

Civil Appendix A
Integrated Planning and Design Analysis and Environmental
Assessment
Waco Metropolitan Area Regional Sewerage System Treatment Plant
Waco and McLennan County, Texas
Brazos River
Section 14 Emergency Streambank and Shoreline Protection

May 2021



US Army Corps
of Engineers®
Fort Worth District

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Existing Conditions:

The project is located at the Waco Metropolitan Area Regional Sewerage System (WMARSS), Central Wastewater Treatment Plant, in McLennan County, Texas. The project is located on the Brazos River south bank. The Brazos River flows in a southeasterly direction. Stream bank erosion is threatening the existing infrastructure in the area. Stream bank erosion is occurring in two sections along the south bank of the Brazos River. Section 1 is an approximate 1,300 linear foot section located on the south bank of the Brazos River between an existing stone riprap stream bank protection project constructed for the WMARSS Central Wastewater Treatment Plant in 2002 and an existing water intake structure owned by the city of Robinson. The existing stone riprap stream bank protection project extends approximately 850-feet downstream. Section 2 of this project begins at the downstream end of the existing stone riprap stream bank protection project and extends approximately 300 linear feet downstream past the Sandy Creek Energy Pump Station. The stream bank height in the project area is approximately 35 feet with approximate 1:1 H:V side slope. The top of bank elevation is 380. The bottom bank elevation is 345.

The top of bank continues to erode, threatening the existing infrastructure located along the Brazos River in the project area. From the year 1995 to the year 2020, the top bank has eroded up to 95 feet. From a 1995 survey provided by the city of Waco, the top of bank was approximately 145 feet from an existing 39 inch diameter gravity sewer main that is located along the top of bank. From a 2019 survey provided by the city of Waco, the top of bank is approximately 50 feet from the existing 39 inch gravity sewer main that flows to the treatment plant. In addition to the existing 39 inch gravity sewer, there are existing 54 inch and 8 inch diameter force mains along the top of bank. Refer to civil appendix for survey exhibits obtained from city of Waco. Currently, the top of bank is only a few feet from an existing drainage swale that was constructed with the 2002 project. **See Figure 1 Project Location**



Figure 1 Project Location

Alternatives for Waco Metropolitan Area Regional Sewerage System (WMARSS) Central Wastewater Treatment Plant

Alternative 1 - Longitudinal Peaked Stone Dike and Tie Back

Alternative 1 consists of a longitudinal peaked stone toe dike placed at the toe along a 1,300-foot section upstream of existing riprap bank protection and 300 feet section downstream of existing riprap on the right bank of the Brazos River. The upstream reach of the stone toe dike would begin approximately 60 feet upstream of The City of Robinson water intake structure. The downstream reach of the stone dike would run adjacent to the Sandy Creek Pump Station. The existing bank should be dressed up by placing fill material at a slope of 2H:1V. The longitudinal stone toe dike would have a triangular cross section with an approximate height of 8 feet, a base width of about 48-feet, and 3H:1V side slopes. The entire 1,600 foot reach of the longitudinal stone toe dike would have stone tie-back dikes extending out perpendicularly from the crest of the longitudinal stone dike to the bank and would be spaced every 100-feet along the longitudinal stone dike. The crest height of the tie-back dikes would match the crest height of the longitudinal stone dike at the juncture of the two and would slope up toward the bank on a slope of 5H:1V. The tie-back dikes would be keyed into the bank 3 feet below the existing ground. The exposed embankment would be planted with native vegetation. This alternative would require approximately 31,200 cubic yards of riprap material into the river channel, 26,200 cubic yards of fill material to dress up bank and 9,400 square yards of native vegetation. See sheet ALT-1 for typical cross section in civil appendix.

Alternative 2 – Stone Riprap Toe Protection (Recommended Plan)

Alternative 2 consists of stone riprap placed at the toe along approximately 1,300-feet upstream of existing riprap bank protection and 300 feet downstream of existing riprap on the right bank of the Brazos River. The upstream reach of the riprap would begin approximately 60 feet upstream of The City of Robinson water intake structure. The downstream reach of the riprap would run adjacent to the Sandy Creek Pump Station. The existing bank should be dressed up by placing fill material at a slope of 2H:1V. An 18-inch thick stone riprap layer will be placed with a 9-inch layer of bedding stone placed over a geotechnical filter fabric along the toe of the dressed up bank and extend to the top of bank to provide erosion protection to the toe of the bank from river scour. The stone riprap will be anchored at top with a 3-foot deep and 3-foot wide anchor trench and keyed at the toe of bank the with 3-foot deep and 10-foot wide key trench. This alternative would require approximately 26,200 cubic yards of fill material to dress up bank, 9,660 cubic yards of riprap material, 17,740 square yards of geotextile filter fabric and 4,410 cubic yards of bedding material into the river channel. See sheet ALT-2 for typical cross section in civil appendix. Alternative 2 has the least amount of earthwork and material of the three alternatives considered. The maintenance for selected plan will be similar to the existing stone riprap project that was constructed in 2002. The city of Waco has experience maintaining stone riprap slope protection.

Alternative 3—Longitudinal Peaked Stone Toe Protection With Bendway Weirs

Alternative 3 consists of bendway weirs constructed of stone in combination with a longitudinal peaked stone toe dike placed at the toe along approximately 1,300-foot section upstream of existing riprap bank protection and 300 feet section downstream of existing riprap on the right bank of the Brazos River. The upstream reach of the stone toe dike would begin approximately 60 feet upstream of The City of Robinson water intake structure. The downstream reach of the stone dike would run adjacent to the Sandy Creek Pump Station. The existing bank should be dressed up by placing fill material at a slope of 2H:1V. Bendway weirs will spaced every 100 feet along the longitudinal stone dike. The weirs will have a trapezoidal cross-section. The weir height will match the crest of the longitudinal stone dike. The weirs will have a 5 foot crest width, 2H:1V side slopes and would slope downward toward the center of the riverbed on a 20H:1V slope. The weirs would be spaced every 100 feet and would extend out toward the centerline of the riverbed 38 feet from the crest of longitudinal stone toe dike. The weirs are angled upstream approximately 10 to 15 degrees from the radius of the bend to direct flow away from the bank toward the center of the riverbed. Tie-backs will extend from the longitudinal stone dike. The crest height of the tie-back dikes would match the crest height of the longitudinal stone dike at the juncture of the two and would slope up toward the bank on a slope of 5H:1V. The tie-back dikes would be keyed into the bank 3 feet below the existing ground. The exposed embankment would be planted with native vegetation. This alternative would require approximately 32,500 cubic yards of riprap material into the river channel, 26,200 cubic yards of fill material to dress up bank and 9,400 square yards of native vegetation. See sheet ALT-3 for typical cross section in civil appendix.

Haul Route Construction access/staging

The site is approximately 1.5 miles from the nearest highway. Two haul route alternatives were evaluated for construction access. In order to avoid railroad crossing, which could cause delays during construction. The PDT decided on the following haul route from Highway 6/TX-340 Loop. Directions to the site are from Highway 6/TX-340 Loop a 4-lane divided asphalt highway to Texas 6 Frontage Rd. From Texas 6 Frontage Rd., head east on 3rd Street. 3rd Street Rd is a 2-lane asphalt road. From 3rd Street, take a left turn on Treatment Plant Rd. Treatment Plant Rd. is a 24 foot wide asphalt road that runs northeast for 1 mile to the WMARSS Central Wastewater Treatment Plant entrance. There is an existing 24 foot wide chain link sliding security gate at the treatment plant entrance. There is an existing dirt maintenance road located on the west side of Treatment Plant Rd that is used by city of Robinson for access to the existing water intake structure. There is an existing 24 foot wide swing gate at the maintenance road entrance that is used to access Robinson city property on the west side of Treatment Plant Rd. See Figure 2 for Haul Route.



Figure 2 Haul Route

Construction access and staging for the 1,300 linear feet of stream bank repairs for Section 1 will be located along the south stream bank. A proposed 3.5 acre stockpile area for Section 1 will be located at the northwest corner of Treatment Plant Rd. south of the treatment plant. Construction access to Section 1 will be from the existing dirt maintenance road and from the northwest corner of Treatment Plant Rd. There are several existing underground utilities located in the construction access/staging area that will need to be protected during construction. See exhibit for the 2019 topographic survey at WMARSS plant that was provided by city of Waco for utility descriptions. For location of construction access and laydown areas, see sheet CH101 in civil appendix.

The construction access, staging and stockpile area for 300 linear feet of stream bank repairs for Section 2 will be within the boundary of the WMARSS Central Wastewater Treatment Plant facility. Construction traffic will need access through existing security gate at the plant entrance on Treatment Plant Rd. A proposed 0.5 acre stockpile area and construction access foot print will be located just to the east of the existing Sandy Creek Energy pump station. There are several existing underground utilities located in the construction access/staging area that will need to be protected during construction. See exhibit for the 2019 topographic survey at WMARSS plant that was provided by city of Waco for utility descriptions. For location of construction access and laydown areas, see sheet CH101 in civil appendix.

Reference Documents:

FHWA-HEC23 Bridge Scour and Stream Instability Countermeasures 3rd edition Volume 1

FHWA-HEC23 Bridge Scour and Stream Instability Countermeasures 3rd edition Volume 2

Longitudinal stone toe protection (from USACE handbook). By David S. Biedenham, Charles M. Elliot, and Chester C. Watson, October 1997

NRCS Chapter 16, Streambank and Shoreline Protection, Part 650 Engineering Field Handbook

An Introduction to Geotextiles in Erosion Control, by J. Paul Guyer, 2013

Technical Presentation: METHODS BASIC LPSTP & LFSTP-90s-Dated 3-9-2015, by Dave Derrick

Technical Presentation: Redirective Stabilization-Bendway Weirs, Rock Vanes, J Hooks, Updated 3-23-2012-B

Technical Presentation: Design of Riprap Protection including Trenchfill and Windrow with notes, by Stephen T. Maynard

APPROXIMATE LOCATION OF BALD EAGLE'S NEST
 (+/-) 1500' FROM SOUTH BANK OF BRAZOS RIVER



FLOOD NOTE:

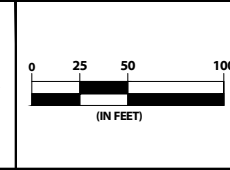
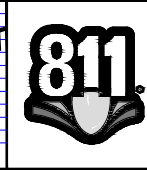
ALL OF THE AREA IS LOCATED WITHIN AN AREA HAVING A DESIGNATION OF ZONE "A" (SHADED) DESCRIBED AS "NO BASE FLOOD ELEVATIONS DETERMINED". ACCORDING TO FLOOD INSURANCE RATE MAP NUMBER 48309C0390C, DATED SEPTEMBER 26, 2008, IN MCLENNAN COUNTY, STATE OF TEXAS.

NOTES:

- The bearings shown hereon are grid bearings and are based on GPS observations, and the Texas State Plane Coordinate System, Central Zone (4203), North American Datum of 1983. An average combined scale factor of 0.99991357386 was utilized for this project or local area. All distances and areas shown are based on "Surface Coordinates". To obtain Grid Coordinates or Grid Distances, multiply by the above referenced average combined scale factor.
- No utilities were located, the utilities lines shown hereon are based on the City of Waco GIS maps.
- Property lines are approximate, a Boundary Survey was not performed.



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PROJECT: CWAC1801020
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CITY OF WACO		SHEET OF SHEETS
TOPOGRAPHIC SURVEY WMARSS PLANT		
COMPARISON OF 2019 GROUND SURVEY VERSUS 1995 AERIAL IMAGE		

APPROXIMATE LOCATION OF BALD EAGLE'S NEST
 (+/-) 1500' FROM SOUTH BANK OF BRAZOS RIVER



FLOOD NOTE:

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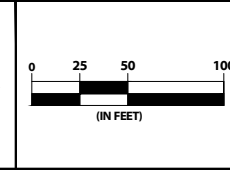
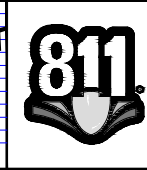
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CITY OF WACO		SHEET OF SHEETS
TOPOGRAPHIC SURVEY WMASS PLANT		
COMPARISON OF 2019 GROUND SURVEY VERSUS 2003 AERIAL IMAGE		

APPROXIMATE LOCATION OF BALD EAGLE'S NEST (+/-) 1500' FROM SOUTH BANK OF BRAZOS RIVER

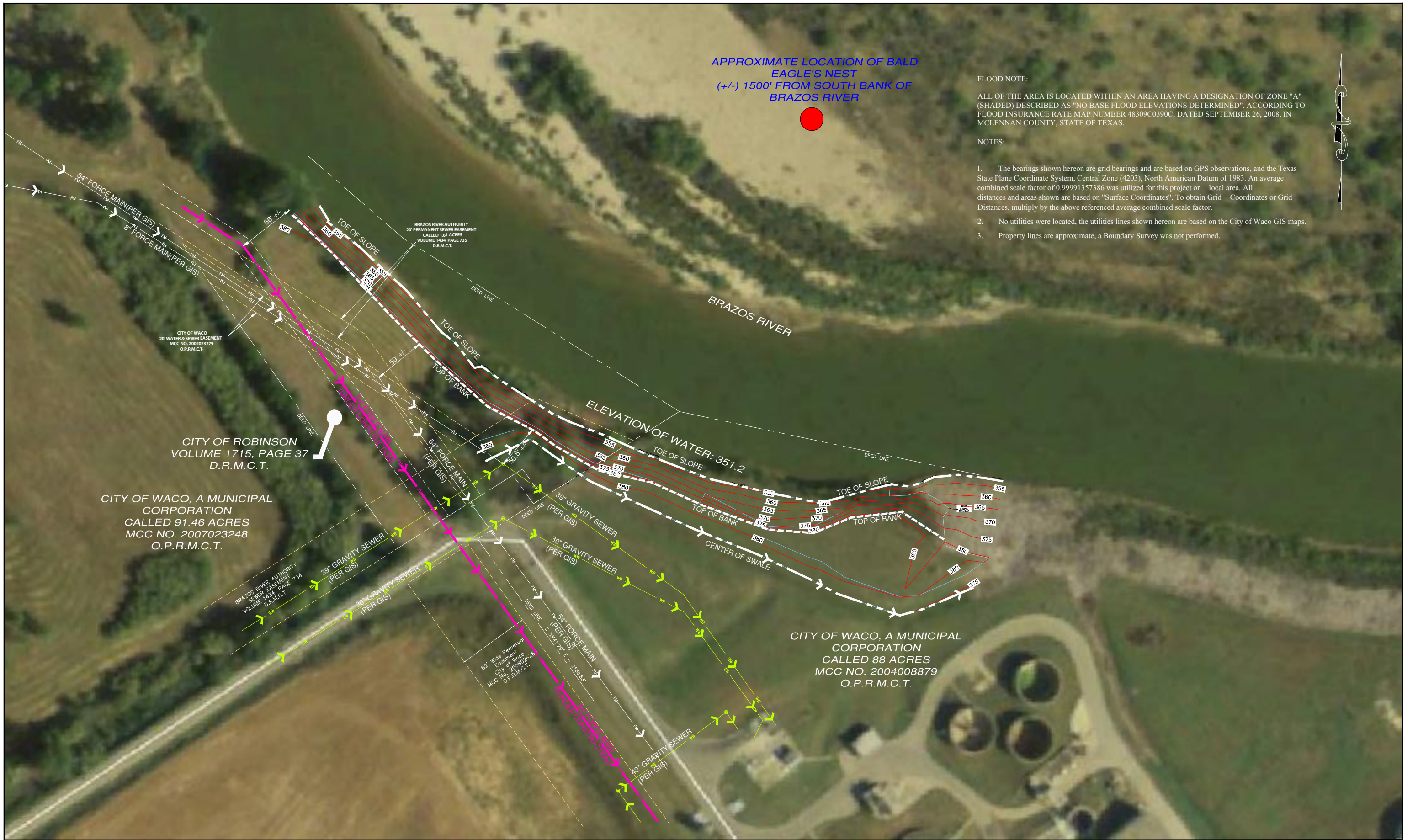


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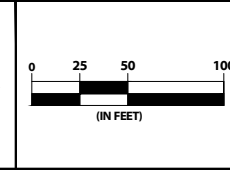
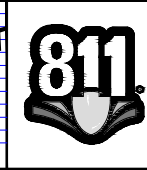
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CITY OF WACO		SHEET OF SHEETS
TOPOGRAPHIC SURVEY WMARSS PLANT		
COMPARISON OF 2019 GROUND SURVEY VERSUS 2008 AERIAL IMAGE		

APPROXIMATE LOCATION OF BALD EAGLE'S NEST
 (+/-) 1500' FROM SOUTH BANK OF BRAZOS RIVER



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CITY OF ROBINSON
 VOLUME 1715, PAGE 37
 D.R.M.C.T.

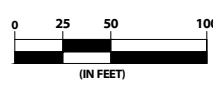
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 MCC NO. 2007023248
 O.P.R.M.C.T.

BRAZOS RIVER AUTHORITY
 SEWER EASEMENT
 VOLUME 1434, PAGE 734
 D.R.M.C.T.

82' Wide Perpetual Easement
 City of Waco
 Mcc No. 20080826
 O.P.R.M.C.T.

CITY OF WACO, A MUNICIPAL CORPORATION
 CALLED 88 ACRES
 MCC NO. 2004008879
 O.P.R.M.C.T.

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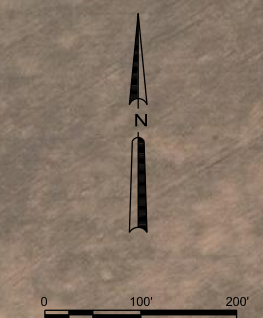
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TOPOGRAPHIC SURVEY WMARSS PLANT		
COMPARISON OF 2019 GROUND SURVEY VERSUS 2015 AERIAL IMAGE		



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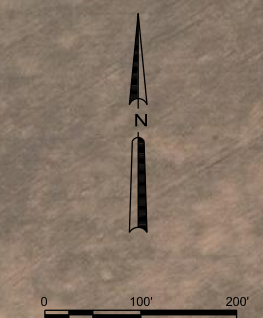
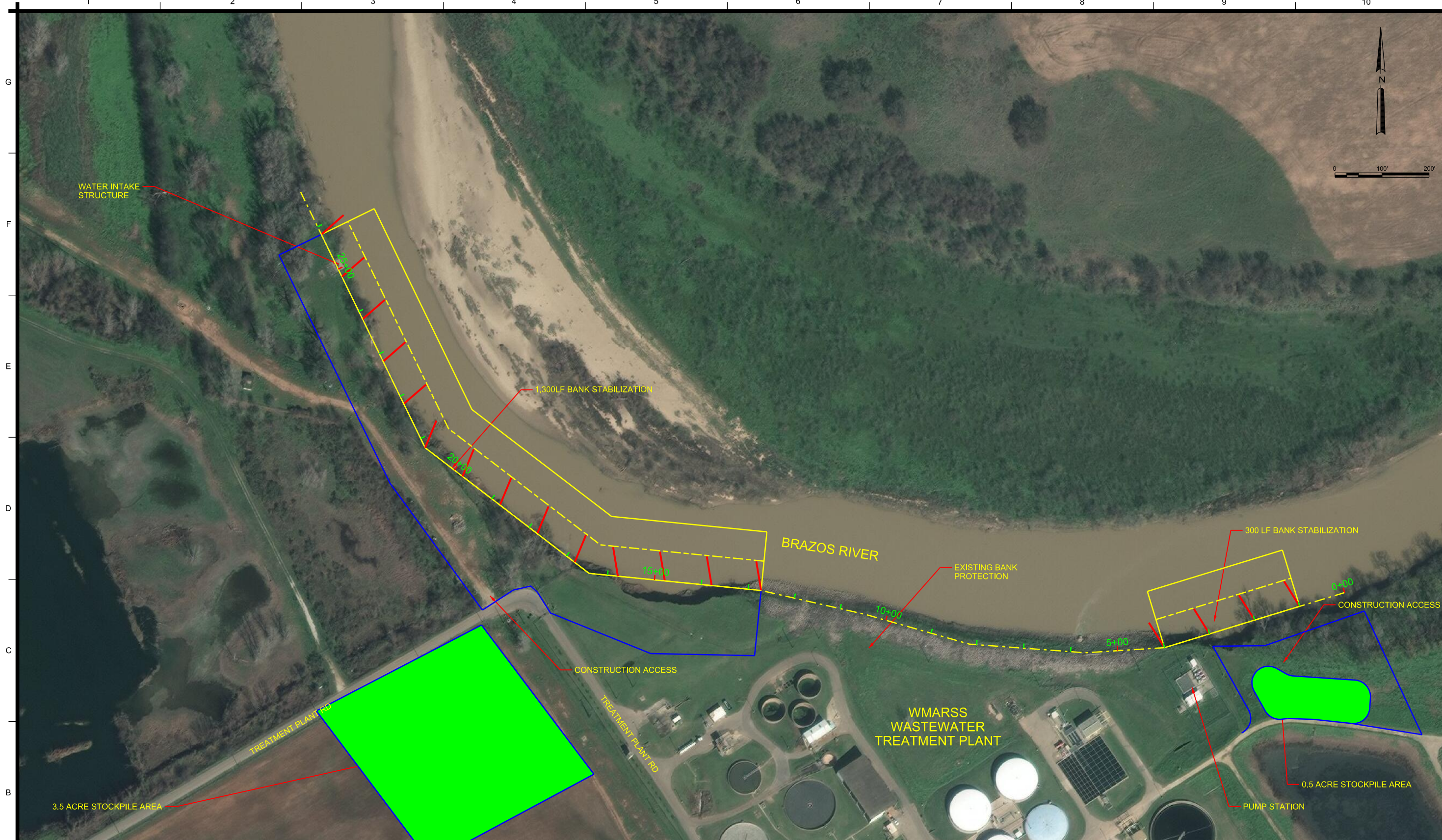
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CONSTRUCTION DIVISION
ENGINEERING BRANCH

WRTP SECTION 14
WACO, MCLENNAN COUNTY, TX
SITE PLAN




NOTE:
BANK STABILIZATION ALTERNATIVES
ALTERNATIVE 1 - LONGITUDINAL PEAKED STONE DIKE AND TIE BACK
ALTERNATIVE 2 - STONE RIPRAP TOE PROTECTION
ALTERNATIVE 3 - LONGITUDINAL PEAKED STONE TOE PROTECTION WITH BENDWAY WEIRS

LEGEND

	PROJECT AREA
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NOTE:
 BANK STABILIZATION ALTERNATIVES
 ALTERNATIVE 1 - LONGITUDINAL PEAKED STONE DIKE AND TIE BACK
 ALTERNATIVE 2 - STONE RIPRAP TOE PROTECTION
 ALTERNATIVE 3 - LONGITUDINAL PEAKED STONE TOE PROTECTION WITH BENDWAY WEIRS

LEGEND	
	PROJECT AREA
	TEMPORARY CONSTRUCTION ACCESS
	STOCKPILE AREA

US Army Corps of Engineers @ Fort Worth District

DATE	DESIGNED BY	DRAWN BY	CHECKED BY	SUBMITTED BY	REVISION	DESCRIPTION

U.S. ARMY CORPS OF ENGINEERS
 FORT WORTH DISTRICT
 819 TALLOR ST.
 FORT WORTH, TEXAS

ENGINEERING/
 CONSTRUCTION DIVISION
 ENGINEERING BRANCH

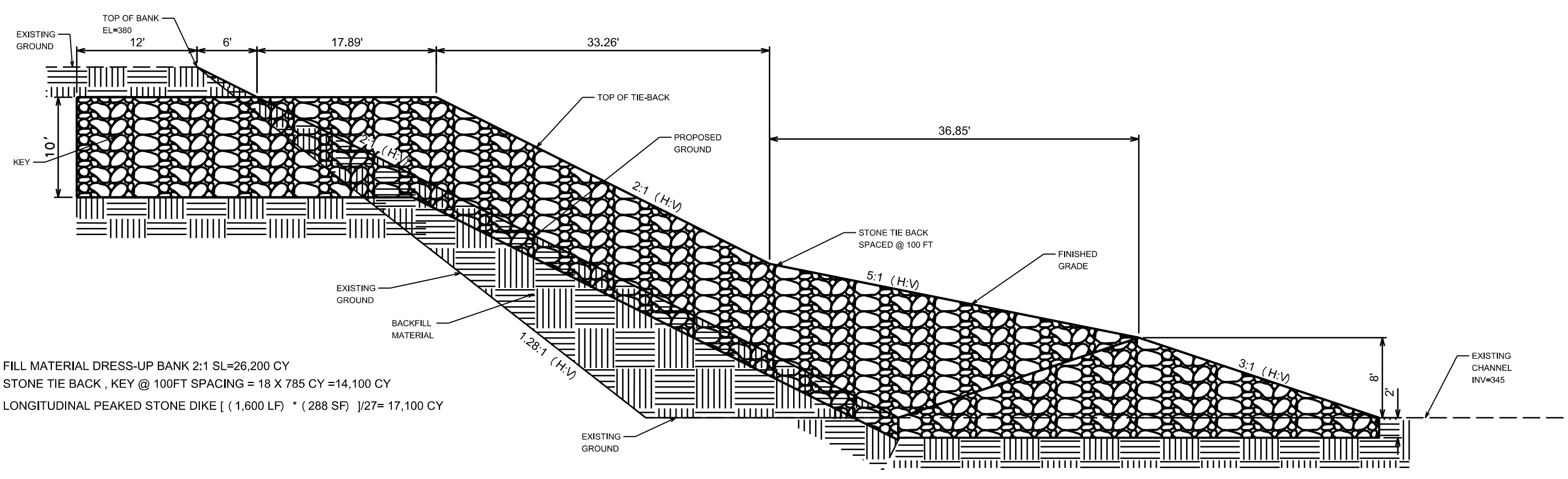
WRTP SECTION 14
 WACO, MCLENNAN COUNTY, TX

CONSTRUCTION ACCESS/LAY DOWN AREAS

SHEET NUMBER
 CH101

US Army Corps of Engineers @ Fort Worth District

Date:	Month/Year:	Revision:
Drawn by:	Checked by:	Submitted by:
U.S. ARMY CORPS OF ENGINEERS FORT WORTH DISTRICT 819 FALLOR ST FORT WORTH, TEXAS		ENGINEERING/ CONSTRUCTION DIVISION ENGINEERING BRANCH
WRTP SECTION 14 WACO, MCLENNAN COUNTY, TX ALTERNATIVE 1 LONGITUDINAL PEAKED STONE DIKE WITH TIE BACK		
SHEET NUMBER ALT-1		



FILL MATERIAL DRESS-UP BANK 2:1 SL=26,200 CY
 STONE TIE BACK , KEY @ 100FT SPACING = 18 X 785 CY =14,100 CY
 LONGITUDINAL PEAKED STONE DIKE [(1,600 LF) * (288 SF)]/27= 17,100 CY

ALTERNATIVE 1
 LONGITUDINAL PEAKED STONE DIKE AND TIE BACK

US Army Corps of Engineers @ Fort Worth District

Date	Description	Mark	Action

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FORT WORTH, TEXAS**

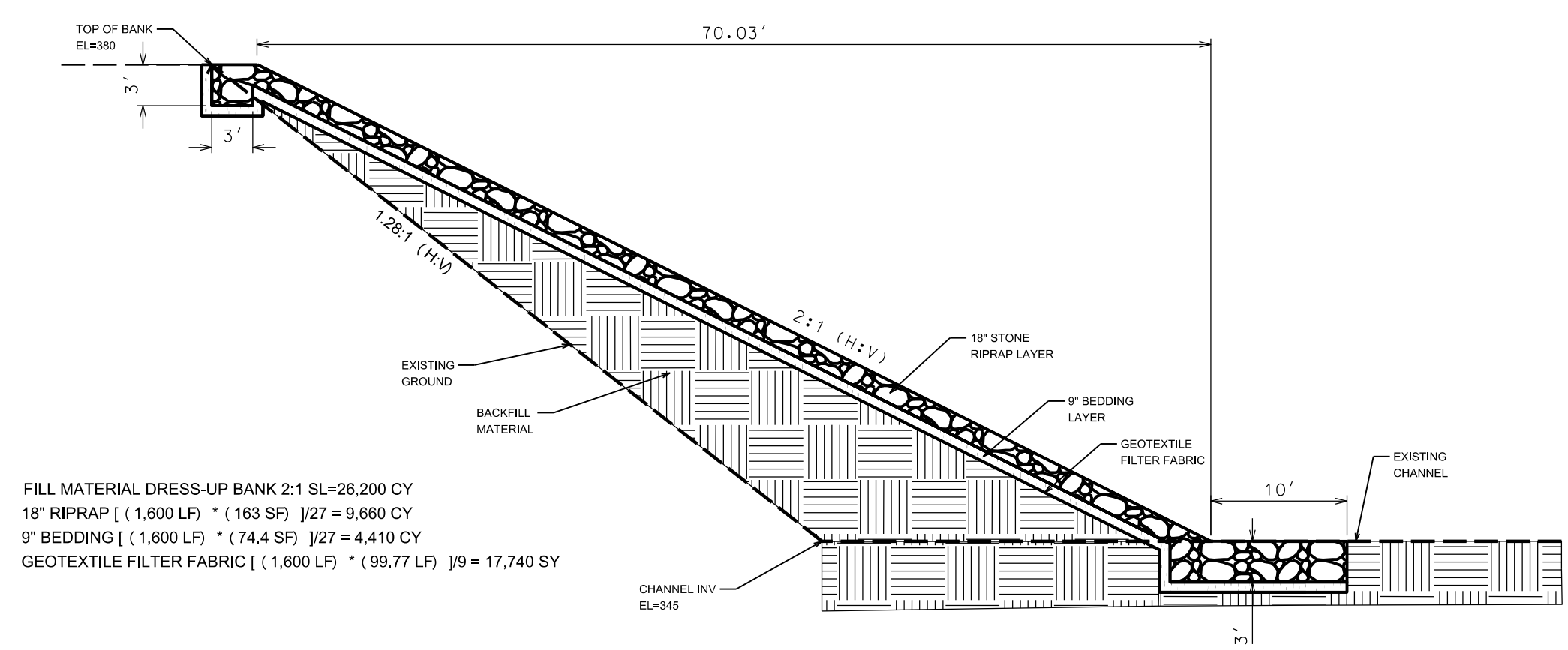
**ENGINEERING/
CONSTRUCTION DIVISION
ENGINEERING BRANCH**

WRTP SECTION 14
WACO, MCLENNAN COUNTY, TX

ALTERNATIVE 2
STONE RIPRAP TOE PROTECTION

**SHEET
NUMBER**

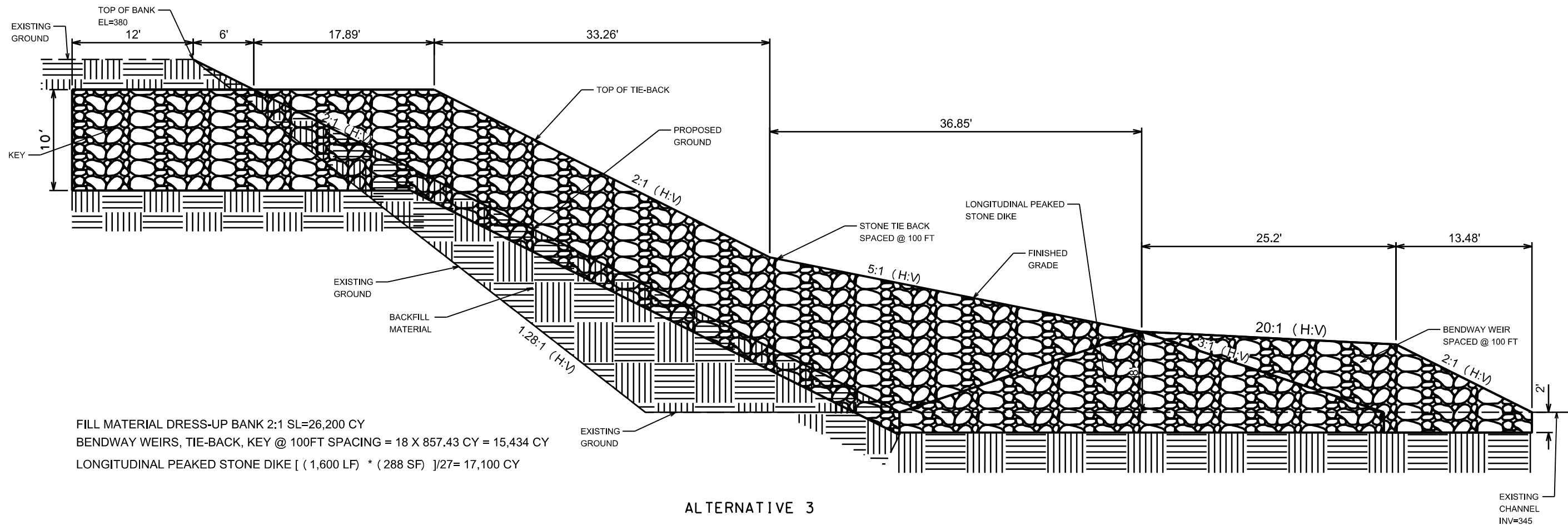
ALT-2



FILL MATERIAL DRESS-UP BANK 2:1 SL=26,200 CY
 18" RIPRAP [(1,600 LF) * (163 SF)]/27 = 9,660 CY
 9" BEDDING [(1,600 LF) * (74.4 SF)]/27 = 4,410 CY
 GEOTEXTILE FILTER FABRIC [(1,600 LF) * (99.77 LF)]/9 = 17,740 SY

ALTERNATIVE 2
STONE RIPRAP TOE PROTECTION

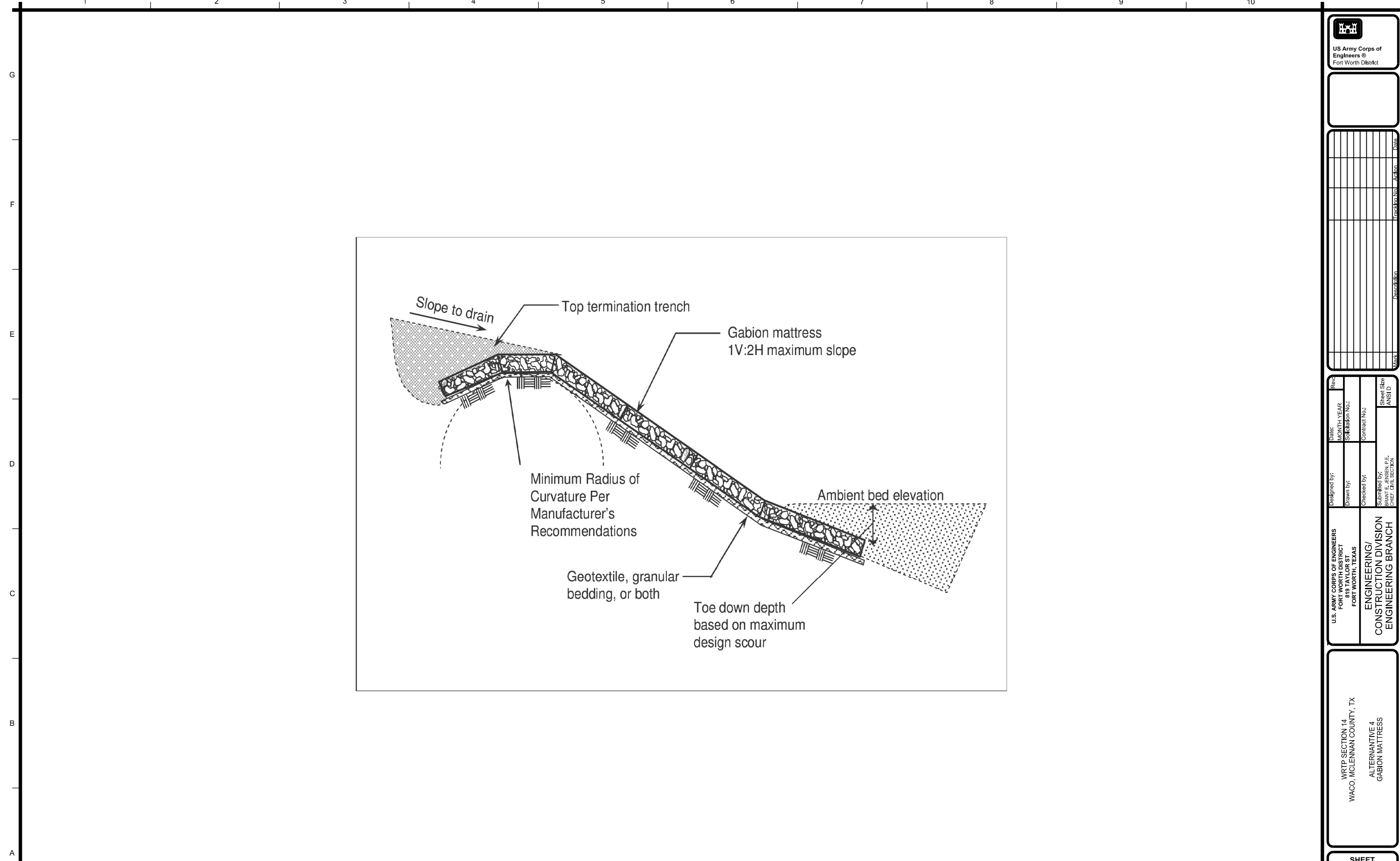
G
F
E
D
C
B
A



FILL MATERIAL DRESS-UP BANK 2:1 SL=26,200 CY
 BENDWAY WEIRS, TIE-BACK, KEY @ 100FT SPACING = 18 X 857.43 CY = 15,434 CY
 LONGITUDINAL PEAKED STONE DIKE [(1,600 LF) * (288 SF)]/27= 17,100 CY

ALTERNATIVE 3
LONGITUDINAL PEAKED STONE TOE PROTECTION
WITH BENDWAY WEIRS

<p>US Army Corps of Engineers Fort Worth District</p>	
<p>Revised: _____</p>	<p>Drawn by: _____</p>
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<p>Month/Year: _____</p>	<p>Submitted by: _____</p>
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<p>WRTP SECTION 14 WACO, MCLENNAN COUNTY, TX</p>	<p>ALTERNATIVE 3 LONGITUDINAL PEAKED STONE TOE PROTECTION WITH BENDWAY WEIRS</p>
<p>SHEET NUMBER</p>	<p>ALT-3</p>

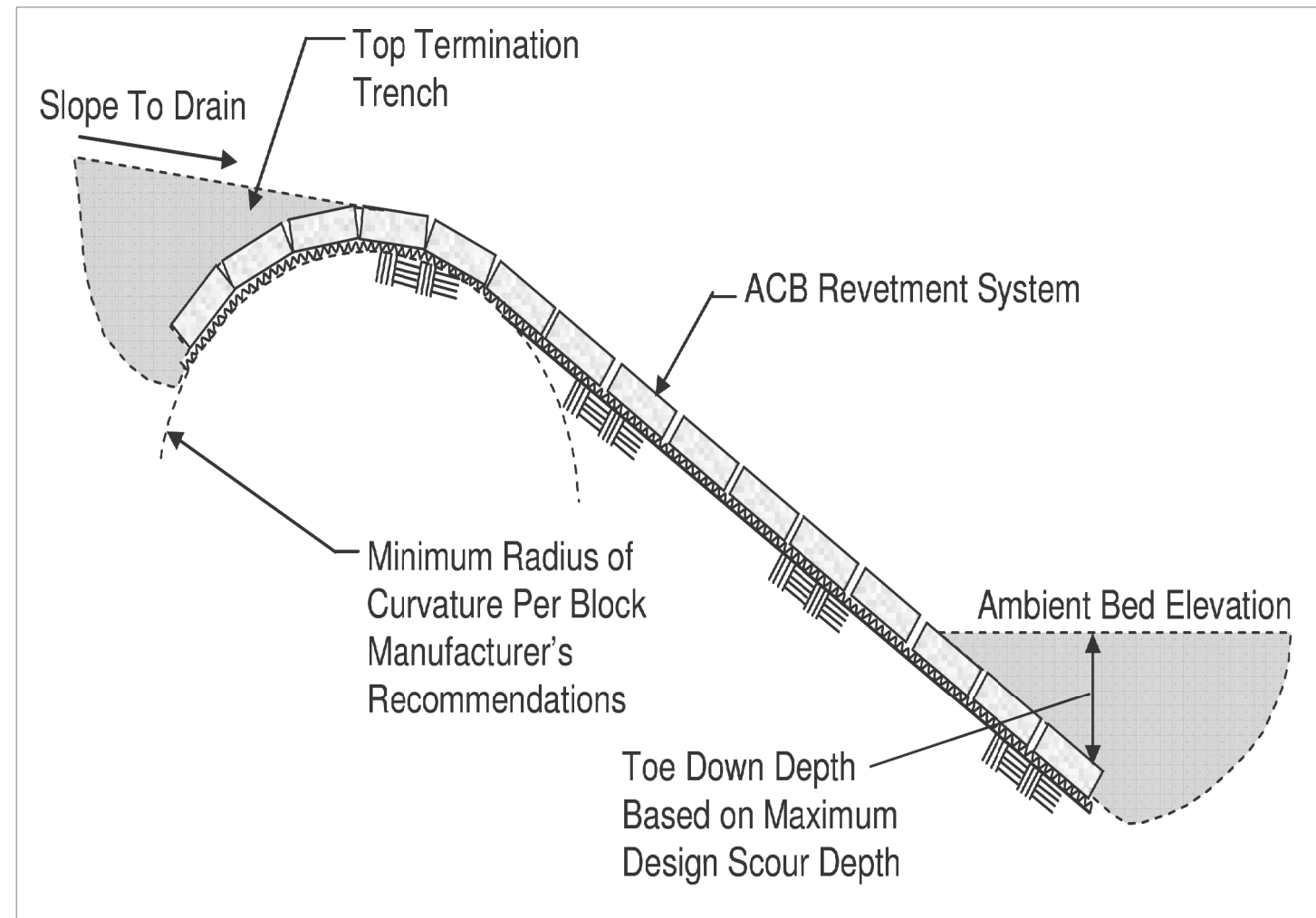


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US Army Corps of Engineers Fort Worth District	
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Checked by:	Solicitation No.:
Submitted by:	Contract No.:
SHEET CIVIL SECTION	SHEET SIZE ANSI D
WRTP SECTION 14 WACO, MCLENNAN COUNTY, TX ALTERNATIVE 5 ARTICULATED CONCRETE BLOCKS	
SHEET NUMBER ALT-5	