Borrow Investigation Report

4-023 (016) 078, PCN 19206
4-023 (019) 087, PCN 19376
North Dakota State Highway 23
Major Rehabilitation
US 83 to Mountrail County

March 6, 2012
MTL/Terracon Project No. M2115106

Prepared for:
Houston Engineering, Inc
Fargo, North Dakota

Prepared by:
MTL/Terracon
Bismarck, North Dakota

Midwest Testing LABORATORY, INC.
A Terracon COMPANY

Offices Nationwide Established in 1965
Employee-Owned terracon.com
Terracon
Geotechnical • Environmental • Construction Materials • Facilities

March 6, 2012

Midwest Testing
LABORATORY, INC.
A Terracon COMPANY

Houston Engineering, Inc
1401 21st Avenue North
Fargo, ND 58102-1814

Attn: Richard Gunderson
Vice-President
P: (701) 237 5065
F: (701) 237 5101
E: drgunderwon@houstoneng.com

Re: Borrow Investigation Report
4-023 (016) 078, PCN 19206
4-023 (019) 087, PCN 19376
North Dakota State Highway 23
Major Rehabilitation
US 83 to Mountrail County
Midwest Testing/Terracon Project No M2115106

Dear Mr. Gunderson:

Midwest Testing Laboratory, Inc (A Terracon Company) has completed the borrow investigation for the above-referenced project. These services were performed in general accordance with our Subconsultant Services Agreement signed by us on June 3, 2011, and signed by your office on June 6, 2011. This report presents the results of the subsurface exploration and provides the results of our laboratory testing program.

We appreciate the opportunity to be of service on this project. If you have any questions concerning this report or if we may be of further service, please contact us.

Sincerely,

MIDWEST TESTING LABORATORY, INC.

Steven S. Smith, P.E.
Senior Project Engineer

STEVEN S. SMITH
REGISTERED
PROFESSIONAL
PE 2863
ENGINEER
NORTH DAKOTA

Chad A. Cowley, P.E.
Senior Staff Engineer

SSS/cb

Copies: 3-Above

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BORROW INVESTIGATION REPORT
4-023 (016) 078, PCN 19206
4-023 (019) 087, PCN 19376
NORTH DAKOTA STATE HIGHWAY 23
MAJOR REHABILITATION
US 83 TO MOUNTRAIL COUNTY

MTL/Terracon Project No. M2125106
March 6, 2012

1.0 INTRODUCTION

The proposed project will consist of rehabilitating North Dakota State Highway 23 in Ward County, North Dakota. This report presents the results of the borrow investigation and associated laboratory testing program.

1.1 Scope of Work

Our scope of work for this investigation is limited to the following items:

- investigate soil conditions within nine borrow areas along the project route
- perform laboratory testing to assist in evaluating borrow site soil conditions. Laboratory testing includes determining moisture content, Atterberg limits, and the percent passing the #200 sieve on selected samples. Additionally, moisture-density relationships were determined on bulk samples.

2.0 SOIL BORINGS AND LABORATORY TESTING

The field work consisted of completing 87 soil test borings within nine borrow areas along the project route. A geotechnical laboratory analysis was performed on representative soil samples. More specific information regarding the field work and laboratory testing is discussed below.

2.1 Field Exploration

Test borings were performed between February 1, and 3, 2012. The borings were advanced with a truck-mounted drill rig at locations discussed with you and as noted on the Boring Location Plans, Exhibits A-1 through A-9, found in Appendix A.

2.1.1. Site Conditions

Nine separate borrow areas were investigated. These borrow areas were typically found in pasture land covered with native grasses. Several borrow areas were adjacent to bodies of water consisting of sloughs, ponds, or other natural drainage areas. Site topography consists primarily of rolling terrain.

2.1.2. Soil Conditions

Variable soil conditions were encountered within the borrow areas. Medium plasticity clays containing varying amounts of sand were the predominant soils identified within the borrow areas. Silty sands, clayey sands, and clayey gravels were also encountered to a lesser extent. The AASHTO classification of the soils encountered within the borrow areas include A-1-b, A-2-4, A-2-6, A-6, and A-7-6 soils.

2.1.3 Groundwater

Groundwater was encountered at eight of the nine borrow area locations. The depth to groundwater was variable, ranging from 4 to 15 feet.

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

2.2 Laboratory Testing

Soil samples were obtained at one foot intervals at each boring location to a depth of 15 feet or until groundwater was encountered. The inplace moisture content was determined on each of these samples. These test results can be found in Appendix A-2.

Additionally, Atterberg limits, percent passing #200 sieve, and the moisture-density relationship was determined on bulk samples obtained from each boring. These test results are also found in Appendix A-2.

3.0 ANALYSIS AND RECOMMENDATIONS

Based on information obtained, it is our opinion that suitable embankment material is located within each of the nine borrow areas included in this investigation. As previously reported to your office, we recommend compaction control Type (A) (NDDOT Specification 203.02G) for all embankment and cut areas. Embankment and cut areas designed to be excavated and recompacted should be compacted to 90 percent of the maximum density as determined by the modified proctor, AASHTO:T180. Moisture contents at the time of compaction should not be less than optimum moisture and no more than five percentage points above the optimum moisture as determined by this same method.

4.0 FIELD INVESTIGATION PROCEDURES

Eighty-seven soil test borings were performed within nine borrow areas between February 1, and 3, 2012. The borings were advanced at locations discussed with you and as shown on the attached Boring Location Plans found in Appendix A. Surface elevations at our test boring locations and the Northings and Eastings were provided by your office.

4.1 Soil Sampling

The borings were advanced with 3¼ inch hollow stem auger, with split barrel soil samples obtained in accordance with ASTM D1586. Bulk samples were obtained by augering up soil from various depths to the surface.

4.2 Soil Classifications

As the borings were advanced in the field and samples obtained, they were visually and manually classified in accordance with ASTM D2488. Representative portions of all samples were returned to the laboratory for review of the field classifications. Once in the laboratory, all samples were also classified in accordance with AASHTO M145. These classifications are shown in the laboratory testing summary found in Appendix A-2.

5.0 GENERAL COMMENTS

MTL/Terracon should be retained to review the final design plans and specifications so comments can be made regarding interpretation and implementation of our geotechnical recommendations in the design and specifications. MTL/Terracon also should be retained to

provide observation and testing services during grading, excavation, foundation construction and other earth-related construction phases of the project.

The analysis and recommendations presented in this report are based upon the limited data obtained from the borings performed at the indicated locations and from other information discussed in this report. This report does not reflect variations that may occur between borings, across the site, or due to the modifying effects of construction or weather. The nature and extent of such variations may not become evident until during or after construction. If variations appear, we should be immediately notified so that further evaluation and supplemental recommendations can be provided.

The scope of services for this project does not include either specifically or by implication any environmental or biological (e.g., mold, fungi, bacteria) assessment of the site or identification or prevention of pollutants, hazardous materials or conditions. If the owner is concerned about the potential for such contamination or pollution, other studies should be undertaken.

This report has been prepared for the exclusive use of our client for specific application to the project discussed and has been prepared in accordance with generally accepted geotechnical engineering practices. No warranties, either express or implied, are intended or made. Site safety, excavation support, and dewatering requirements are the responsibility of others. In the event that changes in the nature, design, or location of the project as outlined in this report are planned, the conclusions and recommendations contained in this report shall not be considered valid unless MTL/Terracon reviews the changes and either verifies or modifies the conclusions of this report in writing.

APPENDIX A

FIELD EXPLORATION

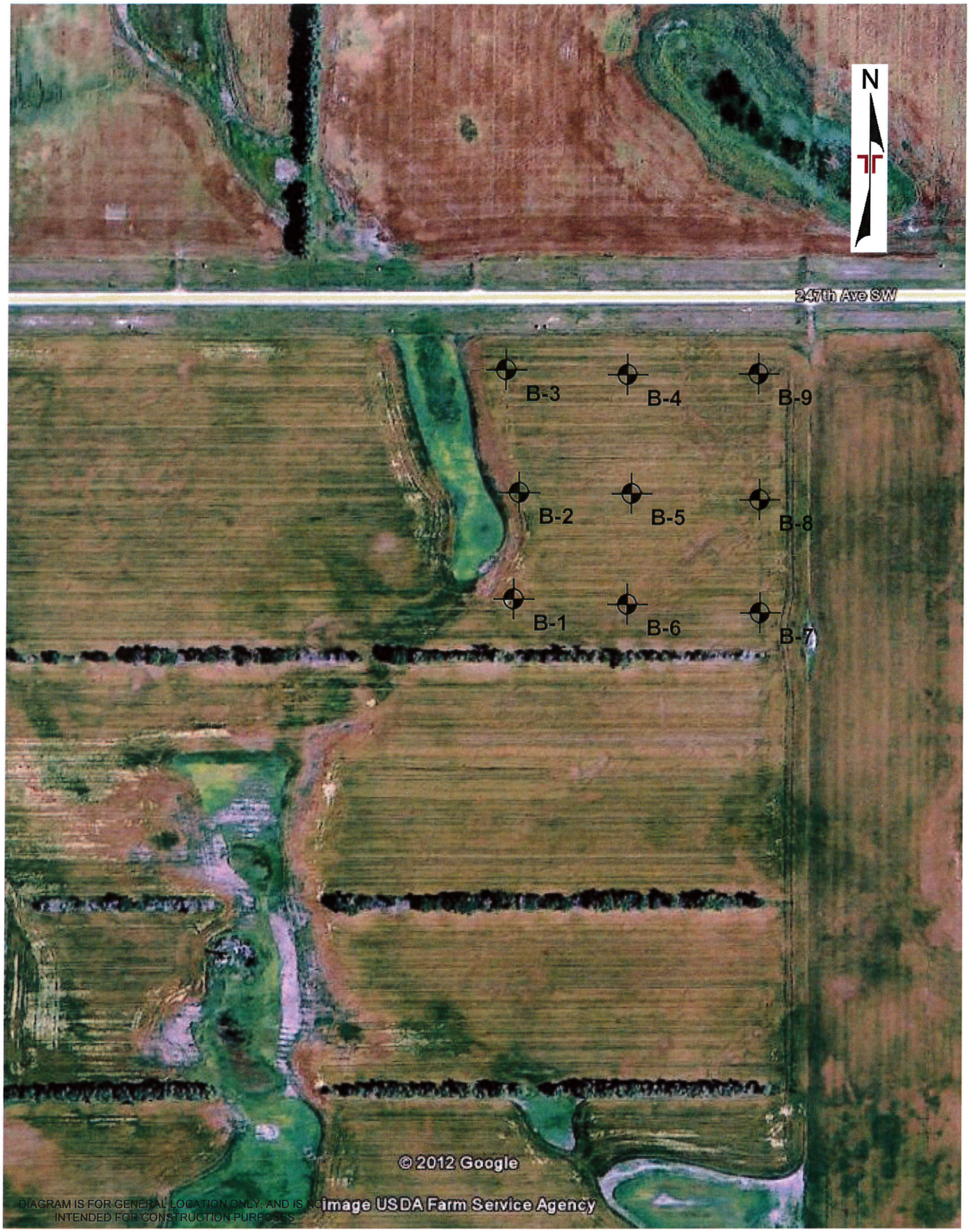

DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

Project Manager: SS	Project No. M2115106	Midwest Testing LABORATORY, INC. A Terracon COMPANY	BORING LOCATION PLAN	FIG No.
Drawn by: SS	Scale: N.T.S		ND Highway 23 Rehabilitation Borrow Area WD-1076 Ward County, North Dakota	A-1
Checked by: CC				
Approved by: SS	Date: 3/1/2012	1805 Hancock Drive PO Box 2084 Bismarck, North Dakota 58502 PH. (701) 258-2833 FAX. (701) 258-2857		

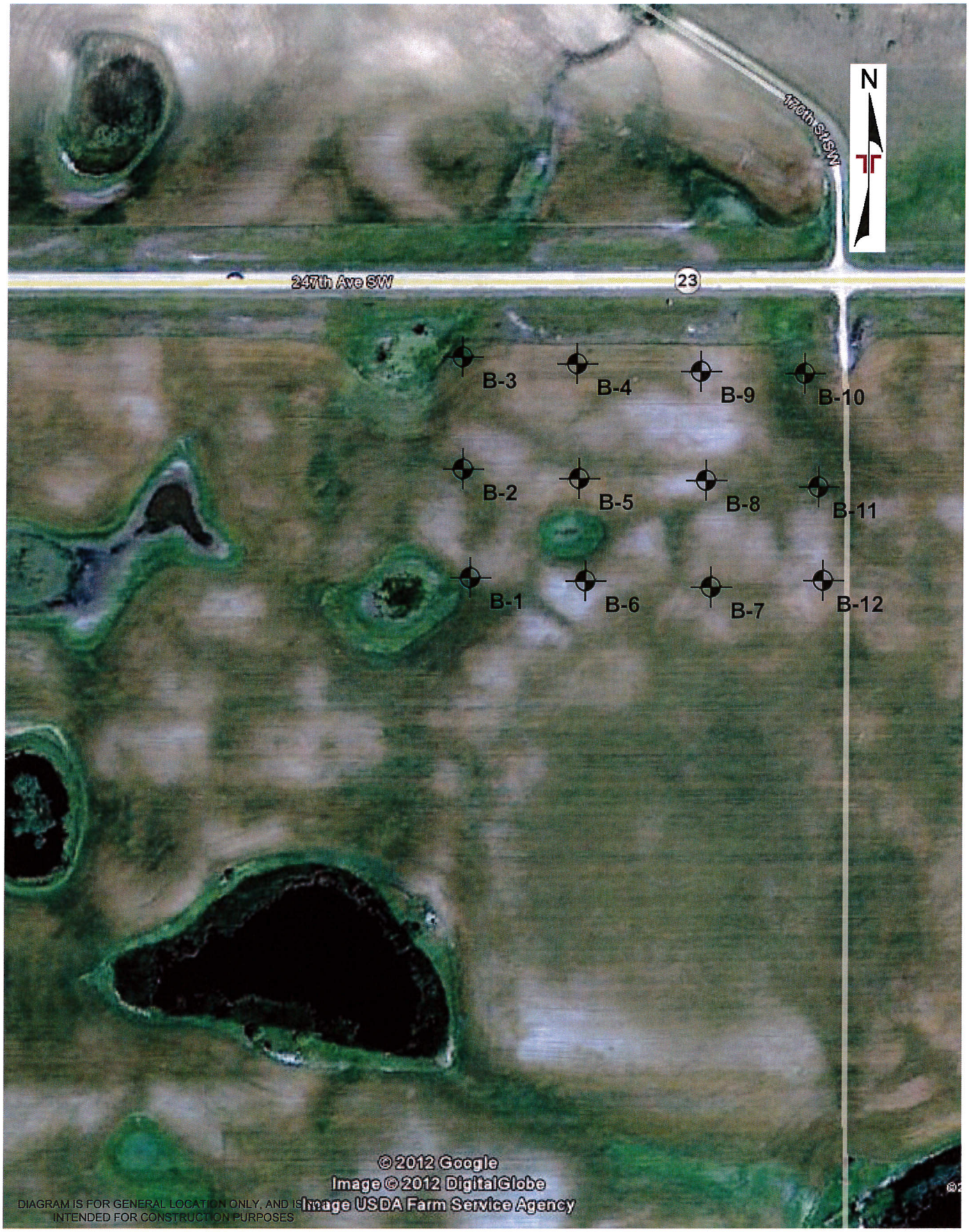

DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

Project Manager: SS	Project No. M2115106	Midwest Testing Laboratory, Inc. A Terracon Company	BORING LOCATION PLAN	FIG No.
Drawn by: SS	Scale: N.T.S		ND Highway 23 Rehabilitation Borrow Area WD-1078 Ward County, North Dakota	A-2
Checked by: CC				
Approved by: SS	Date: 3/1/2012	1805 Hancock Drive PO Box 2084 Bismarck, North Dakota 58502 PH. (701) 258-2833 FAX. (701) 258-2857		

Project Manager: SS	Project No. M2115106	Midwest Testing LABORATORY, INC. A Terracon COMPANY	BORING LOCATION PLAN	FIG No.
Drawn by: SS	Scale: N.T.S		ND Highway 23 Rehabilitation Borrow Area WD-1079 Ward County, North Dakota	A-3
Checked by: CC				
Approved by: SS	Date: 3/1/2012	1805 Hancock Drive PO Box 2084 Bismarck, North Dakota 58502 PH. (701) 258-2833 FAX. (701) 258-2857		

Project Manager: SS	Project No. M2115106	Midwest Testing LABORATORY, INC. A Terracon COMPANY	BORING LOCATION PLAN	FIG No.
Drawn by: SS	Scale: N.T.S	1805 Hancock Drive PO Box 2084 Bismarck, North Dakota 58502	ND Highway 23 Rehabilitation	A-4
Checked by: CC		PH. (701) 258-2833 FAX. (701) 258-2857	Borrow Area WD-1080	
Approved by: SS	Date: 3/1/2012		Ward County, North Dakota	

Project Manager: SS	Project No. M2115106	Midwest Testing LABORATORY, INC. A Terracon COMPANY 1805 Hancock Drive PO Box 2084 Bismarck, North Dakota 58502 PH. (701) 258-2833 FAX. (701) 258-2857	BORING LOCATION PLAN	FIG No.
Drawn by: SS	Scale: N.T.S		ND Highway 23 Rehabilitation Borrow Area WD-1081 Ward County, North Dakota	A-5
Checked by: CC				
Approved by: SS	Date: 3/1/2012			

Project Manager: SS	Project No. M2115106	Midwest Testing LABORATORY, INC. A Terracon COMPANY	BORING LOCATION PLAN
Drawn by: SS	Scale: N.T.S	1805 Hancock Drive PO Box 2084 Bismarck, North Dakota 58502	ND Highway 23 Rehabilitation Borrow Area WD-1083 Ward County, North Dakota
Checked by: CC		PH. (701) 258-2833 FAX. (701) 258-2857	FIG No.
Approved by: SS	Date: 3/1/2012		A-6

DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

Project Manager: SS	Project No. M2115106	Midwest Testing LABORATORY, INC. A Terracon COMPANY	BORING LOCATION PLAN	FIG No.
Drawn by: SS	Scale: N.T.S	1805 Hancock Drive PO Box 2084 Bismarck, North Dakota 58502	ND Highway 23 Rehabilitation	A-7
Checked by: CC		PH. (701) 258-2833 FAX. (701) 258-2857	Borrow Area WD-1084	
Approved by: SS	Date: 3/1/2012		Ward County, North Dakota	

DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

Project Manager: SS	Project No. M2115106	Midwest Testing LABORATORY, INC. A Terracon COMPANY	BORING LOCATION PLAN	FIG No.
Drawn by: SS	Scale: N.T.S		ND Highway 23 Rehabilitation Borrow Area WD-1086 Ward County, North Dakota	A-8
Checked by: CC				
Approved by: SS	Date: 3/1/2012	1805 Hancock Drive PO Box 2084 Bismarck, North Dakota 58502 PH. (701) 258-2833 FAX. (701) 258-2857		

DIAGRAM IS FOR GENERAL LOCATION ONLY AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

Project Manager: SS	Project No. M2115106	Midwest Testing LABORATORY, INC. A Terracon COMPANY	BORING LOCATION DIAGRAM
Drawn by: SS	Scale: N.T.S	1805 Hancock Drive PO Box 2084 Bismarck, North Dakota 58502	ND Highway 23 Rehabilitation Borrow Area WD-1088 Ward County, North Dakota
Checked by: CC		PH. (701) 258-2833 FAX. (701) 258-2857	
Approved by: SS	Date: 3/1/2012		

FIG No. A-9

Midwest Testing LABORATORY, INC. A Terracon COMPANY

BORING LOCATIONS

BORROW AREA WD-1076
NW1/4 SEC 22, T152N, R87W

Boring No.	Northing	Easting	Elevation
1	358,656	1,650,410	2073.62
2	359,022	1,650,427	2075.42
3	359,276	1,650,443	2078.64
4	359,265	1,650,725	2077.15
5	359,016	1,650,708	2079.27
6	358,653	1,650,676	2075.82
7	358,646	1,650,902	2078.60
8	359,013	1,650,901	2076.80
9	359,266	1,650,906	2077.39

BORROW AREA WD-1078
NE1/4 SEC 21, T152N, R85W

Boring No.	Northing	Easting	Elevation
1	358,023	1,710,670	2084.16
2	358,244	1,710,701	2085.04
3	358,527	1,710,701	2081.70
4	358,510	1,710,899	2090.71
5	358,240	1,710,885	2088.77
6	358,026	1,710,893	2096.30
7	358,027	1,711,176	2095.32
8	358,258	1,711,113	2085.73
9	358,500	1,711,127	2085.96
10	358,497	1,711,345	2072.85
11	358,247	1,711,344	2079.20
12	358,033	1,711,337	2094.19

Midwest Testing LABORATORY, INC. A Terracon COMPANY

BORROW AREA WD-1079
SW1/4 SEC 14, T152N, R85W

Boring No.	Northing	Easting	Elevation
1	360,847	1,718,985	2042.76
2	360,841	1,719,199	2043.21
3	360,996	1,719,345	2041.22
4	361,125	1,719,175	2048.17

BORROW AREA WD-1080
SW1/4 SEC 13, T152N, R85W

Boring No.	Northing	Easting	Elevation
1	359,138	1,722,160	2063.27
2	359,153	1,722,399	2071.70
3	359,273	1,722,299	2066.40
4	359,515	1,722,313	2060.63
5	359,723	1,722,323	2062.74
6	359,977	1,722,340	2053.93

BORROW AREA WD-1081
NW1/4 SEC 19, T152N, R84W

Boring No.	Northing	Easting	Elevation
1	358,317	1,728,857	2118.79
2	358,310	1,729,098	2112.84
3	358,313	1,729,406	2109.32
4	358,319	1,729,605	2102.85
5	358,086	1,729,529	2104.36
6	358,132	1,729,366	2108.42
7	358,107	1,729,109	2111.56

BORROW AREA WD-1083 NW1/4 SEC 22, T152N, R84W			
Boring No.	**Northing**	**Easting**	**Elevation**
1	358,188	1,743,427	2122.18
2	358,008	1,743,398	2112.79
3	357,947	1,743,693	2125.76
4	358,147	1,743,724	2120.68

BORROW AREA WD-1084 SE1/4 SEC 15, T152N, R84W			
Boring No.	**Northing**	**Easting**	**Elevation**
1	358,821	1,747,388	2130.49
2	358,701	1,747,366	2133.94
3	358,517	1,747,366	2129.21
4	358,487	1,747,607	2138.04
5	358,654	1,747,619	2140.10
6	358,818	1,747,631	2136.01
7	358,542	1,747,842	2124.29

BORROW AREA WD-1086 NW1/4 SEC 24, T152N, R84W			
Boring No.	**Northing**	**Easting**	**Elevation**
1	357,671	1,753,517	2130.57
2	357,990	1,753,516	2142.97
3	358,027	1,753,857	2144.31
4	358,024	1,754,134	2141.47
5	358,018	1,754,367	2148.34
6	358,021	1,754,538	2147.63
7	358,035	1,754,676	2146.12
8	357,785	1,754,271	2142.92
9	357,797	1,753,939	2152.87
10	357,798	1,753,720	2141.50
11	357,647	1,753,735	2138.15
12	357,639	1,753,976	2148.34
13	357,636	1,754,190	2155.93

BORROW AREA WD-1088 SW1/4 SEC 13, T152N, R86W			
Boring No.	**Northing**	**Easting**	**Elevation**
1	359,053	1,692,563	2101.32
2	359,034	1,692,685	2109.61
3	359,097	1,692,920	2106.36
4	359,224	1,692,816	2109.87
5	359,213	1,692,594	2106.75

APPENDIX B

LABORATORY TESTING

Borrow Investigation Report
ND State Highway 23 ■ Ward County, North Dakota
4-023(016)078, PCN 19206 and 4-923(019)087, PCN 19376
March 6, 2012 ■ MTL/Terracon Project No. M2115106

Midwest Testing LABORATORY, INC. A Terracon COMPANY

BORROW AREA WD-1076

BORING NO.	1		2	3	4	5
SAMPLE NO.	1	2	3	4	5	6
SAMPLE DEPTH (ft)	1.0-5.0	5.0-10.0	1.0-15.0	1.0-15.0	1.0-12.0	1.0-12.0
USCS CLASSIFICATION	CLAYEY SAND	SANDY LEAN CLAY	SANDY LEAN CLAY	SANDY LEAN CLAY	SANDY LEAN CLAY	SANDY LEAN CLAY
AASHTO CLASSIFICATION	A-6(3)	A-6(10)	A-7-6(13)	A-6(7)	A-6(10)	A-7-6(13)
MOISTURE RANGE (%)	15.5-25.6	19.7-25.1	19.2-23.7	11.5-20.7	13.7-23.2	15.5-26.3
AVERAGE MOISTURE (%)	19.0	21.1	21.6	18.0	18.3	19.2
OPTIMUM MOISTURE (%)	10.0	11.2	10.5	10.6	10.3	10.7
MAX DRY DENSITY (pcf)	125.0	126.0	124.0	126.4	126.4	124.8
LL/PL/PI	33/16/17	37/14/23	42/16/26	32/15/17	37/16/21	42/15/27
% PASSING NO. 200	42	57	67	54	64	64

BORROW AREA WD-1076

BORING NO.	6	7	8	9
SAMPLE NO.	7	8	9	10
SAMPLE DEPTH (ft)	1.0-8.0	1.0-7.0	1.0-7.0	2.0-9.0
USCS CLASSIFICATION	CLAYEY SAND	SANDY LEAN CLAY	SANDY LEAN CLAY	SANDY LEAN CLAY
AASHTO CLASSIFICATION	A-6(3)	A-6(8)	A-7-6(12)	A-7-6(13)
MOISTURE RANGE (%)	7.5-21.2	7.5-20.3	8.5-18.4	16.7-19.9
AVERAGE MOISTURE (%)	16.3	14.5	15.5	18.3
OPTIMUM MOISTURE (%)	8.3	9.2	11.8	11.7
MAX DRY DENSITY (pcf)	128.7	127.8	122.5	122.6
LL/PL/PI	30/14/16	37/15/22	42/15/27	43/17/26
% PASSING NO. 200	41	52	62	66

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Midwest Testing LABORATORY, INC. A Terracon COMPANY

BORROW AREA WD-1078

BORING NO.	1	2	3		4	
SAMPLE NO.	11	12	13	14	15	16
SAMPLE DEPTH (ft)	1.0-9.0	1.0-9.0	1.0-10.0	10.0-15.0	1.0-10.0	10.0-15.0
USCS CLASSIFICATION	SANDY LEAN CLAY	SANDY LEAN CLAY	SANDY LEAN CLAY	SANDY LEAN CLAY	SANDY LEAN CLAY	SANDY LEAN CLAY
AASHTO CLASSIFICATION	A-7-6(12)	A-7-6(14)	A-7-6(11)	A-6(12)	A-7-6(14)	A-7-6(14)
MOISTURE RANGE (%)	14.3-39.4	18.1-23.0	15.5-26.1	18.2-19.6	17.4-27.6	17.8-18.6
AVERAGE MOISTURE (%)	24.6	21.4	18.8	19.1	21.2	18.3
OPTIMUM MOISTURE (%)	11.6	12.9	12.1	10.5	11.8	12.4
MAX DRY DENSITY (pcf)	121.9	119.5	122.1	125.5	121.8	121.1
LL/PL/PI	44/16/28	45/16/29	41/15/26	40/15/25	43/15/28	42/15/27
% PASSING NO. 200	57	62	55	64	65	67

BORROW AREA WD-1078

BORING NO.	5	6	7		8	
SAMPLE NO.	17	18	19	20	21	22
SAMPLE DEPTH (ft)	1.0-13.0	1.0-15.0	1.0-10.0	10.0-15.0	1.0-7.0	7.0-15.0
USCS CLASSIFICATION	SANDY LEAN CLAY	SANDY LEAN CLAY	SANDY LEAN CLAY	SANDY LEAN CLAY	SANDY LEAN CLAY	SANDY LEAN CLAY
AASHTO CLASSIFICATION	A-6(9)	A-6(9)	A-6(7)	A-6(7)	A-7-6(11)	A-6(10)
MOISTURE RANGE (%)	16.4-22.6	13.4-28.1	14.0-25.2	13.5-15.9	17.3-21.2	18.4-19.5
AVERAGE MOISTURE (%)	18.4	18.0	19.6	14.5	18.5	18.6
OPTIMUM MOISTURE (%)	10.8	11.1	11.1	10.3	11.0	10.5
MAX DRY DENSITY (pcf)	124.0	125.1	123.4	127.8	122.6	125.6
LL/PL/PI	40/17/23	36/15/21	29/16/13	31/14/17	41/16/25	37/14/23
% PASSING NO. 200	56	56	65	55	60	61

BORROW AREA WD-1078

BORING NO.	9	10	11		12	
SAMPLE NO.	23	24	25	26	27	28
SAMPLE DEPTH (ft)	1.0-15.0	1.0-14.0	1.0-5.0	5.0-10.0	1.0-10.0	10.0-15.0
USCS CLASSIFICATION	SANDY LEAN CLAY	SANDY LEAN CLAY	SANDY LEAN CLAY	SANDY LEAN CLAY	CLAYEY SAND	CLAYEY SAND
AASHTO CLASSIFICATION	A-6(10)	A-7-6(14)	A-7-6(12)	A-6(11)	A-6(5)	A-6(1)
MOISTURE RANGE (%)	14.4-28.4	19.1-34.7	15.2-25.1	19.7-26.4	9.0-17.9	5.4-17.7
AVERAGE MOISTURE (%)	17.8	23.8	21.5	22.8	13.4	12.3
OPTIMUM MOISTURE (%)	11.0	11.0	11.9	12.3	10.2	9.0
MAX DRY DENSITY (pcf)	123.5	124.0	118.6	140.4	126.6	129.6
LL/PL/PI	35/14/21	42/15/27	43/17/26	37/16/21	31/14/17	26/15/11
% PASSING NO. 200	63	67	61	70	47	40

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March 6, 2012 ■ MTL/Terracon Project No. M2115106

Midwest Testing LABORATORY, INC. A Terracon COMPANY

BORROW AREA WD-1088

BORING NO.	1	2		3		4
SAMPLE NO.	29	30	31	32	33	34
SAMPLE DEPTH (ft)	1.0-9.0	1.0-8.0	8.0-15.0	1.0-10.0	10.0-15.0	1.0-15.0
USCS CLASSIFICATION	SANDY LEAN CLAY	CLAYEY SAND	SANDY LEAN CLAY	SANDY LEAN CLAY	SANDY LEAN CLAY	SANDY LEAN CLAY
AASHTO CLASSIFICATION	A-6(7)	A-6(2)	A-6(10)	A-7-6(14)	A-7-6(14)	A-6(11)
MOISTURE RANGE (%)	8.9-33.7	5.7-17.2	14.5-19.8	12.2-21.7	16.7-19.7	6.0-19.1
AVERAGE MOISTURE (%)	14.9	10.5	17	16.3	18.5	15.7
OPTIMUM MOISTURE (%)	9.3	8.6	10.8	11.0	12.5	10.9
MAX DRY DENSITY (pcf)	128.0	125.7	123.8	121.0	122.2	123.8
LL/PL/PI	32/16/16	32/17/15	39/16/23	45/18/27	43/17/26	39/14/25
% PASSING NO. 200	57	40	58	65	69	62

BORROW AREA WD-1088

BORING NO.	5
SAMPLE NO.	35
SAMPLE DEPTH (ft)	1.0-15.0
USCS CLASSIFICATION	SANDY LEAN CLAY
AASHTO CLASSIFICATION	A-6(7)
MOISTURE RANGE (%)	5.6-18.5
AVERAGE MOISTURE (%)	14.8
OPTIMUM MOISTURE (%)	10.6
MAX DRY DENSITY (pcf)	124.3
LL/PL/PI	35/15/20
% PASSING NO. 200	51

BORROW AREA WD-1079

BORING NO.	1	2	3	4
SAMPLE NO.	36	37	38	39
SAMPLE DEPTH (ft)	1.0-15.0	1.0-15.0	1.0-15.0	1.0-15.0
USCS CLASSIFICATION	SILTY SAND	SILTY SAND	SILTY SAND	SILTY SAND
AASHTO CLASSIFICATION	A-1-b(0)	A-2-4(0)	A-2-4(0)	A-2-4(0)
MOISTURE RANGE (%)	4.3-27.1	3.8-17.3	4.8-15.3	3.1-30.5
AVERAGE MOISTURE (%)	8.6	6.7	8	9.3
OPTIMUM MOISTURE (%)	9.4	9.6	10.0	10.8
MAX DRY DENSITY (pcf)	120.0	119.9	130.0	126.4
LL/PL/PI	NP	NP	NP	NP
% PASSING NO. 200	15	17	21	18

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BORROW AREA WD-1080

BORING NO.	1	2		3	4
SAMPLE NO.	40	41	42	43	44
SAMPLE DEPTH (ft)	1.0-15.0	1.0-5.0	5.0-15.0	1.0-10.0	1.0-15.0
USCS CLASSIFICATION	SILTY SAND W/ GRAVEL	CLAYEY SAND	SANDY LEAN CLAY	SAND W/ SILT & GRAVEL	SILTY SAND
AASHTO CLASSIFICATION	A-1-b(0)	A-2-6(2)	A-7-6(14)	A-1-b(0)	A-1-b(0)
MOISTURE RANGE (%)	2.9-18.5	8.4-19.3	19.8-21.7	4.1-11.8	3.7-17.6
AVERAGE MOISTURE (%)	7.2	15.2	20.7	6.2	7.8
OPTIMUM MOISTURE (%)	6.8	8.6	11.5	6.0	7.6
MAX DRY DENSITY (pcf)	137.4	131.8	124.2	132.1	121.8
LL/PL/PI	NP	33/14/19	42/14/28	NP	NP
% PASSING NO. 200	14	34	67	11	15

BORROW AREA WD-1080

BORING NO.	5		6
SAMPLE NO.	45	46	-
SAMPLE DEPTH (ft)	1.0-5.0	5.0-15.0	no sample
USCS CLASSIFICATION	CLAYEY SAND	SANDY LEAN CLAY	
AASHTO CLASSIFICATION	A-6(5)	A-7-6(13)	
MOISTURE RANGE (%)	8.6-19.7	18.7-19.4	waterbearing
AVERAGE MOISTURE (%)	14.1	19.0	at 4 feet
OPTIMUM MOISTURE (%)	8.8	13.0	
MAX DRY DENSITY (pcf)	127.3	123.6	
LL/PL/PI	32/14/18	41/15/26	
% PASSING NO. 200	47	66	

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BORROW AREA WD-1081

BORING NO.	1		2		3	4
SAMPLE NO.	47	48	49	50	51	-
SAMPLE DEPTH (ft)	1.0-7.0	7.0-15.0	10.-6.0	6.0-15.0	1.0-15.0	no sample
USCS CLASSIFICATION	CLAYEY SAND W/ GRAVEL	LEAN CLAY	CLAYEY GRAVEL W/ SAND	LEAN CLAY	SILTY SAND W/ GRAVEL	
AASHTO CLASSIFICATION	A-6(4)	A-6(13)	A-2-6(0)	A-6(12)	A-1-b(0)	
MOISTURE RANGE (%)	2.2-11.9	12.5-20.2	3.3-22.3	17.8-25.4	4.5-22.0	waterbearing
AVERAGE MOISTURE (%)	6.7	17.7	10.3	21.2	9.7	at 4 feet
OPTIMUM MOISTURE (%)	9.5	11.1	8.0	11.8	10.2	
MAX DRY DENSITY (pcf)	130.8	124.1	133.9	121.4	125.4	
LL/PL/PI	37/15/22	37/14/23	33/18/15	36/17/19	NP	
% PASSING NO. 200	40	90	19	89	19	

BORROW AREA WD-1081

BORING NO.	5	6		7	
SAMPLE NO.	52	53	54	55	56
SAMPLE DEPTH (ft)	1.0-10.0	1.0-10.0	10.0-15.0	1.0-5.0	5.0-15.0
USCS CLASSIFICATION	CLAYEY SAND W/ GRAVEL	CLAYEY GRAVEL W/ SAND	CLAYEY SAND	CLAYEY GRAVEL W/ SAND	LEAN CLAY
AASHTO CLASSIFICATION	A-2-6(0)	A-2-4(0)	A-6(5)	A-2-6(0)	A-7-6(15)
MOISTURE RANGE (%)	4.4-42.8	3.5-25.2	11.2-19.8	9.3-19.4	14.8-22.1
AVERAGE MOISTURE (%)	14.5	8.4	15.5	15.6	19.9
OPTIMUM MOISTURE (%)	7.3	6.1	9.9	7.0	11.4
MAX DRY DENSITY (pcf)	134.4	134.3	125.9	138.0	124.4
LL/PL/PI	32/18/14	30/20/10	39/17/22	33/15/18	42/16/26
% PASSING NO. 200	19	14	44	18	95

BORROW AREA WD-1083

BORING NO.	1	2	3		4
SAMPLE NO.	57	58	59	60	61
SAMPLE DEPTH (ft)	1.0-15.0	1.0-15.0	1.0-11.0	11.0-15.0	1.0-10.0
USCS CLASSIFICATION	SANDY LEAN CLAY	SANDY LEAN CLAY	SAND W/ SILT & GRAVEL	CLAYEY SAND W/ GRAVEL	SANDY LEAN CLAY
AASHTO CLASSIFICATION	A-6(10)	A-7-6(12)	A-1-b(0)	A-6(3)	A-6(9)
MOISTURE RANGE (%)	9.0-20.4	15.3-20.8	3.0-12.6	12.6-18.7	12.7-32.7
AVERAGE MOISTURE (%)	15.5	18.2	5.4	16.1	23.4
OPTIMUM MOISTURE (%)	10.1	11.3	8.0	8.7	12.1
MAX DRY DENSITY (pcf)	127.6	124.4	133.8	130.5	117.0
LL/PL/PI	38/15/23	41/16/25	NP	33/14/19	39/18/21
% PASSING NO. 200	61	65	7	38	59

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BORROW AREA WD-1084

BORING NO.	1	2	3	4	5	6
SAMPLE NO.	62	63	64	65	66	67
SAMPLE DEPTH (ft)	1.0-15.0	1.0-15.0	1.0-15.0	1.0-15.0	1.0-15.0	1.0-15.0
USCS CLASSIFICATION	SANDY LEAN CLAY	SANDY LEAN CLAY	SANDY LEAN CLAY	SANDY LEAN CLAY	SANDY LEAN CLAY	SANDY LEAN CLAY
AASHTO CLASSIFICATION	A-6(11)	A-6(7)	A-6(11)	A-6(11)	A-7-6(15)	A-7-6(14)
MOISTURE RANGE (%)	11.6-20.6	9.7-22.8	14.9-23.7	10.4-25.3	13.9-21.6	14.9-23.5
AVERAGE MOISTURE (%)	17.2	15.0	19.0	15.1	16.8	17.1
OPTIMUM MOISTURE (%)	9.1	9.9	11.0	10.2	11.3	11.6
MAX DRY DENSITY (pcf)	126.2	127.0	122.9	127.0	123.6	123.4
LL/PL/PI	38/16/22	34/13/21	39/15/24	38/14/24	43/15/28	42/15/27
% PASSING NO. 200	65	52	64	63	69	67

BORROW AREA WD-1084

BORING NO.	7
SAMPLE NO.	68
SAMPLE DEPTH (ft)	1.0-15.0
USCS CLASSIFICATION	SANDY LEAN CLAY
AASHTO CLASSIFICATION	A-7-6(14)
MOISTURE RANGE (%)	15.3-23.6
AVERAGE MOISTURE (%)	17.7
OPTIMUM MOISTURE (%)	11.6
MAX DRY DENSITY (pcf)	123.5
LL/PL/PI	44/15/29
% PASSING NO. 200	64

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BORROW AREA WD-1086

BORING NO.	1	2	3		4	
SAMPLE NO.	69	70	71	72	73	74
SAMPLE DEPTH (ft)	1.0-15.0	1.0-15.0	1.0-6.0	6.0-10.0	1.0-8.0	8.0-15.0
USCS CLASSIFICATION	SANDY LEAN CLAY	SANDY LEAN CLAY	SANDY LEAN CLAY	CLAYEY SAND W/ GRAVEL	LEAN CLAY W/ SAND	LEAN CLAY W/ SAND
AASHTO CLASSIFICATION	A-7-6(13)	A-6(13)	A-7-6(12)	A-6(4)	A-7-6(17)	A-7-6(15)
MOISTURE RANGE (%)	15.5-23.9	13.1-18.1	13.9-19.8	14.4-18.1	21.8-30.1	17.7-21.1
AVERAGE MOISTURE (%)	17.3	15.9	16.9	15.9	24.7	19.3
OPTIMUM MOISTURE (%)	10.1	10.8	12.3	10.2	13.0	10.3
MAX DRY DENSITY (pcf)	126.0	126.2	120.4	128.6	117.5	125.1
LL/PL/PI	41/15/26	40/14/26	41/15/26	35/15/20	48/19/31	43/16/27
% PASSING NO. 200	67	66	61	42	72	72

BORROW AREA WD-1086

BORING NO.	5		6	7	8
SAMPLE NO.	75	76	77	78	79
SAMPLE DEPTH (ft)	1.0-10.0	10.0-15.0	1.0-15.0	1.0-15.0	1.0-15.0
USCS CLASSIFICATION	SANDY LEAN CLAY	SANDY LEAN CLAY	LEAN CLAY W/ SAND	SANDY LEAN CLAY	SANDY LEAN CLAY
AASHTO CLASSIFICATION	A-7-6(14)	A-7-6(14)	A-7-6(15)	A-7-6(12)	A-7-6(13)
MOISTURE RANGE (%)	15.7-21.2	15.3-21.2	14.0-22.5	14.2-22.3	16.0-22.0
AVERAGE MOISTURE (%)	18.2	18.1	17.5	18.3	18.5
OPTIMUM MOISTURE (%)	12.2	11.9	11.6	11.7	11.7
MAX DRY DENSITY (pcf)	123.1	121.1	122.6	121.7	121.1
LL/PL/PI	43/16/27	43/16/27	44/17/27	41/17/24	43/17/26
% PASSING NO. 200	69	70	70	67	64

BORROW AREA WD-1086

BORING NO.	9		10		11
SAMPLE NO.	80	81	82	83	84
SAMPLE DEPTH (ft)	1.0-7.0	7.0-15.0	1.0-8.0	8.0-15.0	1.0-15.0
USCS CLASSIFICATION	SANDY LEAN CLAY	SANDY LEAN CLAY	SANDY LEAN CLAY	SANDY LEAN CLAY	SANDY LEAN CLAY
AASHTO CLASSIFICATION	A-6(12)	A-6(9)	A-7-6(14)	A-7-6(14)	A-6(9)
MOISTURE RANGE (%)	13.7-21.8	10.6-17.3	15.3-20.4	16.7-18.6	12.4-23.8
AVERAGE MOISTURE (%)	17.1	14.9	17.5	17.5	17.4
OPTIMUM MOISTURE (%)	11.7	9.6	11.0	11.1	10.2
MAX DRY DENSITY (pcf)	122.9	123.4	123.9	124.6	126
LL/PL/PI	40/15/25	36/15/21	44/17/27	42/15/27	35/14/21
% PASSING NO. 200	67	58	69	68	60

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BORROW AREA WD-1086

BORING NO.	12		13
SAMPLE NO.	85	86	87
SAMPLE DEPTH (ft)	1.0-7.0	7.0-15.0	1.0-15.0
USCS CLASSIFICATION	SANDY LEAN CLAY	SANDY LEAN CLAY	SANDY LEAN CLAY
AASHTO CLASSIFICATION	A-7-6(13)	A-6(11)	A-6(12)
MOISTURE RANGE (%)	15.5-25.0	12.0-17.4	15.4-22.9
AVERAGE MOISTURE (%)	18.6	14.8	17.2
OPTIMUM MOISTURE (%)	11.7	11.1	11.6
MAX DRY DENSITY (pcf)	120.4	125.1	122.8
LL/PL/PI	42/16/26	38/15/23	39/14/25
% PASSING NO. 200	67	66	64

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MOISTURE % AT DEPTH

BORROW AREA		WD-1076								
BORING		1	2	3	4	5	6	7	8	9
DEPTH (FT)	1	25.6	19.2	17.3	21.0	20.3	21.2	20.3	18.4	18.6
	2	17.7	19.5	17.5	14.0	20.5	14.5	15.1	13.2	18.4
	3	16.9	23.5	19.7	13.7	19.2	7.5	15.4	14.9	19.1
	4	15.5	19.6	11.5	15.3	17.2	17.7	13.6	17.7	19.9
	5	19.4	20.8	14.3	17.2	17.4	17.7	14.8	18.0	18.2
	6	19.9	21.0	14.5	17.6	18.6	17.2	14.5	17.5	17.2
	7	19.7	20.7	16.9	17.8	19.5	16.1	7.5	8.5	18.6
	8	20.8	22.3	17.3	18.9	18.8	18.8			17.9
	9	19.8	23.7	20.7	20.0	18.2				16.7
	10	25.1	21.0	20.7	19.5	19.0				
	11		22.7	19.3	21.6	15.5				
	12		22.4	20.4	23.2	26.3				
	13		22.3	19.0						
	14		23.0	20.5						
	15		22.5	20.1						

MOISTURE % AT DEPTH

BORROW AREA		WD-1078											
BORING		1	2	3	4	5	6	7	8	9	10	11	12
DEPTH (FT)	1	39.4	23.0	24.5	27.6	22.6	20.1	25.2	21.2	28.4	26.0	15.2	14.5
	2	34.8	21.6	26.1	24.9	20.1	16.9	24.6	18.9	17.5	34.7	24.2	9.4
	3	24.7	18.1	20.5	20.8	17.5	28.1	19.9	18.4	18.4	30.3	25.1	13.5
	4	19.4	20.4	18.4	21.3	19.6	15.9	18.3	17.5	21.2	23.2	22.0	9.2
	5	21.6	21.4	19.1	17.4	18.0	15.2	14.0	18.7	17.8	22.7	20.9	9.0
	6	23.0	22.5	15.8	18.2	19.2	13.4	16.1	17.3	15.8	23.3	19.7	17.9
	7	21.1	21.9	15.7	20.7	17.0	17.5	16.7	17.6	16.5	22.6	21.4	16.7
	8	23.1	22.2	15.5	20.5	17.0	18.1	17.7	18.4	15.7	23.0	22.0	12.4
	9	14.3	21.6	16.0	20.7	16.4	18.1	22.3	18.5	16.6	21.8	24.5	14.8
	10			16.0	19.5	17.3	18.5	21.5	19.5	21.9	21.6	26.4	16.1
	11			18.2	18.6	17.4	15.5	13.7	18.1	14.4	20.8		17.7
	12			19.6	18.4	17.9	17.6	13.5	18.8	15.8	20.4		17.5
	13			19.2	18.3	18.9	18.1	14.1	18.8	16.2	19.1		9.8
	14			19.5	18.3		18.7	15.3	18.3	15.8			5.4
	15			19.2	17.8		18.0	15.9	18.1	14.7			10.9

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MOISTURE % AT DEPTH

BORROW AREA		WD-1079				WD-1080						WD-1081						
BORING		1	2	3	4	1	2	3	4	5	6	1	2	3	4	5	6	7
DEPTH (FT)	1	27.1	17.3	14.0	30.5	16.5	20.0	9.6	10.7	15.3	no samples - waterbearing at 4 ft depth	10.3	21.9	9.4	no samples - waterbearing at 5 ft depth	42.8	25.2	18.9
	2	10.1	9.4	8.4	10.1	14.2	14.7	6.5	17.6	9.0		6.3	5.8	9.3		7.9	10.9	18.2
	3	11.3	7.1	6.2	7.9	10.2	13.8	4.1	13.7	8.6		4.1	4.5	6.5		10.4	4.7	12.1
	4	8.1	4.9	5.7	5.8	18.5	8.4	5.2	8.8	19.7		2.2	3.3	6.8		20.7	4.2	9.3
	5	6.1	4.0	6.3	5.0	7.1	19.3	4.6	5.2	17.9		5.0	4.0	8.2		17.2	3.5	19.4
	6	4.3	5.5	7.1	5.9	4.2	20.2	4.7	3.7	18.8		7.2	22.3	7.0		4.4	3.9	14.8
	7	7.1	4.9	10.2	4.7	3.2	20.3	8.5	3.7	18.7		11.9	17.8	4.5		5.6	4.3	22.1
	8	9.5	4.1	8.1	6.9	2.9	21.0	9.3	4.5	18.8		12.5	18.7	6.5		7.9	4.3	21.9
	9	11.5	3.8	6.8	3.1	3.2	20.7	7.3	4.7	19.1		13.8	25.4	6.4		13.2	4.1	19.9
	10	6.0	4.3	7.6	3.3	4.6	21.7	11.8	4.9	19.3		17.8	22.7	8.1			18.7	21.4
	11	6.7	4.1	5.4	6.7	4.9	21.5		5.3	19.0		20.2	21.1	9.5			11.7	20.2
	12	5.1	4.8	5.8	9.6	4.7	20.2		5.7	18.9		19.2	21.0	11.4			11.2	19.7
	13	7.6	6.3	4.8	14.6	4.7	21.1		7.6	18.8		18.8	21.4	20.1			16.3	19.8
	14	4.0	10.8	15.3	12.8	4.0	20.3		9.8	19.4		19.3	21.3	22.0			18.7	19.6
	15	3.9	8.4		13.1	4.6	19.8		11.6	18.7		19.7	21.6				19.8	19.9

MOISTURE % AT DEPTH

BORROW AREA		WD-1083				WD-1084						
BORING		1	2	3	4	1	2	3	4	5	6	7
DEPTH (FT)	1	20.4	-	8.6	32.7	18.0	22.8	16.2	18.8	19.3	22.1	23.6
	2	17.7	18.9	6.3	12.7	20.6	12.5	16.7	25.3	21.6	23.5	17.9
	3	15.4	20.8	5.8	12.7	19.9	15.0	14.9	20.4	17.5	16.4	18.5
	4	16.5	19.8	3.8	14.9	18.7	13.1	17.0	16.9	13.9	16.1	17.4
	5	16.3	17.2	3.2	15.2	12.8	14.6	17.4	10.4	15.3	16.3	17.4
	6	16.3	16.5	3.5	28.6	11.6	12.1	18.1	14.2	15.9	14.9	16.5
	7	17.4	15.3	3.7	27.6	16.0	9.7	18.8	14.2	15.0	15.3	16.5
	8	14.1	19.0	4.4	29.5	17.1	9.9	19.3	13.1	16.1	15.9	17.5
	9	16.1	18.7	4.0	30.0	16.9	15.3	18.9	13.3	15.4	15.2	15.3
	10	15.3	18.5	3.0	30.7	17.4	13.5	20.7	12.9	16.7	15.6	16.7
	11	9.0	17.5	12.6		17.4	16.1	23.7	13.2	17.4	16.4	17.4
	12	12.2	17.2	13.8		16.1	16.9	21.8	13.9	17.1	17.7	16.7
	13	14.9	17.2	18.7		18.2	18.1	20.7	15.1	17.0	16.9	17.8
	14	15.4	18.2	17.6		18.7	17.4	20.2	14.3	17.1	16.6	17.4
	15	15.4	20.3	17.8		19.3	18.2	20.1	11.2	17.3	17.2	19.5

Borrow Investigation Report
ND State Highway 23 ■ Ward County, North Dakota
4-023(016)078, PCN 19206 and 4-923(019)087, PCN 19376
March 6, 2012 ■ MTL/Terracon Project No. M2115106

Midwest Testing LABORATORY, INC. A Terracon COMPANY

MOISTURE % AT DEPTH

BORROW AREA		WD-1086												
BORING		1	2	3	4	5	6	7	8	9	10	11	12	13
DEPTH (FT)	1	23.9	17.6	16.9	-	18.8	19.3	18.2	22.0	21.8	18.5	19.6	25.0	22.9
	2	18.2	15.3	13.9	30.1	21.2	22.5	18.1	20.2	19.6	20.4	23.8	21.0	18.9
	3	15.9	14.2	17.9	22.6	18.5	19.5	22.3	16.0	18.5	19.0	14.1	18.7	18.5
	4	17.2	17.7	19.8	26.0	20.8	19.8	19.0	16.3	13.7	15.3	12.4	17.7	15.4
	5	16.3	15.7	17.0	21.8	17.5	16.6	16.3	17.5	14.5	16.9	13.4	16.5	17.6
	6	17.2	14.6	16.0	23.5	17.7	16.3	16.2	17.0	16.0	16.3	17.4	15.9	18.1
	7	18.6	14.8	15.9	24.4	17.3	14.3	16.8	16.9	15.9	17.0	17.6	15.5	17.1
	8	17.5	16.6	18.1	24.6	17.0	16.3	14.2	16.5	16.2	16.3	17.5	12.9	15.6
	9	17.7	15.9	14.4	21.0	15.7	17.4	17.4	18.7	16.4	16.7	18.0	12.0	15.4
	10	15.5	16.7	15.3	21.1	17.1	14.7	18.8	18.8	17.4	17.4	16.6	12.6	16.2
	11	16.1	18.1		18.9	16.8	17.3	20.2	18.4	10.6	16.8	16.1	13.3	16.5
	12	16.5	16.1		18.9	15.3	18.0	18.7	19.8	13.2	17.6	17.1	16.8	17.6
	13	16.2	16.5		19.5	18.5	18.2	18.4	20.3	14.5	17.7	18.7	17.4	15.7
	14	16.1	16.3		17.7	18.9	18.4	18.5	18.7	13.2	17.9	19.8	15.7	16.9
	15	16.1	13.1		18.2	21.2	14.0	21.7	21.0	17.3	18.6	18.6	17.3	16.3

MOISTURE % AT DEPTH

BORROW AREA		WD-1088				
BORING		1	2	3	4	5
DEPTH (FT)	1	11.6	17.2	21.7	17.6	-
	2	9.4	10.3	13.5	10.3	9.4
	3	9.2	9.9	12.2	6.0	5.6
	4	8.9	8.5	12.3	-	6.6
	5	14.4	7.1	15.6	13.3	-
	6	16.6	5.7	16.3	15.9	14.1
	7	13.0	8.1	16.9	16.0	16.7
	8	17.3	16.9	17.6	16.4	16.5
	9	33.7	14.5	18.0	16.4	16.6
	10		15.8	18.5	16.0	16.9
	11		14.9	19.0	17.2	17.5
	12		17.7	19.7	17.7	17.3
	13		19.8	19.2	18.6	18.2
	14		18.5	16.7	19.1	18.2
	15		18.1	18.0	19.1	18.5