Burleigh County Water Resource District

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Website: www.bcwrd.org

MISSOURI RIVER CORRECTIONAL CENTER OPERATION AND MAINTENANCE MANUAL

Burleigh County, North Dakota

February 19, 2018

OPERATION & MAINTENANCE MANUAL

Missouri River Correctional Center Flood Control Project

Burleigh County, North Dakota

February 5, 2018

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

Michael H. Gunsch

North Dakota Reg. No. 3052

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

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1 INTRODUCTION

The Missouri River Correctional Center Flood Control Project (Project) was constructed in fall of 2016 through summer of 2017 to provide flood risk reduction to parts of southwest Bismarck, North Dakota. The Project includes earthen levees, two gatewells, and raising of the primary access road to the Missouri River Correctional Center (MRCC), tying into the existing the previously raised 48th Avenue SW. The project was completed on September 27, 2017. The project was constructed according to City of Bismarck Construction Specifications for Municipal Public Works Improvements, which states that the Contractor shall guarantee all work and materials and guarantee the performance of the finished project free from material defect or failure for a period of two years from the date of final payment. Final payment for the project was approved on October 5, 2017.

This Project was sponsored by the Burleigh County Water Resource District (BCWRD).

1.1 PURPOSE OF MANUAL

This operation and maintenance manual summarizes the procedures required for project maintenance during non-flood times and operations during flood times.

The manual has been organized with maps, drawings, and references to the pertinent components for operating and maintaining the project. It begins with a description of the project, followed by standard maintenance procedures, and then concludes with operation procedures for an impending flood, during flood operations, and post-flood operations.

1.2 AUTHORITY

In 2017, the Burleigh County Water Resource District completed construction on the Missouri River Correctional Center Flood Control Project in Bismarck. The BCWRD will be responsible for all primary operation and maintenance functions and all activities will be coordinated under the jurisdiction of the County Emergency Manager with actual operations as noted below.

1.3 RESPONSIBLE PARTY CONTACTS

The flood control regulations strongly recommended that the BCWRD appoint a Project "Superintendent," who is responsible for the development and maintenance of, and directly in charge of, an organization responsible for efficient operation of all structures and facilities during flood periods and for continuous inspection and maintenance of the Project works during periods of low water.

The County has designated the following person as the Superintendent:

Burleigh County Water Resource District designated portfolio lead for the
Missouri River Correctional Center

1.3.1 NOTIFICATION

Additional contact information including name and telephone numbers are provided below. The Superintendent should verify and update contacts and phone numbers at least annually or as necessary.

Agency	Telephone Number
City of Bismarck – Engineering	(701) 355-1505
City of Bismarck – Public Works	(701) 355-1700
City of Bismarck – Police Department	(701) 223-1212
City of Bismarck Floodplain Coordinator	(701) 355-1467
Bismarck Rural Fire Department	(701) 258-5792
Burleigh County Highway Department	(701) 204-7748
Burleigh County – Sheriff's Department	(701) 222-6651
Burleigh County – Emergency Management	(701) 222-6727
North Dakota Department of Emergency Services	(701) 328-8100
North Dakota Department of Transportation	(701) 328-2500
National Weather Service (Bismarck)	(701) 250-4224

1.4 PROJECT LOCATION

The Project is located primarily on the MRCC property on the southwest corner of Bismarck, Burleigh County, North Dakota. The Project is bound on the north by Fox Island, on the west by the Missouri river and on the east by England Street and section line. Figure 1 shows the Project location with respect to the City of Bismarck.

Figure 1: Project Location Map

1.5 PROJECT FEATURES

The Project utilizes earthen levees and two drainage structures to mitigate Missouri River flooding effects and to reduce reliance on emergency measures for the southwest Bismarck Area. The following sections describe the various project components. Appendix D includes plan and profile drawings referencing the proposed and as-built design. The stationing begins at the west end of the project near the Missouri River and extends in two runs approximately northeast and southeast from that point. The northeast run is approximately 4,049 feet long and heads northeast and then east paralleling a drainage channel between Tavis Road and the Missouri River. The southeast run heads southeast and then east connecting to the raised 48th Ave SW that is part of the Burleigh County Flood Control System. An overview of the project features is also illustrated in Figure 2. Note that this project was designed to work in concert with existing and future phases being constructed by the BCWRD, City of Bismarck and Burleigh County.

1.5.1 LEVEE

The Project consists of approximately 9,400 feet of grass covered earthen levee, raised gravel road and raised paved access road levee. The north end of the primary levee was constructed to have a top elevation set at 1636.70, and the proposed profile called for a 0.00% grade to the west until Station 122+00, where the grade changes to 0.01% until Station 100+00 where the north leg of the levee ends. At Station 0+00, the levee top elevation is set at 1636.44 and the levee continues southeast and then east at a -0.01% grade to Station 51+57 where the levee top elevation is set at 1635.70. Up to 2” of long term settlement was expected, resulting in slightly lower long term settled top of levee elevations. The side slopes on both the wet and dry sides of the levee are 4:1. The long-term settled elevations will provide minimum freeboard criteria of 0.7 feet based on recorded water surface elevations experienced during the historic 2011 flood.

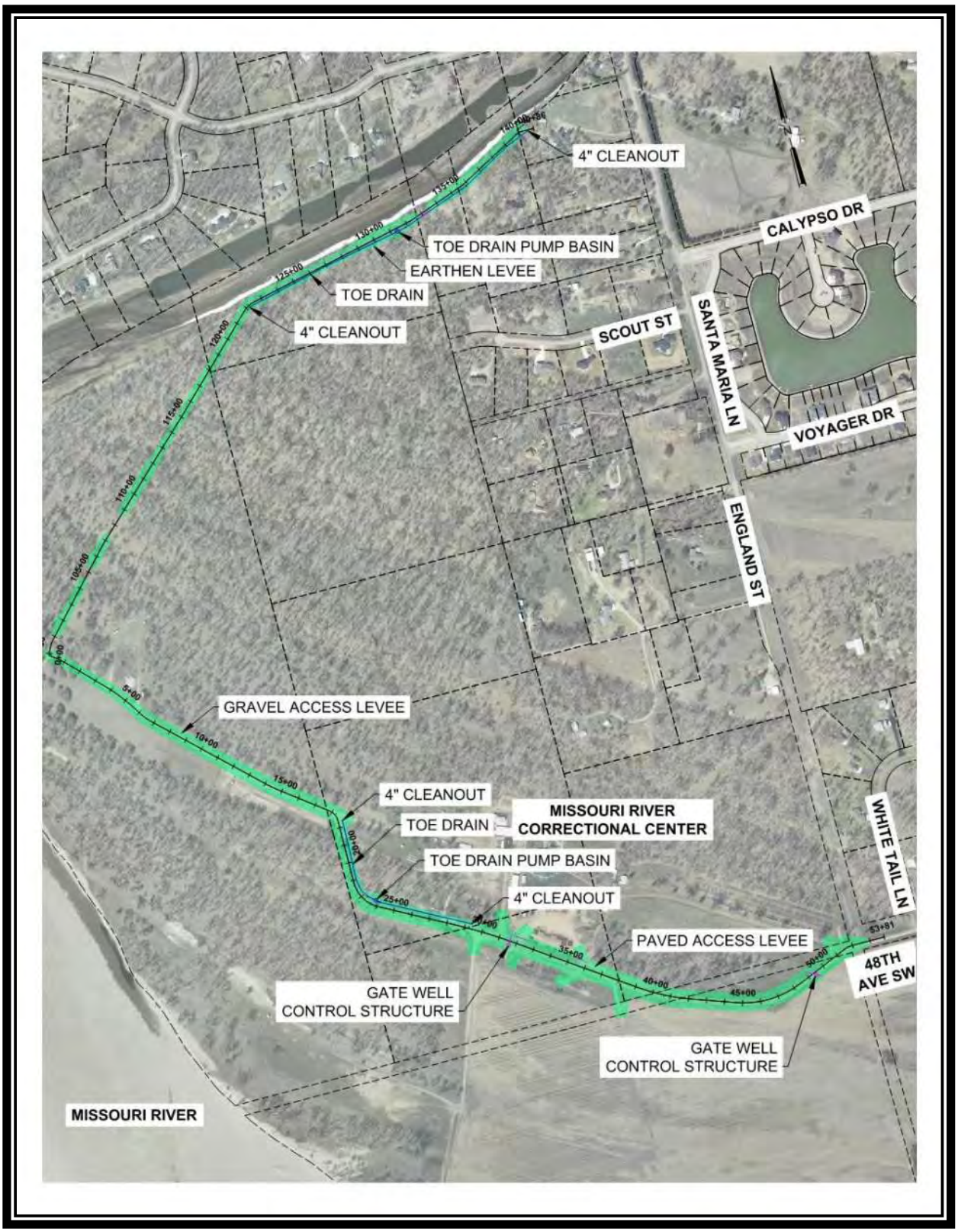

Figure 2: MRCC Flood Control Project Features

1.5.2 DRAINAGE STRUCTURES

As part of the project, an existing 18” RCP was removed and a new culvert with a Gatewell Control Structure with 18”x18” sluice gate was installed at approximately Station 31+61 to allow stormwater to flow south out of the MRCC facility. This pipe ensures that during summer rain events, the storm water continues to the south. The invert elevation of the gated closure is approximately elevation 1630.54. The top of the gatewell manhole is at an elevation of approximately 1636.82.

An additional 18” RCP culvert and Gatewell Control Structure was installed near the east end of the levee to provide additional facility drainage near Sta. 49+30. The invert elevation for this gated closure structure is at approximately 1631.35. The top of the gatewell manhole is at approximately elevation 1636.50.

Table 1: Storm Sewer Outfall Summary

Outfall		**Gravity Outfall**	**Outfall Characteristics**
Reference Letter	Location		
A	West Gatewell (Sta 31+61)	18" RCP	Gatewell Manhole with Sluice Gate
B	East Gatewell (Sta 49+30)	18” RCP	Gatewell Manhole with Sluice Gate

Figure 3: Drainage Structure

1.5.3 TOE DRAIN PUMP BASIN

The project includes a toe drain for the earthen levee sections to remove seepage from the dry side of the levee. These toe drains connect to two pump basins, which can be pumped out over the levee during flood events.

1.5.4 TOE DRAIN CLEANOUT

The toe drains also have cleanouts placed at each end as well as in-line cleanouts on long runs. These cleanouts are to be used for inspection and cleaning of the toe drain system.

Figure 4: Toe Drain Pump Basin and Cleanout

1.6 DATUM AND USGS GAGE

Elevations in this manual, unless otherwise noted, reference the North American Vertical Datum of 1988 (NAVD88). River stages are referenced to the USGS Gage 06342500 (Bismarck Gage) located in Bismarck, North Dakota. Gage zero datum elevation is 1,618.28 ft, National Geodetic Vertical Datum of 1929 (NGVD of 1929) feet above sea level. This equates to an elevation of 1619.62 in NAVD88.

1.7 FLOOD HISTORY

The Missouri River has a long history of flooding with frequent recent occurrences. Three of the top four recorded flood peaks have occurred in the last 20 years (including 1997). Table 2 shows the top 10 peak flood stages recorded at USGS Gage 06342500, Missouri River at Bismarck, ND (Bismarck Gage) during the post-Garrison Dam period from 1954 to 2016.

Table 2: Top Ten Recorded Peak Flood Stages (1954-2016)

USGS 06342500 Missouri River at Bismarck, ND			
Ranking	Year	Streamflow (cfs)	Stage (ft)
1	6/25/2011	155,000	19.05
100-year (BFE)			18.20
2	3/24/2009	30,000	16.11
3	6/13/1975	68,900	14.24
4	6/25/1997	59,500	13.98
5	2/25/1987	35,000	13.92
6	2/14/1988	34,000	13.33
7	3/27/1960	35,000	13.27
8	2/5/1989	26,500	13.12
9	1/17/1992	24,000	12.70
10	3/6/1968	40,300	12.65

1.8 PROJECT PERFORMANCE

This project will greatly enhance the County and City's flood fighting efforts throughout the Southbay Neighborhood. The top of levee elevation was proposed to provide at least 0.7 feet of freeboard above the 2011 maximum recorded River Stage of 19.05 after all anticipated settlement has occurred. This project will not provide FEMA Accreditable protection, which requires three feet of freeboard above the 100-year flow or base flood elevation (BFE).

1.9 BURLEIGH COUNTY FLOOD INSURANCE STUDY

The BFEs in this manual reflect elevations documented in the Burleigh County Flood Insurance Study (FIS)[1] and the current Burleigh County DFIRM which became effective January 16, 2015. The DFIRM can be referenced on FEMA's Map Service Center website at the following link: https://msc.fema.gov/. As identified in Table 2, the gage height of the 100-year BFE at Bismarck is 18.2 feet.

1.10 GENERAL REGULATIONS AND PROCEDURES

1.10.1 REGULATIONS

This manual is to be used as a guide for the operation and maintenance of the MRCC Flood Control Project. Responsible officials should pay particular attention to the flood control operation and maintenance requirements included in subsequent sections of this manual and generally summarized as follows:

- Structures shall be continuously maintained and operated as necessary to obtain the maximum benefits.
- The responsible party for operation and maintenance shall appoint an official "Superintendent". This person is responsible for efficient operation of all structures and facilities during flood periods and periodic inspections during periods of low water.
- A reserve supply of materials needed for flood emergency shall be available at all times.
- No encroachment or trespass that will adversely affect the efficient system operation shall be permitted.
- No improvements or construction shall be conducted on or near the Project features without prior determination that such improvements will not adversely affect the functioning of the protective measures. Any improvements found to be desirable should be constructed in accordance with standard engineering practice.
- Superintendent shall prepare an annual Levee Inspection Report covering inspection, maintenance, and operation of the protective works. Report shall be on file with the BCWRD.
- Owner shall have access to all portions of the protective works at all times.
- Necessary maintenance measures shall be promptly taken or made.
- Appropriate measures shall be taken to ensure that the activities of all private and public facilities are coordinated with the activities of the Superintendent (e.g. private adjacent sand bagging efforts, public works, wastewater, sanitary, etc.).

1.10.2 IMPROVEMENTS AND PROJECT MODIFICATIONS

The County should consider the implications, if any, that may arise from project improvements or modifications as the changes may affect the operation, maintenance or any other aspect of levee effectiveness. Then the operation and maintenance manual may need to be revised to reflect the changes.

1.10.3 ENCROACHMENT OR TRESPASS ON RIGHT OF WAY

No encroachment or trespass which will adversely affect the efficient operation or maintenance of the project works shall be permitted on the rights-of-way for the levee system. The Superintendent shall take whatever action is necessary under local ordinances and under its authority to remove the encroachment or to prosecute the trespassers.

A Vegetation Free Zone (VFZ) shall be enforced which prevents trees and woody vegetation from existing within 15 feet of the levee toe. The VFZ maintains the levee integrity and ensures access exists for inspection, maintenance, and emergency flood fighting efforts. The VFZ also helps prevent tree roots from penetrating the levee or undermining foundations of the flood protection measures. Existing trees within the 15-foot VFZ shall be reviewed on a case-by-case basis to evaluate their effects on the levee system. Additional vegetation management guidance should follow USACE Engineering Technical Letter 1110-2-583[2].

1.10.4 ANNUAL INSPECTION REPORT

The Superintendent must prepare a report documenting the annual project inspection. This inspection should be conducted in early September each year to provide sufficient time for repair or maintenance needs before winter freeze-up. The levee will then be prepared for spring runoff and potential flooding. The inspection should follow the last mowing or the annual mowing to provide a cleaner landscape for locating cracks, animal burrow holes, and other concerning issues within the levee system.

An example annual inspection report has been included in Appendix B that can be used to document the annual inspection. Each report should include information as described in the example with additional notations of issues or needed maintenance. The project as-built maps included in Appendix D should also be printed and attached to each annual inspection report to better describe the reference locations for any corrective measures. The example annual inspection report should be revised as needed to meet the ultimate objective of the report – documenting the levee system conditions to preserve its effectiveness. At a minimum, each report should include a summary of the following:

- Maintenance work identified in the previous inspection
- Maintenance work completed since the last inspection report
- Noted deficiencies where corrective actions should be taken
- Items of potential concern that do not require immediate action, but should be monitored
- Maintenance work scheduled for the next year
- Changes made to the operations and maintenance plan
- Changes in the Superintendent and in other normal or emergency contacts since the last inspection report.
- The manner in which the project functioned during any period of high river flow since the previous report
- Current condition of the Levee System and Storm Sewer Outfalls
- Any other information pertinent to operation and maintenance
- Include photographs of deficiencies with identified locations marked on the maps from Appendix D.

1.10.5 FIVE-YEAR INSPECTION

In addition to the annual inspection, every five years a more in-depth project inspection should be conducted by the BCWRD. In addition to the annual inspection requirements, the five-year inspection will include a review of the design documents and an assessment of the project's structural integrity. Visual review of the toe drain, inlet and outlet pipes is required along with a survey to verify that appropriate levee height is still being maintained. A copy of the five-year inspection shall be maintained by the BCWRD.

1.10.6 POST-FLOOD REPORT

It is advised that a Post-Flood Report be created to document how the system operated after each event. The documentation provides an opportunity to improve upon future flood mitigation efforts. A generalized Post-Flood Report outline is provided in Appendix B. Additional detail pertaining to development of the Post-Flood Report is summarized in Section 6 – Post Flood Report.

1.10.7 REPORTING EVIDENCE OF STRUCTURAL DISTRESS

Any evidence of structural distress of flood control project features should be documented and considered for immediate or future repair. Typical conditions that would indicate distress or initiation of a potential failure include:

- Settlement, sliding, or excessive ground deformation within or near the levee system
- Evidence of internal erosion (piping) in the vicinity of the levee system
- Excessive seepage or an observed increase in seepage quantities through or under the levee system
- Unusual vertical or horizontal movements of the levee system
- Excessive deflection, displacement, or cracking of concrete structures such as gate wells or internal asphalt or concrete lining
- Vibration, binding, or unusual noises or movement associated with gate operation
- Any other indications of distress or potential failure that could inhibit project operation

2 ORDINARY INSPECTIONS, MAINTENANCE, AND OPERATIONS

2.1 GENERAL

This part of the operation and maintenance manual describes the normal operation and maintenance procedures that must be followed when there is no threat of flooding to ensure that the project will continue to provide flood protection in the event of a flood.

Ordinary maintenance of the project works shall follow an established annual recurrence and shall include maintenance work found necessary in annual inspections. In addition, on intervals not to exceed every 5 years, the condition of all culverts/discharge pipes and other drainage structures should be completed using television video camera or visual inspection. In addition, top of levee survey should also be completed on 5-year intervals. The specific sections referenced are as follows:

- Levee
- Toe Drain System
- Drainage Structures
- Erosion Protection

2.2 LEVEE

The Superintendent shall provide maintenance as needed to ensure serviceability of the structures during flood times. The top, side slopes and all areas within 15 feet of the toe of the levee shall be kept free of brush, trees, and other undesirable vegetation. Should excessive vegetation grow within these areas, it shall be removed even with the ground surface with treatment to kill the root system. The levee shall also be kept free of animal burrows, which can affect performance during a flood. Additional repair may be required if burrowing animals or decaying root systems have caused voids in the levee.

The same area shall be kept free of encroachments, such as unauthorized structures, tillage, excavation, pathways, or any other unauthorized use that is detrimental to the performance of the levee.

Grass-covered slopes shall be mowed on a regular basis. At a minimum, mowing must be on an annual mowing program to ensure the serviceability and inspection of the system. Mowing promotes deeper establishment of the root system, which provides increased resistance to erosion due to precipitation and floodwaters. Regular mowing also discourages establishment of trees and brush. Any areas of the levee that become eroded due to natural forces or cracked due to settlement shall be repaired and replanted with an appropriate grass seed mix.

Any disturbance to the levee structure, including the placement of signs, utilities, pathways, etc. shall be coordinated with the Superintendent to ensure compatibility with the flood control features.

The levee height shall be monitored to note any differential settlement of the top of levee annually. At intervals not to exceed 5 years, levee top elevations should be surveyed to ensure design height is being maintained.

2.3 DRAINAGE STRUCTURES

Maintenance and inspection should follow the manufacturer manuals supplied in Appendix C. Manually operated sluice gates shall be examined, oiled, and trial operated annually. Sluice gate actuators have a two-inch square operating nut and are operated by the use of a tee wrench. Operating wrenches for the sluice gates have been provided and are stored at the MRCC maintenance shop.

Pertaining to the flood control gates and structures, annual inspections of all gated outlets should be conducted to ensure that:

- Encroachments are not within 15 feet of the drainage structures
- Pipes, gates and operating mechanisms are in good condition and operate as designed
- Precast concrete, ends sections, trash racks and headwalls as applicable are in good condition
- Inlet and outlet channels are open and free from debris
- Erosion is not occurring adjacent to the structures which might endanger its water tightness or stability

The exact interval at which specific operations take place shall be subject to the discretion of the Superintendent depending on the circumstance. Due to the frequency of flooding (major flooding is typically only caused by spring runoff, major summer Garrison releases and/or ice jams), it is advised that these inspections be only required on an annual basis. Immediate steps should be taken to repair damage, replace missing or broken parts, or remedy adverse conditions disclosed by such inspections. Periodic video or visual inspections per Section 2.1 will also be required.

Normal gate operation involves keeping gates fully open allowing for free flow of water through the structure.

2.4 EROSION PROTECTION

The levee embankment and foundation shall be protected by permanent grass cover. Areas where grass cover has been damaged or destroyed shall be restored or replaced so as not to compromise the integrity of the levee.

Areas with stone or precast concrete riprap, shall be kept free of brush, trees, and undesirable vegetation that can hinder inspection. Any brush, trees, or undesirable vegetation within areas that have been protected with stone or precast concrete riprap shall be sprayed with an approved herbicide and the large brush and trees cut off at grade. Stumps will be treated to kill the root system. Stone or precast concrete riprap displaced by natural events or human intervention will be replaced. Prompt replacement of stone or precast concrete riprap is

necessary to prevent degradation of the underlying aggregate or geotextile filter and accelerated degradation of the erosion protection system.

Grass cover should be mowed prior to the fall inspection to provide a better opportunity to identify cracks, animal burrows and other issues with the embankment material.

3 IMPENDING FLOOD – INSPECTIONS, TESTS, AND OPERATIONS

3.1 GENERAL PREPARATION FOR FLOOD EMERGENCIES

The maintenance procedures in Section 2 allow the system to be ready for operation should it be needed. The procedures in this section will guide operations after a flood has been forecasted. The procedures shall begin each spring before initial runoff and as necessary when the National Weather Service generates its flood forecasts.

When flood stages are imminent, the BCWRD shall arrange for mobilization of necessary personnel, equipment, and supplies depending on the forecasted crest. The mobilization shall ascertain that all personnel are familiar with the operating procedures, and that sufficient personnel are available to provide the required surveillance of all project components during the flood.

To ensure the success of the flood mitigation project, the BCWRD should establish an organization of trained capable personnel to effectively operate and maintain the project. A review should be made each year to ensure that the organization is fully and properly staffed.

3.2 FLOOD WARNING AND PREDICTION

The National Weather Service (NWS) – North Central River Forecast Center in Bismarck, North Dakota provides flood warning and prediction forecasts and outlooks for the Missouri River. Critical flood events on the Missouri River that would cause project operation predominantly to occur during spring runoff and/or ice jam events. The NWS provides probabilistic outlooks leading up to a flood event. As the Missouri River begins to rise, a 7-day deterministic forecast is then produced with estimated river stages and crest dates. This information typically provides sufficient lead time to complete operation of closure structures before floodwaters reach critical stages of the system. The NWS references the Bismarck Gage previously mentioned in Section 1.

Web-link: http://www.weather.gov/mbrfc/

3.3 SUPERINTENDENT RESPONSIBILITIES

Floodwaters reach critical components of the project at different river stages. If flood forecasts show that the Missouri River will reach or exceed 12 feet, which results in a Missouri River elevation of approximately 1628.0± at the project site, the Superintendent shall begin taking the necessary actions to prepare for an impending flood. Throughout the preparation process, the Superintendent shall use discretion as to the extent of action that is necessary based on the forecasted level of flooding.

Actions may include the following:

- Review this operations and maintenance manual
- Assemble and maintain sufficient personnel to provide patrolling of project features while the river remains above the critical elevations of components described in Table 7. These elevations generally reflect the ground elevation on the dry side of the system. The frequency of the patrol shall be at the discretion of the county based on the current river stage, flood forecast, and associated risk.

- Ensure all personnel are familiar with the operating procedures and flood fight activities
- Arrange for mobilization of all necessary personnel, equipment, and supplies
- Perform a pre-flood inspection to ensure drainage gates will close and are not frozen or bound with debris.
- Locate and inspect Toe Drain Pump Basins. Ensure clear access to pump basins.
- Perform maintenance necessary to ensure sufficient operation
- Monitor rainfall forecasts when gates become closed

Table 3: Levee System Patrolling Stages

Name	Project Stationing		River Stage (ft)
	Upstream	Downstream	
Reach 1 – Levee	100+00	140+50	16
Reach 2 – Access Road	0+00	51+57	14

3.4 PREPARATION OF LEVEE

Once a deterministic flood prediction has been made that has forecasted the Missouri River to reach or exceed 12 feet, the Superintendent shall conduct a pre-flood inspection to ensure that the levees are sufficient to provide the designed level of flood protection. At this time, inspection and maintenance records from the previous fall inspection should be reviewed to verify that there are no outstanding issues. Any critical maintenance or repairs should be completed before the start of the flood. Actual patrolling of the levees shall start when the flood waters reach the river stages defined in Table 3. The levee should be patrolled, and all features monitored from this time until the floodwaters recede below the critical river stage.

3.5 PREPARATION OF DRAINAGE STRUCTURES

If the Missouri River is forecasted to reach a river stage of 12 feet, the Superintendent shall conduct a pre-flood inspection to ensure that the drainage structures will operate and close properly once the floodwaters rise and need to be closed. Any trash, debris, ice or other obstructions in drainage structures shall be removed. Inspection shall also involve checking, servicing and trial closure. The procedures also apply to gates not ordinarily operated during floods to assure that they will operate in an emergency, if needed. The gate manuals in Appendix C should be consulted as necessary. Table 4 presents various gate information including the BFE at the gate location, the invert of the gate closure (and corresponding river stage), and the elevation and approximate river stage when the gate shall be closed (Gate Closure Trigger) in accordance with the Interior Drainage Analysis.

Table 4: Critical Drainage Structure Closure Elevations

Outfall Location	Gate Invert		Gate Closure Trigger	
	Elevation (ft)	River Stage (ft)	Closure Elevation (ft)	River Stage (ft)
West Gatewell	1630.54	14.55	1630.90	14.9
East Gatewell	1631.35	15.6	1631.50	15.75

3.6 PREPARATION OF PUMP BASINS

If the Missouri River is forecasted to reach a river stage of 12 feet, the Superintendent shall inspect the Toe Drain Pump Basins for the presence of ground water and ongoing infiltration. Pumps shall be made available to

dewater the pump basins to the wet side of the levee. Care shall be taken so that the pump discharge does not cause erosion on the levee.

4 DURING FLOOD OPERATIONS

4.1 GENERAL

The following sections summarize operations and provide details for operation of specific project features.

4.2 LEVEE

Periodic patrolling of the levees will begin when the river reaches a stage as defined in Table 3. At a minimum, patrolling operations should occur daily, but may be more frequently under the discretion of the BCWRD while considering the magnitude of flood. Patrolling operations should detect locations that require prompt action and correction for any conditions that could jeopardize the integrity of the levee and the stability of the outlet structure. Significant seepage or boils should be monitored closely and repaired promptly.

4.3 DRAINAGE STRUCTURES

The Superintendent will coordinate periodic inspections of the drainage structures, perform maintenance as necessary, and ensure that the gated outlets are operating properly. Procedures may include removing trash, debris, ice, or other obstructions. Exterior ditches should be observed during flooding to ensure that they do not become blocked with sediment, debris, ice jamming, or any other obstruction. River flood stages should be continuously monitored.

4.4 PUMP BASINS

Pumps shall be installed, operated and maintained in the pump basins as needed to dewater the Toe Drain Pump Basins and remove groundwater and seepage from beneath the levee. Pumps shall be adequately sized to dewater the pump basins commensurate with the observed infiltration rate. Pump discharge shall be run to the wet side of the levee in a manner which does not promote erosion or degradation of the levee. Pump and discharge line shall be monitored and checked regularly to ensure proper operation and to look for erosion or other adverse impacts.

4.5 FLOOD EMERGENCY CONDITIONS

A flood emergency is when the flooding conditions approach the predicted design capacity of the project. Floodwaters may threaten to overtop the levee, seepage through the levee may become severe, or a large rainfall event may result in interior runoff that exceeds the capacity of the levee from the inside. All of these will be cause for emergency actions. Emergency actions could include: raising the top of the levee with fill or sandbags, performing emergency repairs to the levee, or bringing in portable pumps. Continuous monitoring of the levee should be performed during flood emergency conditions.

5 POST-FLOOD INSPECTIONS, TESTS, AND OPERATIONS

5.1 GENERAL

Immediately following a flood, or as soon as conditions permit, the Superintendent shall coordinate cleanup of all flood control facilities, make an inspection of the Project and repair all damage to the levee system.

Demobilization of flood control activities should include the following:

- Release of emergency personnel

- Making an inventory of supplies
- Cleaning, storing, and replenishing equipment and supplies
- Preparing a Post-Flood Report that includes flood activities, damages, and repairs (See Section 6)

When demobilization is complete, procedures should revert to normal operation and maintenance as described in Section 2 – Ordinary Inspections, Maintenance, and Operations.

5.2 LEVEE

All areas of levee damaged by high water should be repaired as soon as practicable following high-water periods. Eroded areas should be brought up to the original levee cross section. Stone or precast concrete riprap that has been displaced, washed out, or removed will be replaced. Any areas in which the vegetative slope protection has been damaged should be repaired and seeded or sodded. Normal maintenance will then be resumed.

5.3 DRAINAGE STRUCTURES

Immediately following a flood, all toe drain pump basins and drainage structures, including manholes, pipes, gates, drainage ditches, and headwalls, should be examined for structural damage. Any defects should be corrected to ensure that the structures will function properly in the future. Necessary repairs should be completed as soon as possible.

Outlet channels and drainage ditches should be cleared of sediment and debris. Reshaping of the ditch and replacement of turf will be done as necessary.

All missing or damaged rip-rap (if any) should be replaced along the flood protection embankments. Grass lining should also be restored where damaged in order to protect against future erosion.

6 POST-FLOOD REPORT

After each flood where operation of any component takes place, the Superintendent is encouraged to compile a post-flood report that covers all aspects of the project. The report should document the complete flood history including a log of operations and decisions based on the daily river stages, a discussion of pertinent factors in maintaining the project, and any other relevant information such as what worked and what should be changed prior to the next flood.

Operation and maintenance factors should include problems encountered (including effects of ice on operation), damages incurred, repairs required, and any other significant occurrences during the flood. The record drawings within Appendix D can be used to reference location of documented issues.

If possible, the report should include any other information about operation that may help make operations better during the next flood. Post-flood reports that are properly recorded, well documented, and readily available are valuable in planning to respond to future flood events. A copy of the Post Flood Report should be placed in the County files for documentation and future reference. A sample Post-Flood Report is provided in Appendix B.

7 REFERENCES

1 Federal Emergency Management Agency (FEMA), Flood Insurance Study Number 38015CV000B, Burleigh County, North Dakota.

2 Department of the Army, Corps of Engineers, Engineering Technical Letter 583, “Guidelines for Landscape Planting and Vegetation Management at Levees, Floodwalls, Embankment Dams, and Appurtenant Structures”, 30 April 2014.

3 Houston Engineering, Inc., “Development Summary Report”, 2016.

APPENDIX A

Flood-Fight Handbook

Flood Flight Handbook

US Army Corps of Engineers ®
St. Paul District

2016 Edition

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Flood Fight Handbook

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Section 1: Flood Preparedness Overview

Floods can happen at any time. Common causes include high river levels due to spring snow melt and heavy rain storms. There are many flood preparedness steps that can be taken to increase protection and reduce severity of impact on your home, business, and family.

This handbook describes engineering-related solutions to protect structures from flooding. It will help you determine what supplies and materiel to have on hand, as well as provide detailed guidance on implementing the different solutions.

The three main areas covered in the handbook are sandbag levees (Section 2), earth fill levees (Section 3), and interior drainage (Section 4). Section 5 identifies issues that may be encountered as well as guidance on how to deal with each issue.

There are many excellent sources of information for other areas of preparedness (e.g. family emergency plans, protection of the interior/contents of a structure, and business continuity planning). A list of links to some of these sources can be found in Section 6. The links are only provided as suggested resources and do not constitute endorsement by the U.S. Army Corps of Engineers of the linked websites, or the information, products or services contained therein.

Section 7 includes ten plates with visual diagrams and specifications. These can be used as quick references for personnel involved with implementing different solutions.

Section 2: Sandbagging for Flood Protection

Information in the following section was adapted from the North Dakota State University, Extension Service. A link to their web page is included in Section 6.

A levee is an embankment, floodwall, or structure along a water course whose purpose is flood damage reduction or water conveyance. A properly built sandbag levee can prevent or reduce flood damage. Sandbag levees are labor-intensive, have more opportunities for error during construction, and require disposal procedures after the event. However, sandbag levees do not require heavy equipment and can be constructed by small groups of individuals. Sandbag levees should be used where a very low and relatively short barrier is required or where earth fill would not be practical, such as in the freeboard range along an arterial street. They are very useful where temporary closures are required, such as roads and railroad tracks. The sandbag size, fill material used, and method of placement all influence the effectiveness of the sandbag levee.

This section describes and illustrates a number of suggested techniques for using sandbags and other materials to build temporary flood protection levees. Additional details are shown on ***Plates 1- 3*** in Section 7 of this handbook.

Information about using sandbags for erosion protection on earth fill levees can be found in Section 3.4.1.

2.1 Sandbag Size and Fill Materials

Bags must be filled and placed properly to give the best protection. Any available material can be used to fill sandbags, but sand is easiest to handle. Silt and clay will form a good levee but are more difficult to work with. Different size bags are available, but bags are easier to handle if weight is limited to between 35 and 40 pounds. This weight limit is particularly important when teenagers or older persons will be handling the bags and assisting with emergency operations and levee construction.

Typically, sandbags are filled approximately half full and <u>do not</u> need to be tied, although they may be tied loosely near the top. It is desired that the sandbags lay flat when placed. Overfilled bags reduce the levee's effectiveness by leaving gaps between the bags, allowing water to seep through. ***Figure 1*** illustrates the correct and incorrect ways to prepare sandbags. Tying is not required for a correctly filled sandbag.

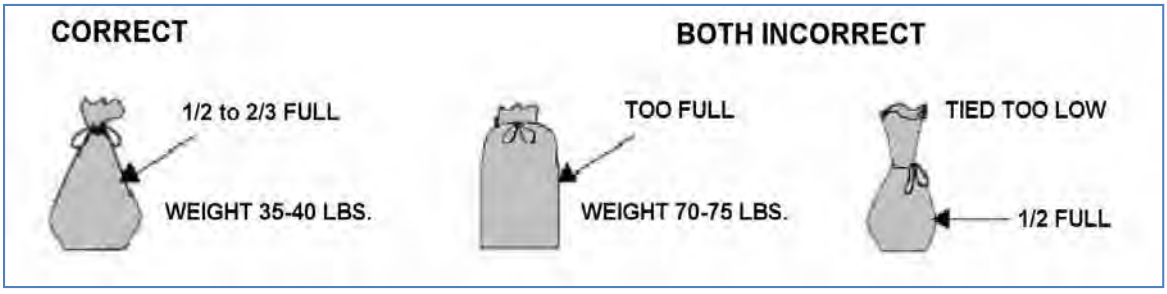

Figure 1: Correct and incorrect sandbag preparation.

Ordinarily, filling sandbags is a two- or three-person operation. One member of the team should place the bottom of the empty bag on the ground slightly in front of wide-spread feet with arms extended. This person may also want to kneel or sit to avoid back strain from bending. The throat of the bag is folded outward about one and one-half inches to form a collar and held in that position to allow a second team member to empty a shovelful of material into the open end, until the bag is one-half to two-thirds full. The third team member stacks and stockpiles the filled sandbags. Gloves should be used to avoid injury, and safety goggles are desirable during dry and windy days. For larger operations, bag-holding racks and funnels on the back of dump trucks, and other power loading equipment can be used to expedite the filling operation.

Contact your county emergency office for information on where to obtain sandbags.

2.2 Site Selection and Preparation

When selecting the location for a levee, consider the ground elevation, ground condition, obstructions, and alignment. For stability, the levee should be kept as short and low as possible. Avoid any obstructions that would weaken the levee, and do not build the levee against a building wall unless the wall has been designed to retain floodwaters. If possible, plan to leave at least 8 feet between the landward toe / base of the levee and any building or obstructions to allow for future levee raises, levee monitoring, construction equipment and vehicles, and to prevent damage to building walls and foundations.

Remove all ice and snow from a strip of land at least as wide as the base of the levee. If the levee will be more than 2-3 feet high, remove a strip of sod to create a bonding trench along the center line of the alignment to better anchor the levee in place, as shown in ***Figure 2.***

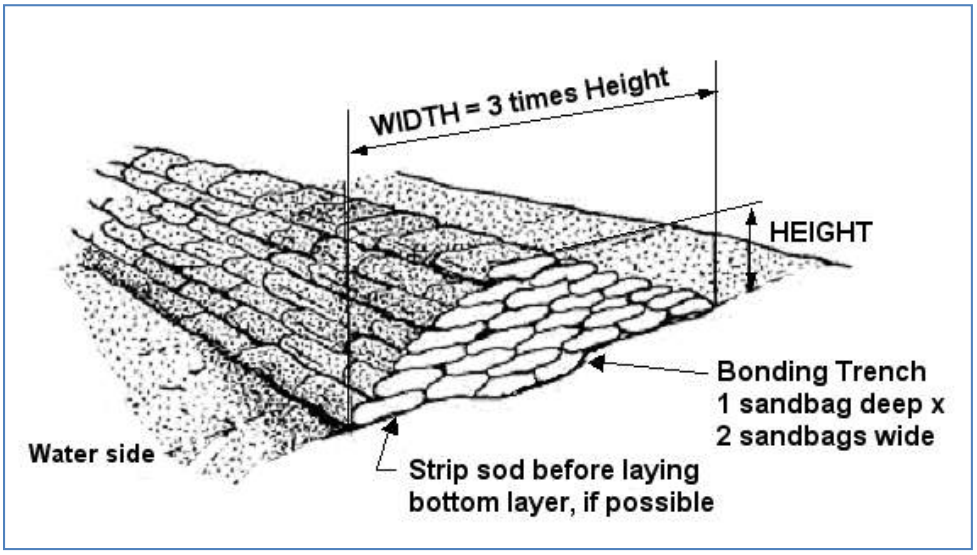

Figure 2 – Proportions of sandbag levee showing bonding trench at base.

2.3 Stacking Sandbags to Form a Levee

Overlap the sandbags as shown in ***Figure 3***, placing the first layer of bags lengthwise along the levee and lapping the bags so the filled portion of one bag lies on the unfilled portion of the previous bag.

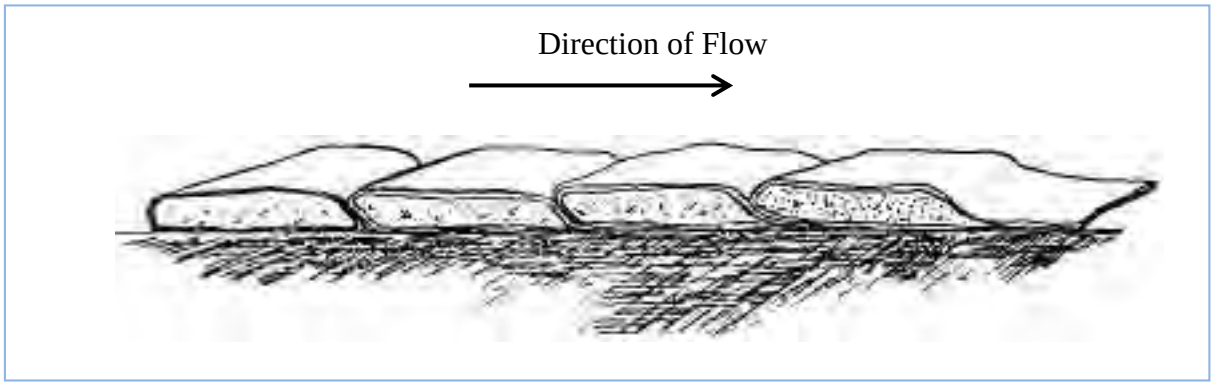

Figure 3 – Sandbag placement

The bags should be placed lengthwise and overlapped parallel to the direction of the river flow. The bonding trench shown in ***Figure 2*** should be filled with a layer that is two sandbags wide by one sandbag high; the first full layer is then placed over this bonding trench. The base of the levee should be three times as wide as the levee is high.

The second layer of bags should be staggered perpendicular to the first layer and placed over the seams of the previous layer, with additional layers laid in alternating directions to the top of the levee, as shown in the "Correct" example in ***Figure 4***. By alternating placement directions, the gaps and seams along the edges and corners in each layer below will be covered and filled in by a sandbag in the next overlying layer. ***Plate 1*** in Section 7 of this handbook illustrates additional details of sandbag placement.

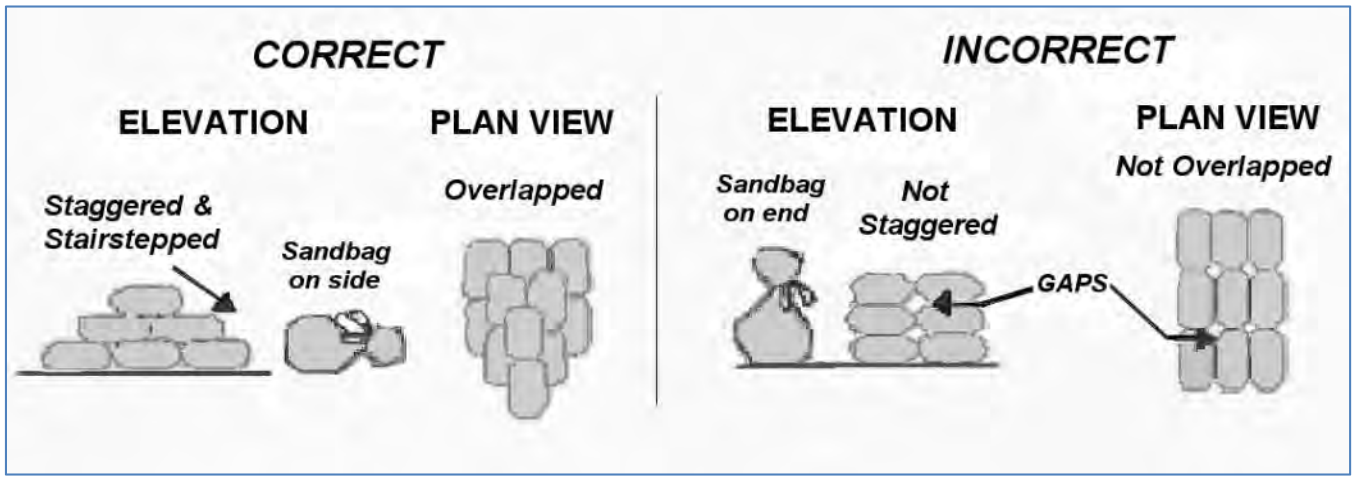

Figure 4 – Correct and incorrect placement of staggered sandbag layers.

2.4 Sealing the Levee

The finished levee can be sealed with a sheet of polyethylene plastic (poly) to improve water tightness. The poly sheeting should be about 6 mils thick, and is generally available in 20-foot-wide by 100-foot-long rolls from construction supply firms, lumberyards, and farm stores.

2.4.1 Anchoring. The poly must always be anchored at the bottom edge and weighted along the top and slope to be effective. Three methods are recommended to anchor the poly on the riverward face of a sandbag levee.

The most successful anchoring method is to place the poly flat on the ground surface extending away from the bottom row of sandbags, and then place one or more rows of sandbags over the flap. The poly should then be unrolled over the anchoring row of sandbags, anchored again, and then up the slope and over the top of the sandbag levee, far enough to allow for anchoring with additional sandbags. This method is illustrated in ***Figure 5*** and shown on ***Plate 2*** in Section 7 of this handbook.

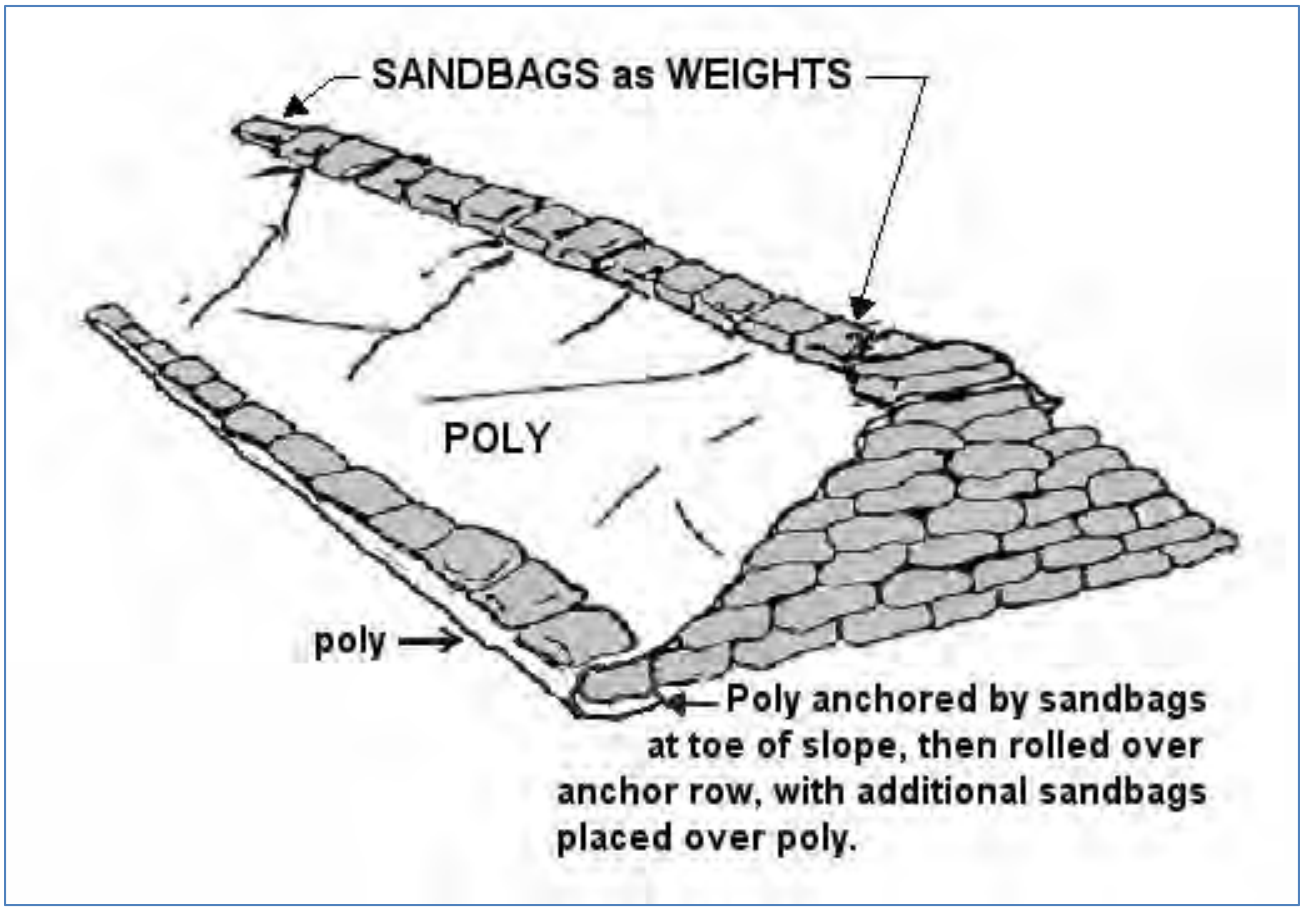

Figure 5 – Preferred method of tucking and anchoring poly with two rows of sandbags

An alternate method to anchor poly is to spread a layer of dirt or sand one inch deep and about one foot wide along the base of the levee on the water side, to create a uniform surface to anchor the poly. Lay the poly sheeting so the bottom edge extends one to two feet beyond the bottom edge of the sandbags over the loose dirt, and then place sandbags over the edge of the poly to anchor. This method is illustrated in ***Figure 6*** and included on ***Plate 2*** in Section 7 of this handbook.

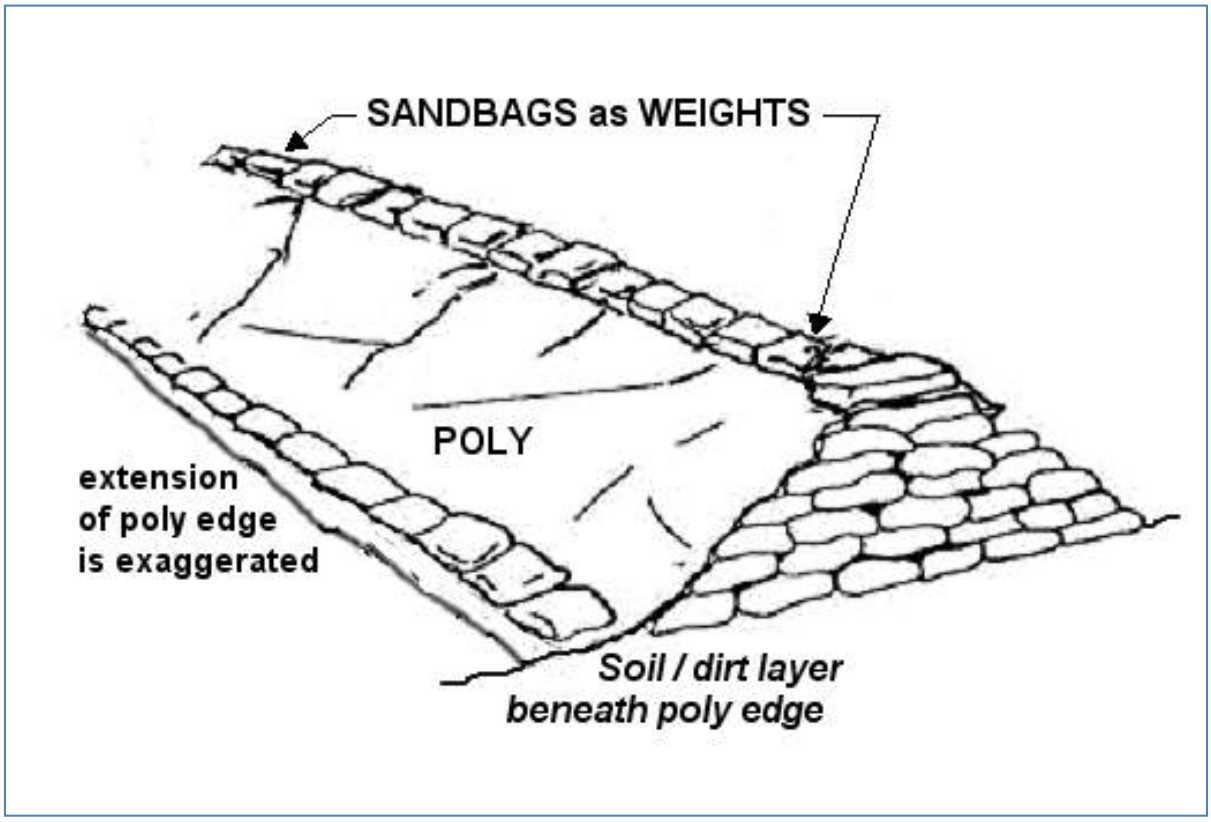

Figure 6 – Poly edge placed over dirt and anchored with a row of sandbags.

A third method to anchor the poly is to excavate a 6-inch or deeper trench along the toe of the levee, place poly in the trench, and backfill the trench, compacting the backfill material or placing a row of sandbags over the trench to prevent loss of the backfill material. This method, illustrated in ***Figure 7,*** will be unsuitable if water levels have reached the sandbags at the toe of the levee.

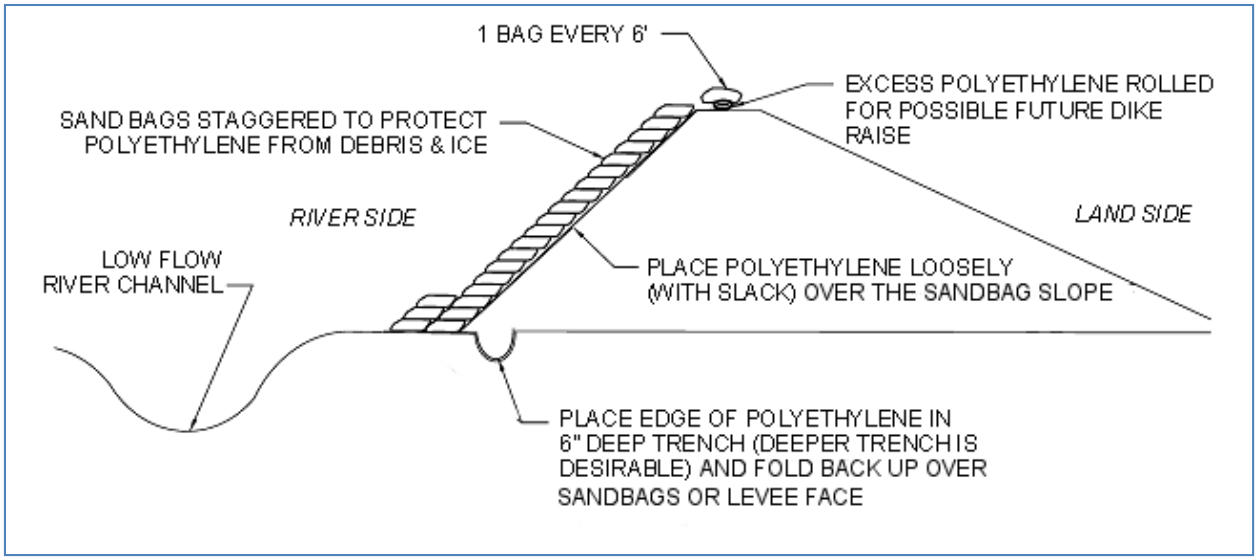

Figure 7 – Poly anchored within a trench (placed under dry conditions).

2.4.2 Placement. Poly should be placed from downstream to upstream along the slopes and the next sheet upstream overlapped by at least 3 feet, as shown on ***Figure 8.*** Overlapping in this direction prevents the current from flowing under the overlap and tearing the poly loose. After the poly is anchored in place, it should be unrolled up the slope and over the top. Lay the poly sheeting down very loosely, as the pressure of the water will make the poly conform easily to the sandbag surface if the poly is loose. If the poly is stretched too tightly the force of the water could puncture the poly.

2.4.3 Weighting. Once the poly is anchored and unrolled, additional sandbags, boards, and/or loose dirt should be used as weights along the top of the levee to keep the poly in place and prevent the wind or river current from disturbing it. These weights are not shown on the illustration. Avoid puncturing the poly with sharp objects or by walking on it.

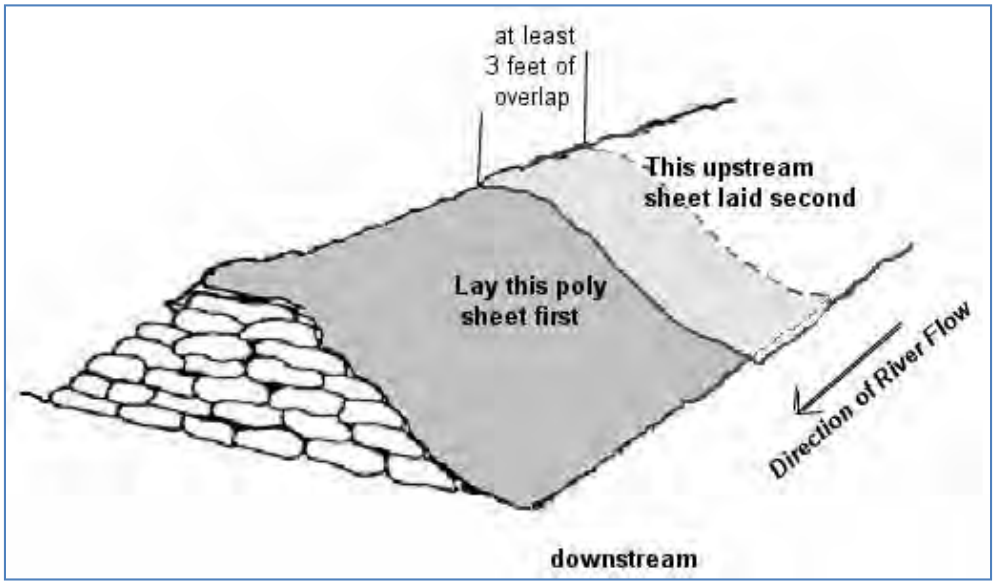

Figure 8 – Poly placement from downstream to upstream with overlap shown.

2.5 Number of Sandbags Needed

The information in ***Table 2.1*** indicates the approximate number of sandbags that are needed for levees of various heights and lengths. Note that 5 feet high is the practical limit of a sandbag levee. If a higher sandbag levee is needed, alternative means of construction should be considered. The preferred height limit is 3 feet.

Estimated Number of Sandbags Per Linear Foot of Levee	
Height in Feet	Bags Required
1	6
2	21
3	45
4	78
5	120

LEVEE HEIGHT	Number of Sandbags Required For Length of Levee									
	50 FT	100 FT	175 FT	200 FT	250 FT	300 FT	350 FT	400 FT	450 FT	500 FT
1 Foot	300	600	1,050	1,200	1,500	1,800	2,100	2,400	2,700	3,000
2 Feet	1,050	2,100	3,675	4,200	5,250	6,300	7,350	8,400	9,450	10,500
3 Feet	2,250	4,500	7,875	9,000	11,250	13,500	15,750	18,000	20,250	22,500
4 Feet	3,900	7,800	13,650	15,600	19,500	23,400	27,300	31,200	35,100	39,000
5 Feet	6,000	12,000	21,000	24,000	30,000	36,000	42,000	48,000	54,000	60,000

Table 2.1 - Estimated number of sandbags needed per foot of length and height of levee

Section 3: Earth Fill Levees

Earth fill levees rather than sandbag levees are the preferred type of emergency flood barrier for large scale flood fights, and their construction should be directed by experienced flood fight workers.

3.1 Foundation Preparation

Prepare the levee footprint as follows prior to placing fill:

- Remove snow from the ground surface and place snow on riverside of levee to eliminate ponding of water behind levee when snow melts.
- Trees should be cut and the stumps removed
- All obstructions above the ground surface should be removed, if possible. This will include brush, structures, snags, and similar debris.
- The foundation should then be stripped of topsoil and surface humus, if possible. Any material removed should be pushed landward of the toe of levee and windrowed.
- Stripping may be impossible if the ground is frozen; in this case, the foundation should be ripped or scarified, if possible, to provide a tough surface for bond with the embankment.

NOTE: Clearing and grubbing, structure removal and stripping should be performed only if time permits.

Every effort should be made to remove all ice or frozen ground. Frost or frozen ground can give a false sense of security in the early stages of a flood fight. It can act as a rigid boundary and support the levee; however, on thawing, soil strength may be reduced sufficiently for cracking or development of slides. It also forms an impervious barrier to prevent seepage. This may result in a considerable build up in pressure under the soils landward of the levee, and, upon thawing, pressure may be sufficient to cause sudden failure of the foundation material resulting in piping , slides, and boils. If the ground is frozen, it must be monitored, and one must be prepared to act quickly if sliding or boiling starts.

3.2 Levee Fill

Earth fill materials for emergency levees will come from local borrow areas. An attempt should be made to use materials that are compatible with the foundation materials as explained below. However, due to time limitations, any local materials may be used if reasonable construction procedures are followed. The materials should not contain large frozen pieces of earth.

Clay Fill: The majority of earth fill levees erected in recent floods consisted of clay or predominantly clay materials. Clay is preferred because the cross-section width can be made smaller with steeper side slopes. Clay is also relatively impervious and has a relatively high resistance to erosion in a compacted state. A disadvantage in using clay is that adequate compaction is difficult to obtain without proper equipment. Another disadvantage is that if the clay is wet, subfreezing temperatures may cause the material to freeze in the borrow pit and in the hauling equipment. Cold and wet weather could cause delays and should definitely be considered in the overall construction effort.

Sand Fill: If sand is used, the cross-section of the levee should comply as closely as possible with recommendations described in the following design section. Flat slopes are important. Steep slopes, without poly coverage, will allow seepage through the levee, creating high outflow on the landward slope and may cause slumping of the slope and eventual failure.

Silt: Material that is primarily silt should be avoided. If it must be used, poly sheeting must always be applied to the river slope. When silt gets wet, it tends to collapse under its own weight and is very susceptible to erosion.

3.3 Levee Design Section

The dimensions of the levee design section are generally dictated by the foundation soils and the materials available for construction. Therefore, even under emergency conditions, an attempt should be made to make the embankment compatible with the foundation. Information on foundation soils should be requested and considered, if available from local officials or engineers. The three foundation conditions and the levee design sections described below are classical and idealized, and assume a sand foundation, a clay foundation, or a thin clay layer over sand foundation. Actual field conditions generally depart from the ideals to various degrees. However, the described levee design sections for each foundation should be used as a guide to reduce the likelihood of serious flood fight problems during high water.

In determining the top width of any type of section, consideration should be given to whether a revised flood level forecast will require additional fill to be placed. A top width adequate for construction equipment will facilitate raising the levee. Finally, actual levee construction will, in many cases, depend on available time, materials, and right-of-way access.

1. **Sand Foundation –** Pervious and permeable (readily allowing water to pass through).

   a. Sand Section: Use a ratio of 1V (V=Vertical) to 3H (H=Horizontal) on the riverside slopes, and a ratio of 1V to 5H on the landward slope, with a 10-foot top width.

   b. Clay Section: Use a ratio of 1V to 2-$^1/_2$H for both the riverside and landside slopes. The bottom width of the levee section should comply with creep ratio criterion; i.e., L (across bottom) should be equal to C x H; where C=9 for fine gravel and 15 for fine sand in the foundation, and H is levee height. This criterion can be met by using berms consisting of material placed on either the landward or riverward side of a levee that extends beyond the normal levee foot print. These berms are placed to control or relieve uplift pressures and lengthen the seepage path, although they will not significantly reduce the volume of seepage. Berms are not as high as the levee itself and thickness should be 3 feet or greater.

2. **Clay Foundations –** Impervious (does not allow water to pass through)

   a. Sand Section: Same as paragraph 1.a. above.

   b. Clay Section: Use a ratio of 1V to 2-1/2H for both the riverside and landside slopes.

3. **Clay Layer over Sand Foundation**

   a. Sand Section. Use the same design as paragraph 1.a. above. Additionally, a landside berm of sufficient thickness may be necessary to prevent rupture of the clay layer. The berm may be composed of sand, gravel, or clay material. Standard design of berms requires considerable information and detailed analysis of soil conditions. However, prior technical assistance may reduce berm construction requirements in any emergency situation.

   b. Clay Section. Use the same design as paragraph 1.b. above. A berm to prevent rupture may also be necessary as described in paragraph 3.a.

Proper compaction of the emergency levee is critical to stability. Use of standard compaction equipment such as a sheepsfoot roller, may not be feasible during emergency operations because of time constraints

or limited equipment availability. It is expected that in most cases the only compaction available will be from hauling and spreading equipment, such as dump trucks and dozers.

3.4 Erosion Protection for Emergency Levees

Erosion (sometimes referred to as scour) protection may be required for earth fill levees. Factors that influence whether or not additional erosion protection is required include levee material (clay levees tend to be much more resistant to erosion than sand levees), channel velocities, presence of ice and/or debris in channel, wave action, and seepage. Methods of protecting levee slopes are numerous and varied. However, during a flood emergency, time, availability of materials, cost, and construction capability may limit the use of certain accepted methods of permanent slope protection.

Field personnel must decide the type and extent of slope protection the emergency levee will need. Several methods of protection have been established that prove highly effective in an emergency. Resourcefulness on the part of the field personnel may be necessary for success. The following is a brief summary of some of the options for providing emergency erosion protection for levees.

3.4.1 Polyethylene and Sandbags. A combination of polyethylene (poly) and sandbags has proven to be one of the most expedient, effective and economical methods of combating slope erosion on earth fill levees.

Anchoring the poly along the riverward toe is important for a successful job. Anchoring methods for poly on sandbag levees, described in Section 2.4.1, should be used for earth fill levees as well.

Ideally, poly and sandbag protection should be placed before water has reached the toe of the levee. However, wet placement may be required due to rising river levels or to replace or maintain damaged poly or poly displaced by the action of the current. Placement of poly on earth fill levees is the same as placement on sandbag levees, as described in Section 2.4.2.

It is mandatory that poly placed on levee slopes be held down by weights. Unless extremely high velocities, heavy debris, or a large amount of ice is anticipated, an effective method of weighting poly is a grid system of sandbags, as shown on ***Plate 4***. A grid system can be constructed faster and requires fewer bags and much less labor than a total covering. Grid systems may include vertical rows of lapped bags or 2x4 boards held down by attached bags.

A grid system of counterweights is more suitable for placement under wet conditions. Counterweights consisting of two or more sandbags connected by a length of quarter-inch rope are saddled over the levee crown with a bag on each slope. The number and spacing of counterweights will depend on the uniformity of the levee slope and current velocity. For the more extreme conditions mentioned previously, a solid blanket of bags over the poly should be used. Sandbag anchors can also be formed at the bottom edge of the poly by bunching the poly around a fistful of sand or rock and tying a sandbag to each fist-sized ball. This counterweight method is shown on ***Plate 5***.

If the counterweight method is used, efficient placement of the poly requires that a sufficient number of the rope and sandbag counterweights be prepared prior to the placement of each poly sheet. Placement consists of first casting out the poly sheet from the top of the levee with the bottom weights in place, and then adding counterweights to slowly sink the poly sheet into place. In most cases the poly will continue to move down slope until the bottom edge reaches the toe of the slope. Sufficient counterweights should be added quickly to ensure that no air voids exist between the poly and the levee face and to keep the poly from flapping or being carried away in the current.

For extreme conditions such as high velocity, excess seepage, ice or debris in the water or wave action, a solid blanket of bags over the poly should be used.

Poly and sandbags can be used in a variety of combinations, and time becomes the factor that may determine which combination to use. While the implementation of poly with sandbags is an effective remedy, it can be overused or misused. For example:

- On well-compacted clay embankments in areas of relatively low velocities, use of poly would be excessive, as compacted clay is unlikely to be scoured out.
- Placement of poly on landward slopes to prevent seepage must **never** be done. This will only force seepage to another exit that may prove more detrimental.
- A critical analysis of each situation should be made before poly and sandbags are used, with a view toward less waste and more efficient use of these materials and available manpower. However, if a situation is doubtful, poly should be used rather than risk a failure.

3.4.2 Riprap. The use of riprap is a positive means of providing slope protection and has been used in a few cases where erosive forces (caused by current, waves, or debris) were too large to effectively control by other means. Objections to using riprap when flood fighting are: (1) the relatively high cost, (2) a large amount may be necessary to protect a given area, (3) limited availability, and (4) little control over placement, particularly in the wet.

3.4.3 Small Groins. Groins extending 10 feet or more into the channel can be effective in deflecting current away from the levees. Groins can be constructed using sandbags, snow fence, rock, compacted earth or any other substantial materials available. Preferably, groins should be placed in the dry and at locations where severe scour may be anticipated. Consideration of the hydraulic aspects of placing groins should be given because haphazard placement may be detrimental. Hydraulic technical assistance should be sought if doubts arise in the use of groins. Construction of groins during high water will be very difficult and results will generally be minimal. If something other than compacted fill is used, some form of anchorage or bonding should be provided; generally snow fence anchored to a tree beyond the toe of levee is used, but junk car bodies can be tied together to act as anchors.

3.4.4 Log Booms. Log booms have been used to protect levee slopes from debris or ice attack. Logs are cabled together and anchored in the levee with a device referred to as a "dead man," often consisting of a concrete block with reinforcing bar, or another heavy anchor. The anchor should be of sufficient size and weight to hold the log boom in place. The log boom is floated out into the current and, depending on the log size, will deflect floating objects and protect the levee.

3.4.5 Miscellaneous Measures. Other available methods of slope protection include placement of straw bales pegged into the slope and spreading straw on the slope and overlaying with snow fencing. Both have been successful against wave action.

3.5 Flashboard and Box Levee Barriers

In addition to earth fill and sandbag levees, two additional types of flood barriers are flashboard and box levees. The construction of flashboard and box levees requires significant time and expense to complete, so they are not very practical for emergency situations unless constructed well in advance of a flood event. However, they may be suitable under certain circumstances. Both are constructed using lumber and earth fill, and they may be used for capping a levee or as a barrier in highly constricted areas. Construction details for these barriers are shown on ***Plate 6***.

3.6 Closures

Closures consist of gaps in the flood barrier system that are to be left open until flood stage reaches a critical elevation, at which point they are blocked and become part of the flood barrier. The critical elevation must be based on the time required to activate the work crew and reach the site, get materials to the site, and complete the construction, along with how fast the river is expected to rise.

Typical examples of closures include roadways and railroad tracks where traffic is allowed to continue to cross the flood barrier until the water level reaches an elevation where the risk of flooding becomes unacceptable. The size and number of closures should be kept to an absolute minimum. Although the means of blocking closures can typically be implemented fairly quickly, unanticipated problems occurring at a critical time when closure activities are underway could result in resources being reallocated elsewhere. This could result in a hole in the line of protection. If water rises faster than expected, sealing the closure can become difficult.

Section 4: Interior Drainage Treatment

High river stages often disrupt the normal drainage of sanitary and storm sewer systems, render sewage treatment plants inoperative, and cause untreated sewage to back up within the system into homes and businesses, and eventually directly into waterways. When the river recedes, some of the sewage and natural storm water runoff may be trapped in low-lying pockets behind the constructed levees, causing the ponded area and soils to become contaminated.

Hastily-constructed levees intended to keep out river water may also seal off normal outlet channels for local runoff, creating large ponds on the landward side of the levees. As the ponded runoff level increases, the levee now becomes vulnerable from both sides, nullifying the protection provided even if the levee is not overtopped. In these cases the ponded runoff will need to be pumped over the levee to the river side. Storm water sewers may also back up because of this ponding.

4.1 Preliminary Work

To arrive at a reasonable plan for interior drainage, field personnel must obtain several items of information:

- Size of drainage area.
- Pumping capacity and/or ponding required. This can be estimated by hydraulic engineering personnel if data are not available.
- Basic plan for treatment.
- Storm and sanitary sewer and water line maps, if available.
- Location of sewer outfalls (both abandoned and in use).
- Inventory of available local pumping facilities.
- Probable location of pumping equipment.
- Whether additional ditching is necessary to drain surface runoff to ponding and/or pump locations.
- Location of septic tanks and drain fields abandoned and in use.

4.2 Pumps: Types, Sizes and Capacities

Pumps vary in type, size, and capacity. Three common pump types are described below.

4.2.1 Crisafulli Pumps. Crisafulli pumps are normally used for pumping storm water from the dry side to the wet side of levees. Crisafulli pumps vary in size from 2-inch to 24-inches and are generally supplied with 50-foot lengths of butyl rubber hose. Care should be taken to prevent damage to the hose. Irrigation pipe or small diameter culverts can also serve as discharge piping. The outlet of a pump discharge line should extend riverward far enough off the toe of the levee so that discharges do not erode the levee slope. The discharge line will most likely need to be staked to a sheet of plywood or a tarp to prevent erosion. The discharge end should be tied down or otherwise fixed to prevent its movement. These pumps must not be operated on slopes greater than 20 degrees from horizontal. ***Table 4.1*** shows sizes and capacities (in gallons per minute, or gpm) of Crisafulli pumps.

10-foot Head			
Pump Size	gpm	Elec. HP	Gas or Diesel HP
2-inch	150	1	-
4-inch	500	7.5	15
6-inch	1,000	10	20
8-inch	3,000	15	25
12-inch	5,000	25	40
16-inch	9,500	40	65
24-inch	25,000	75	140
20-foot Head			
Pump Size	gpm	Elec. HP	Gas or Diesel HP
2-inch	130	1	-
4-inch	490	10	20
6-inch	850	15	25
8-inch	2,450	20	35
12-inch	3,750	30	50
16-inch	8,000	45	85
24-inch	19,000	100	190
30-foot Head			
Pump Size	gpm	Elec. HP	Gas or Diesel HP
2-inch	120	1	
4-inch	475	12	25
6-inch	795	20	35
8-inch	2,150	25	45
12-inch	3,450	35	70
16-inch	7,100	60	125
24-inch	16,600	125	250
NOTE: Use high head pumps for heads over 20 feet.			

Table 4.1 – Crisafulli Pumps

4.2.2 Flygt Pumps. Flygt pumps are centrifugal pumps that are normally used for pumping from manholes or storm sewers where smaller capacities are required, and are submersible. ***Table 4.2*** shows sizes and capacities of Flygt pumps.

Pump Size	Capacity*	Horsepower
3-inch	90 - 150 gpm	1.3 - 2.0 HP
4-inch	100 - 250 gpm	2.7 - 3.5 HP
6-inch	1,150 gpm	30.0 HP
8-inch	2,300 gpm	29.0 HP
10-inch	3,300 gpm	62.0 HP
* at 25-foot head		

Table 4.2 -- Flygt Centrifugal Pumps (Submersible)

4.2.3 Fire Engine Pumps. Fire engine pumps have a 4-inch suction connection and a limited pumping capacity of about 750 gpm. These pumps should only be used if absolutely necessary.

4.3 Determination of Pumping Requirements for Storm Water Runoff

For storm water runoff, the pumping rate in gallons per minute (gpm) = KAM.

- K is a constant, which can be determined from ***Table 4.3.*** The values in this table reflect relatively minor rainfalls; damages from large rainfalls are still possible.
- A is the contributing drainage area in acres.
- M is a reduction factor if one or more substantial ponding areas are available. To determine the value of M, do the following:
    - First, calculate X using the following formula: X = (PA x AD x 100) / A. PA is the pond surface area in acres at maximum allowable pond elevation, AD is the average depth of ponding area in feet, and A is the contributing drainage area in acres.
    - Once you have calculated the value for X, use ***Table 4.4*** to determine the value of M**.**

Area	"Minimum" K value*	"Desirable" K value*
Red River and Souris River Basin	25 to 30	70 to 85
Headwaters Mississippi River Basin	25 to 30	70 to 90
Minnesota River Basin	30 to 35	90 to 100
Mississippi River Basin, Little Falls to St. Croix Basin at Prescott	30 to 35	85 to 95
Mississippi River Basin, Prescott to L/D No. 10	30 to 35	95 to 100
Wisconsin and Chippewa River Basin	30 to 35	85 to 100
Lake Superior Area	25 to 30	70 to 85

* The K value varies from the smaller value for the northern part of the designated area to the larger value for the southern part of the area. The "minimum" K value in the first column is for a 1/10 year recurrence interval (10 rain events per year) varying from 0.5 to 0.7 inch in a 6-hour period. The "desirable" K value in the second column represents a 2-year recurrence interval (1 rain event per 2 years) varying from 1.5 to 2.2 inches in a 6-hour period.

Table 4.3 – Values of K for Computation of Pumping Rates

X	M
0-10	1.0
10-20	0.9
20-25	0.8
25-30	0.7
30-35	0.6
35-40	0.5
40-45	0.4
45-50	0.3
50-55	0.2
55-60	0.1
Greater than 60	0.0

Table 4.4 – Values of M for Adjustment to Pumping Rate

If a long duration flooding is expected, pumping provided should be above the minimum pumping capacities determined in this section. If the foundation is relatively pervious, a seepage allowance of 1 to 2 gpm per linear foot of levee should be added to the pumping rate determined from the above formula. If the foundation consists of a thick clay layer, seepage will be negligible.

Example: Local civil defense officials are considering the emergency construction of approximately 3,000 linear feet of levee, which will seal off the natural outlet for approximately 200 acres of local runoff from a small, non-storm-sewered city on the Minnesota River where 1965 floodwaters exceeded flood stage for 15 days. It is estimated that 20 acres of ponding area with a maximum depth of 4 feet will be available. What pumping capacities can be recommended for the removal of surface runoff and seepage through the levee?

- Assuming this city is in the northern part of the Minnesota River Basin, select K values from ***Table 4.3***.

  K minimum = 30

  K desirable = 90

- Assuming the average depth of the ponding area is 1/2 of the maximum depth:

  Average depth = 1/2 *x* 4.0 = 2.0 feet

  $$X = \frac{20 \; x \; 2.0 \; x \; 100}{200} = 20.0$$

- Select M from ***Table 4.4***

  M = 0.9

- Runoff pumping rate from 200 acres:

  "Minimum" = 30 *x* 200 *x* 0.9 = 5,400 gpm

  "Desirable" = 90 *x* 200 *x* 0.9 = 16,200 gpm

- Seepage:

  3,000 linear feet *x* 1 gpm/foot = 3,000 gpm

- Total Pumping:

  "Minimum" Pumping Rate = 5,400 + 3000 = 8,400 gpm

  "Desirable" Pumping Rate = 16,200 + 3000 = 19,200 gpm

4.4 Determination of Pumping Requirements for Sewer Systems

During high water, increased infiltration into sanitary sewers may necessitate increased pumping at the sewage treatment plant or at manholes at various locations to keep the system functioning. To estimate the quantity of sewage, allow 100 gallons per capita per day for sanitary sewage and an infiltration allowance of 15,000 gallons per mile of sewer per day. In some cases, it will be necessary to pump the entire amount of sewage, and in other cases only the added infiltration will have to be pumped to keep a system in operation.

Example: Estimate pumping capacity required at an emergency pumping station to be set up at the first manhole above the sewage treatment plant for a city of 5,000 population and approximately 30 miles of sewer (estimated from map of city). In this case, it is assumed that the treatment plant will not operate at all.

Computation:

Sewage: $$\frac{5000\ persons\ x\ 100\ gal\ /\ person\ /\ day}{24\ hrs\ /\ day\ x\ 60\ minutes\ /\ hr} = 347\ gpm$$

Infiltration: $$\frac{15000\ gal\ /\ minute\ /\ day\ x\ 30\ min}{24\ hrs\ /\ day\ x\ 60\ minutes\ /\ hr} = 312\ gpm$$

Adding these two values together, the required pumping capacity is 659 gpm. If using a Flygt centrifugal pump from ***Table 4.2***, you could use one 6-inch or three 4-inch pumps.

Table 4.5 indicates the size of pump needed to handle the full flow discharge from sewer pipes up to 24 inches in diameter. ***Table 4.6*** shows sizes and capacities of agricultural type pumps that may be useful in ponding areas or in low areas adjacent to the flood barrier where a sump hole could be excavated. ***Table 4.7*** lists full flow discharge capacities for clay sewer pipes laid on slopes of 0.001 and 0.005 feet per foot. Generally, the smaller pipes are laid on steeper slopes than the larger pipes.

Sewer Pipe Diameter	Probable Required Pump Size
6-inch	2-inch
8-inch	2- to 3-inch
10-inch	3- to 4-inch
12-inch	4- to 6-inch
15-inch	6- to 8-inch
18-inch	6- to 10-inch
21-inch	8- to 10-inch
24-inch	10- to 12-inch

Table 4.5 – Matching Sewer Pipe Size to Pump Size

16-inch Regular Pump @ 540 rpm		
Total Dynamic Head (in feet)	Capacity (gpm)	Brake Horsepower
0	13,500	100
5	12,000	95
10	10,600	91
15	8,900	85
20	7,100	78
25	5,300	70
30	3,300	60
35	1,400	47
38.3	0	36.5
12-inch Regular Pump @ 540 rpm		
Total Dynamic Head (in feet)	Capacity (gpm)	Brake Horsepower
0	5,525	42
5	5,100	40
10	4,600	38
15	3,900	35
20	2,900	30
24.8	0	15.6

Table 4.6 – Pump Discharge Capacities for Ag. Pumps

	S = 0.001		S = 0.005	
Pipe Diameter	Cubic Feet per second (cfs)	Gallons per minute (gpm)	Cubic Feet per second (cfs)	Gallons per minute (gpm)
6-inch	0.19	85	0.35	156
8-inch	0.35	156	0.76	340
10-inch	0.65	292	1.6	720
12-inch	1.2	540	2.5	1,120
15-inch	2.1	945	4.5	2,020
18-inch	3.4	1,520	7.3	3,260
21-inch	5	2,230	11.2	5,000
24-inch	8.2	3,660	15.2	6,800

Table 4.7 – Flow Capacity of Clay Sewer Pipe on two different slopes (S)

4.5 Metal Culverts

Pumping of ponded water is usually preferable to draining the water through a culvert since the tail water (drainage end of culvert) could increase in elevation to a point higher than the inlet, and water could back up into the area being protected. Installation of a flap gate at the outlet end may be desirable to minimize backup.

If a culvert is desired to pass water from a creek through a levee, an engineering-based computation of the drainage basin is required to determine pipe size.

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Section 5: Flood Fight Problems

Many issues can arise during a flood fight. The most valuable asset in problem solving under emergency conditions is capable field personnel. Many problems can be solved quickly and efficiently through the application of common sense and sensitivity to human relations. Physical problems with the levees and related infrastructure can be identified early if a well-organized levee patrol team with a good communication system exists.

The problems most critical to the integrity of the flood barrier system are described below. Current conditions must be taken in to account before implementing a specific solution, including high and low temperatures, frost depth, and the level of water on levee slopes.

5.1 Definitions

Overtopping: Overtopping occurs when water levels exceed the crest elevation of a levee and flow into protected areas. A breach may occur as a result of overtopping. In some cases, a levee may be overtopped without breaching (Non-Breach). In these cases, the water does not erode the levee structure and the levee is still functional for the next event. ***Figure 9*** illustrates overtopping results.

Figure 9 – Possible results when levee is overtopped.

Breach: A rupture, break, or gap in a levee system whose cause has not been determined.

Overtopping Breach: A breach whose cause is known to be a result of overtopping (system exceeded). A breach occurs during overtopping due to damages caused by the water flowing over the top of the levee. Once breached the levee must be repaired to function during the next flood event.

Failure Breach: A breach in a levee system for which a cause is known and which occurred without overtopping. A failure breach occurs due to a failure of the embankment at a level below the top of the levee. ***Figure 10*** illustrates a failure breach.

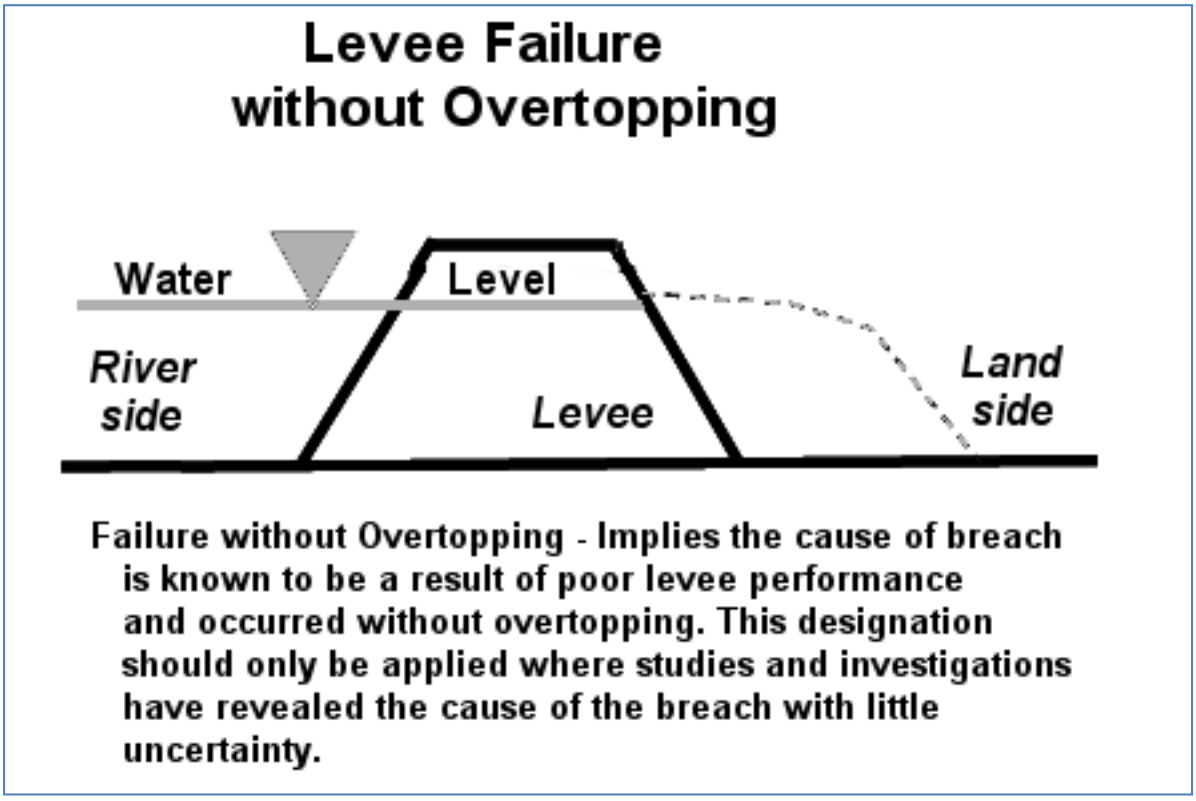


Figure 10 – Failure Breach

The chart below (***Figure 11***) further defines the appropriate flooding descriptions that correspond to the levee responses to rising water.

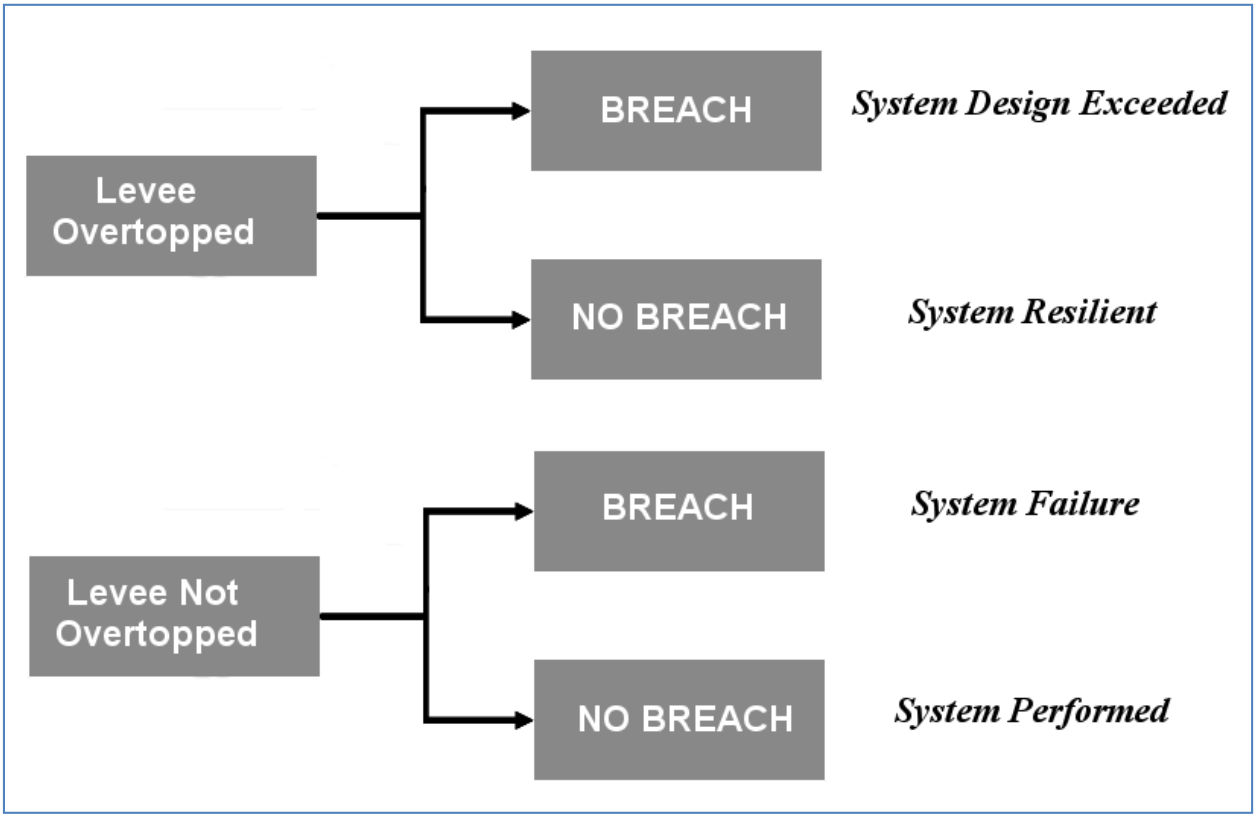


Figure 11 - Appropriate flooding descriptions corresponding to the levee responses to rising

5.2 Overtopping

Since most emergency levees are in urban areas, overtopping should be prevented at any cost. Overtopping will generally be caused by (1) unusual hydrologic phenomena that cause a much higher stage than anticipated, e.g. heavy rainfall or an ice dam in the channel, (2) insufficient time in which to complete the flood barrier, or (3) unexpected settlement or failure of the barrier.

Generally, emergency barriers are built two feet above the predicted crest level. If the crest prediction is raised during construction, additional height must be added to the barrier. On an existing or completed barrier, predictions of increases to water levels or settlement of the barrier will call for some form of capping to raise the barrier. Capping should be done with earth fill or sandbags using normal construction procedures.

5.3 Breaches

Levee breaches may occur as a result of overtopping; however there are other causes as well. Unlike overtopping, the solutions for breaches vary depending on the cause. The following subsections describe the different causes and how to prevent them.

5.4 Seepage

Seepage is percolation of water through or under a levee and generally first appears at the landside toe. Seepage through the levee is likely to occur only in a relatively pervious section. Seepage, as such, is generally not a problem unless (1) the landward levee slope becomes saturated over a large area, (2) seepage water is carrying material from the levee, or (3) pumping capacity is exceeded. Seepage that causes severe sand boils and piping is covered in the next subsection.

Seepage is almost impossible to eliminate and any attempt to do so may create a much more severe condition. Pumping of seepage should be held to a minimum, based on the maximum ponding elevation that can be tolerated without damages. In the past, attempts to keep low areas pumped dry resulted in sand boils, and additional time and effort were then expended in trying to control these sand boils caused by pumping. Therefore, seepage should be permitted if no apparent ill effects are observed and if adequate pumping capacity is available. If seepage causes saturation and sloughing of the landward slope, the section should be flattened to a 1V to 4H ratio or flatter. Material for flattening should be at least as pervious as the existing embankment material to avoid a pressure build up. Do not place clay over sand to flatten a slope.

5.5 Sand Boils

5.5.1 Definition. A sand boil is the rupture of the top foundation stratum landward of a levee caused by excess hydrostatic head in the substratum. Even when a levee is properly constructed and of such mass to resist the destructive action of flood water, water may seep through a sand or gravel stratum under the levee and break through the ground surface on the landside in the form of bubbling springs. When such a seep occurs, a stream of water bursts through the ground surface carrying with it sand or silt that is distributed around the hole in the shape of a cone. Depending on the magnitude of pressure and the size of the boil, it may eventually discharge relatively clear water or it may continue to carry quantities of sand and silt. Sand boils usually occur within 10 to 300 feet from the landside toe of the levee, but in some instances, have occurred up to 1,000 feet away.

5.5.2 Destructive Action. Sand boils can produce three distinctly different effects on a levee, depending on the condition of flow under the levee:

a. Piping Flow. Piping is the active erosion of subsurface material as a result of substratum pressure and concentration of seepage in a localized channel. The flow breaks out at the landside toe in the form of one or more large sand boils. Unless checked, this flow causes the development of a cavern under the levee, resulting in the subsidence of the levee and possible overtopping. This case can be easily recognized by the slumping of the levee crown.

b. Non Piping Flow. In this case, the water flows under pressure beneath the levee without following a defined path, as in the case above. This flow results in one or more boils outcropping at or near the landside toe. The flow from these boils tends to undercut the landside toe, resulting in sloughing of the landward slope.

c. Saturating Flow. In this case, numerous small boils, many of which are scarcely noticeable, outcrop at or near the landside toe. While no boil may appear to be dangerous by itself, the group of boils may cause saturation and flotation ("quickness") of the soil. This can reduce the shear strength of the material at the levee toe to such an extent that failure of the slope through sliding may result.

5.5.3 Combating Sand Boils. All sand boils should be watched closely, especially those within 100 feet of the toe of the levee. All boils should be conspicuously marked with flagging so that patrols can locate them without difficulty and observe changes in their condition. A sand boil that discharges clear water in a steady flow is usually not dangerous to the safety of the levee. However, if the flow of water increases and the sand boil begins to discharge material, corrective action should be undertaken immediately.

The accepted method of treating sand boils is to construct a ring of sandbags around the boil, building up a head of water within the ring sufficient to check the velocity of flow, thereby

preventing further movement of sand and silt. ***Plate 10*** illustrates and describes the techniques for ringing a boil with sandbags. Actual conditions at each sand boil will determine the exact dimensions of the boil and the flow of water from it, and the required sandbag ring.

In general, the following considerations should control construction of the sandbag ring: (1) the base width of the sandbag section on each side of the ring should be no less than 1-1/2 times the contemplated height, (2) weak soils near the boil should be included within the ring, thereby preventing a break through later, and (3) the ring should be sufficient size to permit sacking operations to keep ahead of the flow of water. The height of the ring should only be high enough to stop the movement of soil in the water, and not so high as to completely eliminate seepage. The practice of raising the ring to the river elevation is not necessary and may be dangerous in high stages.

If seepage flow is completely stopped, a new boil will likely develop beyond the ring. This boil could erupt suddenly and cause considerable damage. Where many boils are found to exist in a given area, a ring levee of sandbags should be constructed around the entire area, and, if necessary, water should be pumped into the area to provide sufficient weight to counterbalance the upward pressure.

In the case of smaller sand boils, large diameter metal or concrete pipe can be placed around the boil to reduce the flow of soil material from the boil. In such cases, take care not to stop the water flow from the boil, only the material flow. It may be necessary to cut a hole in the side of the pipe to allow water to exit.

5.6 Erosion

Erosion of the riverside slope is one of the most severe problems that will be encountered during a flood fight. Emergency operations to control erosion include the use of polyethylene sheeting and sandbag anchors. Poly placement along the riverward face of the levee is discussed at length in Section 3.4, Erosion Protection for Emergency Levees.

5.7 Sewer-Related Problems

During a flood fight, continued surveillance of possible sewer problems is necessary. Existing sewers in the protected area may cause problems because of seepage into the lines, leakage through blocked outlets to the river, insufficient manhole pumps, or old or abandoned sewer locations that were not known during pre-flood preparations. Any of these conditions can cause high pressures in parts of the sewer system and lead to backflow, collapse of the lines at weak points, and manhole covers blowing off.

Watertight sluice gates, or flap gates can be used to prevent backflow. Emergency stoppers may be constructed of lumber, sandbags, or other materials, using poly as a seal, preferably placed on the discharge end of the outfall pipe. ***Plate 7*** shows examples of prefabricated pipe stoppers that can be placed in the pipe to block flows. ***Plates 8 and 9*** illustrate methods of sealing off the outlet openings of a manhole with standard materials that are normally available so that the manhole may be used as an emergency pumping station.

If the water level in a manhole approaches the top, additional pumps in other manholes may alleviate the problem. In sanitary sewers, additional pumping may be required at various locations in the system to provide continued service to the homes in the protected area. When pumps are not available, manholes may have to be ringed with sandbags or contained by some other method, such as concrete culverts with

a sandbag base that allows the water to rise up above the top of the manhole. Some leakage may occur that will require safe disposal.

To eliminate the problem of disposing of this leakage from manholes, the ring levee would have to be raised above the river water surface elevation. Doing so creates high pressures on the sewer and should not be done. As with sand boils, it is best to ring the manhole part way to reduce the head and dispose of any leakage that occurs.

Directly weighing down manhole covers with sandbags or other items is not recommended where high heads are possible as this will not work. A 10-foot head on a manhole cover 2 feet in diameter would exert a force of 2,060 pounds. Thus, a counterweight of more than one ton would have to be placed directly on the cover.

5.8 Other Causes of Levee Failure

In addition to the problems covered above, the following conditions could contribute to failure:

- Joining of an earth levee to a solid wall, such as concrete or piling.
- Structures projecting from the riverside of levee.
- A utility line crossing or a drain pipe crossing through the levee fill.
- The elevation of the tops of "stoplogs" on roads or railroad tracks are at a lower elevation than the top of the levee.
- Relying on railroad embankments as levees. Material comprising a railroad embankment may not be suitable as levee fill. Furthermore, the railroad embankment section often has a narrow top width and steep side slopes.
- Allowing pump discharge lines to discharge directly on the riverward levee slope. When discharge lines are allowed to discharge on the levee slope, severe erosion can occur, thus threatening the levee stability. Insure that outlets for pump discharge lines are placed riverward beyond the levee toe, and appropriately anchored to prevent movement.

5.9 Interior Flooding

Even when the levee performs as designed (***Figure 12***), interior flooding can occur. Some of the causes of interior flooding are:

- Seepage
- Sand Boils
- Rainfall Runoff
- Levee Penetrations – drainage conduits designed to drain the interior area during low flows do not close properly during the flood event and allow water to flow from the river side to the interior side.
- Pump Station Failures – pump stations designed to pump interior drainage over the levee can fail during an event due to pump failures loss of power.

Solutions for interior flooding are described in Section 4, Interior Drainage.

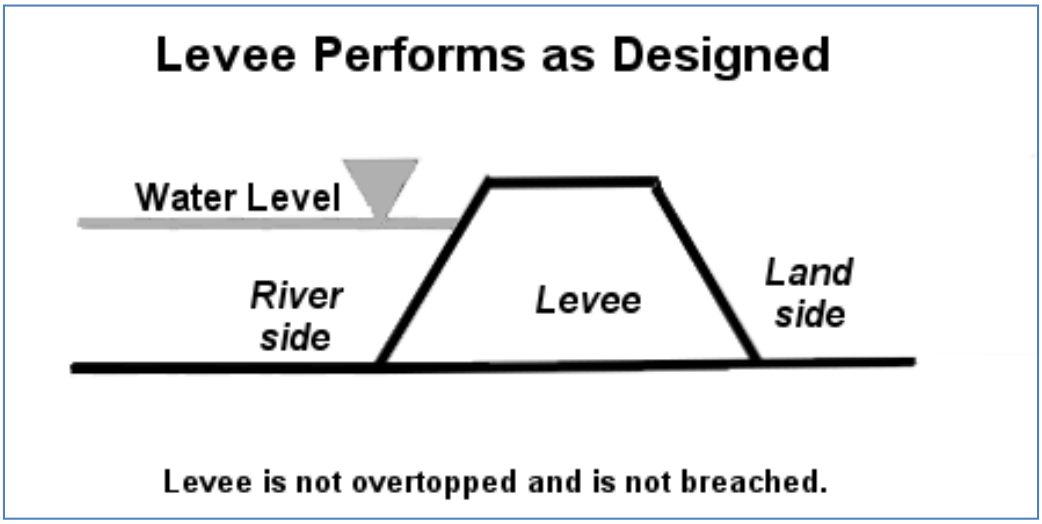


Figure 12 – Levee performs as designed.

Section 6: List of Resources and Hyperlinks

U.S. Army Corps of Engineers, St. Paul District:
http://www.mvp.usace.army.mil/Missions/EmergencyManagement.aspx

Community Emergency Action Plan Guidebook:
http://www.mvp.usace.army.mil/Missions/CivilWorks/FloodRiskManagement/EmergencyActionPlanGuidebook.aspx

NDSU Flood Resources: https://www.ag.ndsu.edu/flood/

Flood Response Training for Community Emergency Response Teams (CERTs):

https://www.fema.gov/media-library/assets/documents/28668

Red Cross Flood Information: http://www.redcross.org/prepare/disaster/flood

Family and Business Preparedness: http://www.ready.gov/

NOTES

Section 7: Plates Showing Emergency Flood Control Activities

PLATE 1: Recommended Method for Sandbag Levee Construction

PLATE 2: Recommended Methods for Anchoring Polyethylene Sheeting at the Levee Toe

PLATE 3: Alternate Method for Anchoring Polyethylene Sheeting at the Levee Toe (when placed in the dry)

PLATE 4: Recommended Method for Placement of Polyethylene Sheeting on Temporary Levees (when placed in the dry)

PLATE 5: Recommended Method for Placement of Polyethylene Sheeting on Temporary Levees (when placed in the wet)

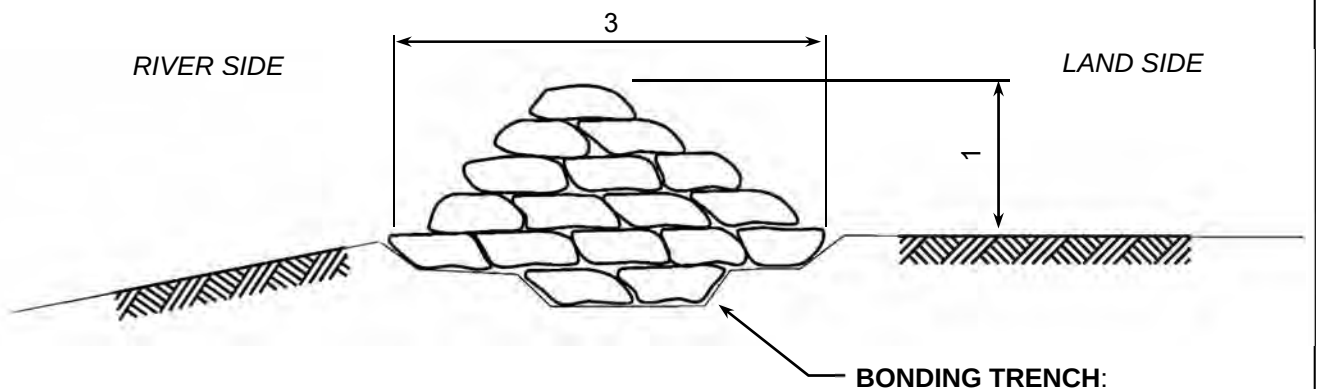
PLATE 6: Recommended Method for Flashboard and Box Levees

PLATE 7: Recommended Method for Plugging Pipes

PLATE 8: Recommended Method for Adapting Manhole for Pumping, Method 1

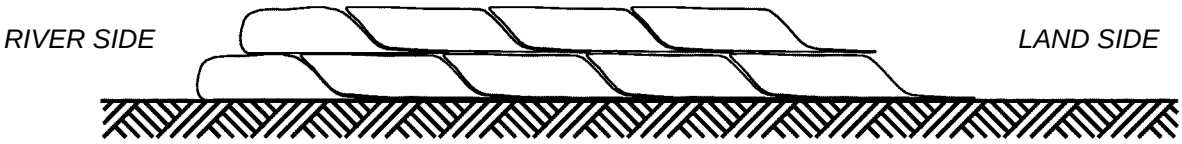
PLATE 9: Recommended Method for Adapting Manhole for Pumping, Method 2

PLATE 10: Recommended Method for Ringing Sand Boils



BONDING TRENCH:
1 SANDBAG DEEP BY
2 SANDBAGS WIDE

LEVEE SECTION



METHOD OF LAPPING SACKS

LEVEE HEIGHT	NUMBER OF SAND BAGS REQUIRED FOR LENGTH OF LEVEE									
	50 FT	100 FT	175 FT	200 FT	250 FT	300 FT	350 FT	400 FT	450 FT	500 FT
1 Foot	300	600	1,050	1,200	1,500	1,800	2,100	2,400	2,700	3,000
2 Feet	1,050	2,100	3,675	4,200	5,250	6,300	7,350	8,400	9,450	10,500
3 Feet	2,250	4,500	7,875	9,000	11,250	13,500	15,750	18,000	20,250	22,500
4 Feet	3,900	7,800	13,650	15,600	19,500	23,400	27,300	31,200	35,100	39,000
5 Feet	6,000	12,000	21,000	24,000	30,000	36,000	42,000	48,000	54,000	60,000

NOTES:

1. START UPSTREAM.
2. STRIP SOD BEFORE LAYING.
3. ALTERNATE DIRECTION OF SACKS WITH BOTTOM LAYER PARALLEL TO FLOW.
4. NEXT LAYER PERPENDICULAR TO FLOW WITH OPEN END AWAY FROM WET SIDE
5. LAP UNFILLED PORTION UNDER NEXT SACK.
6. TYING OR SEWING SACKS NOT NECESSARY.
7. TAMP THOROUGHLY IN PLACE, SACKS SHOULD BE APPROXIMATELY ½-FULL OF SAND.

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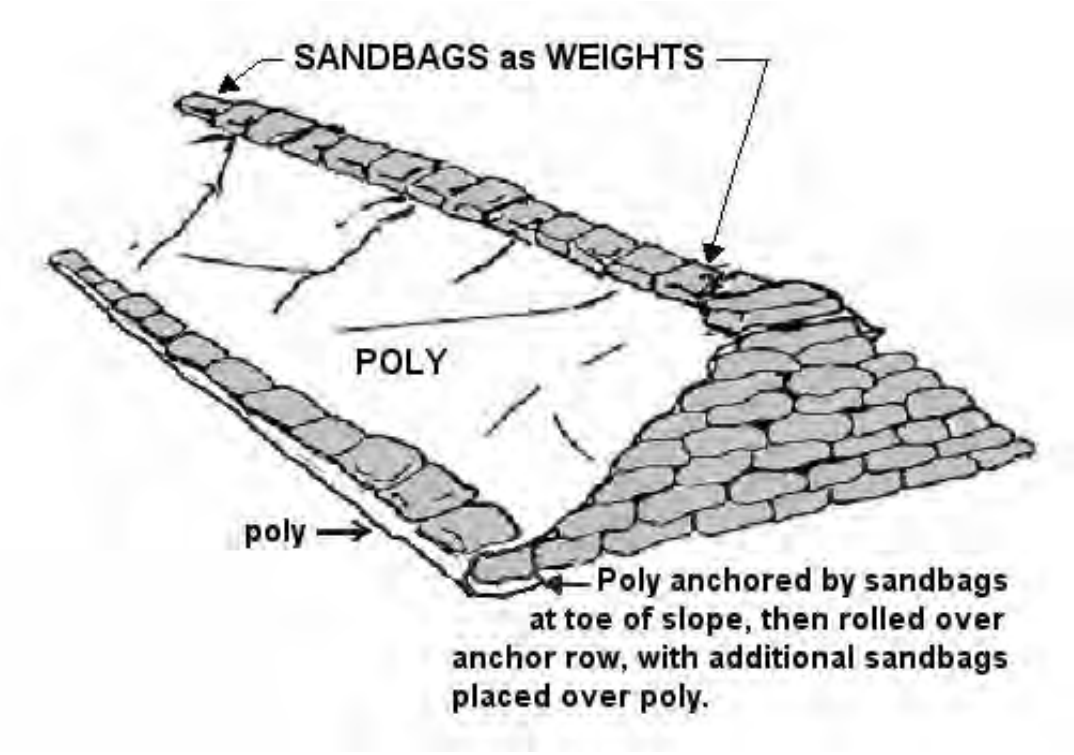
PLATE 1

RECOMMENDED METHOD FOR
SANDBAG LEVEE CONSTRUCTION



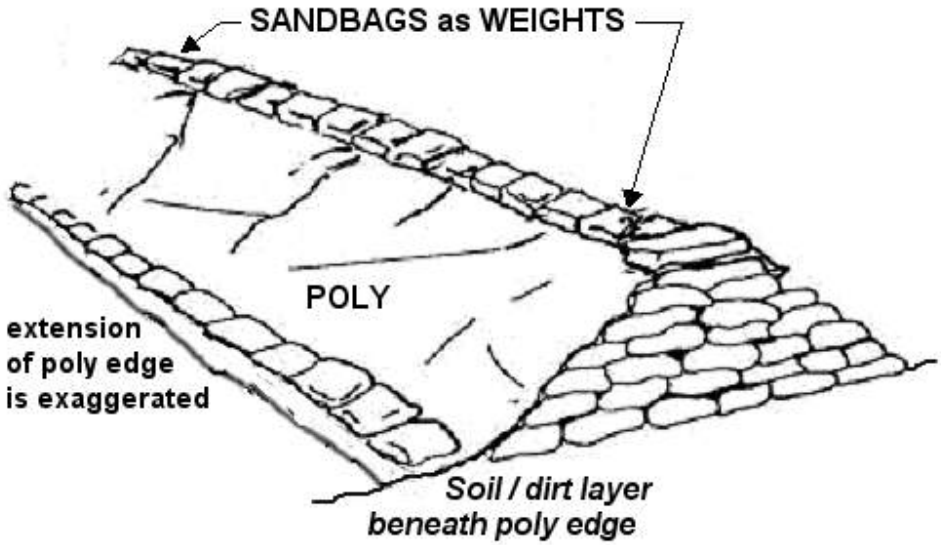


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PLATE 2

RECOMMENDED METHODS FOR ANCHORING POLYETHYLENE SHEETING AT THE LEVEE TOE

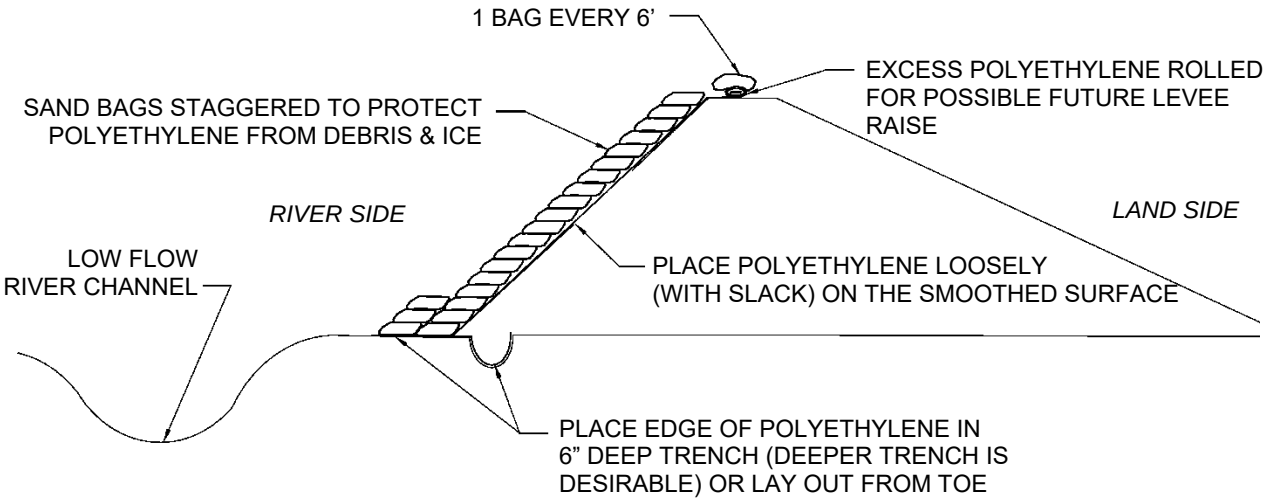

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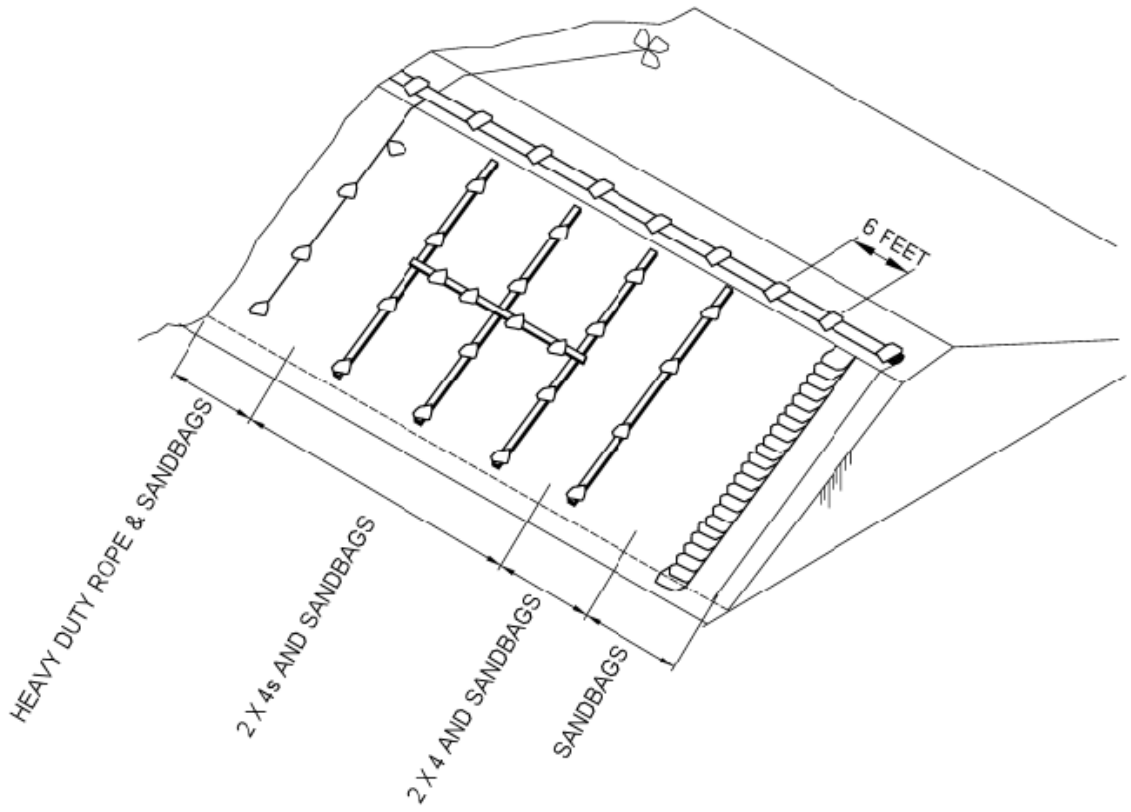
PLATE 3

ALTERNATE METHOD FOR ANCHORING POLYETHYLENE SHEETING AT THE LEVEE TOE (WHEN PLACED IN THE DRY)



RECOMMENDED POLYETHYLENE

1st - 6 MIL BLACK
2nd - 6 MIL CLEAR
3rd - 4 MIL BLACK
4th - 4 MIL CLEAR
5th - 2 MIL BLACK OR CLEAR (USE AS A LAST RESORT)

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PLATE 4

RECOMMENDED METHOD FOR PLACEMENT OF POLYETHYLENE SHEETING ON TEMPORARY LEVEES

(WHEN PLACED IN THE DRY)

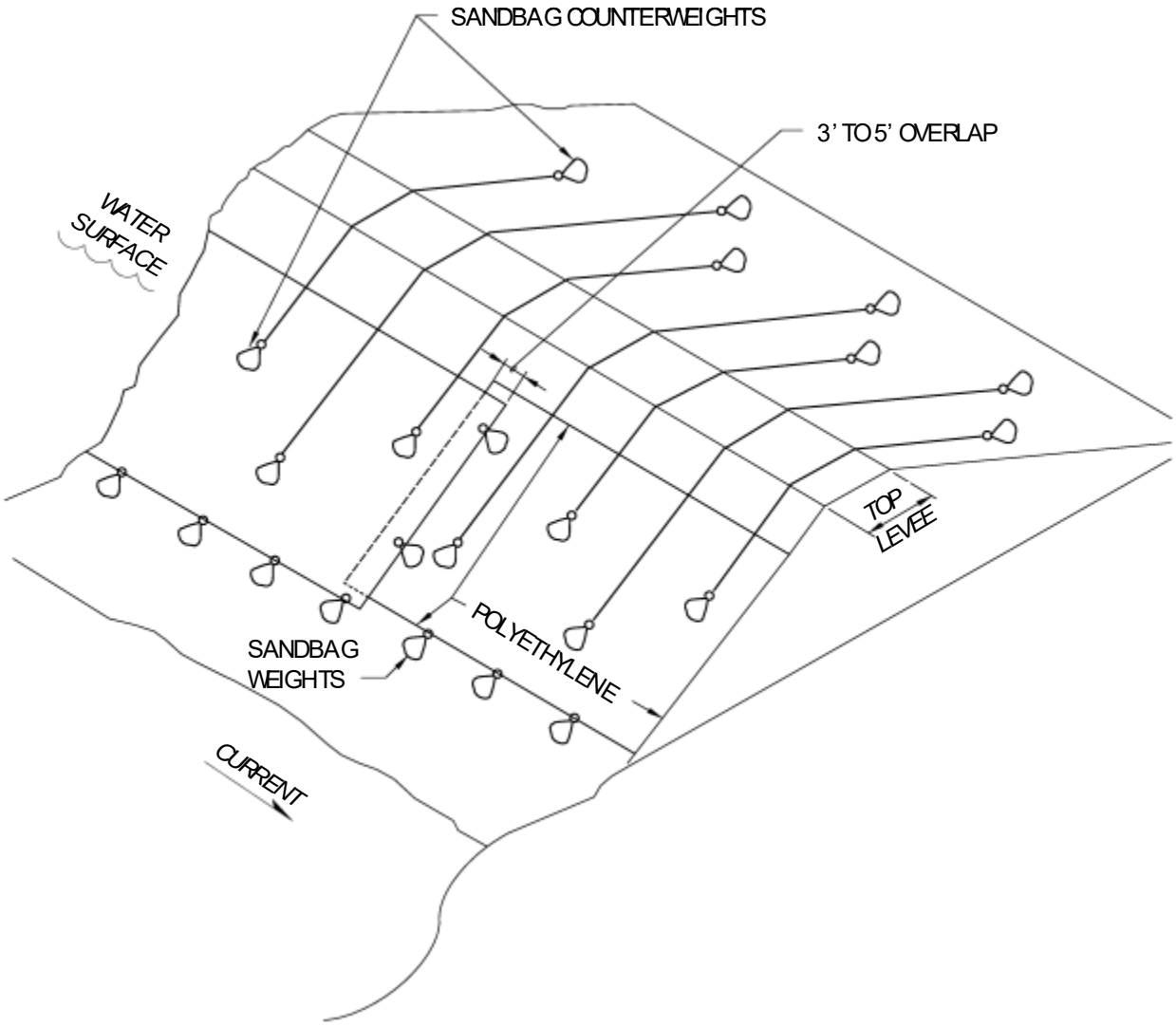

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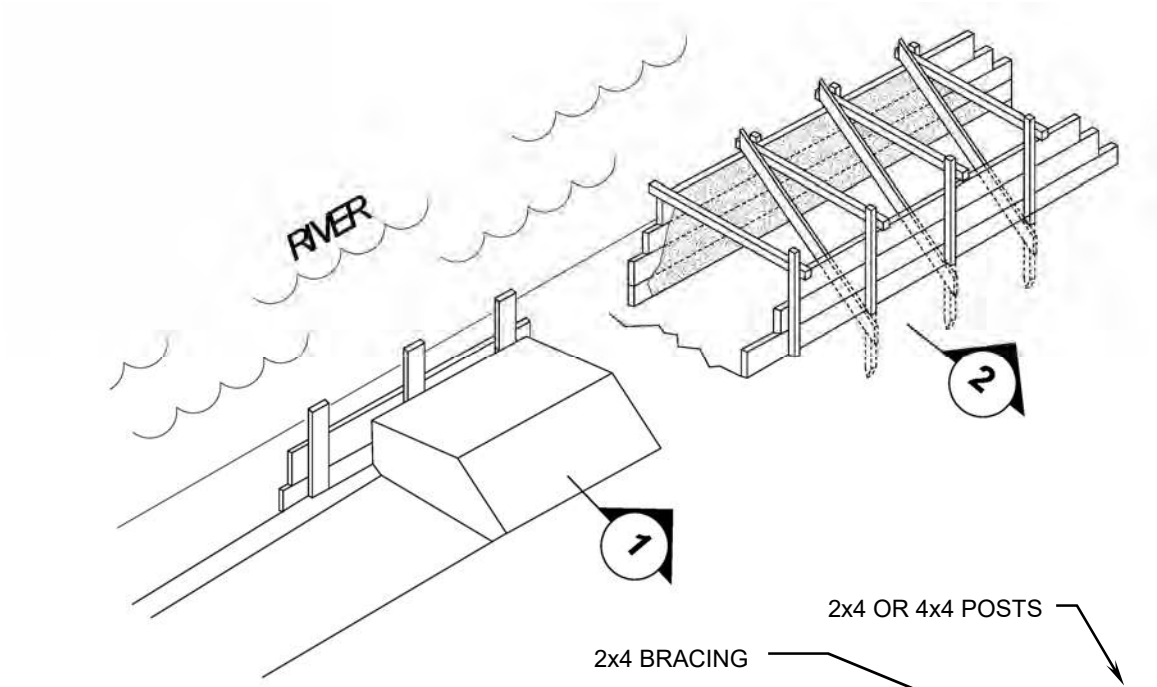
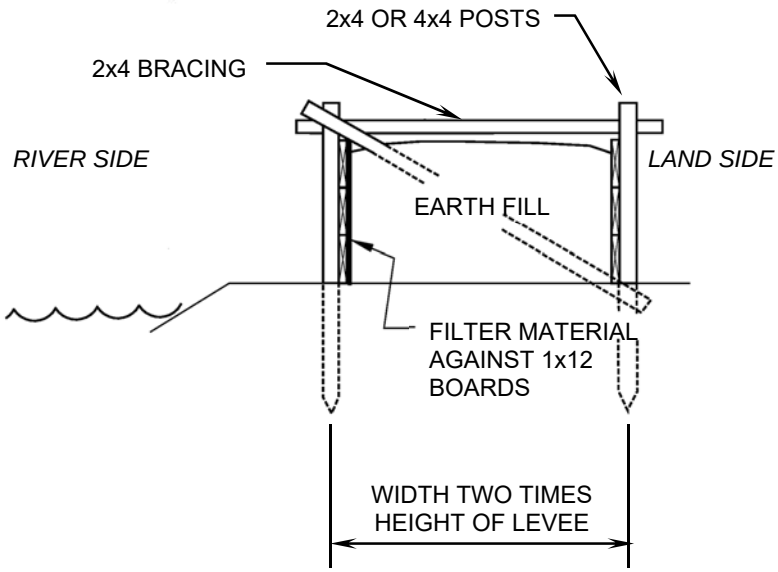
PLATE 5

RECOMMENDED METHOD FOR PLACEMENT OF POLYETHYLENE SHEETING ON TEMPORARY LEVEES

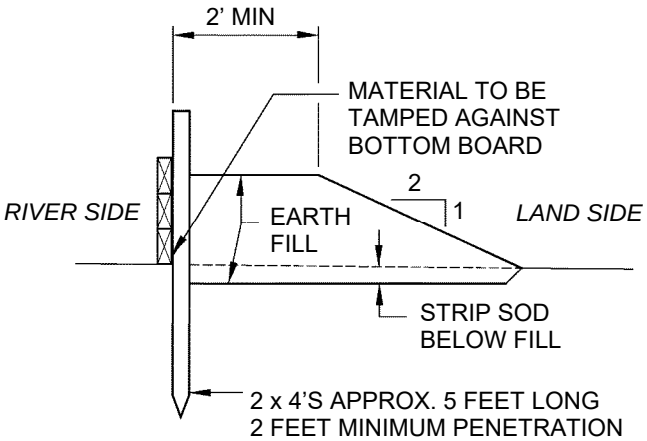
(WHEN PLACED IN THE WET)





BOX
LEVEE

2



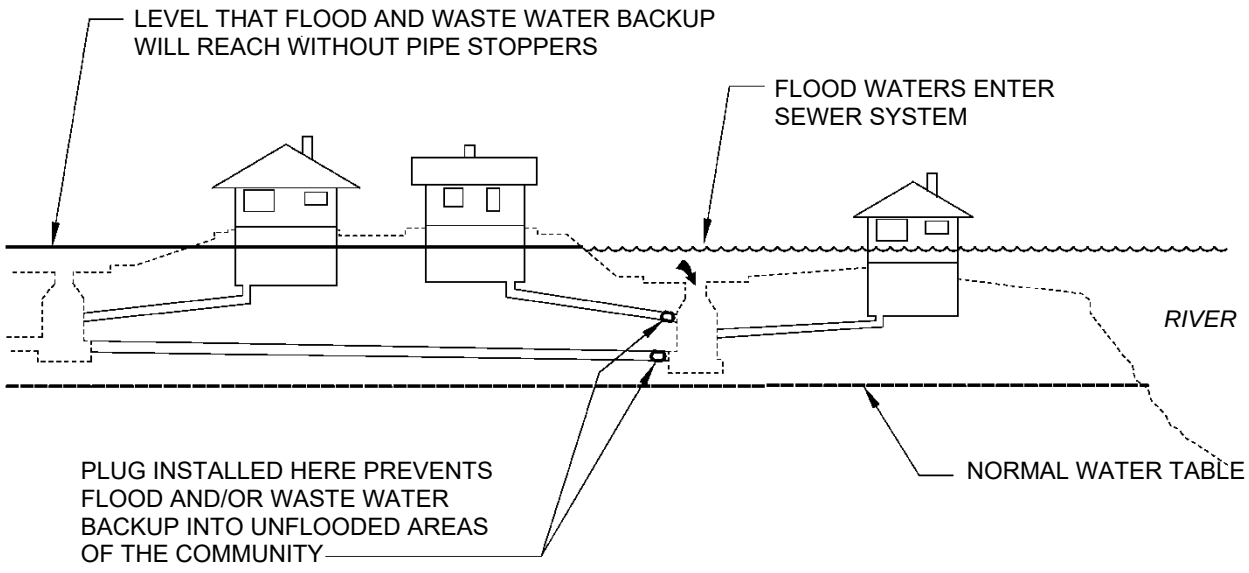
FLASHBOARD LEVEE

1

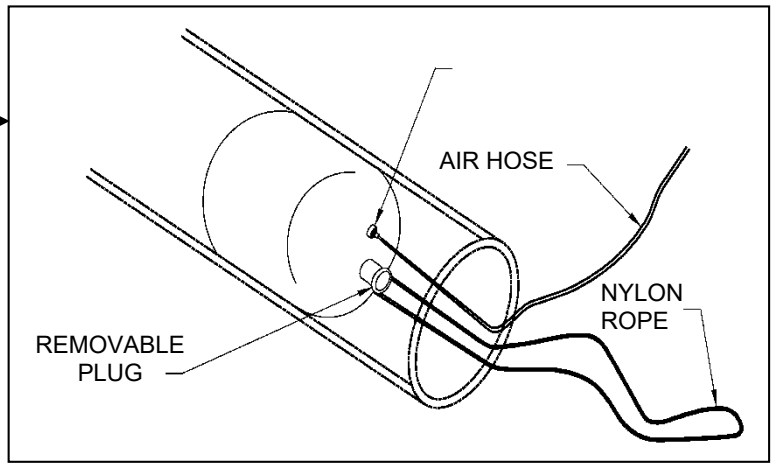
US Army Corps of Engineers
St. Paul District

PLATE 6

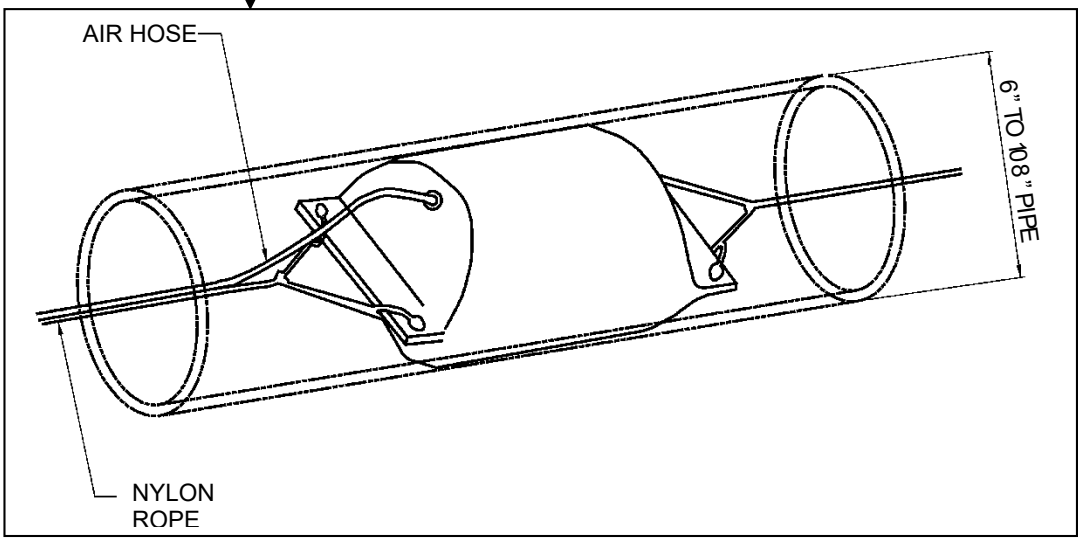
RECOMMENDED METHOD FOR FLASHBOARD AND BOX LEVEES



PIPE STOPPER: DESIGN 1



PIPE STOPPER: DESIGN 2



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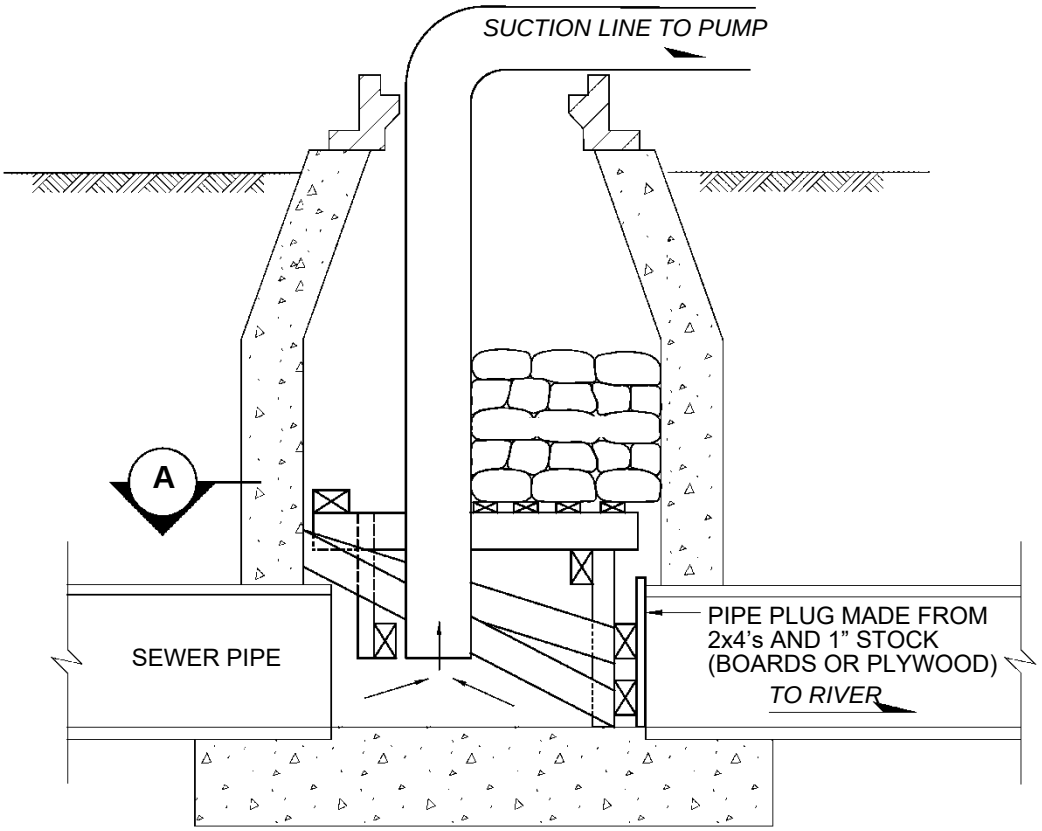
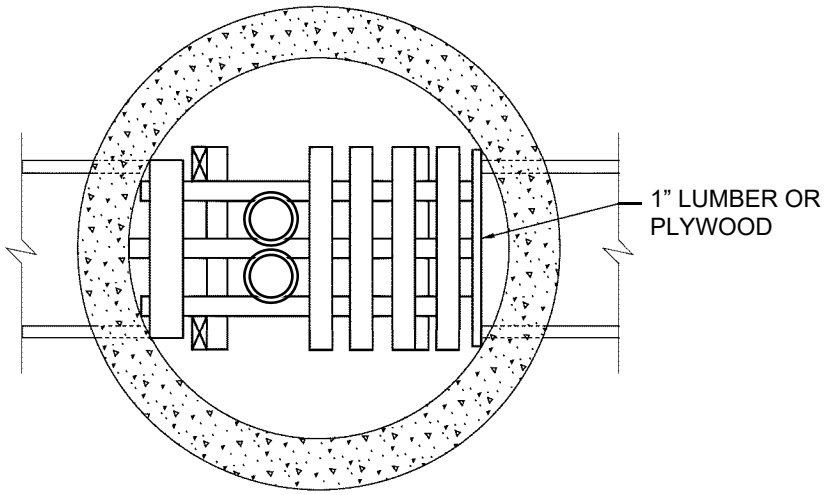
St. Paul District

PLATE 7

RECOMMENDED METHOD FOR PLUGGING PIPES



ADAPTING MANHOLE FOR PUMPING DURING FLOOD EMERGENCY



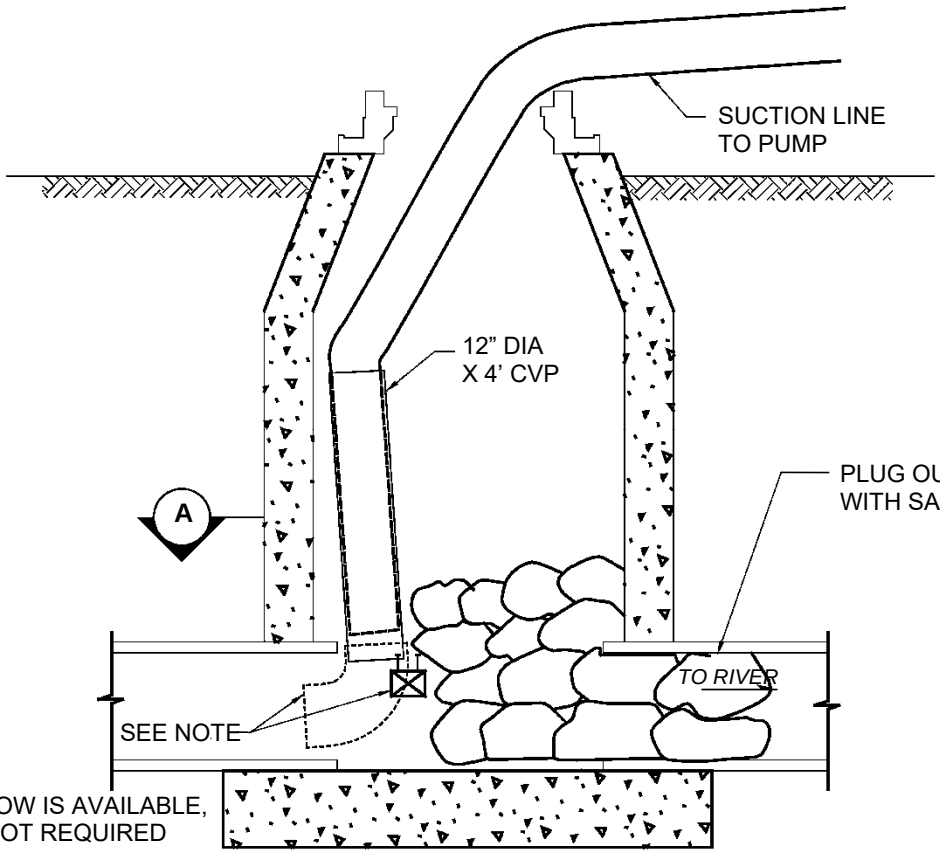
SECTION A

US Army Corps of Engineers
St. Paul District

PLATE 8

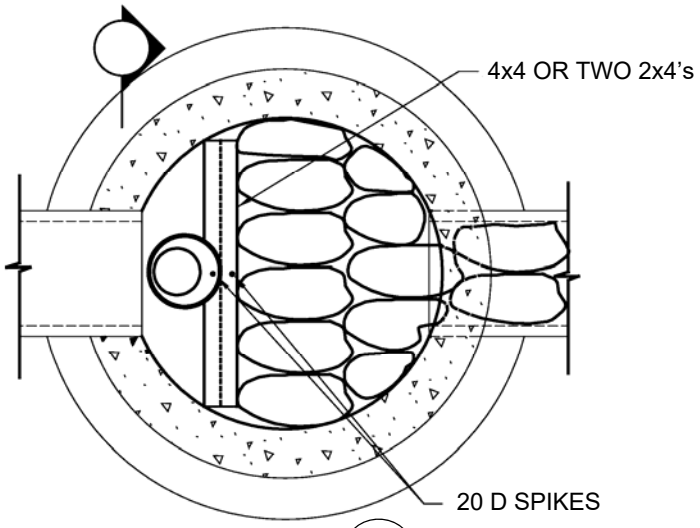
RECOMMENDED METHOD FOR ADAPTING MANHOLE FOR PUMPING

(METHOD 1)



NOTE:
IF A 90º ELBOW IS AVAILABLE,
4X4'S ARE NOT REQUIRED

ADAPTING MANHOLE FOR PUMPING DURING FLOOD EMERGENCY



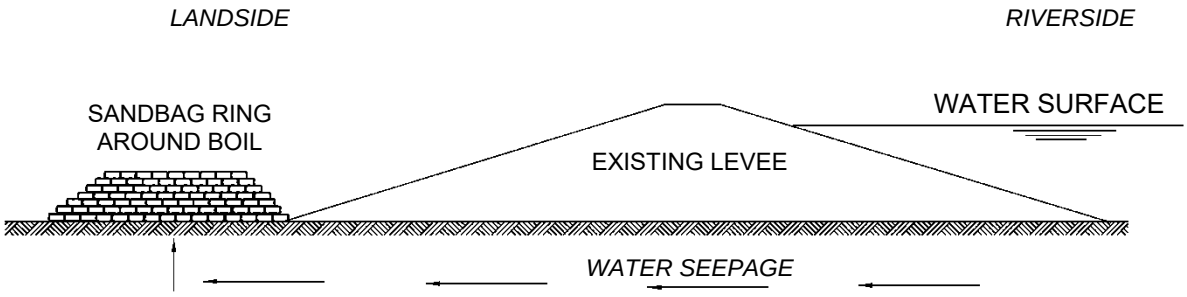
SECTION A

US Army Corps of Engineers
St. Paul District

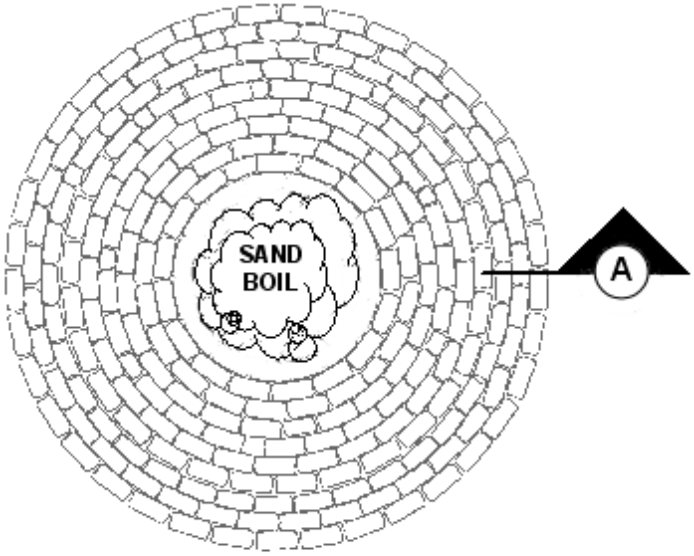
PLATE 9

RECOMMENDED METHOD FOR ADAPTING MANHOLE FOR PUMPING

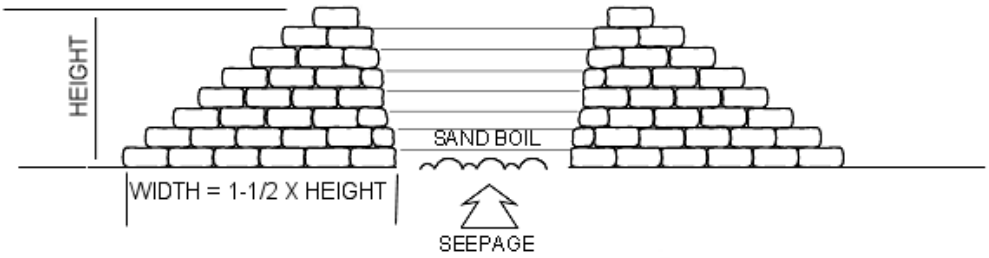
(METHOD 2)



ELEVATION



PLAN VIEW



SECTIONAL ELEVATION — A

NOTES:

1. BOTTOM WIDTH TO BE NO LESS THAN 1-1/2 TIMES THE HEIGHT. TIE INTO LEVEE IF BOIL IS NEAR TOE.
2. ENTIRE BASE TO BE CLEARED AND SCARIFIED.
3. LOOSE EARTH TO BE USED BETWEEN ALL SACKS.
4. ALL JOINTS TO BE STAGGERED.

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PLATE 10

RECOMMENDED METHOD FOR RINGING SAND BOILS

APPENDIX B

Report Examples

B.1 Annual Inspection Report
B.2 Post Flood Report

APPENDIX B.1

Annual Inspection Report

ENGINEERING DEPARTMENT
200 North 3rd Street Fargo, ND 58102
Phone: 701-241-1545 Fax: 701-241-8101

Flood Risk Reduction Projects
Levee Inspection Report

Levee Name/Location: _____

Original Construction Project No. _____ Inspector(s) _____

Superintendent: _____

Inspection Date: _____ Date of Previous Inspection: _____

Reason for Inspection: _____ Scheduled
_____ After Flood
_____ Other (Please Specify) _____
_____

GPS Photos Taken: Y or N Photos Downloaded: Y or N
Saved In: _____

Previous, Most Recent Flood Crest: _____ ft (at Fargo Gage)
Did levee system function properly during high water? Y or N
Issues to be addressed, if any: _____
_____

Reviewed Last Inspection Report: Y or N
Maintenance work completed since last inspection: _____
_____
_____
_____

Were Previously Recommended Corrective Measures Completed: Y or N
If so, describe action taken: _____
_____
_____
_____

Date of Last Top of Levee Survey: _____
*If its been 5 years or more since last survey, schedule one to be completed

Original Designed Top of Levee Elevation: _____

If survey was completed under this inspection, please note any deficiencies in original design elevation (by station). Attach copy of survey with this inspection form.

_____
_____

Condition of Levee

*Specify the approximate locations and take pictures of all issues

Vegetation: _____% Cover

Cracks: Width, Depth & Length of Cracks

Slides or Slumping Issues:

Erosion Issues:

Clear Zone Encroachments: Detail what the Encroachment is

Retaining Wall Condition:

Flood Wall Condition: Possible issues to watch are: random cracking, caulk condition, staining

Lift Station & Gate Wells: Complete inspections with Street Department Staff. Review Street Department notes on maintenance activities since last inspection

Rodent Issues:

Riprap Condition:

Corrective Measures Recommended:

Date Corrective Measures were taken care of: _____

Project Numbers of Repair Projects, (if applicable): _____

Items to be monitored:

Provide Copy of Report to Storm Sewer Utility Division Engineer

APPENDIX B.2

Post-Flood Report

ENGINEERING DEPARTMENT
200 North 3rd Street Fargo, ND 58102
Phone: 701-241-1545 Fax: 701-241-8101

Flood Risk Reduction Projects
Post Flood Report

Levee Name/Location: _____ Date: _____

Original Construction Project No. _____ Superintendent: _____

Recorded Flood Crest: _____ ft (at Fargo Gage) Did floodwaters reach toe of levee? Y or N

Flood History (Describe Warnings Received)

Describe Warnings Received: _____

Operation of each feature:

Levee: _____

Outlet Structures: _____

Daily Tabulation of River Stages: http://water.weather.gov/ahps2/hydrograph.php?wfo=fgf&gage=fgon8

Attach documentation from noaa website.

Notes: _____

Pertinent factors in maintaining levee during flood:

Were any problems encountered during high water? Y or N

Issues to be addressed, if any: _____

Were any damages incurred during high water? *Y or N*

If so, please explain: _____

Are any reparis required? Y or N

If so, please explain: _____

What manpower and resources were required during high water?

Were there any other significant occurrences during high water?

Are there any lessons to be learned that would help with the next high water period?

Other Notes:

APPENDIX C

Manufacturer Manuals

C.1 Sluice Gate Installation and Maintenance Manual

C.2 Sluice Gate Submittal

AQUANOX
WATER CONTROL GATES

S SERIES

INSTALLATION AND MAINTENANCE MANUAL

(Revision 3)

1. TABLE OF CONTENT

2. INTRODUCTION

This manual is intended to provide all the necessary information for the installation, operation and maintenance of **Aquanox** Gates. It is intended to contractors responsible for the installation, to owners and to operators of the equipment, to preventive maintenance supervisor and to potential repairers to clearly diagnose problems and to make proper basic adjustment.

2.1. WARNINGS

 It is important to read this manual before starting any work on the gates.

 It is very important not to exceed the 178N (40 lb) on the gate actuator, either to open or close the gate.

 The seals are factory calibrated. Any changes to this setting will void the warranty.

 When installing the equipment, always apply an anti-seize on the stainless steel fasteners.

 Reduce as much as possible the contact between stainless steel and carbon steel to prevent corrosion contamination. See Appendix 3 for additional information on contamination of stainless steel.

 At all times when working on gates, make sure to comply with local safety standards and wear personal protective equipment.

3. RECEIVING

Despite all the precautions taken during packing, some damage may have occurred during transportation of the goods to their destination. We recommend that you follow the following instructions when receiving your equipment.

Ensure the conformity of the delivered goods before signing the bill of lading.

Look for any anomaly concerning the delivery (damage, missing items in relation to bill of lading, broken pallet, parcel damaged, dented part , deformed pipe , etc.) as this may be a sign of events that may have caused greater damage. Indicate on the bill of lading any abnormality detected, otherwise no claim will be accepted.

After the receipt of the goods, and within 5 working days, verify with the bill of lading that all equipment has been received. Also verify the equipment tag. They must match the items listed on the bill of lading. No claims for missing parts will be accepted after the period of 5 working days.

 Contact **Aquanox** to report any anomalies found or missing parts.

4. STORAGE

Cover and protect all equipment that will not be installed immediately.

- Leave the equipment attached to the pallet;
- Cover with a canvas or tarp;
- Store in a dry, and flat area;
- Do not stack the gates;
- Place the stems and pipes on wooden blocks;
- Place the other parts in a safe place;
- Protect from dust and sand;
- Avoid exposure to UV rays;
- For long-term storage, place inside in a dry and temperate area;
- Refer to the electric actuator documentation for specific storage instruction for this type of equipment.

5. GLOSSARY FOR RISING STEM WITH OPEN FRAME (MODEL S11)

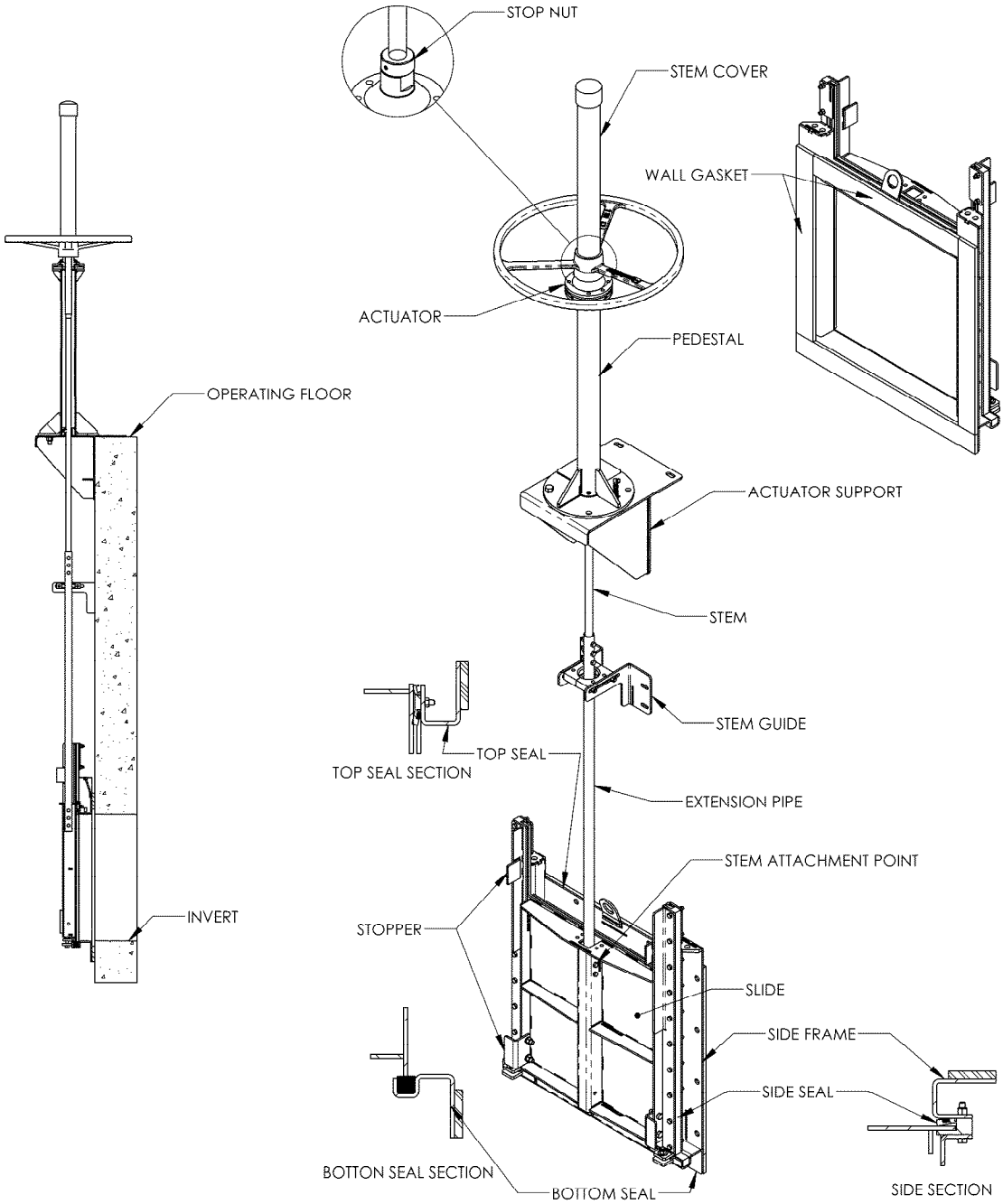


Figure 1

6. GLOSSARY FOR NON-RISING STEM WITH CLOSED FRAME (SÉRIE S22)

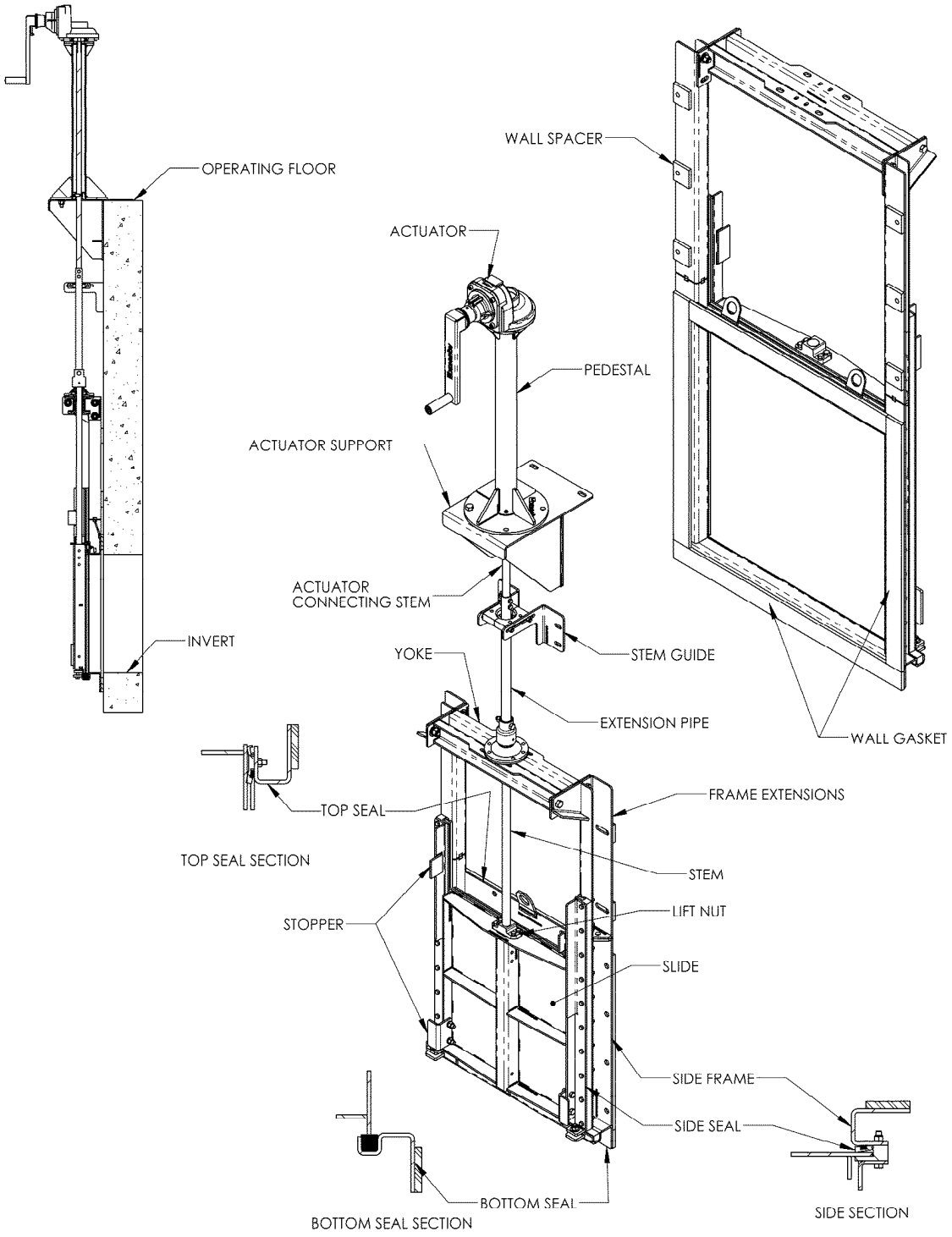


Figure 2

7. PREPARATION FOR INSTALLATION

7.1. NEW CONCRETE WALL

Verify the flatness of the wall on which the gate will be installed. A plumb line, a laser or a straight edge can be used.

- On the whole contact surface between the gate frame and the wall, a maximum variation of 3 mm (1/8'') between the peaks and troughs is the tolerable limit;
- The maximum allowable warp is 3 mm (1/8'') on the total length for each side;
- Maximum vertical alignment of 3 mm (1/8'') over the entire length of the side;
- The wall must be uniform and flat within a tolerance of ± 3 mm (1/8''); imperfections must be rectified and/or filled with a suitable leveling grout.

Verify the distance between the invert and the operating floor. A maximum difference of ± 20 mm (¾'') between the measured distance and the installation drawing is acceptable for the proper operation of the gate.

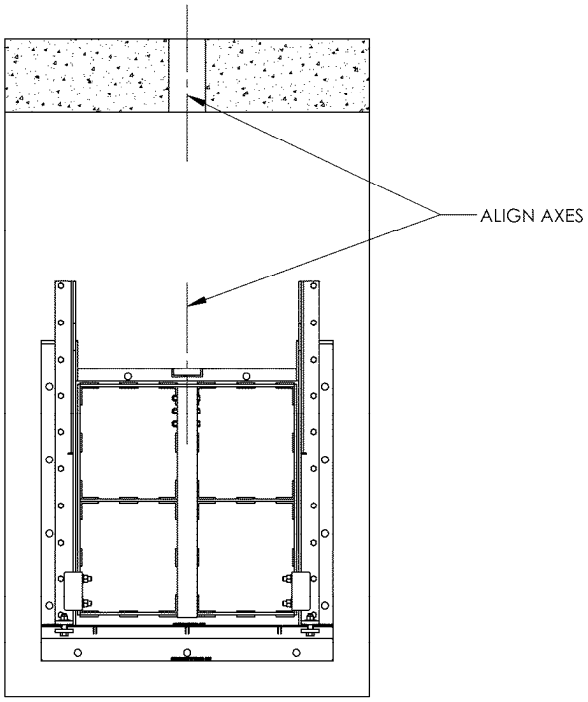


Figure 3

For gates with stem through the top slab

Verify the alignment of the hole in the floor. It should be centered with the stem attachment point of the slide. See the gate installation drawing for the hole diameter in the floor. The stem should not touch the sides of the hole (ref. Figure 3).

7.2. EXISTING CONCRETE WALL

For an installation on an existing concrete wall, make sure that the quality of the concrete meets the minimum installation requirements.

- Verify if there is any concrete spalling;
- Verify the porosity of the concrete;
- Verify the existence of cracks that may compromise the structural integrity of the installation or may create leaks;
- Verify the concrete resistance (refer to the installation drawing to validate the required strength and type of anchor to use).

If corrective work is needed, contact a qualified professional.

8. S11 & S22 GATE INSTALLATION WITH FLOOR MOUNTED ACTUATOR

The side seals are factory adjusted. Any modification of this adjustment will void the warranty.

Always apply an anti-seize on the stainless steel fasteners.

1- Verify for warping of the gate. Make sure the side seals are parallel at ± 3 mm (1/8 "). Dimension " A " should not be greater than 3 mm (1/8") than dimension "B" to allow adequate sliding of the slide, (ref.: Figure 4).

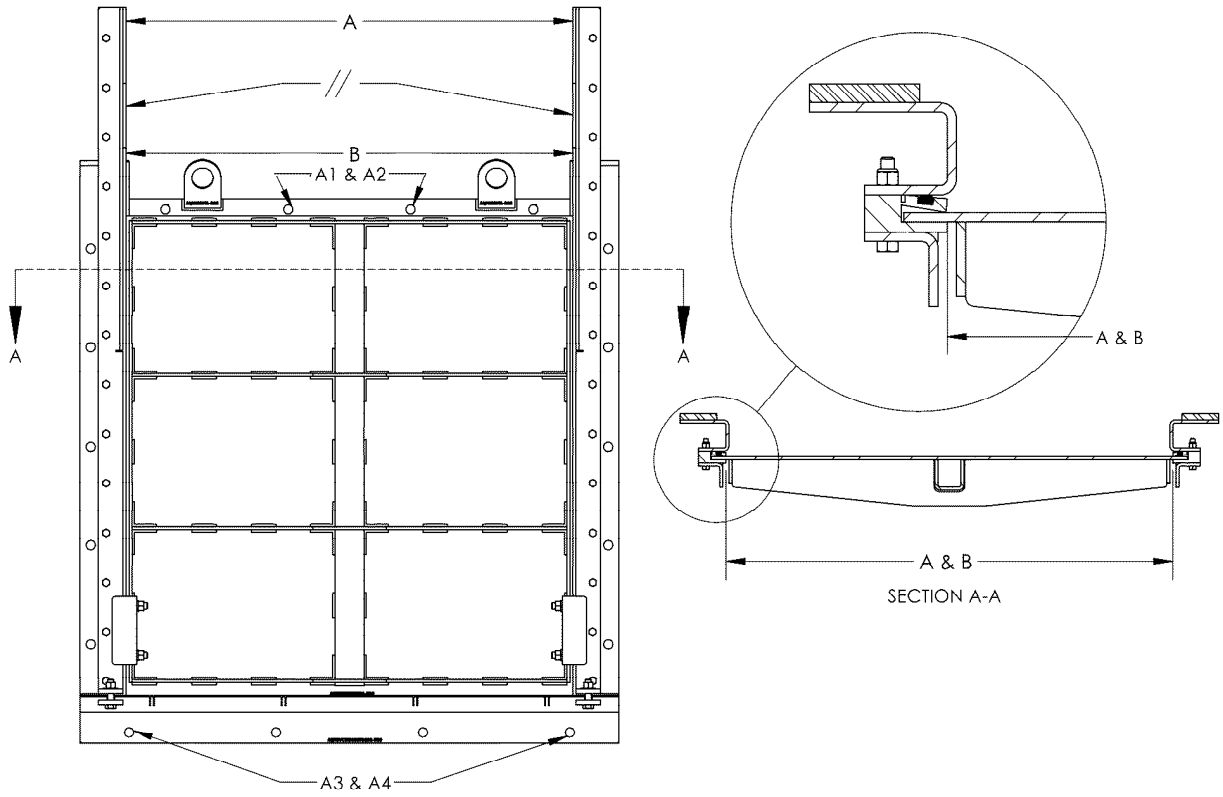


Figure 4

2- Place the gate as per the installation drawing. Level the gate by using as a reference the side frame. The side frame should be vertically plumbed. Verify the alignment with the hole in the top floor slab (if applicable). Mark and drill the two anchor holes closest to the center on the top seal frame (identified A1 & A2 on Figure 4) and install the two anchors. *See Appendix 1 Caution for chemical anchoring.*

3- Install the gate on the two anchors (after curing of concrete if chemical anchors), level and bolt the gate. Mark and drill the two anchor holes positioned on the outside of the bottom seal frame (identified A3 & A4 on Figure 4) and install the two anchors.

4- Verify the straightness of the bottom seal using a straight edge or a stretched cord from one corner to the other. A 2mm (1/16") deformation is acceptable. Adjust as needed using intermediate anchors.

5- Mark and drill the missing holes and remove the gate.

6- Clean the wall from concrete dust.

7- Install the remaining anchors.

8- Clean the gate frame with a degreaser.

9- Bond the wall gasket with a contact adhesive to the frame or insert the wall gasket onto the anchors bolts.

<u>For S22 models, gates with frame extensions and yoke.</u>

Insert the 76 mm x 76 mm (3'' x 3'') wall spacers into the frame extension anchor bolts holes or bond the wall spacers to the frame extensions.

Apply anti-seize on each anchor rods before installing the gate.

10- Install the gate on the anchor rods and screw the nuts. Partially tighten the 4 anchor placed at the 4 corners of the gate face. The frame extensions should not touch the wall. Otherwise, the wall is uneven and must be corrected.

11- Tighten the anchor evenly all around the frame. For model S22, gates with yoke, do not tighten at this point the anchor of the frame extensions. Refer to Figure 5 for the anchor tightening sequence. Proceed with a rotary tightening sequence until a uniform torque is obtained. Make sure the frame extensions do not come in contact with the wall before the outline anchors are completely tightened.

12- Tighten the frame extension anchors to place in the same plane as the lower part of the frame (use a plumb bob, a laser or a straight edge).

Take care not to over tighten the gate anchors as this may affect operating forces and gate leakage.

13- Clean with clear water the side and bottom seals and the gate to remove any residual metal or concrete. Ensure that the environment in which the gate is installed is properly cleaned and there is no more residue (boards, metal rods, etc.) that may affect the proper function of the gate.

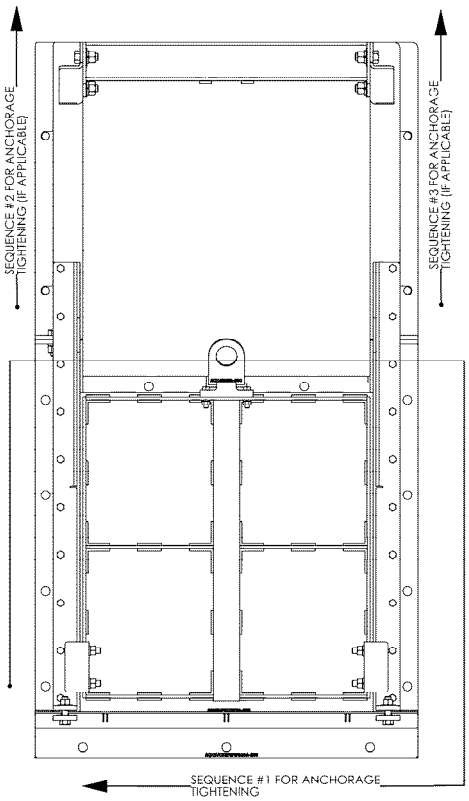


Figure 5

9. S22 GATE INSTALLATION WITH YOKE MOUNTED ACTUATOR

The side seals are factory adjusted. Any modification of this adjustment will void the warranty.

Always apply an anti-seize on the stainless steel fasteners.

1- Place the gate as per the installation drawing. Level the gate. Mark and drill the two anchor holes closest to the center of the top seal frame (identified A1 & A2 on Figure 4) and install the two anchors. *See Appendix 1 Caution for chemical anchoring.*

2- Install the gate on the two anchors (after curing of concrete if chemical anchors), level and bolt the gate. Mark and drill the two anchor holes positioned on the outside of the bottom seal frame (identified A3 & A4 on Figure 4) and install the two anchors. See *Appendix 1 Caution for chemical anchoring.*

3- Verify the straightness of the bottom seal using a straight edge or a stretched cord from one corner to the other. A 2mm (1/16") deformation is acceptable. Adjust as needed using intermediate anchors.

4- Mark and drill the missing holes and remove the gate.

5- Clean the wall from concrete dust.

6- Install the remaining anchors.

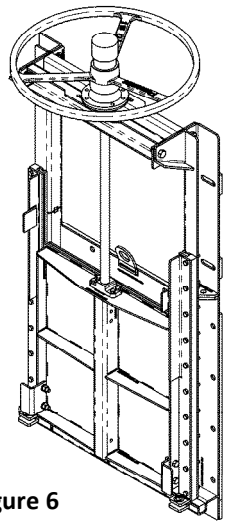


Figure 6

7- Clean the gate frame with a degreaser.

8- Bond the wall gasket with a contact adhesive to the frame or insert the wall gasket onto the anchors bolts.

9- Insert the 76 mm x 76 mm (3'' x 3'') wall spacers into the frame extension anchor bolts holes or bond the wall spacers to the frame extensions.

Apply anti-seize on each anchor rods before installing the gate.

10- Install the gate on the anchor rods and screw the nuts. Partially tighten the 4 anchor placed at the 4 corners of the gate face. The frame extensions should not touch the wall. Otherwise, the wall is uneven and must be corrected.

11- Tighten the anchor evenly all around the frame. Do not tighten at this point the anchors of the frame extensions. Refer to Figure 5 for the anchor tightening sequence. Proceed with a rotary tightening sequence until a uniform torque is obtained. Make sure the frame extensions do not come in contact with the wall before the outline anchors are completely tightened.

12- Tighten the frame extension anchors to place in the same plane as the lower part of the frame (use a plumb bob, a laser or a straight edge).

Take care not to over tighten the gate anchors as this may affect operating forces and gate leakage.

13- Clean with clear water the side and bottom seals and the gate to remove any residual metal or concrete. Ensure that the environment in which the gate is installed is properly cleaned and there is no more residue (boards, metal rods, etc.) that may affect the proper function of the gate.

10. INSTALLATION OF LIFTING COMPONENTS FOR RISING STEM (MODEL S11)

10.1. INSTALLATION WITH PEDESTAL AND RISING STEM

A) MOUNTING WITH A HOLE IN TOP SLAB:

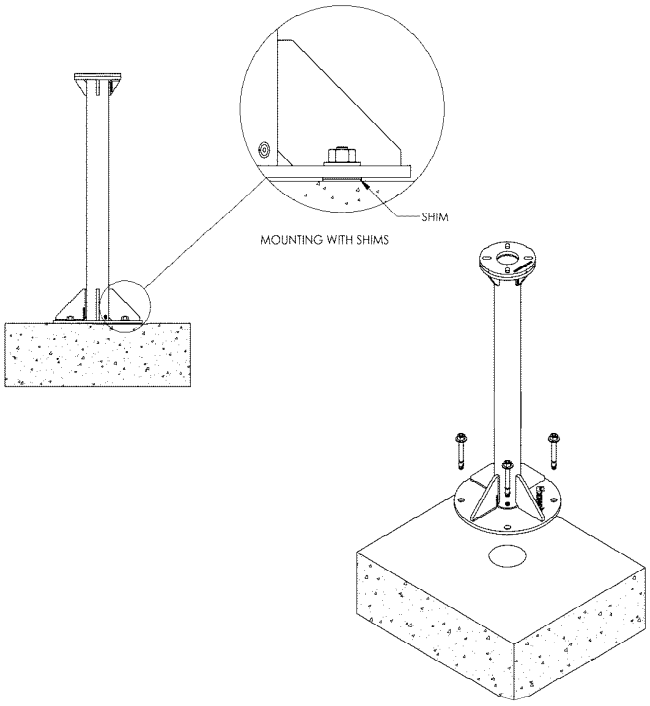


Figure 7

1- Ensure the flatness of the floor on the overall pedestal contact surface.

2- Find the center of stem attachment point of the gate on the top slab hole using a plumb bob or a laser.

3- From the center of stem attachment point just found, mark with 3 or 4 marks at 2mm + R (R + 1/16 ") (R being the radius of the pedestal or half of its diameter (ref.: Figure 8).

4- Center the pedestal within the marks previously made and mark the position of the anchor holes. Drill the holes and insert anchors.

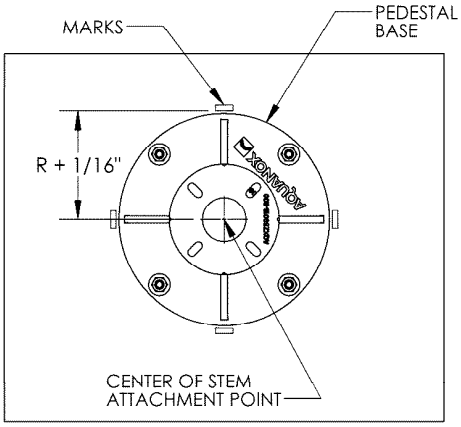


Figure 8

5- Level **the top flange of the pedestal** on the X and Y axes using stainless steel shims of the appropriate thickness.

B) MOUNTING WITH ACTUATOR SUPPORT:

1- Locate the position of the actuator support using a plumb line or a laser aligned with the center of the stem attachment point on the gate.

2- Ensure the flatness of the floor on the entire surface of contact between the actuator support and the concrete (wall and floor).

3- Maintain the support position and check the level in the X and Y axes. Also check the vertical alignment of the actuator support with the stem attachment point on the gate. Correct concrete if needed.

4- Anchor actuator support in position.

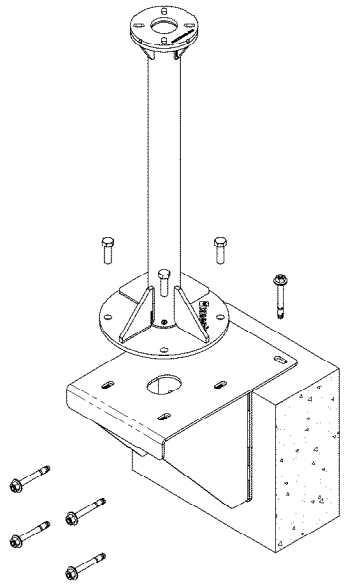


Figure 9

Installation of lifting components for rising stem … continued

1- Mark on the wall the stem guide elevations from the gate invert (refer to the gate installation drawing).

2- Install and bolt the pipe extensions on the gate. Use the installation drawing to position the pipe extensions in the correct order, in the case where more than one pipe extension is required.

3- Install and bolt the stem to the last pipe extension.

4- Install the actuator on the lift rod. Rotate the lifting nut to engage on the thread.

⚠ Firmly hold the actuator until the lifting nut is fully engaged on the threads.

5- Lower the actuator until it is near the pedestal surface and engages the 4 bolts of the mounting flange. Continue to lower the actuator until it sits firmly on the mounting surface. Tighten the bolts.

6- Place all lifting components under tension with one of the following methods:

A. Secure the gate in closed position with a clamp between the slide and the bottom frame.

B. Open the gate until it sits on the stoppers.

7- Apply a force of 178 N (40 lb) to the actuator so that all the lifting elements are in tension.

8- Install the stem guides at the elevations noted in step 1. ⚠ See *Appendix 1 Caution for chemical anchoring.*

9- Once the stem guides are anchored, proceed with final alignment using the bolts located on each side. Tighten into position.

10.2. STOP NUT INSTALLATION

The stop nut is required only for manual gates with rising stems.

Not installing or not installing properly the stop nut can cause excessive leakage or damage to the gate components.

1- Fully close the gate to install the stop nut using one of the following two methods:

   A. Closing the gate under dry condition

      1- Place on the gate bottom seal a thin strip of plastic (the thickness of a plastic bag) of about 50 mm (2'') wide at each corner.

      2- Using the actuator, close the slide until to two plastic strips are well jammed between the slide and the bottom seal.

      3- Continue to close the gate slide 2 to 3mm (1/8”) to compress the bottom seal.

      The gate is now fully closed

   B. Closing the gate with water pressure

      1- Using the actuator, close the gate until the water flow stops. Never apply more than 178 N (40 lb) on the actuator.

      The gate is now fully closed

2- Using the depth measuring blade of a Vernier caliper, measure the distance A1 between the end of the gate stem and the contact surface (top of the lifting nut) (ref.: Figure 10)

3- Open the gate about 300mm (12”).

4- Screw the stop nut on the stem until the distance from the top of the stem and the bottom of the stop nut is equal to distance A1.

5- Secure the stop nut into position by tightening the set screws.

6- Lower the gate into the closed position until the stop nut sits on the contact surface of the lifting nut and rechecks the distance A1. Do not apply a force greater than 178 N (40lb) on the actuator. Reposition the stop nut if necessary.

Figure 10

10.3. LIFTING STEM LUBRICATION AND CLEANING

1- Open the gate to expose the stem threads.

2- Thoroughly clean the stem thread using a plastic or stainless steel brush to prevent contamination of the stem. See Appendix 3 for additional information on stainless steel contamination.

3- Lubricate the stem threads with the proper grease (ref.: Appendix 2 Stem lubrication)

10.4. STEM COVER INSTALLATION

A) ON A GEAR BOX OR ELECTRIC ACTUATOR:

1- Close the gate. Screw the stem cover on the actuator.

2- To prevent water from entering the actuator, seal the base of the tube fitting with silicone.

B) ON A HAND WHEEL WITH THRUST BEARING:

1- To prevent water from entering the actuator and to maintain the stem cover in position, apply silicone on the inside face of the hand wheel hub.

2- Insert the stem cover and allow drying without moving.

10.5. GRADUATED RULER INSTALLATION

1- Fully close the gate

2- Clean the stem cover with mild soap (⚠ do not use solvent).

3- Let dry.

4- Apply the adhesive ruler on the stem cover. The "0" of the ruler must align with the upper end of the gate stem when the gate is fully is closed.

11. INSTALLATION OF LIFTING COMPONENTS FOR NON-RISING STEM (MODEL S22)

11.1. INSTALLATION WITH PEDESTAL AND NON-RISING STEM

A) MOUNTING WITH A HOLE IN TOP SLAB:

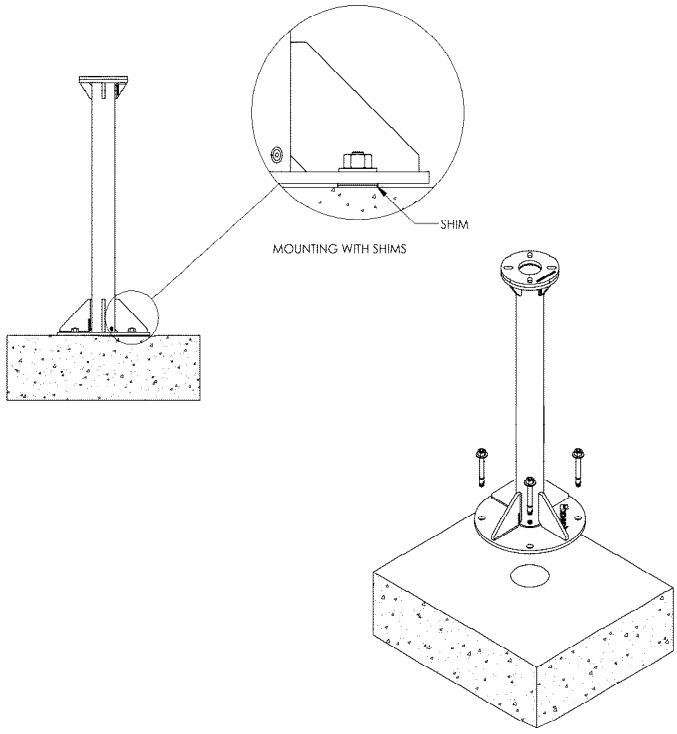


Figure 11

1- Ensure the flatness of the floor on the overall pedestal contact surface.

2- Find the center of stem attachment point of the gate on the top slab hole using a plumb bob or a laser.

3- From the center of stem attachment point just found, mark with 3 or 4 marks at 2mm + R (R + 1/16 ") (R being the radius of the pedestal or half of its diameter (ref.: Figure 12).

4- Center the pedestal within the marks previously made and mark the position of the anchor holes. Drill the holes and insert anchors.

5- Level **the top flange of the pedestal** on the X and Y axes using stainless steel shims of the appropriate thickness (ref.: Figure 11)

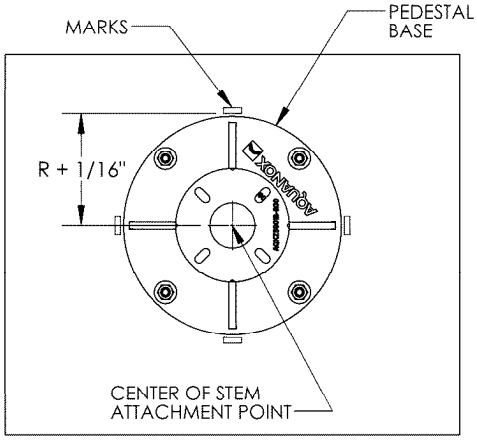


Figure 12

B) MOUNTING WITH ACTUATOR SUPPORT:

1- Locate the position of the actuator support using a plumb line or a laser aligned with the center of the stem attachment point on the gate.

2- Ensure the flatness of the floor on the entire surface of contact between the actuator support and the concrete (wall and floor).

3- Maintain the support position and check the level in the X and Y axes. Also check the vertical alignment of the actuator support with the stem attachment point on the gate. Correct concrete if needed.

4- Anchor actuator support in position.

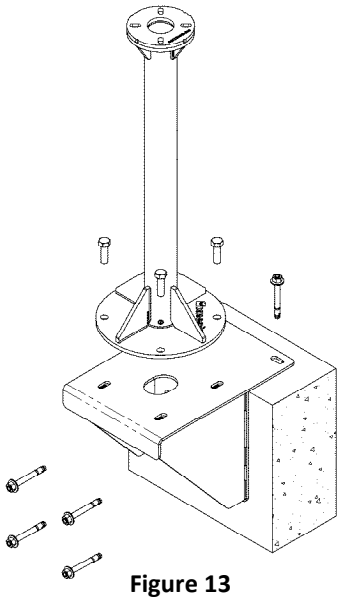


Figure 13

Installation of lifting components for non-rising stem … continued

1- Mark the wall, with a horizontal line, the elevation of the stem guide position from the invert (refer to the gate installation drawing).

2- Mark with a vertical line the center of the stem on each of the corresponding horizontal lines for every stem guide position.

3- Install all stem guides.

4- Bolt the first extension pipe on the gate and insert it into the corresponding stem guide.

5- Adjust the stem guide in the "front to back" axis using the bolts located on each side.

6- Repeat with the other extension pipes if applicable (refer to the gate installation drawing).

7- Install the actuator on the stem, engage the 4 bolts of the mounting flange. Tighten the bolts.

8- Turn the actuator to align the stem and operating nut key ways.

9- Insert the key.

10- Install the cap on the top of the actuator (if applicable).

11- To prevent water from entering the actuator, seal the base of the cap with silicone.

12- Close the gate for the stem cleaning and lubrication.

13- Thoroughly clean the stem thread using a plastic or stainless steel brush to prevent contamination of the stem. See Appendix 3 for additional information on stainless steel contamination.

14- Lubricate the stem threads with the proper grease (ref.: Appendix 2 Stem lubrication)

11.2. INSTALLATION FOR NON-RISING STEM WITH FLOOR OPERATING NUT

1- Find the center of stem attachment point of the gate on the top slab hole using a plumb bob or a laser.

2- Mark the wall, with a horizontal line, the elevation of the stem guide position from the invert (refer to the gate installation drawing).

3- Mark with a vertical line the center of the stem on each of the corresponding horizontal lines for every stem guide position).

4- Bolt the first extension pipe on the gate and insert it into the corresponding stem guide.

5- Adjust the stem guide in the "front to back" axis using the bolts located on each side.

6- Repeat with the other extension pipes if applicable (refer to the gate installation drawing).

7- Bolt operating nut on the upper section of the last extension pipe.

8- Close the gate for the stem cleaning and lubrication.

9- Thoroughly clean the stem thread using a plastic or stainless steel brush to prevent contamination of the stem. See Appendix 3 for additional information on stainless steel contamination.

10- Lubricate the stem threads with the proper grease (ref.: Appendix 2 Stem lubrication)

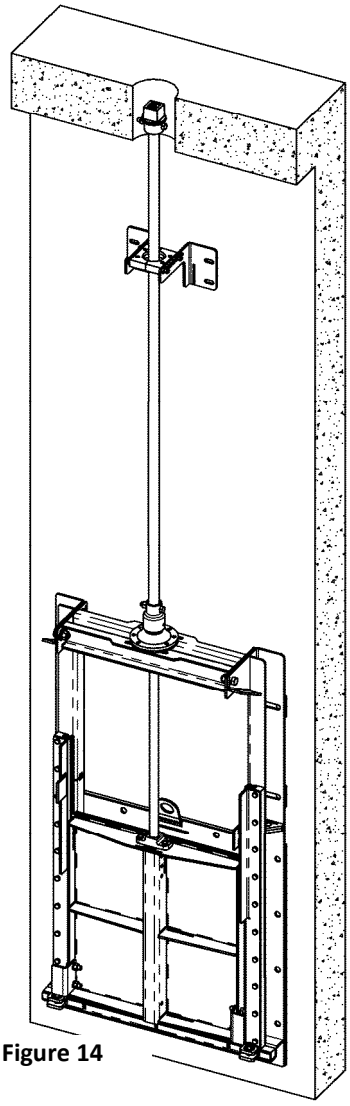


Figure 14

12. TROUBLESHOOTING

 Never use excessive force on the actuator, permanent damage to seals and lifting equipment may result.

Symptoms	Cause	Solution
Leakage	Wood, concrete or other foreign materials on the seals.	Carefully remove what is causing the leak. Check for damage to the seals.
	Gate not properly mounted on the anchors.	Tighten the anchor bolts according to anchor manufacturer's recommendations.
	Top seal anchors too tight.	Partially reduce the tension on the top seal anchors.
	Excess of epoxy around the base of the anchor that prevents a proper compression of the wall gasket.	Remove the gate and remove the excess of epoxy around the bases. Replace the gate.
	Cracks, crumble or porosity in the concrete wall that bypass the seal.	Repair and seal cracks, crumble or porosity.
	The side seal bolts are not well adjusted.	The side seals are factory adjusted. The setting torque is measured to the optimized the ratio between the operation force and leakage rate. Therefore, contact **Aquanox** before adjusting the side seal bolts.
	Stop nut not properly adjusted.	Refer to the installation section to reposition the stop nut.
Excessive operating force	Stem or lift nut dirty or dry.	Clean and lubricate the threads.
	Wood, concrete or other foreign materials on the seals.	Carefully remove what is causing the leak. Check for damage to the seals.
	Misalignment of the lifting components.	Verify and adjust alignment.
	The gate frame improperly installed or warped.	Verify the frame squareness, contact **Aquanox** if the frame is warped.

If there are problems in the operation of a gate and troubleshooting described above offers no solution, contact **Aquanox** (see section 15) and have, if possible, the following information:

- Equipment serial number (indicated on gate slide, or yoke, if any)
- Detailed description of the situation (eg. leakage rate measured on site is considered excessive)
- Photos or videos that can help understand and address the situation

12.1. GATE SETTING

The gate seals were adjusted and tested at the factory and do not require any adjustment after installation. However, the electric actuators need to be field adjusted after the installation. Refer to the electric actuator manual.

13. INSPECTION AND MAINTENANCE

In order to maintain the gates performances at its best, **Aquanox** recommends the following procedure.

13.1. INSPECTION FREQUENCY

Initial inspection: after 25 operation cycles or two weeks after start up, whichever comes first.
Second inspection: 50 cycles after the initial inspection or six months after start up, whichever comes first.
Subsequent inspections: Every 100 operation cycles or every six months, whichever comes first.
If the gate is used intensively or in extreme conditions, perform inspection every three months.
One complete operation cycle corresponds to the opening and closing of the gate.

13.2. GATE MAINTENANCE

Clean the gate with clean water to get rid of any deposit.
Verify whether the guides and seals are in good condition.

13.3. STEM MAINTENANCE

Verify the stem and lift nut thread conditions in order to detect excessive wear.
Open the gate to expose the stem threads.
Thoroughly clean the stem thread using a plastic or stainless steel brush to prevent contamination of the stem. See Appendix 3 for additional information on stainless steel contamination.

Lubricate the stem threads with the proper grease. Refer to Appendix 2 Stem lubrication.
Verify all bolts and fasteners on the stem.

Gate and stem maintenance should be performed at each inspection.

14. WARRANTY

ISE Metal inc. warrants that the series S Slide Gates it manufactures and delivers to the Buyer are free from defects in material, workmanship and fabrication for a period of 60 months from the date of receipt of the equipment at their installation location. To benefit from this warranty, the Buyer shall promptly report in writing any failure during the warranty period. Provided that the buyer has stored, installed, maintained and used the equipment in a workmanlike manner and has complied with the manufacturer's instructions and recommendations put forth in the Installation, Operation and Maintenance Manual, at its discretion, ISE Metal will either correct the defect at its factory or provide the required parts. Shipping costs from the factory to the installation site and/or labor on the equipment installation site are not covered by this warranty. Accessories and equipment supplied by ISE Metal inc. with the gates, but manufactured by others will be protected by the warranty offered to ISE Metal by the manufacturers of the equipment which are transferable to Buyer. ISE Metal inc. will not be held responsible for any direct, indirect, consequential, contingent or incidental damages, repairs, replacements or other fixes and adjustments to the equipment nor any labor costs incurred by the Buyer or its subcontractors or others without the prior written consent of ISE Metal Inc. The effects of corrosion, erosion and normal wear and tear are specifically excluded from this warranty. The Buyer shall not use equipment that is considered defective without first obtaining a written consent of ISE Metal inc., otherwise the Buyer uses the equipment at their own risk and responsibility.

ISE Metal Inc. provides no other warranty or makes no other express or implied representation and any implied warranty of fitness for a particular purpose is declared non-existent.

Corrections by ISE Metal inc. of non-compliance described above constitute complete fulfillment of its responsibility in this manner.

15. CONTACT AQUANOX

If needed, Aquanox can be contacted with the following methods:

Web site: http://www.ISEaquanox.com
Phone: (819) 769-0157 or toll free: 1-855-769-0157
Mailing address: 20 route de Windsor, Sherbrooke (Quebec), Canada, J1C 0E5

APPENDIX 1 CAUTION FOR CHEMICAL ANCHORING

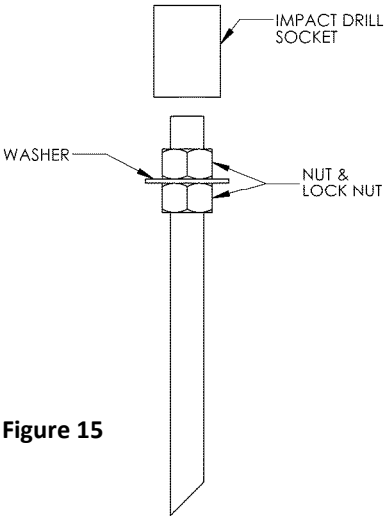


Figure 15

Always ensure compliance with the hole diameters and depths recommended by the manufacturer because the cavity becomes the mixing chamber for the resin/hardener according to the volume of the epoxy bag. A non-compliant hole will result a partial or invalid epoxy curing.
Use an impact wrench when installing the anchor to obtain a homogenous mixture of the two epoxy components. To do so, use a nut, a washer and a lock nut (see Figure 15).
It is very important to stop the impact wrench when the anchor rod reaches the bottom of the hole, because if the rod continues to rotate, the threads will evacuate the epoxy out of the hole. Be sure to wait for the curing time recommended by the manufacturer (proportional to the concrete temperature) before tightening.

Injectable chemical anchor

Always remove the gate before installing the injectable chemical anchors.

Hold the anchor rod centered into the hole and make sure to remove all excess of epoxy around the base of the anchor, because once cured, it will act as a shim and will prevent proper compression of the wall gasket.
Be sure to wait for the curing time recommended by the manufacturer (proportional to the concrete temperature) before tightening.

APPENDIX 2 STEM LUBRICATION

		Type use				
		Standard	Frequent	Frequently submerge	Food industry	Non toxic
Type of grease	Esso Unirex EP2	X				
	Shell Darina XL EP	X				
	Shell SRS 2000	X	X	X		
	Shell FM 2	X			X	X
	Petro-Canada OG-2	X	X	X		
	Petro-Canada Purify-FG	X			X	X
	Prolab OG 700	X	X	X		

* Equivalent greases are also acceptable.

APPENDIX 3 DECONTAMINATION AND PASSIVATION

Contact between stainless steel and carbon steel such as the tooling used during the installation (hammer, wrenches, chain hoist, grinding operation nearby, etc.) may locally contaminate stainless steel creating traces of corrosion. Note that these traces of corrosion are more of an aesthetic nature and generally do not affect the structural integrity of the equipment.

Contamination caused by grinding nearby

Contamination by nails left on the surface

It is possible to remove these traces using a passivation product designed for this purpose on the market. These products are often acid-based, certain precautions must be taken for their use and their possible contact with the sealing system of the gate.

Contact **Aquanox** for more information on this manner.

Fontaine Aquanox
Water Control Gates

SUBMITTAL DRAWINGS

S/O: 1310 **P/O: 160273KK**

Project Name: **Missouri River Correctional Center**

Customer: **Northwestern Power Equipments Co., Inc.**

Date: 2016-08-26
Submittal No.: 1
Revision No.: 0

TABLE OF CONTENT

Item	Ident.	Qty	Model
01	Well #1	1	202-F5X-18x18-B-RMX
02	Wee 12	1	202-F5X-18x18-B-RMX

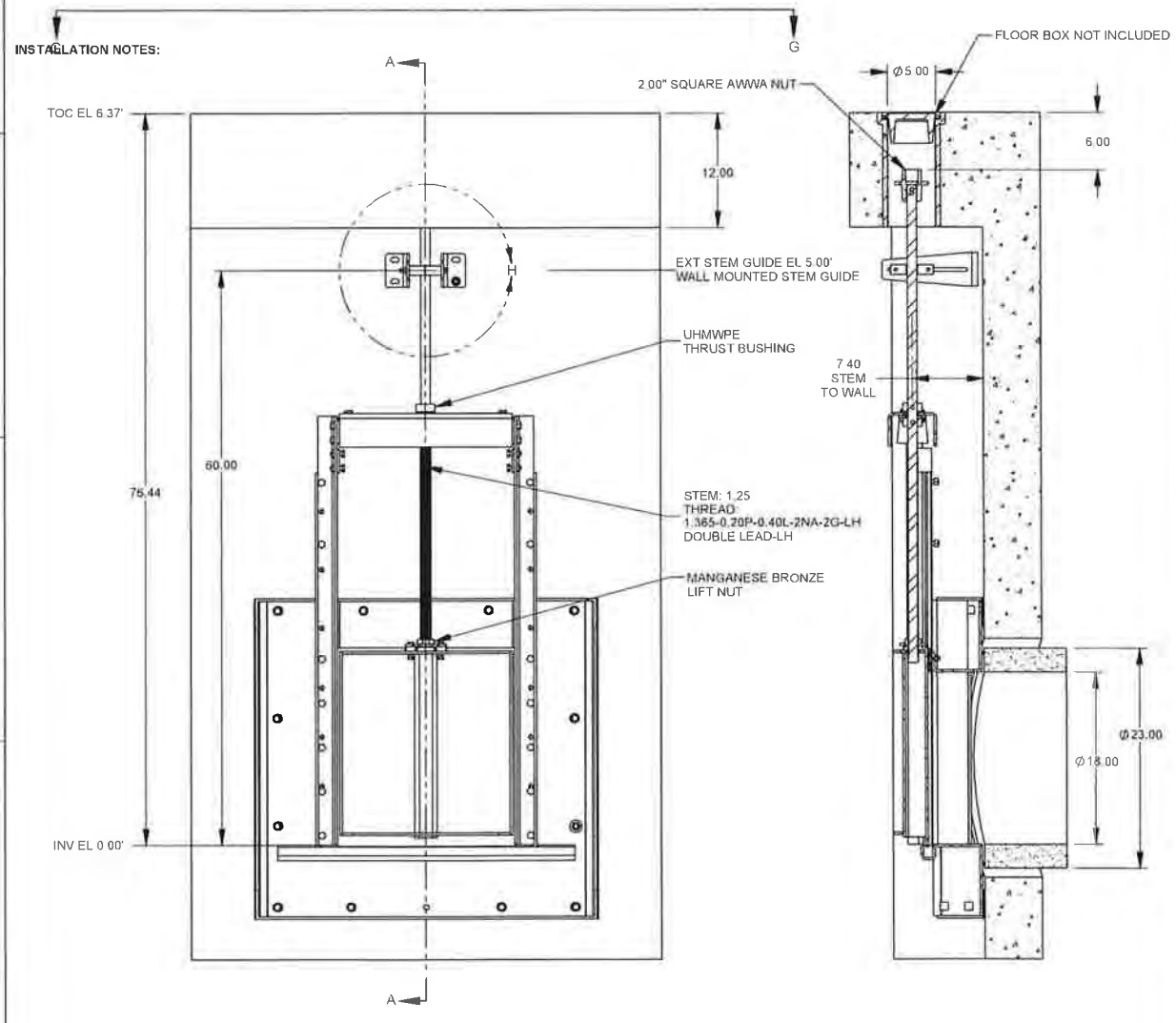
Aquanox Contact: Rosaire St-Laurent
Toll Free: (855) 769-0157 ext 360
rosaire.st-laurent@iseaquanox.com

☒ REVIEWED ☐ FURNISH AS CORRECTED
☐ REJECTED ☐ REVISE AND RESUBMIT
☐ SUBMIT SPECIFIED ITEM

This review is only for general conformance with the design concept of the project and general compliance with the information given in the contract documents. Corrections or comments made on the shop drawings during this review do not relieve contractor from compliance with the requirements of the plans and specifications. Approval of a specific item shall not include approval of an assembly of which the item is a component. Contractor is responsible for: dimensions to be confirmed and correlated at the jobsite; information that pertains solely to the fabrication processes or to the means, methods, techniques, sequences and procedures of construction; coordination of his or her work with that of all other trades; and for performing all work in a safe and satisfactory manner.

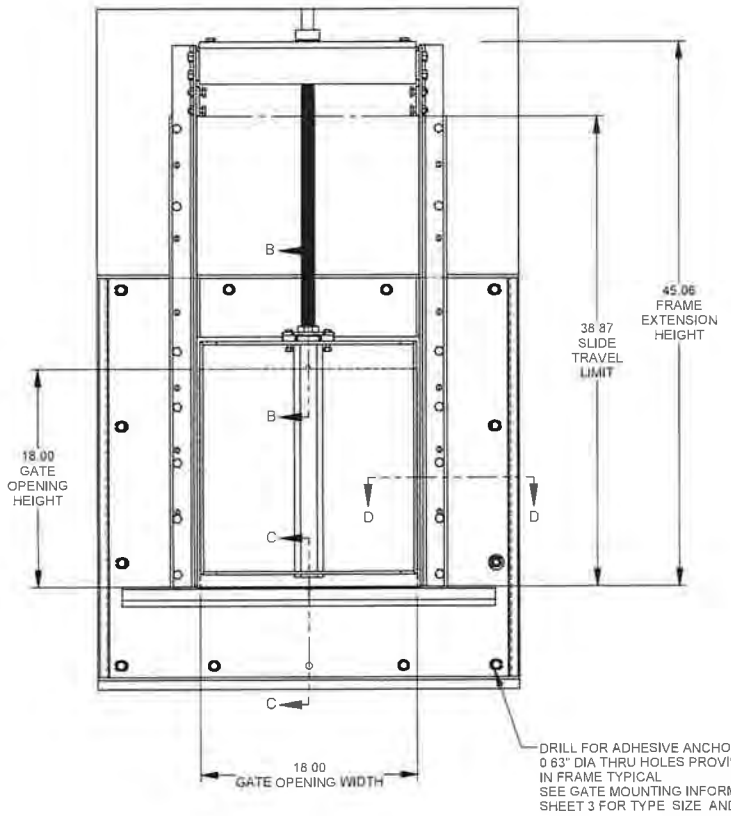
HOUSTON ENGINEERING, INC.
DATE 10/7/16 BY TGJ

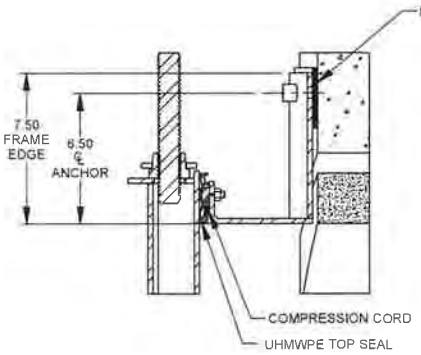
REV	DESCRIPTION	APP	DATE
0	I ISSUED FOR APPROVAL	CB	01/08/2016



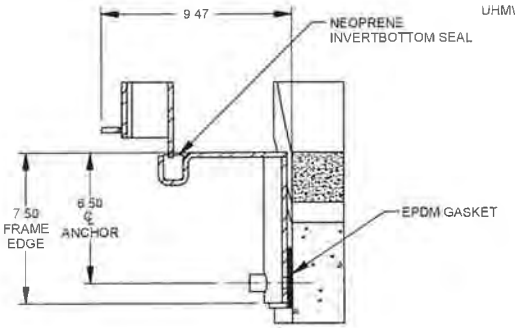
1. ALL DIMENSIONS IN INCHES [mm] UNLESS OTHERWISE NOTED
2. RODNEY HUNT FONTAINE TO SUPPLY ANCHOR BOLT HARDWARE; INSTALLER TO SUPPLY ADHESIVE
3. INSTALL ANCHOR BOLTS PER MANUFACTURERS INSTRUCTIONS
4. SEE GATE MOUNTING INFORMATION TABLE SHEET 3 FOR TYPE, SIZE, AND QUANTITY

CUSTOMER	NORTHWESTERN POWER EQUIPMENT	RODNEY HUNT-FONTAINE		SERIES 20 SLIDE GATE	
PROJECT	Missouri River Correctional Center			INSTALLATION DRAWING	
PROJECT LOCATION	Bismarck, North Dakota		DRAWN BELISLE-C		
GATE LOCATION	Well 1		DATE 01/08/2016	GATE INSTALLATION	
GATE NO.	SG-1	DESIGN HEAD 6 FT	APPROVED BELISLE-C	V202 18 18 B RMX STD AWI ASS	
ORDER NO.	5169999	QUANTITY 1	DATE 01/08/2016	DWG NO 5169999-101-I	REV 0
SPECIFICATION SHEET	Quote:5213-1605-0222-01	ITEM NUMBER 10	MATERIAL SS 304L	SCALE 1:64	ORDER NO 5169999 SHEET 1 OF 3

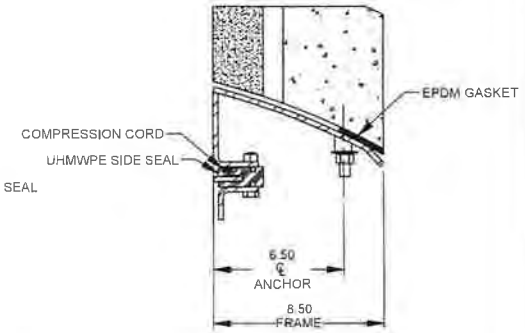




SECTION B-B
SCALE 1 6



SECTION C-C
SCALE 1 6



SECTION D-D
SCALE 1 6

GATE ASSEMBLY NOTES:

1	WALL MOUNTING GASKET	EPDM
2	SIDE SEAL	UHMWPE
3	TOP SEAL	UHMWPE
4	INVERT SEAL	NEOPRENE
5	COMPRESSION CORD	BUNA-N

CUSTOMER	NORTHWESTERN POWER EQUIPMENT		
PROJECT	Missouri River Correctional Center		
PROJECT LOCATION	Bismarck North Dakota		
GATE LOCATION	Well 1		
GATE NO	SG-1	DESIGN HEAD	6 FT
ORDER NO	5169999	QUANTITY	1
SPECIFICATION SHEET	Quote 5213-1606-0222-01	ITEM NUMBER	10

TOLERANCE UNLESS OTHERWISE SPECIFIED

DEC DIM	MACHINE	CAST	FABRICATE
X/XX	±1/8	±1/8	±1/8
X	±0.030	±0.250	±0.250
.XX	±0.015	±0.125	±0.125
.XXX	±0.005	±0.060	±0.060
ANGLE	±1°0'	±2°0	±2°0'

SURFACE ROUGHNESS 250

RODNEY HUNT-FONTAINE

DRAWN	BELISLE-C	
DATE	01/08/2016	
APPROVED	BELISLE-C	
DATE	01/08/2016	
MATERIAL	SS 304L	

SERIES 20 SLIDE GATE

INSTALLATION DRAWING

GATE INSTALLATION

V202 18 18 B RMX STD AWI ASS

DWG NO 5169999-101-I REV 0

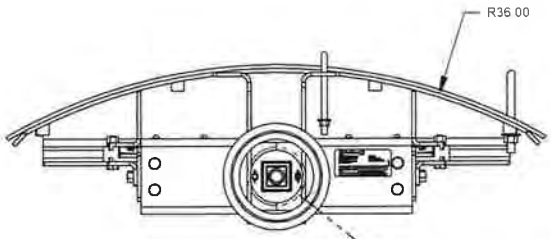
SCALE 1 128 ORDER NO 5169999 SHEET 2 OF 3

GATE MOUNTING INFORMATION

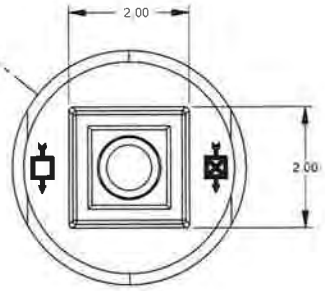
COMPONENT	TYPE	DESCRIPTION	QUANTITY	EMBEDMENT	DRILL HOLE DIA
GATE	ADHESIVE	1/2-13 UNC X 5.50 LG - THREADED STUD SS316 - HILTI-HY 200 ADHESIVE OR EQUAL	14	4 25	0.56
STEM GUIDE	ADHESIVE	3/8-16 UNC X 5.50 LG - THREADED STUD SS316 - HILTI-HY 200 ADHESIVE OR EQUAL	4	4 25	0 44
WALL BRACKET	N/A	N/A	N/A	N/A	N/A
PEDESTAL	N/A	N/A	N/A	N/A	N/A

INSTALLATION NOTES:

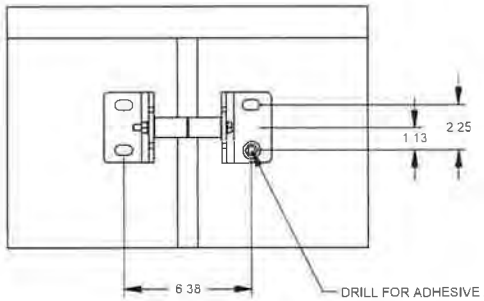
1 RODNEY HUNT FONTAINE TO SUPPLY ANCHOR BOLT HARDWARE INSTALLER TO SUPPLY ADHESIVE
2 INSTALL ANCHOR BOLTS PER MANUFACTURERS INSTRUCTIONS
3 ALL TABLE DIMENSIONS IN INCHES
4 ALL WEIGHTS IN LBS UNLESS OTHERWISE NOTED



SECTION G-G
OPERATING FLOOR PLAN VIEW
SCALE 1 8

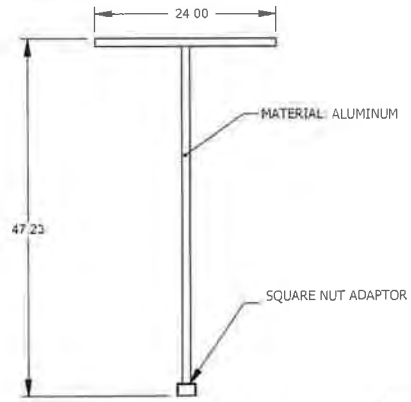


DETAIL E
SCALE 1 2
SQAURE NUT



DRILL FOR ADHESIVE ANCHORS
4X 0 50" DIA THRU HOLES PROVIDED
IN STEM GUIDE TYPICAL
SEE GATE MOUNTING INFORMATION TABLE
SHEET 3 FOR ANCHOR TYPE SIZE AND QUANTITY

DETAIL H
STEM GUIDE MOUNTING DETAIL
SCALE 1 6



T-WRENCH

ITEM	PART NUMBER	PART DESCRIPTION	WEIGHT	QTY
3	5169999-101-0	GATE ASSEMBLY - V202 18 18 B RMX STD AWI ASS	221	1
2	5169999-104-0	ACTUATOR ASSEMBLY -FLOOR BOX AND T-WRENCH	40	1
1	5169999-103-0	STEM ASSEMBLY - V202 18 18 B RMX STD AWI ASS	20	1

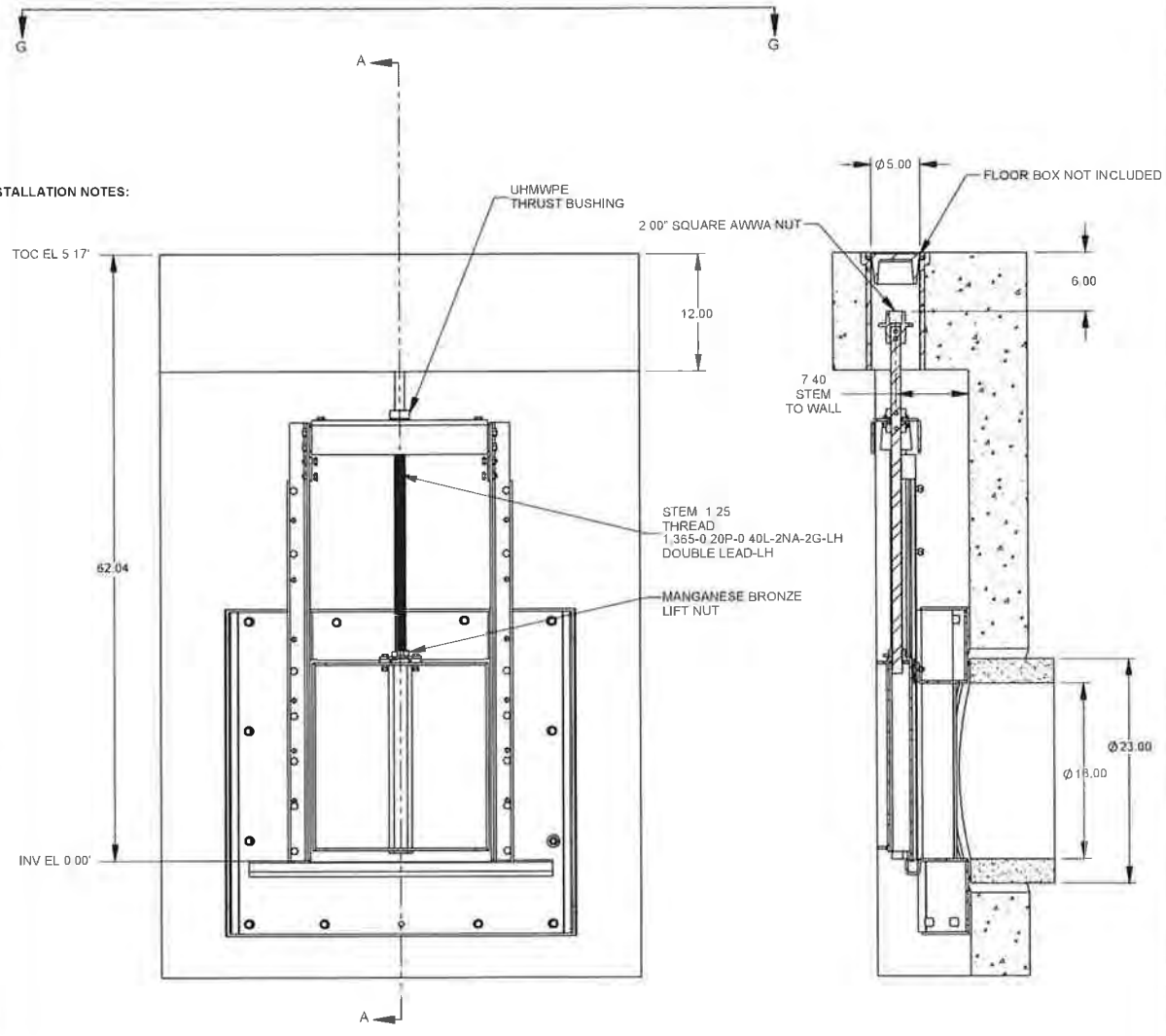
CUSTOMER	NORTHWESTERN POWER EQUIPMENT		
PROJECT	Missouri River Correctional Center		
PROJECT LOCATION	Bismarck North Dakola		
GATE LOCATION	Well 1		
GATE NO	SG-1	DESIGN HEAD	6 FT
ORDER NO	5169999	QUANTITY	1
SPECIFICATION SHEET	Quote 5213-1606-0222-01	ITEM NUMBER	10

TOLERANCE UNLESS OTHERWISE SPECIFIED			
DEC DIM	MACHINE	CAST	FABRICATE
X/XX	±1/8	±1/8	±1/8
X	±0.030	±0.250	±0.250
XX	±0.015	±0.125	±0.125
XXX	±0.005	±0.060	±0.060
ANGLE	±1°0'	±2°0	±2°0'
SURFACE ROUGHNESS		250	

RODNEY HUNT-FONTAINE

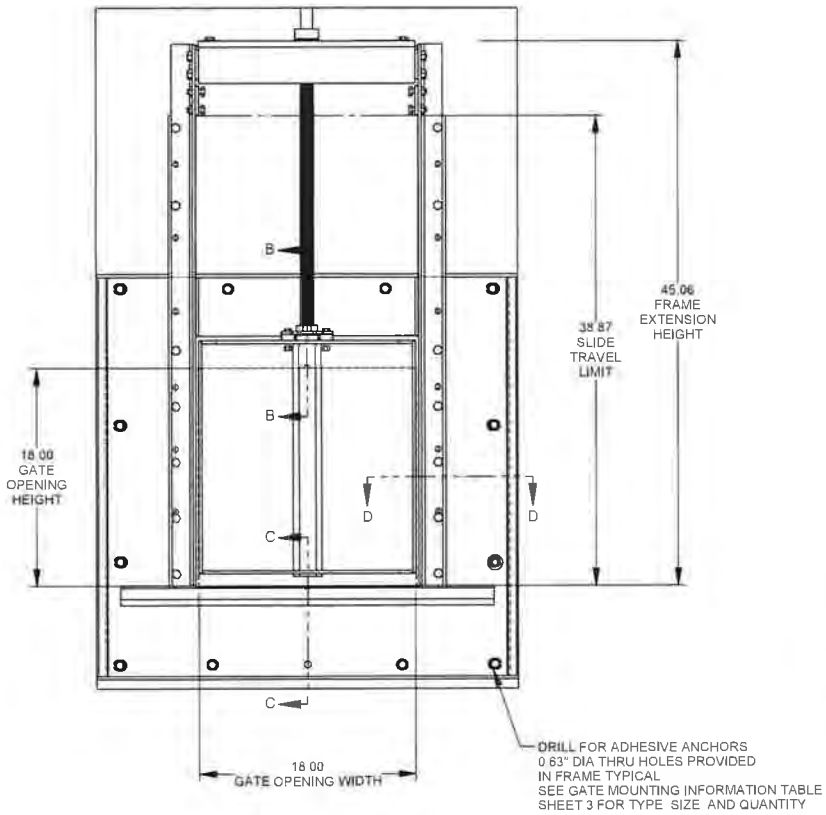
DRAWN	BELISLE-C	**SERIES 20 SLIDE GATE**	
DATE	01/08/2016	INSTALLATION DRAWING	
APPROVED	BELISLE-C	GATE INSTALLATION	
DATE	01/08/2016	V202 18 18 B RMX STD AWI ASS	
MATERIAL	SS 304L	DWG NO 5169999-101-I	REV 0
SCALE	1 128	ORDER NO 5169999	SHEET 3 OF 3

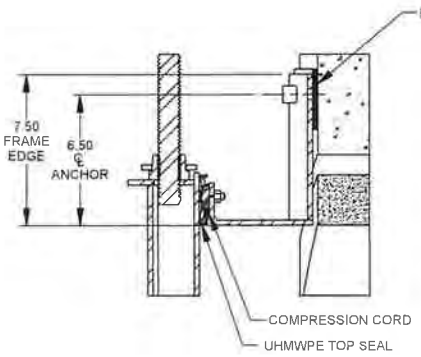
REV	DESCRIPTION	APP	DATE
0	1 ISSUED FOR APPROVAL	CB	01/08/2016



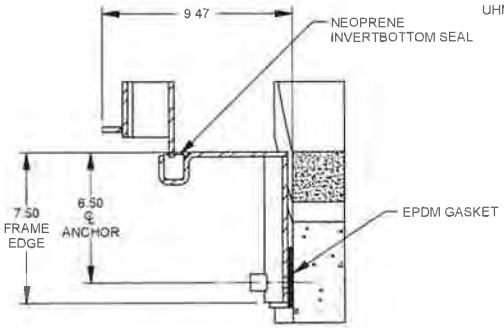
1. ALL DIMENSIONS IN INCHES [mm] UNLESS OTHERWISE NOTED
2. RODNEY HUNT FONTAINE TO SUPPLY ANCHOR BOLT HARDWARE INSTALLER TO SUPPLY ADHESIVE
3. INSTALL ANCHOR BOLTS PER MANUFACTURERS INSTRUCTIONS
4. SEE GATE MOUNTING INFORMATION TABLE SHEET 3 FOR TYPE SIZE, AND QUANTITY

CUSTOMER	NORTHWESTERN POWER EQUIPMENT			RODNEY HUNT-FONTAINE		SERIES 20 SLIDE GATE	
PROJECT	Missouri River Correctional Center					INSTALLATION DRAWING	
PROJECT LOCATION	Bismarck, North Dakota				DRAWN BELISLE-C	GATE INSTALLATION	
GATE LOCATION	Well 2				DATE 01/08/2016		
GATE NO.	SG-2	DESIGN HEAD	5 FT	THIS DRAWING CONTAINS CONFIDENTIAL	APPROVED BELISLE-C	V202 18 18 B RMX STD AWI ASS	
ORDER NO.	5169999	QUANTITY	1		DATE 01/08/2016	DWG NO 5169999-111-I	REV 0
SPECIFICATION SHEET	Quote 5213-1605-0222-01	ITEM NUMBER	11	DRAWING IS EXPRESSLY PROHIBITED	MATERIAL SS 304L	SCALE 1:64	ORDER NO 5169999 SHEET 1 OF 3





SECTION B-B
SCALE 1 6



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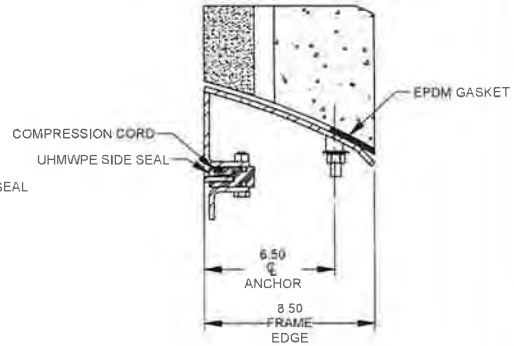
SCALE 1 6



SECTION D-D
SCALE 1 6

GATE ASSEMBLY NOTES:

1	WALL MOUNTING GASKET	EPDM
2	SIDE SEAL	UHMWPE
3	TOP SEAL	UHMWPE
4	INVERT SEAL	NEOPRENE
5	COMPRESSION CORD	BUNA-N

CUSTOMER	NORTHWESTERN POWER EQUIPMENT		
PROJECT	Missouri River Correctional Center		
PROJECT LOCATION	Bismarck North Dakota		
GATE LOCATION	Well 2		
GATE NO	SG-2	DESIGN HEAD	5 FT
ORDER NO	5169999	QUANTITY	1
SPECIFICATION SHEET	Quote 5213-1606-0222-01	ITEM NUMBER	11

TOLERANCE UNLESS OTHERWISE SPECIFIED

DEC DIM	MACHINE	CAST	FABRICATE
X/XX	±1/8	±1/8	±1/8
X	±0.030	±0.250	±0.250
XX	±0.015	±0.125	±0.125
XXX	±0.005	±0.060	±0.060
ANGLE	±1°0	±2°0'	±2°0

SURFACE ROUGHNESS 250

RODNEY HUNT-FONTAINE

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DRAWN	BELISLE-C	
DATE	01/08/2016	
APPROVED	BELISLE-C	
DATE	01/08/2016	
MATERIAL	SS 304L	

SERIES 20 SLIDE GATE

INSTALLATION DRAWING

GATE INSTALLATION

V202 18 18 B RMX STD AWI ASS

DWG NO 5169999-111-I REV 0

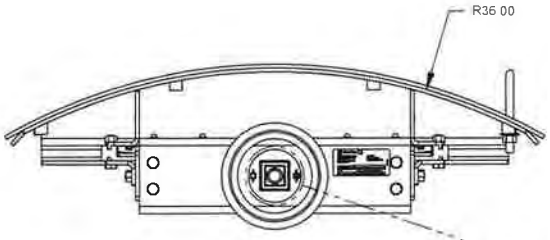
SCALE 1 128 ORDER NO 5169999 SHEET 2 OF 3

GATE MOUNTING INFORMATION

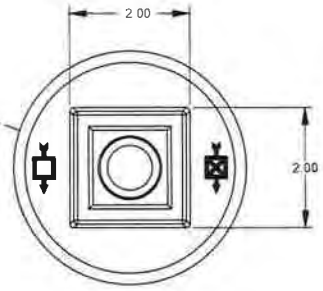
COMPONENT	TYPE	DESCRIPTION	QUANTITY	EMBEDMENT	DRILL HOLE DIA
GATE	ADHESIVE	1/2-13 UNC X 5.50 LG - THREADED STUD SS316 - HILTI-HY 200 ADHESIVE OR EQUAL	14	4.25	0.56
STEM GUIDE	N/A	N/A	N/A	N/A	N/A
WALL BRACKET	N/A	N/A	N/A	N/A	N/A
PEDESTAL	N/A	N/A	N/A	N/A	N/A

INSTALLATION NOTES:

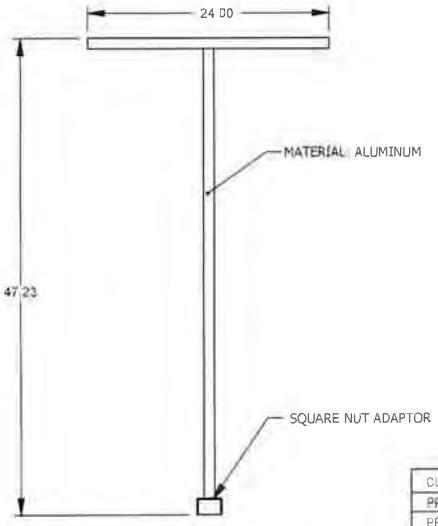
1 RODNEY HUNT FONTAINE TO SUPPLY ANCHOR BOLT HARDWARE INSTALLER TO SUPPLY ADHESIVE
2 INSTALL ANCHOR BOLTS PER MANUFACTURERS INSTRUCTIONS
3 ALL TABLE DIMENSIONS IN INCHES
4 ALL WEIGHTS IN LBS UNLESS OTHERWISE NOTED



SECTION G-G
OPERATING FLOOR PLAN VIEW
SCALE 1 8



DETAIL E
SCALE 1 2
SQUARE NUT



T-WRENCH

ITEM	PART NUMBER	PART DESCRIPTION	WEIGHT	QTY
3	5169999-111-0	GATE ASSEMBLY - V202 18 18 B RMX STD AWI ASS	221	1
2	5169999-114-0	ACTUATOR ASSEMBLY -FLOOR BOX AND T-WRENCH	40	1
1	5169999-113-0	STEM ASSEMBLY - V202 18 18 B RMX STD AWI ASS	10	1

CUSTOMER	NORTHWESTERN POWER EQUIPMENT		
PROJECT	Missouri River Correctional Center		
PROJECT LOCATION	Bismarck North Dakota		
GATE LOCATION	Well 2		
GATE NO	SG-2	DESIGN HEAD	5 FT
ORDER NO	5169999	QUANTITY	1
SPECIFICATION SHEET	Quote 5213-1606-0222-01	ITEM NUMBER	1

TOLERANCE UNLESS OTHERWISE SPECIFIED

DEC. DIM	MACHINE	CAST	FABRICATE
X/XX	±1/8	±1/8	±1/8
X	±0.030	±0.250	±0.250
XX	±0.015	±0.125	±0.125
XXX	±0.005	±0.060	±0.060
ANGLE	±1°0	±2°0'	±2°0

SURFACE ROUGHNESS 250

RODNEY HUNT-FONTAINE

DRAWN	BELISLE-C	
DATE	01/08/2016	
APPROVED	BELISLE-C	
DATE	01/08/2016	
MATERIAL	SS 304L	

SERIES 20 SLIDE GATE

INSTALLATION DRAWING
GATE INSTALLATION
V202 18 18 B RMX STD AWI ASS
DWG NO 5169999-111-I REV 0
SCALE 1 128 ORDER NO 5169999 SHEET 3 OF 3

APPENDIX D

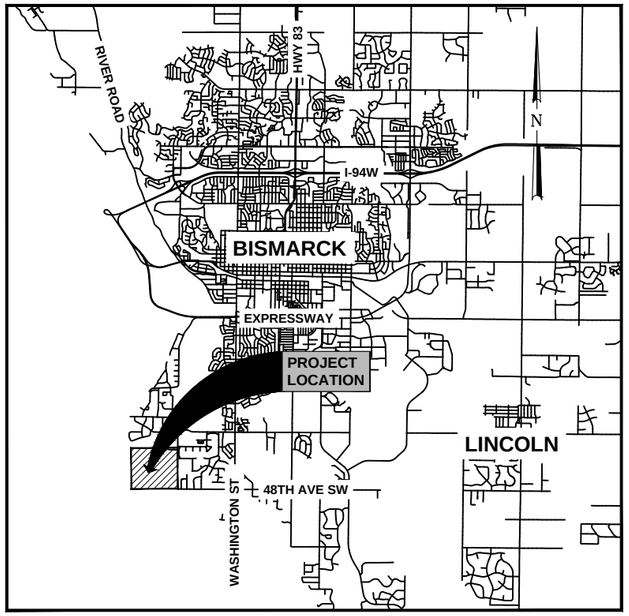
Missouri River Correctional Center Flood Control Project

CONSTRUCTION PLANS FOR

MISSOURI RIVER CORRECTIONAL CENTER FLOOD CONTROL PROJECT

BURLEIGH COUNTY, NORTH DAKOTA

APRIL 2016



VICINITY MAP

LOCATION MAP

ENGINEER'S CERTIFICATE

I, TRAVIS JOHNSON, A REGISTERED PROFESSIONAL ENGINEER IN THE STATE OF NORTH DAKOTA, HEREBY CERTIFY THAT THE CONSTRUCTION PLANS FOR THE MISSOURI RIVER CORRECTIONAL CENTER FLOOD CONTROL PROJECT, BURLEIGH COUNTY, NORTH DAKOTA WERE PREPARED UNDER MY SUPERVISION AND ARE COMPLETE AND CORRECT TO THE BEST OF MY KNOWLEDGE AND BELIEF.

TRAVIS JOHNSON /S/ DATE: 04/26/2016

TRAVIS G. JOHNSON, PE
REGISTERED PROFESSIONAL ENGINEER
NORTH DAKOTA REGISTRATION NO. PE-5746

THIS DOCUMENT WAS ORIGINALLY ISSUED AND SEALED BY TRAVIS G. JOHNSON REGISTRATION NUMBER PE-5746 ON 04/26/2016 AND THE ORIGINAL DOCUMENT IS STORED AT HOUSTON ENGINEERING INC. 3712 LOCKPORT ST BISMARCK, ND 58503

SHEET INDEX

UTILITY NOTE:

THE UNDERGROUND UTILITIES SHOWN HAVE BEEN LOCATED FROM FIELD SURVEY INFORMATION, AS-BUILT MAPS AS PROVIDED BY MUNICIPALITIES OR UTILITY COMPANIES, AND/OR EXISTING DRAWINGS. THERE IS NO GUARANTEE THAT THE UNDERGROUND UTILITIES SHOWN INDICATE ALL SUCH UTILITIES IN THE AREA, EITHER IN SERVICE OR ABANDONED. NOR IS THERE A GUARANTEE THAT THE UNDERGROUND UTILITIES SHOWN ARE IN THE EXACT LOCATION INDICATED. THE CONTRACTOR SHALL DETERMINE THE EXACT LOCATION OF ALL EXISTING UTILITIES. THE CONTRACTOR AGREES TO BE FULLY RESPONSIBLE FOR ANY AND ALL DAMAGES WHICH MAY RESULT FROM THEIR FAILURE TO EXACTLY LOCATE AND PRESERVE ANY AND ALL UTILITIES.

GOVERNING STANDARDS:

MANUAL FOR UNIFORM TRAFFIC CONTROL DEVICES (MUTCD), 2009 EDITION. THIS SPECIFICATION INCLUDES THE SHAPES, COLORS, AND FONTS USED IN ROAD MARKINGS AND SIGNS. ALL TRAFFIC CONTROL DEVICES MUST CONFORM TO THESE STANDARDS.

PREPARED BY: Houston Engineering Inc. *BISMARCK, NORTH DAKOTA*

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RECORD DRAWING:10-24-17

HEI PROJECT NO. 6025-012

H:\Bismarck\JBN\6025 Burleigh Co. WRD\6025-012 MRCC Flood Control\CAD\Plans\COVER SHEET.dwg-1-10/24/2017 4:03 PM-(tpaul)

CONSTRUCTION NOTES

1. THE TOPSOIL IN ALL AREAS TO BE DISTURBED SHALL BE STRIPPED, STOCKPILED, AND RESPREAD. THE TOPSOIL SHALL BE PLACED AT A MINIMUM DEPTH OF 4 INCHES APPLIED TO THE ROADWAY SIDESLOPES AND ANY DISTURBED AREAS. ALL WORK AS DESCRIBED ABOVE SHALL BE PAID FOR BY THE UNIT PRICE BID FOR "TOPSOILING".
2. GRADE AND SHAPE AS NECESSARY USING EXCAVATION MATERIAL FIRST. BORROW MATERIAL SHALL BE PLACED SECOND AND ONLY AFTER EXCAVATION MATERIAL IS USED UP. SOIL MUST BE FREE FROM MASSES OF ORGANIC MATTER, STICKS, BRANCHES, ROOTS, AND OTHER DEBRIS, INCLUDING HAZARDOUS AND REGULATED SOLID WASTES.
3. AGGREGATE SURFACE SHALL BE CONSTRUCTED TO PLAN IN ACCORDANCE WITH CITY OF BISMARCK SPECIFICATION SECTION 302. AGGREGATE GRADATION TESTING IS AT THE DISCRETION OF THE FIELD ENGINEER. COST OF OBTAINING, HAULING, AND CONSTRUCTING AGGREGATE SHALL BE PAID FOR BY THE UNIT PRICE BID FOR "CLASS 13 AGGREGATE SURFACE".
4. HYDRO MULCHING SHALL BE PLACED WITHIN 24 HOURS AFTER THE SEEDING HAS BEEN COMPLETED. HYDRO MULCHING SHALL BE APPLIED UNIFORMLY OVER THE SEEDED AREAS AT A RATE OF 2 TONS PER ACRE.
5. WATER FOR COMPACTION & DUST CONTROL SHALL BE OBTAINED FROM AN APPROVED SOURCE AND THE CONTRACTOR SHALL OBTAIN ALL NECESSARY PERMITS.
6. THE CONTRACTOR SHALL KEEP ALL STOCKPILES AND CONSTRUCTION EQUIPMENT WITHIN THE DESIGNATED CONSTRUCTION LIMITS. NO PERMISSION HAS BEEN GRANTED FROM ANY ADJACENT LANDOWNERS. THE CONTRACTOR SHALL NOTIFY THE ENGINEER OF ANY AGREEMENT WITH ADJACENT LANDOWNERS ASSOCIATED WITH CONSTRUCTION ACTIVITIES.
7. THE CONTRACTOR IS COMPLETELY RESPONSIBLE FOR ALL PROJECT SITE SAFETY.
8. ALL BENCHMARKS SHOWN IN ARE NAVD 88.
9. CONSTRUCTION STAKING WILL BE SUPPLIED BY THE OWNER. THE CONTRACTOR SHALL PROTECT AND PRESERVE ALL SURVEY STAKES AND MONUMENTS. STAKES OR MONUMENTS DAMAGED BY THE CONTRACTOR SHALL BE REPLACED AT THE CONTRACTOR'S EXPENSE BY THE OWNER'S SURVEYOR.
10. THIS PROJECT SHALL BE COVERED UNDER A STATE OF NORTH DAKOTA, NATIONAL POLLUTION DISCHARGE ELIMINATION SYSTEM (NPDES) STORMWATER DISCHARGE PERMIT. THE CONTRACTOR WILL BE THE ORIGINATOR AND SIGNER OF THIS PERMIT AND BE RESPONSIBLE FOR CONTROLLING EROSION AND SEDIMENT RUNOFF FROM THE PROJECT. THE CONTRACTOR SHALL SUBMIT A STORM WATER POLLUTION PREVENTION PLAN (SWPPP) TO THE ENGINEER FOR REVIEW PRIOR TO COMMENCING ANY WORK ON THE PROJECT SITE.
11. CONTRACTOR SHALL PLACE EROSION CONTROL AS SHOWN ON THE PLANS, AS REQUIRED BY NPDES PERMIT, AND AS DIRECTED BY THE ENGINEER.
12. THE CONTRACTOR SHALL NOTIFY SURVEYOR 72 HOURS IN ADVANCE FOR SURVEY REQUESTS..
13. LOCATE AND PROTECT ALL EXISTING UTILITIES.
14. THE CONTRACTOR SHALL BE RESPONSIBLE FOR THE CITY OF BISMARCK EXCAVATION PERMITS AND ALL ASSOCIATED COSTS.
15. ALL SITE CONSTRUCTION INCLUDING COMPACTION TESTING MUST CONFORM TO THE MOST RECENT EDITION OF THE CITY OF BISMARCK CONSTRUCTION SPECIFICATIONS FOR MUNICIPAL PUBLIC WORKS IMPROVEMENTS EXCEPT AS AMENDED BY CONSTRUCTION NOTES. THE CONTRACTOR SHALL BE RESPONSIBLE FOR COORDINATING TESTING. THE OWNER AND ENGINEER SHALL BE SUPPLIED WITH COPIES OF ALL TEST REPORTS.
16. LOT DIMENSIONS SHOWN ARE PER PLAT. FIELD DIMENSIONS VARY FROM THE DIMENSIONS AND BEARINGS SHOWN.
17. A PORTION OF THE PROJECT AREA IS WITHIN A RECORDED FLOOD PLAIN.
18. A COMPACTION FACTOR OF 25% HAS BEEN ADDED TO ALL FILL MATERIAL.
19. THE COST OF CUTTING AND REMOVAL OF EXISTING ASPHALT PAVEMENT SHALL BE INCLUDED IN THE UNIT PRICE BID FOR "REMOVE ASPHALT".

ESTIMATED QUANTITIES

Item No.	Description	Unit	QUANTITY
1	CLEARING AND GRUBBING	LS	1
2	TREE REMOVAL 12" TO 24"	EA	75
3	TREE REMOVAL OVER 24"	EA	30
4	WATER	M GAL	50
5	UNCLASSIFIED EXCAVATION	CY	9,357
6	BORROW EXCAVATION	CY	53,390
7	SUBGRADE PREPARATION	SY	13,480
8	STRAW WATTLES,12 INCH DIAMETER	LF	6,465
9	CLASS 5 AGGREGATE BASE	TON	2,336
10	CLASS 13 AGGREGATE SURFACE	TON	3,114
11	AC STABILIZED BASE (CLASS A)	TON	831
12	AC SURFACE COURSE (CLASS A)	TON	831
13	ASPHALT CEMENT	GAL	23,800
14	BITUMINOUS TACK COAT	GAL	747
15	18" STORM SEWER PIPE	LF	340
16	18" FLARED END SECTION	EA	8
17	TOPSOILING	CY	11,839
18	SEEDING CLASS II	AC	14.68
19	REMOVE AND RESET SIGN	EA	21
20	REMOVE ASPHALT	SY	911
21	REMOVE AGGREGATE SURFACING	SY	14,599
22	REMOVE PIPE ALL TYPES AND SIZES	LF	149
23	REMOVE AND RESET FENCE	LF	239
24	CONTRACT BOND	L SUM	1
25	MOBILIZATION	L SUM	1
26	TEMPORARY ACCESS	L SUM	1
27	8" TOE DRAIN	LF	2,864
28	4" CLEANOUT	EA	6
29	TOE DRAIN PUMP BASIN	EA	2
30	GATE WELL CONTROL STRUCTURE	EA	2

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RECORD DRAWING:10-24-17

LEGEND

	EXISTING	NEW
WATER MAIN	W	W
SANITARY SEWER MAIN	SS	SS
SANITARY SEWER FORCE	SS F	SS F
STORM SEWER MAIN	STS	STS
STORM INLET		
MANHOLE		
CLEANOUT		
FIRE HYDRANT		
GATE VALVE		
CURBSTOP		
UTILITY POLE		
W / GUY WIRE		
LIGHT POLE		
TELEPHONE RISER		
ELECTRICAL PLUG IN		
OVERHEAD POWER	P	
UNDERGROUND ELECTRIC	UGE	
UNDERGROUND TELEPHONE	UGT	
UNDERGROUND FIBER OPTIC	FO	
CABLE TV	CTV	
GAS MAIN	GAS GAS	GAS GAS
CONIFEROUS TREE		
DECIDUOUS TREE		
SHRUB		
HEDGE		
SIGN		
FENCE	X X	X X
RAILROAD TRACKS		
SPOT ELEVATION	x897.165	898.55TC 898.05G
STANDARD CURB & GUTTER		
MOUNTABLE CURB & GUTTER		
CURB & INVERTED GUTTER		
BUILDING		
NEW ASPHALT		
NEW CONCRETE		
THICKENED EDGE SIDEWALK		
RIGHT OF WAY LINE	R/W	
DIRECTION OF DRAINAGE		
DRAINAGE DIRECTION		
IRON MONUMENT FOUND		
IRON MONUMENT SET		
CHISELED MARK ON CONCRETE		
PK NAIL		
SOIL BORING		

SITE PLAN CONSTRUCTION NOTES

1. ALL CONSTRUCTION MUST CONFORM TO THE MOST RECENT EDITION OF THE CITY OF BISMARCK CONSTRUCTION SPECIFICATIONS FOR MUNICIPAL PUBLIC WORKS IMPROVEMENTS AS WELL AS STATE COUNTY AND FEDERAL REQUIREMENTS. COORDINATE WITH CITY STAFF REGARDING CITY UTILITIES.
2. ALL PERMITS NECESSARY FOR THE WORK OF THE CIVIL PLANS SHALL BE PAID AND OBTAINED BY THE CONTRACTOR. THE OWNER WILL PAY SURVEYING AND MATERIALS TESTING DIRECTLY. ANY RETESTS DUE TO FAILING TESTS SHALL BE PAID FOR BY THE CONTRACTOR. THE OWNER RESERVES THE RIGHT TO INCREASE OR DECREASE THE FREQUENCY OF TESTING BEYOND SPECIFIED.
3. PLACE TYPE 3 BARRICADE WHERE INDICATED. BARRICADES SHALL BE LEFT IN PLACE AT THE END OF THE PROJECT. ALL TEMPORARY CONSTRUCTION SIGNAGE AND TRAFFIC CONTROL SHALL BE CONSIDERED INCIDENTAL.
4. EARTHWORK QUANTITIES REPRESENT TOTALS FOR THE ENTIRE SITE.

BASIS OF ESTIMATE

EARTHWORK
CUT = 9,357
FILL = 53,390
(EARTH WORK QUANTITIES FOR LEVEE CONSTRUCTION WERE CALCULATED ASSUMING 6" OF TOPSOIL REMOVAL.)

TOPSOIL, SEEDING AND MULCHING
DISTURBED AREAS WITHIN CONSTRUCTION LIMITS

AC STABILIZED BASE & AC SURFACE COURSE
2.0 TON/CY

ASPHALT CEMENT
6.0% OF HBP

ASPHALT CEMENT
232.26 GAL/TON

BITUMINOUS TACK COAT
0.05 GAL/SY

RIPRAP-TYPE VL
1.7 TON/CY

ABBREVIATIONS

ABAN	ABANDON
ABND	ABANDONED
BC	BEGIN CURVE
BCR	BEGIN CURB RETURN
BLDG	BUILDING
BLKG	BLOCKING
BM	BENCH MARK
BNSF	BURLINGTON NORTHERN SANTA FE
BVC	BEGIN VERTICAL CURVE
C&G	CURB AND GUTTER
CATV	CABLE TELEVISION
CI	CAST IRON
CIP	CAST IRON PIPE / CAST IN PLACE
CIPP	CAST IN PLACE PIPE
CJ	CONSTRUCTION JOINT
CLSM	CONTROLLED LOW STRENGTH MATERIAL
CMP	CORRUGATED METAL PIPE
CMU	CONCRETE MASONRY UNIT
CO	CLEANOUT
CONC	CONCRETE
COORD	COORDINATE
COR	CORNER
COTG	CLEANOUT TO GRADE
CP	CANADIAN PACIFIC
CPLG	COUPLING
CPVC	CHLORINATED POLYVINYL CHLORIDE
CSP	CORRUGATED STEEL PIPE
CU	COPPER
CULV	CULVERT
CV	CHECK VALVE
DI	DUCTILE IRON
DIP	DUCTILE IRON PIPE
DMH	DROP MANHOLE
DWLS	DOWELS
DWY	DRIVEWAY
EA	EACH
EC	END CURVE
ECC	ECCENTRIC
ECR	END CURB RETURN
EG	EXISTING GRADE
EL	ELEVATION
ELEC	ELECTRICAL
ENCL	ENCLOSURE
ENT	ENTRANCE
EP	EDGE OF PAVEMENT
EPT	ETHYLENE PROPYLENE
ESMT	EASEMENT
EX	EXISTING
FD	FEEDER
FF	FINISHED FLOOR
FG	FINISHED GRADE
FH	FIRE HYDRANT
FL	FLOWLINE
FLR	FLOOR
G	GAS
GB	GRADE BREAK
GI	GALVANIZED IRON
GIP	GALVANIZED IRON PIPE
GM	GAS METER
GV	GATE VALVE
HBP	HOT BITUMINOUS PAVEMENT
HGL	HYDRAULIC GRADE LINE
HWL	HIGH WATER LEVEL
HYD	HYDRAULIC / HYDRANT
INV	INVERT
MCR	MIDDLE OF CURB RETURN
MH	MANHOLE
MON	MONUMENT
NPS	NOMINAL PIPE SIZE
PC	POINT OF CURVATURE
PI	POINT OF INTERSECTION
PNL	PANEL
POB	POINT OF BEGINNING
POC	POINT OF CONNECTION
POT	POINT OF TANGENT
PRC	POINT OF REVERSE CURVE
PT	POINT OF TANGENCY
PTFE	POLYTETRAFLUOROETHYLENE (TEFLON)
R	RADIUS
R/W	RIGHT OF WAY
RC	REINFORCED CONCRETE
RCP	REINFORCED CONCRETE PIPE
RED	REDUCER
REV	REVISION
RR	RAILROAD
STC	SLEEVE-TYPE COUPLING
SW	SIDEWALK
SWD	SIDEWALK DRAIN

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No.	Revision	Date	By

Houston Engineering Inc.
Bismarck
P: 701.323.0200
F: 701.323.0300

Drawn by AV | Date 11-3-15 | Checked by TGJ | Scale AS SHOWN

MRCC FLOOD CONTROL PROJECT
BURLEIGH COUNTY WATER RESOURCE DISTRICT
BURLEIGH COUNTY, NORTH DAKOTA

NOTES, QUANTITIES, SYMBOLS & ABBREVIATIONS
PROJECT NO. 6025-012

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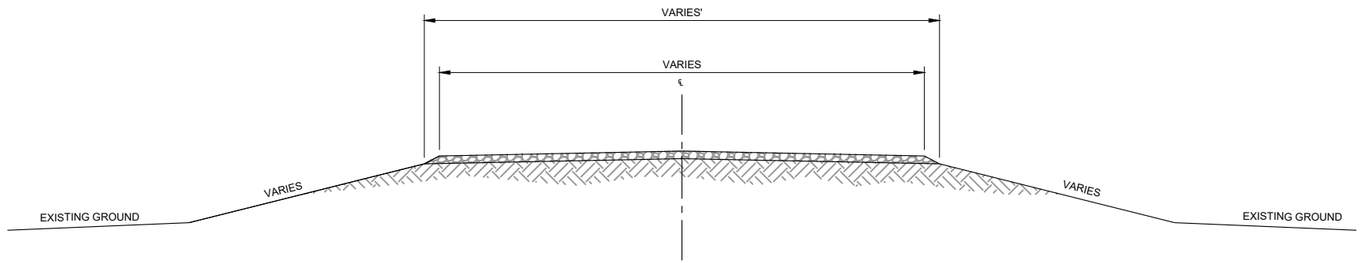
MRCC FLOOD CONTROL PROJECT
BURLEIGH COUNTY WATER RESOURCE DISTRICT
BURLEIGH COUNTY, NORTH DAKOTA

OVERVIEW

PROJECT NO. 6025-012

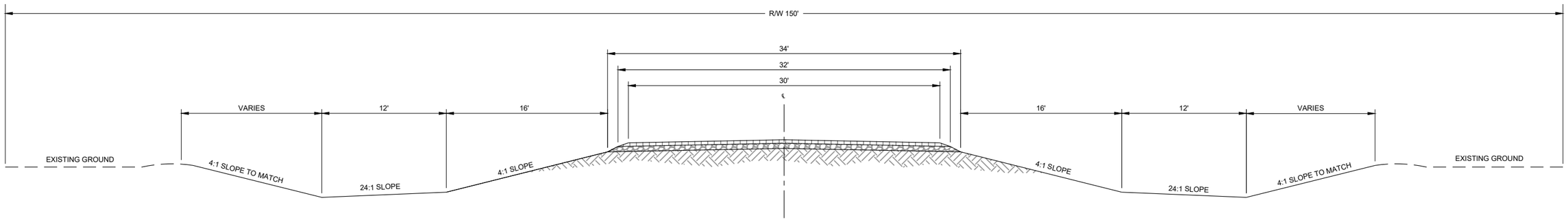
SHEET 3 of 51

H:\Bismarck\BN\6025 Burleigh Co. WRD\6025-012 MRCC Flood Control\CAD\Plans\Overview.dwg-Overview-10/24/2017 4:04 PM-(paul)



EXISTING TYPICAL ROADWAY SECTION - MRCC ACCESS ROAD

NOT TO SCALE



EXISTING TYPICAL ROADWAY SECTION - 48TH AVENUE SW STA 51+34 - 52+83

NOT TO SCALE

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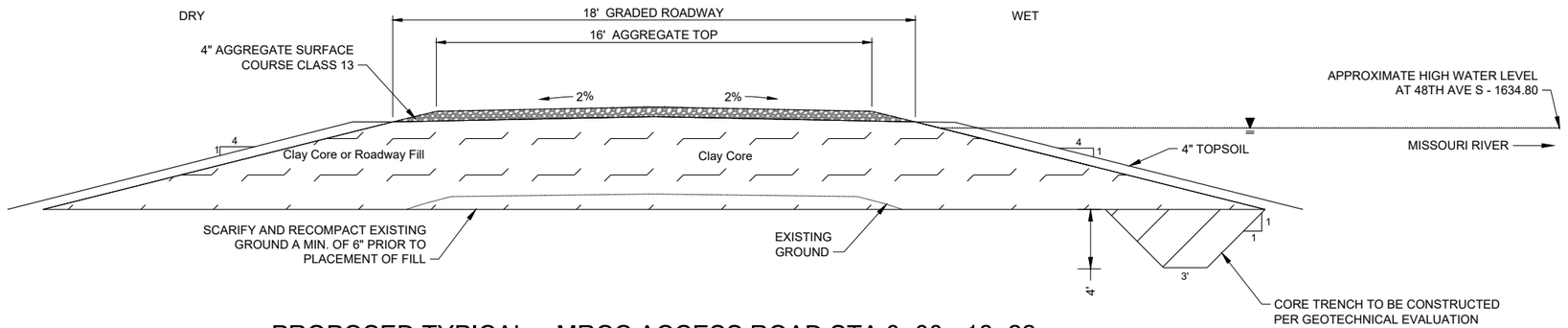
MRCC FLOOD CONTROL PROJECT
BURLEIGH COUNTY WATER RESOURCE DISTRICT
BURLEIGH COUNTY, NORTH DAKOTA

EXISTING TYPICAL SECTION

PROJECT NO. 6025-012

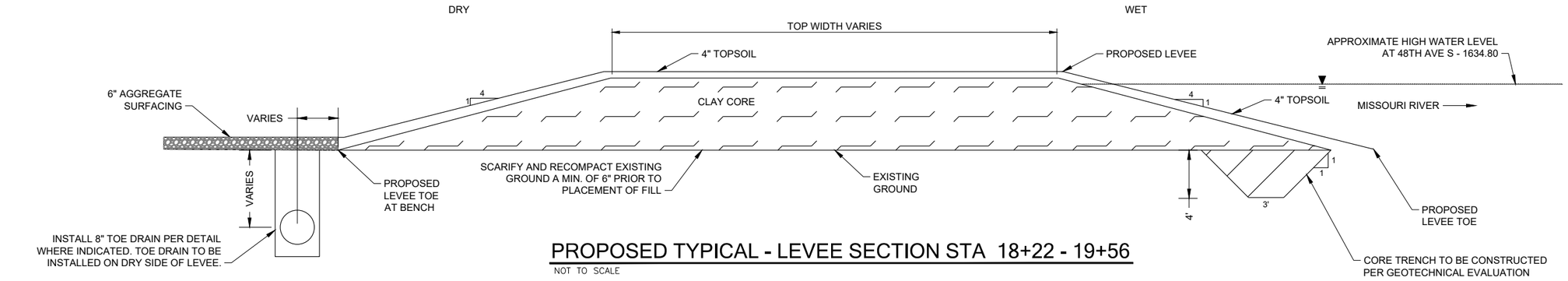
SHEET 4 of 51



NOTES:
ALL AREAS INSIDE R/W LIMITS THAT ARE NOT GRAVEL OR PAVED ARE TO BE SEEDED. (UNLESS OTHERWISE NOTED) R/W LIMITS TO BE STAKED IN FIELD.

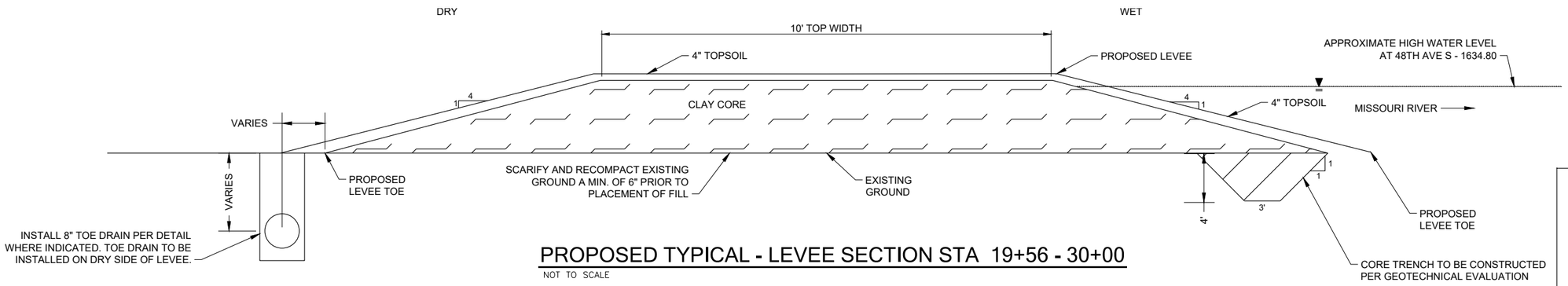
PROPOSED TYPICAL - MRCC ACCESS ROAD STA 0+00 - 18+22

NOT TO SCALE



PROPOSED TYPICAL - LEVEE SECTION STA 18+22 - 19+56

NOT TO SCALE



PROPOSED TYPICAL - LEVEE SECTION STA 19+56 - 30+00

NOT TO SCALE

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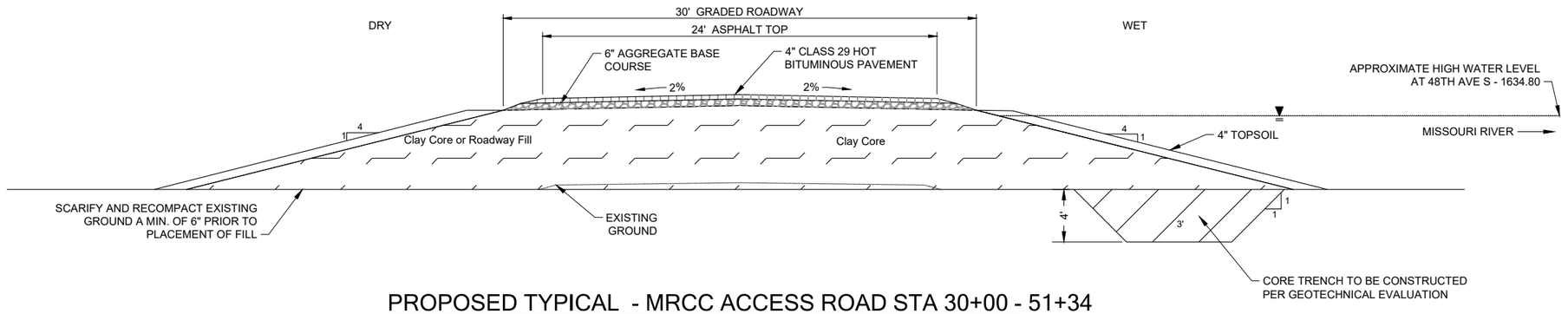
TGJ	AS SHOWN

MRCC FLOOD CONTROL PROJECT
BURLEIGH COUNTY WATER RESOURCE DISTRICT
BURLEIGH COUNTY, NORTH DAKOTA

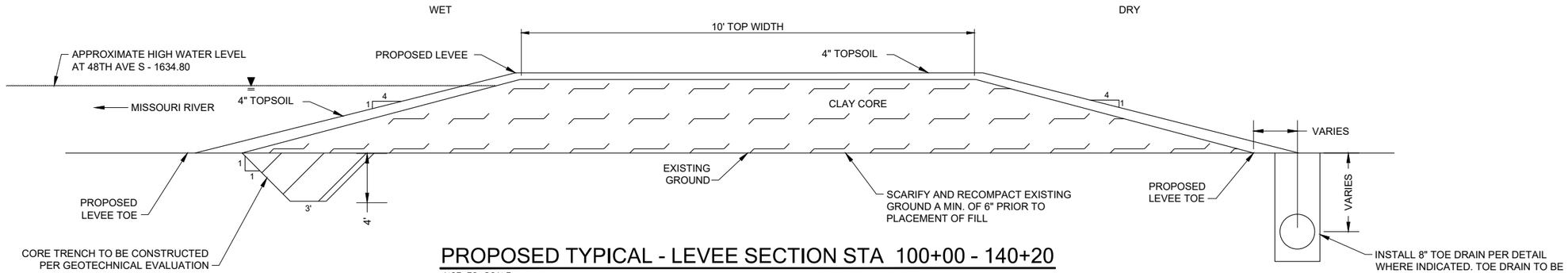
PROPOSED TYPICAL SECTION
PROJECT NO. 6025-012

SHEET 5 of 51



PROPOSED TYPICAL - MRCC ACCESS ROAD STA 30+00 - 51+34

NOT TO SCALE



PROPOSED TYPICAL - LEVEE SECTION STA 100+00 - 140+20

NOT TO SCALE

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Bismarck
P: 701.323.0200
F: 701.323.0300

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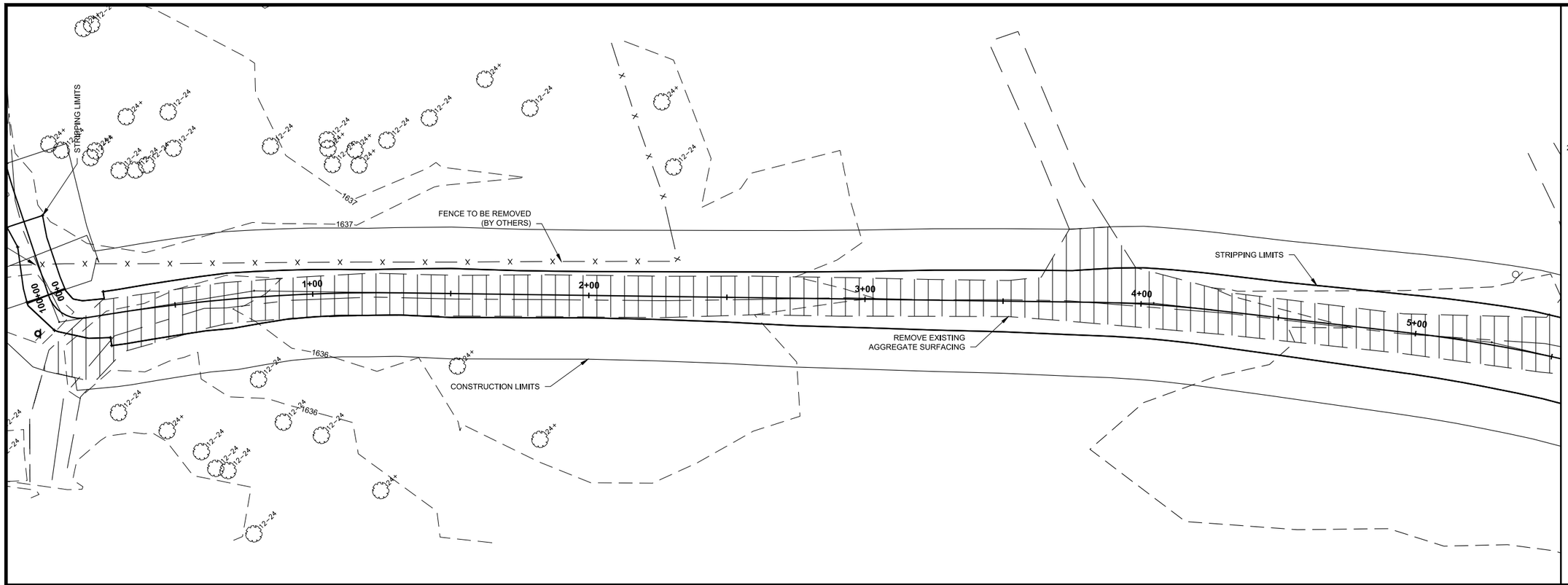
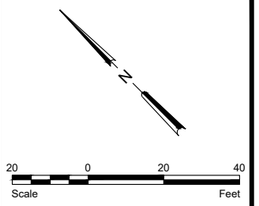
AV	11-3-15
Checked by	Scale
TGJ	AS SHOWN

MRCC FLOOD CONTROL PROJECT
BURLEIGH COUNTY WATER RESOURCE DISTRICT
BURLEIGH COUNTY, NORTH DAKOTA

PROPOSED TYPICAL SECTION
PROJECT NO. 6025-012





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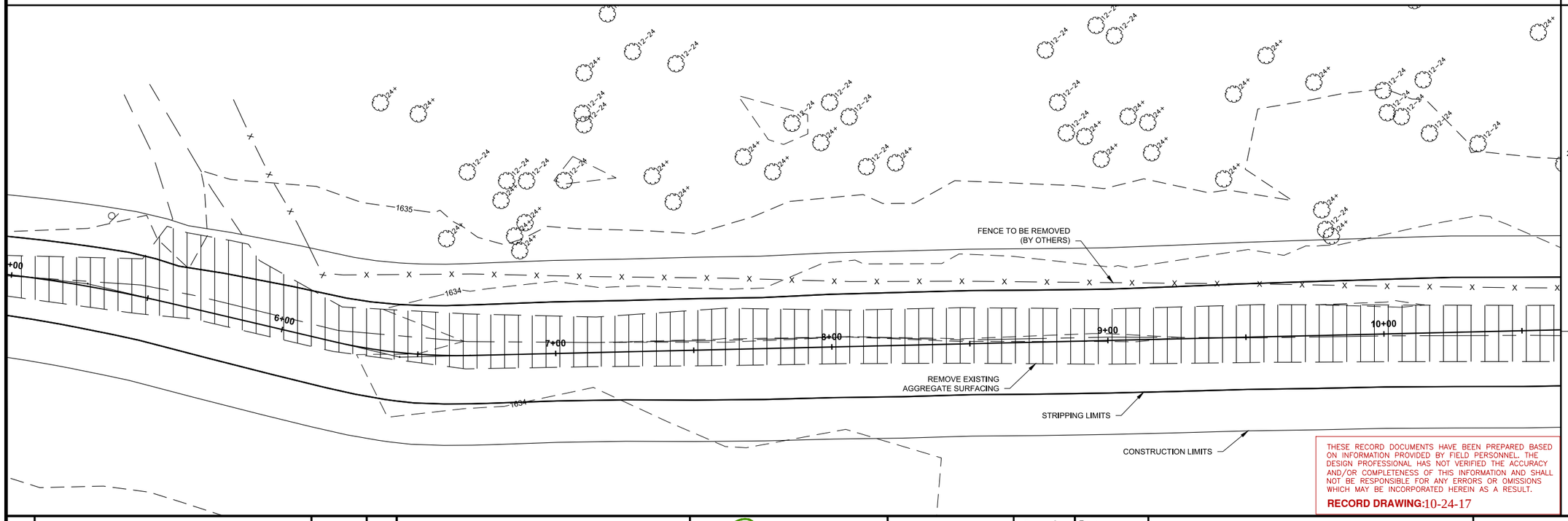
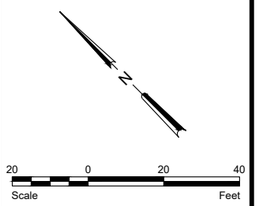
GRAVEL REMOVAL

ASPHALT REMOVAL





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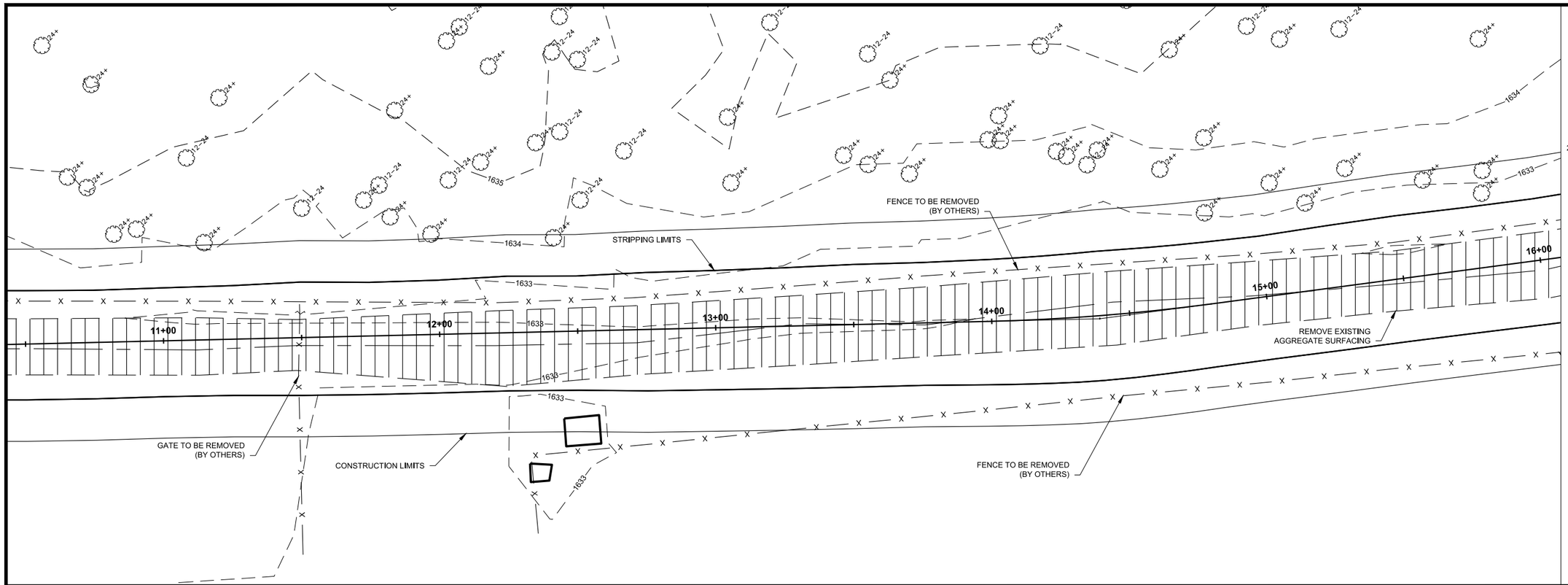
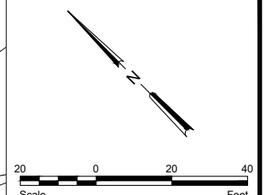
MRCC FLOOD CONTROL PROJECT
BURLEIGH COUNTY WATER RESOURCE DISTRICT
BURLEIGH COUNTY, NORTH DAKOTA

REMOVALS

PROJECT NO. 6025-012

SHEET 7 of 51





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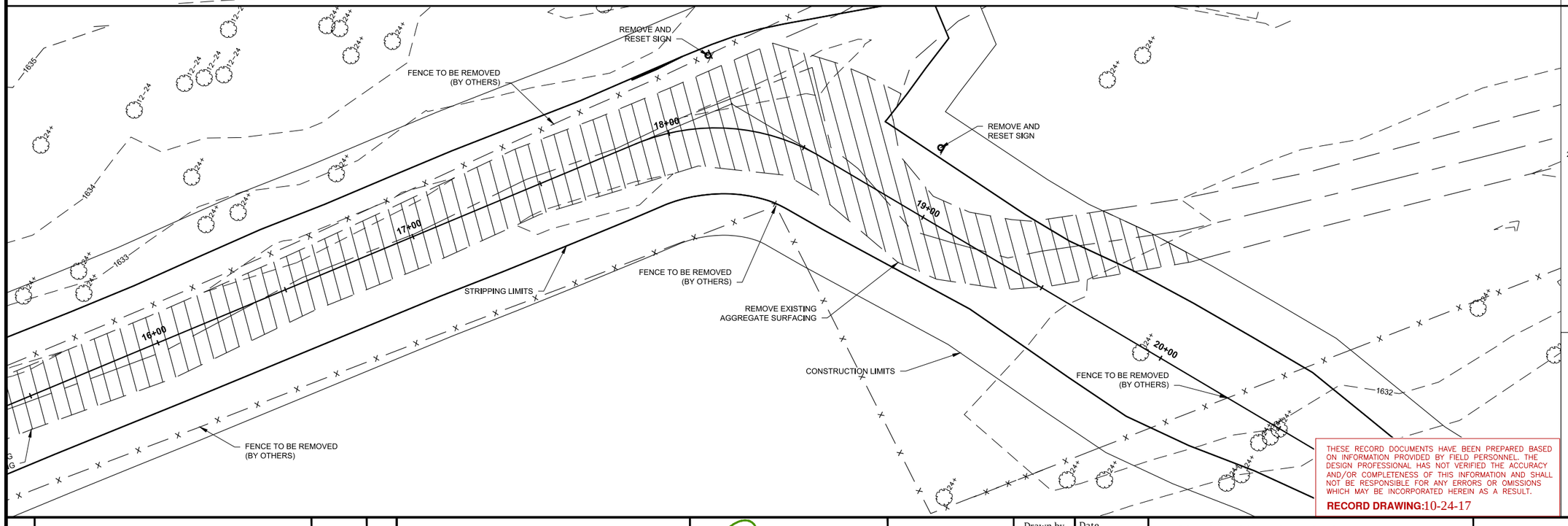
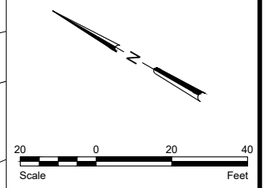
GRAVEL REMOVAL

ASPHALT REMOVAL





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MRCC FLOOD CONTROL PROJECT
BURLEIGH COUNTY WATER RESOURCE DISTRICT
BURLEIGH COUNTY, NORTH DAKOTA

REMOVALS

PROJECT NO. 6025-012

SHEET 8 of 51

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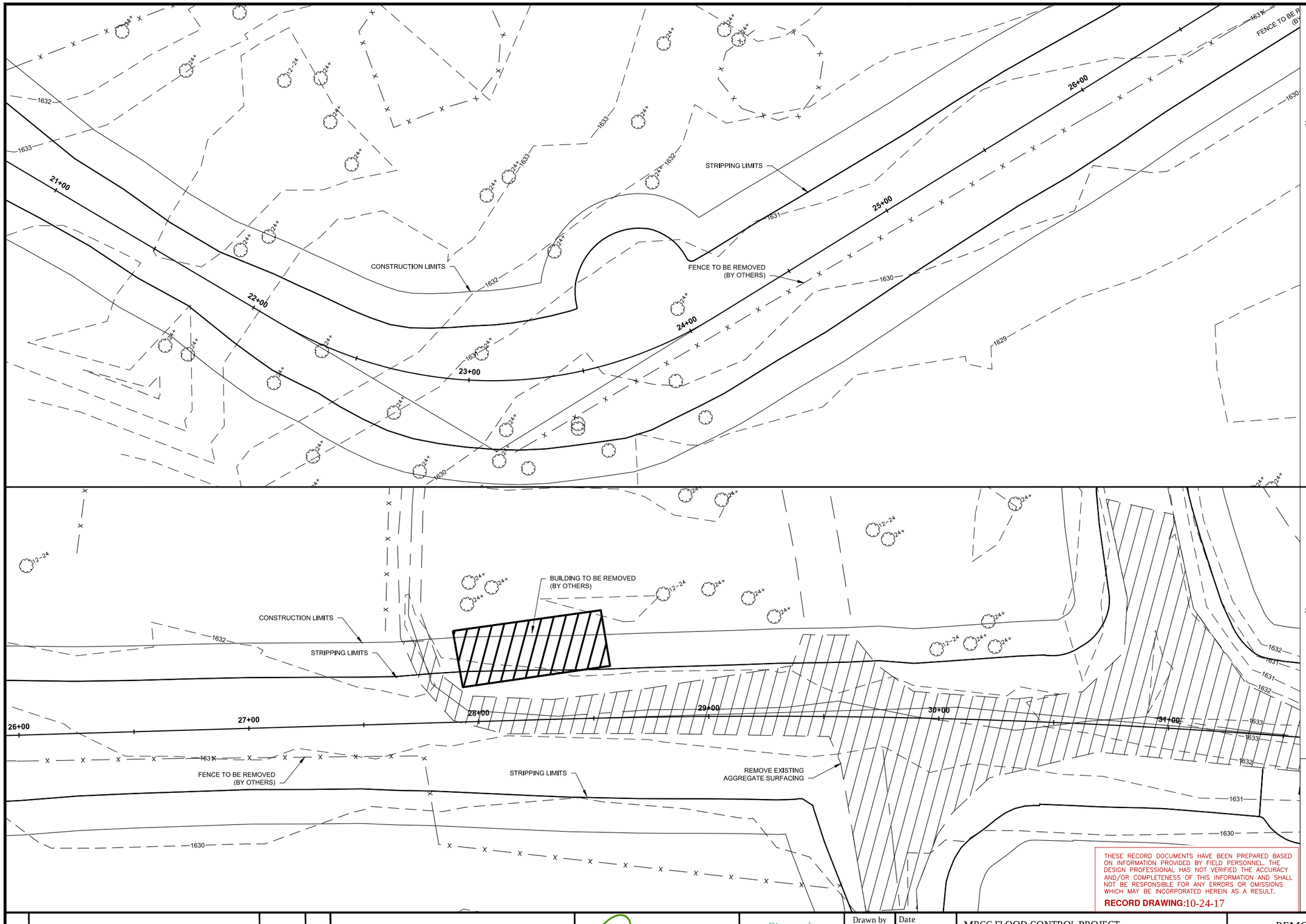

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Scale Feet

LEGEND

GRAVEL REMOVAL

ASPHALT REMOVAL

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Checked by TGJ | Scale AS SHOWN

MRCC FLOOD CONTROL PROJECT
BURLEIGH COUNTY WATER RESOURCE DISTRICT
BURLEIGH COUNTY, NORTH DAKOTA

REMOVALS

PROJECT NO. 6025-012

SHEET 9 of 51

H:\Bismarck\JBN\6025 Burleigh Co. WRD\6025-012 MRCC Flood Control\CAD\Plans\Removals.dwg-RemovalS3-10/24/2017 4:06 PM-(tpaul)

EXISTING 12IN PLASTIC TO BE REMOVED
INV: 1629.83
INV: 1629.89
INV: 1630.42
EXISTING 18IN RCP TO BE REMOVED
INV: 1629.32
REMOVE EXISTING AGGREGATE SURFACING
STRIPPING LIMITS
CONSTRUCTION LIMITS
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INV: 1630.95
REMOVE AND RESET SIGN
32+00
33+00
34+00
35+00
36+00
37+00
38+00
39+00
40+00
41+00
42+00
GAS
S/S
24+
12-24
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1632
1633

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Scale Feet

LEGEND
GRAVEL REMOVAL
ASPHALT REMOVAL

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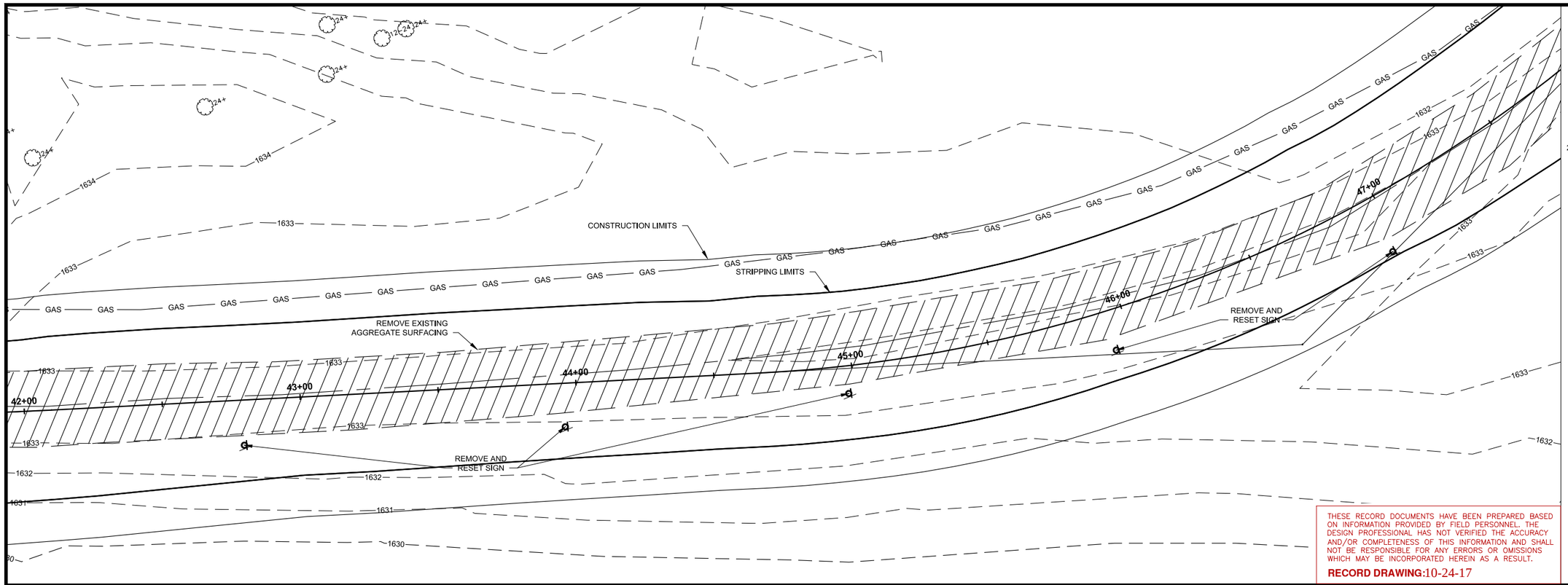
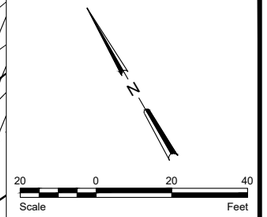
MRCC FLOOD CONTROL PROJECT
BURLEIGH COUNTY WATER RESOURCE DISTRICT
BURLEIGH COUNTY, NORTH DAKOTA

REMOVALS
PROJECT NO. 6025-012

SHEET
10 of 51





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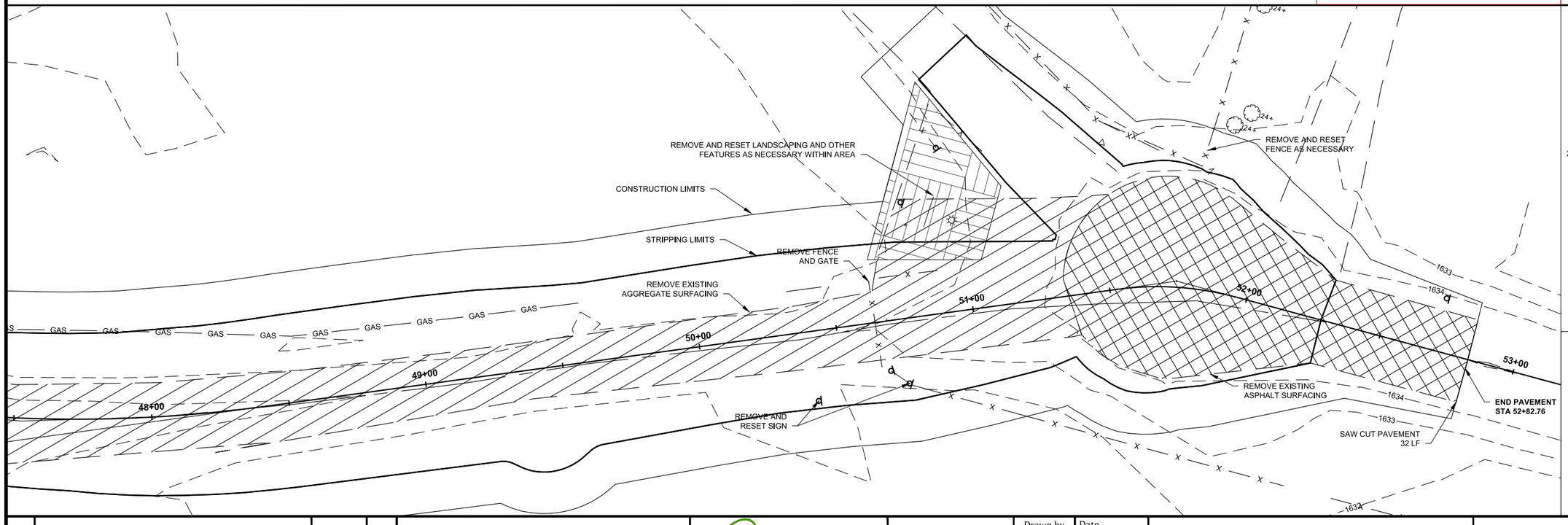

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MRCC FLOOD CONTROL PROJECT
BURLEIGH COUNTY WATER RESOURCE DISTRICT
BURLEIGH COUNTY, NORTH DAKOTA

REMOVALS

PROJECT NO. 6025-012

SHEET 11 of 51

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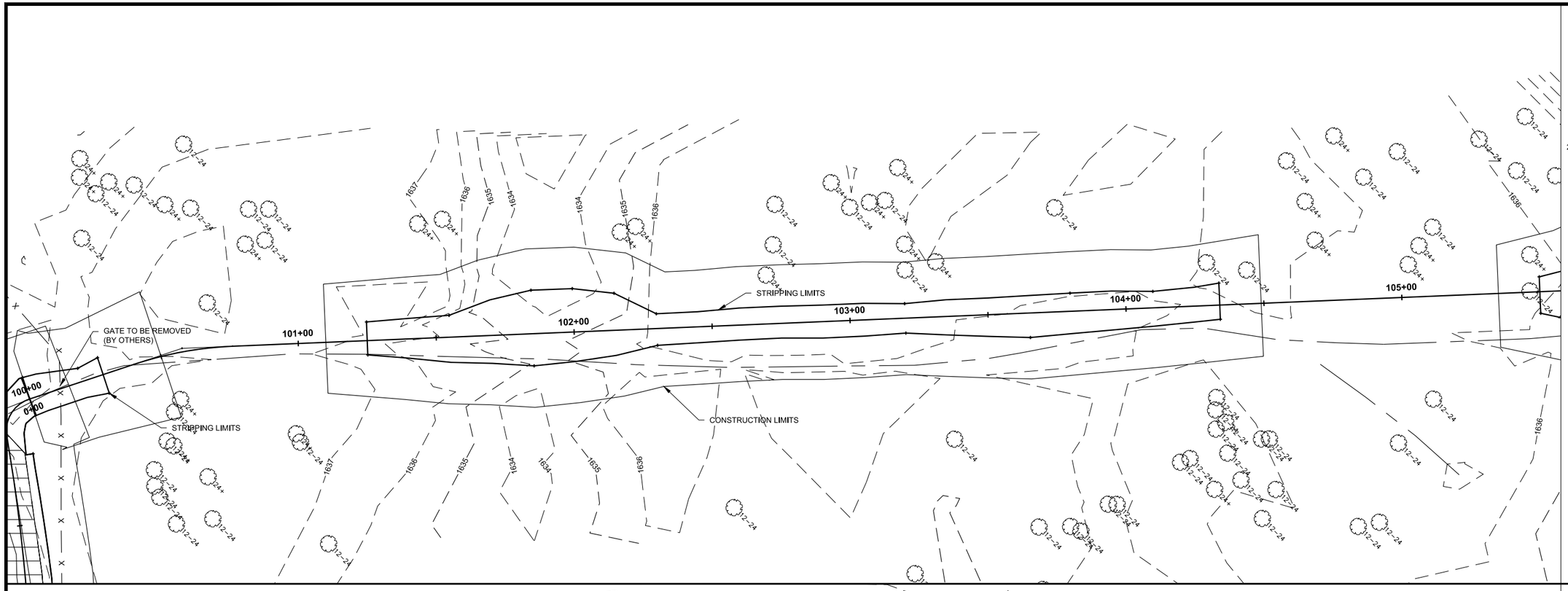

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LEGEND

GRAVEL REMOVAL

ASPHALT REMOVAL

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MRCC FLOOD CONTROL PROJECT
BURLEIGH COUNTY WATER RESOURCE DISTRICT
BURLEIGH COUNTY, NORTH DAKOTA

REMOVALS

PROJECT NO. 6025-012

SHEET 12 of 51

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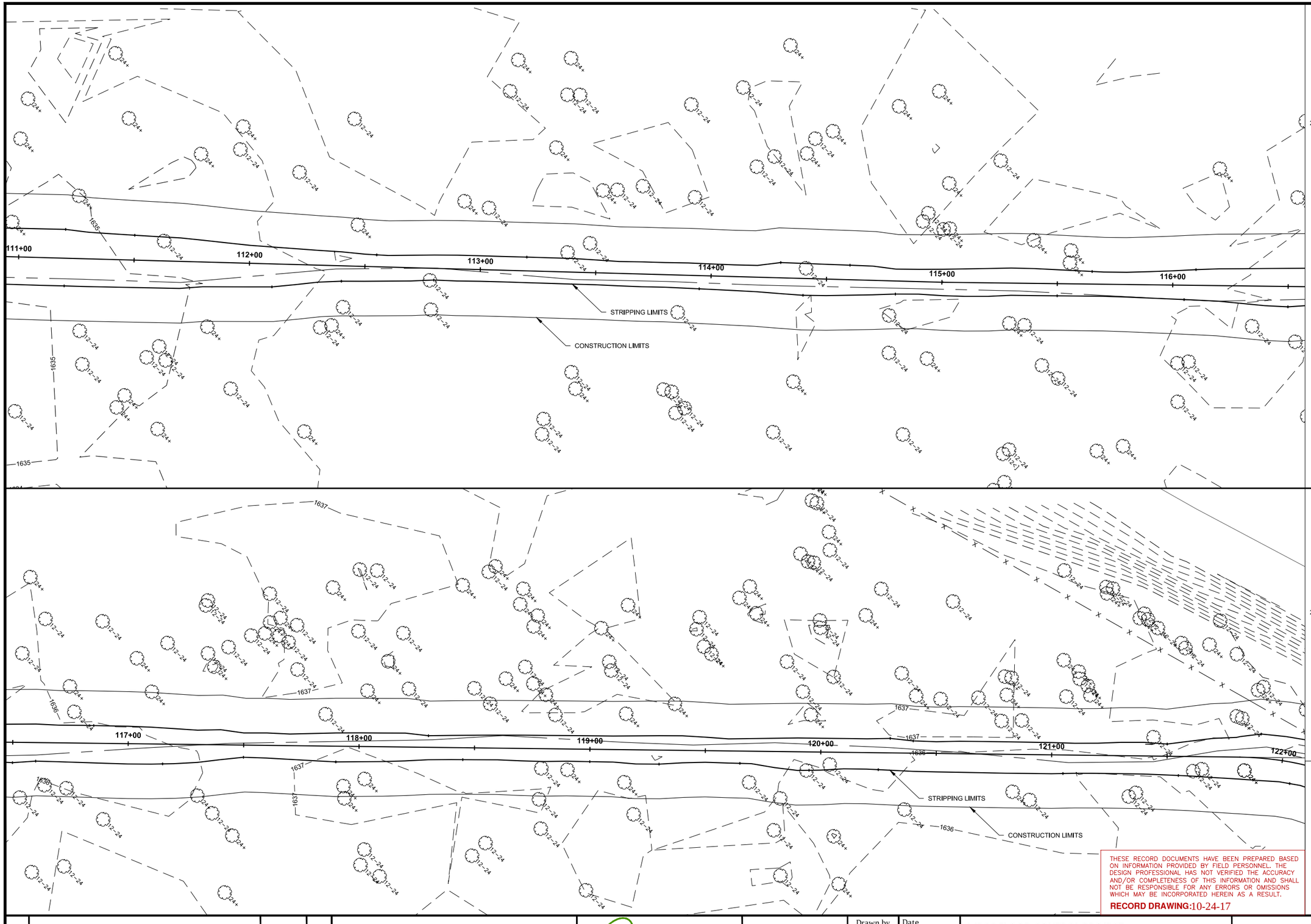

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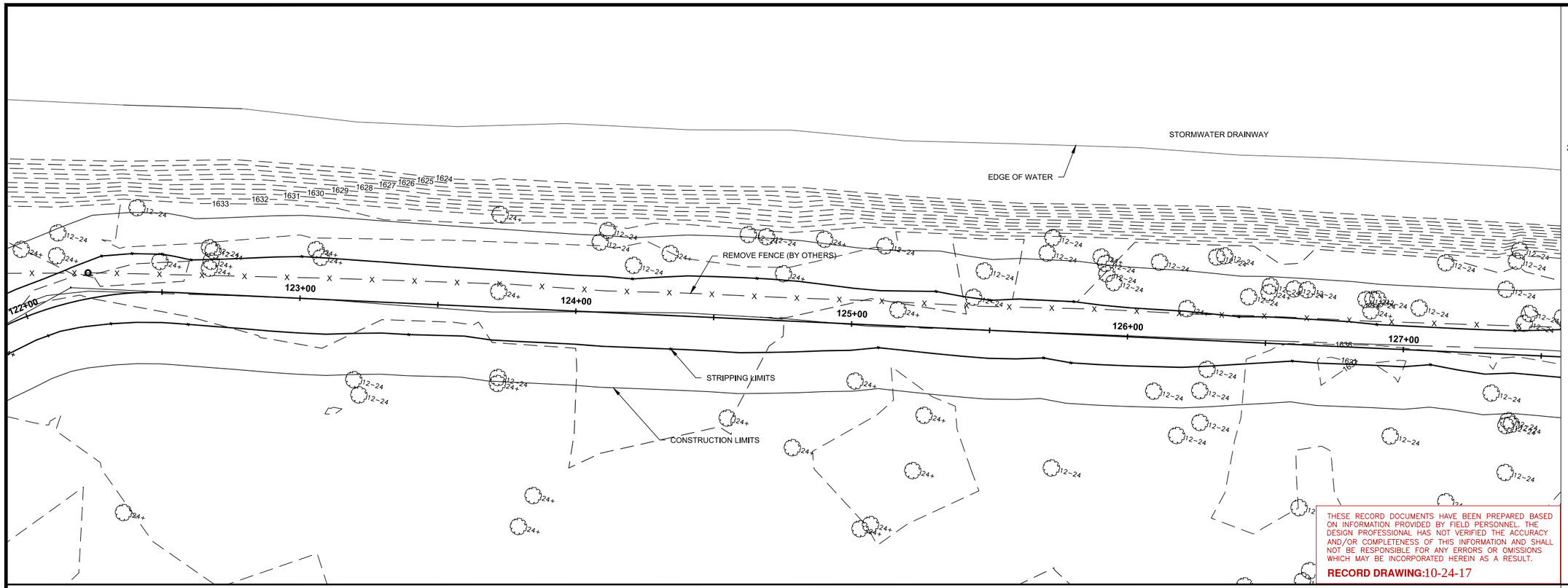
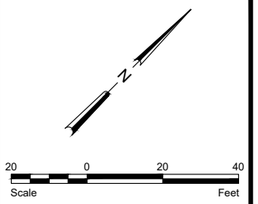
MRCC FLOOD CONTROL PROJECT
BURLEIGH COUNTY WATER RESOURCE DISTRICT
BURLEIGH COUNTY, NORTH DAKOTA

REMOVALS

PROJECT NO. 6025-012

SHEET 13 of 51





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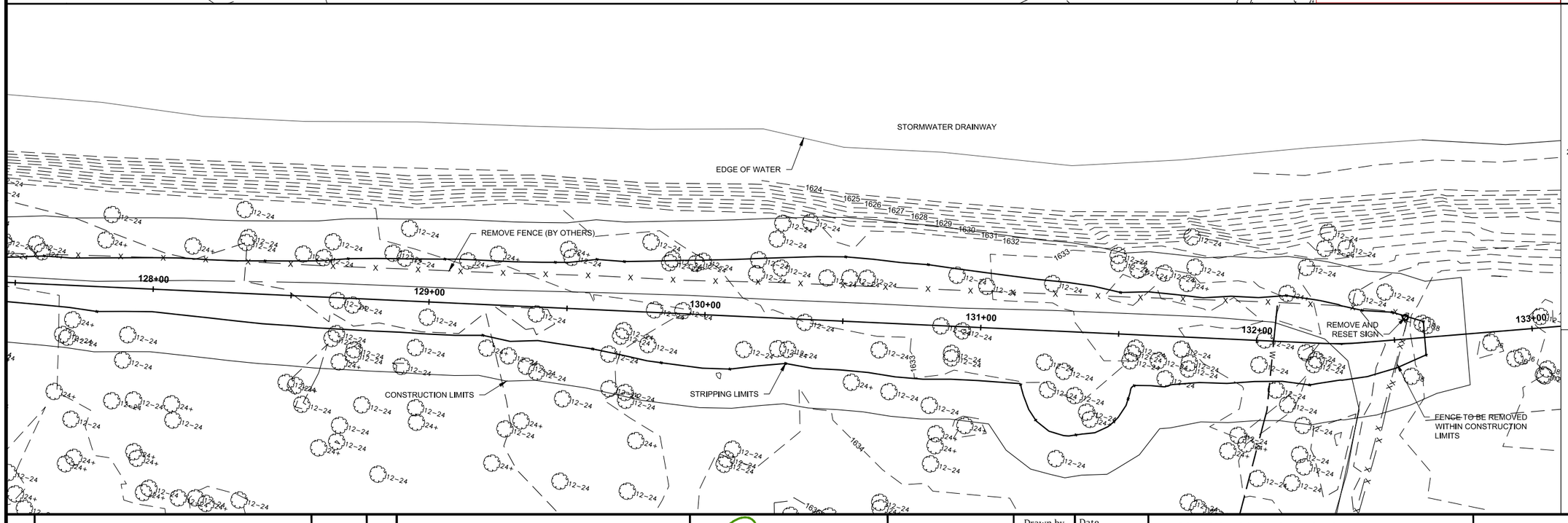

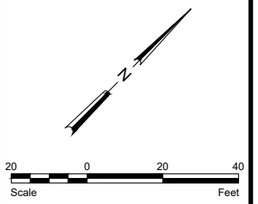

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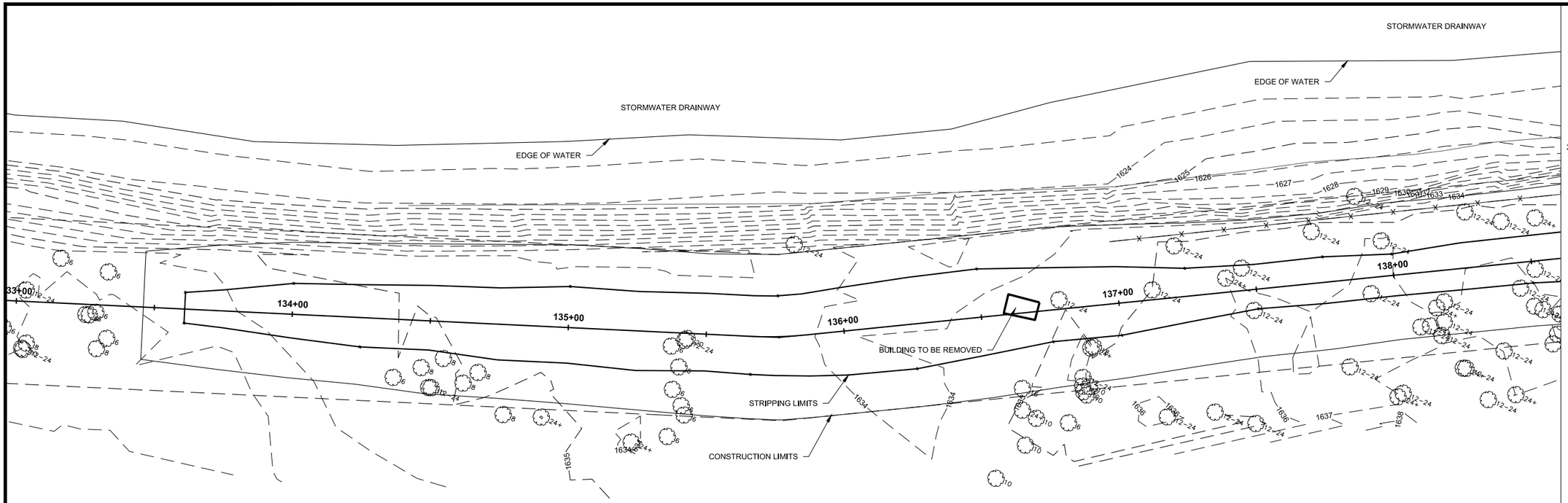
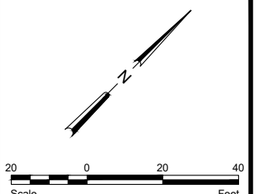
BURLEIGH COUNTY, NORTH DAKOTA

REMOVALS

PROJECT NO. 6025-012

SHEET 14 of 51





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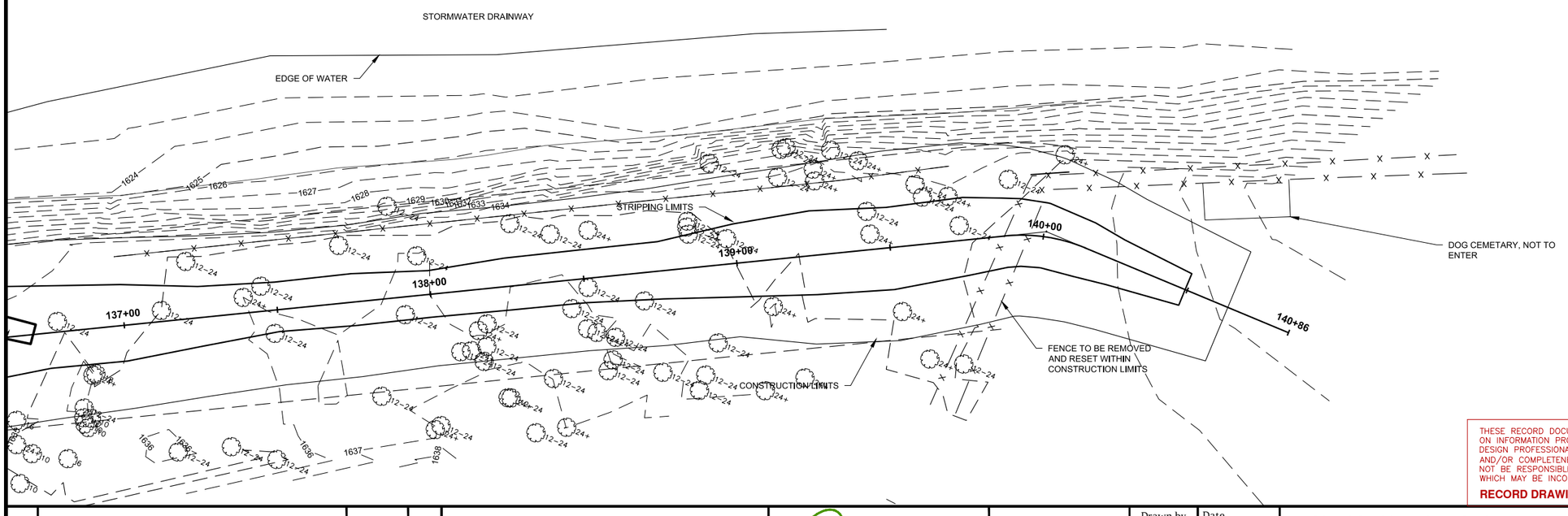

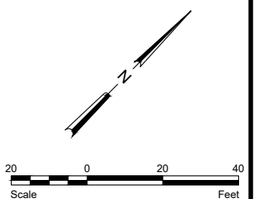

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BURLEIGH COUNTY, NORTH DAKOTA

REMOVALS

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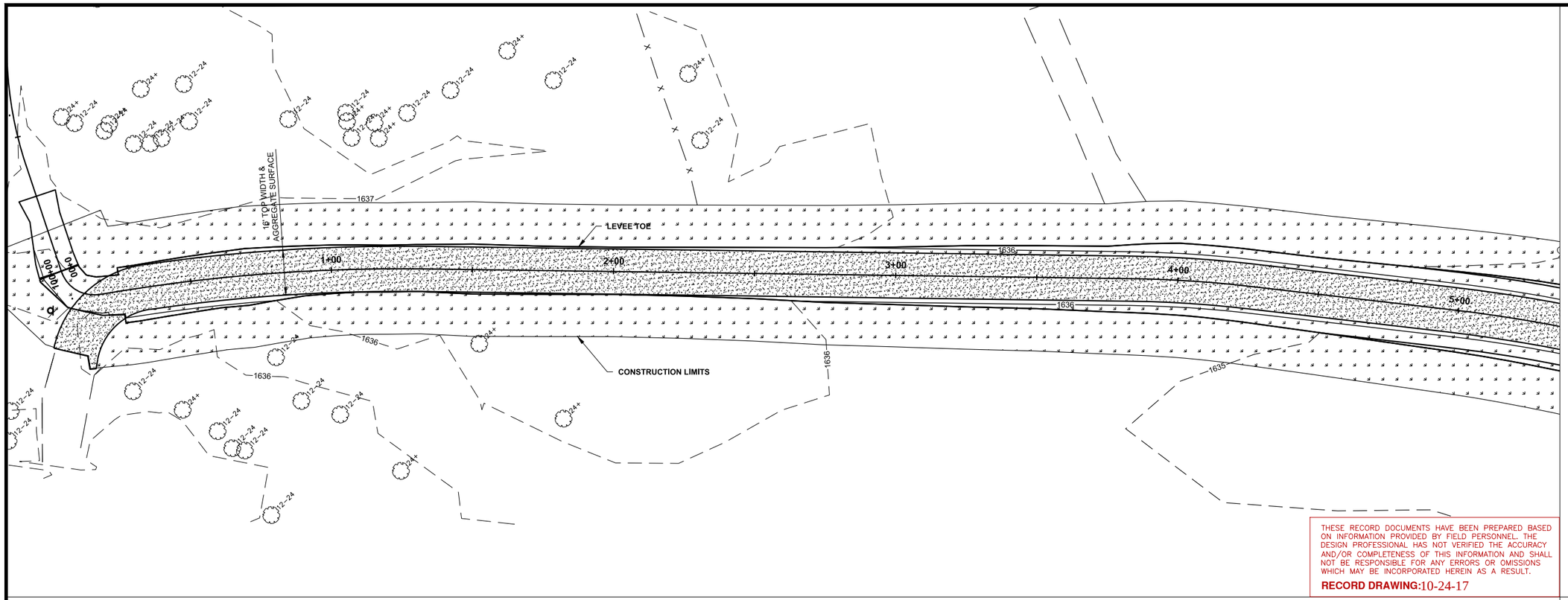
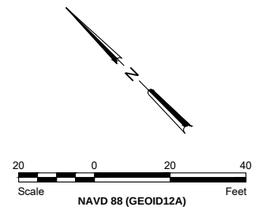
SHEET 15 of 51





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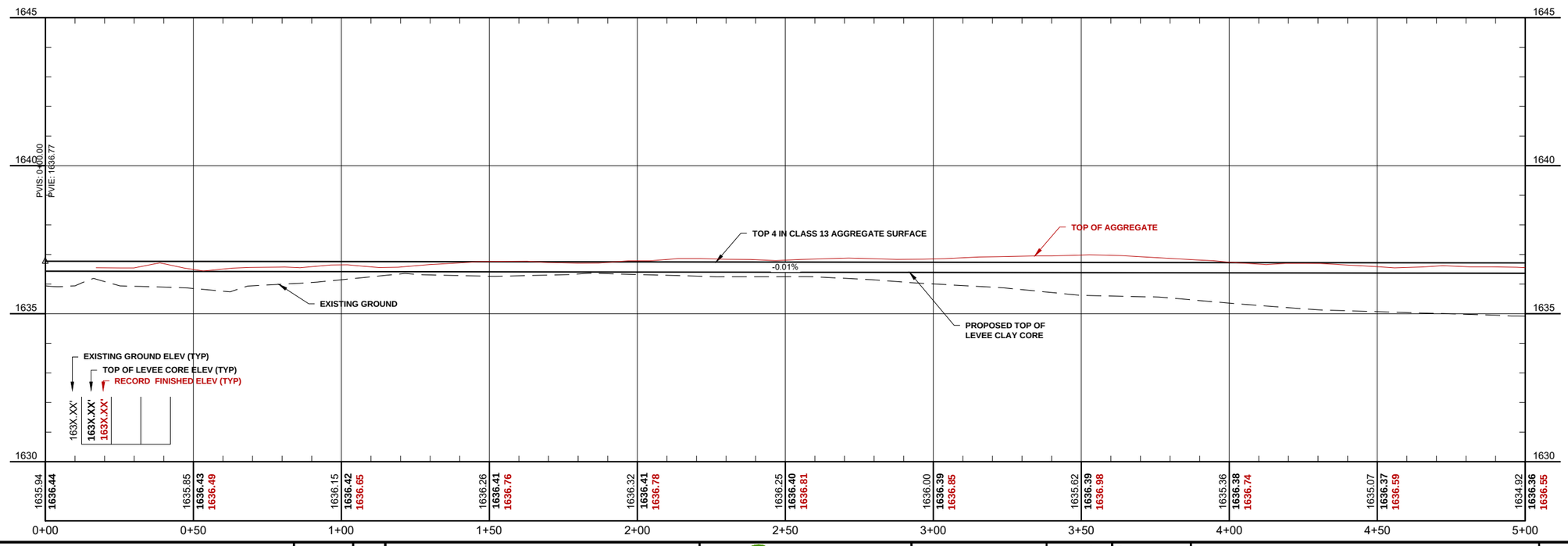
SEEDING

AGGREGATE SURFACE

ASPHALT SURFACE



NOTE: PROPOSED TOP OF LEVEE CLAY CORE PROFILE ACCOUNTS FOR 2" OF SETTLEMENT AS CALCULATED BY BRAUN INTERTEC

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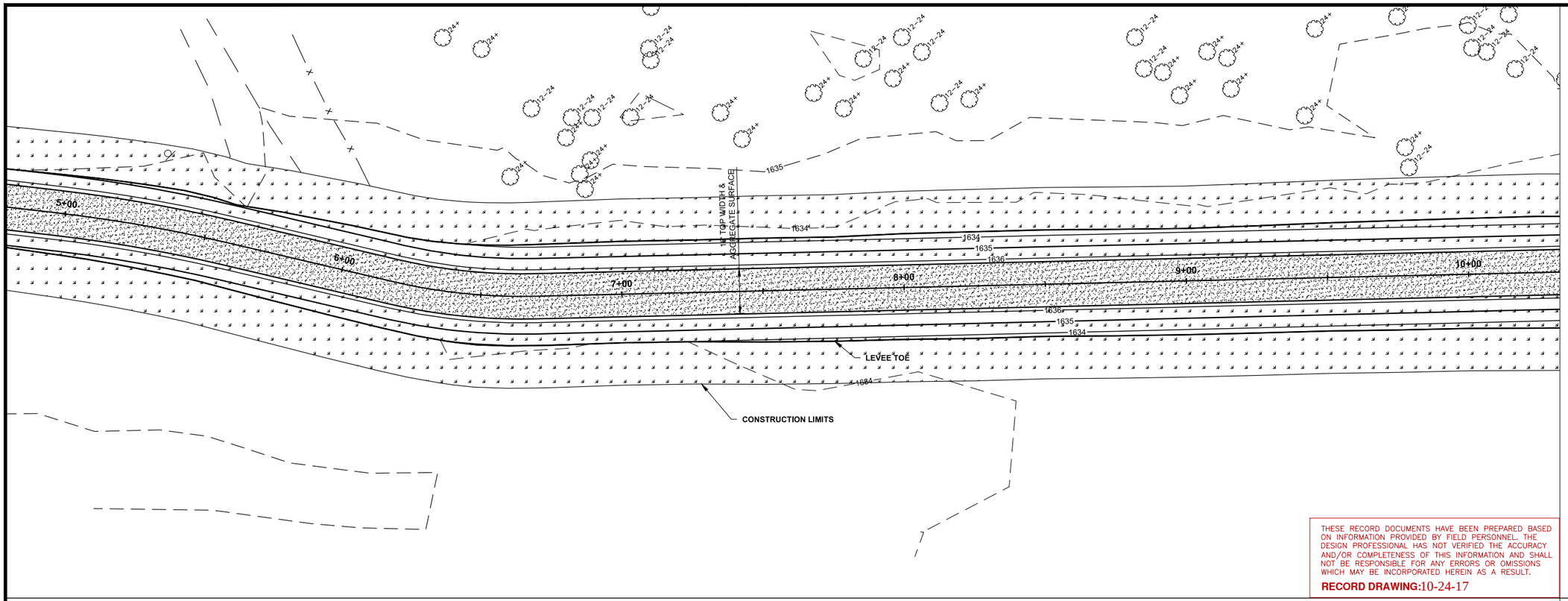
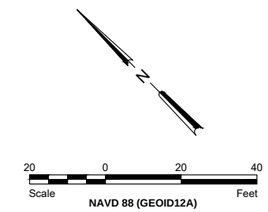
MRCC FLOOD CONTROL PROJECT
BURLEIGH COUNTY WATER RESOURCE DISTRICT
BURLEIGH COUNTY, NORTH DAKOTA

PLAN & PROFILE SOUTH

PROJECT NO. 6025-012

SHEET 16 of 51





LEGEND

- SEEDING
- AGGREGATE SURFACE
- ASPHALT SURFACE

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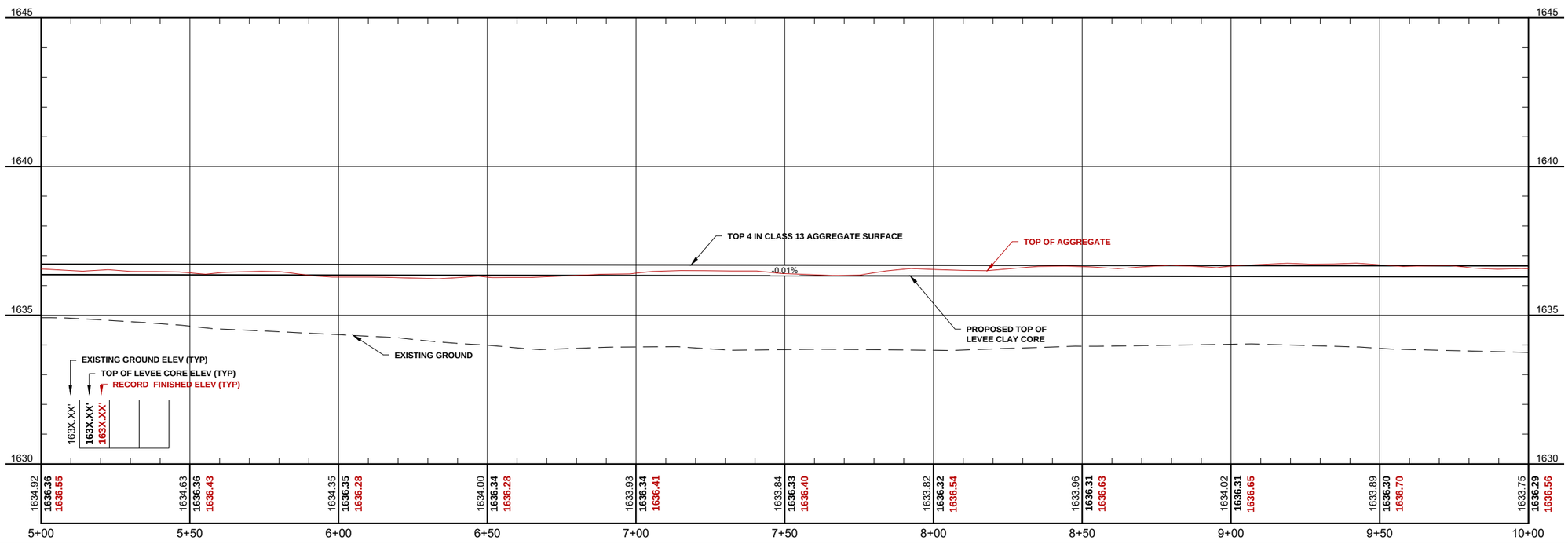

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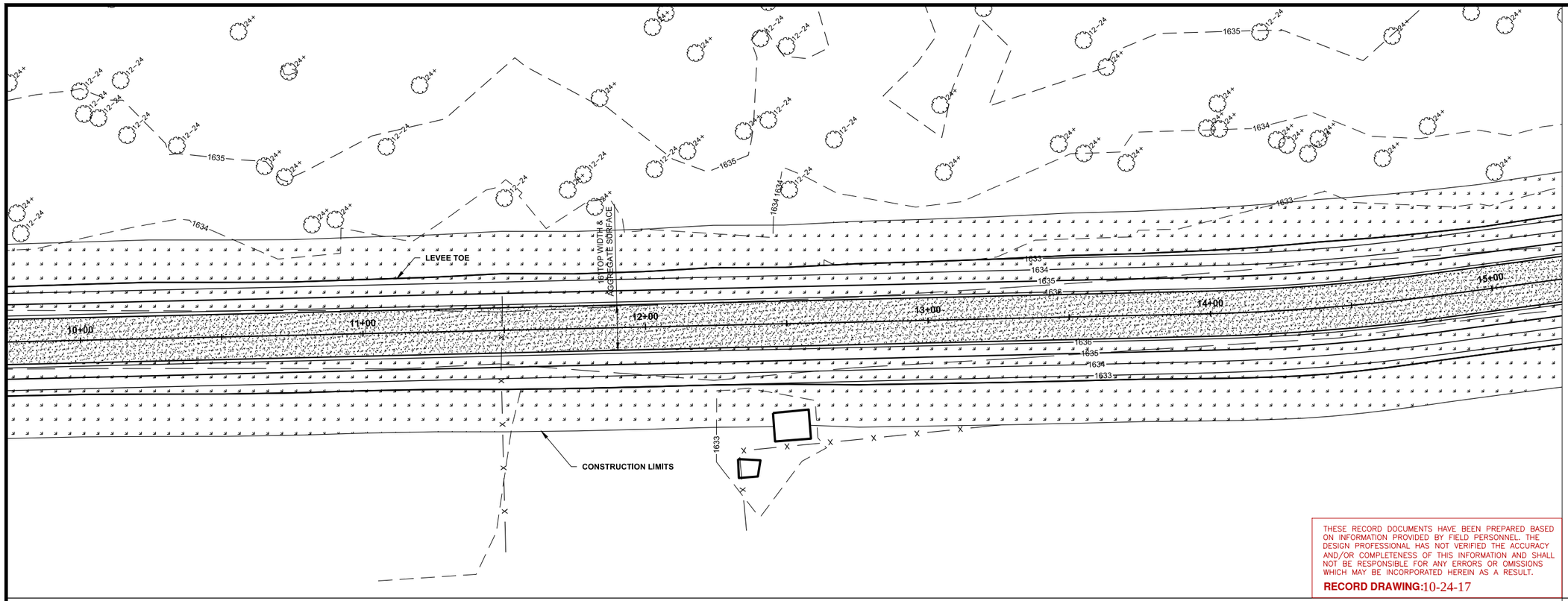
TGJ	AS SHOWN

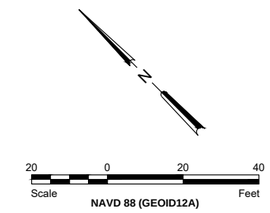
MRCC FLOOD CONTROL PROJECT
BURLEIGH COUNTY WATER RESOURCE DISTRICT
BURLEIGH COUNTY, NORTH DAKOTA

PLAN & PROFILE SOUTH

PROJECT NO. 6025-012

SHEET 17 of 51





LEGEND

- SEEDING
- AGGREGATE SURFACE
- ASPHALT SURFACE

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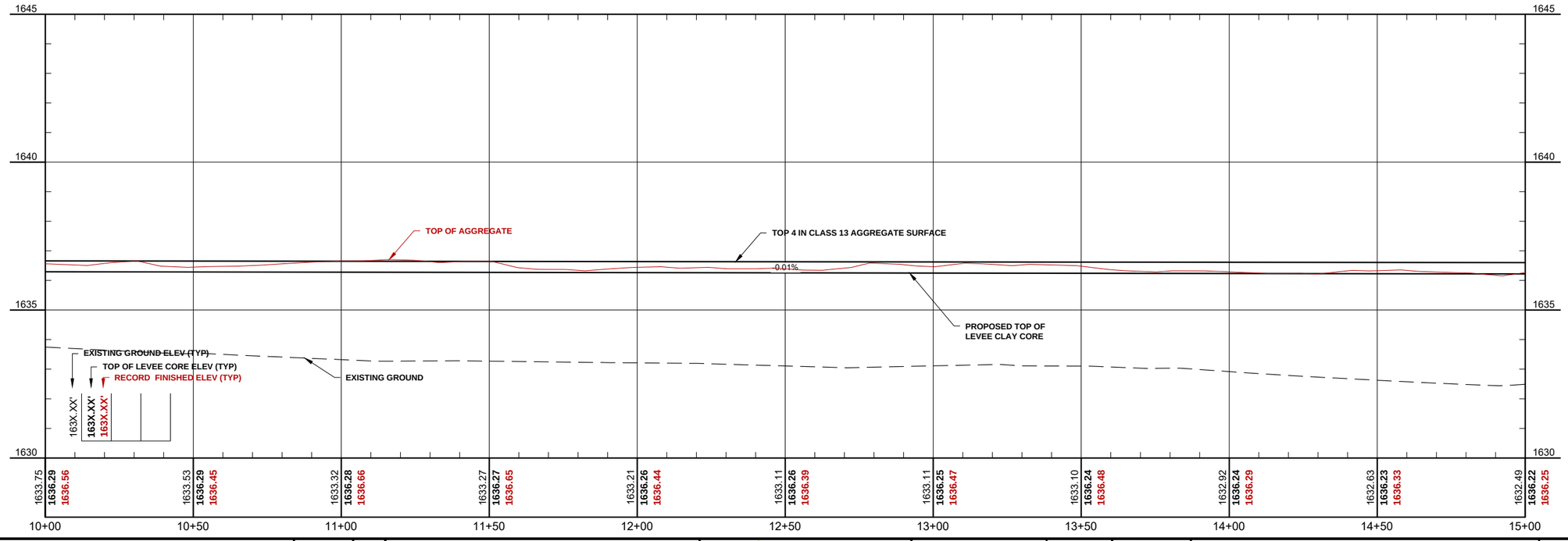

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Houston Engineering Inc.
Bismarck
P: 701.323.0200
F: 701.323.0300

Drawn by	Date
AV	11-3-15
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TGJ	AS SHOWN

MRCC FLOOD CONTROL PROJECT
BURLEIGH COUNTY WATER RESOURCE DISTRICT
BURLEIGH COUNTY, NORTH DAKOTA

PLAN & PROFILE SOUTH

PROJECT NO. 6025-012

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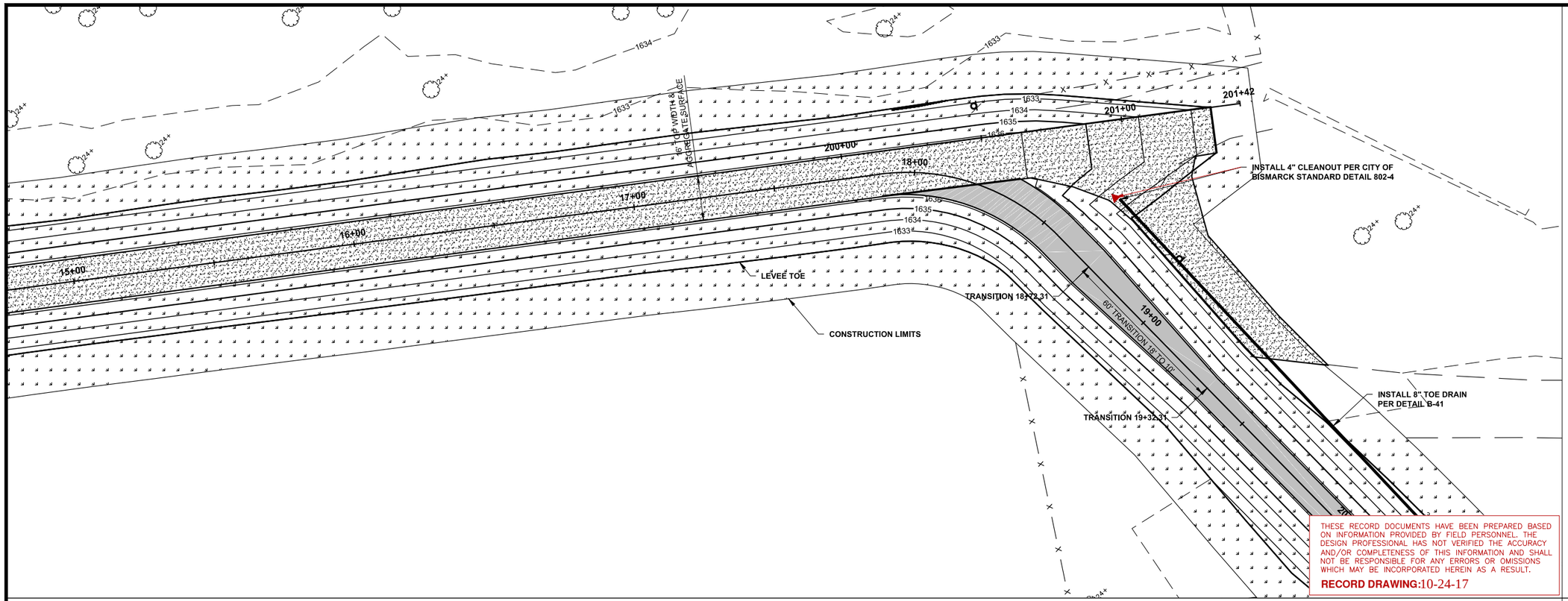

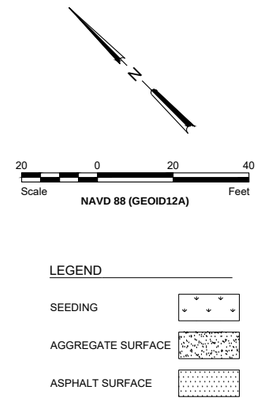

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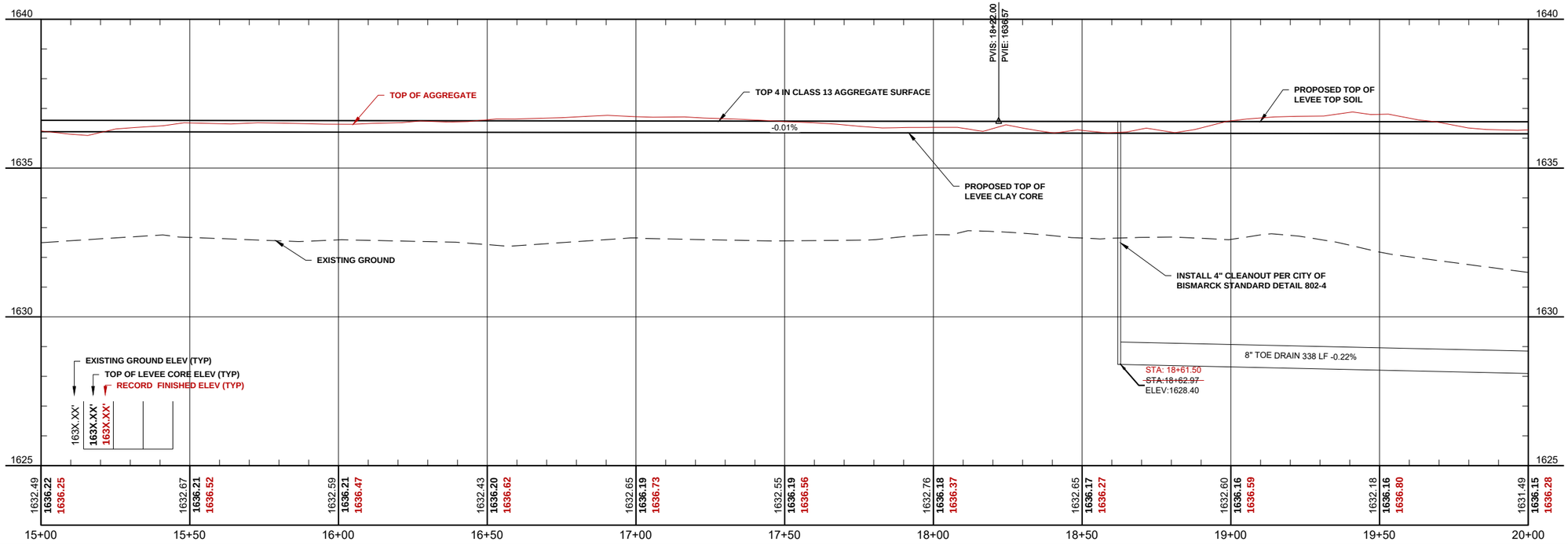

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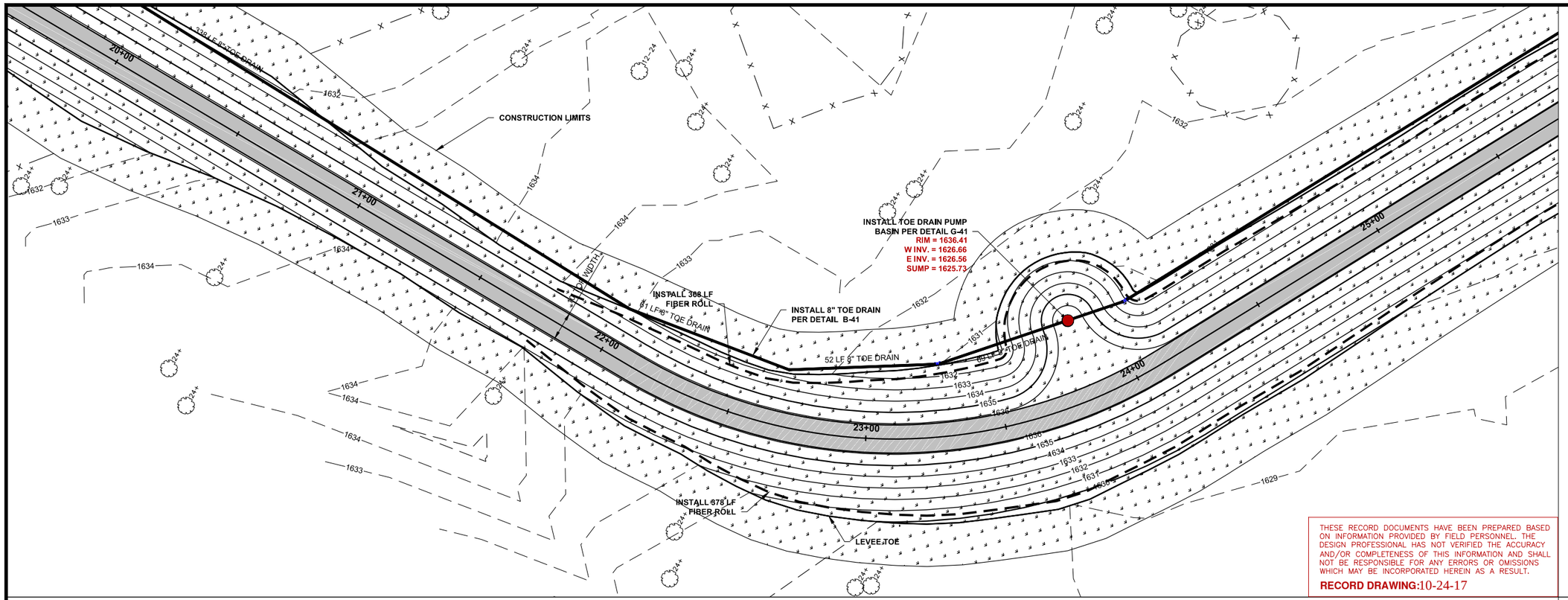

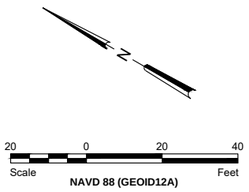

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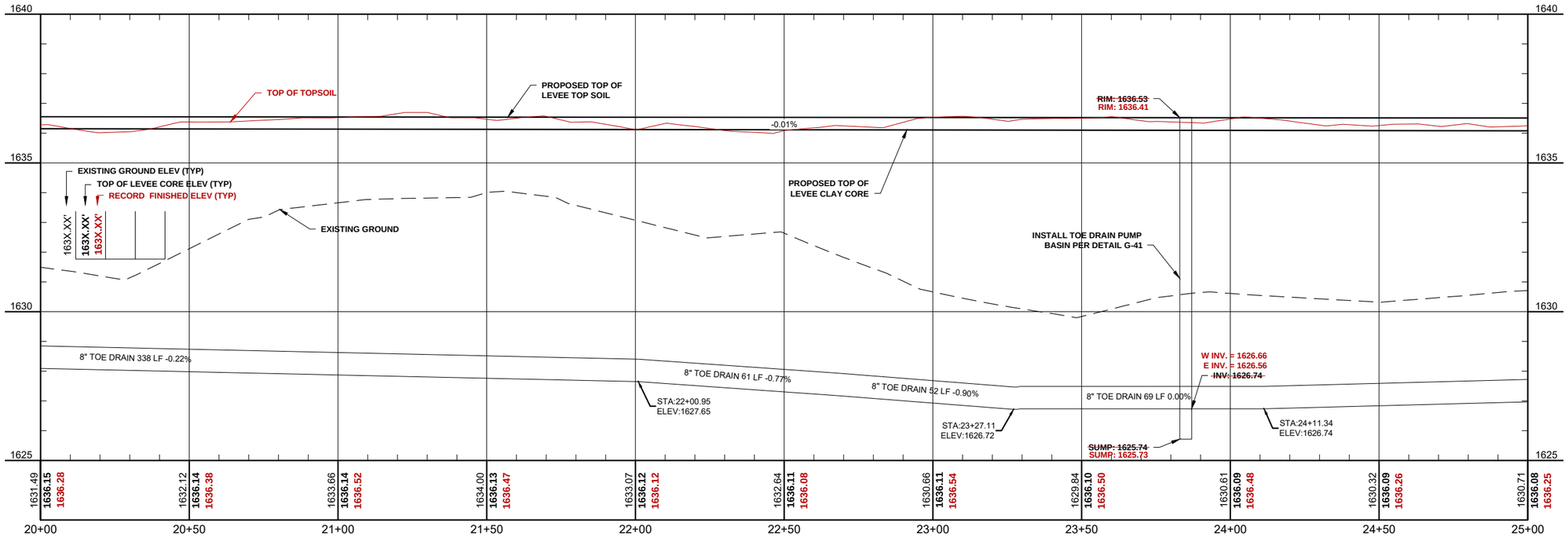

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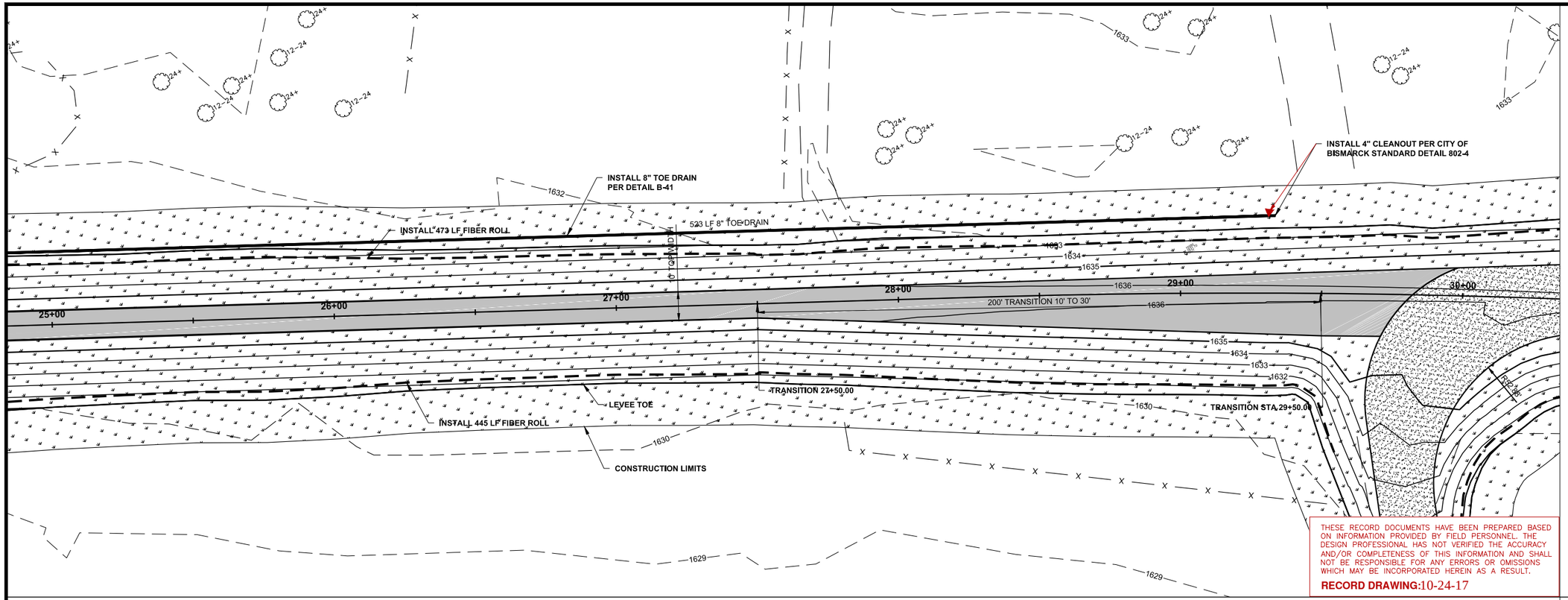

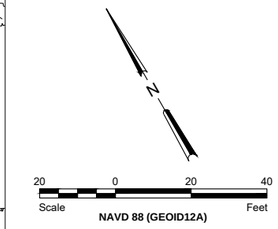

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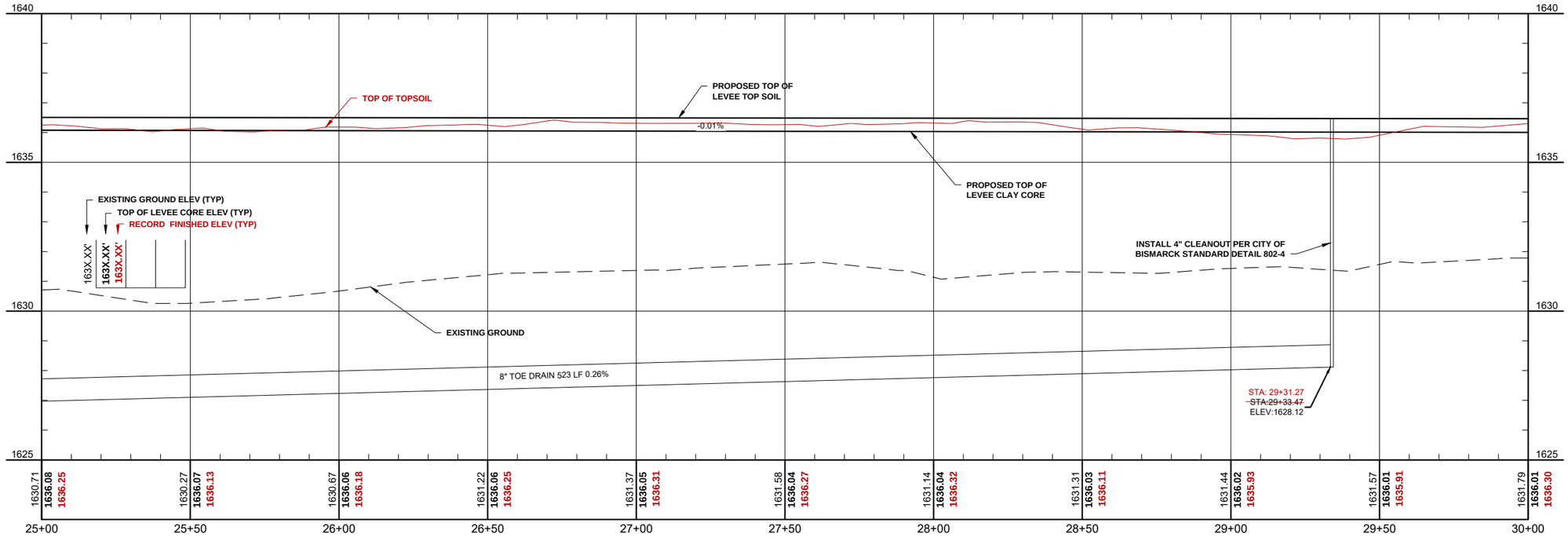

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SHEET 21 of 51

OUT PER CITY OF
ARD DETAIL 802-4

INSTALL 185 LF FIBER ROLL

INV: 1630.88
INV: 1630.75

INV: 1630.50
INV: 1630.90

94 LF
INSTALL 85 LF 18" RCP CULVERT
WITH FLARED END SECTIONS
INV: 1631.13
INV: 1630.96

INSTALL 287 LF FIBER ROLL

INSTALL 50 LF FIBER ROLL

INV: 1631.20
INV: 1631.27

30+00
31+00
32+00
33+00
34+00
35+00

220'-00"

230'-00"

24' ASPHALT WIDTH

30' TOW WIDTH

STS

GAS

BEGIN PAVEMENT
STA 30+46.31

INSTALL 74 LF 18" RCP CULVERT
WITH GATE WELL PER DETAIL
A-41 & FLARED END SECTIONS
RIM = 1636.82
N INV. (GATE) = 1630.54
S INV. = 1630.50
SUMP = 1630.51

INV: 1630.00
INV: 1630.34

INSTALL 269 LF FIBER ROLL

INSTALL 308 LF FIBER ROLL

LEVEE TOE

CONSTRUCTION LIMITS

INSTALL 54 LF FIBER ROLL

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RECORD DRAWING:10-24-17

N

20 0 20 40
Scale Feet

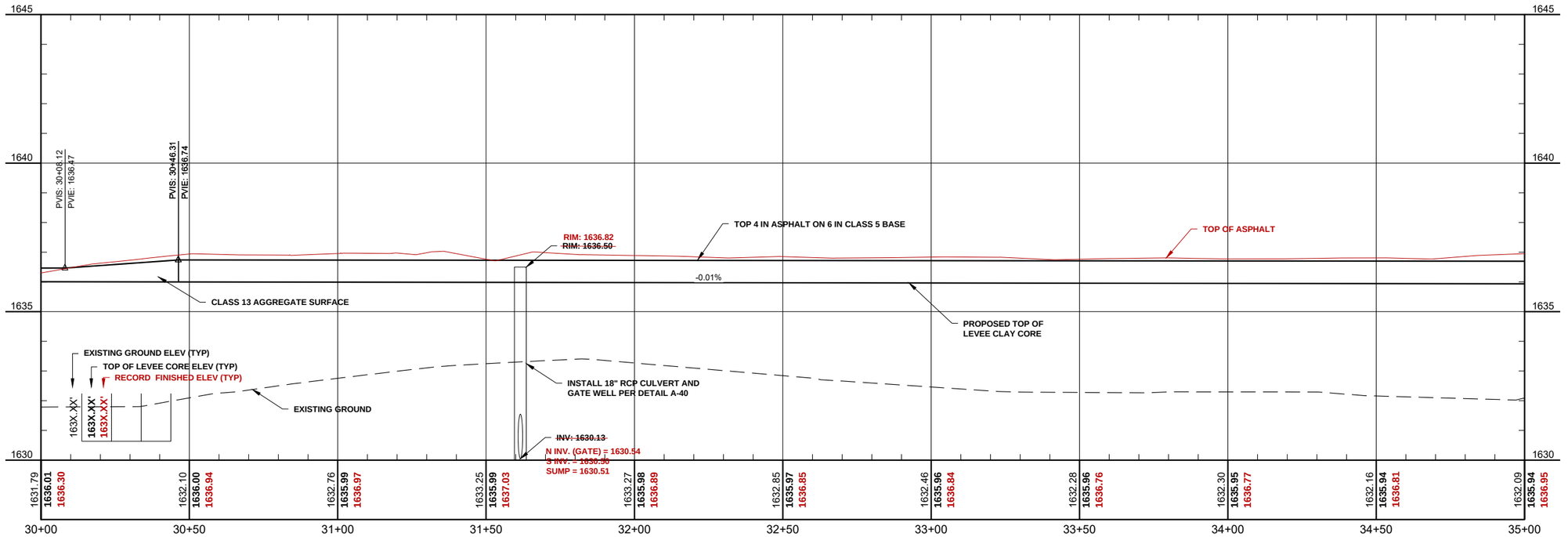
NAVD 88 (GEOID12A)

LEGEND

SEEDING

AGGREGATE SURFACE

ASPHALT SURFACE



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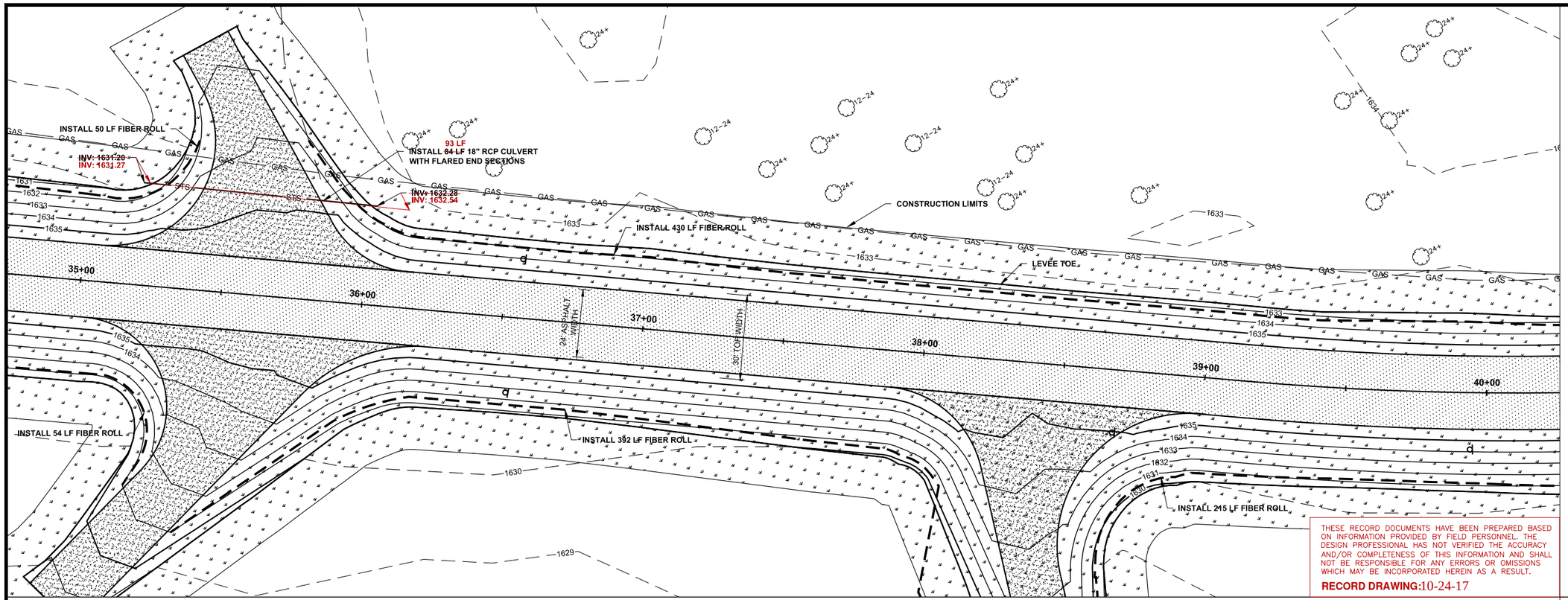

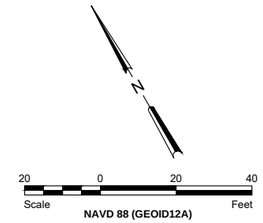

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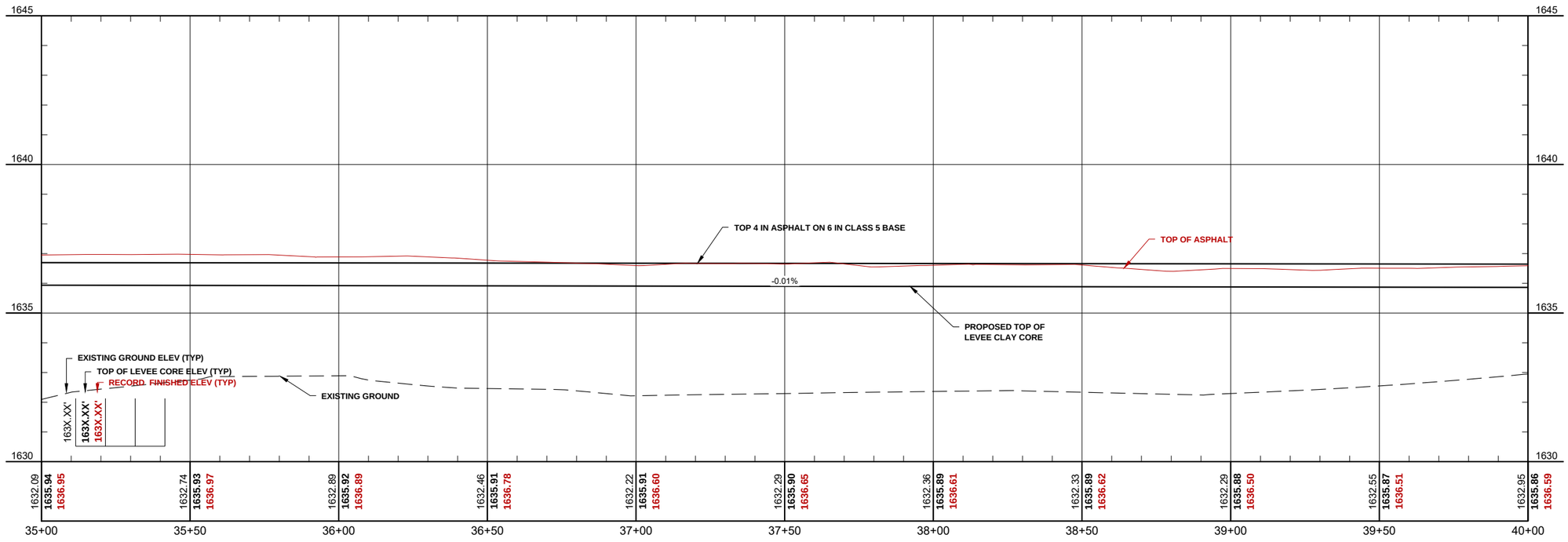

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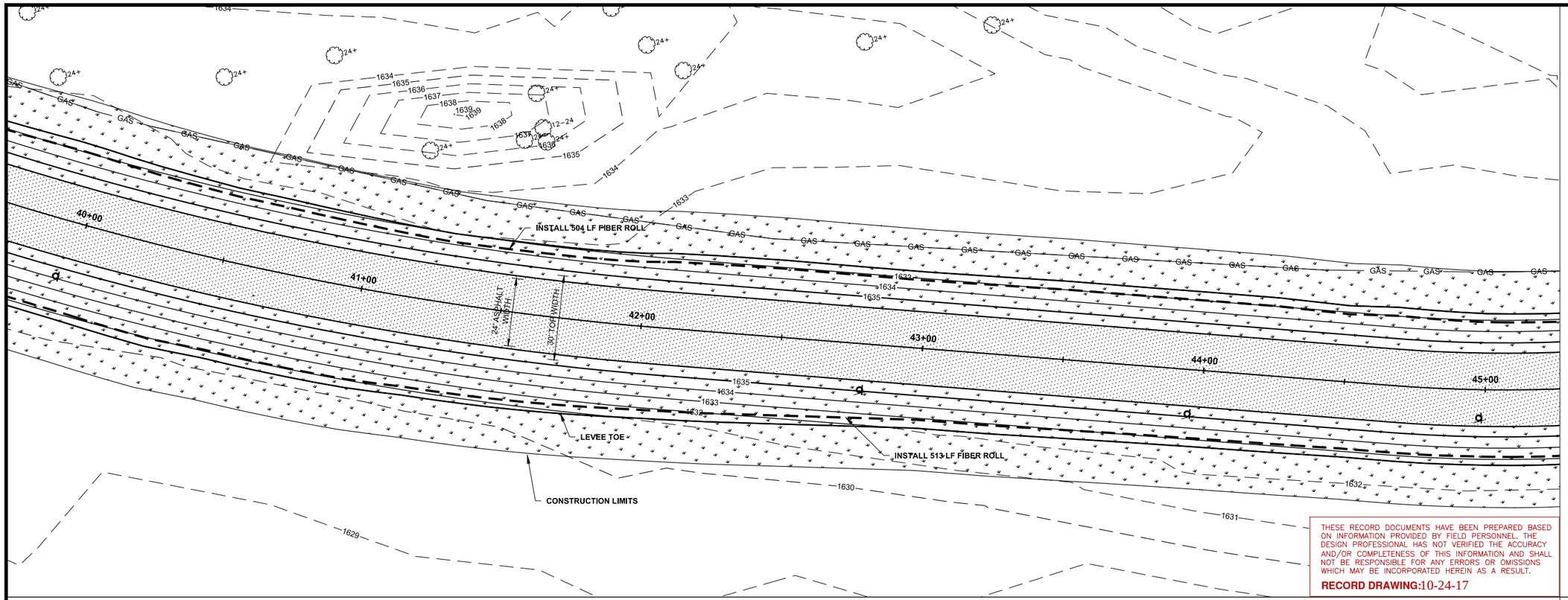

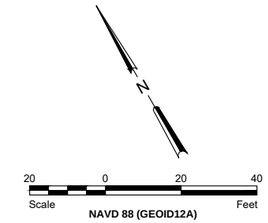

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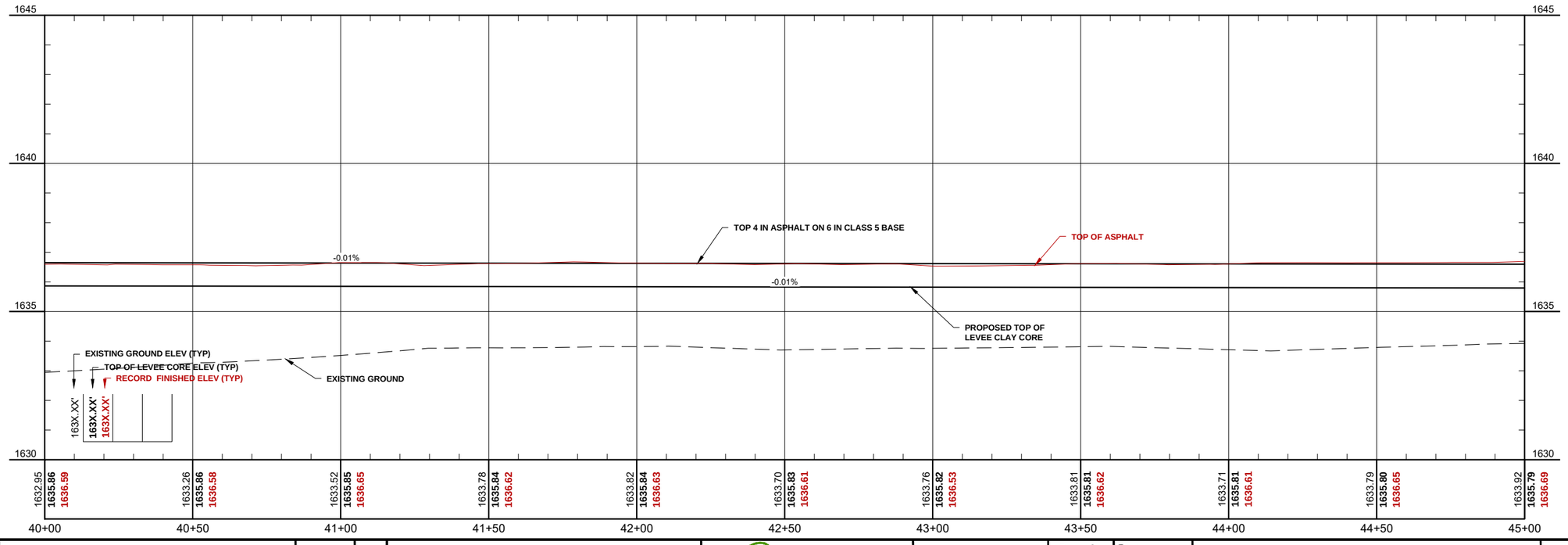

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SHEET 24 of 51

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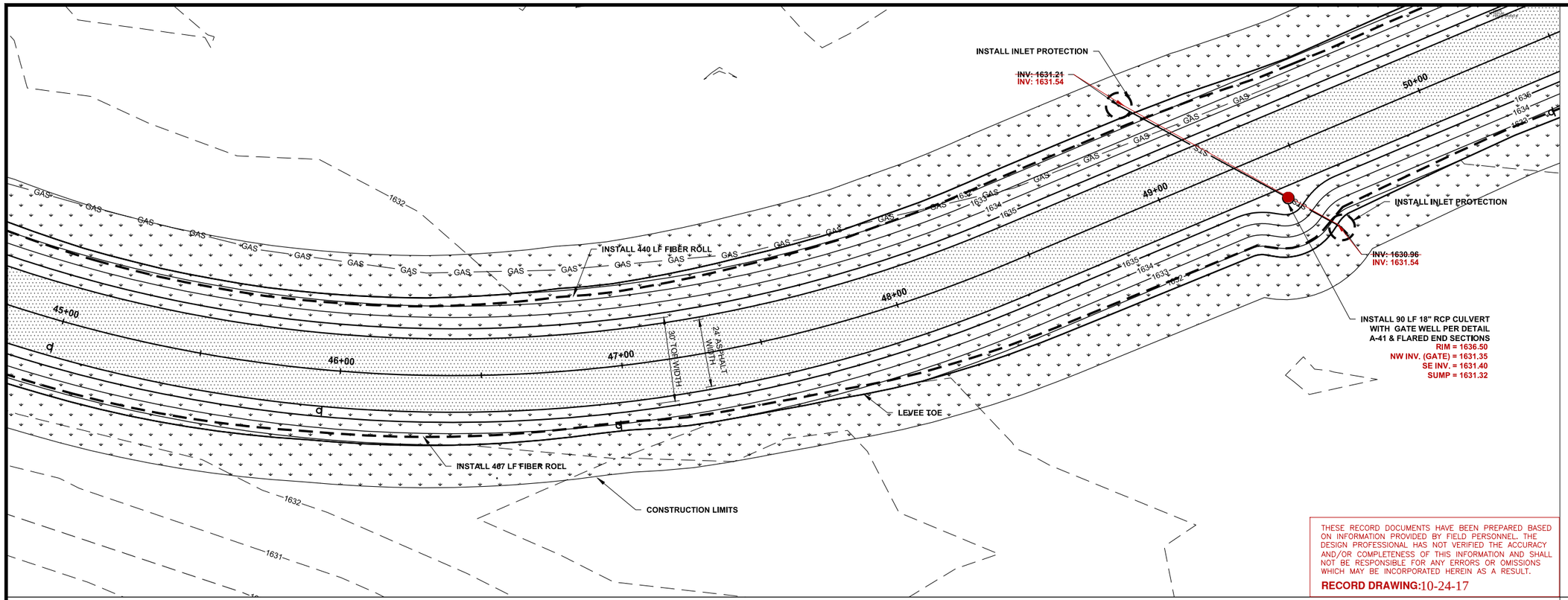

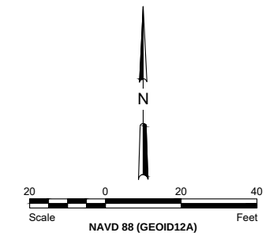

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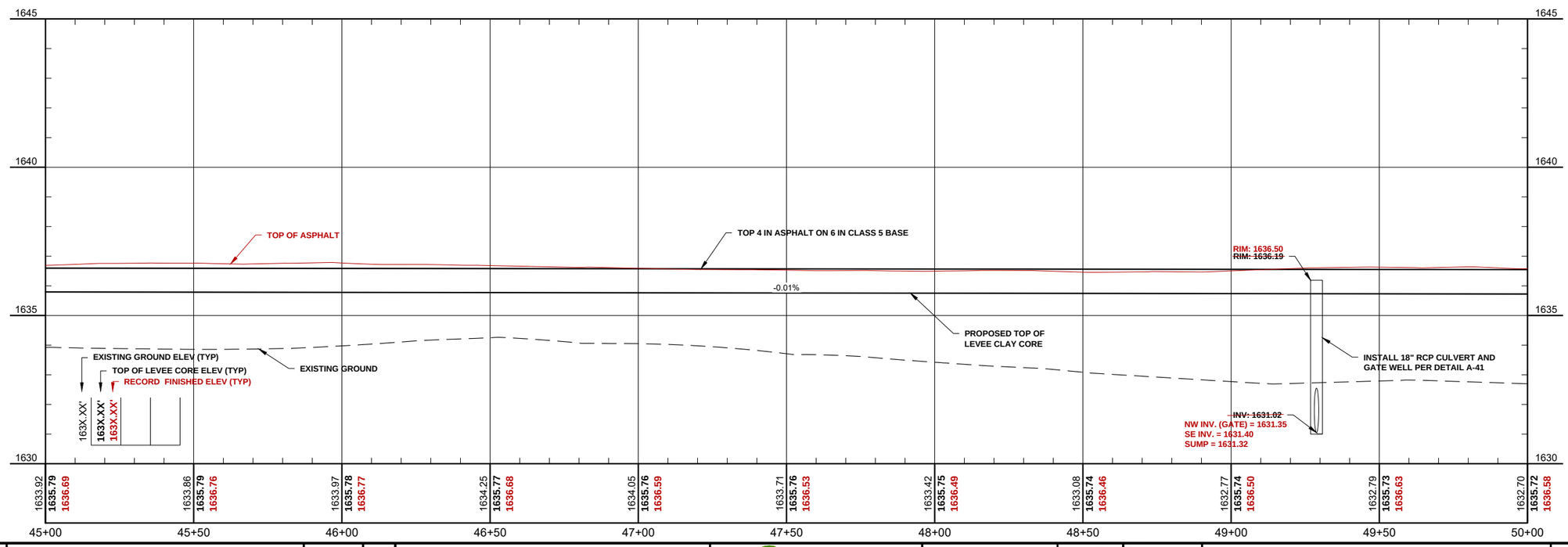

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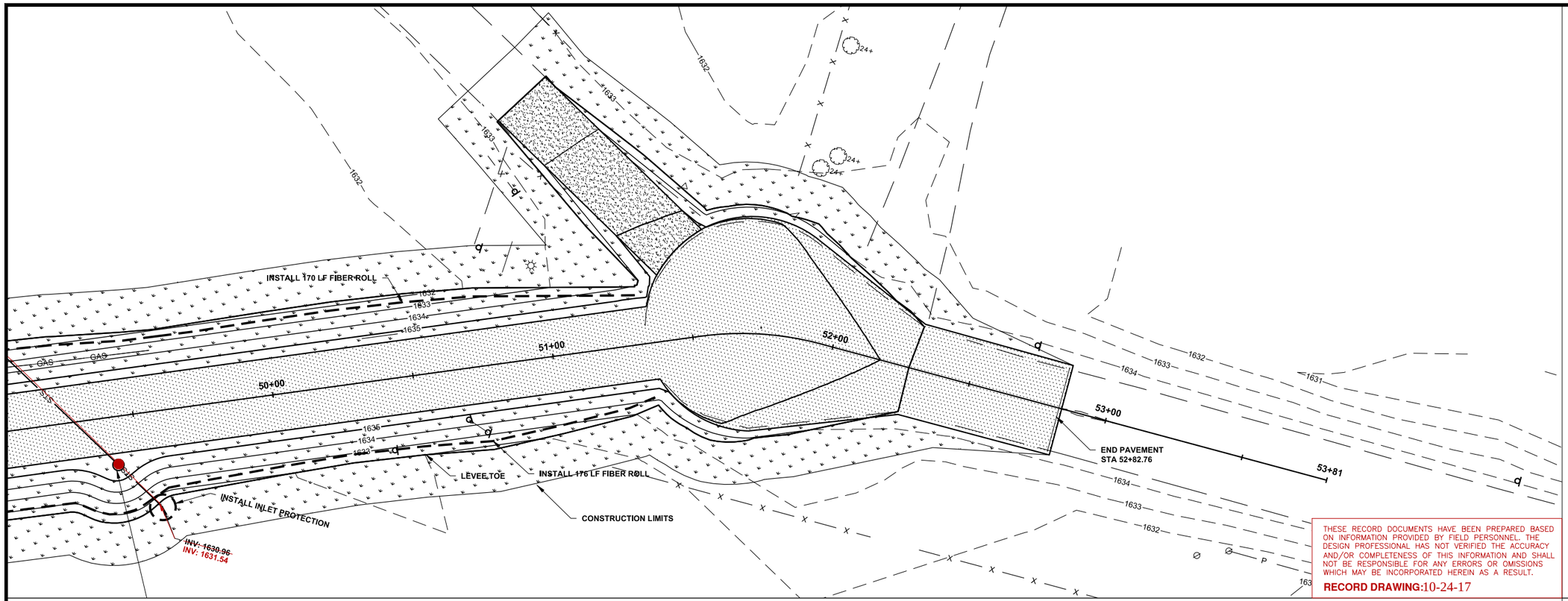

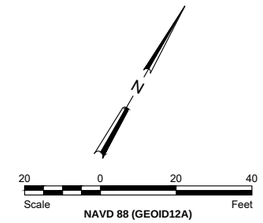

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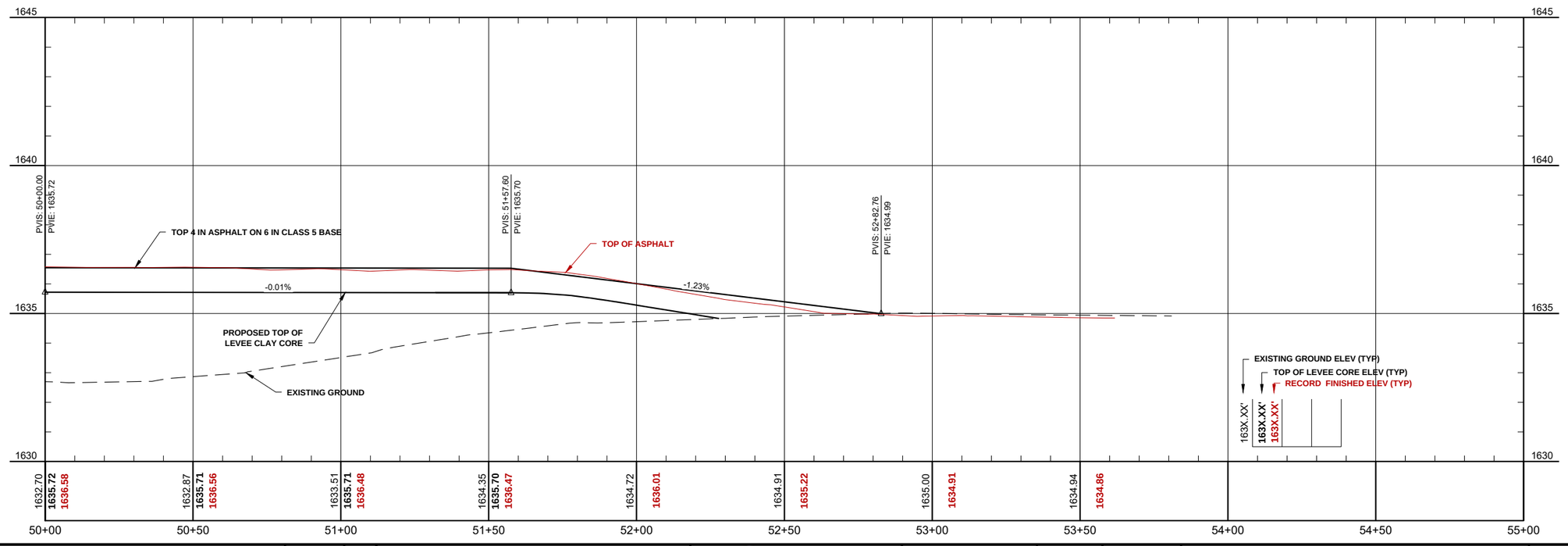

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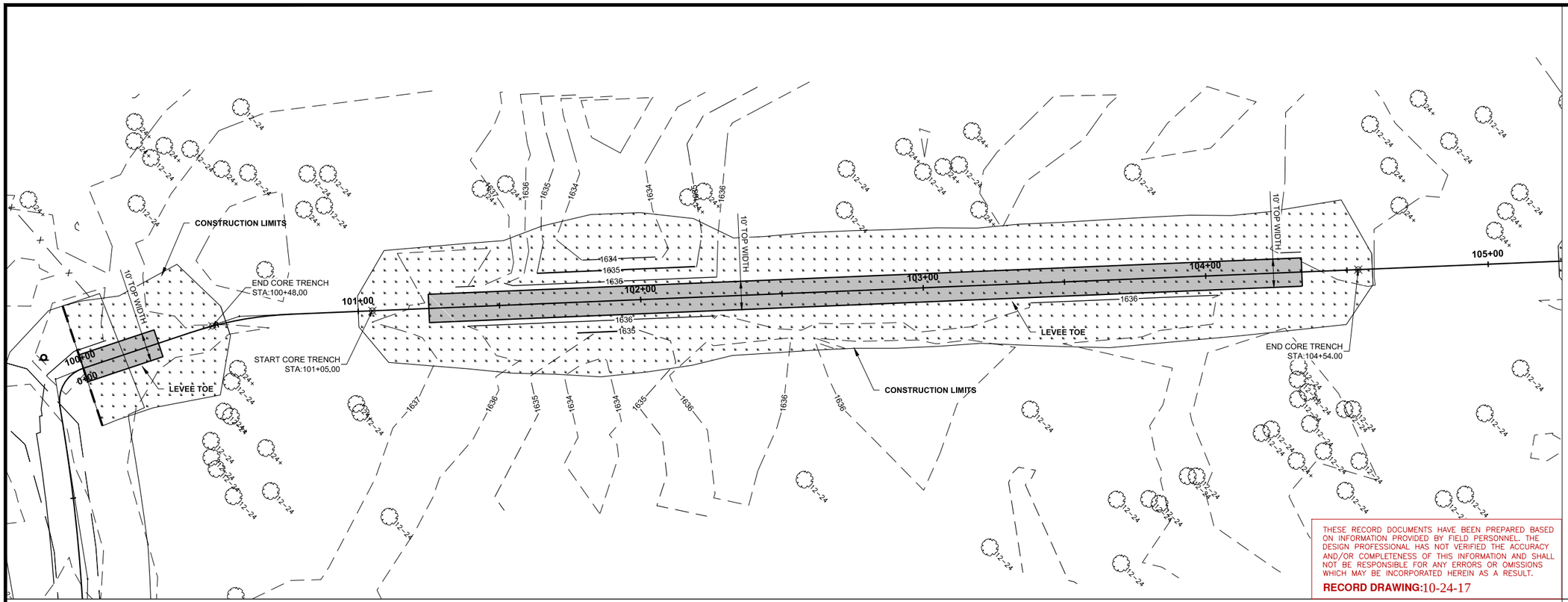

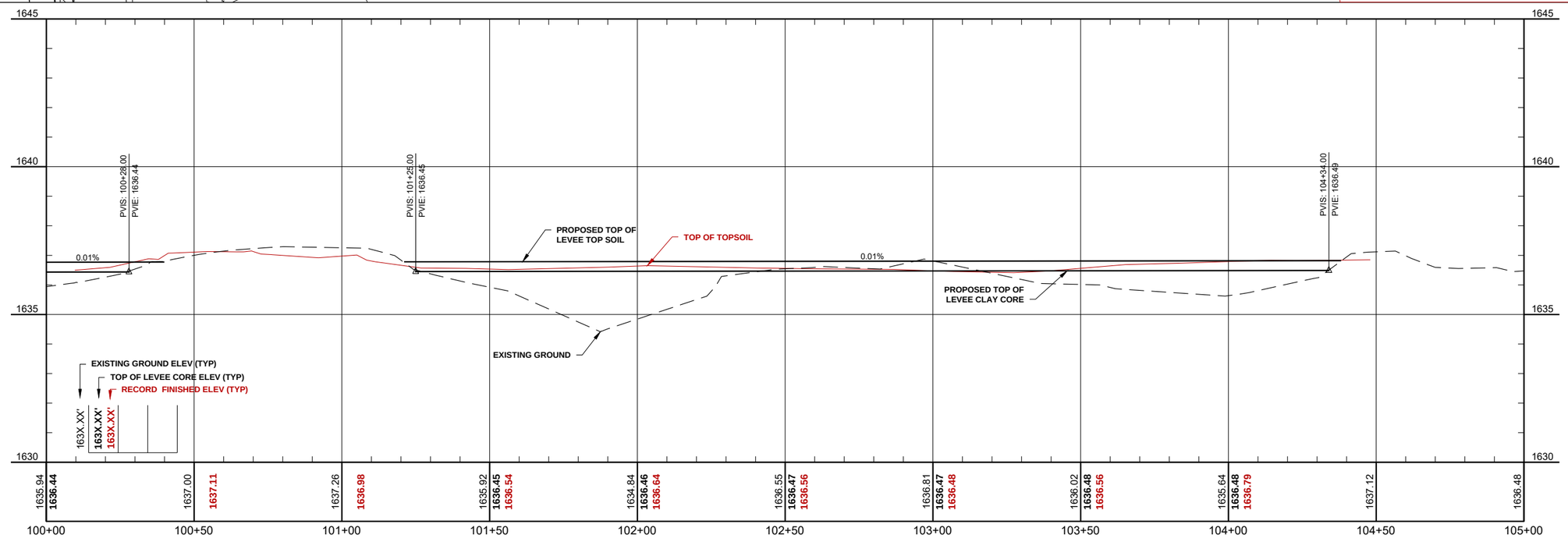

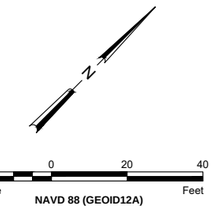

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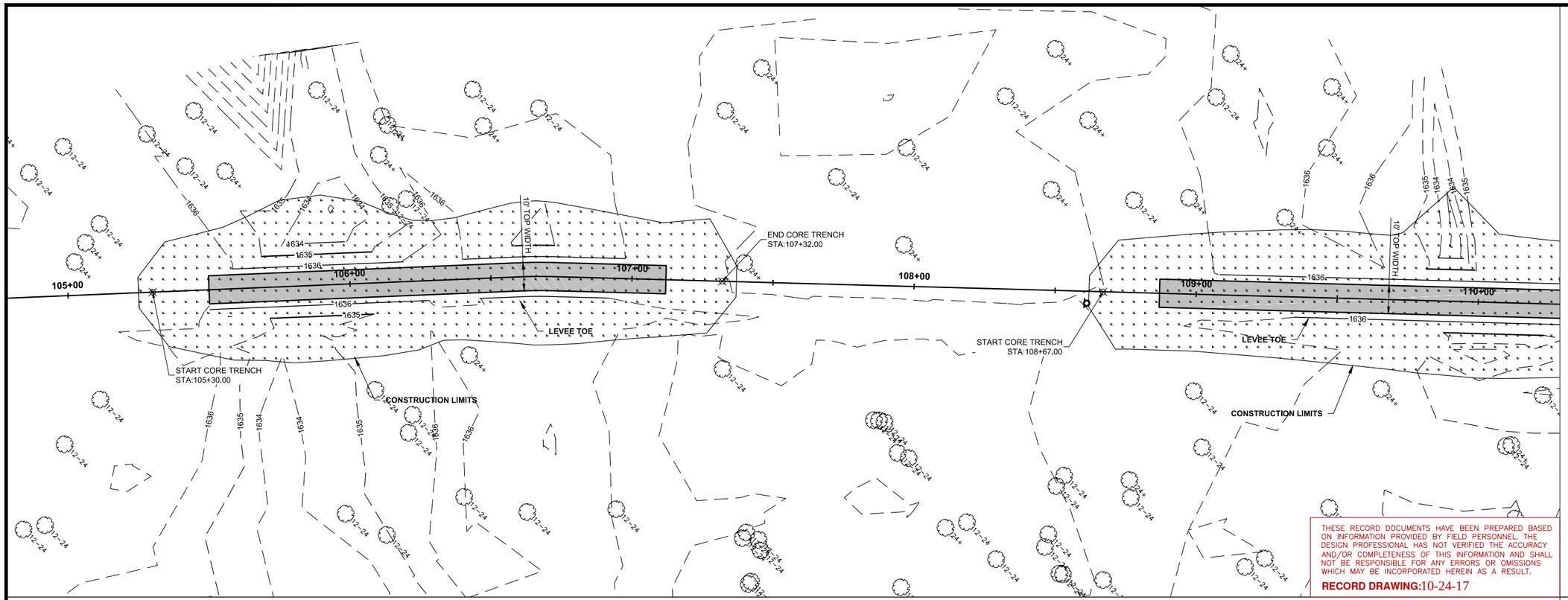
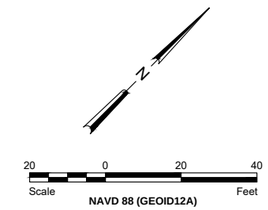
PLAN & PROFILE NORTH

PROJECT NO. 6025-012

SHEET 27 of 51





LEGEND

- SEEDING
- AGGREGATE SURFACE
- ASPHALT SURFACE

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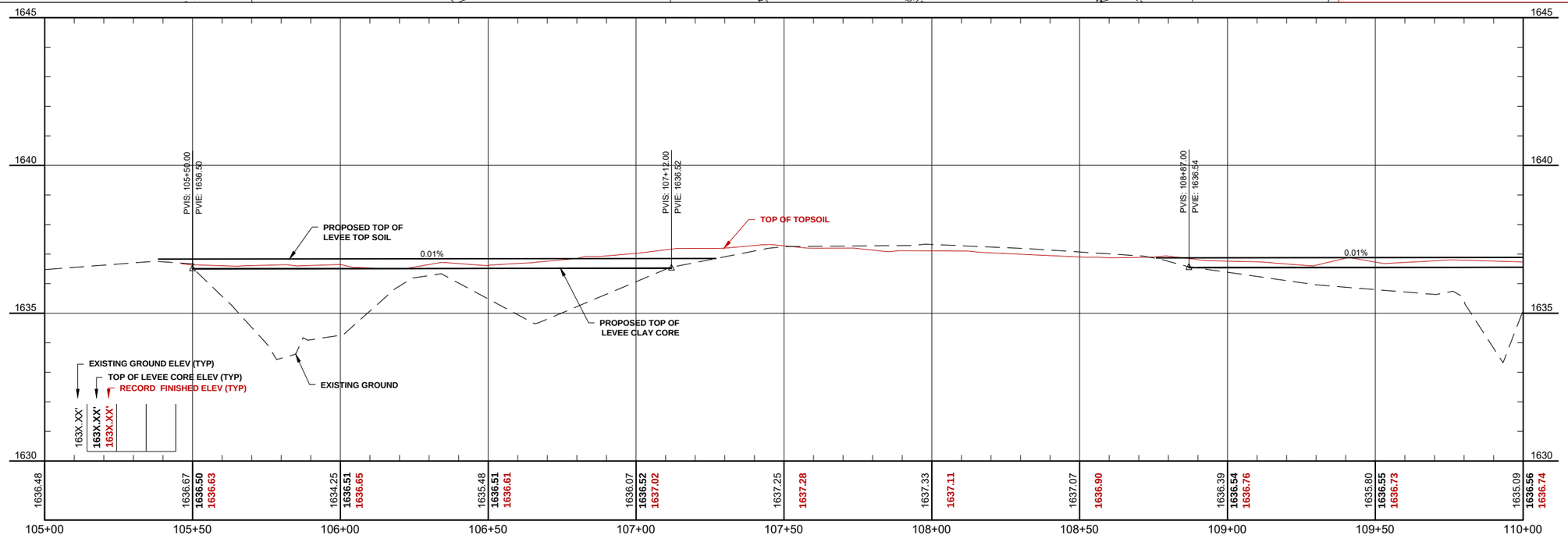
RECORD DRAWING:10-24-17



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No.	Revision	Date	By

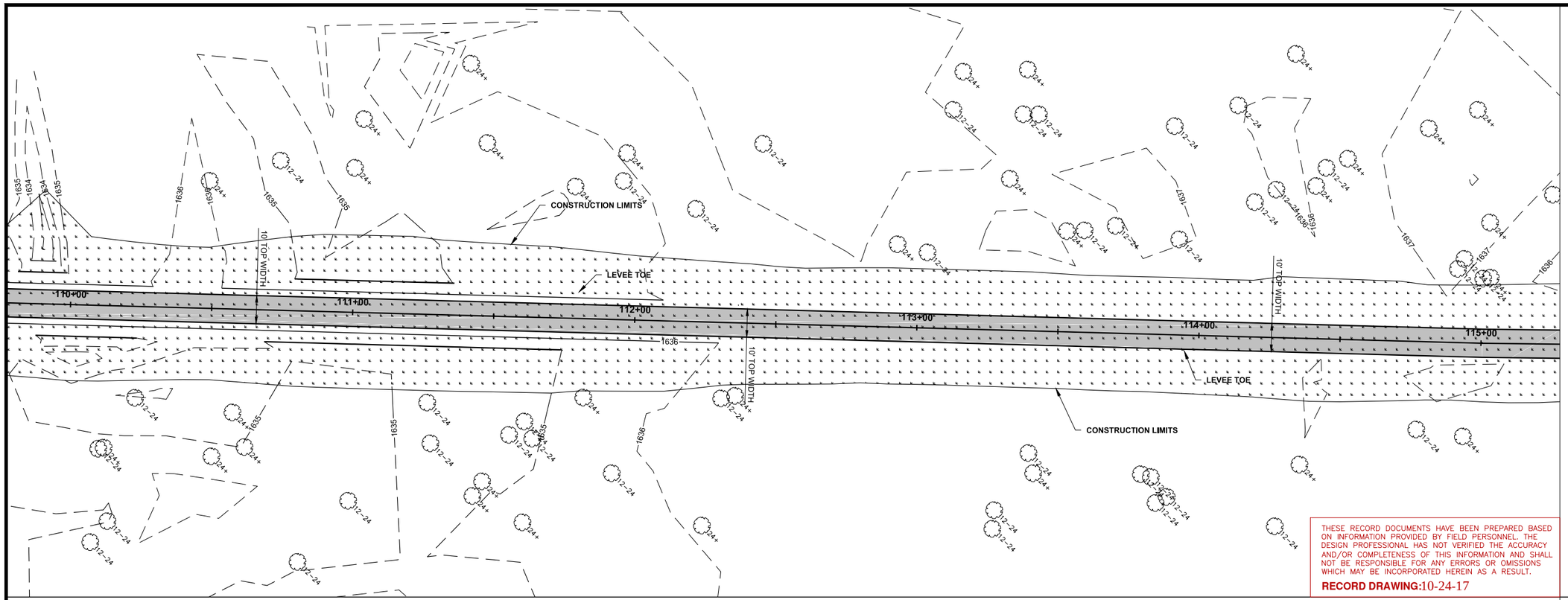
Houston Engineering Inc.
Bismarck
P: 701.323.0200
F: 701.323.0300

Drawn by	Date
AV	11-3-15
Checked by	Scale
TGJ	AS SHOWN

MRCC FLOOD CONTROL PROJECT
BURLEIGH COUNTY WATER RESOURCE DISTRICT
BURLEIGH COUNTY, NORTH DAKOTA

PLAN & PROFILE NORTH

PROJECT NO. 6025-012



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Scale Feet

NAVD 88 (GEOID12A)

LEGEND

SEEDING

AGGREGATE SURFACE

ASPHALT SURFACE

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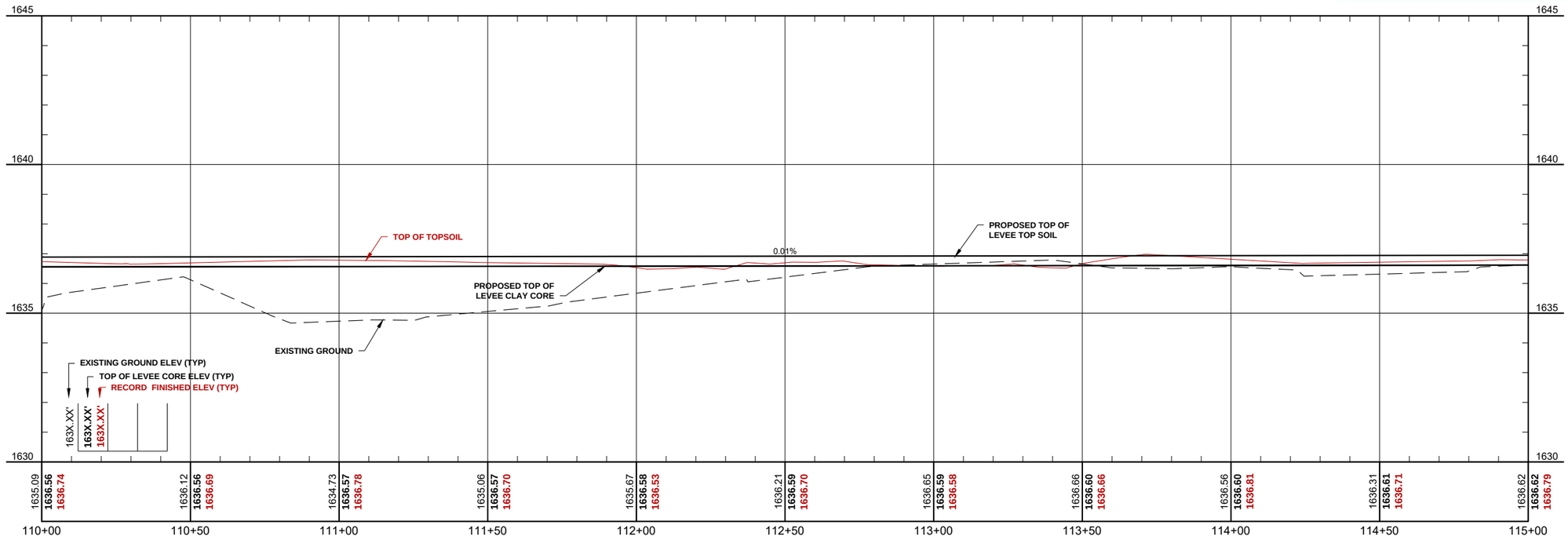

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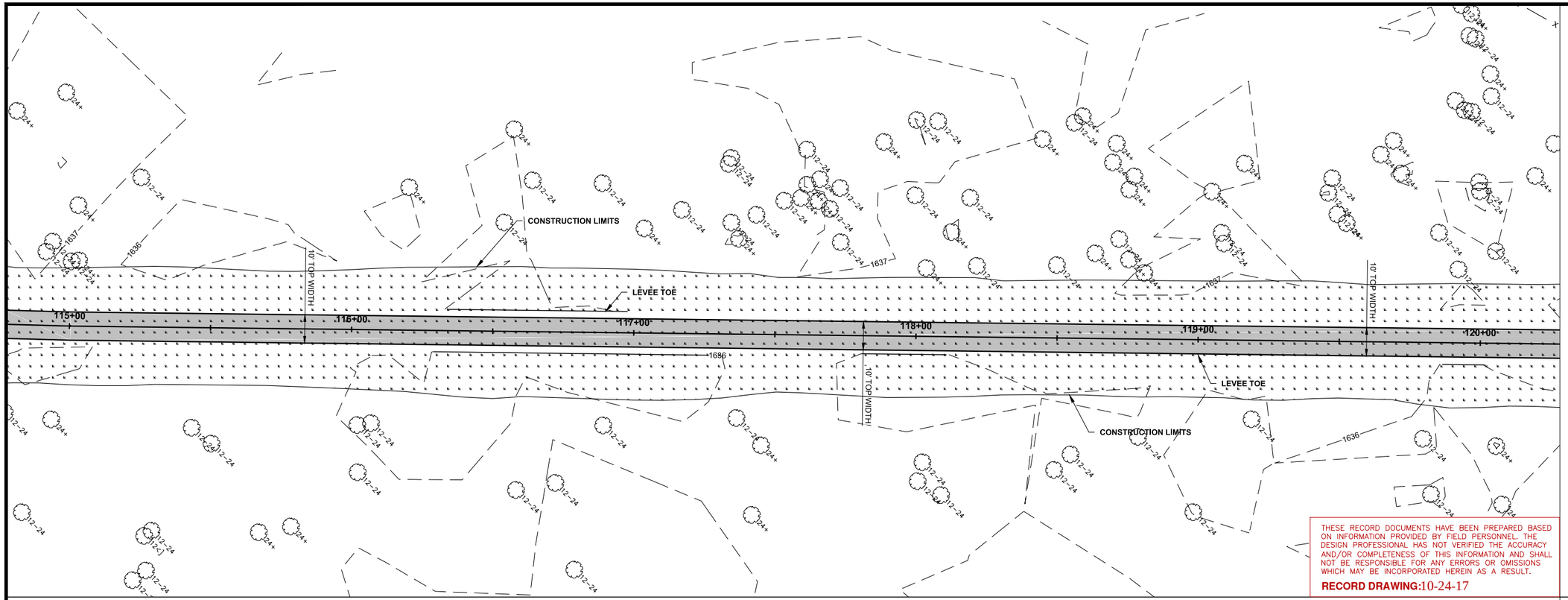
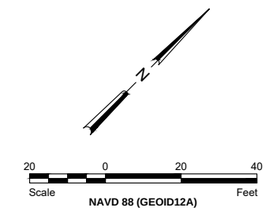
MRCC FLOOD CONTROL PROJECT
BURLEIGH COUNTY WATER RESOURCE DISTRICT
BURLEIGH COUNTY, NORTH DAKOTA

PLAN & PROFILE NORTH

PROJECT NO. 6025-012

SHEET 29 of 51





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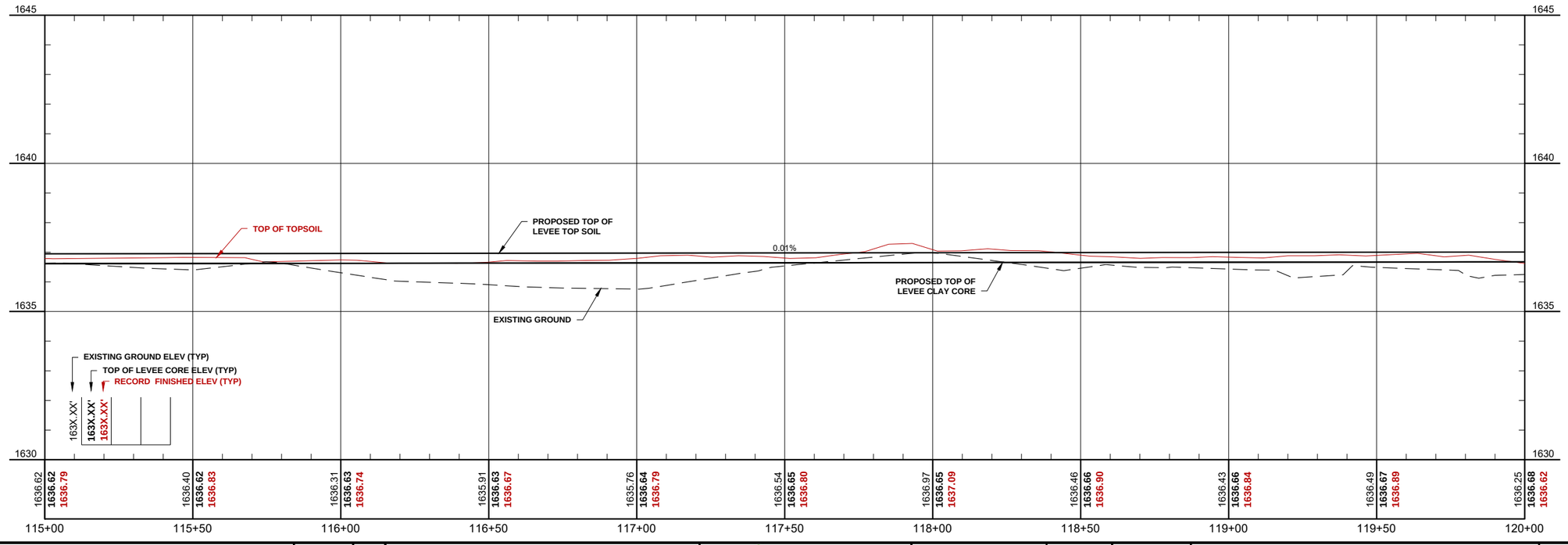

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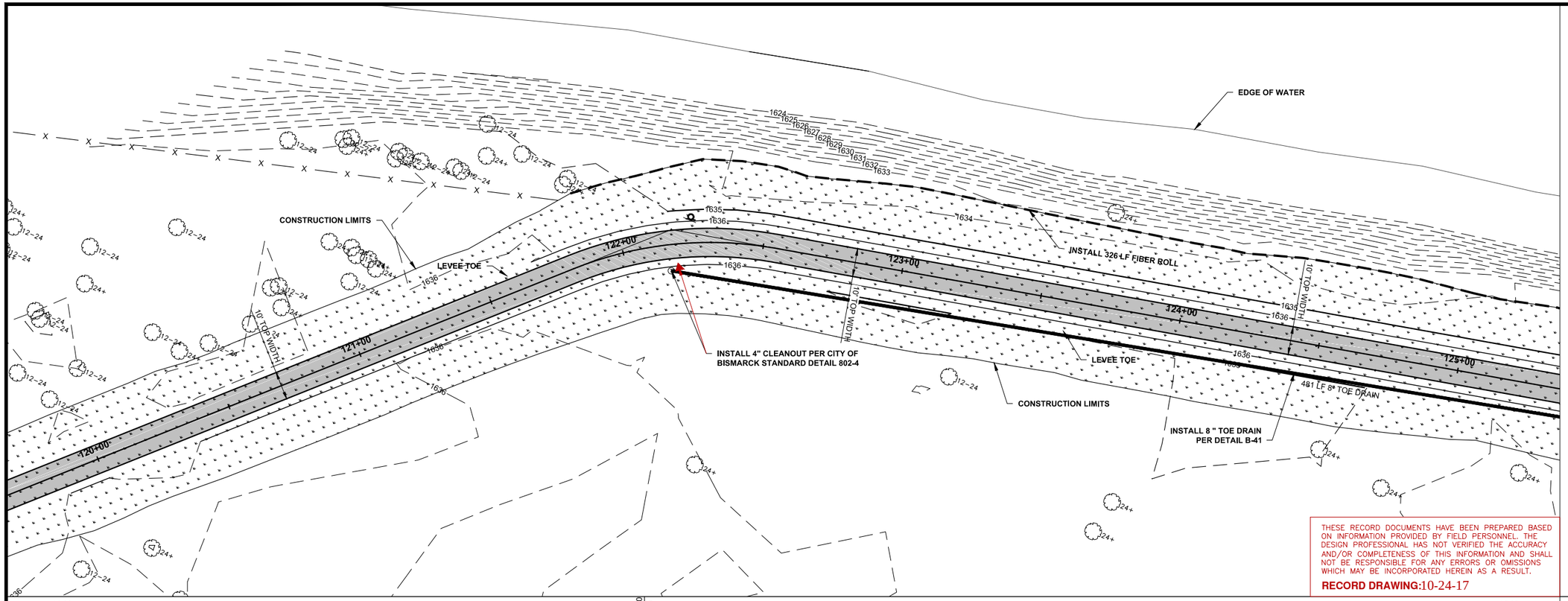
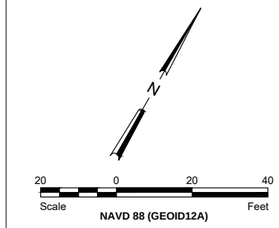
BURLEIGH COUNTY, NORTH DAKOTA

PLAN & PROFILE NORTH

PROJECT NO. 6025-012





LEGEND

- SEEDING
- AGGREGATE SURFACE
- ASPHALT SURFACE

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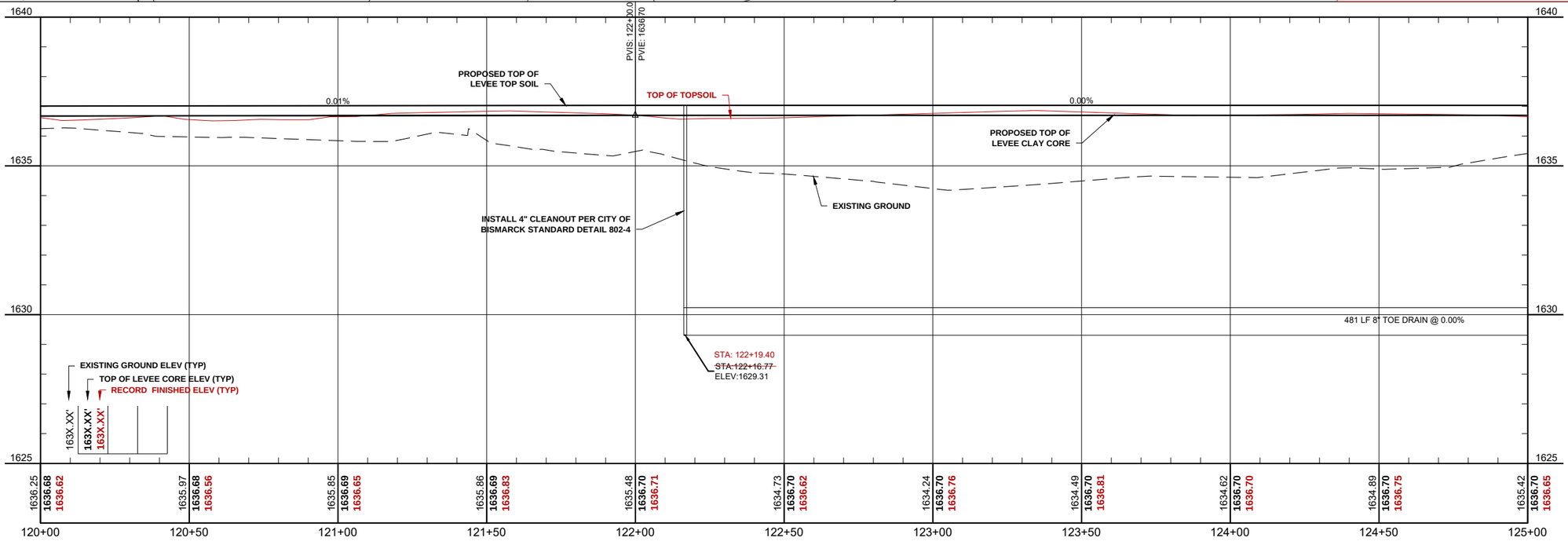

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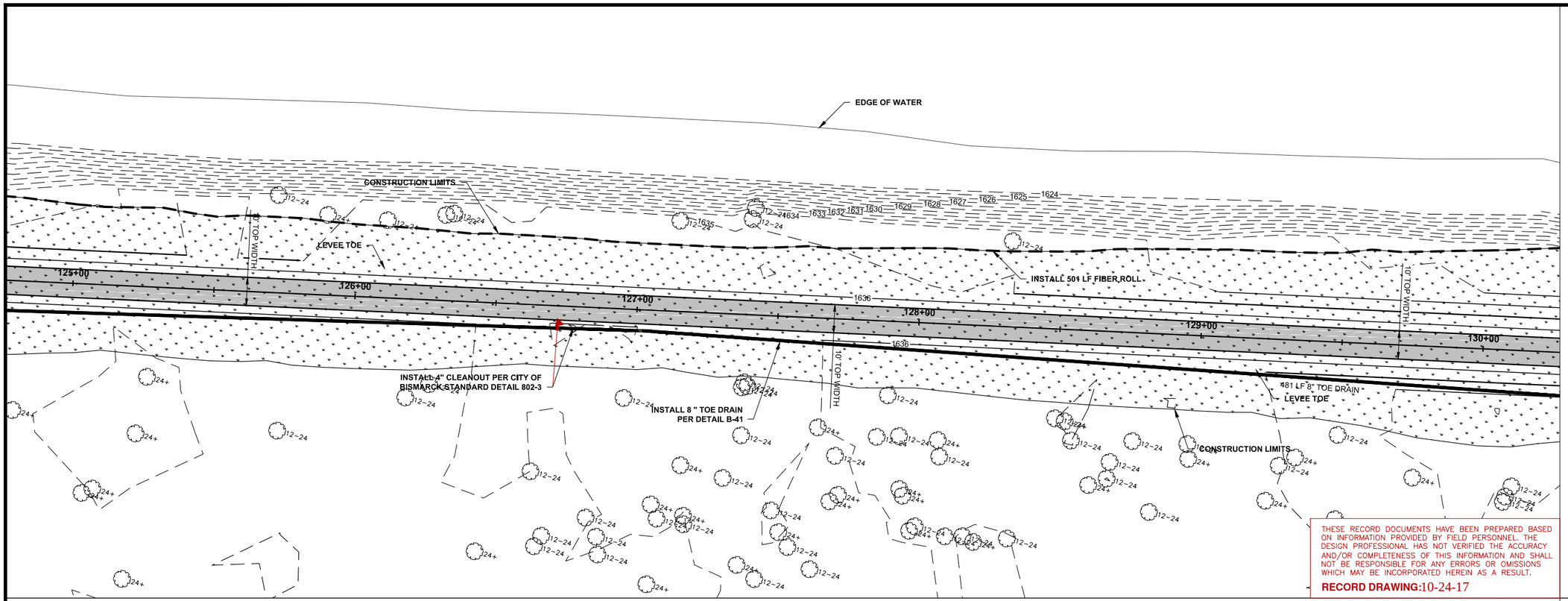
MRCC FLOOD CONTROL PROJECT
BURLEIGH COUNTY WATER RESOURCE DISTRICT
BURLEIGH COUNTY, NORTH DAKOTA

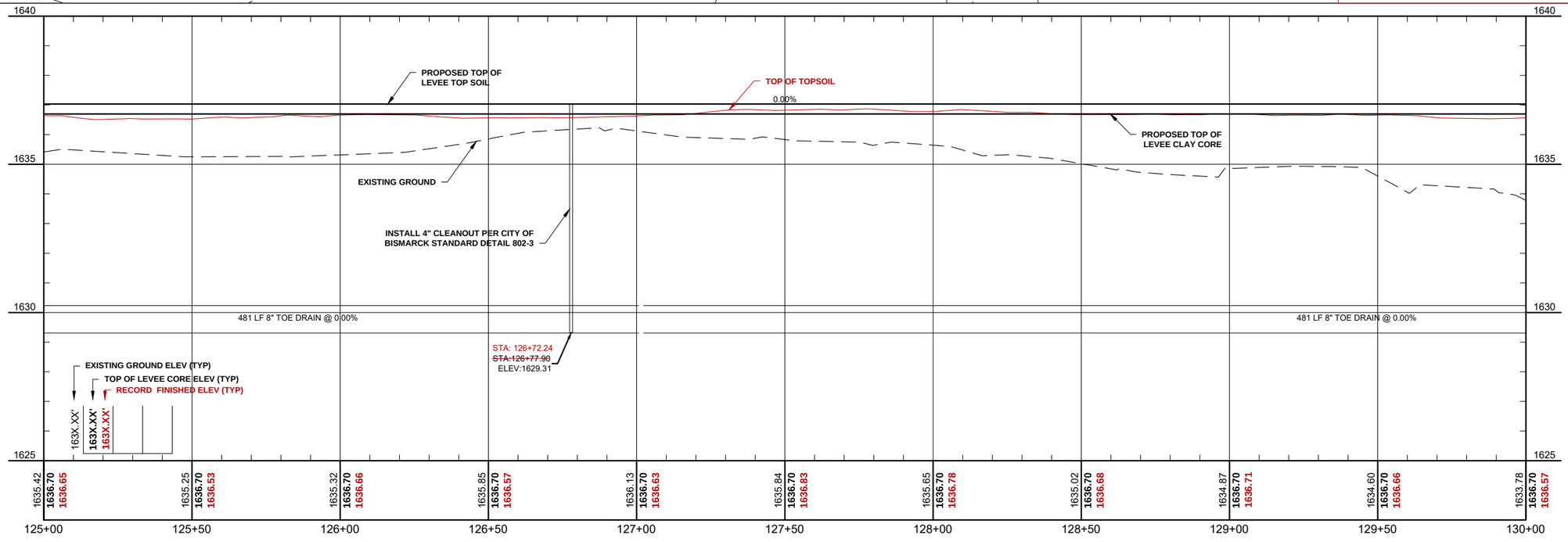
PLAN & PROFILE NORTH

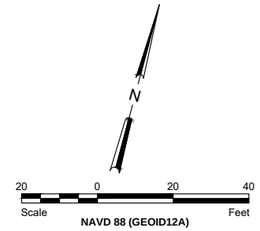
PROJECT NO. 6025-012

SHEET 31 of 51

H:\Bismarck\BN\6025 Burleigh Co. WRD\6025-012 MRCC Flood Control\CAD\Plans\Plan & Profile North.dwg-P&PN5-10/24/2017 4:13 PM-(tpaul)







LEGEND

- SEEDING
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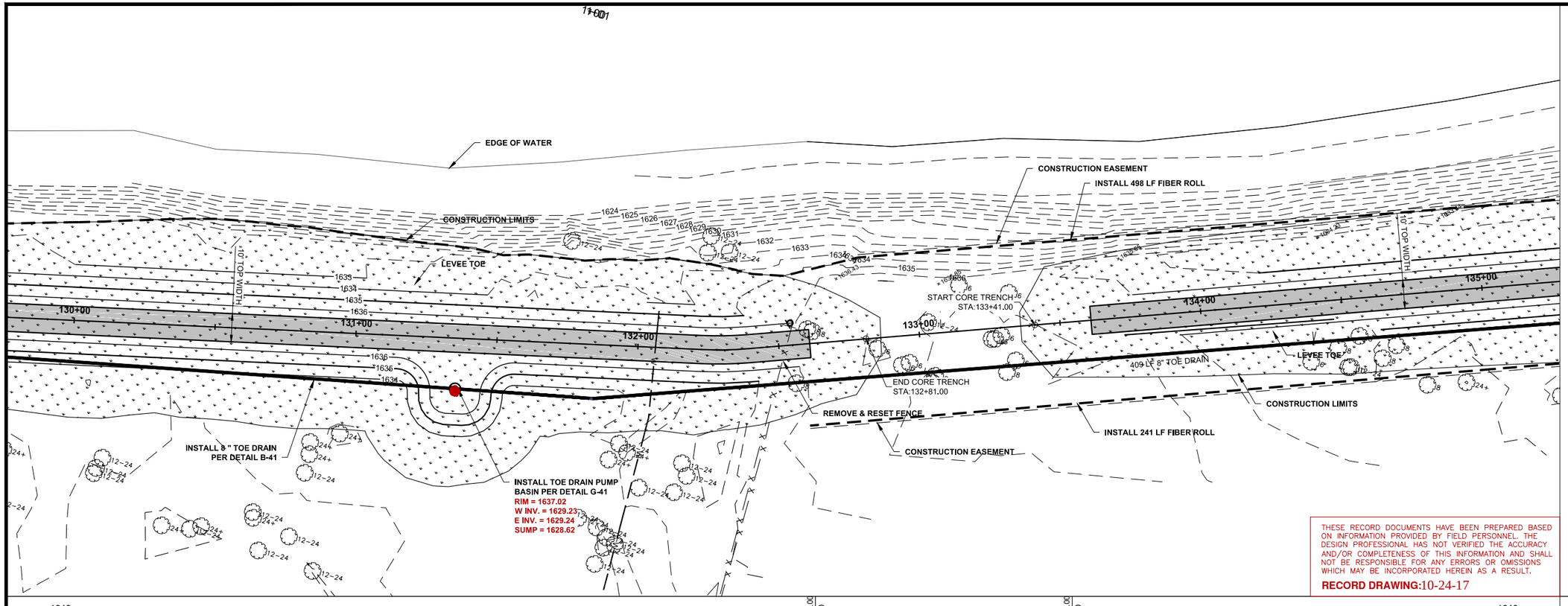
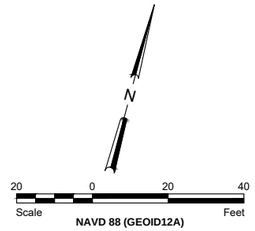
MRCC FLOOD CONTROL PROJECT
BURLEIGH COUNTY WATER RESOURCE DISTRICT
BURLEIGH COUNTY, NORTH DAKOTA

PLAN & PROFILE NORTH

PROJECT NO. 6025-012

SHEET 32 of 51





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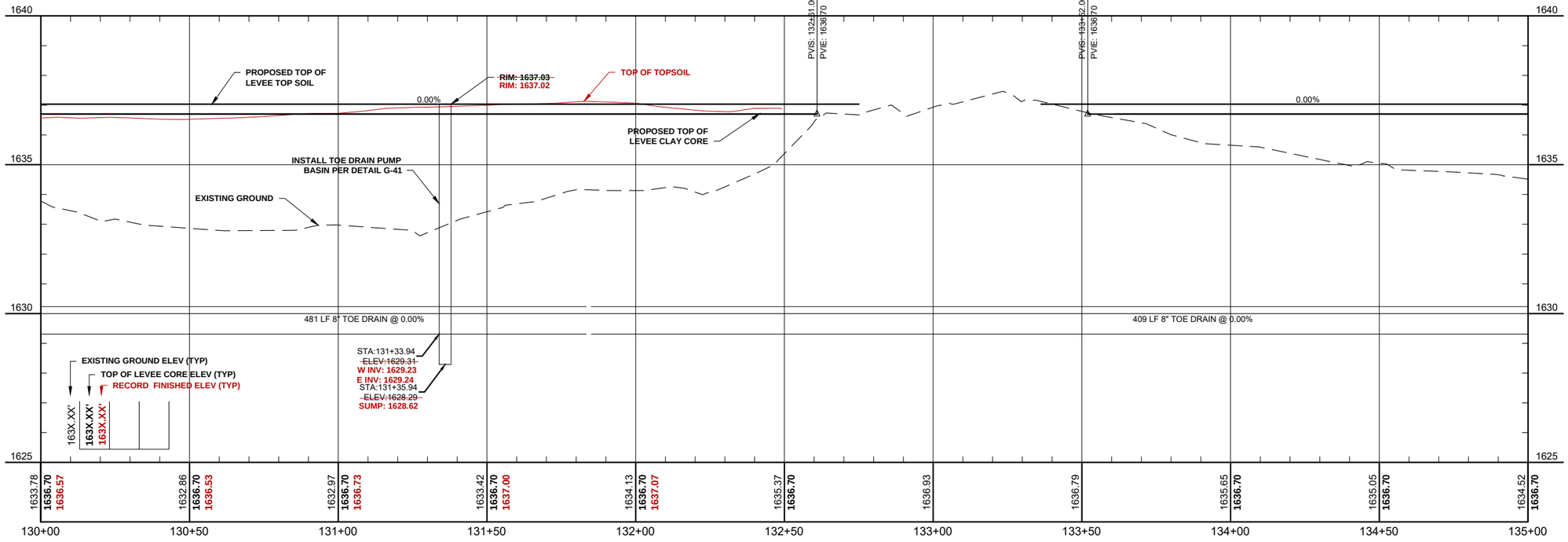

1633.78	1632.86	1632.97	1633.42
1636.70	1636.70	1636.70	1636.70
1636.57	1636.53	1636.73	1637.00

1634.13	1635.37	1636.93	1636.79
1636.70	1636.70		
1637.07			

1635.65	1635.05	1634.52
1636.70	1636.70	1636.70

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BURLEIGH COUNTY WATER RESOURCE DISTRICT
BURLEIGH COUNTY, NORTH DAKOTA

PLAN & PROFILE NORTH

PROJECT NO. 6025-012

SHEET 33 of 51

EDGE OF WATER

CONSTRUCTION LIMITS

REMOVE & RESET FENCE

PET CEMETERY
DO NOT DISTURB

LEVEE TOE

10' TOP WIDTH

INSTALL 509 LF FIBER ROLL

CONSTRUCTION EASEMENT

135+00

136+00

137+00

138+00

139+00

140+00

END CORE TRENCH
STA:140+69.29

140+86

142 LF 8" TOE DRAIN

INSTALL 4" CLEANOUT PER CITY OF
BISMARCK STANDARD DETAIL 802-4

308 LF 8" TOE DRAIN

INSTALL 8 " TOE DRAIN
PER DETAIL B-41

INSTALL 488 LF FIBER ROLL

CONSTRUCTION EASEMENT

CONSTRUCTION LIMITS

INSTALL 4" CLEANOUT PER CITY OF
BISMARCK STANDARD DETAIL 802-3

N

20 0 20 40
Scale Feet

NAVD 88 (GEOID12A)

LEGEND

SEEDING

AGGREGATE SURFACE

ASPHALT SURFACE

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RECORD DRAWING:10-24-17

PVIS: 140+49.30
PVIE: 1636.70

NOTE: PROPOSED TOP OF LEVEE CLAY CORE PROFILE ACCOUNTS FOR 2" OF SETTLEMENT AS CALCULATED BY BRAUN INTERTEC

PROPOSED TOP OF LEVEE TOP SOIL

PROPOSED TOP OF LEVEE CLAY CORE

EXISTING GROUND

0.00%

409 LF 8" TOE DRAIN @ 0.00%

308 LF 8" TOE DRAIN @ 0.07%

142 LF 8" TOE DRAIN @ 0.04%

STA:136+00.00
ELEV:1629.31

STA:140+48.79
ELEV:1629.56

EXISTING GROUND ELEV (TYP)

TOP OF LEVEE CORE ELEV (TYP)

163X.XX'

163X.XX'

1640 1635 1630 1625

135+00	135+50	136+00	136+50	137+00	137+50	138+00	138+50	139+00	139+50	140+00
1634.52	1634.70	1633.90	1634.23	1634.82	1635.96	1635.99	1635.61	1634.97	1634.45	1635.38
1636.70	1636.70	1636.70	1636.70	1636.70	1636.70	1636.70	1636.70	1636.70	1636.70	1636.70

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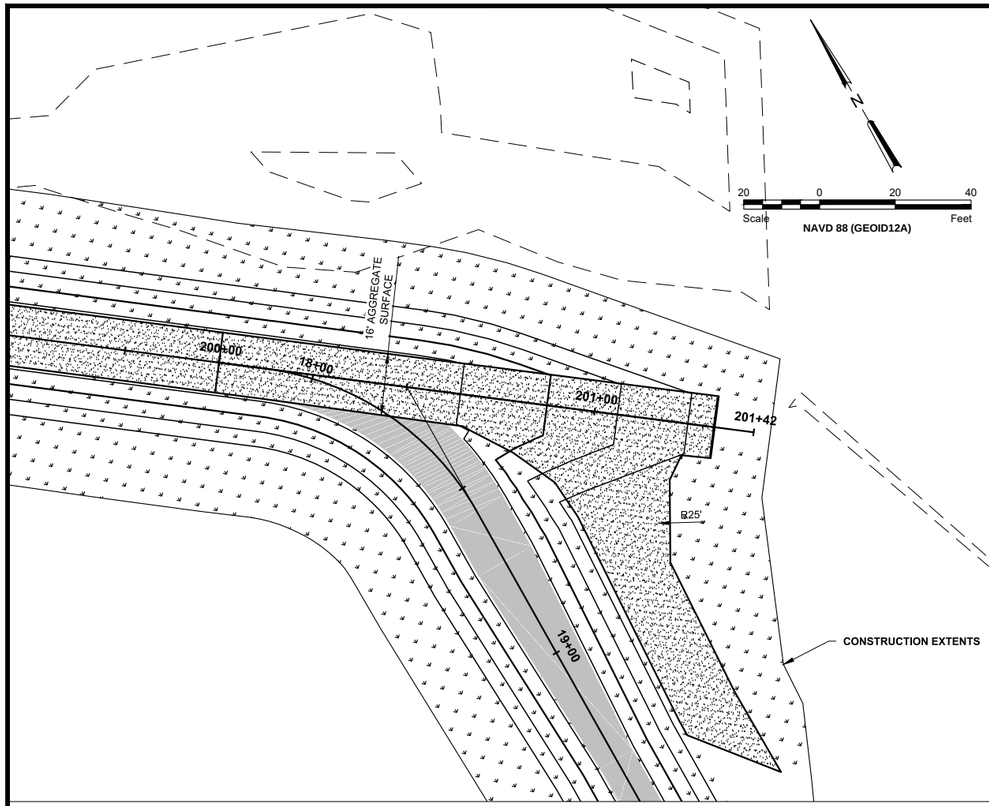
TGJ	AS SHOWN

MRCC FLOOD CONTROL PROJECT
BURLEIGH COUNTY WATER RESOURCE DISTRICT
BURLEIGH COUNTY, NORTH DAKOTA

PLAN & PROFILE NORTH

PROJECT NO. 6025-012

SHEET 34 of 51



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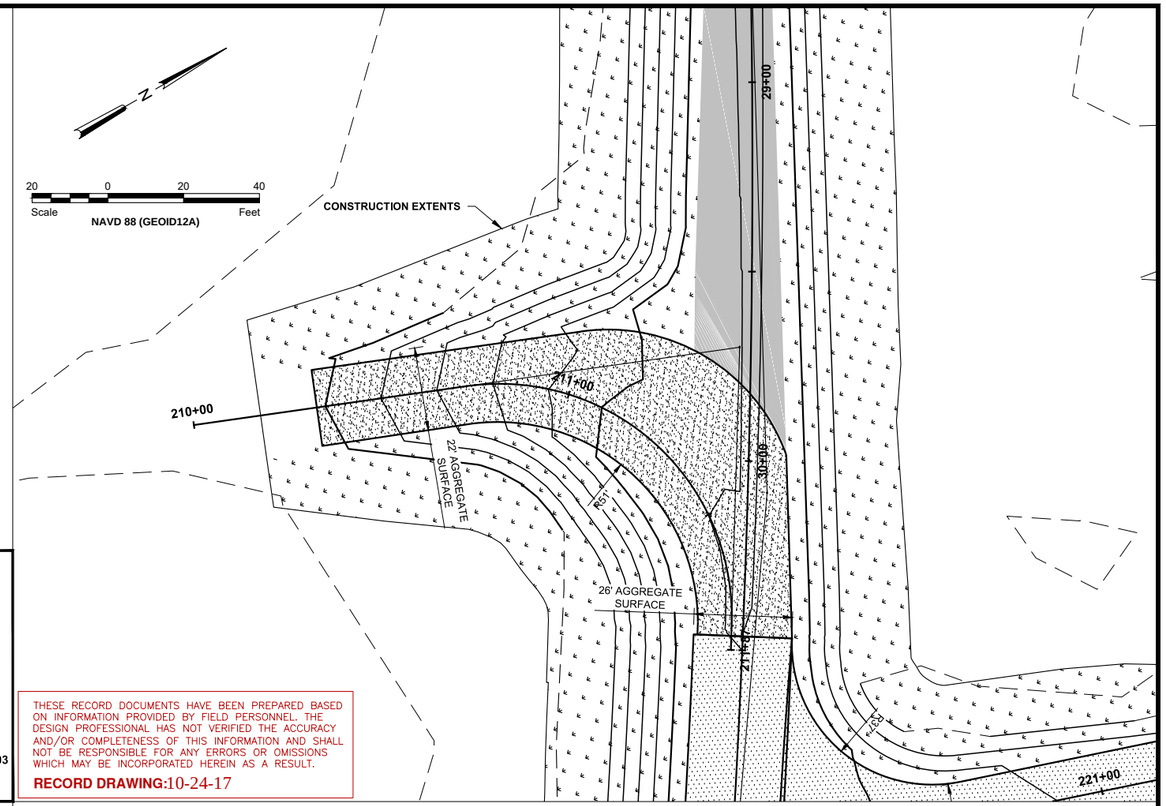

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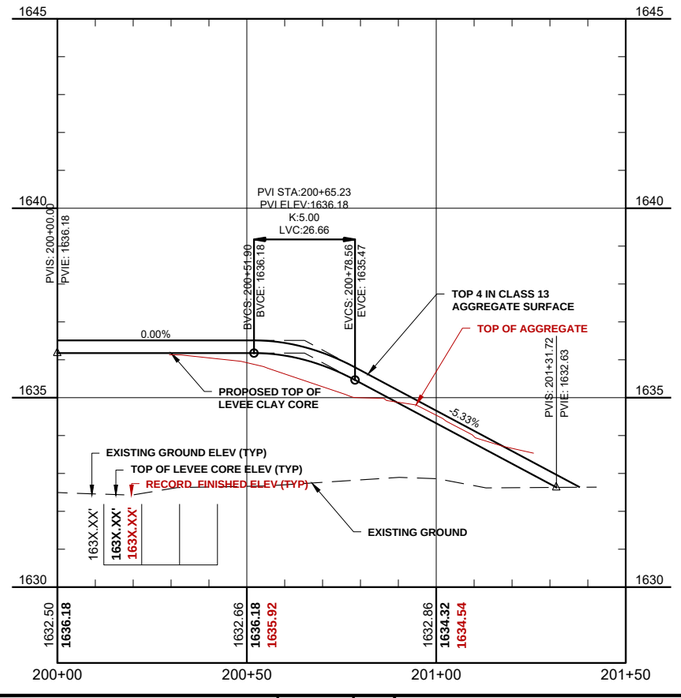

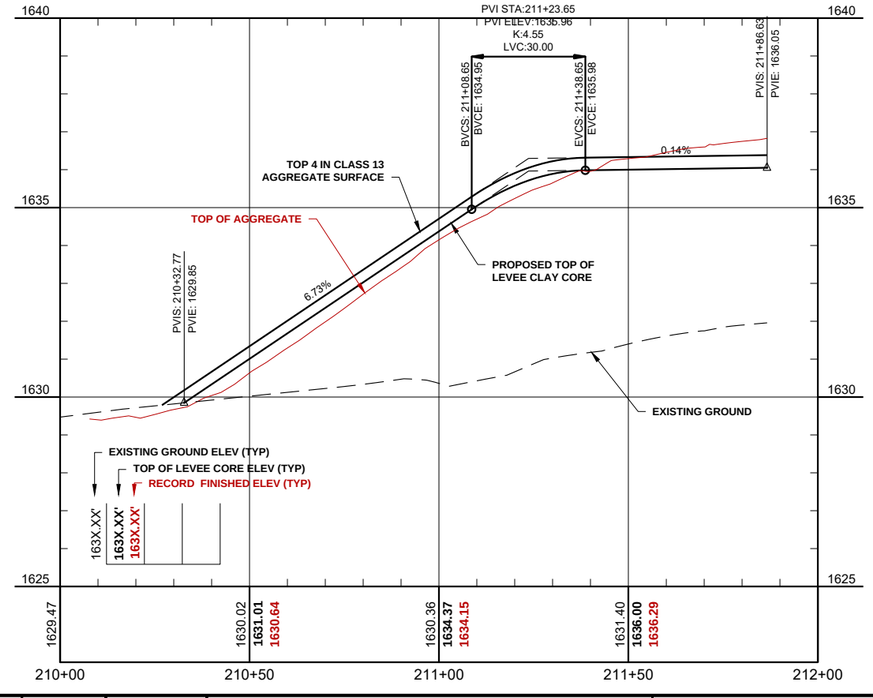

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MRCC FLOOD CONTROL PROJECT
BURLEIGH COUNTY WATER RESOURCE DISTRICT
BURLEIGH COUNTY, NORTH DAKOTA

MRCC APPROACH

PROJECT NO. 6025-012

SHEET 35 of 51

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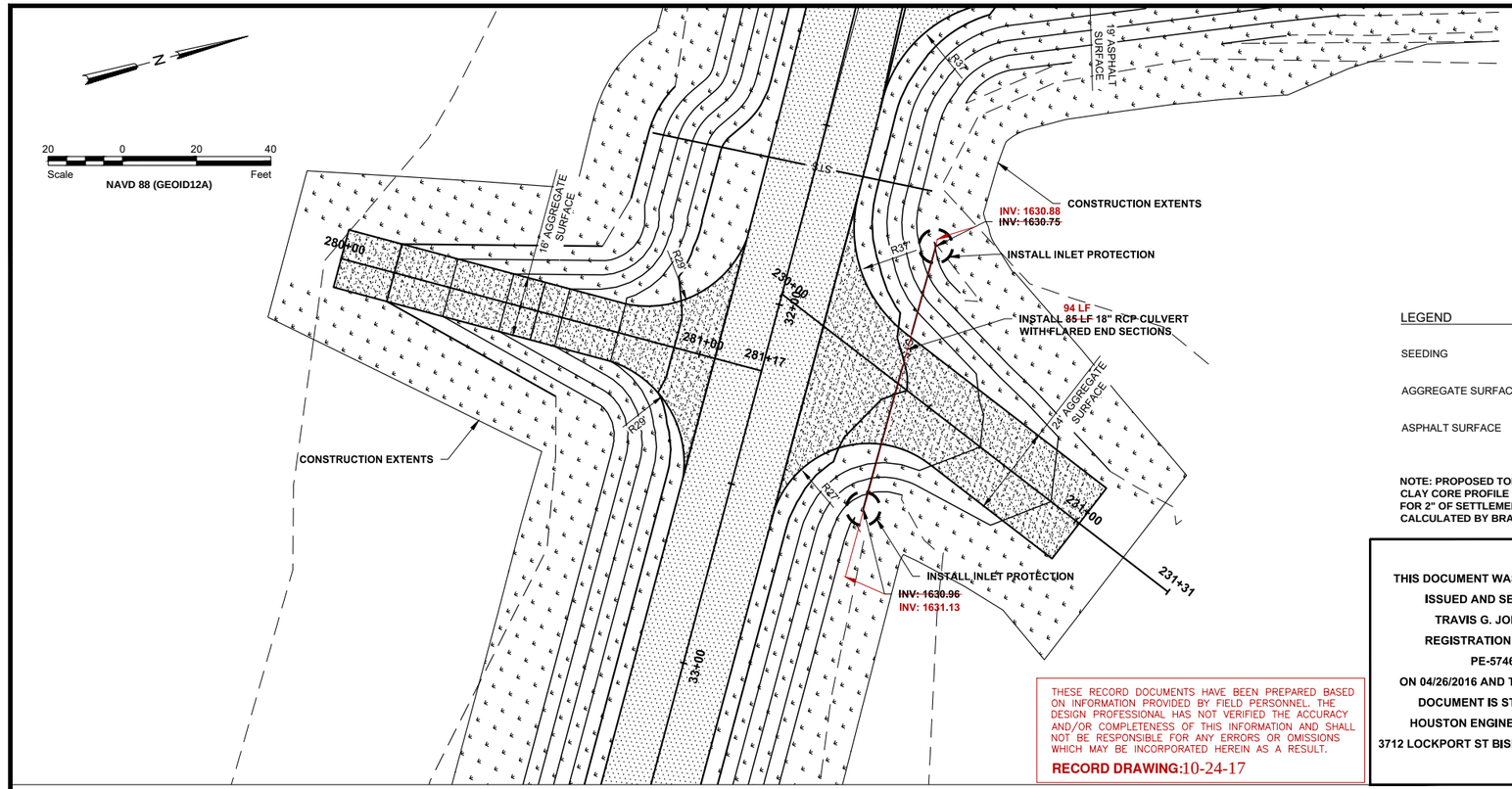

LEGEND

- SEEDING
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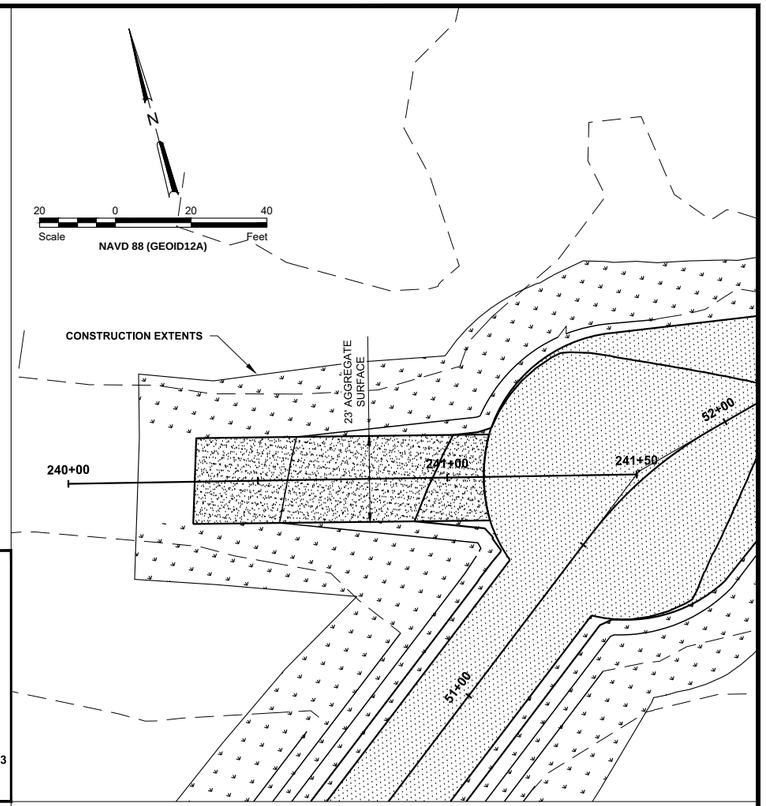

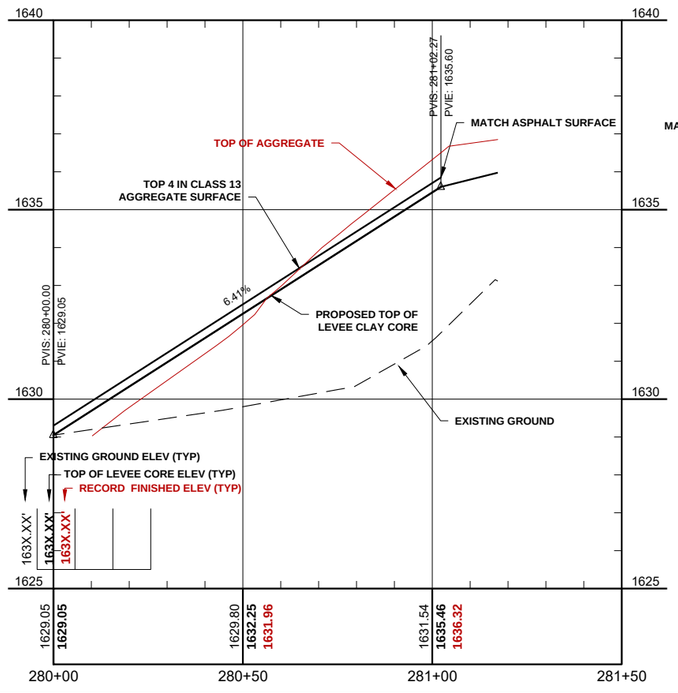

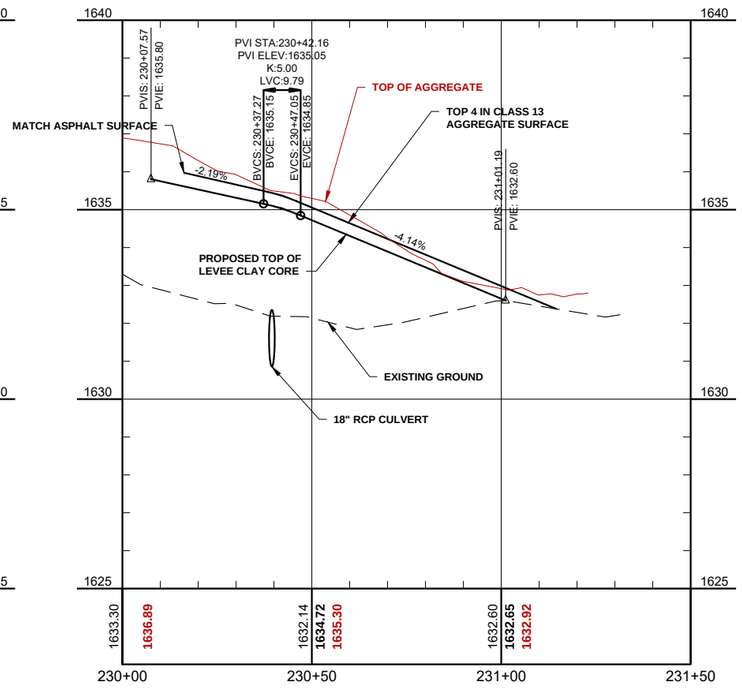

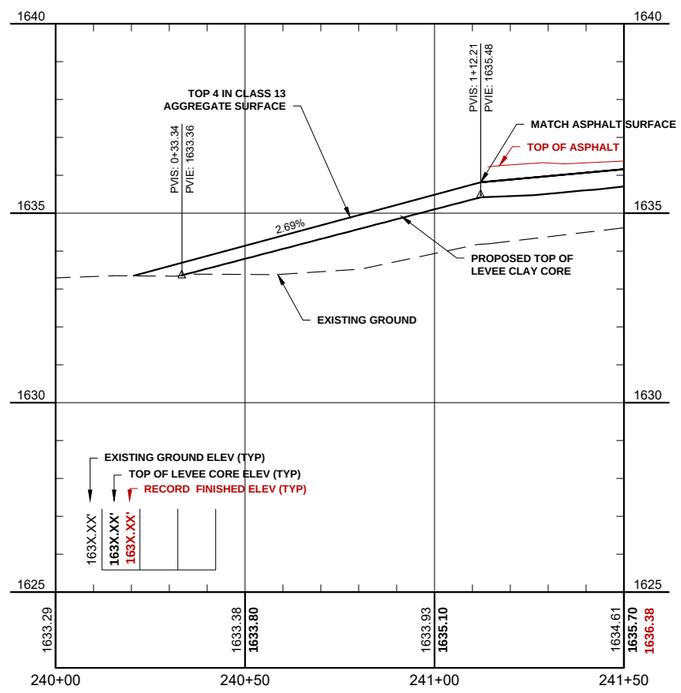

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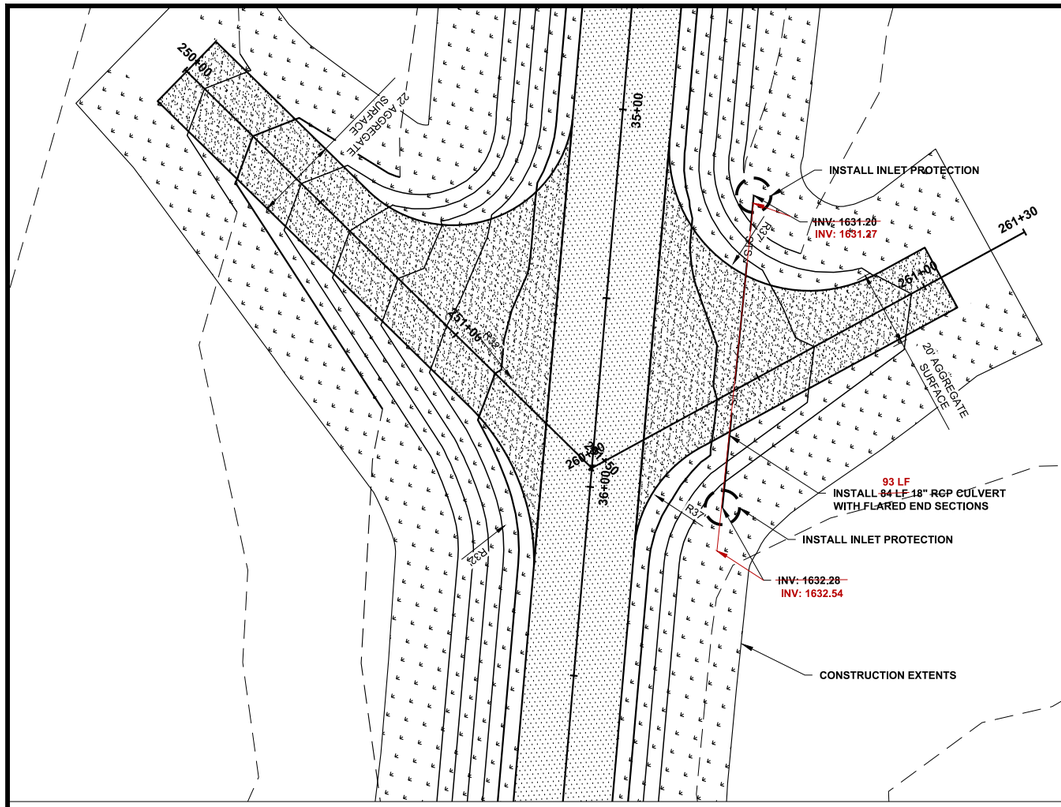
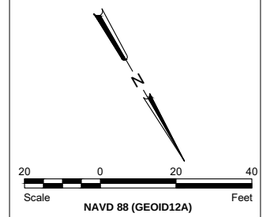
MRCC FLOOD CONTROL PROJECT
BURLEIGH COUNTY WATER RESOURCE DISTRICT
BURLEIGH COUNTY, NORTH DAKOTA

MRCC APPROACH

PROJECT NO. 6025-012

SHEET 36 of 51





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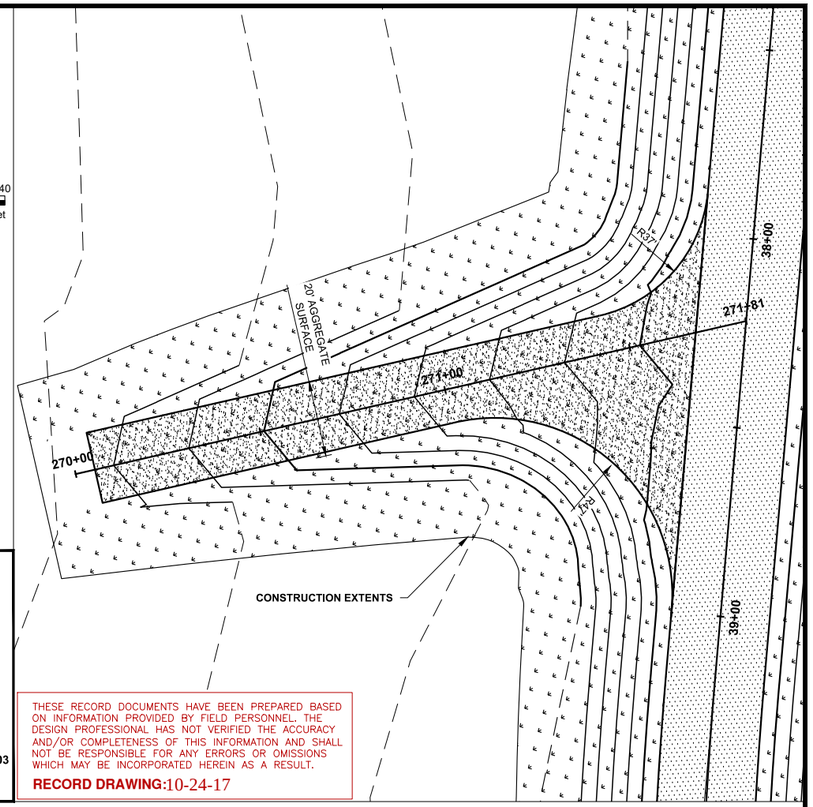

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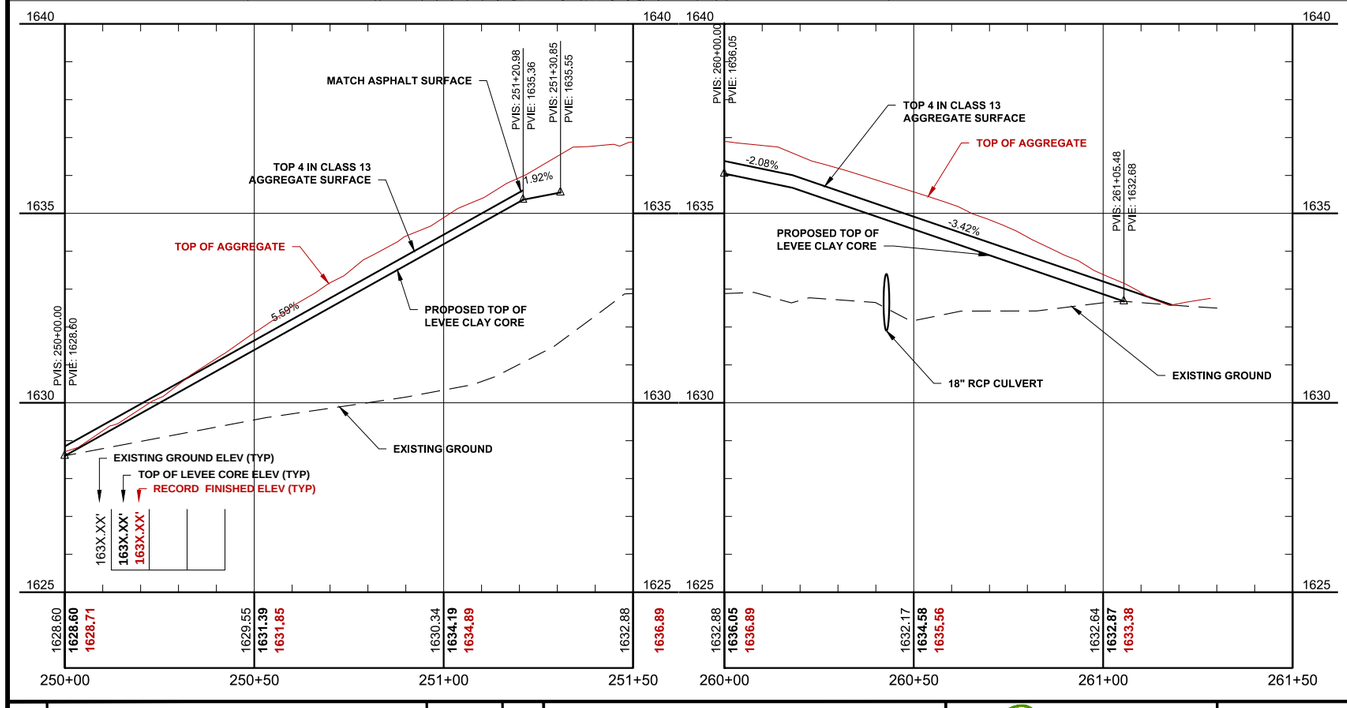

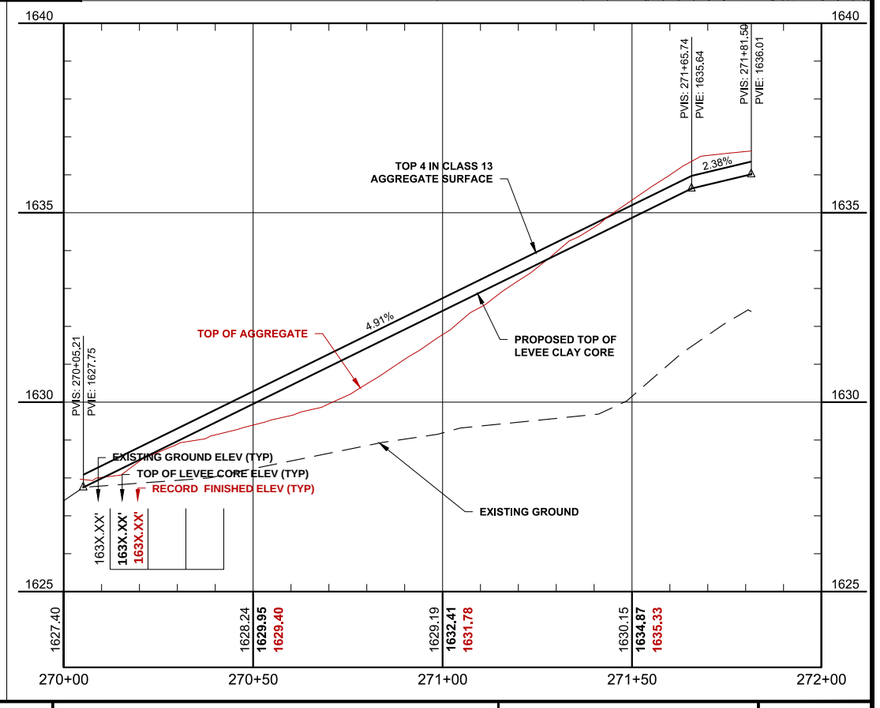

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Houston Engineering Inc.

Bismarck
P: 701.323.0200
F: 701.323.0300

Drawn by	Date
AV	11-3-15
Checked by	Scale
TGJ	AS SHOWN

MRCC FLOOD CONTROL PROJECT
BURLEIGH COUNTY WATER RESOURCE DISTRICT
BURLEIGH COUNTY, NORTH DAKOTA

MRCC APPROACH
PROJECT NO. 6025-012

SHEET
37 of 51

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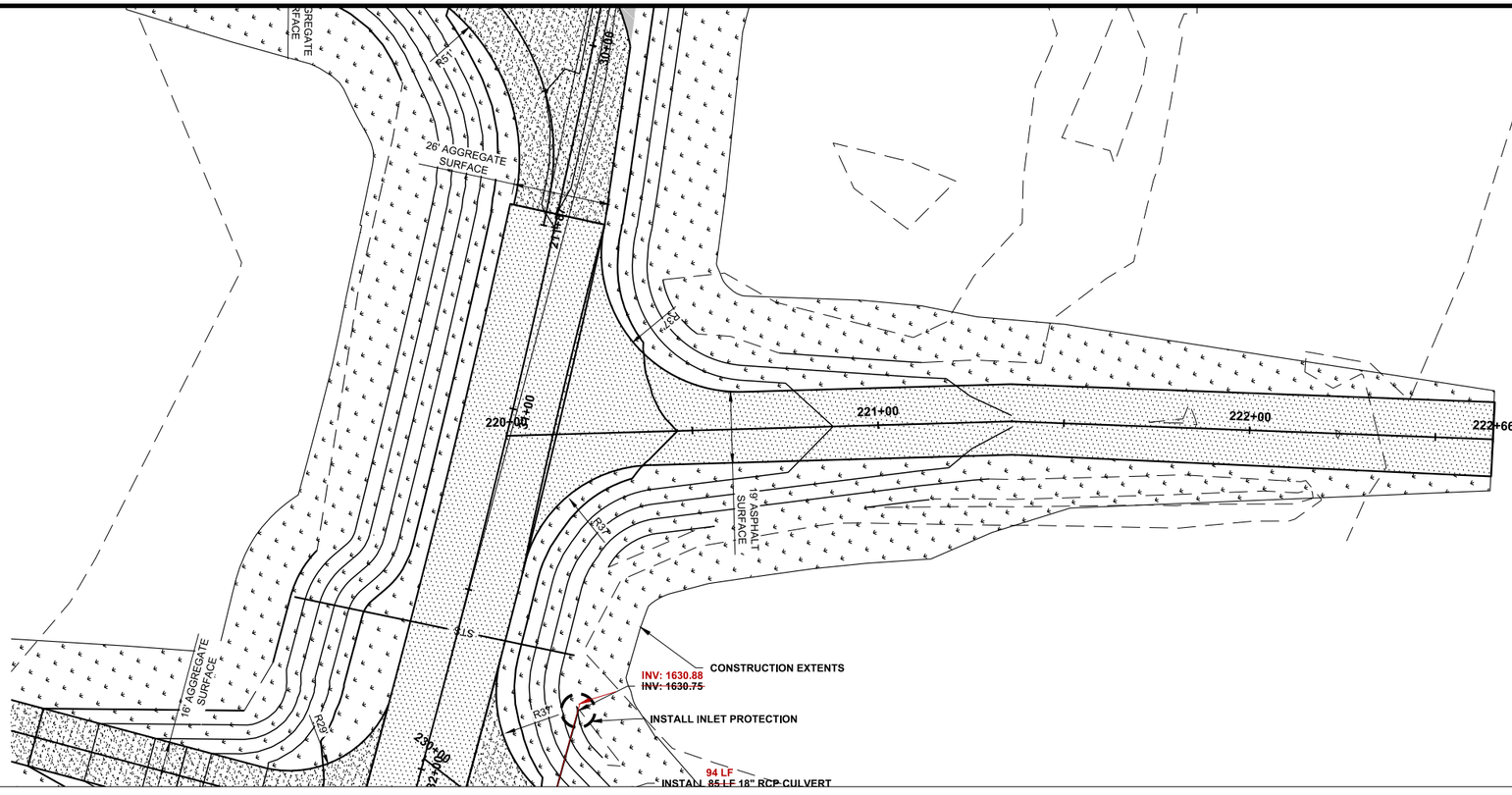

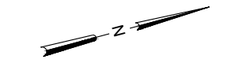

20 0 20 40
Scale Feet

NAVD 88 (GEOID12A)

LEGEND

SEEDING

AGGREGATE SURFACE

ASPHALT SURFACE

NOTE: PROPOSED TOP OF LEVEE CLAY CORE PROFILE ACCOUNTS FOR 2" OF SETTLEMENT AS CALCULATED BY BRAUN INTERTEC

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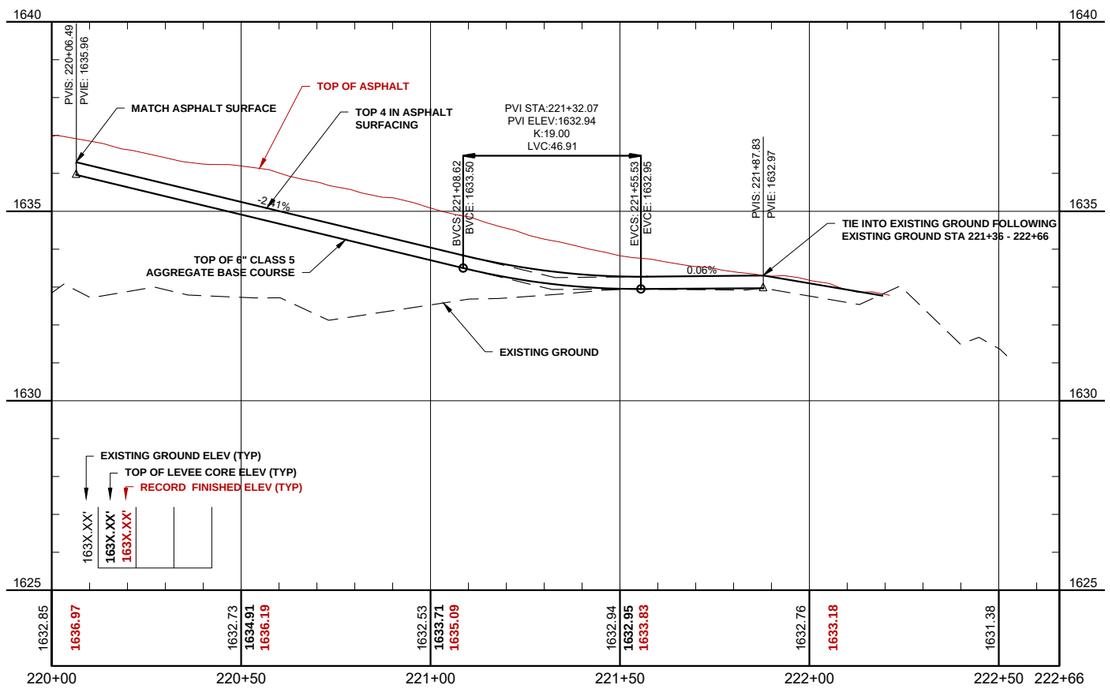

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MRCC FLOOD CONTROL PROJECT
BURLEIGH COUNTY WATER RESOURCE DISTRICT
BURLEIGH COUNTY, NORTH DAKOTA

MRCC APPROACH

PROJECT NO. 6025-012

SHEET 38 of 51

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MRCC FLOOD CONTROL PROJECT
BURLEIGH COUNTY WATER RESOURCE DISTRICT
BURLEIGH COUNTY, NORTH DAKOTA

TEMPORARY ACCESS

PROJECT NO. 6025-012

SHEET 39 of 51

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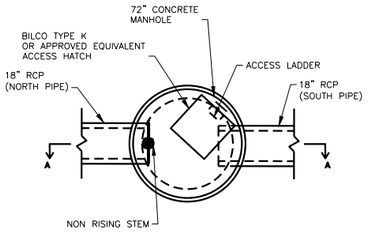
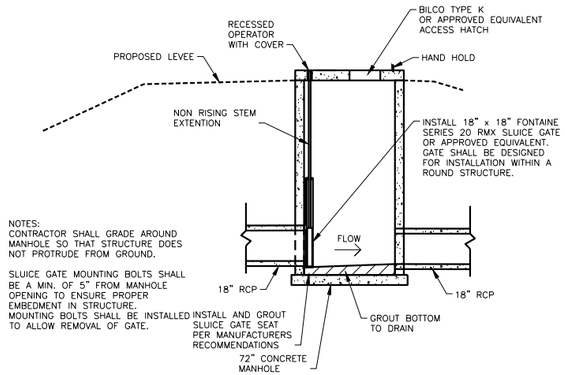
BURLEIGH COUNTY WATER RESOURCE DISTRICT
BURLEIGH COUNTY, NORTH DAKOTA

TRAFFIC CONTROL

PROJECT NO. 6025-012



PLAN VIEW

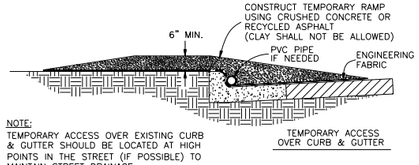


NOTES:
CONTRACTOR SHALL GRADE AROUND MANHOLE SO THAT STRUCTURE DOES NOT PROTRUDE FROM GROUND.

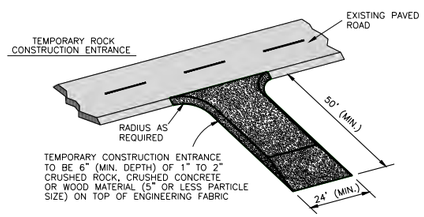
SLUICE GATE MOUNTING BOLTS SHALL BE A MIN. OF 5" FROM MANHOLE OPENING TO ENSURE PROPER EMBEDMENT IN STRUCTURE. MOUNTING BOLTS SHALL BE INSTALLED TO ALLOW REMOVAL OF GATE.

SECTION A - A

A 41 GATEWELL DETAIL (STA. 31+61 and 49+29)
NOT TO SCALE



NOTE:
TEMPORARY ACCESS OVER EXISTING CURB & GUTTER SHOULD BE LOCATED AT HIGH POINTS IN THE STREET (IF POSSIBLE) TO MAINTAIN STREET DRAINAGE



NOTES:
1. A TEMPORARY CONSTRUCTION ENTRANCE SHALL BE CONSTRUCTED AT ALL LOCATIONS WHERE CONSTRUCTION VEHICLES OR EQUIPMENT ENTER OR EXIT THE CONSTRUCTION SITES THAT ARE OVER 5 ACRES AND MAY BE REQUIRED BETWEEN 1 AND 5 ACRES AS DIRECTED BY THE ENGINEER.

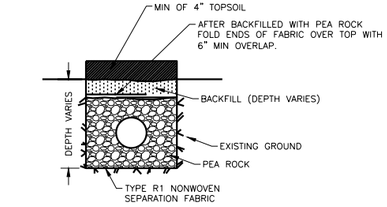
2. UPON COMPLETION OF THE PROJECT, THE CONTRACTOR SHALL REMOVE THE TEMPORARY CONSTRUCTION ENTRANCE UNLESS NOTED OTHERWISE, AND THE SITE SHALL BE RESTORED TO IT'S PREVIOUS CONDITION.

3. ENTRANCES SHALL BE MAINTAINED IN A MANNER TO MINIMIZE THE TRACKING OF SEDIMENT ONTO PAVED SURFACES.

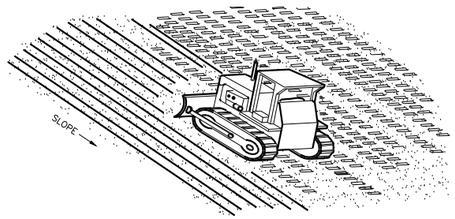
4. THE LOCATION OF TEMPORARY ENTRANCES SHALL BE AS SHOWN ON THE PLANS. IF NOT SHOWN ON THE PLANS, THE CONTRACTOR SHALL COORDINATE THE LOCATIONS WITH THE ENGINEER.

5. COSTS ASSOCIATED WITH CONSTRUCTION, MAINTENANCE AND REMOVAL OF TEMPORARY ENTRANCES SHALL BE INCLUDED IN THE BID ITEM "TEMPORARY CONSTRUCTION ENTRANCE".

F 41 TEMP. CONSTRUCTION ENTRANCE
NOT TO SCALE



B 41 8" TOE DRAIN
NOT TO SCALE



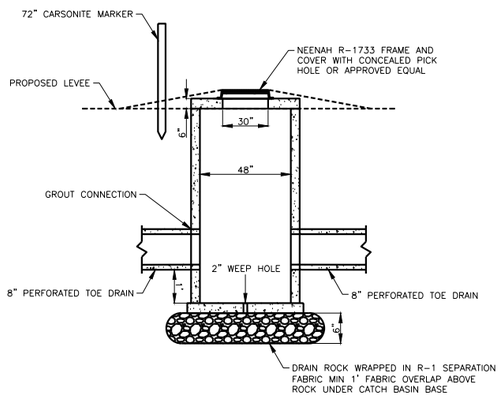
NOTE
'TRACKING' WITH MACHINERY UP AND DOWN THE SLOPE PROVIDES GROOVES THAT WILL CATCH SEED, FERTILIZER, MULCH, RAINFALL AND REDUCE RUNOFF.

ALL DISTURBED SLOPES TO BE TRACKED AS SHOWN BETWEEN TIME OF EMBANKMENT AND SEEDING.

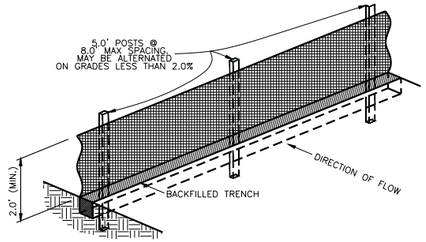
C 41 SURFACE ROUGHENING
NOT TO SCALE

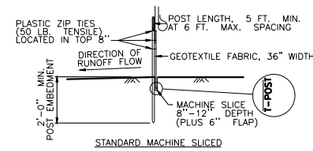
NOTES:
1. CRETEX P2 GASKETED JOINT FOR 48" MANHOLES OR EXTERIOR SEAL BY PRESS-SEAL GASKET CORP. EZ WRAP AND EZ STIK NO. 4 PRIMER CRETEX SPECIALTY PRODUCTS "MAC WRAP", OR AN APPROVED EQUAL IF SPECIFIED.

2. STEPS SHALL NOT BE INSTALLED

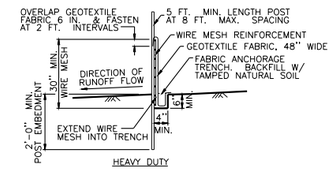


G 41 TOE DRAIN PUMP BASIN
NOT TO SCALE



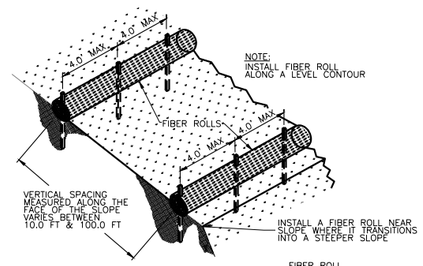


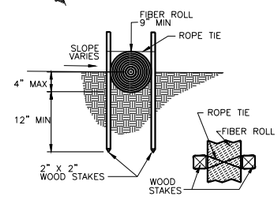
STANDARD MACHINE SLICED

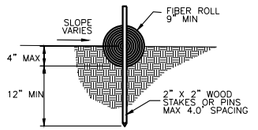


HEAVY DUTY

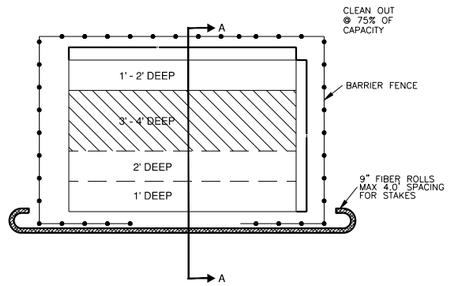
D 41 SILT FENCE
NOT TO SCALE



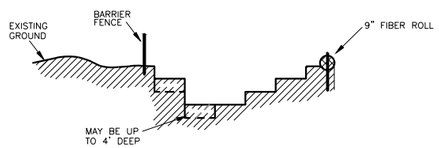




E 41 FIBER ROLL INSTALLATION
NOT TO SCALE



PLAN VIEW



SECTION A-A

NOTES:
1. CONTRACTOR SHALL INSTALL SIGNING DESIGNATING CONCRETE WASHOUT AREA.
2. CONTRACTOR SHALL EMPTY WASHOUT AREA WHEN IT REACHES 75% OF CAPACITY.
3. CONTRACTOR SHALL LINE WASHOUT WITH A MINIMUM 10 MIL PLASTIC OR COMPACT EXISTING CLAY TO FORM IMPERMEABLE LINER.

H 41 CONCRETE WASHOUT
NOT TO SCALE

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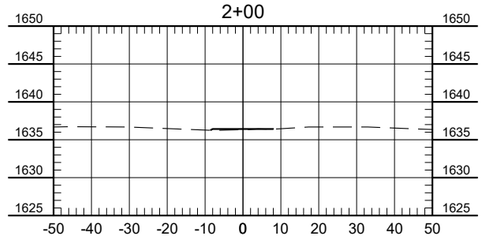
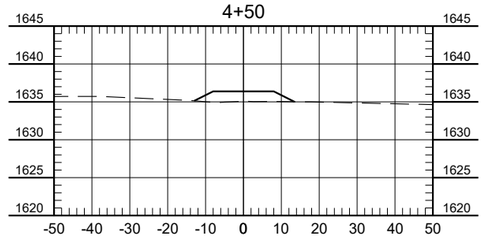
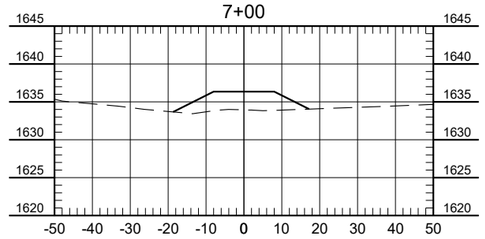
MRCC FLOOD CONTROL PROJECT
BURLEIGH COUNTY WATER RESOURCE DISTRICT
BURLEIGH COUNTY, NORTH DAKOTA

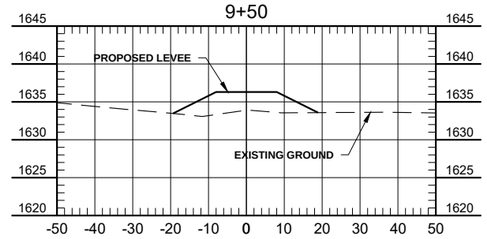
DETAILS
PROJECT NO. 6025-012

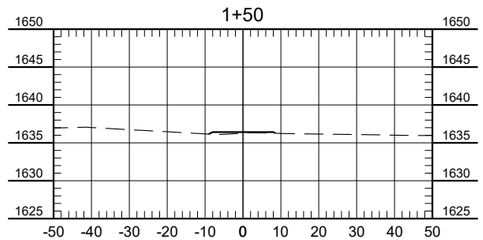
SHEET
41 of 51

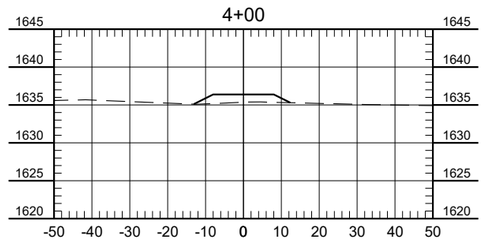


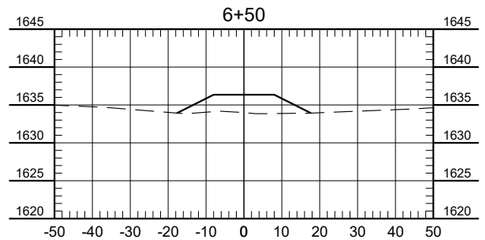


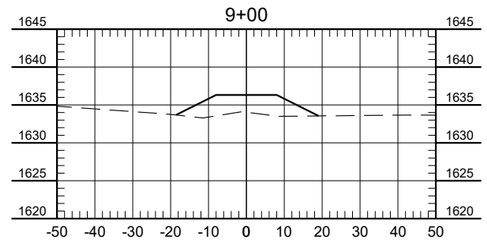


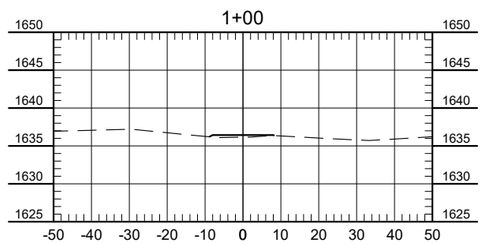


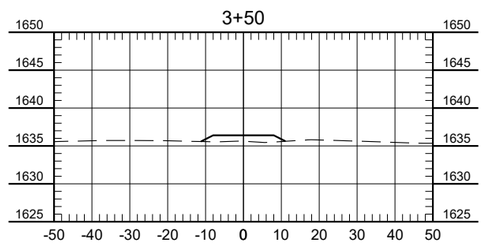


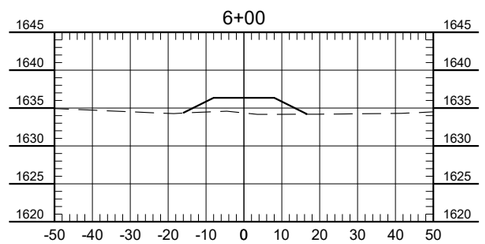


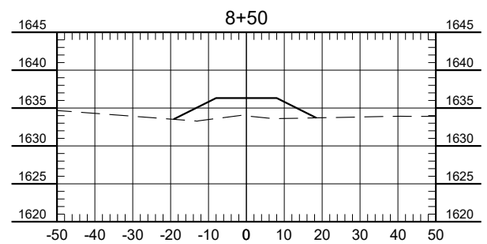


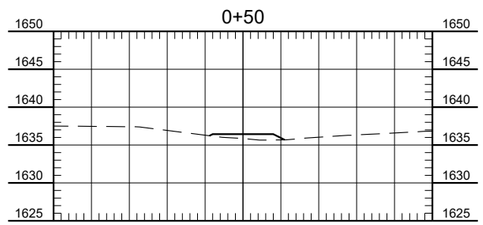


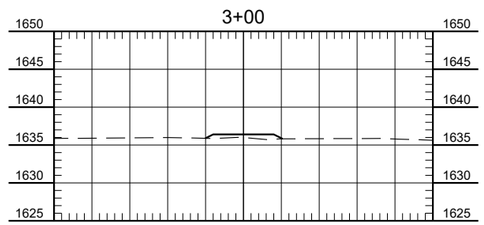


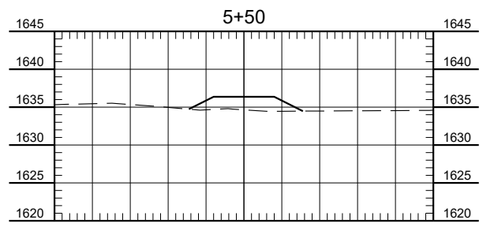


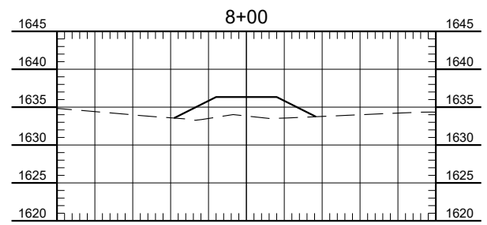


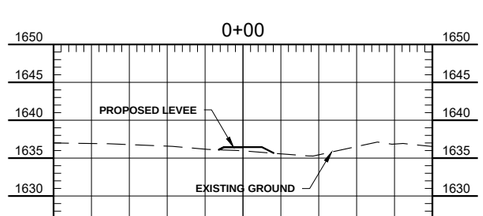


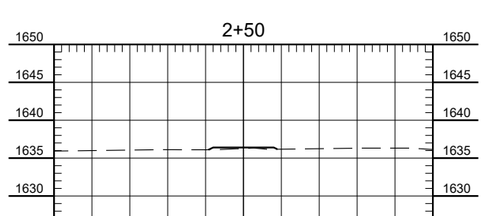


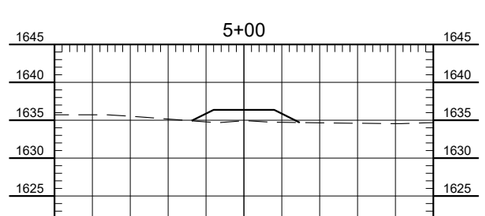


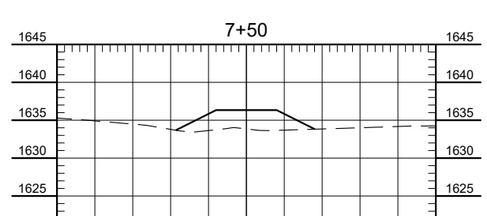












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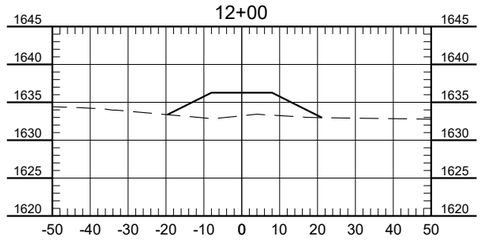
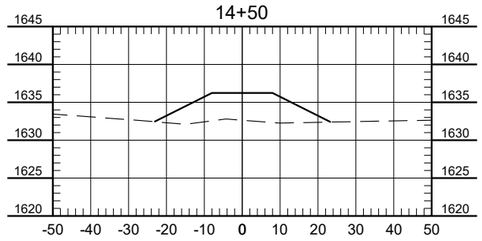
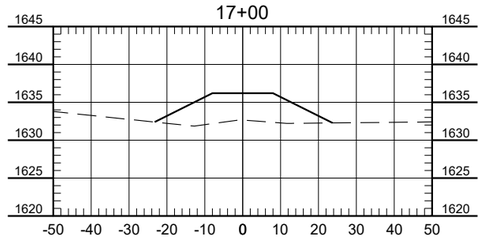
MRCC FLOOD CONTROL PROJECT
BURLEIGH COUNTY WATER RESOURCE DISTRICT
BURLEIGH COUNTY, NORTH DAKOTA

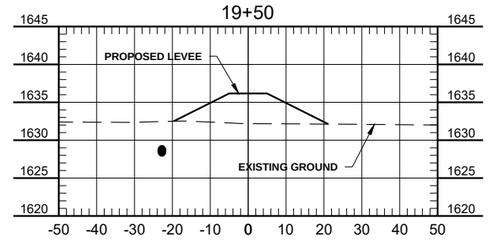
SOUTH CROSS SECTION

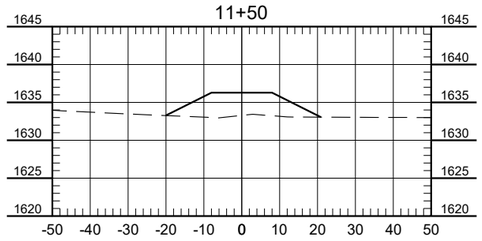
PROJECT NO. 6025-012

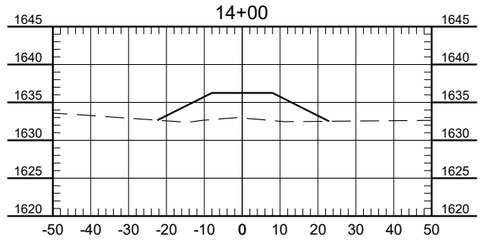


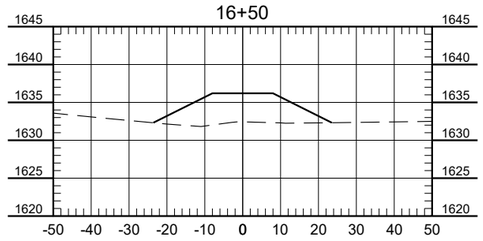


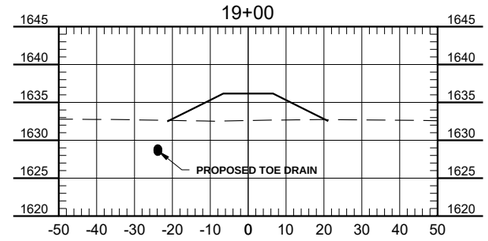


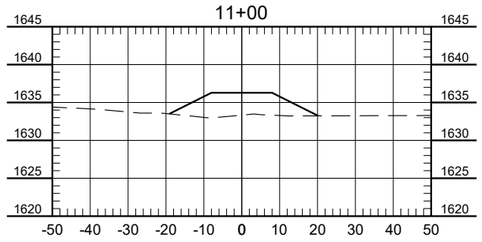


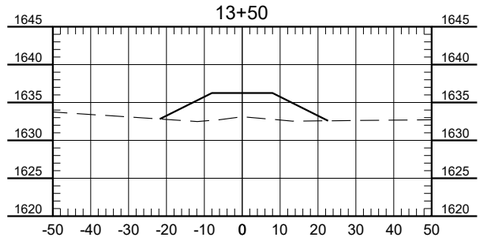


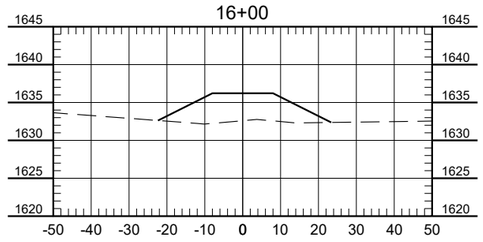


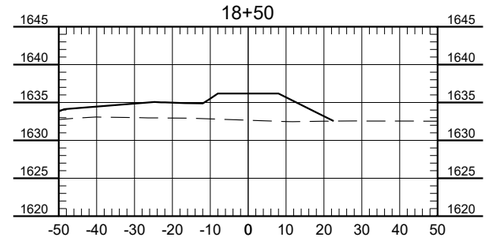


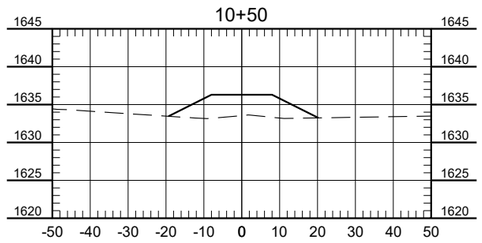


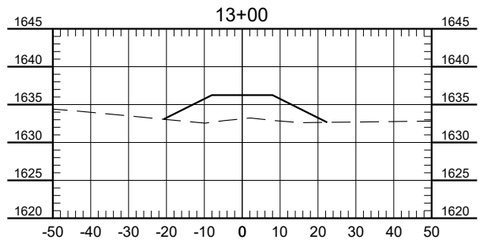


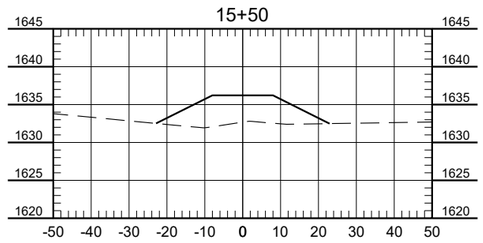


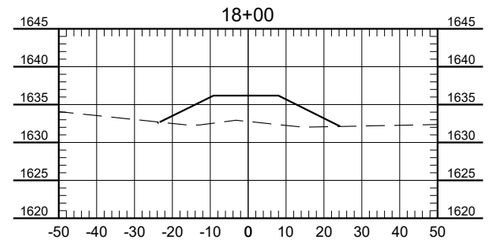


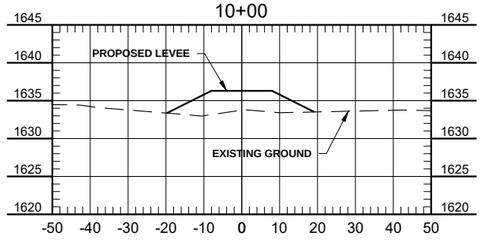


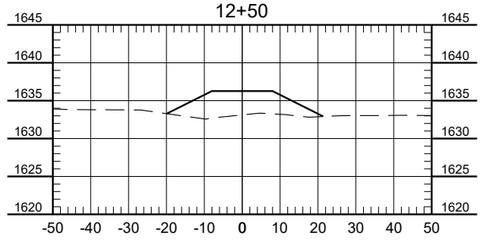


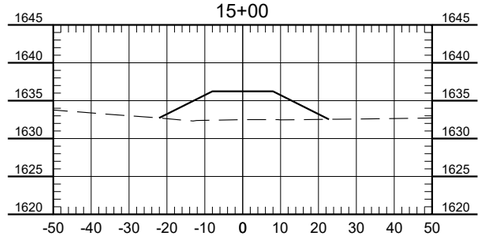


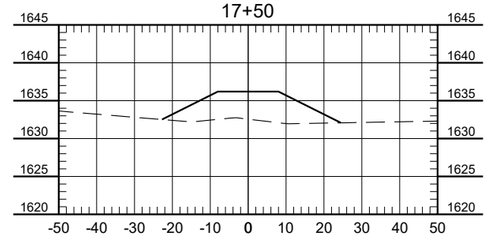












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No.	Revision	Date	By

Houston Engineering Inc.
Bismarck
P: 701.323.0200
F: 701.323.0300

Drawn by	Date
AV	11-3-15
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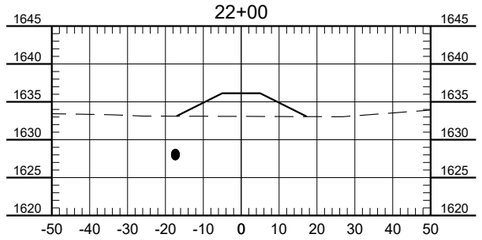
TGJ	AS SHOWN

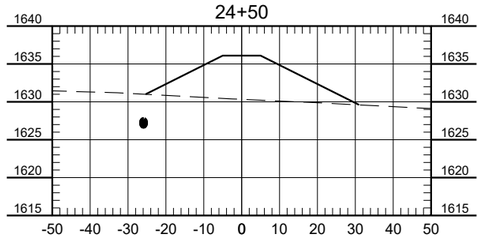
MRCC FLOOD CONTROL PROJECT
BURLEIGH COUNTY WATER RESOURCE DISTRICT
BURLEIGH COUNTY, NORTH DAKOTA

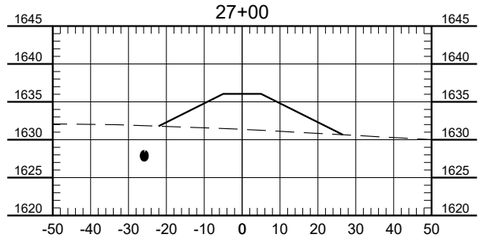
SOUTH CROSS SECTION

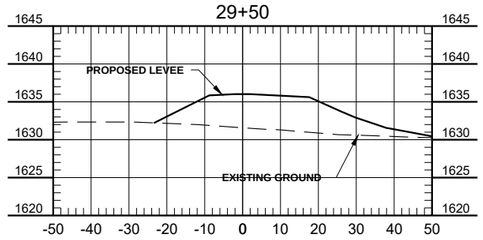
PROJECT NO. 6025-012

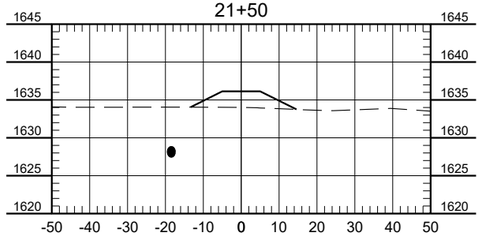
SHEET 43 of 51

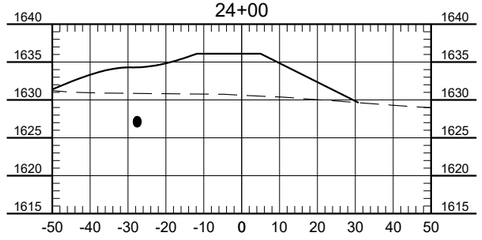


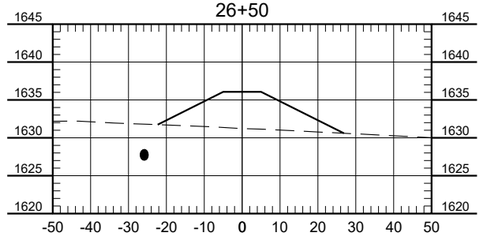


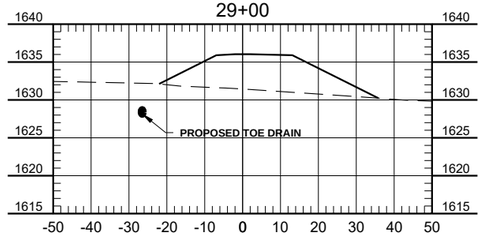


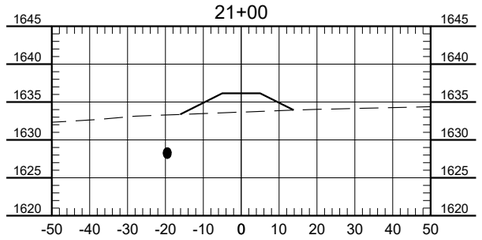


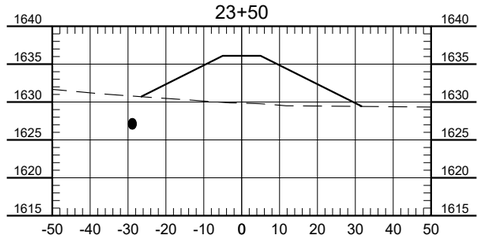


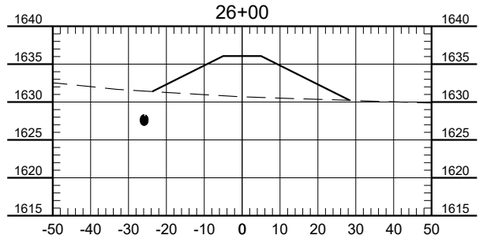


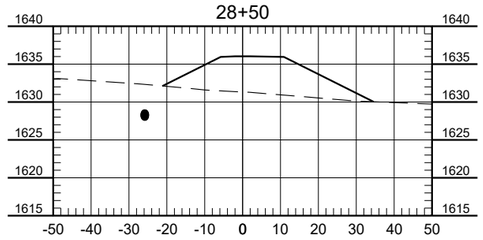


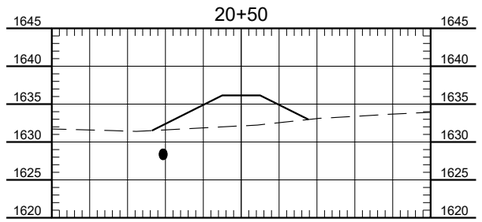


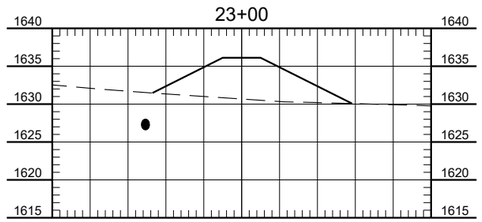


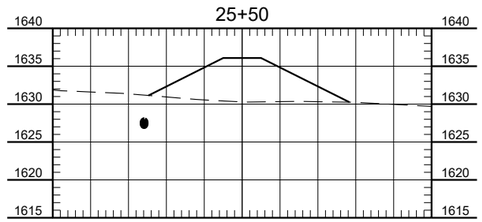


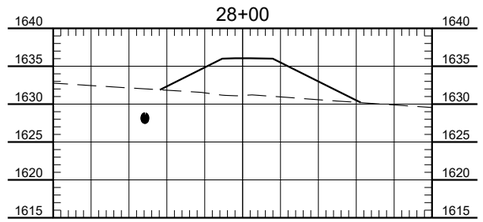


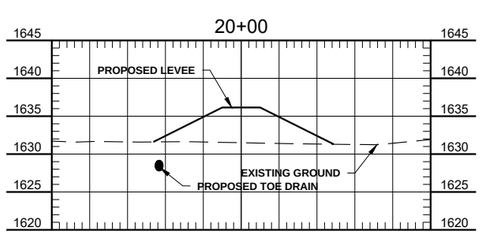


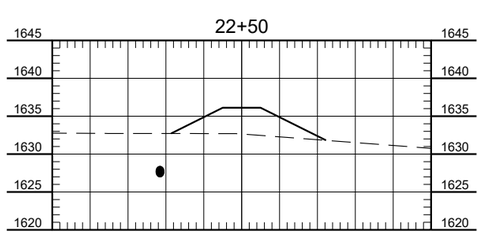


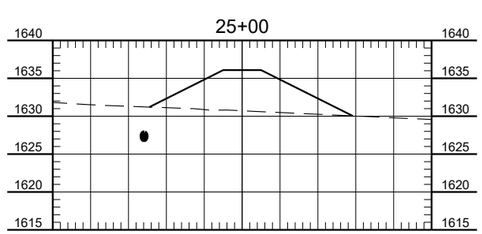


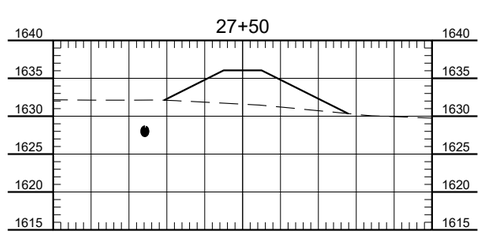












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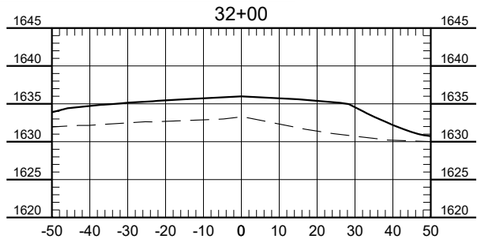

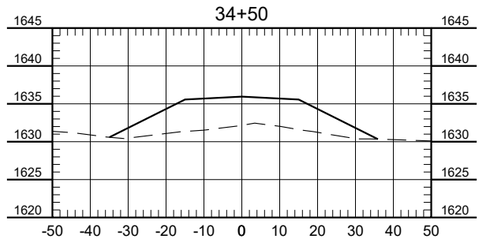

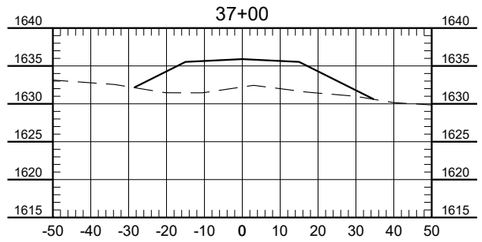

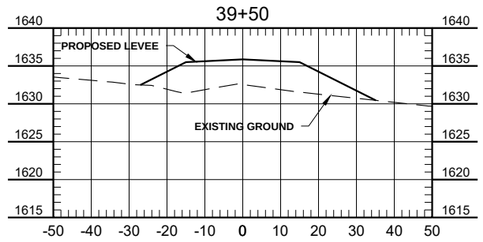

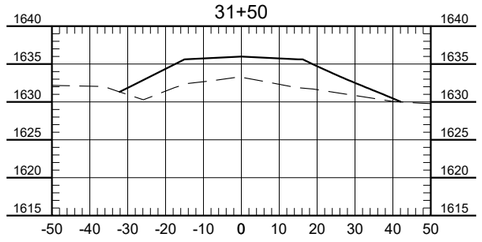

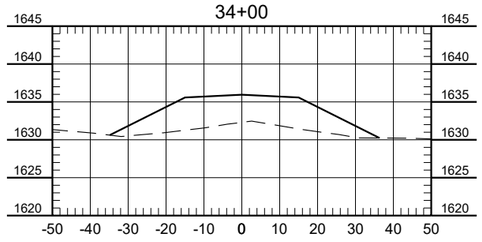

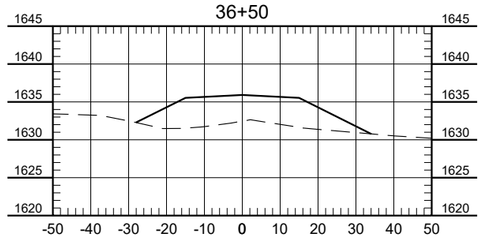

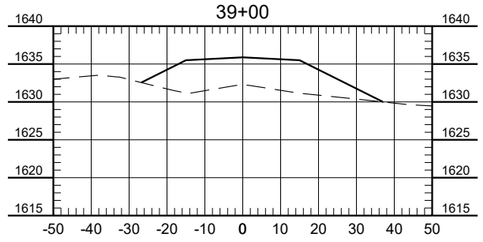

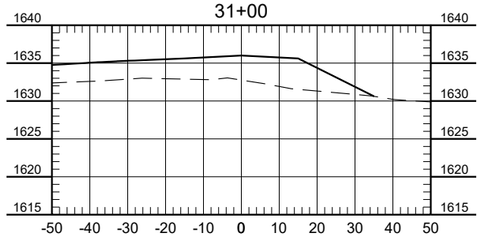

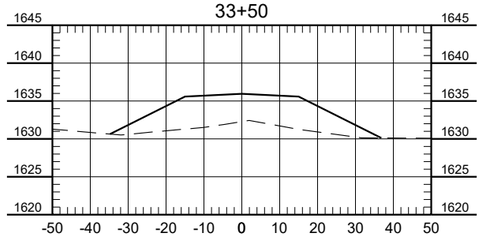

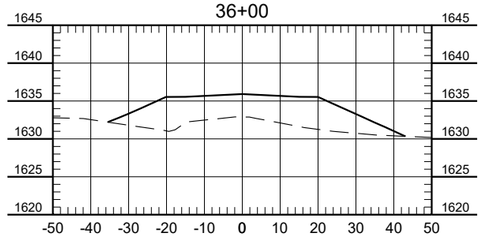

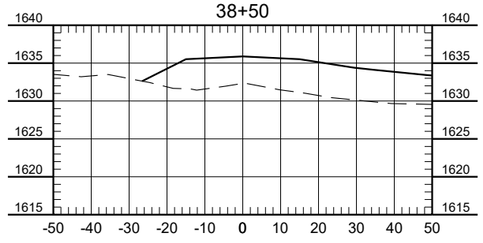

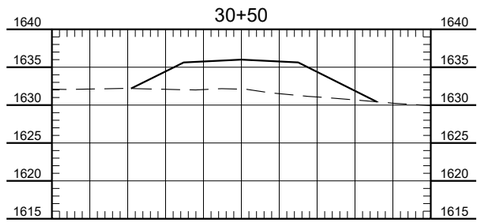

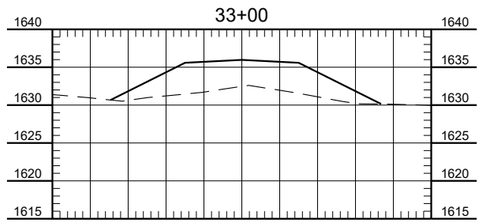

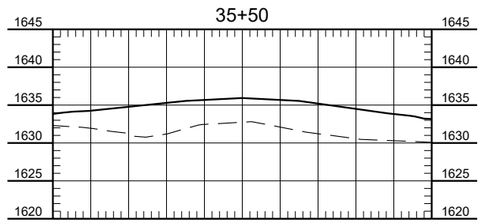

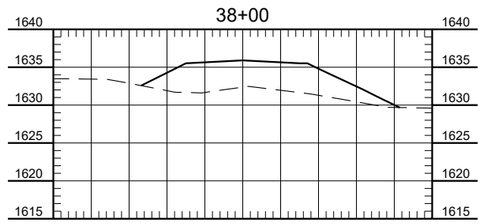

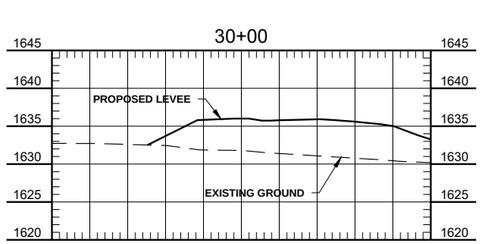

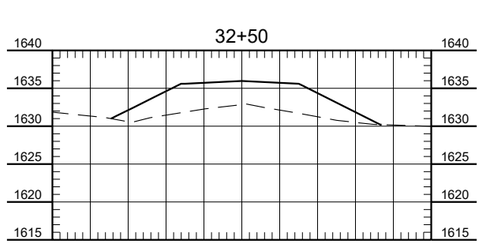

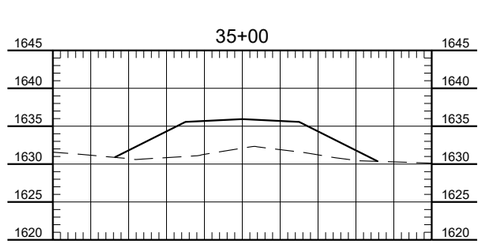

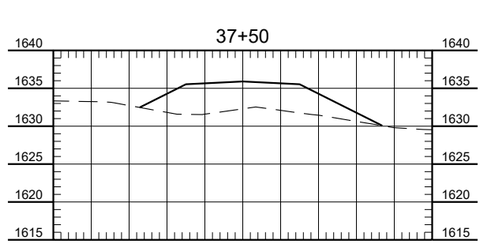

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P: 701.323.0200
F: 701.323.0300

Drawn by	Date
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TGJ	AS SHOWN

MRCC FLOOD CONTROL PROJECT
BURLEIGH COUNTY WATER RESOURCE DISTRICT
BURLEIGH COUNTY, NORTH DAKOTA

SOUTH CROSS SECTIONS

PROJECT NO. 6025-012

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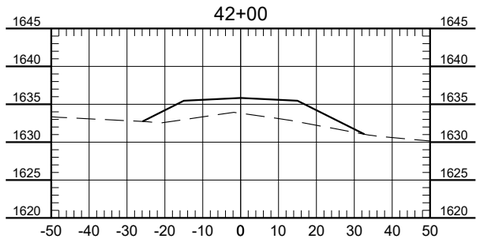

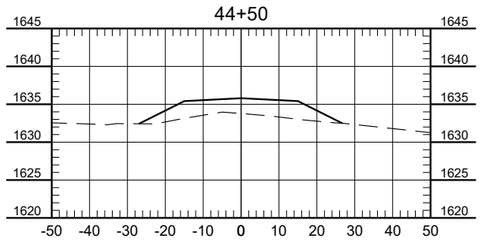

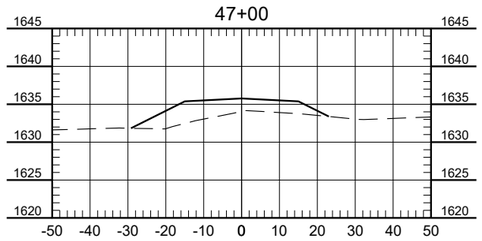

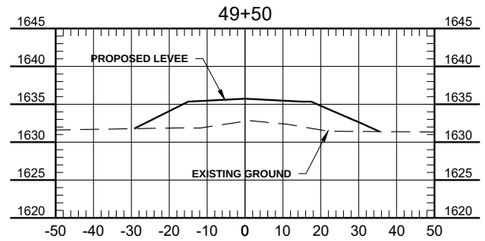

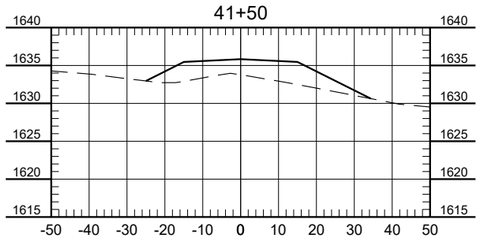

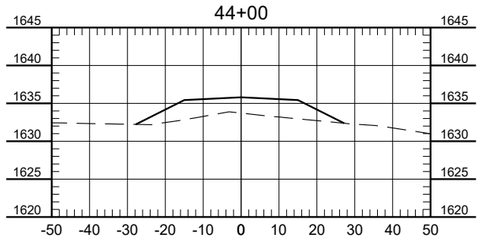

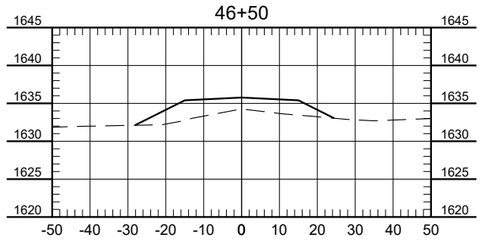

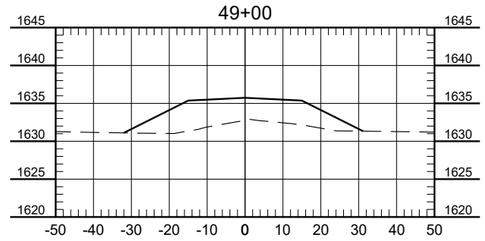

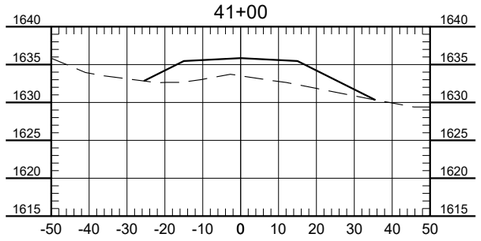

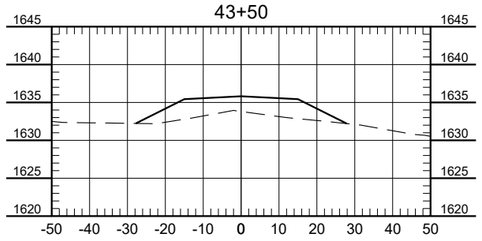

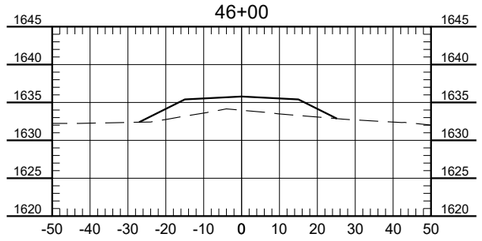

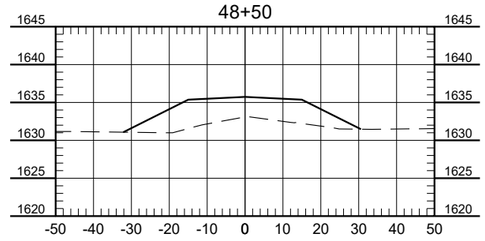

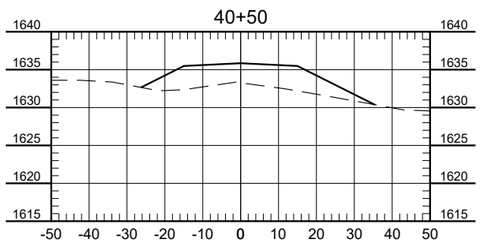

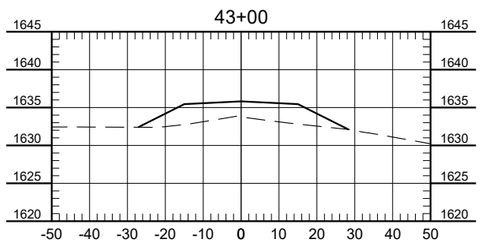

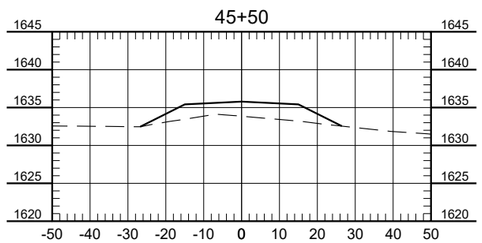

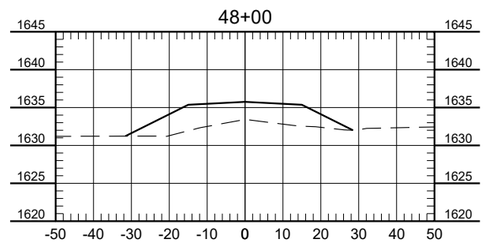

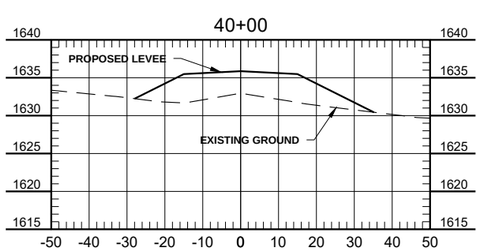

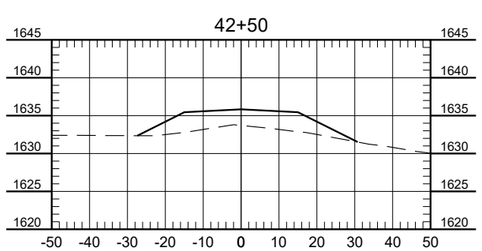

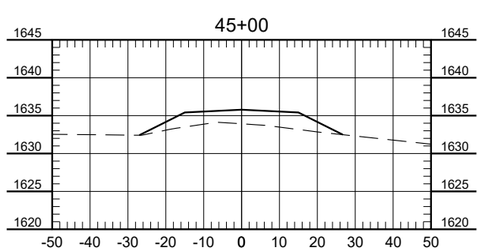

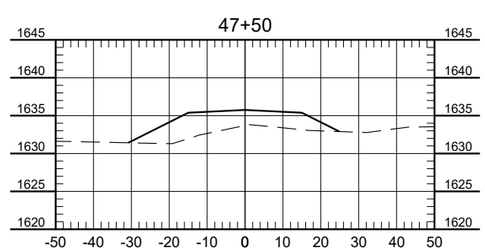

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MRCC FLOOD CONTROL PROJECT
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BURLEIGH COUNTY, NORTH DAKOTA

SOUTH CROSS SECTIONS

PROJECT NO. 6025-012

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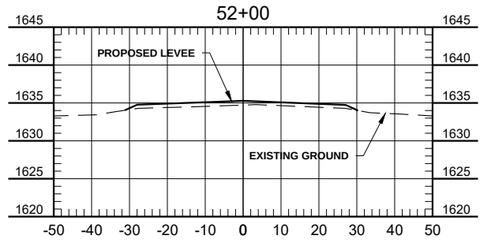
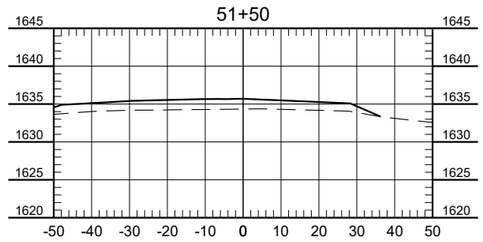
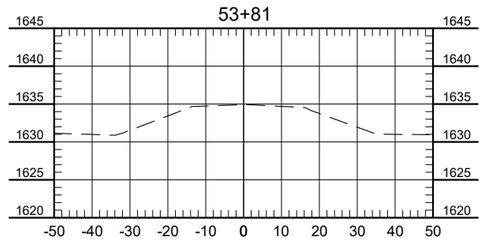
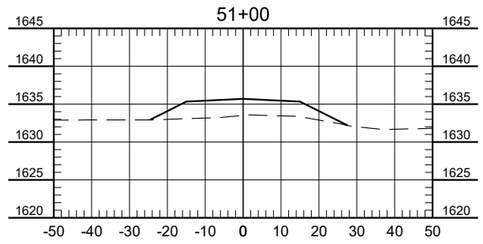
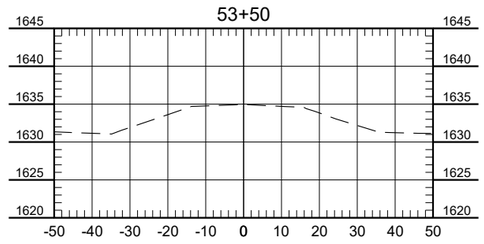
H:\Bismarck\BN\6025 Burleigh Co. WRD\6025-012 MRCC Flood Control\CAD\Plans\Cross Sections South.dwg-x-sec55-10/24/2017 4:16 PM-(tpaul)

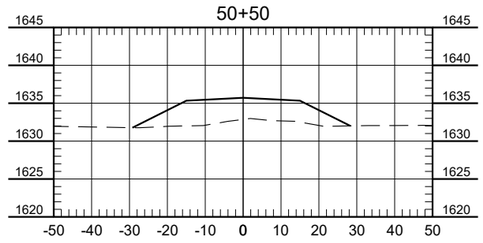


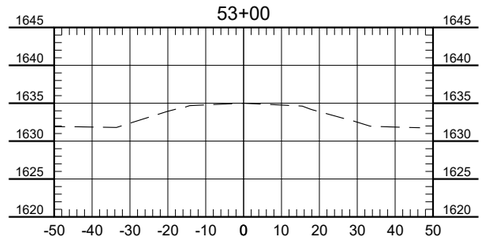


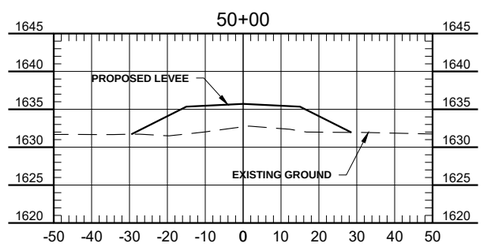


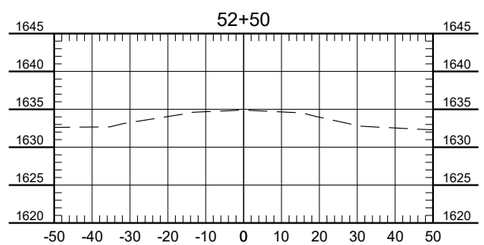












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BURLEIGH COUNTY, NORTH DAKOTA

SOUTH CROSS SECTIONS

PROJECT NO. 6025-012

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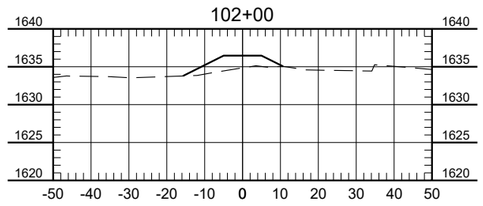

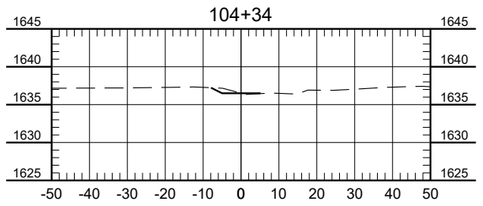

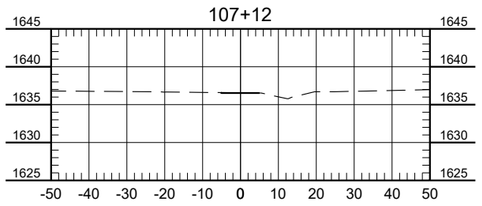

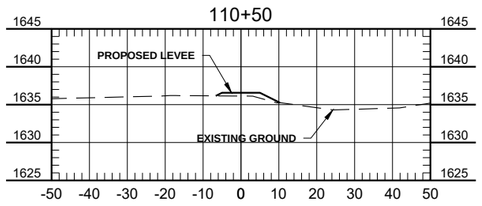

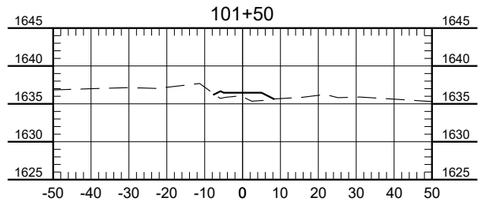

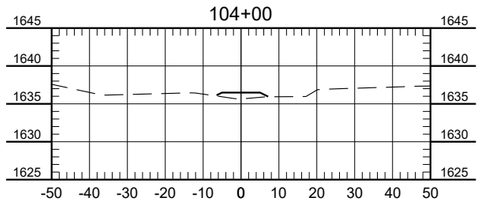

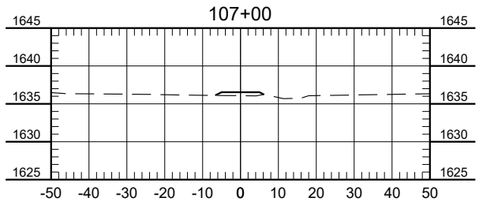

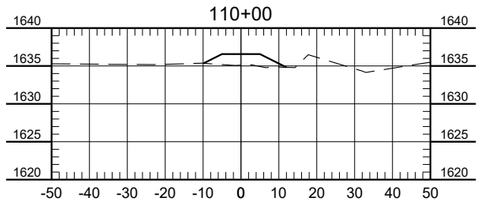

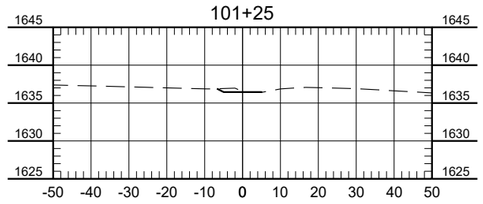

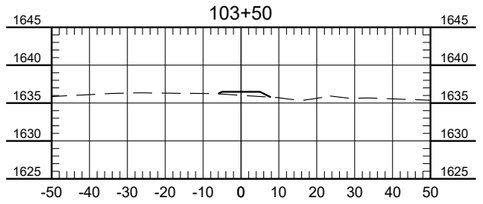

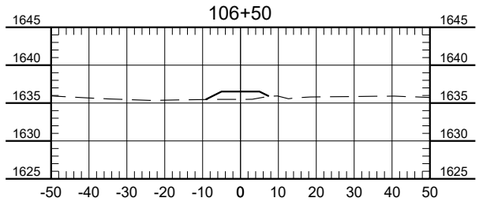

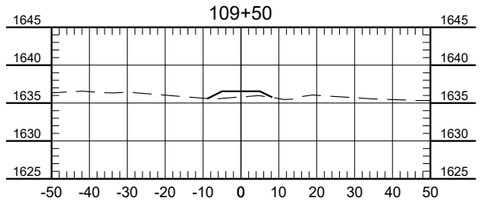

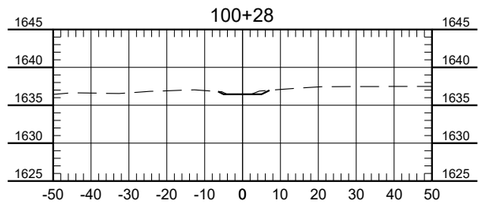

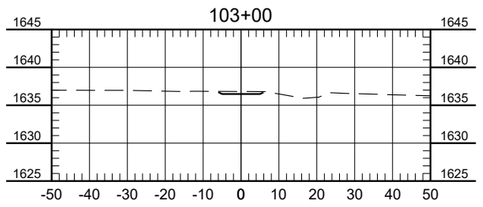

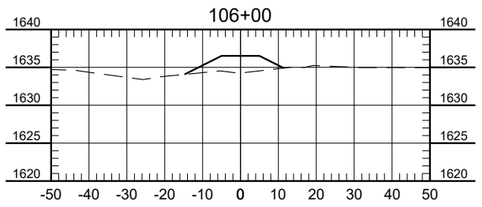

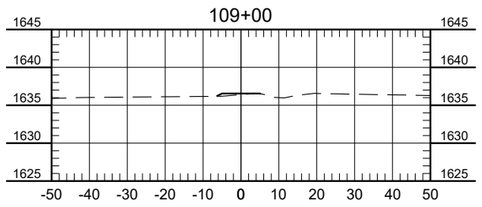

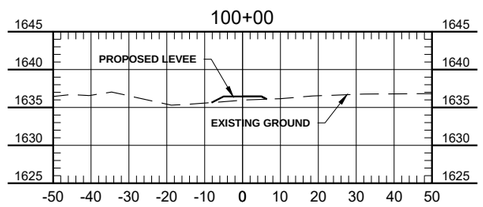

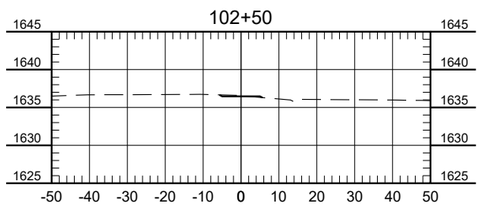

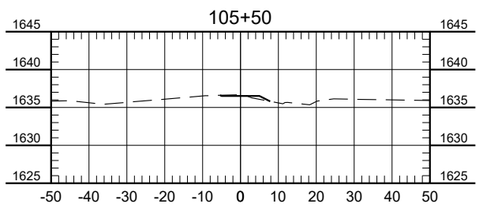

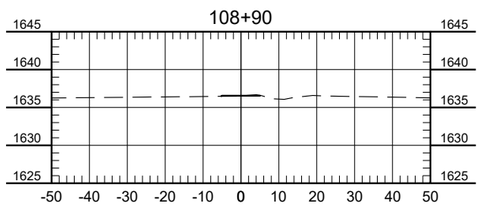

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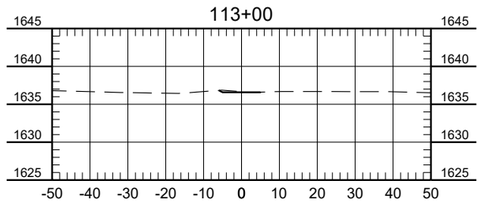

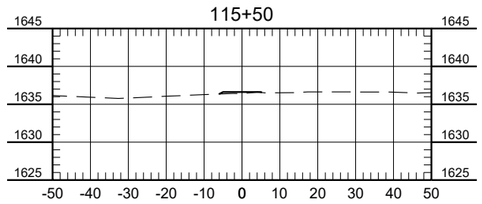

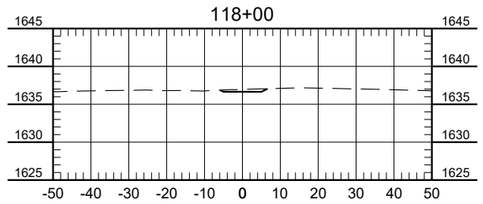

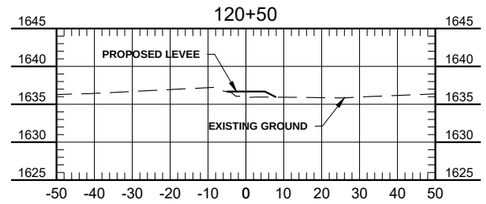

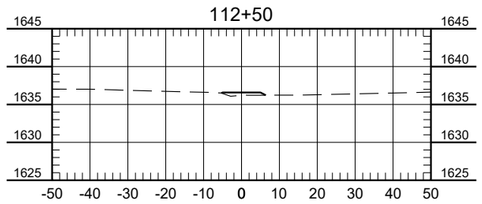

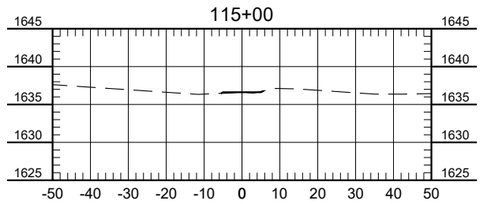

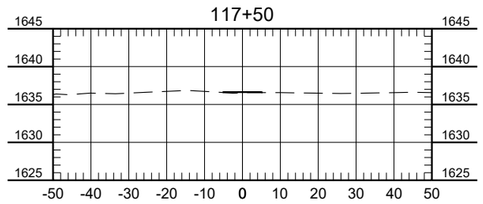

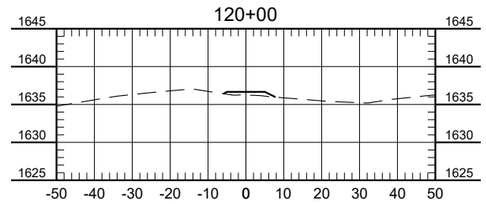

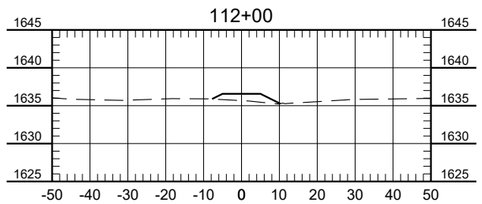

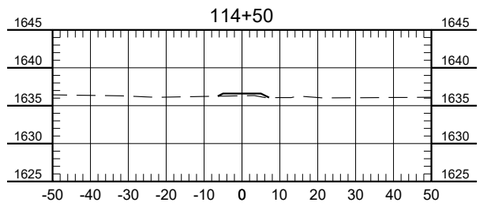

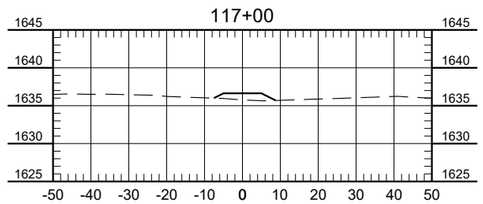

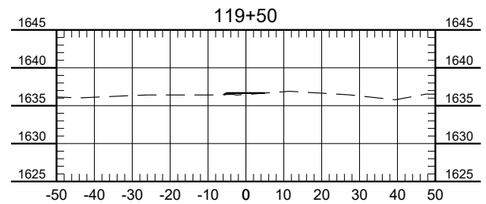

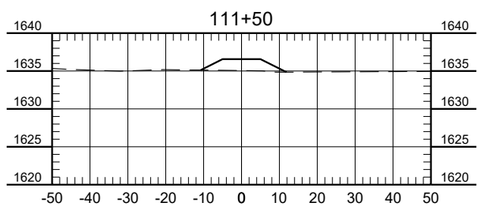

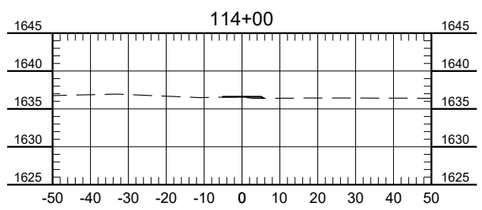

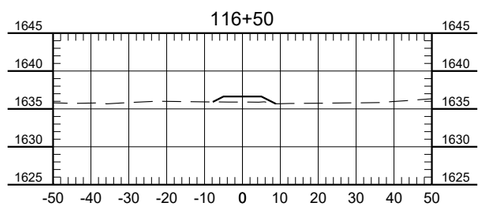

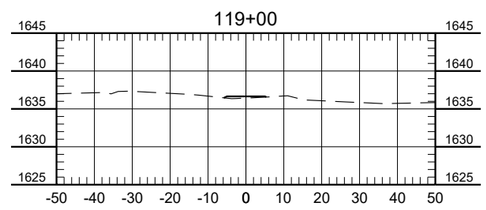

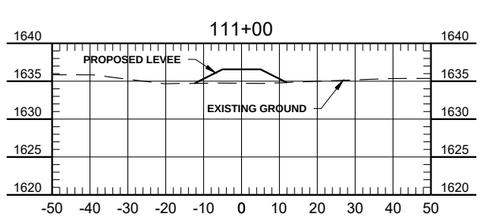

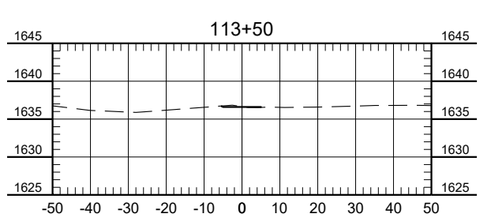

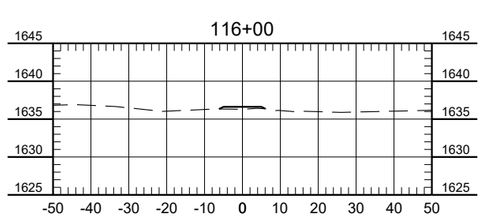

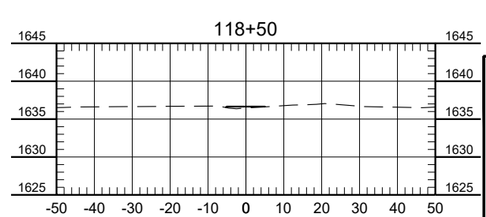

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No.	Revision	Date	By

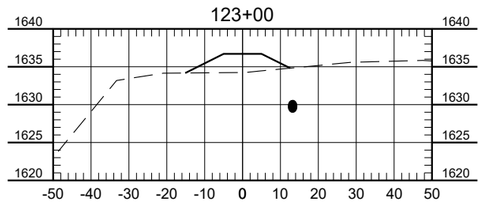
Houston Engineering Inc.
Bismarck
P: 701.323.0200
F: 701.323.0300

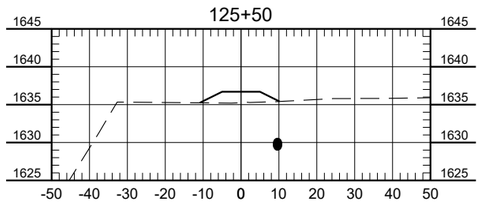
Drawn by	Date
AV	11-3-15
Checked by	Scale
TGJ	AS SHOWN

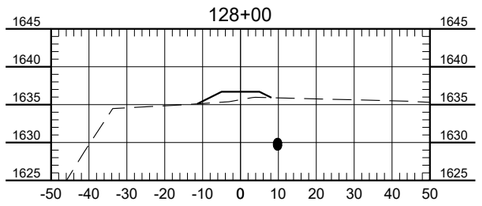
MRCC FLOOD CONTROL PROJECT
BURLEIGH COUNTY WATER RESOURCE DISTRICT
BURLEIGH COUNTY, NORTH DAKOTA

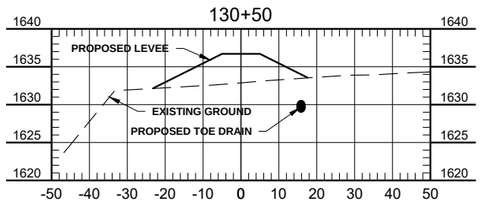
NORTH CROSS SECTIONS

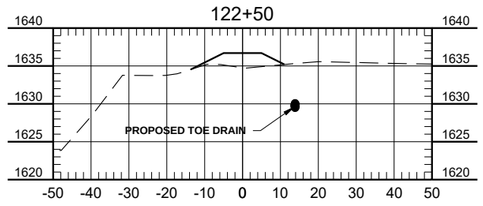
PROJECT NO. 6025-012

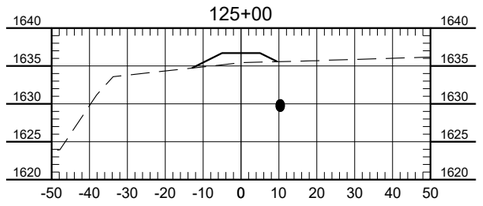


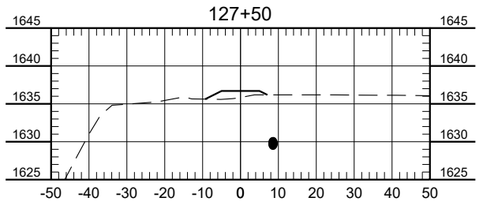


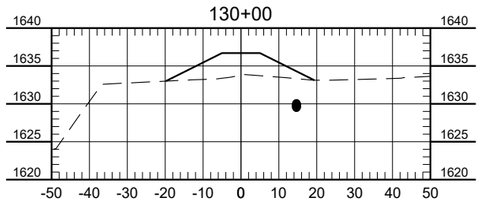


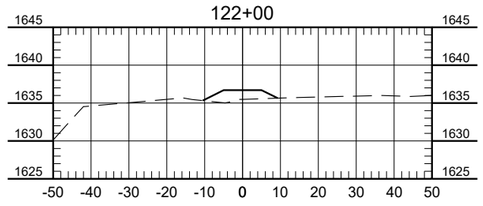


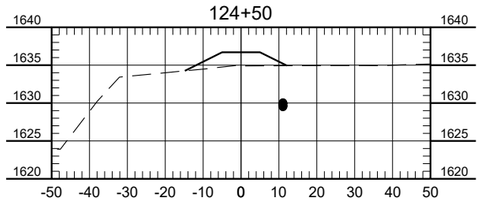


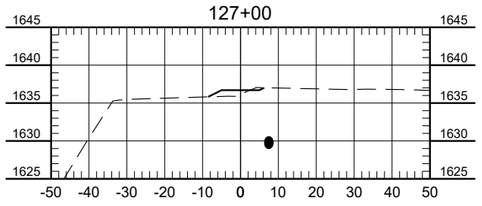


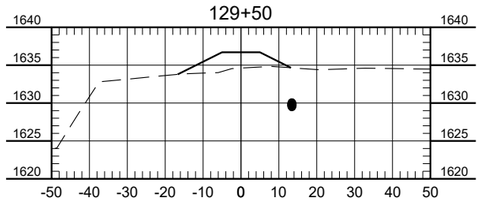


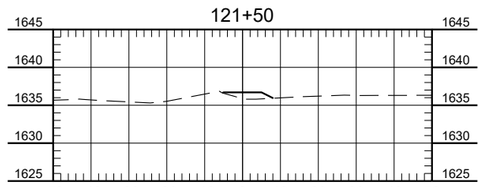


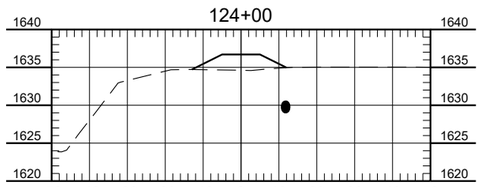


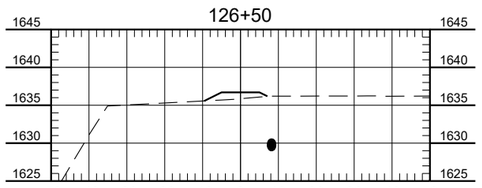


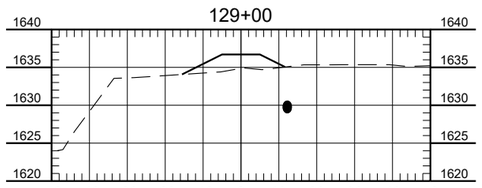


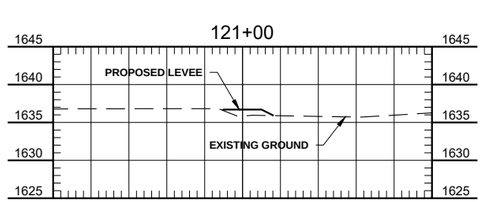


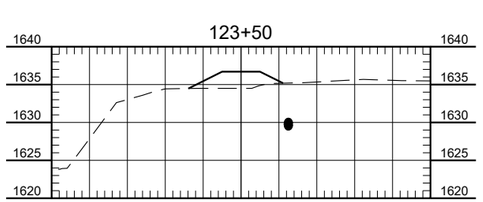


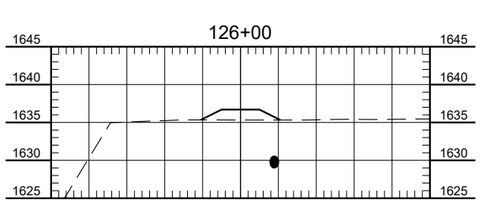


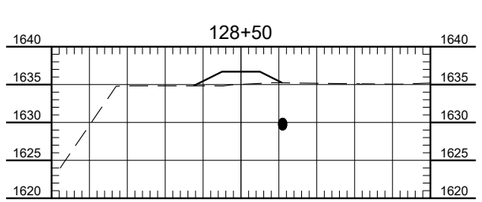












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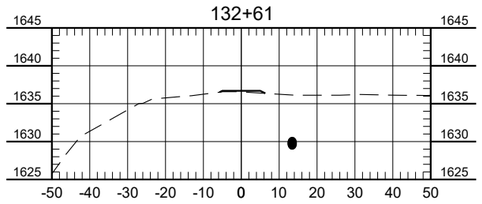
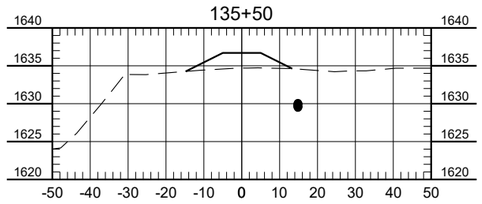
MRCC FLOOD CONTROL PROJECT
BURLEIGH COUNTY WATER RESOURCE DISTRICT
BURLEIGH COUNTY, NORTH DAKOTA

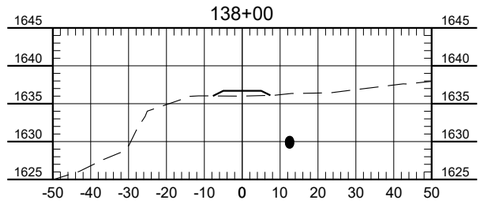
NORTH CROSS SECTIONS

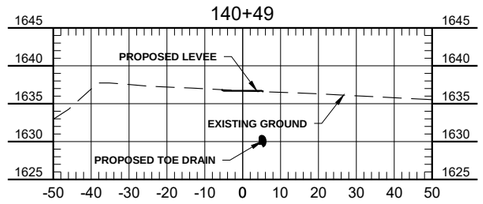
PROJECT NO. 6025-012

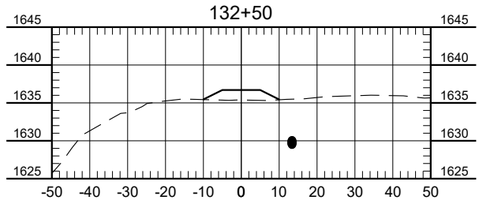
SHEET 50 of 51

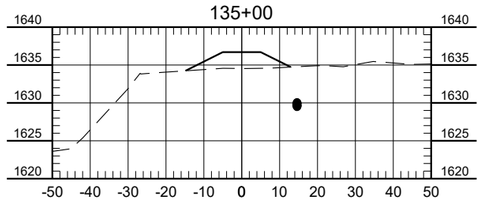


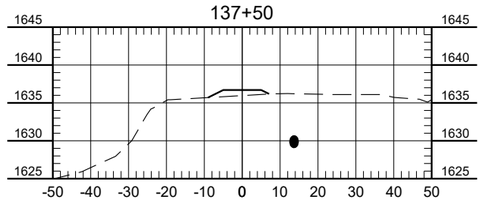


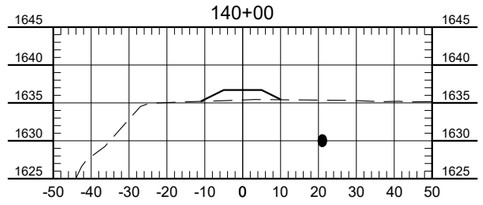


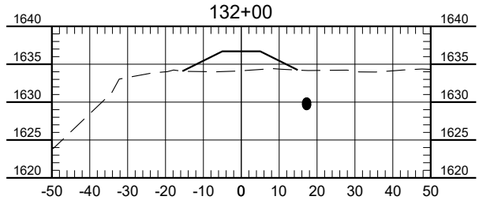


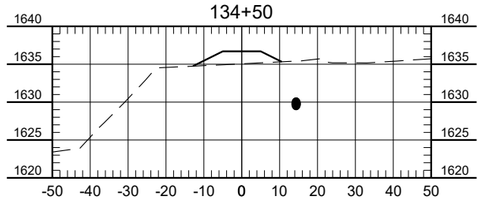


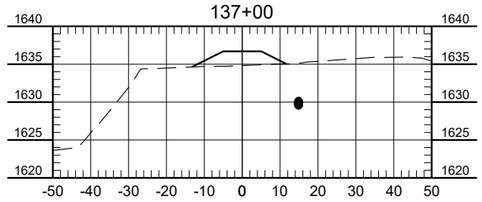


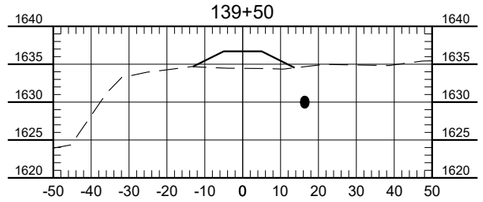


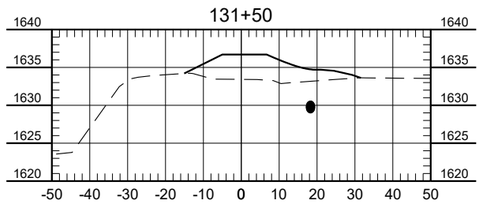


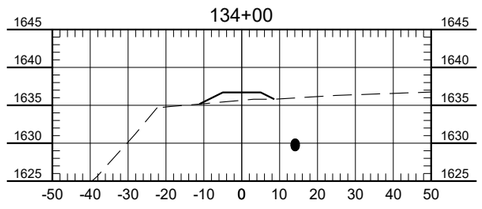


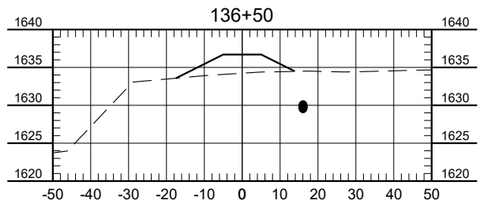


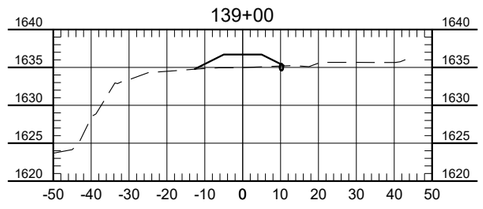


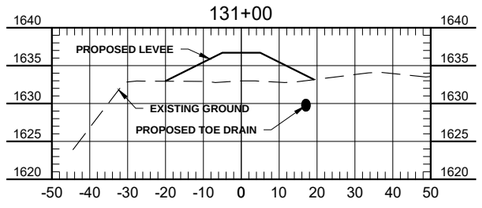


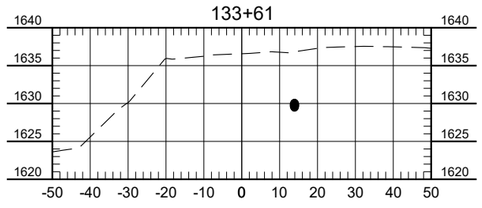


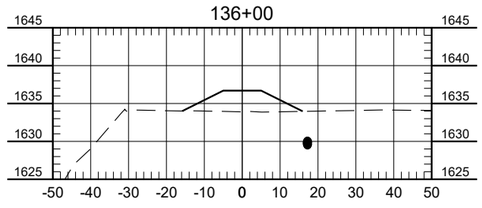


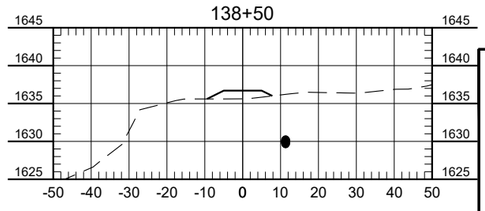












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No.	Revision	Date	By

Houston Engineering Inc.
Bismarck
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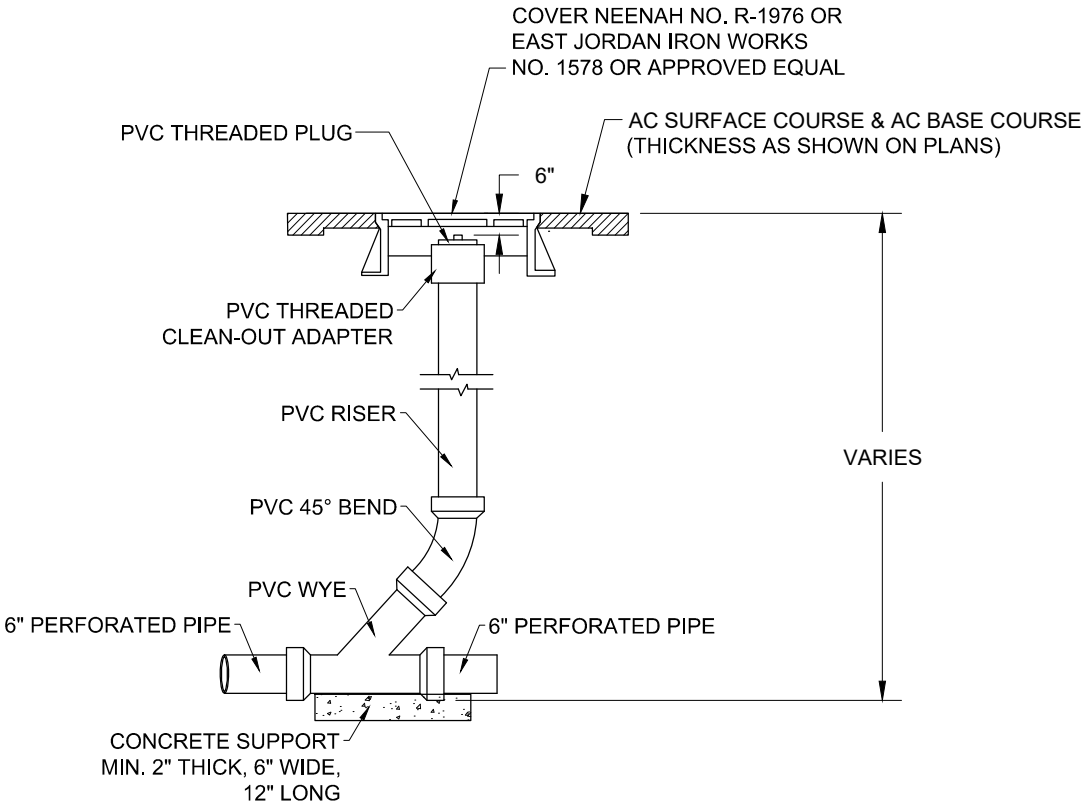
Drawn by	Date
AV	11-3-15
Checked by	Scale
TGJ	AS SHOWN

MRCC FLOOD CONTROL PROJECT
BURLEIGH COUNTY WATER RESOURCE DISTRICT
BURLEIGH COUNTY, NORTH DAKOTA

NORTH CROSS SECTIONS

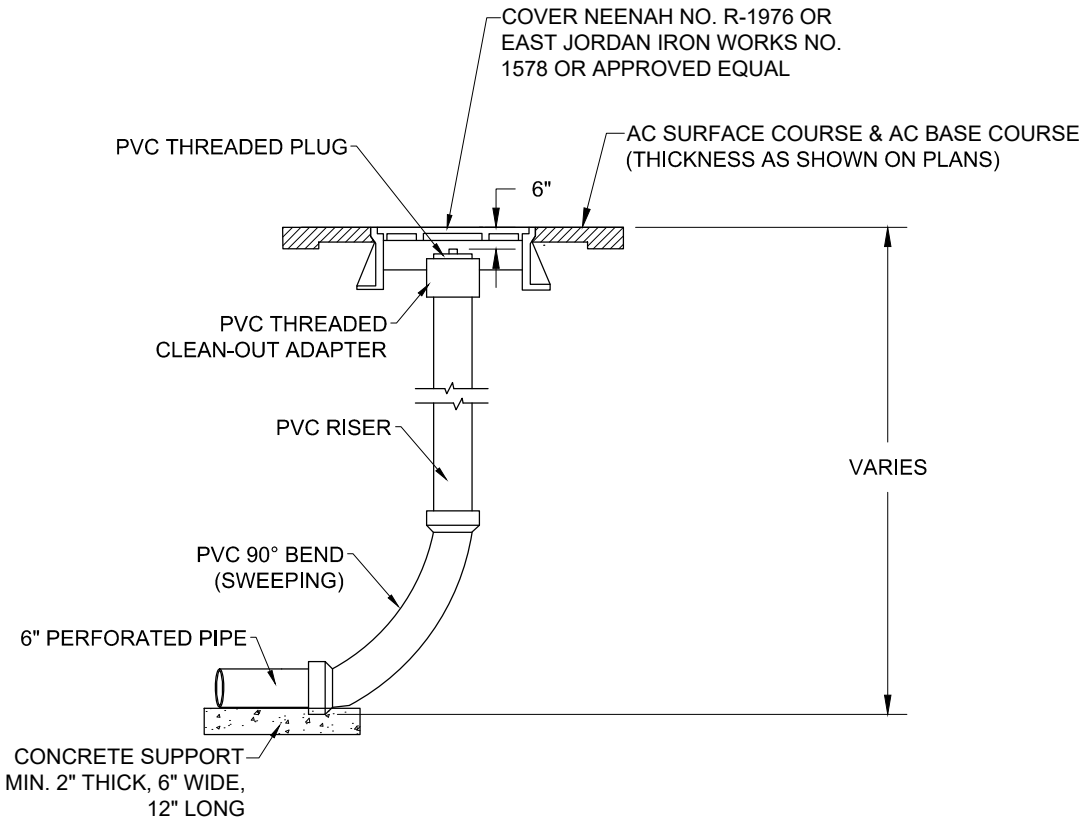
PROJECT NO. 6025-012

SHEET 51 of 51



SECTION VIEW

Bismarck Engineering Department	**PERFORATED PIPE IN-LINE CLEANOUT**	SCALE: Not to Scale DATE: 3/2017	STANDARD DETAIL NO. **802-3**



SECTION VIEW

Bismarck Engineering Department	**PERFORATED PIPE END OF RUN CLEANOUT**	SCALE: Not to Scale DATE: 3/2017	STANDARD DETAIL NO. **802-4**