	155.9	157.2	154.7		
H Dry Weight / Container	grams	145.6	142.1	142.1	138.1		
I Moisture Loss = G - H	grams	11.7	13.8	15.1	16.6		
J Tare Weight of Container	grams	37.0	37.7	37.6	37.2		
K Dry Soil = H - J	grams	108.6	104.4	104.5	100.9		
L %Moisture = (I / K) x 100	%	10.8%	13.2%	14.4%	16.5%		

ASTM D4643 AASHTO T217 or T265 Tested by: ss



MOISTURE-DENSITY RELATIONS OF SOILS

North Dakota Department Of Transportation, Materials & Research Division

SFN 10063 (Rev. 03-2006)

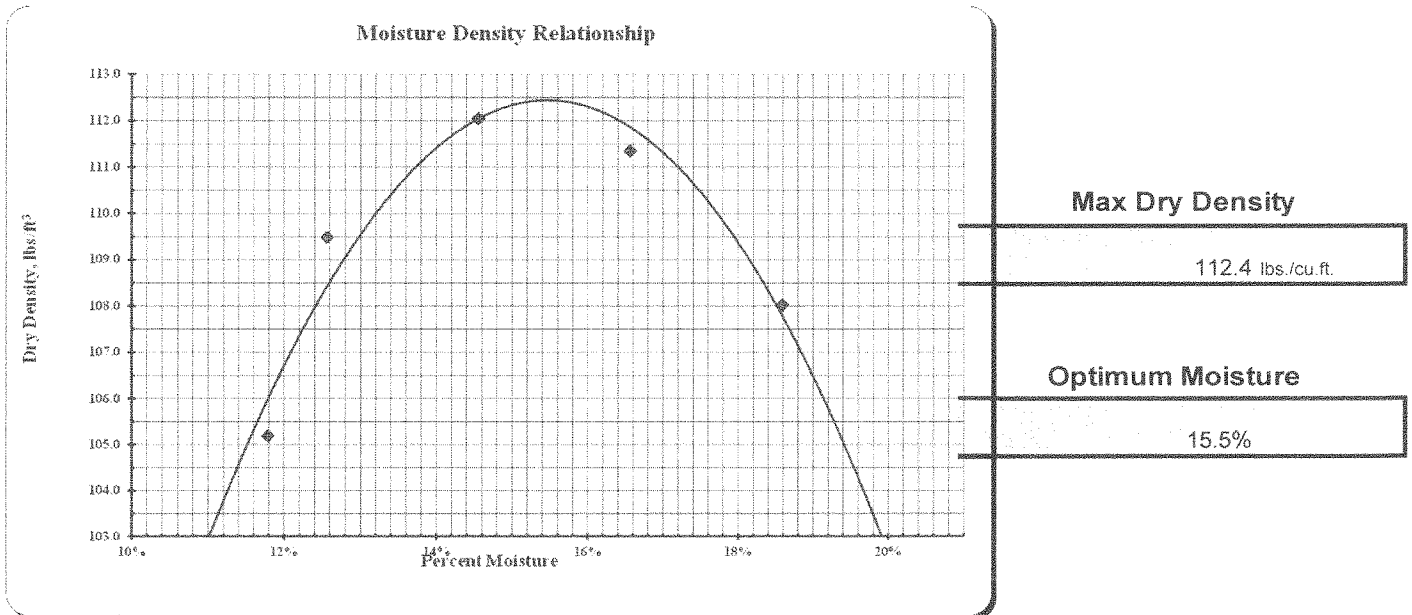
Project No. NH-3-281(130)148		PCN		Station		Depth Below Grade	
Offset From Centerline				Type of Soil			
ASTHO Designation T-180		Date 12/12/2016				958	
Density		Test Count		5			
Determination No.		1		2		3	
A Volume of Mold		cu. ft.		0.0333		0.0333	
		lbs.		8.32		8.51	
C Weight of Mold		lbs.		4.41		4.41	
D Weight of Compacted Soil = B - C		lbs.		3.92		4.10	
E Wet Density = D / A		lbs./cu.ft.		117.6		123.2	
F Dry Density = (E x 100) / (100 + L)		lbs./cu.ft.		105.2		109.5	

Moisture Content

AASHTO T99 or T180 Tested by:

Container No.		1	2	3	4	5
G Wet Weight / Container	grams	152.3	152.9	155.2	147.9	148.1
H Dry Weight / Container	grams	140.1	140.0	140.2	132.1	130.7
I Moisture Loss = G - H	grams	12.2	12.9	15.0	15.8	17.4
J Tare Weight of Container	grams	36.6	37.3	37.1	36.7	37.1
K Dry Soil = H - J	grams	103.5	102.7	103.1	95.4	93.6
L %Moisture = (I / K) x 100	%	11.8%	12.6%	14.5%	16.6%	18.6%

ASTM D4643 AASHTO T217 or T265 Tested by: ss



MOISTURE-DENSITY RELATIONS OF SOILS

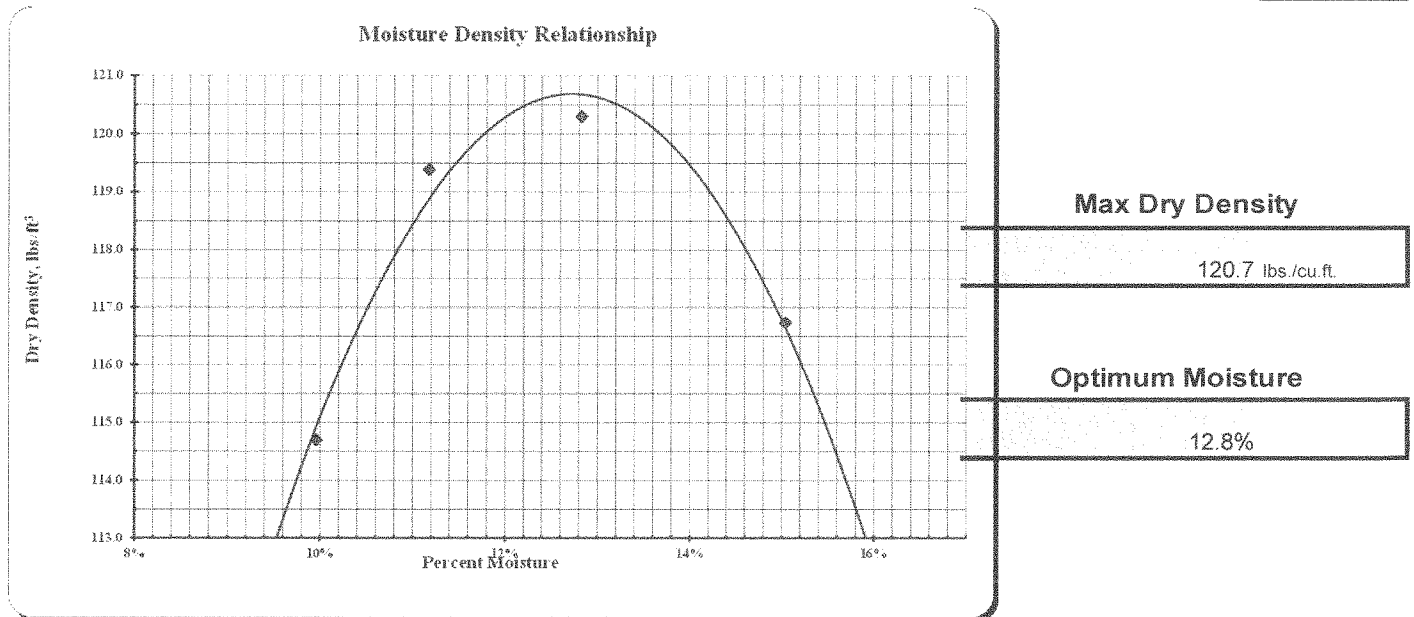
North Dakota Department Of Transportation, Materials & Research Division

SFN 10063 (Rev. 03-2006)

Project No. NH-3-281(130)148		PCN		Station		Depth Below Grade	
Offset From Centerline				Type of Soil			
AASHTO Designation T-180		Date 12/12/2016				959	
Density		Test Count		4			
Determination No.		1		2		3	
A Volume of Mold		cu. ft.		0.0333		0.0333	
		lbs.		8.61		8.83	
C Weight of Mold		lbs.		4.41		4.41	
D Weight of Compacted Soil = B - C		lbs.		4.20		4.42	
E Wet Density = D / A		lbs./cu.ft.		126.1		132.7	
F Dry Density = (E x 100) / (100 + L)		lbs./cu.ft.		114.7		119.4	

Moisture Content		AASHTO T99 or T180 Tested by:					
Container No.		6		7		8	
G Wet Weight / Container		grams		149.7		151.7	
H Dry Weight / Container		grams		139.5		140.1	
I Moisture Loss = G - H		grams		10.2		11.6	
J Tare Weight of Container		grams		37.1		36.3	
K Dry Soil = H - J		grams		102.4		103.8	
L %Moisture = (I / K) x 100		%		10.0%		11.2%	

ASTM D4643 AASHTO T217 or T265 Tested by: ss



MOISTURE-DENSITY RELATIONS OF SOILS

North Dakota Department Of Transportation, Materials & Research Division

SFN 10063 (Rev. 03-2006)

Project No. NH-3-281(130)148	PCN	Station	Depth Below Grade
Offset From Centerline	Type of Soil		
AASHTO Designation T-180	Date 12/12/2016	960	

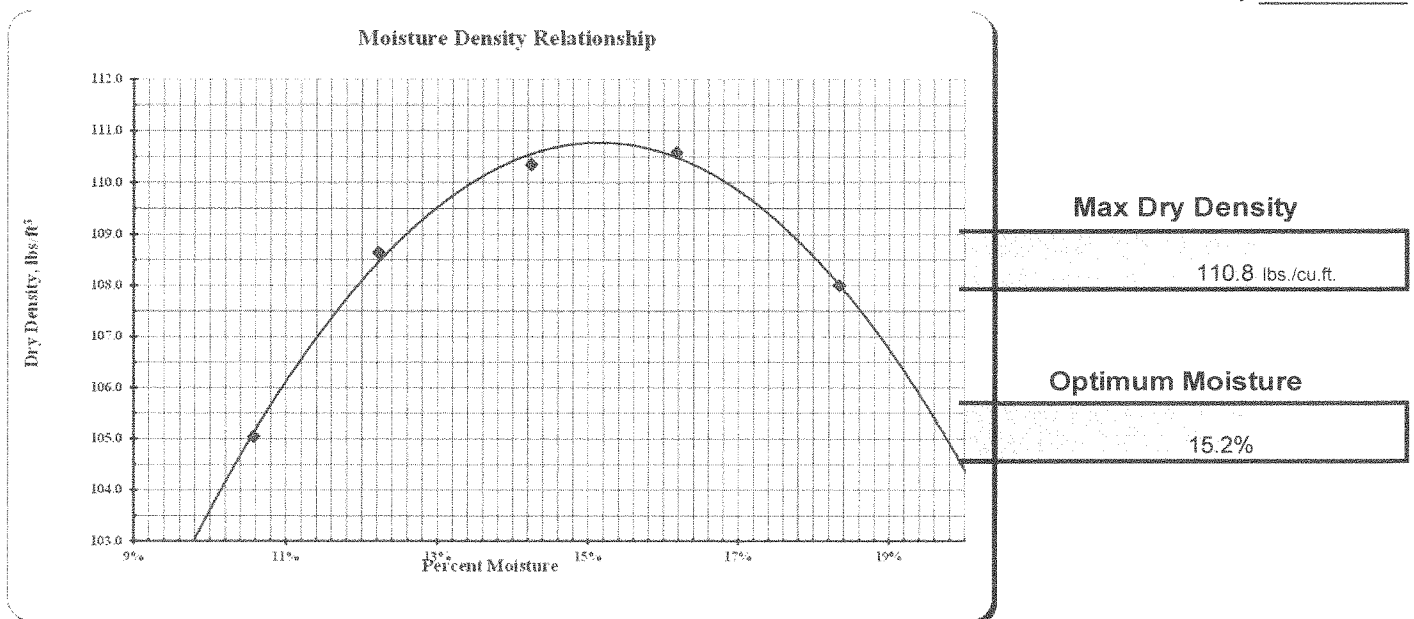
Density	Test Count	5				
Determination No.	1	2	3	4	5	6
A Volume of Mold cu. ft.	0.0333	0.0333	0.0333	0.0333	0.0333	0.0333
	lbs.	8.28	8.47	8.61	8.69	8.66
C Weight of Mold lbs.	4.41	4.41	4.41	4.41	4.41	4.41
D Weight of Compacted Soil = B - C lbs.	3.87	4.06	4.20	4.28	4.26	
E Wet Density = D / A lbs./cu.ft.	116.2	121.9	126.1	128.5	127.8	
F Dry Density = (E x 100) / (100 + L) lbs./cu.ft.	105.0	108.6	110.3	110.6	108.0	#VALUE!

Moisture Content

AASHTO T99 or T180 Tested by:

Container No.	10	11	12	13	14	
G Wet Weight / Container grams	148.6	157.5	154.0	151.3	156.0	
H Dry Weight / Container grams	137.9	144.4	139.4	135.4	137.7	
I Moisture Loss = G - H grams	10.7	13.1	14.6	15.9	18.3	
J Tare Weight of Container grams	36.7	37.2	36.9	37.1	37.9	
K Dry Soil = H - J grams	101.2	107.2	102.5	98.3	99.8	
L %Moisture = (I / K) x 100 %	10.6%	12.2%	14.2%	16.2%	18.3%	

ASTM D4643 AASHTO T217 or T265 Tested by: ss



MOISTURE-DENSITY RELATIONS OF SOILS

North Dakota Department Of Transportation, Materials & Research Division

SFN 10063 (Rev. 03-2006)

Project No. NH-3-281(130)148	PCN	Station	Depth Below Grade			
Offset From Centerline		Type of Soil				
AASHTO Designation T-180	Date 12/12/2016	961				
Density	Test Count	5				
Determination No.	1	2	3	4	5	6
A Volume of Mold cu. ft.	0.0333	0.0333	0.0333	0.0333	0.0333	0.0333
lbs.	8.34	8.56	8.69	8.73	8.66	
C Weight of Mold lbs.	4.41	4.41	4.41	4.41	4.41	4.41
D Weight of Compacted Soil = B - C lbs.	3.93	4.15	4.28	4.32	4.25	
E Wet Density = D / A lbs./cu.ft.	118.1	124.5	128.6	129.8	127.6	
F Dry Density = (E x 100) / (100 + L) lbs./cu.ft.	105.1	110.1	111.9	110.6	107.1	#VALUE!

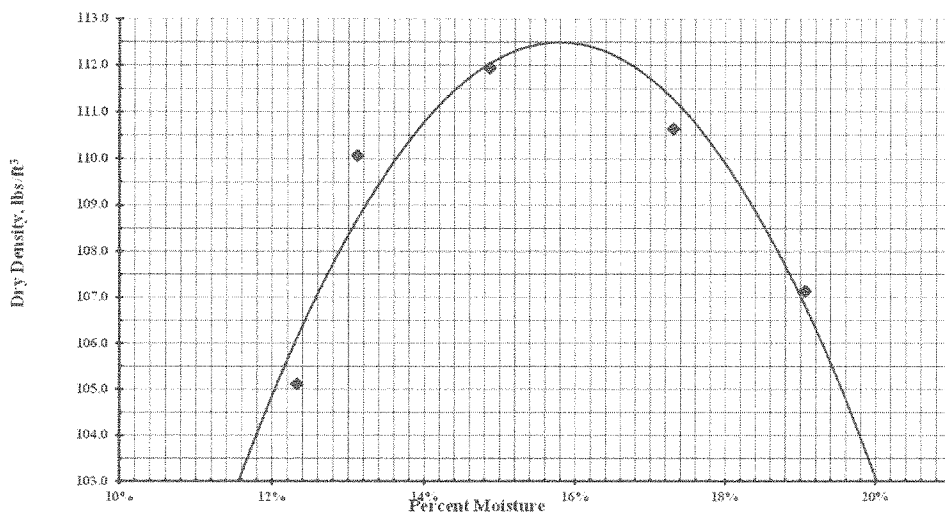
Moisture Content

AASHTO T99 or T180 Tested by:

Container No.	15	16	17	18	19
G Wet Weight / Container grams	149.4	149.3	158.9	150.3	148.9
H Dry Weight / Container grams	137.1	136.3	143.1	133.6	131.0
I Moisture Loss = G - H grams	12.3	13.0	15.8	16.7	17.9
J Tare Weight of Container grams	37.3	37.2	36.8	37.1	37.1
K Dry Soil = H - J grams	99.8	99.1	106.3	96.5	93.9
L %Moisture = (I / K) x 100 %	12.3%	13.1%	14.9%	17.3%	19.1%

ASTM D4643 AASHTO T217 or T265 Tested by: ss

Moisture Density Relationship



Max Dry Density

112.5 lbs./cu. ft.

Optimum Moisture

15.8%

MOISTURE-DENSITY RELATIONS OF SOILS

North Dakota Department Of Transportation, Materials & Research Division

SFN 10063 (Rev. 03-2006)

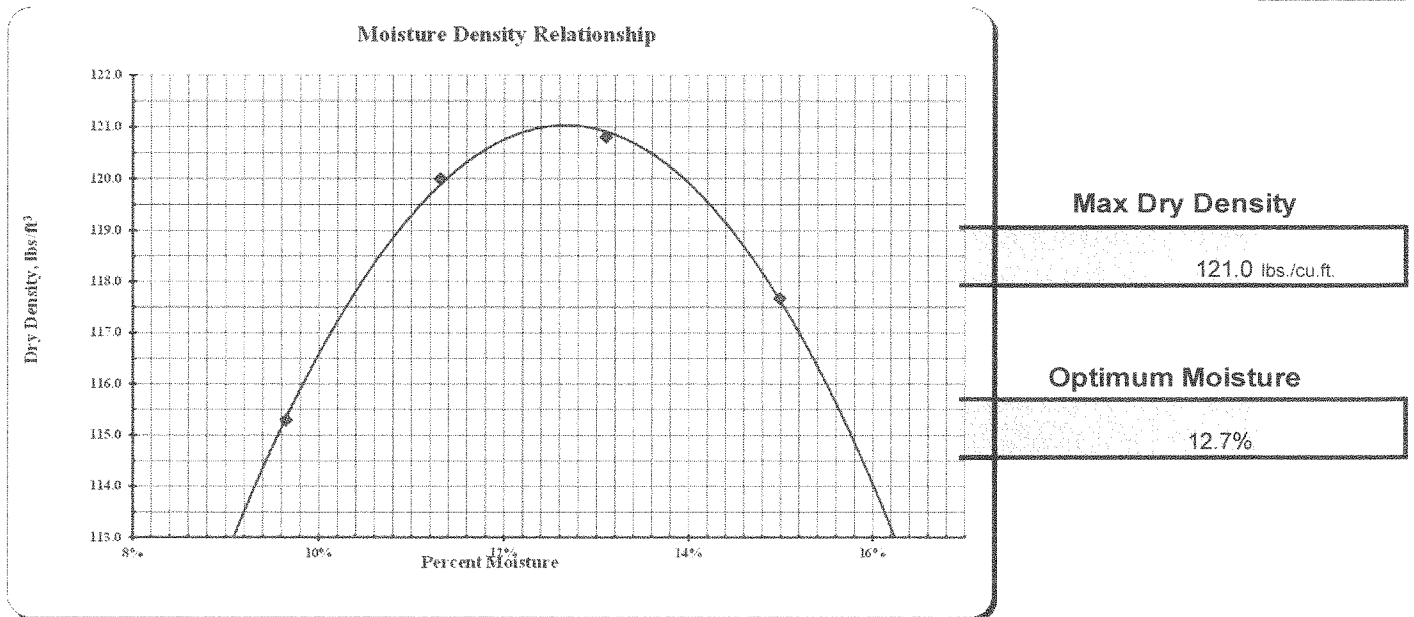
Project No. NH-3-281(130)148		PCN		Station		Depth Below Grade	
Offset From Centerline				Type of Soil			
ASTHO Designation T-180		Date 12/12/2016				962	
Density		Test Count		4			
Determination No.		1		2		3	
A Volume of Mold		cu. ft.		0.0333		0.0333	
		lbs.		8.62		8.87	
C Weight of Mold		lbs.		4.41		4.42	
D Weight of Compacted Soil = B - C		lbs.		4.21		4.45	
E Wet Density = D / A		lbs./cu.ft.		126.4		133.6	
F Dry Density = (E x 100) / (100 + L)		lbs./cu.ft.		115.3		120.0	

Moisture Content

AASHTO T99 or T180 Tested by:

Container No.		20	21	22	23		
G	Wet Weight / Container	grams	155.8	160.1	151.8	151.7	
H	Dry Weight / Container	grams	145.3	147.6	138.5	136.8	
I	Moisture Loss = G - H	grams	10.5	12.5	13.3	14.9	
J	Tare Weight of Container	grams	36.5	37.1	37.0	37.4	
K	Dry Soil = H - J	grams	108.8	110.5	101.5	99.4	
L	%Moisture = (I / K) x 100	%	9.7%	11.3%	13.1%	15.0%	

ASTM D4643 AASHTO T217 or T265 Tested by: ss



MOISTURE-DENSITY RELATIONS OF SOILS

North Dakota Department Of Transportation, Materials & Research Division

SFN 10063 (Rev. 03-2006)

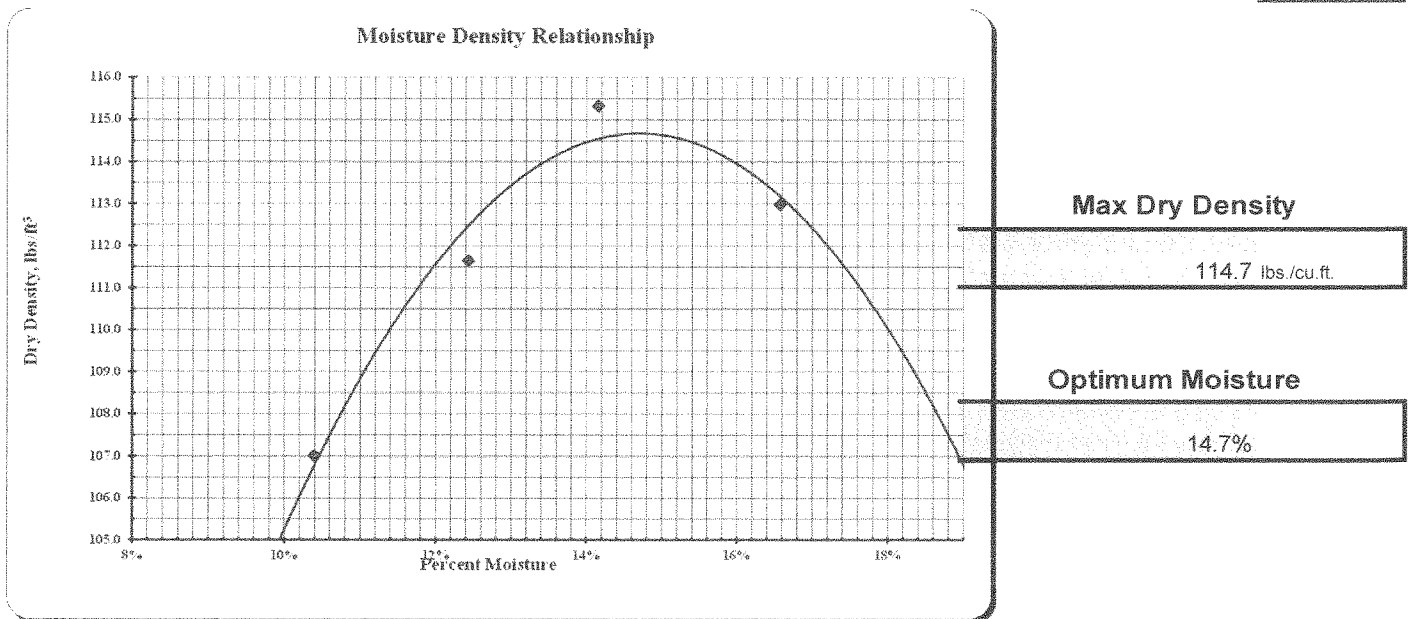
Project No. NH-3-281(130)148		PCN		Station		Depth Below Grade	
Offset From Centerline				Type of Soil			
AASHTO Designation T-180		Date 12/12/2016				963	
Density		Test Count		4			
Determination No.		1		2		3	
A Volume of Mold		cu. ft.		0.0333		0.0333	
		lbs.		8.36		8.60	
C Weight of Mold		lbs.		4.42		4.42	
D Weight of Compacted Soil = B - C		lbs.		3.93		4.18	
E Wet Density = D / A		lbs./cu.ft.		118.1		125.5	
F Dry Density = (E x 100) / (100 + L)		lbs./cu.ft.		107.0		111.6	

Moisture Content

AASHTO T99 or T180 Tested by:

Container No.		24	25	26	27		
G Wet Weight / Container	grams	149.8	159.3	149.8	160.5		
H Dry Weight / Container	grams	139.2	145.8	135.8	142.9		
I Moisture Loss = G - H	grams	10.6	13.5	14.0	17.6		
J Tare Weight of Container	grams	37.2	37.2	36.9	36.7		
K Dry Soil = H - J	grams	102.0	108.6	98.9	106.2		
L %Moisture = (I / K) x 100	%	10.4%	12.4%	14.2%	16.6%		

ASTM D4643 AASHTO T217 or T265 Tested by: ss



MOISTURE-DENSITY RELATIONS OF SOILS

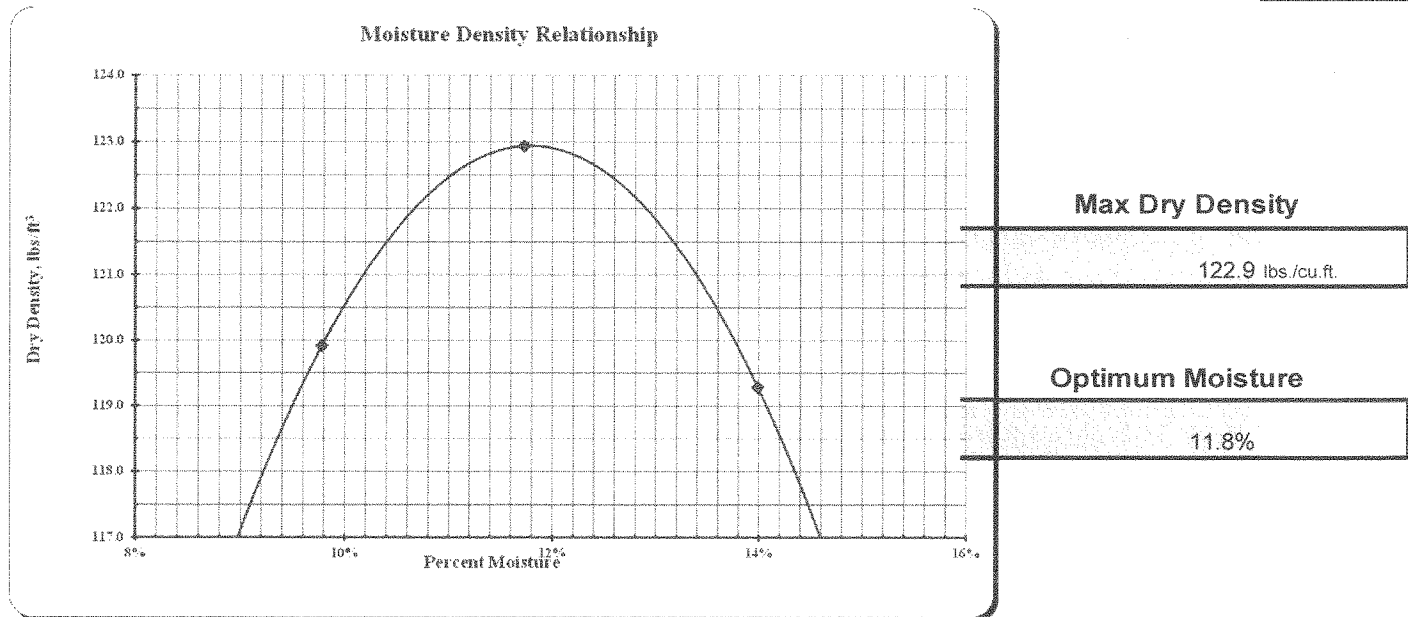
North Dakota Department Of Transportation, Materials & Research Division

SFN 10063 (Rev. 03-2006)

Project No. NH-3-281(130)148		PCN		Station		Depth Below Grade	
Offset From Centerline				Type of Soil			
AASHTO Designation T-180		Date 12/12/2016				964	
Density		Test Count		3			
Determination No.		1		2		3	
A Volume of Mold		cu. ft.		0.0333		0.0333	
		lbs.		8.81		9.00	
C Weight of Mold		lbs.		4.42		4.42	
D Weight of Compacted Soil = B - C		lbs.		4.38		4.57	
E Wet Density = D / A		lbs./cu.ft.		131.7		137.4	
F Dry Density = (E x 100) / (100 + L)		lbs./cu.ft.		119.9		122.9	

Moisture Content			AASHTO T99 or T180 Tested by:			
Container No.			28		29	
G Wet Weight / Container			grams		152.8	
H Dry Weight / Container			grams		142.5	
I Moisture Loss = G - H			grams		10.3	
J Tare Weight of Container			grams		37.2	
K Dry Soil = H - J			grams		105.3	
L %Moisture = (I / K) x 100			%		9.8%	

ASTM D4643 AASHTO T217 or T265 Tested by: ss



MOISTURE-DENSITY RELATIONS OF SOILS

North Dakota Department Of Transportation, Materials & Research Division

SFN 10063 (Rev. 03-2006)

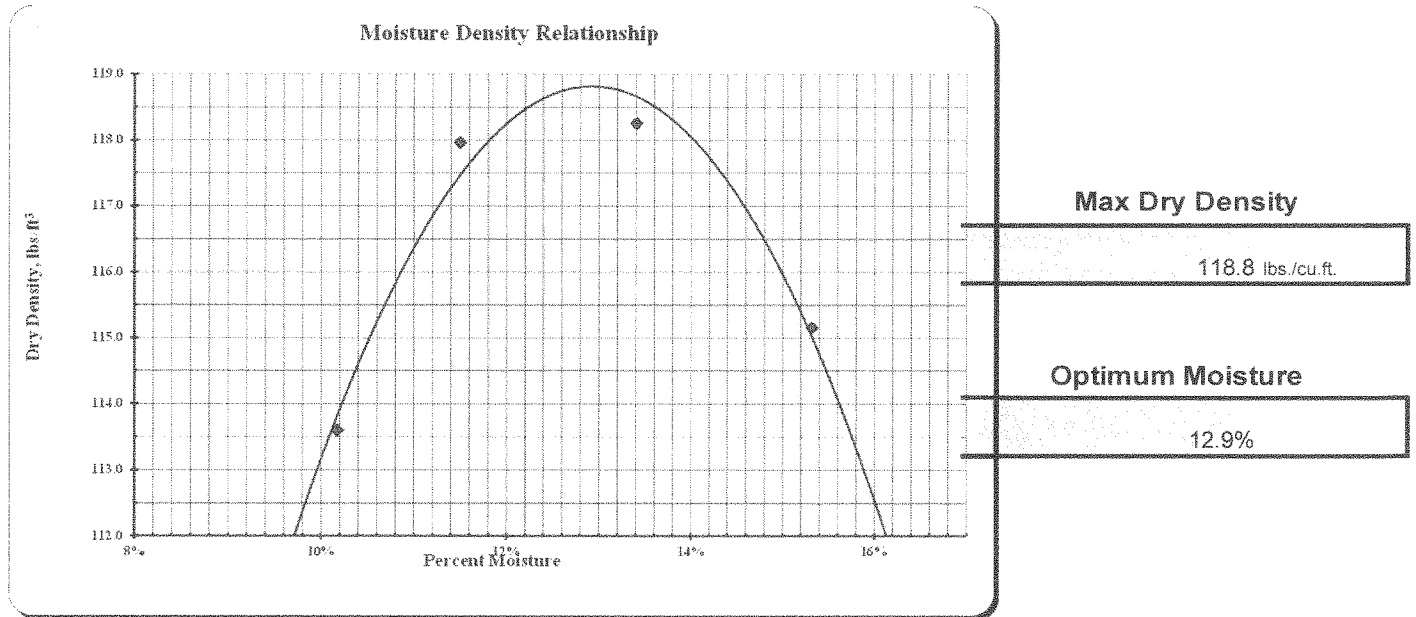
Project No. NH-3-281(130)148		PCN		Station		Depth Below Grade	
Offset From Centerline				Type of Soil			
AASHTO Designation T-180		Date 12/13/2016				965	
Density		Test Count		4			
Determination No.		1		2		3	
A Volume of Mold		cu. ft.		0.0333		0.0333	
		lbs.		8.59		8.80	
C Weight of Mold		lbs.		4.42		4.42	
D Weight of Compacted Soil = B - C		lbs.		4.17		4.38	
E Wet Density = D / A		lbs./cu.ft.		125.2		131.5	
F Dry Density = (E x 100) / (100 + L)		lbs./cu.ft.		113.6		118.0	

Moisture Content

AASHTO T99 or T180 Tested by:

Container No.		31	32	33	34		
G Wet Weight / Container	grams	156.1	155.2	157.2	156.2		
H Dry Weight / Container	grams	145.1	143.0	143.0	140.5		
I Moisture Loss = G - H	grams	11.0	12.2	14.2	15.7		
J Tare Weight of Container	grams	37.0	36.9	37.1	38.0		
K Dry Soil = H - J	grams	108.1	106.1	105.9	102.5		
L %Moisture = (I / K) x 100	%	10.2%	11.5%	13.4%	15.3%		

ASTM D4643 AASHTO T217 or T265 Tested by: ss



MOISTURE-DENSITY RELATIONS OF SOILS

North Dakota Department Of Transportation, Materials & Research Division

SFN 10063 (Rev. 03-2006)

Project No. NH-3-281(130)148	PCN	Station	Depth Below Grade				
Offset From Centerline		Type of Soil					
AASTHO Designation T-180	Date 12/13/2016					966	
Density	Test Count	3					
Determination No.	1	2	3	4	5	6	
A Volume of Mold cu. ft.	0.0333	0.0333	0.0333	0.0333	0.0333	0.0333	
lbs.	8.75	8.94	8.93				
C Weight of Mold lbs.	4.42	4.42	4.42	4.42	4.42	4.42	
D Weight of Compacted Soil = B - C lbs.	4.33	4.52	4.51				
E Wet Density = D / A lbs./cu.ft.	129.9	135.7	135.5				
F Dry Density = (E x 100) / (100 + L) lbs./cu.ft.	118.3	122.0	119.7	#VALUE!	#VALUE!	#VALUE!	

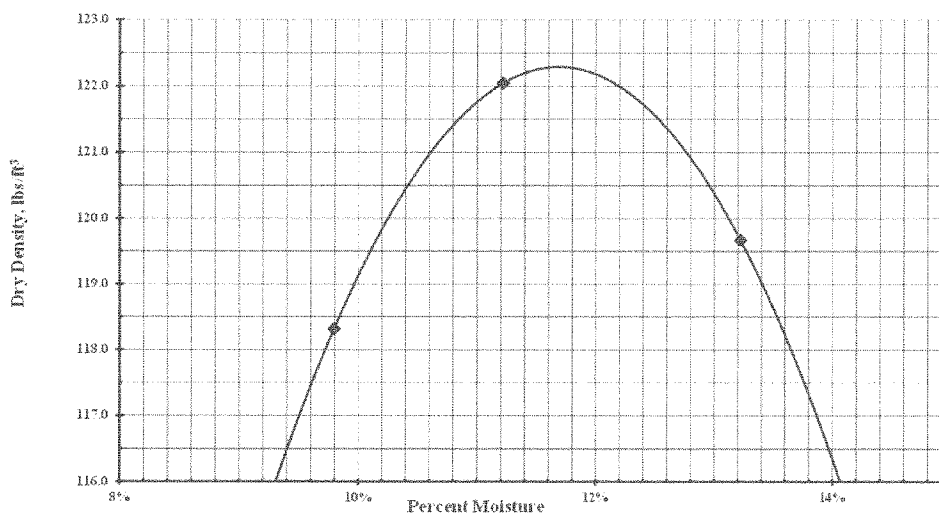
Moisture Content

AASHTO T99 or T180 Tested by:

Container No.	35	36	37			
G Wet Weight / Container grams	150.7	154.2	152.9			
H Dry Weight / Container grams	140.6	142.4	139.4			
I Moisture Loss = G - H grams	10.1	11.8	13.5			
J Tare Weight of Container grams	37.5	37.2	37.3			
K Dry Soil = H - J grams	103.1	105.2	102.1			
L %Moisture = (I / K) x 100 %	9.8%	11.2%	13.2%			

ASTM D4643 AASHTO T217 or T265 Tested by: ss

Moisture Density Relationship



Max Dry Density

122.3 lbs./cu.ft.

Optimum Moisture

11.7%

MOISTURE-DENSITY RELATIONS OF SOILS

North Dakota Department Of Transportation, Materials & Research Division

SFN 10063 (Rev. 03-2006)

Project No. NH-3-281(130)148	PCN	Station	Depth Below Grade			
Offset From Centerline		Type of Soil				
AASTHO Designation T-180	Date 12/13/2016	967				
Density	Test Count	4				
Determination No.	1	2	3	4	5	6
A Volume of Mold cu. ft.	0.0333	0.0333	0.0333	0.0333	0.0333	0.0333
lbs.	8.42	8.62	8.76	8.75		
C Weight of Mold lbs.	4.42	4.42	4.42	4.42	4.42	4.42
D Weight of Compacted Soil = B - C lbs.	4.00	4.20	4.34	4.33		
E Wet Density = D / A lbs./cu.ft.	120.2	126.1	130.3	130.2		
F Dry Density = (E x 100) / (100 + L) lbs./cu.ft.	108.9	112.4	114.2	111.0	#VALUE!	#VALUE!

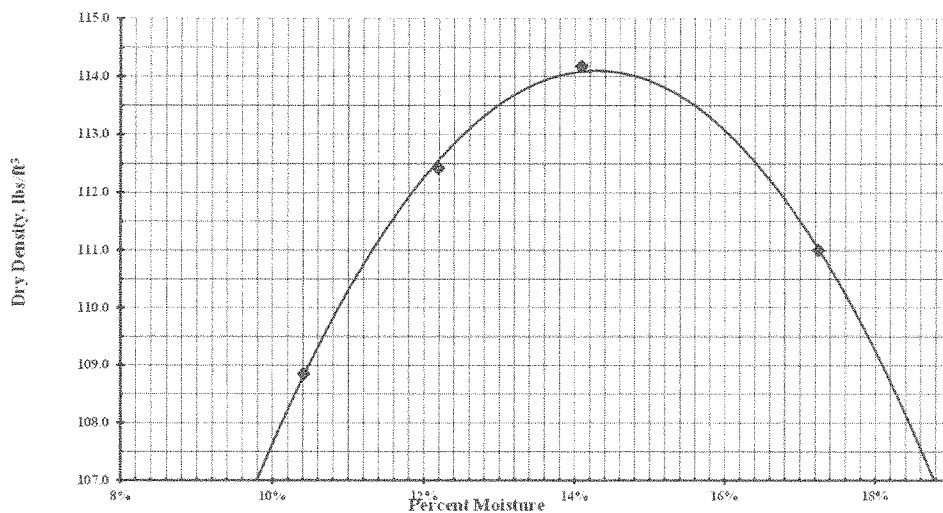
Moisture Content

AASHTO T99 or T180 Tested by:

Container No.	38	39	40	41		
G Wet Weight / Container grams	153.6	153.5	152.9	152.8		
H Dry Weight / Container grams	142.6	140.9	138.6	135.8		
I Moisture Loss = G - H grams	11.0	12.6	14.3	17.0		
J Tare Weight of Container grams	36.9	37.5	37.1	37.2		
K Dry Soil = H - J grams	105.7	103.4	101.5	98.6		
L %Moisture = (I / K) x 100 %	10.4%	12.2%	14.1%	17.2%		

ASTM D4643 AASHTO T217 or T265 Tested by: ss

Moisture Density Relationship



Max Dry Density

114.1 lbs./cu.ft.

Optimum Moisture

14.3%

MOISTURE-DENSITY RELATIONS OF SOILS

North Dakota Department Of Transportation, Materials & Research Division

SFN 10063 (Rev. 03-2006)

Project No. NH-3-281(130)148	PCN	Station	Depth Below Grade
Offset From Centerline	Type of Soil		
AASHTO Designation T-180	Date 12/13/2016	968	
Density	Test Count	4	
Determination No.	1	2	3
A Volume of Mold	0.0333	0.0333	0.0333
	lbs.	8.65	8.85
C Weight of Mold	4.42	4.42	4.42
D Weight of Compacted Soil = B - C	4.23	4.42	4.51
E Wet Density = D / A	127.1	132.9	135.4
F Dry Density = (E x 100) / (100 + L)	116.2	119.3	119.6

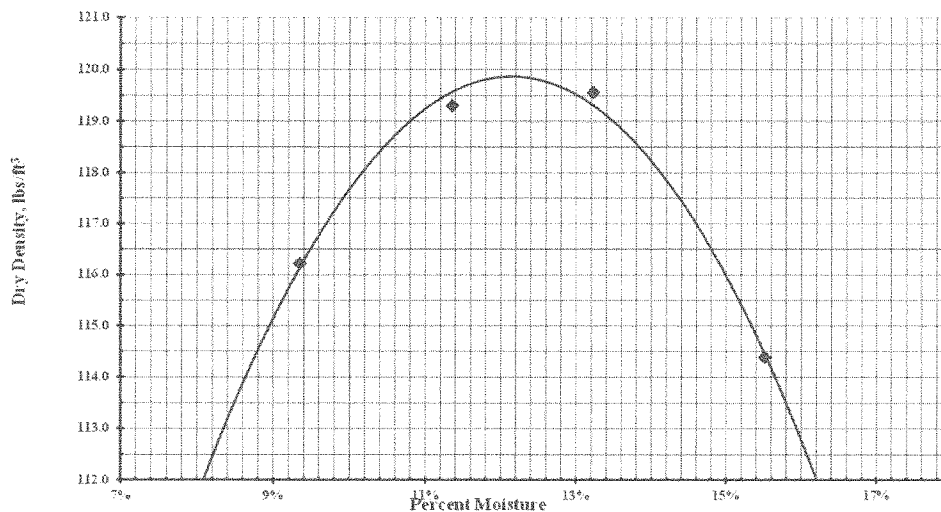
Moisture Content

AASHTO T99 or T180 Tested by:

Container No.	42	43	44	45		
G Wet Weight / Container	149.0	152.7	154.3	149.3		
H Dry Weight / Container	139.4	140.9	140.6	134.3		
I Moisture Loss = G - H	9.6	11.8	13.7	15.0		
J Tare Weight of Container	36.7	37.0	37.0	37.6		
K Dry Soil = H - J	102.7	103.9	103.6	96.7		
L %Moisture = (I / K) x 100	9.3%	11.4%	13.2%	15.5%		

ASTM D4643 AASHTO T217 or T265 Tested by: ss

Moisture Density Relationship



Max Dry Density

119.9 lbs./cu. ft.

Optimum Moisture

12.1%

MOISTURE-DENSITY RELATIONS OF SOILS

North Dakota Department Of Transportation, Materials & Research Division

SFN 10063 (Rev. 03-2006)

Project No. NH-3-281(130)148	PCN	Station	Depth Below Grade
Offset From Centerline		Type of Soil	
AASHTO Designation T-180	Date 12/13/2016	969	

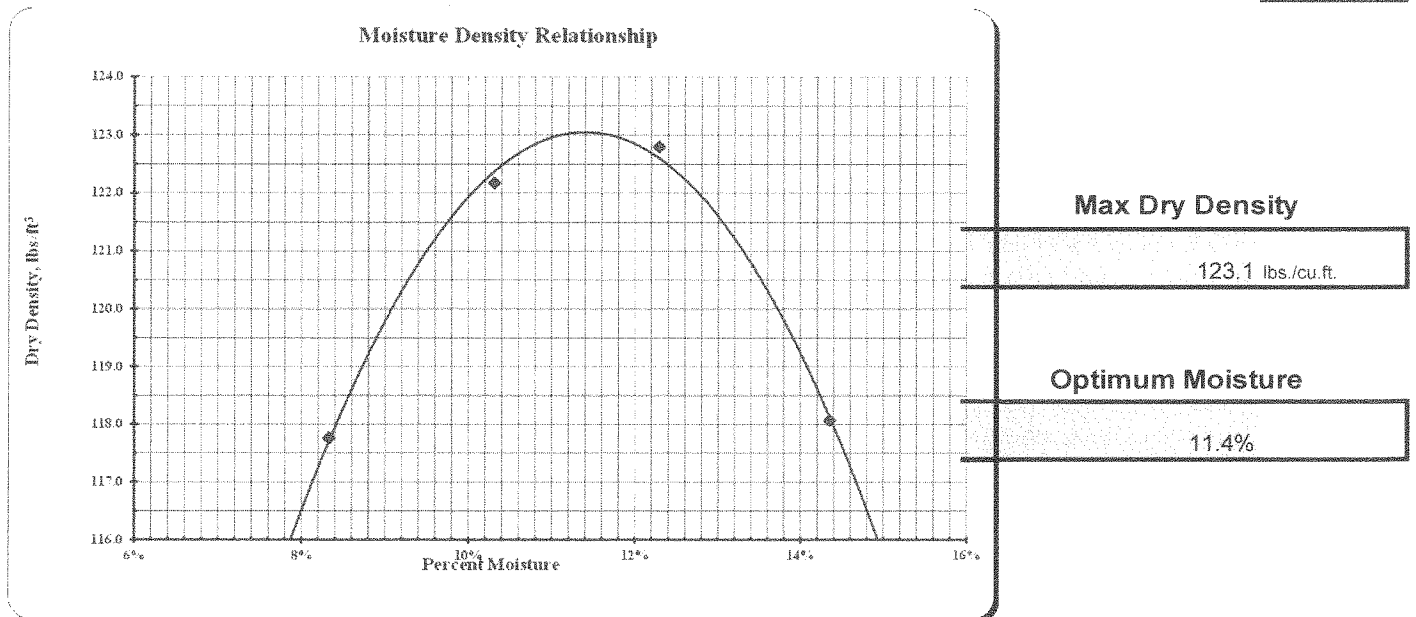
Density		Test Count					
		4					
Determination No.		1	2	3	4	5	6
A	Volume of Mold	cu. ft.	0.0333	0.0333	0.0333	0.0333	0.0333
		lbs.	8.67	8.91	9.01	8.92	
C	Weight of Mold	lbs.	4.42	4.42	4.42	4.42	4.42
D	Weight of Compacted Soil = B - C	lbs.	4.25	4.49	4.59	4.50	
E	Wet Density = D / A	lbs./cu.ft.	127.6	134.8	137.9	135.0	
F	Dry Density = (E x 100) / (100 + L)	lbs./cu.ft.	117.8	122.2	122.8	118.1	#VALUE!

Moisture Content

AASHTO T99 or T180 Tested by:

Container No.		46	47	48	49		
G	Wet Weight / Container	grams	150.3	147.2	157.7	160.0	
H	Dry Weight / Container	grams	141.6	136.9	144.5	144.6	
I	Moisture Loss = G - H	grams	8.7	10.3	13.2	15.4	
J	Tare Weight of Container	grams	37.1	37.0	37.1	37.3	
K	Dry Soil = H - J	grams	104.5	99.9	107.4	107.3	
L	%Moisture = (I / K) x 100	%	8.3%	10.3%	12.3%	14.4%	

ASTM D4643 AASHTO T217 or T265 Tested by: ss



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Offset From Centerline		Type of Soil	
AASHTO Designation T-180	Date 12/13/2016	970	

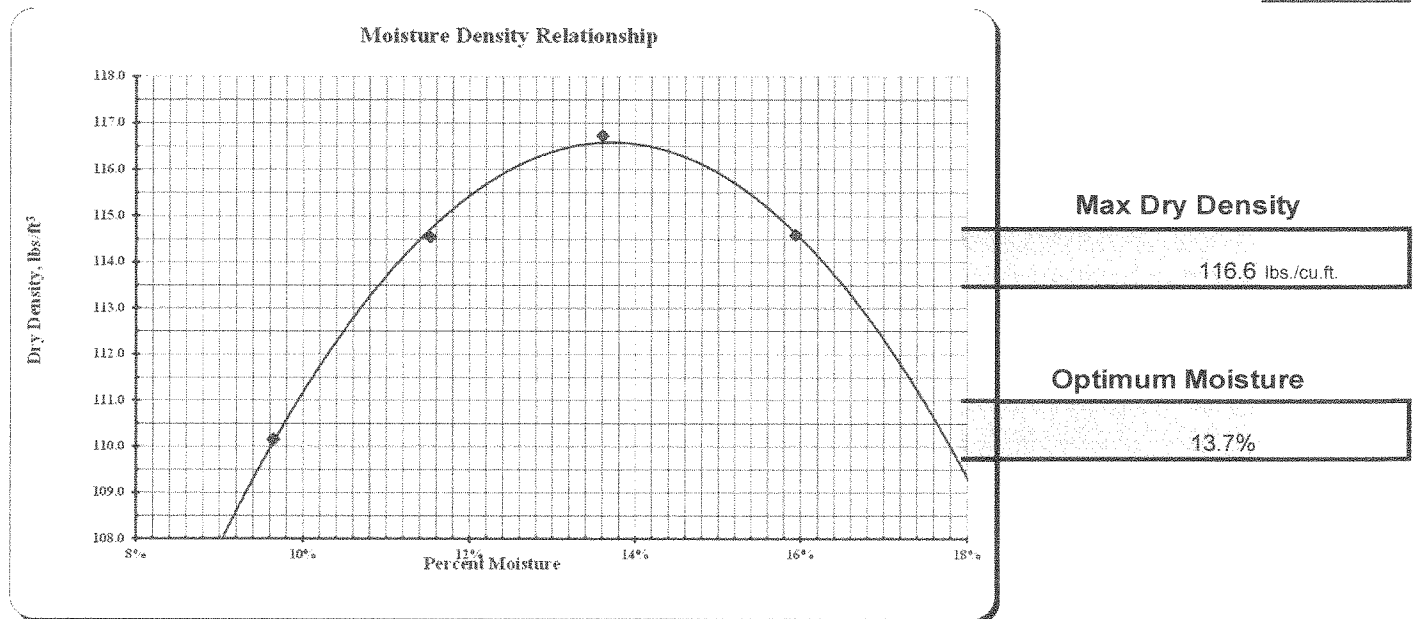
Density		Test Count					
		4					
Determination No.		1	2	3	4	5	6
A	Volume of Mold	cu. ft.	0.0333	0.0333	0.0333	0.0333	0.0333
		lbs.	8.44	8.68	8.84	8.84	
C	Weight of Mold	lbs.	4.42	4.42	4.42	4.42	4.42
D	Weight of Compacted Soil = B - C	lbs.	4.02	4.25	4.42	4.42	
E	Wet Density = D / A	lbs./cu.ft.	120.8	127.7	132.6	132.9	
F	Dry Density = (E x 100) / (100 + L)	lbs./cu.ft.	110.2	114.5	116.7	114.6	#VALUE!

Moisture Content

AASHTO T99 or T180 Tested by:

Container No.		50	51	52	53		
G	Wet Weight / Container	grams	157.5	147.5	158.4	155.7	
H	Dry Weight / Container	grams	146.9	136.1	143.9	139.4	
I	Moisture Loss = G - H	grams	10.6	11.4	14.5	16.3	
J	Tare Weight of Container	grams	37.0	37.2	37.3	37.1	
K	Dry Soil = H - J	grams	109.9	98.9	106.6	102.3	
L	%Moisture = (I / K) x 100	%	9.6%	11.5%	13.6%	15.9%	

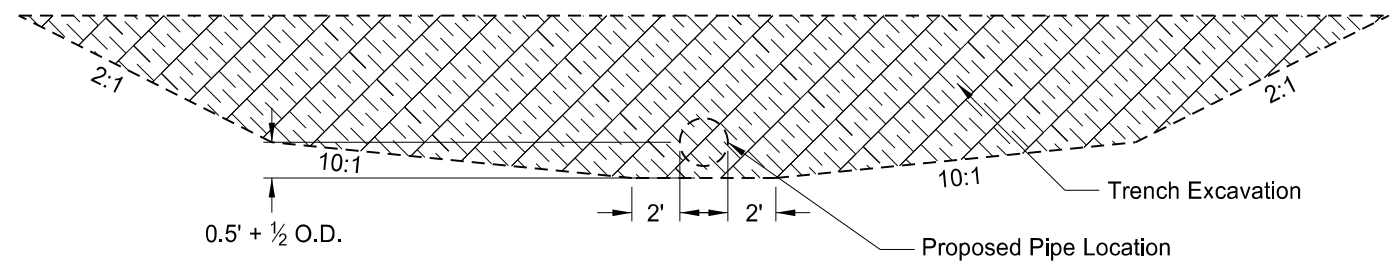
ASTM D4643 AASHTO T217 or T265 Tested by: ss



APPENDIX F

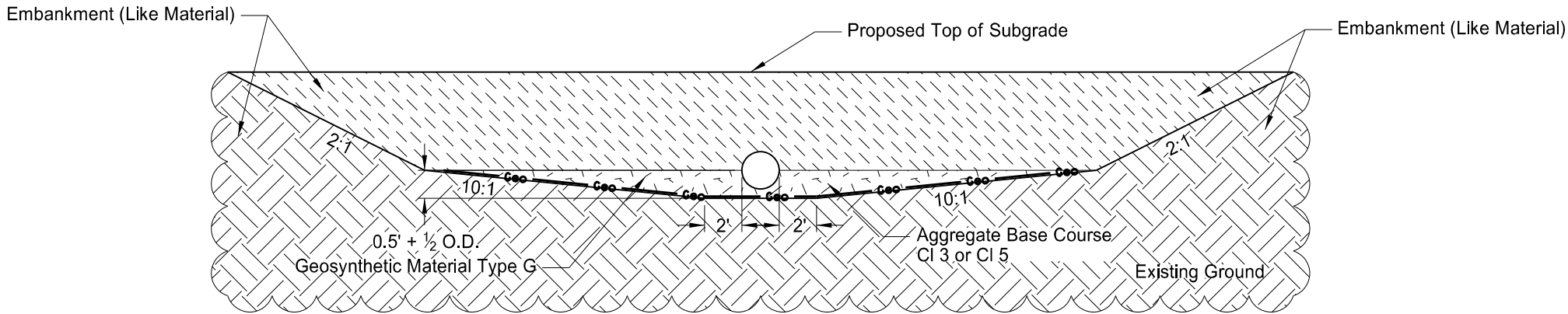
ALTERNATIVE PIPE BACKFILL DETAIL

	STATE	PROJECT NO.	SECTION NO.	SHEET NO.
	ND		20	



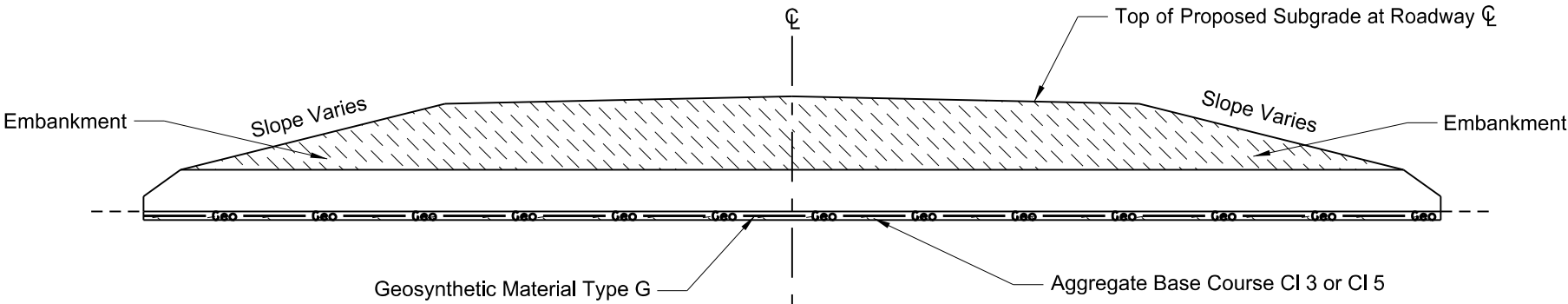
EXCAVATION DETAIL

- Pay Items
- 1) Pipe*
 - 2) Geosynthetic Material Type G
 - 3) Removal of Pipe (if required)
- *Included in Pipe Pay Item
- 1) Pipe
 - 2) Trench Excavation
 - 3) Aggregate Base Course CI 3 or CI 5
 - 4) Embankment



INSTALLATION DETAIL

- NOTES:
- 1) This drawing applies to new/replaced mainline and paved intersection roadway concrete pipes only (including ramps). It does not include pipes in approaches.
 - 2) Embankment may be either Borrow Excavation or Common Excavation - Type A. Borrow Excavation is required to have a Group and Subgroup Classification the same as the excavated material as defined by AASHTO M 145. Common Excavation - Type A is required to be the material excavated during trench excavation.



CROSS SECTION

This document is preliminary and not for construction or implementation purposes.

Pipe Backfill Detail
for Centerline Pipes at New Locations