Missouri River Correctional Center

HoustonEngineering Inc.

Preliminary Engineering Memorandum

To: **Burleigh County WRD**

From: **Craig Odenbach, PE**
Michael H. Gunsch, PE

Date: **April 28, 2015**

Subject: **MRCC Flood Hazard Mitigation**
Preliminary Engineering Report

BACKGROUND

The Missouri River Correctional Center (MRCC) is located on property south of the Fox Island backwater channel, west of Tavis Road and north of 48th Avenue SW (see **Figure 1**).

The MRCC and surrounding properties were subjected to significant flooding during both the 2009 ice jam event and the 2011 flood event. The extent of flooding during these two events is illustrated in **Figure 2** and **Figure 3**. Due to these recent events and the inability to adequately protect the area during the 2011 flood, the Burleigh County Water Resource District (BCWRD) was requested to assess the feasibility of providing flood protection to these properties. A feasibility assessment was completed as part of the Burleigh County Flood Hazard Mitigation Program. The MRCC site is designated as **FHMP #23** (see **Figure 4**). In addition to providing protection for the MRCC facilities, there are rural residential properties located to the east that would be protected if a flood control levee system were constructed along the Missouri River, as shown in **Figure 1**. The protection area for this facility is illustrated in **Figure 5**. There are no lots located within the Bismarck City limits included within the assessment district, as it was determined they would not benefit from the project.

This project was originally put to a vote of the residents in January, 2014. The project as originally configured was rejected by the voters at that time. Subsequently, residents have submitted a petition to re-vote the project, with signatures from a majority of the eligible voters. Also, subsequent to the initial vote, the ND State Water Commission has revised their cost share policy to allow pre-approval of assessment projects so that the reduced commitment could be voted rather than the full amount, and the State Water Commission has pre-approved this project. Therefore, the BCWRD has agreed to again sponsor the project and bring to a second vote of the residents.

DESIGN CONSIDERATIONS

Any levee system providing flood protection to the Missouri River Correctional Center and the adjoining rural residential properties must tie into the Tavis Road grade raise at the northeastern extent and into the proposed grade raise on 48th Avenue SW at the southeastern extent of the project area or use intervening high ground to achieve the required closure. The project design needs to recognize this project's function as one component of an integrated flood control system for the South Bismarck area. The connecting features are the 48th Avenue SW and Washington Street Grade Raise, **FHMP #24** and **FHMP #25**.

The proposed levee alignment illustrated in **Figure 1** was selected to coincide with the location of the existing MRCC access roadway and an existing earthen trail used to access their perimeter fencing. Staying outside the regulatory floodway was also a design requirement. The floodway boundary is shown in **Figure 1**.

The level of protection to be provided by this levee is a key design consideration. The maximum river stage during the 2011 event, at the USGS Missouri River Bismarck Stream Gage, was 19.3 feet. Thus constructing a levee system based on a 20.0 foot stage would provide protection on a 2011 event with 0.7 foot of freeboard. This approach does not provide the three feet of freeboard required for FEMA levee certification and the removal of the protected properties from the floodplain. The County has taken the position that removing properties from the designated floodplain under the National Flood Insurance Program is not a goal of their flood hazard mitigation projects.

There are those who question the need to construct to a 20.0 foot stage, given the extreme nature of the 2011 event, as the peak flows were considered equivalent to a 500-year event. However, another important consideration for flood protection in this area is the impact from ice jams. The primary Missouri River reach in Burleigh County subject to ice jam concerns is located just below the confluence of the Heart River, which is located just west of the MRCC. Ice jams have been recorded on a number of occasions and were evaluated as part of the currently effective 2005 Flood Insurance Study. The highest recorded ice jam stage at the Missouri River Gage prior to the 2009 event was 14.8 feet, recorded in 1983. Based on measured flood elevations, the 2009 ice jam event represented approximately a 50-year open water event, with equivalent flood stages between 17 feet and 18 feet in the Fox Island area. Many professionals working with Missouri River flood issues are justifiably concerned that the new river geomorphology, resulting from the 2011 flood and its associated degradation and deposition, has created a river system that is more susceptible to ice jam flooding.

For the purpose of this preliminary engineering analysis, construction to a 20.0 foot stage was assumed. The southeastern extent of the proposed levee would be coupled with the access roadway for the Missouri River Correctional Facility. The roadway/levee would include a 28 foot top width and 4:1 side slopes, which is a typical township roadway section. This would have a gravel surface to the primary buildings and access locations. This may be paved at a later date by the MRCC. This roadway/levee would be constructed with either a clay core or potentially all clay materials. The final determination on this would be the available soil materials and economic/design considerations. A geotechnical evaluation will be required to determine the final design configuration; however a proposed typical section for the roadway/levee is illustrated in **Figure 6**.

The rest of the proposed levee would be constructed as an earthen trail with a 12 foot top width and 4:1 side slopes. The trail/levee would be constructed entirely of clay materials, and would have a core trench similar to the roadway/levee. In many locations the trail/levee height is very shallow, and in these areas no core trench would be required. A typical trail section is illustrated in **Figure 7**.

FIGURE 1
Missouri River Correctional Center – Location Map

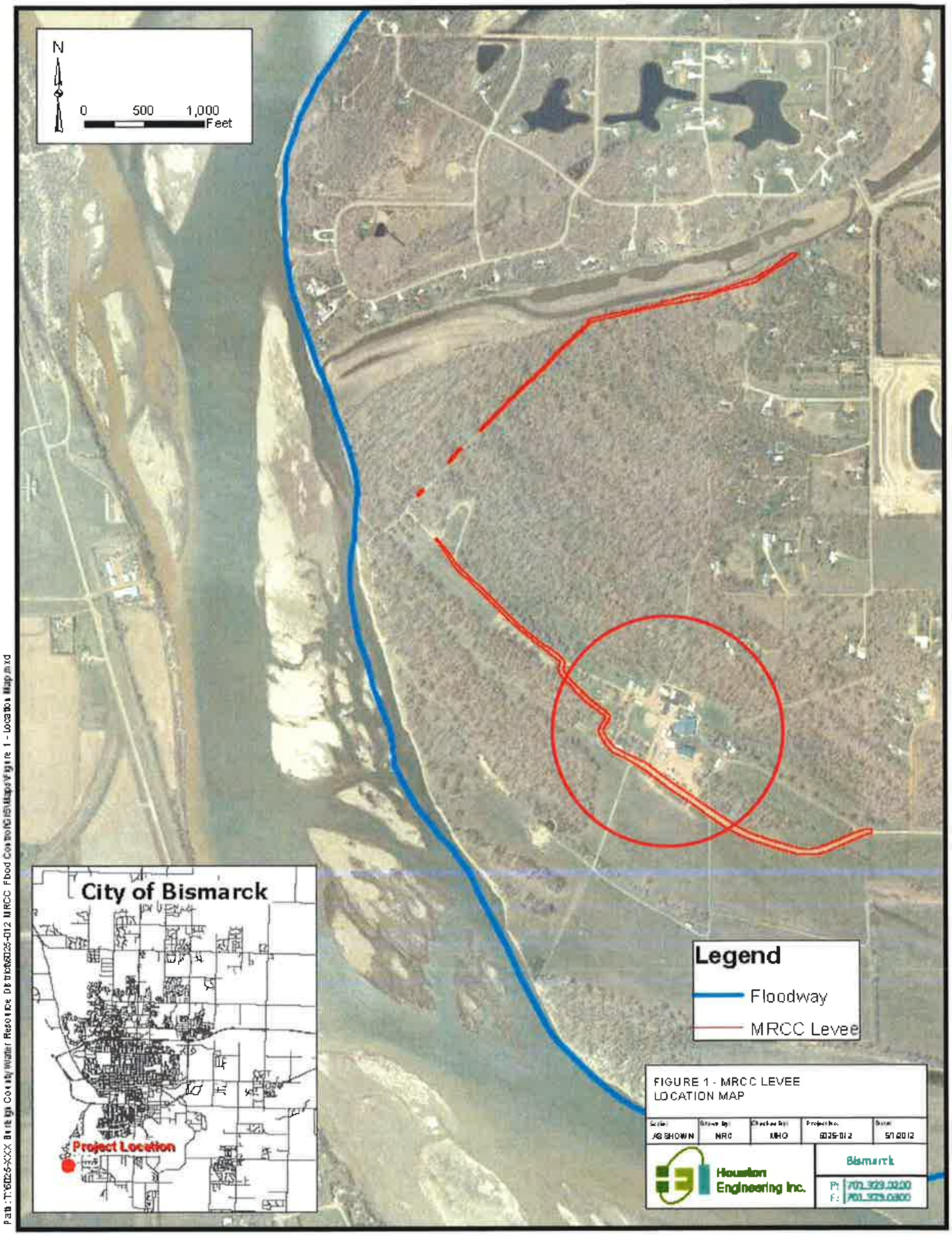


FIGURE 2

Missouri River Correctional Center - 2009 Flood Event

Looking east toward MRCC

Looking east toward MRCC – Fox Island is to the left

FIGURE 3
Missouri River Correctional Center - 2011 Flood Event (July)

FIGURE 4

Burleigh County Flood Hazard Mitigation Plan – FHMP #23, 24 and 25

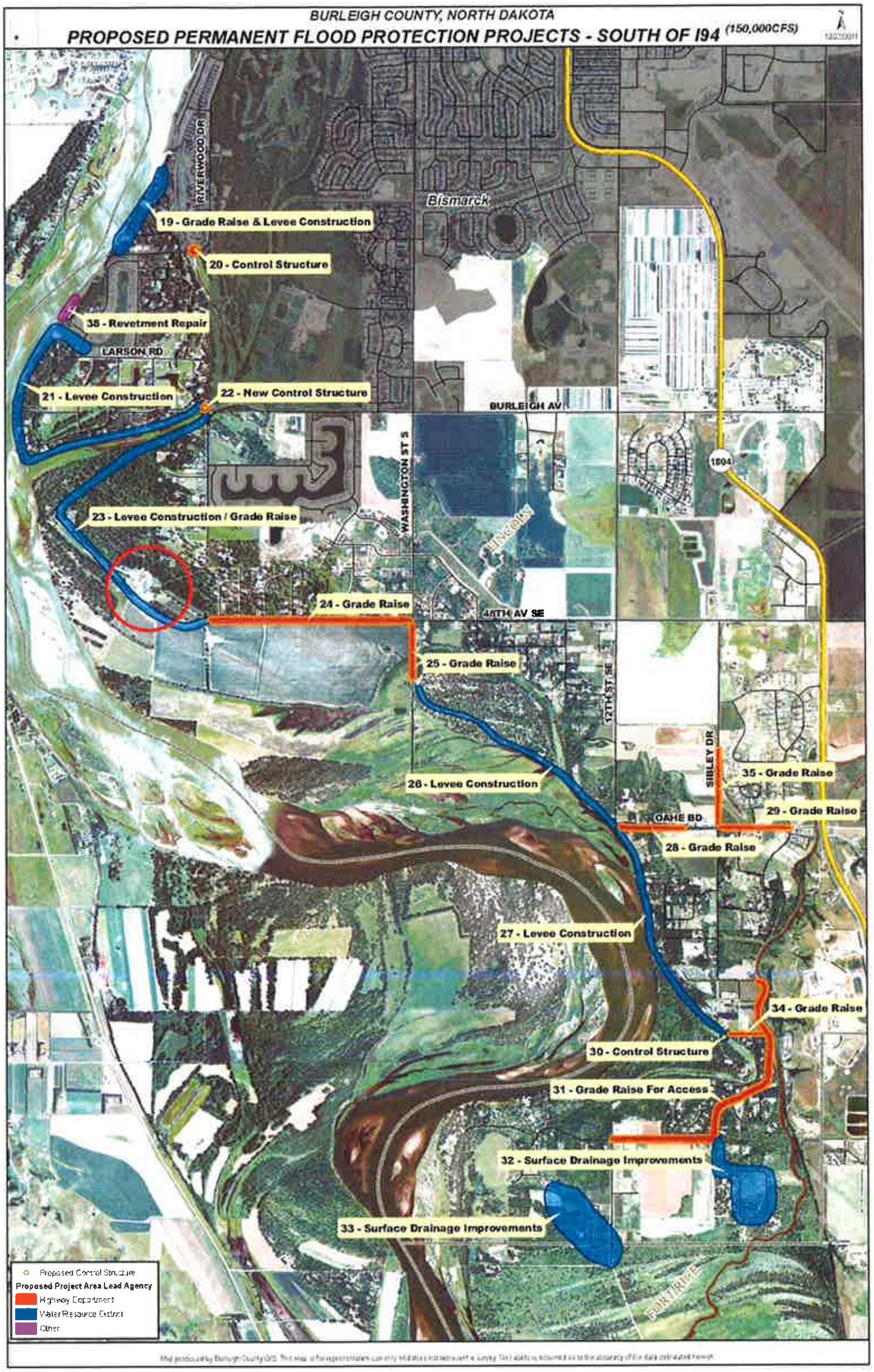
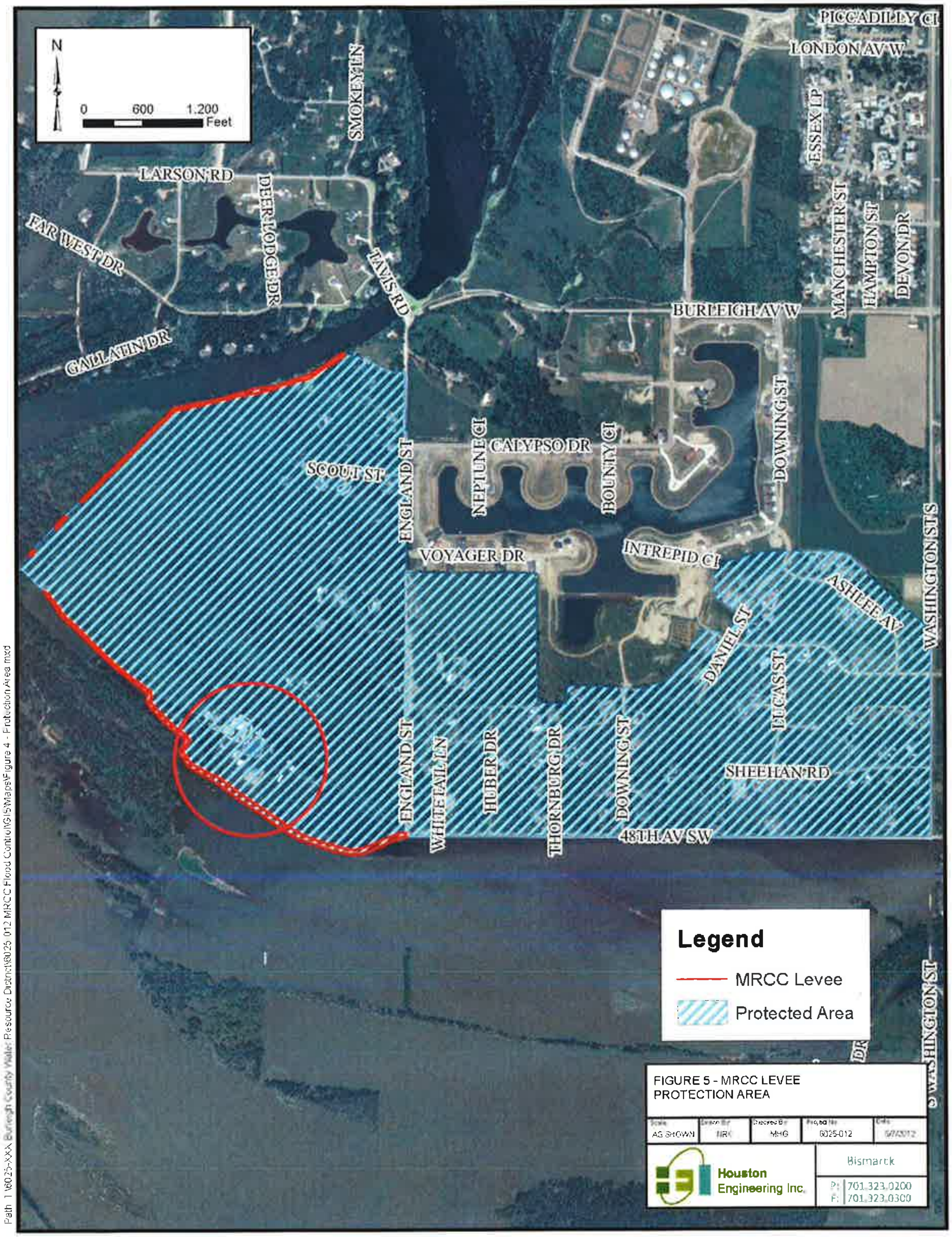


FIGURE 5
Missouri River Correctional Center – Protection Area



Path: 1:\6025-XXX Burleigh County Water Resource District\6025_012 MRCC Flood Control\GIS\Maps\Figure 4 - Protection Area.mxd

PERMITS

Since the proposed levee would be capable of diverting more than 50 acre-feet of water a construction permit would be required from the North Dakota State Engineer in accordance with North Dakota Century Code Section 61-16.1-38. No permit should be required from the Corps of Engineers under either their Section 404 or Section 10 authority, as no fill will be placed in wetlands or waters of the United States.

The levee will also be constructed completely outside the regulatory floodway but within the mapped floodplain; therefore, a floodplain development permit will be required from the Burleigh County Floodplain Administrator. The potential impacts to water surface elevations resulting from this encroachment into the floodplain as well as other proposed flood control projects in Burleigh County will be assessed separately.

OPINION OF PROBABLE CONSTRUCTION COST

The Opinion of Probable Cost (OPC) for constructing this flood hazard mitigation project was separated into two components, the roadway/levee section and the trail/levee section. These costs are based on an assumed height of 20.0 and the typical sections illustrated in **Figure 6** and **Figure 7**. These OPC's consider a number of cost factors including contingencies, engineering, geotechnical and administration. A detailed breakdown is provided at the end of this memorandum.

Roadway Construction Cost	$ 825,986
Trail Construction Cost	$ 809,540
Total Construction Cost	**$ 1,635,526**

FIGURE 6
Missouri River Correctional Center – Typical Roadway Section

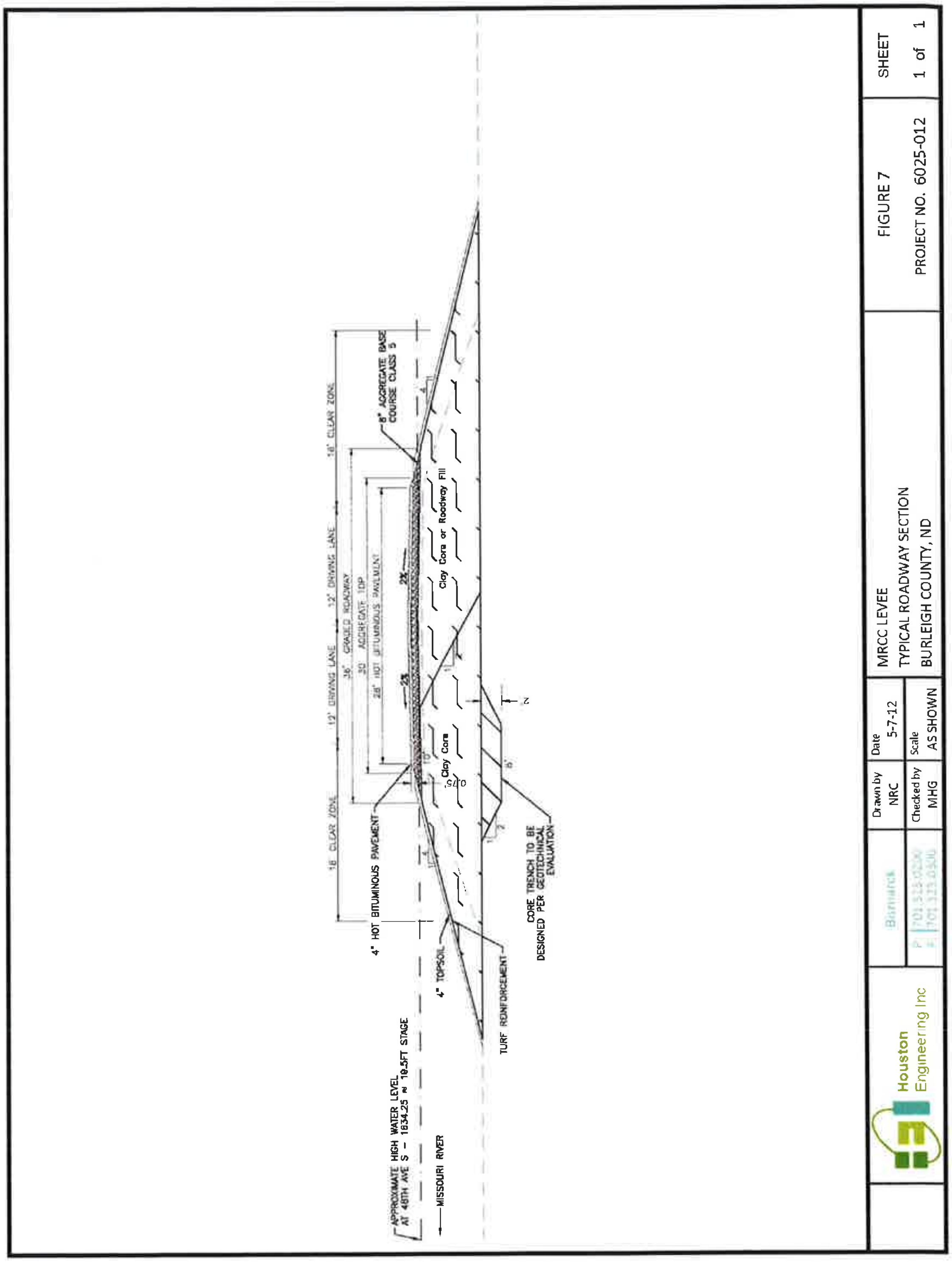
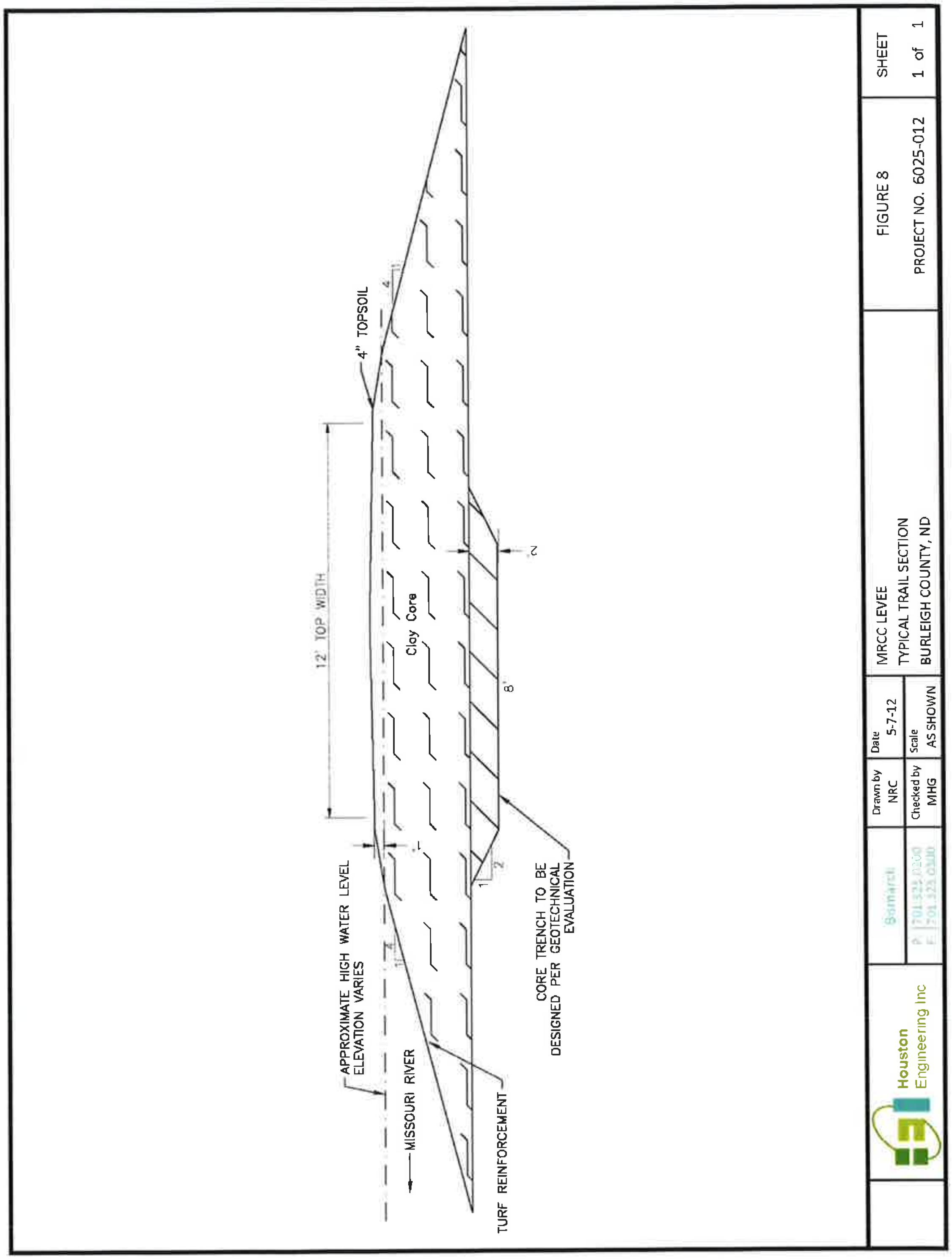


FIGURE 7
Missouri River Correctional Center – Typical Trail Section



ASSESSMENT

With the conclusion of the 2013 legislative session, the amount of money available through the Department of Corrections for construction of the Missouri River Correctional Center Flood Control Project was quantified. Subsequently, it is now necessary to develop an equitable approach for assessing the remaining costs to the private landowners.

The Department of Corrections included $349,950 in their budget for their project contribution. This number was based on preliminary opinions of probable cost for the access roadway segment of the project, assuming that the State Water Commission cost share would be available for the grade raise portion of that segment, but not the roadway surfacing. Those original cost estimates have since been updated, and the revised breakdown is provided in the following table.

	Levee	Roadway		Total Cost	SWC Assistance	MRCC	Assessed Cost
		Levee	Road Surface				
Engineering	$113,863	$93,164	$22,886	$229,913	$72,459		
Administration	$50,607	$41,407	$11,308	$103,322	0		
Geotechnical	$12,500	$12,500		$25,000	$15,000		
Construction	$632,570	$517,575	$127,146	$1,277,291	$690,087		
Total	**$809,540**	**$664,645**	**$161,341**	**$1,635,526**	**$777,546**	**$349,950**	**$508,030**

Thus, with a contribution of $349,950 from the Department of Corrections (DoC) and SWC cost share pre-approved, the total cost to be assessed to private landowners is $508,030.

A potential assessment list has been prepared, which includes all lot owners north of 48th Avenue who would have been affected by the 2011 flood event, if no emergency measures had been taken to raise 48th Avenue and England Street. This includes an area east of Washington Street as illustrated in **Figure 8** attached to this memorandum. Eliminating properties owned by the State of North Dakota leaves 154 parcels. A listing of these parcels is attached to this memorandum.

Two approaches for distributing the project cost were originally examined. One approach was to simply divide the cost equally among all parcels. Another was to divide the cost among the landowners based on the acreage owned. There are some considerations, however, that need to be weighed when determining which approach is more appropriate. Most of the benefitted area is developed as rural residential, so a majority of the lots range generally between 1.5 acres and 2.5 acres, with outliers at either end. The largest lot within the benefitted area is 39.85 acres. Then there are a handful of parcels that vary in size from 5 to 10 acres. On the other end of the spectrum, there are also a number of very small parcels less than 0.5 acre.

If costs were equally spread across all parcels, each parcel would be assessed $3,299. The downside to this approach is that the extremely small parcels would be assessed the same as the 40 acre parcel, which many may view as being less than equitable.

One alternative to address the widely varying lot sizes is to vary the assessment percentages between the smallest and the largest lots. This approach would be based on the intent of statutory language that assessments are to be based on "benefits received". In the case of the smallest lots, they are not receiving the same level of benefit, given their lack of suitability for residential use. For the largest lots, they contain only one residence even though the acreage is much larger. These larger lots may one day be subdivided, in which case it would be equitable to assess them more. Future subdivision of these properties can be addressed through the reassessment process as outlined under *NDCC 61-16.1-26 Reassessment of benefits*.

The approach that has generally been followed by the BCWRD in developing local flood control projects has been to assess equally regardless of lot size, unless there are some mitigating circumstances that justify varying the percentages based on benefits. In this case the lot size outliers need to be addressed and this justifies adjusting the approach in this instance.

The approach developed would assess all lots between 5 acres and 1 acre in size at 50% with the lots between 5 acres and 10 acres in size assessed at 75%, lots greater than 10 acres assessed at 100% and lots smaller than 1 acre assessed at 10%. This accounts for the fact that the larger lots receive a greater benefit because they have more area being protected and the smaller lots are receiving a much smaller benefit given their small size and, in some instances, their unsuitability for residential development. After additional consideration of a projected 2011 flood boundary there were several lots identified as having only partial impacts, as they are on the periphery of the flood along Glenwood Drive, but still affected. It is recommended these be assessed at 25% to recognize this status. The following table summarizes the resulting projected assessments obtained using this approach.

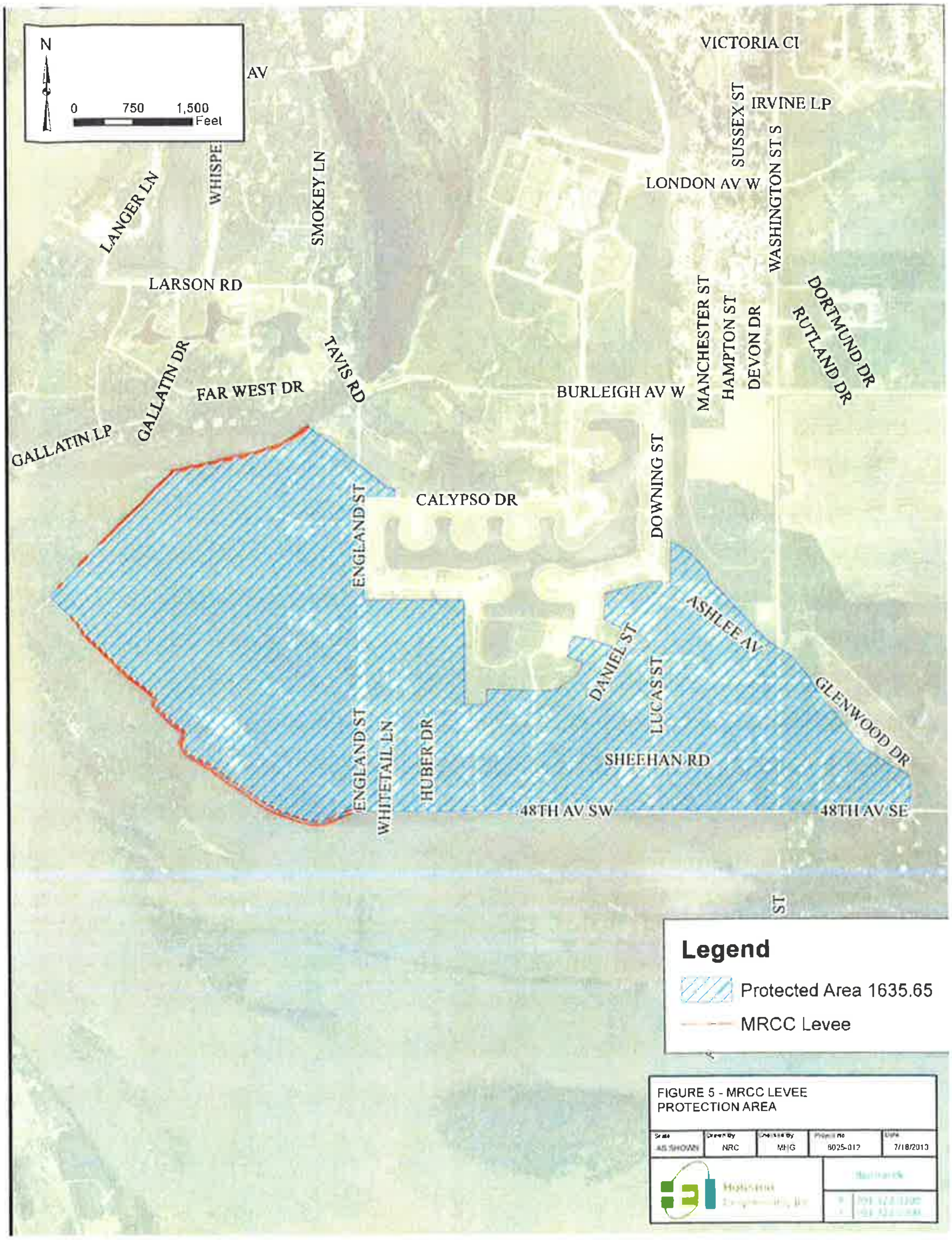
Lot Size	Percent Assessment	Assessment
➢ 10 acres	100%	$7,012
10 < > 5 acres	75%	$5,259
5 < > 1 acres	50%	$3,506
5 < > 1 acres [1]	25%	$1,753
< 1 acre	10%	$701
[1] Lots on periphery of projected 2011 event - partial impact		

A spreadsheet listing the resulting assessments is included in the Appendices.

APPENDICES

- Assessment List
- Preliminary plan and profile sheets for the proposed levee system
- Geotechnical Report

FIGURE 8
Benefitted Area



Missouri River Correctional Center Flood Control Project - 4/27/2015

Parcel ID	Owner	Property Address	Mailing Address	Mailing City	Mailing Zip	Benefit Area	% Benefit	Assessment With SWC Cost Share
38-138-80-00-19-220	NELSON, JEFFREY M & MARY ELLEN	3640 ENGLAND ST	3640 ENGLAND ST	BISMARCK ND	58504-8961	2.13	0.5	$ 3,506.07
38-138-80-00-19-250	MILLER, RANDALL R & ELIZABETH	3918 ENGLAND ST	3918 ENGLAND ST	BISMARCK ND	58504-8969	3.15	0.5	$ 3,506.07
38-138-80-00-19-255	SANDERS, BONNIE	3910 ENGLAND ST	3910 ENGLAND ST	BISMARCK ND	58504-8969	5.27	0.75	$ 5,259.11
38-138-80-00-19-270	MATTHEWS, BRIAN & JENNIFER	3912 ENGLAND ST	3912 ENGLAND ST	BISMARCK ND	58504	2.87	0.5	$ 3,506.07
38-138-80-00-19-271	MILLER, RANDALL & ELIZABETH		3918 ENGLAND ST	BISMARCK ND	58504	0.24	0.1	$ 701.21
38-138-80-00-19-275	HEATON, MATTHEW P	3908 ENGLAND ST	3908 ENGLAND ST	BISMARCK ND	58504	3.12	0.5	$ 3,506.07
38-138-80-00-19-825	JACOBSON, LAUREEN W	4310 ENGLAND ST	4220 ENGLAND ST	BISMARCK ND	58504-8963	9.93	0.75	$ 5,259.11
38-138-80-00-20-610	ROSWICK, ROBERT J & JULIE F	4315 ENGLAND ST	4315 ENGLAND ST	BISMARCK ND	58504-8970	38.88	1	$ 7,012.15
38-138-80-00-20-850	LANGER, GARY L	4620 S WASHINGTON ST	4620 S WASHINGTON ST	BISMARCK ND	58504-8014	1.64	0.5	$ 3,506.07
38-138-80-00-20-855	ZIEGLER, RAYMOND & TERRI		PO BOX 1212	BISMARCK ND	58502	0.3	0.1	$ 701.21
38-138-80-00-20-860	NELSON,STEVEN & WEIGEL,LUCILLE	280 SW 48TH AV	280 48TH AVE SW	BISMARCK ND	58504-8901	0.48	0.1	$ 701.21
38-138-80-00-20-875	ESHOO, NORMAN S & JUDY D	680 SW 48TH AV	680 48TH AVE SW	BISMARCK ND	58504-8959	12.19	1	$ 7,012.15
38-138-80-00-20-880	LEMER, JERID L & RAELENE M	540 SW 48TH AV	540 48TH AVE SW	BISMARCK ND	58504-8958	2.04	0.5	$ 3,506.07
38-138-80-00-20-882	ZIEGLER, RAYMOND & TERRI	210 SW 48TH AV	PO BOX 1212	BISMARCK ND	58502	1.17	0.5	$ 3,506.07
38-138-80-00-20-886	SIEMS, BURT F & EMMA & SIEMS,>	580 SE 48TH AV	222 W OWENS AV	BISMARCK ND	58501	4.15	0.5	$ 3,506.07
38-138-80-00-20-888	BOUCHE, KELLY M & CANDICE J	380 SW 48TH AV	515 N 16TH ST	BISMARCK ND	58501	1.56	0.5	$ 3,506.07
38-138-80-00-20-890	KVANDE, DEBORAH		302 E 3RD AVE S	CAVALIER ND	58220-4205	2.7	0.5	$ 3,506.07
38-138-80-00-20-892	SLETTEN, OLE T & GIENGER,RANEE		2500 RIVER RD	HENSLER ND	58530-9500	1.5	0.5	$ 3,506.07
38-138-80-00-20-894	SLETTEN, OLE T & GIENGER,RANEE	310 SW 48TH AV	2500 RIVER RD	HENSLER ND	58530-9500	1.96	0.5	$ 3,506.07
38-138-80-02-01-010	HEINERT, TED & NANETTE	4704 WHITE TAIL LA	3749 MONTREAL ST	BISMARCK ND	58503	2.15	0.5	$ 3,506.07
38-138-80-02-01-020	KOVASH, TODD M & KRISTI J	4604 WHITE TAIL LA	4604 WHITE TAIL LN	BISMARCK ND	58504	2.14	0.5	$ 3,506.07
38-138-80-02-01-030	BOND, ROBERT & VIRGEAN	4520 WHITE TAIL LA	4520 WHITE TAIL LN	BISMARCK ND	58504-8600	2.15	0.5	$ 3,506.07
38-138-80-02-01-040	DINGUS, PATRICK & ROSALIE	4512 WHITE TAIL LA	4512 WHITETAIL LN	BISMARCK ND	58504	2.15	0.5	$ 3,506.07
38-138-80-02-01-050	THOMPSON, MATTHEW A & JEANENE	4430 WHITE TAIL LA	3207 E AVENUE C	BISMARCK ND	58501	2.15	0.5	$ 3,506.07
38-138-80-02-02-010	ANDERSON, JORDAN & KARI	4601 WHITE TAIL LA	4601 WHITE TAIL LN	BISMARCK ND	58504	2	0.5	$ 3,506.07
38-138-80-02-02-020	RADER, BARRY & CAREY	4604 HUBER DR	1108 WESTWOOD ST	BISMARCK ND	58504	2	0.5	$ 3,506.07
38-138-80-02-02-030	PIATZ, MICHAEL	4704 HUBER DR	4704 HUBER DR	BISMARCK ND	58504	1.98	0.5	$ 3,506.07
38-138-80-02-02-040	FROELICH, MARK & CAROL	4701 WHITE TAIL LA	4701 WHITETAIL LN	BISMARCK ND	58504	2.03	0.5	$ 3,506.07
38-138-80-02-03-010	MUEHLER, MICHAEL & SUSAN	4501 HUBER DR	4501 HUBER DR	BISMARCK ND	58504-8862	2.18	0.5	$ 3,506.07
38-138-80-02-03-020	MEYHOFF, BRUCE & ROBIN	4601 HUBER DR	4601 HUBER DR	BISMARCK ND	58504	2.18	0.5	$ 3,506.07
38-138-80-02-03-030	SCHMIDT, THOMAS & CARISSA	4701 HUBER DR	1308 N 11TH ST	BISMARCK ND	58501-2704	2.15	0.5	$ 3,506.07
38-138-80-03-01-010	SPLONSKOWSKI, TIMOTHY	106 ASHLEE AV	823 LAMBTON AVE #3	BISMARCK ND	58504	2.1	0.5	$ 3,506.07
38-138-80-03-01-020	JOHNSON, MICHAEL P & KIMBERLY	130 ASHLEE AV	704 DOVER DR	BISMARCK ND	58504	1.18	0.25	$ 1,753.04
38-138-80-03-01-030	RONINGEN, MARK W & YELENA	216 ASHLEE AV	216 ASHLEE AVE	BISMARCK ND	58504	1.83	0.25	$ 1,753.04
38-138-80-03-01-040	SENGER, BRYAN L & LORRAINE	308 ASHLEE AV	308 ASHLEE AVE	BISMARCK ND	58504-8827	2.1	0.5	$ 3,506.07
38-138-80-03-01-050	SCHANER, ROBIN L & LANEE E	400 ASHLEE AV	400 ASHLEE AVE	BISMARCK ND	58504-8831	2.1	0.5	$ 3,506.07
38-138-80-03-02-010	GEIGER, DANIEL & MARILYN	4026 DANIEL ST	1702 W WICHITA DR	BISMARCK ND	58504	2.02	0.5	$ 3,506.07
38-138-80-03-02-020	SCHMITCKE, GARY & BARBARA	4114 DANIEL ST	4114 DANIEL ST	BISMARCK ND	58504-8845	1.91	0.5	$ 3,506.07
38-138-80-03-02-030	WYNVEEN, JOSHUA A & KELLY L	4126 DANIEL ST	4126 DANIEL ST	BISMARCK ND	58504	1.35	0.25	$ 1,753.04
38-138-80-03-03-010	STEFFES, CLARENCE & MAR-JO	4115 DANIEL ST	4115 DANIEL ST	BISMARCK ND	58504	2	0.5	$ 3,506.07
38-138-80-03-03-020	KLEIN, JEROME & HELEN	407 ASHLEE AV	1706 SO RENO DR	BISMARCK ND	58504-7064	2	0.5	$ 3,506.07
38-138-80-03-03-030	ELL, TODD & LORI	ASHLEE AV	2519 COOLIDGE AVE	BISMARCK ND	58501-2264	2	0.5	$ 3,506.07
38-138-80-03-03-040	KASEMAN, LENORE	223 ASHLEE AV	223 ASHLEE AVE	BISMARCK ND	58504	2	0.5	$ 3,506.07
38-138-80-03-03-050	KLEIN, JASON	201 ASHLEE AV	3805 BAY SHORE BEND SE	MANDAN ND	58554-6305	2	0.5	$ 3,506.07
38-138-80-03-03-060	FRYSLIE, THOMAS V & JUDITH H	218 GLENWOOD DR	218 GLENWOOD DR	BISMARCK ND	58504	2	0.5	$ 3,506.07
38-138-80-03-03-070	WERNER, JACK A & BONNIE L	310 GLENWOOD DR	39 CAPTAIN MARSH DR	MANDAN ND	58554	2	0.5	$ 3,506.07
38-138-80-03-03-080	STEWART, NATHAN J & KATIE C	328 GLENWOOD DR	328 GLENWOOD DR	BISMARCK ND	58504	2	0.5	$ 3,506.07
38-138-80-03-03-090	SENGER, BRYAN L & LORRAINE F	418 GLENWOOD DR	308 ASHLEE AVE	BISMARCK ND	58504	2	0.5	$ 3,506.07
38-138-80-03-03-100	KISSE, JOHN A	512 GLENWOOD DR	PO BOX 562	BISMARCK ND	58502-0562	2	0.5	$ 3,506.07
38-138-80-03-04-010	BECK, DEAN M & TRACY L	119 GLENWOOD DR	119 GLENDWOOD DR	BISMARCK ND	58504	2	0.5	$ 3,506.07
38-138-80-03-04-020	SENGER, BRYAN L & LORRAINE F	213 GLENWOOD DR	308 ASHLEE AVE	BISMARCK ND	58504	2.22	0.5	$ 3,506.07
38-138-80-03-04-030	WANNER, JESSE &	303 GLENWOOD DR	303 GLENWOOD DR	BISMARCK ND	58504	2.22	0.5	$ 3,506.07
38-138-80-03-04-040	WELTON, MATTHEW J & >	319 GLENWOOD DR	319 GLENWOOD DR	BISMARCK ND	58504-8025	2	0.5	$ 3,506.07
38-138-80-03-04-050	DOUGHERTY, MARK & MARLYS J	409 GLENWOOD DR	409 GLENWOOD DR	BISMARCK ND	58504-8026	2	0.5	$ 3,506.07
38-138-80-03-04-060	CLARK, JESSE D & SARA M	4405 LUCAS ST	4405 LUCAS ST	BISMARCK ND	58504	2	0.5	$ 3,506.07
38-138-80-03-04-070	CROTEAU, JAMES E & LYNN A	408 COURTNEY CI	1624 N LYNCH	MESA AZ	85207-3181	1.49	0.5	$ 3,506.07
38-138-80-03-04-080	HAGEN, DUSTIN L & TRISHA E	324 COURTNEY CI	PO BOX 338	BISMARCK ND	58502	1.5	0.5	$ 3,506.07
38-138-80-03-04-090	HARTMAN, CINDY	331 COURTNEY CI	6700 KINGSWOOD RD	BISMARCK ND	58503-9255	1.62	0.5	$ 3,506.07
38-138-80-03-04-100	FAHRNI, LOWELL & CORRIN	4420 S WASHINGTON ST	4420 S WASHINGTON ST	BISMARCK ND	58504	1.5	0.5	$ 3,506.07

Total Assessed Percentage	72.45
Total Assessed Value	$ 508,030.00
Total Assessment Per Area	$ 7,012.15

38-138-80-03-04-110	JACOBSON, COLT A & JENNA M	320 SHEEHAN RD	12045 89TH AVE SE	BISMARCK ND	58504	2	0.5	$	3,506.07
38-138-80-03-04-120	TABORSKY, LARRY & AMY	413 COURTNEY CI	2810 NORWOOD LN	VENICE FL	34292-7415	2	0.5	$	3,506.07
38-138-80-03-05-010	SAND, ROSELLEN M	527 SHEEHAN RD	527 SHEEHAN RD	BISMARCK ND	58504	2	0.5	$	3,506.07
38-138-80-03-05-020	SCHOCK, DARIN L & STACY L	509 SHEEHAN RD	509 SHEEHAN RD	BISMARCK ND	58504	2	0.5	$	3,506.07
38-138-80-03-05-030	ELSBERRY, TERRY & JULIE	421 SHEEHAN RD	3900 HWY 2 & 52 W	MINOT ND	58701-2813	2	0.5	$	3,506.07
38-138-80-03-05-040	UNRATH, CHAD & ERICA	325 SHEEHAN RD	325 SHEEHAN RD	BISMARCK ND	58504	1.52	0.5	$	3,506.07
38-138-80-03-06-010	KELLER, KEN & MARION	4309 DANIEL ST	3723 RUSSETT LN	NORTHBROOK IL	60062-4254	2	0.5	$	3,506.07
38-138-80-03-06-020	BERGSTROM, DENNIS & SANDY	4314 LUCAS ST	33 LITTLE KNIFE	NEW TOWN ND	58763	2	0.5	$	3,506.07
38-138-80-03-06-030	ARTZ, JONATHAN D & LOREN L	506 KAMBRI CI	506 KAMBRI CI	BISMARCK ND	58504-7511	1.62	0.5	$	3,506.07
38-138-80-03-06-040	SELK, RODY & JENNIFER	4403 DANIEL ST	4403 DANIEL ST	BISMARCK ND	58504	1.62	0.5	$	3,506.07
38-138-80-03-06-050	BOECKEL, TRAVIS L & ALICIA M	517 KAMBRI CI	517 KAMBRI CIR	BISMARCK ND	58504	1.51	0.5	$	3,506.07
38-138-80-03-06-060	HILL, JASON D	505 KAMBRI CI	PO BOX 273	STANTON ND	58571	1.5	0.5	$	3,506.07
38-138-80-03-06-070	HODGE, TIFFANY A	4520 LUCAS ST	409 SOUTHWOOD AVE	BISMARCK ND	58504-6258	2	0.5	$	3,506.07
38-138-80-03-06-080	SAND, ROSELLEN M	526 SHEEHAN RD	527 SHEEHAN RD	BISMARCK ND	58504	2	0.5	$	3,506.07
38-138-80-03-07-010	WOODKE, STEVEN P & LEAH R	4306 DANIEL ST	4306 DANIEL ST	BISMARCK ND	58504	2	0.5	$	3,506.07
38-138-80-03-07-020	THOMPSON, ROGER W & SANDY K	4324 DANIEL ST	4324 DANIEL ST	BISMARCK ND	58504-8825	1.56	0.5	$	3,506.07
38-138-80-03-07-030	SORENSON, DAVID & JESSICA	4406 DANIEL ST	4406 DANIEL ST	BISMARCK ND	58504	1.6	0.5	$	3,506.07
38-138-80-0A-01-010	FERDERER, WAYNE R & JACQUI J	3550 ENGLAND ST	3550 ENGLAND ST	BISMARCK ND	58504-8967	3.85	0.25	$	1,753.04
38-138-80-0D-01-010	GJESTVANG, RORY	3500 ENGLAND ST	3500 ENGLAND ST	BISMARCK ND	58504-8967	0.82	0.1	$	701.21
38-138-80-0E-01-010	HUBER, GARY L & GEORGIE ANN	4500 THORNBURG DR	4500 THORNBURG DR	BISMARCK ND	58504	5.08	0.75	$	5,259.11
38-138-80-0G-01-010	NELSON, GREGORY T	3760 ENGLAND ST	3760 ENGLAND ST	BISMARCK ND	58504-8968	2.03	0.5	$	3,506.07
38-138-80-0G-01-020	NELSON, GREGORY T	1604 SCOUT ST	3760 ENGLAND ST	BISMARCK ND	58504-8968	2.07	0.5	$	3,506.07
38-138-80-0G-01-030	NELSON BUILDERS LLC	1700 SCOUT ST	1205 VOYAGER DR	BISMARCK ND	58504	2.21	0.5	$	3,506.07
38-138-80-0G-01-040	HUBBARD, MATTHEW & GWEN	3710 ENGLAND ST	3710 ENGLAND ST	BISMARCK ND	58504-8968	2.92	0.5	$	3,506.07
38-138-80-0G-01-050	HUBBARD, MATTHEW & GWEN	1730 SCOUT ST	3710 ENGLAND ST	BISMARCK ND	58504-8968	1.54	0.5	$	3,506.07
38-138-80-0G-01-060	ANDRE, ANN	1740 SCOUT ST	2200 FAR WEST DR	BISMARCK ND	58504-8835	1.55	0.5	$	3,506.07
38-138-80-0G-02-010	BALZER, GENE K & LORI A	1517 SCOUT ST	1517 SCOUT ST	BISMARCK ND	58504	1.31	0.5	$	3,506.07
38-138-80-0G-02-020	WHITTEMORE, DAVID & PAMELA	1601 SCOUT ST	1834 E CAPITOL AVE #234	BISMARCK ND	58501	1.3	0.5	$	3,506.07
38-138-80-0G-02-030	PRESZLER, DALE & KRISTI	1617 SCOUT ST	1617 SCOUT ST	BISMARCK ND	58504-8813	1.32	0.5	$	3,506.07
38-138-80-0G-02-040	HEINERT, RAYMOND A & BECKY K	1701 SCOUT ST	1701 SCOUT ST	BISMARCK ND	58504	1.28	0.5	$	3,506.07
38-138-80-0G-02-050	TORGERSON, EARL T & PAMELA J	1717 SCOUT ST	1733 SCOUT ST	BISMARCK ND	58504-8849	1.43	0.5	$	3,506.07
38-138-80-0G-02-060	TORGERSON, EARL T & PAMELA J	1733 SCOUT ST	1733 SCOUT ST	BISMARCK ND	58504-8849	1.67	0.5	$	3,506.07
38-138-80-0J-01-010	DEICHERT, RYAN & SARA	3820 ENGLAND ST	414 N 22ND ST	BISMARCK ND	58501	1.59	0.5	$	3,506.07
38-138-80-14-01-010	BLOTSKE, ALLEN & JOANN	4110 ENGLAND ST	4110 ENGLAND ST	BISMARCK ND	58504-8990	3.62	0.5	$	3,506.07
38-138-80-14-01-015	BLOTSKE, ALLEN & JOANN	4106 ENGLAND ST	4110 ENGLAND ST	BISMARCK ND	58504-8990	1.49	0.5	$	3,506.07
38-138-80-21-01-010	FAZEKAS, MICHAEL & LORETTA	3906 ENGLAND ST	3906 ENGLAND ST	BISMARCK ND	58504	1.56	0.5	$	3,506.07
38-138-80-21-01-020	FAZEKAS, MICHAEL & LORETTA	3902 ENGLAND ST	3906 ENGLAND ST	BISMARCK ND	58504	1.57	0.5	$	3,506.07
38-138-80-22-01-010	JACOBSON, LAUREEN W	4220 ENGLAND ST	4220 ENGLAND ST	BISMARCK ND	58504-8963	5	0.5	$	3,506.07
38-138-80-24-01-010	LIPP, TOM & KATHY	4744 THORNBURG DR	4744 THORNBURG DR	BISMARCK ND	58504-8812	1.91	0.5	$	3,506.07
38-138-80-24-01-020	SPEIDEL, JERRY & DONNA	4660 THORNBURG DR	4660 THORNBURG DR	BISMARCK ND	58504-8810	1.99	0.5	$	3,506.07
38-138-80-24-01-030	MUEHLER, WAYNE A	4530 THORNBURG DR	4530 THORNBURG DR	BISMARCK ND	58504-8808	1.98	0.5	$	3,506.07
38-138-80-24-02-010	LADUCER, JAMES K	4745 THORNBURG DR	4616 EARHART DR	BISMARCK ND	58504	1.89	0.5	$	3,506.07
38-138-80-24-02-020	ZAINHOFSKY,FREDERICK J & MYRNA	4655 THORNBURG DR	1207 S 7TH ST	BISMARCK ND	58504-6536	1.97	0.5	$	3,506.07
38-138-80-24-02-030	ZAINHOFSKY, JON F & KATI L	4505 THORNBURG DR	4505 THORNBURG DR	BISMARCK ND	58504-8808	1.97	0.5	$	3,506.07
38-138-80-24-02-040	OLHEISER, CASEY & LACEY	4435 THORNBURG DR	4435 THORNBURG DR	BISMARCK ND	58504	2	0.5	$	3,506.07
38-138-80-24-02-050	ROGSTAD, DAVID	4600 DOWNING ST	4600 DOWNING ST	BISMARCK ND	58504	1.95	0.5	$	3,506.07
38-138-80-24-02-060	COLLING, MICHEAL & JAN	4700 DOWNING ST	4700 DOWNING ST	BISMARCK ND	58504-8816	1.95	0.5	$	3,506.07
38-138-80-24-02-070	HOUSE, RYAN B	4730 DOWNING ST	4730 DOWNING ST	BISMARCK ND	58504	1.84	0.5	$	3,506.07
38-138-80-24-03-010	BEAN, DAMIAN & LISA	4735 DOWNING ST	4735 DOWNING ST	BISMARCK ND	58504-8817	1.86	0.5	$	3,506.07
38-138-80-24-03-020	HELLMAN, KORY D & TANIA	4705 DOWNING ST	4705 DOWNING ST	BISMARCK ND	58504	1.95	0.5	$	3,506.07
38-138-80-24-03-030	BRAUNBERGER, GARY S & JODY L	4607 DOWNING ST	4525 DOWNING ST	BISMARCK ND	58504-8804	1.96	0.5	$	3,506.07
38-138-80-24-03-040	BRAUNBERGER, GARY S & JODY L	4525 DOWNING ST	4525 DOWNING ST	BISMARCK ND	58504-8804	1.95	0.5	$	3,506.07
38-138-80-24-03-050	NEUMANN, CASEY J & GENA M	4429 DOWNING ST	4429 DOWNING ST	BISMARCK ND	58504	1.95	0.5	$	3,506.07
38-138-80-24-04-010	SMITH, STEPHANIE A	4420 THORNBURG DR	4420 THORNBURG DR	BISMARCK ND	58504	1.97	0.5	$	3,506.07
38-138-80-24-04-020	BURTNESS, JASON; JORJA; KRISTI	4440 THORNBURG DR	4440 THORNBURG DR	BISMARCK ND	58504	2.2	0.5	$	3,506.07
38-138-80-27-01-010	WETCH, TIM & CARLA	4002 ENGLAND ST	3924 ENGLAND ST	BISMARCK ND	58504	0.29	0.1	$	701.21
38-138-80-27-01-020	IGOE, CODY	4022 ENGLAND ST	815 N 32ND ST	BISMARCK ND	58501	1.5	0.5	$	3,506.07
38-138-80-27-01-030	MILLER, DENNIS S & TAMARA M	4030 ENGLAND ST	4030 ENGLAND ST	BISMARCK ND	58504	3.09	0.5	$	3,506.07
38-138-80-27-01-040	STEELE, CHAD &	4100 ENGLAND ST	605 YORKSHIRE LN	BISMARCK ND	58504	1.5	0.5	$	3,506.07
38-138-80-27-01-050	ECKROTH, RODNEY & LUWANNA	4304 ENGLAND ST	4330 ENGLAND ST	BISMARCK ND	58504	1.55	0.5	$	3,506.07
38-138-80-27-01-060	ECKROTH, RODNEY & LUWANNA	4330 ENGLAND ST	4330 ENGLAND ST	BISMARCK ND	58504	7.59	0.75	$	5,259.11
38-138-80-35-01-010	LEINIUS, NEIL C & JANE K	4403 GLENWOOD DR	1119 UNIVERSITY DR #1324	BISMARCK ND	58504	1.21	0.25	$	1,753.04
38-138-80-35-01-020	SCHMIDT, DAN & MICHELLE	4423 GLENWOOD DR	1524 OMAHA DRIVE	BISMARCK ND	58504-7126	0.27	0.1	$	701.21
38-138-80-35-02-010	LADUCER, JAMES K & SUSAN C	4404 GLENWOOD DR	4616 EARHART LN	BISMARCK ND	58504-7681	2.02	0.5	$	3,506.07
38-138-80-35-02-020	POLLERT, WYATT W & KELLY L	4444 GLENWOOD DR	4444 GLENWOOD DR	BISMARCK ND	58504-8067	1.66	0.25	$	1,753.04

38-138-80-35-02-030	POLLERT, WYATT W & KELLY L	4488 GLENWOOD DR	4444 GLENWOOD DR	BISMARCK ND	58504	1.21	0.25	$	1,753.04
38-138-80-35-02-040	LADUCER, JAMES K & SUSAN C	4504 EARHART LA	4616 EARHART LN	BISMARCK ND	58504-7681	1.29	0.25	$	1,753.04
38-138-80-35-02-050	LADUCER, JAMES K & SUSAN C	4535 EARHART LA	4616 EARHART LN	BISMARCK ND	58504-7681	2.18	0.5	$	3,506.07
38-138-80-35-02-060	LADUCER, JAMES K & SUSAN C		4616 EARHART LN	BISMARCK ND	58504-7681	2.02	0.5	$	3,506.07
38-138-80-35-02-080	LADUCER, JAMES K & SUSAN C	4616 EARHART LA	4616 EARHART LN	BISMARCK ND	58504-7681	4.12	0.5	$	3,506.07
38-138-80-35-02-090	GAYTON, ROBERT H & ROXANA M	4700 EARHART LA	4700 EARHART LN	BISMARCK ND	58504-7679	1.94	0.5	$	3,506.07
38-138-80-35-02-100	STUMPF, CLIFFORD J	4730 EARHART LA	4730 EARHART LN	BISMARCK ND	58504-7679	1.94	0.5	$	3,506.07
38-138-80-35-03-010	MARTELL, IRENE M	4733 EARHART LA	4733 EARHART LN	BISMARCK ND	58504-7679	2.43	0.5	$	3,506.07
38-138-80-35-03-020	FETCH, KENNETH	4701 EARHART LA	4701 EARHART LN	BISMARCK ND	58504-7679	2	0.5	$	3,506.07
38-138-80-35-03-030	WAGNER, FRANKLIN & ANGELINE	4611 EARHART LA	4611 EARHART LN	BISMARCK ND	58504-7681	2.05	0.5	$	3,506.07
38-138-80-35-03-040	AXVIG, RANDY & SUSAN	4550 GLENWOOD DR	4550 GLENWOOD DR	BISMARCK ND	58504-8000	1.59	0.25	$	1,753.04
38-138-80-35-03-050	PUKLICH, ELYSE L & >	4570 GLENWOOD DR	4570 GLENWOOD DR	BISMARCK ND	58504	1.31	0.25	$	1,753.04
38-138-80-35-03-060	RAKOWSKI, RANDY L & JANA L	4620 GLENWOOD DR	4620 GLENWOOD DR	BISMARCK ND	58504-8003	1.17	0.25	$	1,753.04
38-138-80-35-03-070	SKJONSBY, RICHARD W &	4646 GLENWOOD DR	PO BOX 4105	BISMARCK ND	58502-4105	2.31	0.25	$	1,753.04
38-138-80-35-03-090	REUTHER, WAYNE A & KAREN L	4746 GLENWOOD DR	4746 GLENWOOD DR	BISMARCK ND	58504-8066	3.37	0.5	$	3,506.07
38-138-80-50-00-010	HARILDSTAD, DERRICK & NICOLE	4730 S WASHINGTON ST	4730 S WASHINGTON ST	BISMARCK ND	58504-8016	1.23	0.5	$	3,506.07
38-138-80-61-01-010	LARSON, DAVID K & DEBORAH A	3600 ENGLAND ST	3600 ENGLAND ST	BISMARCK ND	58504	3.58	0.25	$	1,753.04
38-138-80-61-01-030	BOGERT, MARK W & DEBORAH	3700 ENGLAND ST	3700 ENGLAND ST	BISMARCK ND	58504-8968	2.4	0.5	$	3,506.07
38-138-80-67-01-010	ZOLLER, WILLIAM & SHERYL	160 SW 48TH AV	160 SW 48TH AVE	BISMARCK ND	58504	1.05	0.1	$	701.21
38-138-80-73-01-010	HAUSAUER, LORI J	4430 S WASHINGTON ST	4430 S WASHINGTON ST	BISMARCK ND	58503-8010	1.91	0.5	$	3,506.07
38-138-80-73-01-020	THOMPSON, ROBERT W & LAVERNE	4410 S WASHINGTON ST	4410 S WASHINGTON ST	BISMARCK ND	58504-8010	1.5	0.5	$	3,506.07
38-138-80-76-01-010	MOSER, WADE & LYNN	3425 ENGLAND ST	1105 W BURLEIGH AVE	BISMARCK ND	58504	1.77	0.25	$	1,753.04
38-138-80-81-03-090	NEUMANN, CASEY & GENA		4429 DOWNING ST	BISMARCK ND	58504	1.6	0.5	$	3,506.07
38-138-80-83-01-010	LARSON, DAVID K & DEBORAH A		3600 ENGLAND ST	BISMARCK ND	58504	1.47	0.25	$	1,753.04
38-138-80-89-01-010	STUMPF, DANA	110 SHEEHAN RD	110 SHEENAN RD	BISMARCK ND	58504-8978	1.95	0.5	$	3,506.07
38-138-80-89-01-020	KLEIN, MARK & RENEA	200 SHEEHAN RD	200 SHEEHAN RD	BISMARCK ND	58504-8972	1.99	0.5	$	3,506.07
38-138-80-89-01-030	GOETZFRIED, DARRIN M & TRCEY A	230 SHEEHAN RD	230 SHEEHAN RD	BISMARCK ND	58504-8972	2.15	0.5	$	3,506.07
38-138-80-89-02-010	FISCHER, RANDAL L & STACY J	201 SHEEHAN RD	201 SHEEHAN RD	BISMARCK ND	58504-8972	2.03	0.5	$	3,506.07
38-138-80-89-02-020	REICHERT, MATHEW E & SHELLY M	231 SHEEHAN RD	231 SHEEHAN RD	BISMARCK ND	58504	1.86	0.5	$	3,506.07
38-138-80-91-01-010	WETCH, TIMOTHY P & CARLA M	3924 ENGLAND ST	3924 ENGLAND ST	BISMARCK ND	58504-8969	2.47	0.5	$	3,506.07

$ 508,030.00

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

PRELIMINARY

No.	Revision	Date	By

Houston Engineering Inc.

Bismarck

P: 701.323.0200
F: 701.323.0300

Drawn by	Date	
NRC	5-7-12	MRCC FLOOD CONTROL ROADWAY/LEVEE
Checked by	Scale	
MHG	AS SHOWN	Burleigh County, ND

Overview

PROJECT NO. 6025-012

SHEET 1 of 5

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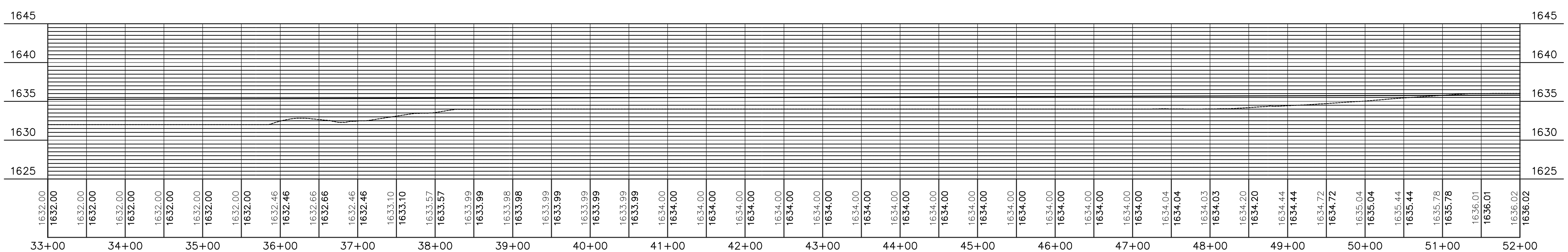

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PRELIMINARY

No.	Revision	Date	By

Houston Engineering Inc.

Bismarck
P: 701.323.0200
F: 701.323.0300

Drawn by	Date		
NRC	5-7-12	MRCC Levee	Plan & Profile Sta. 33-52 PROJECT NO. 6025-012
Checked by	Scale		SHEET
MHG	AS SHOWN	Burleigh County, ND	3 of 5

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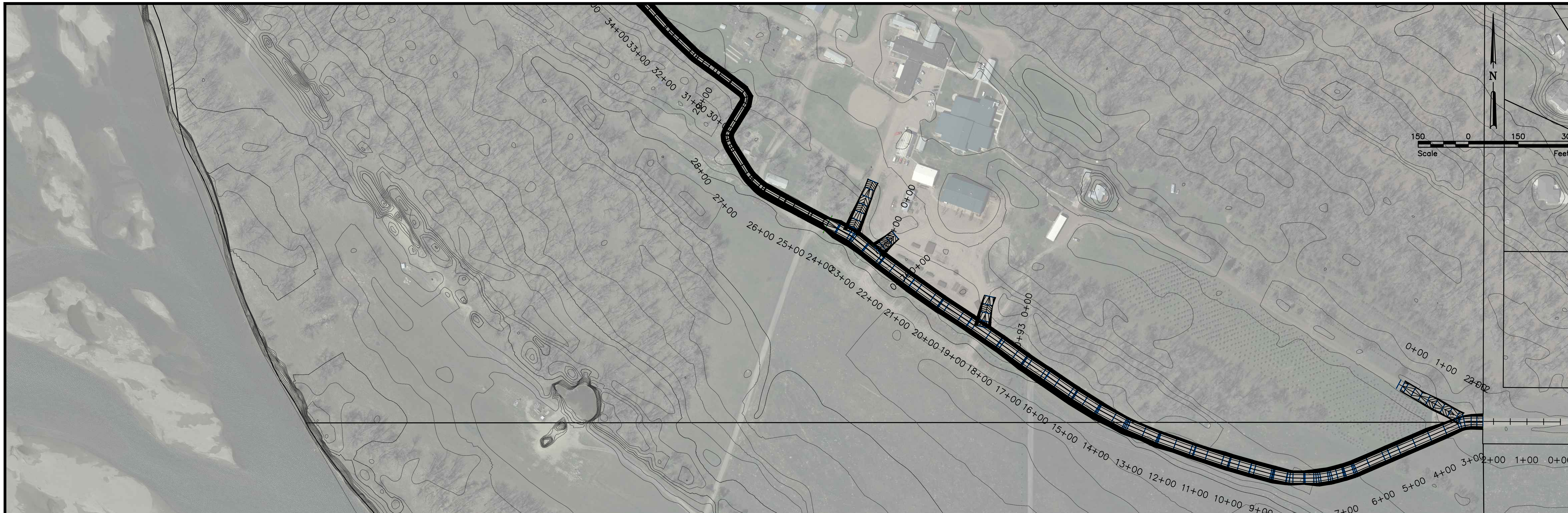

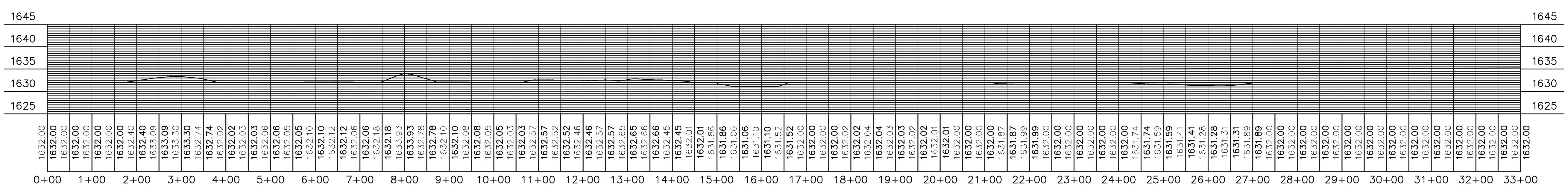

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No.	Revision	Date	By

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Bismarck
P: 701.323.0200
F: 701.323.0300

Drawn by	Date
NRC	5-7-12
Checked by	Scale
MHG	AS SHOWN

MRCC Levee
Burleigh County, ND

Plan & Profile
Sta. 0-33
PROJECT NO. 6025-012

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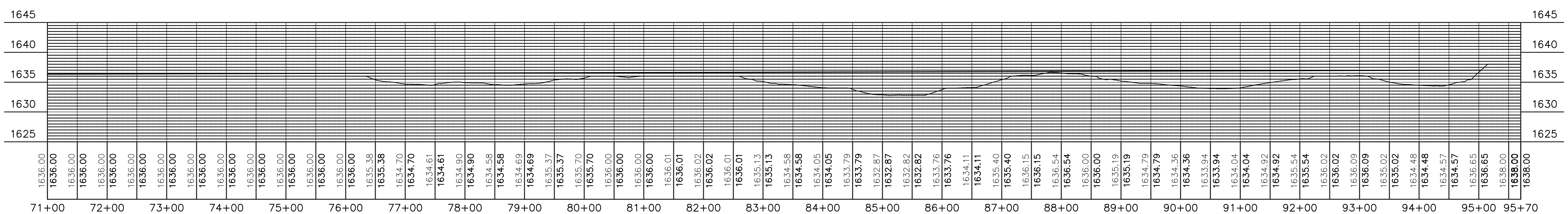

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Houston Engineering Inc.

Bismarck
P: 701.323.0200
F: 701.323.0300

Drawn by	Date	
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Checked by	Scale	
MHG	AS SHOWN	Burleigh County, ND

Plan & Profile
Sta. 71-End
PROJECT NO. 6025-012

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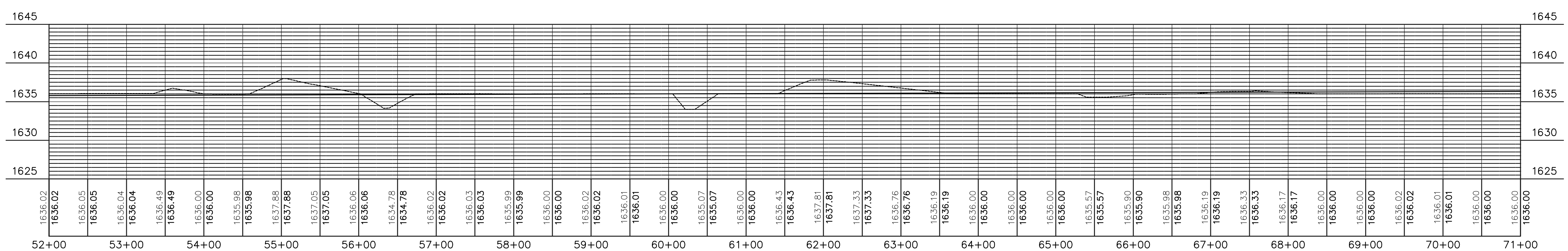

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PRELIMINARY

No.	Revision	Date	By

Houston Engineering Inc.

Bismarck

P: 701.323.0200
F: 701.323.0300

Drawn by	Date			
NRC	5-7-12	MRCC Levee	Plan & Profile Sta. 52-71 PROJECT NO. 6025-012	SHEET
Checked by	Scale			
MHG	AS SHOWN	Burleigh County, ND		4 of 5

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Geotechnical Evaluation Report

Proposed Levee Around The Facility of
Missouri River Correction and Rehabilitation Center
North of 48th Ave SW and West of Tavis Road
Bismarck, North Dakota

Prepared for

Department of Corrections & Rehabilitation, North Dakota

Professional Certification:
I hereby certify that this plan, specification, or 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.

Debashis Sikdar

DEBASHIS SIKDAR
REGISTERED
PROFESSIONAL
PE 5646
8-3-12
ENGINEER
NORTH DAKOTA

Debashis Sikdar, PE
Project Engineer
Registration Number: PE-5646
August 3, 2012

Project BM-12-02634

Braun Intertec Corporation

BRAUN INTERTEC

Braun Intertec Corporation
1341 South 20th Street, Suite 5
Bismarck, ND 58504

Phone: 701.255.7180
Fax: 701.255.7208
Web: braunintertec.com

August 3, 2012 Project BM-12-02634

Mr. Dick Frohlich
Plant Service Director
Department of Corrections and Rehabilitation
PO Box 5521
Bismarck, ND 58506-5521.

Re: Geotechnical Evaluation
Proposed Levee Around The Facility of
Missouri River Correction and Rehabilitation Center
North of 48th Ave SW and West of Tavis Road
Bismarck, North Dakota

Dear Mr. Frohlich:

We are pleased to present this Geotechnical Evaluation Report for proposed improvements of levee around the Missouri River Correction and Rehabilitation Center (MRCR), located North of 48th Ave SW and West of Tavis Road in Bismarck, North Dakota. We understand that the project consists of the grade-raise of the roads/trails around the facility approximately by 3 to 5 feet which will act as the flood control levee. Our evaluation was completed in general accordance with US Department of Homeland Security-Federal Emergency Management Agency (DHS-FEMA) provisions for Riverine Structures. DHS-FEMA requires a demonstration of structure stability under end-of-construction, long-term steady-state, flood stage, post-flood drawdown, and earthquake conditions, as applicable. The agency also requires an analysis of seepage, piping and uplift potential due to flooding, and an analysis of structure settlement.

The levee to be constructed is located approximately 1500 feet from the Missouri River and is separated by low lying backwater area at the south and a wooded area at the west. The stability of the proposed road/levees associated with this project will likley not be influenced by seasonal or longer-term water levels or failure caused by erosion from the Missouri River.

Stability and Performance Summary

Factors of safety associated with levee stability under end-of-construction, long-term steady-state, flood stage, and post-flood drawdown conditions all exceeded their respective DHS-FEMA minimum factor of safeties. The stability analyses also demonstrated adequate bearing for the improved and new levees.

Levee settlement is not anticipated to exceed 2-inches.

Flood-induced seepage, piping or uplift is not likely to impact the downstream (land) sides of the improved roads acting as levees. We do not anticipate that flood water will penetrate through the levees, instead likely seeping only from the upstream (flood) sides of the levees, and from grades below the upstream toes of the levees, during post-flood drawdown; this seepage is not considered problematic.

Remarks

Thank you for making Braun Intertec your geotechnical consultant for this project. If you have questions about this report, or if there are other services that we can provide in support of our work to date, please call Debashis Sikdar at 701.232.8701 or Steve Nagle at 701.238.3425.

Sincerely,

BRAUN INTERTEC CORPORATION

Debashis Sikdar

Debashis Sikdar, PE
Project Engineer

Amy Olson for

Steven P. Nagle, PE
Vice President/ Principal Engineer

MRCR-Levee Report

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Appendices

A. Introduction

A.1. Project Description

Houston Engineering, Inc., is preparing plans for Department of Corrections and Rehabilitation which will consist of proposed levee construction around the Missouri River Corrections and Rehabilitation (MRCR) center located North of 48th Ave SW and West of Tavis Road in Bismarck, North Dakota. The proposed levee will be tied with the 48th Avenue SW in the southeastern side and Tavis Road-levee system in the northeastern side. As per current plan, the existing roads/trails will be raised by approximately 3 to 5 feet which will act as flood control levee. The proposed levee is located approximately 1500 feet away from the Missouri River and is separated by low lying backwater area at the south and wooded area at the west.

A.2. Purpose

Though located approximately 1500 feet north of the Missouri River, this MRCR facility is vulnerable to occasional flooding in the past few years. In 2011 the flood water touched its highest level under record which correspond to a 500-year flood event and inundated a major portion of the urban areas surrounding the project site. In an effort to encounter a flood of this magnitude, Department of Corrections and Rehabilitation is planning to raise the grades of the roads/trails around its facility approximately by 3 to 5 feet from its existing elevation. These raised roads/trails will act as a flood control levee. The road acting as levee is proposed to be designed following the guidelines administered by the US Department of Homeland Security-Federal Emergency Management Agency (DHS-FEMA).

DHS-FEMA requires a demonstration of structure stability under end-of-construction, long-term steady-state, flood stage, post-flood drawdown, and earthquake conditions, as applicable. DHS-FEMA minimum factors of safety for structure stability are 1.3 for end-of-construction, 1.4 for long-term steady-state, 1.4 for flood stage, 1.0 to 1.2 for post-flood drawdown, and 1.0 for earthquake conditions. The agency also requires an analysis of flood-induced seepage, piping and uplift, a demonstration of bearing capacity, and a settlement analysis. This report serves to assist in the certification effort that the proposed development meets the minimum factor of safeties required per DHS-FEMA guidelines of riverine structures.

A.3. Background Information and Reference Documents

To facilitate our evaluation, we were provided with or reviewed the following information or documents:

- A plan of the levee improvements with surface topography, dated 07/30/2012 (from Houston Engineering).
- Two Cross sections showing proposed development, dated 06/06/2012 (Houston Engineering).
- Maximum flood stage and drawdown information (Houston Engineering).
- A copy of *Design and Construction of Levees*, Engineer Manual EM 1110-2-1913 (Corps of Engineers, April 30, 2000).
- 48th Ave Levee project (Braun Intertec Project No. BM-12-02222).

We also reviewed geologic maps and aerial photos of the project area. Geologically, the area is underlain by a thick sequence of river-deposited soils, consisting mainly of silty sands.

A.4. Organization of This Report

Two appendices are attached to the report. Appendix “A” contains a plan sheet showing site topography, proposed levee alignments, and exploration locations along with two general sections along the trails and roads around the facility provided by Houston Engineering. The Appendix “A” also contains logs of our exploratory borings that characterizes the local geologic profile, and presents the results of penetration resistance tests, laboratory index (moisture content, Percent 200 and Atterberg limit) tests, and groundwater measurements.

The Appendix “B” contains a spreadsheet summarizing the strength, hydraulic and deformation parameters assigned to the materials and geologic formations represented in our analytical models, and qualifying the improved and new levees relative to structure stability and performance.

Appendix “B” also contains the results from the analytical models of the typical cross sections of “Trails” and “Roads” provided by Houston Engineering Demonstrated are factors of safety for structure stability under end-of-construction, long-term steady-state, flood stage, and post-flood drawdown reflecting piezometric conditions associated with anticipated maximum 2011-year flood elevation (500-year flood events) for the site. The results are supported by hydraulic graphics showing the configuration of the piezometric surface at intervals during flood-induced infiltration and drawdown-induced seepage where the factors of safety were determined to be near minimum values. Also presented are graphics contouring levee settlement.

A.5. Scope of Services

Our scope of services for this project was originally submitted as a Proposal to Mr. Dick Frohlich, Plant Service Director of Department of Corrections and Rehabilitation on May 14, 2012. A signed authorization for the project was obtained from Mr. Frohlich on May 16, 2012. Tasks performed in accordance with the scope of services outlined in that document included:

- Drilling penetration test borings to depths of 20 to 40 feet below existing surface, within the limits of the area of slope instability.
- Performing the following laboratory test program:
  - Five moisture content,
  - Four percentage 200 (P 200%), and
  - Two Atterberg Limit tests.
- Analyzing stability of proposed road section at selected locations, and developing a design recommendation for stabilization of the slope.

As per our contract, some of the laboratory and subsurface soil information obtained from the adjacent 48th Ave Levee project (Braun Intertec Project No. BM-12-02222) was used in the analysis and design for this section of levee. However, to certify this levee meeting the requirements of DHS-FEMA criteria, more rigorous sub-surface investigation and laboratory testing would be required.

Information obtained from the field exploration, laboratory testing and analyses were used to write this geotechnical evaluation report that included:

- A sketch showing boring locations and site features of interest along the flood control levee alignment.
- Logs of the borings describing the materials encountered and presenting the results of our groundwater measurements and laboratory tests.
- A summary of the subsurface profile and groundwater conditions encountered.
- A summary of the strength, stiffness and hydraulic properties generated or estimated from our laboratory tests for the materials comprising the subsurface profile.
- The results of our stability, settlement and seepage analyses.

- Recommendations for design of new levee foundation subgrades, and for selecting, placing and compacting new levee fill.

Our scope of services was performed under the terms of our June 15, 2006, General Conditions.

A.5.a. Exploration Staking and Surveying

We staked the exploration locations and cleared them of existing underground utilities. Houston Engineering later surveyed the exploration locations and provided the location elevations.

B. Results

B.1. Exploration Logs

B.1.a. Log of Boring Sheets

Log of Boring sheets for our penetration test borings are included in Appendix A. The logs identify and describe the geologic materials that were penetrated, and present the results of penetration resistance tests performed within them, laboratory tests performed on penetration test samples retrieved from them, and groundwater measurements.

Strata boundaries were inferred from changes in the penetration test samples and the auger cuttings. Because sampling was not performed continuously, the strata boundaries are only approximate. The boundary depths likely vary away from the boring locations, and the boundaries themselves may also occur as gradual rather than abrupt transitions. The boring location plan with site topography is also presented in Appendix A.

B.1.b. Geologic Origins

Geologic origins assigned to the materials shown on the logs and referenced within this report were based on: (1) a review of the background information and reference documents cited above, (2) visual classification of the various geologic material samples retrieved during the course of our subsurface exploration, (3) penetration resistance testing performed for the project, (4) laboratory test results, and (5) available common knowledge of the geologic processes and environments that have impacted the site and surrounding area in the past.

B.2. Geologic Profile

We performed three penetration test borings, the locations of which are shown on the Boring Location Plan in Appendix A. Borings ST-01 and ST-03 were drilled to 20 feet depth below existing grade. Boring ST-02 was terminated as planned at a depth of 40 feet.

Penetration resistance testing was performed at 2 1/2-foot intervals to a depth of 20 feet, and at 5-foot vertical intervals at greater depths. One thin-walled tube sample was also obtained from Boring ST-02.

The borings completed along the proposed levees encountered alluvium soils comprising of lean clay, silty clay, silty sand and poorly graded sand with silt to the boring completion depths of 20 to 40 feet below existing grade. Predominantly the site encountered alluvium deposit of loose granular silty sand (N_{SPT}= 2 to 5) at the top fifteen feet (approximately to an elevation of 1615 feet) followed by loose to medium dense-sands at the deeper depths (N_{SPT}= 5 to 14).

B.2.a. Groundwater

Groundwater levels observed or measured while drilling are indicated on the boring logs. Groundwater was observed in the depth ranging from 6 1/2 to 11 feet with cave-in depth at 5 1/4 feet at Boring ST-01 during or immediate after completion of drilling. Seasonal and annual fluctuations of groundwater should be anticipated.

B.3. Laboratory Testing

The following laboratory tests were performed on penetration test samples or thin-walled tube samples: five moisture content tests, two Atterberg limit tests and four percent passing the 200 sieve (P200) tests. As per our contract of agreement for this project in order to minimize the cost for this project, some of the test results (consolidated-undrained (CU) triaxial compression tests (with pore pressure measurements), and two consolidation tests with time-rate measurements etc.) performed for the adjacent “48th Avenue Levee Project (Braun Intertec Project No. BM-12-02222) were used in the slope stability analysis for this project.

The results of the moisture contents, P200 and Atterberg limit test results are presented on the boring logs.

B.4. Stability and Performance Analyses

We evaluated structure stability under end-of-construction, long-term steady-state, flood stage, and post-flood drawdown conditions with GeoStudio 2007, version 7.15, by Geo-Slope International. We also used GeoStudio 2007 to evaluate seepage, piping and uplift potential, bearing capacity, and settlement.

Components of GeoStudio 2007 used in our analyses included Seep/W for seepage, Slope/W for slope stability, and Sigma/W for settlement. Seep/W and Sigma/W are finite element programs that allow in-situ hydraulic and stress/strain conditions to be contoured on a structured mesh, which can then be subjected to external hydraulic boundary conditions or material loads on a steady state (single time step) or transient (multiple time step) basis. Mesh response and the timing of that response are governed by hydraulic and stress/strain properties assigned to the geologic materials present near each mesh node.

Seep/W was used to model the progression and regression of seepage "fronts" during flooding and post-flood drawdown. The models were "flooded," and the opportunity for seepage maximized by assuming the flood stage was achieved instantaneously. Profiles of the advancing seepage front, whose progression was governed by the hydraulic properties of the geologic materials subjected to inundation, were obtained for three time steps over the 500 year flood periods.

The influence of the advancing seepage front on the stability of the levees' upstream and downstream slopes was then evaluated with Slope/W by determining factors of safety for each of the time steps based on force and moment equilibrium; to reflect changing pore pressure conditions due to flood-induced infiltration, the Slope/W flood analyses were performed using drained effective stress post-peak shear strength parameters. Seepage, uplift and piping potential were also evaluated at this time.

Houston Engineering provided us the high flood elevation (1634.55 feet), low flood elevation (1630.18 feet), and drawdown period (55 days) corresponding to 500-year flood event for this project. A steep drawdown function was generated based on the information obtained from Houston Engineering. Flood recession was then modeled using this recession function. Seep/W was again used to generate receding seepage fronts at six time steps over a 55-day drawdown period for structure stability determinations by Slope/W. Drained effective stress post-peak shear strength parameters were again used in the Slope/W analyses.

The end-of-construction and long-term steady-state conditions were assumed to occur independent of flooding and drawdown; Slope/W alone was used to analyze these conditions. The end-of-construction analyses were performed using undrained total stress shear strength parameters, the steady-state analyses using drained effective stress post-peak parameters.

We omitted a demonstration of structure stability under earthquake conditions. DHS-FEMA's National Earthquake Hazards Reduction Program (NEHRP) maps indicate that the project is located in an area of limited seismicity, and not likely to experience unfavorable ground accelerations.

B.4.a. Recommendations and Reporting

Our results were used primarily to develop an opinion regarding the ability of the improved roads to function as a flood control levee meeting the requirements of DHS-FEMA criteria for flood control structure stability and performance.

We were asked to do minimum subsoil exploration for this levee and also were asked to use the test results from the adjacent 48th Avenue-levee project (Braun Intertec Project No. BM-12-02222). However, as we noted this evaluation does not meet the more rigorous sub-surface investigation and laboratory testing required to meet the requirements of DHS-FEMA criteria required for levee certificaiton.

C. Results

C.1. General Site Conditions

A flood control levee is proposed to be constructed by Department of Corrections and Rehabilitation around the MRCR center located North of 48th Ave SW and West of Tavis Road in Bismarck, North Dakota. The proposed levee will be tied with the 48th Avenue SW in the southeastern side and Tavis Road-levee system in the northeastern side. As per current plan, the existing roads/trails will be raised by approximately 3 to 5 feet which will act as flood control levee. The proposed levee is located approximately 1500 feet away from the Missouri River and is separated by low lying backwater area at the south and wooded area at the west. The area is predominantly underlain by alluvium sand and silt; and possesses moderately high hydraulic conductivities.

C.2. Subsurface Geologic Profile

C.2.a. Geologic Materials

The borings at the proposed site generally encountered alluvium deposits primarily comprising of lean clay, silty clay, silty sand and poorly graded sand with silt to the boring completion depths of 20 to 40 feet below existing grade. Predominantly the site encountered alluvium deposit of loose granular silty sand (N_{SPT}= 2 to 5) at the top fifteen feet (approximately to an elevation of 1615 feet) followed by loose to medium dense-sands at the deeper depths (N_{SPT}= 5 to 14). The stability of the levee will be mainly influenced by the higher permeability granular soils.

C.2.b. Groundwater

Groundwater levels observed or measured while drilling are indicated on the boring logs. Groundwater was observed in the depth ranging from 6 1/2 to 11 feet with cave-in depth at 5 1/4 feet at the boring ST-01 during or immediate after completion of drilling. Seasonal and annual fluctuations of groundwater should be anticipated.

C.3. Structure Stability

C.3.a. Selection and Development of Analytical Cross Sections

Two typical sections (one for trails and one for roads around the MRCR center) were provided by Houston Engineering. The top widths of the trail and road portions of the levees are proposed to be 10 feet and 24 feet, respectively. Both the levee sections have side slopes of 4(H):1(V) with a top elevation of 1635.00 feet (with reference to NAVD 88 datum). The top of the proposed levee has 0.7 feet of free board relative to the 500-year flood event.

Also a four feet deep inspection trench with side slopes of 1(H):1(V) and bottom width of 3 feet was proposed for both the levee sections. The sections are provided in Appendix A of this report. For analytical purposes, we analyzed both the sections for this project alignment.

C.3.b. Hydrographs

Houston Engineering provided us the high flood elevation (1634.55 feet), low pool elevation (1630.18 feet), and drawdown period (55 days) corresponding to 2011 year flood (500-year flood event) for this project, which are similar to the adjacent 48th Avenue levee project. A steep drawdown function was generated based on the information obtained from Houston Engineering. Flood recession was then modeled using this recession function. Seep/W was again used to generate receding seepage fronts at six time steps over a 55-day drawdown period for structure stability determinations by Slope/W.

We projected the recession portions of the hydrographs out 80 days to highlight the probable disparity between the rates at which flood water recedes from the surface and dissipates from within the levees. The hydrographs show the flood stage developing rather quickly and dissipating more slowly. We assumed that the 500 year flood elevations would be attained instantaneously, held for 8 days, and then drawn down at varying rates over the next 80 or so days. These are the time-dependent elevations or functions applied to our analytical models as hydraulic boundary conditions.

C.3.c. Geologic Profiles

The seepage, stability and deformation graphics in the Analyses appendices identify: (1) material types and stratum boundaries, (2) structure location and geometry, (3) in-situ, transient and/or steady-state piezometric conditions, (4) the location and configuration of the failure surface having generated the lowest factors of safety for each particular analytical condition, and/or (5) in-situ and post-construction stress/strain conditions.

Excluding localized differences in the existing ground surface geometry, each cross section contains proposed levee fill extending to 1635 feet. For the purpose of the analysis we have simplified the on-site soils into two major categories; (1) loose deposit of sand at the surface up to an elevation of 1615 feet; (2) Medium dense sand layer below the elevation of 1615 feet to the bottom depth of the model at 1570 feet. The in-situ or initial groundwater surface is assumed conservatively at elevation 1630 feet.

C.3.d. Material Parameters

Drained post-peak shear strength, undrained cohesion, hydraulic conductivity and modulus parameters assigned to the various materials/formations incorporated into our analytical models are summarized in the in the Appendix B. The colors assigned to the materials in the spreadsheet match those applied to the analytical graphics in the Analyses appendices.

C.3.e. Computed Factors of Safety

Levee stability under end-of-construction, steady state, flood stage, and post-flood drawdown conditions proved favorable. The detail factors of safety of both the sections are provided on the spreadsheet in the Analytical Summary of Appendix B. As indicated in the Analytical Summary- spreadsheet, factors of safety for all conditions met or exceeded FEMA minimums for the 500 year flood events: Factors of safety for the end-of-construction condition exceeded 3.2 (1.3 being the FEMA minimum); factors of safety for the steady state condition exceeded 2.5 (1.4 being the FEMA minimum); factors of safety for the flood stage exceeded 1.9 (1.4 being the minimum); and factors of safety under post-flood drawdown conditions exceeded 1.7 at one to 23 days post-flood (1.0-1.2 being the range of FEMA minimums).

C.4. Structure Performance

C.4.a. Foundation Bearing Capacity

The stability analyses performed for this project have demonstrated adequate bearing for the proposed levee.

C.4.b. Levee Settlement

Our deformation analyses indicate that levee settlement is not likely to exceed 1-to-2 inches.

For typical levees, the settlement is rounded up to the nearest half foot to maintain the required freeboard for a "certified" levee. It should be noted that the settlement at this site will occur gradually across the site and we do not anticipate differential settlement causing issues on the road surface.

C.4.c. Seepage, Uplift and Piping Commentary

Flood-induced seepage, piping or uplift is not likely to impact the downstream (land) sides of the improved road/ levees. Our seepage analyses indicate that flood water is not likely to penetrate through the levees, instead likely seeping only from the upstream (flood) sides of the levees, and from grades below the upstream toes of the levees, during post-flood drawdown; this seepage is not considered problematic.

D. Recommendations

D.1. Removals and Initial Subgrade Preparation

D.1.a. Vegetation and Topsoil Stripping

We recommend stripping vegetation and/or topsoil/ from beneath the emergency fills, along with vegetation and topsoil beyond the limits of the emergency fill but still within the road/levee footprint.

D.1.b. Inspection Trench

We recommend completing an inspection trench parallel to and along the river side edge of the new levees that will be improved or constructed. We recommend that the inspection trench extend to a depth below the stripped ground surface equal to the height of the overlying levee, with a minimum depth of 3 feet and a maximum depth of 4 feet below the stripped ground surface. The bottom of the inspection trench should be at least 3 feet wide, or wide enough to accommodate compaction equipment. We recommend to lay the side slopes of the trench at gradients no steeper than 1(H):1(V).

D.2. Levee Construction

D.2.a. Selection, Placement and Compaction of Levee Fill

In our opinion, imported fill soil should be used for inspection trench and levee fills. The specification of the imported fill soil should conform the following characteristics:

- Liquid limit greater than 30 percent;
- Plasticity index greater than 15;
- And less than 50 percent passing a 200 sieve.

A soil meeting the above specifications should have a coefficient of permeability less than $3x10^{-8}$ cm/sec, which is what we assumed in our computer model.

Prior to compaction, we recommend moisture conditioning the levee fill to moisture contents within one percentage point below to three percentage points above their optimum moisture contents.

We recommend spreading levee fill in loose lifts 6 to 12 inches thick. Levee fill placed on slopes steeper than 4:1 (horizontal: vertical) should be benched into the slopes so that the fill is compacted in horizontal lifts and structurally integrated *into*, as opposed to simply bearing *on*, the slopes.

We recommend compacting excavation backfill and general levee fill to at least 95 percent of their maximum standard Proctor dry densities with moisture content between -1% to +3% of their optimum moisture content.

D.2.b. Levee Slope Finishing and Protection

We recommend compacting levee slopes to at least 95 percent of the exposed soils' maximum standard Proctor dry densities. We assume that others will evaluate the ability of or need for conventional embankment vegetation to limit surface erosion, localized scour and sloughing, and develop specifications for vegetation or other forms of surface protection (erosion control mats or armor).

D.2.c. Post-Construction Grade Adjustments

We currently do not anticipate that the levee will settle more than approximately 2 inches. Overbuilding the levee by at least this amount should therefore preclude needing to adjust grades in the future.

D.3. Construction Quality Control

D.3.a. Excavation Observations

We recommend having a geotechnical engineer observe all excavations related to levee construction. The purpose of the observations is to evaluate the competence of the geologic materials exposed in the excavations, and the adequacy of required excavation oversizing.

D.3.b. Materials Testing

We recommend density tests be taken in levee fill.

D.3.c. Cold Weather Precautions

If site grading and construction is anticipated during cold weather, all snow and ice should be removed from structure subgrades prior to placing excavation backfill or additional required fill. No backfill or fill should be placed on frozen subgrades. No frozen soils should be used as backfill or fill.

E. Procedures

E.1. Penetration Test Borings

E.1.a. Drilling Methods and Procedures

The penetration test borings were drilled with a truck-mounted core and auger drill equipped with hollow-stem auger. The borings were performed in accordance with ASTM D 1586. Sample intervals and type are shown on the boring logs.

E.1.b. Boring Log Preparation

Strata boundaries shown on the Log of Boring sheets were inferred from changes in the penetration test samples and the auger cuttings. Because sampling was not performed continuously, the strata boundary depths are only approximate. The boundary depths likely vary away from the boring locations, and the boundaries themselves may also occur as gradual rather than abrupt transitions.

Geologic origins assigned to the materials shown on the logs and referenced within this report were based on: (1) a review of the background information and reference documents cited above, (2) visual classification of the various geologic material samples retrieved during the course of our subsurface exploration, (3) penetration resistance and other in-situ testing performed for the project, (4) laboratory test results, and (5) available common knowledge of the geologic processes and environments that have impacted the site and surrounding area in the past.

E.2. Material Classification and Testing

The geologic materials encountered were visually and manually classified in accordance with ASTM Test Method D 2488. A chart explaining the classification system is attached. Samples were sealed in jars or bags and returned to our facility for review and storage. The results of the laboratory tests performed on geologic material samples are noted on or follow the appropriate attached exploration logs. The tests were performed in general accordance with ASTM procedures.

E.3. Groundwater Measurements

The drillers checked for groundwater as the penetration test borings were advanced, and again after auger withdrawal. The boreholes were then backfilled with auger cuttings or grouted.

F. Qualifications

F.1. Variations in Subsurface Conditions

F.1.a. Material Strata

Our evaluation, analyses and recommendations were developed from a limited amount of site and subsurface information. It is not standard engineering practice to retrieve material samples from exploration locations continuously with depth, and therefore strata boundaries and thicknesses must be inferred to some extent. Strata boundaries may also be gradual transitions, and can be expected to vary in depth, elevation and thickness away from the exploration locations.

Variations in subsurface conditions present between exploration locations may not be revealed until additional exploration work is completed, or construction commences. If any such variations are revealed, our recommendations should be re-evaluated. Such variations could increase construction costs, and a contingency should be provided to accommodate them.

F.1.b. Groundwater Levels

Groundwater measurements were made under the conditions reported herein and shown on the exploration logs, and interpreted in the text of this report. The observation period was short, and groundwater can be expected to fluctuate in response to rainfall, flooding, irrigation, seasonal freezing and thawing, surface drainage modifications and other seasonal and annual factors.

F.2. Continuity of Professional Responsibility

F.2.a. Plan Review

This report is based on a limited amount of information, and a number of assumptions were necessary to help us develop our recommendations. It is recommended that our firm review the geotechnical aspects of the designs and specifications, and evaluate whether the design is as expected, if any design changes have affected the validity of our recommendations, and if our recommendations have been correctly interpreted and implemented in the designs and specifications.

F.2.b. Construction Observations and Testing

It is recommended that we be retained to perform observations and tests during construction. This will allow correlation of the subsurface conditions encountered during construction with those encountered by the borings, and provide continuity of professional responsibility.

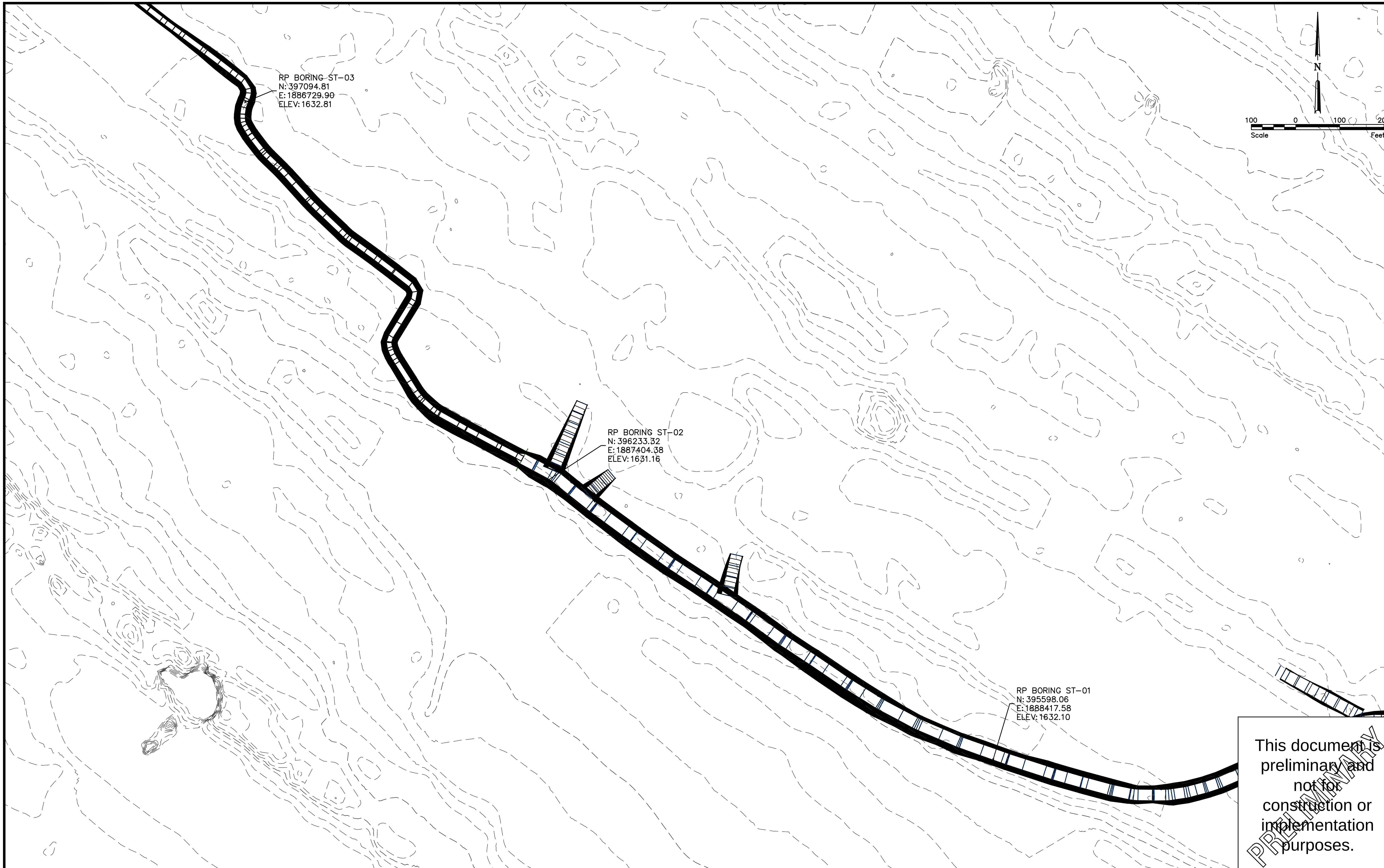
F.3. Use of Report

This report is for the exclusive use of the parties to which it has been addressed. Without written approval, we assume no responsibility to other parties regarding this report. Our evaluation, analyses and recommendations may not be appropriate for other parties or projects.

F.4. Standard of Care

In performing its services, Braun Intertec used that degree of care and skill ordinarily exercised under similar circumstances by reputable members of its profession currently practicing in the same locality. No warranty, express or implied, is made.

Appendix A



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

PRELIMINARY

No.	Revision	Date	By

Houston Engineering Inc.

Bismarck

P: 701.323.0200
F: 701.323.0300

Drawn by NRC | Date 7-30-12
Checked by MHG | Scale AS SHOWN

MISSOURI RIVER CORRECTION & REHABILITATION FACILITY - LEVEE
BISMARCK, ND

SOIL BORINGS LOCATION PLAN
PROJECT NO. 6025-012

SHEET 1 of 1

T:\6025-XXX Burleigh County Water Resource District\6025-012 MRCC Flood Control\CAD\Alignment 4-16-12.dwg -Soil Borings-7/30/2012 12:57 PM-(ncullen)

BRAUN INTERTEC

LOG OF BORING

Braun Project BM-12-02634
Geotechnical Evaluation
Missouri River Correctional Facility
48th Ave SW and West of Tavis Road
Bismarck, North Dakota

BORING: **ST-01**

LOCATION: 395598.06 N, 1888417.58 E See Sketch.

DRILLER:

METHOD: 3 1/4" HSA, Autohammer

DATE: **6/7/12**

SCALE: **1" = 4'**

(See Descriptive Terminology sheet for explanation of abbreviations)

Elev. feet 1632.1	Depth feet 0.0	Symbol	Description of Materials (Soil-ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	MC %	Tests or Notes
1631.8	0.3	CL	SANDY LEAN CLAY, with roots, trace Gravel, brown and gray, wet. (Topsoil)	5			
		SP-SM	POORLY GRADED SAND with SILT, fine- to medium-grained, brown, wet, very loose to medium dense. (Alluvium)	4			
			-waterbearing at 4 1/2 feet.	5		32	P200=8.8%
					▽		
				4			
				5			
				14			
				16			
			-gray below 17 feet.	10			
1611.1	21.0			11			
			END OF BORING.				
			Water observed at a depth of 6 1/2 feet with 7 feet of hollow-stem auger in the ground.				
			Water not observed to cave-in depth of 5 1/4 feet immediately after withdrawal of auger.				
			Boring then backfilled with bentonite grout.				

LOG OF BORING N:\GINT\PROJECTS\BISMARCK\2012\02634.GPJ BRAUN_V8_CURRENT.GDT 8/1/12 12:51

BRAUN INTERTEC

LOG OF BORING

Braun Project BM-12-02634
Geotechnical Evaluation
Missouri River Correctional Facility
48th Ave SW and West of Tavis Road
Bismarck, North Dakota

BORING: **ST-02**

LOCATION: 396233.32 N, 1887404.38 E See Sketch.

DRILLER: | METHOD: 3 1/4" HSA, Autohammer | DATE: **6/11/12** | SCALE: **1" = 4'**

Elev. feet 1631.2	Depth feet 0.0	Symbol	Description of Materials (Soil-ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	MC %	qp tsf	Tests or Notes
1630.2	1.0	CL	LEAN CLAY with SAND, gray, wet. (Alluvium)	7			2 1/2	
		SM	SILTY SAND, fine- to medium-grained, brown, wet, very loose to medium dense. (Alluvium)	6				
			-Lean Clay seams from 4 1/2 to 8 1/2 feet.	4		30		P200=34%
				22				
			-gray, waterbearing below 9 1/2 feet.	9	▽			
1617.2	14.0			3				
1612.2	19.0	CL-ML	SILTY CLAY, gray, wet, soft. (Alluvium)	2		45		LL=32, PL=18, PI=15
				TW				LL=NP, PL=NP, PI=NP
		SM	SILTY SAND, fine- to medium-grained, gray, wet, loose to medium dense. (Alluvium)	12		29		P200=15.2%
				6				
				5				
				5				
			-with GRAVEL, trace Lignite, waterbearing at 29 1/2 feet.	13				

(See Descriptive Terminology sheet for explanation of abbreviations)

LOG OF BORING N:\GINT\PROJECTS\BISMARCK\2012\02634.GPJ BRAUN_V8_CURRENT.GDT 8/1/12 12:51

BRAUN[SM] INTERTEC

LOG OF BORING

Braun Project BM-12-02634 Geotechnical Evaluation Missouri River Correctional Facility 48th Ave SW and West of Tavis Road Bismarck, North Dakota	BORING: **ST-02 (cont.)** LOCATION: 396233.32 N, 1887404.38 E See Sketch.

DRILLER:	METHOD: 3 1/4" HSA, Autohammer	DATE: **6/11/12**	SCALE: **1" = 4'**

Elev. feet 1599.2	Depth feet 32.0	Symbol	Description of Materials (Soil-ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	MC %	qp tsf	Tests or Notes
			SILTY SAND, fine- to medium-grained, gray, wet, loose to medium dense. (Alluvium) *(continued)*	*				*No Recovery.
				11				
1594.7	36.5	SM	SILTY SAND, fine- to coarse-grained, with Lignite and Gravel lenses, dark gray and black, waterbearing, loose to medium dense. (Alluvium)					
				5		40		P200=14.6%
1590.2	41.0		END OF BORING. Water observed at a depth of 11 feet with 12 feet of hollow-stem auger in the ground. Boring then backfilled with bentonite grout.					

(See Descriptive Terminology sheet for explanation of abbreviations)

LOG OF BORING N:\GINT\PROJECTS\BISMARCK\2012\02634.GPJ BRAUN_V8_CURRENT.GDT 8/1/12 12:51

BRAUN℠ INTERTEC

LOG OF BORING

Braun Project BM-12-02634 Geotechnical Evaluation Missouri River Correctional Facility 48th Ave SW and West of Tavis Road Bismarck, North Dakota	BORING: ST-03 LOCATION: 397094.81 N, 1886729.9 E See Sketch.

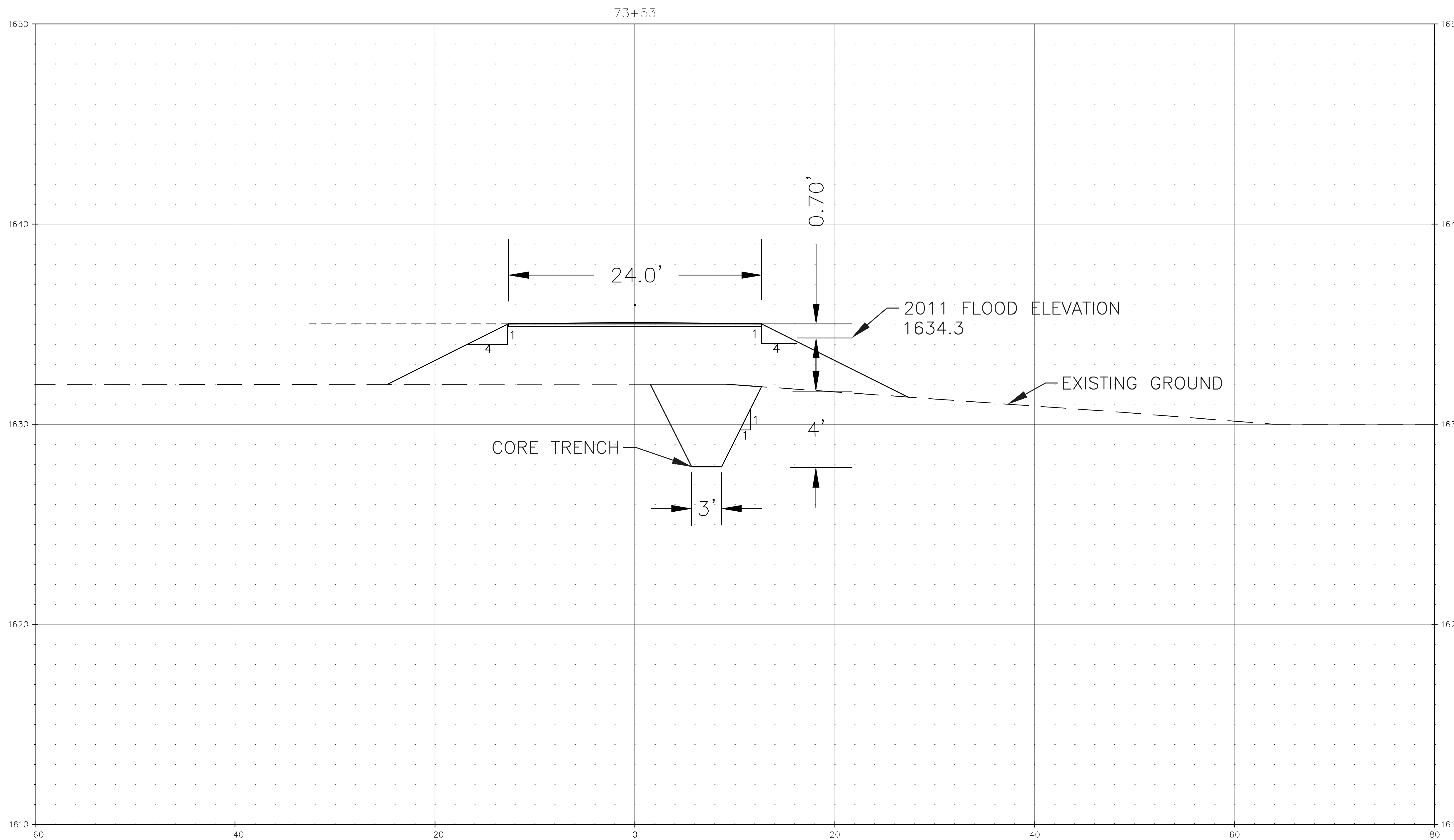
DRILLER:	METHOD: 3 1/4" HSA, Autohammer	DATE: 6/8/12	SCALE: 1" = 4'

Elev. feet 1632.8	Depth feet 0.0	Symbol	Description of Materials (Soil-ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	Tests or Notes
1631.8	1.0	SP-SM	POORLY GRADED SAND with SILT, fine- to coarse-grained, with GRAVEL, LIGNITE and roots, black, wet. (Topsoil)	5		
1611.8	21.0	SM	SILTY SAND, fine- to medium-grained, with Clay seams, brown, wet, very loose to medium dense. (Alluvium) -waterbearing below 7 feet.	4 3 2 5 9 6 22 21	▽	
			END OF BORING. Water observed at a depth of 6 2/3 feet with 19 1/2 feet of hollow-stem auger in the ground. Boring then backfilled with bentonite grout.			

(See Descriptive Terminology sheet for explanation of abbreviations)

LOG OF BORING N:\GINT\PROJECTS\BISMARCK\2012\02634.GPJ BRAUN_V8_CURRENT.GDT 8/1/12 12:51

MRCC LEVEE — TYPICAL ROAD SECTION



DATUM:
NAVD 88
GEOID 03

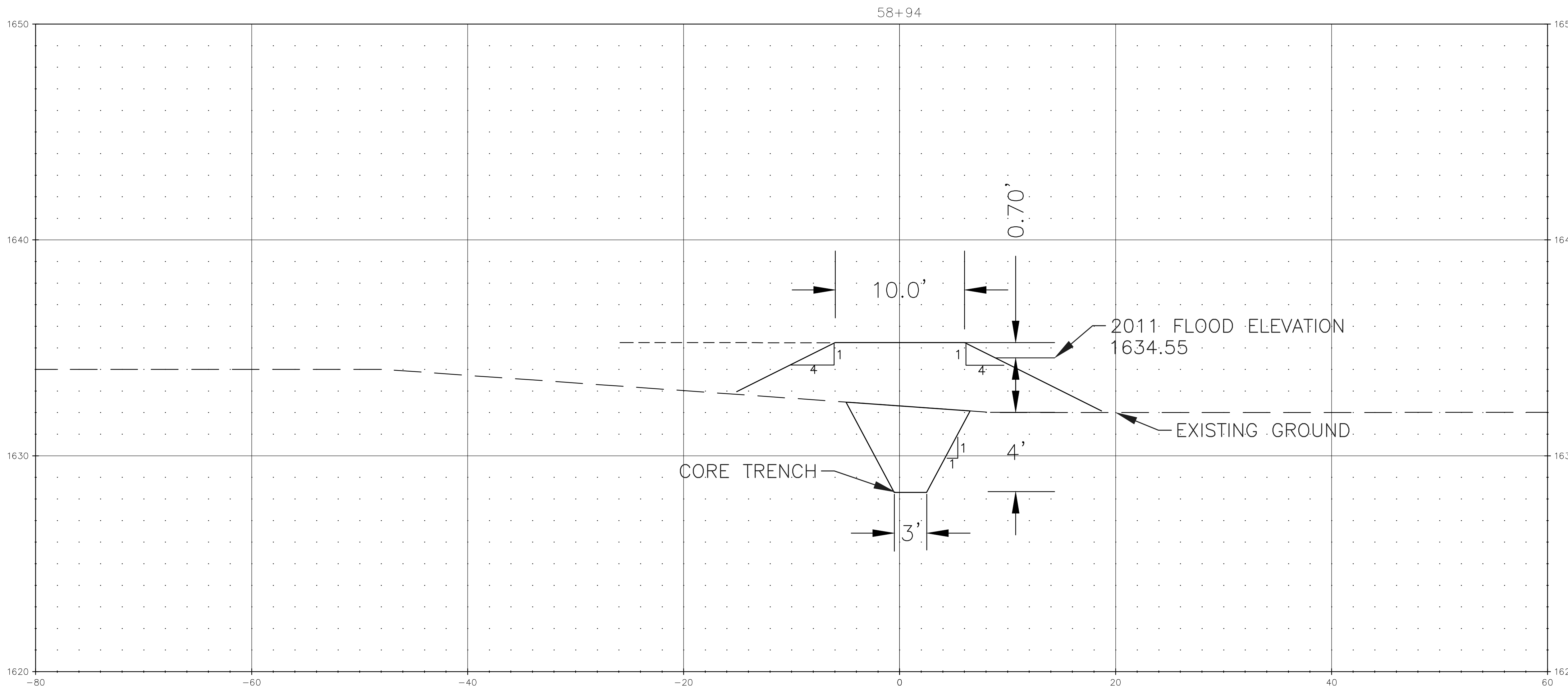
This document is preliminary and not for construction or implementation purposes.

PRELIMINARY

T:\6025-XXX Burleigh County Water Resource District\6025-012 MRCC Flood Control\CAD\Alignment 4-16-12.dwg -Typ. Road-6/6/2012 3:47 PM-(chovey)

Houston Engineering Inc.	Bismarck P: 701.323.0200 F: 701.323.0300	Drawn by NRC Checked by MHG	Date 6-6-12 Scale AS SHOWN	MRCC LEVEE TYPICAL ROADWAY SECTION BURLEIGH COUNTY, ND	FIGURE 6 PROJECT NO. 6025-012	SHEET 1 of 1

MRCC LEVEE – TYPICAL TRAIL SECTION



DATUM:
NAVD 88
GEOID 03

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

PRELIMINARY

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Houston Engineering Inc.	Bismarck P: 701.323.0200 F: 701.323.0300	Drawn by NRC	Date 6-6-12	MRCC LEVEE TYPICAL TRAIL SECTION BURLEIGH COUNTY, ND	FIGURE 7 PROJECT NO. 6025-012	SHEET 1 of 1
		Checked by MHG	Scale AS SHOWN			

Appendix B

BM-12-02634: Missouri River Correction and Rehabilitation Center Levee

Shear Strength Parameters

		Effective Stress Analyses		Total Stress Analyses	
Formation	**Unit Weight**	**Ø, Post-Peak**	**C**	**Ø, Post-Peak**	**C**
Fill	118	28 deg	0 psf	0 deg	500 psf
Surface Sand	110	24 deg	0 psf	24 deg	0 psf
Sandy Soil	120	30 deg	0 psf	30 deg	0 psf

Hydraulic and Deformation Parameters

Formation	**k_v**	**k_h**	**k_v/k_h**	**E**
Fill	.01 ft/day	.01 ft/day	1.0	100000 psf
Surface Sand	10 ft/day	10 ft/day	1.0	100000 psf
Sandy Soil	10 ft/day	10 ft/day	1.0	200000 psf

BM-12-02634: Missouri River Correction and Rehabilitation Center Levee

Structure Stability and Performance

Section	Factors of Safety[A]					
	End-of Construction	Long-Term Steady-State	Flood Stage	Post-Flood Drawdown	Seepage/Uplift/Piping[B]	Levee Settlement (Feet)
Trail Section	4.2	3.12	1.91	1.77	No Issues	0.14
Road Section	3.19	2.57	1.97	1.71	No Issues	0.12

[A] **DHS-FEMA and USACE Minimums:**

End-of-Construction = 1.3

Long-Term Steady-State = 1.4 for undisturbed section or 1.2 for failed section

Flood Stage = 1.4

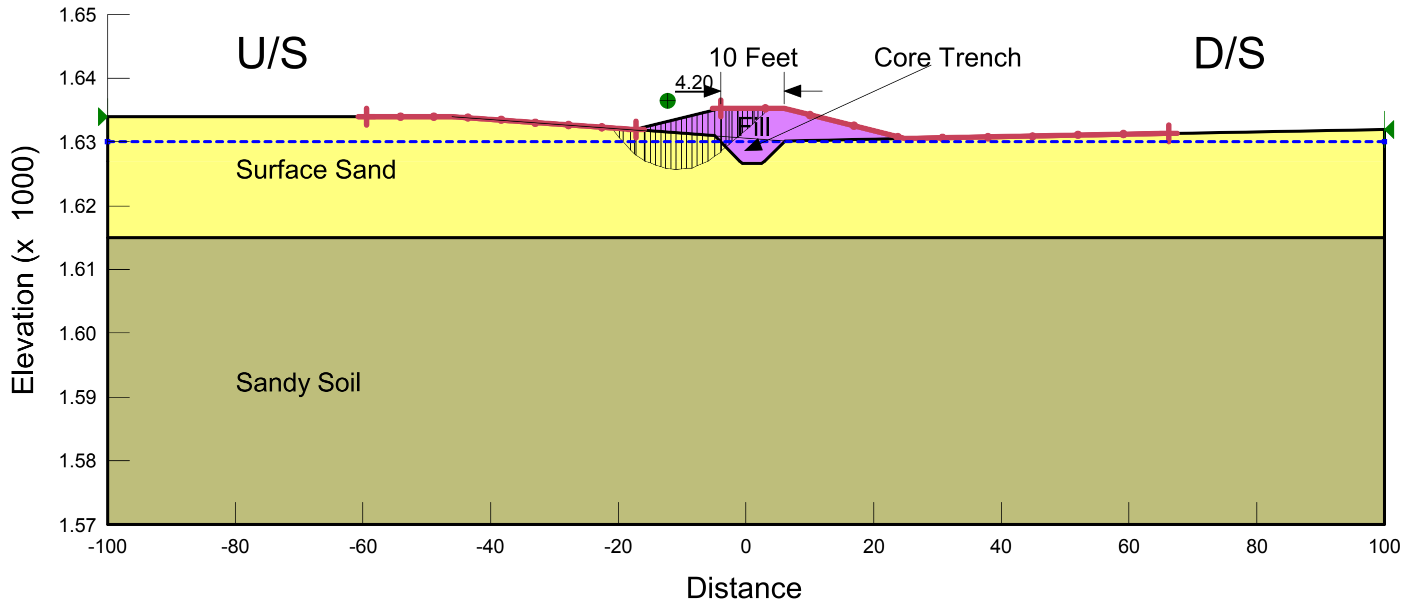
Post-Flood Drawdown = 1.0-1.2

[B] **Indicates whether flooding is likely to cause seepage, piping or uplift on the downstream side of the structure**

BM-12-02634: MRCC Levee-Trail Section
Missouri River Correction and Rehabilitation Center
Bismarck, ND
Side Slopes 4(H):1(V)

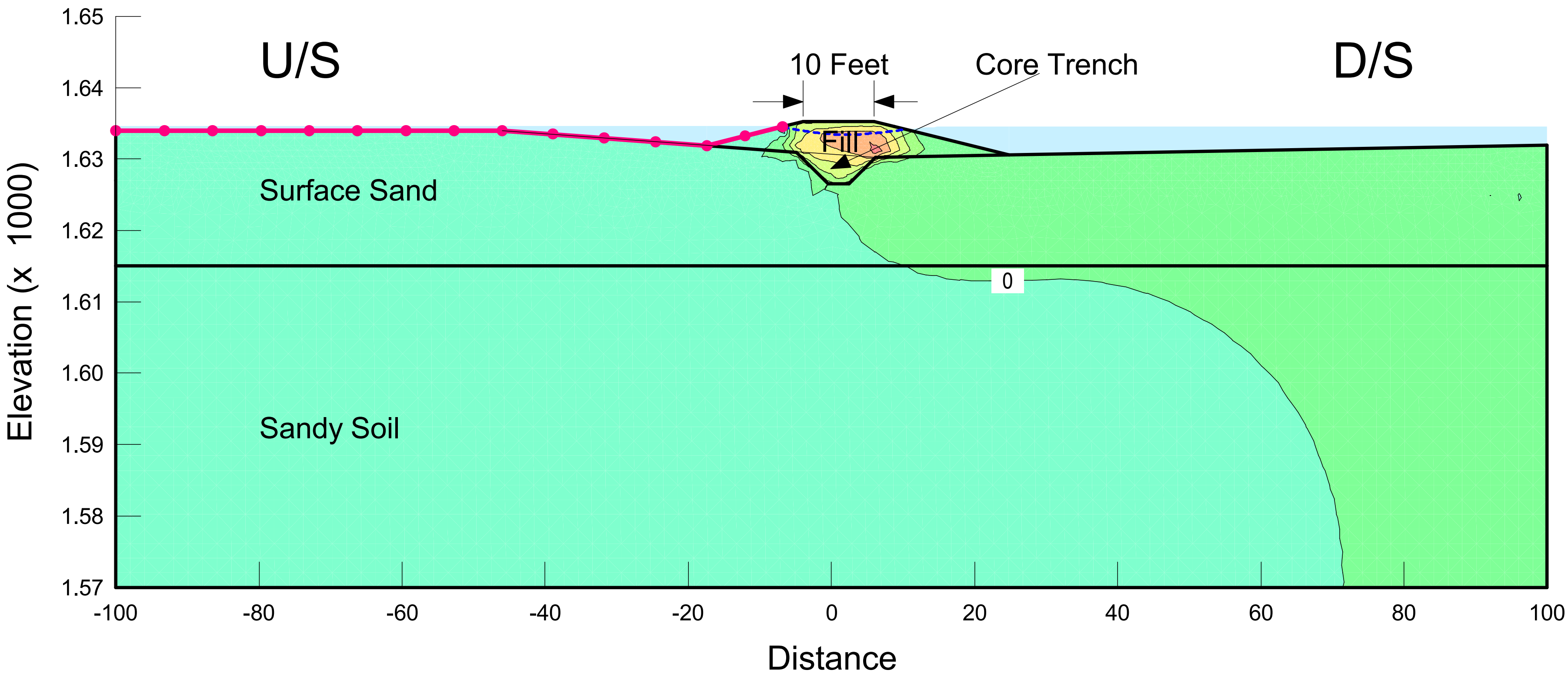
End-of-Construction Stability
Total Stress Analysis

Factor of Safety: 4.20



BM-12-02634: MRCC Levee-Trail Section
Missouri River Correction and Rehabilitation Center
Bismarck, ND
Side Slopes 4(H):1(V)

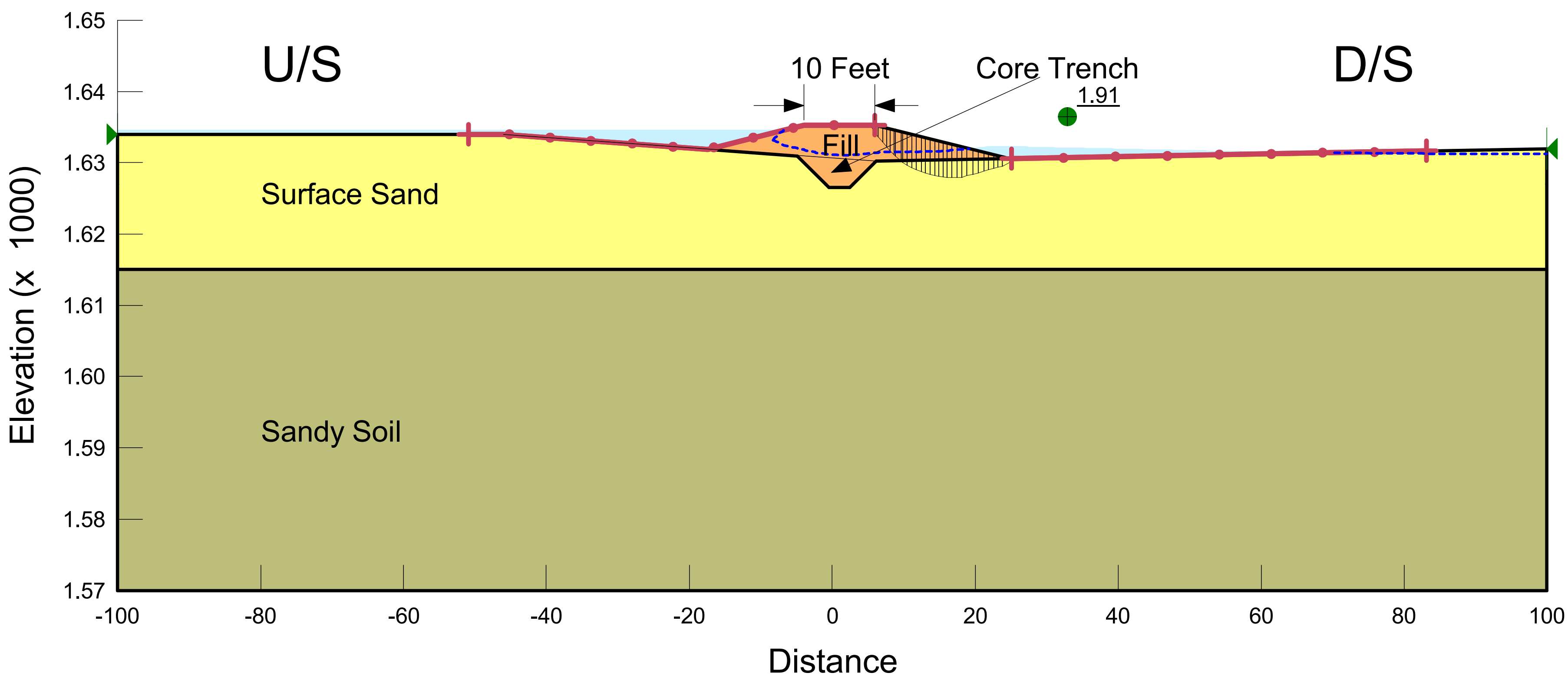
Flood Infiltration Limits



BM-12-02634: MRCC Levee-Trail Section
Missouri River Correction and Rehabilitation Center
Bismarck, ND
Side Slopes 4(H):1(V)

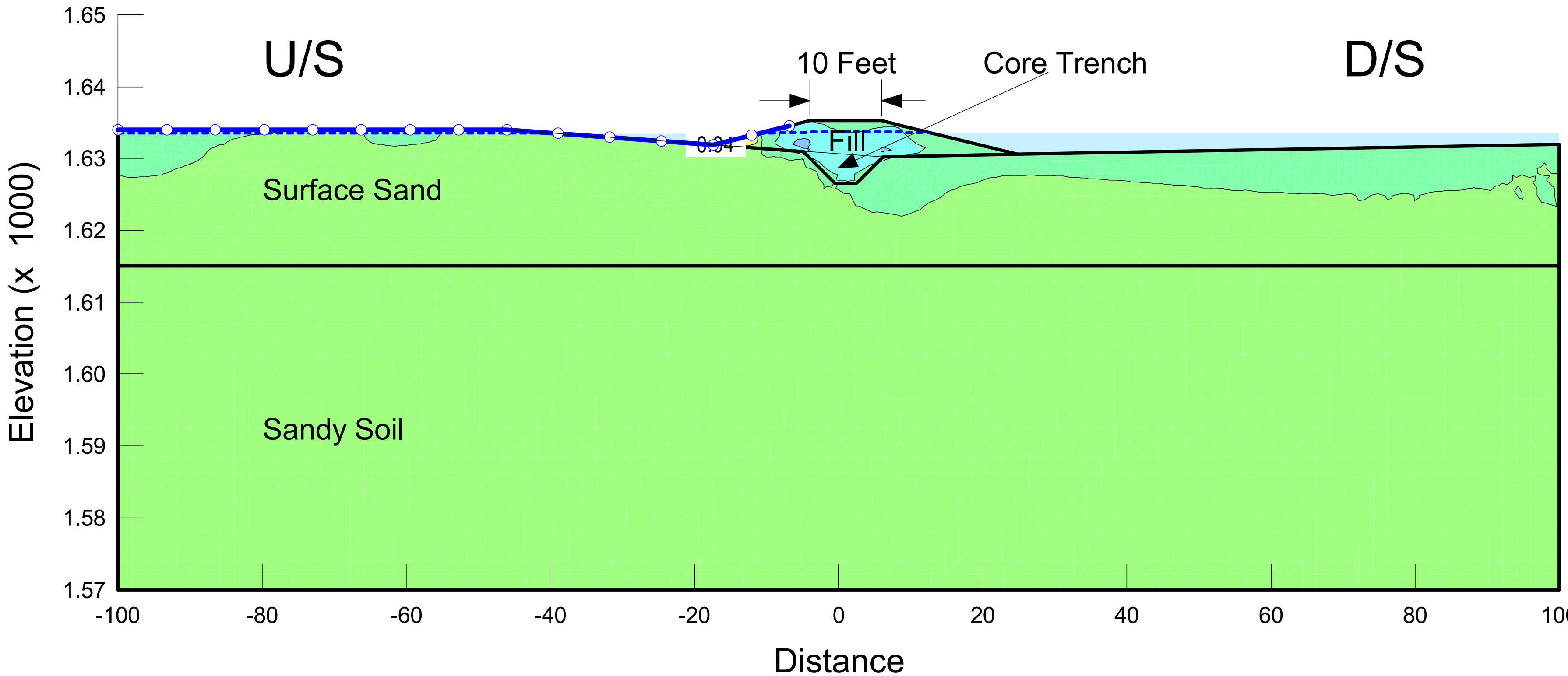
Flood Stage Stability
Effective Stress Analysis

Factor of Safety: 1.91



BM-12-02634: MRCC Levee-Trail Section
Missouri River Correction and Rehabilitation Center
Bismarck, ND
Side Slopes 4(H):1(V)

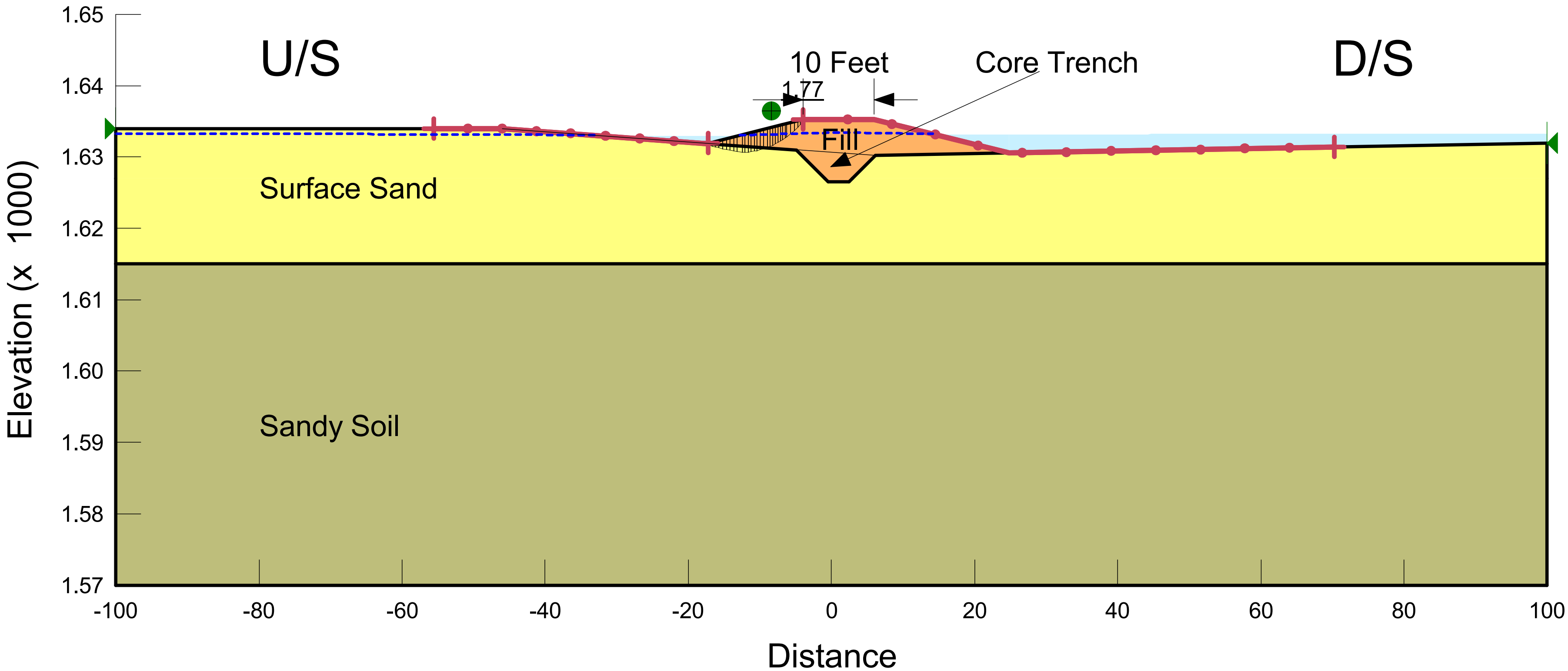
Drawdown Stage Infiltration Limits



BM-12-02634: MRCC Levee-Trail Section
Missouri River Correction and Rehabilitation Center
Bismarck, ND
Side Slopes 4(H):1(V)

Drawdown Stage Stability
Effective Stress Analysis

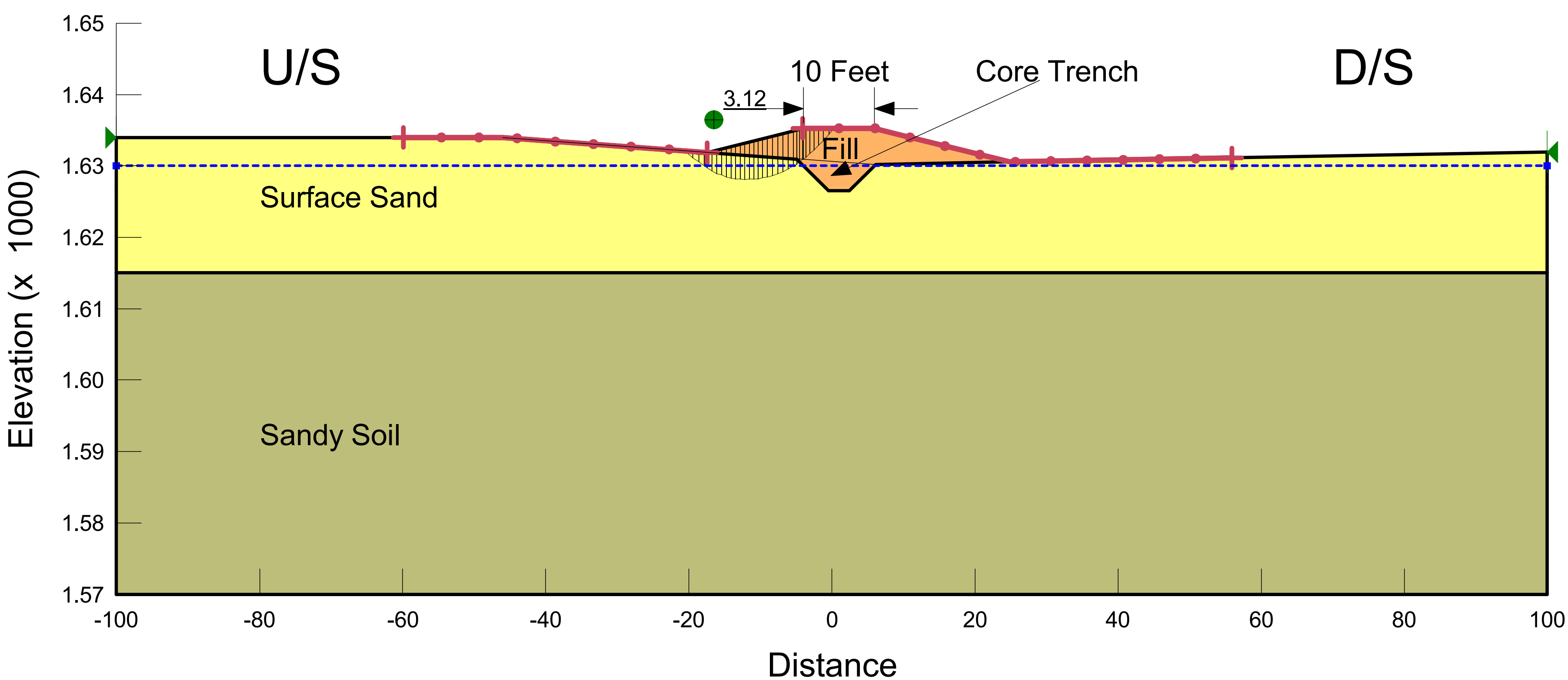
Factor of Safety: 1.77



BM-12-02634: MRCC Levee-Trail Section
Missouri River Correction and Rehabilitation Center
Bismarck, ND
Side Slopes 4(H):1(V)

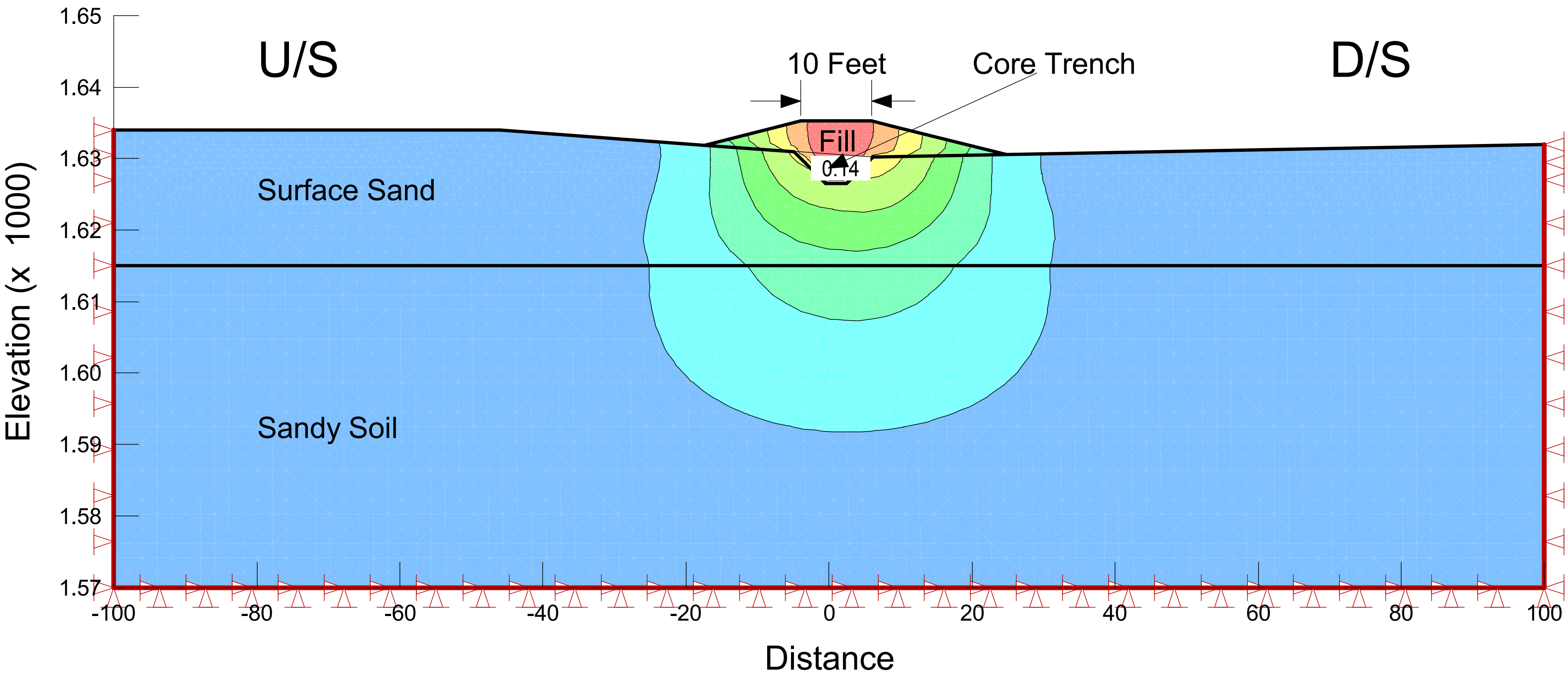
Long Term Stability
Effective Stress Analysis

Factor of Safety: 3.12



BM-12-02634: MRCC Levee-Trail Section
Missouri River Correction and Rehabilitation Center
Bismarck, ND
Side Slopes 4(H):1(V)

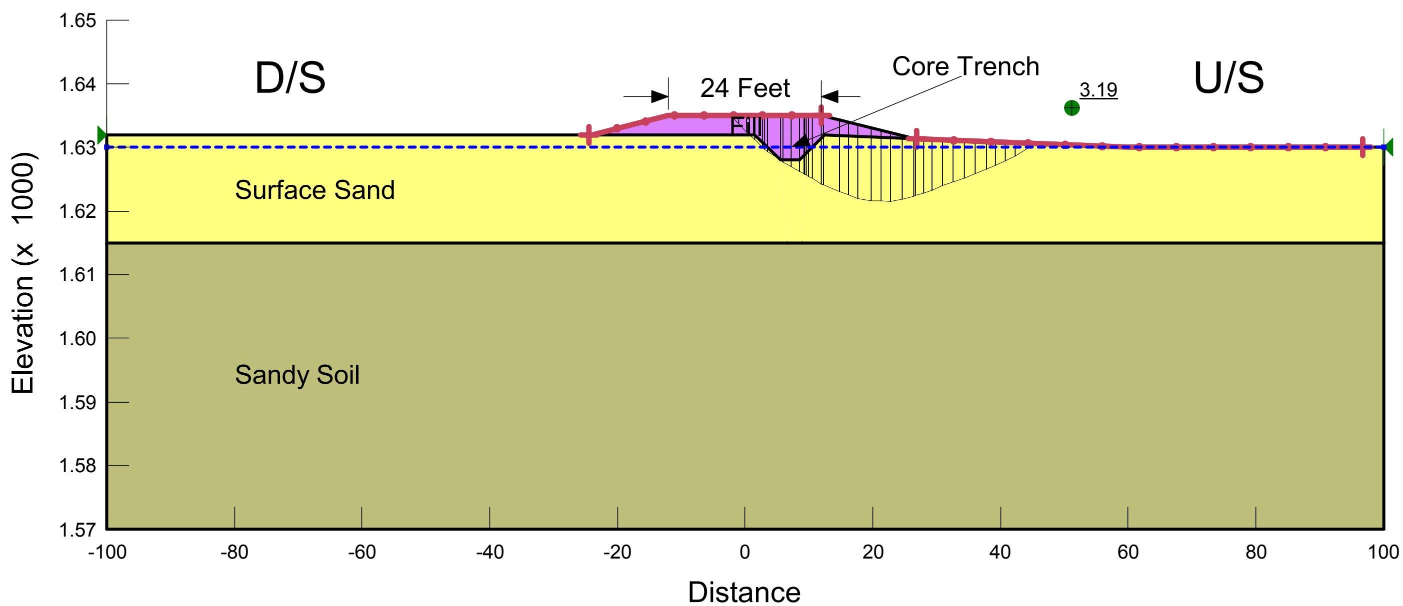
Settlement



BM-12-02634: MRCC Levee-Road Section
Missouri River Correction and Rehabilitation Center
Bismarck, ND
Side Slopes 4(H):1(V)

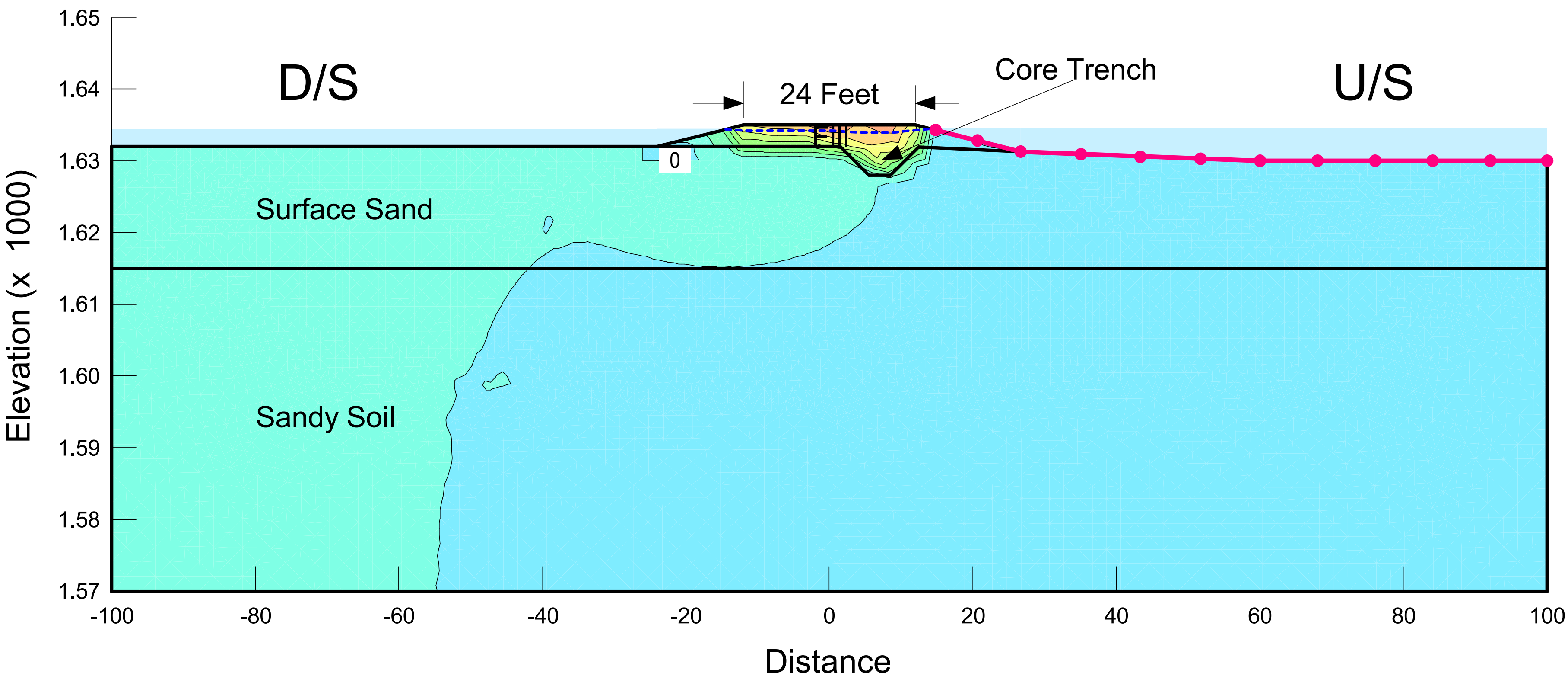
End-of-Construction Stability
Total Stress Analysis

Factor of Safety: 3.19



BM-12-02634: MRCC Levee-Road Section
Missouri River Correction and Rehabilitation Center
Bismarck, ND
Side Slopes 4(H):1(V)

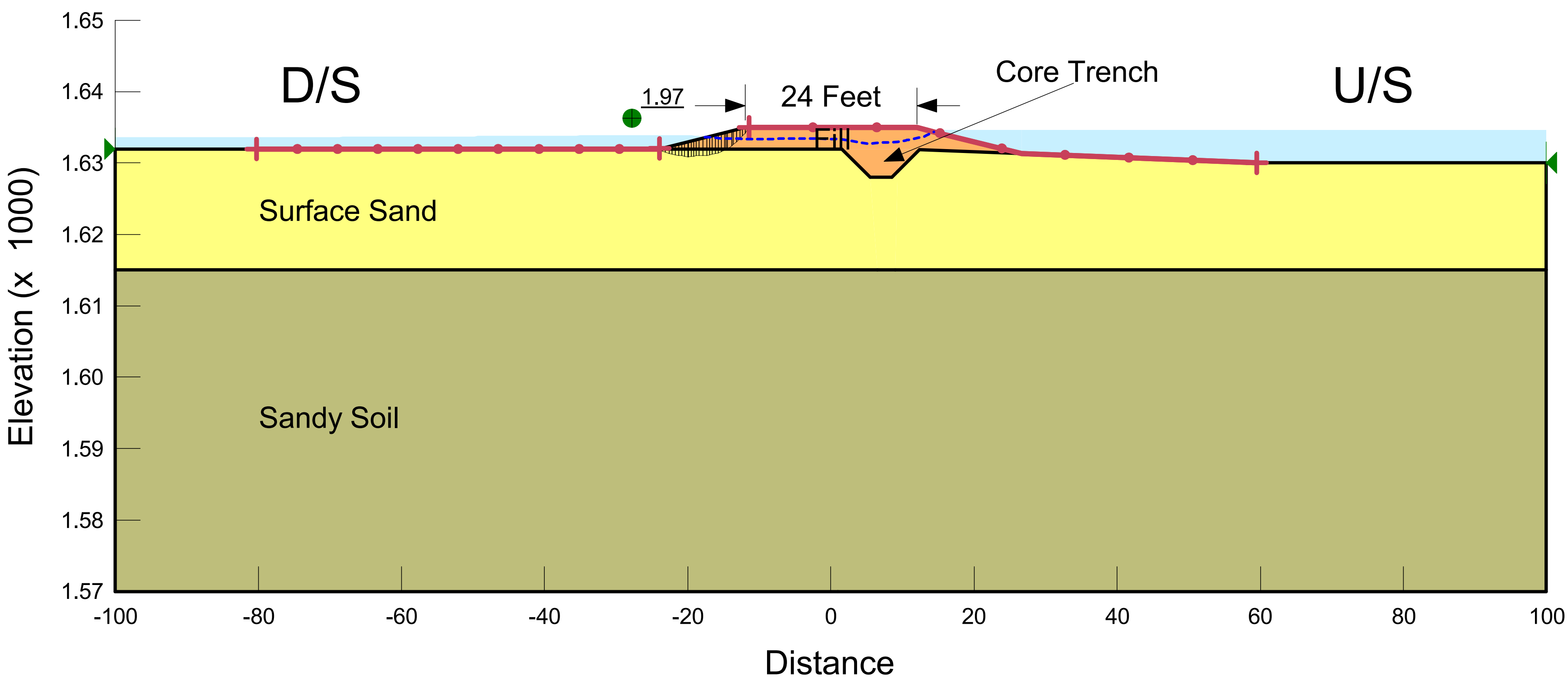
Flood Infiltration Limits



BM-12-02634: MRCC Levee-Road Section
Missouri River Correction and Rehabilitation Center
Bismarck, ND
Side Slopes 4(H):1(V)

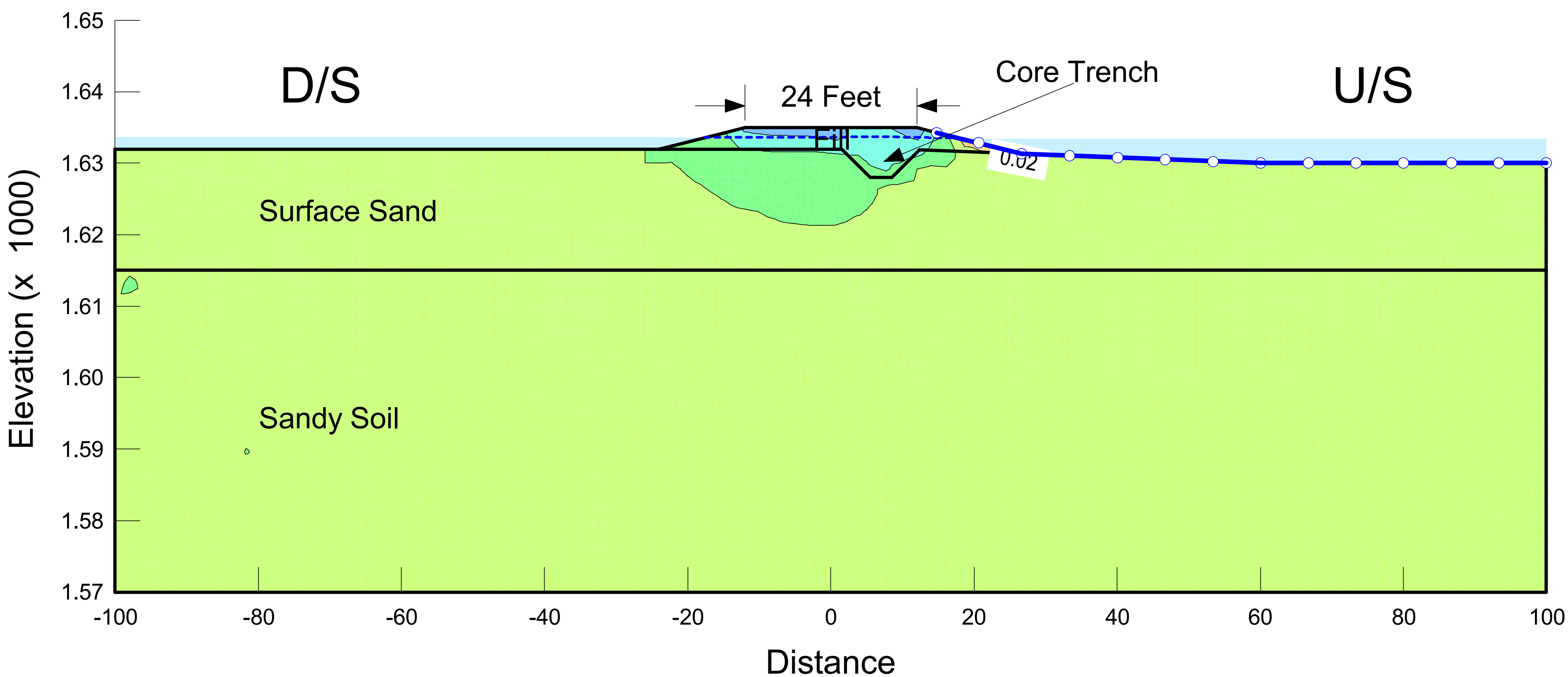
Flood Stage Stability
Effective Stress Analysis

Factor of Safety: 1.97



BM-12-02634: MRCC Levee-Road Section
Missouri River Correction and Rehabilitation Center
Bismarck, ND
Side Slopes 4(H):1(V)

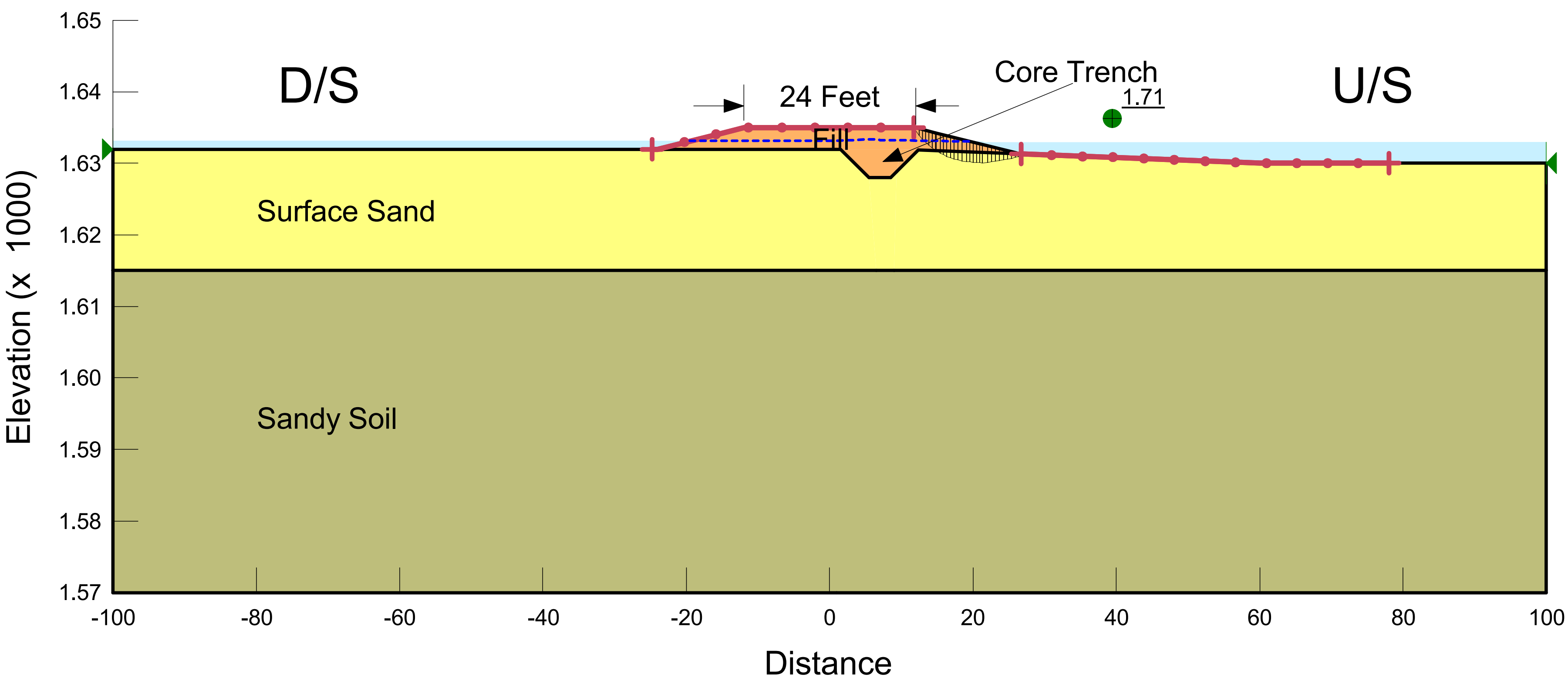
Drawdown Stage Infiltration Limits



BM-12-02634: MRCC Levee-Road Section
Missouri River Correction and Rehabilitation Center
Bismarck, ND
Side Slopes 4(H):1(V)

Drawdown Stage Stability
Effective Stress Analysis

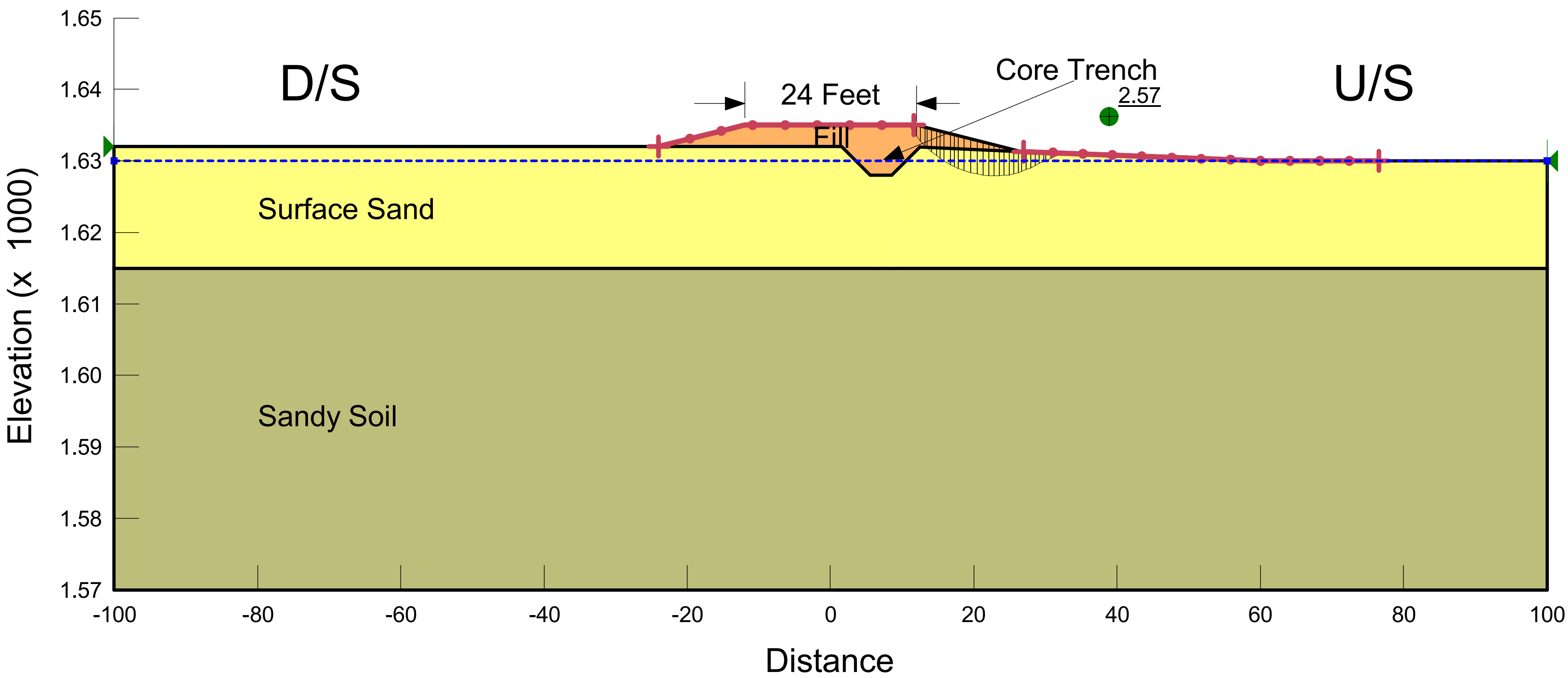
Factor of Safety: 1.71



BM-12-02634: MRCC Levee-Road Section
Missouri River Correction and Rehabilitation Center
Bismarck, ND
Side Slopes 4(H):1(V)

Long Term Stability
Effective Stress Analysis

Factor of Safety: 2.57



BM-12-02634: MRCC Levee-Road Section
Missouri River Correction and Rehabilitation Center
Bismarck, ND
Side Slopes 4(H):1(V)

Settlement