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APPENDIX G
Section 4
Structural Design

GENERAL

This chapter describes the assumptions, methods, and any special conditions that relate to the preliminary design work stability analyses and preliminary structural design of the sluice structures, drainage structures, bridges, and floodwall. Also reference the Civil Section of this appendix for additional information on the project features.

STRUCTURAL DESCRIPTIONS

STRUCTURES FOR THE COLORADO RIVER LEVEES AND SUMPS

Wal-Mart Drainage Area

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The sump area will be drained by 2 proposed 7' x 7' box culverts with sluice gates and flap gates for control of the hydraulic flows. Drainage structures will have standard TXDOT inlet and outlet structures.

NANYA Plastics Drainage Area

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Two 60" diameter drainage pipes with sluice gates and flap gates will drain this sump area when the Colorado River is not in flood stage. As on the other structures, the proposal is to use standard TXDOT designs including the headwalls and wing walls.

Hughes Street Drainage Area

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The Hughes Street drainage area requires the three following structures: two 7'x7' box drainage structures, three 60" CMP structures from Caney Creek to Hughes Street Sump Area, and an existing 48" pipe from the landfill to be fitted with a flap gate. Precast reinforced concrete box culvert structures (cast in place concrete (CIP) could be used but that is not seen as a better alternative to the precast option at this time. The proposal is to use standard TXDOT structure designs including the headwalls and wingwalls.

Ford Street Drainage Area

A 54" diameter drainage pipe is required through the levee that will have a sluice gate and flap gate for control. As on the other structures, the proposal is to use standard TXDOT designs including the headwalls and wing walls.

Sunset Street Drainage Area

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A 48" diameter drainage pipe is required through the levee that will have a sluice gate and flap gate for control. As on the other structures, the proposal is to use standard TXDOT designs including the headwalls and wing walls.

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Polk Street/Richmond Street Drainage Area

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The drainage structure at this location requires three 60” drainage pipe structures from the corner of Caney Street and Polk Street to the Colorado River under the proposed flood wall. The proposal is to use standard TXDOT designs including the headwalls and wingwalls. The flap gate and sluice gate will be required for control of water through this structure.

Rusk Street Drainage Area

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The Rusk Street Sump will consist of an existing 48” diameter pipe will pass under the proposed flood wall. This pipe will require a flap gate on the discharge end.

Black/Collins Street Drainage Area

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This drainage will use a 60” diameter pipe with a sluice gate and flap gate for controls. As on the other structures, the proposal is to use standard TXDOT designs including the headwalls and wingwalls.

Alabama Street Drainage Area

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2-7’x7’ box culverts will drain this area with sluice gates and flap gates

STRUCTURES FOR BAUGHMAN SLOUGH LEVEE AND CHANNEL

Railroad Drainage Area

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A 66” diameter pipe will be required through this proposed levee at the west end of the Baughman Slough Levee sump area. The pipe will require a flap gate and sluice gate to allow for controlled releases of water. Additionally, a 48” diameter pipe will be needed to the east of the 66” pipe at the intersection with Richmond road. This structure will also have a flap gate and sluice gate to allow for controlled releases of water. The proposal for both structures is to use standard TXDOT designs including the headwalls and wing walls.

AHLDAG Drainage Area

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2-7’x7’ box culverts will drain this sump area with the use of sluice gate and flap gate for control.

The Baughman Slough channel improvement has two local traffic roads crossing the new drainage canal at Junior College Boulevard and County Road CR235 (Moers Road) requiring 114’ bridges with 28’ wide roadways. Quantities are based on standard TXDOT designs for abutments, prestressed concrete I-beams (type C), and interior pier bents.

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Floodwall

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The functional design requirements and technical design criteria for the preliminary stability analysis and design of the floodwall are noted in the following paragraphs. The preliminary stability analyses were based on assumptions of geotechnical parameters as noted in the following paragraphs due to no information being available to the structural designer at the time of the analysis. The Corps of Engineers program CTWALL X00153 was used to conduct the preliminary stability analysis. Two floodwall sections were investigated. The first section is a typical section and is the recommended section for future investigations. The second section incorporates a split footing to provide a sidewalk. The plain wall with a separate sidewalk is recommended for future design development. At the time of the analyses, it was recommended by the geotechnical designer that a minimum of a 4' cutoff be provided to aid in seepage control and stability. Based on the preliminary analysis, the resultant ratio for overturning is slightly over one-third with 100% of the base in compression and an overturning ratio of slightly over 1.5. The uplift pressures obtained from the analyses are as follows: heel- 500 pounds per square foot (psf), toe – 250 psf, bottom of the key – 480 psf, and top of the key – 400 psf. The load factor used was 1.9. The resulting factors of safety are as follows: Bearing – 6.67 and Sliding 2.125.

Sluice Gate Structures

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Due to the preliminary phase, no preliminary structural design has been conducted for the sluice gate structures. Based on the sizes of the structures proposed and on other projects with similar features, the following alternatives should be considered for sluice gate structures during the design phase of the project: reinforced cast-in-place (CIP) concrete, precast reinforced concrete pipe (RCP), and CMP. The final selection will be based on the lifespan, loading requirements, and sizing requirements. As with the other drainage features, the use of TXDOT standards will be maximized.

REFERENCES

a. EM 1110-2-2000, "Standard Practice for Concrete for Civil Works Structures", 1 February 1994.

b. EM 1110-2-2104, "Strength Design for Reinforced Concrete Hydraulic Structures", 30 June 1992.

c. EM 1110-2-2105, "Design of Hydraulic Steel Structures", 31 March 1993.

d. EM 1110-2-2400, "Structural Design of Spillways and Outlet Works", 2 November 1964.

e. EM 1110-2-2502, "Retaining and Flood Walls", 29 September 1989.

f. ETL 1110-2-256, "Sliding Stability for Concrete Structures", 24 June 1981.

g. ETL 1110-2-307, "Floatation Stability Criteria for Concrete Hydraulic Structures", 20 August 1987.

h. ETL 1110-2-322, "Retaining and Flood Walls", 15 October 1990.

i. Standard Specifications for Highway Bridges, Published by the American Association of State Highway and Transportation Officials, latest edition.

j. ACI 318-01, Building Code Requirements for Reinforced Concrete, by the American Concrete Institute, 2001.

MATERIAL PROPERTIES

a. Unit Weights. Weight units are pounds per cubic foot.

Water	62.5
Concrete	150.0
Steel	490.0
Earth (moist)	120.0
Earth (saturated)	125.0

b. Lateral Pressures. Pressure units are pounds per square foot per foot of depth except for wind. Wind pressure is pounds per square foot, and is uniform over the structure height.

Water	62.5
Soil -- Reference part 5.4 Foundations. At Rest pressures are used.	
Wind	30.0

c. Concrete. All concrete will have a 28-day ultimate compressive strength of 3000 psi, except for the bridge deck and the bridge girders. The bridge deck concrete will have a 28-day strength of 4000 psi. The concrete for the bridge girders will have a 28-day strength of 5000 psi. Where concrete is subjected to flowing water, having velocities equal to or greater than 40 fps, the maximum size of aggregates will be 1-1/2 inches. The maximum aggregate sizes for other areas will be as follows:

Bridge Deck	3/4"
Bridge Girders	3/4"
Floodwalls	1-1/2"
Headwalls	1-1/2"

d. Reinforcement. All standard concrete reinforcement will be ASTM A615, Grade 60. Standard reinforcement, used for the bridge deck and girders will be epoxy coated for corrosion protection. Prestressing strands for the bridge girders will conform to ASTM A416 and will be 7-wire, uncoated, stress relieved strand, Grade 270. Concrete coverage for standard reinforcement will be as follows:

Surfaces in contact with foundation	6"
Surfaces subjected to high flow velocity	6"
Other formed hydraulic surfaces	4"
Other surfaces in accordance with applicable specifications.	

e. Other Materials. Other materials will be based on standard material requirements as required by the Corps of Engineers design guidance and recommendations from the Corps of Engineers Research Lab (CERL).

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FOUNDATION

No final geotechnical design parameters were available at the time of the structural analysis required for the project. No foundation analyses were made for the miscellaneous structures due to the preliminary stage of the design. The preliminary assumptions made for the floodwall were based on discussions with the geotechnical engineer and are indicated as follows. The foundation requirements will be finalized in the later design stages. Minimal changes are anticipated from the design parameters assumed for the structures.

Floodwall Foundation	
Angle of Internal Friction	28.0 Degrees
Lateral earth pressure coefficient (at-rest)	0.7
Cohesion	0.0 Kips/Sq.Ft.
Allowable Bearing Pressure	2.0 Kips/Sq.Ft.

DESIGN FORCES

Forces for the preliminary stability analysis of the floodwall, in addition to the weights and lateral pressures already listed, are in accordance with the references listed above.