moore engineering, inc.

PRELIMINARY DESIGN REPORT
UPPER MAPLE RIVER WATERSHED RCPP

Prepared for

Cass County Joint Water Resource District

August 2020

Prepared by
Josh Hassell, PE
Ben Kugler, PE
Kyle Hafliger, PE

I hereby certify that this report was prepared by me or under my direct supervision, and that I am a duly Registered Professional Engineer under the laws of the State of North Dakota.

_____

Joshua M. Hassell, PE
ND Registration No. PE-9132
Date:_____

Table of Contents

List of Tables

List of Figures

List of Appendices

1 Background

1.1 Authority

The Cass County Joint Water Resource District (District) was established to address the common issues related to the four water resource districts in Cass County, which include the Maple River Water Resource District, the Southeast Cass Water Resource District, the North Cass Water Resource District and the Rush River Water Resource District.

The District is the sponsoring local organization (SLO) and entered into a cooperative agreement with the Natural Resource Conservation Service (NRCS) to engage in watershed planning in the Upper Maple River watershed, a subwatershed of the Maple River. The Upper Maple River watershed is located in the northwest corner of Cass County and extends west into Barnes County and north into Steele County. The cooperative agreement is funded under the Regional Conservation Partnership Program (RCPP) as authorized in the 2014 Farm Bill.

The District utilized guidance included in the Watershed Protection and Flood Prevention Act of 1954 (PL-566) to help facilitate the watershed planning.

1.2 Location

The District's planning area for the Upper Maple River watershed study is shown in Figure 1.1. The study area includes parts of Cass County, Barnes County and Steele County, North Dakota. This area is north and west of Fargo, ND and north and east of Valley City, ND. Agriculture dominates the land use covering almost 95 percent of the land area in the watershed planning area.

1.3 Flood History

Within the Upper Maple River watershed excess runoff and intense rain events cause frequent overland and overbank flooding causing damages nearly every year. This flooding causes damages to fields due to erosion, crop losses, delayed planting which reduces yields. Flooding also overtops and washes out roads, damages bridges and culverts and further disrupts transportation systems. Flooding of cropland also degrades water quality.

1.4 Proposed Project Alternative

Dam Alternative #2A, shown in Figure 1.2, proposes to construct an impoundment consisting of approximately 12,100 feet of embankment to provide flood protection from the tributary of the Maple River to infrastructure and cropland during various rainfall and spring flood events. The alternative will include a principal spillway consisting of a 48" RCP pipe with a two way covered riser and an emergency spillway consisting of two straight drop concrete spillways. This alternative will also include a grade raise to the existing township road to provide access when the impoundment is not in use. Two small farm levees will also be constructed to protect farmsteads in the upper end of the backwater pool from inundation to the top of dam.

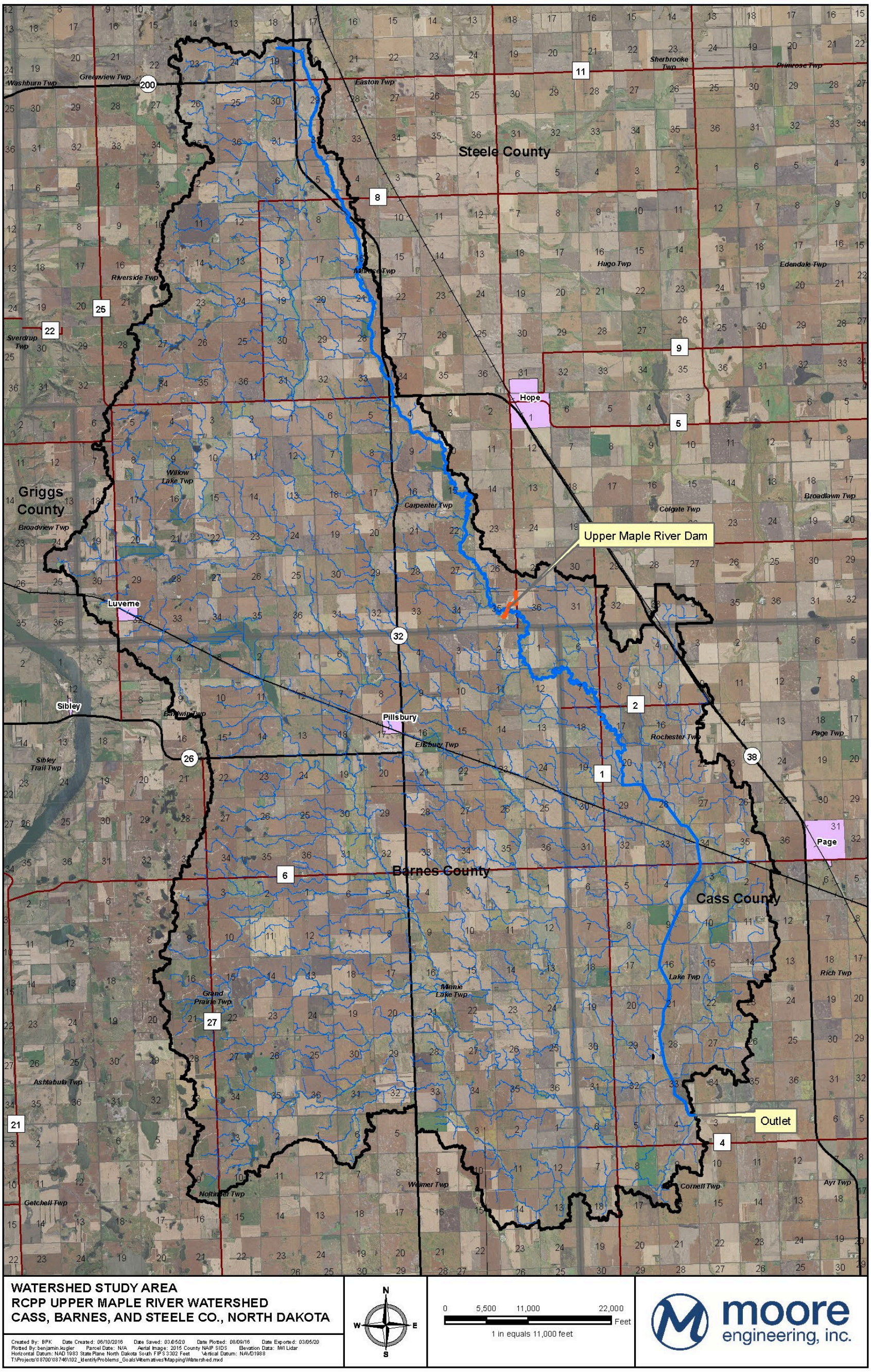


Figure 1.1 Upper Maple River Watershed Study Area

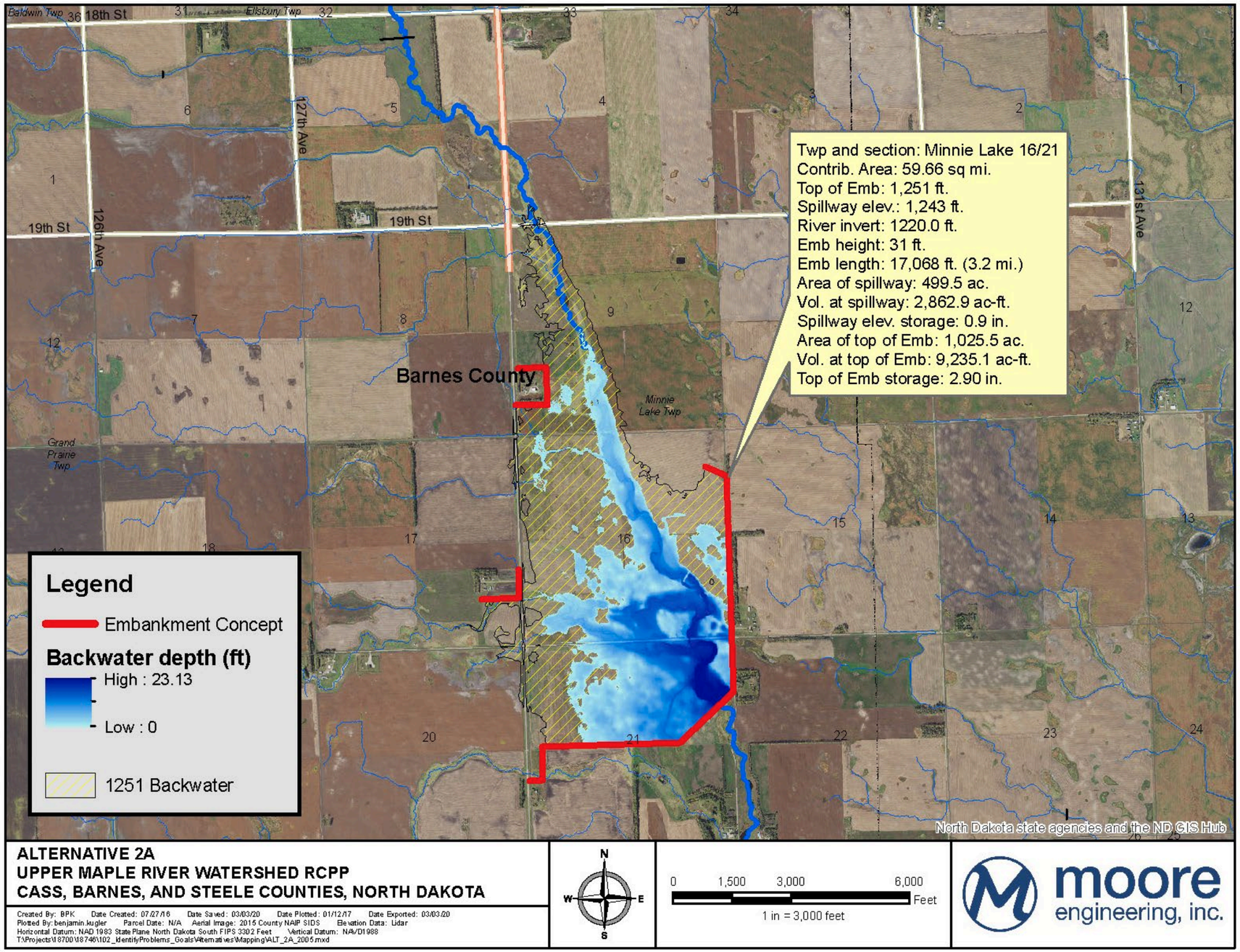


Figure 1.2 Proposed Alternative 2A

2 Hydrology & Hydraulics

2.1 Hydrology

2.1.1 Existing Hydrologic Models

A study was done in 2011, known as the "Basin Wide Modeling Approach", in which HEC-HMS models were created for all major tributary watersheds that drain into the Red River of the North upstream of Halstad, Minnesota [1]. The Maple River watershed was one of the HEC-HMS models created in the 2011 study, which includes the Upper Maple River watershed.

The Maple River HEC-HMS model created from the 2011 "Basin Wide Modeling Approach" study was updated to incorporate proposed storage sites throughout the Maple River watershed, including the Upper Maple River watershed, in the "Maple River Comprehensive Detention Plan" study completed in 2014 [2]. Several sub-basins were broken up in the 2014 model to model the storage sites.

2.1.2 Watershed Delineation

Watersheds for the alternative was developed based on 2008 LiDAR that has been hydraulically corrected during the Maple River Comprehensive Detention Plan study. Watershed delineation was completed utilizing delineation tools in ArcGIS. Maps of the watersheds for the alternative are included in Figure 2.2.

2.1.3 Upper Maple River HEC-HMS Model Development

The latest existing HEC-HMS model developed for the Maple River Comprehensive Detention Plan in the 2014 study was updated for use to model Alternatives 2A for the Upper Maple River watershed RCPP plan [2]. The updated HEC-HMS model only includes the Upper Maple River watershed. The sub-basins were further broken up in the Upper Maple River watershed, mainly at the detention site locations from the 2014 study, and also broken up at the Alternative 2A location. The model was further modified in all of the other site locations for purpose of accurately modeling existing conditions, and using the exact same model to model proposed conditions.

2.2 Alternative Hydraulic River Modeling

2.2.1 Existing Hydraulic Model

There are no existing hydraulic models that were large enough or detailed enough to model these alternatives through the watershed. Therefore, it was determined that creation of a new HEC-RAS 2-D model was the preferred route moving forward.

2.2.2 HEC-RAS 2-D Model Development

The 2-D model was created using HEC-RAS version 5.0.5.

2.2.2.1 Coordinate System

The vertical datum used for the unsteady Upper Maple River watershed 2-D HEC-RAS model is the North American Vertical Datum of 1988 (NAVD88). The horizontal datum used is the North American Datum of 1983, North Dakota State Plane South with linear units of feet.

2.2.2.2 Boundary Conditions

The HEC-RAS 2-D model covers the entire Upper Maple River watershed area that is downstream of the Upper Maple River Dam. To account for the flow that comes from the Upper Maple River Dam, an inflow hydrograph is applied on the Maple River at the upstream boundary condition immediately downstream of the Upper Maple River Dam. Downstream of the dam, no local inflow hydrographs are applied anywhere in the watershed in the 2-D HEC-RAS model. Instead, precipitation is applied over the entire extent area of the RAS model, described in further detail in the model hydrology section. There is a normal depth boundary condition surrounding all of the lower elevation areas of the entire watershed boundary, capturing any flow that leaves the watershed, and also including the water exiting the downstream end of the model on the Maple River. The boundary condition will account for flow lost out of the watershed due to breakouts. Since the boundary condition lines were set mainly on section line roads, there are minor small areas outside of the watershed boundary that will just flow out of the model when precipitation is applied in that area. A slope is assigned to each normal depth boundary condition line.

2.2.2.3 2-D Areas

The 2-D HEC-RAS model uses three 2-D areas to model the entire Upper Maple River watershed, two in the north half of the watershed and one in the south half of the watershed. The 2-D areas are modeled using a mesh grid with 250 feet by 250 feet cell resolution. The edge of each cell acts as a weir in the model, calculating flow over the weir. The weir is defined by the LiDAR surface used in the model. The smaller the resolution of the mesh grid cells, the more accurate the flow is over the 2-D areas.

2.2.2.4 Breaklines

There are several breaklines in each 2-D area in the model. Break lines are used to better define the mesh terrain for accuracy. Break lines are necessary to ensure the 250-foot mesh cell covers the high ground and abrupt grade changes accurately. The breaklines are mainly located along each section across the roadways or high ground. All other levees and high ground barriers also have breaklines as well. Without the breaklines, the cell faces will not always line up across the highest ground and water would leak across the roadway or high ground barriers at a lower elevation, greatly influencing the discharge or water surface in that location. The edge of each cell acts as a weir in the model, calculating flow over the weir. The weir is defined by the LiDAR surface used in the model. Along the breaklines, the mesh cell resolution in the model is finer, at 150 feet along all breaklines throughout the watershed except for a few project features, which have mesh resolutions of 20 to 50 feet. The mesh cells are fine enough to capture the highest ground.

2.2.2.5 2-D Connections

In the HEC-RAS model, 2-D connections are used wherever there is a culvert crossing or weir structure, or at the boundary between two 2-D areas. The breaklines already define the weir elevations across the roadways, so the 2-D connections only span on the roadway near the culvert crossing (about 50 feet on each side of the culvert). The culverts in the model use the LiDAR elevation rather than the actual surveyed elevation. The model requires that the culvert invert should be higher than the elevation of the LiDAR surface. However, the elevation from the LiDAR surface is usually higher than the surveyed culvert invert due to surface resolution. For proposed culverts, for example at the Upper Maple River alternatives, the LiDAR is modified to account for the project being built. The LiDAR for those culverts would be lowered down to the actual culvert elevations since they are significant to the modeling results, unlike most of the culverts in the rest of the watershed.

Connections within the same 2-D area uses the 2-D equation method for overtopping rather than the weir equation, which calculates the flow the same way as crossing over the breaklines away from the culvert crossings. The 2-D connections that border between two 2-D areas span across the entire area rather than only at the culvert crossing since that is the only option for flow to transfer from 2-D area to 2-D area. The 2-D connections that border two 2-D areas can only use the weir equation for overtopping.

2.2.3 Model hydrology

The hydrology for the 2-D HEC-RAS model uses the same methodology as in the 2011 Basin Wide Modeling Approach study, focusing on tributaries of the Red River of the North upstream of Halstad, Minnesota. Hydrology was created for the 2-, 5-, 10-, 25-, 50-, 100-, and 500-year scenarios with return periods of 24 hours. The inflow hydrograph out of the Upper Maple River Dam, applied at the upstream boundary conditions, is from the newly created Upper Maple River watershed HEC-HMS model. Instead of using the total precipitation that is used from the Basin Wide modeling approach for each synthetic scenario, the total precipitation uses the Atlas 14 values, which are slightly higher. The Atlas 14 values are the point rainfall values, so an area reduction factor is multiplied to the point rainfall for each 2-D area to determine the adjusted uniform total rainfall applied to each 2-D area. Stated earlier, precipitation hyetographs (only including the runoff excluding the infiltration) are uniformly applied to each 2-D area in the watershed rather than local inflow hydrographs applied on the main river. The total runoff hyetograph rather than the total rainfall hyetograph is applied in the HEC-RAS model, since there is no infiltration in the HEC-RAS model. To determine the total runoff, the total drainage area and average curve number of each 2-D area is calculated. The average curve number for each 2-D area is calculated based off of the raster grid of the curve numbers used for the Basin Wide Approach study. Taking the adjusted total rainfall, curve number, and basin area into account for each 2-D area, the total runoff for each synthetic scenario can be determined for each 2-D area. The SCS Type-II rainfall distribution is assumed, the same as in the Basin Wide Modeling Approach.

2.2.4 Alternative 2A – HEC-RAS Modifications

Modifications to the HEC-RAS model for Alternative 2A included adding the dam embankment to the LiDAR surface as well as burning the emergency spillway into the LiDAR surface. Internal 2-D connections were added to model the principal spillway culvert on the channel, for water flowing over the emergency spillway, and for a portion of the top of dam embankment. Breaklines were also added along the dam embankment so the cell faces would capture the highest elevations of the dam embankment to prevent overtopping at elevations lower than the embankment.

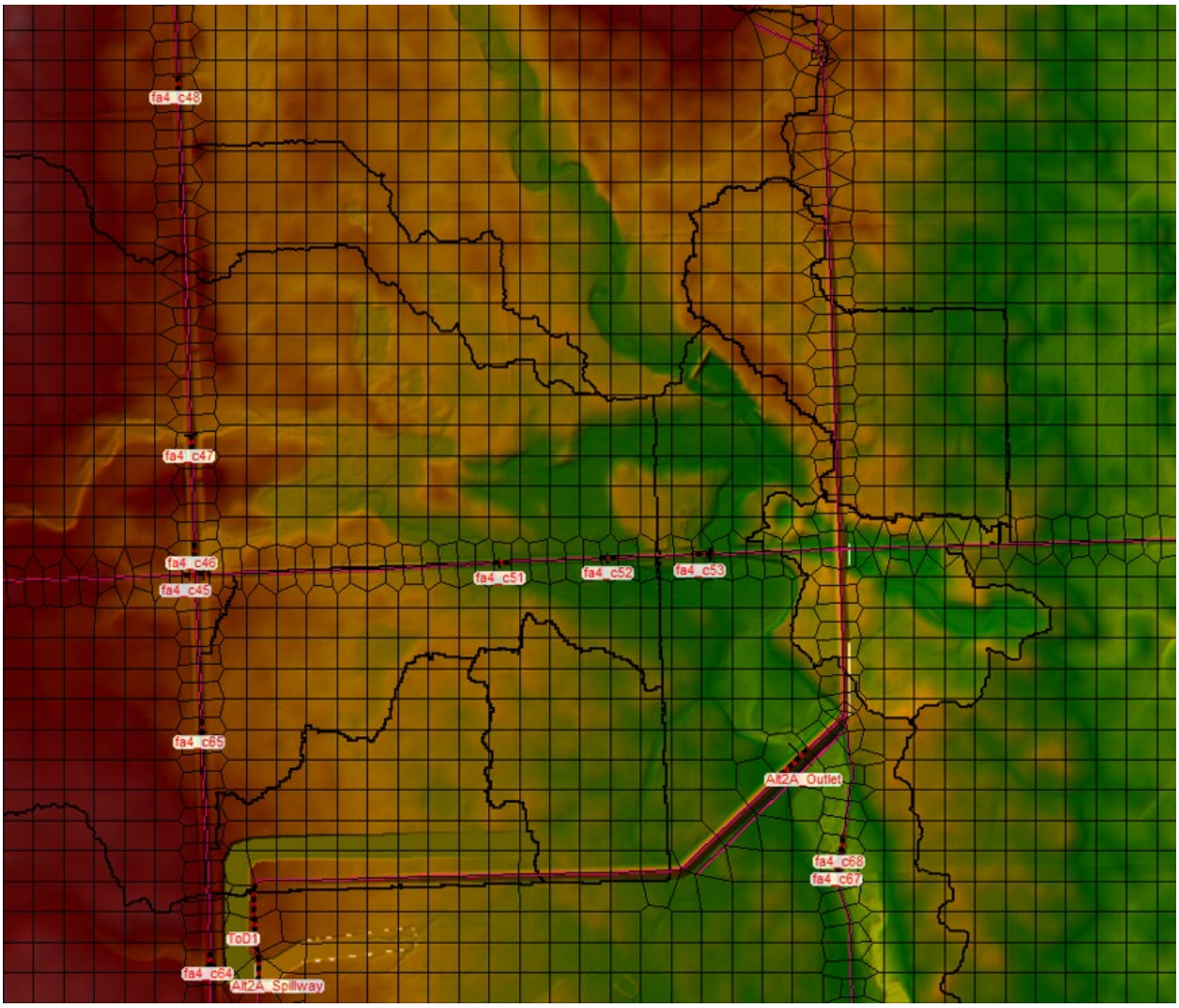


Figure 2.1 HEC-RAS Geometry Layout - Alternative 2A

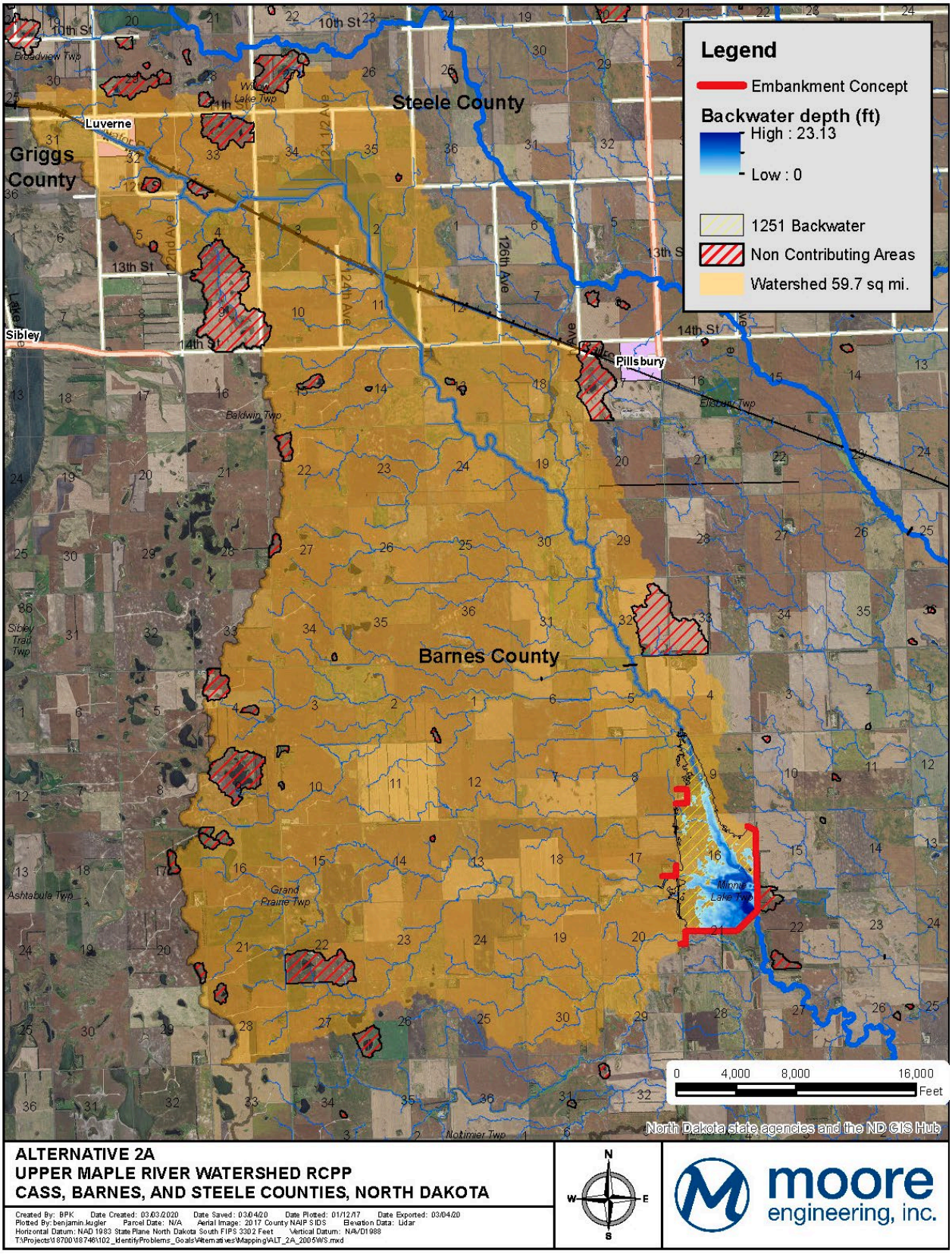


Figure 2.2 Alternative 2A Watershed Design Considerations

2.3 Datum

Coordinate System and Projection: North American Datum 1983 (NAD83),
North Dakota State Plane South, Linear Units of Feet
Vertical Datum: North American Vertical Datum of 1988 (NAVD 88)

2.4 Geotechnical

Barr Engineering Company was retained by Moore Engineering, Inc. to complete a preliminary geotechnical investigation and evaluation of Impoundment Alternative 2A. Their report titled, "Preliminary Geotechnical Engineering Analysis and Report: Upper Maple River Watershed Detention Plan – Site 2A" contains their analysis [3]. The analysis shows that the preliminary cross section of 8 foot crest width with 3H:1V side slopes meet the minimum requirements for all factors of safety. Additionally, the report analyzed the estimated settlement for the embankment. The estimated long-term settlement at the center of the embankment is 3-4 inches. The dam embankment was raised 4 inches to account for the settlement.

2.5 Storage Information

Impoundment Alternative 2A:

An analysis of the topographic information at the proposed dam location shows that the highest reasonable top of dam elevation is the 1251.0 foot contour, with a maximum volume of 9,235.1 acre-feet (2.90" of runoff). Also, from analysis of the site, the emergency spillway elevation was determined to be 1,243.0 feet, with a storage volume of 2862.9 acre-feet (0.90" of runoff). See Figure 3.1 for Elevation-Area-Storage information developed from LiDAR and Table 3.1 for exact values. Figure 2.2 shows the backwater extents associated with the elevations of the concrete spillway (the blue shaded area with the darkest blue representing the deepest areas) and the top of the dam (light yellow hatched area with a black border).

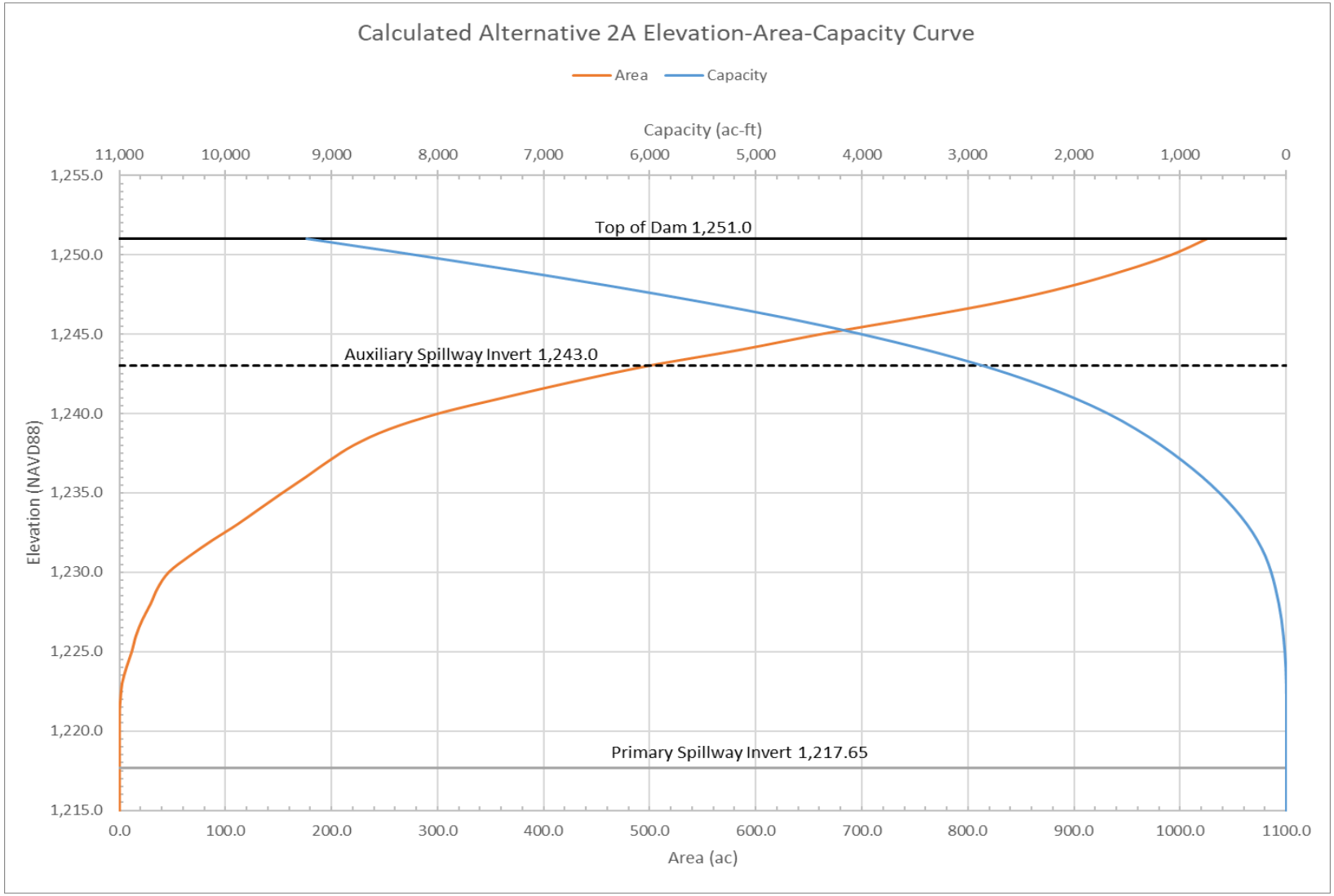


Figure 3.2 Alternative 2A Elevation-Area-Capacity Curve

Table 3.1 Alternative 2A Elevation-Area-Capacity Data

Alternative 2A Elevation-Area-Capacity Information*			
Elevation (ft)	Area (ac)	Storage(ac-ft)	Volume (in)**
1217	0	0.0	0.00
1220***	0.0	0.0	0.00
1221	0.3	0.1	0.00
1222	1.1	0.7	0.00
1223	2.7	2.4	0.00
1224	6.8	6.7	0.00
1225	11.8	16.0	0.01
1226	15.8	29.6	0.01
1227	21.8	47.7	0.01
1228	29.6	73.0	0.02
1229	36.3	105.2	0.03
1230	46.8	145.2	0.05
1231	66.0	199.8	0.06
1232	87.7	275.3	0.09
1233	111.3	372.7	0.12
1234	132.5	492.8	0.15
1235	154.0	633.7	0.20
1236	176.2	795.7	0.25
1237	197.4	979.3	0.31
1238	221.2	1184.4	0.37
1239	254.2	1417.1	0.45
1240	301.6	1688.4	0.53
1241	363.2	2015.3	0.63
1242	428.4	2406.3	0.76
1243	499.5	2862.9	0.90
1244	585.2	3399.5	1.07
1245	662.5	4016.3	1.26
1246	749.2	4714.5	1.48
1247	830.4	5498.5	1.73
1248	895.6	6354.7	2.00
1249	947.8	7269.4	2.28
1250	992.1	8230.7	2.59
1251	1025.5	9235.1	2.90

*Developed utilizing 2008 LiDAR
**Watershed Area - 59.7 sq. mi.
*** 1220 is minimum elevation from LiDAR
a minimal amount of storage was included
to account for primary spillway invert

2.6 Design Standards

The impoundment alternatives were designed to meet the criteria as defined in Design of Small Dams and Reservoirs USDA NRCS TR-60 [5]. Preliminary outlet structures for Alternative 2A were sized per requirements listed TR-60. Alternative 2A is assumed to be a Significant Hazard Dam as outlined in Section 3.7 Hazard Classification. Per TR-60, the hazard classification establishes the design criteria for the dams. A hydrologic and hydraulic analysis of Alternative 2A was completed utilizing HEC-HMS in order to determine outlet structure sizing's that meet the requirements of TR-60 while maximizing benefits to downstream areas. The HEC-HMS models developed during preliminary alternative screening were used to model the smaller events (2- to 100-year events) as this model was calibrated specifically for these smaller events a separate single basin model for the alternative was developed for use in determining TR-60 requirements using the base HUR watershed characteristic grids to determine watershed characteristics including Time of Concentration (Tc), and Curve Number. All HEC-HMS models utilized the Clark Unit Hydrograph as utilized in the base preliminary alternative models and HUR models. Watershed delineations were based on a hydraulically corrected 5m DEM surface from LiDAR collected in 2008. Table 3.2 includes a summary of the watershed parameters utilized in the modeling of the outlet structure configurations for Alternatives 2A.

2.6.1 Principal Spillway Requirements

For a Significant Hazard Dam TR-60 requires the Principal Spillway Hydrograph (PSH) event to pass the 50-year event without the use of a vegetated auxiliary spillway. The PSH event utilizes a nested 1-day/10-day volume distribution. Runoff depths were obtained from a 100-year 10-day runoff grid developed from Figure 2-1 (a) in TR-60. 50-year and 25-year 10-day runoff depths were developed from the multipliers in Figure 2-1 (a) in TR-60. The Quick Return Flow (QRF) rate was determined from Figure 2-1 (c) in TR-60. Rainfall depths for all events was obtained from NOAA Atlas 14. During the 50-Year 10-day Runoff event, if greater than 15% of the peak volume remains 10 days after the simulation peak with the QRF included, the remainder of the volume is then set as the initial conditions for all events, and all events were then reanalyzed.

2.6.2 Auxiliary Spillway and Freeboard Requirements

For a Significant Hazard Dam, TR-60 requires that the Auxiliary Spillway be able to safely pass a Freeboard Hydrograph (FBH) developed from Table 2-5 in TR-60. A long (greater of either Tc or 24-hour) and short (6-hour) duration event was analyzed for each alternative. Both FBH and SDH utilized the latest MSE 3 rainfall distributions. The TR-60 equation used to compute the FBH for a Significant Hazard Dam is:

$$P_{100} + 0.40(PMP - P_{100})$$

TR-60 also requires the analysis of a Spillway Design Hydrograph (SDH) to analyze the stability of the auxiliary spillway. The SDH was analyzed with a long (greater of either Tc or 24-hour) and short (6-hour) event. The TR-60 equation used to compute the SDH for a Significant Hazard Dam is:

$$P_{100} + 0.12(PMP - P_{100})$$

Table 3.2 Alternative 2A Hydrologic Parameter Summary

Alternative 2A	
24-Hour Weighted Curve Number	73.7
Storage Coefficient	26.7
Time of Concentration (Tc) (hours)	33.0
PMP 6-hour depth from HMR 51 Figure 18 (in)	22.2
PMP 33-hour depth interpolated from HMR 51 Figures	29.1
100-year 6-hour rainfall from Atlas 14 (in)	4.4
100-year 33-hour rainfall interpolated from Atlas 14 (in)	6.0
Drainage Area (sq mi)	59.6
Correction Figure 2-3 TR-60	0.83
FBH6hr (P100+0.4*(PMP-P100))	9.5
FBH33hr (P100+0.4*(PMP-P100))	12.6
SDH6hr (P100+0.12*(PMP-P100))	5.4
SDH33hr (P100+0.12*(PMP-P100))	7.3

2.7 Outlet Sizing Hydraulics

Outlet structure capacity was modeled within HEC-HMS. The Primary Spillway for the alternative was modeled as a RCP culvert. An assumed length of 250 feet was used. An entrance and exit loss coefficient of 0.5 and 1 respectively was selected. There was an assumed 0.2 ft. drop from upstream to downstream, with the upstream invert at the minimum elevation in the upstream pool as measured from 2008 LiDAR. A Manning's n value of 0.013 was utilized. For vegetated spillways and dam embankment, a weir coefficient of 2.6 was selected. For structural concrete spillways a weir coefficient of 3.1 was selected.

As the area protected by the dam downstream is almost entirely agricultural, the peak reduction for smaller events was a priority as the bulk of economic damages to agriculture occur on smaller events. The project team felt that a 10-year event was considered manageable for the current drainage system, so a goal of the sizing was to reduce the small events as much as feasible while maintaining the larger events to a flow rate similar to a 10-year event. Multiple outlet configurations for the Alternative were analyzed including both structural and vegetated spillways. A preliminary check of the flow velocities on the vegetated spillway alternatives was conducted assuming a calculated average velocity based on flow area over the emergency spillway was checked, but no detailed geotechnical analysis into embankment stability for a vegetated spillway was conducted. It was a goal to maintain approximately 4 fps assuming a consistent velocity based on flow rate and flow area. Utilizing The North Dakota Dam Design Handbook a mixture of sod forming and bunch grasses with a 5% slope and easily eroded soils has a permissible velocity of 4 fps. It was determined that structural spillways would be the focus of the analysis, as the feasible locations for the auxiliary spillways would not be able to accommodate that large of width, and the primary spillway capacity necessary to not utilize the vegetated spillway on a 50-year event resulted in higher flow rates for the smaller events (approximately 10-year and lower). A summary of all the different outlet configurations is included in Table 3.3. Based on peak flow reductions of the smaller events, it was determined to proceed with the alternatives that result in the highest reduction in small event peak flows while being constructible as well as realistic in size. The selected configuration for Alternative 2A was a 48 in. RCP primary spillway and an 80 foot concrete auxiliary spillway. A summary of the modeled event for the selected configuration is included in Table 3.4. A calculated rating curve for the alternative is included in Figure 3.2. Event hydrographs for the Alternative are included in Appendix B.

Table 3.3 Alternative 2A Modeled Configurations

Alternative 2A Modeled Configurations												
Configuration	Pipe Diameter (in)	Spillway Width (ft)	Spillway Construction	Estimated Pipe Invert	Embankment Elevation	Spillway Elevation	Spillway Freeboard (ft)	Vegtated Spillway used on 50-Year Event (PSH)	<15% of PSH plus QRF Remains?	Model Starting Elevation	Auxillary Spillway Stability (SDH)	Freeboard Hydrograph Event Contained (FBH)
1	78	175	Vegitated	1217.65	1251.00	1246.00	5.0	No	Yes	1220.0	Under 4 fps	Yes
2	84	125	Vegitated	1217.65	1251.00	1245.00	6.0	No	Yes	1220.0	Under 4 fps	Yes
3	48	133	Concrete	1217.65	1251.00	1245.00	6.0	No	No	1240.5	Structural Spillway	Yes
4	60	120	Concrete	1217.65	1251.00	1245.00	6.0	No	Yes	1220.0	Structural Spillway	Yes
5	72	112	Concrete	1217.65	1251.00	1245.00	6.0	No	Yes	1220.0	Structural Spillway	Yes
6	84	104	Concrete	1217.65	1251.00	1245.00	6.0	No	Yes	1220.0	Structural Spillway	Yes
7	48	101	Concrete	1217.65	1251.00	1244.00	7.0	No	No	1239.0	Structural Spillway	Yes
8	48	80	Concrete	1217.65	1251.00	1243.00	8.0	No	No	1237.0	Structural Spillway	Yes

Selected Configuration

Table 3.4 Alternative 2A Selected Configuration Event Peak Summary

Peak Summary - HEC-HMS Model with 48"/80' Concrete Spillway Weir 8' Below TOE

Frequency (yr)	2	5	10	25	50	100	25	50	100	25	50	100	SDH	SDH	FBH	FBH
Duration	24-hr	24-hr	24-hr	24-hr	24-hr	24-hr	10-day	10-day	10-day	RO	RO	RO	6-hr	33-hr	6-hr	33-hr
Total Rainfall (in)	2.26	2.88	3.43	4.32	5.08	5.91	6.38	7.24	8.17	-	-	-	5.40	7.25	9.54	12.63
Total Runoff (in)	0.47	0.81	1.18	1.82	2.40	3.08	1.89	2.45	3.10	3.21	3.89	4.59	2.66	4.23	6.29	9.17
Q, Inflow (cfs)	572.2	1013.5	1487.2	2301.2	3076.3	3937.4	923.9	1250.2	1634.2	1813.8	2222.9	2632.6	2271.5	3528.7	5377.1	7653.2
Q, Outflow (cfs)	226.4	250.9	273.8	724.1	1173.9	1745.9	274.7	536.4	822.5	890.1	1196.1	1500.6	1313.4	2375.4	3922.1	5848.8
Peak Stage (ft.)	1237.6	1240.7	1243.1	1244.5	1245.3	1246.3	1243.1	1244.0	1244.7	1244.8	1245.4	1245.9	1245.6	1247.1	1249.0	1250.9
Peak Storage (Acre-ft.)	1095.8	1920.2	2907.3	3695.8	4257.4	4914.9	2911.3	3422.5	3823.6	3907.1	4284.2	4632.7	4422.3	5608.9	7240.4	9158.0
Peak Reduction, %	60.43%	75.24%	81.59%	68.53%	61.84%	55.66%	70.27%	57.09%	49.67%	50.93%	46.19%	43.00%	42.18%	32.68%	27.06%	23.58%
Peak Storage (in)	0.3	0.6	0.9	1.2	1.3	1.5	0.9	1.1	1.2	1.2	1.3	1.5	1.4	1.8	2.3	2.9

	Culvert (in)	48	1217.65	RCPP	Initial Elevation Based on 50-Year PSH (50YrRO) with QRF	SDH : Spillway Design Hydrograph = P100 + 0.12(PMP-P100)
	Spillway (ft)	80	1243	Concrete	1237	FBH: Freeboard Hydrograph = P100 + 0.4(PMP-P100)
	Top of Dam:		1251			

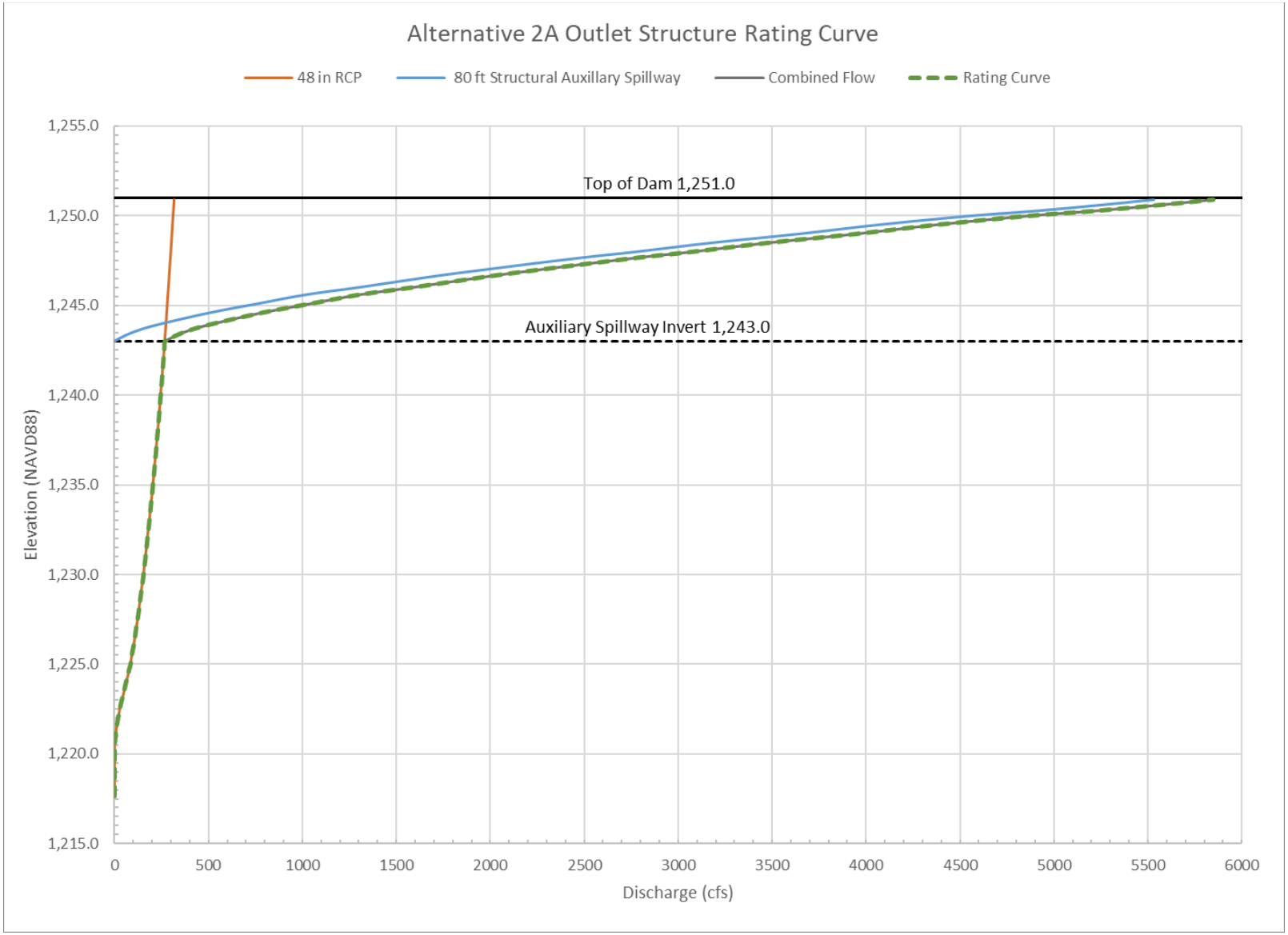


Figure 3.2 Alternative 2A Selected Configuration Rating Curve

2.8 Dam Breach Analysis

2.8.1 Hydrograph Development

Dam breach hydrographs were developed utilizing the equations presented in TR-60 and routing procedure from TR-66. The Dam breach hydrographs were developed utilizing spreadsheets obtained from the NRCS website. A summary of the dam breach calculation inputs are included for the alternative in Table 3.5. The resulting hydrographs are included in Figure 3.3.

Table 3.5 Alternative 2A TR-60 Dam Breach Inputs

Input	Value
dam crest elevation	1251
w.s. elev at time of breach	1250.9
dam top width (feet)	8
dam side slope (upstream, SSup:1)	3
dam side slope (downstream, SSdn:1)	3
valley floor elev	1217
resv vol at time of breach (acre-feet)	9166.1
valley width at dam axis & w.s. elev (feet)	5280
timestep (minutes) for breach hydrograph	6

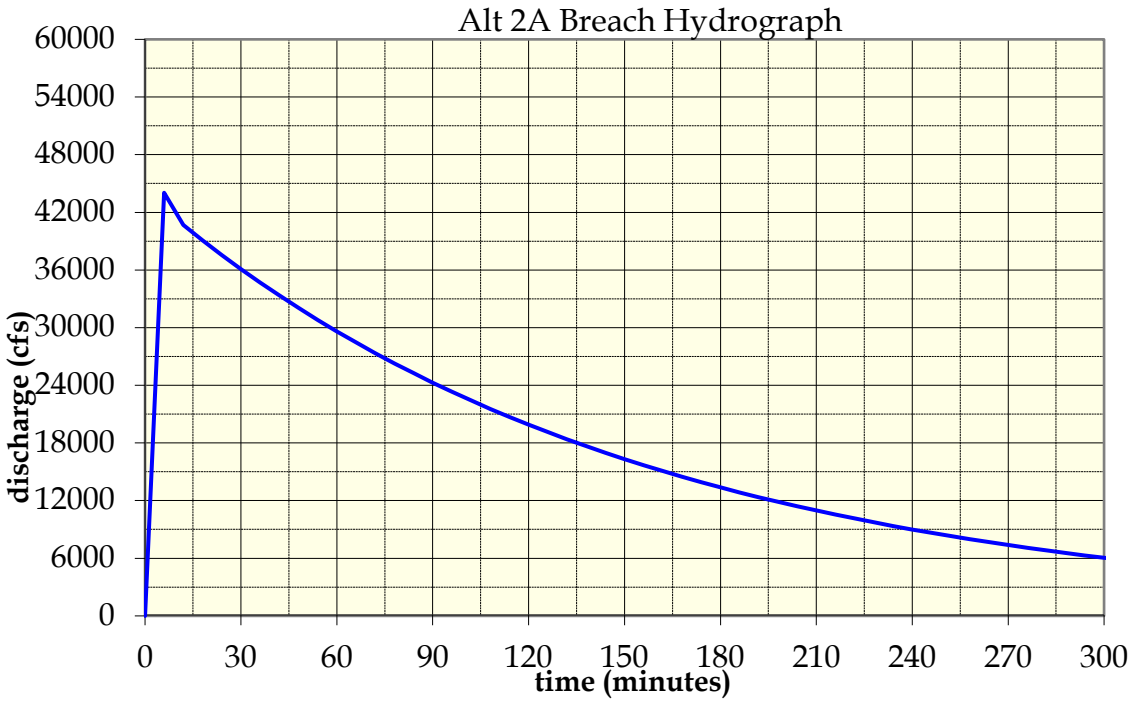


Figure 3.3 Alternative 2A TR-60 Dam Breach Hydrograph

2.8.2 Modeling/Results

The TR-60 dam breach hydrographs were then routed through the HEC-RAS 2-D model developed for the alternative. For the TR-60 dam breach scenarios, there is no other flow applied in the model except for the dam breach hydrograph, meaning the removal of the UMRD upstream boundary condition inflow and all of the precipitation in the model. The TR-60 dam breach hydrograph is applied as a point inflow applied immediately downstream of the dam outlet for the modeled Alternative. Based on the modeling results, there are no residential structures that would be inundated by Alternative 2A. Overview and individual dam breach impact maps for Alternatives 2A are included in Appendices C, respectively.

2.9 Hazard Classification

Stated earlier, it is assumed for this design that the Upper Maple River Alternative 2A Dams would be classified as Significant Hazard Dams based on the definitions presented in section 520.21 E of the NRCS Title 210 National Engineering Manual [6] that defines Significant Hazard Potential as "where failure may damage isolated homes, main highways, or minor railroads, or interrupt service of relatively important public utilities".

2.10 Principal Spillway Design

The principal spillways were sized based on input from the project team during the planning process. During those meetings, the team felt as though the areas downstream of the impoundments could handle a 10yr-24hr event discharges with minimal impacts on the landscape. Therefore, we sized the principal spillway to have a peak discharge as close to the existing conditions 10yr-24hr event peak discharge. In the alternative, matching the existing conditions peak discharge resulted in a 48" RCP principal spillway pipe. This size was incorporated into a 2-way covered riser which was designed per guidance of Technical Release No. 29, *Hydraulics of Two Way Covered Risers* [7]. The 48" riser structures were checked back to verify that the design requirements as stated in Section 3.4.1 were met. With the guidance of Hydraulic Engineering Circular No. 14 Third Edition*, Hydraulic Design of Energy Dissipaters for Culverts and Channels* (HEC-14), a Colorado State University (CSU) [8] rigid boundary stilling basin were selected for both alternatives. Table 3.6 shows the design calculations of the two-way covered risers for Alternative 2A, respectively. Figure 3.4 and Figure 3.5 shows the two-way covered riser rating curve and dimensions for Alternative 2A.

Table 3.6 Two-Way Covered Riser Calculations for Alternative 2A

D (pipe diameter) = 4 ft

$1.0 \leq L/D \leq 10.0$ Assume L/D = 3
L (inside length of riser) = 12 ft

$N_{ih} \geq 3D$ Assume $N_{ih} = 3D$
N_{ih} (vertical distance from the pipe invert at the riser to the crest of the covered inlet of the riser) = 12 ft

Based on table in TR-29: required L_o/D=0.4 or higher
Required L_o (anti-vortex plate overhang, measured from the outside of the sidewall)= 1.6 ft or higher
Assumed L_o = 4 ft

H_o (pressure flow head)= FDH HW - FDH TW
FDH HW= 1251 ft, FDH TW= 1224.77 ft
H_o= 26.23 ft

$N_{hc(max)} = 1.17D^{2/3}$= 2.95 ft
$N_{hc(min)} = 0.42D$= 1.68 ft
Assumed N_{hc} (vertical opening of the covered inlet of the riser)= 2.9 ft

Curve A: $Q_{hc} = C_w(2L)H_h^{3/2} = 3.1\ (2L)H_h^{3/2}$

Curve B: $H_h/D = N_{hc}/D$

Curve C: $\frac{H_h}{D} = \frac{N_{hc}}{D} - \left(\frac{0.2}{L/D} - 0.1 \log_{10} \frac{L_o}{D}\right) + \left(0.1 - 0.05 \frac{L_o}{D}\right) \frac{Q_{hc}}{(2L)D^{3/2}}$

Curve D: $Q_{hc} = C_b a_b \sqrt{2gH_o}$

Hh/D	Hh	Q	Curve A	Curve B	Curve C (Hh)	Curve D
0.00	0.00	0.00	0.00		2.63	320.34
0.25	1.00	74.40	74.40		2.75	447.60
0.50	2.00	210.43	210.43		2.97	545.96
0.70	2.80	349.15	349.15		3.19	613.64
0.75	3.00	386.59	386.59		3.25	629.13
0.90	3.58	504.70	504.70		3.44	672.93
1.00	4.00	595.20	595.20	595.20	3.59	702.52
1.00	4.00	702.52	595.20	702.52	3.76	702.52
1.25	5.00	768.94	831.82		3.87	768.94
1.50	6.00	830.06	1093.45		3.96	830.06
1.75	7.00	886.98	1377.91		4.06	886.98
2.00	8.00	940.46	1683.48		4.14	940.46
2.25	9.00	991.05	2008.80		4.22	991.05
2.50	10.00	1039.19	2352.73		4.30	1039.19
2.75	11.00	1085.20	2714.33		4.37	1085.20
3.00	12.00	1129.33	3092.75		4.44	1129.33
3.25	13.00	1171.80	3487.29		4.51	1171.80
3.50	14.00	1212.78	3897.31		4.58	1212.78
3.75	15.00	1252.43	4322.25		4.64	1252.43
4.00	16.00	1290.85	4761.60		4.70	1290.85
4.25	17.00	1328.17	5214.90		4.76	1328.17
4.50	18.00	1364.46	5681.74		4.82	1364.46
4.75	19.00	1399.82	6161.74		4.88	1399.82
5.00	20.00	1434.30	6654.54		4.93	1434.30
5.25	21.00	1467.98	7159.82		4.99	1467.98
5.50	22.00	1500.89	7677.27		5.04	1500.89
5.75	23.00	1533.11	8206.63		5.09	1533.11
6.00	24.00	1564.65	8747.62		5.14	1564.65
6.25	25.00	1595.58	9300.00		5.19	1595.58
6.50	26.00	1625.92	9863.54		5.24	1625.92
6.75	27.00	1655.70	10438.03		5.29	1655.70
7.00	28.00	1684.95	11023.26		5.34	1684.95

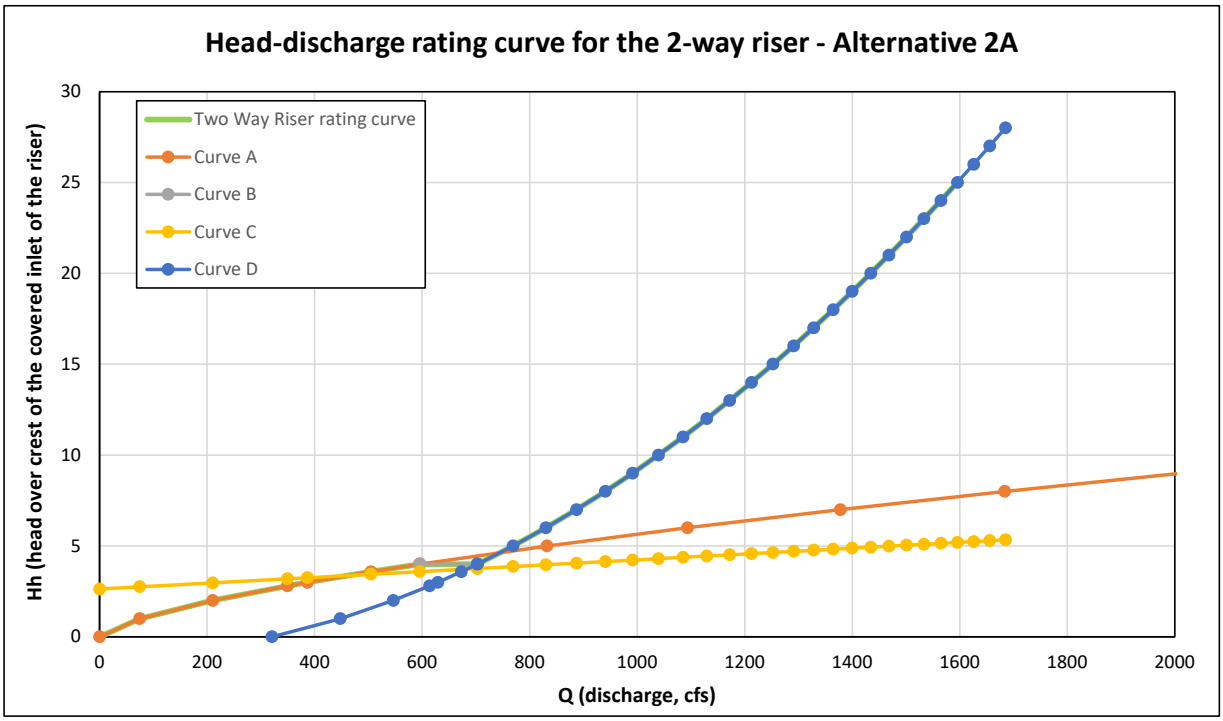


Figure 3.4 Two-Way Covered Riser Rating Curve - Alternative 2A

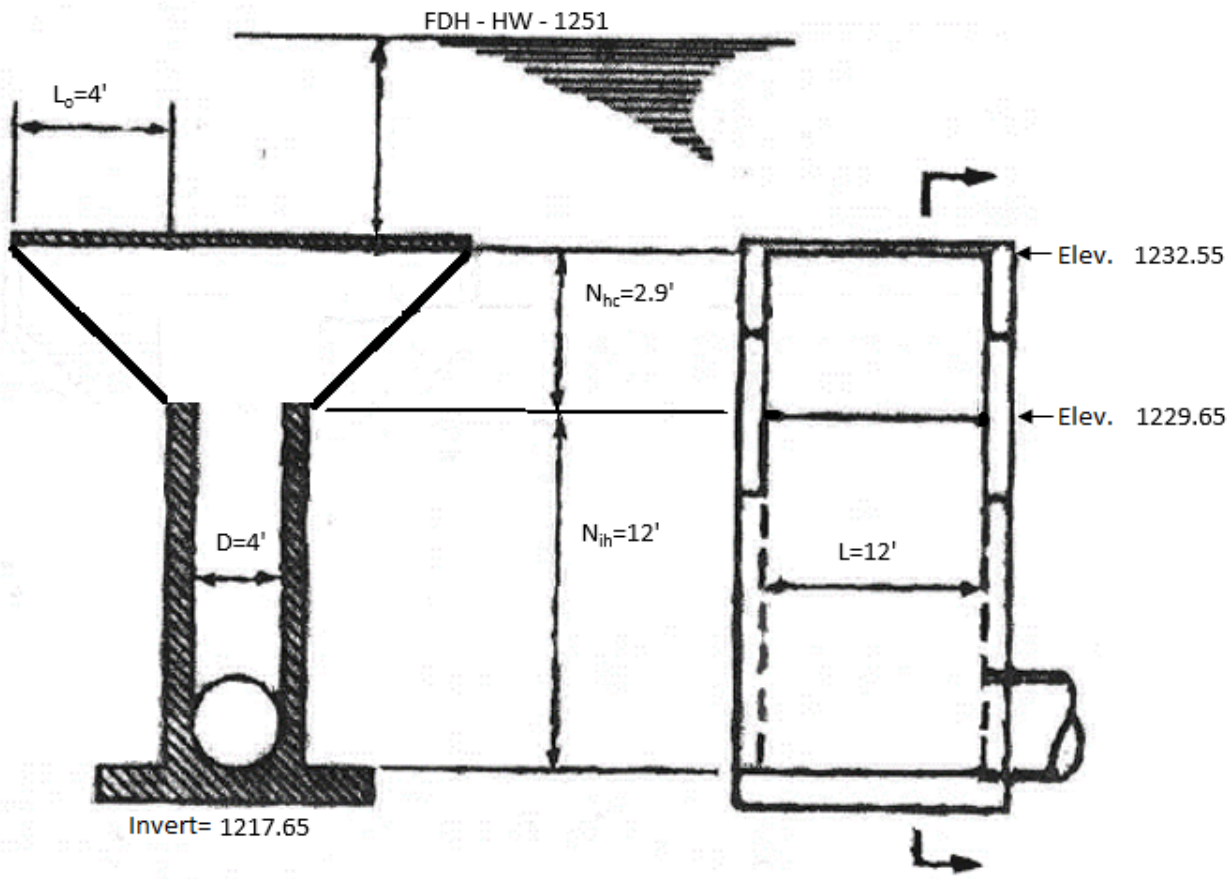


Figure 3.5 Two Way Covered Riser Design - Alternative 2A

2.11 Emergency Spillway Design

Multiple spillway types were considered for use on these alternatives. The types of spillways that were considered consisted of vegetative, straight drop, and baffle chute. Ultimately the straight drop spillway was included in the preliminary design of these impoundment alternatives.

2.11.1 Vegetative Spillway

Per TR-60, vegetative spillways are not acceptable for spillways that are utilized more frequently than the 50-yr event. For the alternative, the spillways are utilized during the 50-yr event or smaller. Therefore, a vegetative spillway was not considered during this phase.

2.11.2 Straight Drop

This spillway alternative is likely the more costly spillway type; however, this spillway was selected preliminarily due to unknowns regarding a baffle chute or other alternative (RCC) that would require additional geotechnical evaluation prior to being considered. This spillway was designed based on the design standards in Technical Paper No. 15, *Straight Drop Spillway Stilling Basin* (TP-15) [9]The following information is a summary of the straight drop spillway design for the impoundment alternative.

Alternative 2A

Table 3.7 Drop 1 Analysis - Alternative 2A

Design Methodology from Technical Paper No. 15, Series B - "Straight Drop Spillway Stilling Basin"

---------->	Input
---------->	Calculated

Design Weir Elevation (ft) =	1,243.00
Design Weir Length (ft) =	80.00
Design Flow Rate, Q (cfs) =	5,540
Design End Sill Elev (ft) =	1,228.00

Critical Depth, d_c, above spillway crest (ft) =	5.30
Head in approach to crest, H, above spillway crest (ft) =	7.95
Minimum Tailwater depth above basin floor (ft)=	11.40

Actual TW depth using discharge channel normal depth as design with pre-determined slope.

Channel Bottom Width (ft) =	80.0	
Side Slope __ h : 1 v =	4.0	
Channel Slope (ft/ft) =	0.050%	
Manning's n for channel =	0.035	
Normal Depth in Channel (ft) =	11.40	Use as minimum berm height for discharge channel.
Channel Capacity (cfs) at Input Normal Depth	5,541	

Stuctural Dimensions

Floor Block Height (ft) =	4.2	
Width/Spacing of Floor Block (ft) =	2.1	(± 0.15d_c is permissible)
End Sill Height (ft) =	2.1	
Actual TW Above Basin Floor (ft) =	13.5	
Design Floor Elevation (ft) =	1,225.88	
Minimum Sidewall Height Above TW (ft) =	4.51	
Minimum Sidewall Elevation (ft) =	1,243.91	

Determine L_B

Dimension	Unit	For TW above	
y	ft	-17.12	
y/d_c	- -	-3.230019946	
y_t	ft	-3.60	
y_t/d_c	- -	-0.679204787	
x_a	ft	21.43	use 21.5
x_b	ft	4.2402528	Use 4.5
Distance to floor blocks	ft	25.67	Use 26
x_c	ft	9.28	Use 10
L_B minimum	ft	34.94	Use 35

Table 3.8 Drop 2 Analysis - Alternative 2A

Design Methodology from Technical Paper No. 15, Series B - "Straight Drop Spillway Stilling Basin"			
	---------->	Input	
	---------->	Calculated	
Design Weir Elevation (ft) =	1,225.91		
Design Weir Length (ft) =	80.00		
Design Flow Rate, Q (cfs) =	5,540		
Design End Sill Elev (ft) =	1,216.85		
Critical Depth, d_c, above spillway crest (ft) =		5.30	
Head in approach to crest, H, above spillway crest (ft) =		7.95	
Minimum Tailwater depth above basin floor (ft)=		11.40	
Actual TW depth using discharge channel normal depth as design with pre-determined slope.			
Channel Bottom Width (ft) =		80.0	
Side Slope __ h : 1 v =		4.0	
Channel Slope (ft/ft) =		0.050%	
Manning's n for channel =		0.035	
Normal Depth in Channel (ft) =		11.40	Use as minimum berm height for discharge channel.
Channel Capacity (cfs) at Input Normal Depth		5,541	
Stuctural Dimensions			
Floor Block Height (ft) =		4.2	
Width/Spacing of Floor Block (ft) =		2.1	(± 0.15d_c is permissible)
End Sill Height (ft) =		2.1	
Actual TW Above Basin Floor (ft) =		13.5	
Design Floor Elevation (ft) =		1,214.73	
Minimum Sidewall Height Above TW (ft) =		4.51	
Minimum Sidewall Elevation (ft) =		1,232.76	

Determine L_B

Dimension	Unit	For TW above	
y	ft	-11.18	
y/d_c	- -	-2.109332048	
y_t	ft	2.34	
y_t/d_c	- -	0.441483112	
x_a	ft	23.38	use 23.5
x_b	ft	4.2402528	Use 4.5
Distance to floor blocks	ft	27.62	Use 27.75
x_c	ft	9.28	Use 10
L_B minimum	ft	36.89	Use 37

2.11.3 Baffle Chute

This spillway alternative may be less costly than the straight drop spillway; however, the optimal placement of this type of spillway would likely need to occur on an area of constructed embankment. At this point in the design, the geotechnical evaluation is preliminary and does not explore in detail the varying spillway alternatives. Therefore, we cannot confidently say that the construction of this type of spillway on constructed embankment will meet all factors of safety. However, the sizing of this spillway has been included such that during final design, this option can be explored further to determine its viability for construction. This spillway was sized per the Design Methodology from U.S. Department of Interior, Bureau of Reclamation, Water Resource Technical Publication – "Design of Small Dams" [10]. The following information is a summary of the baffle chute spillway design for both impoundment alternatives.

Alternative 2A:

Table 3.9 Baffle Chute Spillway Design - Alternative 2A

Design Discharge:					
Freeboard Design Hydrograph Discharge =			5539.50	cfs	
Freeboard Design Hydrograph Unit Discharge =			69.24		
Design Discharge, Typically 2/3 * Design[1] =			3877.65	cfs	
Design Unit Discharge, q =			48.47	cfs/ft	
Critical Depth, D_c =			4.18	ft	
Block Dimensions:					
Block Height Perp. to Slope, H =			3.34	ft	**3'-5"**
Top Block Width, 0.2H (9"Min) =			0.67	ft	**9"**
Bottom Block Width, H/2 + 0.2H =			1.81	ft	**1'-10"**
Block Width and Spacing, 1.5H =			5.01	ft	**5'-1"**
Block Width at sidewall, (1/3H to 2/3H)			1.88	ft	**1'-11"**
Block Row Spacing, 3H =			10.03	ft	**10'-1"**
Sidewall Dimensions:					
Critical Depth of 1/3 Max Discharege =			2.55	ft	
Sidewall Height Perp. to Slope, 3H+1/3D_c =			12.58	ft	**12'-7"**
Entrance Sidwall Height, 1.5 Freeboard D_c			8.14	ft	**8'-2"**
Fujimoto Entrance:					
Wide Portion, 1.25 H =			4.18	ft	**4'-3"**
Short Portion, 5/8 H =			2.09	ft	**2'-2"**
Spillway Width:					
	QTY	WIDTH (Inches)	Total Inch		
Sidwall Blocks	2	**22.5**	**45.00**		
Voids	7	**61**	**427.00**		
Blocks	8	**61**	**488.00**		**Ft**
			960.00	=	**80**
Design Methodology from U.S. Department of the Interior, Bureau of Reclamation, Water Resource Technical Publication - "Design of Small Dams"					

2.12 Cost Estimate

The cost for Alternative 2A is shown below in Table 3.10.

Table 3.10 Alternatives Cost Estimate Comparison

Item	Impoundment Alternative 2A
Construction	$6,299,530
Contingencies	$640,585.80
Engineering – Preliminary	$100,000
Engineering – Civil Design	$440,967.10
Geotechnical Engineering	$150,000
Construction Engineering	$440,967.10
Land Surveying	$50,000
Utility Relocation	$100,000
Utility Relocation Coordination	$15,000
Right-of-Way Acquisition	$2,910,000
Wetland Mitigation	$497,950
Legal & Adm. Fees	$50,000
Right-of-Way Negotiations	$50,000
Operation & Maintenance Plan	$40,000
Fiscal	$15,000
Total Project Cost	**$11,800,000**

2.13 Operation & Maintenance

Operation & maintenance activities will occur over the life of the project. All activities will be completed by the Project Owner, or a designated representative with experience in these activities. Specific responsibilities will be identified and further defined with the Project Owner during final design. Annual maintenance items that have been factored into these costs are mowing, gravel replacement/repair, debris removal, sediment removal and pipe inspections. The frequency of inspection during a flood will likely be daily or more frequent depending on the water surface elevation behind the impoundments.

3 Project Impacts (Results)

During the 1% chance event, Alternative 2A has a maximum benefit in the Upper Maple River watershed of approximately 1,381 acres for the 1-day period with the maximum inundation. The project benefits persist until about 2 days after the maximum inundation, when project impacts start to occur. These impacts are less in magnitude than the maximum project benefits during the time with the most widespread inundation. During the 2 day period where benefits occur, Alternative 2A provides a total of 2,474 acres of benefit in the Upper Maple River watershed during the 1% chance event. During the 1% chance event, immediately downstream of the dam outlet, Alternative 2A provides peak flow reductions of 56-percent. The total benefits stated above exclude the inundated area in the dam backwater pool. Benefit and impacted areas during the 1% event during the 1-day period with maximum inundation for Alternative 2A can be seen in Figure 4.1. Outlet dam hydrographs for Alternative 2A are shown in Appendix B, respectively.

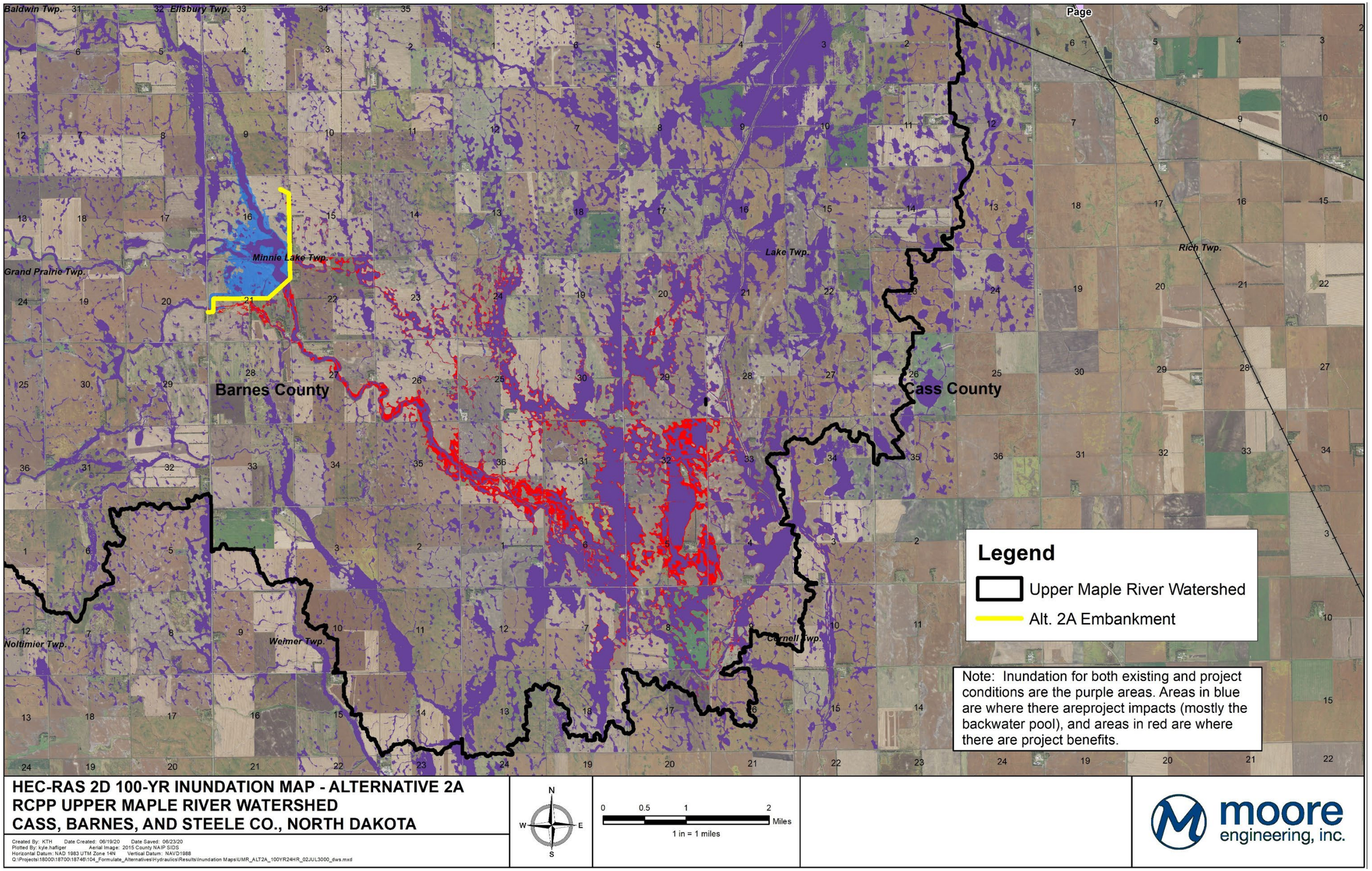


Figure 4.1 Alternative 2A Inundation Map - 1% Chance (100-yr) Event

4 Bibliography

[1] Houston Engineering Inc. et. al., "Fargo-Moorhead Metro Basin-Wide Modeling Approach Hydrologic Modeling, HEC-HMS Model Development Various Tributaries above the Red River of the North at Halstad, MN," Fargo, ND, 2011.

[2] Moore Engineering Inc., "Maple River Watershed Comprehensive Detention Plan," West Fargo, ND, 2014.

[3] Barr Engineering Inc., "Preliminary Geotechnical Engineering Report - Upper Maple River Watershed Alt2A Dam Embankment, Barnes County, North Dakota," Minneapolis, MN, 2019.

[4] Barr Engineering Inc., "Preliminary Geotechnical Engineering Report - Upper Maple River Watershed Alt5 Dam Embankment, Barnes County, North Dakota," Minneapolis, MN, 2019.

[5] Natural Resources Conservation Service, "Technical Release No. 60 - Earth Dams and Reservoirs," United States Department of Agriculture, 2005.

[6] NRCS, "Title 210 - National Engineering Manual Part 520 - Soil and Water Resource Development Subpart C - Dams," 2017.

[7] United States Soil Conservation Service, "Technical Release No. 29, Hydraulics of Two-Way Covered Risers," Water Resources Publications, Littleton, CO.

[8] U.S. Department of Transportation & Federal Highway Administration, "Hydraulic Engineering Center No. 14, Third Edition - Hydraulic Design of Energy Dissipators for Culverts and Channels," National Highway Institute, 2006.

[9] C. A. Donnelly and F. W. Blaisdell, "Technical Paper No. 15, Series B - Straight Drop Spillway Stilling Basin," Minnesota Agricultural Experiment Station; St. Anthony Falls Hydraulic Laboratory, Minneapolis, MN, 1954.

[10] U.S. Department of the Interior, Bureau of Reclamation, "Design of Small Dams," Washington, DC, 1987.

[11] U.S. Army Corps of Engineers, "EM-1110-2-1413 - Hydrologic Analysis of Interior Areas," 1987.

[12] US Army Corps of Engineers, "Supplemental Draft Feasibility Report and Environmental Impact Statement - Appendix A-4b: Hydrology," St Paul, MN, April 2011.

[13] FM Diversion Authority, "FM Diversion CLOMR Submittal," 2017.

Appendix A Alternative 2A Plans & Cost Estimate

FILE LOCATION: R:\Projects\18000\18700\18746\DRAWINGS\DESIGN\18746-ALT-2A-PP.dwg

RCPP/PL566
UPPER MAPLE RIVER WATERSHED
ALTERNATIVE 2A

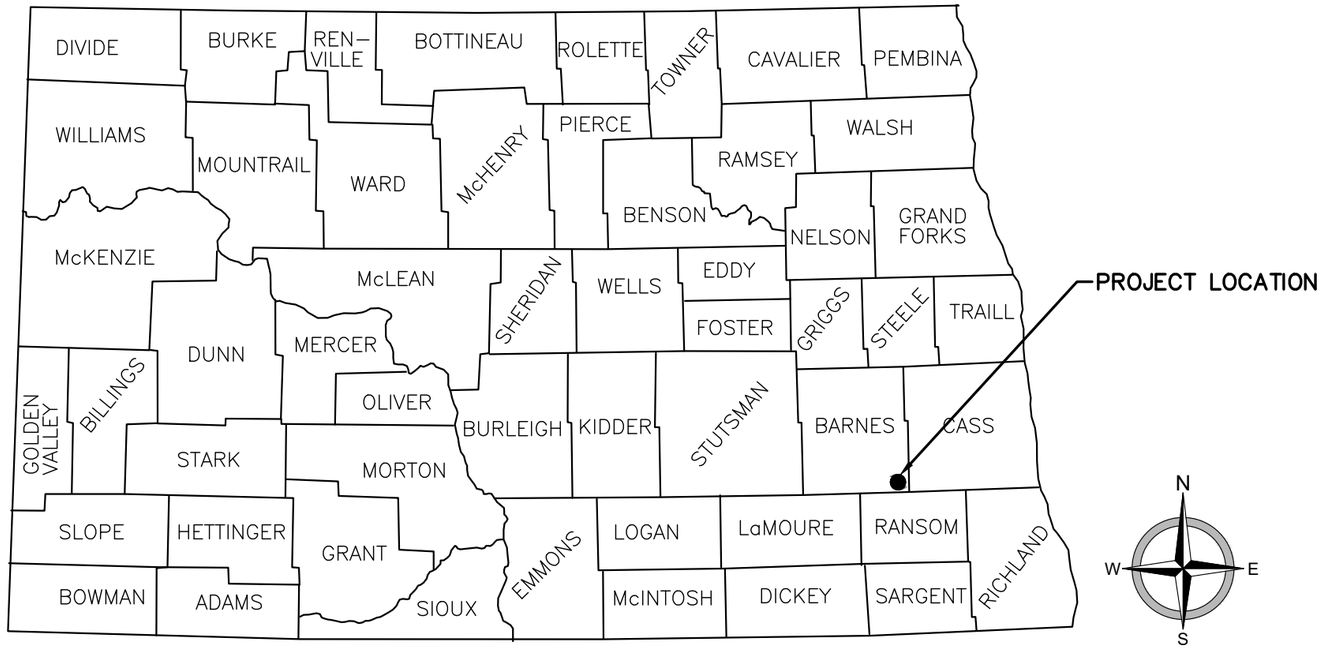
CASS COUNTY JOINT
WATER RESOURCE DISTRICT

BARNES COUNTY, NORTH DAKOTA

moore engineering, inc.
Consulting Engineering • Land Surveying
925 10th Avenue East • West Fargo, North Dakota
www.mooreengineeringinc.com

NRCS Practice Standard	Job Class
560 - Access Road	II (<2 mi)
656 - Constructed Wetland	V (793 ac-ft)
402 - Dam	VIII (59.7 sqmi)
356 - Dike	III (<6 ft)
362 - Diversion	II (12 cfs)
582 - Open Channel	IV (150 cfs)
533 - Pumping Plant	VII (5400 gpm)
587 - Structure for Water Control	III (24")
606 - Subsurface Drain	V (264 ac)
659 - Wetland Enhancement	IV (< 6 ft)
657 - Wetland Restoration	IV (< 6 ft)
342 - Critical Area Planting	IV
327 - Conservation Cover	IV

VICINITY MAP



PROJECT No. 18746

PRELIMINARY

FILE LOCATION: R:\Projects\18000\18700\18746\DRAWINGS\DESIGN\18746-ALT-2A-PP.dwg

PRELIMINARY

TABLE OF CONTENTS

GENERAL

CIVIL

TOTAL SHEETS: 39

moore engineering, inc.

TABLE OF CONTENTS
RCPP/PL566 UPPER MAPLE RIVER WATERSHED ALTERNATIVE 2A
CASS COUNTY JOINT WATER RESOURCE DISTRICT
BARNES COUNTY, NORTH DAKOTA
TABLE OF CONTENTS

DATE:	02.13.25
REVISED:	----
REVISED:	----
REVISED:	----
REVISED:	----
REVISED:	----
RECORD:	----
PROJECT No.	18746
MANAGER:	KRL
DESIGNER:	ZJT
DRAFTER:	ZJT
REVIEWER:	JMH

G-002

SHEET 2 OF 2

CIVIL LEGEND

- BENCHMARK
- IRON MONUMENT FOUND
- EXISTING GAS LINE MARKER
- EXISTING GAS GATE VALVE
- EXISTING POWER POLE
- EXISTING LIGHT POLE
- EXISTING LIGHT POLE W/SIGN
- EXISTING GUY WIRE
- EXISTING TRAFFIC SIGNAL ARM
- EXISTING SIGN
- EXISTING CULVERT W/FLARED END SECTION (F.E.S.)
- EXISTING FLARED END SECTION (F.E.S.)
- EXISTING CURB STOP
- EXISTING HYDRANT W/GATE VALVE
- EXISTING GATE VALVE
- EXISTING FITTINGS
- EXISTING PLUG
- EXISTING PROPANE TANK
- EXISTING SANITARY SEWER MANHOLE
- EXISTING SANITARY SEWER CLEANOUT
- EXISTING STORM SEWER CATCH BASIN
- EXISTING STORM SEWER MANHOLE
- W — EXISTING WATER MAIN
- EXISTING WATER SERVICE W/CURB STOP
- SS — EXISTING SANITARY SEWER
- SS–FM — EXISTING SANITARY FORCEMAIN
- EXISTING SANITARY SEWER SERVICE
- ST — EXISTING STORM SEWER
- ST–FM — EXISTING STORM SEWER FORCEMAIN
- STEAM — EXISTING STEAM PIPE
- EXISTING AIR CONDITIONER
- U — EXISTING UTILITY PEDESTAL
- EXISTING UTILITY MANHOLE
- C — EXISTING UNDERGROUND COMMUNICATIONS
- F — EXISTING UNDERGROUND FIBER
- T — EXISTING UNDERGROUND TELEPHONE
- OHT — EXISTING OVERHEAD TELEPHONE
- TV — EXISTING UNDERGROUND TELEVISION
- OHTV — EXISTING OVERHEAD TELEVISION
- G — EXISTING UNDERGROUND GAS
- E — EXISTING UNDERGROUND ELECTRIC
- OHP — EXISTING OVERHEAD POWER
- X — EXISTING BARBED WIRE FENCE
- EXISTING CHAIN LINK/STEEL FENCE
- EXISTING PVC/WOOD FENCE
- EXISTING SHRUB
- EXISTING STUMP
- EXISTING TREE/TREE CLUSTER
- EXISTING SPRINKLER HEAD
- 12 — EXISTING CLUSTER BOX UNIT (CBU)
- EXISTING MAILBOX
- EXISTING CURB AND GUTTER
- CURB AND GUTTER REMOVAL & REPLACEMENT
- REMOVE EXISTING SURFACE
- EXISTING ASPHALT SURFACE
- EXISTING CONCRETE SURFACE
- EXISTING DECORATIVE COLORED CONCRETE
- EXISTING GRANULAR SURFACE
- EXISTING SIDEWALK/MULTI–USE PATH (UNKNOWN SURFACE)
- EXISTING LANDSCAPING
- EXISTING RIPRAP
- EXISTING WETLANDS
- EXISTING PERMANENT POOL

- NEW LIGHT POLE
- NEW LIGHT POLE W/SIGN
- NEW GUY WIRE
- NEW SIGN
- TRAFFIC CONTROL – DRUM
- TRAFFIC CONTROL – TUBULAR MARKER
- NEW CULVERT W/FLARED END SECTION (F.E.S.)
- NEW FLARED END SECTION (F.E.S.)
- NEW CURB STOP
- NEW HYDRANT W/GATE VALVE
- NEW GATE VALVE
- NEW TAPPING SLEEVE
- NEW FITTINGS
- NEW PLUG
- NEW SANITARY SEWER MANHOLE
- NEW SANITARY SEWER CLEANOUT
- NEW STORM SEWER CATCH BASIN
- NEW STORM SEWER MANHOLE
- W — NEW WATER MAIN
- NEW WATER SERVICE W/CURB STOP (S.B. ELEV.)
- SS — NEW SANITARY SEWER
- SS–FM — NEW SANITARY FORCEMAIN
- NEW SANITARY SEWER SERVICE (S.S. ELEV.)
- ST — NEW STORM SEWER
- ST–FM — NEW STORM SEWER FORCEMAIN
- STEAM — NEW STEAM PIPE
- IN — INSULATION PER DETAIL
- X — NEW BARBED WIRE FENCE
- NEW CHAIN LINK/STEEL FENCE
- NEW PVC/WOOD FENCE
- NEW INFLOW CURB AND GUTTER (MOUNTABLE/KNOCKED DOWN)
- NEW OUTFLOW CURB AND GUTTER (MOUNTABLE/KNOCKED DOWN)
- NEW INFLOW CURB AND GUTTER (HIGHBACK)
- NEW OUTFLOW CURB AND GUTTER (HIGHBACK)
- NEW CURB PAINT
- NEW ASPHALT SURFACE
- NEW CONCRETE SURFACE
- NEW CONCRETE APPROACH/DRIVEWAY
- NEW DECORATIVE COLORED CONCRETE
- NEW GRANULAR SURFACE
- NEW CRUSHED CONCRETE SURFACE
- NEW CONCRETE SIDEWALK/MULTI–USE PATH
- NEW DETECTABLE WARNING PANEL
- NEW RIPRAP
- NEW PERMANENT POOL
- NEW LANDSCAPING
- MILLING – 2" UNIFORM
- MILLING – 2" TAPERED
- ASPHALT PATCH
- LEVELING COURSE
- OVERLAY
- CHIPSEAL AND FOG COAT
- NEW CONCRETE VALLEY GUTTER
- NEW MEDIAN NOSE APRON
- NEW ADA RAMP W/WARNING PANEL
- 12 — NEW CLUSTER BOX UNIT (CBU)
- NEW MAILBOX
- NEW LARGE DECIDUOUS TREE
- NEW SMALL DECIDUOUS TREE
- NEW SHRUB
- NEW LARGE EVERGREEN TREE
- NEW SMALL EVERGREEN TREE

- DRAINAGE BREAK LINE
- EXISTING DRAINAGE DIRECTION
- 2.0% — FINISHED DRAINAGE DIRECTION & SLOPE
- 4:1 — FINISHED GRADE
- 895 — EXISTING CONTOUR ELEVATION
- 895 — FINISHED CONTOUR ELEVATION
- 900.07 FL — GRADE ELEVATIONS
- GRASS BUFFER
- PERMANENT STABILIZATION AREA
- SEDIMENTATION CONTROL WATTLE
- SEDIMENTATION CONTROL FENCE
- ROCK CHECK
- S.C.E. — STABILIZED CONSTRUCTION ENTRANCE
- CONCRETE WASHOUT
- INLET PROTECTION DEVICE

ABBREVIATIONS:
BOC = BACK OF CURB
BOW = BACK OF WALK
C = COMMUNICATION
CB# = STORM SEWER CATCH BASIN
CL = CENTERLINE
CSP = CORRUGATED STEEL PIPE
CO# = SANITARY SEWER CLEANOUT
CS# = CONTROL STRUCTURE
DIA = DIAMETER
DIP = DUCTILE IRON PIPE
E = ELECTRICAL
ECC = EDGE OF CRUSHED CONCRETE
EG = EXISTING GRADE
EOC = EDGE OF CONCRETE
EOP = EDGE OF PAVEMENT
EOW = EDGE OF WALK
EG= EXISTING GRADE
EX = EXISTING
F = FIBER OPTIC
FES = FLARED END SECTION
FG = FINISHED GRADE
FL = FLOWLINE
FM = FORCEMAIN
G = GAS LINE
HP = HIGH POINT
INV = INVERT
LP = LOW POINT
MATCH = MATCH
M# = STORM SEWER MANHOLE
MT# = STORM SEWER TEE MANHOLE
MM# = STORM SEWER MULTI–MANHOLE
MC = MIDPOINT OF CURVE
OHP = OVERHEAD POWER
OHT = OVERHEAD TELEPHONE
OHTV = OVERHEAD TELEVISION
PC = POINT OF CURVATURE
PRC = POINT OF REVERSE CURVE
PVC = POLYVINYL CHLORIDE PIPE
PT = POINT OF TANGENCY
RIM = RIM OF STRUCTURE
S# = SANITARY SEWER MANHOLE
S.B. ELEV. = STOP BOX ELEVATION
S.S. ELEV. = SANITARY SEWER SERVICE INVERT
S.S. = SANITARY SEWER
S.T. = STORM SEWER
STA = ALIGNMENT STATION
T = TELEPHONE
TOC = TOP OF CONCRETE
TOP = TOP OF PAVEMENT
TOP = TOP OF PIPE
TOW = TOP OF WALK
TR# = SANITARY TELEVISING RISER
TRANS = TRANSFORMER
TV = TELEVISION
U = UTILITY (UNKNOWN UTILITY)

PRELIMINARY

moore engineering, inc.

CIVIL LEGEND
RCPP/PL566 UPPER MAPLE RIVER WATERSHED ALTERNATIVE 2A
CASS COUNTY JOINT WATER RESOURCE DISTRICT
BARNES COUNTY, NORTH DAKOTA
CIVIL LEGEND

DATE:	02.13.25
REVISED:	----
REVISED:	----
REVISED:	----
REVISED:	----
REVISED:	----
RECORD:	----
PROJECT No.	18746
MANAGER:	KRL
DESIGNER:	ZJT
DRAFTER:	ZJT
REVIEWER:	JMH

C-001

SHEET 1 OF 37

CLEARING AND GRUBBING/DEMOLITION:

1. THE CONTRACTOR SHALL EXERCISE CARE IN THEIR CONSTRUCTION OPERATIONS TO ENSURE THAT TREES, SHRUBS, FENCES, BUILDINGS AND GRASSES WITHIN THE RIGHT-OF-WAY AND CONSTRUCTION EASEMENT NOT DESIGNATED FOR REMOVAL ARE NOT DISTURBED. ANY CHANGE TO THESE ITEMS SHALL BE REPAIRED OR REPLACED AT THE CONTRACTOR'S EXPENSE.
2. TREES AND BRANCHES MAY BE GROUND UP ON-SITE AND USED AS TEMPORARY OR PERMANENT MULCH.
3. ALL CLEARING AND GRUBBING WORK SHALL BE INCIDENTAL TO THE PROJECT.

UTILITIES:

1. NOT ALL UTILITIES MAY BE SHOWN. PRIOR TO DIGGING, IT IS THE CONTRACTOR'S RESPONSIBILITY TO CALL FOR UTILITY LOCATES AND TO IMMEDIATELY NOTIFY THE ENGINEER OF ANY CONFLICTS. IT SHALL BE THE CONTRACTOR'S RESPONSIBILITY TO VERIFY AND COORDINATE THEIR ACTIVITIES AND SCHEDULE ALL UTILITY RELOCATIONS. UTILITY LOCATES CAN BE REQUESTED FROM "NORTH DAKOTA ONE CALL".
2. CONTRACTOR MAY NEED TO WORK IN CONJUNCTION WITH UTILITY COMPANIES DURING CONSTRUCTION. CONTRACTOR MUST NOTIFY ENGINEER PRIOR TO DOING WORK WITH ANY AND ALL UTILITY COMPANIES. THERE SHALL BE NO CHANGE ORDERS FOR SCHEDULING CONFLICTS WITH UTILITY COMPANIES
3. THE CONTRACTOR SHALL LOCATE ALL BURIED UTILITIES ON THE SITE PRIOR TO DIGGING AND SHALL PROTECT THEM DURING CONSTRUCTION.
4. UTILITY PEDESTALS MAY BE PLACED PRIOR TO CONSTRUCTION OF SPOIL BANK AREAS. IF THIS IS DONE, UTILITY COMPANIES WILL SET PEDESTALS AT APPROPRIATE HEIGHTS TO MATCH EXPECTED SPOIL BANK HEIGHTS. CONTRACTOR IS RESPONSIBLE FOR MAINTAINING THE INTEGRITY OF SOILS AROUND THESE NEW PEDESTALS. CONTRACTOR WILL BE RESPONSIBLE FOR DAMAGE TO PEDESTALS DURING CONSTRUCTION AND WILL BEAR ALL COSTS OF REPLACEMENT OR REPAIR OF DAMAGED PEDESTALS.

CONSTRUCTION LIMITS:

1. THE CONTRACTOR SHALL LIMIT WORK TO WITHIN THE CONSTRUCTION EASEMENTS AND RIGHT OF WAY SHOWN ON THE PLANS. CONTRACTOR IS RESPONSIBLE FOR ALL DAMAGE EXPENSE FOR WORK DONE OUTSIDE OF PROJECT RIGHT-OF-WAY.
2. CONTRACTOR VEHICLES, EQUIPMENT, AND MATERIALS SHALL BE STORED WITHIN THE SITE.

SIGNS AND DELINEATORS:

1. ALL EXISTING SIGNS, DELINEATORS, MAILBOXES, AND BRIDGE END MARKERS WITHIN THE SITE SHALL BE REMOVED, SALVAGED, AND RESET. ANY ITEMS REMOVED SHALL BE NEATLY STOCKPILED ON THE PROJECT RIGHT-OF-WAY AND ARE TO REMAIN THE PROPERTY OF THE OWNER. THIS WORK SHALL BE CONSIDERED INCIDENTAL TO THE PROJECT.
2. ANY DAMAGED SIGNS SHALL BE REPLACED AT CONTRACTORS EXPENSE.
3. THE CONTRACTOR SHALL INSPECT ALL SIGNS, DELINEATORS, AND MAIL BOXES PRIOR TO CONSTRUCTION AND NOTIFY ENGINEER OF ANY DAMAGES. THE CONTRACTOR SHALL BE RESPONSIBLE FOR ANY DAMAGES IDENTIFIED AFTER CONSTRUCTION BEGINS.

HAUL ROADS:

1. IT SHALL BE THE CONTRACTOR'S RESPONSIBILITY TO INVESTIGATE THE SUITABILITY OF ROUTES WITH THE AGENCY HAVING CONTROL OF THE ROADS AND ACQUIRE THEIR APPROVAL PRIOR TO SUBMITTING A BID AND DOING THE WORK.
2. ANY DAMAGE TO ROADS AS A RESULT OF HAULING SHALL BE REPAIRED AT THE CONTRACTOR'S EXPENSE AND AT NO COST TO THE OWNER.
3. TEMPORARY HAUL ROADS AND RAMPS REQUIRED SHALL BE INCIDENTAL TO THE PROJECT.

SPOIL BANKS:

1. EXCAVATED MATERIAL, UNLESS OTHERWISE USED ON THE PROJECT, SHALL BE PLACED IN SPOIL BANKS ADJACENT TO THE CHANNEL.
2. SPOIL BANKS SHALL NOT IMPEDE EXISTING DRAINAGE. THE CONTRACTOR WILL BE LIABLE FOR DAMAGE FROM ANY BLOCKED DRAINAGE.
3. CONTRACTOR SHALL CONSTRUCT BERM AT THE MINIMUM BERM ELEVATION WITH EXCESS EXCAVATION BEING DISPOSED OF IN THE PRIMARY DISPOSAL AREA AS SHOWN.
4. CONTRACTOR MAY CONSTRUCT BERMS AT A HIGHER ELEVATION THAN THE MINIMUM HEIGHT IN AREAS WHERE PRIMARY DISPOSAL AREA HAS BEEN FILLED. ONCE THE PRIMARY DISPOSAL AREA IS FILLED, THE SECONDARY DISPOSAL AREA SHALL BE USED.
5. IF POWER LINES ARE NEEDED TO BE RELOCATED, THEY WILL BE DESIGNED TO PROVIDE ADEQUATE CLEARANCE FROM PROPOSED MINIMUM BERM ELEVATIONS. CONTRACTOR SHALL ENSURE NO FILL IS PLACED WITHIN 18' OF VERTICAL CLEARANCE UNDER OVERHEAD POWER LINES FOR NODAK ELECTRIC COOPERATIVE.
6. NO SPOIL SHALL BE PLACED ON A ROAD UNLESS THE PLANS SPECIFICALLY CALL FOR BUILDING UP THE ROAD AT THAT LOCATION OR IF MATERIAL IS NEEDED TO BRING ROAD BACK TO GRADE AFTER CULVERT INSTALLATION AT SECTION LINE.
7. IN AREAS WHERE SPOIL EXCEEDS WHAT IS REQUIRED TO CONSTRUCT THE MINIMUM BERM AND TO FILL THE PRIMARY DISPOSAL AREA, SPOIL SHALL THEN BE MOVED LATERALLY AND PARALLEL TO THE DRAIN TO UNIFORMLY RAISE THE SPOIL BANK. END HAULING SPOIL TO ACHIEVE THIS SHALL BE INCIDENTAL TO SPOIL BANK LEVELING.
8. TOP OF BERM SHALL BE GRADED SMOOTH AND LEVEL TO THE SATISFACTION OF THE ENGINEER. EXCESS EXCAVATION SHALL BE SPOILED BEHIND THE BERM, GENTLY GRADED AND MATCHING INTO THE EXISTING FIELD. THE CONSTRUCTION EASEMENT AREA SHALL BE UTILIZED FOR THE EXCESS EXCAVATION MATERIAL.
9. IT MAY ALSO BE NECESSARY TO MOVE SPOIL PARALLEL TO THE DRAIN TO ENSURE THAT THE SPOIL BANK APPEARS UNIFORM WITH THE GRADE OF THE SPOIL BANK MATCHING THE MINIMUM BERM GRADE.
10. TOLERANCE SHALL BE NO MORE THAN ONE FOOT VARIANCE FROM A MAXIMUM ACTUAL FILL TO A MINIMUM ACTUAL FILL AT A GRADE LINE PARALLEL TO THE MINIMUM BERM. (I.E. IF ONE SET UP A LASER AT GRADE AND WALKED THE BERM MAKING MARKS ON THE GRADE ROD, AT THE END OF THE MILE, THE MARKS SHOULD ALL BE WITHIN A ONE FOOT INTERVAL.)
11. THIS VARIANCE OF ONE FOOT DOES NOT APPLY TO BREAK OUT LOCATIONS.

CHANNEL APPEARANCE:

1. THE FINAL CONSTRUCTED CHANNEL SECTION SHALL FORM NEAT LINES WHEN VIEWED FROM ONE END OF A MILE TO THE OTHER END OF A MILE.
2. WAVINESS, BUMPS, OR DIVOTS SHALL NOT EXCEED MORE THAN 0.2' FROM THE DESIRED CHANNEL PROFILE.

PROJECT SCHEDULE:

1. CHANNEL CONSTRUCTION SHALL BEGIN AT THE DOWNSTREAM END AND PROCEED UPSTREAM. ALL CHANNEL WORK AND CULVERT INSTALLATION SHALL BE COMPLETED ON OR BEFORE SEPTEMBER 12TH, 2014. ACCEPTANCE OF FINAL SEEDING SHALL TAKE PLACE NO LATER THAN OCTOBER 24TH, 2014.
2. IF THE CONTRACTOR WANTS TO WORK IN MORE THAN ONE AREA OF THE PROJECT AT ONE TIME, THE CONTRACTOR MUST NOTIFY THE ENGINEER IN WRITING PRIOR TO DOING THE WORK. THE ENGINEER MAY OR MAY NOT GRANT THE CONTRACTOR'S REQUEST.

PROJECT MAINTENANCE:

1. THE CONTRACTOR SHALL HOLD A PRE-CONSTRUCTION MEETING PRIOR TO COMMENCING WORK ON THIS SITE.
2. IT IS THE CONTRACTOR'S RESPONSIBILITY FOR CHANNEL MAINTENANCE, WEED CONTROL, EROSION CONTROL AND REPAIR, SILT REMOVAL AND SPOILING, RE-GRADING BOTTOM AND RE-GRADING SIDE SLOPES UNTIL SEED IS ESTABLISHED. IT SHOULD BE THE INTENT TO ESTABLISH SEED GROWTH AS SOON AS CHANNEL AREAS ARE COMPLETED.
3. CONTRACTOR IS RESPONSIBLE FOR WEED CONTROL WITHIN THE PROJECT SITE THROUGHOUT DURATION OF PROJECT AND IT SHALL BE CONSIDERED INCIDENTAL TO THE PROJECT. THIS MAY REQUIRE TILLING OR SPRAYING THE PROJECT SITE.

DISPOSAL NOTES:

1. NO MATERIAL, OTHER THAN SOIL, SHALL BE WASTED ON THE SITE OR IN THE SPOIL BANK AREA.
2. REMOVED PIPES, BRIDGE DECKS, BRIDGE PIERS, EXISTING WEIR MATERIALS, TREES, ROOTS, PLASTIC, WOOD, METAL, TIRES AND OTHER CONSTRUCTION MATERIAL OR DEBRIS SHALL BE PROPERLY DISPOSED OF OFF SITE. THIS WORK SHALL BE INCIDENTAL TO THE PROJECT UNLESS OTHERWISE SPECIFIED.
3. ANY REMOVED ITEMS NOT SALVAGED AS SHOWN ON THE PLANS BECOME THE PROPERTY OF THE CONTRACTOR AND ARE THE CONTRACTOR'S RESPONSIBILITY ONCE OFF THE SITE.
4. NO MATERIAL MAY BE BURIED OR BURNED ON SITE.
5. ROCK MATERIAL PICKED FROM PROJECT SITE SHALL BE UTILIZED AT CULVERT CROSSINGS OR DISPOSED OF OFF SITE.

SURVEY NOTES:

1. CONTRACTOR REQUESTED SURVEYS CONDUCTED AFTER CONSTRUCTION IS COMPLETE FOR THE PURPOSE OF VERIFYING EXCAVATION AND EMBANKMENT QUANTITIES SHALL BE AT THE CONTRACTOR'S EXPENSE.
2. IF CONTRACTOR UTILIZES GPS EQUIPMENT FOR SHAPING PURPOSES, CONTRACTOR MAY REQUEST DIGITAL POINT FILES FROM THE ENGINEER TO CREATE A FINISHED GROUND SURFACE TO UPLOAD INTO CONTRACTOR'S MACHINERY.
3. ENGINEER REQUIRES A 48 HOUR NOTICE FOR ANY CONTRACTOR REQUESTED SURVEY. CONTRACTOR SHALL COORDINATE WITH RPR FOR SCHEDULING.

TRAFFIC CONTROL:

1. THE CONTRACTOR SHALL PROVIDE, IMPLEMENT, INSTALL, MAINTAIN, AND REMOVE ALL NECESSARY TRAFFIC CONTROL DEVICES AS REQUIRED BY THE CONTRACTOR'S CONSTRUCTION MEANS AND METHODS.
2. THE CONTRACTOR SHALL PROVIDE, MAINTAIN, AND REMOVE TEMPORARY APPROACHES, CROSSINGS, AND INTERSECTIONS AS NECESSARY DURING CONSTRUCTION.
3. THE CONTRACTOR SHALL PROVIDE A METHOD OF PROTECTING TRAFFIC AND PEDESTRIANS FROM CONSTRUCTION AREAS AND SHALL ALLOW ACCESS TO ALL AREAS BY FIRE, POLICE, AND OTHER EMERGENCY PERSONNEL.
4. ALL TRAFFIC CONTROL MEASURES NEEDED TO COMPLETE THE WORK SHALL BE INCIDENTAL TO THE PROJECT.

INTERCEPT CULVERT NOTES:

1. ALL EXISTING INTERCEPT PIPES, FLARED END SECTIONS, AND FLAP GATES ALONG THE FIELD SHALL BE REMOVED UNLESS SPECIFIED OTHERWISE IN THE PLANS.
2. ASSUMED QUANTITIES AND SIZES OF NEW PIPES, FLARED END SECTIONS, AND FLAP GATES ARE REFLECTED IN THE BID PROPOSAL. QUANTITY, LOCATION, SIZE, AND INVERT ELEVATIONS OF ALL NEW INTERCEPT PIPES AND NEW FIELD ACCESS PIPES SHALL BE DETERMINED BY THE ENGINEER IN THE FIELD.
3. NEW INTERCEPT PIPES SHALL BE INSTALLED AS SHOWN IN INTERCEPT PIPE DETAIL SHOWN ON SHEET C-503.
4. NEW INTERCEPT PIPES SHALL HAVE RIPRAP INSTALLED AT THE OUTLET OF EACH PIPE AS SHOWN IN THE INTERCEPT PIPE - RIPRAP DETAIL SHOWN ON SHEET C-505.
5. ALL ITEMS ASSOCIATED WITH INSTALLING NEW INTERCEPT PIPE, FLARED END SECTIONS, FLAP GATES, RIPRAP, AND RIPRAP FILTER BLANKET SHALL BE PAID FOR AT THE BID ITEM PRICE IN THE BID PROPOSAL.
6. UNLESS CALLED OUT IN THE PLANS OR SPECIFICATIONS, ALL OTHER ITEMS NEEDED TO INSTALL INTERCEPT PIPES AND ASSOCIATED ITEMS SHALL BE CONSIDERED INCIDENTAL TO THE INSTALLATION OF THE PIPE (EX. DIRTWORK TO INSTALL PIPE AND PIPE CONNECTING BANDS).

PERMANENT CONSTRUCTION EASEMENT:

1. PERMANENT CONSTRUCTION EASEMENT AREA SHALL BE COMPLETELY FREE OF DEBRIS, GARBAGE, ROCKS, TREES, WOOD, PLASTIC, METAL, AND ALL OTHER WASTE PRIOR TO THE COMPLETION OF THE PROJECT.
2. CONTRACTOR SHALL DISC PERMANENT CONSTRUCTION EASEMENT AREA UPON COMPLETION OF THE WORK TO RESTORE AREA TO PRE-PROJECT CONDITIONS (EG. NO HARD COMPACTED AREAS).

DRAIN TILE NOTES:

1. EXISTING DRAIN TILE INFRASTRUCTURE ON THE SITE, WHETHER SHOWN ON THE PLANS OR NOT, SHALL BE ADDRESSED IN ACCORDANCE WITH SECTION 4.04 AND ARTICLE 7 OF THE GENERAL CONDITIONS. UPON WRITTEN REQUEST, OWNER WILL PROVIDE CONTRACTOR WITH COPIES OF ALL KNOWN UTILITY PERMITS ASSOCIATED WITH DRAIN TILE INFRASTRUCTURE ON THE SITE AND CONTACT INFORMATION FOR ALL LANDOWNERS IMMEDIATELY ADJACENT TO THE SITE.

PRELIMINARY

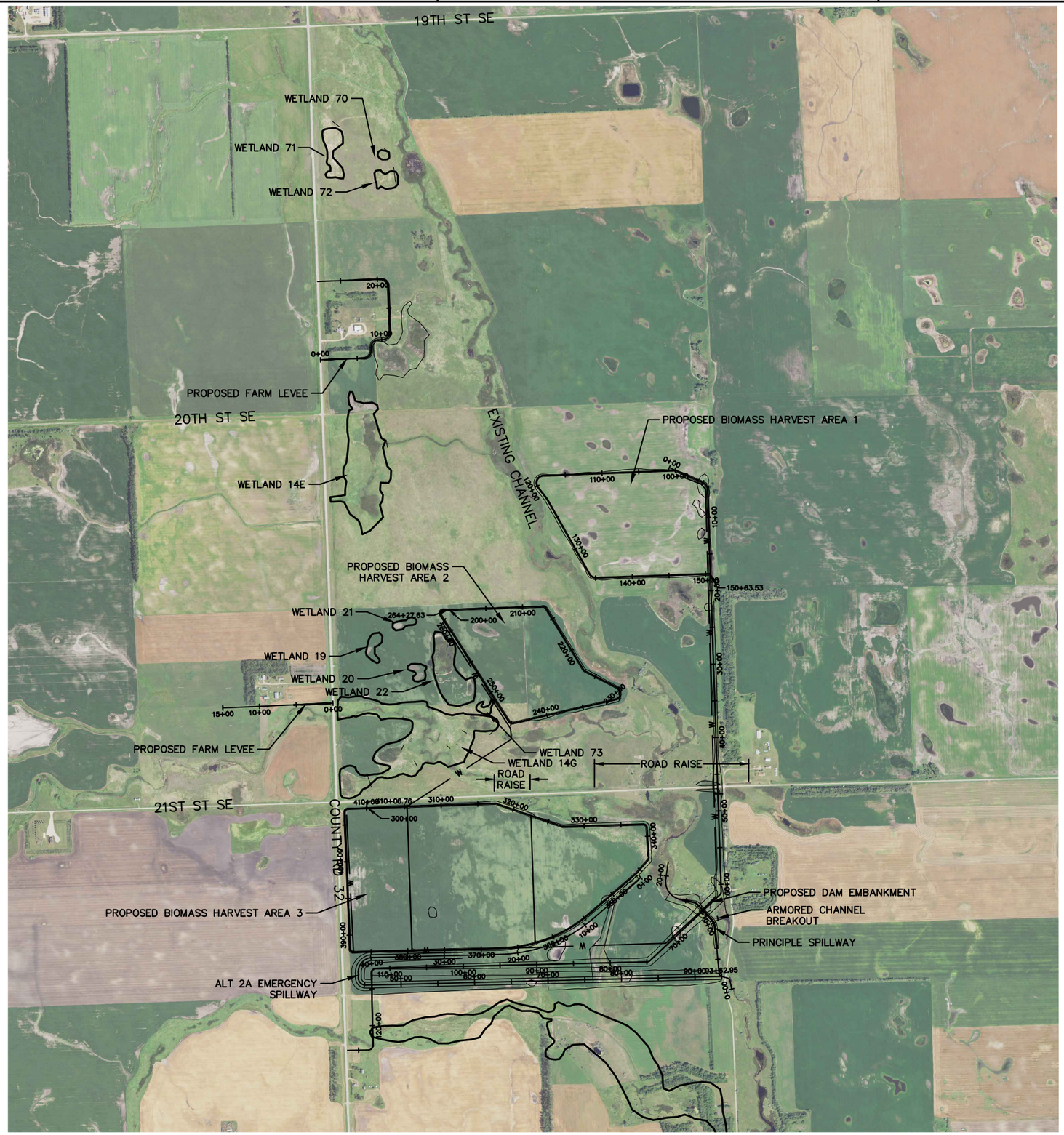
moore engineering, inc.

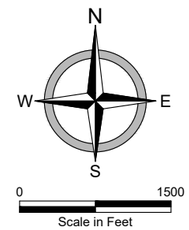
CIVIL NOTES
RCPP/PL566 UPPER MAPLE RIVER WATERSHED ALTERNATIVE 2A
CASS COUNTY JOINT WATER RESOURCE DISTRICT
BARNES COUNTY, NORTH DAKOTA
GENERAL

DATE:	02.13.25
REVISED:	----
REVISED:	----
REVISED:	----
REVISED:	----
REVISED:	----
RECORD:	----
PROJECT No.	18746
MANAGER:	KRL
DESIGNER:	ZJT
DRAFTER:	ZJT
REVIEWER:	JMH

C-002

FILE LOCATION: R:\Projects\18000\18700\18746\DRAWINGS\DESIGN\18746-ALT-2A-PP.dwg





PRELIMINARY

EROSION CONTROL NOTES:

1. WORK MAY NOT START UNTIL NOTICE OF INTENT (NOI) HAS BEEN SUBMITTED TO THE NORTH DAKOTA DEPARTMENT OF HEALTH AND 7 BUSINESS DAYS HAVE PASSED.
2. PERMIT No. NDR10-0000 SHALL BE USED AS A GUIDE FOR STORM WATER MANAGEMENT ON THIS PROJECT.
3. CONTRACTOR SHALL DESIGNATE AN EROSION CONTROL SUPERVISOR WHO WILL BE IN CONTROL OF REVIEWING AND MODIFYING THE SWPPP, CONDUCTS THE REQUIRED SITE INSPECTIONS., AND PREPARES THE INSPECTION REPORTS AS PER NDR10-0000 OR AS STATED IN THE PLANS.
4. CONTRACTOR IS RESPONSIBLE FOR THE DAY-TO-DAY OPERATION OF THE SWPPP AND SHALL NOTIFY THE ENGINEER IF ANY PROBLEMS ARISE.
5. SITE INSPECTIONS ARE REQUIRED EVERY 14 DAYS OR AFTER A RAINFALL EVENT GREATER THAN 0.25 INCHES IN 24 HOURS. ALL INSPECTIONS MUST BE DOCUMENTED IN THE SWPPP. CONTRACTOR SHALL PROVIDE ENGINEER WITH A COPY OF EACH INSPECTION REPORT. CONTRACTOR SHALL PROVIDE ON-SITE RAIN GAUGE TO MEASURE RAINFALL TOTALS.
6. THE RECEIVING WATER IS NELSON DRAIN NO. 28, A TRIBUTARY TO THE RED RIVER. BMP'S SHALL BE USED TO MINIMIZE ANY SEDIMENT FROM PROJECT SITE INTO THE RECEIVING WATERS.
7. ALL AREAS NOT WORKED IN FOR 14 DAYS SHALL BE TEMPORARY MULCHED. THIS WORK IS PART OF STORM WATER MANAGEMENT AND WILL NOT BE PAID FOR AS ADDITIONAL WORK.
8. TRACKED SEDIMENT SHALL BE REMOVED FROM ALL ROADS WITHIN 24 HOURS OF SEDIMENT TRACKING. IF SEDIMENT TRACKING IS SEVERE, A CONSTRUCTION ENTRANCE SHALL BE INSTALLED IN ACCORDANCE WITH NDR10-0000 OR AS SHOWN IN THE PLANS.
9. TEMPORARY ROCK CHECKS SHALL BE INSTALLED PRIOR TO STARTING WORK IN ANY AREA OF THE PROJECT. THEY SHALL BE CONSTRUCTED IN ACCORDANCE WITH THE PLANS
10. THE CONTRACTOR IS RESPONSIBLE FOR CONTROLLING PROJECT SITE DUST. WATERING PROJECT SITE AS WELL AS WATERING THE HAUL ROADS MAY BE NEEDED.
11. CONTRACTOR IS RESPONSIBLE FOR NON-HAZARDOUS WASTE BROUGHT TO AND STORED AT THE SITE. ALL TRASH AND DEBRIS SHALL BE PICKED UP DAILY AND DISPOSED OF IN PROPER CONTAINERS. NO MATERIAL IS ALLOWED TO BE BURIED ON SITE. ALL OIL, GAS, AND OTHER PETROLEUM PRODUCTS SHALL BE STORED IN SEALED CONTAINERS WITH PROPER LABELS.
12. ALL SPILLS SHALL BE CLEANED UP IMMEDIATELY. ENGINEER SHALL BE NOTIFIED IMMEDIATELY OF ANY SPILL.
13. ALL ITEMS THAT ARE REQUIRED BY NDR10-0000 OR AS SHOWN IN THE PLANS AS PART OF STORM WATER MANAGEMENT SHALL BE PAID FOR BY THE STORM WATER MANAGEMENT PAY ITEM UNLESS A SEPARATE BID ITEM IS SPECIFIED.
14. ALL CULVERTS SHALL HAVE RIPRAP INSTALLED UPSTREAM AND DOWNSTREAM OF THEM WITHIN 3 DAYS OF BEING INSTALLED.
15. CONTRACTOR IS RESPONSIBLE FOR MAKING SURE SUBCONTRACTORS STAY IN COMPLIANCE WITH STORM WATER MANAGEMENT GUIDELINES.
16. ALL EQUIPMENT SHALL ARRIVE ON-SITE IN A CLEAN, OPERABLE MANNER. EXCESS DIRT, VEGETATION, OIL, GREASE, OR ANY OTHER CONTAMINANTS SHALL BE CLEANED OFF PRIOR TO ENTERING PROJECT SITE.
17. CONTRACTOR SHALL MAINTAIN A STOCKPILE OF APPROPRIATE BMP'S ON-SITE FOR USE IN EMERGENCY SITUATIONS. THE STOCKPILE SHOULD INCLUDE EROSION CONTROL BLANKET, SILT FENCE, SPARE RIPRAP, AND SEEDING MATERIAL
18. CONTRACTOR IS ENCOURAGED TO INSTALL PERMANENT STABILIZATION IN STAGES AS PORTIONS OF THE PROJECT REACH FINAL GRADES.
19. AT THE COMPLETION OF THE PROJECT, PERMANENT GRASS SEEDING SHALL BE INSTALLED. PERMANENT SEEDING IS PAID FOR BY A BID ITEM AND IS NOT PART OF STORM WATER MANAGEMENT.

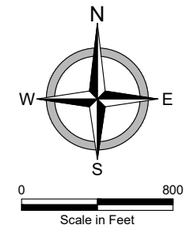
moore engineering, inc.

GENERAL LAYOUT AND EROSION CONTROL PLAN
RCPP/PL566 UPPER MAPLE RIVER WATERSHED ALTERNATIVE 2A
CASS COUNTY JOINT WATER RESOURCE DISTRICT
BARNES COUNTY, NORTH DAKOTA
GENERAL LAYOUT AND EROSION CONTROL PLAN

DATE:	02.13.25
REVISED:	----
REVISED:	----
REVISED:	----
REVISED:	----
REVISED:	----
RECORD:	----
PROJECT No.	18746
MANAGER:	KRL
DESIGNER:	ZJT
DRAFTER:	ZJT
REVIEWER:	JMH

C-101

SHEET 3 OF 37



PRELIMINARY

ALTERNATE 2A DAM EMBANKMENT ALIGNMENT LINE AND CURVE TABLE

Number	Length	Radius	Delta	Bearing	Start Sta.	End Sta.	Start Northing/Easting	End Northing/Easting
L100	510.79	N/A	N/A	S65°57'37"E	0+00	5+10.79	542337.70/2647893.45	542129.62/2648359.94
C100	100.55	90.00	64°00'48"	S33°57'13"E	5+10.79	6+11.35	542129.62/2648359.94	542050.48/2648413.22
L101	5485.04	N/A	N/A	S1°56'49"E	6+11.35	60+96.38	542050.48/2648413.22	536568.61/2648599.57
C101	50.89	60.00	48°35'47"	S22°21'05"W	60+96.38	61+47.27	536568.61/2648599.57	536522.94/2648580.79
L102	1304.10	N/A	N/A	S46°38'58"W	61+47.27	74+51.37	536522.94/2648580.79	535627.73/2647632.49
C102	47.58	65.00	41°56'18"	S67°37'07"W	74+51.37	74+98.95	535627.73/2647632.49	535610.01/2647589.48
L103	3691.34	N/A	N/A	S88°35'16"W	74+98.95	111+90.29	535610.01/2647589.48	535519.03/2643899.25
C103	93.83	59.98	89°37'41"	S43°46'25"W	111+90.29	112+84.12	535519.03/2643899.25	535457.98/2643840.76
L104	986.88	N/A	N/A	S1°02'26"E	112+84.12	122+71.01	535457.98/2643840.76	534471.26/2643858.68
C104	94.35	60.00	90°06'05"	S44°00'37"W	122+71.01	123+65.36	534471.26/2643858.68	534410.17/2643799.67
L105	284.17	N/A	N/A	S89°03'39"W	123+65.36	126+49.53	534410.17/2643799.67	534405.52/2643515.54

HORIZONTAL CONTROL

NORTH DAKOTA COORDINATE SYSTEM OF 1983, NAD83, SOUTH ZONE
COMBINATION FACTOR (cf) = .9998710
ALL COORDINATES ARE BARNES COUNTY GROUND COORDINATES

VERTICAL CONTROL

NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD88)

BENCHMARKS/SURVEY CONTROL

PRIOR TO PROJECT START, OWNER WILL SET AND ESTABLISH BENCHMARKS AND SURVEY CONTROL FOR THE PROJECT, AND CLEARLY MARK RIGHT-OF-WAY.

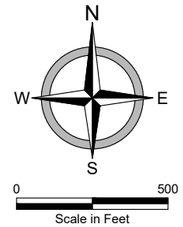
moore engineering, inc.

ALIGNMENT LAYOUT AND CONTROL
RCPP/PL566 UPPER MAPLE RIVER WATERSHED ALTERNATIVE 2A
CASS COUNTY JOINT WATER RESOURCE DISTRICT
BARNES COUNTY, NORTH DAKOTA
ALTERNATE 2A DAM EMBANKMENT

DATE:	02.13.25
REVISED:	----
REVISED:	----
REVISED:	----
REVISED:	----
REVISED:	----
RECORD:	----
PROJECT No.	18746
MANAGER:	KRL
DESIGNER:	ZJT
DRAFTER:	ZJT
REVIEWER:	JMH

C-102

SHEET 4 OF 37



PRELIMINARY

ALTERNATE 2A PRIMARY SPILLWAY ALIGNMENT LINE AND CURVE TABLE

Number	Length	Radius	Delta	Bearing	Start Sta.	End Sta.	Start Northing/Easting	End Northing/Easting
L200	115.49	N/A	N/A	N12°59'00"W	0+00	1+15.49	535239.17/2648744.26	535351.71/2648718.32
C200	53.04	50.00	60°46'44"	N43°22'22"W	1+15.49	1+68.53	535351.71/2648718.32	535388.48/2648683.58
L201	81.53	N/A	N/A	N73°45'44"W	1+68.53	2+50.07	535388.48/2648683.58	535411.28/2648605.30
C201	60.00	50.00	68°45'12"	N39°23'08"W	2+50.07	3+10.07	535411.28/2648605.30	535454.92/2648569.47
L202	621.53	N/A	N/A	N5°00'32"W	3+10.07	9+31.59	535454.92/2648569.47	536074.07/2648515.20
C202	133.84	200.00	38°20'30"	N24°10'47"W	9+31.59	10+65.43	536074.07/2648515.20	536193.90/2648461.40
L203	271.62	N/A	N/A	N43°21'02"W	10+65.43	13+37.06	536193.90/2648461.40	536391.42/2648274.94
C203	59.72	100.00	34°13'05"	N60°27'35"W	13+37.06	13+96.78	536391.42/2648274.94	536420.43/2648223.75
L204	188.59	N/A	N/A	N77°34'07"W	13+96.78	15+85.36	536420.43/2648223.75	536461.03/2648039.58
C204	374.35	250.00	85°47'41"	N34°40'17"W	15+85.36	19+59.71	536461.03/2648039.58	536740.93/2647845.97
L205	230.43	N/A	N/A	N8°13'34"E	19+59.71	21+90.15	536740.93/2647845.97	536969.00/2647878.94

HORIZONTAL CONTROL

NORTH DAKOTA COORDINATE SYSTEM OF 1983, NAD83, SOUTH ZONE
COMBINATION FACTOR (cf) = .9998710
ALL COORDINATES ARE BARNES COUNTY GROUND COORDINATES

VERTICAL CONTROL

NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD88)

BENCHMARKS/SURVEY CONTROL

PRIOR TO PROJECT START, OWNER WILL SET AND ESTABLISH BENCHMARKS AND SURVEY CONTROL FOR THE PROJECT, AND CLEARLY MARK RIGHT-OF-WAY.

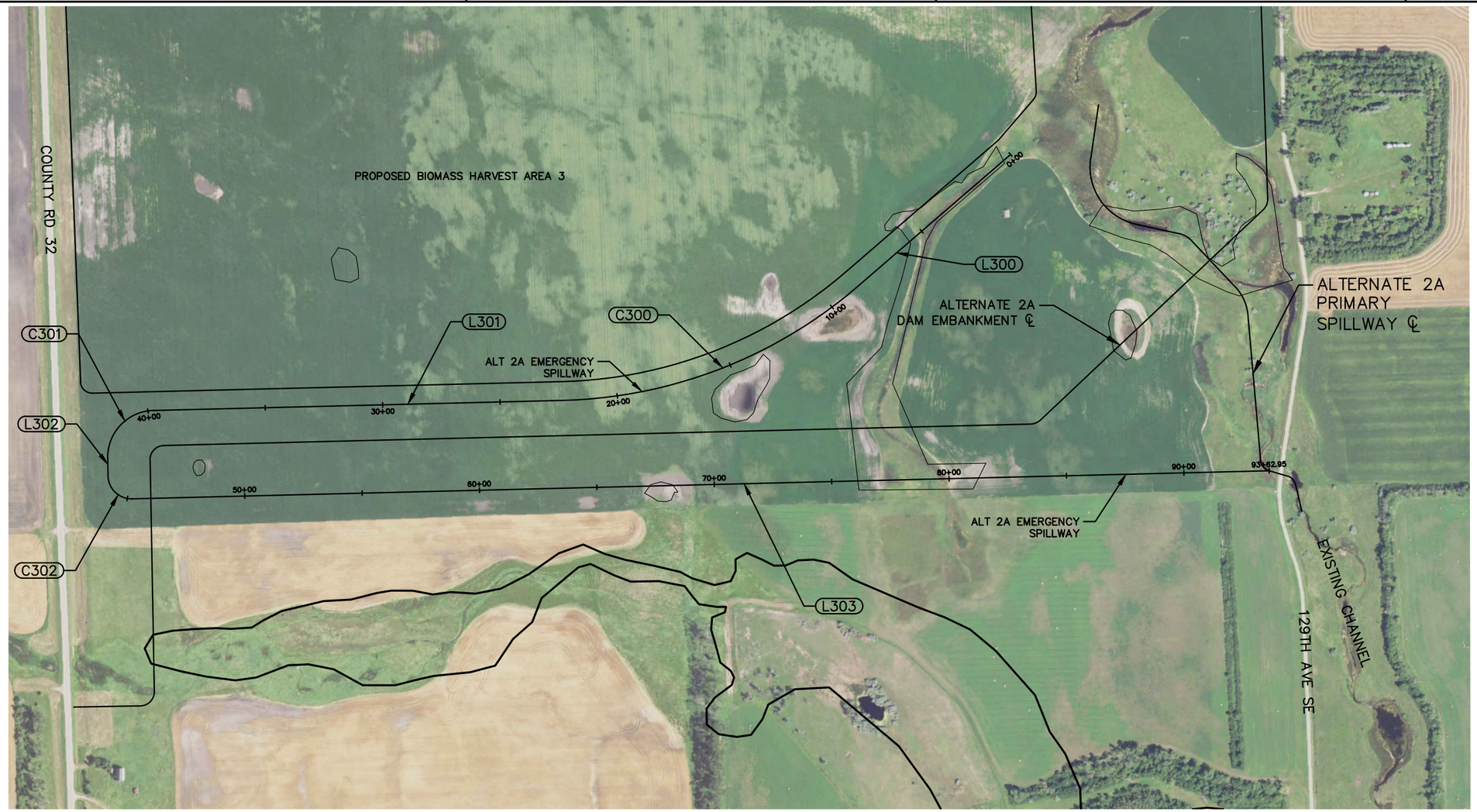
moore engineering, inc.

ALIGNMENT LAYOUT AND CONTROL
RCPP/PL566 UPPER MAPLE RIVER WATERSHED ALTERNATIVE 2A
CASS COUNTY JOINT WATER RESOURCE DISTRICT
BARNES COUNTY, NORTH DAKOTA
ALTERNATE 2A PRIMARY SPILLWAY

DATE:	02.13.25
REVISED:	----
REVISED:	----
REVISED:	----
REVISED:	----
REVISED:	----
RECORD:	----
PROJECT No.	18746
MANAGER:	KRL
DESIGNER:	ZJT
DRAFTER:	ZJT
REVIEWER:	JMH

C-103

SHEET 5 OF 37



PRELIMINARY

ALTERNATE 2A EMERGENCY SPILLWAY ALIGNMENT LINE AND CURVE TABLE

Number	Length	Radius	Delta	Bearing	Start Sta.	End Sta.	Start Northing/Easting	End Northing/Easting
L300	859.74	N/A	N/A	S49°12'10"W	0+00	8+59.74	536758.00/2647504.55	536196.26/2646853.71
C300	1374.79	2000.00	39°23'06"	S68°53'43"W	8+59.74	22+34.53	536196.26/2646853.71	535710.92/2645596.23
L301	1741.11	N/A	N/A	S88°35'16"W	22+34.53	39+75.64	535710.92/2645596.23	535668.01/2643855.65
C301	312.86	200.00	89°37'42"	S43°46'25"W	39+75.64	42+88.51	535668.01/2643855.65	535464.44/2643660.61
L302	74.36	N/A	N/A	S1°02'26"E	42+88.51	43+62.87	535464.44/2643660.61	535390.09/2643661.96
C302	157.73	100.00	90°22'18"	S46°13'35"E	43+62.87	45+20.59	535390.09/2643661.96	535291.94/2643764.41
L303	4842.36	N/A	N/A	N88°35'16"E	45+20.59	93+62.95	535291.94/2643764.41	535411.28/2648605.30

HORIZONTAL CONTROL

NORTH DAKOTA COORDINATE SYSTEM OF 1983, NAD83, SOUTH ZONE
COMBINATION FACTOR (cf) = .9998710
ALL COORDINATES ARE BARNES COUNTY GROUND COORDINATES

VERTICAL CONTROL

NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD88)

BENCHMARKS/SURVEY CONTROL

PRIOR TO PROJECT START, OWNER WILL SET AND ESTABLISH BENCHMARKS AND SURVEY CONTROL FOR THE PROJECT, AND CLEARLY MARK RIGHT-OF-WAY.

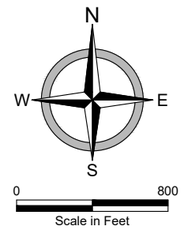
moore engineering, inc.

ALIGNMENT LAYOUT AND CONTROL
RCPP/PL566 UPPER MAPLE RIVER WATERSHED ALTERNATIVE 2A
CASS COUNTY JOINT WATER RESOURCE DISTRICT
BARNES COUNTY, NORTH DAKOTA
ALTERNATE 2A EMERGENCY SPILLWAY

DATE:	02.13.25
REVISED:	----
REVISED:	----
REVISED:	----
REVISED:	----
REVISED:	----
RECORD:	----
PROJECT No.	18746
MANAGER:	KRL
DESIGNER:	ZJT
DRAFTER:	ZJT
REVIEWER:	JMH

C-104

SHEET 6 OF 37



PRELIMINARY

ALTERNATE 2A FARM LEVEE ALIGNMENT LINE AND CURVE TABLE								
Number	Length	Radius	Delta	Bearing	Start Sta.	End Sta.	Start Northing/Easting	End Northing/Easting
L400	594.45	N/A	N/A	N87°51'54"E	0+00	5+94.45	543804.48/2643145.29	543826.63/2643739.32
C400	157.08	100.00	90°00'00"	N42°51'54"E	5+94.45	7+51.53	543826.63/2643739.32	543930.28/2643835.53
L401	42.82	N/A	N/A	N2°08'06"W	7+51.53	7+94.34	543930.28/2643835.53	543973.07/2643833.93
C401	157.08	100.00	90°00'00"	N42°51'54"E	7+94.34	9+51.42	543973.07/2643833.93	544076.73/2643930.14
L402	65.33	N/A	N/A	N87°51'54"E	9+51.42	10+16.75	544076.73/2643930.14	544079.16/2643995.42
C402	157.08	100.00	90°00'00"	N42°51'54"E	10+16.75	11+73.83	544079.16/2643995.42	544182.82/2644091.63
L403	623.37	N/A	N/A	N2°08'06"W	11+73.83	17+97.20	544182.82/2644091.63	544805.75/2644068.40
C403	157.08	100.00	90°00'00"	N47°08'06"W	17+97.20	19+54.28	544805.75/2644068.40	544901.96/2643964.75
L404	859.78	N/A	N/A	S87°51'54"W	19+54.28	28+14.06	544901.96/2643964.75	544869.93/2643105.57

ALTERNATE 2A FARM LEVEE ALIGNMENT LINE AND CURVE TABLE								
Number	Length	Radius	Delta	Bearing	Start Sta.	End Sta.	Start Northing/Easting	End Northing/Easting
L500	1500.00	N/A	N/A	S87°31'44"W	0+00	15+00	539130.47/2643315.30	539065.79/2641816.70

HORIZONTAL CONTROL

NORTH DAKOTA COORDINATE SYSTEM OF 1983, NAD83, SOUTH ZONE
COMBINATION FACTOR (cf) = .9998710
ALL COORDINATES ARE BARNES COUNTY GROUND COORDINATES

VERTICAL CONTROL

NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD88)

BENCHMARKS/SURVEY CONTROL

PRIOR TO PROJECT START, OWNER WILL SET AND ESTABLISH BENCHMARKS AND SURVEY CONTROL FOR THE PROJECT, AND CLEARLY MARK RIGHT-OF-WAY.

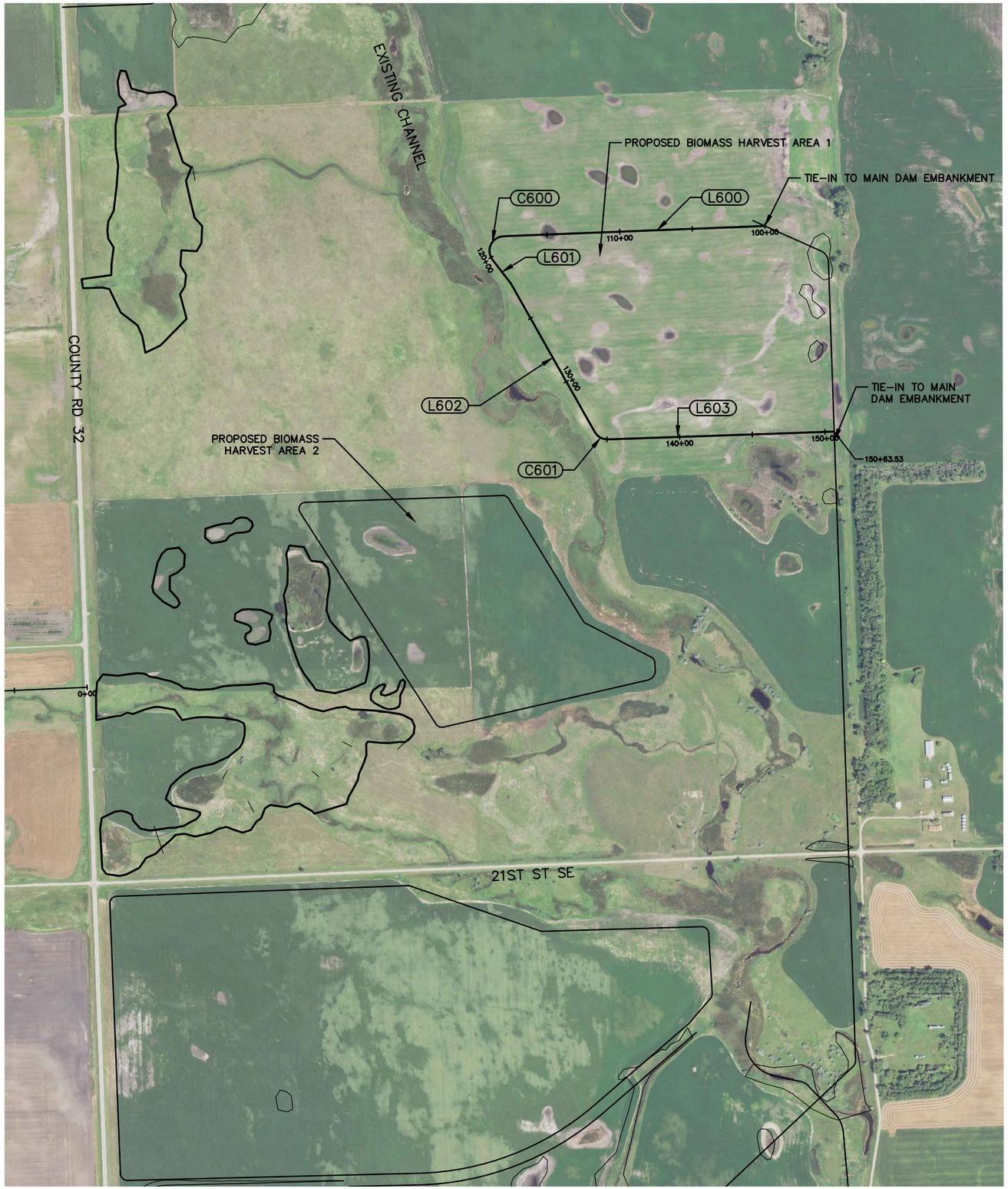
moore engineering, inc.

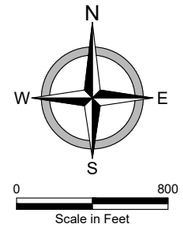
ALIGNMENT LAYOUT AND CONTROL
RCPP/PL566 UPPER MAPLE RIVER WATERSHED ALTERNATIVE 2A
CASS COUNTY JOINT WATER RESOURCE DISTRICT
BARNES COUNTY, NORTH DAKOTA
FARM LEVEES

DATE:	02.13.25
REVISED:	----
REVISED:	----
REVISED:	----
REVISED:	----
REVISED:	----
RECORD:	----
PROJECT No.	18746
MANAGER:	KRL
DESIGNER:	ZJT
DRAFTER:	ZJT
REVIEWER:	JMH

C-105

SHEET 7 OF 37





PRELIMINARY

BIOMASS HARVESTING AREA 1 ALIGNMENT LINE AND CURVE TABLE

Number	Length	Radius	Delta	Bearing	Start Sta.	End Sta.	Start Northing/Easting	End Northing/Easting
L600	1799.40	N/A	N/A	S87°45'16"W	100+00	117+99.40	542300.78/2647976.20	542230.28/2646178.19
C600	219.11	100.00	125°32'27"	S24°59'02"W	117+99.40	120+18.51	542230.28/2646178.19	542069.08/2646103.08
L601	205.01	N/A	N/A	S37°47'11"E	120+18.51	122+23.51	542069.08/2646103.08	541907.06/2646228.69
L602	1173.89	N/A	N/A	S29°27'52"E	122+23.51	133+97.41	541907.06/2646228.69	540885.00/2646806.11
C601	109.10	100.00	62°30'33"	S60°43'09"E	133+97.41	135+06.51	540885.00/2646806.11	540834.25/2646896.62
L603	1557.02	N/A	N/A	N88°01'35"E	135+06.51	150+63.53	540834.25/2646896.62	540887.87/2648452.72

HORIZONTAL CONTROL

NORTH DAKOTA COORDINATE SYSTEM OF 1983, NAD83, SOUTH ZONE
COMBINATION FACTOR (cf) = .9998710
ALL COORDINATES ARE BARNES COUNTY GROUND COORDINATES

VERTICAL CONTROL

NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD88)

BENCHMARKS/SURVEY CONTROL

PRIOR TO PROJECT START, OWNER WILL SET AND ESTABLISH BENCHMARKS AND SURVEY CONTROL FOR THE PROJECT, AND CLEARLY MARK RIGHT–OF–WAY.

moore engineering, inc.

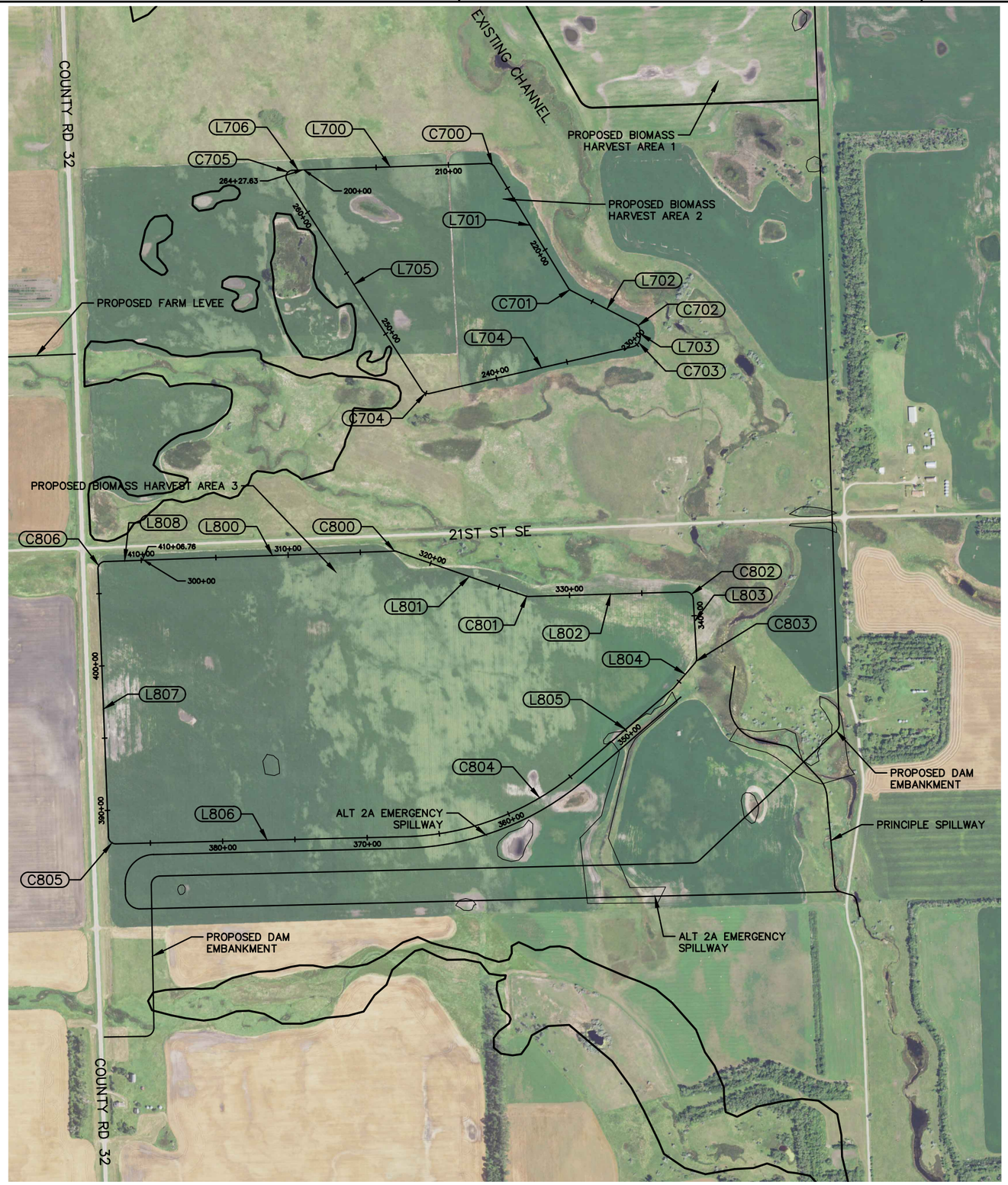
ALIGNMENT LAYOUT AND CONTROL
RCPP/PL566 UPPER MAPLE RIVER WATERSHED ALTERNATIVE 2A
CASS COUNTY JOINT WATER RESOURCE DISTRICT
BARNES COUNTY, NORTH DAKOTA
ALTERNATE 2A BIOMASS HARVEST AREA 1

DATE:	02.13.25
REVISED:	----
REVISED:	----
REVISED:	----
REVISED:	----
REVISED:	----
RECORD:	----
PROJECT No.	18746
MANAGER:	KRL
DESIGNER:	ZJT
DRAFTER:	ZJT
REVIEWER:	JMH

C-106

SHEET 8 OF 37

FILE LOCATION: R:\Projects\18000\18700\18746\DRAWINGS\DESIGN\18746-ALT-2A-PP.dwg



HORIZONTAL CONTROL

NORTH DAKOTA COORDINATE SYSTEM OF 1983, NAD83, SOUTH ZONE
COMBINATION FACTOR (cf) = .9998710
ALL COORDINATES ARE BARNES COUNTY GROUND COORDINATES

VERTICAL CONTROL

NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD88)

BENCHMARKS/SURVEY CONTROL

PRIOR TO PROJECT START, OWNER WILL SET AND ESTABLISH BENCHMARKS AND SURVEY CONTROL FOR THE PROJECT, AND CLEARLY MARK RIGHT-OF-WAY.

N W E S

0 800
Scale in Feet

PRELIMINARY

BIOMASS HARVESTING AREA 2 ALIGNMENT LINE AND CURVE TABLE

Number	Length	Radius	Delta	Bearing	Start Sta.	End Sta.	Start Northing/Easting	End Northing/Easting
L700	1275.37	N/A	N/A	N87°59'38"E	200+00	212+75.37	540403.98/2644896.21	540448.62/2646170.81
C700	52.90	50.00	60°37'27"	S61°41'38"E	212+75.37	213+28.28	540448.62/2646170.81	540424.69/2646215.24
L701	980.66	N/A	N/A	S31°22'55"E	213+28.28	223+08.94	540424.69/2646215.24	539587.49/2646725.91
C701	27.35	50.00	31°20'24"	S47°03'07"E	223+08.94	223+36.29	539587.49/2646725.91	539569.08/2646745.68
L702	503.43	N/A	N/A	S62°43'19"E	223+36.29	228+39.72	539569.08/2646745.68	539338.35/2647193.13
C702	52.23	50.00	59°51'13"	S32°47'42"E	228+39.72	228+91.95	539338.35/2647193.13	539296.42/2647220.15
L703	50.78	N/A	N/A	S2°52'06"E	228+91.95	229+42.73	539296.42/2647220.15	539245.70/2647222.69
C703	88.24	63.26	79°55'07"	S37°05'28"W	229+42.73	230+30.96	539245.70/2647222.69	539180.89/2647173.69
L704	1443.86	N/A	N/A	S77°03'01"W	230+30.96	244+74.83	539180.89/2647173.69	538857.33/2645766.55
C704	61.29	50.00	70°14'05"	N67°49'56"W	244+74.83	245+36.12	538857.33/2645766.55	538879.03/2645713.27
L705	1726.77	N/A	N/A	N32°42'53"W	245+36.12	262+62.88	538879.03/2645713.27	540331.88/2644780.03
C705	94.80	45.00	120°42'31"	N27°38'22"E	262+62.88	263+57.69	540331.88/2644780.03	540401.18/2644816.32
L706	69.95	N/A	N/A	N87°59'38"E	263+57.69	264+27.63	540401.18/2644816.32	540403.63/2644886.22

BIOMASS HARVESTING AREA 3 ALIGNMENT LINE AND CURVE TABLE

Number	Length	Radius	Delta	Bearing	Start Sta.	End Sta.	Start Northing/Easting	End Northing/Easting
L800	1732.47	N/A	N/A	N87°54'23"E	300+00	317+32.47	537703.99/2643787.93	537767.28/2645519.24
C800	18.44	50.00	21°07'45"	S81°31'44"E	317+32.47	317+50.91	537767.28/2645519.24	537764.58/2645537.38
L801	946.76	N/A	N/A	S70°57'52"E	317+50.91	326+97.66	537764.58/2645537.38	537455.79/2646432.36
C801	18.08	50.00	20°43'16"	S81°19'30"E	326+97.66	327+15.74	537455.79/2646432.36	537453.08/2646450.14
L802	1088.69	N/A	N/A	N88°18'52"E	327+15.74	338+04.43	537453.08/2646450.14	537485.10/2647538.36
C802	77.06	50.00	88°18'17"	S47°31'59"E	338+04.43	338+81.49	537485.10/2647538.36	537438.07/2647589.74
L803	411.02	N/A	N/A	S3°22'51"E	338+81.49	342+92.51	537438.07/2647589.74	537027.77/2647613.98
C803	38.52	50.00	44°08'30"	S18°41'24"W	342+92.51	343+31.03	537027.77/2647613.98	536992.18/2647601.94
L804	229.22	N/A	N/A	S40°45'39"W	343+31.03	345+60.25	536992.18/2647601.94	536818.56/2647452.28
L805	859.74	N/A	N/A	S49°12'10"W	345+60.25	354+19.99	536818.56/2647452.28	536256.82/2646801.44
C804	1319.80	1920.00	39°23'06"	S68°53'43"W	354+19.99	367+39.79	536256.82/2646801.44	535790.90/2645594.26
L806	1998.71	N/A	N/A	S88°35'16"W	367+39.79	387+38.50	535790.90/2645594.26	535741.64/2643596.15
C805	77.81	50.00	89°09'47"	N46°49'50"W	387+38.50	388+16.31	535741.64/2643596.15	535789.66/2643544.96
L807	1854.05	N/A	N/A	N2°14'57"W	388+16.31	406+70.36	535789.66/2643544.96	537642.28/2643472.20
C806	78.68	50.00	90°09'20"	N42°49'43"E	406+70.36	407+49.04	537642.28/2643472.20	537694.21/2643520.34
L808	257.72	N/A	N/A	N87°54'23"E	407+49.04	410+06.76	537694.21/2643520.34	537703.63/2643777.89

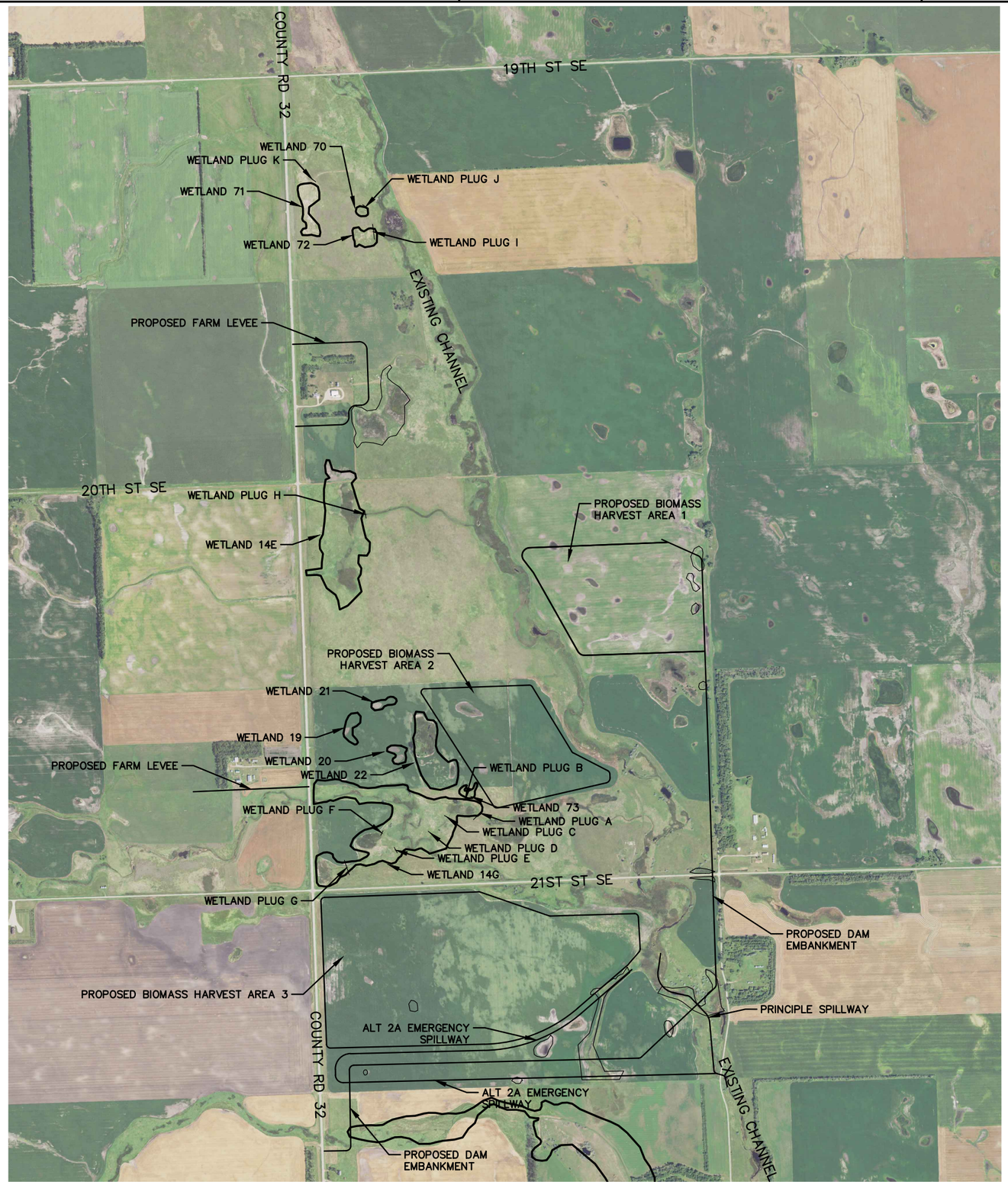
moore engineering, inc.

ALIGNMENT LAYOUT AND CONTROL
RCPP/PL566 UPPER MAPLE RIVER WATERSHED ALTERNATIVE 2A
CASS COUNTY JOINT WATER RESOURCE DISTRICT
BARNES COUNTY, NORTH DAKOTA
ALTERNATE 2A BIOMASS HARVEST AREAS 2 & 3

DATE:	02.13.25
REVISED:	----
REVISED:	----
REVISED:	----
REVISED:	----
REVISED:	----
RECORD:	----
PROJECT No.	18746
MANAGER:	KRL
DESIGNER:	ZJT
DRAFTER:	ZJT
REVIEWER:	JMH

C-107

SHEET 9 OF 37



WETLAND PLUG TABULATION

	WETLAND PLUG ID	TOP ELEVATION	APPROXIMATE FILL REQUIRED (CU YD)
SITE 2A	A	1247.00	1160
	B	1242.0	200
	C	1240.0	80
	D	1239.0	70
	E	1240.0	100
	F	1241.0	80
	G	1247.0	1250
	H	1245.0	400
	I	1250.0	760
	J	1248.00	110
	K	1252.0	270
	TOTAL		4480.0

N
W E
S
0 1500
Scale in Feet

PRELIMINARY

WETLAND IMPROVEMENTS TABULATION

	WETLAND ID	PRE-PROJECT AREA (ACRES)	POST PROJECT AREA (ACRES)	NET WETLAND GAIN (ACRES)	MEANS OF IMPROVEMENT
SITE 2A	14G	21.10	29.0	7.9	WETLAND PLUG (RESTORATION)
	14E	13.8	18.8	5.0	WETLAND PLUG (RESTORATION)
	19	1.2	1.2	0.0	RESTORE FUNCTIONS
	20	0.9	0.9	0.0	RESTORE FUNCTIONS
	21	0.7	0.7	0.0	RESTORE FUNCTIONS
	22	5.1	5.1	0.0	RESTORE FUNCTIONS
	BIOMASS HARVEST AREA 1	0.0	66.4	66.4	BIOMASS HARVEST AREA
	BIOMASS HARVEST AREA 2	0.0	47.9	47.9	BIOMASS HARVEST AREA
	BIOMASS HARVEST AREA 3	0.0	150.34	150.3	BIOMASS HARVEST AREA
	70	0.00	0.4	0.4	WETLAND PLUG (RESTORATION)
	71	0.0	2.8	2.8	WETLAND PLUG (RESTORATION)
	72	0.0	1.5	1.5	WETLAND PLUG (RESTORATION)
	73	0.0	0.6	0.6	WETLAND PLUG (RESTORATION)
	TOTAL	42.8	325.6	282.8	RESTORATIONS AND CREATIONS

moore engineering, inc.

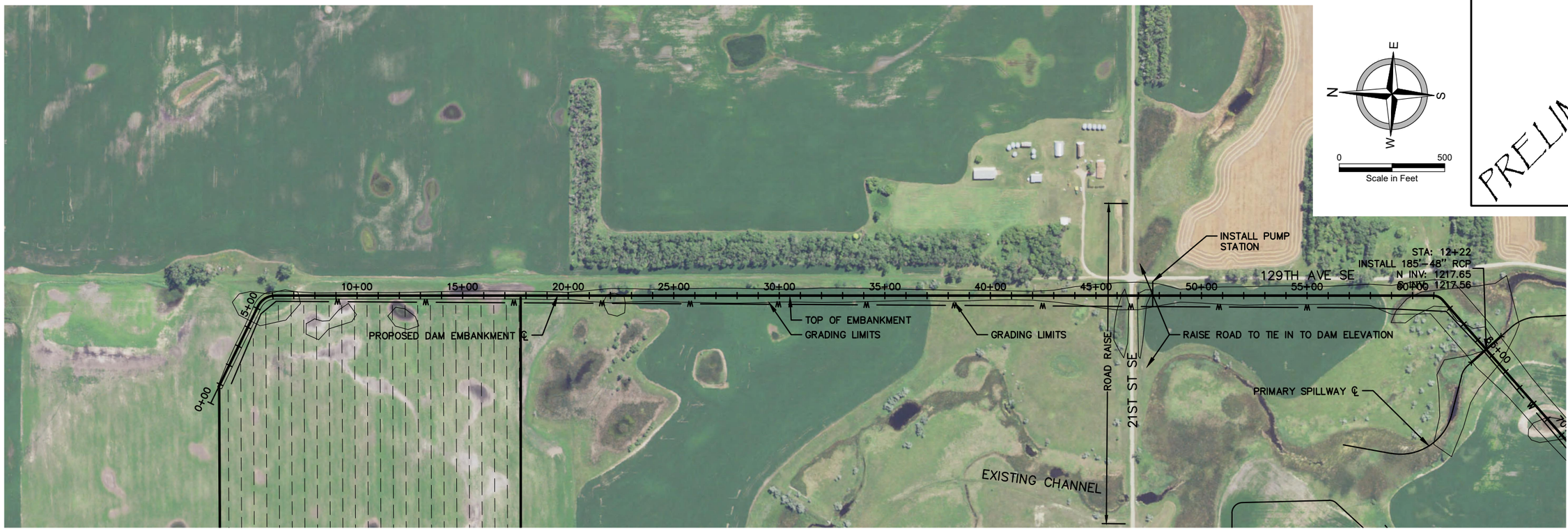
WETLAND LAYOUT AND TABULATIONS
RCPP/PL566 UPPER MAPLE RIVER WATERSHED ALTERNATIVE 2A
CASS COUNTY JOINT WATER RESOURCE DISTRICT
BARNES COUNTY, NORTH DAKOTA
WETLAND IMPROVEMENTS

DATE:	02.13.25
REVISED:	----
REVISED:	----
REVISED:	----
REVISED:	----
REVISED:	----
RECORD:	----
PROJECT No.	18746
MANAGER:	KRL
DESIGNER:	ZJT
DRAFTER:	ZJT
REVIEWER:	JMH

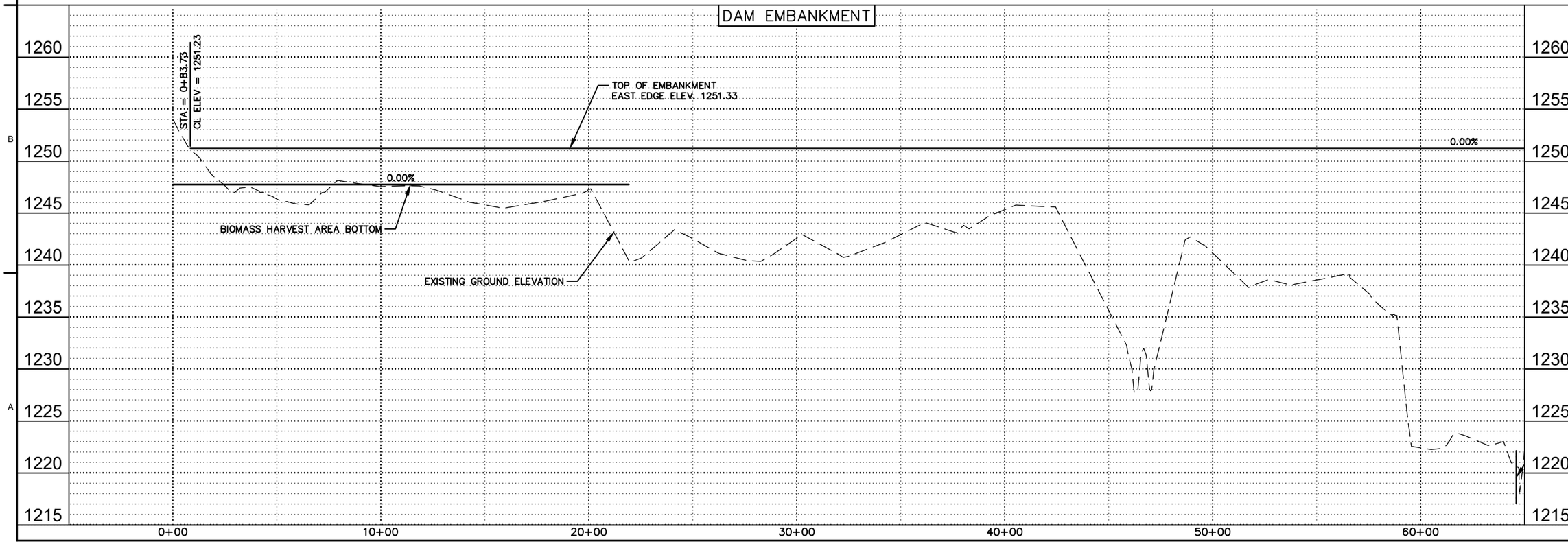
C-108

SHEET 10 OF 37

FILE LOCATION: R:\Projects\18000\18700\18746\DRAWINGS\DESIGN\18746-ALT-2A-PP.dwg



PRELIMINARY



moore engineering, inc.

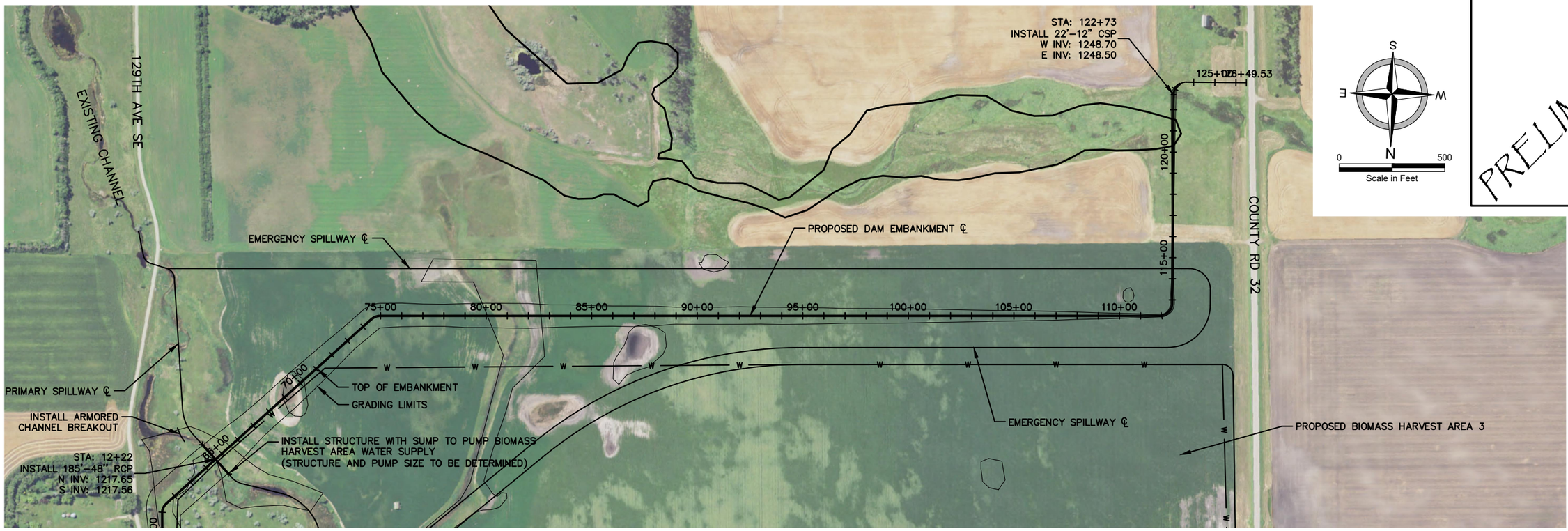
PLAN AND PROFILE
RCPP/PL566 UPPER MAPLE RIVER WATERSHED ALTERNATIVE 2A
CASS COUNTY JOINT WATER RESOURCE DISTRICT
BARNES COUNTY, NORTH DAKOTA
DAM EMBANKMENT

DATE:	02.13.25
REVISED:	----
REVISED:	----
REVISED:	----
REVISED:	----
REVISED:	----
RECORD:	----
PROJECT No.	18746
MANAGER:	KRL
DESIGNER:	ZJT
DRAFTER:	ZJT
REVIEWER:	JMH

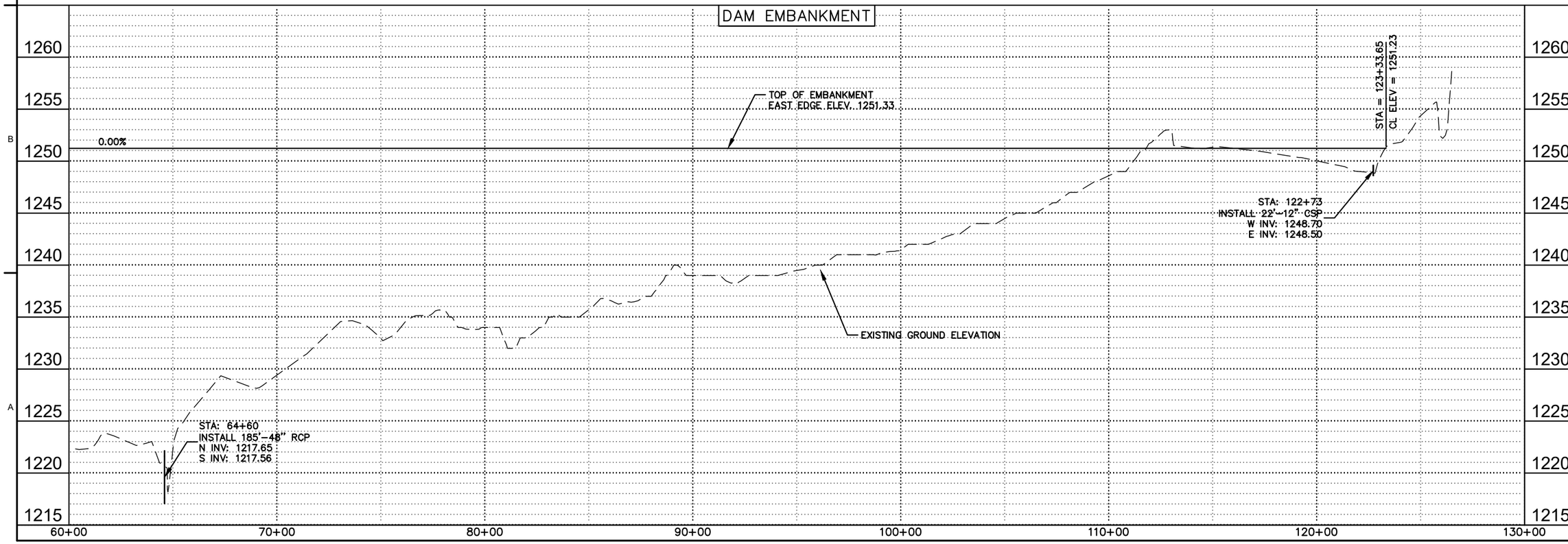
C-201

SHEET 11 OF 37

FILE LOCATION: R:\Projects\18000\18700\18746\DRAWINGS\DESIGN\18746-ALT-2A-PP.dwg



PRELIMINARY



moore engineering, inc.

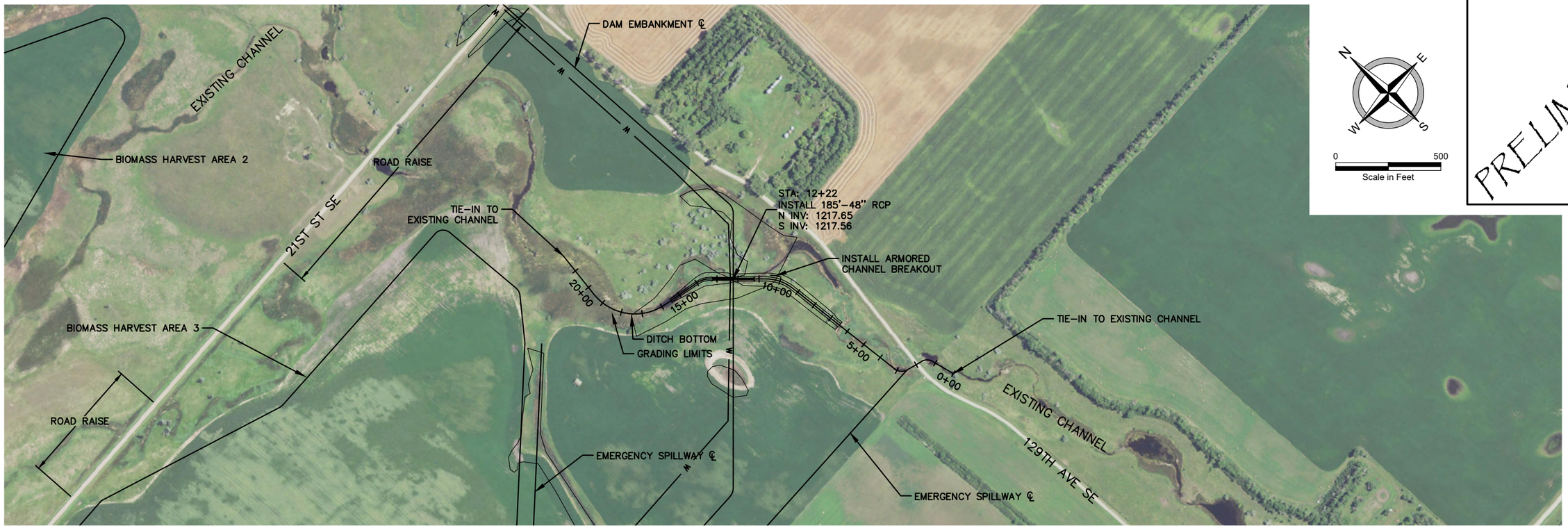
PLAN AND PROFILE
RCPP/PL566 UPPER MAPLE RIVER WATERSHED ALTERNATIVE 2A
CASS COUNTY JOINT WATER RESOURCE DISTRICT
BARNES COUNTY, NORTH DAKOTA
DAM EMBANKMENT

DATE:	02.13.25
REVISED:	----
REVISED:	----
REVISED:	----
REVISED:	----
REVISED:	----
RECORD:	----
PROJECT No.	18746
MANAGER:	KRL
DESIGNER:	ZJT
DRAFTER:	ZJT
REVIEWER:	JMH

C-202

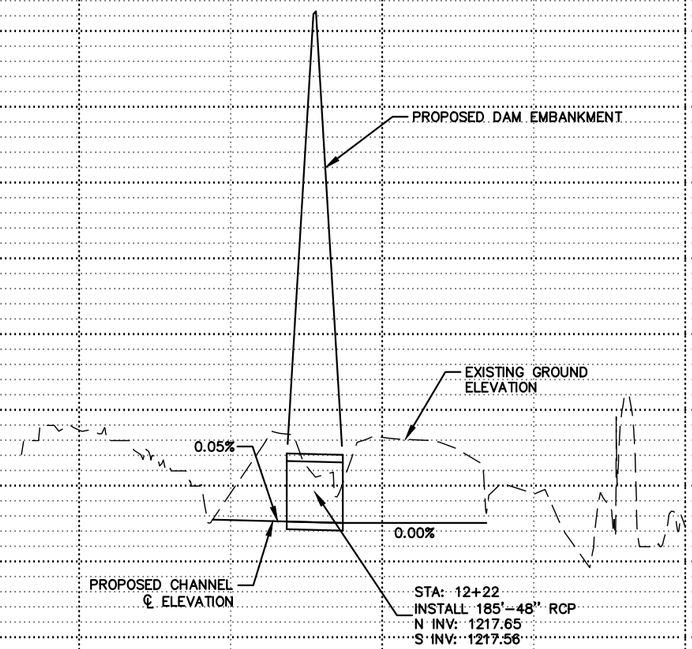
SHEET 12 OF 37

FILE LOCATION: R:\Projects\18000\18700\18746\DRAWINGS\DESIGN\18746-ALT-2A-PP.dwg



PRELIMINARY

PRIMARY SPILLWAY



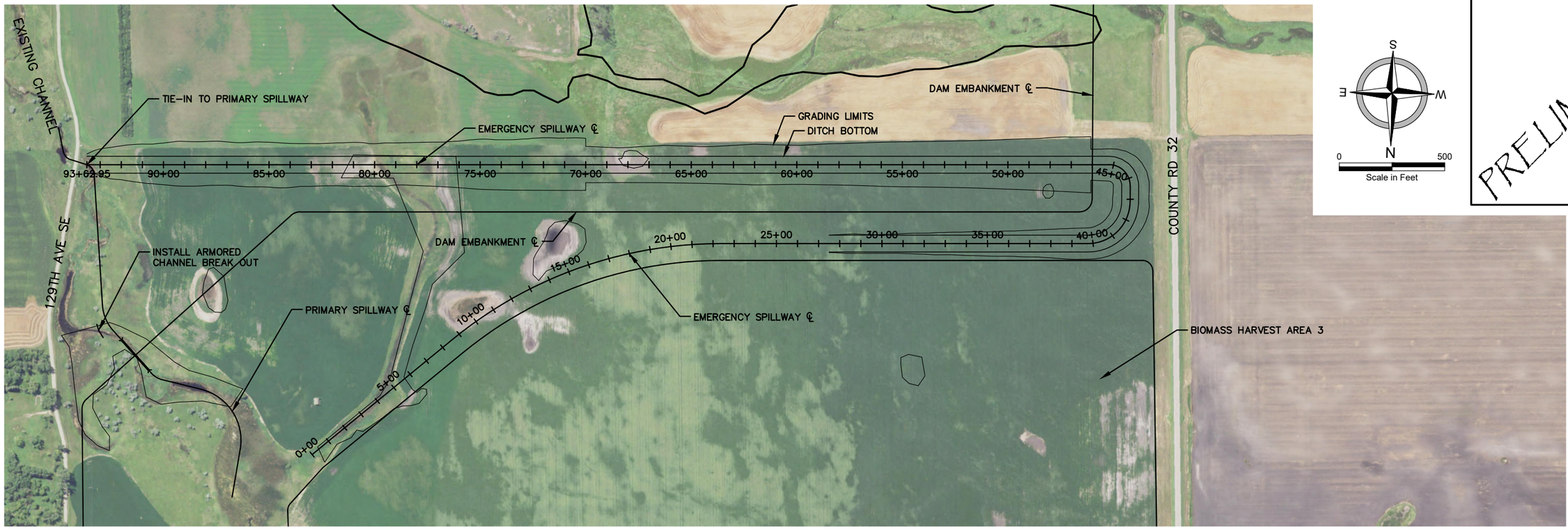
moore engineering, inc.

PLAN AND PROFILE
RCPP/PL566 UPPER MAPLE RIVER WATERSHED ALTERNATIVE 2A
CASS COUNTY JOINT WATER RESOURCE DISTRICT
BARNES COUNTY, NORTH DAKOTA
PRIMARY SPILLWAY

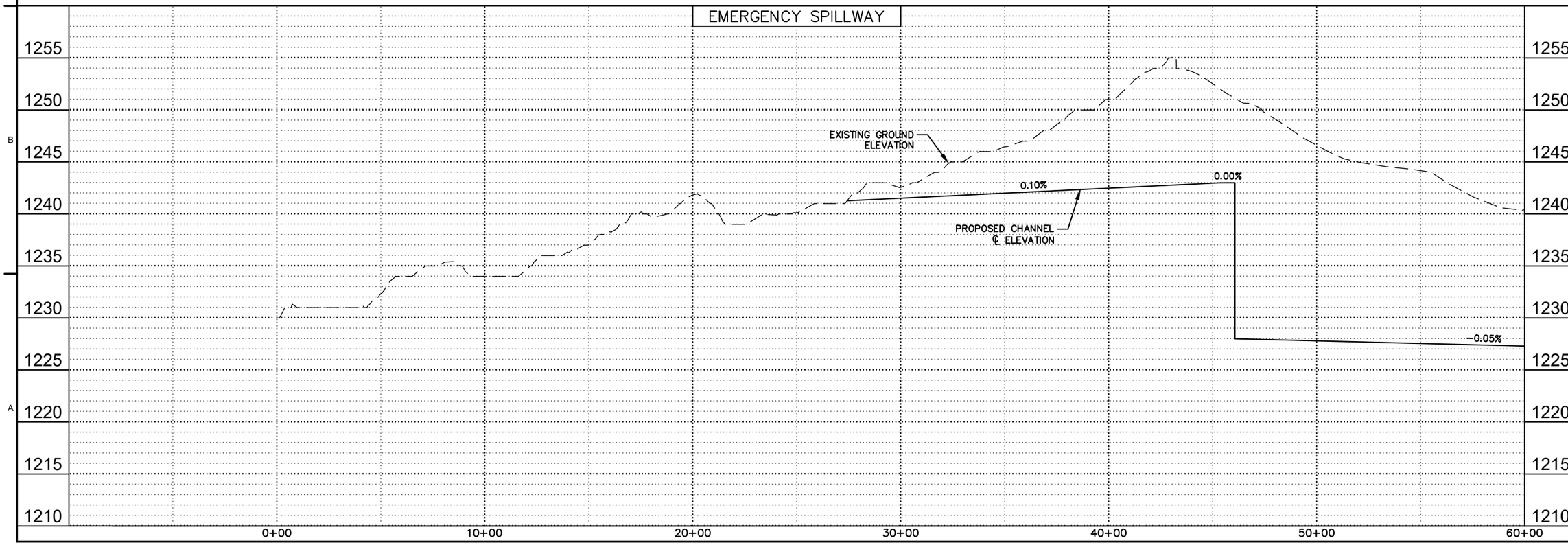
DATE:	02.13.25
REVISED:	----
REVISED:	----
REVISED:	----
REVISED:	----
REVISED:	----
RECORD:	----
PROJECT No.	18746
MANAGER:	KRL
DESIGNER:	ZJT
DRAFTER:	ZJT
REVIEWER:	JMH

C-203

SHEET 13 OF 37



PRELIMINARY



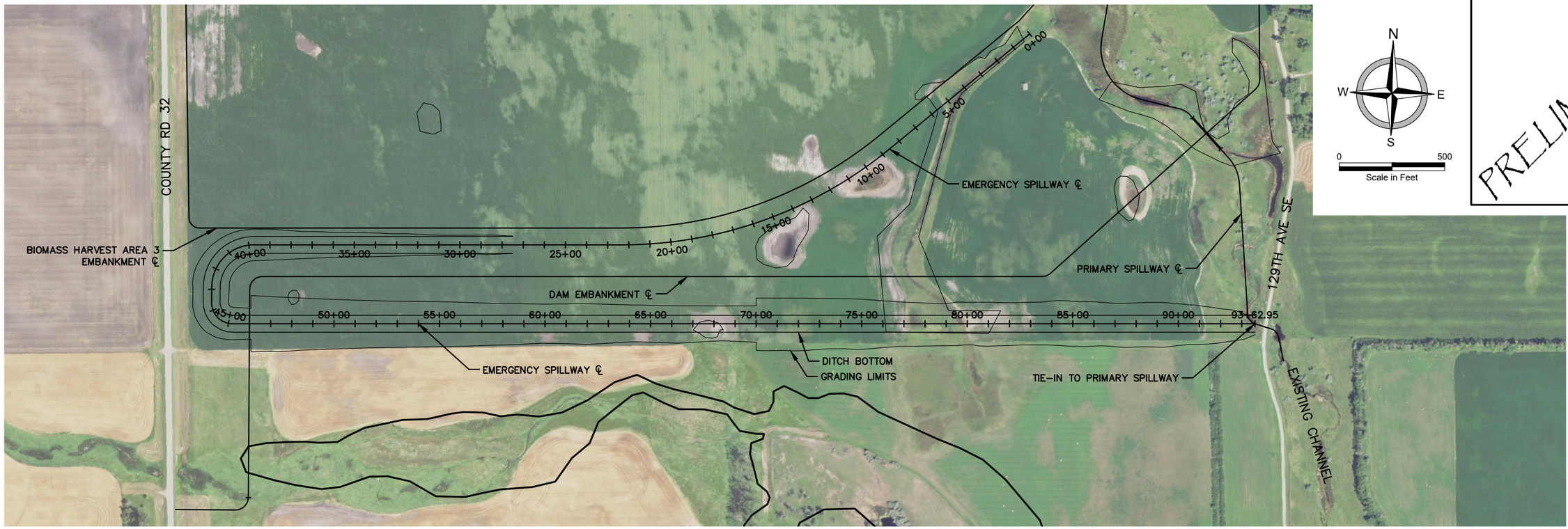
moore engineering, inc.

PLAN AND PROFILE
RCPP/PL566 UPPER MAPLE RIVER WATERSHED ALTERNATIVE 2A
CASS COUNTY JOINT WATER RESOURCE DISTRICT
BARNES COUNTY, NORTH DAKOTA
EMERGENCY SPILLWAY

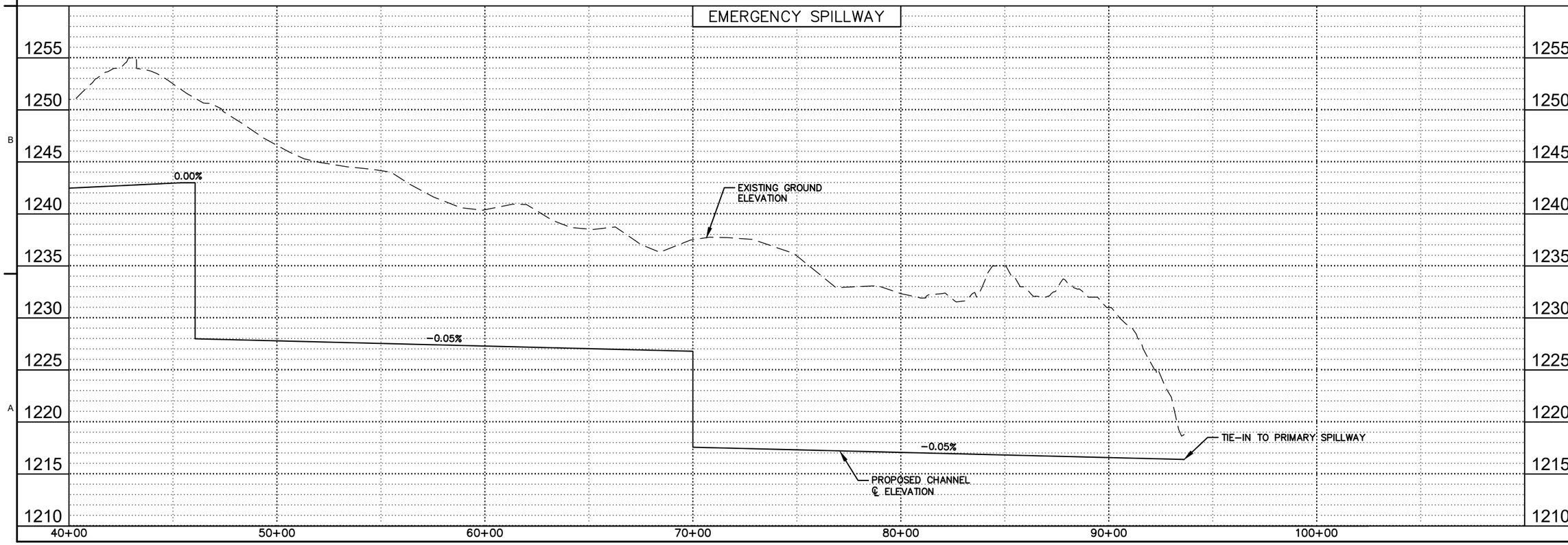
DATE:	02.13.25
REVISED:	----
REVISED:	----
REVISED:	----
REVISED:	----
REVISED:	----
RECORD:	----
PROJECT No.	18746
MANAGER:	KRL
DESIGNER:	ZJT
DRAFTER:	ZJT
REVIEWER:	JMH

C-204

SHEET 14 OF 37



PRELIMINARY



moore engineering, inc.

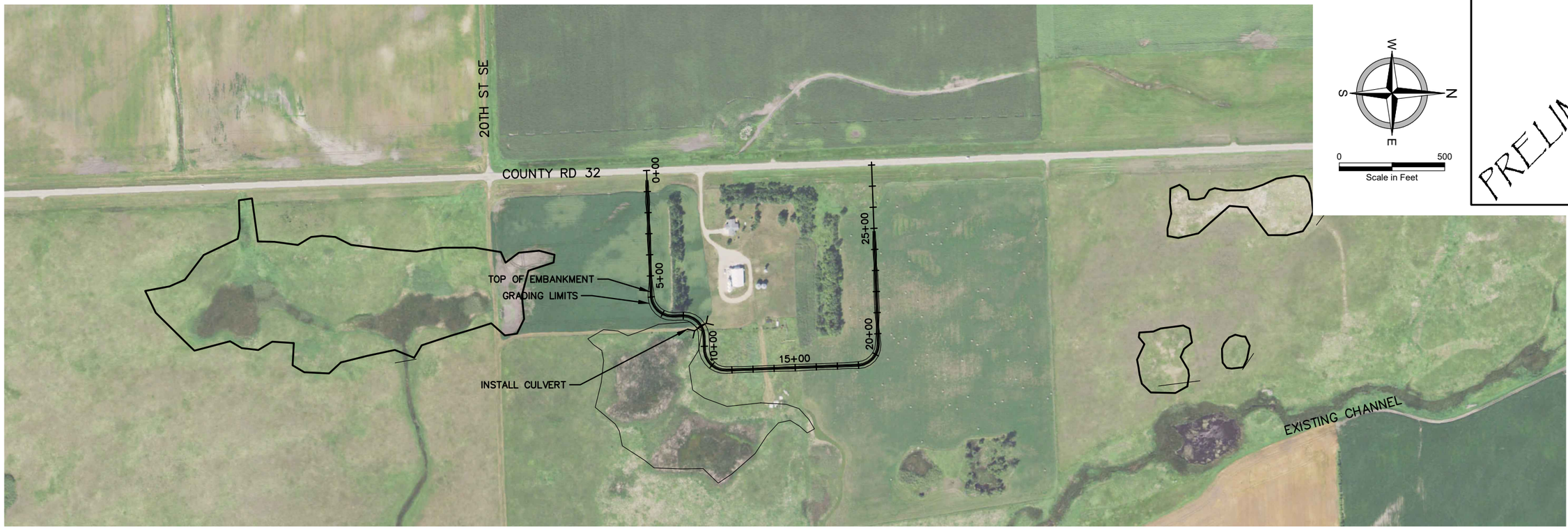
PLAN AND PROFILE
RCPP/PL566 UPPER MAPLE RIVER WATERSHED ALTERNATIVE 2A
CASS COUNTY JOINT WATER RESOURCE DISTRICT
BARNES COUNTY, NORTH DAKOTA
EMERGENCY SPILLWAY

DATE:	02.13.25
REVISED:	----
REVISED:	----
REVISED:	----
REVISED:	----
REVISED:	----
RECORD:	----
PROJECT No.	18746
MANAGER:	KRL
DESIGNER:	ZJT
DRAFTER:	ZJT
REVIEWER:	JMH

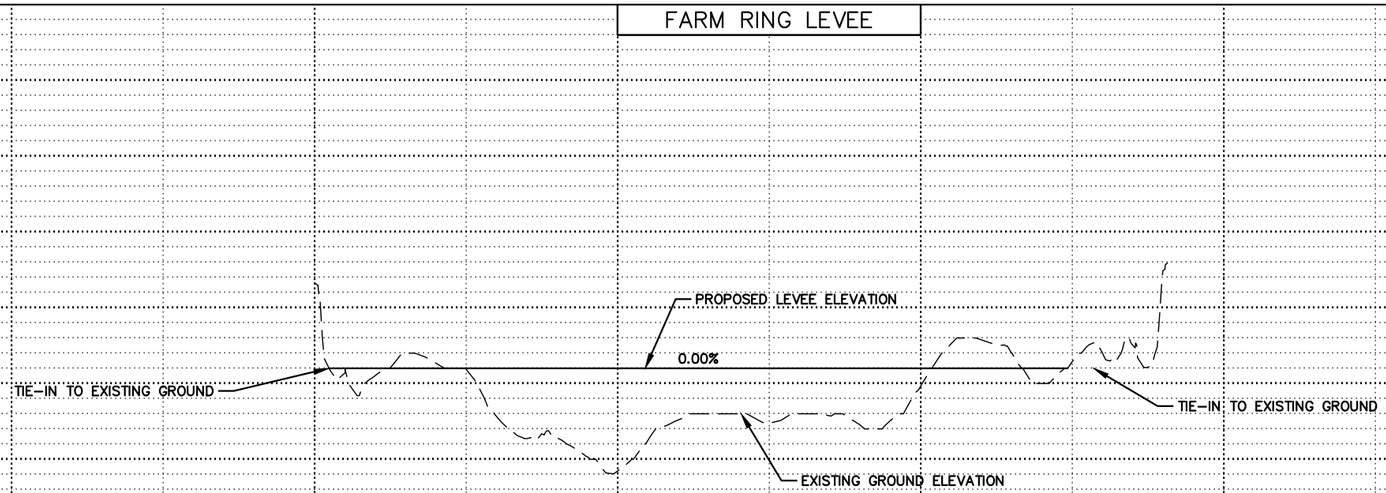
C-205

SHEET 15 OF 37

FILE LOCATION: R:\Projects\18000\18700\18746\DRAWINGS\DESIGN\18746-ALT-2A-PP.dwg



PRELIMINARY



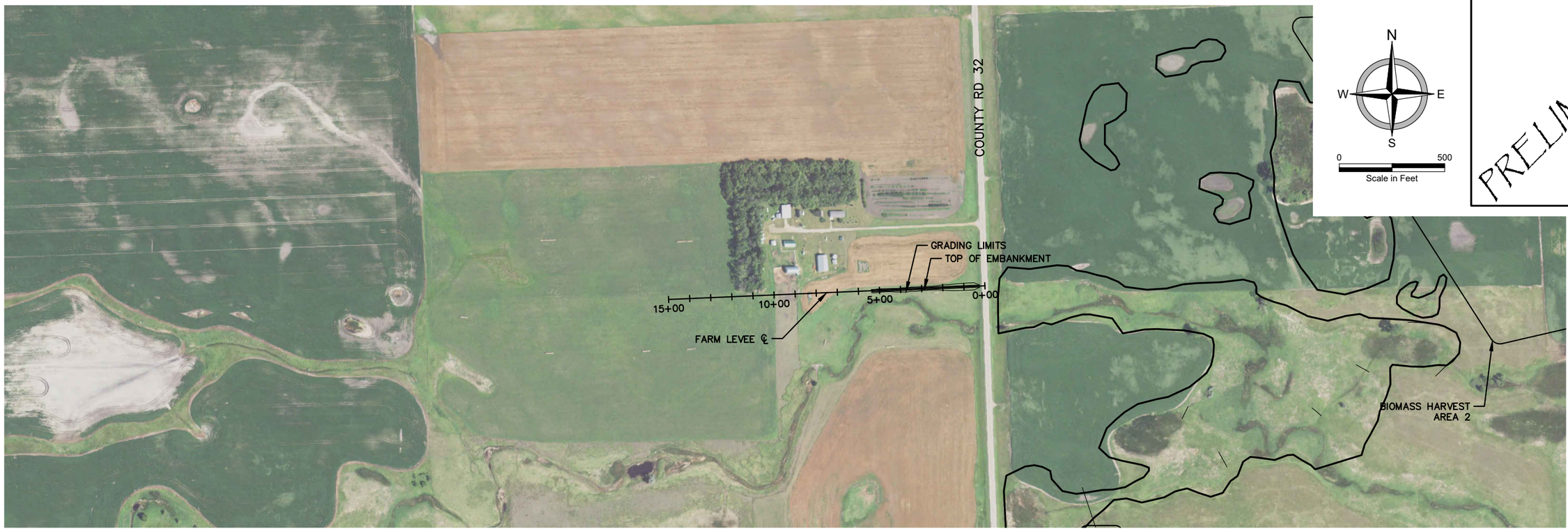
moore engineering, inc.

PLAN AND PROFILE
RCPP/PL566 UPPER MAPLE RIVER WATERSHED ALTERNATIVE 2A
CASS COUNTY JOINT WATER RESOURCE DISTRICT
BARNES COUNTY, NORTH DAKOTA
FARM RING LEVEE

DATE:	02.13.25
REVISED:	----
REVISED:	----
REVISED:	----
REVISED:	----
REVISED:	----
RECORD:	----
PROJECT No.	18746
MANAGER:	KRL
DESIGNER:	ZJT
DRAFTER:	ZJT
REVIEWER:	JMH

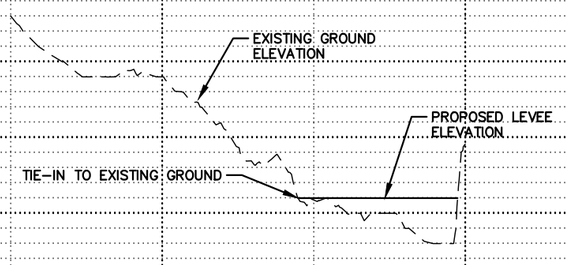
C-206

SHEET 16 OF 37



PRELIMINARY

FARM LEVEE



moore engineering, inc.

PLAN AND PROFILE
RCPP/PL566 UPPER MAPLE RIVER WATERSHED ALTERNATIVE 2A
CASS COUNTY JOINT WATER RESOURCE DISTRICT
BARNES COUNTY, NORTH DAKOTA
FARM LEVEE

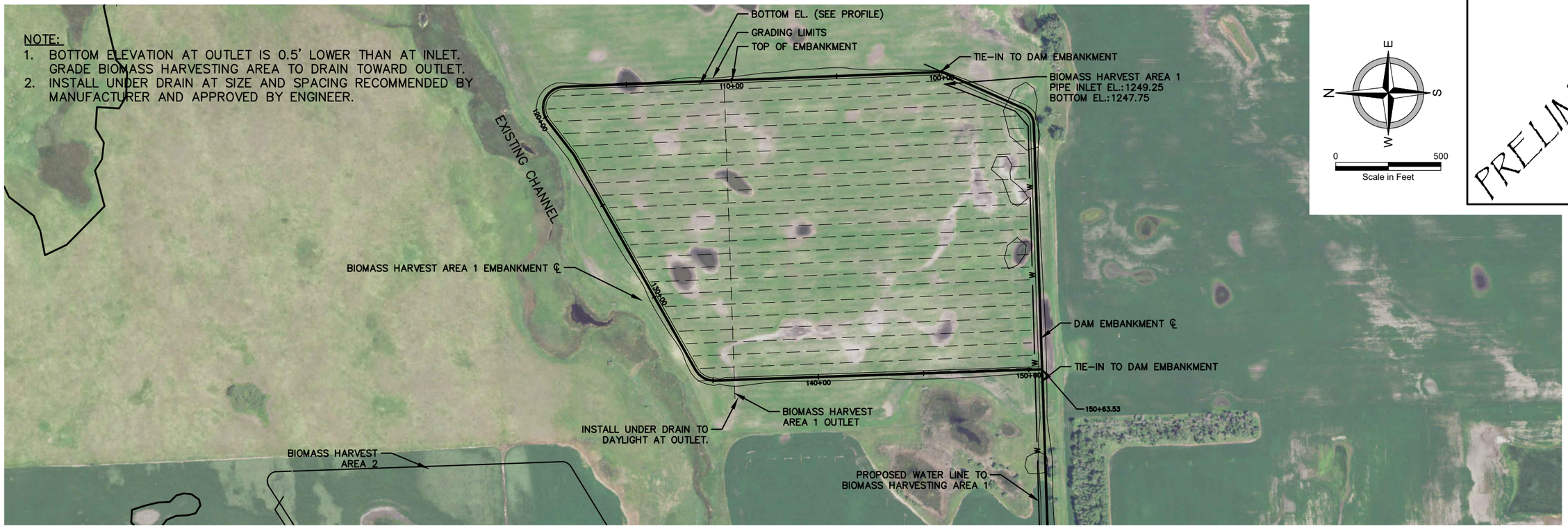
DATE:	02.13.25
REVISED:	----
REVISED:	----
REVISED:	----
REVISED:	----
REVISED:	----
RECORD:	----
PROJECT No.	18746
MANAGER:	KRL
DESIGNER:	ZJT
DRAFTER:	ZJT
REVIEWER:	JMH

C-207

SHEET 17 OF 37

FILE LOCATION: R:\Projects\18000\18700\18746\DRAWINGS\DESIGN\18746-ALT-2A-PP.dwg

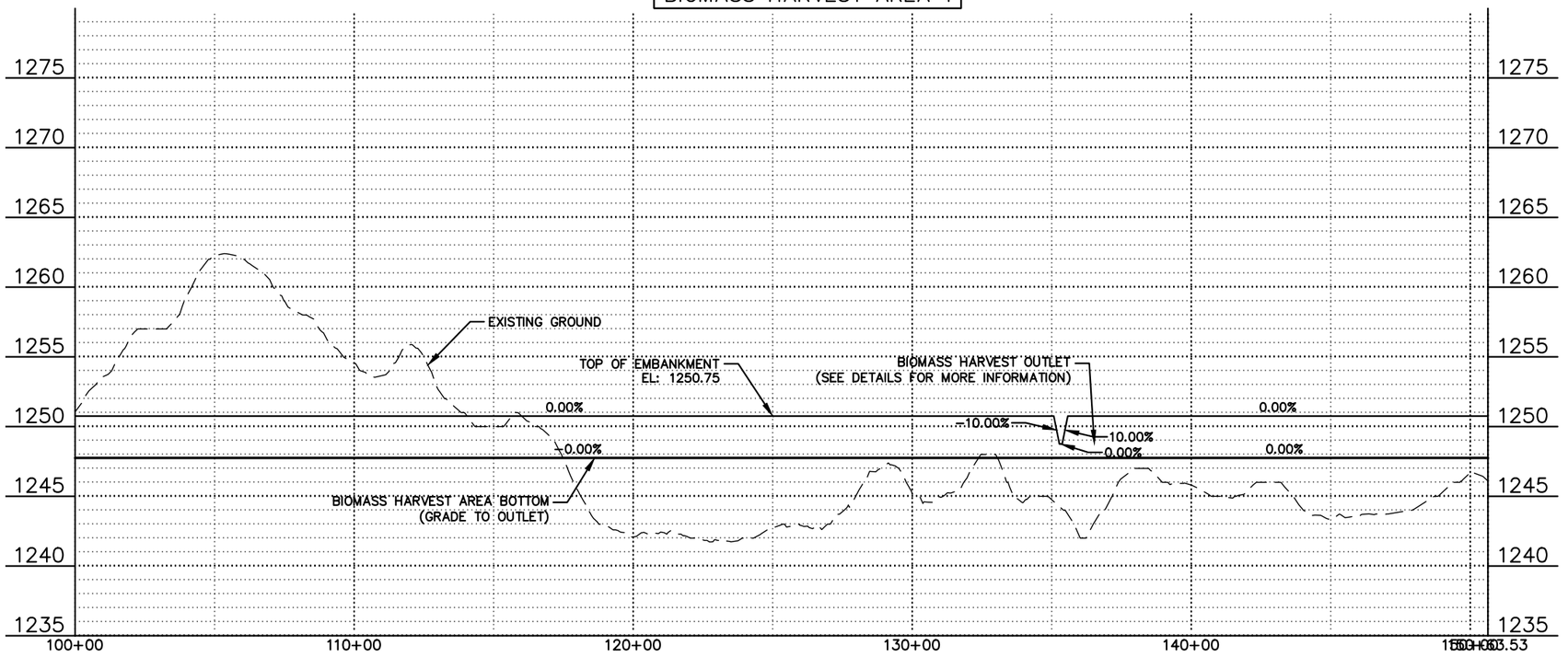
NOTE:
1. BOTTOM ELEVATION AT OUTLET IS 0.5' LOWER THAN AT INLET. GRADE BIOMASS HARVESTING AREA TO DRAIN TOWARD OUTLET.
2. INSTALL UNDER DRAIN AT SIZE AND SPACING RECOMMENDED BY MANUFACTURER AND APPROVED BY ENGINEER.



PRELIMINARY

moore engineering, inc.

BIOMASS HARVEST AREA 1



PLAN AND PROFILE
RCPP/PL566 UPPER MAPLE RIVER WATERSHED ALTERNATIVE 2A
CASS COUNTY JOINT WATER RESOURCE DISTRICT
BARNES COUNTY, NORTH DAKOTA
BIOMASS HARVEST AREA 1

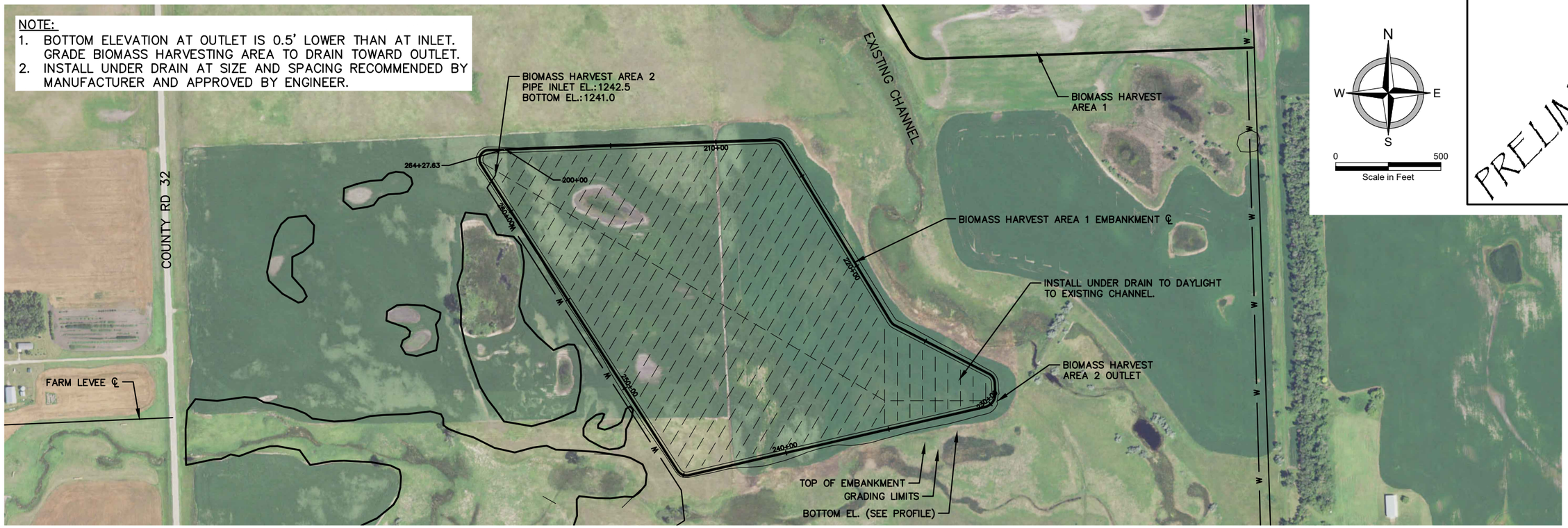
DATE:	02.13.25
REVISED:	----
REVISED:	----
REVISED:	----
REVISED:	----
REVISED:	----
RECORD:	----
PROJECT No.	18746
MANAGER:	KRL
DESIGNER:	ZJT
DRAFTER:	ZJT
REVIEWER:	JMH

C-208

SHEET 18 OF 37

FILE LOCATION: R:\Projects\18000\18700\18746\DRAWINGS\DESIGN\18746-ALT-2A-PP.dwg

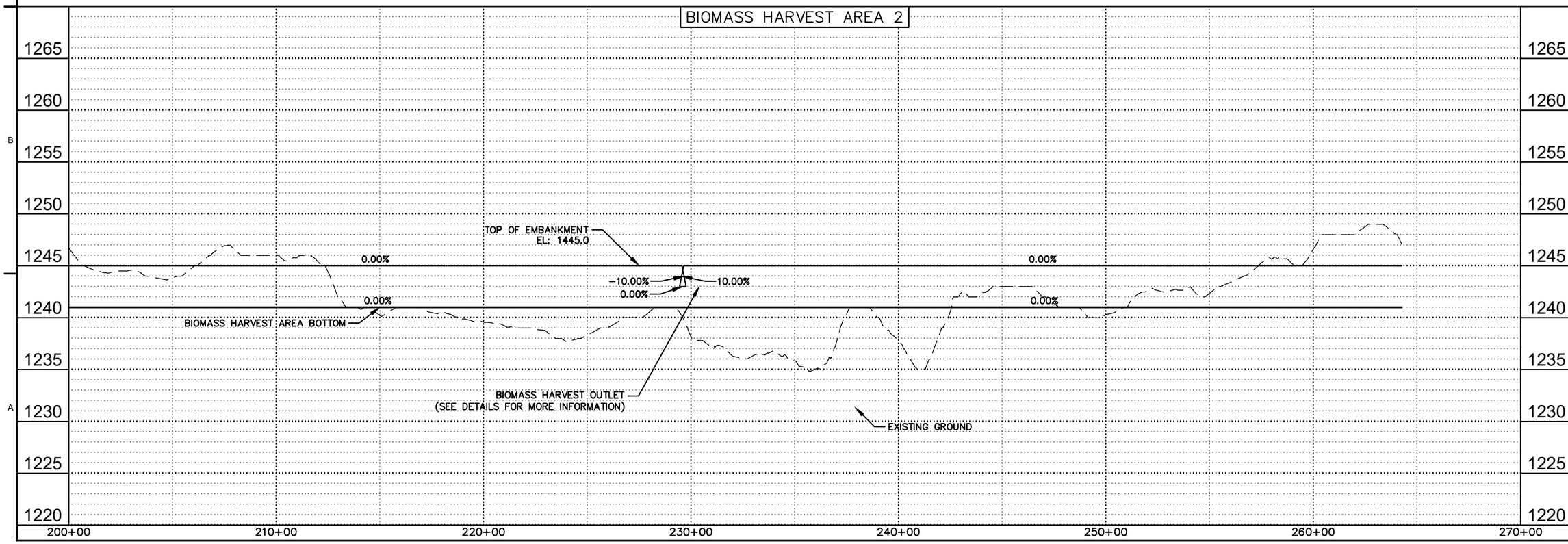
NOTE:
1. BOTTOM ELEVATION AT OUTLET IS 0.5' LOWER THAN AT INLET. GRADE BIOMASS HARVESTING AREA TO DRAIN TOWARD OUTLET.
2. INSTALL UNDER DRAIN AT SIZE AND SPACING RECOMMENDED BY MANUFACTURER AND APPROVED BY ENGINEER.



N
W E
S
0 500
Scale in Feet

PRELIMINARY

BIOMASS HARVEST AREA 2



moore engineering, inc.

PLAN AND PROFILE
RCPP/PL566 UPPER MAPLE RIVER WATERSHED ALTERNATIVE 2A
CASS COUNTY JOINT WATER RESOURCE DISTRICT
BARNES COUNTY, NORTH DAKOTA
BIOMASS HARVEST AREA 2

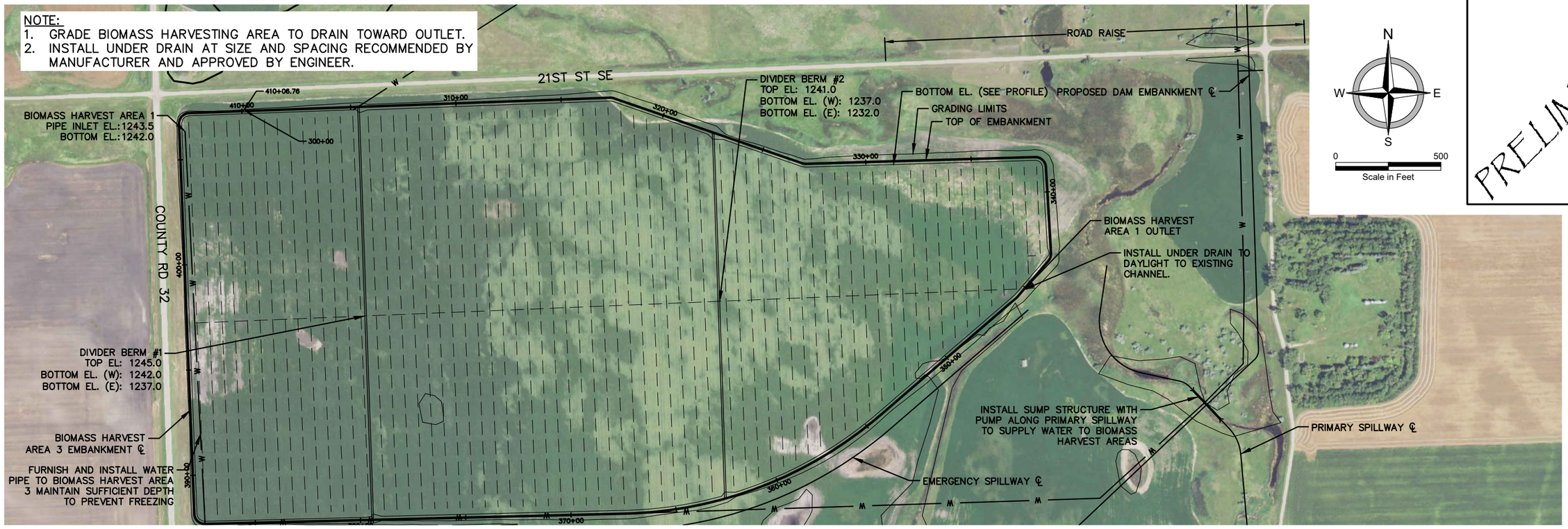
DATE:	02.13.25
REVISED:	----
REVISED:	----
REVISED:	----
REVISED:	----
REVISED:	----
RECORD:	----
PROJECT No.	18746
MANAGER:	KRL
DESIGNER:	ZJT
DRAFTER:	ZJT
REVIEWER:	JMH

C-209

SHEET 19 OF 37

FILE LOCATION: R:\Projects\18000\18700\18746\DRAWINGS\DESIGN\18746-ALT-2A-PP.dwg

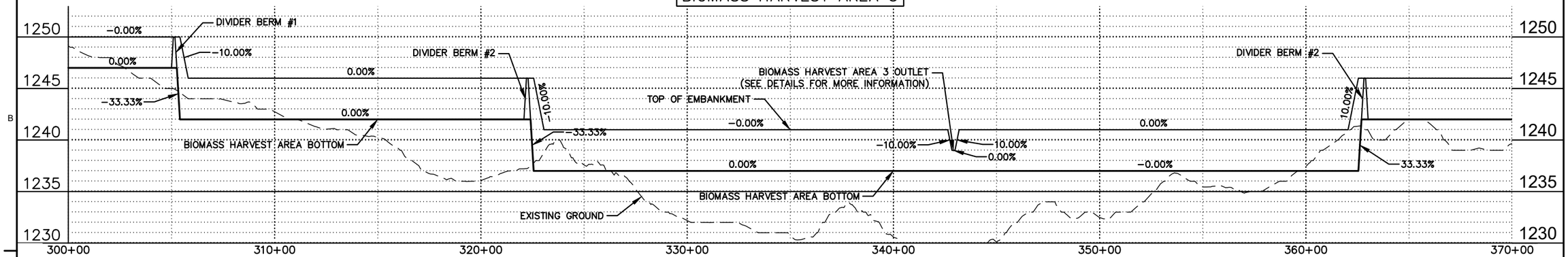
NOTE:
1. GRADE BIOMASS HARVESTING AREA TO DRAIN TOWARD OUTLET.
2. INSTALL UNDER DRAIN AT SIZE AND SPACING RECOMMENDED BY MANUFACTURER AND APPROVED BY ENGINEER.

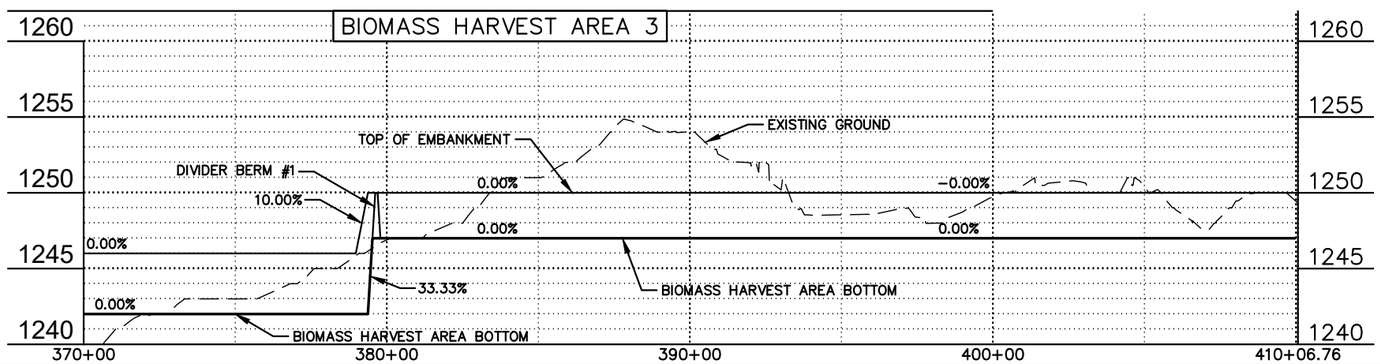


N
W E
S
0 500
Scale in Feet

PRELIMINARY

BIOMASS HARVEST AREA 3





moore engineering, inc.

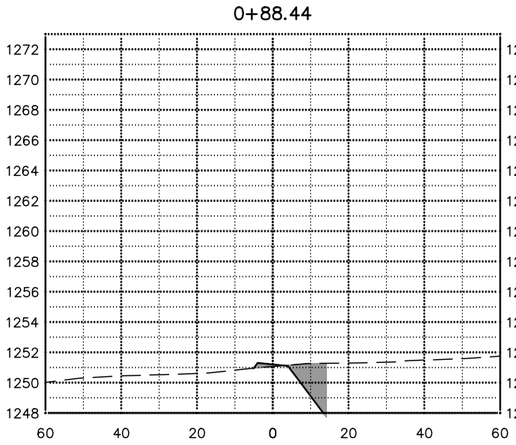
PLAN AND PROFILE
RCPP/PL566 UPPER MAPLE RIVER WATERSHED ALTERNATIVE 2A
CASS COUNTY JOINT WATER RESOURCE DISTRICT
BARNES COUNTY, NORTH DAKOTA
BIOMASS HARVEST AREA 3

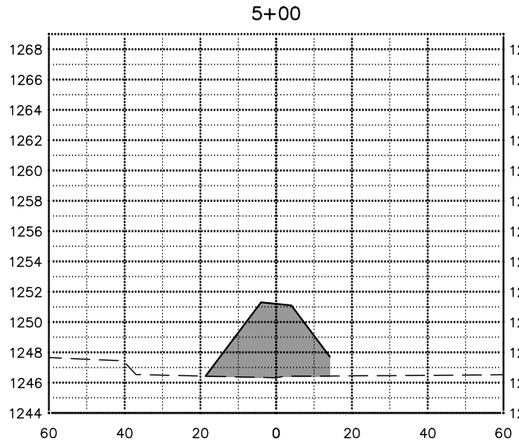
DATE:	02.13.25
REVISED:	----
REVISED:	----
REVISED:	----
REVISED:	----
REVISED:	----
RECORD:	----
PROJECT No.	18746
MANAGER:	KRL
DESIGNER:	ZJT
DRAFTER:	ZJT
REVIEWER:	JMH

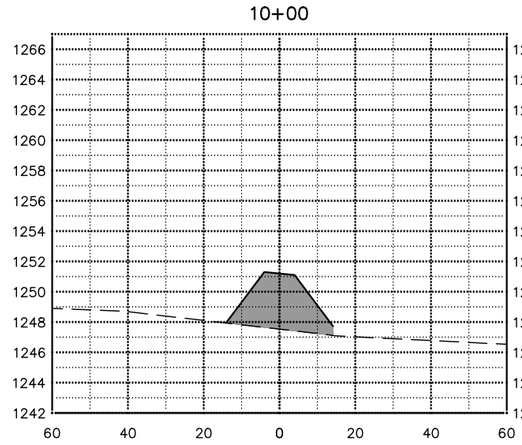
C-210

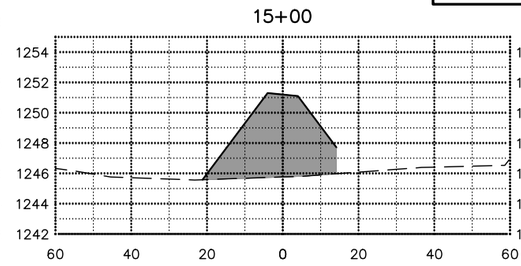
SHEET 20 OF 37

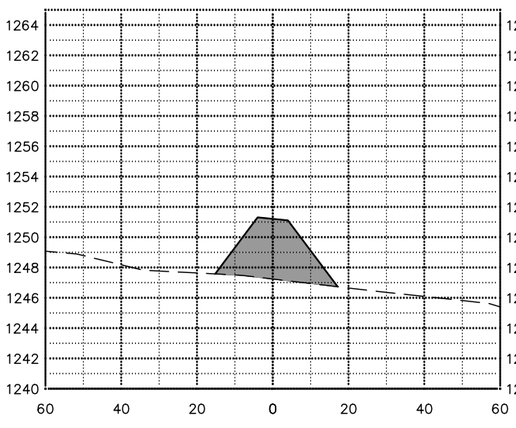
FILE LOCATION: R:\Projects\18000\18700\18746\DRAWINGS\DESIGN\18746-ALT-2A-PP.dwg

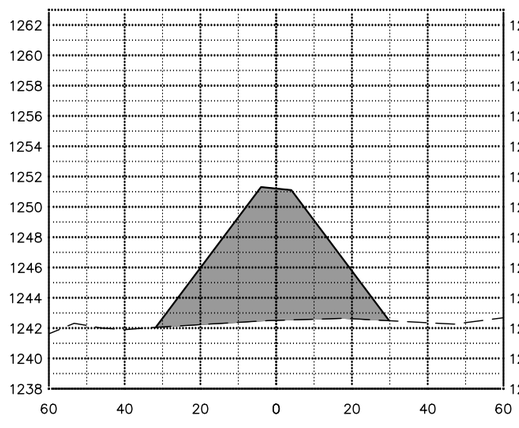


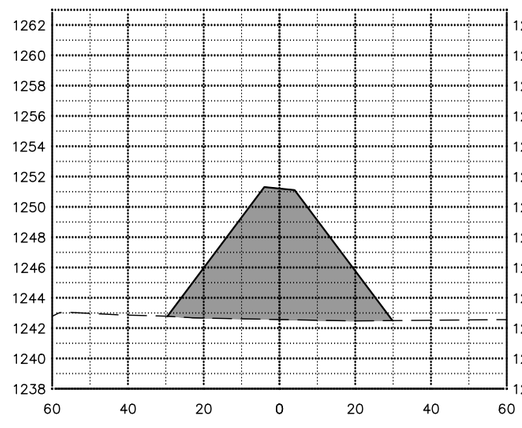


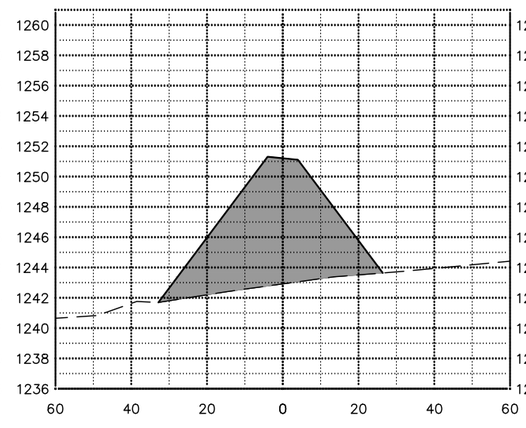


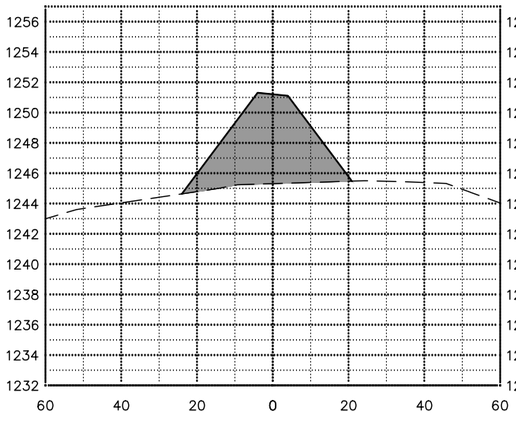


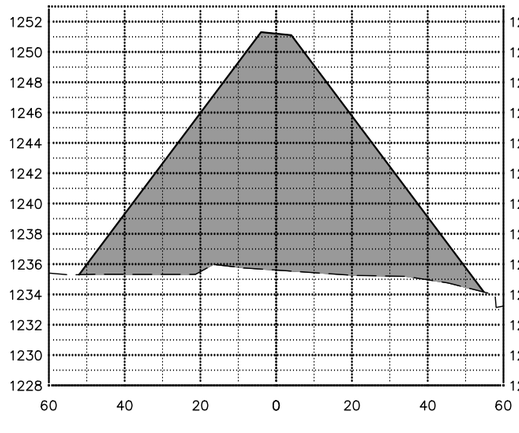


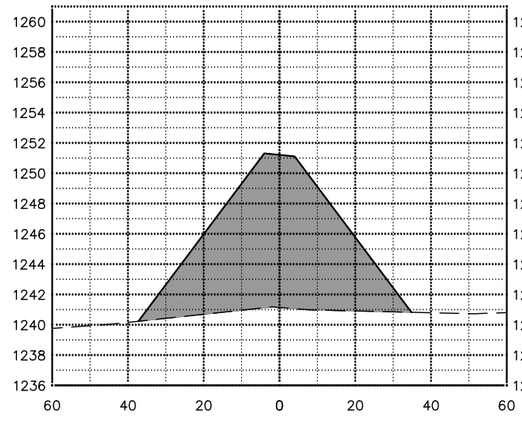


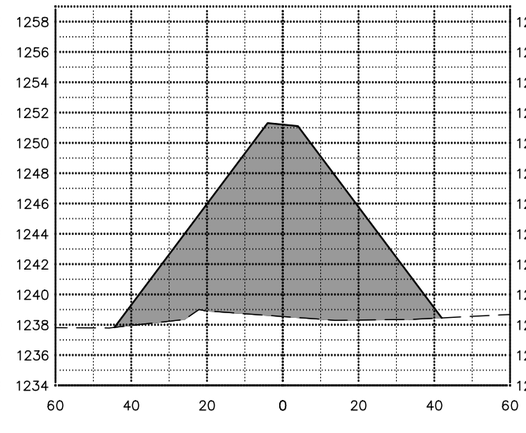












PRELIMINARY

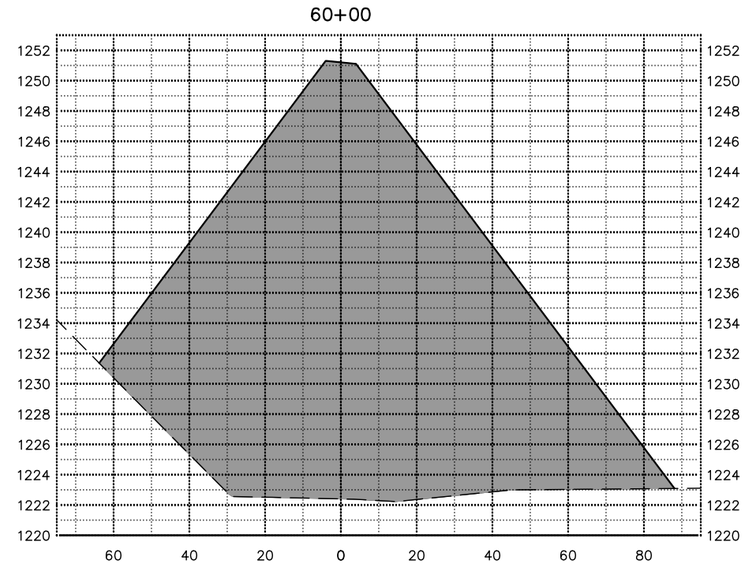
moore engineering, inc.

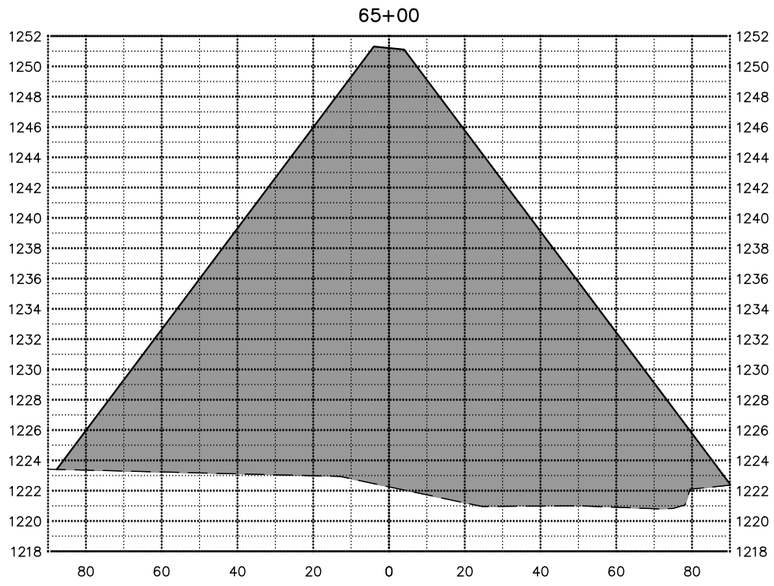
CROSS SECTIONS
RCPP/PL566 UPPER MAPLE RIVER WATERSHED ALTERNATIVE 2A
CASS COUNTY JOINT WATER RESOURCE DISTRICT
BARNES COUNTY, NORTH DAKOTA
DAM EMBANKMENT

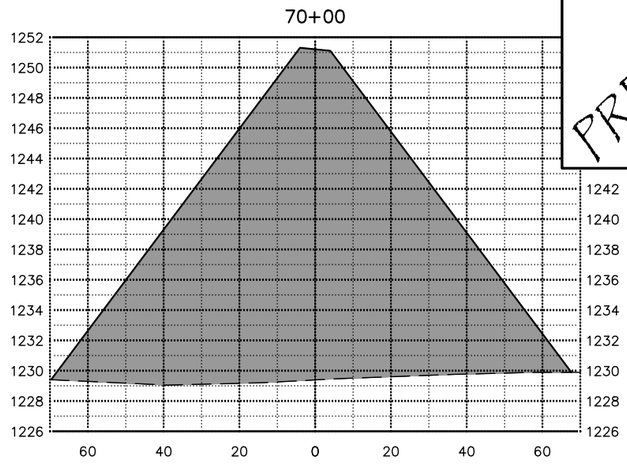
DATE:	02.13.25
REVISED:	----
REVISED:	----
REVISED:	----
REVISED:	----
REVISED:	----
RECORD:	----
PROJECT No.	18746
MANAGER:	KRL
DESIGNER:	ZJT
DRAFTER:	ZJT
REVIEWER:	JMH

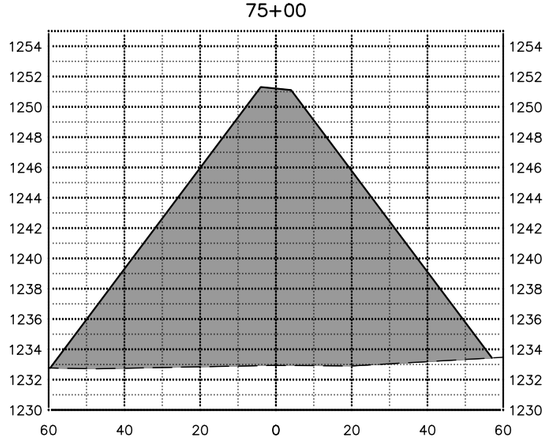
C-301

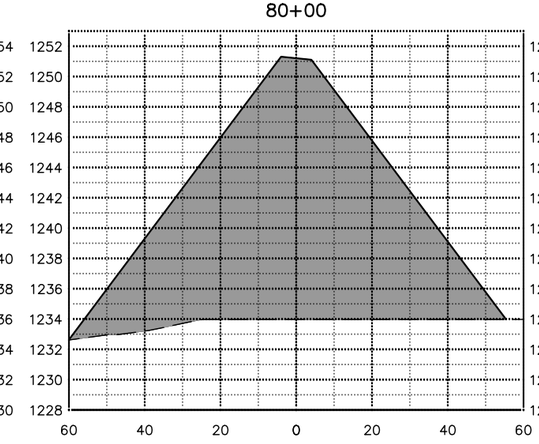
SHEET 21 OF 37

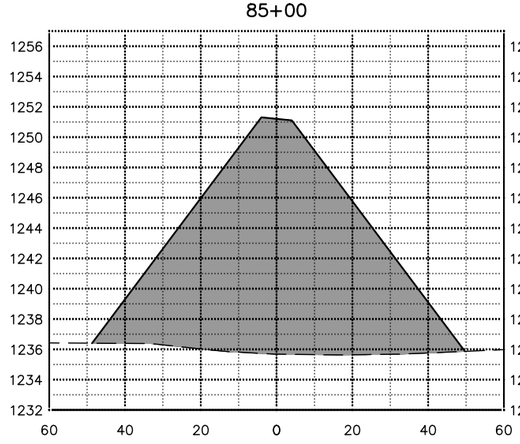


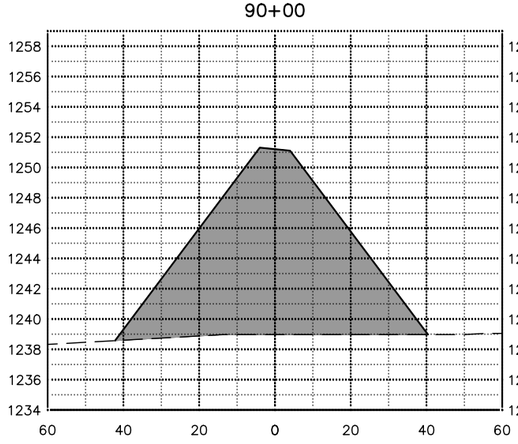


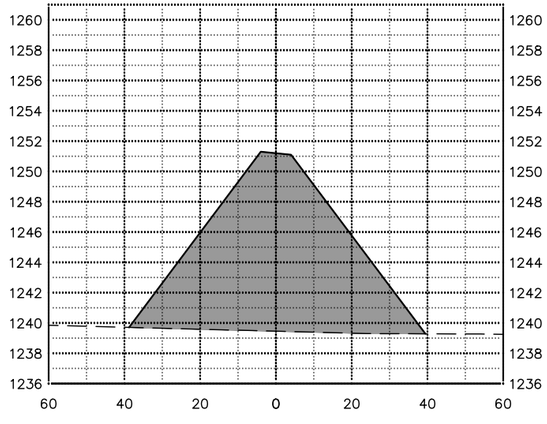


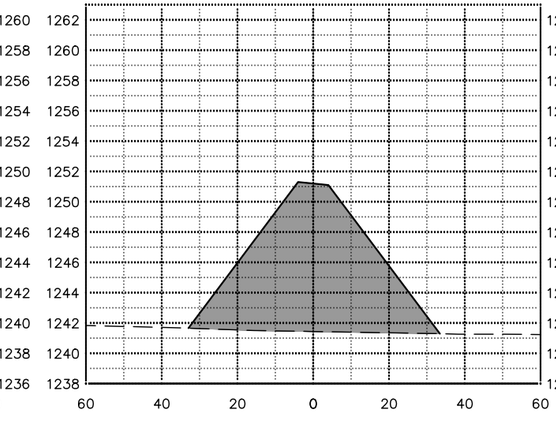


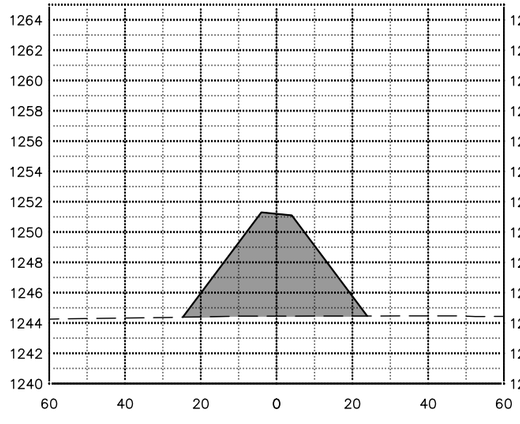


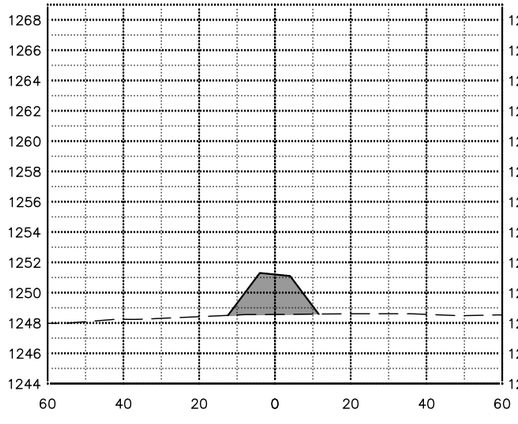












PRELIMINARY

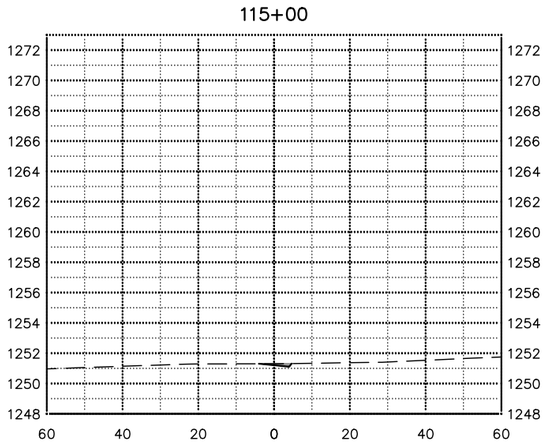
moore engineering, inc.

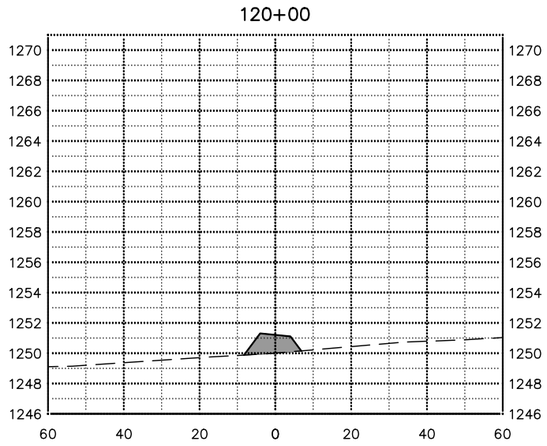
CROSS SECTIONS
RCPP/PL566 UPPER MAPLE RIVER WATERSHED ALTERNATIVE 2A
CASS COUNTY JOINT WATER RESOURCE DISTRICT
BARNES COUNTY, NORTH DAKOTA
DAM EMBANKMENT

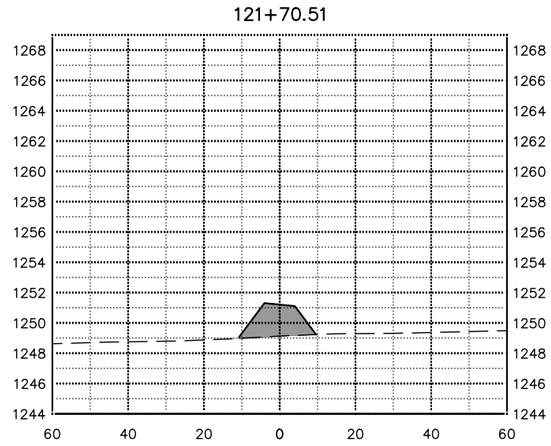
DATE:	02.13.25
REVISED:	----
REVISED:	----
REVISED:	----
REVISED:	----
REVISED:	----
RECORD:	----
PROJECT No.	18746
MANAGER:	KRL
DESIGNER:	ZJT
DRAFTER:	ZJT
REVIEWER:	JMH

C-302

SHEET 22 OF 37







EARTHWORK VOLUMES

Station	Cut Area (Ft^2)	Fill Area (Ft^2)	Cut Vol (Yd^3)	Fill Vol (Yd^3)	Total Cut (Yd^3)	Total Fill (Yd^3)
0+88.44	18.54	1.27	0.00	0.00	0.00	0.00
5+00	0.00	105.08	141.28	810.58	141.28	810.58
10+00	0.00	69.47	0.00	1617.13	141.28	2427.71
15+00	0.00	127.15	0.00	1820.55	141.28	4248.26
20+00	0.00	79.79	0.00	1916.11	141.28	6164.37
25+00	0.00	301.30	0.00	3528.61	141.28	9692.98
30+00	0.00	292.46	0.00	5497.82	141.28	15190.79
35+00	0.00	278.07	0.00	5282.72	141.28	20473.52
40+00	0.00	155.02	0.00	4010.12	141.28	24483.64
45+00	0.00	883.91	0.00	9619.78	141.28	34103.42
50+00	0.00	405.49	0.00	11938.94	141.28	46042.36
55+00	0.00	592.15	0.00	9237.43	141.28	55279.79
60+00	0.00	2404.07	0.00	27742.80	141.28	83022.59
65+00	0.00	2758.75	0.00	47470.96	141.28	130493.55
70+00	0.00	1593.51	0.00	40298.72	141.28	170792.27
75+00	0.00	1146.04	0.00	25405.46	141.28	196197.72
80+00	0.00	1052.82	0.00	20359.75	141.28	216557.47
85+00	0.00	824.58	0.00	17383.28	141.28	233940.75
90+00	0.00	552.16	0.00	12747.56	141.28	246688.32
95+00	0.00	507.25	0.00	9809.36	141.28	256497.68
100+00	0.00	363.49	0.00	8062.46	141.28	264560.14
105+00	0.00	191.16	0.00	5135.67	141.28	269695.81
110+00	0.00	42.06	0.00	2159.47	141.28	271855.28
115+00	0.89	0.00	8.30	388.99	149.57	272244.27
120+00	0.00	13.93	8.26	129.01	157.83	272373.28
121+70.51	0.00	29.82	0.00	138.15	157.83	272511.43

PRELIMINARY

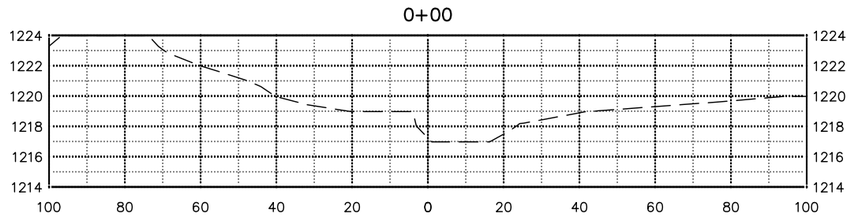
moore engineering, inc.

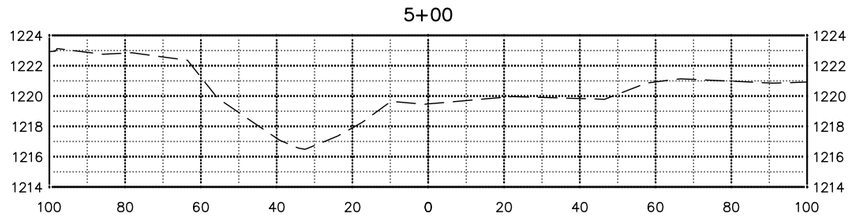
CROSS SECTIONS
RCPP/PL566 UPPER MAPLE RIVER WATERSHED ALTERNATIVE 2A
CASS COUNTY JOINT WATER RESOURCE DISTRICT
BARNES COUNTY, NORTH DAKOTA
DAM EMBANKMENT

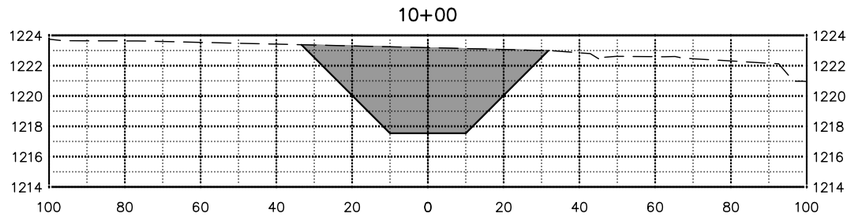
DATE:	02.13.25
REVISED:	----
REVISED:	----
REVISED:	----
REVISED:	----
REVISED:	----
RECORD:	----
PROJECT No.	18746
MANAGER:	KRL
DESIGNER:	ZJT
DRAFTER:	ZJT
REVIEWER:	JMH

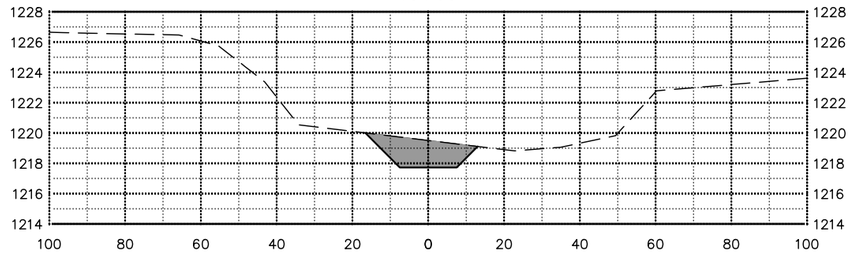
C-303

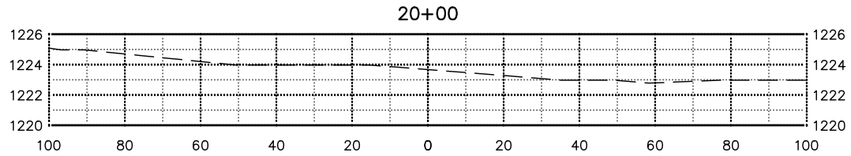
SHEET 23 OF 37

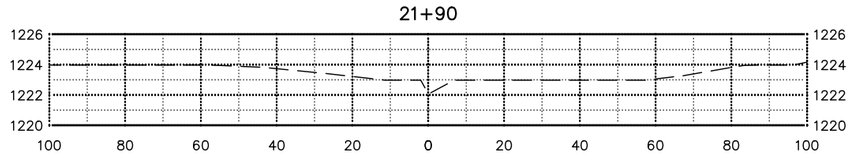












EARTHWORK VOLUMES

Station	Cut Area (Ft^2)	Fill Area (Ft^2)	Cut Vol (Yd^3)	Fill Vol (Yd^3)	Total Cut (Yd^3)	Total Fill (Yd^3)
0+00	0.00	0.00	0.00	0.00	0.00	0.00
5+00	0.00	0.00	0.00	0.00	0.00	0.00
10+00	240.61	0.00	2227.02	0.00	2227.02	0.00
15+00	40.13	0.00	2596.01	0.00	4823.03	0.00
20+00	0.00	0.00	373.36	0.00	5196.39	0.00
21+90	0.00	0.00	0.00	0.00	5196.39	0.00

PRELIMINARY

moore engineering, inc.

CROSS SECTIONS
RCPP/PL566 UPPER MAPLE RIVER WATERSHED ALTERNATIVE 2A
CASS COUNTY JOINT WATER RESOURCE DISTRICT
BARNES COUNTY, NORTH DAKOTA
PRIMARY SPILLWAY

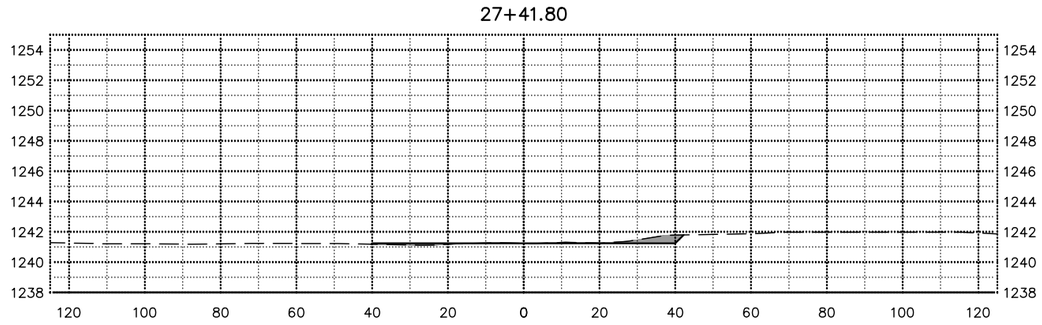
DATE:	02.13.25
REVISED:	----
REVISED:	----
REVISED:	----
REVISED:	----
REVISED:	----
RECORD:	----
PROJECT No.	18746
MANAGER:	KRL
DESIGNER:	ZJT
DRAFTER:	ZJT
REVIEWER:	JMH

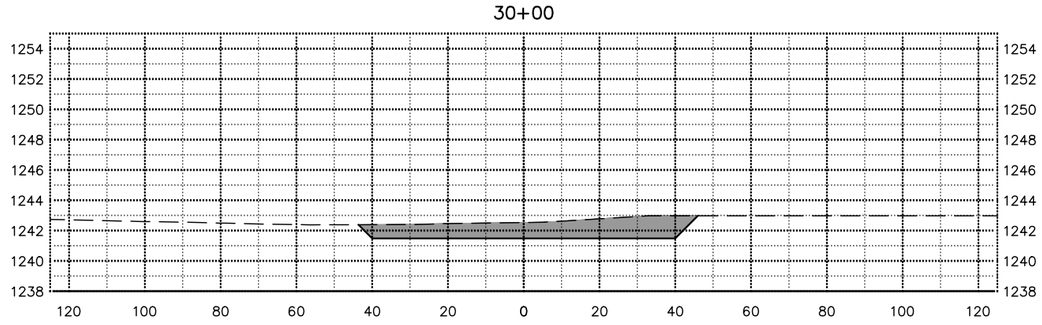
C-304

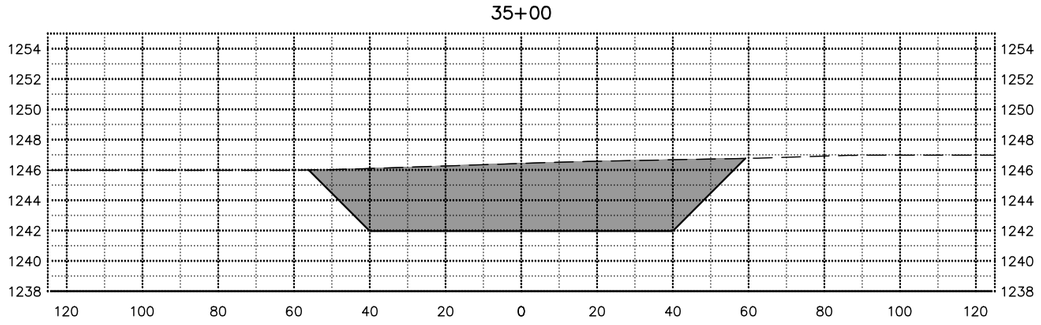
SHEET 24 OF 37

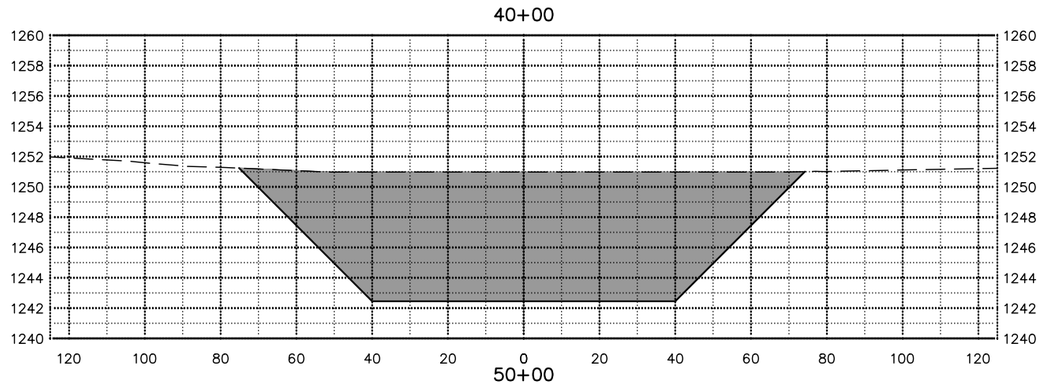
FILE LOCATION: R:\Projects\18000\18700\18746\DRAWINGS\DESIGN\18746-ALT-2A-PP.dwg

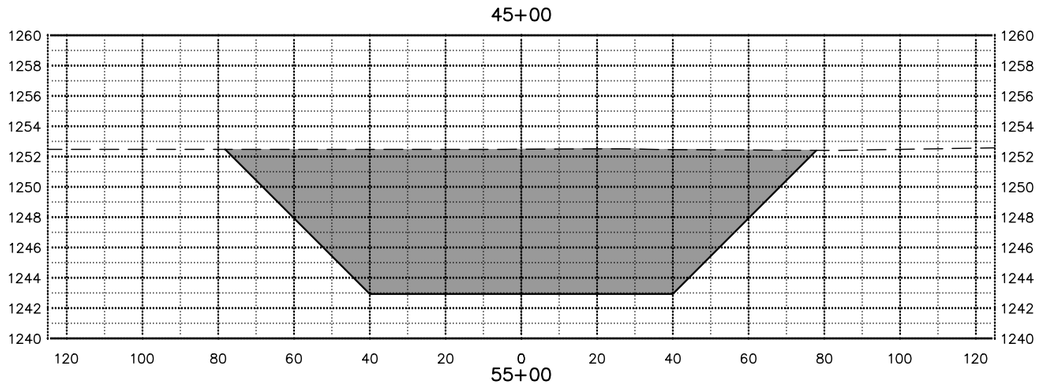
PRELIMINARY

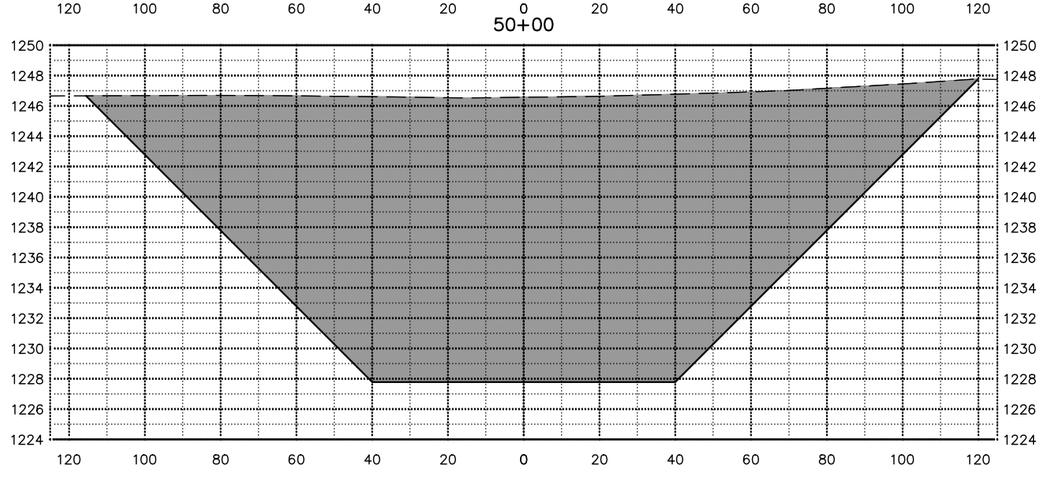


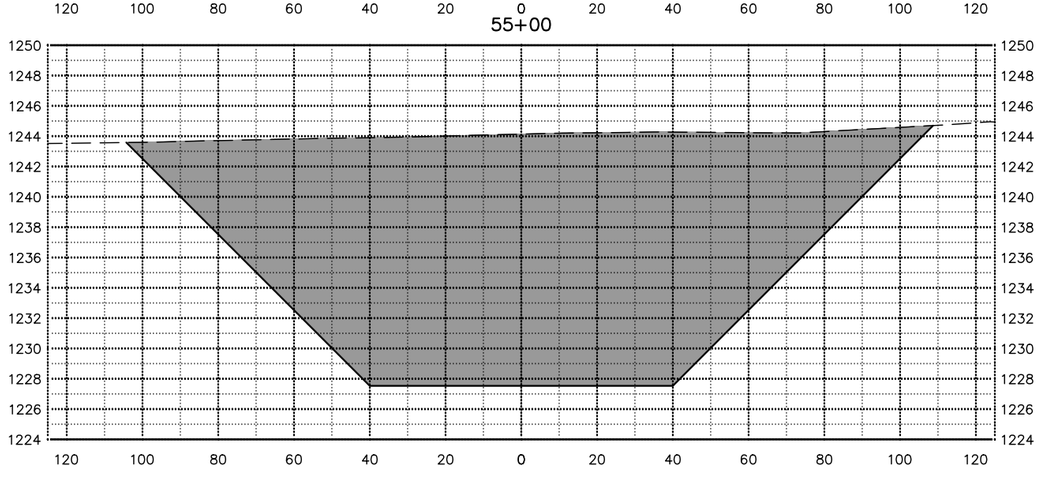












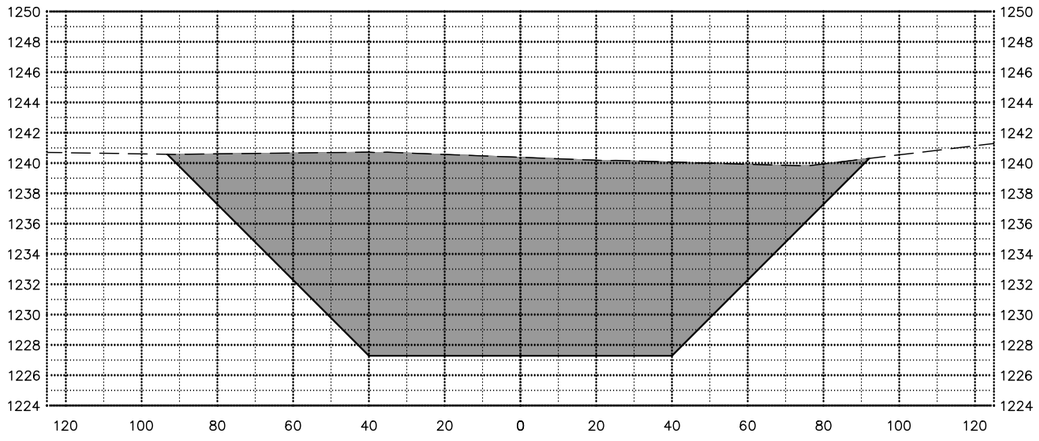
moore engineering, inc.

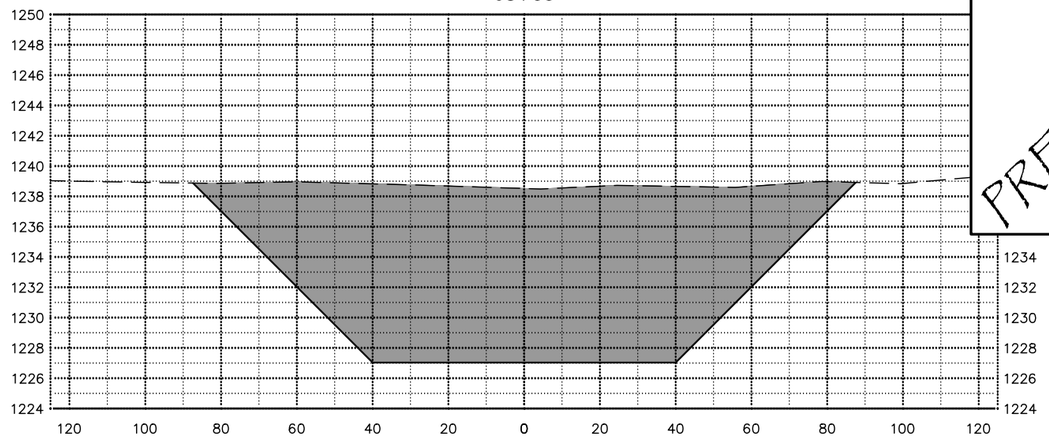
CROSS SECTIONS
RCPP/PL566 UPPER MAPLE RIVER WATERSHED ALTERNATIVE 2A
CASS COUNTY JOINT WATER RESOURCE DISTRICT
BARNES COUNTY, NORTH DAKOTA
EMERGENCY SPILLWAY

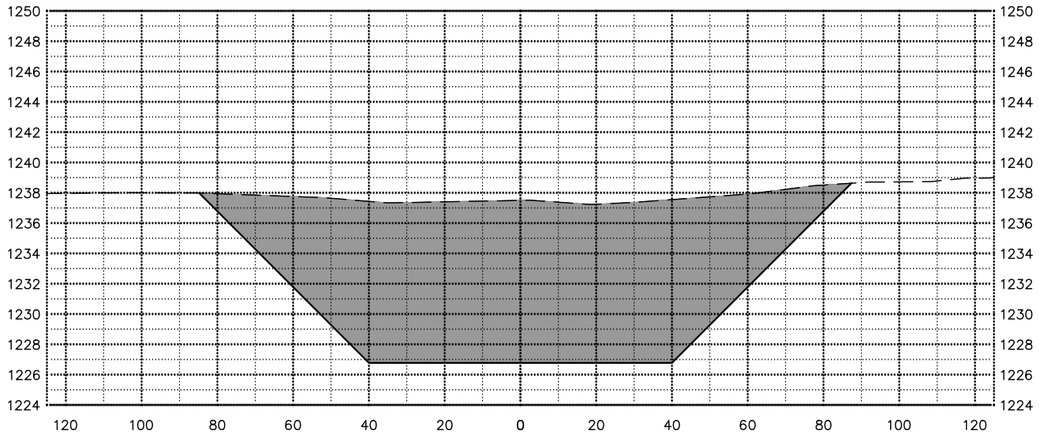
DATE:	02.13.25
REVISED:	----
REVISED:	----
REVISED:	----
REVISED:	----
REVISED:	----
RECORD:	----
PROJECT No.	18746
MANAGER:	KRL
DESIGNER:	ZJT
DRAFTER:	ZJT
REVIEWER:	JMH

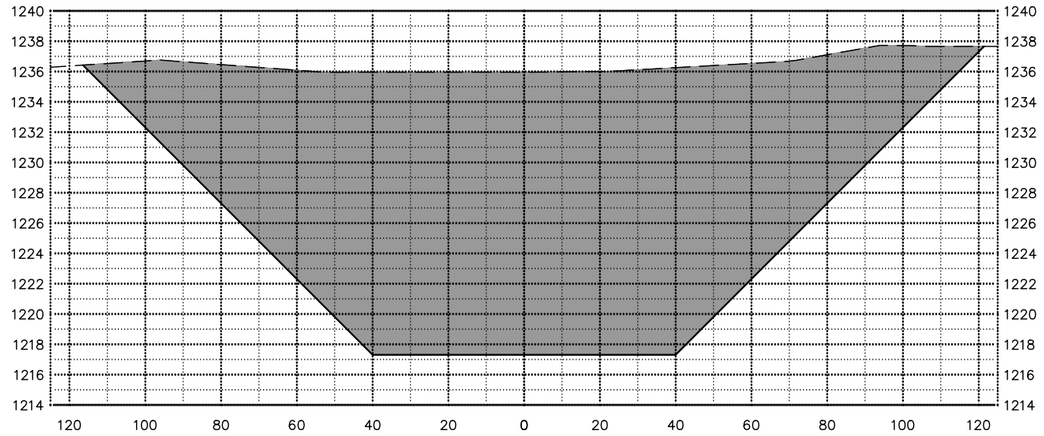
C-305

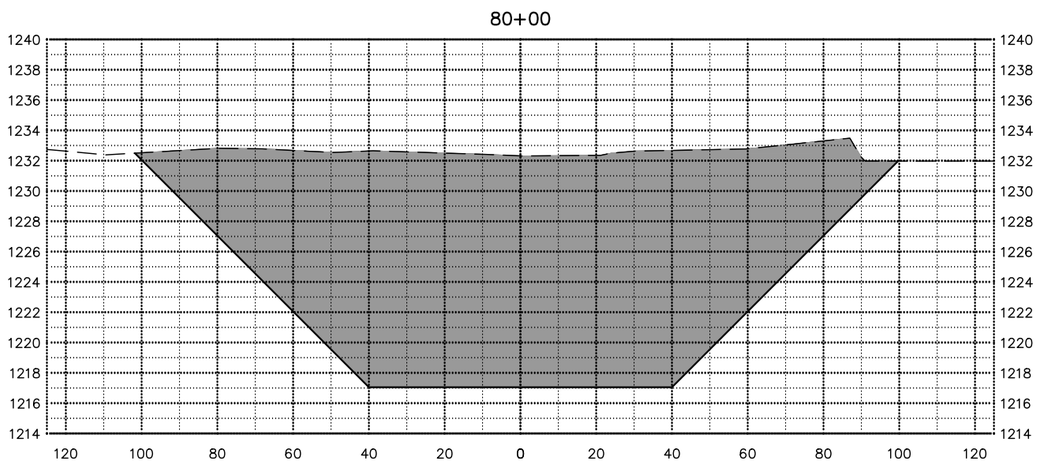
SHEET 25 OF 37

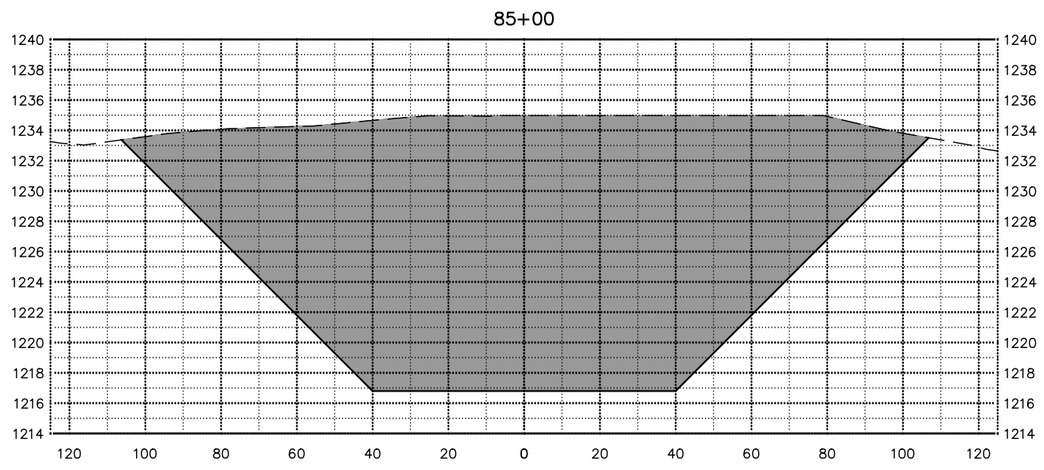












PRELIMINARY

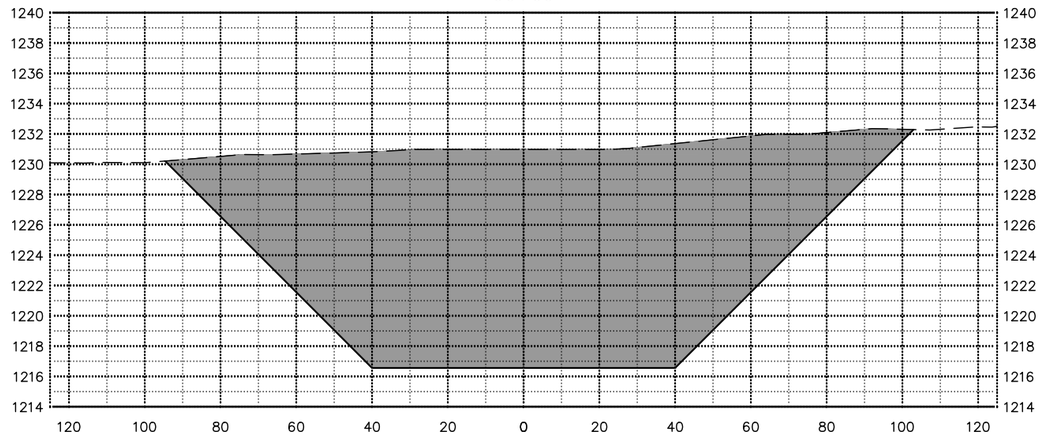
moore engineering, inc.

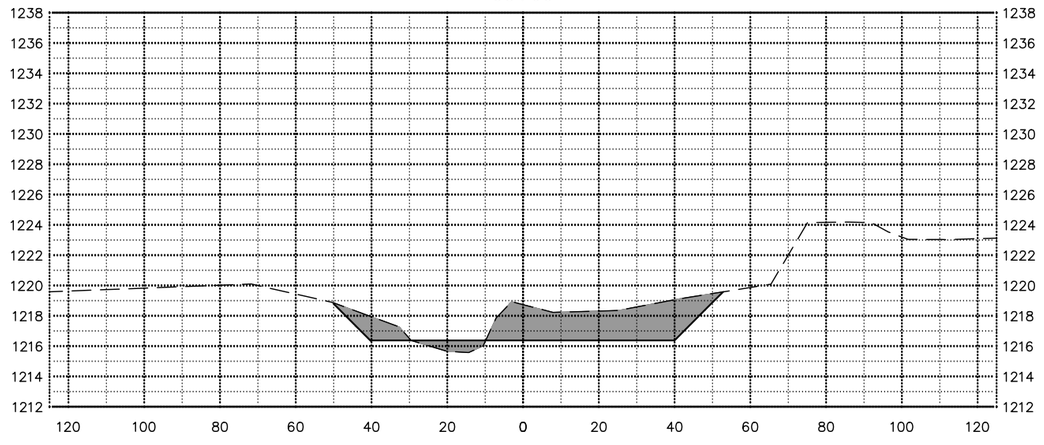
CROSS SECTIONS
RCPP/PL566 UPPER MAPLE RIVER WATERSHED ALTERNATIVE 2A
CASS COUNTY JOINT WATER RESOURCE DISTRICT
BARNES COUNTY, NORTH DAKOTA
EMERGENCY SPILLWAY

DATE:	02.13.25
REVISED:	----
REVISED:	----
REVISED:	----
REVISED:	----
REVISED:	----
RECORD:	----
PROJECT No.	18746
MANAGER:	KRL
DESIGNER:	ZJT
DRAFTER:	ZJT
REVIEWER:	JMH

C-306

SHEET 26 OF 37





EARTHWORK VOLUMES

Station	Cut Area (Ft^2)	Fill Area (Ft^2)	Cut Vol (Yd^3)	Fill Vol (Yd^3)	Total Cut (Yd^3)	Total Fill (Yd^3)
27+41.80	6.65	2.11	0.00	0.00	0.00	0.00
30+00	96.06	0.00	491.13	10.08	491.13	10.08
35+00	433.66	0.00	4904.82	0.00	5395.96	10.08
40+00	975.35	0.00	13047.96	0.00	18443.92	10.08
45+00	1126.69	0.00	19448.09	0.00	37892.01	10.08
50+00	2973.54	0.00	37978.90	0.00	75870.91	10.08
55+00	2419.33	0.00	49933.98	0.00	125804.89	10.08
60+00	1727.63	0.00	38397.74	0.00	164202.63	10.08
65+00	1486.46	0.00	29760.07	0.00	193962.70	10.08
70+00	1344.55	0.00	26213.05	0.00	220175.75	10.08
75+00	3002.78	0.00	40253.10	0.00	260428.86	10.08
80+00	2215.64	0.00	48318.72	0.00	308747.58	10.08
85+00	2681.66	0.00	45345.32	0.00	354092.89	10.08
90+00	2024.48	0.00	43575.37	0.00	397668.26	10.08
93+60	137.99	10.10	14416.51	67.31	412084.77	77.38

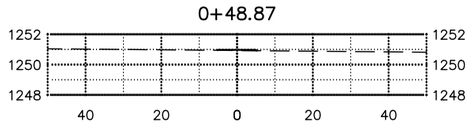
PRELIMINARY

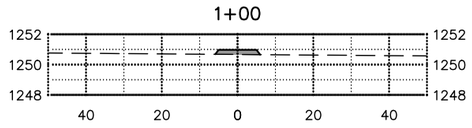
moore
engineering, inc.

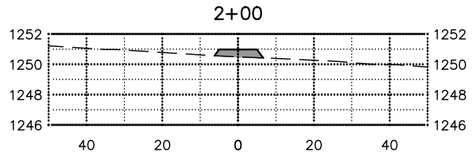
CROSS SECTIONS
RCPP/PL566 UPPER MAPLE RIVER WATERSHED ALTERNATIVE 2A
CASS COUNTY JOINT WATER RESOURCE DISTRICT
BARNES COUNTY, NORTH DAKOTA
EMERGENCY SPILLWAY

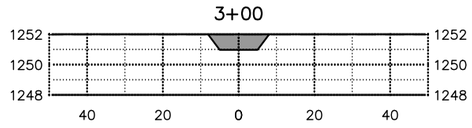
DATE:	02.13.25
REVISED:	----
REVISED:	----
REVISED:	----
REVISED:	----
REVISED:	----
RECORD:	----
PROJECT No.	18746
MANAGER:	KRL
DESIGNER:	ZJT
DRAFTER:	ZJT
REVIEWER:	JMH

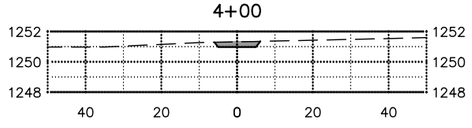
C-307

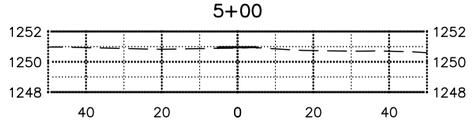


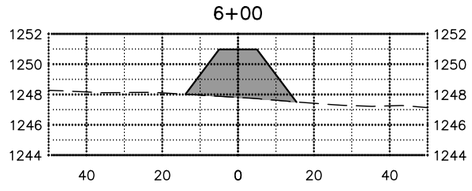


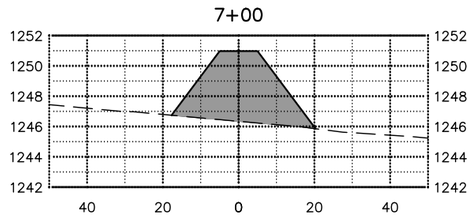


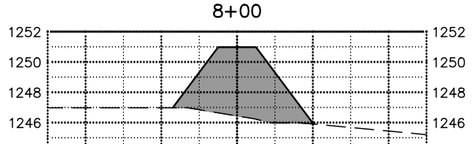


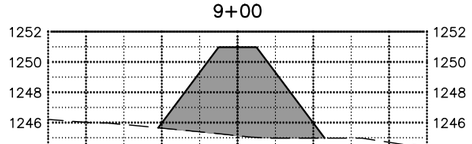


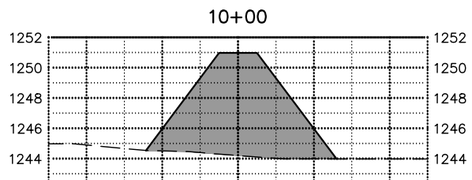


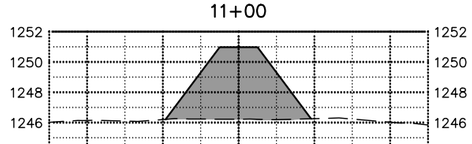


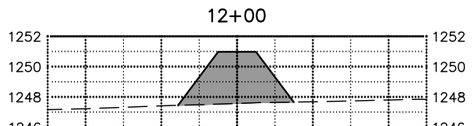


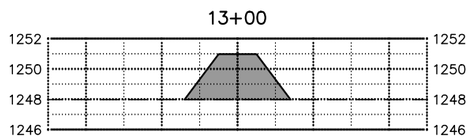


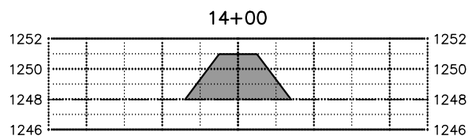


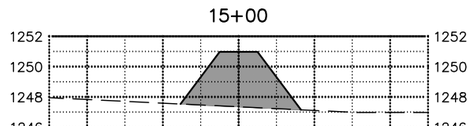


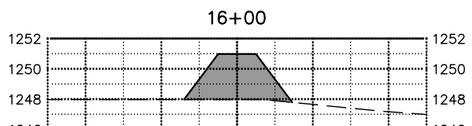


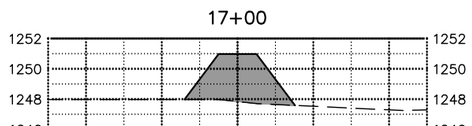


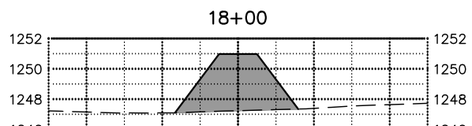


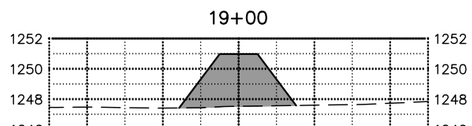


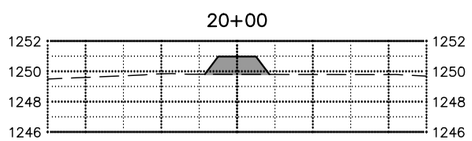


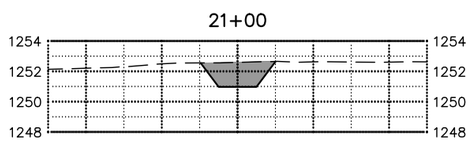


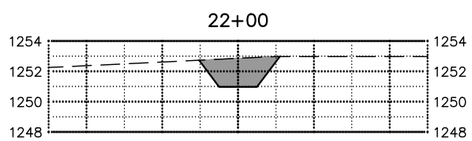


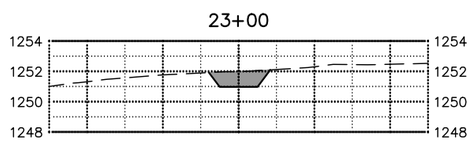












PRELIMINARY

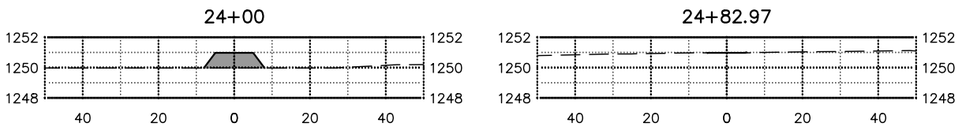
moore engineering, inc.

CROSS SECTIONS
RCPP/PL566 UPPER MAPLE RIVER WATERSHED ALTERNATIVE 2A
CASS COUNTY JOINT WATER RESOURCE DISTRICT
BARNES COUNTY, NORTH DAKOTA
FARM RING LEVEE

DATE:	02.13.25
REVISED:	----
REVISED:	----
REVISED:	----
REVISED:	----
REVISED:	----
RECORD:	----
PROJECT No.	18746
MANAGER:	KRL
DESIGNER:	ZJT
DRAFTER:	ZJT
REVIEWER:	JMH

C-308

SHEET 28 OF 37



EARTHWORK VOLUMES

Station	Cut Area (Ft^2)	Fill Area (Ft^2)	Cut Vol (Yd^3)	Fill Vol (Yd^3)	Total Cut (Yd^3)	Total Fill (Yd^3)
0+48.87	0.00	0.43	0.00	0.00	0.00	0.00
1+00	0.00	3.33	0.00	3.56	0.00	3.56
2+00	0.00	5.54	0.00	16.43	0.00	19.99
3+00	13.00	0.00	24.07	10.25	24.07	30.24
4+00	3.82	0.00	31.15	0.00	55.22	30.24
5+00	0.00	0.58	7.07	1.08	62.29	31.32
6+00	0.00	62.27	0.00	116.43	62.29	147.74
7+00	0.00	111.21	0.00	323.81	62.29	471.55
8+00	0.00	107.71	0.00	407.55	62.29	879.10
9+00	0.00	157.66	0.00	486.27	62.29	1365.37
10+00	0.00	204.47	0.00	667.96	62.29	2033.33
11+00	0.00	115.02	0.00	594.05	62.29	2627.38
12+00	0.00	69.14	0.00	340.84	62.29	2968.22
13+00	0.00	57.00	0.00	233.60	62.29	3201.82
14+00	0.00	57.00	0.00	211.11	62.29	3412.93
15+00	0.00	75.95	0.00	246.20	62.29	3659.13
16+00	0.00	57.67	0.00	247.44	62.29	3906.57
17+00	0.00	61.46	0.00	220.60	62.29	4127.17
18+00	0.00	79.56	0.00	261.15	62.29	4388.32
19+00	0.00	70.67	0.00	277.54	62.29	4665.86
20+00	0.00	15.85	0.00	160.08	62.29	4825.93
21+00	24.05	0.00	44.53	29.35	106.83	4855.29
22+00	29.48	0.00	99.12	0.00	205.95	4855.29
23+00	13.37	0.00	79.34	0.00	285.29	4855.29
24+00	0.00	13.00	24.76	24.07	310.05	4879.36
24+82.97	0.00	0.00	0.00	19.98	310.05	4899.34

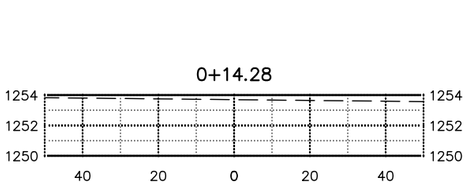
PRELIMINARY

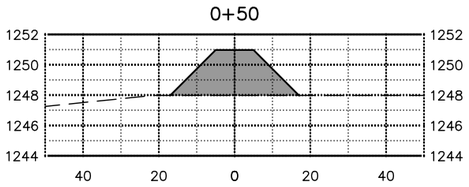
moore engineering, inc.

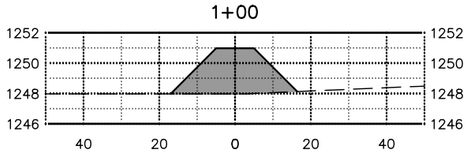
CROSS SECTIONS
RCPP/PL566 UPPER MAPLE RIVER WATERSHED ALTERNATIVE 2A
CASS COUNTY JOINT WATER RESOURCE DISTRICT
BARNES COUNTY, NORTH DAKOTA
FARM RING LEVEE

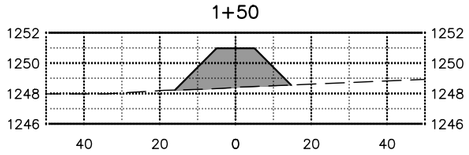
DATE:	02.13.25
REVISED:	----
REVISED:	----
REVISED:	----
REVISED:	----
REVISED:	----
RECORD:	----
PROJECT No.	18746
MANAGER:	KRL
DESIGNER:	ZJT
DRAFTER:	ZJT
REVIEWER:	JMH

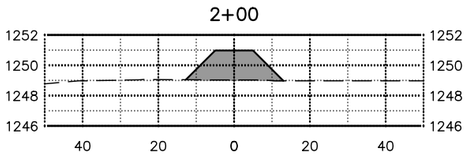
C-309

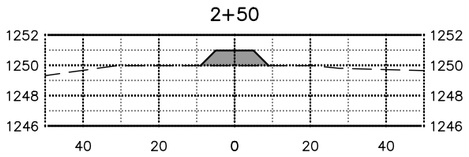


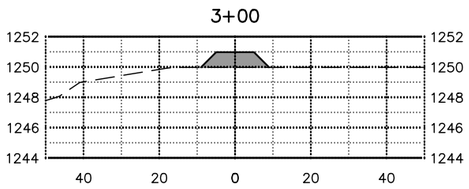


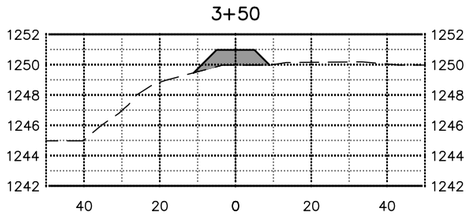


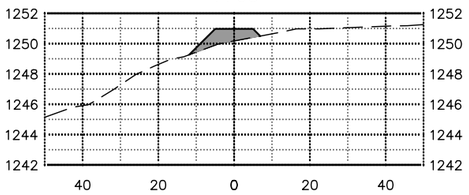


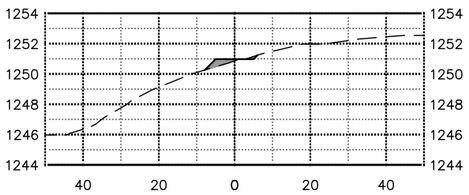


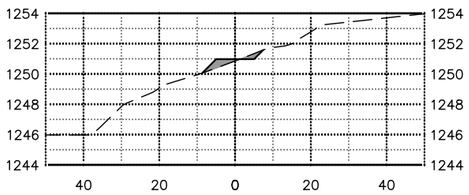


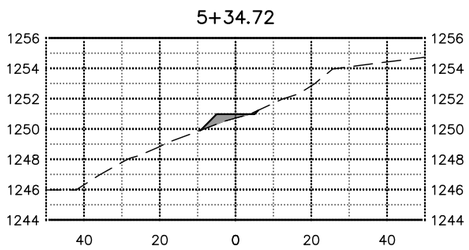












EARTHWORK VOLUMES

Station	Cut Area (Ft^2)	Fill Area (Ft^2)	Cut Vol (Yd^3)	Fill Vol (Yd^3)	Total Cut (Yd^3)	Total Fill (Yd^3)
0+14.28	0.00	0.00	0.00	0.00	0.00	0.00
0+50	0.00	66.00	0.00	43.66	0.00	43.66
1+00	0.00	64.97	0.00	121.27	0.00	164.93
1+50	0.00	52.67	0.00	108.92	0.00	273.85
2+00	0.00	34.74	0.00	80.93	0.00	354.79
2+50	0.00	14.00	0.00	45.13	0.00	399.91
3+00	0.00	14.00	0.00	25.93	0.00	425.84
3+50	0.00	15.47	0.00	27.29	0.00	453.13
4+00	0.00	12.24	0.00	25.66	0.00	478.78
4+50	0.27	2.35	0.25	13.50	0.25	492.29
5+00	1.10	2.92	1.27	4.87	1.52	497.16
5+34.72	0.15	4.09	0.81	4.51	2.33	501.67

PRELIMINARY

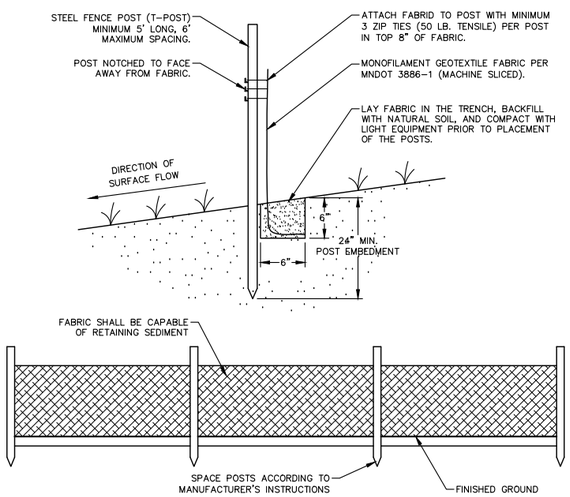
moore engineering, inc.

CROSS SECTIONS
RCPP/PL566 UPPER MAPLE RIVER WATERSHED ALTERNATIVE 2A
CASS COUNTY JOINT WATER RESOURCE DISTRICT
BARNES COUNTY, NORTH DAKOTA
FARM LEVEE

DATE:	02.13.25
REVISED:	----
REVISED:	----
REVISED:	----
REVISED:	----
REVISED:	----
RECORD:	----
PROJECT No.	18746
MANAGER:	KRL
DESIGNER:	ZJT
DRAFTER:	ZJT
REVIEWER:	JMH

C-310

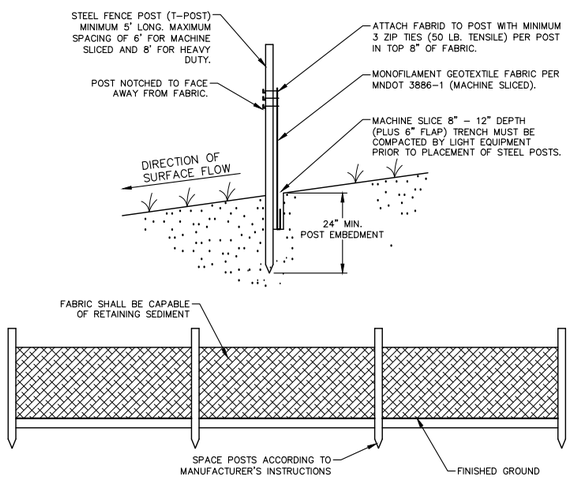
SHEET 30 OF 37



STANDARD SILT FENCE DETAIL

NO SCALE *WRG-312500-01 02.15.17*

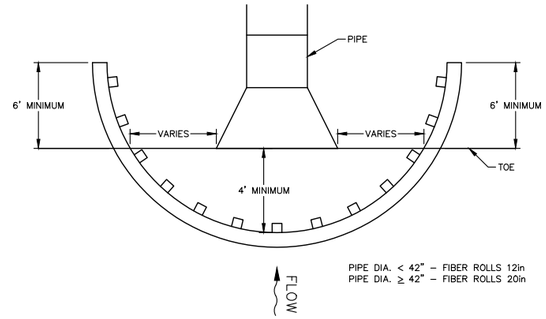
NOTES:
1. INSPECT AND REPAIR AFTER EACH STORM EVENT, AND REMOVE SEDIMENT WHEN NECESSARY.
2. REMOVED SEDIMENTS SHALL BE DEPOSITED IN AN AREA THAT WILL NOT CONTRIBUTE SEDIMENT OFF-SITE AND CAN BE PERMANENTLY STABILIZED.



MACHINED SILT FENCE DETAIL

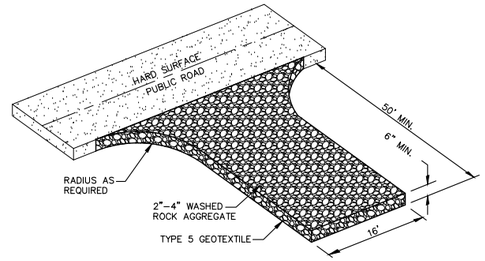
NO SCALE *WRG-312500-02 12.15.17*

NOTES:
1. INSPECT AND REPAIR AFTER EACH STORM EVENT, AND REMOVE SEDIMENT WHEN NECESSARY.
2. REMOVED SEDIMENTS SHALL BE DEPOSITED IN AN AREA THAT WILL NOT CONTRIBUTE SEDIMENT OFF-SITE AND CAN BE PERMANENTLY STABILIZED.



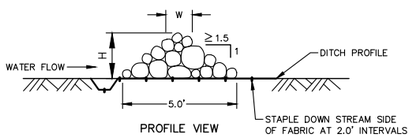
FIBER ROLL PROTECTION INLET OF PIPE END

NO SCALE *WRG-312500-03 02.15.17*



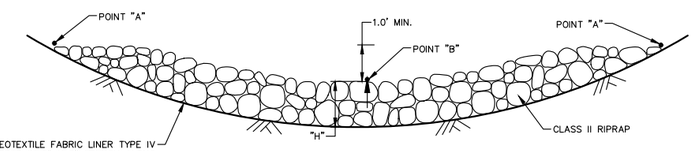
TEMPORARY ROCK - SITE ENTRANCE

NO SCALE *WRG-312500-04 02.15.17*



NOTES:
1. ROCK DITCH CHEK SHALL BE REMOVED FROM CLEAR ZONE AFTER SEEDING OR TURF IS ESTABLISHED AND PRIOR TO FINAL ACCEPTANCE.
2. POINT "A" MUST BE 1'-0" MIN. HIGHER THAN POINT "B" TO ENSURE THAT WATER FLOWS OVER THE CHECK AND NOT AROUND THE ENDS.

HEIGHT OF CHECK (H)	CLASS RIPRAP	TOP WIDTH (W)
2'-0"	II	12"-18"



CROSS SECTION

TEMPORARY ROCK CHECK DETAIL

NO SCALE *WRG-312500-05 02.15.17*

PRELIMINARY

moore engineering, inc.

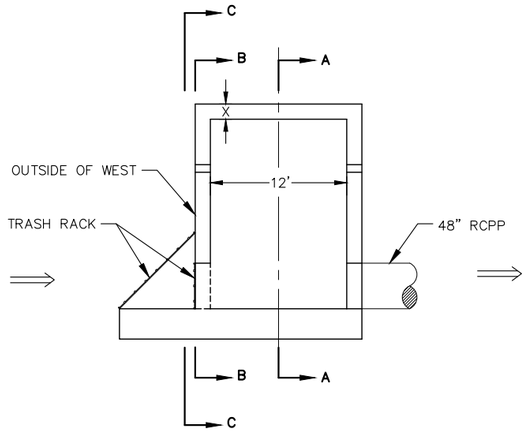
EROSION CONTROL DETAILS
RCPP/PL566 UPPER MAPLE RIVER WATERSHED ALTERNATIVE 2A
CASS COUNTY JOINT WATER RESOURCE DISTRICT
BARNES COUNTY, NORTH DAKOTA
EROSION CONTROL DETAILS

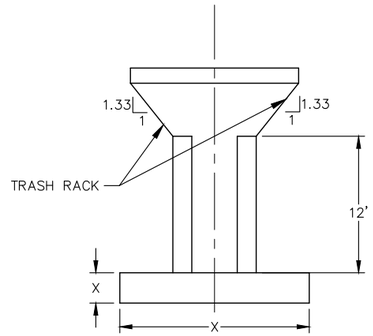
DATE:	05.25.23
REVISED:	----
REVISED:	----
REVISED:	----
REVISED:	----
REVISED:	----
RECORD:	----
PROJECT No.	18746
MANAGER:	KRL
DESIGNER:	ZJT
DRAFTER:	ZJT
REVIEWER:	JMH

C-501

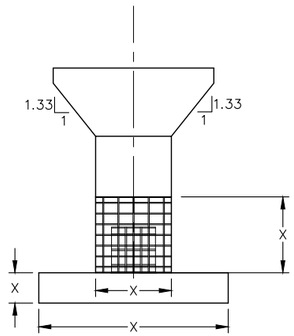
SHEET 31 OF 39

PRELIMINARY

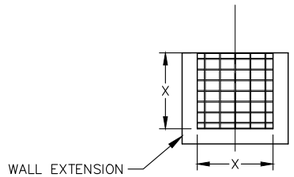




SECTION A–A



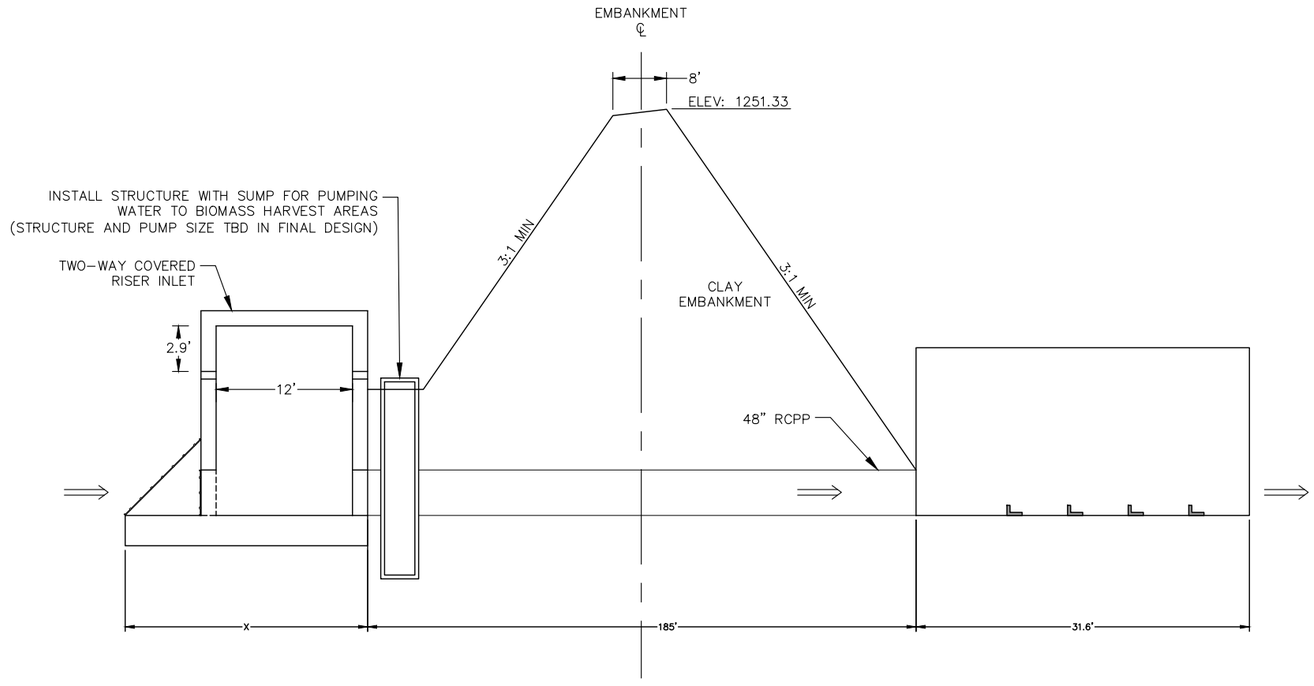
SECTION B–B



SECTION C–C

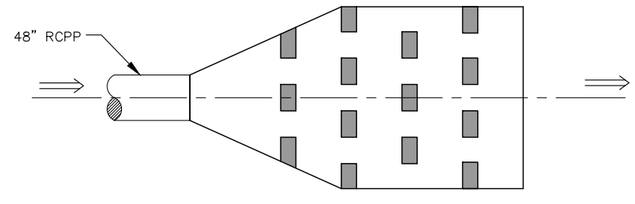
TWO-WAY COVERED RISER

NO SCALE

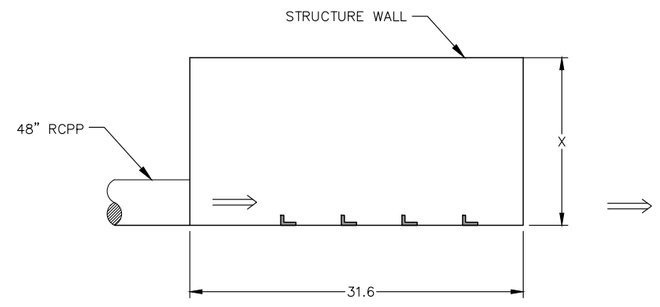


PRIMARY SPILLWAY STRUCTURE

NO SCALE



PLAN



SIDE

PRIMARY SPILLWAY OUTLET

NO SCALE

NOTES:
1. MEASUREMENTS DENOTED WITH "X" TO BE DETERMINED IN CONJUNCTION WITH STRUCTURAL AND GEOTECH DURING FINAL DESIGN.

moore engineering, inc.

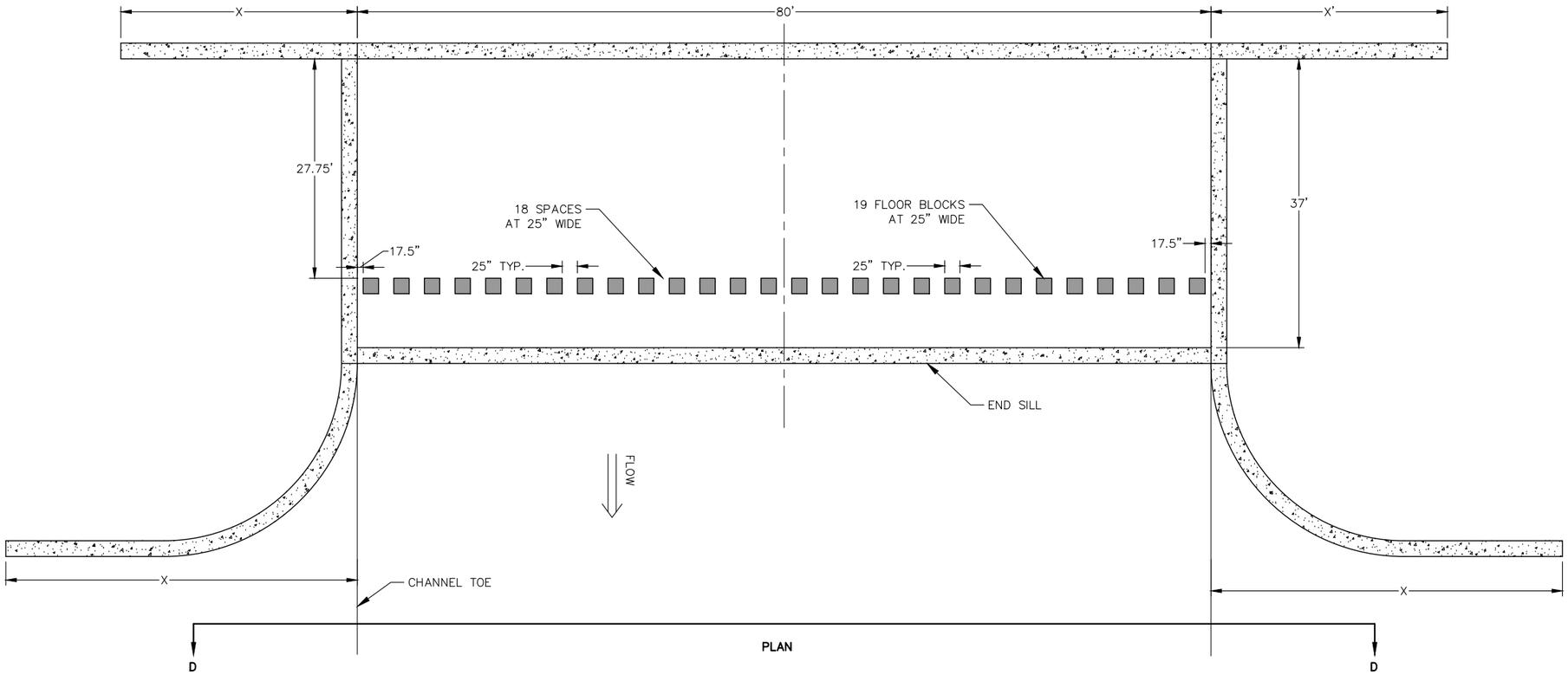
PRIMARY SPILLWAY OUTLET STRUCTURE DETAIL
RCPP/PL566 UPPER MAPLE RIVER WATERSHED ALTERNATIVE 2A
CASS COUNTY JOINT WATER RESOURCE DISTRICT
BARNES COUNTY, NORTH DAKOTA
PRIMARY SPILLWAY OUTLET STRUCTURE DETAIL

DATE:	05.25.23
REVISED:	----
REVISED:	----
REVISED:	----
REVISED:	----
REVISED:	----
RECORD:	----
PROJECT No.	18746
MANAGER:	KRL
DESIGNER:	ZJT
DRAFTER:	ZJT
REVIEWER:	JMH

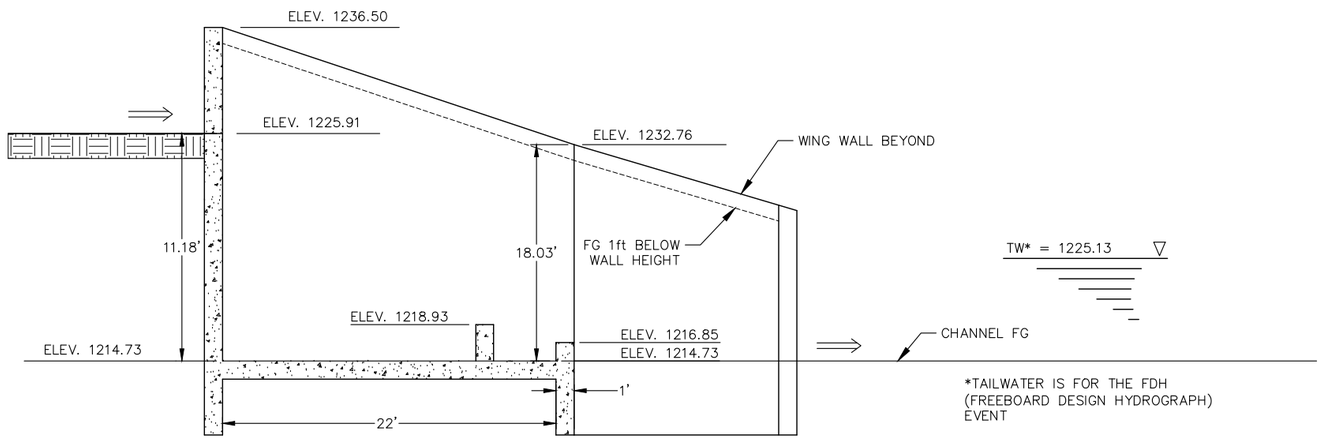
C-502

SHEET 32 OF 39

PRELIMINARY



PLAN



SECTION AT CENTER LINE

NOTES:
1. MEASUREMENTS DENOTED WITH "X" TO BE DETERMINED IN CONJUNCTION WITH STRUCTURAL AND GEOTECH DURING FINAL DESIGN.

DOWNSTREAM DROP STRUCTURE (EMERGENCY SPILLWAY)

NO SCALE

moore engineering, inc.

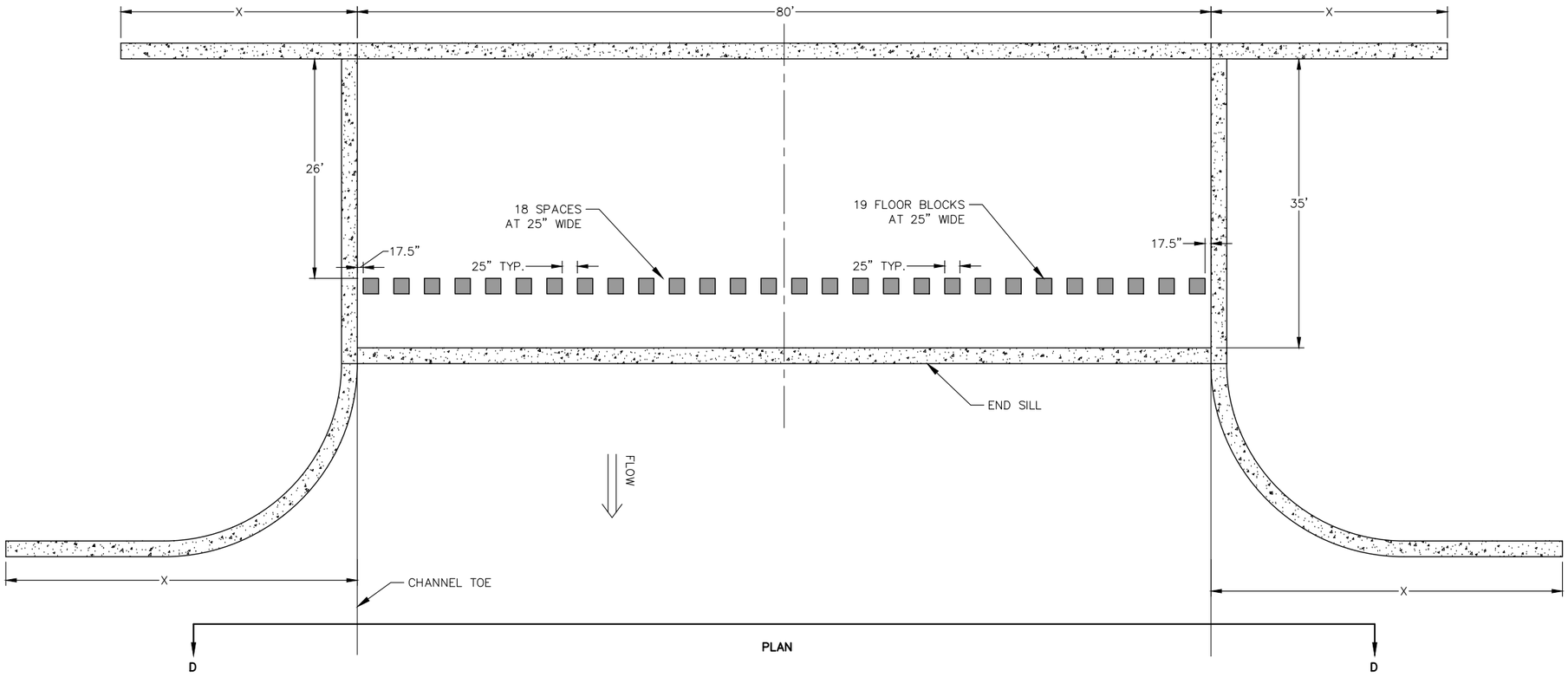
DOWNSTREAM DROP STRUCTURE DETAIL
RCPP/PL566 UPPER MAPLE RIVER WATERSHED ALTERNATIVE 2A
CASS COUNTY JOINT WATER RESOURCE DISTRICT
BARNES COUNTY, NORTH DAKOTA
DOWNSTREAM DROP STRUCTURE DETAILS

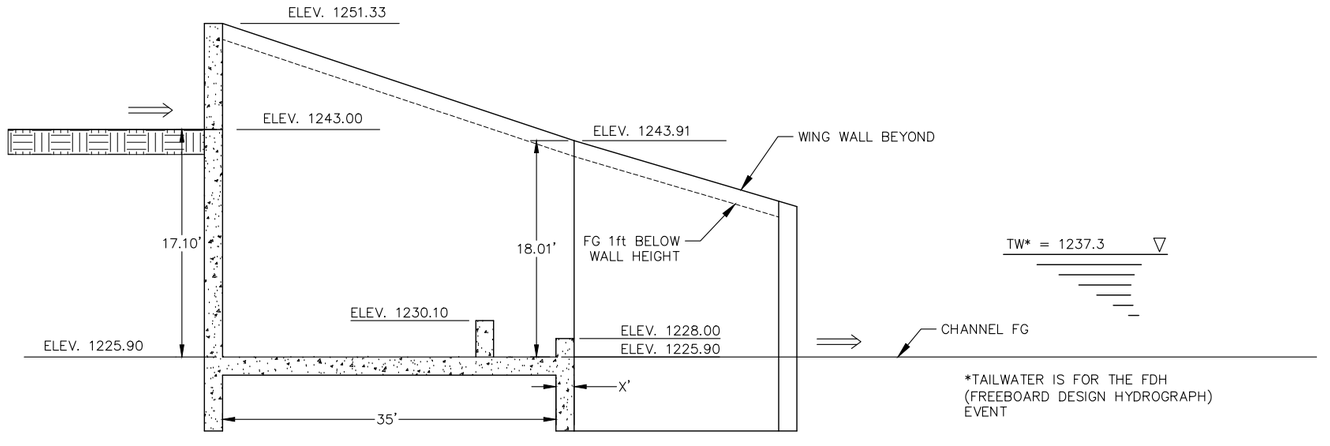
DATE:	05.25.23
REVISED:	----
REVISED:	----
REVISED:	----
REVISED:	----
REVISED:	----
RECORD:	----
PROJECT No.	18746
MANAGER:	KRL
DESIGNER:	ZJT
DRAFTER:	ZJT
REVIEWER:	JMH

C-503

SHEET 33 OF 39

PRELIMINARY





SECTION AT CENTER LINE

NOTES:
1. MEASUREMENTS DENOTED WITH "X" TO BE DETERMINED IN CONJUNCTION WITH STRUCTURAL AND GEOTECH DURING FINAL DESIGN.

UPSTREAM DROP STRUCTURE (EMERGENCY SPILLWAY)

NO SCALE

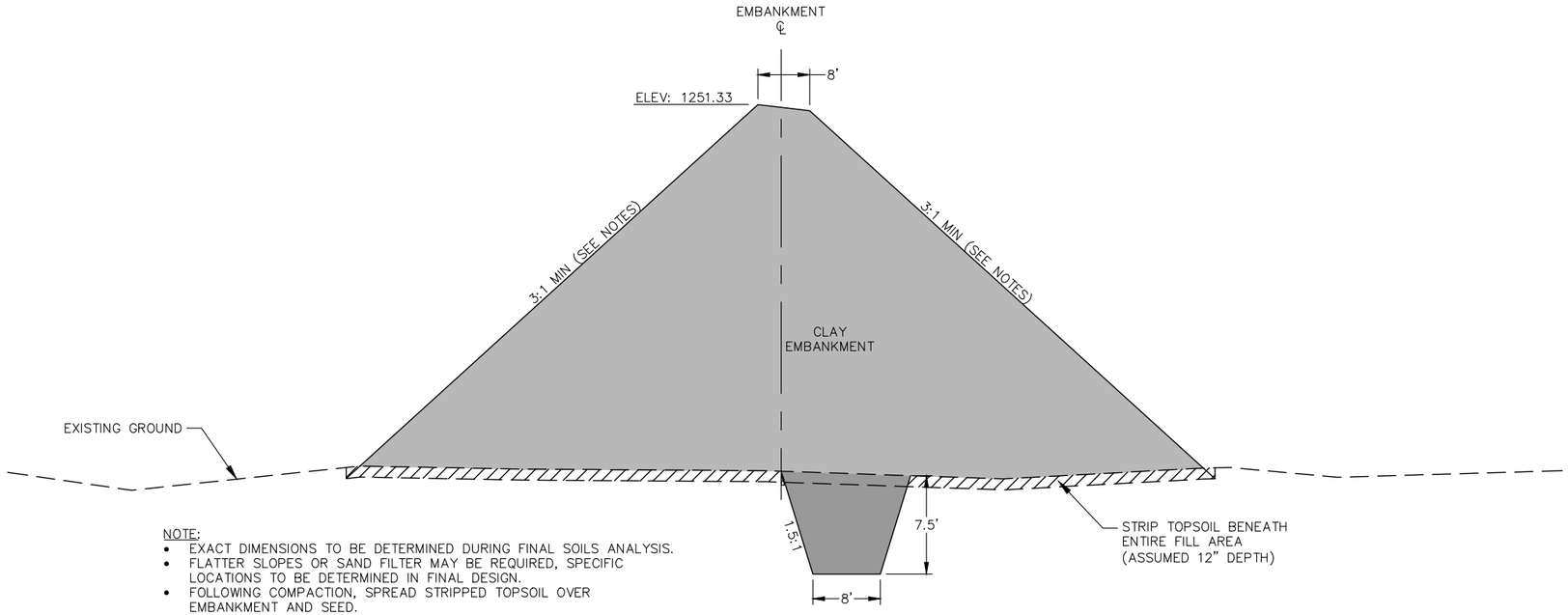
moore engineering, inc.

UPSTREAM DROP STRUCTURE DETAIL
RCPP/PL566 UPPER MAPLE RIVER WATERSHED ALTERNATIVE 2A
CASS COUNTY JOINT WATER RESOURCE DISTRICT
BARNES COUNTY, NORTH DAKOTA
UPSTREAM DROP STRUCTURE DETAIL

DATE:	05.25.23
REVISED:	----
REVISED:	----
REVISED:	----
REVISED:	----
REVISED:	----
RECORD:	----
PROJECT No.	18746
MANAGER:	KRL
DESIGNER:	ZJT
DRAFTER:	ZJT
REVIEWER:	JMH

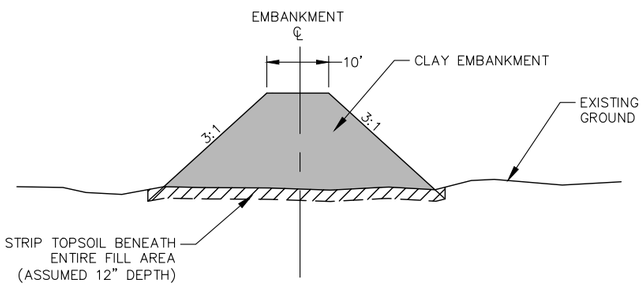
C-504

SHEET 34 OF 39



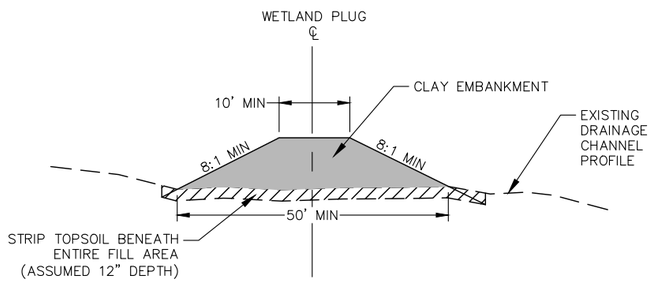
NOTE:
- EXACT DIMENSIONS TO BE DETERMINED DURING FINAL SOILS ANALYSIS.
- FLATTER SLOPES OR SAND FILTER MAY BE REQUIRED, SPECIFIC LOCATIONS TO BE DETERMINED IN FINAL DESIGN.
- FOLLOWING COMPACTION, SPREAD STRIPPED TOPSOIL OVER EMBANKMENT AND SEED.

TYPICAL DAM EMBANKMENT CROSS SECTIONS
NO SCALE



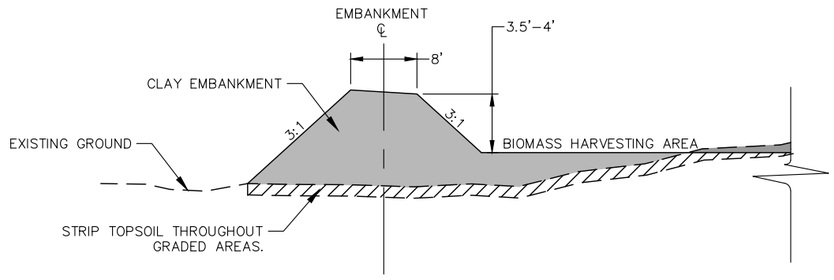
NOTE:
SEE PLAN AND PROFILE SHEETS FOR ELEVATIONS

FARM LEVEE TYPICAL SECTION
NO SCALE



NOTE:
HEIGHT VARIES, SEE WETLAND RESTORATION SHEET FOR ELEVATION INFORMATION.

WETLAND PLUG DETAIL
NO SCALE



NOTE:
SEE PROFILES FOR ELEVATION INFORMATION.

TYPICAL BIOMASS HARVEST AREA EMBANKMENT CROSS SECTIONS
NO SCALE

PRELIMINARY

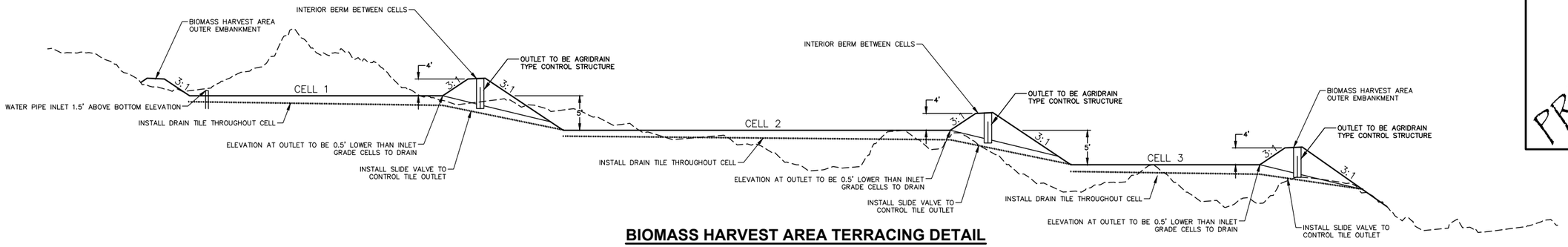
moore engineering, inc.

TYPICAL DAM EMBANKMENT SECTION
RCPP/PL566 UPPER MAPLE RIVER WATERSHED ALTERNATIVE 2A
CASS COUNTY JOINT WATER RESOURCE DISTRICT
BARNES COUNTY, NORTH DAKOTA
TYPICAL EMBANKMENT SECTIONS

DATE:	05.25.23
REVISED:	----
REVISED:	----
REVISED:	----
REVISED:	----
REVISED:	----
RECORD:	----
PROJECT No.	18746
MANAGER:	KRL
DESIGNER:	ZJT
DRAFTER:	ZJT
REVIEWER:	JMH

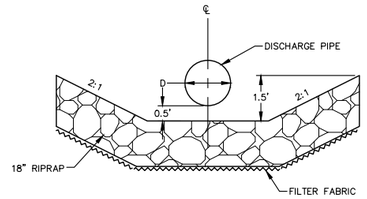
C-505

SHEET 35 OF 39

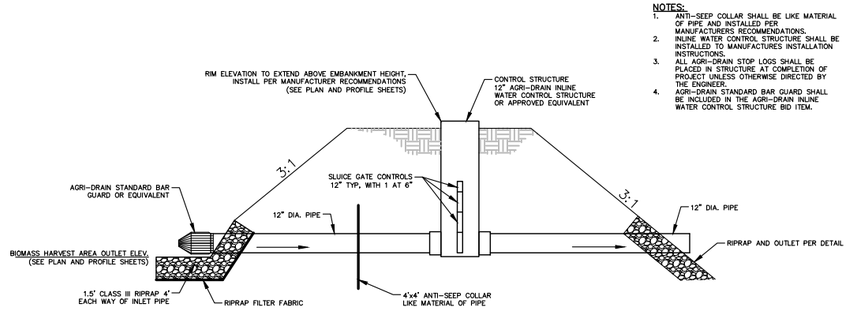


BIOMASS HARVEST AREA TERRACING DETAIL

NO SCALE

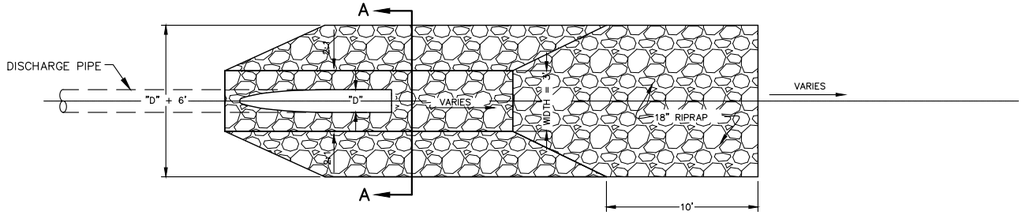


SECTION A–A

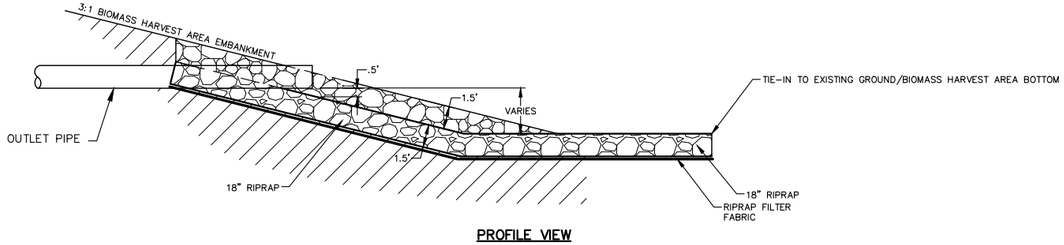


BIOMASS HARVEST AREA CONTROL STRUCTURE

NO SCALE



PLAN VIEW



PROFILE VIEW

PIPE OUTLET DETAIL

NO SCALE

PRELIMINARY

moore engineering, inc.

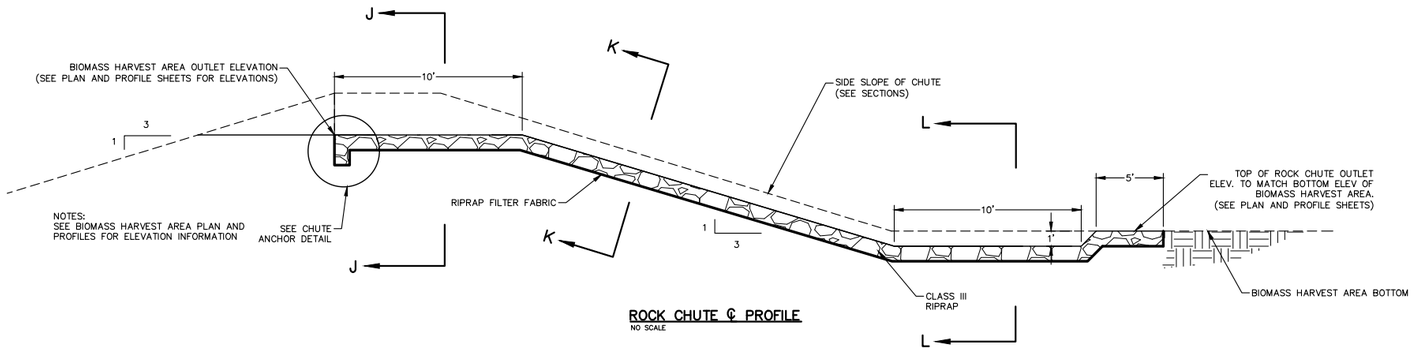
TYPICAL BIOMASS HARVEST AREA DETAILS
RCPP/PL566 UPPER MAPLE RIVER WATERSHED ALTERNATIVE 2A
CASS COUNTY JOINT WATER RESOURCE DISTRICT
BARNES COUNTY, NORTH DAKOTA
TYPICAL BIOMASS HARVEST AREA DETAILS

DATE:	05.25.23
REVISED:	----
REVISED:	----
REVISED:	----
REVISED:	----
REVISED:	----
RECORD:	----
PROJECT No.	18746
MANAGER:	KRL
DESIGNER:	ZJT
DRAFTER:	ZJT
REVIEWER:	JMH

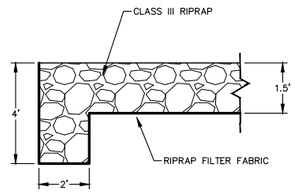
C-506

SHEET 36 OF 39

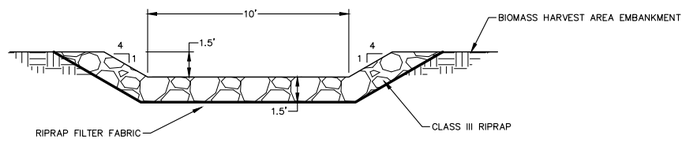
PRELIMINARY



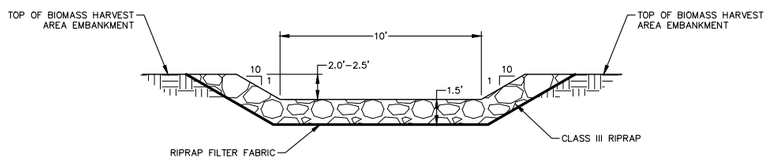
ROCK CHUTE ℄ PROFILE
NO SCALE



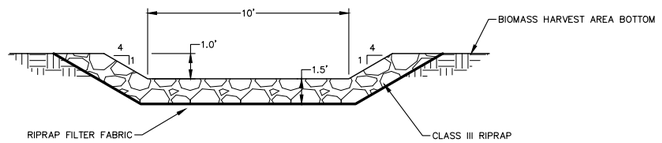
CHUTE ANCHOR DETAIL
NO SCALE



TYPICAL SECTION K–K
NO SCALE



TYPICAL SECTION J–J
NO SCALE



TYPICAL SECTION L–L
NO SCALE

BIOMASS HARVEST AREA EMERGENCY OVERFLOW DETAIL

NO SCALE

moore engineering, inc.

TYPICAL BIOMASS HARVEST AREA INLET & OUTLET DETAILS
RCPP/PL566 UPPER MAPLE RIVER WATERSHED ALTERNATIVE 2A
CASS COUNTY JOINT WATER RESOURCE DISTRICT
BARNES COUNTY, NORTH DAKOTA
TYPICAL BIOMASS HARVEST AREA INLET & OUTLET DETAILS

DATE:	05.25.23
REVISED:	----
REVISED:	----
REVISED:	----
REVISED:	----
REVISED:	----
RECORD:	----
PROJECT No.	18746
MANAGER:	KRL
DESIGNER:	ZJT
DRAFTER:	ZJT
REVIEWER:	JMH

C-507

SHEET 38 OF 39

FILE LOCATION: R:\Projects\18000\18700\18746\DRAWINGS\DESIGN\18746-ALT-2A-PP.dwg

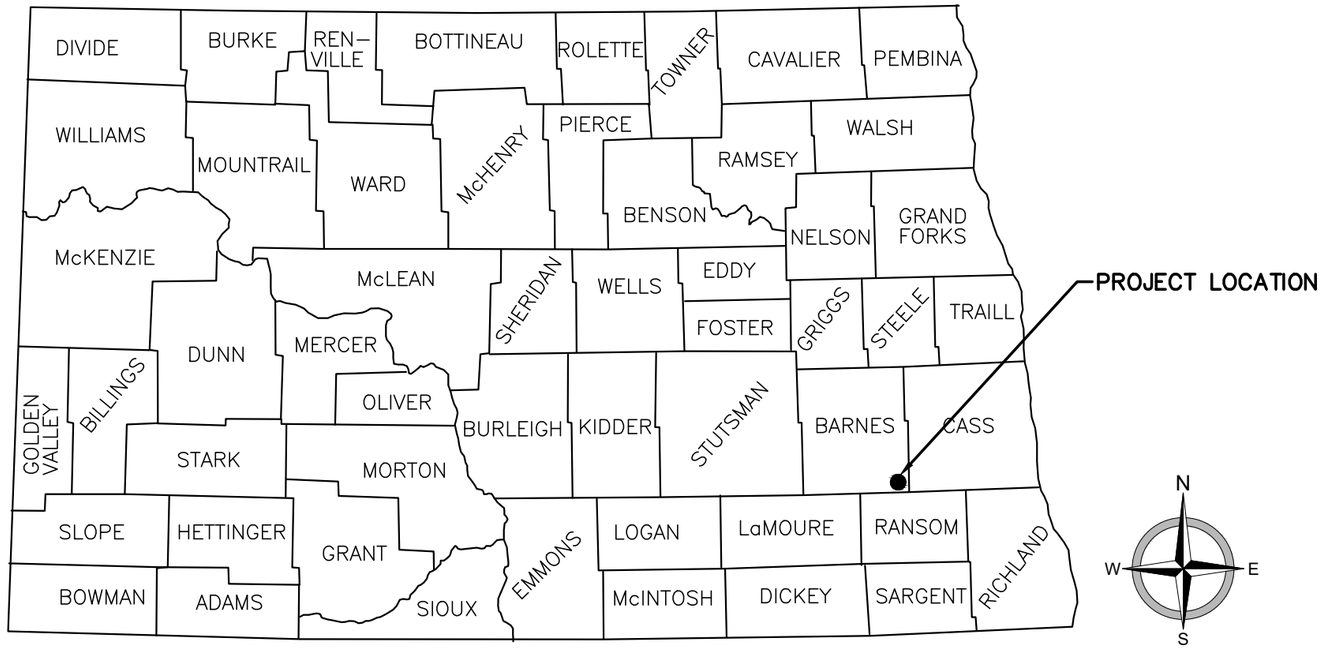
RCPP/PL566
UPPER MAPLE RIVER WATERSHED
ALTERNATIVE 2A

CASS COUNTY JOINT
WATER RESOURCE DISTRICT

BARNES COUNTY, NORTH DAKOTA

moore engineering, inc.
Consulting Engineering • Land Surveying
925 10th Avenue East • West Fargo, North Dakota
www.mooreengineeringinc.com

VICINITY MAP



PROJECT No. 18746

PRELIMINARY

FILE LOCATION: R:\Projects\18000\18700\18746\DRAWINGS\DESIGN\18746-ALT-2A-PP.dwg

TABLE OF CONTENTS

GENERAL

CIVIL

TOTAL SHEETS: 30

PRELIMINARY

moore engineering, inc.

TABLE OF CONTENTS
RCPP/PL566 UPPER MAPLE RIVER WATERSHED ALTERNATIVE 2A
CASS COUNTY JOINT WATER RESOURCE DISTRICT
BARNES COUNTY, NORTH DAKOTA
TABLE OF CONTENTS

DATE:	05.25.23
REVISED:	----
REVISED:	----
REVISED:	----
REVISED:	----
REVISED:	----
RECORD:	----
PROJECT No.	18746
MANAGER:	KRL
DESIGNER:	ZJT
DRAFTER:	ZJT
REVIEWER:	JMH

G-002

SHEET 2 OF 2

CIVIL LEGEND

- BENCHMARK
- IRON MONUMENT FOUND
- EXISTING GAS LINE MARKER
- EXISTING GAS GATE VALVE
- EXISTING POWER POLE
- EXISTING LIGHT POLE
- EXISTING LIGHT POLE W/SIGN
- EXISTING GUY WIRE
- EXISTING TRAFFIC SIGNAL ARM
- EXISTING SIGN
- EXISTING CULVERT W/FLARED END SECTION (F.E.S.)
- EXISTING FLARED END SECTION (F.E.S.)
- EXISTING CURB STOP
- EXISTING HYDRANT W/GATE VALVE
- EXISTING GATE VALVE
- EXISTING FITTINGS
- EXISTING PLUG
- EXISTING PROPANE TANK
- EXISTING SANITARY SEWER MANHOLE
- EXISTING SANITARY SEWER CLEANOUT
- EXISTING STORM SEWER CATCH BASIN
- EXISTING STORM SEWER MANHOLE
- W — EXISTING WATER MAIN
- EXISTING WATER SERVICE W/CURB STOP
- SS — EXISTING SANITARY SEWER
- SS–FM — EXISTING SANITARY FORCEMAIN
- EXISTING SANITARY SEWER SERVICE
- ST — EXISTING STORM SEWER
- ST–FM — EXISTING STORM SEWER FORCEMAIN
- STEAM — EXISTING STEAM PIPE
- EXISTING AIR CONDITIONER
- U — EXISTING UTILITY PEDESTAL
- EXISTING UTILITY MANHOLE
- C — EXISTING UNDERGROUND COMMUNICATIONS
- F — EXISTING UNDERGROUND FIBER
- T — EXISTING UNDERGROUND TELEPHONE
- OHT — EXISTING OVERHEAD TELEPHONE
- TV — EXISTING UNDERGROUND TELEVISION
- OHTV — EXISTING OVERHEAD TELEVISION
- G — EXISTING UNDERGROUND GAS
- E — EXISTING UNDERGROUND ELECTRIC
- OHP — EXISTING OVERHEAD POWER
- X — EXISTING BARBED WIRE FENCE
- EXISTING CHAIN LINK/STEEL FENCE
- EXISTING PVC/WOOD FENCE
- EXISTING SHRUB
- EXISTING STUMP
- EXISTING TREE/TREE CLUSTER
- EXISTING SPRINKLER HEAD
- 12 — EXISTING CLUSTER BOX UNIT (CBU)
- EXISTING MAILBOX
- EXISTING CURB AND GUTTER
- CURB AND GUTTER REMOVAL & REPLACEMENT
- REMOVE EXISTING SURFACE
- EXISTING ASPHALT SURFACE
- EXISTING CONCRETE SURFACE
- EXISTING DECORATIVE COLORED CONCRETE
- EXISTING GRANULAR SURFACE
- EXISTING SIDEWALK/MULTI–USE PATH (UNKNOWN SURFACE)
- EXISTING LANDSCAPING
- EXISTING RIPRAP
- EXISTING WETLANDS
- EXISTING PERMANENT POOL

- NEW LIGHT POLE
- NEW LIGHT POLE W/SIGN
- NEW GUY WIRE
- NEW SIGN
- TRAFFIC CONTROL – DRUM
- TRAFFIC CONTROL – TUBULAR MARKER
- NEW CULVERT W/FLARED END SECTION (F.E.S.)
- NEW FLARED END SECTION (F.E.S.)
- NEW CURB STOP
- NEW HYDRANT W/GATE VALVE
- NEW GATE VALVE
- NEW TAPPING SLEEVE
- NEW FITTINGS
- NEW PLUG
- NEW SANITARY SEWER MANHOLE
- NEW SANITARY SEWER CLEANOUT
- NEW STORM SEWER CATCH BASIN
- NEW STORM SEWER MANHOLE
- W — NEW WATER MAIN
- NEW WATER SERVICE W/CURB STOP (S.B. ELEV.)
- SS — NEW SANITARY SEWER
- SS–FM — NEW SANITARY FORCEMAIN
- NEW SANITARY SEWER SERVICE (S.S. ELEV.)
- ST — NEW STORM SEWER
- ST–FM — NEW STORM SEWER FORCEMAIN
- STEAM — NEW STEAM PIPE
- IN — INSULATION PER DETAIL
- X — NEW BARBED WIRE FENCE
- NEW CHAIN LINK/STEEL FENCE
- NEW PVC/WOOD FENCE
- NEW INFLOW CURB AND GUTTER (MOUNTABLE/KNOCKED DOWN)
- NEW OUTFLOW CURB AND GUTTER (MOUNTABLE/KNOCKED DOWN)
- NEW INFLOW CURB AND GUTTER (HIGHBACK)
- NEW OUTFLOW CURB AND GUTTER (HIGHBACK)
- NEW CURB PAINT
- NEW ASPHALT SURFACE
- NEW CONCRETE SURFACE
- NEW CONCRETE APPROACH/DRIVEWAY
- NEW DECORATIVE COLORED CONCRETE
- NEW GRANULAR SURFACE
- NEW CRUSHED CONCRETE SURFACE
- NEW CONCRETE SIDEWALK/MULTI–USE PATH
- NEW DETECTABLE WARNING PANEL
- NEW RIPRAP
- NEW PERMANENT POOL
- NEW LANDSCAPING
- MILLING – 2" UNIFORM
- MILLING – 2" TAPERED
- ASPHALT PATCH
- LEVELING COURSE
- OVERLAY
- CHIPSEAL AND FOG COAT
- NEW CONCRETE VALLEY GUTTER
- NEW MEDIAN NOSE APRON
- NEW ADA RAMP W/WARNING PANEL
- 12 — NEW CLUSTER BOX UNIT (CBU)
- NEW MAILBOX
- NEW LARGE DECIDUOUS TREE
- NEW SMALL DECIDUOUS TREE
- NEW SHRUB
- NEW LARGE EVERGREEN TREE
- NEW SMALL EVERGREEN TREE

- DRAINAGE BREAK LINE
- EXISTING DRAINAGE DIRECTION
- 2.0% — FINISHED DRAINAGE DIRECTION & SLOPE
- 4:1 — FINISHED GRADE
- 895 — EXISTING CONTOUR ELEVATION
- 895 — FINISHED CONTOUR ELEVATION
- 900.07 / FL — GRADE ELEVATIONS
- GRASS BUFFER
- PERMANENT STABILIZATION AREA
- SEDIMENTATION CONTROL WATTLE
- SEDIMENTATION CONTROL FENCE
- ROCK CHECK
- S.C.E. — STABILIZED CONSTRUCTION ENTRANCE
- CONCRETE WASHOUT
- INLET PROTECTION DEVICE

ABBREVIATIONS:

BOC = BACK OF CURB
BOW = BACK OF WALK
C = COMMUNICATION
CB# = STORM SEWER CATCH BASIN
CL = CENTERLINE
CSP = CORRUGATED STEEL PIPE
CO# = SANITARY SEWER CLEANOUT
CS# = CONTROL STRUCTURE
DIA = DIAMETER
DIP = DUCTILE IRON PIPE
E = ELECTRICAL
ECC = EDGE OF CRUSHED CONCRETE
EG = EXISTING GRADE
EOC = EDGE OF CONCRETE
EOP = EDGE OF PAVEMENT
EOW = EDGE OF WALK
EG= EXISTING GRADE
EX = EXISTING
F = FIBER OPTIC
FES = FLARED END SECTION
FG = FINISHED GRADE
FL = FLOWLINE
FM = FORCEMAIN
G = GAS LINE
HP = HIGH POINT
INV = INVERT
LP = LOW POINT
MATCH = MATCH
M# = STORM SEWER MANHOLE
MT# = STORM SEWER TEE MANHOLE
MM# = STORM SEWER MULTI–MANHOLE
MC = MIDPOINT OF CURVE
OHP = OVERHEAD POWER
OHT = OVERHEAD TELEPHONE
OHTV = OVERHEAD TELEVISION
PC = POINT OF CURVATURE
PRC = POINT OF REVERSE CURVE
PVC = POLYVINYL CHLORIDE PIPE
PT = POINT OF TANGENCY
RIM = RIM OF STRUCTURE
S# = SANITARY SEWER MANHOLE
S.B. ELEV. = STOP BOX ELEVATION
S.S. ELEV. = SANITARY SEWER SERVICE INVERT
S.S. = SANITARY SEWER
S.T. = STORM SEWER
STA = ALIGNMENT STATION
T = TELEPHONE
TOC = TOP OF CONCRETE
TOP = TOP OF PAVEMENT
TOP = TOP OF PIPE
TOW = TOP OF WALK
TR# = SANITARY TELEVISING RISER
TRANS = TRANSFORMER
TV = TELEVISION
U = UTILITY (UNKNOWN UTILITY)

PRELIMINARY

moore engineering, inc.

CIVIL LEGEND
RCPP/PL566 UPPER MAPLE RIVER WATERSHED ALTERNATIVE 2A
CASS COUNTY JOINT WATER RESOURCE DISTRICT
BARNES COUNTY, NORTH DAKOTA
CIVIL LEGEND

DATE:	05.25.23
REVISED:	----
REVISED:	----
REVISED:	----
REVISED:	----
REVISED:	----
RECORD:	----
PROJECT No.	18746
MANAGER:	KRL
DESIGNER:	ZJT
DRAFTER:	ZJT
REVIEWER:	JMH

C-001

SHEET 1 OF 39

CLEARING AND GRUBBING/DEMOLITION:

1. THE CONTRACTOR SHALL EXERCISE CARE IN THEIR CONSTRUCTION OPERATIONS TO ENSURE THAT TREES, SHRUBS, FENCES, BUILDINGS AND GRASSES WITHIN THE RIGHT-OF-WAY AND CONSTRUCTION EASEMENT NOT DESIGNATED FOR REMOVAL ARE NOT DISTURBED. ANY CHANGE TO THESE ITEMS SHALL BE REPAIRED OR REPLACED AT THE CONTRACTOR'S EXPENSE.
2. TREES AND BRANCHES MAY BE GROUND UP ON-SITE AND USED AS TEMPORARY OR PERMANENT MULCH.
3. ALL CLEARING AND GRUBBING WORK SHALL BE INCIDENTAL TO THE PROJECT.

UTILITIES:

1. NOT ALL UTILITIES MAY BE SHOWN. PRIOR TO DIGGING, IT IS THE CONTRACTOR'S RESPONSIBILITY TO CALL FOR UTILITY LOCATES AND TO IMMEDIATELY NOTIFY THE ENGINEER OF ANY CONFLICTS. IT SHALL BE THE CONTRACTOR'S RESPONSIBILITY TO VERIFY AND COORDINATE THEIR ACTIVITIES AND SCHEDULE ALL UTILITY RELOCATIONS. UTILITY LOCATES CAN BE REQUESTED FROM "NORTH DAKOTA ONE CALL".
2. CONTRACTOR MAY NEED TO WORK IN CONJUNCTION WITH UTILITY COMPANIES DURING CONSTRUCTION. CONTRACTOR MUST NOTIFY ENGINEER PRIOR TO DOING WORK WITH ANY AND ALL UTILITY COMPANIES. THERE SHALL BE NO CHANGE ORDERS FOR SCHEDULING CONFLICTS WITH UTILITY COMPANIES
3. THE CONTRACTOR SHALL LOCATE ALL BURIED UTILITIES ON THE SITE PRIOR TO DIGGING AND SHALL PROTECT THEM DURING CONSTRUCTION.
4. UTILITY PEDESTALS MAY BE PLACED PRIOR TO CONSTRUCTION OF SPOIL BANK AREAS. IF THIS IS DONE, UTILITY COMPANIES WILL SET PEDESTALS AT APPROPRIATE HEIGHTS TO MATCH EXPECTED SPOIL BANK HEIGHTS. CONTRACTOR IS RESPONSIBLE FOR MAINTAINING THE INTEGRITY OF SOILS AROUND THESE NEW PEDESTALS. CONTRACTOR WILL BE RESPONSIBLE FOR DAMAGE TO PEDESTALS DURING CONSTRUCTION AND WILL BEAR ALL COSTS OF REPLACEMENT OR REPAIR OF DAMAGED PEDESTALS.

CONSTRUCTION LIMITS:

1. THE CONTRACTOR SHALL LIMIT WORK TO WITHIN THE CONSTRUCTION EASEMENTS AND RIGHT OF WAY SHOWN ON THE PLANS. CONTRACTOR IS RESPONSIBLE FOR ALL DAMAGE EXPENSE FOR WORK DONE OUTSIDE OF PROJECT RIGHT-OF-WAY.
2. CONTRACTOR VEHICLES, EQUIPMENT, AND MATERIALS SHALL BE STORED WITHIN THE SITE.

SIGNS AND DELINEATORS:

1. ALL EXISTING SIGNS, DELINEATORS, MAILBOXES, AND BRIDGE END MARKERS WITHIN THE SITE SHALL BE REMOVED, SALVAGED, AND RESET. ANY ITEMS REMOVED SHALL BE NEATLY STOCKPILED ON THE PROJECT RIGHT-OF-WAY AND ARE TO REMAIN THE PROPERTY OF THE OWNER. THIS WORK SHALL BE CONSIDERED INCIDENTAL TO THE PROJECT.
2. ANY DAMAGED SIGNS SHALL BE REPLACED AT CONTRACTORS EXPENSE.
3. THE CONTRACTOR SHALL INSPECT ALL SIGNS, DELINEATORS, AND MAIL BOXES PRIOR TO CONSTRUCTION AND NOTIFY ENGINEER OF ANY DAMAGES. THE CONTRACTOR SHALL BE RESPONSIBLE FOR ANY DAMAGES IDENTIFIED AFTER CONSTRUCTION BEGINS.

HAUL ROADS:

1. IT SHALL BE THE CONTRACTOR'S RESPONSIBILITY TO INVESTIGATE THE SUITABILITY OF ROUTES WITH THE AGENCY HAVING CONTROL OF THE ROADS AND ACQUIRE THEIR APPROVAL PRIOR TO SUBMITTING A BID AND DOING THE WORK.
2. ANY DAMAGE TO ROADS AS A RESULT OF HAULING SHALL BE REPAIRED AT THE CONTRACTOR'S EXPENSE AND AT NO COST TO THE OWNER.
3. TEMPORARY HAUL ROADS AND RAMPS REQUIRED SHALL BE INCIDENTAL TO THE PROJECT.

SPOIL BANKS:

1. EXCAVATED MATERIAL, UNLESS OTHERWISE USED ON THE PROJECT, SHALL BE PLACED IN SPOIL BANKS ADJACENT TO THE CHANNEL.
2. SPOIL BANKS SHALL NOT IMPEDE EXISTING DRAINAGE. THE CONTRACTOR WILL BE LIABLE FOR DAMAGE FROM ANY BLOCKED DRAINAGE.
3. CONTRACTOR SHALL CONSTRUCT BERM AT THE MINIMUM BERM ELEVATION WITH EXCESS EXCAVATION BEING DISPOSED OF IN THE PRIMARY DISPOSAL AREA AS SHOWN.
4. CONTRACTOR MAY CONSTRUCT BERMS AT A HIGHER ELEVATION THAN THE MINIMUM HEIGHT IN AREAS WHERE PRIMARY DISPOSAL AREA HAS BEEN FILLED. ONCE THE PRIMARY DISPOSAL AREA IS FILLED, THE SECONDARY DISPOSAL AREA SHALL BE USED.
5. IF POWER LINES ARE NEEDED TO BE RELOCATED, THEY WILL BE DESIGNED TO PROVIDE ADEQUATE CLEARANCE FROM PROPOSED MINIMUM BERM ELEVATIONS. CONTRACTOR SHALL ENSURE NO FILL IS PLACED WITHIN 18' OF VERTICAL CLEARANCE UNDER OVERHEAD POWER LINES FOR NODAK ELECTRIC COOPERATIVE.
6. NO SPOIL SHALL BE PLACED ON A ROAD UNLESS THE PLANS SPECIFICALLY CALL FOR BUILDING UP THE ROAD AT THAT LOCATION OR IF MATERIAL IS NEEDED TO BRING ROAD BACK TO GRADE AFTER CULVERT INSTALLATION AT SECTION LINE.
7. IN AREAS WHERE SPOIL EXCEEDS WHAT IS REQUIRED TO CONSTRUCT THE MINIMUM BERM AND TO FILL THE PRIMARY DISPOSAL AREA, SPOIL SHALL THEN BE MOVED LATERALLY AND PARALLEL TO THE DRAIN TO UNIFORMLY RAISE THE SPOIL BANK. END HAULING SPOIL TO ACHIEVE THIS SHALL BE INCIDENTAL TO SPOIL BANK LEVELING.
8. TOP OF BERM SHALL BE GRADED SMOOTH AND LEVEL TO THE SATISFACTION OF THE ENGINEER. EXCESS EXCAVATION SHALL BE SPOILED BEHIND THE BERM, GENTLY GRADED AND MATCHING INTO THE EXISTING FIELD. THE CONSTRUCTION EASEMENT AREA SHALL BE UTILIZED FOR THE EXCESS EXCAVATION MATERIAL.
9. IT MAY ALSO BE NECESSARY TO MOVE SPOIL PARALLEL TO THE DRAIN TO ENSURE THAT THE SPOIL BANK APPEARS UNIFORM WITH THE GRADE OF THE SPOIL BANK MATCHING THE MINIMUM BERM GRADE.
10. TOLERANCE SHALL BE NO MORE THAN ONE FOOT VARIANCE FROM A MAXIMUM ACTUAL FILL TO A MINIMUM ACTUAL FILL AT A GRADE LINE PARALLEL TO THE MINIMUM BERM. (I.E. IF ONE SET UP A LASER AT GRADE AND WALKED THE BERM MAKING MARKS ON THE GRADE ROD, AT THE END OF THE MILE, THE MARKS SHOULD ALL BE WITHIN A ONE FOOT INTERVAL.)
11. THIS VARIANCE OF ONE FOOT DOES NOT APPLY TO BREAK OUT LOCATIONS.

CHANNEL APPEARANCE:

1. THE FINAL CONSTRUCTED CHANNEL SECTION SHALL FORM NEAT LINES WHEN VIEWED FROM ONE END OF A MILE TO THE OTHER END OF A MILE.
2. WAVINESS, BUMPS, OR DIVOTS SHALL NOT EXCEED MORE THAN 0.2' FROM THE DESIRED CHANNEL PROFILE.

PROJECT SCHEDULE:

1. CHANNEL CONSTRUCTION SHALL BEGIN AT THE DOWNSTREAM END AND PROCEED UPSTREAM. ALL CHANNEL WORK AND CULVERT INSTALLATION SHALL BE COMPLETED ON OR BEFORE SEPTEMBER 12TH, 2014. ACCEPTANCE OF FINAL SEEDING SHALL TAKE PLACE NO LATER THAN OCTOBER 24TH, 2014.
2. IF THE CONTRACTOR WANTS TO WORK IN MORE THAN ONE AREA OF THE PROJECT AT ONE TIME, THE CONTRACTOR MUST NOTIFY THE ENGINEER IN WRITING PRIOR TO DOING THE WORK. THE ENGINEER MAY OR MAY NOT GRANT THE CONTRACTOR'S REQUEST.

PROJECT MAINTENANCE:

1. THE CONTRACTOR SHALL HOLD A PRE-CONSTRUCTION MEETING PRIOR TO COMMENCING WORK ON THIS SITE.
2. IT IS THE CONTRACTOR'S RESPONSIBILITY FOR CHANNEL MAINTENANCE, WEED CONTROL, EROSION CONTROL AND REPAIR, SILT REMOVAL AND SPOILING, RE-GRADING BOTTOM AND RE-GRADING SIDE SLOPES UNTIL SEED IS ESTABLISHED. IT SHOULD BE THE INTENT TO ESTABLISH SEED GROWTH AS SOON AS CHANNEL AREAS ARE COMPLETED.
3. CONTRACTOR IS RESPONSIBLE FOR WEED CONTROL WITHIN THE PROJECT SITE THROUGHOUT DURATION OF PROJECT AND IT SHALL BE CONSIDERED INCIDENTAL TO THE PROJECT. THIS MAY REQUIRE TILLING OR SPRAYING THE PROJECT SITE.

DISPOSAL NOTES:

1. NO MATERIAL, OTHER THAN SOIL, SHALL BE WASTED ON THE SITE OR IN THE SPOIL BANK AREA.
2. REMOVED PIPES, BRIDGE DECKS, BRIDGE PIERS, EXISTING WEIR MATERIALS, TREES, ROOTS, PLASTIC, WOOD, METAL, TIRES AND OTHER CONSTRUCTION MATERIAL OR DEBRIS SHALL BE PROPERLY DISPOSED OF OFF SITE. THIS WORK SHALL BE INCIDENTAL TO THE PROJECT UNLESS OTHERWISE SPECIFIED.
3. ANY REMOVED ITEMS NOT SALVAGED AS SHOWN ON THE PLANS BECOME THE PROPERTY OF THE CONTRACTOR AND ARE THE CONTRACTOR'S RESPONSIBILITY ONCE OFF THE SITE.
4. NO MATERIAL MAY BE BURIED OR BURNED ON SITE.
5. ROCK MATERIAL PICKED FROM PROJECT SITE SHALL BE UTILIZED AT CULVERT CROSSINGS OR DISPOSED OF OFF SITE.

SURVEY NOTES:

1. CONTRACTOR REQUESTED SURVEYS CONDUCTED AFTER CONSTRUCTION IS COMPLETE FOR THE PURPOSE OF VERIFYING EXCAVATION AND EMBANKMENT QUANTITIES SHALL BE AT THE CONTRACTOR'S EXPENSE.
2. IF CONTRACTOR UTILIZES GPS EQUIPMENT FOR SHAPING PURPOSES, CONTRACTOR MAY REQUEST DIGITAL POINT FILES FROM THE ENGINEER TO CREATE A FINISHED GROUND SURFACE TO UPLOAD INTO CONTRACTOR'S MACHINERY.
3. ENGINEER REQUIRES A 48 HOUR NOTICE FOR ANY CONTRACTOR REQUESTED SURVEY. CONTRACTOR SHALL COORDINATE WITH RPR FOR SCHEDULING.

TRAFFIC CONTROL:

1. THE CONTRACTOR SHALL PROVIDE, IMPLEMENT, INSTALL, MAINTAIN, AND REMOVE ALL NECESSARY TRAFFIC CONTROL DEVICES AS REQUIRED BY THE CONTRACTOR'S CONSTRUCTION MEANS AND METHODS.
2. THE CONTRACTOR SHALL PROVIDE, MAINTAIN, AND REMOVE TEMPORARY APPROACHES, CROSSINGS, AND INTERSECTIONS AS NECESSARY DURING CONSTRUCTION.
3. THE CONTRACTOR SHALL PROVIDE A METHOD OF PROTECTING TRAFFIC AND PEDESTRIANS FROM CONSTRUCTION AREAS AND SHALL ALLOW ACCESS TO ALL AREAS BY FIRE, POLICE, AND OTHER EMERGENCY PERSONNEL.
4. ALL TRAFFIC CONTROL MEASURES NEEDED TO COMPLETE THE WORK SHALL BE INCIDENTAL TO THE PROJECT.

INTERCEPT CULVERT NOTES:

1. ALL EXISTING INTERCEPT PIPES, FLARED END SECTIONS, AND FLAP GATES ALONG THE FIELD SHALL BE REMOVED UNLESS SPECIFIED OTHERWISE IN THE PLANS.
2. ASSUMED QUANTITIES AND SIZES OF NEW PIPES, FLARED END SECTIONS, AND FLAP GATES ARE REFLECTED IN THE BID PROPOSAL. QUANTITY, LOCATION, SIZE, AND INVERT ELEVATIONS OF ALL NEW INTERCEPT PIPES AND NEW FIELD ACCESS PIPES SHALL BE DETERMINED BY THE ENGINEER IN THE FIELD.
3. NEW INTERCEPT PIPES SHALL BE INSTALLED AS SHOWN IN INTERCEPT PIPE DETAIL SHOWN ON SHEET C-503.
4. NEW INTERCEPT PIPES SHALL HAVE RIPRAP INSTALLED AT THE OUTLET OF EACH PIPE AS SHOWN IN THE INTERCEPT PIPE - RIPRAP DETAIL SHOWN ON SHEET C-505.
5. ALL ITEMS ASSOCIATED WITH INSTALLING NEW INTERCEPT PIPE, FLARED END SECTIONS, FLAP GATES, RIPRAP, AND RIPRAP FILTER BLANKET SHALL BE PAID FOR AT THE BID ITEM PRICE IN THE BID PROPOSAL.
6. UNLESS CALLED OUT IN THE PLANS OR SPECIFICATIONS, ALL OTHER ITEMS NEEDED TO INSTALL INTERCEPT PIPES AND ASSOCIATED ITEMS SHALL BE CONSIDERED INCIDENTAL TO THE INSTALLATION OF THE PIPE (EX. DIRTWORK TO INSTALL PIPE AND PIPE CONNECTING BANDS).

PERMANENT CONSTRUCTION EASEMENT:

1. PERMANENT CONSTRUCTION EASEMENT AREA SHALL BE COMPLETELY FREE OF DEBRIS, GARBAGE, ROCKS, TREES, WOOD, PLASTIC, METAL, AND ALL OTHER WASTE PRIOR TO THE COMPLETION OF THE PROJECT.
2. CONTRACTOR SHALL DISC PERMANENT CONSTRUCTION EASEMENT AREA UPON COMPLETION OF THE WORK TO RESTORE AREA TO PRE-PROJECT CONDITIONS (EG. NO HARD COMPACTED AREAS).

DRAIN TILE NOTES:

1. EXISTING DRAIN TILE INFRASTRUCTURE ON THE SITE, WHETHER SHOWN ON THE PLANS OR NOT, SHALL BE ADDRESSED IN ACCORDANCE WITH SECTION 4.04 AND ARTICLE 7 OF THE GENERAL CONDITIONS. UPON WRITTEN REQUEST, OWNER WILL PROVIDE CONTRACTOR WITH COPIES OF ALL KNOWN UTILITY PERMITS ASSOCIATED WITH DRAIN TILE INFRASTRUCTURE ON THE SITE AND CONTACT INFORMATION FOR ALL LANDOWNERS IMMEDIATELY ADJACENT TO THE SITE.

PRELIMINARY

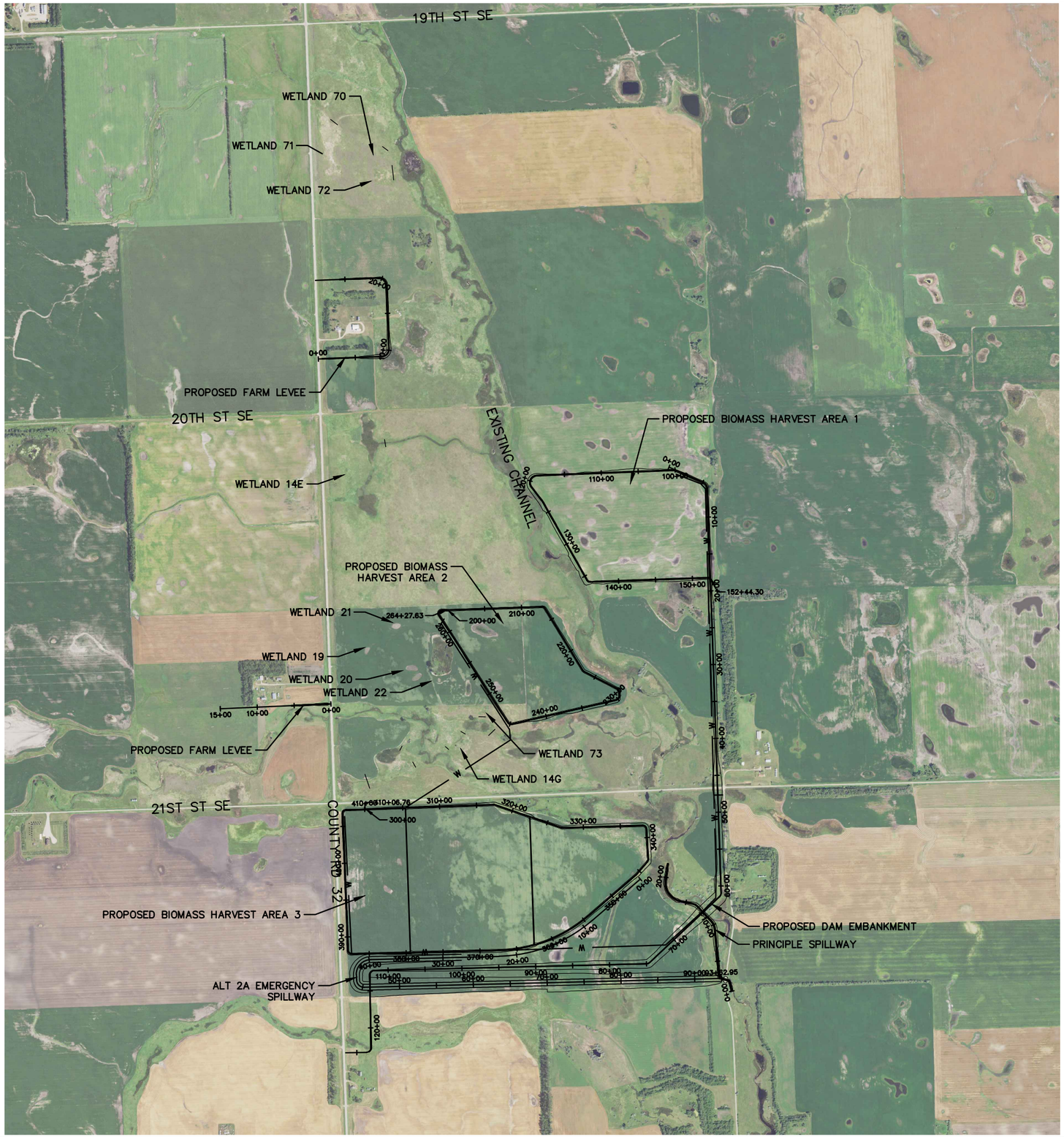
moore engineering, inc.

CIVIL NOTES
RCPP/PL566 UPPER MAPLE RIVER WATERSHED ALTERNATIVE 2A
CASS COUNTY JOINT WATER RESOURCE DISTRICT
BARNES COUNTY, NORTH DAKOTA
GENERAL

DATE:	05.25.23
REVISED:	----
REVISED:	----
REVISED:	----
REVISED:	----
REVISED:	----
RECORD:	----
PROJECT No.	18746
MANAGER:	KRL
DESIGNER:	ZJT
DRAFTER:	ZJT
REVIEWER:	JMH

C-002

SHEET 2 OF 39



N
W E
S
0 1500
Scale in Feet

PRELIMINARY

EROSION CONTROL NOTES:

1. WORK MAY NOT START UNTIL NOTICE OF INTENT (NOI) HAS BEEN SUBMITTED TO THE NORTH DAKOTA DEPARTMENT OF HEALTH AND 7 BUSINESS DAYS HAVE PASSED.
2. PERMIT No. NDR10-0000 SHALL BE USED AS A GUIDE FOR STORM WATER MANAGEMENT ON THIS PROJECT.
3. CONTRACTOR SHALL DESIGNATE AN EROSION CONTROL SUPERVISOR WHO WILL BE IN CONTROL OF REVIEWING AND MODIFYING THE SWPPP, CONDUCTS THE REQUIRED SITE INSPECTIONS., AND PREPARES THE INSPECTION REPORTS AS PER NDR10-0000 OR AS STATED IN THE PLANS.
4. CONTRACTOR IS RESPONSIBLE FOR THE DAY-TO-DAY OPERATION OF THE SWPPP AND SHALL NOTIFY THE ENGINEER IF ANY PROBLEMS ARISE.
5. SITE INSPECTIONS ARE REQUIRED EVERY 14 DAYS OR AFTER A RAINFALL EVENT GREATER THAN 0.25 INCHES IN 24 HOURS. ALL INSPECTIONS MUST BE DOCUMENTED IN THE SWPPP. CONTRACTOR SHALL PROVIDE ENGINEER WITH A COPY OF EACH INSPECTION REPORT. CONTRACTOR SHALL PROVIDE ON-SITE RAIN GAUGE TO MEASURE RAINFALL TOTALS.
6. THE RECEIVING WATER IS NELSON DRAIN NO. 28, A TRIBUTARY TO THE RED RIVER. BMP'S SHALL BE USED TO MINIMIZE ANY SEDIMENT FROM PROJECT SITE INTO THE RECEIVING WATERS.
7. ALL AREAS NOT WORKED IN FOR 14 DAYS SHALL BE TEMPORARY MULCHED. THIS WORK IS PART OF STORM WATER MANAGEMENT AND WILL NOT BE PAID FOR AS ADDITIONAL WORK.
8. TRACKED SEDIMENT SHALL BE REMOVED FROM ALL ROADS WITHIN 24 HOURS OF SEDIMENT TRACKING. IF SEDIMENT TRACKING IS SEVERE, A CONSTRUCTION ENTRANCE SHALL BE INSTALLED IN ACCORDANCE WITH NDR10-0000 OR AS SHOWN IN THE PLANS.
9. TEMPORARY ROCK CHECKS SHALL BE INSTALLED PRIOR TO STARTING WORK IN ANY AREA OF THE PROJECT. THEY SHALL BE CONSTRUCTED IN ACCORDANCE WITH THE PLANS
10. THE CONTRACTOR IS RESPONSIBLE FOR CONTROLLING PROJECT SITE DUST. WATERING PROJECT SITE AS WELL AS WATERING THE HAUL ROADS MAY BE NEEDED.
11. CONTRACTOR IS RESPONSIBLE FOR NON-HAZARDOUS WASTE BROUGHT TO AND STORED AT THE SITE. ALL TRASH AND DEBRIS SHALL BE PICKED UP DAILY AND DISPOSED OF IN PROPER CONTAINERS. NO MATERIAL IS ALLOWED TO BE BURIED ON SITE. ALL OIL, GAS, AND OTHER PETROLEUM PRODUCTS SHALL BE STORED IN SEALED CONTAINERS WITH PROPER LABELS.
12. ALL SPILLS SHALL BE CLEANED UP IMMEDIATELY. ENGINEER SHALL BE NOTIFIED IMMEDIATELY OF ANY SPILL.
13. ALL ITEMS THAT ARE REQUIRED BY NDR10-0000 OR AS SHOWN IN THE PLANS AS PART OF STORM WATER MANAGEMENT SHALL BE PAID FOR BY THE STORM WATER MANAGEMENT PAY ITEM UNLESS A SEPARATE BID ITEM IS SPECIFIED.
14. ALL CULVERTS SHALL HAVE RIPRAP INSTALLED UPSTREAM AND DOWNSTREAM OF THEM WITHIN 3 DAYS OF BEING INSTALLED.
15. CONTRACTOR IS RESPONSIBLE FOR MAKING SURE SUBCONTRACTORS STAY IN COMPLIANCE WITH STORM WATER MANAGEMENT GUIDELINES.
16. ALL EQUIPMENT SHALL ARRIVE ON-SITE IN A CLEAN, OPERABLE MANNER. EXCESS DIRT, VEGETATION, OIL, GREASE, OR ANY OTHER CONTAMINANTS SHALL BE CLEANED OFF PRIOR TO ENTERING PROJECT SITE.
17. CONTRACTOR SHALL MAINTAIN A STOCKPILE OF APPROPRIATE BMP'S ON-SITE FOR USE IN EMERGENCY SITUATIONS. THE STOCKPILE SHOULD INCLUDE EROSION CONTROL BLANKET, SILT FENCE, SPARE RIPRAP, AND SEEDING MATERIAL
18. CONTRACTOR IS ENCOURAGED TO INSTALL PERMANENT STABILIZATION IN STAGES AS PORTIONS OF THE PROJECT REACH FINAL GRADES.
19. AT THE COMPLETION OF THE PROJECT, PERMANENT GRASS SEEDING SHALL BE INSTALLED. PERMANENT SEEDING IS PAID FOR BY A BID ITEM AND IS NOT PART OF STORM WATER MANAGEMENT.

moore engineering, inc.

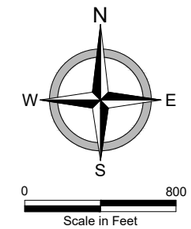
GENERAL LAYOUT AND EROSION CONTROL PLAN
RCPP/PL566 UPPER MAPLE RIVER WATERSHED ALTERNATIVE 2A
CASS COUNTY JOINT WATER RESOURCE DISTRICT
BARNES COUNTY, NORTH DAKOTA
GENERAL LAYOUT AND EROSION CONTROL PLAN

DATE:	05.25.23
REVISED:	----
REVISED:	----
REVISED:	----
REVISED:	----
REVISED:	----
RECORD:	----
PROJECT No.	18746
MANAGER:	KRL
DESIGNER:	ZJT
DRAFTER:	ZJT
REVIEWER:	JMH

C-101

SHEET 3 OF 39

FILE LOCATION: R:\Projects\18000\18700\18746\DRAWINGS\DESIGN\18746-ALT-2A-PP.dwg



PRELIMINARY

ALTERNATE 2A DAM EMBANKMENT ALIGNMENT LINE AND CURVE TABLE

Number	Length	Radius	Delta	Bearing	Start Sta.	End Sta.	Start Northing/Easting	End Northing/Easting
L100	510.79	N/A	N/A	S65°57'37"E	0+00	5+10.79	542337.70/2647893.45	542129.62/2648359.94
C100	100.55	90.00	64°00'48"	S33°57'13"E	5+10.79	6+11.35	542129.62/2648359.94	542050.48/2648413.22
L101	5485.04	N/A	N/A	S1°56'49"E	6+11.35	60+96.38	542050.48/2648413.22	536568.61/2648599.57
C101	50.89	60.00	48°35'47"	S22°21'05"W	60+96.38	61+47.27	536568.61/2648599.57	536522.94/2648580.79
L102	1304.10	N/A	N/A	S46°38'58"W	61+47.27	74+51.37	536522.94/2648580.79	535627.73/2647632.49
C102	47.58	65.00	41°56'18"	S67°37'07"W	74+51.37	74+98.95	535627.73/2647632.49	535610.01/2647589.48
L103	3691.34	N/A	N/A	S88°35'16"W	74+98.95	111+90.29	535610.01/2647589.48	535519.03/2643899.25
C103	93.83	59.98	89°37'41"	S43°46'25"W	111+90.29	112+84.12	535519.03/2643899.25	535457.98/2643840.76
L104	986.88	N/A	N/A	S1°02'26"E	112+84.12	122+71.01	535457.98/2643840.76	534471.26/2643858.68
C104	94.35	60.00	90°06'05"	S44°00'37"W	122+71.01	123+65.36	534471.26/2643858.68	534410.17/2643799.67
L105	284.17	N/A	N/A	S89°03'39"W	123+65.36	126+49.53	534410.17/2643799.67	534405.52/2643515.54

HORIZONTAL CONTROL

NORTH DAKOTA COORDINATE SYSTEM OF 1983, NAD83, SOUTH ZONE
COMBINATION FACTOR (cf) = .9998710
ALL COORDINATES ARE BARNES COUNTY GROUND COORDINATES

VERTICAL CONTROL

NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD88)

BENCHMARKS/SURVEY CONTROL

PRIOR TO PROJECT START, OWNER WILL SET AND ESTABLISH BENCHMARKS AND SURVEY CONTROL FOR THE PROJECT, AND CLEARLY MARK RIGHT-OF-WAY.

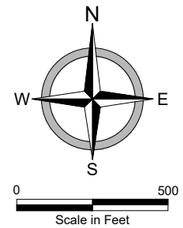
moore engineering, inc.

ALIGNMENT LAYOUT AND CONTROL
RCPP/PL566 UPPER MAPLE RIVER WATERSHED ALTERNATIVE 2A
CASS COUNTY JOINT WATER RESOURCE DISTRICT
BARNES COUNTY, NORTH DAKOTA
ALTERNATE 2A DAM EMBANKMENT

DATE:	05.25.23
REVISED:	----
REVISED:	----
REVISED:	----
REVISED:	----
REVISED:	----
RECORD:	----
PROJECT No.	18746
MANAGER:	KRL
DESIGNER:	ZJT
DRAFTER:	ZJT
REVIEWER:	JMH

C-102

SHEET 4 OF 39



PRELIMINARY

ALTERNATE 2A PRIMARY SPILLWAY ALIGNMENT LINE AND CURVE TABLE

Number	Length	Radius	Delta	Bearing	Start Sta.	End Sta.	Start Northing/Easting	End Northing/Easting
L200	115.49	N/A	N/A	N12°59'00"W	0+00	1+15.49	535239.17/2648744.26	535351.71/2648718.32
C200	53.04	50.00	60°46'44"	N43°22'22"W	1+15.49	1+68.53	535351.71/2648718.32	535388.48/2648683.58
L201	81.53	N/A	N/A	N73°45'44"W	1+68.53	2+50.07	535388.48/2648683.58	535411.28/2648605.30
C201	60.00	50.00	68°45'12"	N39°23'08"W	2+50.07	3+10.07	535411.28/2648605.30	535454.92/2648569.47
L202	621.53	N/A	N/A	N5°00'32"W	3+10.07	9+31.59	535454.92/2648569.47	536074.07/2648515.20
C202	133.84	200.00	38°20'30"	N24°10'47"W	9+31.59	10+65.43	536074.07/2648515.20	536193.90/2648461.40
L203	271.62	N/A	N/A	N43°21'02"W	10+65.43	13+37.06	536193.90/2648461.40	536391.42/2648274.94
C203	59.72	100.00	34°13'05"	N60°27'35"W	13+37.06	13+96.78	536391.42/2648274.94	536420.43/2648223.75
L204	188.59	N/A	N/A	N77°34'07"W	13+96.78	15+85.36	536420.43/2648223.75	536461.03/2648039.58
C204	374.35	250.00	85°47'41"	N34°40'17"W	15+85.36	19+59.71	536461.03/2648039.58	536740.93/2647845.97
L205	230.43	N/A	N/A	N8°13'34"E	19+59.71	21+90.15	536740.93/2647845.97	536969.00/2647878.94

HORIZONTAL CONTROL

NORTH DAKOTA COORDINATE SYSTEM OF 1983, NAD83, SOUTH ZONE
COMBINATION FACTOR (cf) = .9998710
ALL COORDINATES ARE BARNES COUNTY GROUND COORDINATES

VERTICAL CONTROL

NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD88)

BENCHMARKS/SURVEY CONTROL

PRIOR TO PROJECT START, OWNER WILL SET AND ESTABLISH BENCHMARKS AND SURVEY CONTROL FOR THE PROJECT, AND CLEARLY MARK RIGHT-OF-WAY.

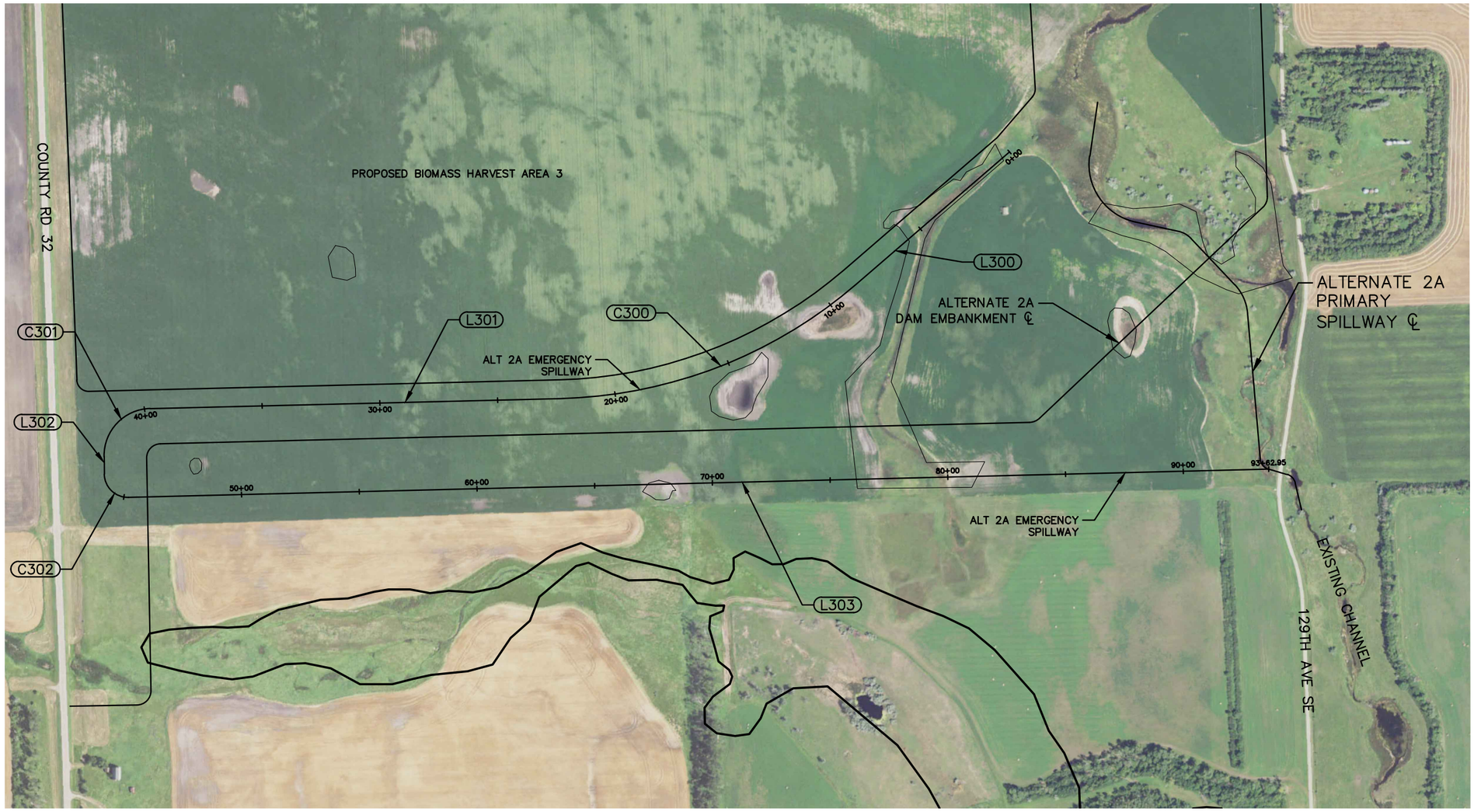
moore engineering, inc.

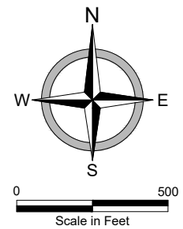
ALIGNMENT LAYOUT AND CONTROL
RCPP/PL566 UPPER MAPLE RIVER WATERSHED ALTERNATIVE 2A
CASS COUNTY JOINT WATER RESOURCE DISTRICT
BARNES COUNTY, NORTH DAKOTA
ALTERNATE 2A PRIMARY SPILLWAY

DATE:	05.25.23
REVISED:	----
REVISED:	----
REVISED:	----
REVISED:	----
REVISED:	----
RECORD:	----
PROJECT No.	18746
MANAGER:	KRL
DESIGNER:	ZJT
DRAFTER:	ZJT
REVIEWER:	JMH

C-103

SHEET 5 OF 39





PRELIMINARY

ALTERNATE 2A EMERGENCY SPILLWAY ALIGNMENT LINE AND CURVE TABLE								
Number	Length	Radius	Delta	Bearing	Start Sta.	End Sta.	Start Northing/Easting	End Northing/Easting
L300	859.74	N/A	N/A	S49°12'10"W	0+00	8+59.74	536758.00/2647504.55	536196.26/2646853.71
C300	1374.79	2000.00	39°23'06"	S68°53'43"W	8+59.74	22+34.53	536196.26/2646853.71	535710.92/2645596.23
L301	1741.11	N/A	N/A	S88°35'16"W	22+34.53	39+75.64	535710.92/2645596.23	535668.01/2643855.65
C301	312.86	200.00	89°37'42"	S43°46'25"W	39+75.64	42+88.51	535668.01/2643855.65	535464.44/2643660.61
L302	74.36	N/A	N/A	S1°02'26"E	42+88.51	43+62.87	535464.44/2643660.61	535390.09/2643661.96
C302	157.73	100.00	90°22'18"	S46°13'35"E	43+62.87	45+20.59	535390.09/2643661.96	535291.94/2643764.41
L303	4842.36	N/A	N/A	N88°35'16"E	45+20.59	93+62.95	535291.94/2643764.41	535411.28/2648605.30

HORIZONTAL CONTROL

NORTH DAKOTA COORDINATE SYSTEM OF 1983, NAD83, SOUTH ZONE
COMBINATION FACTOR (cf) = .9998710
ALL COORDINATES ARE BARNES COUNTY GROUND COORDINATES

VERTICAL CONTROL

NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD88)

BENCHMARKS/SURVEY CONTROL

PRIOR TO PROJECT START, OWNER WILL SET AND ESTABLISH BENCHMARKS AND SURVEY CONTROL FOR THE PROJECT, AND CLEARLY MARK RIGHT-OF-WAY.

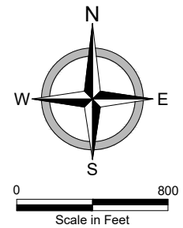
moore engineering, inc.

ALIGNMENT LAYOUT AND CONTROL
RCPP/PL566 UPPER MAPLE RIVER WATERSHED ALTERNATIVE 2A
CASS COUNTY JOINT WATER RESOURCE DISTRICT
BARNES COUNTY, NORTH DAKOTA
ALTERNATE 2A EMERGENCY SPILLWAY

DATE:	05.25.23
REVISED:	----
REVISED:	----
REVISED:	----
REVISED:	----
REVISED:	----
RECORD:	----
PROJECT No.	18746
MANAGER:	KRL
DESIGNER:	ZJT
DRAFTER:	ZJT
REVIEWER:	JMH

C-104

SHEET 6 OF 39



PRELIMINARY

ALTERNATE 2A FARM RING LEVEE ALIGNMENT LINE AND CURVE TABLE								
Number	Length	Radius	Delta	Bearing	Start Sta.	End Sta.	Start Northing/Easting	End Northing/Easting
L400	859.78	N/A	N/A	N87°51'54"E	0+00	8+59.78	543804.48/2643145.29	543836.51/2644004.47
C400	157.08	100.00	90°00'00"	N42°51'54"E	8+59.78	10+16.86	543836.51/2644004.47	543940.17/2644100.67
L401	866.18	N/A	N/A	N2°08'06"W	10+16.86	18+83.04	543940.17/2644100.67	544805.75/2644068.40
C401	157.08	100.00	90°00'00"	N47°08'06"W	18+83.04	20+40.12	544805.75/2644068.40	544901.96/2643964.75
L402	859.78	N/A	N/A	S87°51'54"W	20+40.12	28+99.90	544901.96/2643964.75	544869.93/2643105.57

ALTERNATE 2A FARM LEVEE ALIGNMENT LINE AND CURVE TABLE								
Number	Length	Radius	Delta	Bearing	Start Sta.	End Sta.	Start Northing/Easting	End Northing/Easting
L500	1500.00	N/A	N/A	S87°31'44"W	0+00	15+00	539130.47/2643315.30	539065.79/2641816.70

HORIZONTAL CONTROL

NORTH DAKOTA COORDINATE SYSTEM OF 1983, NAD83, SOUTH ZONE
COMBINATION FACTOR (cf) = .9998710
ALL COORDINATES ARE BARNES COUNTY GROUND COORDINATES

VERTICAL CONTROL

NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD88)

BENCHMARKS/SURVEY CONTROL

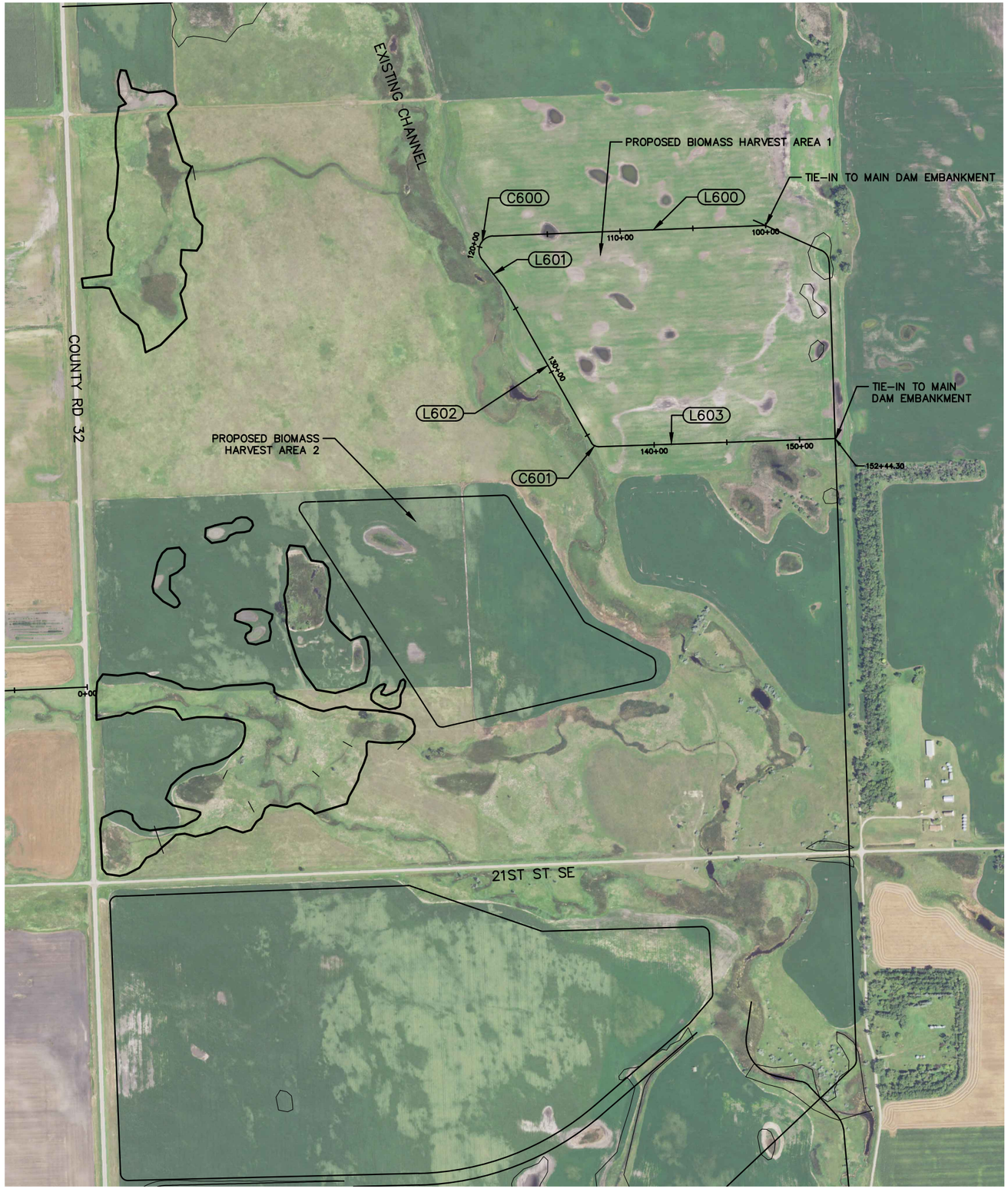
PRIOR TO PROJECT START, OWNER WILL SET AND ESTABLISH BENCHMARKS AND SURVEY CONTROL FOR THE PROJECT, AND CLEARLY MARK RIGHT-OF-WAY.

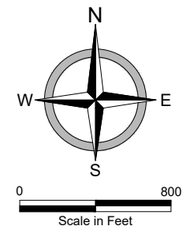
moore engineering, inc.

ALIGNMENT LAYOUT AND CONTROL
RCPP/PL566 UPPER MAPLE RIVER WATERSHED ALTERNATIVE 2A
CASS COUNTY JOINT WATER RESOURCE DISTRICT
BARNES COUNTY, NORTH DAKOTA
FARM LEVEES

DATE:	05.25.23
REVISED:	----
REVISED:	----
REVISED:	----
REVISED:	----
REVISED:	----
RECORD:	----
PROJECT No.	18746
MANAGER:	KRL
DESIGNER:	ZJT
DRAFTER:	ZJT
REVIEWER:	JMH

C-105





PRELIMINARY

BIOMASS HARVESTING AREA 1 ALIGNMENT LINE AND CURVE TABLE

Number	Length	Radius	Delta	Bearing	Start Sta.	End Sta.	Start Northing/Easting	End Northing/Easting
L600	1873.13	N/A	N/A	S87°45'16"W	100+00	118+73.13	542300.78/2647976.20	542227.39/2646104.51
C600	219.11	100.00	125°32'27"	S24°59'02"W	118+73.13	120+92.24	542227.39/2646104.51	542066.19/2646029.40
L601	243.51	N/A	N/A	S37°47'11"E	120+92.24	123+35.75	542066.19/2646029.40	541873.75/2646178.60
L602	1225.02	N/A	N/A	S29°27'52"E	123+35.75	135+60.77	541873.75/2646178.60	540807.17/2646781.17
C601	54.55	50.00	62°30'33"	S60°43'09"E	135+60.77	136+15.32	540807.17/2646781.17	540781.80/2646826.42
L603	1628.98	N/A	N/A	N88°01'35"E	136+15.32	152+44.30	540781.80/2646826.42	540837.90/2648454.44

HORIZONTAL CONTROL

NORTH DAKOTA COORDINATE SYSTEM OF 1983, NAD83, SOUTH ZONE
COMBINATION FACTOR (cf) = .9998710
ALL COORDINATES ARE BARNES COUNTY GROUND COORDINATES

VERTICAL CONTROL

NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD88)

BENCHMARKS/SURVEY CONTROL

PRIOR TO PROJECT START, OWNER WILL SET AND ESTABLISH BENCHMARKS AND SURVEY CONTROL FOR THE PROJECT, AND CLEARLY MARK RIGHT–OF–WAY.

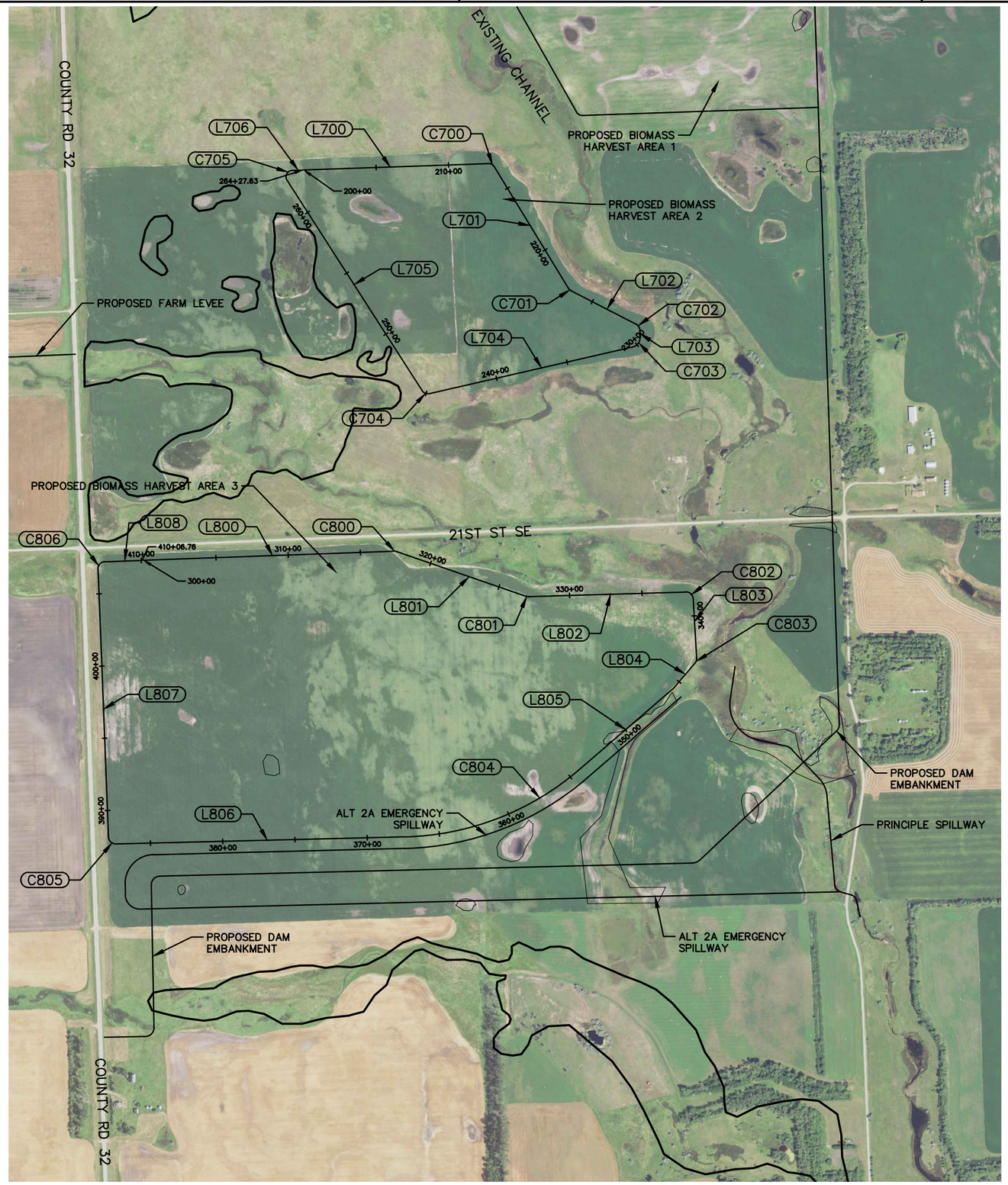
moore engineering, inc.

ALIGNMENT LAYOUT AND CONTROL
RCPP/PL566 UPPER MAPLE RIVER WATERSHED ALTERNATIVE 2A
CASS COUNTY JOINT WATER RESOURCE DISTRICT
BARNES COUNTY, NORTH DAKOTA
ALTERNATE 2A BIOMASS HARVEST AREA 1

DATE:	05.25.23
REVISED:	----
REVISED:	----
REVISED:	----
REVISED:	----
REVISED:	----
RECORD:	----
PROJECT No.	18746
MANAGER:	KRL
DESIGNER:	ZJT
DRAFTER:	ZJT
REVIEWER:	JMH

C-106

SHEET 8 OF 39



HORIZONTAL CONTROL

NORTH DAKOTA COORDINATE SYSTEM OF 1983, NAD83, SOUTH ZONE
COMBINATION FACTOR (cf) = .9998710
ALL COORDINATES ARE BARNES COUNTY GROUND COORDINATES

VERTICAL CONTROL

NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD88)

BENCHMARKS/SURVEY CONTROL

PRIOR TO PROJECT START, OWNER WILL SET AND ESTABLISH BENCHMARKS AND SURVEY CONTROL FOR THE PROJECT, AND CLEARLY MARK RIGHT-OF-WAY.

N W E S

0 800
Scale in Feet

PRELIMINARY

BIOMASS HARVESTING AREA 2 ALIGNMENT LINE AND CURVE TABLE

Number	Length	Radius	Delta	Bearing	Start Sta.	End Sta.	Start Northing/Easting	End Northing/Easting
L700	1275.37	N/A	N/A	N87°59'38"E	200+00	212+75.37	540403.98/2644896.21	540448.62/2646170.81
C700	52.90	50.00	60°37'27"	S61°41'38"E	212+75.37	213+28.28	540448.62/2646170.81	540424.69/2646215.24
L701	980.66	N/A	N/A	S31°22'55"E	213+28.28	223+08.94	540424.69/2646215.24	539587.49/2646725.91
C701	27.35	50.00	31°20'24"	S47°03'07"E	223+08.94	223+36.29	539587.49/2646725.91	539569.08/2646745.68
L702	503.43	N/A	N/A	S62°43'19"E	223+36.29	228+39.72	539569.08/2646745.68	539338.35/2647193.13
C702	52.23	50.00	59°51'13"	S32°47'42"E	228+39.72	228+91.95	539338.35/2647193.13	539296.42/2647220.15
L703	50.78	N/A	N/A	S2°52'06"E	228+91.95	229+42.73	539296.42/2647220.15	539245.70/2647222.69
C703	88.24	63.26	79°55'07"	S37°05'28"W	229+42.73	230+30.96	539245.70/2647222.69	539180.89/2647173.69
L704	1443.86	N/A	N/A	S77°03'01"W	230+30.96	244+74.83	539180.89/2647173.69	538857.33/2645766.55
C704	61.29	50.00	70°14'05"	N67°49'56"W	244+74.83	245+36.12	538857.33/2645766.55	538879.03/2645713.27
L705	1726.77	N/A	N/A	N32°42'53"W	245+36.12	262+62.88	538879.03/2645713.27	540331.88/2644780.03
C705	94.80	45.00	120°42'31"	N27°38'22"E	262+62.88	263+57.69	540331.88/2644780.03	540401.18/2644816.32
L706	69.95	N/A	N/A	N87°59'38"E	263+57.69	264+27.63	540401.18/2644816.32	540403.63/2644886.22

BIOMASS HARVESTING AREA 3 ALIGNMENT LINE AND CURVE TABLE

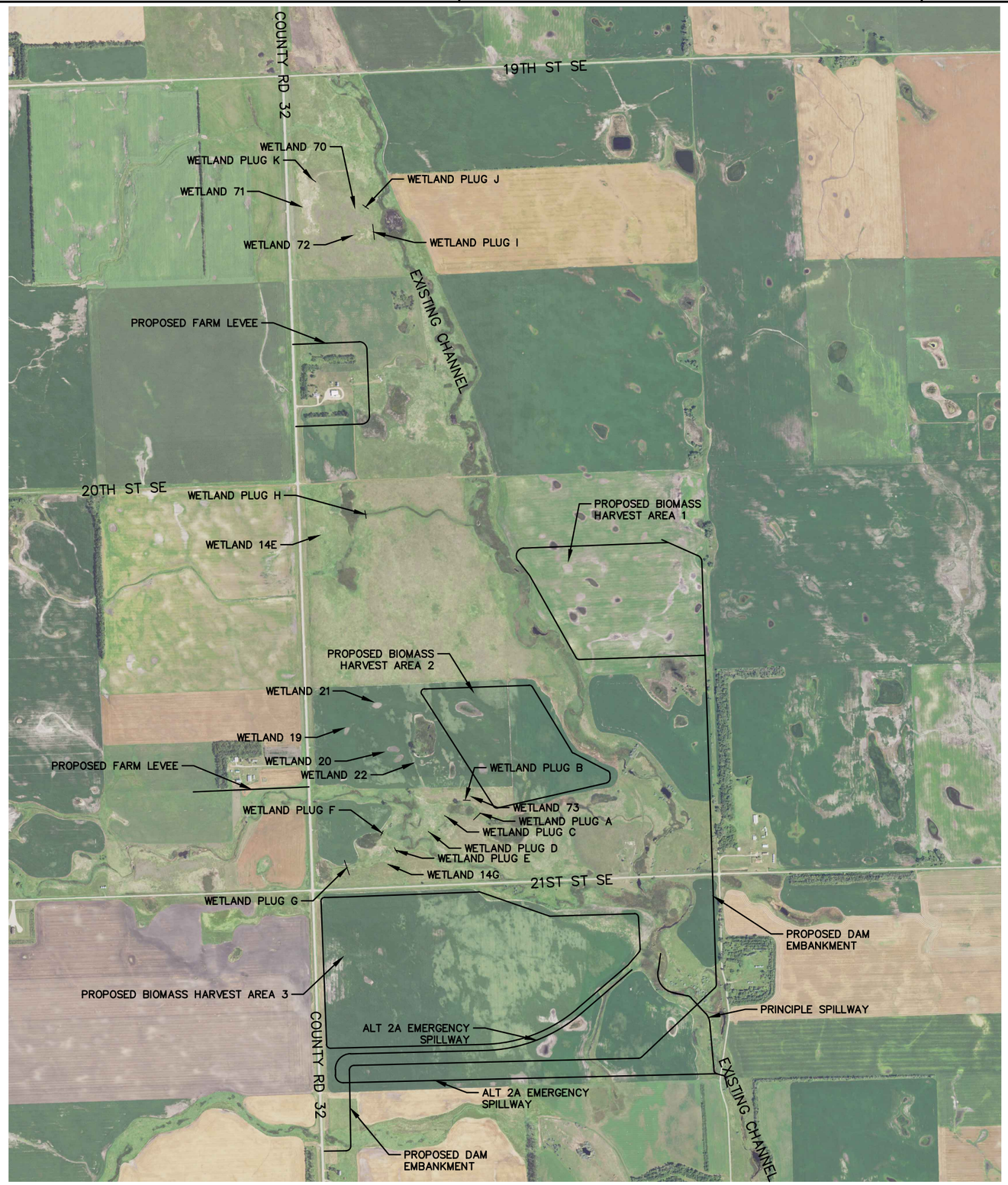
Number	Length	Radius	Delta	Bearing	Start Sta.	End Sta.	Start Northing/Easting	End Northing/Easting
L800	1732.47	N/A	N/A	N87°54'23"E	300+00	317+32.47	537703.99/2643787.93	537767.28/2645519.24
C800	18.44	50.00	21°07'45"	S81°31'44"E	317+32.47	317+50.91	537767.28/2645519.24	537764.58/2645537.38
L801	946.76	N/A	N/A	S70°57'52"E	317+50.91	326+97.66	537764.58/2645537.38	537455.79/2646432.36
C801	18.08	50.00	20°43'16"	S81°19'30"E	326+97.66	327+15.74	537455.79/2646432.36	537453.08/2646450.14
L802	1088.69	N/A	N/A	N88°18'52"E	327+15.74	338+04.43	537453.08/2646450.14	537485.10/2647538.36
C802	77.06	50.00	88°18'17"	S47°31'59"E	338+04.43	338+81.49	537485.10/2647538.36	537438.07/2647589.74
L803	411.02	N/A	N/A	S3°22'51"E	338+81.49	342+92.51	537438.07/2647589.74	537027.77/2647613.98
C803	38.52	50.00	44°08'30"	S18°41'24"W	342+92.51	343+31.03	537027.77/2647613.98	536992.18/2647601.94
L804	229.22	N/A	N/A	S40°45'39"W	343+31.03	345+60.25	536992.18/2647601.94	536818.56/2647452.28
L805	859.74	N/A	N/A	S49°12'10"W	345+60.25	354+19.99	536818.56/2647452.28	536256.82/2646801.44
C804	1319.80	1920.00	39°23'06"	S68°53'43"W	354+19.99	367+39.79	536256.82/2646801.44	535790.90/2645594.26
L806	1998.71	N/A	N/A	S88°35'16"W	367+39.79	387+38.50	535790.90/2645594.26	535741.64/2643596.15
C805	77.81	50.00	89°09'47"	N46°49'50"W	387+38.50	388+16.31	535741.64/2643596.15	535789.66/2643544.96
L807	1854.05	N/A	N/A	N2°14'57"W	388+16.31	406+70.36	535789.66/2643544.96	537642.28/2643472.20
C806	78.68	50.00	90°09'20"	N42°49'43"E	406+70.36	407+49.04	537642.28/2643472.20	537694.21/2643520.34
L808	257.72	N/A	N/A	N87°54'23"E	407+49.04	410+06.76	537694.21/2643520.34	537703.63/2643777.89

moore engineering, inc.

ALIGNMENT LAYOUT AND CONTROL
RCPP/PL566 UPPER MAPLE RIVER WATERSHED ALTERNATIVE 2A
CASS COUNTY JOINT WATER RESOURCE DISTRICT
BARNES COUNTY, NORTH DAKOTA
ALTERNATE 2A BIOMASS HARVEST AREAS 2 & 3

DATE:	05.25.23
REVISED:	----
REVISED:	----
REVISED:	----
REVISED:	----
REVISED:	----
RECORD:	----
PROJECT No.	18746
MANAGER:	KRL
DESIGNER:	ZJT
DRAFTER:	ZJT
REVIEWER:	JMH

C-107



FILE LOCATION: R:\Projects\18000\18700\18746\DRAWINGS\DESIGN\18746-ALT-2A-PP.dwg

WETLAND PLUG TABULATION

	WETLAND PLUG ID	TOP ELEVATION	APPROXIMATE FILL REQUIRED (CU YD)
SITE 2A	A	1247.00	1160
	B	1242.0	200
	C	1240.0	80
	D	1239.0	70
	E	1240.0	100
	F	1241.0	80
	G	1247.0	1250
	H	1245.0	400
	I	1250.0	760
	J	1248.00	110
	K	1252.0	270
	TOTAL		4480.0

N
W E
S
0 1500
Scale in Feet

PRELIMINARY

WETLAND IMPROVEMENTS TABULATION

	WETLAND ID	PRE-PROJECT AREA (ACRES)	POST PROJECT AREA (ACRES)	NET WETLAND GAIN (ACRES)	MEANS OF IMPROVEMENT
SITE 2A	14G	21.10	29.0	7.9	WETLAND PLUG (RESTORATION)
	14E	13.8	18.8	5.0	WETLAND PLUG (RESTORATION)
	19	1.2	1.2	0.0	RESTORE FUNCTIONS
	20	0.9	0.9	0.0	RESTORE FUNCTIONS
	21	0.7	0.7	0.0	RESTORE FUNCTIONS
	22	5.1	5.1	0.0	RESTORE FUNCTIONS
	BIOMASS HARVEST AREA 1	0.0	88.8	88.8	BIOMASS HARVEST AREA
	BIOMASS HARVEST AREA 2	0.0	52.3	52.3	BIOMASS HARVEST AREA
	BIOMASS HARVEST AREA 3	0.0	113.80	113.8	BIOMASS HARVEST AREA
	70	0.00	0.4	0.4	WETLAND PLUG (RESTORATION)
	71	0.0	2.8	2.8	WETLAND PLUG (RESTORATION)
	72	0.0	1.5	1.5	WETLAND PLUG (RESTORATION)
	73	0.0	0.6	0.6	WETLAND PLUG (RESTORATION)

moore engineering, inc.

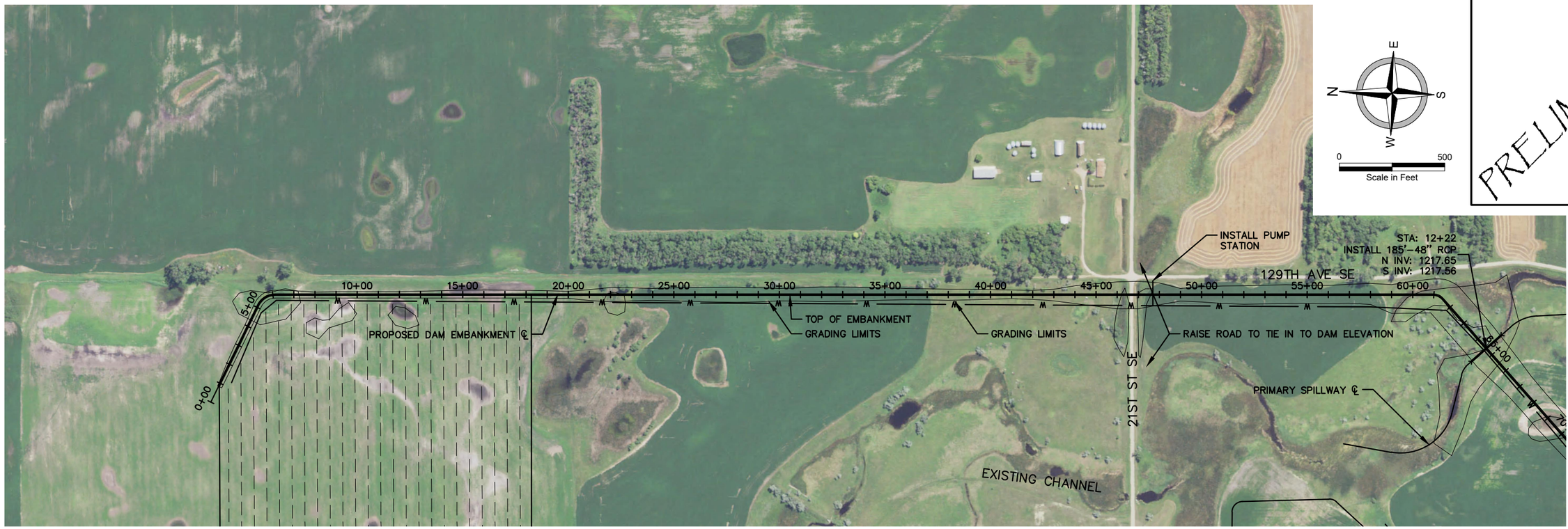
WETLAND LAYOUT AND TABULATIONS
RCPP/PL566 UPPER MAPLE RIVER WATERSHED ALTERNATIVE 2A
CASS COUNTY JOINT WATER RESOURCE DISTRICT
BARNES COUNTY, NORTH DAKOTA
WETLAND IMPROVEMENTS

DATE:	05.25.23
REVISED:	----
REVISED:	----
REVISED:	----
REVISED:	----
REVISED:	----
RECORD:	----
PROJECT No.	18746
MANAGER:	KRL
DESIGNER:	ZJT
DRAFTER:	ZJT
REVIEWER:	JMH

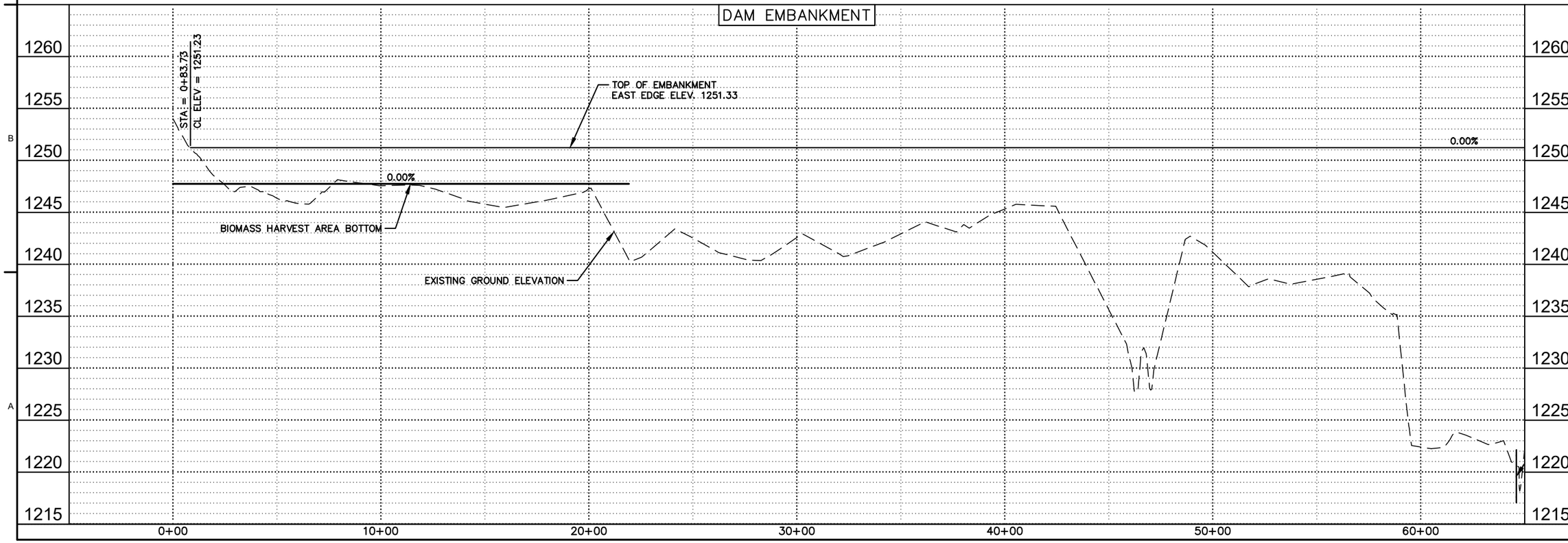
C-108

SHEET 10 OF 39

FILE LOCATION: R:\Projects\18000\18700\18746\DRAWINGS\DESIGN\18746-ALT-2A-PP.dwg



PRELIMINARY



moore engineering, inc.

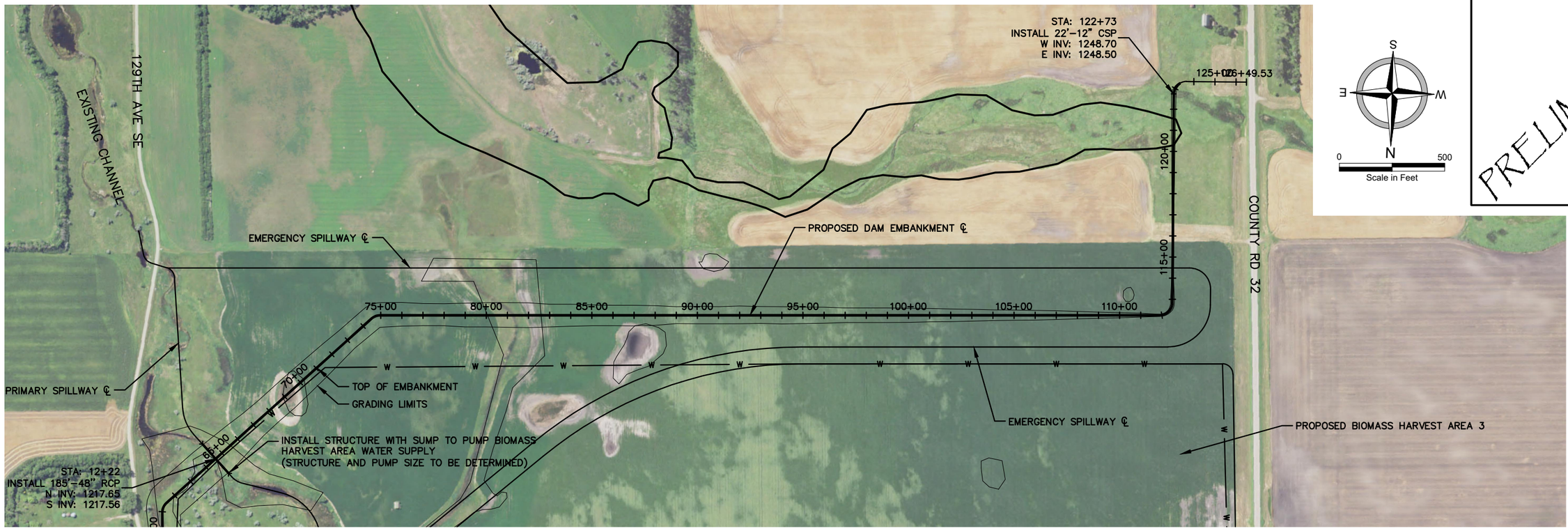
PLAN AND PROFILE
RCPP/PL566 UPPER MAPLE RIVER WATERSHED ALTERNATIVE 2A
CASS COUNTY JOINT WATER RESOURCE DISTRICT
BARNES COUNTY, NORTH DAKOTA
DAM EMBANKMENT

DATE:	05.25.23
REVISED:	----
REVISED:	----
REVISED:	----
REVISED:	----
REVISED:	----
RECORD:	----
PROJECT No.	18746
MANAGER:	KRL
DESIGNER:	ZJT
DRAFTER:	ZJT
REVIEWER:	JMH

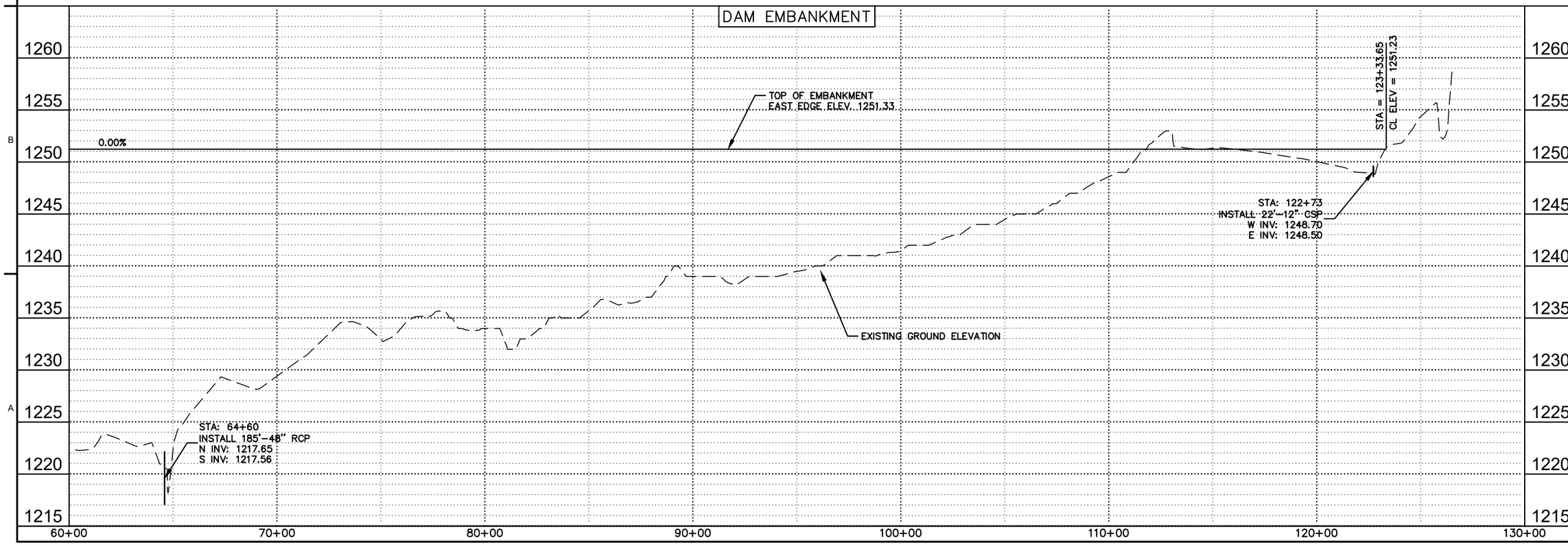
C-201

SHEET 11 OF 39

FILE LOCATION: R:\Projects\18000\18700\18746\DRAWINGS\DESIGN\18746-ALT-2A-PP.dwg



PRELIMINARY



moore engineering, inc.

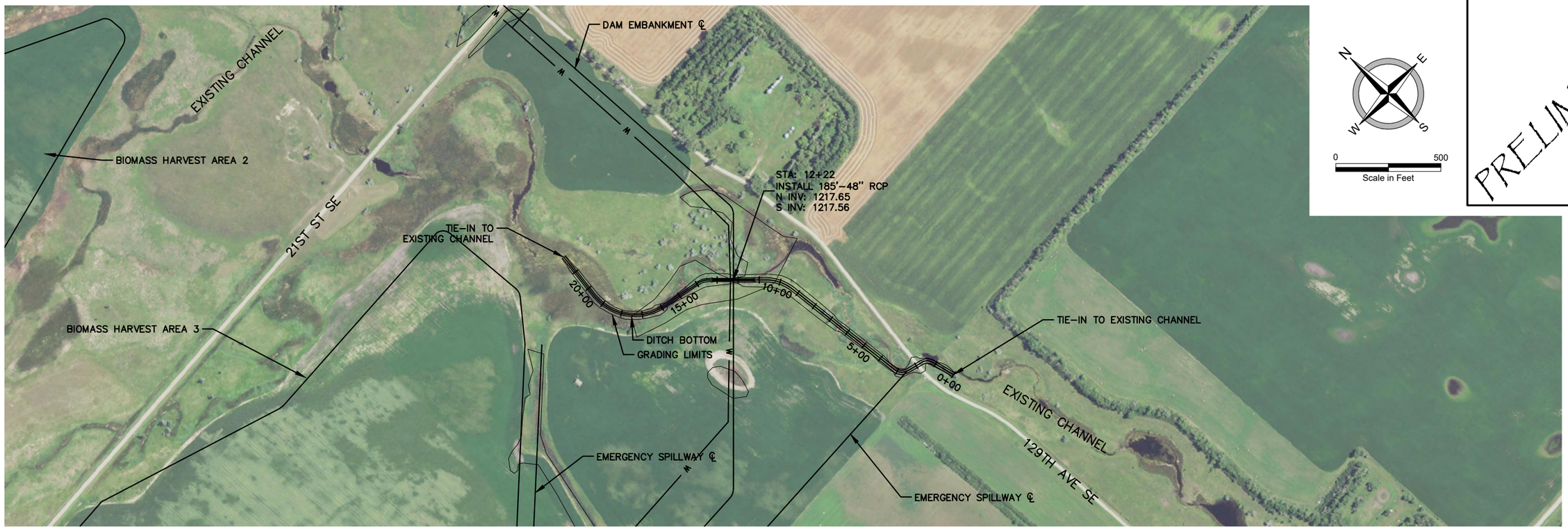
PLAN AND PROFILE
RCPP/PL566 UPPER MAPLE RIVER WATERSHED ALTERNATIVE 2A
CASS COUNTY JOINT WATER RESOURCE DISTRICT
BARNES COUNTY, NORTH DAKOTA
DAM EMBANKMENT

DATE:	05.25.23
REVISED:	----
REVISED:	----
REVISED:	----
REVISED:	----
REVISED:	----
RECORD:	----
PROJECT No.	18746
MANAGER:	KRL
DESIGNER:	ZJT
DRAFTER:	ZJT
REVIEWER:	JMH

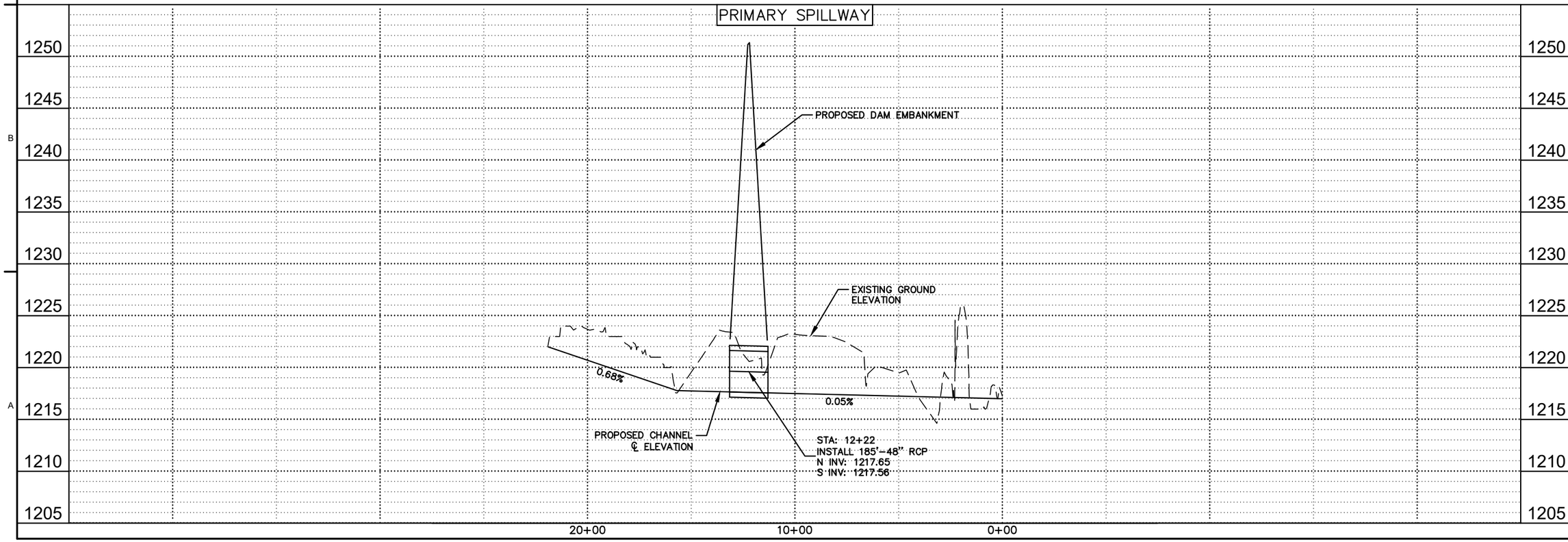
C-202

SHEET 12 OF 39

FILE LOCATION: R:\Projects\18000\18700\18746\DRAWINGS\DESIGN\18746-ALT-2A-PP.dwg



PRELIMINARY



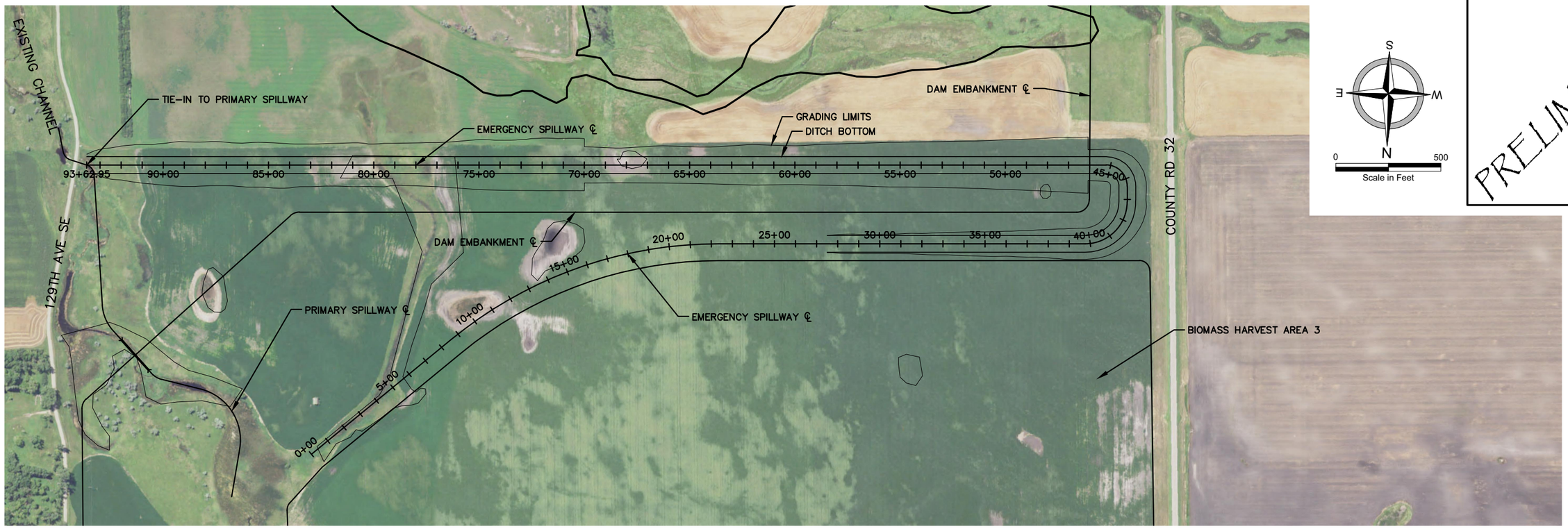
moore engineering, inc.

PLAN AND PROFILE
RCPP/PL566 UPPER MAPLE RIVER WATERSHED ALTERNATIVE 2A
CASS COUNTY JOINT WATER RESOURCE DISTRICT
BARNES COUNTY, NORTH DAKOTA
PRIMARY SPILLWAY

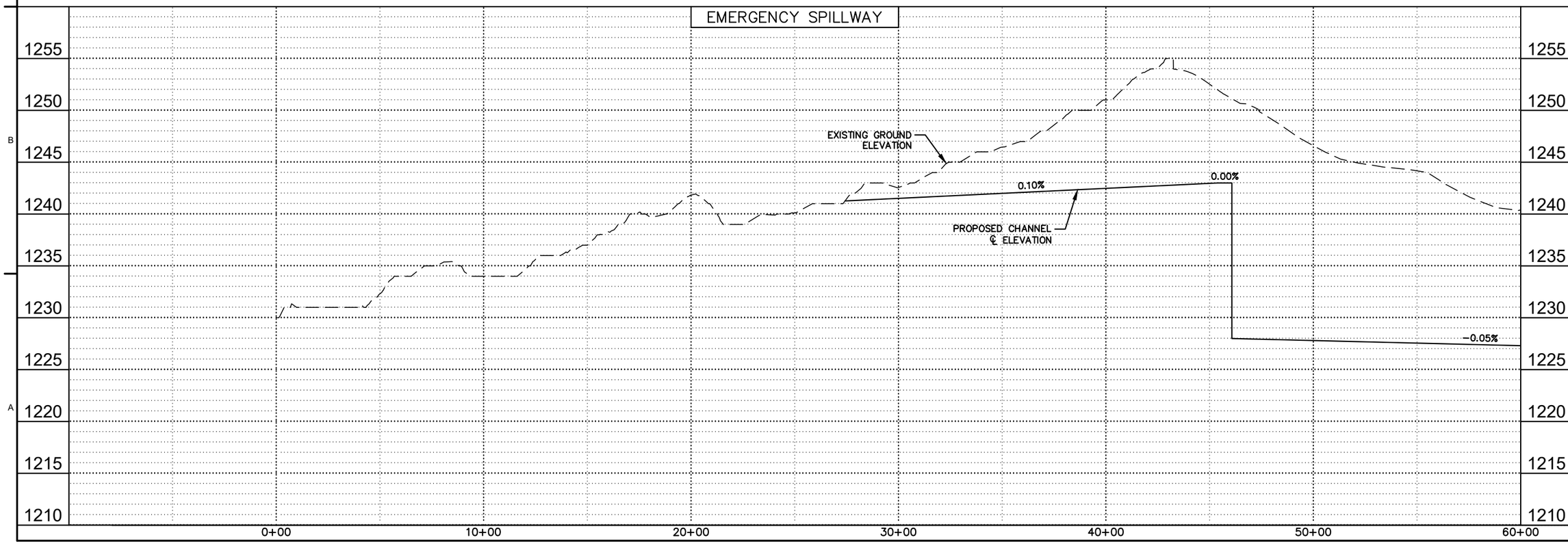
DATE:	05.25.23
REVISED:	----
REVISED:	----
REVISED:	----
REVISED:	----
REVISED:	----
RECORD:	----
PROJECT No.	18746
MANAGER:	KRL
DESIGNER:	ZJT
DRAFTER:	ZJT
REVIEWER:	JMH

C-203

SHEET 13 OF 39



PRELIMINARY



moore engineering, inc.

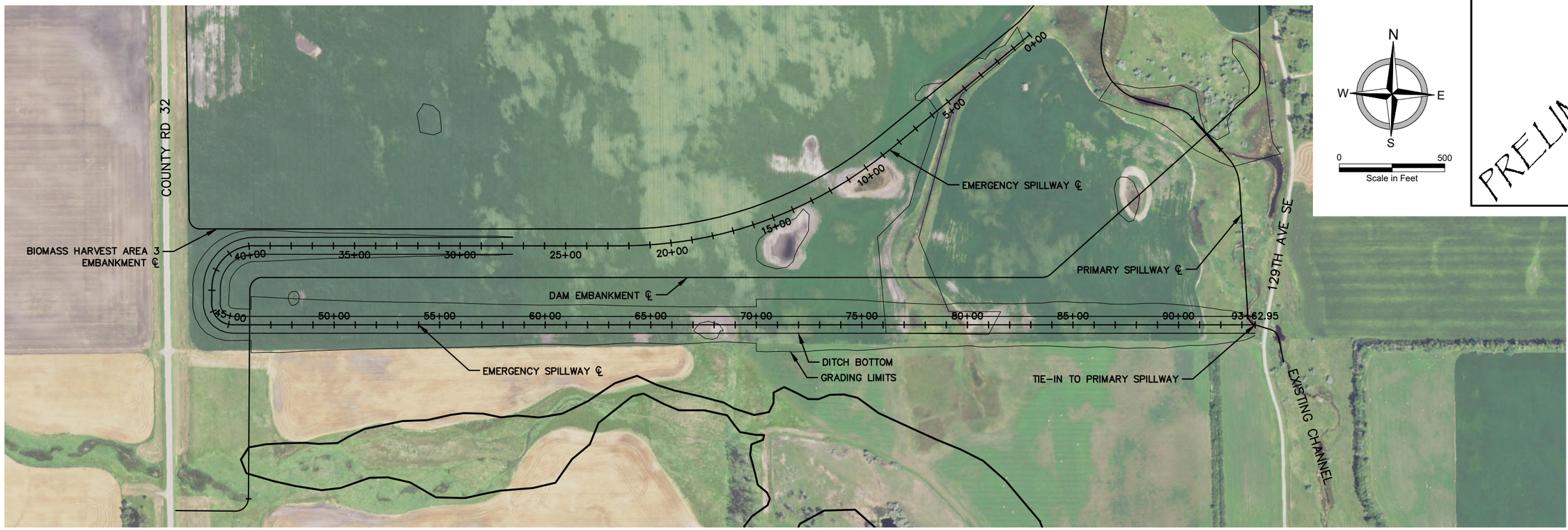
PLAN AND PROFILE
RCPP/PL566 UPPER MAPLE RIVER WATERSHED ALTERNATIVE 2A
CASS COUNTY JOINT WATER RESOURCE DISTRICT
BARNES COUNTY, NORTH DAKOTA
EMERGENCY SPILLWAY

DATE:	05.25.23
REVISED:	----
REVISED:	----
REVISED:	----
REVISED:	----
REVISED:	----
RECORD:	----
PROJECT No.	18746
MANAGER:	KRL
DESIGNER:	ZJT
DRAFTER:	ZJT
REVIEWER:	JMH

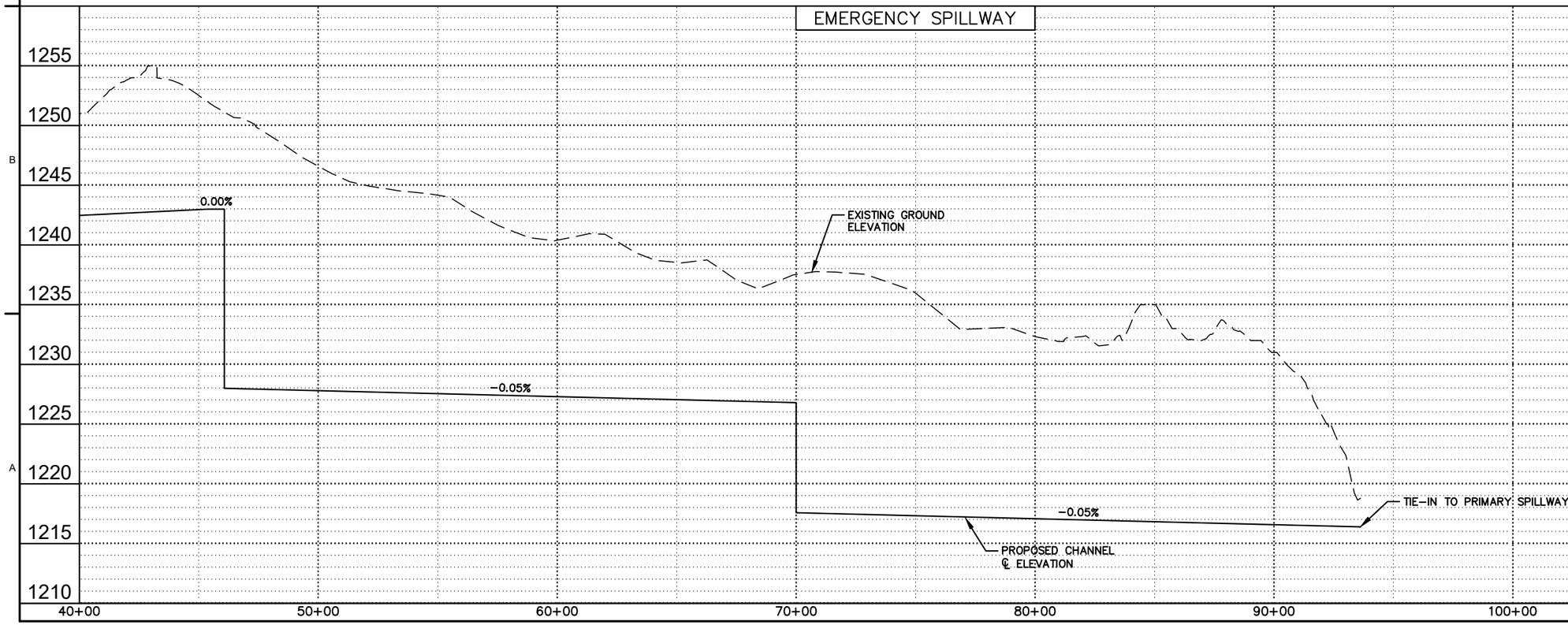
C-204

SHEET 14 OF 39

FILE LOCATION: R:\Projects\18000\18700\18746\DRAWINGS\DESIGN\18746-ALT-2A-PP.dwg



PRELIMINARY



moore engineering, inc.

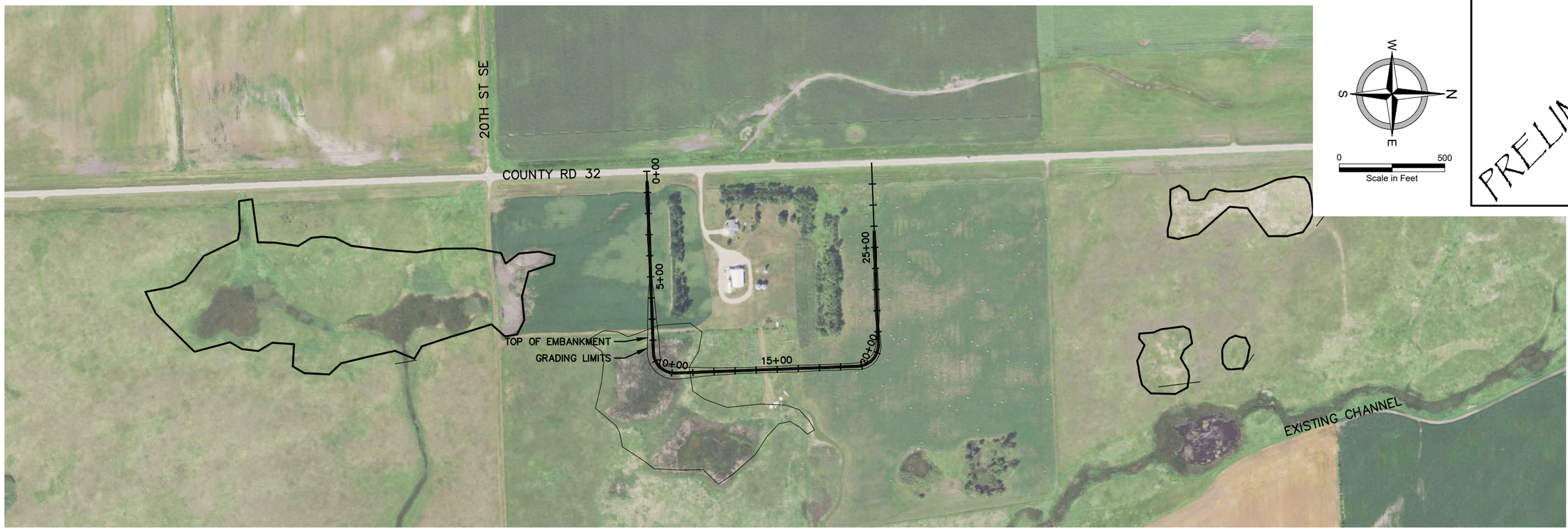
PLAN AND PROFILE
RCPP/PL566 UPPER MAPLE RIVER WATERSHED ALTERNATIVE 2A
CASS COUNTY JOINT WATER RESOURCE DISTRICT
BARNES COUNTY, NORTH DAKOTA
EMERGENCY SPILLWAY

DATE:	05.25.23
REVISED:	----
REVISED:	----
REVISED:	----
REVISED:	----
REVISED:	----
RECORD:	----
PROJECT No.	18746
MANAGER:	KRL
DESIGNER:	ZJT
DRAFTER:	ZJT
REVIEWER:	JMH

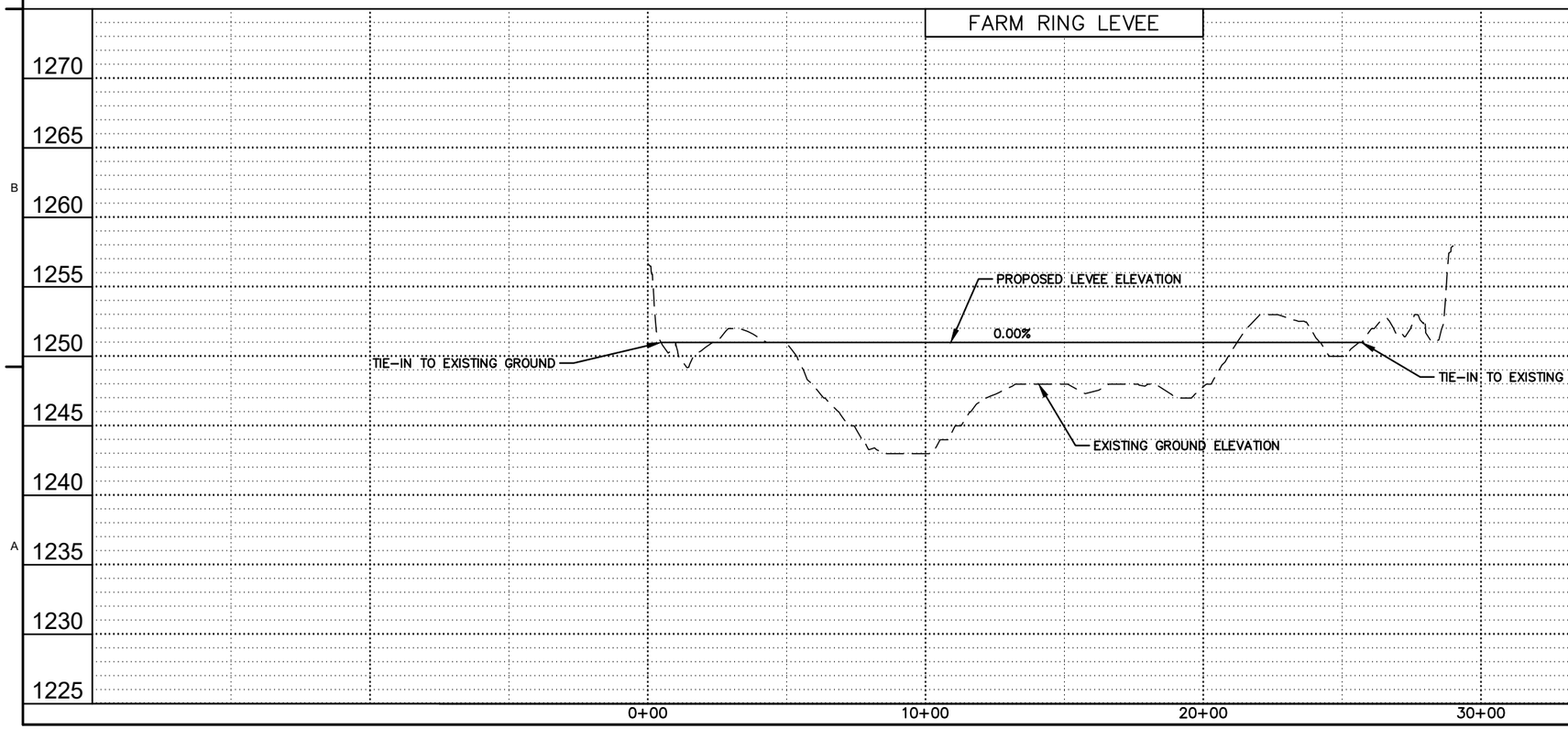
C-205

SHEET 15 OF 39

FILE LOCATION: R:\Projects\18000\18700\18746\DRAW\NGS\DESIGN\18746-ALT-2A-PP.dwg



PRELIMINARY



moore engineering, inc.

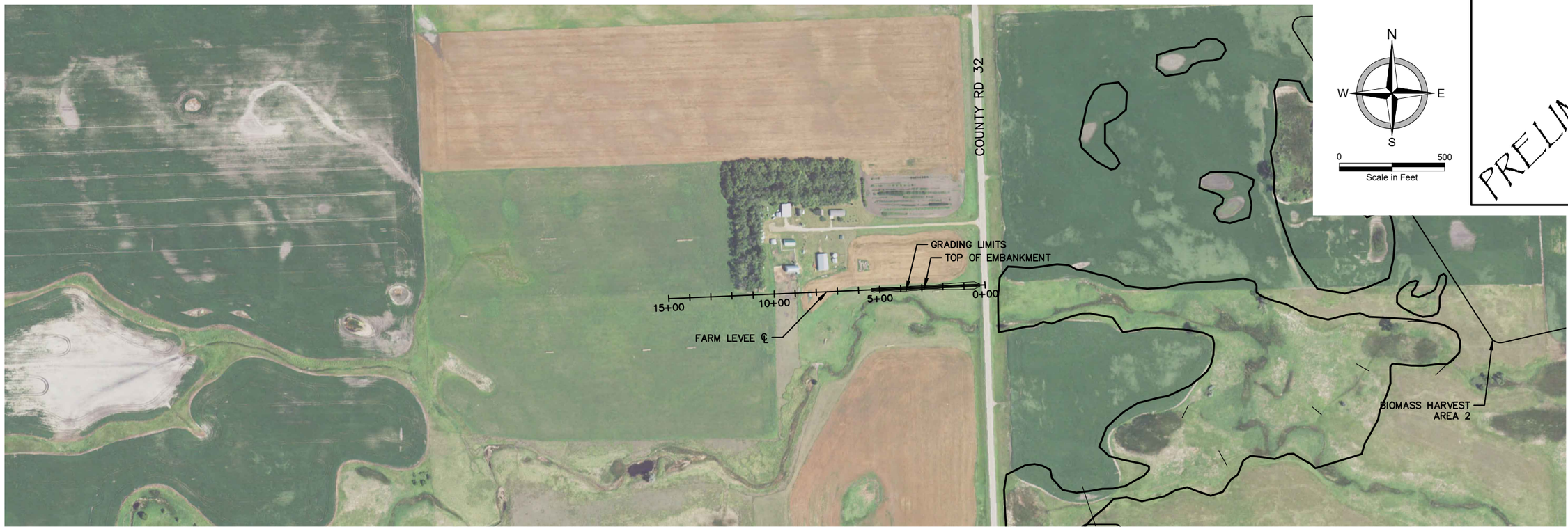
PLAN AND PROFILE
RCPP/PL566 UPPER MAPLE RIVER WATERSHED ALTERNATIVE 2A
CASS COUNTY JOINT WATER RESOURCE DISTRICT
BARNES COUNTY, NORTH DAKOTA
FARM RING LEVEE

DATE:	05.25.23
REVISED:	----
REVISED:	----
REVISED:	----
REVISED:	----
REVISED:	----
RECORD:	----
PROJECT No.	18746
MANAGER:	KRL
DESIGNER:	ZJT
DRAFTER:	ZJT
REVIEWER:	JMH

C-206

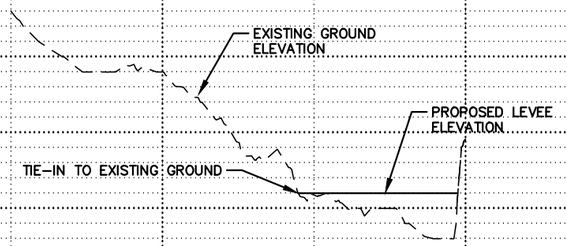
SHEET 16 OF 39

FILE LOCATION: R:\Projects\18000\18700\18746\DRAWINGS\DESIGN\18746-ALT-2A-PP.dwg



PRELIMINARY

FARM LEVEE



1270 1265 1260 1255 1250 1245 1240 1235 1230 1225

10+00 0+00

moore engineering, inc.

PLAN AND PROFILE
RCPP/PL566 UPPER MAPLE RIVER WATERSHED ALTERNATIVE 2A
CASS COUNTY JOINT WATER RESOURCE DISTRICT
BARNES COUNTY, NORTH DAKOTA
FARM LEVEE

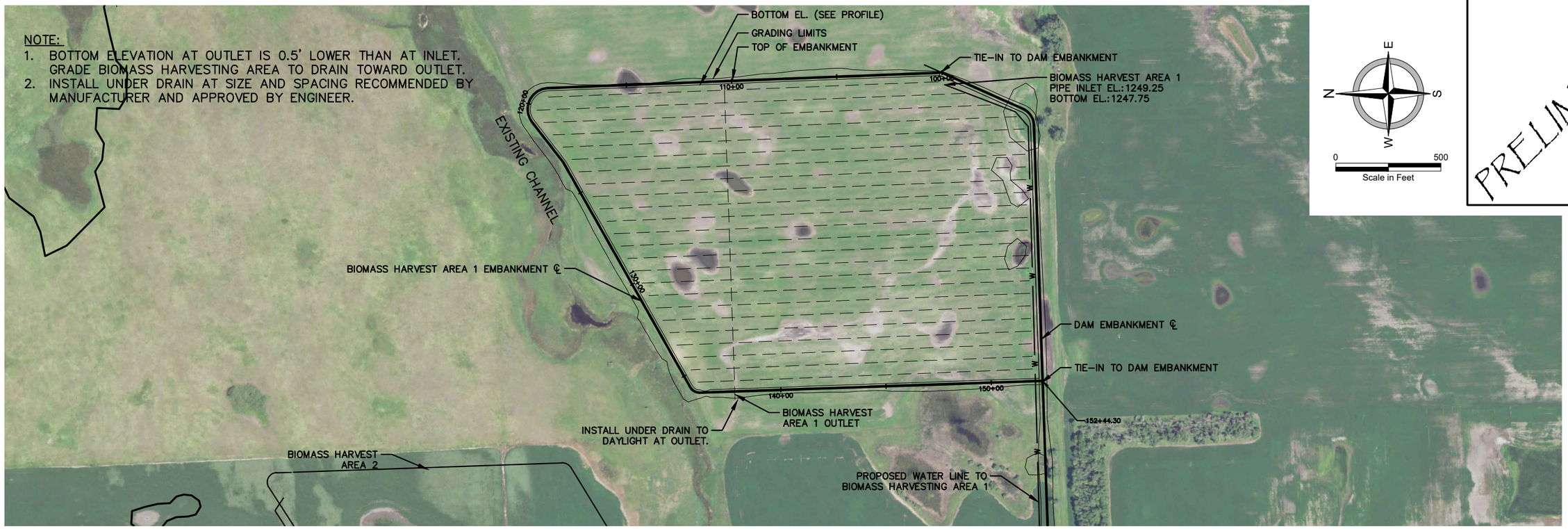
DATE:	05.25.23
REVISED:	----
REVISED:	----
REVISED:	----
REVISED:	----
REVISED:	----
RECORD:	----
PROJECT No.	18746
MANAGER:	KRL
DESIGNER:	ZJT
DRAFTER:	ZJT
REVIEWER:	JMH

C-207

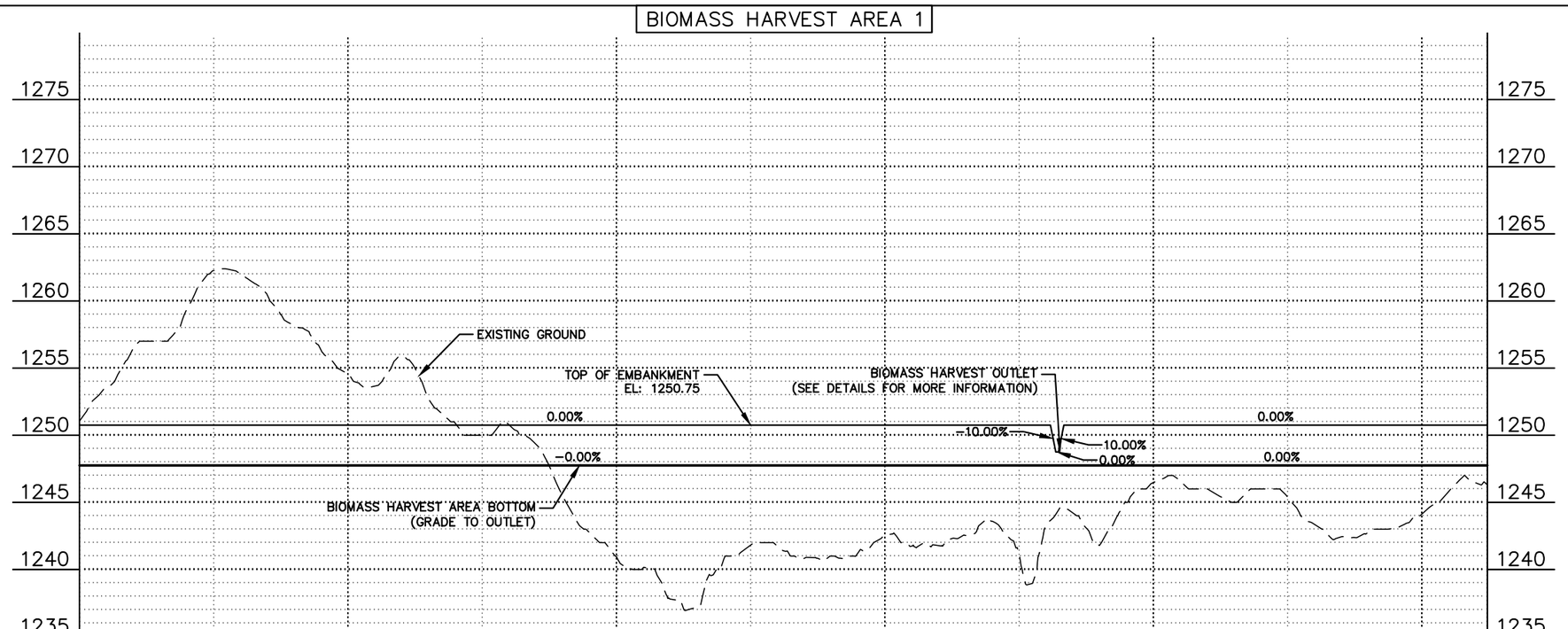
SHEET 17 OF 39

FILE LOCATION: R:\Projects\18000\18700\18746\DRAWINGS\DESIGN\18746-ALT-2A-PP.dwg

NOTE:
1. BOTTOM ELEVATION AT OUTLET IS 0.5' LOWER THAN AT INLET. GRADE BIOMASS HARVESTING AREA TO DRAIN TOWARD OUTLET.
2. INSTALL UNDER DRAIN AT SIZE AND SPACING RECOMMENDED BY MANUFACTURER AND APPROVED BY ENGINEER.



PRELIMINARY



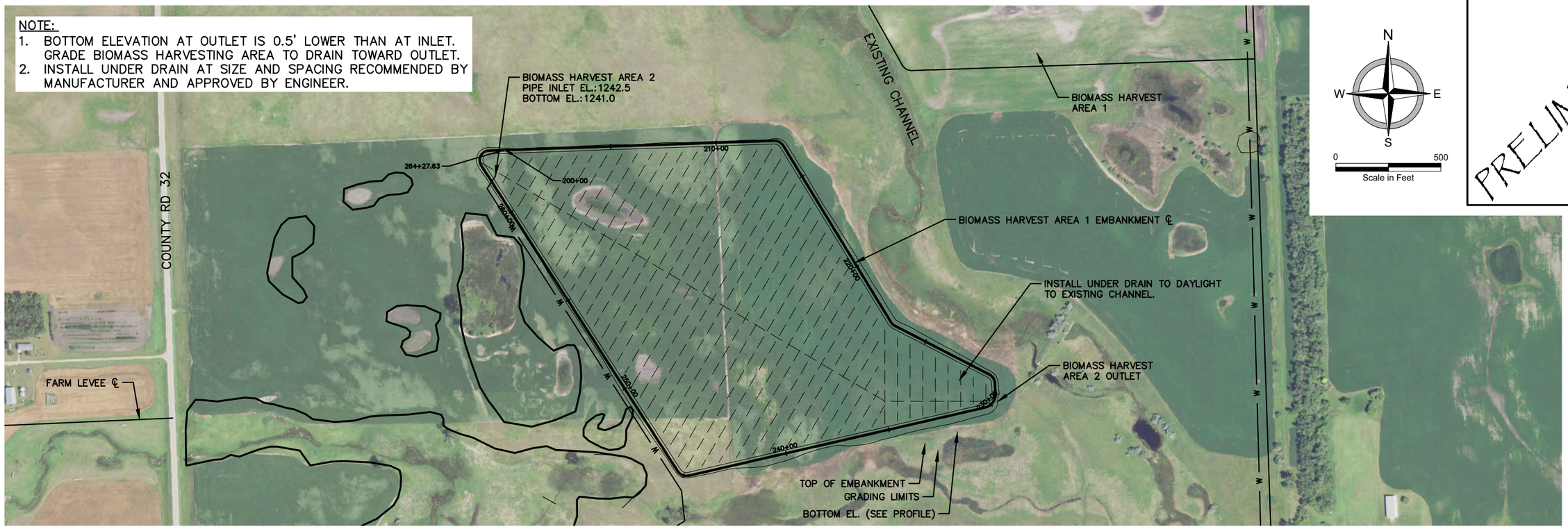
moore engineering, inc.

PLAN AND PROFILE
RCPP/PL566 UPPER MAPLE RIVER WATERSHED ALTERNATIVE 2A
CASS COUNTY JOINT WATER RESOURCE DISTRICT
BARNES COUNTY, NORTH DAKOTA
BIOMASS HARVEST AREA 1

DATE:	05.25.23
REVISED:	----
REVISED:	----
REVISED:	----
REVISED:	----
REVISED:	----
RECORD:	----
PROJECT No.	18746
MANAGER:	KRL
DESIGNER:	ZJT
DRAFTER:	ZJT
REVIEWER:	JMH

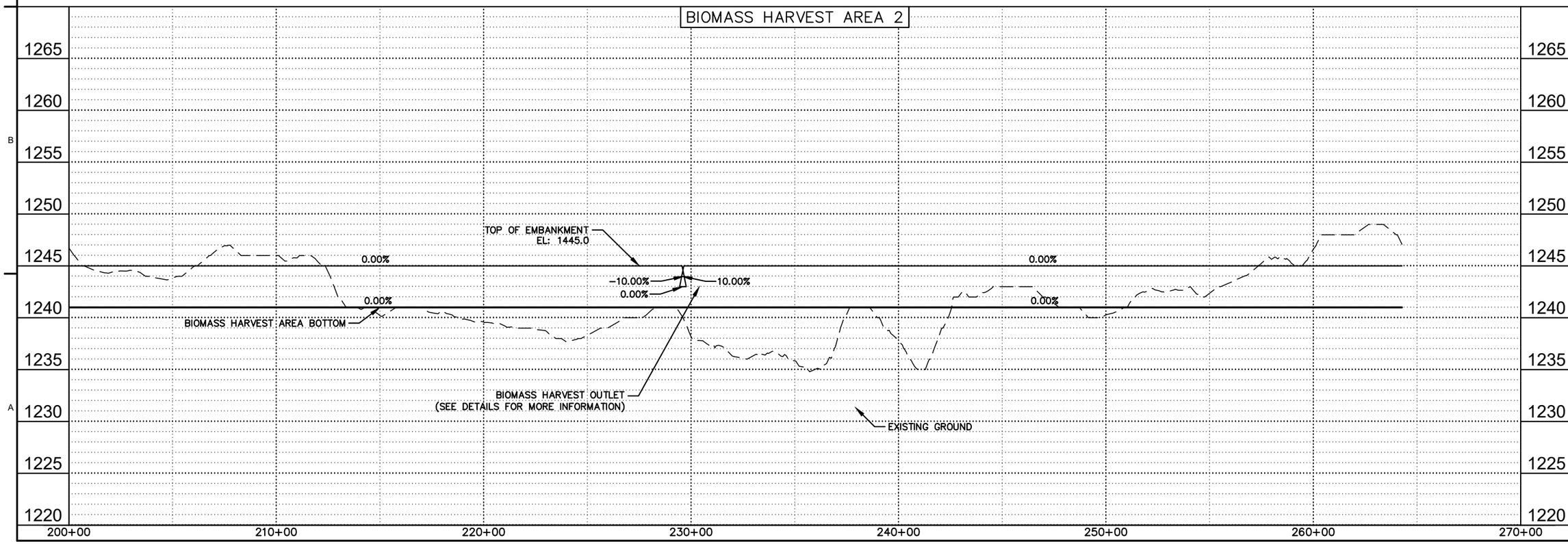
FILE LOCATION: R:\Projects\18000\18700\18746\DRAWINGS\DESIGN\18746-ALT-2A-PP.dwg

NOTE:
1. BOTTOM ELEVATION AT OUTLET IS 0.5' LOWER THAN AT INLET. GRADE BIOMASS HARVESTING AREA TO DRAIN TOWARD OUTLET.
2. INSTALL UNDER DRAIN AT SIZE AND SPACING RECOMMENDED BY MANUFACTURER AND APPROVED BY ENGINEER.



PRELIMINARY

BIOMASS HARVEST AREA 2



moore engineering, inc.

PLAN AND PROFILE
RCPP/PL566 UPPER MAPLE RIVER WATERSHED ALTERNATIVE 2A
CASS COUNTY JOINT WATER RESOURCE DISTRICT
BARNES COUNTY, NORTH DAKOTA
BIOMASS HARVEST AREA 2

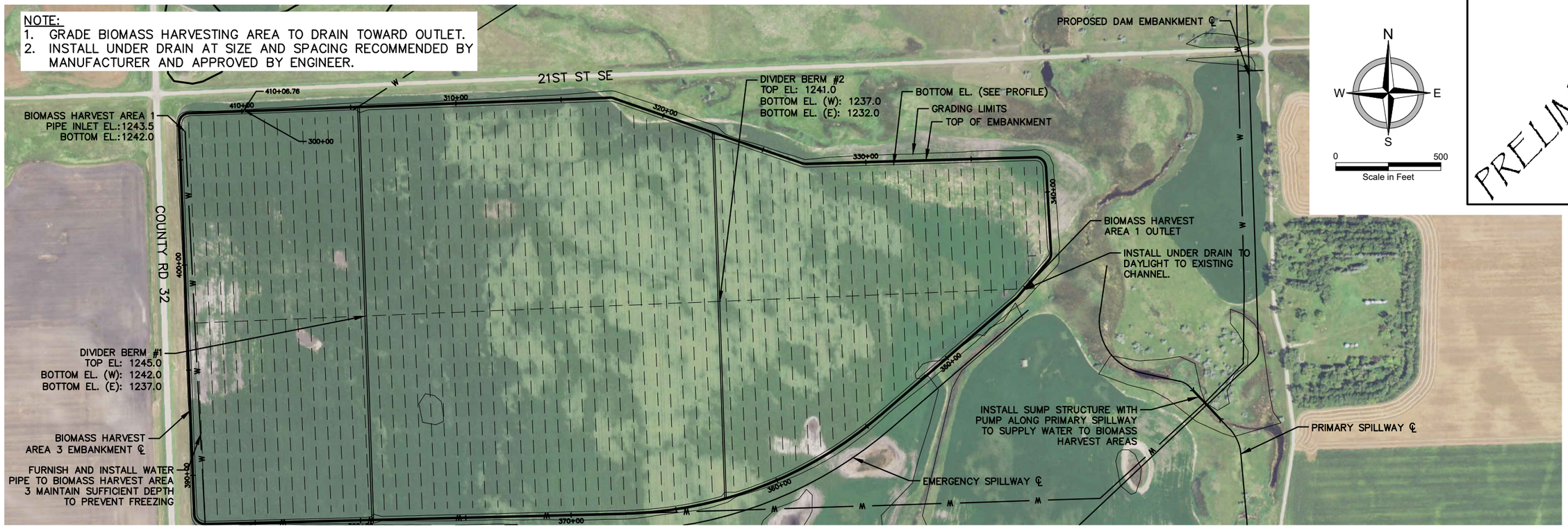
DATE:	05.25.23
REVISED:	----
REVISED:	----
REVISED:	----
REVISED:	----
REVISED:	----
RECORD:	----
PROJECT No.	18746
MANAGER:	KRL
DESIGNER:	ZJT
DRAFTER:	ZJT
REVIEWER:	JMH

C-209

SHEET 19 OF 39

FILE LOCATION: R:\Projects\18000\18700\18746\DRAWINGS\DESIGN\18746-ALT-2A-PP.dwg

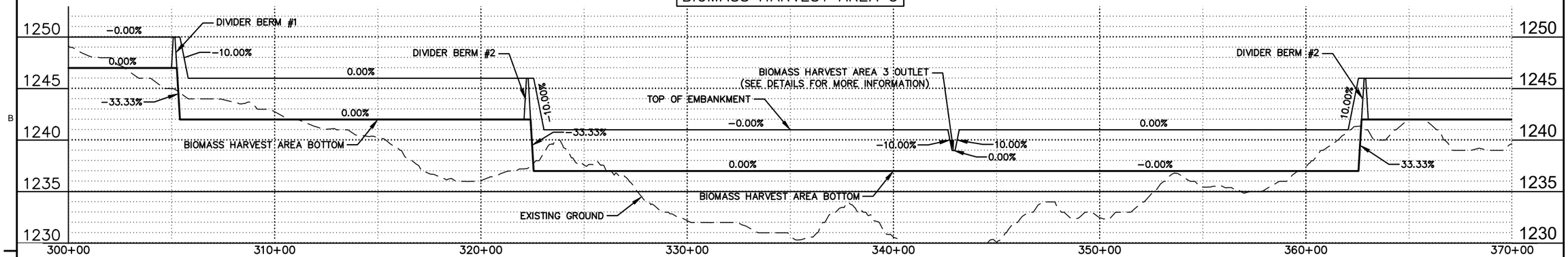
NOTE:
1. GRADE BIOMASS HARVESTING AREA TO DRAIN TOWARD OUTLET.
2. INSTALL UNDER DRAIN AT SIZE AND SPACING RECOMMENDED BY MANUFACTURER AND APPROVED BY ENGINEER.



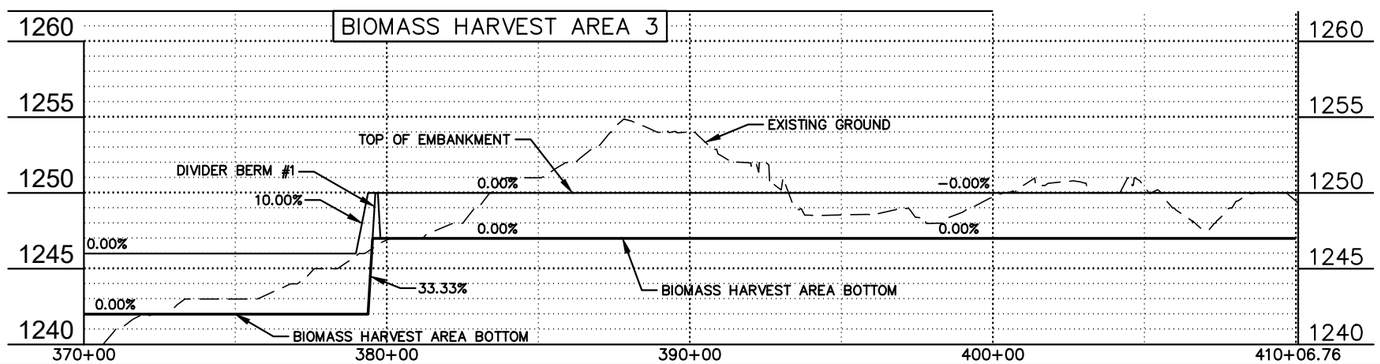
N
W E
S
0 500
Scale in Feet

PRELIMINARY

BIOMASS HARVEST AREA 3



BIOMASS HARVEST AREA 3



moore engineering, inc.

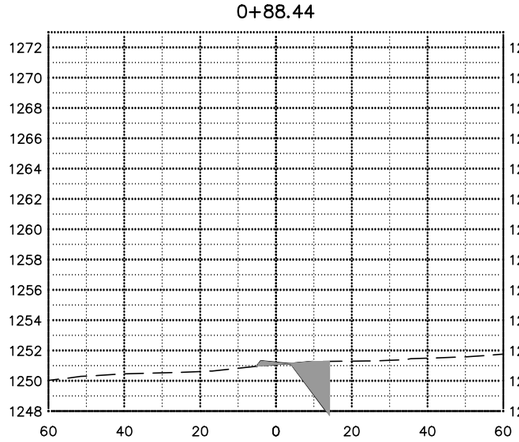
PLAN AND PROFILE
RCPP/PL566 UPPER MAPLE RIVER WATERSHED ALTERNATIVE 2A
CASS COUNTY JOINT WATER RESOURCE DISTRICT
BARNES COUNTY, NORTH DAKOTA
BIOMASS HARVEST AREA 3

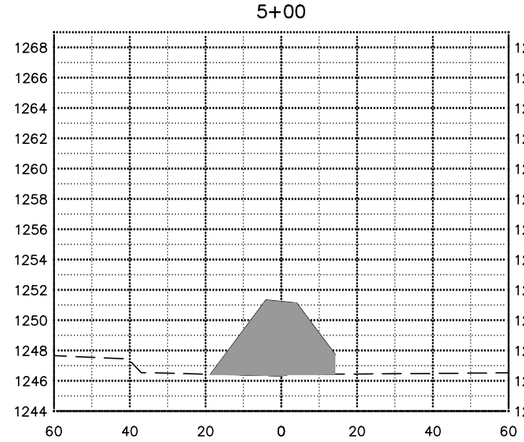
DATE:	05.25.23
REVISED:	----
REVISED:	----
REVISED:	----
REVISED:	----
REVISED:	----
RECORD:	----
PROJECT No.	18746
MANAGER:	KRL
DESIGNER:	ZJT
DRAFTER:	ZJT
REVIEWER:	JMH

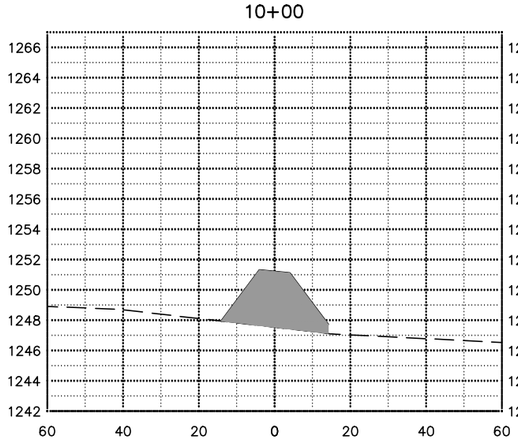
C-210

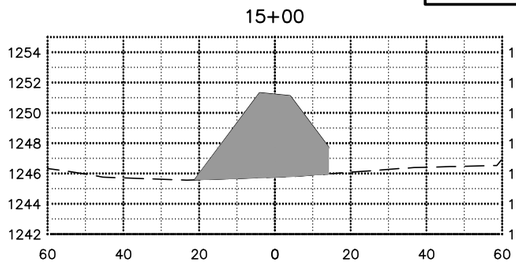
SHEET 20 OF 39

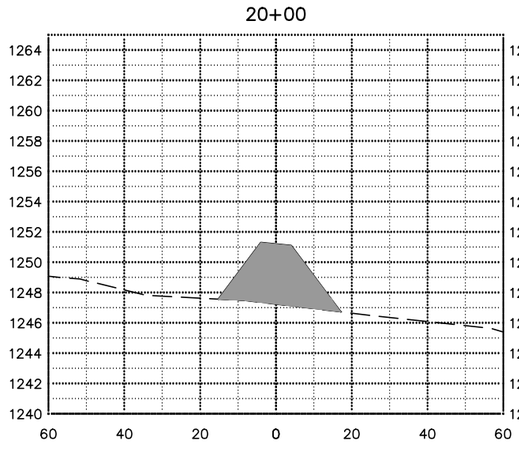
FILE LOCATION: R:\Projects\18000\18700\18746\DRAWINGS\DESIGN\18746-ALT-2A-PP.dwg

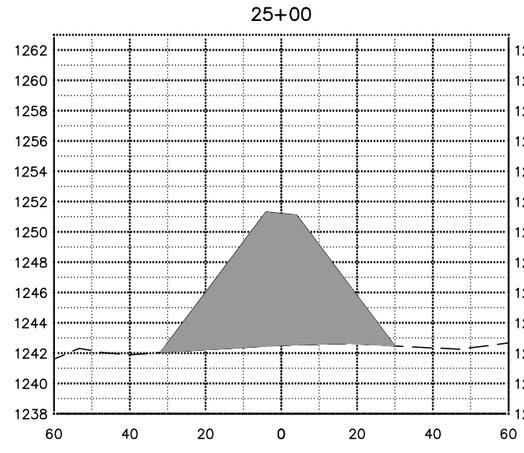


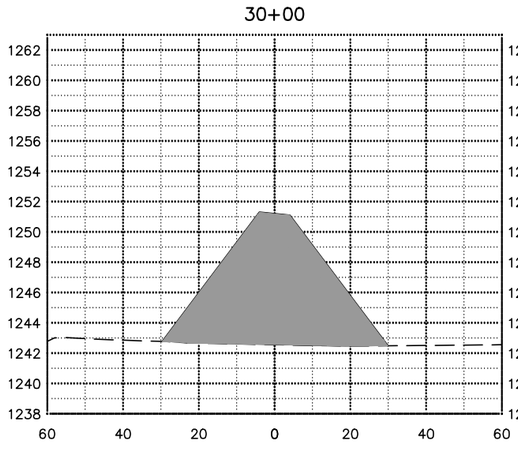


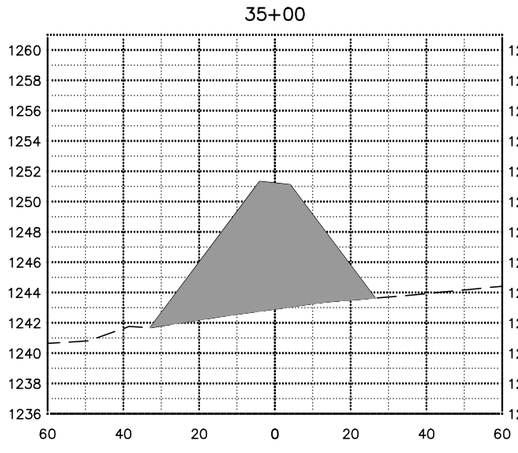


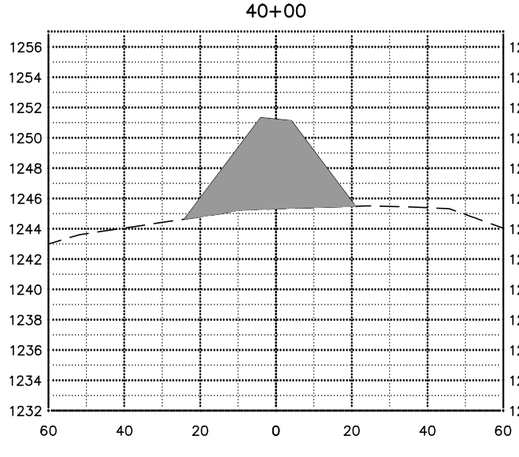


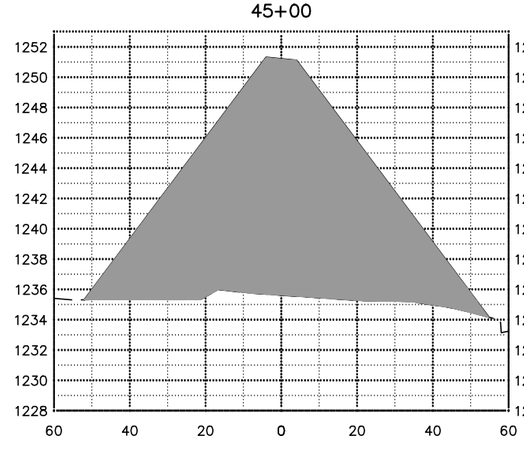


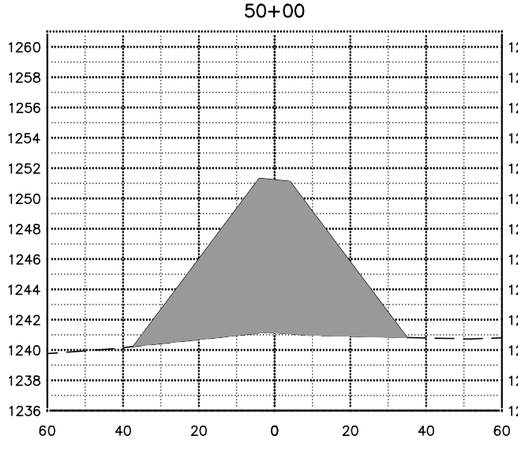


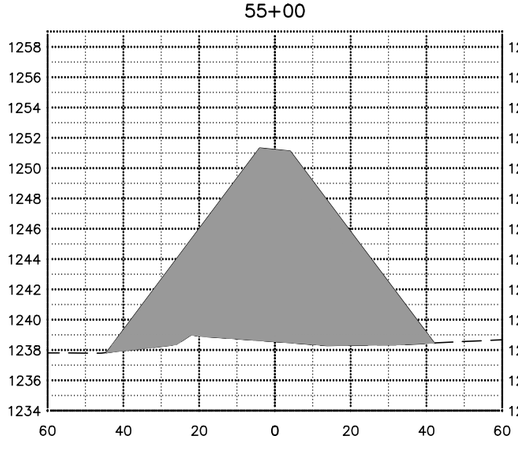












PRELIMINARY

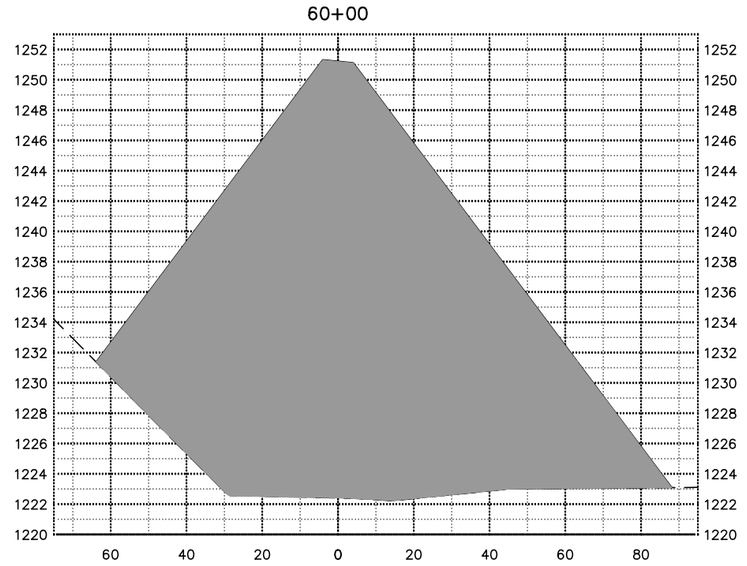
moore engineering, inc.

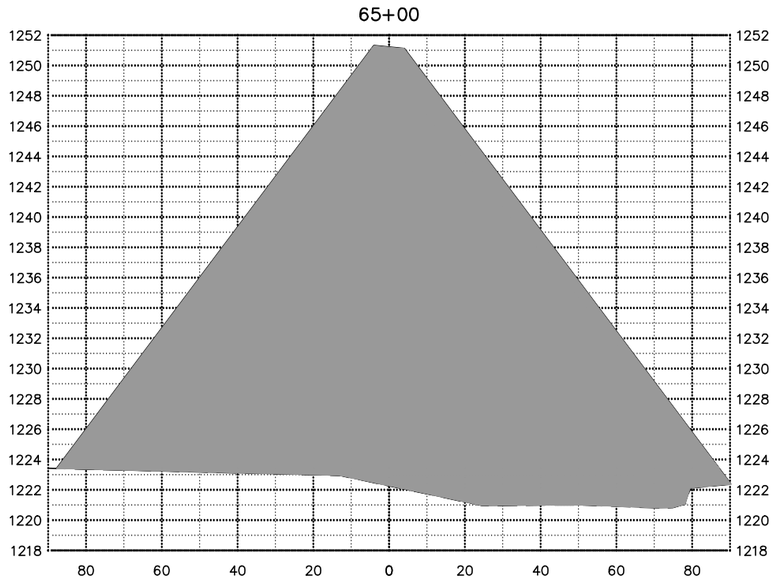
CROSS SECTIONS
RCPP/PL566 UPPER MAPLE RIVER WATERSHED ALTERNATIVE 2A
CASS COUNTY JOINT WATER RESOURCE DISTRICT
BARNES COUNTY, NORTH DAKOTA
DAM EMBANKMENT

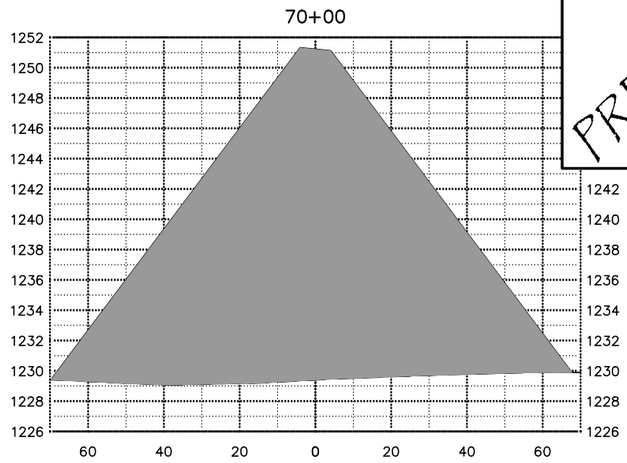
DATE:	05.25.23
REVISED:	----
REVISED:	----
REVISED:	----
REVISED:	----
REVISED:	----
RECORD:	----
PROJECT No.	18746
MANAGER:	KRL
DESIGNER:	ZJT
DRAFTER:	ZJT
REVIEWER:	JMH

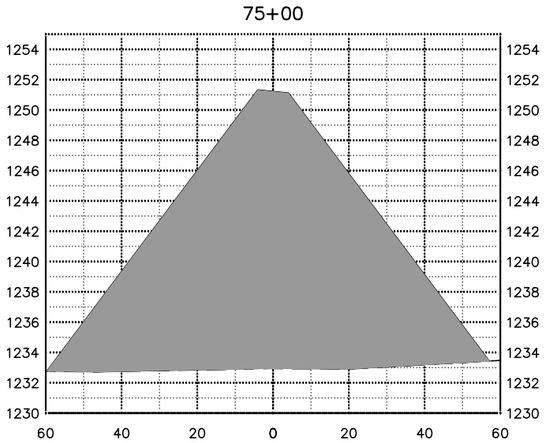
C-301

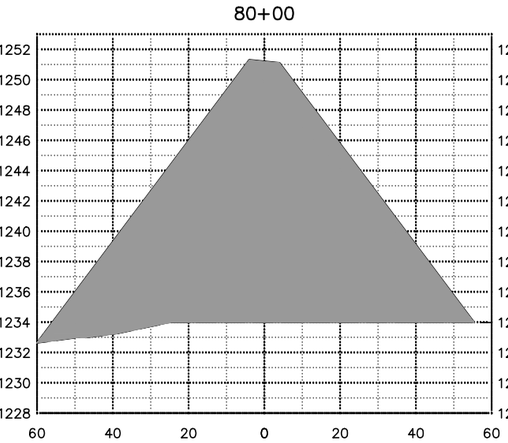
SHEET 21 OF 39

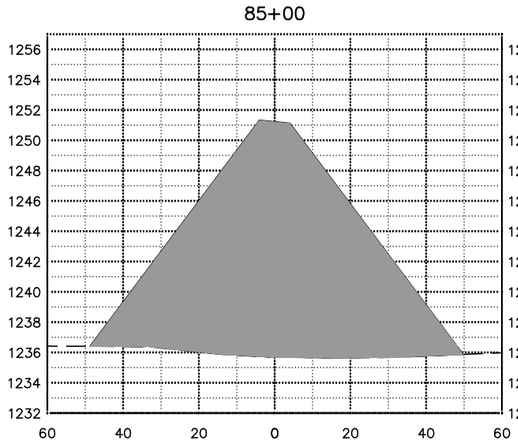


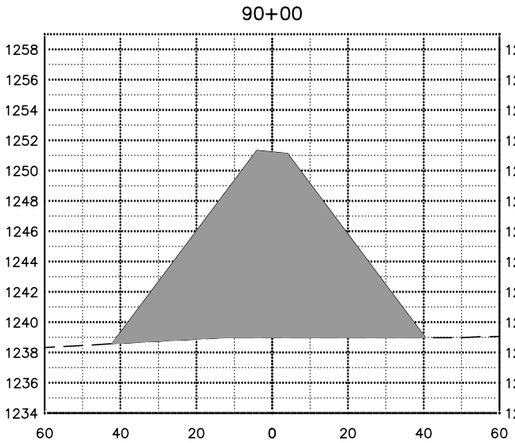


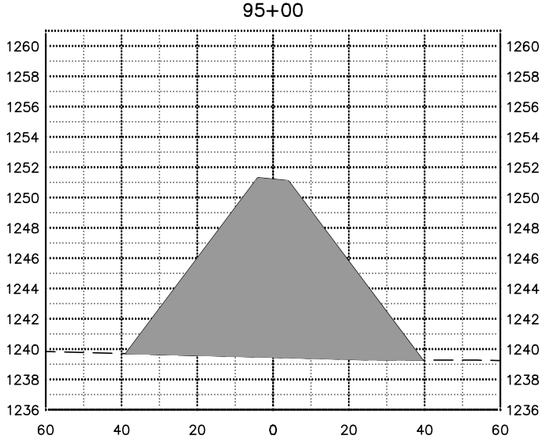


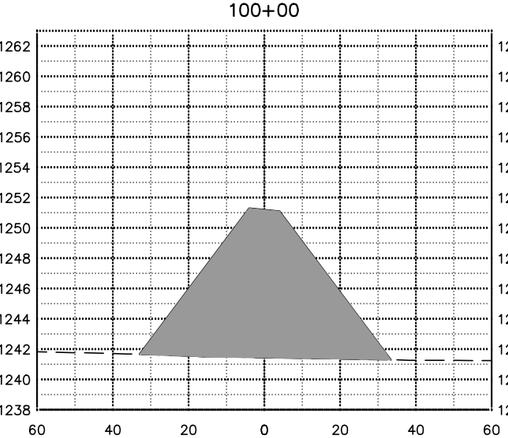


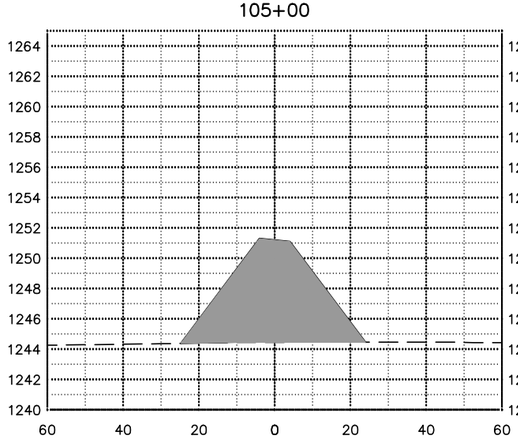


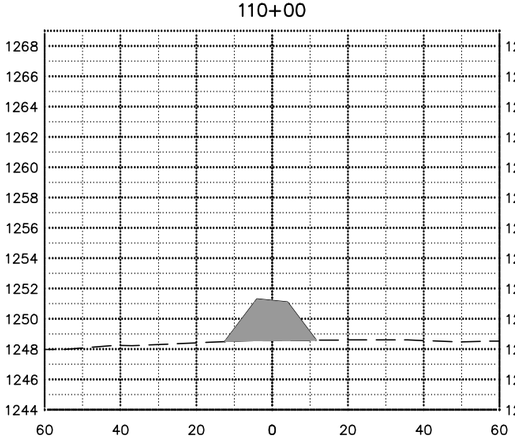












PRELIMINARY

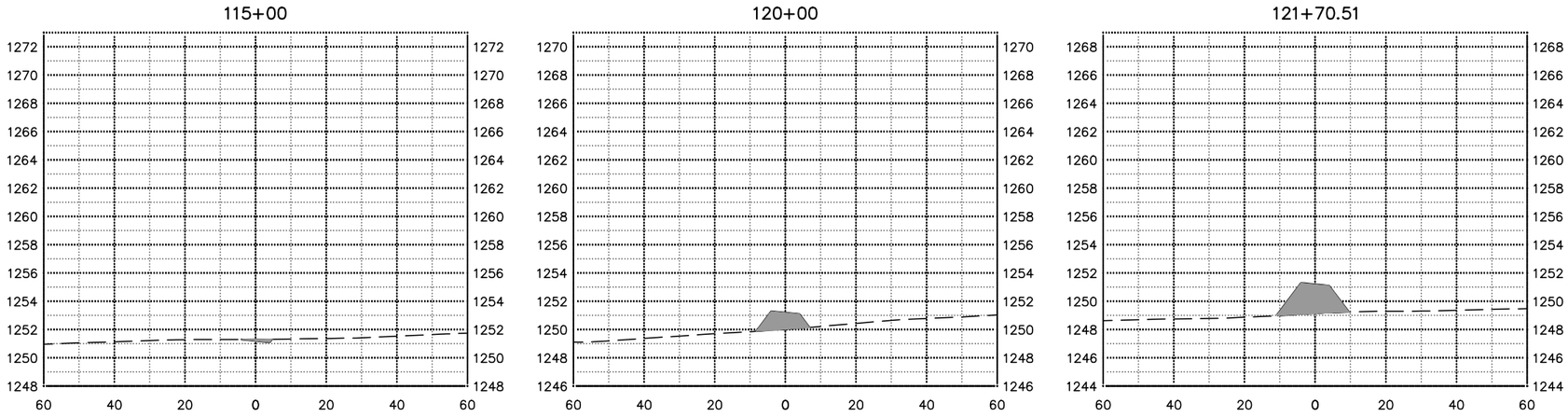
moore engineering, inc.

CROSS SECTIONS
RCPP/PL566 UPPER MAPLE RIVER WATERSHED ALTERNATIVE 2A
CASS COUNTY JOINT WATER RESOURCE DISTRICT
BARNES COUNTY, NORTH DAKOTA
DAM EMBANKMENT

DATE:	05.25.23
REVISED:	----
REVISED:	----
REVISED:	----
REVISED:	----
REVISED:	----
RECORD:	----
PROJECT No.	18746
MANAGER:	KRL
DESIGNER:	ZJT
DRAFTER:	ZJT
REVIEWER:	JMH

C-302

SHEET 22 OF 39



EARTHWORK VOLUMES

Station	Cut Area (Ft^2)	Fill Area (Ft^2)	Cut Vol (Yd^3)	Fill Vol (Yd^3)	Total Cut (Yd^3)	Total Fill (Yd^3)
0+88.44	18.54	1.27	0.00	0.00	0.00	0.00
5+00	0.00	105.08	141.28	810.58	141.28	810.58
10+00	0.00	69.47	0.00	1617.13	141.28	2427.71
15+00	0.00	127.15	0.00	1820.55	141.28	4248.26
20+00	0.00	79.79	0.00	1916.11	141.28	6164.37
25+00	0.00	301.30	0.00	3528.61	141.28	9692.98
30+00	0.00	292.46	0.00	5497.82	141.28	15190.79
35+00	0.00	278.07	0.00	5282.72	141.28	20473.52
40+00	0.00	155.02	0.00	4010.12	141.28	24483.64
45+00	0.00	883.91	0.00	9619.78	141.28	34103.42
50+00	0.00	405.49	0.00	11938.94	141.28	46042.36
55+00	0.00	592.15	0.00	9237.43	141.28	55279.79
60+00	0.00	2404.07	0.00	27742.80	141.28	83022.59
65+00	0.00	2758.75	0.00	47470.96	141.28	130493.55
70+00	0.00	1593.51	0.00	40298.72	141.28	170792.27
75+00	0.00	1146.04	0.00	25405.46	141.28	196197.72
80+00	0.00	1052.82	0.00	20359.75	141.28	216557.47
85+00	0.00	824.58	0.00	17383.28	141.28	233940.75
90+00	0.00	552.16	0.00	12747.56	141.28	246688.32
95+00	0.00	507.25	0.00	9809.36	141.28	256497.68
100+00	0.00	363.49	0.00	8062.46	141.28	264560.14
105+00	0.00	191.16	0.00	5135.67	141.28	269695.81
110+00	0.00	42.06	0.00	2159.47	141.28	271855.28
115+00	0.89	0.00	8.30	388.99	149.57	272244.27
120+00	0.00	13.93	8.26	129.01	157.83	272373.28
121+70.51	0.00	29.82	0.00	138.15	157.83	272511.43

PRELIMINARY

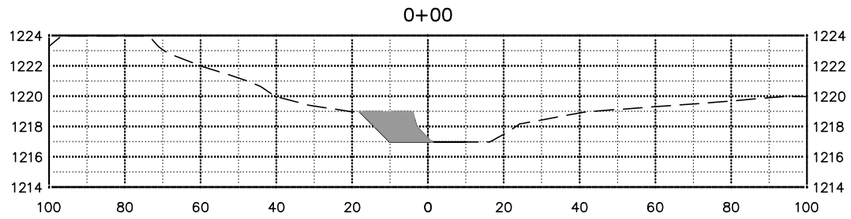
moore engineering, inc.

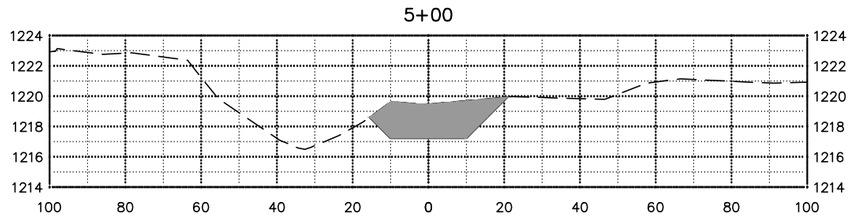
CROSS SECTIONS
RCPP/PL566 UPPER MAPLE RIVER WATERSHED ALTERNATIVE 2A
CASS COUNTY JOINT WATER RESOURCE DISTRICT
BARNES COUNTY, NORTH DAKOTA
DAM EMBANKMENT

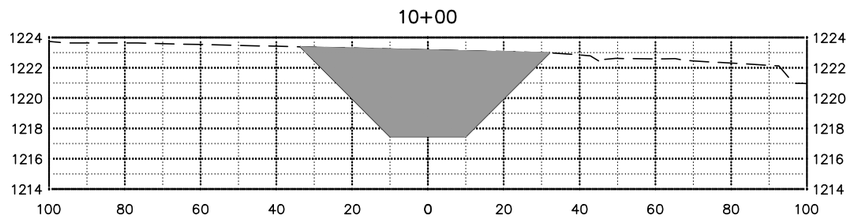
DATE:	05.25.23
REVISED:	----
REVISED:	----
REVISED:	----
REVISED:	----
REVISED:	----
RECORD:	----
PROJECT No.	18746
MANAGER:	KRL
DESIGNER:	ZJT
DRAFTER:	ZJT
REVIEWER:	JMH

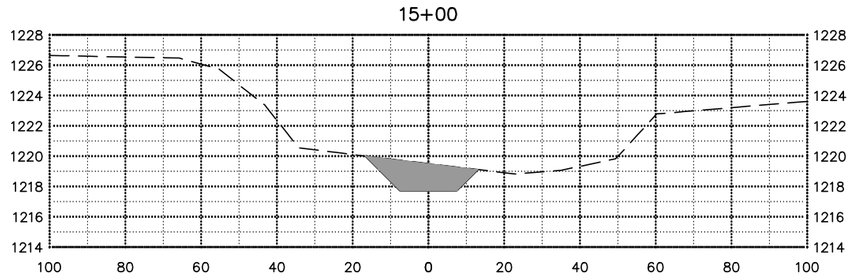
C-303

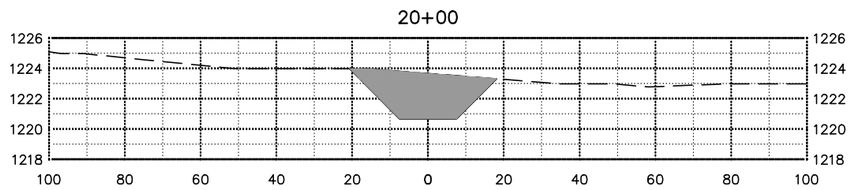
SHEET 23 OF 39

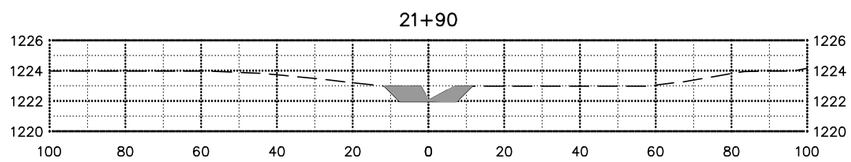












EARTHWORK VOLUMES

Station	Cut Area (Ft^2)	Fill Area (Ft^2)	Cut Vol (Yd^3)	Fill Vol (Yd^3)	Total Cut (Yd^3)	Total Fill (Yd^3)
0+00	23.58	0.00	0.00	0.00	0.00	0.00
5+00	66.93	0.00	838.37	0.00	838.37	0.00
10+00	245.09	0.00	2888.90	0.00	3727.27	0.00
15+00	40.26	0.00	2638.66	0.00	6365.93	0.00
20+00	80.71	0.00	1124.52	0.00	7490.45	0.00
21+90	14.91	0.00	336.44	0.00	7826.89	0.00

PRELIMINARY

moore engineering, inc.

CROSS SECTIONS
RCPP/PL566 UPPER MAPLE RIVER WATERSHED ALTERNATIVE 2A
CASS COUNTY JOINT WATER RESOURCE DISTRICT
BARNES COUNTY, NORTH DAKOTA
PRIMARY SPILLWAY

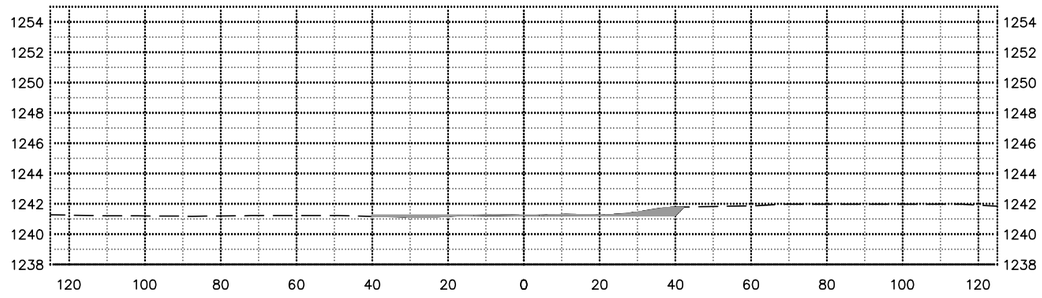
DATE:	05.25.23
REVISED:	----
REVISED:	----
REVISED:	----
REVISED:	----
REVISED:	----
RECORD:	----
PROJECT No.	18746
MANAGER:	KRL
DESIGNER:	ZJT
DRAFTER:	ZJT
REVIEWER:	JMH

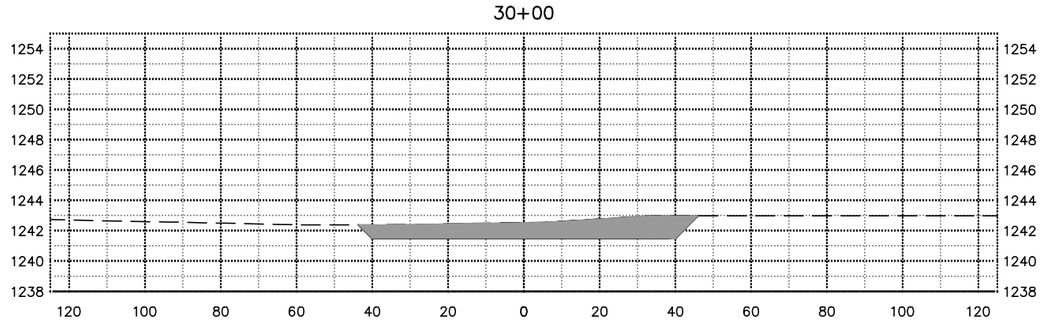
C-304

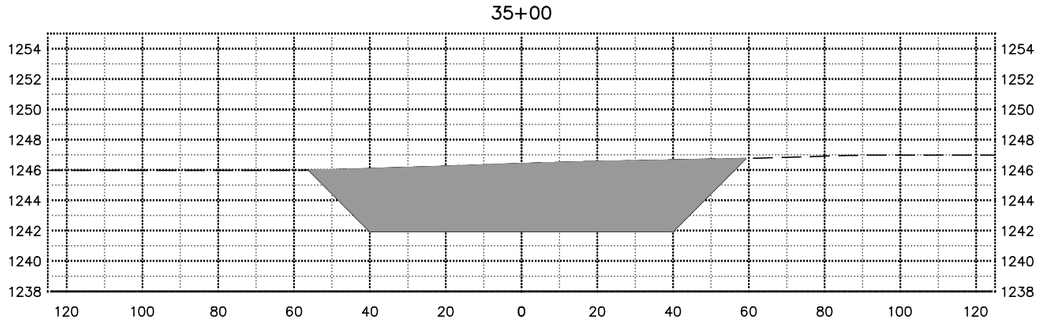
SHEET 24 OF 39

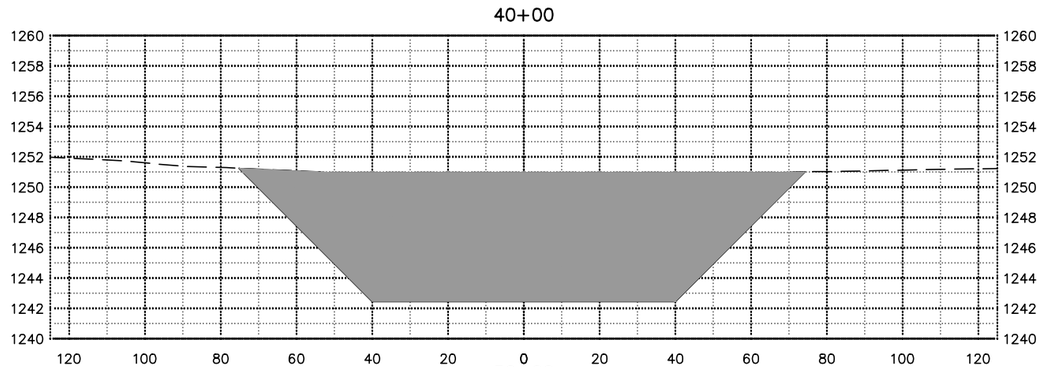
FILE LOCATION: R:\Projects\18000\18700\18746\DRAWINGS\DESIGN\18746-ALT-2A-PP.dwg

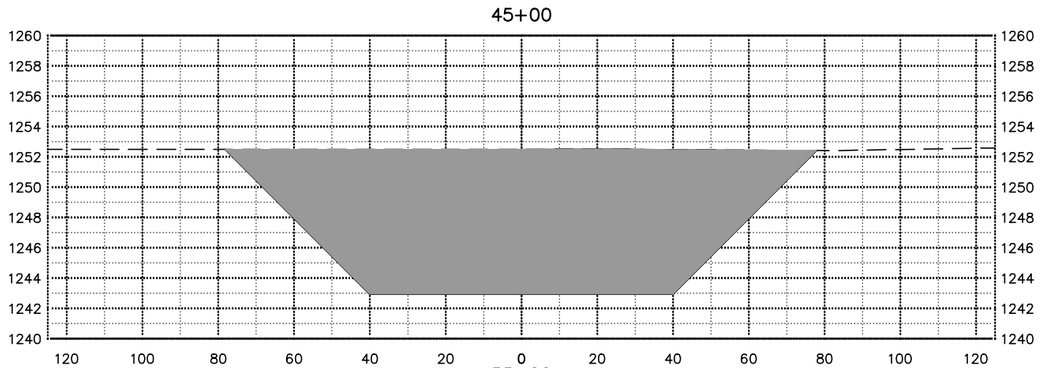
PRELIMINARY

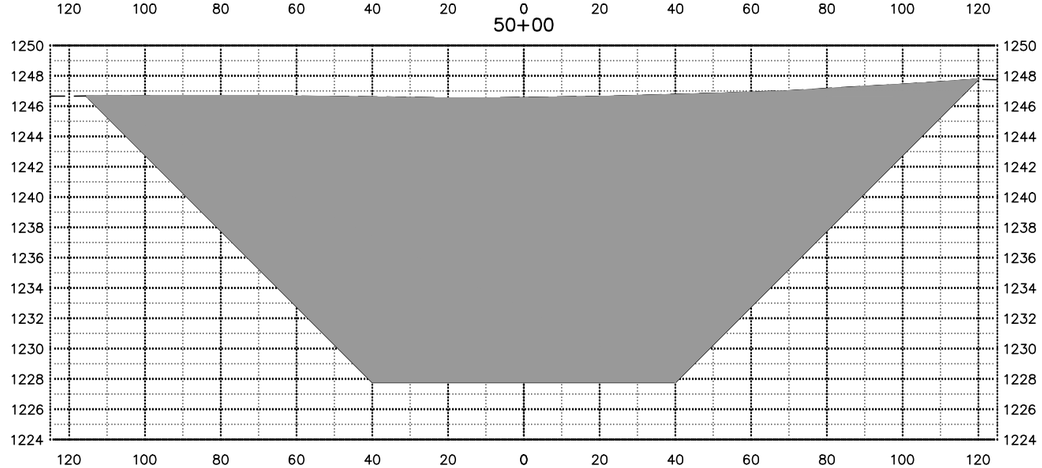


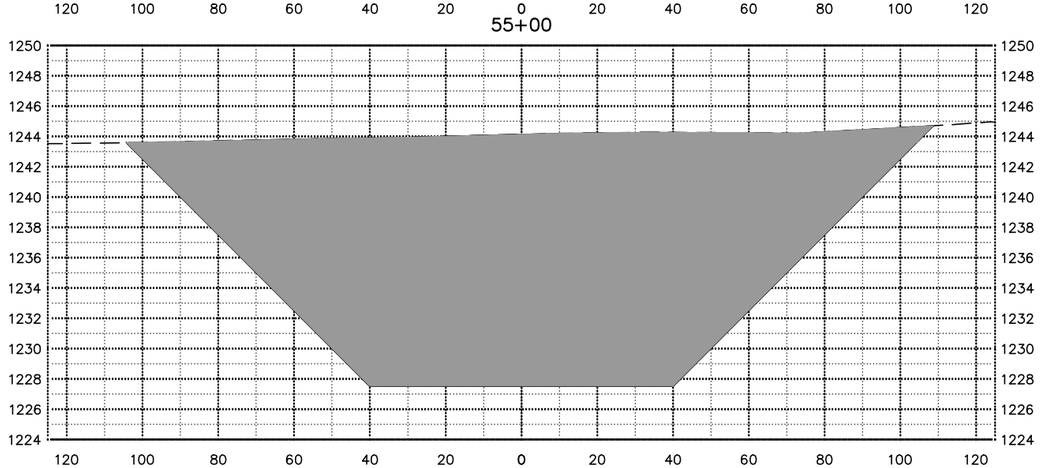












moore engineering, inc.

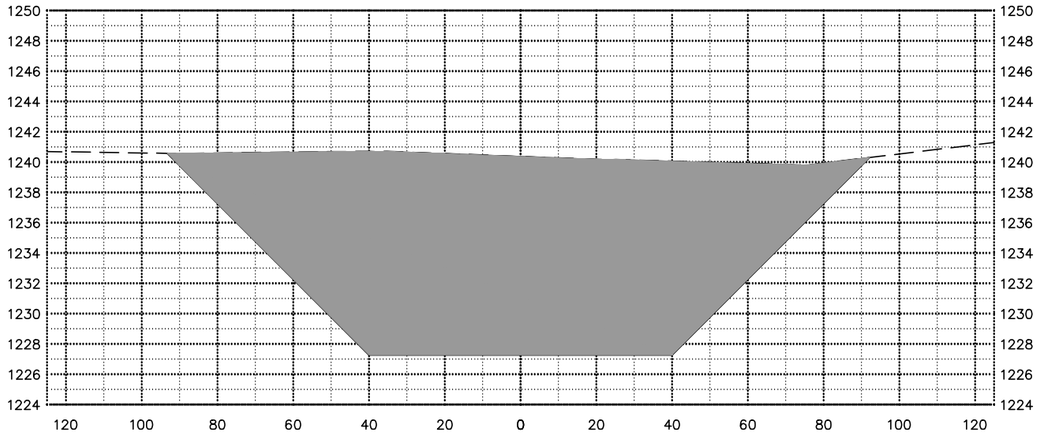
CROSS SECTIONS
RCPP/PL566 UPPER MAPLE RIVER WATERSHED ALTERNATIVE 2A
CASS COUNTY JOINT WATER RESOURCE DISTRICT
BARNES COUNTY, NORTH DAKOTA
EMERGENCY SPILLWAY

DATE:	05.25.23
REVISED:	----
REVISED:	----
REVISED:	----
REVISED:	----
REVISED:	----
RECORD:	----
PROJECT No.	18746
MANAGER:	KRL
DESIGNER:	ZJT
DRAFTER:	ZJT
REVIEWER:	JMH

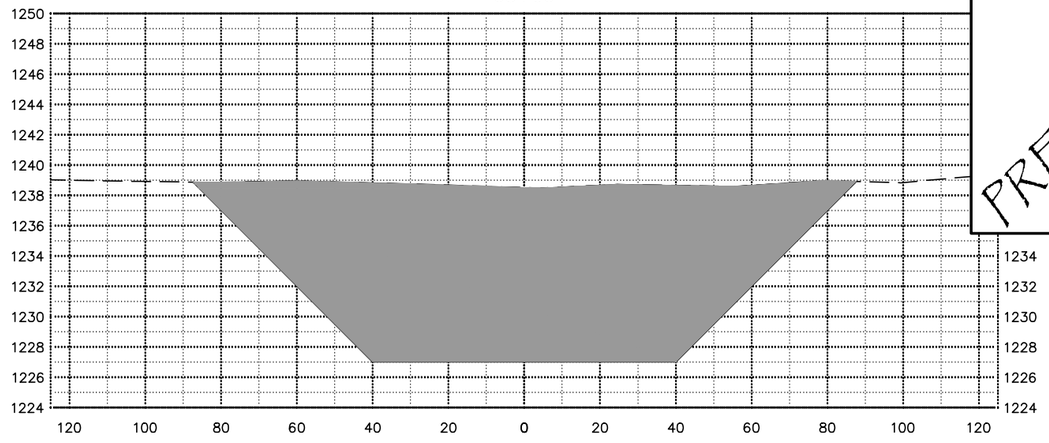
C-305

SHEET 25 OF 39

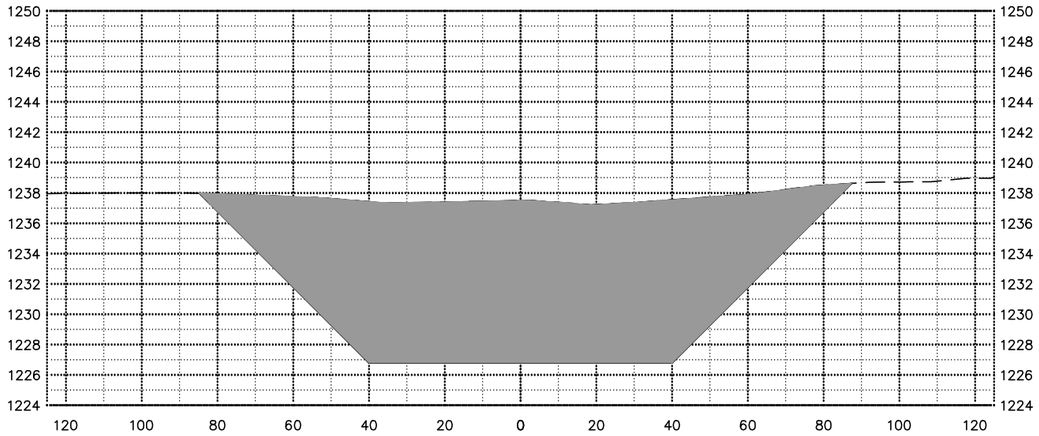
60+00



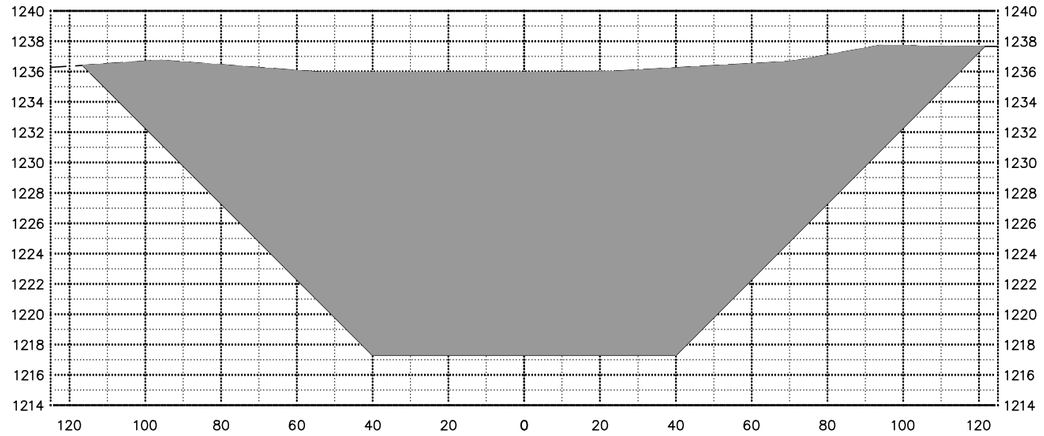
65+00



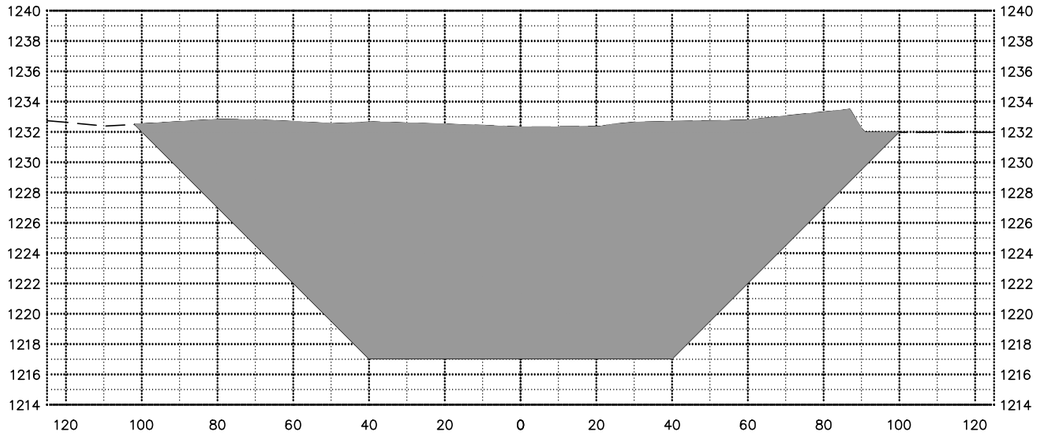
70+00



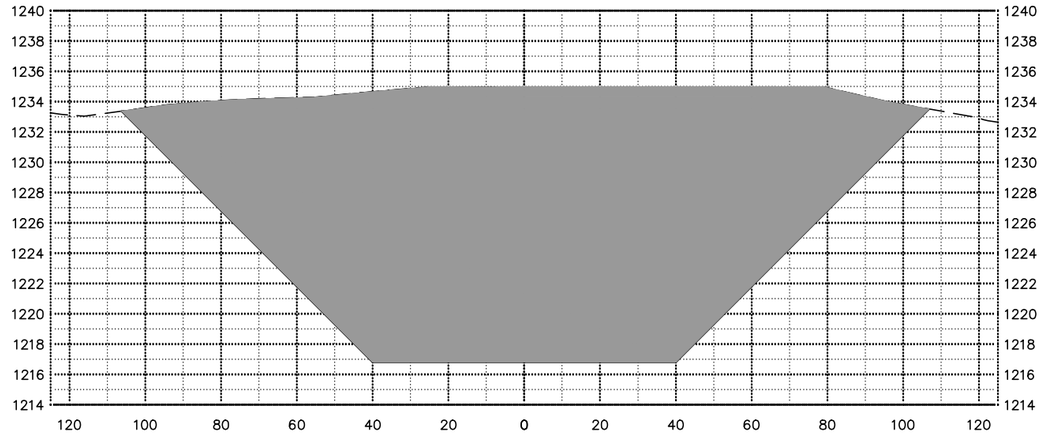
75+00



80+00



85+00



PRELIMINARY

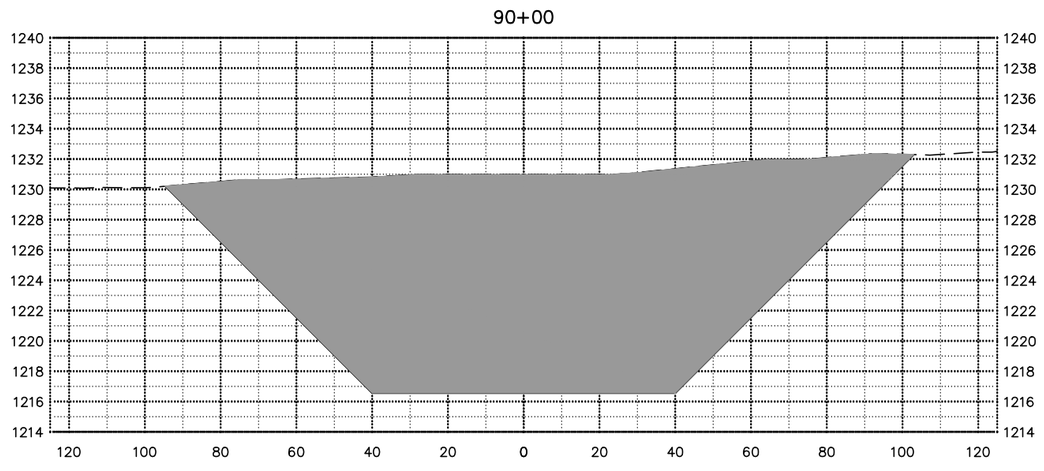
moore engineering, inc.

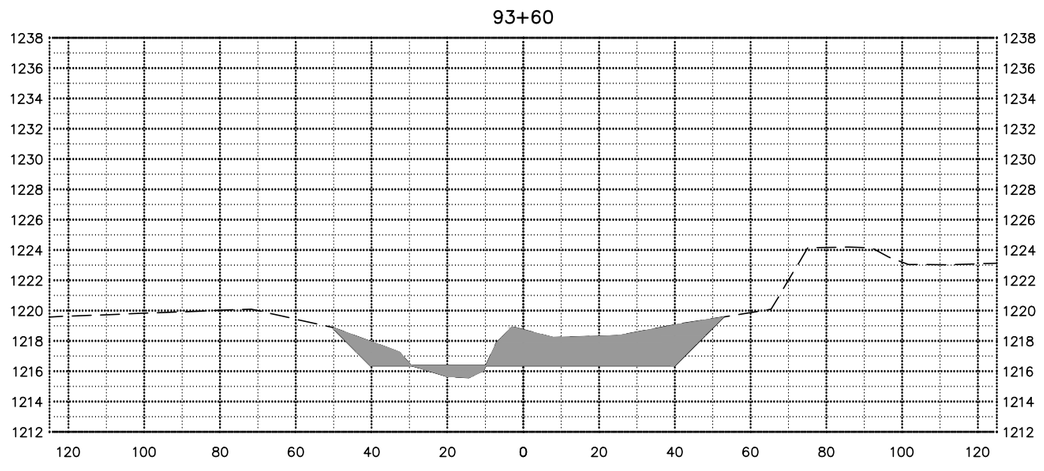
CROSS SECTIONS
RCPP/PL566 UPPER MAPLE RIVER WATERSHED ALTERNATIVE 2A
CASS COUNTY JOINT WATER RESOURCE DISTRICT
BARNES COUNTY, NORTH DAKOTA
EMERGENCY SPILLWAY

DATE:	05.25.23
REVISED:	----
REVISED:	----
REVISED:	----
REVISED:	----
REVISED:	----
RECORD:	----
PROJECT No.	18746
MANAGER:	KRL
DESIGNER:	ZJT
DRAFTER:	ZJT
REVIEWER:	JMH

C-306

SHEET 26 OF 39





EARTHWORK VOLUMES

Station	Cut Area (Ft^2)	Fill Area (Ft^2)	Cut Vol (Yd^3)	Fill Vol (Yd^3)	Total Cut (Yd^3)	Total Fill (Yd^3)
27+41.80	6.65	2.11	0.00	0.00	0.00	0.00
30+00	96.06	0.00	491.13	10.08	491.13	10.08
35+00	433.66	0.00	4904.82	0.00	5395.96	10.08
40+00	975.35	0.00	13047.96	0.00	18443.92	10.08
45+00	1126.69	0.00	19448.09	0.00	37892.01	10.08
50+00	2973.54	0.00	37978.90	0.00	75870.91	10.08
55+00	2419.33	0.00	49933.98	0.00	125804.89	10.08
60+00	1727.63	0.00	38397.74	0.00	164202.63	10.08
65+00	1486.46	0.00	29760.07	0.00	193962.70	10.08
70+00	1344.55	0.00	26213.05	0.00	220175.75	10.08
75+00	3002.78	0.00	40253.10	0.00	260428.86	10.08
80+00	2215.64	0.00	48318.72	0.00	308747.58	10.08
85+00	2681.66	0.00	45345.32	0.00	354092.89	10.08
90+00	2024.48	0.00	43575.37	0.00	397668.26	10.08
93+60	137.99	10.10	14416.51	67.31	412084.77	77.38

PRELIMINARY

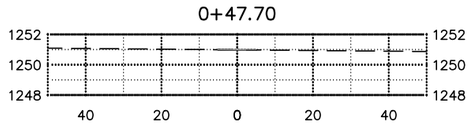
moore engineering, inc.

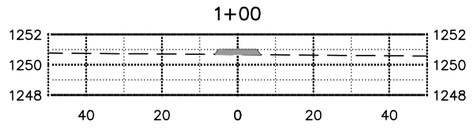
CROSS SECTIONS
RCPP/PL566 UPPER MAPLE RIVER WATERSHED ALTERNATIVE 2A
CASS COUNTY JOINT WATER RESOURCE DISTRICT
BARNES COUNTY, NORTH DAKOTA
EMERGENCY SPILLWAY

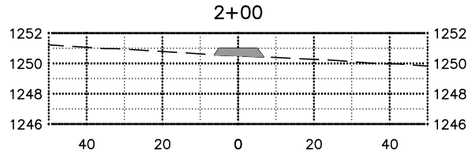
DATE:	05.25.23
REVISED:	----
REVISED:	----
REVISED:	----
REVISED:	----
REVISED:	----
RECORD:	----
PROJECT No.	18746
MANAGER:	KRL
DESIGNER:	ZJT
DRAFTER:	ZJT
REVIEWER:	JMH

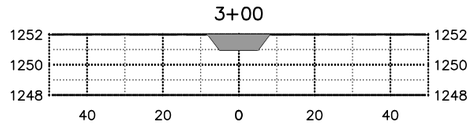
C-307

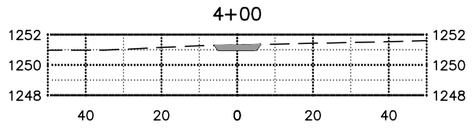
SHEET 27 OF 39

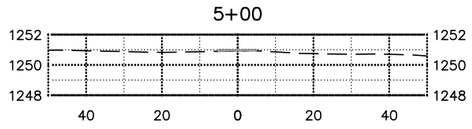


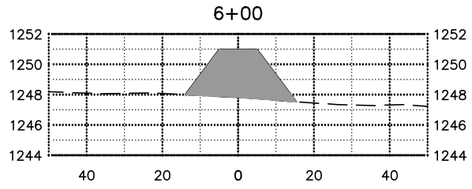


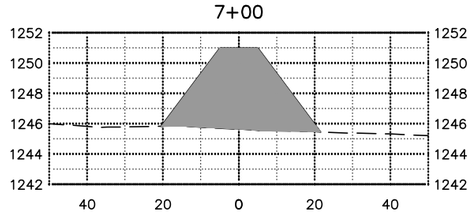


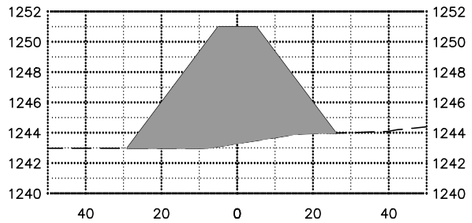


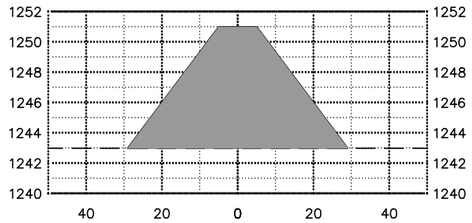


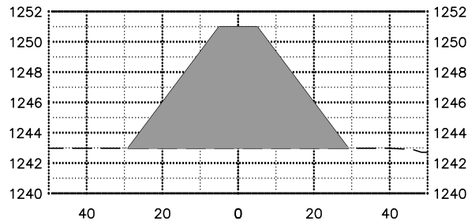


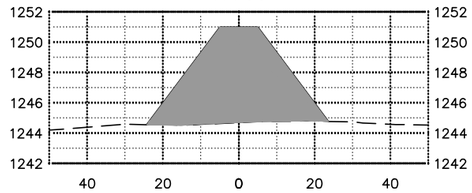


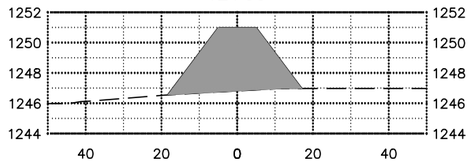


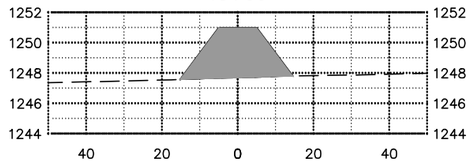


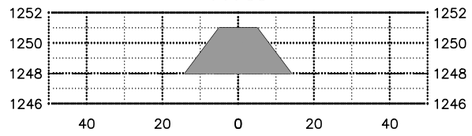


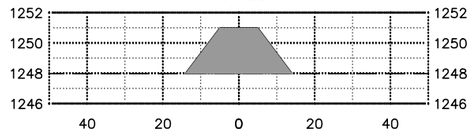


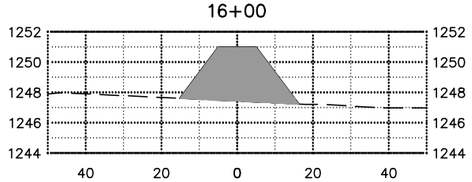


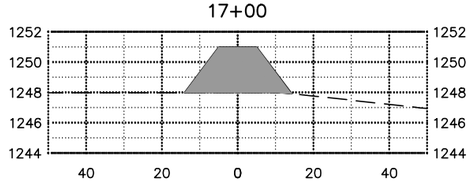


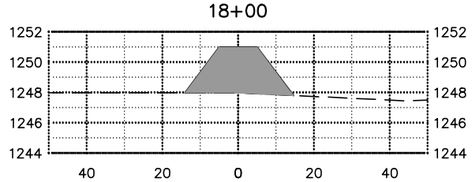


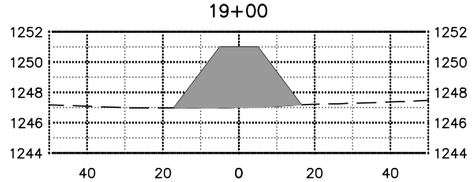


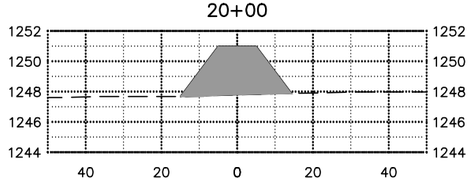


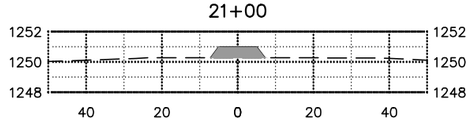


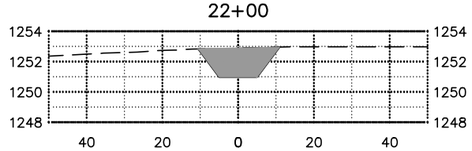


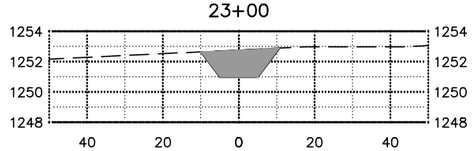












PRELIMINARY

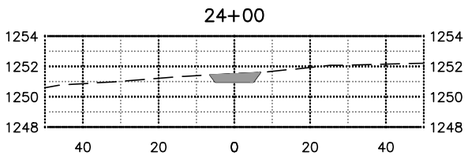
moore engineering, inc.

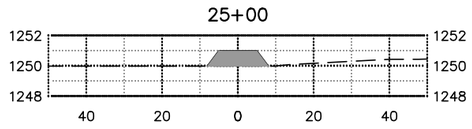
CROSS SECTIONS
RCPP/PL566 UPPER MAPLE RIVER WATERSHED ALTERNATIVE 2A
CASS COUNTY JOINT WATER RESOURCE DISTRICT
BARNES COUNTY, NORTH DAKOTA
FARM RING LEVEE

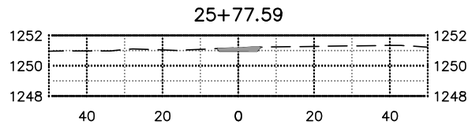
DATE:	05.25.23
REVISED:	----
REVISED:	----
REVISED:	----
REVISED:	----
REVISED:	----
RECORD:	----
PROJECT No.	18746
MANAGER:	KRL
DESIGNER:	ZJT
DRAFTER:	ZJT
REVIEWER:	JMH

C-308

SHEET 28 OF 39







EARTHWORK VOLUMES

Station	Cut Area (Ft^2)	Fill Area (Ft^2)	Cut Vol (Yd^3)	Fill Vol (Yd^3)	Total Cut (Yd^3)	Total Fill (Yd^3)
0+47.70	0.06	0.01	0.00	0.00	0.00	0.00
1+00	0.00	3.33	0.06	3.24	0.06	3.24
2+00	0.00	5.54	0.00	16.43	0.06	19.66
3+00	13.00	0.00	24.07	10.25	24.14	29.92
4+00	3.82	0.00	31.15	0.00	55.28	29.92
5+00	0.00	0.58	7.07	1.08	62.36	30.99
6+00	0.00	62.33	0.00	116.51	62.36	147.50
7+00	0.00	138.54	0.00	371.99	62.36	519.49
8+00	0.00	249.42	0.00	718.44	62.36	1237.93
9+00	0.00	272.00	0.00	963.06	62.36	2200.99
10+00	0.00	272.00	0.00	1007.41	62.36	3208.40
11+00	0.00	182.09	0.00	840.70	62.36	4049.10
12+00	0.00	93.93	0.00	511.16	62.36	4560.26
13+00	0.00	65.15	0.00	294.60	62.36	4854.86
14+00	0.00	57.00	0.00	226.20	62.36	5081.06
15+00	0.00	57.00	0.00	211.11	62.36	5292.17
16+00	0.00	73.71	0.00	242.06	62.36	5534.23
17+00	0.00	57.11	0.00	242.27	62.36	5776.50
18+00	0.00	58.40	0.00	213.91	62.36	5990.41
19+00	0.00	86.40	0.00	268.14	62.36	6258.55
20+00	0.00	62.86	0.00	275.82	62.36	6534.37
21+00	0.00	8.50	0.00	132.05	62.36	6666.42
22+00	30.08	0.00	55.70	15.74	118.06	6682.16
23+00	27.45	0.00	106.54	0.00	224.60	6682.16
24+00	6.24	0.00	62.40	0.00	287.00	6682.16
25+00	0.00	13.00	11.56	24.07	298.55	6706.23
25+77.59	2.11	0.00	3.03	18.68	301.58	6724.91

PRELIMINARY

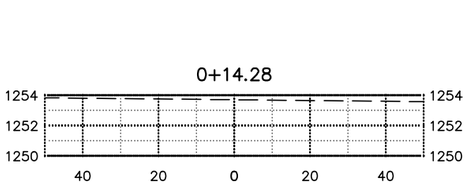
moore engineering, inc.

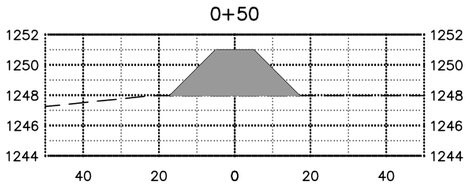
CROSS SECTIONS
RCPP/PL566 UPPER MAPLE RIVER WATERSHED ALTERNATIVE 2A
CASS COUNTY JOINT WATER RESOURCE DISTRICT
BARNES COUNTY, NORTH DAKOTA
FARM RING LEVEE

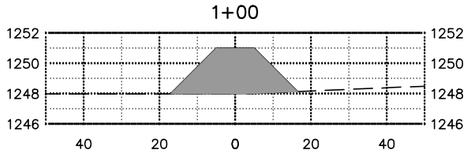
DATE:	05.25.23
REVISED:	----
REVISED:	----
REVISED:	----
REVISED:	----
REVISED:	----
RECORD:	----
PROJECT No.	18746
MANAGER:	KRL
DESIGNER:	ZJT
DRAFTER:	ZJT
REVIEWER:	JMH

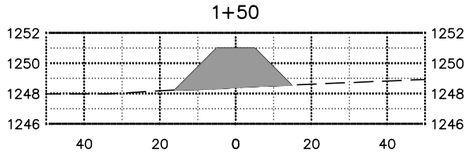
C-309

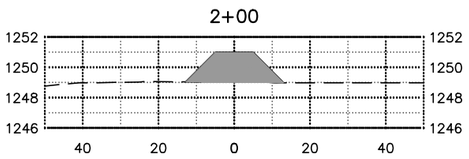
SHEET 29 OF 39

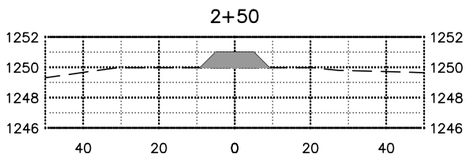


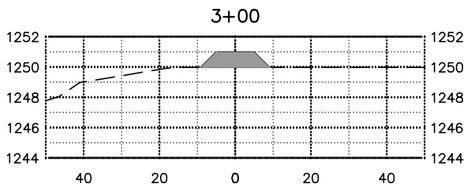


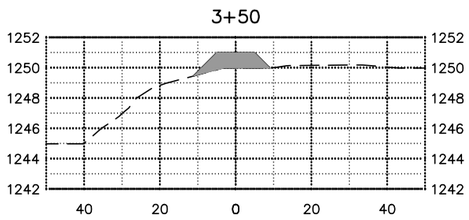


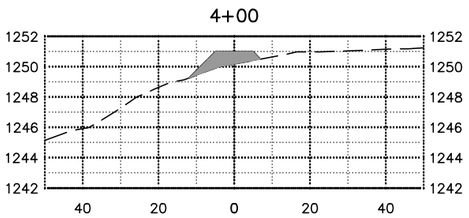


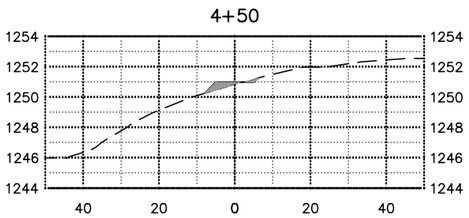


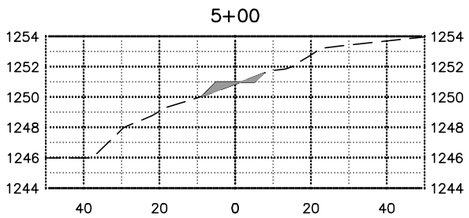


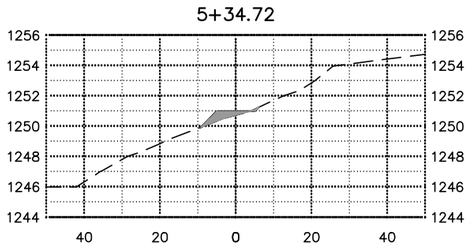












EARTHWORK VOLUMES

Station	Cut Area (Ft^2)	Fill Area (Ft^2)	Cut Vol (Yd^3)	Fill Vol (Yd^3)	Total Cut (Yd^3)	Total Fill (Yd^3)
0+14.28	0.00	0.00	0.00	0.00	0.00	0.00
0+50	0.00	66.00	0.00	43.66	0.00	43.66
1+00	0.00	64.97	0.00	121.27	0.00	164.93
1+50	0.00	52.67	0.00	108.92	0.00	273.85
2+00	0.00	34.74	0.00	80.93	0.00	354.79
2+50	0.00	14.00	0.00	45.13	0.00	399.91
3+00	0.00	14.00	0.00	25.93	0.00	425.84
3+50	0.00	15.47	0.00	27.29	0.00	453.13
4+00	0.00	12.24	0.00	25.66	0.00	478.78
4+50	0.27	2.35	0.25	13.50	0.25	492.29
5+00	1.10	2.92	1.27	4.87	1.52	497.16
5+34.72	0.15	4.09	0.81	4.51	2.33	501.67

PRELIMINARY

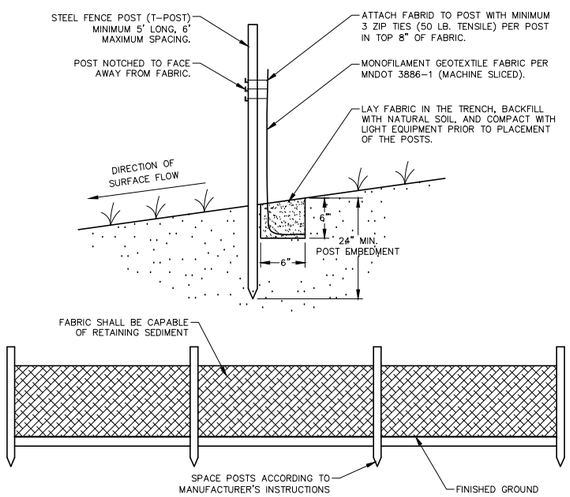
moore engineering, inc.

CROSS SECTIONS
RCPP/PL566 UPPER MAPLE RIVER WATERSHED ALTERNATIVE 2A
CASS COUNTY JOINT WATER RESOURCE DISTRICT
BARNES COUNTY, NORTH DAKOTA
FARM LEVEE

DATE:	05.25.23
REVISED:	----
REVISED:	----
REVISED:	----
REVISED:	----
REVISED:	----
RECORD:	----
PROJECT No.	18746
MANAGER:	KRL
DESIGNER:	ZJT
DRAFTER:	ZJT
REVIEWER:	JMH

C-310

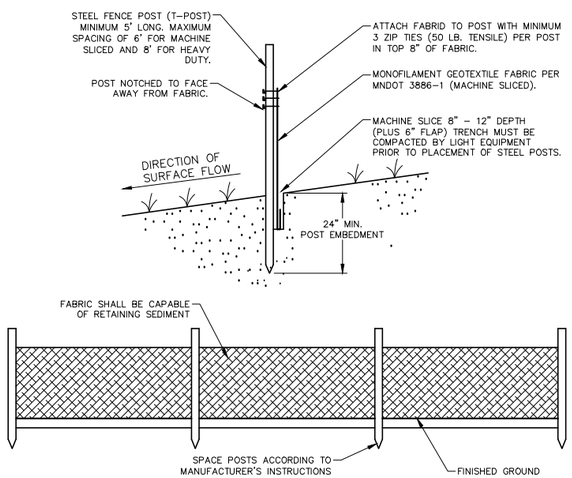
SHEET 30 OF 39



STANDARD SILT FENCE DETAIL

NO SCALE *WRG-312500-01 02.15.17*

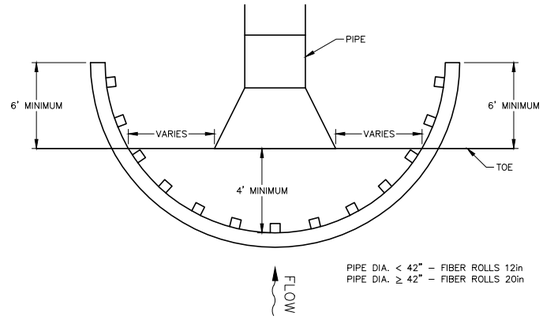
NOTES:
1. INSPECT AND REPAIR AFTER EACH STORM EVENT, AND REMOVE SEDIMENT WHEN NECESSARY.
2. REMOVED SEDIMENTS SHALL BE DEPOSITED IN AN AREA THAT WILL NOT CONTRIBUTE SEDIMENT OFF-SITE AND CAN BE PERMANENTLY STABILIZED.



MACHINED SILT FENCE DETAIL

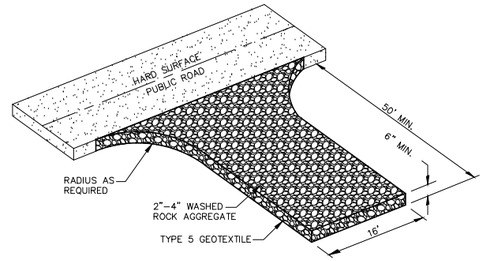
NO SCALE *WRG-312500-02 12.15.17*

NOTES:
1. INSPECT AND REPAIR AFTER EACH STORM EVENT, AND REMOVE SEDIMENT WHEN NECESSARY.
2. REMOVED SEDIMENTS SHALL BE DEPOSITED IN AN AREA THAT WILL NOT CONTRIBUTE SEDIMENT OFF-SITE AND CAN BE PERMANENTLY STABILIZED.



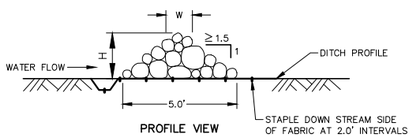
FIBER ROLL PROTECTION INLET OF PIPE END

NO SCALE *WRG-312500-03 02.15.17*



TEMPORARY ROCK - SITE ENTRANCE

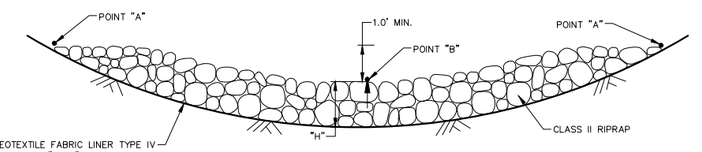
NO SCALE *WRG-312500-04 02.15.17*



PROFILE VIEW

NOTES:
1. ROCK DITCH CHEK SHALL BE REMOVED FROM CLEAR ZONE AFTER SEEDING OR TURF IS ESTABLISHED AND PRIOR TO FINAL ACCEPTANCE.
2. POINT "A" MUST BE 1'-0" MIN. HIGHER THAN POINT "B" TO ENSURE THAT WATER FLOWS OVER THE CHECK AND NOT AROUND THE ENDS.

HEIGHT OF CHECK (H)	CLASS RIPRAP	TOP WIDTH (W)
2'-0"	II	12"-18"



CROSS SECTION

TEMPORARY ROCK CHECK DETAIL

NO SCALE *WRG-312500-05 02.15.17*

PRELIMINARY

moore engineering, inc.

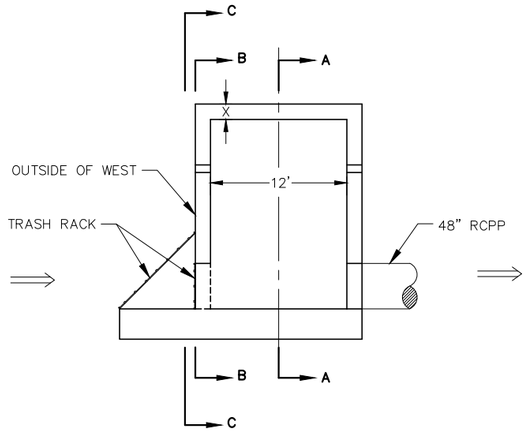
EROSION CONTROL DETAILS
RCPP/PL566 UPPER MAPLE RIVER WATERSHED ALTERNATIVE 2A
CASS COUNTY JOINT WATER RESOURCE DISTRICT
BARNES COUNTY, NORTH DAKOTA
EROSION CONTROL DETAILS

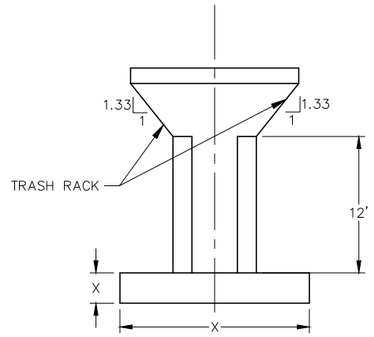
DATE:	05.01.20
REVISED:	----
REVISED:	----
REVISED:	----
REVISED:	----
REVISED:	----
RECORD:	----
PROJECT No.	18746
MANAGER:	KRL
DESIGNER:	ZJT
DRAFTER:	RJK
REVIEWER:	JMH

C-501

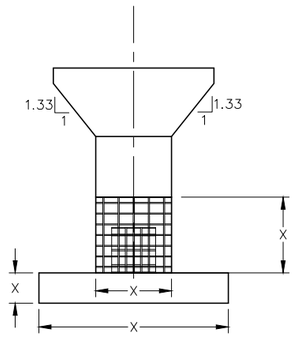
SHEET 32 OF 39

PRELIMINARY

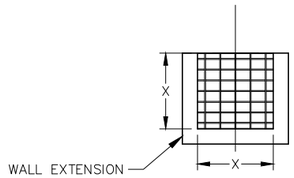




SECTION A–A



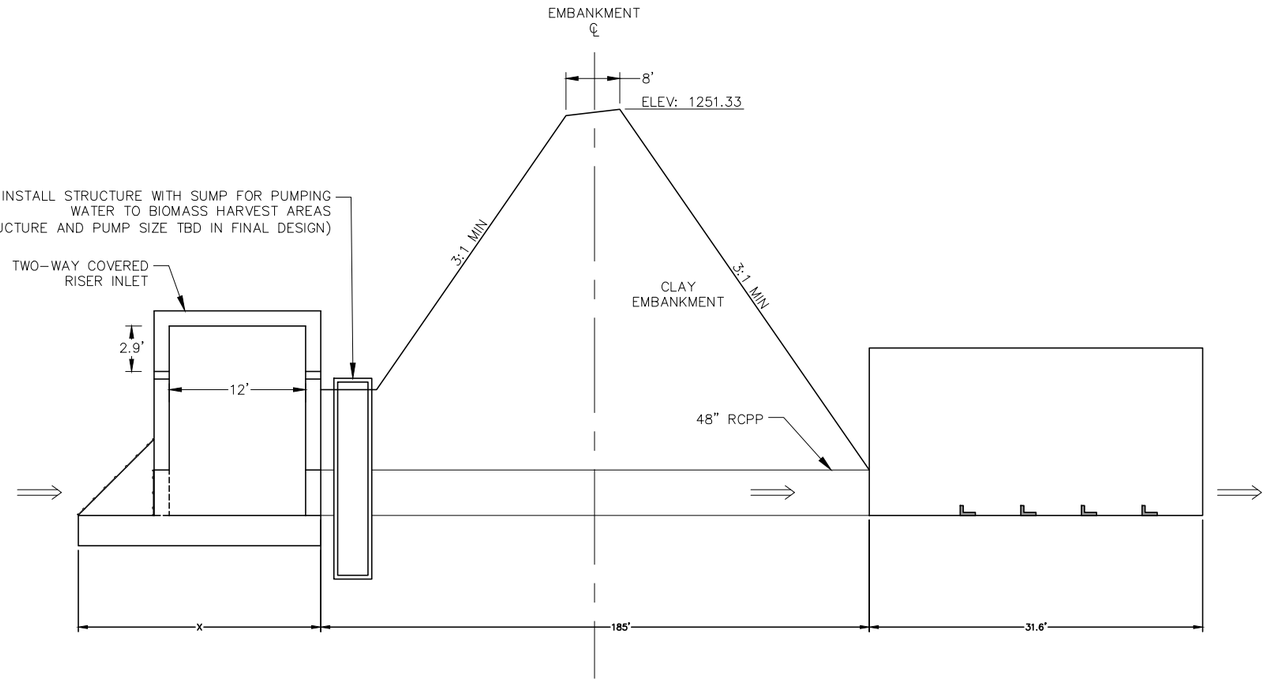
SECTION B–B



SECTION C–C

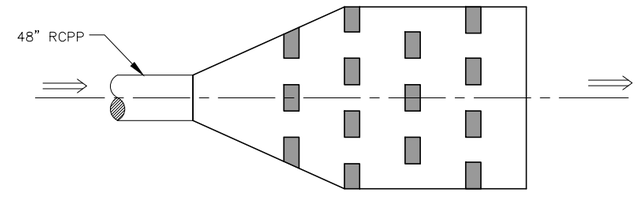
TWO-WAY COVERED RISER

NO SCALE

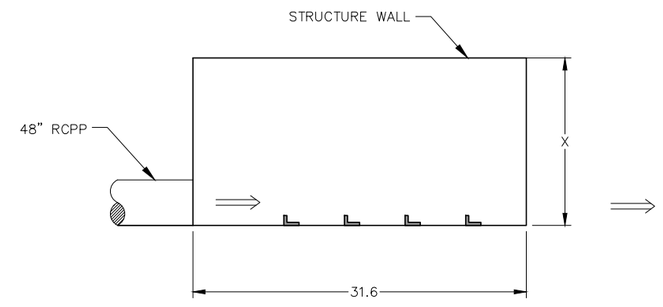


PRIMARY SPILLWAY STRUCTURE

NO SCALE



PLAN



SIDE

PRIMARY SPILLWAY OUTLET

NO SCALE

NOTES:
1. MEASUREMENTS DENOTED WITH "X" TO BE DETERMINED IN CONJUNCTION WITH STRUCTURAL AND GEOTECH DURING FINAL DESIGN.

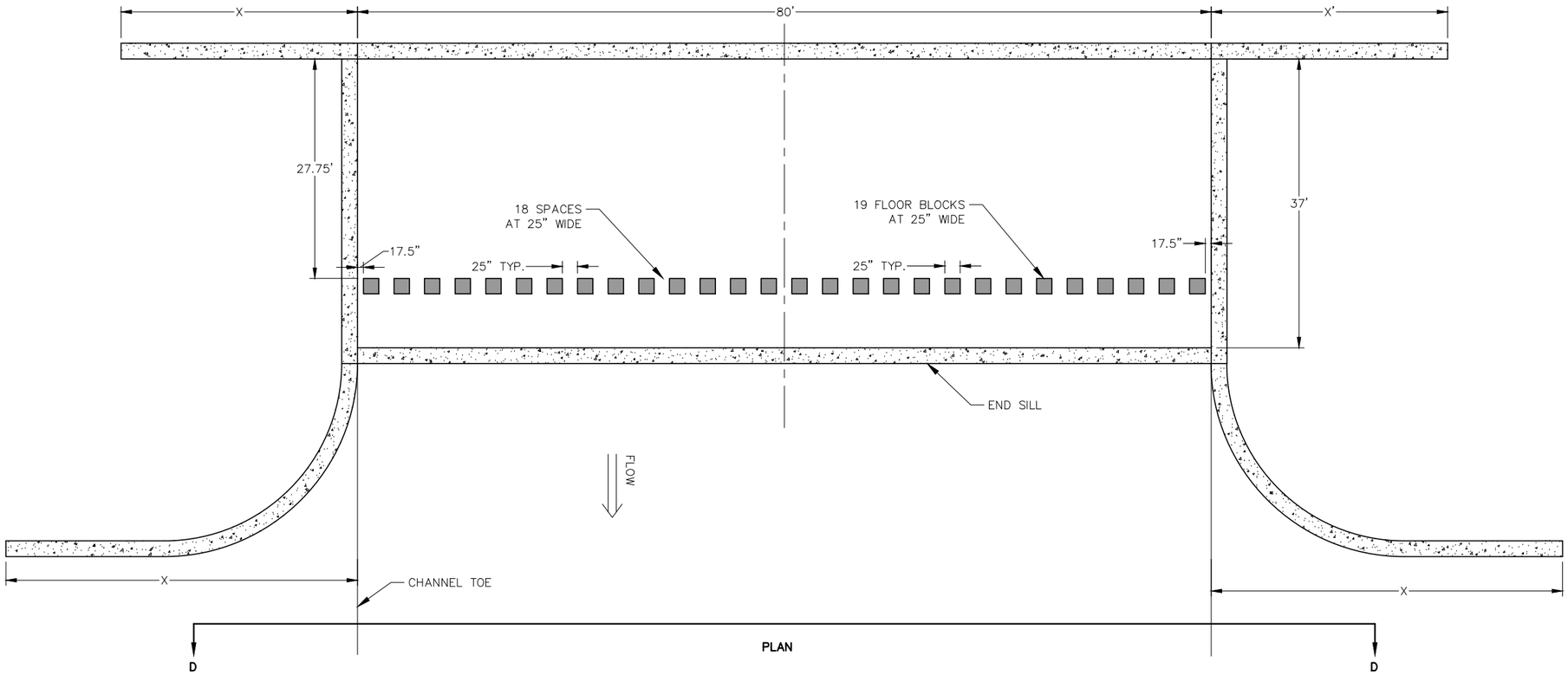
moore engineering, inc.

PRIMARY SPILLWAY OUTLET STRUCTURE DETAIL
RCPP/PL566 UPPER MAPLE RIVER WATERSHED ALTERNATIVE 2A
CASS COUNTY JOINT WATER RESOURCE DISTRICT
BARNES COUNTY, NORTH DAKOTA
PRIMARY SPILLWAY OUTLET STRUCTURE DETAIL

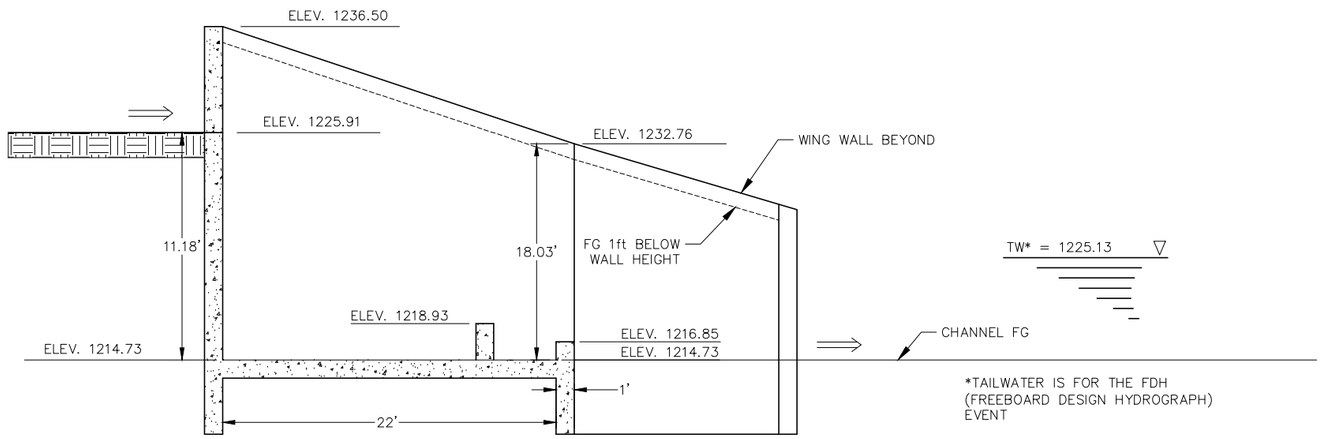
DATE:	05.01.20
REVISED:	----
REVISED:	----
REVISED:	----
REVISED:	----
REVISED:	----
RECORD:	----
PROJECT No.	18746
MANAGER:	KRL
DESIGNER:	ZJT
DRAFTER:	RJK
REVIEWER:	JMH

C-502

SHEET 33 OF 39



PLAN



SECTION AT CENTER LINE

NOTES:
1. MEASUREMENTS DENOTED WITH "X" TO BE DETERMINED IN CONJUNCTION WITH STRUCTURAL AND GEOTECH DURING FINAL DESIGN.

DOWNSTREAM DROP STRUCTURE (EMERGENCY SPILLWAY)

NO SCALE

PRELIMINARY

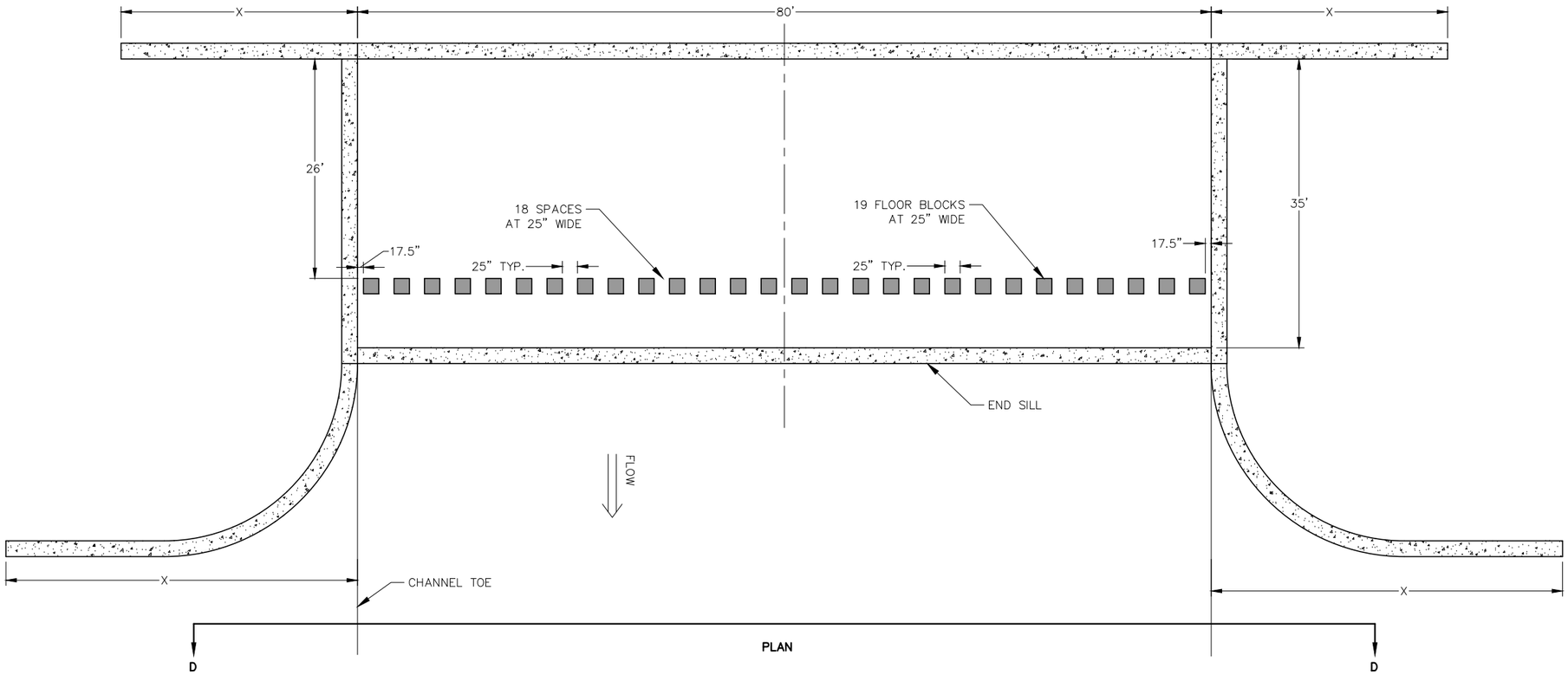
moore engineering, inc.

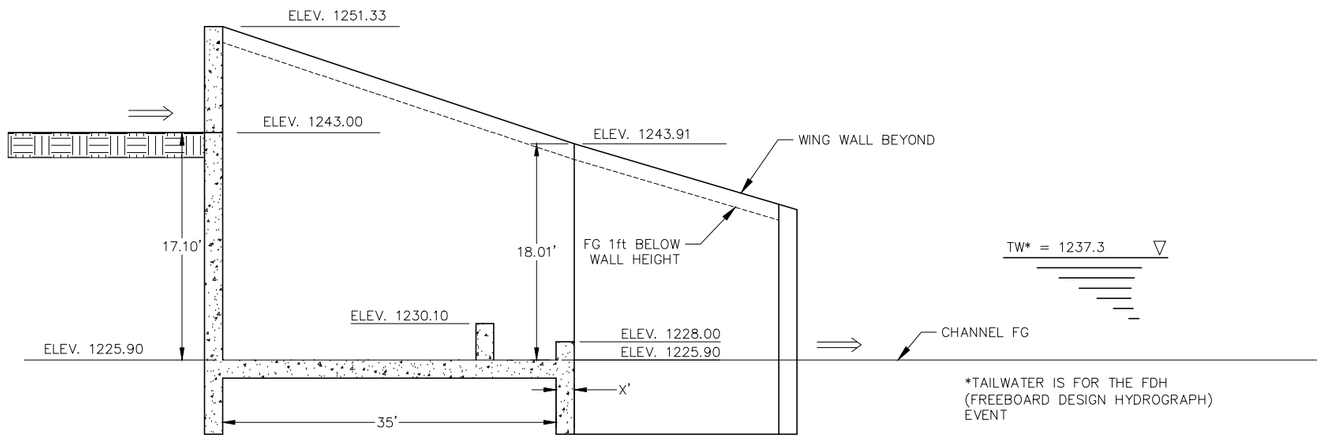
DOWNSTREAM DROP STRUCTURE DETAIL
RCPP/PL566 UPPER MAPLE RIVER WATERSHED ALTERNATIVE 2A
CASS COUNTY JOINT WATER RESOURCE DISTRICT
BARNES COUNTY, NORTH DAKOTA
DOWNSTREAM DROP STRUCTURE DETAILS

DATE:	05.01.20
REVISED:	----
REVISED:	----
REVISED:	----
REVISED:	----
REVISED:	----
RECORD:	----
PROJECT No.	18746
MANAGER:	KRL
DESIGNER:	ZJT
DRAFTER:	RJK
REVIEWER:	JMH

C-503

SHEET 34 OF 39





SECTION AT CENTER LINE

NOTES:
1. MEASUREMENTS DENOTED WITH "X" TO BE DETERMINED IN CONJUNCTION WITH STRUCTURAL AND GEOTECH DURING FINAL DESIGN.

UPSTREAM DROP STRUCTURE (EMERGENCY SPILLWAY)

NO SCALE

PRELIMINARY

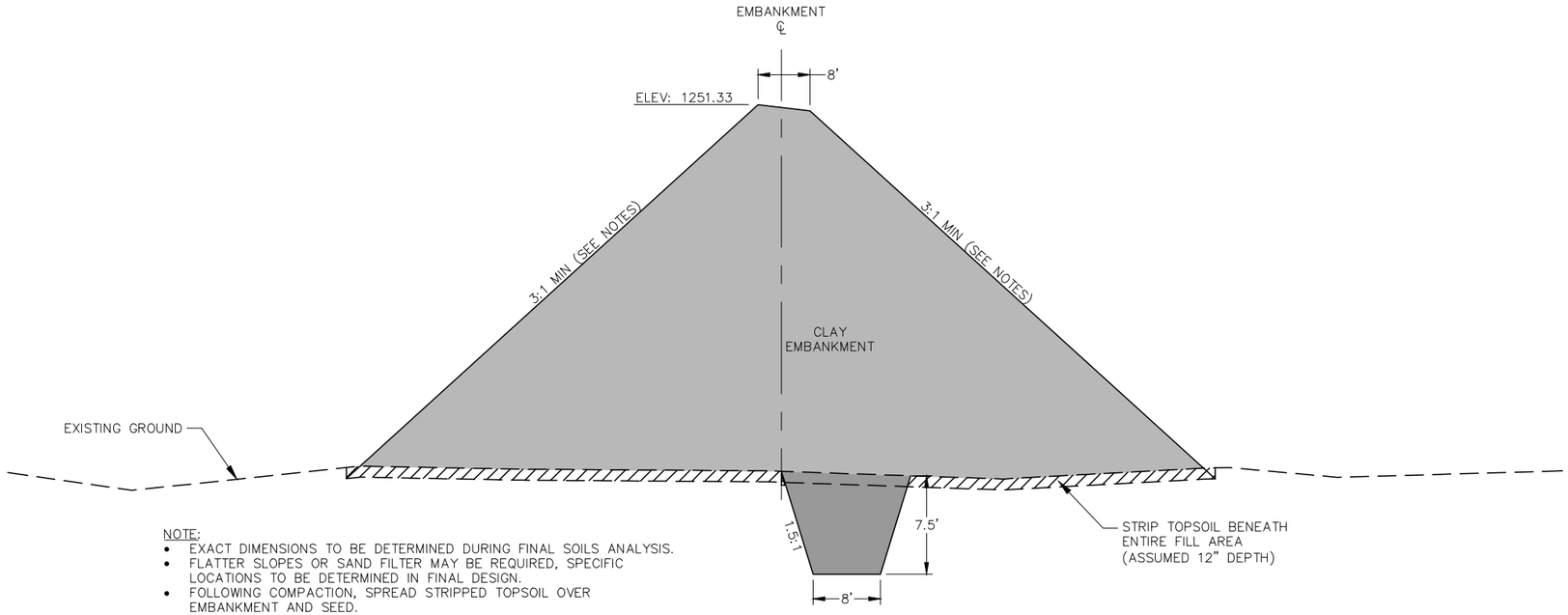
moore engineering, inc.

UPSTREAM DROP STRUCTURE DETAIL
RCPP/PL566 UPPER MAPLE RIVER WATERSHED ALTERNATIVE 2A
CASS COUNTY JOINT WATER RESOURCE DISTRICT
BARNES COUNTY, NORTH DAKOTA
UPSTREAM DROP STRUCTURE DETAIL

DATE:	05.01.20
REVISED:	----
REVISED:	----
REVISED:	----
REVISED:	----
REVISED:	----
RECORD:	----
PROJECT No.	18746
MANAGER:	KRL
DESIGNER:	ZJT
DRAFTER:	RJK
REVIEWER:	JMH

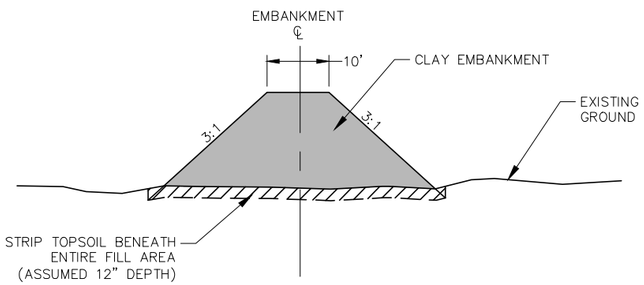
C-504

SHEET 35 OF 39



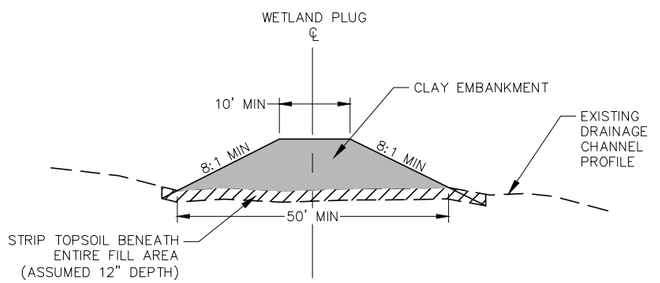
NOTE:
- EXACT DIMENSIONS TO BE DETERMINED DURING FINAL SOILS ANALYSIS.
- FLATTER SLOPES OR SAND FILTER MAY BE REQUIRED, SPECIFIC LOCATIONS TO BE DETERMINED IN FINAL DESIGN.
- FOLLOWING COMPACTION, SPREAD STRIPPED TOPSOIL OVER EMBANKMENT AND SEED.

TYPICAL DAM EMBANKMENT CROSS SECTIONS
NO SCALE



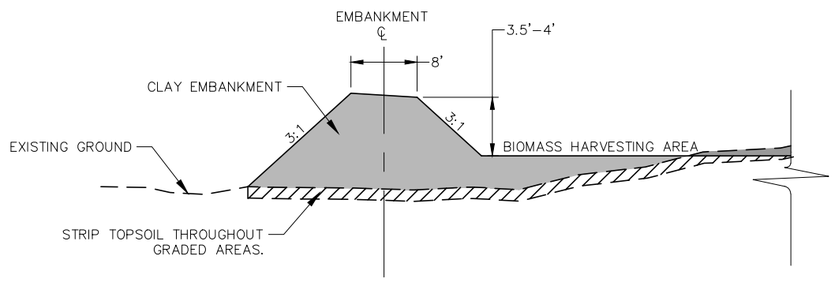
NOTE:
SEE PLAN AND PROFILE SHEETS FOR ELEVATIONS

FARM LEVEE TYPICAL SECTION
NO SCALE



NOTE:
HEIGHT VARIES, SEE WETLAND RESTORATION SHEET FOR ELEVATION INFORMATION.

WETLAND PLUG DETAIL
NO SCALE



NOTE:
SEE PROFILES FOR ELEVATION INFORMATION.

TYPICAL BIOMASS HARVEST AREA EMBANKMENT CROSS SECTIONS
NO SCALE

PRELIMINARY

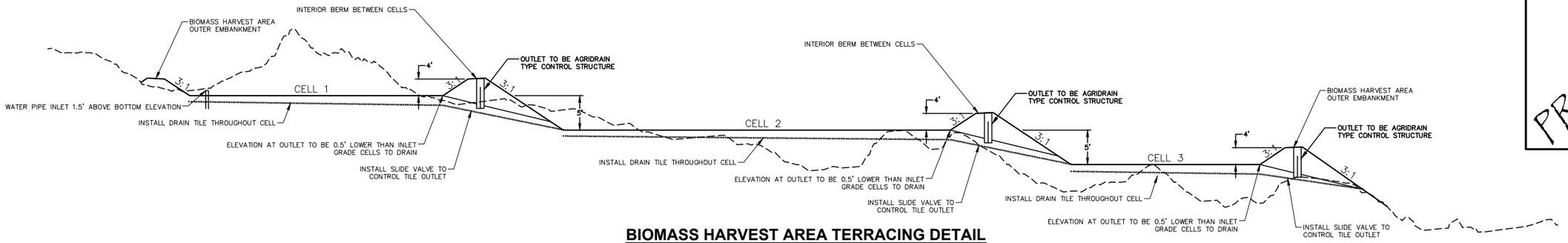
moore engineering, inc.

TYPICAL DAM EMBANKMENT SECTION
RCPP/PL566 UPPER MAPLE RIVER WATERSHED ALTERNATIVE 2A
CASS COUNTY JOINT WATER RESOURCE DISTRICT
BARNES COUNTY, NORTH DAKOTA
TYPICAL EMBANKMENT SECTIONS

DATE:	05.01.20
REVISED:	----
REVISED:	----
REVISED:	----
REVISED:	----
REVISED:	----
RECORD:	----
PROJECT No.	18746
MANAGER:	KRL
DESIGNER:	ZJT
DRAFTER:	RJK
REVIEWER:	JMH

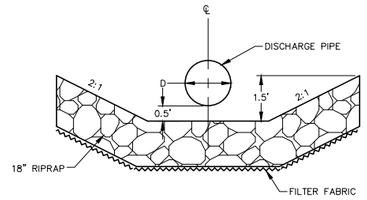
C-505

SHEET 36 OF 39

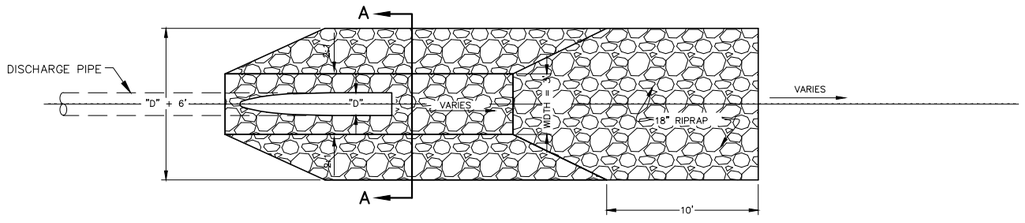


BIOMASS HARVEST AREA TERRACING DETAIL

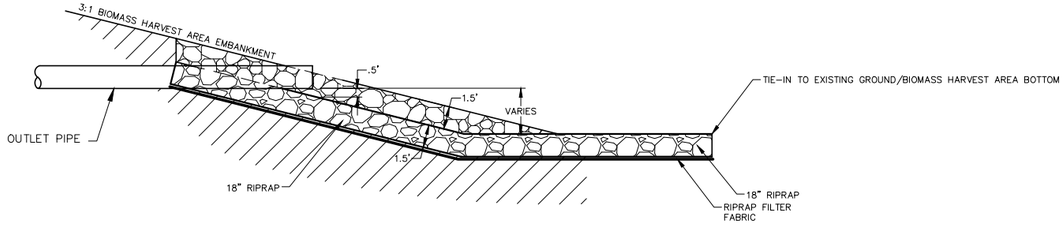
NO SCALE



SECTION A–A



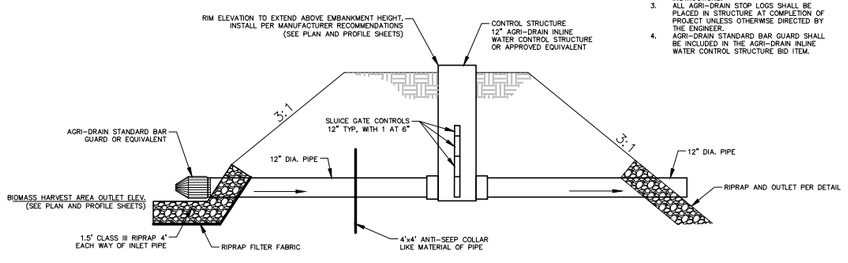
PLAN VIEW



PROFILE VIEW

PIPE OUTLET DETAIL

NO SCALE



NOTES:

1. ANTI–SEEP COLLAR SHALL BE LIKE MATERIAL OF PIPE AND INSTALLED PER MANUFACTURERS RECOMMENDATIONS.
2. INLINE WATER CONTROL STRUCTURE SHALL BE INSTALLED TO MANUFACTURES INSTALLATION INSTRUCTIONS.
3. ALL AGRI–DRAIN STOP LOGS SHALL BE PLACED IN STRUCTURE AT COMPLETION OF PROJECT UNLESS OTHERWISE DIRECTED BY THE ENGINEER.
4. AGRI–DRAIN STANDARD BAR GUARD SHALL BE INCLUDED IN THE AGRI–DRAIN INLINE WATER CONTROL STRUCTURE BID ITEM.

BIOMASS HARVEST AREA CONTROL STRUCTURE

NO SCALE

PRELIMINARY

moore engineering, inc.

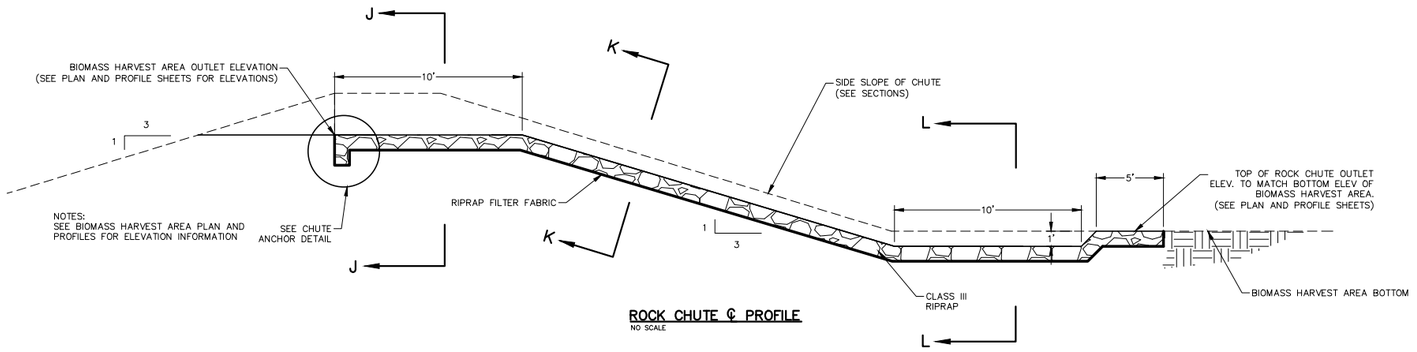
TYPICAL BIOMASS HARVEST AREA DIVERSION CHANNEL DETAILS
RCPP/PL566 UPPER MAPLE RIVER WATERSHED ALTERNATIVE 2A
CASS COUNTY JOINT WATER RESOURCE DISTRICT
BARNES COUNTY, NORTH DAKOTA
TYPICAL BIOMASS HARVEST AREA DIVERSION CHANNEL DETAILS

DATE:	05.01.20
REVISED:	----
REVISED:	----
REVISED:	----
REVISED:	----
REVISED:	----
RECORD:	----
PROJECT No.	18746
MANAGER:	KRL
DESIGNER:	ZJT
DRAFTER:	RJK
REVIEWER:	JMH

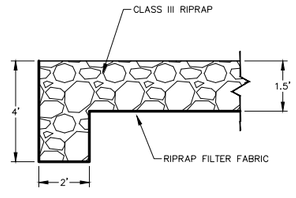
C-506

SHEET 37 OF 39

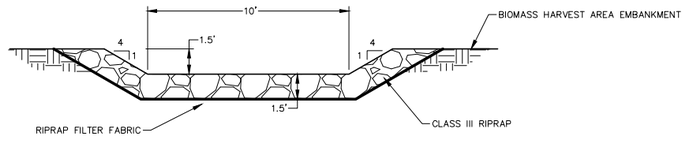
PRELIMINARY



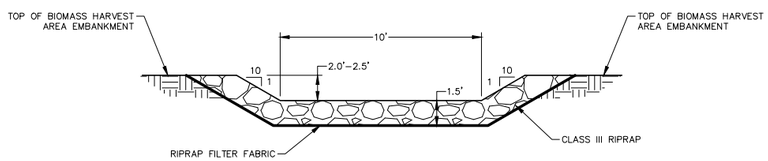
ROCK CHUTE ℄ PROFILE
NO SCALE



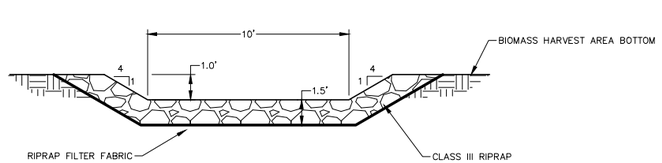
CHUTE ANCHOR DETAIL
NO SCALE



TYPICAL SECTION K–K
NO SCALE



TYPICAL SECTION J–J
NO SCALE



TYPICAL SECTION L–L
NO SCALE

BIOMASS HARVEST AREA EMERGENCY OVERFLOW DETAIL

NO SCALE

moore engineering, inc.

TYPICAL BIOMASS HARVEST AREA INLET & OUTLET DETAILS
RCPP/PL566 UPPER MAPLE RIVER WATERSHED ALTERNATIVE 2A
CASS COUNTY JOINT WATER RESOURCE DISTRICT
BARNES COUNTY, NORTH DAKOTA
TYPICAL BIOMASS HARVEST AREA INLET & OUTLET DETAILS

DATE:	05.01.20
REVISED:	----
REVISED:	----
REVISED:	----
REVISED:	----
REVISED:	----
RECORD:	----
PROJECT No.	18746
MANAGER:	KRL
DESIGNER:	ZJT
DRAFTER:	RJK
REVIEWER:	JMH

C-507

SHEET 38 OF 39

Upper Maple River RCPP
Cass County Joint Water Resource District
Cass County, North Dakota
Alternative 2A

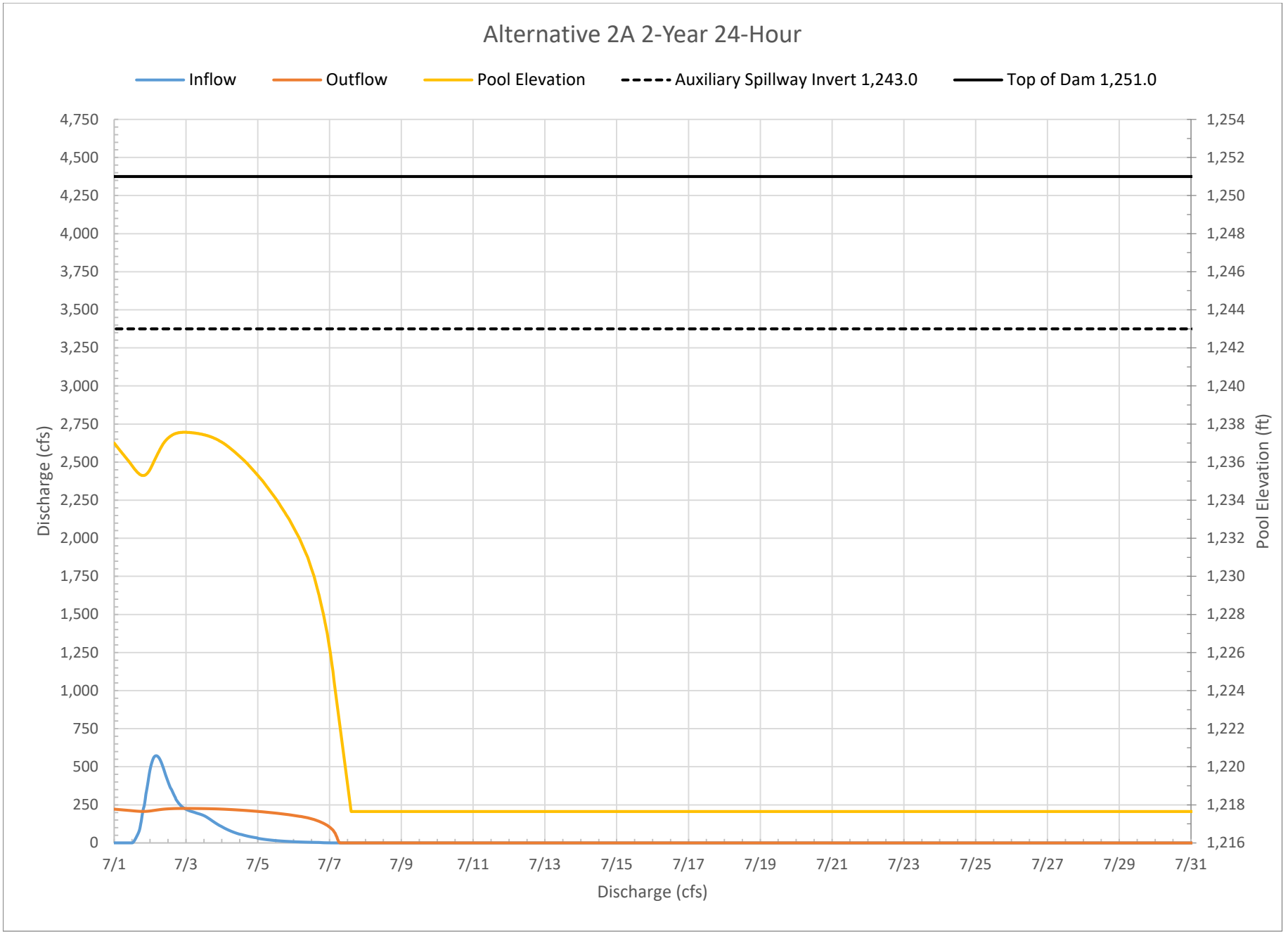
Engineer's Preliminary Opinion of Probable Cost

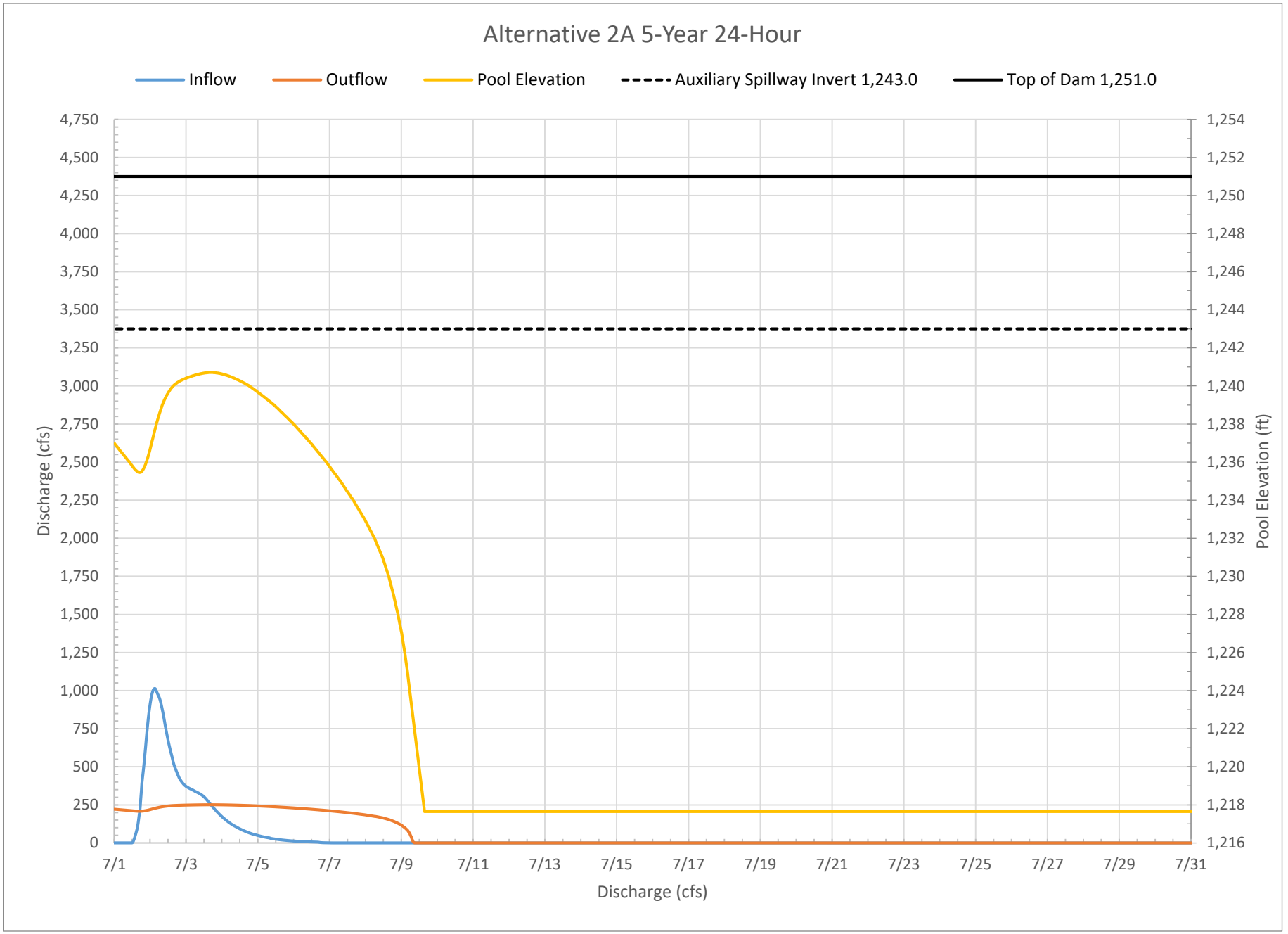
						FUNDING SOURCES			
BID ITEM NO. & DESCRIPTION	UNIT	QUANTITY	UNIT PRICE	TOTAL	Federal	NDSWC	RRJWRD	Cass County	LOCAL
Dam									
1. Topsoil Stripping & Spreading	AC	51	$1,300.00	$66,300.00	$49,725.00	$10,773.75	$3,770.81	$1,015.22	$1,015.22
2. Excavation - Common (Spoil)	CY	420,000	$2.10	$882,000.00	$661,500.00	$143,325.00	$50,163.75	$13,505.63	$13,505.63
3. Embankment - Select Clay	CY	272,650	$2.25	$613,462.50	$460,096.88	$99,687.66	$34,890.68	$9,393.64	$9,393.64
4. Embankment - Filter Sand	CY	12,500	$20.50	$256,250.00	$192,187.50	$41,640.63	$14,574.22	$3,923.83	$3,923.83
5. Embankment - Filter Keyway/Inspection Trench	CY	13,500	$2.30	$31,050.00	$23,287.50	$5,045.63	$1,765.97	$475.45	$475.45
6. Reinforced Concrete (Primary Spillway)	CY	80	$1,250.00	$100,000.00	$75,000.00	$16,250.00	$5,687.50	$1,531.25	$1,531.25
7. Reinforced Concrete (Emergency Spillway)	CY	1,050	$1,250.00	$1,312,500.00	$984,375.00	$213,281.25	$74,648.44	$20,097.66	$20,097.66
8. Reinforced Concrete Pressure Pipe 48"	LF	186	$750.00	$139,500.00	$104,625.00	$22,668.75	$7,934.06	$2,136.09	$2,136.09
9. Trash Racks - Two Way Riser	LS	1	$10,000.00	$10,000.00	$7,500.00	$1,625.00	$568.75	$153.13	$153.13
10. Steel Baffle Assembly	LS	1	$23,000.00	$23,000.00	$17,250.00	$3,737.50	$1,308.13	$352.19	$352.19
11. Riprap Type I	CY	6,350	$70.00	$444,500.00	$333,375.00	$72,231.25	$25,280.94	$6,806.41	$6,806.41
12. Riprap Type III	CY	950	$70.00	$66,500.00	$49,875.00	$10,806.25	$3,782.19	$1,018.28	$1,018.28
13. Riprap Filter Blanket	SY	21,000	$3.00	$63,000.00	$47,250.00	$10,237.50	$3,583.13	$964.69	$964.69
14. Seeding - Standard Type III	AC	51.0	$1,000.00	$51,000.00	$38,250.00	$8,287.50	$2,900.63	$780.94	$780.94
15. Aggregate Surface Course (Access Road)	CY	250	$30.00	$7,500.00	$5,625.00	$1,218.75	$426.56	$114.84	$114.84
16. Timber Bollards - (6') (Access Road)	EA	50	$470.00	$23,500.00	$17,625.00	$3,818.75	$1,336.56	$359.84	$359.84
17. Gate - (14') (Access Road)	EA	2	$1,375.00	$2,750.00	$2,062.50	$446.88	$156.41	$42.11	$42.11
18. Fence - Barbed Wire (12 1/2 Gaged)	LF	60,000	$6.20	$372,000.00	$279,000.00	$46,500.00	$30,225.00	$8,137.50	$8,137.50
19. Stockwater	EA	4	$5,000.00	$20,000.00	$15,000.00	$2,500.00	$1,625.00	$437.50	$437.50
Road Raise									
20. Embankment	CY	40,000	$2.25	$90,000.00	$67,500.00	$14,625.00	$5,118.75	$1,378.13	$1,378.13
21. Aggregate Surface Course	CY	560	$30.00	$16,800.00	$12,600.00	$2,730.00	$955.50	$257.25	$257.25
22. Road Closure Gate	EA	1	$3,300.00	$3,300.00	$2,475.00	$536.25	$187.69	$50.53	$50.53
Farmstead Levees									
23. Topsoil Stripping & Spreading	AC	2	$1,300.00	$2,600.00	$1,950.00	$422.50	$147.88	$39.81	$39.81
24. Embankment	CY	7,250	$3.00	$21,750.00	$16,312.50	$3,534.38	$1,237.03	$333.05	$333.05
25. Corrugated Metal Pipe - 24"	LF	400	$35.00	$14,000.00	$10,500.00	$2,275.00	$796.25	$214.38	$214.38
26. Flap Gate - 24" Cast Iron	EA	4	$2,000.00	$8,000.00	$6,000.00	$1,300.00	$455.00	$122.50	$122.50
27. Flared End Section - 24" CMP	EA	4	$265.00	$1,060.00	$795.00	$172.25	$60.29	$16.23	$16.23
Biomass Harvest Areas & Channel									
28. Topsoil Stripping & Spreading	AC	275	$1,300.00	$357,500.00	$268,125.00	$44,687.50	$29,046.88	$7,820.31	$7,820.31
29. Excavation - Common (Spoil)	CY	365,305	$2.10	$767,140.50	$575,355.38	$95,892.56	$62,330.17	$16,781.20	$16,781.20
30. Embankment	CY	408,579	$2.25	$919,302.75	$689,477.06	$114,912.84	$74,693.35	$20,109.75	$20,109.75
31. Riprap Type III	CY	340	$70.00	$23,800.00	$17,850.00	$2,975.00	$1,933.75	$520.63	$520.63
32. Water Supply Pump	EA	2	$75,000.00	$150,000.00	$112,500.00	$18,750.00	$12,187.50	$3,281.25	$3,281.25
33. 24" PVC Pipe	LF	5,800	$55.00	$319,000.00	$239,250.00	$39,875.00	$25,918.75	$6,978.13	$6,978.13
34. Underdrain Pipe	LF	180,400	$8.50	$1,533,400.00	$1,150,050.00	$191,675.00	$124,588.75	$33,543.13	$33,543.13
35. Seeding - Cattail	AC	255	$900.00	$229,500.00	$172,125.00	$28,687.50	$18,646.88	$5,020.31	$5,020.31
36. Seeding - Standard Type III	AC	20	$900.00	$18,000.00	$13,500.00	$2,250.00	$1,462.50	$393.75	$393.75
Wetland Restorations/Creation/Mitigation									
37. Topsoil Stripping & Spreading	AC	4	$1,300.00	$5,200.00	$2,600.00	$1,300.00	$845.00	$227.50	$227.50
38. Embankment	CY	4,480	$2.25	$10,080.00	$5,040.00	$2,520.00	$1,638.00	$441.00	$441.00
39. Seeding - Standard Type III	AC	4	$900.00	$3,600.00	$1,800.00	$900.00	$585.00	$157.50	$157.50
Miscellaneous									
40. Mobilization	LS	1	$445,592.50	$445,592.50	$334,194.38	$72,408.78	$25,343.07	$6,823.14	$6,823.14
41. Temporary Traffic Control	LS	1	$4,400.00	$4,400.00	$3,300.00	$715.00	$250.25	$67.38	$67.38
42. Storm Water Management	LS	1	$10,000.00	$10,000.00	$7,500.00	$1,625.00	$568.75	$153.13	$153.13
43. Clearing & Grubbing	LS	1	$6,500.00	$6,500.00	$4,875.00	$1,056.25	$369.69	$99.53	$99.53
44. Demolition	LS	1	$1,500.00	$1,500.00	$1,125.00	$243.75	$85.31	$22.97	$22.97
45. Dewatering	LS	1	$33,500.00	$33,500.00	$25,125.00	$5,443.75	$1,905.31	$512.97	$512.97
46. Field Office & Laboratory	LS	1	$15,000.00	$15,000.00	$11,250.00	$2,437.50	$853.13	$229.69	$229.69
47. Permanent Traffic Control	LS	1	$7,000.00	$7,000.00	$5,250.00	$1,137.50	$398.13	$107.19	$107.19
48. Material Testing	Allowance	1	$100,000.00	$100,000.00	$75,000.00	$16,250.00	$5,687.50	$1,531.25	$1,531.25
Construction Subtotal				$9,602,338.25	$7,197,033.69	$1,385,420.34	$662,924.74	$178,479.74	$178,479.74
Engineering - Design & Construction				$1,131,931.75	$848,948.81	$141,491.47	$91,969.45	$24,761.01	$24,761.01
Operation & Maintenance Plan				$40,000.00	$0.00	$20,000.00	$13,000.00	$3,500.00	$3,500.00
Legal				$50,000.00	$0.00	$0.00	$32,500.00	$8,750.00	$8,750.00
Bond Issuance / Financing				$15,000.00	$0.00	$0.00	$9,750.00	$2,625.00	$2,625.00
Right-of-Way Acquisition				$3,755,730.00	$0.00	$1,877,865.00	$1,220,612.25	$328,626.38	$328,626.38
Right-of-Way Negotiations				$50,000.00	$0.00	$25,000.00	$16,250.00	$4,375.00	$4,375.00
Land Surveying				$50,000.00	$0.00	$25,000.00	$16,250.00	$4,375.00	$4,375.00
Utility Relocations				$100,000.00	$0.00	$50,000.00	$32,500.00	$8,750.00	$8,750.00
Utility Relocation Coordination				$15,000.00	$0.00	$7,500.00	$4,875.00	$1,312.50	$1,312.50
TOTAL PROJECT COST				$14,810,000.00	$8,045,982.50	$3,532,276.81	$2,100,631.45	$565,554.62	$565,554.62

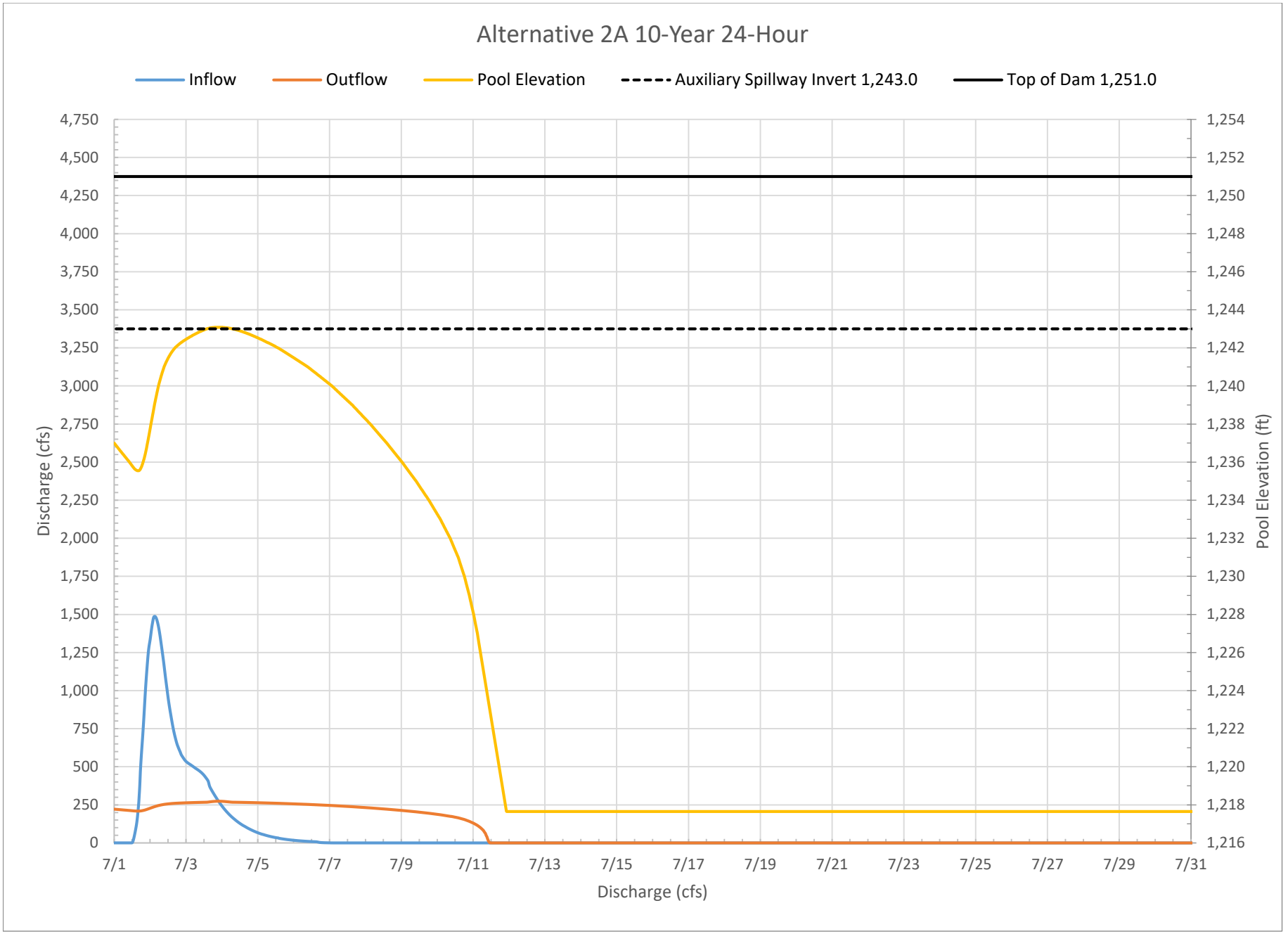
moore engineering, inc.

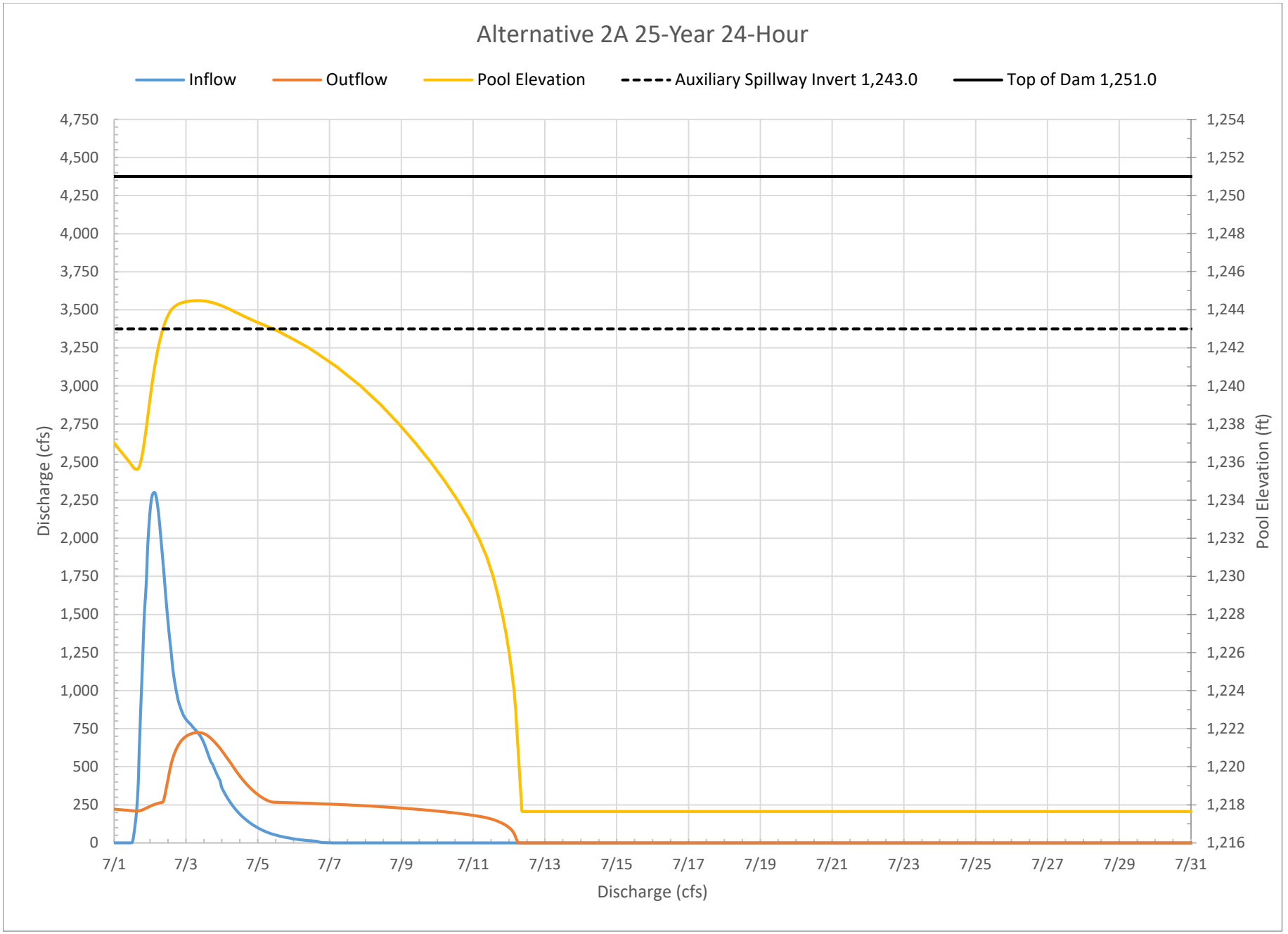
[14] Barr Engineering Inc., "Preliminary Geotechnical Engineering Report Rush River Watershed - Amenia Levee Alternative Sites Alt1 and Alt2 Cass County, North Dakota," 2019.

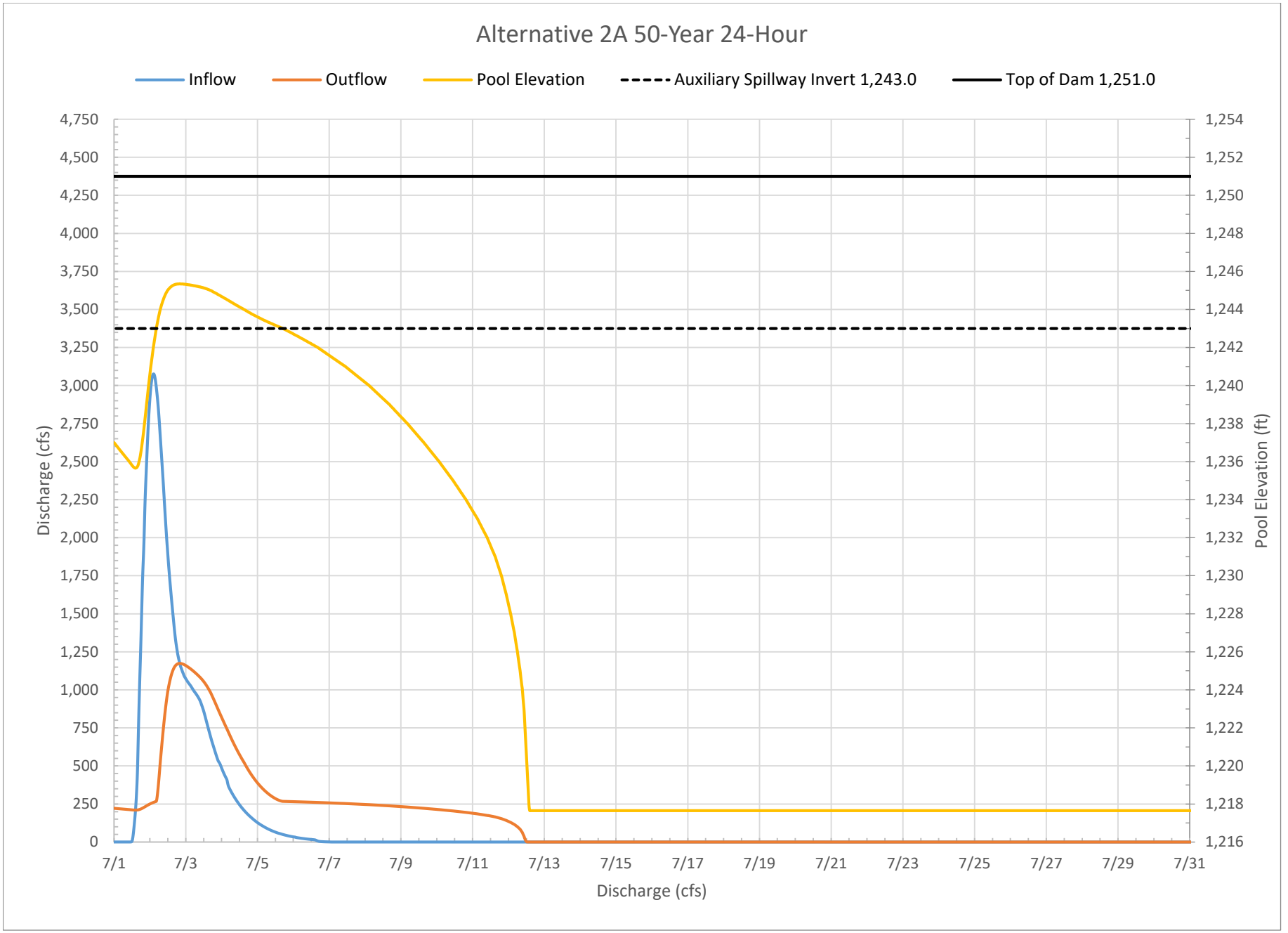
Appendix B Alternative 2A Event Hydrographs

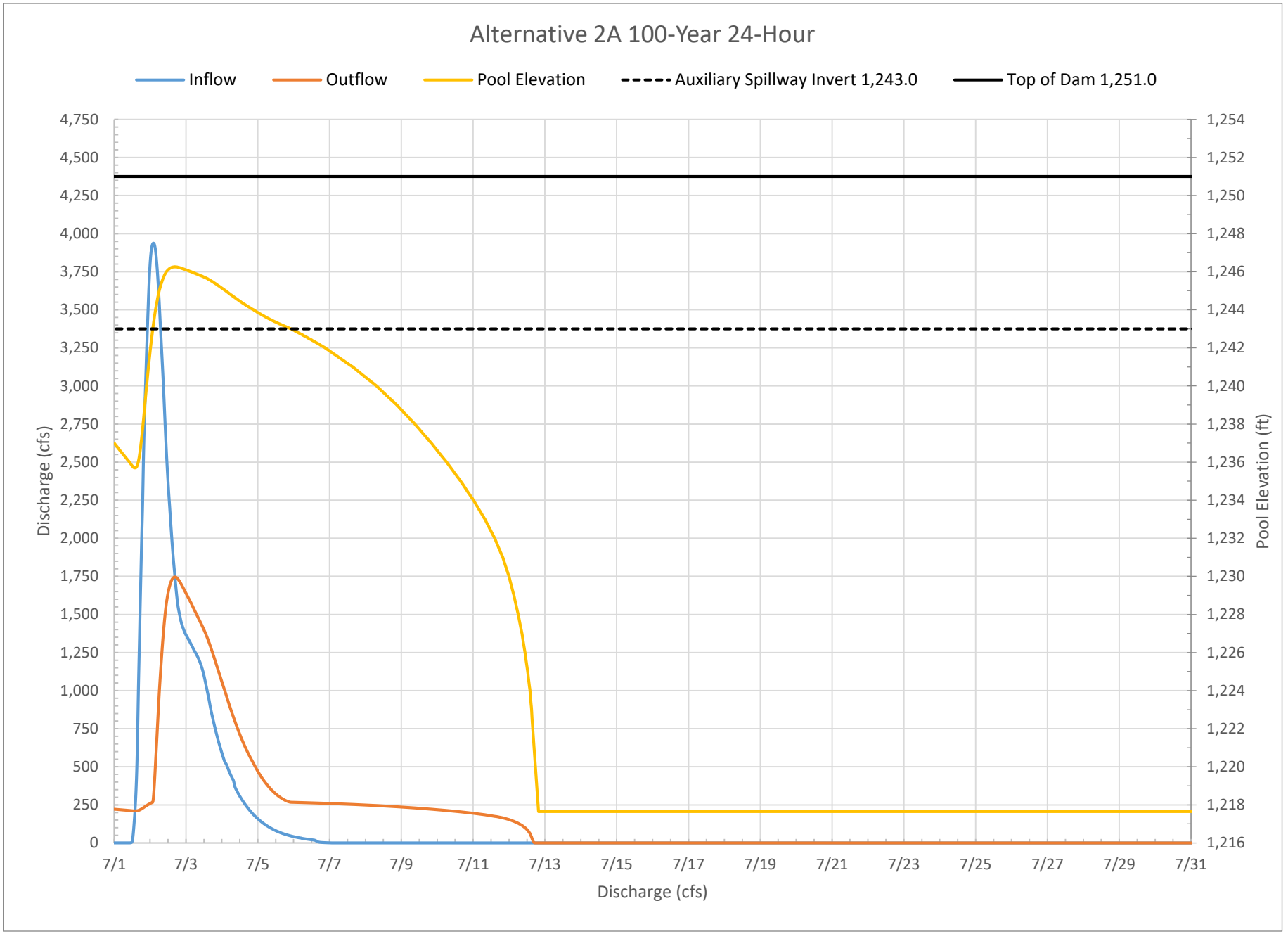

Alternative 2A 2-Year 24-Hour
Inflow
Outflow
Pool Elevation
Auxiliary Spillway Invert 1,243.0
Top of Dam 1,251.0
Discharge (cfs)
Pool Elevation (ft)
4,750
4,500
4,250
4,000
3,750
3,500
3,250
3,000
2,750
2,500
2,250
2,000
1,750
1,500
1,250
1,000
750
500
250
0
1,254
1,252
1,250
1,248
1,246
1,244
1,242
1,240
1,238
1,236
1,234
1,232
1,230
1,228
1,226
1,224
1,222
1,220
1,218
1,216
7/1
7/3
7/5
7/7
7/9
7/11
7/13
7/15
7/17
7/19
7/21
7/23
7/25
7/27
7/29
7/31
Discharge (cfs)

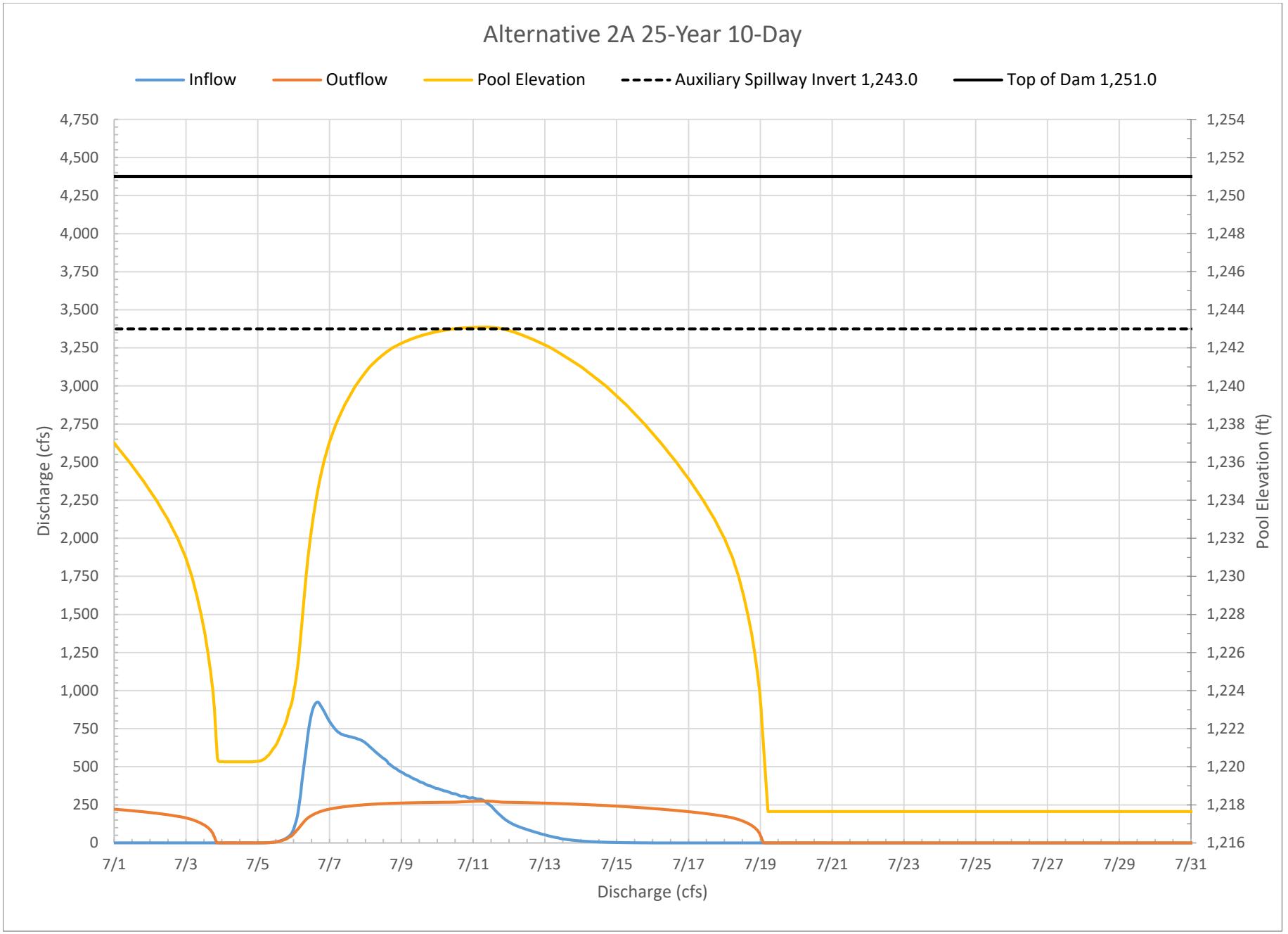

Alternative 2A 5-Year 24-Hour
Inflow
Outflow
Pool Elevation
Auxiliary Spillway Invert 1,243.0
Top of Dam 1,251.0
Discharge (cfs)
Pool Elevation (ft)
4,750
4,500
4,250
4,000
3,750
3,500
3,250
3,000
2,750
2,500
2,250
2,000
1,750
1,500
1,250
1,000
750
500
250
0
1,254
1,252
1,250
1,248
1,246
1,244
1,242
1,240
1,238
1,236
1,234
1,232
1,230
1,228
1,226
1,224
1,222
1,220
1,218
1,216
7/1
7/3
7/5
7/7
7/9
7/11
7/13
7/15
7/17
7/19
7/21
7/23
7/25
7/27
7/29
7/31
Discharge (cfs)

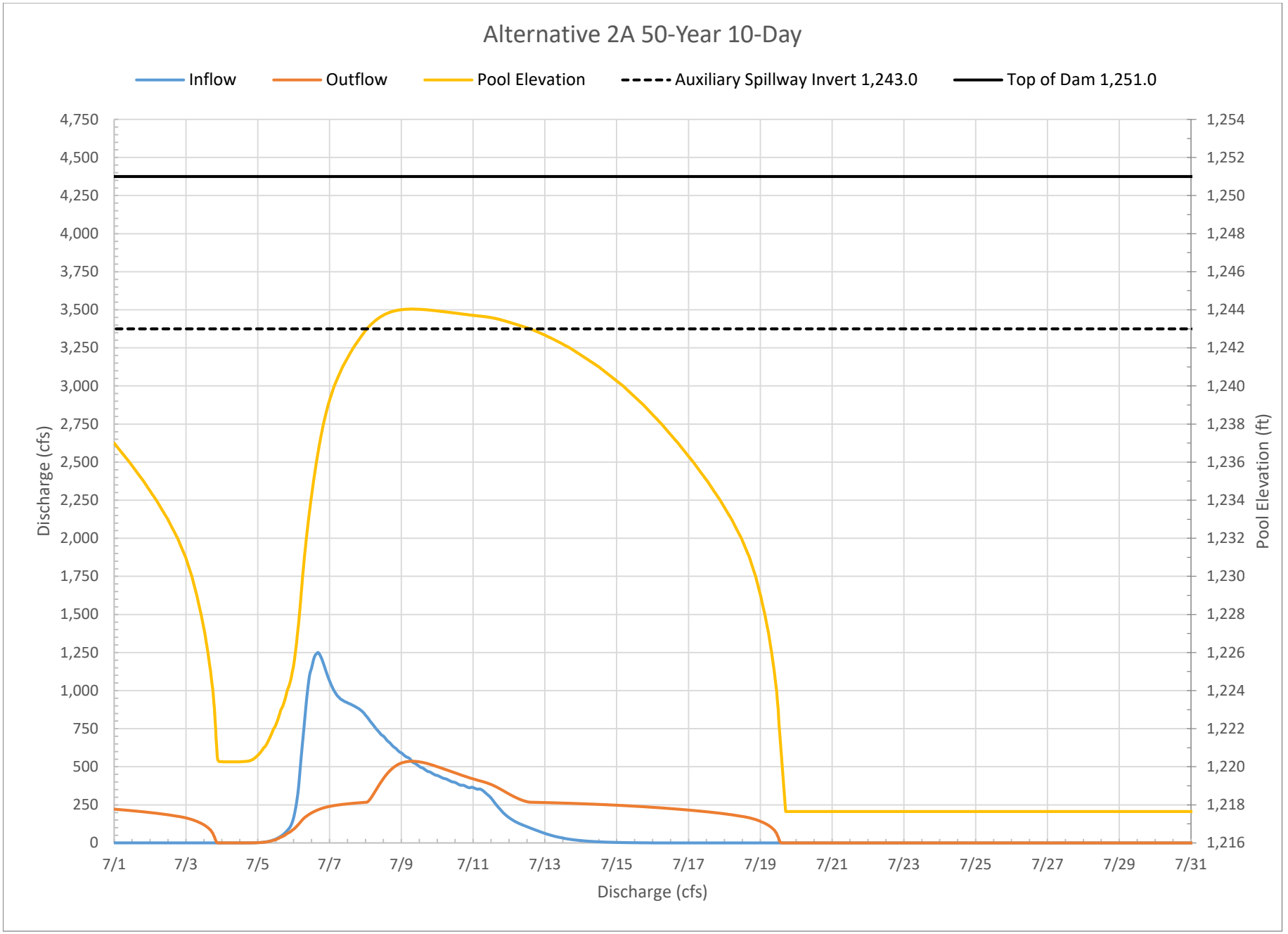

Alternative 2A 10-Year 24-Hour
Inflow
Outflow
Pool Elevation
Auxiliary Spillway Invert 1,243.0
Top of Dam 1,251.0
Discharge (cfs)
Pool Elevation (ft)
4,750
4,500
4,250
4,000
3,750
3,500
3,250
3,000
2,750
2,500
2,250
2,000
1,750
1,500
1,250
1,000
750
500
250
0
1,254
1,252
1,250
1,248
1,246
1,244
1,242
1,240
1,238
1,236
1,234
1,232
1,230
1,228
1,226
1,224
1,222
1,220
1,218
1,216
7/1
7/3
7/5
7/7
7/9
7/11
7/13
7/15
7/17
7/19
7/21
7/23
7/25
7/27
7/29
7/31
Discharge (cfs)

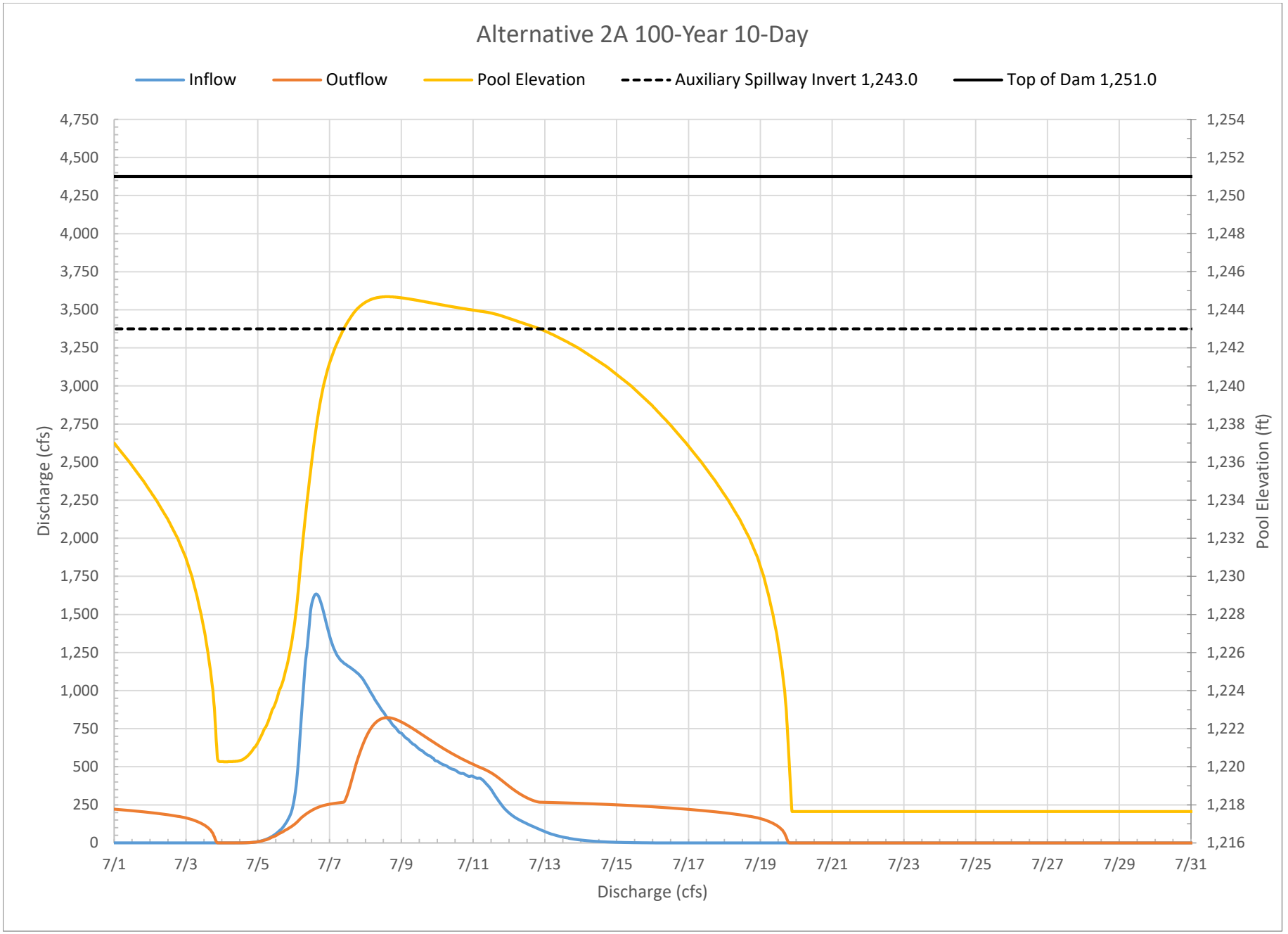

Alternative 2A 25-Year 24-Hour
Inflow
Outflow
Pool Elevation
Auxiliary Spillway Invert 1,243.0
Top of Dam 1,251.0
Discharge (cfs)
Pool Elevation (ft)
4,750
4,500
4,250
4,000
3,750
3,500
3,250
3,000
2,750
2,500
2,250
2,000
1,750
1,500
1,250
1,000
750
500
250
0
1,254
1,252
1,250
1,248
1,246
1,244
1,242
1,240
1,238
1,236
1,234
1,232
1,230
1,228
1,226
1,224
1,222
1,220
1,218
1,216
7/1
7/3
7/5
7/7
7/9
7/11
7/13
7/15
7/17
7/19
7/21
7/23
7/25
7/27
7/29
7/31
Discharge (cfs)

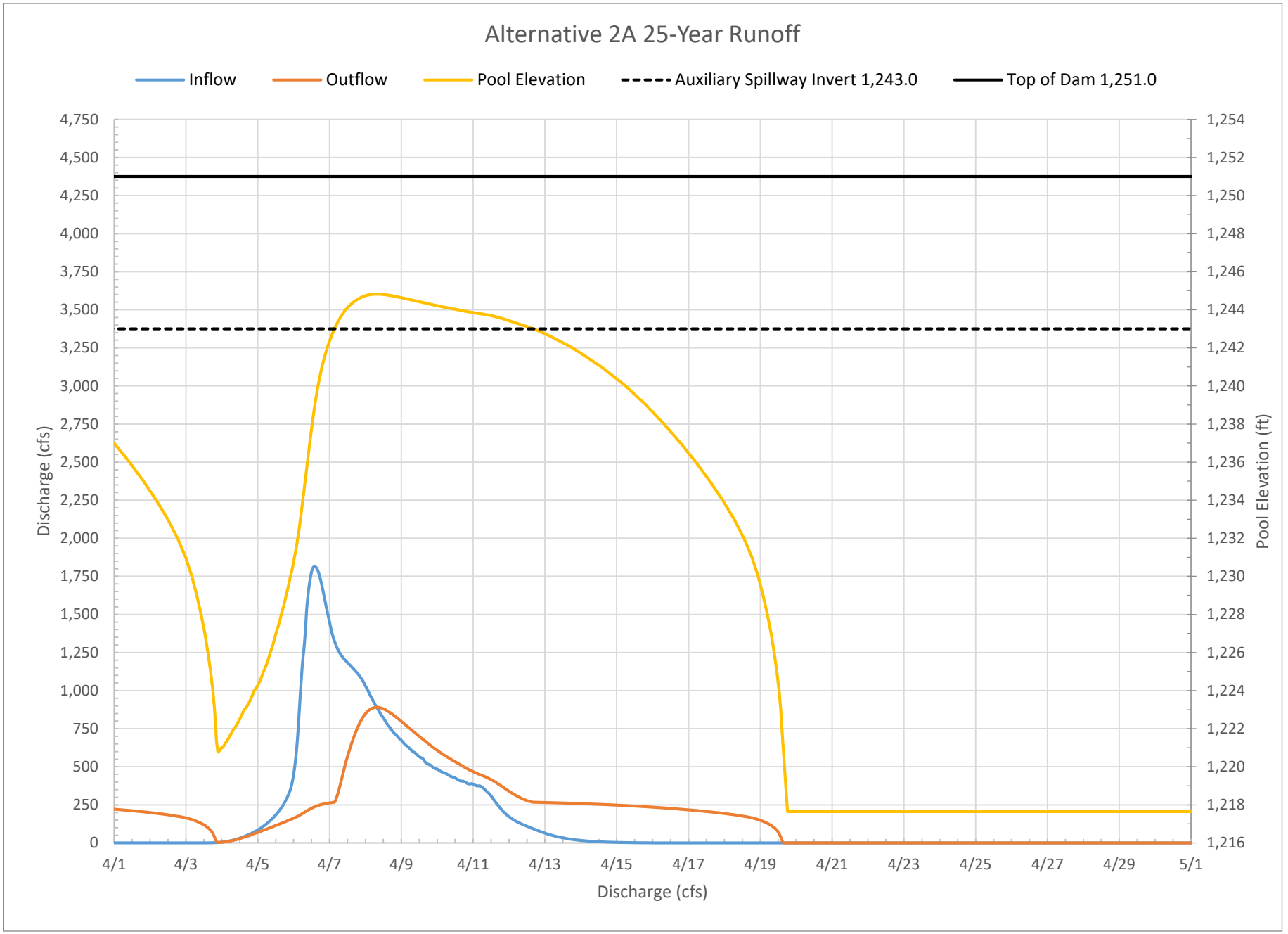

Alternative 2A 50-Year 24-Hour
Inflow
Outflow
Pool Elevation
Auxiliary Spillway Invert 1,243.0
Top of Dam 1,251.0
Discharge (cfs)
Pool Elevation (ft)
4,750
4,500
4,250
4,000
3,750
3,500
3,250
3,000
2,750
2,500
2,250
2,000
1,750
1,500
1,250
1,000
750
500
250
0
1,254
1,252
1,250
1,248
1,246
1,244
1,242
1,240
1,238
1,236
1,234
1,232
1,230
1,228
1,226
1,224
1,222
1,220
1,218
1,216
7/1
7/3
7/5
7/7
7/9
7/11
7/13
7/15
7/17
7/19
7/21
7/23
7/25
7/27
7/29
7/31
Discharge (cfs)

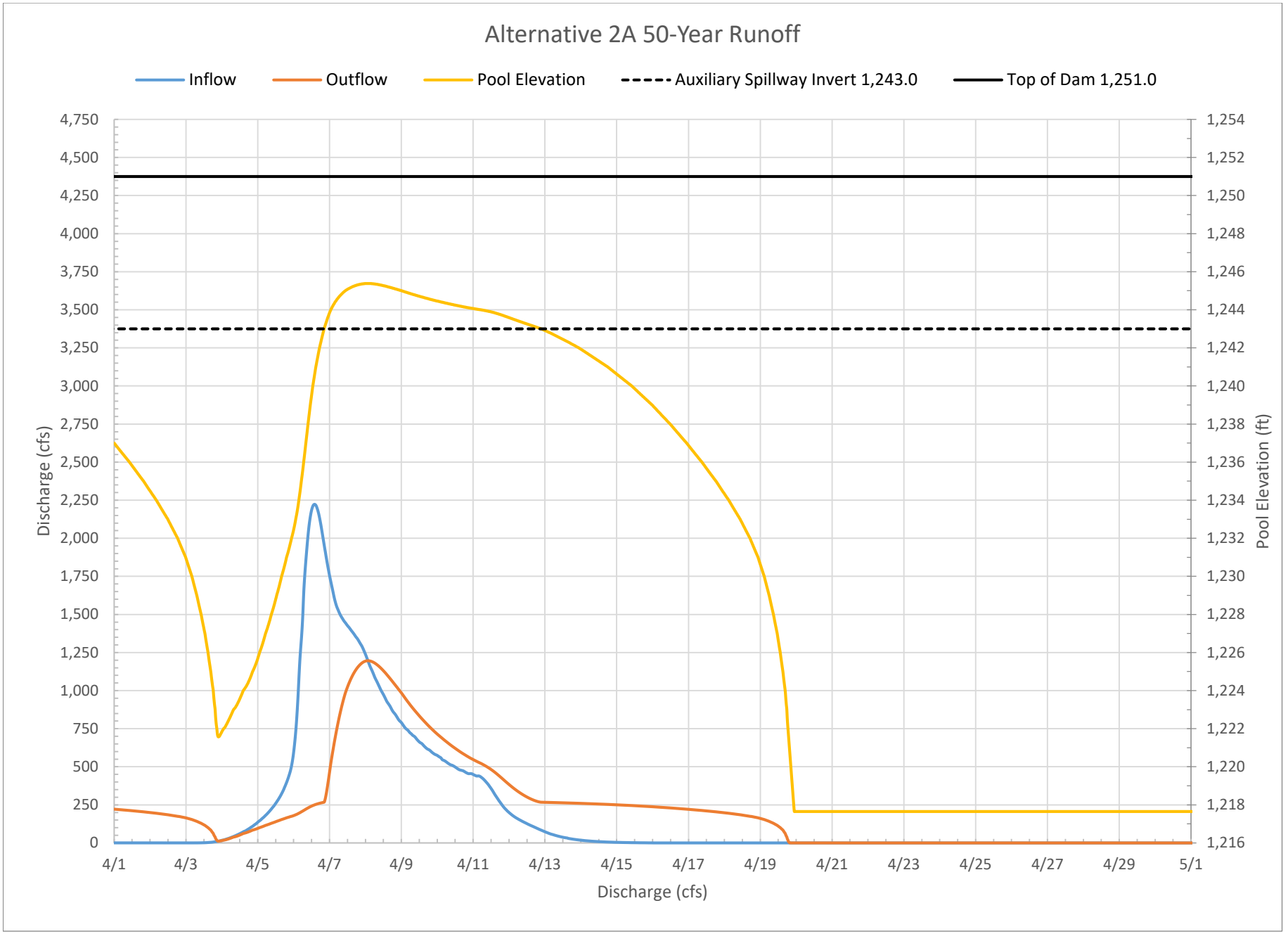

Alternative 2A 100-Year 24-Hour
Inflow
Outflow
Pool Elevation
Auxiliary Spillway Invert 1,243.0
Top of Dam 1,251.0
Discharge (cfs)
Pool Elevation (ft)
4,750
4,500
4,250
4,000
3,750
3,500
3,250
3,000
2,750
2,500
2,250
2,000
1,750
1,500
1,250
1,000
750
500
250
0
1,254
1,252
1,250
1,248
1,246
1,244
1,242
1,240
1,238
1,236
1,234
1,232
1,230
1,228
1,226
1,224
1,222
1,220
1,218
1,216
7/1
7/3
7/5
7/7
7/9
7/11
7/13
7/15
7/17
7/19
7/21
7/23
7/25
7/27
7/29
7/31
Discharge (cfs)

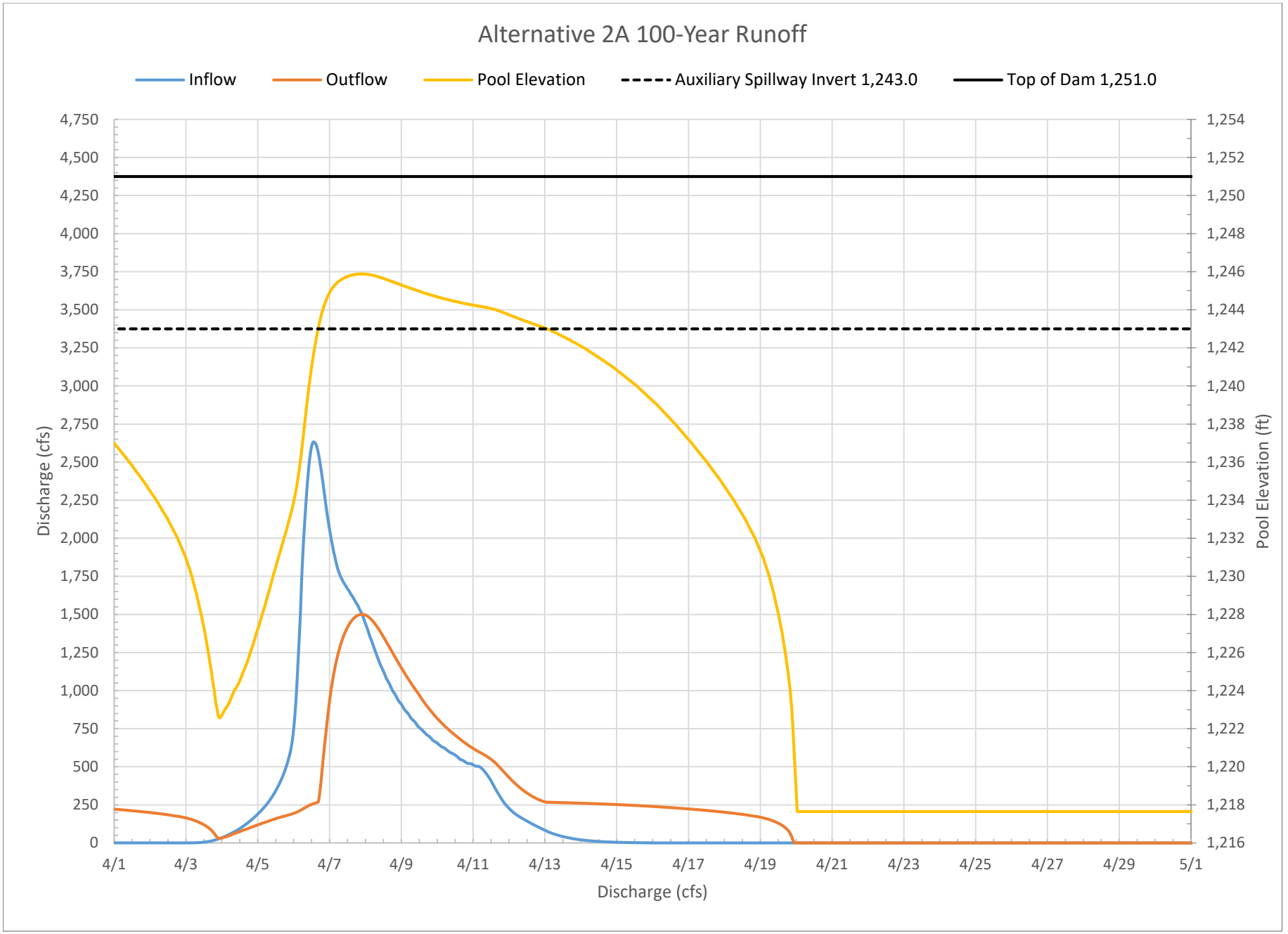

Alternative 2A 25-Year 10-Day
Inflow
Outflow
Pool Elevation
Auxiliary Spillway Invert 1,243.0
Top of Dam 1,251.0
Discharge (cfs)
Pool Elevation (ft)
4,750
4,500
4,250
4,000
3,750
3,500
3,250
3,000
2,750
2,500
2,250
2,000
1,750
1,500
1,250
1,000
750
500
250
0
1,254
1,252
1,250
1,248
1,246
1,244
1,242
1,240
1,238
1,236
1,234
1,232
1,230
1,228
1,226
1,224
1,222
1,220
1,218
1,216
7/1
7/3
7/5
7/7
7/9
7/11
7/13
7/15
7/17
7/19
7/21
7/23
7/25
7/27
7/29
7/31
Discharge (cfs)

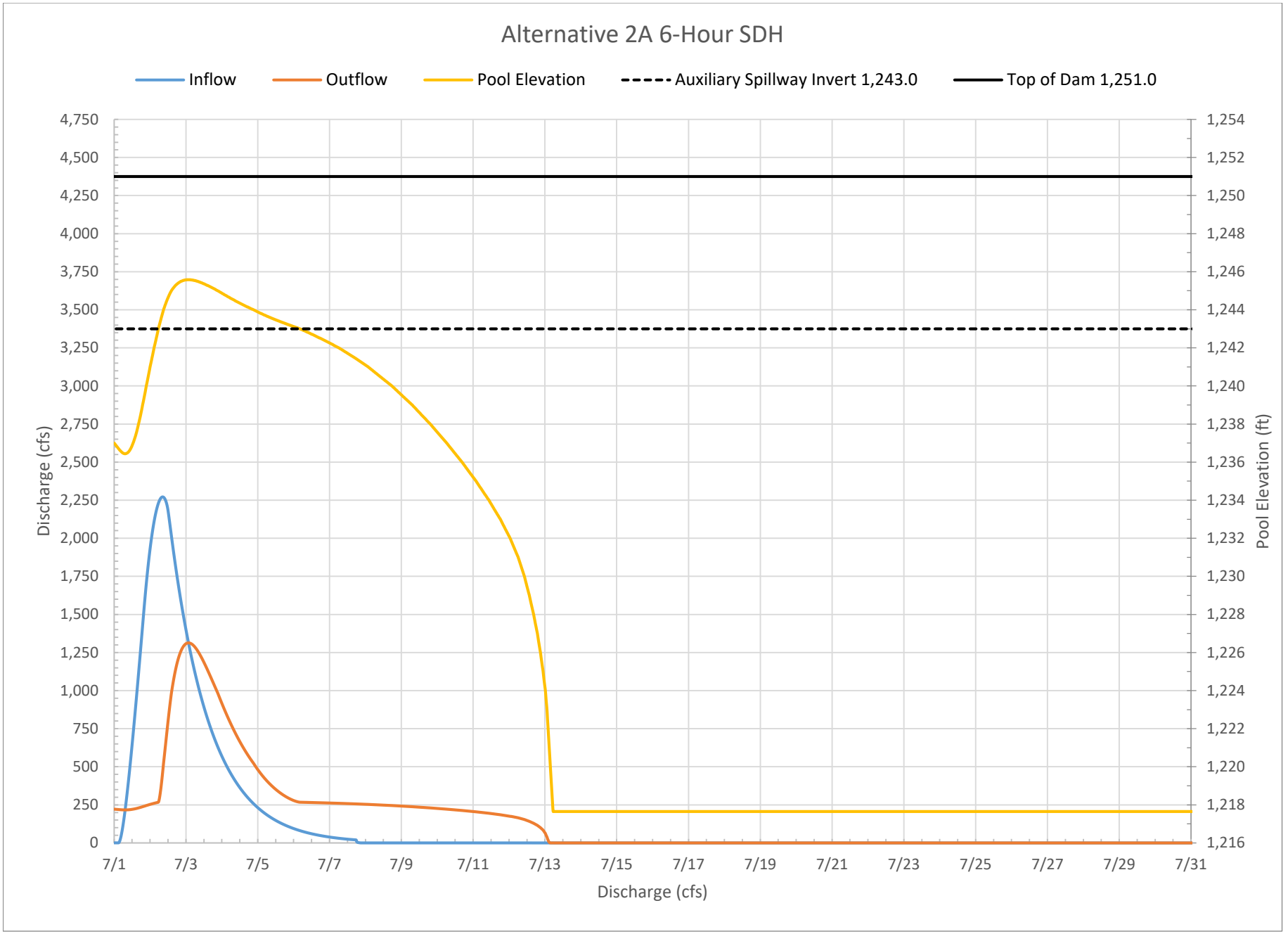

Alternative 2A 50-Year 10-Day
Inflow
Outflow
Pool Elevation
Auxiliary Spillway Invert 1,243.0
Top of Dam 1,251.0
Discharge (cfs)
Pool Elevation (ft)
4,750
4,500
4,250
4,000
3,750
3,500
3,250
3,000
2,750
2,500
2,250
2,000
1,750
1,500
1,250
1,000
750
500
250
0
1,254
1,252
1,250
1,248
1,246
1,244
1,242
1,240
1,238
1,236
1,234
1,232
1,230
1,228
1,226
1,224
1,222
1,220
1,218
1,216
7/1
7/3
7/5
7/7
7/9
7/11
7/13
7/15
7/17
7/19
7/21
7/23
7/25
7/27
7/29
7/31
Discharge (cfs)

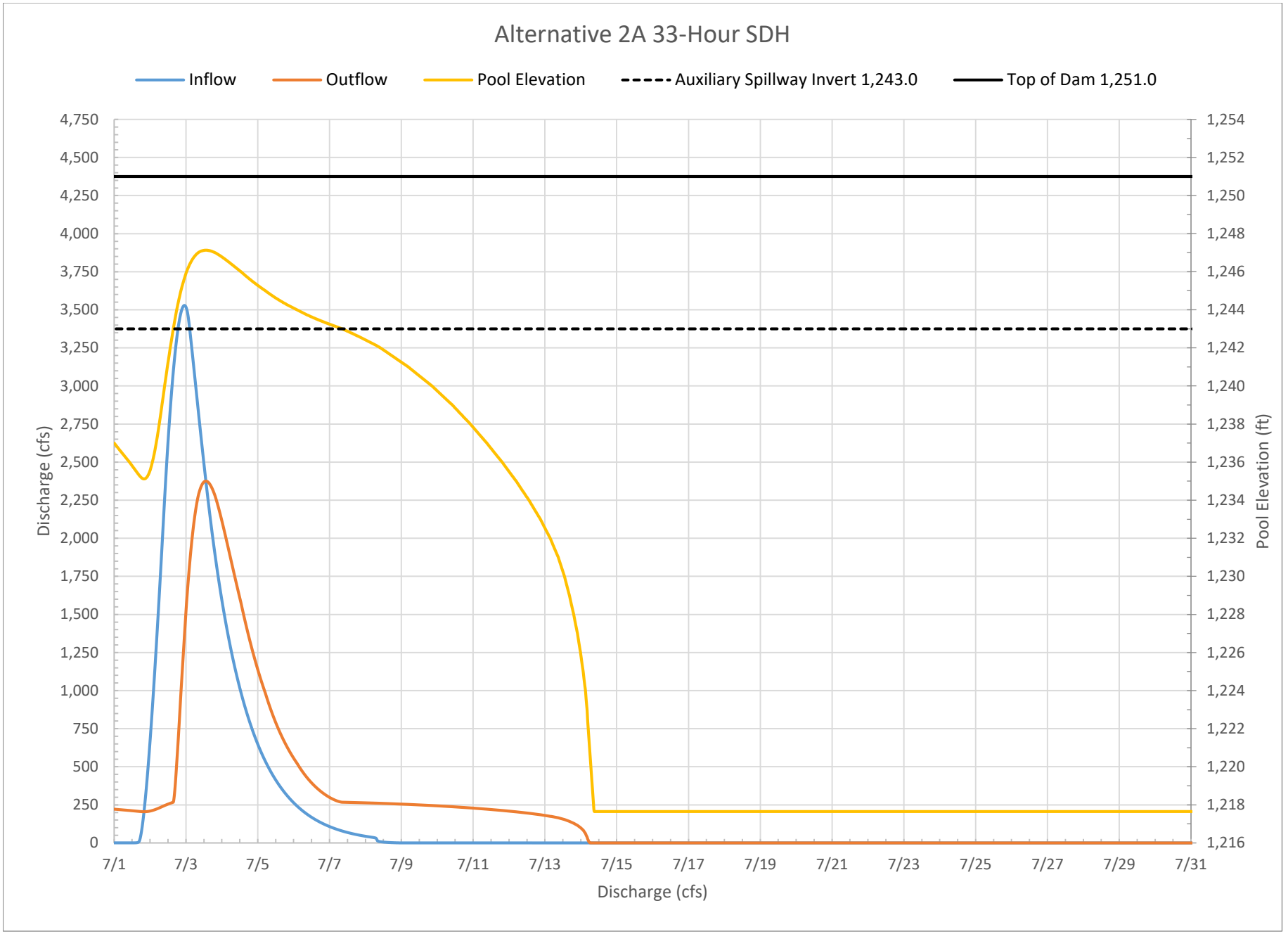

Alternative 2A 100-Year 10-Day
Inflow
Outflow
Pool Elevation
Auxiliary Spillway Invert 1,243.0
Top of Dam 1,251.0
Discharge (cfs)
Pool Elevation (ft)
4,750
4,500
4,250
4,000
3,750
3,500
3,250
3,000
2,750
2,500
2,250
2,000
1,750
1,500
1,250
1,000
750
500
250
0
1,254
1,252
1,250
1,248
1,246
1,244
1,242
1,240
1,238
1,236
1,234
1,232
1,230
1,228
1,226
1,224
1,222
1,220
1,218
1,216
7/1
7/3
7/5
7/7
7/9
7/11
7/13
7/15
7/17
7/19
7/21
7/23
7/25
7/27
7/29
7/31
Discharge (cfs)

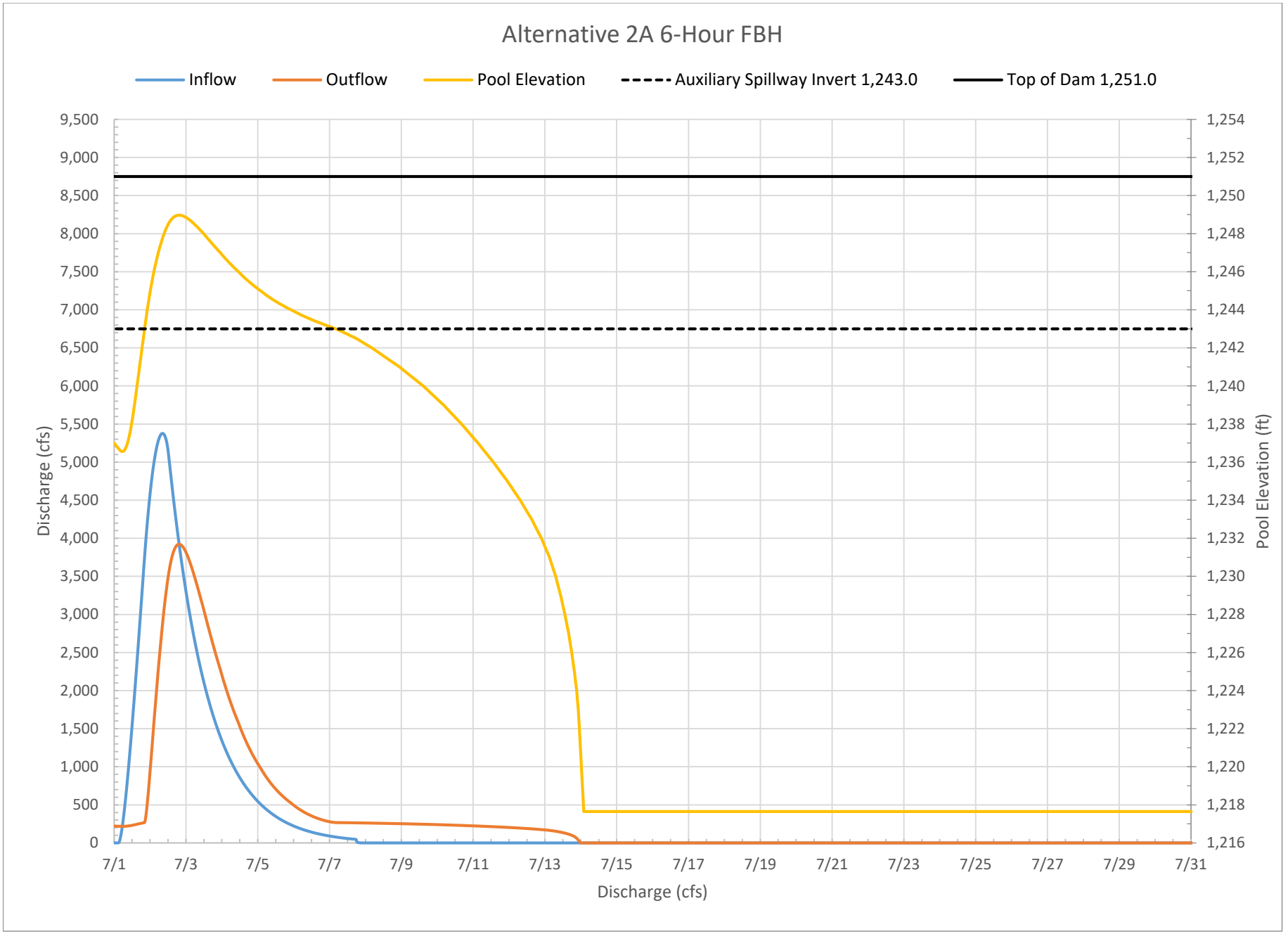

Alternative 2A 25-Year Runoff
Inflow
Outflow
Pool Elevation
Auxiliary Spillway Invert 1,243.0
Top of Dam 1,251.0
Discharge (cfs)
Pool Elevation (ft)
4,750
4,500
4,250
4,000
3,750
3,500
3,250
3,000
2,750
2,500
2,250
2,000
1,750
1,500
1,250
1,000
750
500
250
0
1,254
1,252
1,250
1,248
1,246
1,244
1,242
1,240
1,238
1,236
1,234
1,232
1,230
1,228
1,226
1,224
1,222
1,220
1,218
1,216
4/1
4/3
4/5
4/7
4/9
4/11
4/13
4/15
4/17
4/19
4/21
4/23
4/25
4/27
4/29
5/1
Discharge (cfs)

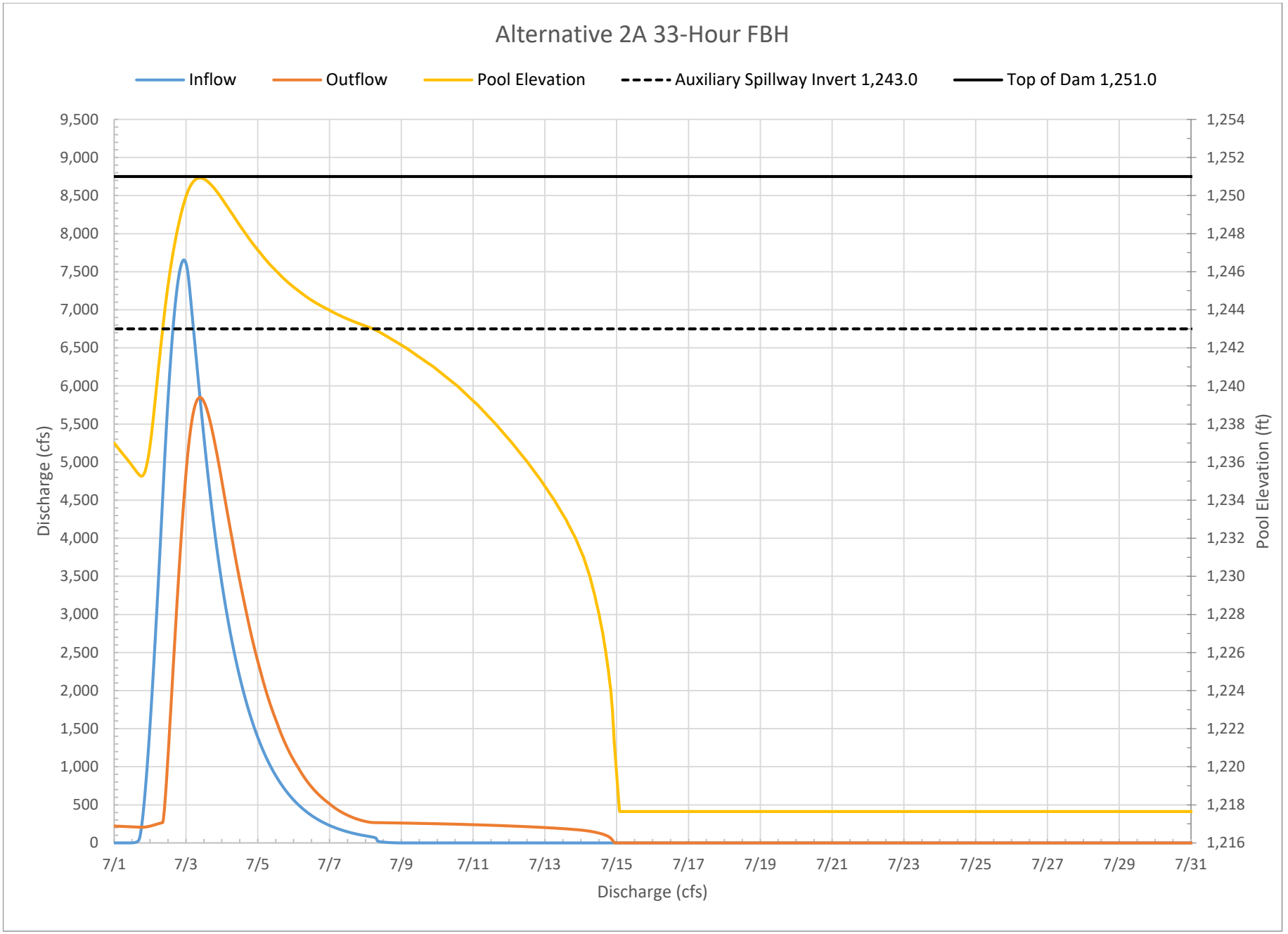

Alternative 2A 50-Year Runoff
Inflow
Outflow
Pool Elevation
Auxiliary Spillway Invert 1,243.0
Top of Dam 1,251.0
Discharge (cfs)
Pool Elevation (ft)
4,750
4,500
4,250
4,000
3,750
3,500
3,250
3,000
2,750
2,500
2,250
2,000
1,750
1,500
1,250
1,000
750
500
250
0
1,254
1,252
1,250
1,248
1,246
1,244
1,242
1,240
1,238
1,236
1,234
1,232
1,230
1,228
1,226
1,224
1,222
1,220
1,218
1,216
4/1
4/3
4/5
4/7
4/9
4/11
4/13
4/15
4/17
4/19
4/21
4/23
4/25
4/27
4/29
5/1
Discharge (cfs)


Alternative 2A 100-Year Runoff
Inflow
Outflow
Pool Elevation
Auxiliary Spillway Invert 1,243.0
Top of Dam 1,251.0
Discharge (cfs)
Pool Elevation (ft)
4,750
4,500
4,250
4,000
3,750
3,500
3,250
3,000
2,750
2,500
2,250
2,000
1,750
1,500
1,250
1,000
750
500
250
0
1,254
1,252
1,250
1,248
1,246
1,244
1,242
1,240
1,238
1,236
1,234
1,232
1,230
1,228
1,226
1,224
1,222
1,220
1,218
1,216
4/1
4/3
4/5
4/7
4/9
4/11
4/13
4/15
4/17
4/19
4/21
4/23
4/25
4/27
4/29
5/1
Discharge (cfs)


Alternative 2A 6-Hour SDH
Inflow
Outflow
Pool Elevation
Auxiliary Spillway Invert 1,243.0
Top of Dam 1,251.0
Discharge (cfs)
Pool Elevation (ft)
4,750
4,500
4,250
4,000
3,750
3,500
3,250
3,000
2,750
2,500
2,250
2,000
1,750
1,500
1,250
1,000
750
500
250
0
1,254
1,252
1,250
1,248
1,246
1,244
1,242
1,240
1,238
1,236
1,234
1,232
1,230
1,228
1,226
1,224
1,222
1,220
1,218
1,216
7/1
7/3
7/5
7/7
7/9
7/11
7/13
7/15
7/17
7/19
7/21
7/23
7/25
7/27
7/29
7/31
Discharge (cfs)


Alternative 2A 33-Hour SDH
Inflow
Outflow
Pool Elevation
Auxiliary Spillway Invert 1,243.0
Top of Dam 1,251.0
Discharge (cfs)
Pool Elevation (ft)
4,750
4,500
4,250
4,000
3,750
3,500
3,250
3,000
2,750
2,500
2,250
2,000
1,750
1,500
1,250
1,000
750
500
250
0
1,254
1,252
1,250
1,248
1,246
1,244
1,242
1,240
1,238
1,236
1,234
1,232
1,230
1,228
1,226
1,224
1,222
1,220
1,218
1,216
7/1
7/3
7/5
7/7
7/9
7/11
7/13
7/15
7/17
7/19
7/21
7/23
7/25
7/27
7/29
7/31
Discharge (cfs)


Alternative 2A 6-Hour FBH
Inflow
Outflow
Pool Elevation
Auxiliary Spillway Invert 1,243.0
Top of Dam 1,251.0
Discharge (cfs)
Pool Elevation (ft)
9,500
9,000
8,500
8,000
7,500
7,000
6,500
6,000
5,500
5,000
4,500
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
1,254
1,252
1,250
1,248
1,246
1,244
1,242
1,240
1,238
1,236
1,234
1,232
1,230
1,228
1,226
1,224
1,222
1,220
1,218
1,216
7/1
7/3
7/5
7/7
7/9
7/11
7/13
7/15
7/17
7/19
7/21
7/23
7/25
7/27
7/29
7/31
Discharge (cfs)


Alternative 2A 33-Hour FBH
Inflow
Outflow
Pool Elevation
Auxiliary Spillway Invert 1,243.0
Top of Dam 1,251.0
Discharge (cfs)
Pool Elevation (ft)
9,500
9,000
8,500
8,000
7,500
7,000
6,500
6,000
5,500
5,000
4,500
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
1,254
1,252
1,250
1,248
1,246
1,244
1,242
1,240
1,238
1,236
1,234
1,232
1,230
1,228
1,226
1,224
1,222
1,220
1,218
1,216
7/1
7/3
7/5
7/7
7/9
7/11
7/13
7/15
7/17
7/19
7/21
7/23
7/25
7/27
7/29
7/31
Discharge (cfs)

Appendix C Alternative 2A Dam Breach Maps

Legend

ALT2A

Depth (ft)

20.1

0

Upper Maple River Watershed

Greenview Twp
Easton Twp
Riverside Twp
Melrose Twp
Hugo Twp
Edendale Twp
Sverdrup Twp
Hope
Griggs County
Willow Lake Twp
Carpenter Twp
Colgate Twp
Broadlawn Twp
Steele County
Broadview Twp
Luverne
Sibley
Pillsbury
Sibley Trail Twp
Baldwin Twp
Ellsbury Twp
Rochester Twp
Page Twp
Cass County
Page
Barnes County
ALT 2A
Grand Prairie Twp
Lake Twp
Rich Twp
Ashtabula Twp
Weimer Twp
Ayr Twp
Getchell Twp

ALT 2A: DAM BREACH INUNDATION MAP
RCPP UPPER MAPLE RIVER WATERSHED
CASS, BARNES, AND STEELE CO., NORTH DAKOTA

N
W
E
S

0 5,500 11,000 22,000 Feet

1 in equals 10,550 feet

moore engineering, inc.

Created By: BPK Date Created: 06/10/2016 Date Saved: 03/06/20 Date Plotted: 08/09/16 Date Exported: 03/06/20
Plotted By: benjamin.kugler Parcel Date: N/A Aerial Image: 2015 County NAIP SIDS Elevation Data: IWI Lidar
Horizontal Datum: NAD 1983 StatePlane North Dakota South FIPS 3302 Feet Vertical Datum: NAVD1988
Q:\Projects\18000\18700\18746\104_Formulate_Alternatives\Hydraulics\Results\UMR_DamBreachmapAlt2A.mxd

Legend

ALT2A

Residential Structures

Depth (ft)

20.1

0

Upper Maple River Watershed

Ellsbury Twp

Minnie Lake Twp

Barnes County

Lake Twp

Cass County

Veimer Twp

Comall Twp

ALT 2A

ALT 2A: DAM BREACH INUNDATION MAP
RCPP UPPER MAPLE RIVER WATERSHED
CASS, BARNES, AND STEELE CO., NORTH DAKOTA

N

W E

S

0 2,500 5,000 10,000 Feet

1 in equals 5,000 feet

moore engineering, inc.

Created By: BPK Date Created: 06/10/2016 Date Saved: 03/06/20 Date Plotted: 08/09/16 Date Exported: 03/06/20
Plotted By: benjamin.kugler Parcel Date: N/A Aerial Image: 2015 County NAIP SIDS Elevation Data: IWI Lidar
Horizontal Datum: NAD 1983 StatePlane North Dakota South FIPS 3302 Feet Vertical Datum: NAVD1988
Q:\Projects\18000\18700\18746\104_Formulate_Alternatives\Hydraulics\Results\UMR_DamBreachmapAlt2AZoom.mxd

ALT2A: DAM BREACH RESIDENTIAL STRUCTURES
RCPP UPPER MAPLE RIVER WATERSHED
CASS, BARNES, AND STEELE CO., NORTH DAKOTA

Created By: BPK Date Created: 03/06/2020 Date Saved: 03/06/20 Date Plotted: 08/09/16 Date Exported: 03/06/20
Plotted By: benjamin.kugler Parcel Date: N/A Aerial Image: 2019 County NAIP SIDS Elevation Data: Lidar
Horizontal Datum: NAD 1983 StatePlane North Dakota South FIPS 3302 Feet Vertical Datum: NAVD1988
Q:\Projects\18000\18700\18746\104_Formulate_Alternatives\Hydraulics\Results\UMR_DamBreachmapAlt2AStructures.mxd

N W E S

0 50 100 200 Feet

1 in = 100 feet

moore engineering, inc.

ALT2A: DAM BREACH RESIDENTIAL STRUCTURES
RCPP UPPER MAPLE RIVER WATERSHED
CASS, BARNES, AND STEELE CO., NORTH DAKOTA

Created By: BPK Date Created: 03/06/2020 Date Saved: 03/06/20 Date Plotted: 08/09/16 Date Exported: 03/06/20
Plotted By: benjamin.kugler Parcel Date: N/A Aerial Image: 2019 County NAIP SIDS Elevation Data: Lidar
Horizontal Datum: NAD 1983 StatePlane North Dakota South FIPS 3302 Feet Vertical Datum: NAVD1988
Q:\Projects\18000\18700\18746\104_Formulate_Alternatives\Hydraulics\Results\UMR_DamBreachmapAlt2AStructures.mxd

N W E S

0 50 100 200 Feet

1 in = 100 feet

moore engineering, inc.

ALT2A: DAM BREACH RESIDENTIAL STRUCTURES
RCPP UPPER MAPLE RIVER WATERSHED
CASS, BARNES, AND STEELE CO., NORTH DAKOTA

Created By: BPK Date Created: 03/06/2020 Date Saved: 03/06/20 Date Plotted: 08/09/16 Date Exported: 03/06/20
Plotted By: benjamin.kugler Parcel Date: N/A Aerial Image: 2019 County NAIP SIDS Elevation Data: Lidar
Horizontal Datum: NAD 1983 StatePlane North Dakota South FIPS 3302 Feet Vertical Datum: NAVD1988
Q:\Projects\18000\18700\18746\104_Formulate_Alternatives\Hydraulics\Results\UMR_DamBreachmapAlt2AStructures.mxd

N
W E
S

0 50 100 200 Feet

1 in = 100 feet

moore engineering, inc.

ALT2A: DAM BREACH RESIDENTIAL STRUCTURES
RCPP UPPER MAPLE RIVER WATERSHED
CASS, BARNES, AND STEELE CO., NORTH DAKOTA

Created By: BPK Date Created: 03/06/2020 Date Saved: 03/06/20 Date Plotted: 08/09/16 Date Exported: 03/06/20
Plotted By: benjamin.kugler Parcel Date: N/A Aerial Image: 2019 County NAIP SIDS Elevation Data: Lidar
Horizontal Datum: NAD 1983 StatePlane North Dakota South FIPS 3302 Feet Vertical Datum: NAVD1988
Q:\Projects\18000\18700\18746\104_Formulate_Alternatives\Hydraulics\Results\UMR_DamBreachmapAlt2AStructures.mxd

N W E S

0 50 100 200 Feet

1 in = 100 feet

moore engineering, inc.

ALT2A: DAM BREACH RESIDENTIAL STRUCTURES
RCPP UPPER MAPLE RIVER WATERSHED
CASS, BARNES, AND STEELE CO., NORTH DAKOTA

Created By: BPK Date Created: 03/06/2020 Date Saved: 03/06/20 Date Plotted: 08/09/16 Date Exported: 03/06/20
Plotted By: benjamin.kugler Parcel Date: N/A Aerial Image: 2019 County NAIP SIDS Elevation Data: Lidar
Horizontal Datum: NAD 1983 StatePlane North Dakota South FIPS 3302 Feet Vertical Datum: NAVD1988
Q:\Projects\18000\18700\18746\104_Formulate_Alternatives\Hydraulics\Results\UMR_DamBreachmapAlt2AStructures.mxd

N
W E
S

0 50 100 200 Feet

1 in = 100 feet

moore engineering, inc.

ALT2A: DAM BREACH RESIDENTIAL STRUCTURES
RCPP UPPER MAPLE RIVER WATERSHED
CASS, BARNES, AND STEELE CO., NORTH DAKOTA

Created By: BPK Date Created: 03/06/2020 Date Saved: 03/06/20 Date Plotted: 08/09/16 Date Exported: 03/06/20
Plotted By: benjamin.kugler Parcel Date: N/A Aerial Image: 2019 County NAIP SIDS Elevation Data: Lidar
Horizontal Datum: NAD 1983 StatePlane North Dakota South FIPS 3302 Feet Vertical Datum: NAVD1988
Q:\Projects\18000\18700\18746\104_Formulate_Alternatives\Hydraulics\Results\UMR_DamBreachmapAlt2AStructures.mxd

N
W E
S

0 50 100 200 Feet

1 in = 100 feet

moore engineering, inc.

ALT2A: DAM BREACH RESIDENTIAL STRUCTURES
RCPP UPPER MAPLE RIVER WATERSHED
CASS, BARNES, AND STEELE CO., NORTH DAKOTA

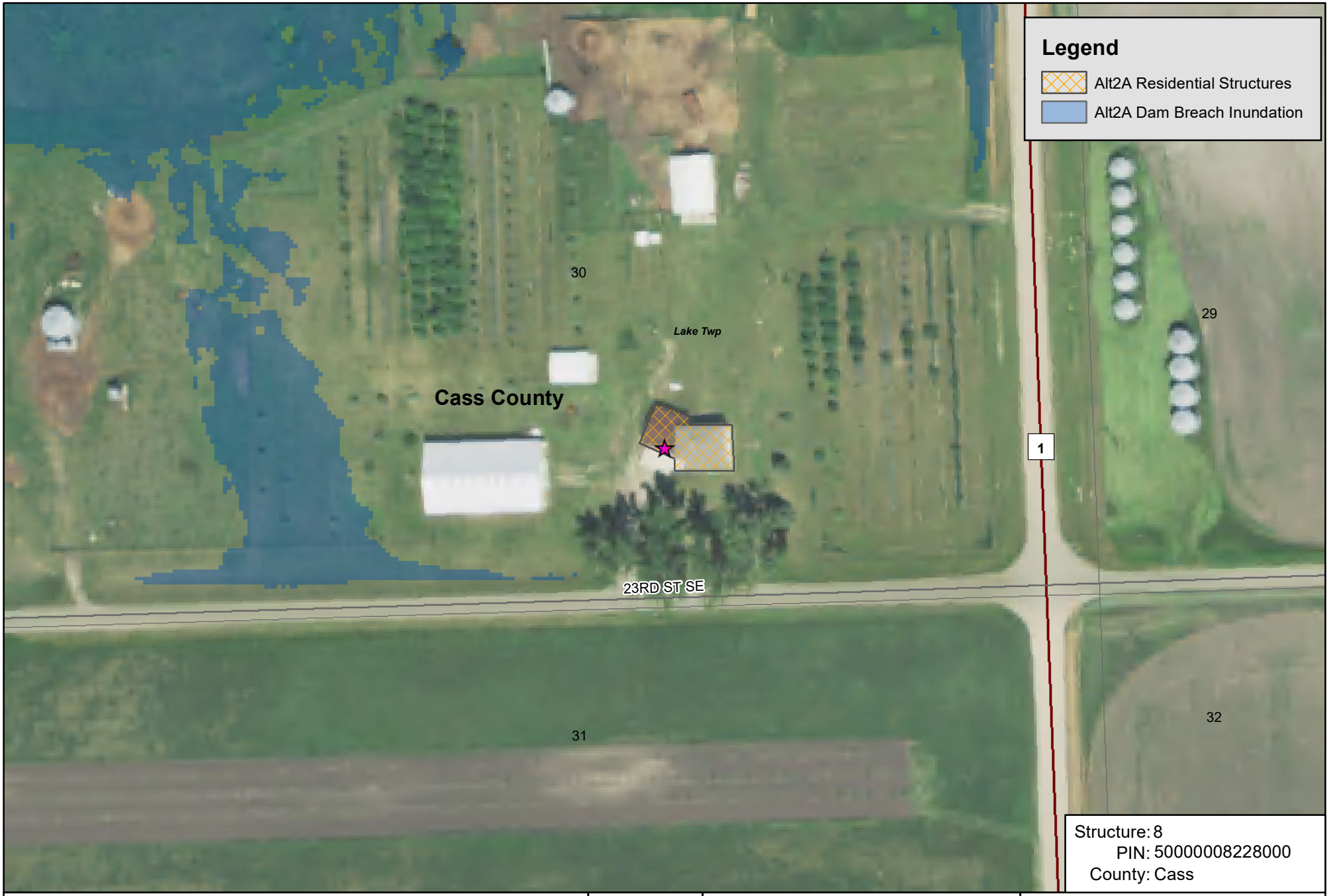
Created By: BPK Date Created: 03/06/2020 Date Saved: 03/06/20 Date Plotted: 08/09/16 Date Exported: 03/06/20
Plotted By: benjamin.kugler Parcel Date: N/A Aerial Image: 2019 County NAIP SIDS Elevation Data: Lidar
Horizontal Datum: NAD 1983 StatePlane North Dakota South FIPS 3302 Feet Vertical Datum: NAVD1988
Q:\Projects\18000\18700\18746\104_Formulate_Alternatives\Hydraulics\Results\UMR_DamBreachmapAlt2AStructures.mxd

N W E S

0 50 100 200 Feet

1 in = 100 feet

moore engineering, inc.



ALT2A: DAM BREACH RESIDENTIAL STRUCTURES
RCPP UPPER MAPLE RIVER WATERSHED
CASS, BARNES, AND STEELE CO., NORTH DAKOTA

Created By: BPK Date Created: 03/06/2020 Date Saved: 03/06/20 Date Plotted: 08/09/16 Date Exported: 03/06/20
Plotted By: benjamin.kugler Parcel Date: N/A Aerial Image: 2019 County NAIP SIDS Elevation Data: Lidar
Horizontal Datum: NAD 1983 StatePlane North Dakota South FIPS 3302 Feet Vertical Datum: NAVD1988
Q:\Projects\18000\18700\18746\104_Formulate_Alternatives\Hydraulics\Results\UMR_DamBreachmapAlt2AStructures.mxd

N W E S

0 50 100 200 Feet

1 in = 100 feet

moore engineering, inc.

ALT2A: DAM BREACH RESIDENTIAL STRUCTURES
RCPP UPPER MAPLE RIVER WATERSHED
CASS, BARNES, AND STEELE CO., NORTH DAKOTA

Created By: BPK Date Created: 03/06/2020 Date Saved: 03/06/20 Date Plotted: 08/09/16 Date Exported: 03/06/20
Plotted By: benjamin.kugler Parcel Date: N/A Aerial Image: 2019 County NAIP SIDS Elevation Data: Lidar
Horizontal Datum: NAD 1983 StatePlane North Dakota South FIPS 3302 Feet Vertical Datum: NAVD1988
Q:\Projects\18000\18700\18746\104_Formulate_Alternatives\Hydraulics\Results\UMR_DamBreachmapAlt2AStructures.mxd

N W E S

0 50 100 200 Feet

1 in = 100 feet

moore engineering, inc.

ALT2A: DAM BREACH RESIDENTIAL STRUCTURES
RCPP UPPER MAPLE RIVER WATERSHED
CASS, BARNES, AND STEELE CO., NORTH DAKOTA

Created By: BPK Date Created: 03/06/2020 Date Saved: 03/06/20 Date Plotted: 08/09/16 Date Exported: 03/06/20
Plotted By: benjamin.kugler Parcel Date: N/A Aerial Image: 2019 County NAIP SIDS Elevation Data: Lidar
Horizontal Datum: NAD 1983 StatePlane North Dakota South FIPS 3302 Feet Vertical Datum: NAVD1988
Q:\Projects\18000\18700\18746\104_Formulate_Alternatives\Hydraulics\Results\UMR_DamBreachmapAlt2AStructures.mxd

N W E S

0 50 100 200 Feet

1 in = 100 feet

moore engineering, inc.

ALT2A: DAM BREACH RESIDENTIAL STRUCTURES
RCPP UPPER MAPLE RIVER WATERSHED
CASS, BARNES, AND STEELE CO., NORTH DAKOTA

Created By: BPK Date Created: 03/06/2020 Date Saved: 03/06/20 Date Plotted: 08/09/16 Date Exported: 03/06/20
Plotted By: benjamin.kugler Parcel Date: N/A Aerial Image: 2019 County NAIP SIDS Elevation Data: Lidar
Horizontal Datum: NAD 1983 StatePlane North Dakota South FIPS 3302 Feet Vertical Datum: NAVD1988
Q:\Projects\18000\18700\18746\104_Formulate_Alternatives\Hydraulics\Results\UMR_DamBreachmapAlt2AStructures.mxd

N W E S

0 50 100 200 Feet

1 in = 100 feet

moore engineering, inc.

ALT2A: DAM BREACH RESIDENTIAL STRUCTURES
RCPP UPPER MAPLE RIVER WATERSHED
CASS, BARNES, AND STEELE CO., NORTH DAKOTA

Created By: BPK Date Created: 03/06/2020 Date Saved: 03/06/20 Date Plotted: 08/09/16 Date Exported: 03/06/20
Plotted By: benjamin.kugler Parcel Date: N/A Aerial Image: 2019 County NAIP SIDS Elevation Data: Lidar
Horizontal Datum: NAD 1983 StatePlane North Dakota South FIPS 3302 Feet Vertical Datum: NAVD1988
Q:\Projects\18000\18700\18746\104_Formulate_Alternatives\Hydraulics\Results\UMR_DamBreachmapAlt2AStructures.mxd

N
W E
S

0 50 100 200 Feet

1 in = 100 feet

moore engineering, inc.

ALT2A: DAM BREACH RESIDENTIAL STRUCTURES
RCPP UPPER MAPLE RIVER WATERSHED
CASS, BARNES, AND STEELE CO., NORTH DAKOTA

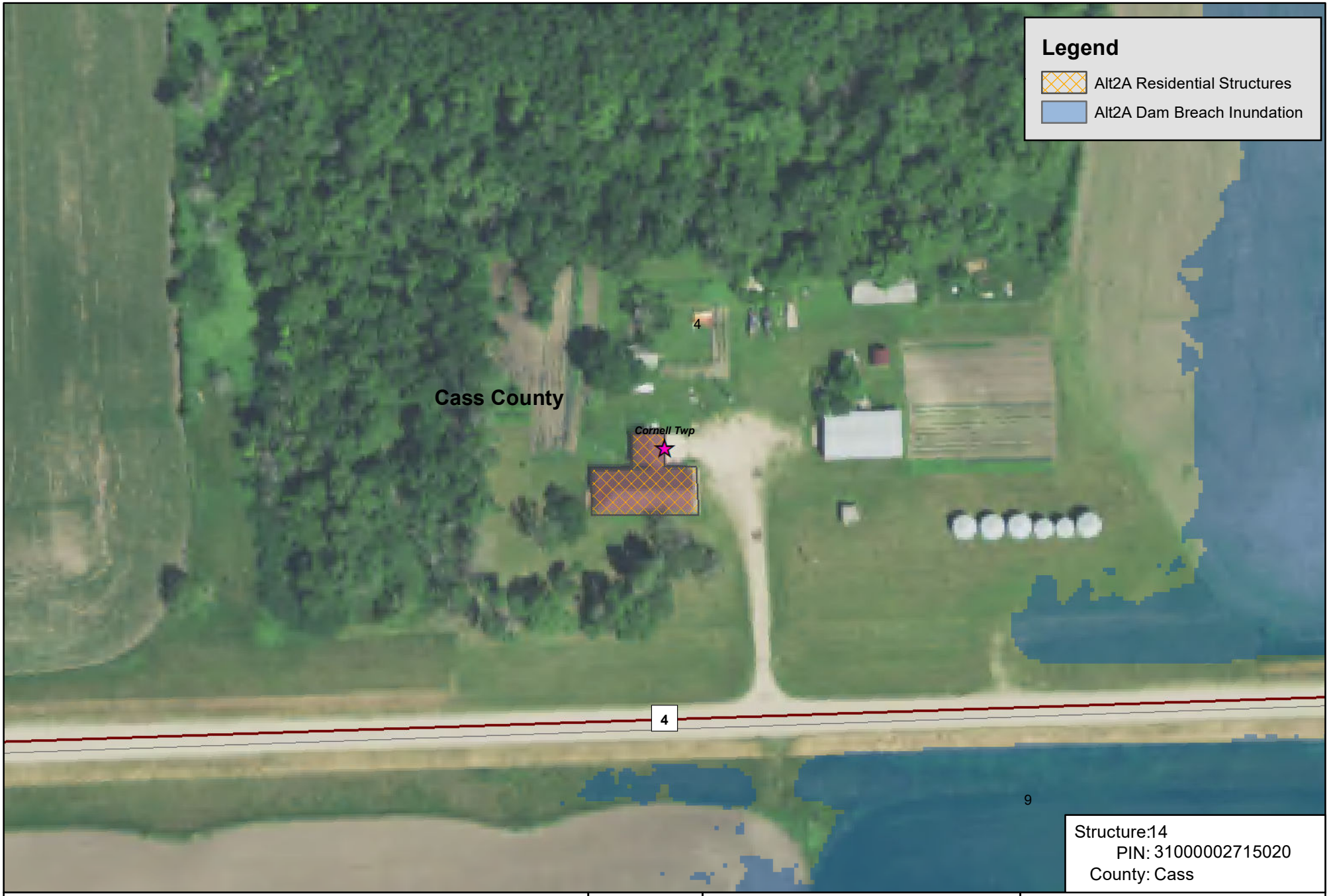
Created By: BPK Date Created: 03/06/2020 Date Saved: 03/06/20 Date Plotted: 08/09/16 Date Exported: 03/06/20
Plotted By: benjamin.kugler Parcel Date: N/A Aerial Image: 2019 County NAIP SIDS Elevation Data: Lidar
Horizontal Datum: NAD 1983 StatePlane North Dakota South FIPS 3302 Feet Vertical Datum: NAVD1988
Q:\Projects\18000\18700\18746\104_Formulate_Alternatives\Hydraulics\Results\UMR_DamBreachmapAlt2AStructures.mxd

N W E S

0 50 100 200 Feet

1 in = 100 feet

moore engineering, inc.



ALT2A: DAM BREACH RESIDENTIAL STRUCTURES
RCPP UPPER MAPLE RIVER WATERSHED
CASS, BARNES, AND STEELE CO., NORTH DAKOTA

Created By: BPK Date Created: 03/06/2020 Date Saved: 03/06/20 Date Plotted: 08/09/16 Date Exported: 03/06/20
Plotted By: benjamin.kugler Parcel Date: N/A Aerial Image: 2019 County NAIP SIDS Elevation Data: Lidar
Horizontal Datum: NAD 1983 StatePlane North Dakota South FIPS 3302 Feet Vertical Datum: NAVD1988
Q:\Projects\18000\18700\18746\104_Formulate_Alternatives\Hydraulics\Results\UMR_DamBreachmapAlt2AStructures.mxd

N W E S

0 50 100 200 Feet

1 in = 100 feet

moore engineering, inc.