

# 2021

## West Bank & Vicinity GRR Appendix A – Levees Design



**US Army Corps  
of Engineers®**  
New Orleans District

U.S. Army Corps of Engineers, New Orleans  
District

Non-Federal Sponsor: Coastal Protection and  
Restoration Authority Board of Louisiana

March 2021

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## WEST BANK & VICINITY GRR APPENDIX A – LEVEES DESIGN

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## WEST BANK & VICINITY GRR APPENDIX A – LEVEES DESIGN

### 1 INTRODUCTION

#### 1.1 OVERVIEW

This appendix describes the methodology used to calculate quantities based on the projected levee lifts required to achieve the estimated design elevations for two alternative plans that will exclude the 1% AEP and 0.5% AEP coastal storms from the leveed area in the year 2073 for the intermediate sea level rise scenario. For the scope of this study and the size of the study area, certain reaches were chosen to represent the other reaches in the system in order to reduce the number of reaches that would need to be analyzed. Explanation of why certain reaches were chosen to represent others can be found in the Geotechnical Appendix B. This appendix contains examples of representative cross sections from the representative levee reaches around the West Bank and Vicinity (WBV) project areas which were used to calculate quantities for the system. The locations of the representative reaches used and discussed in this report are shown in Figure 1, highlighted in green. The quantity table in Enclosure 1 lists all of the reaches and has a representative reach column to show which representative reach was used to quantify each of the individual reaches. Explanation of why certain reaches were chosen to represent others can be found in the Geotechnical Appendix B. The cross sections included in the analysis depict each of the representative sections at the time of the last levee lift, whether by USACE or by CPRAB and SLFPA-E or by the local levee district as an allowed Section 408 alteration to the levee reach. The elevation of last levee lift and the design grade for each reach is stated in the paragraphs below. All elevations are referenced to NAVD88 (2004.65), unless otherwise noted.



Figure 1. West Bank and Vicinity Representative Reach Locations



## 2 REPRESENTATIVE REACHES

The following paragraphs discuss the construction history of the last lift of the representative reaches and include a map of their location and a typical cross section of the last lift. Armoring is not shown in the typical sections.

### 2.1 WBV-12 HERO CANAL REACH.

#### 2.1.1 WBV-12

WBV-12 is the representative reach for reach WBV-09a (Hero to Oakville), WBV-12, and WBV-90 (GIWW-West Closure Complex). The WBV-12 levee reach was last lifted by the non-federal sponsor in 2017 to an elevation of 13.0. The 2007 design grade is El. 10.5; the 2057 design grade is El. 14.0. This reach was armored with HPTRM in 2018.

The levee has a 10-foot-wide crown, 1:3 landside side slope and a 1:4 flood side slope. The contract provided 2 feet of overbuild in anticipation of future subsidence. Landside stability berms with a reinforcing geotextile were required between B/L STA 126+55 and B/L STA 151+05. Landside stability berms without a reinforcing geotextile were required from B/L STA 151+05 to B/L STA 176+05 and from B/L STA 191+55 to B/L STA 244+00. Landside stability berms were not required between levee B/L STA 124+70 and B/L STA 126+05 and between B/L STA 176+55 and B/L STA 178+66.

During construction the plans were modified to install a soil-bentonite slurry cutoff trench between B/L STA 158+00 and B/L STA 215+00 and a sheet pile cutoff wall between B/L STA 220+00 and B/L STA 244+90 on the flood side of the levee.

In 2014, to prevent bank erosion along the Hero Canal levee at the intersection of Hero Canal and the GIWW, a foreshore dike was constructed along the bank line of Hero Canal between C/L STA 236+6 and 244+90.

Material used to enlarge the levee was obtained from both government-furnished borrow area "N" along Walker Road and a contractor-furnished borrow area and contractor furnished borrow areas.

### 2.2 WBV-ARM-16 SYSTEM ARMORING (WBV-12)

This reach was armored in 2018 under contract WBV-ARM-16. The armoring contract consisted of placing HPTRM along the crown and protected side of the levee. The HPTRM was secured to the levee using percussion driven earth anchors placed at 5 ft. intervals and 12-inch metal pins placed between the percussion driven earth anchors. Once placed the HPTRM was covered with Bermuda sod and fertilized.

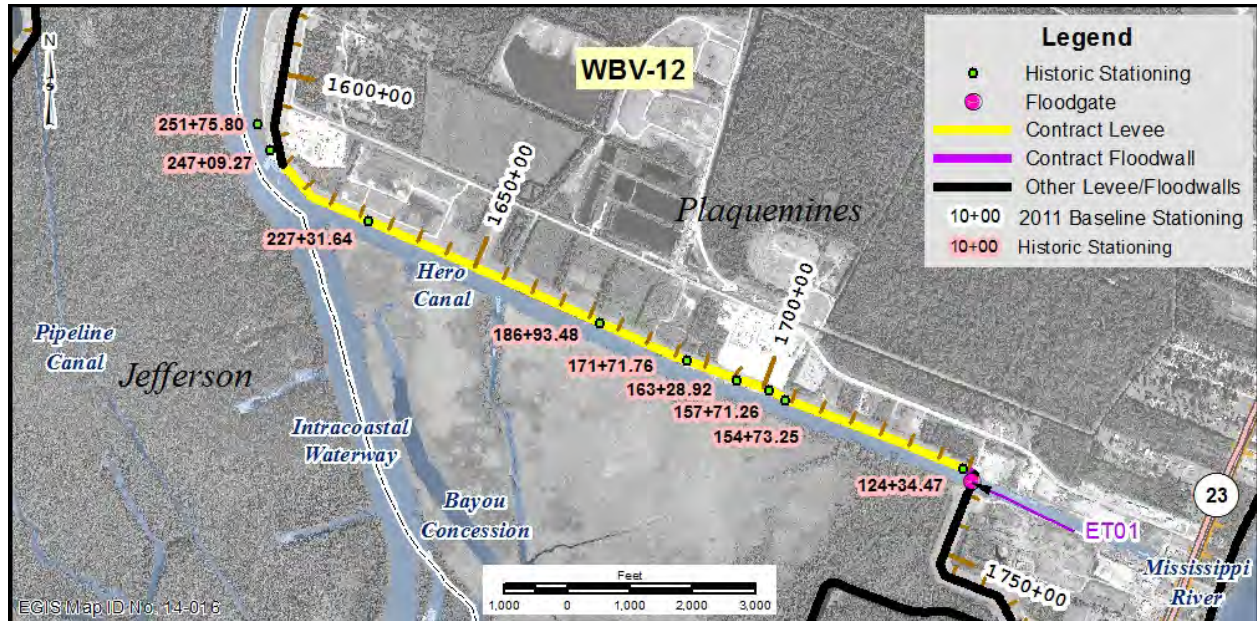


Figure 2. WBV-12 Levee Reach

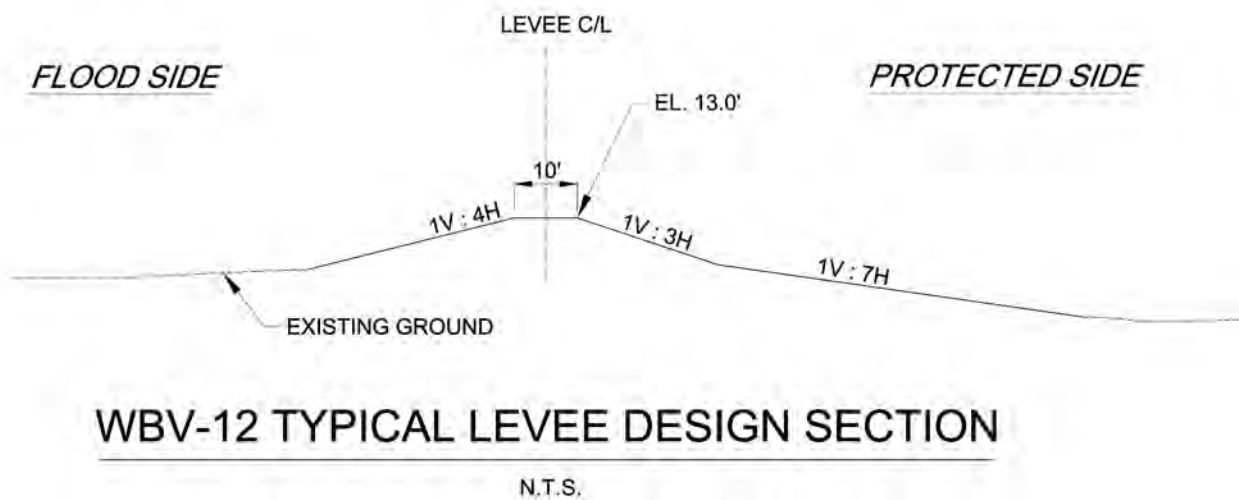


Figure 3. WBV-12 Typical Levee Section



### 2.3 WBV 47.1, 47.2A ALGIERS LOCK TO BELLE CHASE HWY.

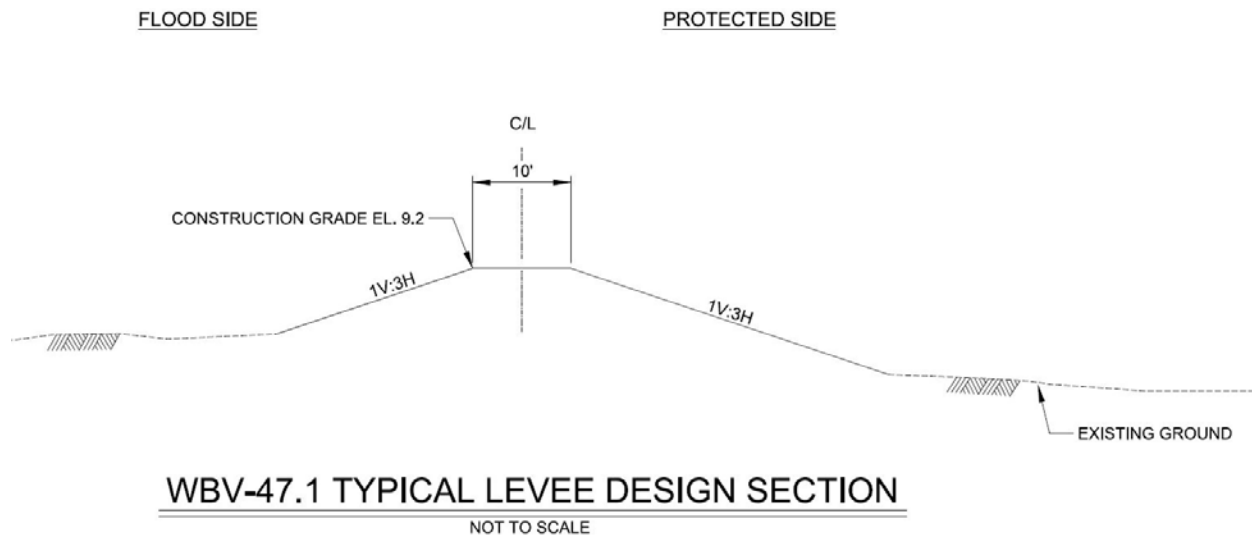
The WBV-14.7 reach is the representative reach for WBV-06a.2 (Belle Chase Highway to Hero Cutoff West), WBV-47.1, WBV-48.2 (Belle Chase Hwy to Algiers Lock East), and WBV-49.1 (Hero Levee to Belle Chase Highway West). These reaches are considered interior levees in the HSDRRS system. They are not along the perimeter of the HSDRRS system.

The WBV 47.1 levee reach was last lifted by USACE to 9.2 in 2011. The design grade is 8.5. This contract involved raising levees to authorized level of protection along a reach of approximately 3.7 miles along the western side of the Algiers Canal. The work consisted of clearing and grubbing, compacted levee and berm embankment, silt fences, truck wash-down racks, borrow pit management, construction of access roads, fertilizing, seeding, mulching, and deep soil mixing. Deep soil mixing was required at Entergy's high-powered aerial crossing to eliminate the need for a landside stability berm at the tower.

Specifically, this contract added levee crown with land side stability berms, straddle levee enlargements with land side stability berms, land side levee enlargements with stability berms, canal side levee enlargements, and land side levee enlargements on approximately 2.9 miles of earthen levee. The project extended in a southerly direction along the west side of the Algiers Canal from the Algiers Canal Lock to a point approximately 700 feet north of Planters Pump Station.



Figure 4. WBV-47.1, WBV-47.2 Levee Reach



**Figure 5. WBV-47.1 Typical Levee Section**

## 2.4 WBV-71 WESTERN TIE-IN LEVEES (NORTH-SOUTH).

### 2.4.1 WBV-71

WBV-71 is the representative reach for WBV-17b.2, WBV-18.2, and WBV-71. This levee reach was last lifted by USACE to El. 11.5 in 2013. The 2007 1% hydraulic design elevation is 11.5. The required 2057 1% hydraulic design elevation for the WBV-71 levee was 13.0 ft. This contract was armored in 2016.

This segment of the Hurricane and Storm Damage Risk Reduction System (HSDRRS) consisted of 1.3 miles of levee, located in St. Charles Parish on the west bank of the Mississippi River, in the vicinity of the Davis Pond Freshwater Diversion Canal.

The contract began at 2011 B/L STA 0+00 on the west end of the WBV alignment (the Western Tie-In (WTI) in St. Charles Parish, south of LA Highway 18, south of the Union Pacific Railroad tracks and just south of the WTI WBV-77 Project T-wall tie-in) and proceeded east to 2011 B/L STA 75+37.6.

The WBV-71 construction contract consisted of: clearing and grubbing; constructing access ramps and a maintenance road; enlarging an existing earthen levee and berms (north-south segment); constructing a new earthen levee and berms (west-east segment); excavating a drainage ditch; installing swales; constructing a new levee ramp; access road surfacing; and turf establishment. The west-east segment included a sand base with high strength geo-textile fabric installed on top of the sand base before clay embankment was placed and compacted. It should be noted that access road surfacing occurred only in the vicinity of levee ramps.

This earthen levee, constructed by DQSI, LLC, had a 10 ft. crown width with an original design grade of El. 9.0 ft. and a construction grade of El. 11.5 ft., with 1 vertical on 4 horizontal levee side slopes. A 2012 levee lift raised the construction grade crown to El. 12.0 ft. Thus the construction contract provided approximately 3 ft. of overbuild after completion of the 2012

levee lift. A wave berm had a 1 vertical on 14 horizontal side slope from berm toe to a shoreline of El. 6.5 ft. There was also at least a 15 ft. wide vegetation-free zone. Also on the west-east levee segment, there was a 5-strand barb wire fence with wood posts embedded in the levee and berms crossing near a property boundary; this pre-existing fence was re-installed through USACE as part of the WBV-71 2012 levee lift. There was an earthen roadway levee ramp crossing near Coulee Road. The first lift required minor landside stability berms between STA 52+35 and 76+77.

The 2012 levee lift was constructed by two separate construction contracts. The typical levee section included a wave berm. The elevation for the wave berm must be monitored since it was a factor for establishing the required 1% hydraulic design elevation for the levee crown.

#### 2.4.2 WBV-ARM-08 SYSTEM ARMORING (WBV-71 AND WBV-72)

This armoring contract WBV-ARM-08 included armoring a segment of the HSDRRS from 2011 B/L STA 5+82 to B/L STA 241+36, consisting of 4 miles of levee. The armoring contract reach is comprised of two contract reaches (WBV-71 and WBV-72) that were constructed under the original WBV contracts.

The armoring contract consisted of placing HPTRM along the protected side of the levee. The HPTRM was secured to the levee using percussion driven earth anchors placed at 5 ft. intervals and 12-inch metal pins placed between the percussion driven earth anchors. Once placed the HPTRM was covered with Bermuda sod and fertilized.

There are several locations in the contract reach where the HPTRM abuts to concrete where concrete scour protection is placed at the intersection of a levee and floodwall as well as at concrete ramps and miscellaneous concrete pads throughout the reach. Where the HPTRM abuts to concrete, an anchor trench was placed running parallel to the edge of the hardened surface. Existing crushed stone ramps located on the protected side of the levee were concrete paved during the armoring contracts by placing 6" thick concrete on top of the existing crushed stone.

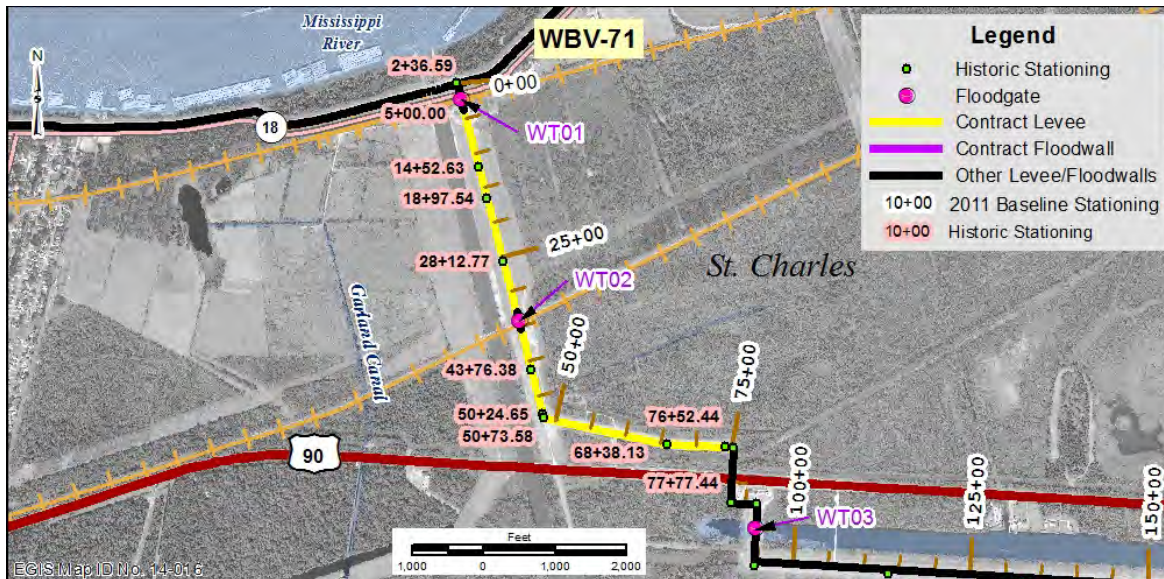
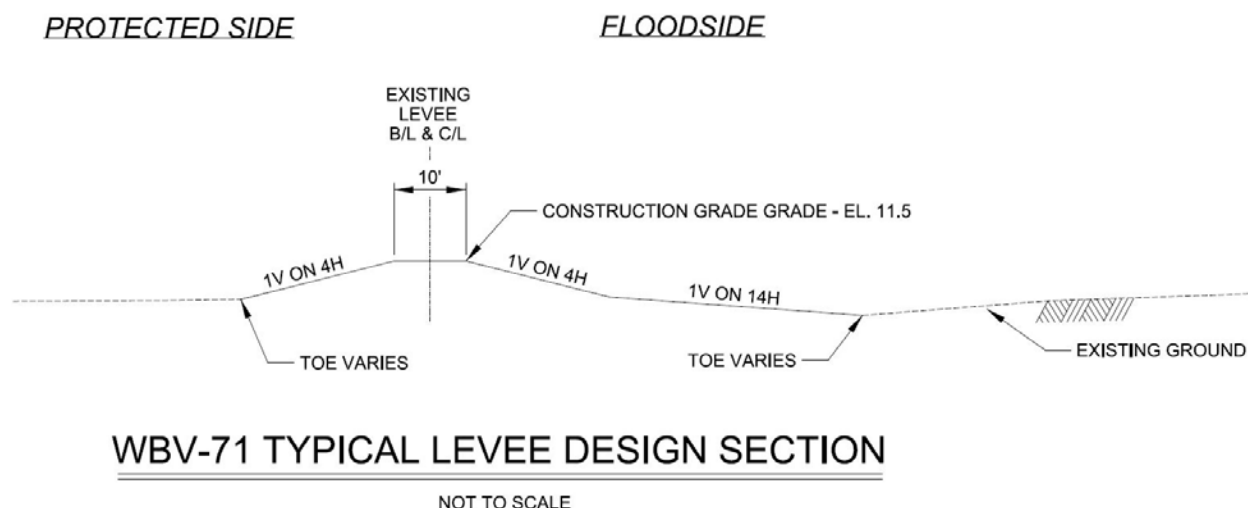


Figure 6. WBV-71 Baseline Stationing





**Figure 7. WBV-71 Typical Levee Section**

## 2.5 WBV-14B.2 ORLEANS VILLAGE TO HIGHWAY 45 LEVEE

### 2.5.1 WBV-14B.2

WBV-14B.2 is the representative reach for WBV-14B.2, WBV-14e.2 (V-Line Levee, East of Vertex), and WBV 14f.2 (Highway 45 Levee).

This segment of the HSDRRS consists of approximately 3.12 miles of levee. It is located on the west bank of the Mississippi River in the Westwego to Harvey area. The contract begins at 2011 B/L STA 930+40, and proceeds STA 990+53, where it connects to the fronting protection located at Ames Pump Station (WBV-37). The levee then resumes on the south side of Mount Kennedy pump station at STA 990+53 and continues to STA 1086+59 where it ties into the fronting floodwall for a pipeline crossing. It then resumes at STA 1088+61 on the east side of the floodwall and continues to STA 1093+67 where it terminates at the access road to Hwy 45.

This levee reach is currently being constructed by the non-federal sponsor to EL.14, to be complete in 2020. The required 1% hydraulic design elevation for the levee is 10.5 ft. in 2007 and 14 ft. in 2057. This contract provided 3.5 ft. of overbuild achieving a construction grade of approximate elevation 14 ft. During construction the existing levee was degraded and the center line of the new levee was shifted toward the flood side. Ramps providing access from the protected side to the flood side were constructed at several locations in the contract reach.

### 2.5.2 WBV-ARM-07

This armoring contract included armoring the WBV-14B.2 reach and is currently under construction.

The armoring contract consisted of placing HPTRM along the protected side of the levee. The HPTRM was secured to the levee using percussion driven earth anchors placed at 5 ft. intervals and 12-inch metal pins placed between the percussion driven earth anchors. Once placed the HPTRM was covered with Bermuda sod and fertilized.

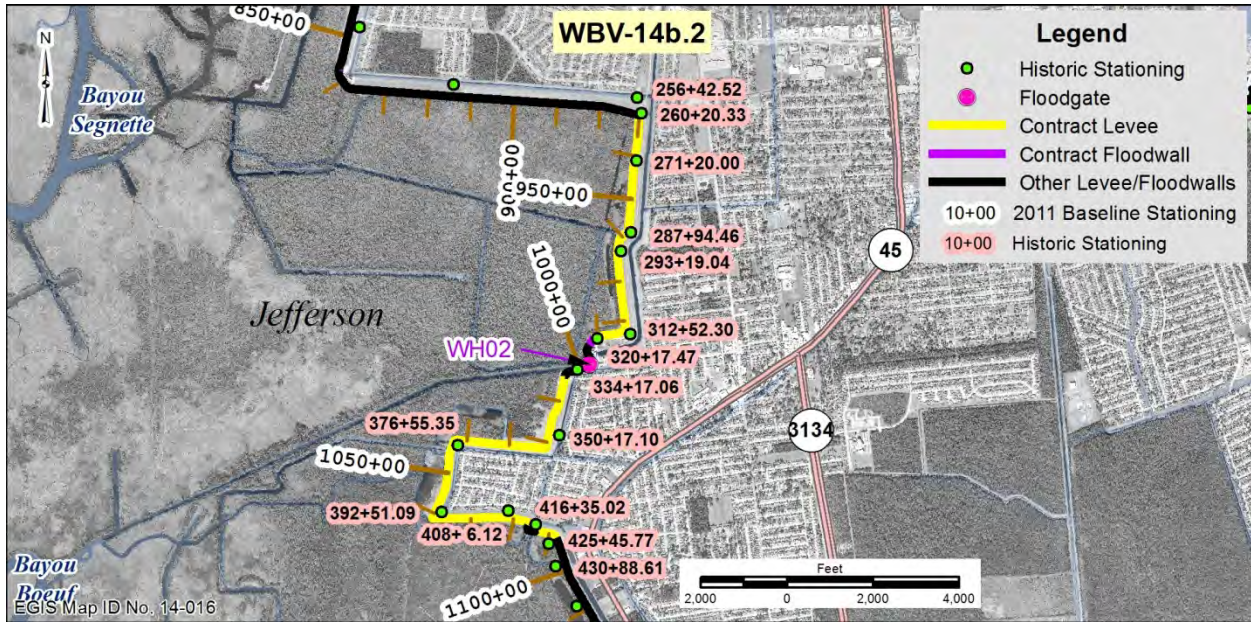


Figure 8. WBV-14b.2 Levee Reach

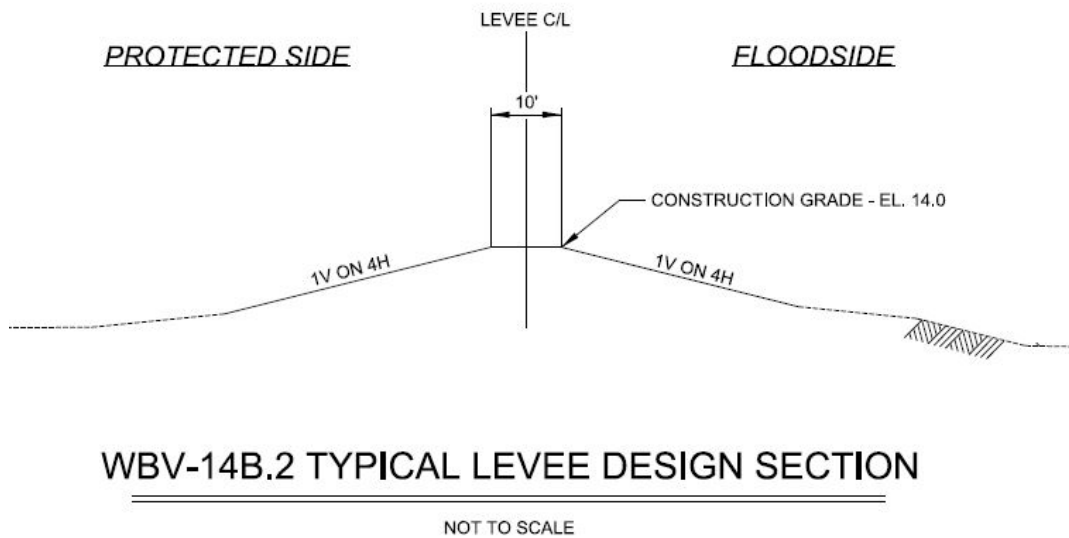


Figure 9. WBV-14.B2 Typical Levee Section

## 2.6 WBV-14C.2 NEW WESTWEGO PS TO ORLEANS VILLAGE.

### 2.6.1 WBV-14C.2

This segment of the HSDRRS WBV consisted of raising approximately 3.5 miles of existing earthen levee to the 100-year level of protection. This reach is located on the west bank of the Mississippi River in the Westwego area in Jefferson Parish, Louisiana. This levee reach is



currently being constructed by the non-federal sponsor to EL.14, to be complete in 2020. The required 1% hydraulic design elevation for the levee is 10.5 ft. in 2007 and 14 ft. in 2057. The last lift was to EL. 13.5 in 2011.

The last contract in 2011 began at 2011 B/L STA 745+05 and proceeded to a no-work area from B/L STA 854+75 to B/L STA 862+68 constructed under the contract Fronting Protection Westminster Pumping Station (WBV-30). The levee work continued from B/L STA 862+68 and concluded at Option Area A (STA 925+31), which is the Gulf South pipeline relocation. Option Area A was not exercised under this contract; the Gulf South pipeline relocation was accomplished under the contract Westwego to Harvey Utility Crossings and Miscellaneous Sector Gate Retrofits (WBV-14j).

This contract provided 3.0 ft. of overbuild achieving a construction grade of approximate EL. 13.5 ft. During construction, the existing levee was degraded and the center line of the new levee was shifted toward the flood side. The required 1% hydraulic design elevation for the floodwalls is 14 ft. in 2057.

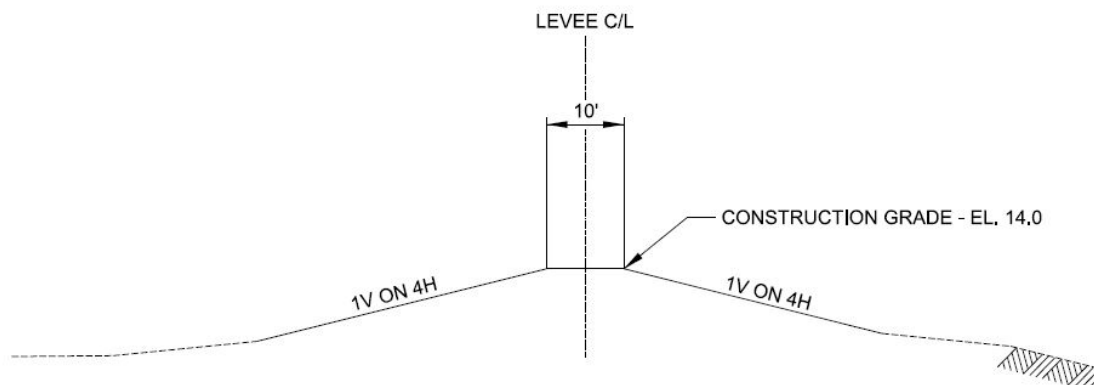
A ramp crosses the levee near 2011 Baseline STA. 801+00. The ramp provides access to Lapalco Blvd. (on the protected side) and Westwego Seaplane Airport (on the flood side). Although it is not essential to the function of the system it is maintained in accordance with this manual.

## 2.6.2 WBV-ARM-17 SYSTEM ARMORING (WBV-14C.2)

This armoring contract included armoring the WBV-14C.2 reach and is currently under construction.

The armoring contract consisted of placing HPTRM along the protected side of the levee. The HPTRM was secured to the levee using percussion driven earth anchors placed at 5 ft. intervals and 12-inch metal pins placed between the percussion driven earth anchors. Once placed the HPTRM was covered with Bermuda sod and fertilized.



*PROTECTED SIDE**FLOODSIDE*

## WBV-14C.2 TYPICAL LEVEE DESIGN SECTION

NOT TO SCALE

**Figure 11. WBV-14c.2 Typical Levee Section**

### 2.7 WBV-15A.2 LAKE CATAOUCHE PS#1 TO SEGNETTE STATE PARK.

#### 2.7.1 WBV-15A.2

This segment of the HSDRRS consists of approximately 3.75 linear miles of levee located within the Lake Cataouatche Reach of the West Bank and Vicinity portion of the Greater New Orleans HSDRRS in Jefferson Parish, Louisiana. This contract is currently being armored with HPTRM.

The contract begins at the Lake Cataouatche Pump Station (2011 B/L STA 428+14.57) and extends generally west to east to the WBV-24 Segnette State Park Floodwall (2011 B/L STA 625+34.52). This contract is bounded by the Lake Cataouatche Outer Canal immediately to the south and the Cataouatche Inner Canal immediately to the north.

The required 1% hydraulic design elevation for the WBV-15a.2 levee is 11.5 feet in 2007 and 15.5 feet in 2057 (NAVD88 (2004.65)). The levee relies on stability berms constructed on both the protected and flood sides to function under storm conditions. Foreshore protection was constructed under contract WBV-15a.2a on the flood side to provide erosion protection from daily wave action. Riprap on the flood side berm provides protection during storm events. The levee was constructed with approximately 2 feet of overbuild to elevation 13.5 feet (NAVD88 (2004.65)) to extend the period of effective risk reduction. The typical levee section for this contract includes a wave berm. The elevation for the wave berm must be monitored since it is a factor for establishing the required 1% hydraulic design elevation for the levee crown.

Also included in the contract design and construction were swales in vicinity of reported High Moisture Areas (HMA).

## 2.7.2 WBV-ARM-05 SYSTEM ARMORING (WBV-15A.2)

This reach is currently being armored in 2019 with HPTRM. The armoring contract will consist of placing HPTRM along the crown and protected side of the levee. The armoring contract consisted of placing HPTRM along the protected side of the levee. The HPTRM was secured to the levee using percussion driven earth anchors placed at 5 ft. intervals and 12-inch metal pins placed between the percussion driven earth anchors. Once placed the HPTRM was covered with Bermuda sod and fertilized.

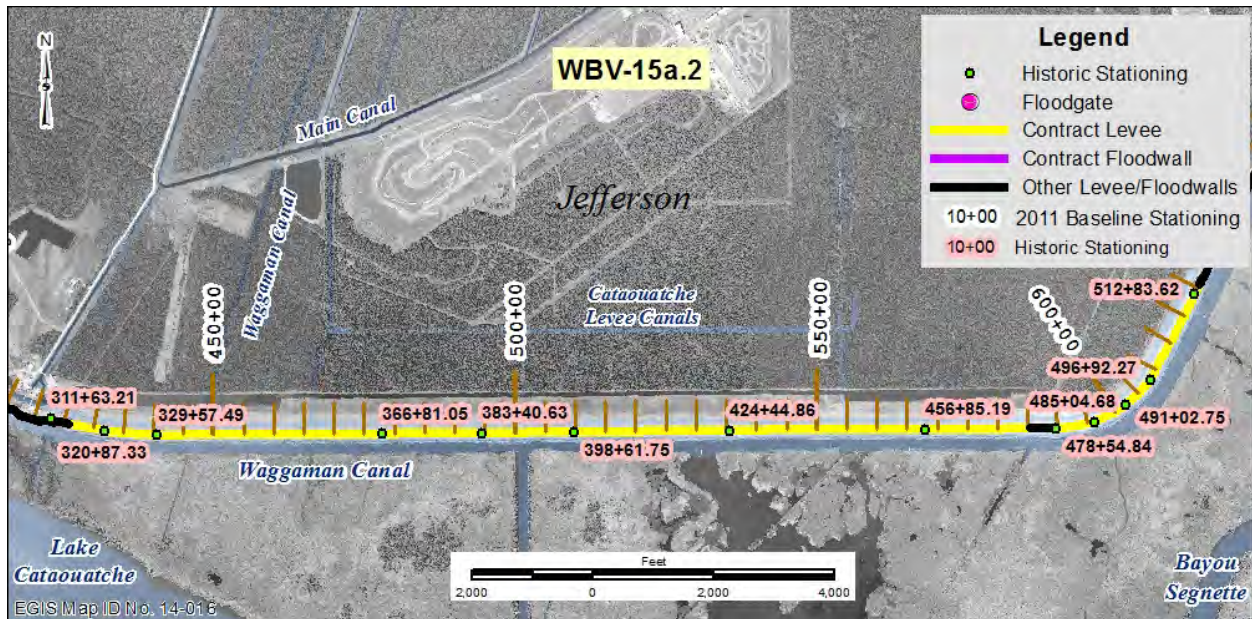


Figure 12. WBV-15a.2

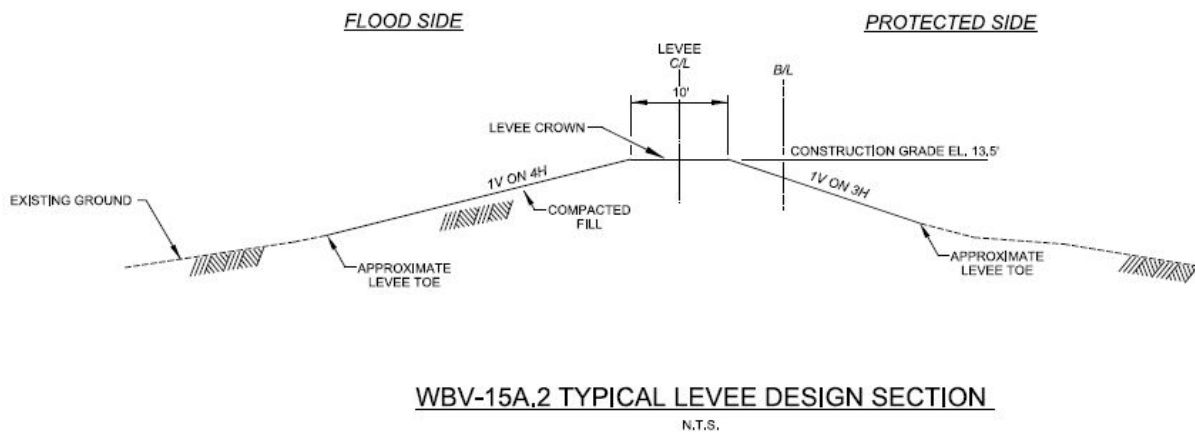


Figure 13. WBV-15a.2 Typical Levee Section



## 2.8 WBV-MRL-01.2B REACH, AUGUSTA TO OAKVILLE

WBV-MRL-01.2B is the representative reach for reaches WBV-MRL-01.2B, and WBV-MRL-3.2 (Belle Chase to Oak Point).

### 2.8.1 WBV-MRL-01.2B

This segment of the HSDRRS is located in Plaquemines Parish, Louisiana and is part of the West Bank and Vicinity, Mississippi River Levee (WBV-MRL) Co-Located Project. The entire contract reach consists of approximately 5,000 ft. of levee.

The WBV-MRL-01.2B contract begins just downstream of the Chevron Oronite Plant at River Mile 72 then continues downriver to the Oakville community; ending approximately a quarter of a mile downstream of River Mile 71. The contract reach begins in Plaquemines Parish at B/L STA 512+00 and ends at B/L STA 560+40. The required 1% hydraulic design elevation for this reach is 21.0 ft. in 2007 and 24.5 ft. in 2057.

In order to reach the required hydraulic design elevation, a flood side shift of the levee centerline from B/L STA 513+28 to B/L STA 522+47.99, B/L STA 524+98.20 to B/L STA 528+56.52, and B/L STA 534+19.02 to Baseline STA 559+50 was necessary. Between these baseline stations, the levee was constructed with approximately 1.5 ft. of overbuild to Elevation 22.5 ft. in order to extend the period of effective risk reduction. Also, there is a straddle of the existing levee from B/L STA 522+47.99 to B/L STA 524+98.20. This section of levee was also overbuilt by approximately 1.5 ft. to Elevation 22.5 ft.

Additionally, there is a landside shift of the levee centerline from B/L STA 528+56.52 to B/L STA 534+19.02. This reach of levee was constructed with approximately 2.0 ft. of overbuild to Elevation 23.0 ft. Also, due to the proximity of an adjacent borrow pit in this reach of levee, a stability berm was constructed to Elevation 9.0 ft. It should be noted the adjacent

Concrete slope pavement for the Mississippi River Levee (MRL) portion of the contract was constructed on the flood side slope throughout the entire reach.

### 2.8.2 WBV-ARM-03 SYSTEM ARMORING (WBV-MRL-01.2B)

This reach was armored with HPTRM and Articulated Concrete Blocks (ACBs). The armoring contract consisted of placing High Performance Turf Reinforcement Mat HPTRM along the protected side of the levee. The HPTRM was secured to the levee using percussion driven earth anchors placed at 5 ft. intervals and 12-inch metal pins placed between the percussion driven earth anchors. Once placed the HPTRM was covered with Bermuda sod and fertilized.

On the protected side slope near the crown, the HPTRM is pinned to the slope surface, after the placement of crushed stone at the crown slope to maintain a 1V:3H slope. HPTRM is then further anchored by the placement of ACBs on top as further described below. HPTRM should not be driven on for a minimum of two days following heavy rain.

In areas where the protected side slopes of the levee were built steeper than 1V on 3H, caution is advised for cutting grass.

In this contract reach, in addition to placing HPTRM, ACBs were placed on the crown of the levee, extending down the protected and flood side levee slopes for a distance of approximately

7 feet. Prior to placing the ACBs crushed stone was graded on the crown and added to the slopes of the levee as ACB subbase. The spaces between ACBs were backfilled with sand. On the protected side, HPTRM extends from the ACBs down the levee slope to 16 feet past the levee toe where it terminates in an anchor trench.

There are several locations in the contract reach where the HPTRM and ACBs abuts to concrete at miscellaneous concrete pads, and/or turn around pads throughout the reach. Where the HPTRM abuts to concrete, an anchor trench is placed running parallel to the edge of the concrete. Existing crushed stone ramps located on the protected side of the levee were concrete paved during the armoring contracts by placing 6" thick concrete on top of the existing crushed stone.

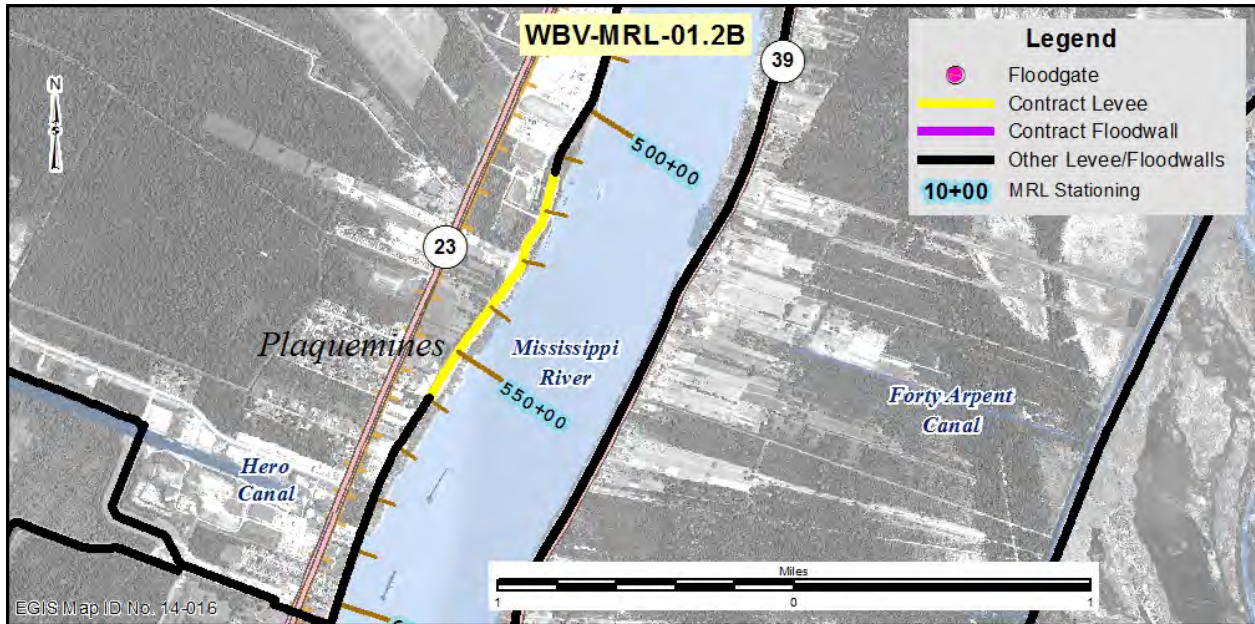


Figure 14. WBV-MRL-01.2B

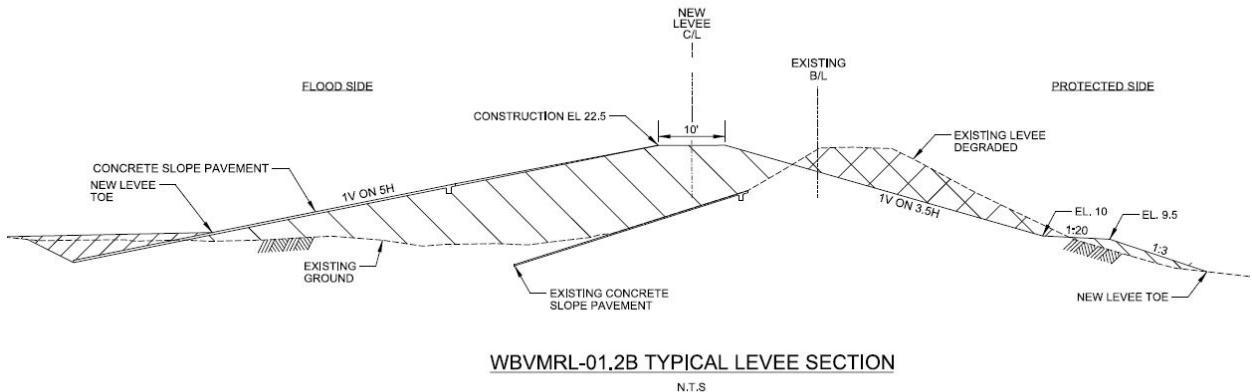


Figure 15. WBVMRL-1.2B Typical Levee Section



## 2.9 WBV-MRL-6.1 PARISH LINE TO ENGLISH TURN BEND

### 2.9.1 WBV-MRL-6.1

WBV-MRL-6.1 is the representative reach for reaches WBV-MRL-5.2 (English Turn Bend) and WBV-MRL-6.1.

The WBV-MRL-6.1 segment of the Hurricane and Storm Damage Risk Reduction System (HSDRRS) consists of 3.3 miles of levee located on the West Bank of the Mississippi River Levee (MRL) in Plaquemines Parish. It begins at West Plaquemine Baseline STA. 0+00 and extends downriver to STA. 174+00.

This contract is a part of HSDRRS/MRL co-located area. The HSDRRS/MRL co-located project area is defined as the area in which the HSDRRS design elevations are higher than the MR&T design elevations. However since the MR&T was established and maintained by previous authority that is not superseded by the HSDRRS authority, the projects are said to co-exist or coincide, meaning they serve a dual purpose of providing risk reduction from both riverine flooding and hurricane surge flooding. Therefore the contract used a combination of Mississippi River and Tributaries (MR&T) and HSDRRS funding.

At B/L STA 0+00, the MR&T authorized grade is 19.5 ft. At STA 174+00 the MR&T authorized grade is 18.5 ft. Between the stations the MR&T authorized elevation is a linear transition between the elevations. Under the co-located work, the levee was first designed to meet the MR&T authorized grade. Additional embankment was placed on top of the MR&T levee to meet the required West Bank and Vicinity (WBV) HSDRRS 1% hydraulic design elevation. From STA 0+00 to 74+00, the WBV HSDRRS 1% hydraulic design elevation is 20.0 ft. in 2007 and 24.0 ft. in 2057. From STA 74+00 to 174+00, the WBV HSDRRS 1% hydraulic elevation is 20.5 ft. in 2007 and 24.5 ft. in 2057. From STA 0+00 to 174+00, the levee was constructed to an elevation of 21.0 ft. to provide overbuild to the required WBV HSDRRS 1% hydraulic elevation.

The levee enlargement was constructed by offsetting the centerline of the levee towards the protected side. The embankment material tied into the top of the existing flood side slope pavement. A 9 inch crushed stone wearing surface was placed on the crown of the levee.

### 2.9.2 WBV-ARM-11

The WBV-ARM-11 contract armored reaches WBV-MRL-5.2 and WBV-MRL-6.1 and also included a lift to EL 22.0 of the WBV-MRL-5.2 from B/L STA 195+00 to 255+15 and a landside berm to WBV-MRL-6.1 between C/L STA 72+50 to 92+00 and 125+83 to 131+57.

This reach was armored with HPTRM and Articulated Concrete Blocks (ACBs). The armoring contract consisted of placing High Performance Turf Reinforcement Mat HPTRM along the protected side of the levee. The HPTRM was secured to the levee using percussion driven earth anchors placed at 5 ft. intervals and 12-inch metal pins placed between the percussion driven earth anchors. Once placed the HPTRM was covered with Bermuda sod and fertilized.

On the protected side slope near the crown, the HPTRM is pinned to the slope surface, after the placement of crushed stone at the crown slope to maintain a 1V:3H slope. HPTRM is then further anchored by the placement of ACBs on top as further described below. HPTRM should not be driven on for a minimum of two days following heavy rain.

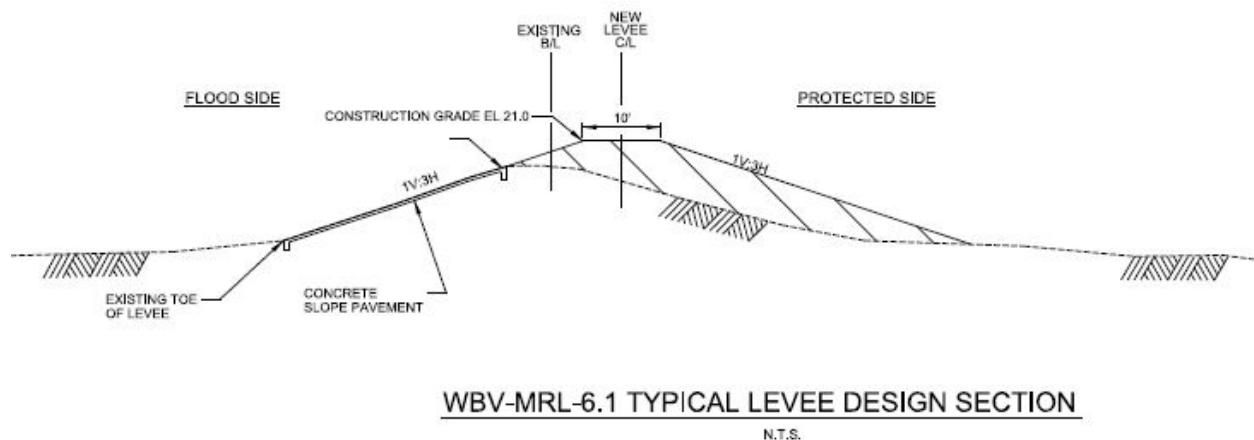
In areas where the protected side slopes of the levee were built steeper than 1V on 3H, caution is advised for cutting grass.

In this contract reach, in addition to placing HPTRM, ACBs were placed on the crown of the levee, extending down the protected and flood side levee slopes for a distance of approximately 7 feet. Prior to placing the ACBs crushed stone was graded on the crown and added to the slopes of the levee as ACB subbase. The spaces between ACBs were backfilled with sand. On the protected side, HPTRM extends from the ACBs down the levee slope to 16 feet past the levee toe where it terminates in an anchor trench.

There are several locations in the contract reach where the HPTRM and ACBs abuts to concrete at miscellaneous concrete pads, and/or turn around pads throughout the reach. Where the HPTRM abuts to concrete, an anchor trench is placed running parallel to the edge of the concrete. Existing crushed stone ramps located on the protected side of the levee were concrete paved during the armoring contracts by placing 6" thick concrete on top of the existing crushed stone.



Figure 16. WBV-MRL-06.1



**Figure 17. WBV-MRL-6.1 Typical Levee Design**

## 2.10 WBV-MRL-7.1 REACH, WEST CROSSOVER POINT TO PARISH LINE.

### 2.10.1 WBV-MRL-7.1

This segment of the HSDRRS consists of 3.6 miles of levee along the Mississippi River Levee (MRL) in Orleans Parish. The contract begins at 2004 Orleans West Levee District B/L STA 552+10 (river mile 85.5) and ends at STA 745+25 (river mile 81). At STA 745+25 WBV-MRL 7.1 ties into the start of WBV-MRL 6.1.

This contract is a part of HSDRRS/MRL co-located area. The HSDRRS/MRL co-located project area is defined as the area in which the HSDRRS design elevations are higher than the MR&T design elevations. However since the MR&T was established and maintained by previous authority that is not superseded by the HSDRRS authority, the projects are said to co-exist or coincide, meaning they serve a dual purpose of providing risk reduction from both riverine flooding and hurricane surge flooding. Therefore the contract used a combination of Mississippi River and Tributaries (MR&T) and HSDRRS funding.

At STA 552+10, the MR&T authorized grade is 20.0 ft. At STA 745+25 the MR&T authorized grade is 19.5 ft. The MR&T authorized elevation is a linear transition between the elevations. Under the co-located work, the levee was first designed to meet the MR&T authorized grade. Additional embankment was placed on top of the MR&T levee to meet the required WBV HSDRRS 1% hydraulic design elevation. From STA 552+10 to 745+25, the WBV HSDRRS 1% hydraulic design elevation is 20.0 ft. in 2007 and 24.0 ft. in 2057. The levee was constructed to an elevation of 21.0 ft. to provide overbuild to the required WBV HSDRRS 1% hydraulic elevation.

The levee enlargement was constructed by offsetting the centerline of the levee towards the protected side. The embankment material tied into the top of the existing flood side slope pavement. A 9 inch crushed stone wearing surface was placed on the crown of the levee.

From STA 606+00 to STA 630+00, grouted rip rap was placed along the toe of the protected side of the levee. The grouted rip rap was placed to keep the toe of the levee on the back side of the drainage running parallel with the highway while trying to maintain a 3:1 slope. The required 1% hydraulic design elevation for the levee is 24.0 ft. in 2057.



## 2.10.2 WBV-ARM-09 SYSTEM ARMORING (WBV-MRL-7.1)

This reach was armored with HPTRM and Articulated Concrete Blocks (ACBs). The armoring contract consisted of placing High Performance Turf Reinforcement Mat HPTRM along the protected side of the levee. The HPTRM was secured to the levee using percussion driven earth anchors placed at 5 ft. intervals and 12-inch metal pins placed between the percussion driven earth anchors. Once placed the HPTRM was covered with Bermuda sod and fertilized.

On the protected side slope near the crown, the HPTRM is pinned to the slope surface, after the placement of crushed stone at the crown slope to maintain a 1V:3H slope. HPTRM is then further anchored by the placement of ACBs on top as further described below. HPTRM should not be driven on for a minimum of two days following heavy rain.

In areas where the protected side slopes of the levee were built steeper than 1V on 3H, caution is advised for cutting grass.

In this contract reach, in addition to placing HPTRM, ACBs were placed on the crown of the levee, extending down the protected and flood side levee slopes for a distance of approximately 7 feet. Prior to placing the ACBs crushed stone was graded on the crown and added to the slopes of the levee as ACB subbase. The spaces between ACBs were backfilled with sand. On the protected side, HPTRM extends from the ACBs down the levee slope to 16 feet past the levee toe where it terminates in an anchor trench.

The layer of crushed stone in addition to the ACB mat brings the final elevation of the levee crown to El 22 ft.

There are several locations in the contract reach where the HPTRM and ACBs abuts to concrete at miscellaneous concrete pads, and/or turn around pads throughout the reach. Where the HPTRM abuts to concrete, an anchor trench is placed running parallel to the edge of the concrete. Existing crushed stone ramps located on the protected side of the levee were concrete paved during the armoring contracts by placing 6" thick concrete on top of the existing crushed stone.

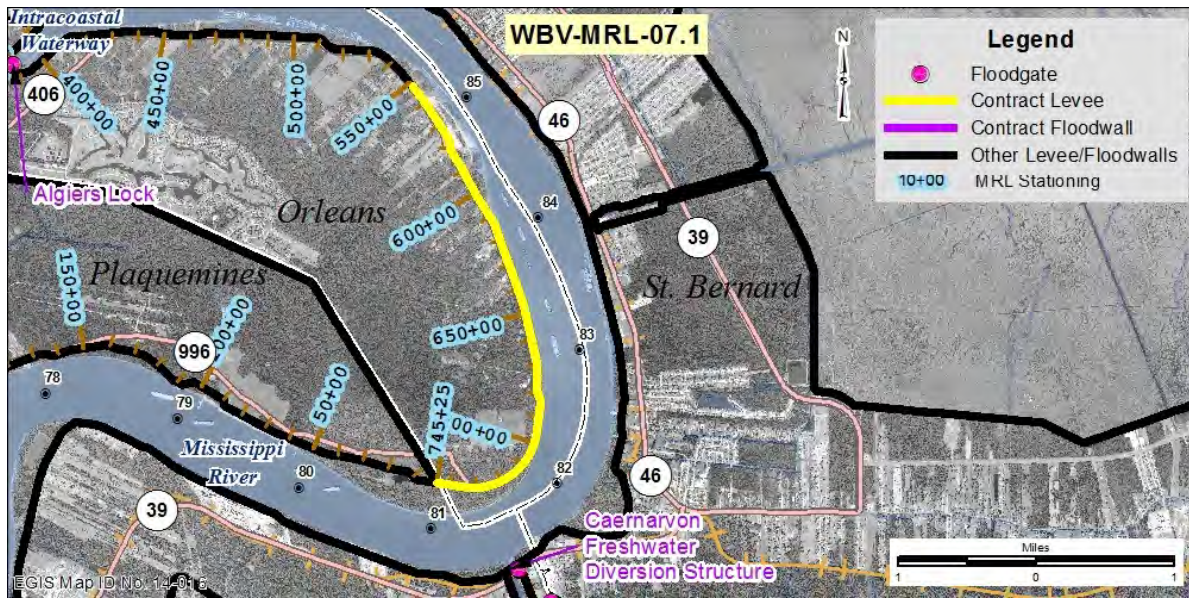
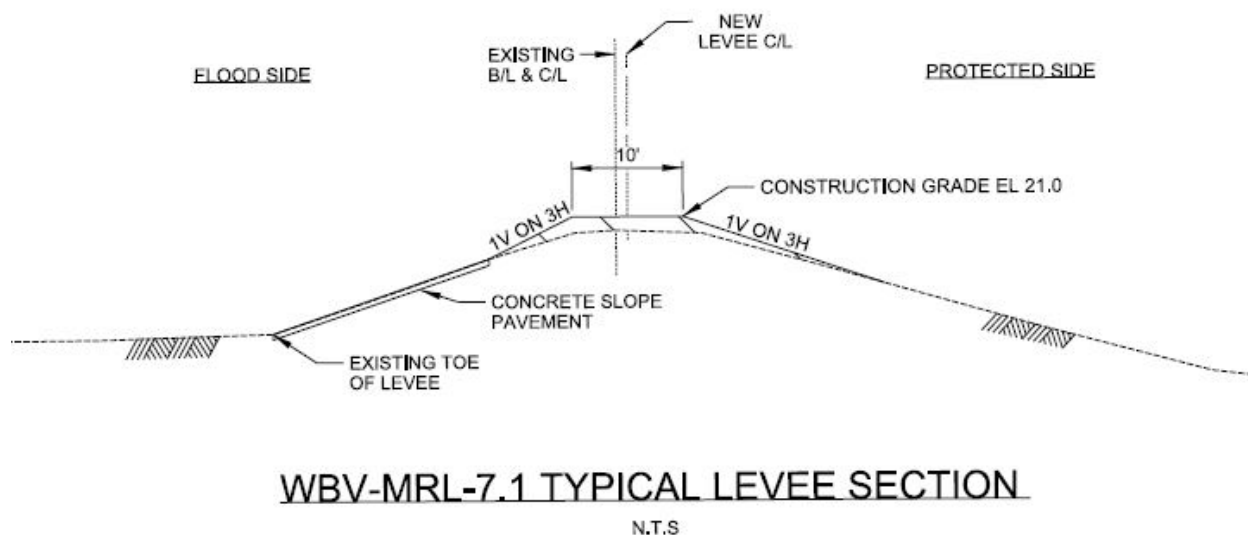


Figure 18. WBV-MRL-7.1



**Figure 19. WBV-MRL-7.1 Typical Levee Section**

#### 2.11 WBV-MRL-09 AND WBV-MRL-11

These levee reaches were not part of the WBV system as they were north of the west bank 2011 1% HSDRRS cross over point at river mile 85.5. The new 2073 cross over point, however, is at river mile 95.5 for the intermediate condition. For explanation on adjusted crossover points see the H&H appendix. The WBV-MRL-09 reach is from the Plaquemines Parish line to the east side Algiers Lock. The WBV-MRL-10 reach consists of the Algiers Lock Forebay levees. WBV-MRL-11 extends from east of the west of the Algiers Lock Forebay to the Greater New Orleans Bridge. The MR&T design grade or MRL 1973 project grade for the reach varies from 23 EL. to 19.5. The 1% 2011 HSDRRS design grade is EL 20. The MRL levees have a crushed stone surfacing crown and concrete slope paving (CSP) on the flood side slope.

No prior lift schedules were available for settlement for these reaches. From visual approximation of the survey profile, levee crest is EL 18 to EL 21. Minimal settlement is expected (approximately 6 inches of settlement from 2023 to 2073). It was conservatively assumed that there would be three lifts of three feet each for the 1% alternative.

There are areas along the MRL where bank factors of safety are critical and levee enlargements may require land side shifts or construction of sub-aqueous rock stability berms so that required bank factors of safety can be maintained. This analysis will be required during the PED phase of the work and may affect the overall project cost.



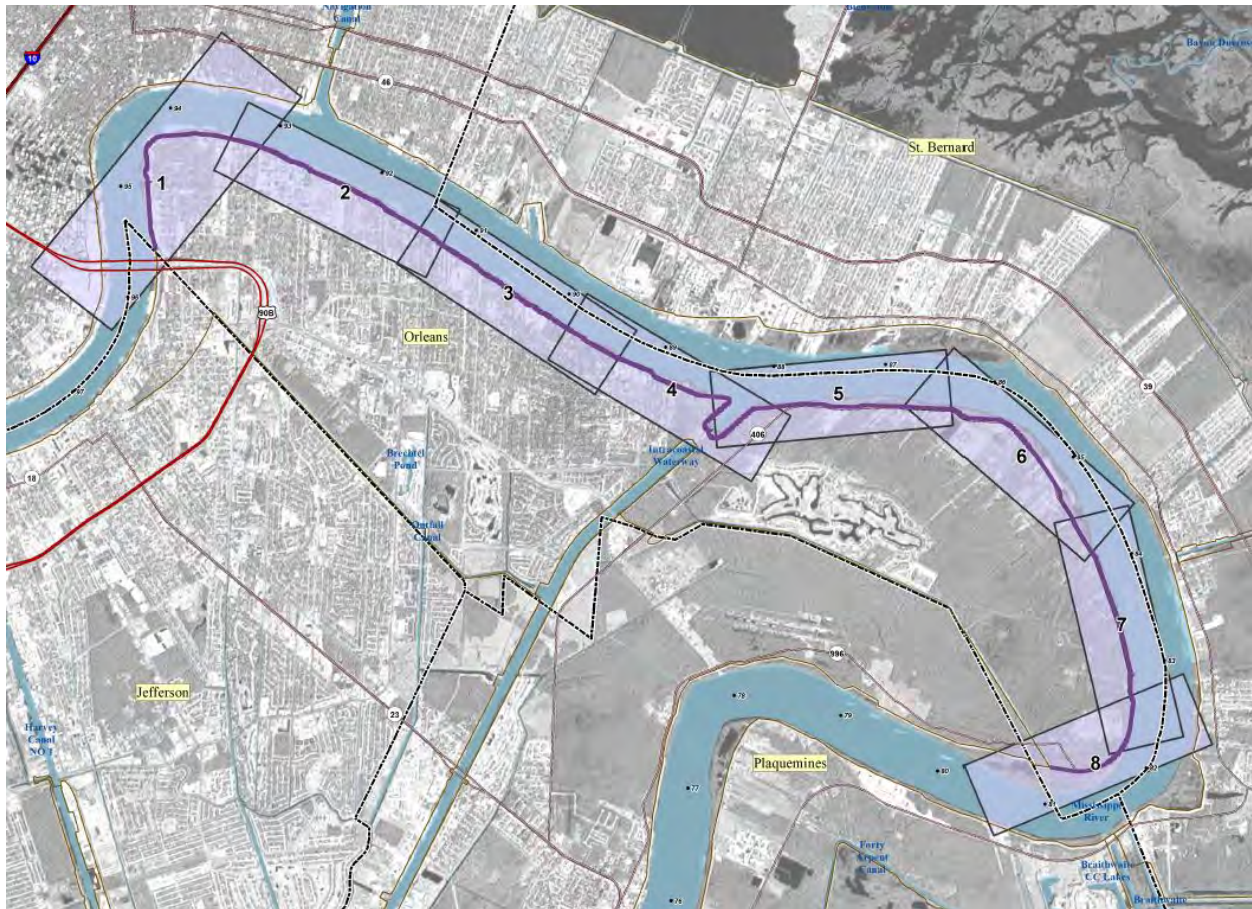


Figure 20. WBV-MRL Levee Reaches

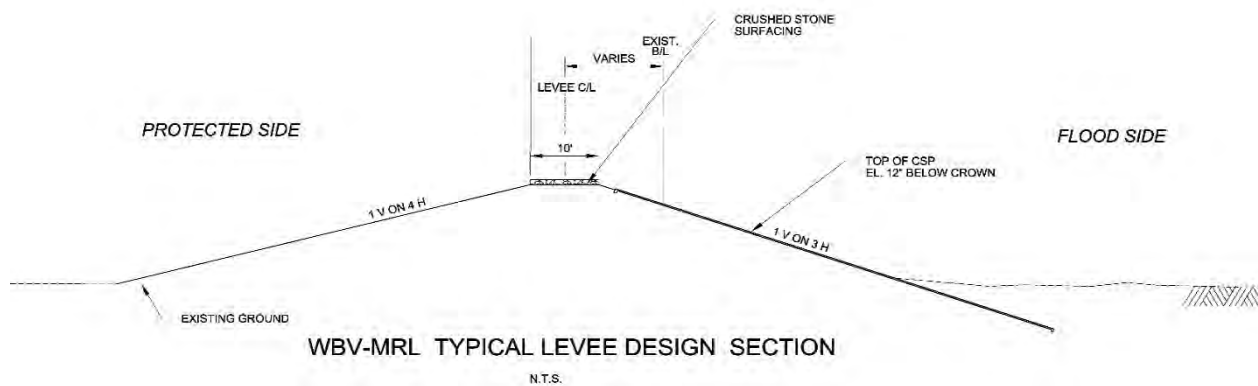


Figure 21. WBV-MRL Typical Levee Section

## 2.12 INTERIOR WBV LEVEES

There are several reaches in the WBV system that are not included in the perimeter levees, but are inside of the system. These reaches were analyzed (see the Geotechnical Appendix B) and it was determined that only WBV-14a.2 would require a lift. Quantities are shown in Section 3.1 below. The interior levee reaches include:

WBV-06a.2 Belle Chase Hwy to Hero Cutoff (West)

WBV-14a.2 Harvey Canal West Bank Levees  
WBV-47.1 Algiers Lock to Belle Chase Hwy (West)  
WBV-48.2 Belle Chase to Algiers Lock (East)  
WBV-49.1 Hero Levee to Belle Chase Hwy (East)

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#### 2.12.1 WBV-14A.2

This reach is located along the west bank of the Harvey Canal between the New Estelle Pump Station and the Lapalco Bridge and includes two reaches of new levee and a new pile founded floodwall. The southern levee reach measures approximately 885 LF and the northern levee reach measures approximately 3,780 LF. The new geotextile reinforced levee was offset 82 ft. to the protected side from the centerline of the existing levee and was constructed to elevation 12.0 ft. Stability berms were required on both sides of the levee crown. The levee ties into the existing Harvey Canal levee at its limits.

This project is located behind the Western Closure Complex and the required 1% hydraulic design elevation is 8.5 ft. in 2007 and 2057.

Additional work was completed in the project area under WBV-86. Under WBV-86, deficient levee reaches were raised, the scour protection at the levee to floodwall transition was removed and replaced, additional fill was placed to eliminate ponding along the levee and floodwall berms, additional turf was established, and a new crushed stone road was installed between the floodwall and the Entergy tower.

According to the geotechnical analysis of this study, a 2 foot lift was required by 2019 to maintain.

### 3 TSP QUANTITY CALCULATION – INTERMEDIATE 1% DESIGN

Due to the enormity of the entire system, representative reaches were chosen and lift schedules were developed for some reaches and applied to representative reaches. For explanation on development of lift schedules refer to the Geotechnical Appendix B. The following table represents the results of the geotechnical analysis and lift schedules for each reach. Only two lifts are required for WBV. These represent conservative estimates of when the next lift may be required and should NOT be interpreted as predictions of when a reach may become deficient. A short-term delay in first lifts is not expected to adversely project performance.

Contract ID	Contract	1st Lift			2nd Lift		
		Year	Height (FT)	Fill (CY)	Year	Height (FT)	Fill (CY)
WBV-09a	Hero Canal to Oakville - Hero Canal to PS	2028	3.000	52,924	2051	3	52,924
WBV-12	Hero Canal Reach 1	2028	3.000	141,675	2051	3	141,675
WBV-14a.2	Harvey Canal West Bank Levees	N/A	N/A	N/A	N/A	N/A	N/A
WBV-14b.2	Orleans Village to Hwy 45 Levee	2051	3.000	156,089	N/A	N/A	N/A
WBV-14c.2	New Westwego PS to Orleans Village	2053	2.500	184,306	N/A	N/A	N/A
WBV-14e.2 and 14i	V-line Levee, east of Vertex and LA Hwy 3134 Tie-in	2051	3.000	170,056	N/A	N/A	N/A
WBV-14f.2	Hwy 45 Levee	2051	3.000	165,844	N/A	N/A	N/A
WBV-15a.2	Lake Cataouatche PS to Segnette State Park	2032	2.000	147,999	2062	2	147,999
WBV-71	Western Tie-In Levees - (North-South)	2039	2.000	52,578	2052	2	N/A
WBV-72 & 18.2 & 17b.2	Western Tie-In Levees - (East-West)	2039	2.000	161,804	2052	2	N/A
WBV-90	GIWW-West Closure Complex	2028	3.500	59,472	2051	3.5	59,472
WBV-MRL 1.2b	Augusta to Oakville	2025	2	31,356	2048	2.5	39,194
WBV-MRL 3.2	Belle Chasse to Oak Point	2025	2	85,385	2045	2.5	106,731
WBV-MRL 5.2	English Turn Bend	2040	1.5	100,806	N/A	N/A	N/A
WBV-MRL 6.1	Parish Line to English Turn Bend	2040	1.5	41,144	N/A	N/A	N/A
WBV-MRL 7.1	West Crossover Point to Parish Line	N/A	N/A	N/A	N/A	N/A	N/A
WBV-MRL-9	Algiers Lock Forebay to W. Crossover Point to Parish Line	2040	2	121,867	N/A	N/A	N/A
WBV-MRL-11	GNO Bridge to Algiers Lock	2060	2	321,778	N/A	N/A	N/A

**Figure 22. Intermediate 1% Design Lift Schedule**

#### 3.1 INTERIOR LEVEE QUANTITIES

These represent conservative estimates of when the next lift may be required and should NOT be interpreted as predictions of when a reach may become deficient. A short-term delay in first lifts is not expected to adversely project performance.

Contract ID	Contract	Representative Reach	1st Lift		
			Year	Height (FT)	Fill (CY)
WBV-06a.2	Belle Chasse Hwy to Hero Cutoff (West) - Phase 2	WBV-47.1	N/A	N/A	N/A
WBV-14a.2	Harvey Canal West Bank Levees - Phase 2	WBV14a.2	2024	2.000	34,548
WBV-47.1	Algiers Lock to Belle Chasse Hwy (West)	WBV-47.1	N/A	N/A	N/A
WBV-48.2	Belle Chasse to Algiers Lock (East) - Phase 2		N/A	N/A	N/A
WBV-49.1	Hero Levee to Belle Chasse Hwy (East)		N/A	N/A	N/A

**Figure 23. Interior Levees Intermediate 1% Design Lift Schedule**

### 3.2 LEVEE LIFT QUANTITY CALCULATION ASSUMPTIONS

Quantities for each lift were calculated based on cross sectional area. Although some areas may require a flood side shift due to right of way restrictions, it was assumed due to the scope of the study for the quantities, that all lifts are straddle lifts and no berms are affected. The only site investigations that were done was a profile survey of the levee crown elevations.

Some levee reaches have concrete paved transitions from levee to floodwall. It is assumed that with each lift, the slope paving would need to be removed, lifted, and replaced to 1 foot below the levee design elevation. Demolished existing slope pavement could potentially, as done in the past, be stockpiled as a toe dike 10 feet riverward of the flood side levee toe to act as a wave break during high river stages.

Silt fence quantities were calculated by doubling the reach length, assuming it would be required on both sides of the levee, and a 25% contingency was added for staging areas.

Embankment quantities were calculated using cross sectional areas. Clearing, grubbing, seeding, and mulching quantities are assumed to be the same, in acres per lift.

Staging areas and access routes are assumed to be the same as during the previous lifts.

Quantities calculated for each reach are located in Enclosure 1 at the end of this appendix.

### 3.3 ARMORING

It is assumed that all previously placed armoring for each reach would need to be removed before each lift and then replaced after construction of each lift as was previously constructed and described in the paragraphs above. Armoring consists of HPTRM or ACBs. As previously done, because MRL levees have all-weather access roads on the crown, so ACBs were placed on these reaches as the method of armoring. All other reaches have HPTRM.

#### 3.3.1 WBV-MRL LEVEES

The HPTRM will be placed on the landside of the levee and generally extend a distance of 15-ft. past the land side levee toe and terminate in an anchor trench. After the initial placement of the HPTRM on the land side, the HPTRM is anchored using percussion driven earth anchors in a specific pattern so that the HPTRM maintains contact with the levee surface. Additional steel pins are used in between the percussion driven earth anchors to further anchor the HPTRM.

ACBs are placed on the crown of the levee, extending down the land and flood side levee slopes for a distance of approximately 7 feet. On the flood side, the ACBs terminate in an anchor trench. On the land side, the ACBs and filter fabric are placed on top of the HPTRM and anchored. As part of the installation of the ACBs, crushed stone was added and graded on the levee crown and side slopes.

#### 3.3.2 ALL OTHER WBV REACHES

HPTRM armoring is placed from a distance of 4 feet down the flood side slope from the levee crown and extends across the levee crown, down the land side slope, and then extends an additional 15 feet past the landside toe. The HPTRM was secured to the levee using percussion driven earth anchors placed at 5 ft. intervals and 12-inch metal pins placed between the percussion driven earth anchors. Additionally, the flood side and landside limits of the HPTRM



were secured in a minimum 1 ft. by 1 ft. anchor trench. Once placed the HPTRM was covered with Bermuda sod and fertilized.

### 3.4 MRL SLOPE PAVING

All MRL levees have concrete slope paving on the flood side slope. It is assumed for this alternative that the slope paving will need to be removed and replaced with expansion of the levee footprint. The quantities are included in enclosure 1.

### 3.5 FORESHORE FRONTING PROTECTION RIPRAP

For some reaches, foreshore protection was added per HSDRRS guidelines to prevent foreshore shore erosion along the lakefront. It is assumed that to maintain the 1% level of protection additional foreshore riprap would need to be replaced. It is assumed that an additional 15 foot width of riprap would need to be replaced. Quantities are calculated in enclosure 1 at the end of this appendix.

## 4 QUANTITY CALCULATION – INTERMEDIATE 0.5% DESIGN STORM

Hydraulic design elevations were calculated for the 0.5% intermediate design or 200 year storm. For explanation on these calculations see the H&H appendix. Due to time constraints, lift schedules and curves were not developed for this option. Design elevations for the 200 year storm were interpolated from the 100 and 500 year intermediate design storm elevation to come up with an estimation of lifts. The increase in lift from the 100 year elevation was either added to the last 100 year lift or an additional lift was added in keeping with the previous maximum lift of 3 feet. See enclosure 2 for lift schedules and estimates quantities. The same assumptions from the 1% design quantity calculations apply. This alternative is not the selected plan.

## 5 GENERAL ASSUMPTIONS

### 5.1 UTILITY RELOCATIONS

Because all lifts would generally straddle the footprint of a previous lift, it is assumed that no utility relocations would be required.

### 5.2 RIGHT OF WAY

For the intermediate 1% and 0.5% design storm, the new footprint was compared to the existing right of way limits for the last levee lift for the representative reaches to determine if any new right of way would be required. For most of the WBV reaches, for the intermediate design condition slight land side of flood side shifts would eliminate the need for additional easement.

The WBV-MRL-5.2 alignment contains a levee setback toward the Mississippi River between B/L STA 103+00 to 138+00. In order to lift this section, it will require that the levee be shifted landside, in alignment with the rest of the reach and this would require additional land side right-of-way.

WBV-MRL-01.2b would also require some additional land side easement from B/L STA 522+47.99 to B/L STA 524+98.20 because a straddle lift is required due to stability, a flood side shift is not possible.



WBV-MRL-10 is the reach that surrounds the Algiers Lock Forebay and is currently levee. However due to the limited land in this area, surrounding industry and utility conflicts, for the purpose of this study it was assumed that this reach from B/L STA 362+00 to 415+00 would be converted to floodwall with the next lift.

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## APPENDIX A - ENCL 1 - 1% DESIGN STORM

### West Bank and Vicinity

Contract ID	Contract	Representative Reach	Length (FT)	X-Section Distance(FT)	transitions	Toe to toe	Silt Fence (LF/Lift)	Seeding and Mulching , C&G (Ac/Lift)	1st Lift			2nd Lift			ARMORING	FORESHORE PROTECTION (CY)	FORESHORE PROTECTION (SF)	Slope Paving (SQ)
									Year	Height (FT)	Fill (CY)	Year	Height (FT)	Fill (CY)				
WBV-06a.2 & 3b	Belle Chasse Hwy to Hero Cutoff (West)	WBV-47.1	SEE INTERIOR LEVEES TABLE				N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
WBV-09a	Hero Canal to Oakville - Hero Canal to PS	WBV-12	4763	350	4	100	11,908	47.8	2028	3.000	52,924	2051	3	52,924		N/A	N/A	N/A
WBV-12	Hero Canal Reach 1		12029	170	3	106	30,073	58.7	2028	3.000	141,675	2051	3	141,675		ARM-16	2667	18000
WBV-14a.2	Harvey Canal West Bank Levees	WBV14a.2	SEE INTERIOR LEVEES TABLE				N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
WBV-14b.2	Orleans Village to Hwy 45 Levee	WBV-14b.2	14048	130	5	100	35,120	52.4	2051	3.000	156,089	N/A	N/A	N/A		N/A	N/A	N/A
WBV-14c.2	New Westwego PS to Orleans Village	WBV-14c.2	17309	300	4	115	43,272	149	2053	2.500	184,306	N/A	N/A	N/A	ARM-17	N/A	N/A	N/A
WBV-14e.2 and 14i	V-line Levee, east of Vertex and LA Hwy 3134 Tie-in	WBV-14b.2	15305	135	1	100	38,263	59.3	2051	3.000	170,056	N/A	N/A	N/A	ARM-06	N/A	N/A	N/A
WBV-14f.2	Hwy 45 Levee		14926	135	5	100	37,315	57.8	2051	3.000	165,844	N/A	N/A	N/A	ARM-02	N/A	N/A	N/A
WBV-15a.2	Lake Cataouatche PS #1 to Segnette State Park	WBV-15a.2	19980	130	2	100	49,950	74.5	2032	2.000	147,999	2062	2	147,999	ARM15	N/A	N/A	N/A
WBV-47.1	Algiers Lock to Belle Chasse Hwy (West)	WBV-47.1	SEE INTERIOR LEVEES TABLE				N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
WBV-48.2	Belle Chasse to Algiers Lock ( East)	WBV-48.2					N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A		N/A	N/A	N/A
WBV-49.1	Hero Levee to Belle Chasse Hwy (East)						N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A		N/A	N/A	N/A
WBV-71	Western Tie-In Levees - (North-South)	WBV 71	7098	250	3	100	17,745	50.9	2039	2.000	52,578	2052	2	N/A	ARM-08	N/A	N/A	N/A
WBV-72,18.2, & 17b.2	Western Tie-In Levees - (East-West)		31205	200	3	70	78,013	179.1	2039	2.000	161,804	2052	2	N/A		N/A	N/A	N/A
WBV-90	GIWW-West Closure Complex	WBV-12	4209	250	2	109	10,523	30.2	2028	3.500	59,472	2051	3.5	59,472	ARM-01	33481	226000	N/A
WBV-MRL 1.2b	Augusta to Oakville	WBV-MRL-1.2b	4233	150	4	100	10,583	18.2	2025	2	31,356	2048	2.5	39,194	ARM-03	N/A	N/A	1820
WBV-MRL 3.2	Belle Chasse to Oak Point		11527	150	2	100	28,818	49.6	2025	2	85,385	2045	2.5	106,731	ARM-10	N/A	N/A	4957
WBV-MRL 5.2	English Turn Bend	WBV-MRL-6.1	18145	150	2	100	45,363	78.1	2040	1.5	100,806	N/A	N/A	N/A	ARM-11	N/A	N/A	7802
WBV-MRL 6.1	Parish Line to English Turn Bend		7406	150	2	100	18,515	31.9	2040	1.5	41,144	N/A	N/A	N/A		N/A	N/A	3185
WBV-MRL 7.1	West Crossover Point to Parish Line	WBV-MRL-7.1	20134	150	4	97	50,335	86.7	N/A	N/A	N/A	N/A	N/A	N/A	ARM-09	N/A	N/A	8658
WBV-MRL-9	Algiers Lock Forebay to W. Crossover Point to Parish Line		13710	160	1	120	34,275	62.9	2040	2	121,867	N/A	N/A	N/A	N/A	N/A	N/A	6855
WBV-MRL-11	GNO Bridge to Algiers Lock		36200	160	1	120	90,500	166.2	2060	2	321,778	N/A	N/A	N/A	N/A	N/A	N/A	18100

## West Bank and Vicinity