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US Army Corps of Engineers
New Orleans District

Engineering Alternative Report WBV- 48.2 Highway 23 to Algiers Lock

95% Submittal

Westbank of the Mississippi River in the Vicinity of New Orleans, Louisiana; East of Harvey Canal Hurricane Protection Project

Orleans and Plaquemines Parish, Louisiana

August 12, 2008

Engineering Alternative Report, WBV-48.2
Highway 23 to Algiers Lock
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Task Order: 006

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1. Executive Summary

This report presents the results of analyses to provide alternate methods of raising the existing hurricane protection facilities to 100-year (one percent chance of occurring in any year) levels along the east side of the Algiers Canal from Highway 23 to Algiers Lock. The project area for this investigation has been subdivided into geographical reaches of protection for which earthen levee and structural alternatives were evaluated. The reaches are indicated in Figure 1 and described in Table ES-1 with the alternatives investigated for each segment as per the project scope of work (SOW).

Table ES -1 – Project Reaches and Alternatives

Project Reach	Alternatives
New Orleans and Gulf Railroad Gate Structure and Floodwall at Highway 23	• 18- foot wide swing gate with connecting T-walls
Highway 23 to Orleans Parish Landfill	• All earthen levee enlargement, unreinforced • All earthen levee enlargement, reinforced with geotextile • Reinforced concrete T-wall at the existing landside levee toe
Orleans Parish Landfill	• Floodward alignment of T-wall • Landward alignment of T-wall adjacent to Woodland Highway
Orleans Parish Landfill to Woodland Highway Bridge	• All earthen levee enlargement, unreinforced • All earthen levee enlargement, reinforced with geotextile • Reinforced concrete T-wall at the existing landside levee toe
Beneath Woodland Highway Bridge	• Landward alignment of T-wall
Woodland Highway Bridge to Algiers Lock	• All earthen levee enlargement, unreinforced • All earthen levee enlargement, reinforced with geotextile • Reinforced concrete T-wall at the existing landside levee toe

The U.S. Army of Corps of Engineers Protection Restoration Office (USACE-PRO) provided access to historical data such as design memoranda (DM), construction and

design drawings, and existing survey data. Additional survey data was obtained for the Orleans Parish Landfill landside and perimeter as part of this task order.

The SOW requests the development of the above alternatives to attain 100-year (one percent chance of occurring in any year) protection levels to the design criteria detailed in Section 7. This Draft Report shall provide the following information for consideration and action forward by the USACE-PRO:

- Describe existing conditions
- Describe alternatives for providing the required level of protection
- Provide geotechnical and structural analyses and civil modeling of the alternatives at the subdivided reaches
- Describe the design criteria utilized
- Identify potential Right-of-Way (ROW) impacts and relocations for the alternatives
- Identify environmental conditions
- Provide estimated costs and construction schedules

The following preliminary construction cost estimates are a summary of all alternatives for each of the project reaches.

Table ES-2 – Project Reaches and Alternatives Cost Summary

Project Reach	Alternative	Cost (1)
New Orleans and Gulf Railroad Gate Structure and Floodwall at Highway 23	18 foot wide swing gate with connecting T-walls	$6,941,000
Highway 23 to Orleans Parish Landfill	All earthen levee enlargement, unreinforced	$54,300,000
	All earthen levee enlargement, reinforced with geotextile	$38,568,000
	Reinforced concrete T-wall at the existing landside levee toe	$133,314,000
Orleans Parish Landfill	Floodward alignment of T-wall	$52,824,000
	Landward alignment of T-wall adjacent to Woodland Highway	$57,816,000
Orleans Parish Landfill to Woodland Highway Bridge	All earthen levee enlargement, unreinforced	$6,172,000
	All earthen levee enlargement, reinforced with geotextile	$5,797,000
	Reinforced concrete T-wall at the existing landside levee toe	$12,132,000
Beneath Woodland Highway Bridge	Landward alignment of T-wall	$3,039,000
Woodland Highway Bridge to Algiers Lock	All earthen levee enlargement, unreinforced	$24,496,000
	All earthen levee enlargement, reinforced with geotextile	$17,136,000
	Reinforced concrete T-wall at the existing landside levee toe	$56,594,000

(1) Net present value over 50 years

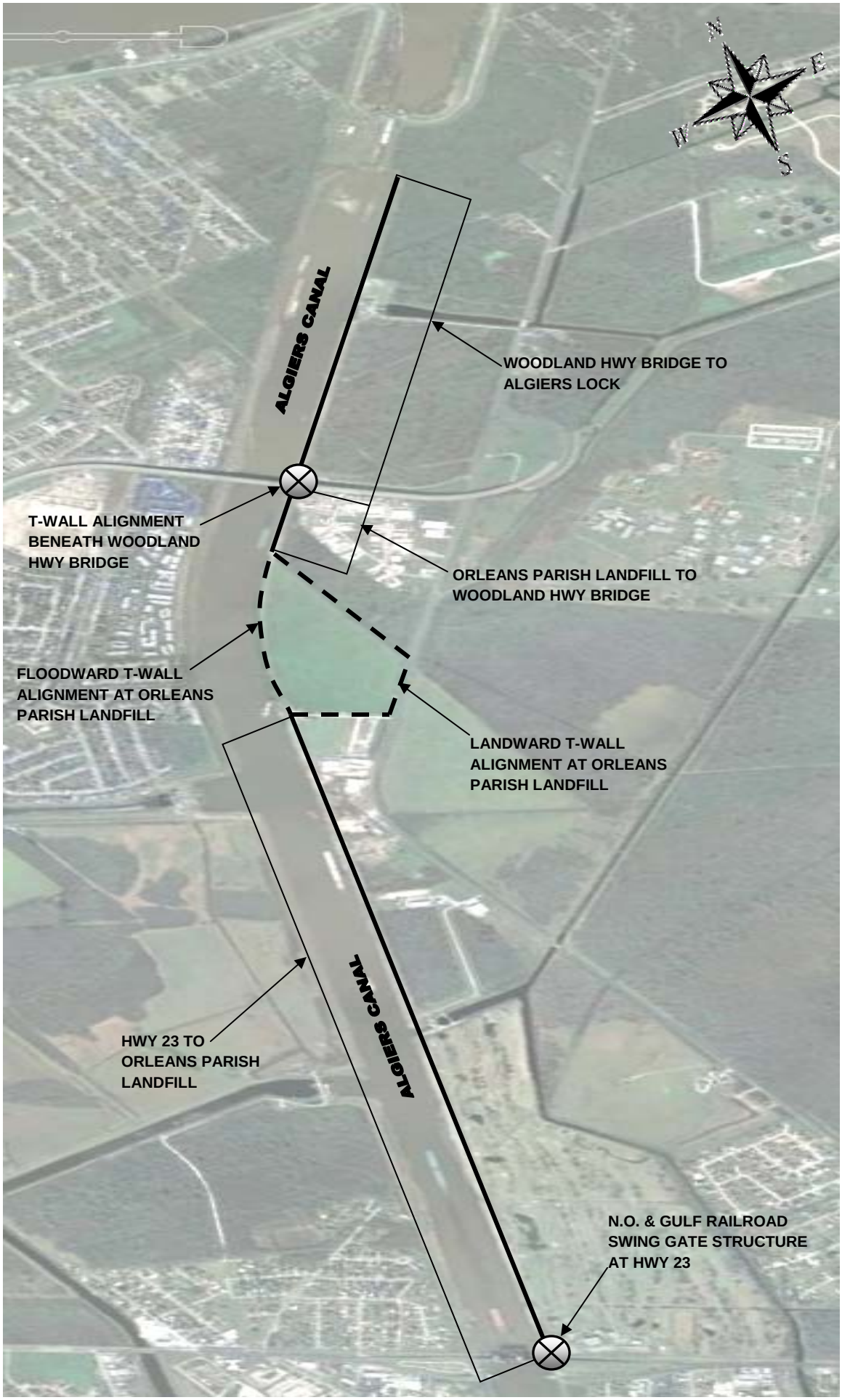

Figure 1 Project Reaches

2. Introduction

This report summarizes results of an investigation conducted by the Bioengineering ARCADIS, LLC Joint Venture consisting of ARCADIS, Bioengineering Group, and HNTB Corporations under Contract No.: W912P8-07-D--0062, Task Order 006, with the U.S. Army Corps of Engineers, New Orleans District Protection Restoration Office (USACE-PRO). The report title is:

Engineering Alternative Report
Westbank of the Mississippi River in the Vicinity of New Orleans, Louisiana
East of Harvey Canal Hurricane Protection Project
WBV- 48.2 Highway 23 to Algiers Lock
Orleans and Plaquemines Parish, Louisiana

The investigation presents analyses and recommendations to provide a 100-year (one percent chance of occurring in any year) level of protection in the form of earthen levee and structural alternatives along the east side of the Algiers Canal from Highway 23 to Algiers Lock. The project area has been subdivided into reaches based on geologic and geotechnical data including specific sites for investigation as dictated in the scope of work. “Worst reaches” were chosen based on existing engineering data for further refinement of levee alternatives that resulted in the largest footprint and for structural alternatives that resulted in the highest cost. One “worst reach” shear line was developed at the existing levee center and toe line from the subsurface information provided by USACE-PRO in accordance with the scope of work to be used for stability analysis of the design alternatives. The center and toe shear lines were developed in accordance with Section 3.1.2.1of the “Hurricane and Storm Damage Risk Reduction System (HSDRRS) – Design Guidelines, New Orleans District”, October 2007. All geotechnical data and survey information was provided by USACE-PRO with the exception of supplemental survey for the abandoned Orleans Parish Landfill area as part of this work order.

The alternatives investigated for three reaches (Highway 23 to Orleans Parish Landfill, Orleans Parish Landfill to Woodland Highway Bridge, and Woodland Highway Bridge to Algiers Lock) included:

- All earthen levee enlargement, unreinforced;
- All earthen levee enlargement, reinforced with geotextile;
- Reinforced concrete T-wall at the existing landside levee toe.

The alternatives investigated for SOW specified reaches included:

- Swing gate at the New Orleans and Gulf Railroad tracks;

- Structural alternative beneath the Woodland Highway Bridge;
- Floodward alignment of T-wall at the Orleans Parish Landfill;
- Landward alignment of T-wall adjacent to Woodland Highway at the Orleans Parish Landfill.

3. Purpose and Scope of Study

3.1 Objectives

The purpose of this report is to present the results of an analysis of HSDRRS alternatives and to recommend the most feasible alternative based on engineering investigation.

The objective of the study was to prepare feasibility-level designs, calculations, cost estimates, construction duration estimates, and an analysis of alternatives for replacement of the existing hurricane protection with new protection to 100-year (one percent chance of occurring in any year) elevations within the limits of the project area. New protection shall consist of both earthen levee and structural alternatives. Areas both flood side and protected side impacted by the proposed alternatives have been described. Portions of the documentation shall become part of a larger report for the Sector Gate South Study, for which reaches of protection addressed in this report will only be constructed to 2007, one percent elevations.

3.2 Level of Detail

In accordance with the Scope of Work (SOW), this report is a self-contained, feasibility-level Engineering Alternative Report (EAR) that investigates means and methods of raising the hurricane protection to 100-year (one percent chance of occurring in any year) levels. The level of engineering analysis and design detail for this report shall support the cost estimates within a 25 percent general contingency.

4. Description of Existing Protection

4.1 Project Location

This project is located in Orleans and Plaquemines Parishes, Louisiana, and is part of the East Harvey Canal, Louisiana, Hurricane Protection Project. The project area is bounded by Highway 23 at the southernmost limit and Algiers Lock at the northernmost limit; roughly paralleling the east side of the Algiers Canal.

4.2 Type of Protection

There are currently earthen levees, T-walls, I-walls, floodgates, and pumping stations to protect against storm events along the existing project alignment.

The existing flood protection consists of an earthen levee along the Algiers Canal between the Algiers Lock and the Highway 23 Bridge. The elevation of the top of the existing levee varies, but is generally around El. 9.0 feet. This elevation includes approximately two feet of fill that has been added as interim protection. At the Orleans Parish Landfill the existing earthen levee has been augmented with a sheet pile I-wall for interim protection, in addition to receiving the additional two feet of fill. See Photo 4 in Appendix F. Two pump stations (Belle Chase Pump Station No. 2 and New Orleans Sewerage and Water Board Pump Station No. 11) penetrate the protective levee, as does the New Orleans and Gulf Railroad track adjacent to Highway 23. The railroad penetration is at an elevation of approximately El. 3.0 feet and is currently unprotected. The details of the pump station tie-ins are being designed under a different contract.

4.3 Limits of Right-of-Way

The limits of the existing Right-Of-Way (ROW) are shown in the plan layout plates in Appendix A. Existing ROW information provided by the USACE-PRO generally appears to extend about 75 to 100 feet landward of the existing USACE-PRO baseline.

The only section of the project that does not contain any existing ROW is the landward T-wall alternative (Option 2) at the Orleans Parish Landfill. The T-wall alignment runs away from the existing levee, travels along Woodland Highway, and then follows the perimeter of the landfill back to the existing levee.

The all earthen levee alternative, which has the maximum footprint, has adequate clearance to provide a 15-foot vegetation free zone on both the protected and flood sides and will be in compliance with current guidance and policy. Levee designs will include tree removal, sloping, grading, placing fill, etc. necessary to achieve a maintainable 15-foot vegetation free zone from the toe of the levee on both the flood and protected sides. All plans and specifications (P & S) for HSDRRS levee contracts will ensure standards are met with respect to maintenance corridors.

4.4 Level of Protection

The current levees and floodwalls provide Standard Project Hurricane (SPH) protection as detailed in Design Memorandum (DM) No. 2, January 1999. At the time, this corresponded to hurricane surge elevation of 7.5 feet and required design elevations of 9.5 feet for levees and 11.5 feet for floodwalls. The North American Vertical Datum

(NAVD) for this report and plates is NAVD88 (2004.65). The post Hurricane Katrina design elevations for this task order are 10.5 feet for levees (year 2007) and 14.0 feet for levees and structures (year 2057). In selection of a "worst reach" for design considerations an existing levee elevation of 9.0 feet was used. It should be noted that no protection exists at the railroad crossing at the southern limits of the project boundary. Based upon the April 30, 2008 site walk it appears that sand bags are used in times of high water to match the top of levee elevation along the canal at the railroad crossing.

5. Description of Proposed Alternatives

5.1 Type of Protection

5.1.1 All Earthen Levee Enlargement, Unreinforced

This alternative consists of a protected side enlargement of the existing earthen levee. The current 4 to 1 (horizontal to vertical) floodside slope of the existing levee would be maintained in a landside shift to a maximum overbuild crown height at elevation 15.5 feet. A 10-foot wide crown would be maintained at the top of the levee followed by a 4 to 1 landside slope. To support this design it is necessary to construct a protected side stability berm beginning at elevation 6.0 feet with a slope of 15 to 1. A 100- foot long floodside stability berm comprised of riprap at elevation 6.0 feet and 4 to 1 slope to the floodside toe is also required.

5.1.2 All Earthen Levee Enlargement, Reinforced with Geotextile

This alternative consists of a protected side enlargement of the existing earthen levee. The current 4 to 1(horizontal to vertical) floodside slope of the existing levee would be maintained in a landside shift to a maximum overbuild crown height at elevation 15.5 feet. However, the existing levee would need to be degraded to elevation -2.0 feet to allow the installation of a geotextile to provide floodside stability. A second layer of geotextile will be placed at elevation 1.0 feet to provide additional support. A 10-foot wide crown would be maintained at the top of the levee followed by a 4 to 1 landside slope. To support the levee, the placement of a geotextile fabric with minimum allowable unit tensile strength of 24,600 lb/ft at 5% strain is required at elevation -2.0 feet beneath the levee. The geotextile placed at elevation 1.0 feet would require a minimum allowable unit tensile strength of 12,300 lb/ft at 5% strain. Utility crossings would require slightly higher geotextile strength of 30,200 lb/ft and 15,100 lb/ft at elevation -2.0 feet and 1.0 feet respectively.

5.1.3 Reinforced Concrete T-wall

The reinforced concrete T-wall option is proposed at those locations where an increased earthen levee section is not an option due to site constraints. This situation occurs at existing permanent structures that do not allow for the placement of new levee fill and cannot be economically relocated. An example is beneath the Highway 407 Bridge. It is also proposed that T-walls be used at the landfill site due to property constraints. Also, one of the overall project alternatives is to span the T-wall the length of the existing levee, tying it into the chosen landfill levee alternative and existing permanent structures. At each location where T-wall is proposed, earthen fill material will be placed between the existing levee and the proposed T-wall and graded to drain.

The walls at these locations are intended to be long enough to protect the affected structures and allow for a smooth transition from proposed levee section to T-wall and back to proposed levee section (if chosen for adjacent reach).

5.2 Alignment

In general, the alignment of the reinforced concrete T-wall follows the existing levee alignment with the exception of the landfill where it follows the property line.

The centerline of the proposed unreinforced levees is approximately 21.5 feet on the protected side of the existing levee centerline.

6. Project Reaches

6.1 New Orleans and Gulf Railroad Gate and Floodwall Structure at Highway 23

6.1.1 Design Evaluation

For this project reach, only one alternative was considered for evaluation. Presently, no protection is in place apart from the existing levee. The proposed alternative involves the construction of a new railroad gate designed to achieve the required level of protection, as well as transition walls to maintain protection to adjoining structures. The proposed railroad gate is a swing-type gate with a clear opening of eighteen feet. The gate is supported by concrete piers cast integrally with the adjacent T-wall sections that serve as transitions back to the earthen levee section.

6.1.2 Geotechnical

The Railroad Gate structure was evaluated using the shear lines included in Appendix B-2 of the Geotechnical Engineering Report. Stability analysis, Pile Calculations, and

Seepage Results are included in Appendix B-7 of the Geotechnical Engineering Report. Stability analyses for the 2057 Design Grade were completed for this alternative.

Stability analysis, Pile Calculations, and Seepage Results are included in Appendix B-5 of the Geotechnical Engineering Report for the T-wall alternative for this reach of the project. The T-wall for this analysis was located on the landside toe of the existing levee.

6.1.3 Structural

A railroad flood gate is proposed to be located adjacent to the northbound lane of Highway 23, where the New Orleans and Gulf Railroad track breaches the protective levee on the south bank of Algiers Canal. The project scope calls for the proposed gate to be 18 feet wide. The gate height is estimated to be approximately 13 feet, based on an existing grade elevation of approximately El. 3.0 feet and a required level of protection of El. 14.0 feet plus 2 feet of structural superiority.

Being in the 12-foot to 16-foot height range, the gate can have two or three girders, as per HSDRRS. A three-girder design has been selected to avoid the “fracture critical” issues that exist with a two-girder design.

According to HSDRRS, Algiers Canal is rated for a Case No.1 impact load of 100,000 pounds. Given the presence of the railroad bridge structural steel immediately adjacent to the proposed gate, it is highly unlikely that a vessel can approach the gate to deliver the impact load. However, in the event of a Case No.1 impact, a larger sized top girder has been designed for this purpose. If it is decided that the presence of the railroad bridge serves to prevent vessel impact, then a smaller girder size (similar to the lower girders) is adequate for the gate design.

Analysis of HP14X89 pile reactions with Ensoft’s GROUP software indicates that the piles will be adequate to support the pier using 3 rows of 4 piles. Required pile lengths based on the capacity curves from the only shear line in this report are approximately 70 ft long.

6.1.4 Civil

The New Orleans and Gulf Railroad Gate Structures at the Highway 23 reach of the project are shown on Sheets 2 through 4 in Appendix A. The railroad gate and T-wall alignment would begin at the Limit of Work on the south end of the project. The T-wall would start at approximately 30 feet from the south pier of the proposed railroad gate. The alignment, along the toe of the existing levee, interferes with two power poles on the south side of the railroad. These power poles would need to be relocated.

The 18-foot wide railroad gate structure would be centered on the railroad tracks. The T-wall coming off of the north pier of the gate structure would extend on an alignment and continue a T-wall along the toe of the existing levee or transition to a proposed earthen levee according to the detail shown on Sheet 13. A T-wall is the only alternative considered for the railroad gate reach of the project.

6.1.5 Recommendations

[USACE-PRO]

6.2 Levee/Floodwall - Highway 23 to Orleans Parish Landfill

6.2.1 Design Evaluation

Three separate alternatives were evaluated to upgrade the existing earthen levee to 100-year (one percent chance of occurring in any year) elevations along the east side of Algiers Canal between Highway 23 and the Orleans Parish Landfill. The authorized elevation specified in the SOW is 10.5 feet for year 2007 and 14.0 feet for year 2057. Earthen levees were analyzed with interim construction events to maintain an elevation above the design elevation based upon straight line interpolation over the 50 year design life. Structural alternatives were designed for the year 2057 design elevation (14.0 feet).

Alternative 1 expands the existing levee in a landside shift to raise the level of protection to a maximum overbuild elevation of 15.5 feet. Stability berms on both the flood and protected sides of the levee will be required to maintain stability during storm events.

Alternative 2 expands the existing levee in a landside shift to raise the level of protection to a maximum overbuild elevation of 15.5 feet. Two layers of high tensile strength geotextile reinforcement were considered for this alternative to provide stability during flood events and reduce the ROW requirements for stability berms.

Alternative 3 considers a pile supported concrete T-wall along the landside toe of the existing earthen levee with the top of floodwall at elevation 14.0 feet. The void space between the new T-wall and the existing levee will be backfilled to match the existing levee elevation and eliminate water from ponding after a storm event.

Transition structures for levee alternatives to the north and south of this geographic reach were also evaluated to maintain a constant level of protection over the entire project length.

6.2.2 Geotechnical

The Levee/Floodwall between Highway 23 and the Orleans Parish Landfill was evaluated using the shear lines included in Appendix B-2 of the Geotechnical Engineering Report.

Stability analysis, Settlement Calculations, and Seepage Results are included in Appendix B-3 of the Geotechnical Engineering Report for the unreinforced levee alternative for this reach of the project. Stability analyses for the 2007 Overbuild, 2057 Overbuild, and the 2057 Design Grade were completed for this alternative.

Stability analysis, Settlement Calculations, and Seepage Results are included in Appendix B-4 of the Geotechnical Engineering Report for the reinforced levee alternative for this reach of the project. Stability analyses for the 2007 Overbuild, 2057 Overbuild, and the 2057 Design Grade were completed for this alternative.

Stability analysis, Pile Calculations, and Seepage Results are included in Appendix B-5 of the Geotechnical Engineering Report for the T-wall alternative for this reach of the project. The T-wall for this analysis was located on the landside toe of the existing levee.

6.2.3 Structural

Apart from serving as a third alternative, no structural floodwall is envisioned for this project reach. However, if site constraints determine that an additional floodwall section is needed, or should the T-wall, Project Length Alternative be chosen, then the reinforced concrete T-wall previously described in section 5.1.3 (used beneath the Woodland Highway 407 Bridge) would be adequate for use at this location. The length of the wall will be no longer than is necessary to serve as a levee tie-in, after which the earthen levee section will resume.

Stability analysis indicated the presence of unbalanced loads with the T-wall located on the protected side of the levee and backfill placed between the existing levee and new

T-wall. With the combination of high critical loading conditions, additional lateral loads applied to the piles from the unbalanced loads, and weak subsurface soils the pile design required closer spacing of the pile rows along the length of the wall, increased batter of the piles, and increased lengths required for the piles. The pile design developed for this alignment is likely not practical unless no other alternatives are feasible.

6.2.4 Civil

The Highway 23 to Orleans Parish Landfill reach of the project is shown on Sheets 5 through 10 and Sheets 14 through 19 in Appendix A. These sheets include plan/profile and ROW information for various levee height build conditions and three levee type alternatives. Inroads was used to model an unreinforced earthen levee for the 2007 plus overbuild condition (elevation 14.0 feet) and the 2057 plus overbuild condition (elevation 15.5 feet). Modeling was also performed for a reinforced earthen levee at the same elevations. The third levee alternative, the T-wall, was modeled for the 2057 elevation of 14.0 feet (no overbuild).

Each of the earthen levee alternatives would include a transition to the T-wall coming from the railroad reach of the project to the south. The detail for those transitions is shown on Sheet 13. After the transition, the earthen sections (see typical sections on Sheet 11) would generally follow an offset from the existing alignment along the Bayou Barriere Golf Course. The T-wall section would follow along the toe of the existing levee. Fill material would be placed between the existing levee and the new T-wall at a height approximately equal to the existing levee. The levee alternatives would tie into the existing pump station (Belle Chasse Pump Station 2) near USACE-PRO Station 627+87 (details to be designed under separate contract). Picking up on the other side of the pump station, the alternatives would continue north to the landfill area around USACE-PRO Station 680+00. The landfill area only has two T-wall options, so the earthen levee alternatives would transition into a T-wall at the appropriate location.

Several tee boxes, greens, and ponds fall within the proposed construction limits, especially for the earthen raise options. Most of them are eliminated for the T-wall option. While the provided topography files appear to locate some of the tee boxes, etc. with a slight shift in position, it does not change the impact. Those locations will need to be refined as the design process continues. There are businesses, including large buildings, towards the northern end of this reach which lie within the proposed construction limits of the earthen levee alternatives. The T-wall option avoids the majority of those conflicts.

The two unreinforced levee alternatives would require berms which extend into the canal in order to stabilize the slope of the proposed sections. There are several significant items to note with regard to constructing that slope into the canal. First, the berm would need to be placed as rock in order to keep it from eroding and washing away. Secondly, the impact to the navigation channel would need to be investigated. A draw depth and width of canal needs to be maintained for traffic on the canal. In addition, the flow area would be reduced by the fill placed in the canal which could alter the hydraulic response to frequently seen rainfall events. The reduced flow area could cause higher water surface elevations or increase velocities for a given event.

6.2.5 Recommendations

[USACE-PRO]

6.3 Floodwalls – Orleans Parish Landfill

6.3.1 Design Evaluation

For this project reach, two alternatives were considered for evaluation. The first alternative locates a new proposed T-wall along the floodside of the existing levee toe immediately adjacent to the water along the edge of the canal. The second alternative locates a new proposed T-wall along the landfill's property line on the protected side. One leg of this alignment parallels Woodland Hwy 407. Presently, no protection is in place apart from the existing levee.

6.3.2 Geotechnical

Stability analysis, Pile Calculations, and Seepage Results are included in Appendix B-5 of the Geotechnical Engineering Report for the T-wall alternative located on the landside toe of the existing levee for this reach of the project.

Based upon discussions with USACE-PRO an analysis was also performed with the T-wall located on the flood side toe of the existing levee. Stability analysis, Pile Calculations, and Seepage Results are included in Appendix B-6 of the Geotechnical Engineering Report for the Floodside T-wall alternative.

6.3.3 Structural

There are two alternatives outlined within the project scope for the abandoned Orleans Parish Landfill (Section 1.3.1 Item Nos. 6 and 7) due to the environmental sensitivity of compromising the landfill's contents. The use of a levee toe wall on the canal side for a length of 2700 feet is one alternative. The other alternative is a configuration which

would wrap around the landward side of the landfill adjacent to Woodland Highway for a total length of 3722 feet. Both alternatives will tie into either the earthen levee or the T-wall alternative chosen outside of the landfill limits abutting the Algiers Canal.

Again, due to the sensitivity of the landfill's contents, the project scope does not allow for fill material to be placed between the wall face and the existing landfill elevation (Section 1.3.1). No construction may take place within the interior of the landfill. Therefore, there will be no soil load on the wall. The usual hydraulic and impact loads are considered as well as the structure's own weight.

Survey information in the area of the landfill indicates that the ground elevation at the landside levee toe is approximately El. -4.0 feet, while the existing landfill crest is approximately El. 9.0 feet; the same as the existing earthen levee. Ground elevation on the canal side is at El. 0.0 feet with the top of the wall at a protected level of El. 14.0 feet. The result is a wall 18 feet high with a potential hydrostatic pressure load elevation of El. 14.0 feet.

A Class No.1 barge impact load of 100,000 pounds is applied to the floodward wall, as instructed in HSDRRS. This point load is distributed over a 5- foot length of wall in addition to length gained along a 45 degree angle (HSDRRS Section 5.9). The existing levee remains in place to serve as interim protection as well as to serve as future barge impact protection for the landward wall option. Therefore, only a Class No. 3 minimal impact load of 500 pounds per linear foot is applied to the landward wall.

The reinforced concrete T-wall is designed using 4000 psi concrete and 60,000 psi rebar, as required by HSDRRS. Wall thickness varies from a minimum of 24 inches at the top (HSDRRS) to 36 inches at the base of the wall stem. The HSDRRS allows a maximum thickness of 48 inches.

Minimum temperature reinforcing steel is provided at a ratio of 0.0028 (area of steel to area of concrete) as per HSDRRS, with half being placed on each face of the wall stem. Minimum concrete cover over the reinforcing steel is 4 inches for thicknesses of 24 inches and higher (HSDRRS).

As per HSDRRS, all loads have been increased by a factor of 1.7 for dead and live loads, as well as an additional 1.3 for hydraulic considerations. The unit weight of water is given as 64 pcf and concrete as 150 pcf (HSDRRS). As per standard American Concrete Institute (ACI) 318-05 protocol, strength reduction (phi) factors of 0.9 for bending and 0.85 for shear are used in the design (HSDRRS).

Stability analysis indicated the presence of unbalanced loads with the T-wall located on the protected side of the levee and backfill placed between the existing levee and new

T-wall. With the combination of high critical loading conditions, additional lateral loads applied to the piles from the unbalanced loads, and weak subsurface soils the pile design required closer spacing of the pile rows along the length of the wall, increased batter of the piles, and increased lengths required for the piles. The pile design developed for this alignment is likely not practical unless no other alternatives are feasible.

A summary of all load and design criteria is provided in Table 3 in section 7.7.

6.3.4 Civil

The Orleans Parish Landfill reach of the project is shown on Sheets 20 through 27 in Appendix A. While the only project alternative for the landfill area is a structural T-wall, there were two options investigated. Option 1 would be a T-wall on the flood side of the existing levee. The wall would approximately follow along the existing levee at elevation 0.0 feet with fill placed between the proposed wall and the existing levee (graded to drain). Option 2 would be a T-wall which would follow an alignment to go around the back of the landfill. The alignment heads east to Woodland Highway, and then follows the highway for a distance before turning north along the tree line heading back to the existing levee. A complete land survey and boring information has not been provided to determine if the proposed alignment will avoid the potentially hazardous waste under the surface. It is assumed that the landfill would not be penetrated during the proposed construction, but further investigation would be needed as the design process moves forward.

Option 1 at the landfill area would begin with a transition from the earthen section or connection to the T-wall (depending upon the chosen alternative for the previous project reach) at USACE-PRO Station 680+00. It would go just west of some existing concrete slabs possibly remaining from a communication tower. Seven points of intersection (PIs) would be introduced into the alignment as the top of the wall footing follows along elevation 0.0 feet. The T-wall transitions or ties into the next reach of the project at USACE-PRO Station 706+68.

In order to protect against potential collision from a barge or ship traveling the canal, a series of dolphins would need to be placed at 30-foot spacings along the proposed alignment. This would result in the construction of approximately 85 structures to protect the wall. Details of the dolphins are shown on Sheet 12.

Option 2 at the landfill area would begin with a transition from the earthen section or connection to the T-wall at USACE-PRO Station 680+00 and head northeast for a short distance before turning east to Woodland Highway. The alignment turns along Woodland Highway west of the ditch running along the west side of the road. As it would reach the existing tree line along the edge of the landfill, the T-wall would turn north toward the existing levee. The wall would then transition to an improved earthen levee or connect to a T-wall at the next reach of the project at USACE-PRO Station 706+68.

The alignment option around the landfill would go through private land its entire length. It essentially cuts off access to the land with the T-wall, and therefore would require a gate or complete purchase of the land. A gate anywhere along the proposed wall could be a safety hazard and liability with respect to the integrity of the protection system. Also, the land could be inundated for lengths of time when the existing levee is breached in high water situations. Therefore, purchasing the entire area between the proposed T-wall and existing levee would be necessary. A series of power poles, a utility box, and a transformer have been identified in the construction limits of the proposed wall, which would need to be relocated or protected. The alignment would mostly miss the trees along the east side of the landfill, but would require some removals on the north end.

6.3.5 Recommendations

[USACE-PRO]

6.4 Levee/Floodwall - Orleans Parish Landfill to Woodland Highway Bridge

6.4.1 Design Evaluation

Three separate alternatives were evaluated to upgrade the existing earthen levee to 100-year (one percent chance of occurring in any year) elevations along the east side of Algiers Canal between Highway 23 and Orleans Parish Landfill. The authorized elevation specified in the SOW is 10.5 feet for year 2007 and 14.0 feet for year 2057. Earthen levees were analyzed with interim construction events to maintain an elevation above the design elevation based upon straight line interpolation over the 50-year design life. Structural alternatives were designed for the year 2057 design elevation (14.0 feet).

Alternative 1 expands the existing levee in a landside shift to raise the level of protection to a maximum overbuild elevation of 15.5 feet. Stability berms on both the flood and protected sides of the levee will be required to maintain stability during storm events.

Alternative 2 expands the existing levee in a landside shift to raise the level of protection to a maximum overbuild elevation of 15.5 feet. Two layers of high tensile strength geotextile reinforcement were considered for this alternative to provide stability during flood events and reduce the ROW requirements for stability berms.

Alternative 3 considers a pile supported concrete T-wall along the landside toe of the existing earthen levee with the top of floodwall at elevation 14.0 feet. The void space between the new T-wall and the existing levee will be backfilled to match the existing levee elevation and eliminate water from ponding after a storm event.

Transition structures for levee alternatives to the north and south of this geographic reach were also evaluated to maintain a constant level of protection over the entire project length.

6.4.2 Geotechnical

The Levee/Floodwall from the Orleans Parish Landfill to the Woodland Highway Bridge was evaluated using the shear lines included in Appendix B-2 of the Geotechnical Engineering Report.

Stability analysis, Settlement Calculations, and Seepage Results are included in Appendix B-3 of the Geotechnical Engineering Report for the unreinforced levee alternative for this reach of the project. Stability analyses for the 2007 Overbuild, 2057 Overbuild, and the 2057 Design Grade were completed for this alternative.

Stability analysis, Settlement Calculations, and Seepage Results are included in Appendix B-4 of the Geotechnical Engineering Report for the reinforced levee alternative for this reach of the project. Stability analyses for the 2007 Overbuild, 2057 Overbuild, and the 2057 Design Grade were completed for this alternative.

Stability analysis, Pile Calculations, and Seepage Results are included in Appendix B-5 of the Geotechnical Engineering Report for the T-wall alternative for this reach of the project. The T-wall for this analysis was located on the landside toe of the existing levee.

6.4.3 Structural

At this point, no structural floodwall is envisioned for this levee section. However, if site constraints (such as nearby cell phone towers) determine that a floodwall section is needed, or should the T- wall, Project Length Alternative be chosen, then the protected-side levee toewall used beneath the Woodland Highway 407 Bridge should be adequate for use. The length of the wall will be no longer than is necessary to

bypass the offending structure, or meet the Alternative Project Length, after which the earthen levee section will be resumed.

Stability analysis indicated the presence of unbalanced loads with the T-wall located on the protected side of the levee and backfill placed between the existing levee and new T-wall. With the combination of high critical loading conditions, additional lateral loads applied to the piles from the unbalanced loads, and weak subsurface soils the pile design required closer spacing of the pile rows along the length of the wall, increased batter of the piles, and increased lengths required for the piles. The pile design developed for this alignment is likely not practical unless no other alternatives are feasible.

6.4.4 Civil

The Orleans Parish Landfill to Woodland Highway Bridge reach of the project is shown on Sheets 28 through 33 in Appendix A. The sheets include plan/profile and ROW information for various levee height build conditions and three levee type alternatives. Inroads was used to model an unreinforced earthen levee for the 2007 plus overbuild condition (elevation 14.0 feet) and the 2057 plus overbuild condition (elevation 15.5 feet). Modeling was also performed for a reinforced earthen levee at the same elevations. The third levee alternative, the T-wall, was modeled for the 2057 elevation of 14.0 feet (no overbuild).

Each of the earthen levee alternatives would include a transition to the T-wall coming from the Orleans Parish Landfill reach of the project to the south at USACE-PRO Station 706+68. The detail for those transitions is shown on Sheet 13. After the transition, the earthen sections (see typical sections on Sheet 11) would generally follow an offset from the existing alignment along the existing protected side slope. The T-wall section would follow along the toe of the existing levee. Fill material would be placed between the existing levee and the new T-wall at a height approximately equal to the existing levee. The levee alternatives would transition to the proposed T-wall under the Woodland Highway Bridge near USACE-PRO Station 715+73. The T-wall option would simply connect to the T-wall at that station.

A communications power yard, storage yard, and a few buildings fall within the proposed construction limits, especially for the earthen raise options. Most of them are eliminated for the T-wall option.

The two unreinforced levee alternatives would require berms which extend into the canal in order to stabilize the slope of the proposed sections. There are several significant items to note with regard to constructing that slope into the canal. First, the berm would need to be placed as rock in order to keep it from eroding and washing away. Secondly, the impact to the navigation channel would need to be investigated. A draw depth and width of the canal needs to be maintained for traffic on the canal. In addition, the flow area would be reduced by the fill placed in the canal which could alter the hydraulic response to frequently seen rainfall events. The reduced flow area could cause higher water surface elevations or increase velocities for a given event.

6.4.5 Recommendations

[USACE-PRO]

6.5 Floodwall – Beneath Woodland Highway Bridge

6.5.1 Design Evaluation

For this project reach, only one alternative was considered for evaluation. Presently, no protection (apart from the existing levee) is in place. A new concrete T-wall has been designed to be located at the landside levee toe to preclude new levee fill from impacting the existing bridge piers. The void between the new wall and existing levee crest will be filled with new levee material.

6.5.2 Geotechnical

Stability analysis, Pile Calculations, and Seepage Results are included in Appendix B-5 of the Geotechnical Engineering Report for the T-wall alternative located on the landside toe of the existing levee for this reach of the project.

6.5.3 Structural

The inclusion of a T-wall beneath the Woodland Highway 407 Bridge is stipulated in the project scope (Section 1.3.1 Item No. 5) due to the proximity of the existing bridge support piers to the levee. The use of a landside levee toe wall at this location is envisioned as a means of preventing the placement of levee fill material against the bridge piers.

The project scope also calls for a wedge of fill material to be placed between the wall face and the existing levee slope (Section 1.3.4). This wedge of fill material introduces a soil load on the wall, in addition to the usual hydraulic and impact loads and the weight of the structure itself.

Survey information in the area of the bridge indicates that the ground elevation at the landside levee toe is approximately El. -2.0 feet, while the existing levee crest is at approximately El. 9.0 feet with the top of the wall at a protected level of El. 14.0 feet. The result is a wall 16 feet high with 11 feet of soil load and a potential hydrostatic pressure load elevation of 14.0 feet.

A Class No.1 barge impact load of 100,000 pounds is applied to the wall, as instructed in HSDRRS. This point load is distributed over a 5-foot length of wall in addition to length gained along a 45-degree angle (HSDRRS Section 5.9). The existing levee remains in place to serve as interim protection as well as to serve as future barge impact protection.

The reinforced concrete T-wall is designed using 4000 psi concrete and 60,000 psi rebar, as required by HSDRRS. Wall thickness varies from a minimum of 24 inches at the top (HSDRRS) to 36 inches at the base of the wall stem. The HSDRRS allows a maximum thickness of 48 inches.

Minimum temperature reinforcing steel is provided at a ratio of 0.0028 (area of steel to area of concrete) as per HSDRRS, with half being place on each face of the wall stem. Minimum concrete cover over the reinforcing steel is 4 inches for thicknesses of 24 inches and higher (HSDRRS).

As per HSDRRS, all loads have been increased by a factor of 1.7 for dead and live loads, as well as an additional 1.3 for hydraulic considerations. The unit weight of water is given as 64 pcf and concrete as 150 pcf (HSDRRS). As per standard American Concrete Institute (ACI) 318-05 protocol, strength reduction (phi) factors of 0.9 for bending and 0.85 for shear are used in the design (HSDRRS).

Stability analysis indicated the presence of unbalanced loads with the T-wall located on the protected side of the levee and backfill placed between the existing levee and new T-wall. With the combination of high critical loading conditions, additional lateral loads applied to the piles from the unbalanced loads, and weak subsurface soils the pile design required closer spacing of the pile rows along the length of the wall, increased batter of the piles, and increased lengths required for the piles. The pile design developed for this alignment is likely not practical unless no other alternatives are feasible.

A summary of all load and design criteria is provided in Table 3 in Section 7.7.

6.5.4 Civil

The Beneath Woodland Highway Bridge reach of the project is shown on Sheets 34 and 35 in Appendix A. The only project alternative for this area is a structural T-wall. Matching into the T-wall option alignment for the project reach to the south (USACE-PRO Station 715+73) and the T-wall option alignment for the project reach to the north (USACE-PRO Station 718+42), an alignment under the bridge was modeled which avoids interference with the bridge substructure. If the earthen alternatives are chosen for the tie-in reaches, then there would be transitions to the T-wall under the bridge following the detail on Sheet 13. The proposed T-wall alignment does not interfere with any structures or known utilities.

6.5.5 Recommendations

[USACE-PRO]

6.6 Levee/Floodwall – Woodland Highway Bridge to Algiers Lock

6.6.1 Design Evaluation

Three separate alternatives were evaluated to upgrade the existing earthen levee to 100-year (one percent chance of exceedance) elevations along the east side of Algiers Canal between Highway 23 and Orleans Parish Landfill. The authorized elevation specified in the SOW is 10.5 feet for year 2007 and 14.0 feet for year 2057. Earthen levees were analyzed with interim construction events to maintain an elevation above the design elevation based upon straight line interpolation over the 50 year design life. Structural alternatives were designed for the year 2057 design elevation (14.0 feet).

Alternative 1 expands the existing levee in a landside shift to raise the level of protection to a maximum overbuild elevation of 15.5 feet. Stability berms on both the flood and protected sides of the levee will be required to maintain stability during storm events.

Alternative 2 expands the existing levee in a landside shift to raise the level of protection to a maximum overbuild elevation of 15.5 feet. Two layers of high tensile strength geotextile reinforcement were considered for this alternative to provide stability during flood events and reduce the ROW requirements for stability berms.

Alternative 3 considers a pile supported concrete T-wall along the landside toe of the existing earthen levee with the top of floodwall at elevation 14.0 feet. The void space between the new T-wall and the existing levee will be backfilled to match the existing levee elevation and eliminate water from ponding after a storm event.

Transition structures for levee alternatives to the north and south of this geographic reach were also evaluated to maintain a constant level of protection over the entire project length.

6.6.2 Geotechnical

The Levee/Floodwall from Woodland Highway Bridge to Algiers Lock was evaluated using the shear lines included in Appendix B-2 of the Geotechnical Engineering Report.

Stability analysis, Settlement Calculations, and Seepage Results are included in Appendix B-3 of Geotechnical Engineering Report for the unreinforced levee alternative for this reach of the project. Stability analyses for the 2007 Overbuild, 2057 Overbuild, and the 2057 Design Grade were completed for this alternative.

Stability analysis, Settlement Calculations, and Seepage Results are included in Appendix B-4 of Geotechnical Engineering Report for the reinforced levee alternative for this reach of the project. Stability analyses for the 2007 Overbuild, 2057 Overbuild, and the 2057 Design Grade were completed for this alternative.

Stability analysis, Pile Calculations, and Seepage Results are included in Appendix B-5 of Geotechnical Engineering Report for the T-wall alternative for this reach of the project. The T-wall for this analysis was located on the landside toe of the existing levee.

6.6.3 Structural

At this point, no structural floodwall is envisioned for this levee section. However, if site constraints determine that a floodwall section is needed, or should the T-wall Project Length Alternative be chosen, then the protected-side levee toewall used beneath the Woodland Highway 407 Bridge should be adequate for use. The length of the wall will be no longer than necessary to bypass the offending structure, or meet the Project Length Alternative, after which the earthen levee section will be resumed.

Stability analysis indicated the presence of unbalanced loads with the T-wall located on the protected side of the levee and backfill placed between the existing levee and new T-wall. With the combination of high critical loading conditions, additional lateral loads applied to the piles from the unbalanced loads, and weak subsurface soils, the pile design required closer spacing of the pile rows along the length of the wall, increased batter of the piles, and increased lengths required for the piles. The pile design developed for this alignment is likely not practical unless no other alternatives are feasible.

6.6.4 Civil

The Woodland Highway Bridge to Algiers Lock reach of the project is shown on Sheets 36 through 41 in Appendix A. The sheets include plan/profile and ROW information for various levee height build conditions and three levee type alternatives. Inroads was used to model an unreinforced earthen levee for the 2007 plus overbuild condition (elevation 14.0 feet) and the 2057 plus overbuild condition (elevation 15.5 feet). Modeling was also performed for a reinforced earthen levee at the same elevations. The third levee alternative, the T-wall, was modeled for the 2057 elevation of 14.0 feet (no overbuild).

Each of the earthen levee alternatives would include a transition to the T-wall coming from the Beneath Woodland Highway Bridge reach of the project to the south at USACE-PRO Station 718+42. The detail for those transitions is shown on Sheet 13. After the transition, the earthen sections (see typical sections on Sheet 11) would generally follow an offset from the existing alignment along the existing protected side slope. The T-wall section would follow along the toe of the existing levee. Fill material would be placed between the existing levee and the new T-wall at a height approximately equal to the existing levee (graded to drain). The levee alternatives would tie into the existing New Orleans Sewerage and Water Board (NOS & WB) Pump Station 11 at USACE-PRO Station 744+05 and then start up again on the north side at USACE-PRO Station 752+00. The alignment would continue to the existing slope (at elevation 14.0 feet) at the Algiers Lock near USACE-PRO Station 768+10. The T-wall option would transition to the earthen embankment at that station.

While there are some utilities within the proposed construction limits for all alternatives, there are no other structures known to be affected.

The two unreinforced levee alternatives would require berms which extend into the canal in order to stabilize the slope of the proposed sections. There are several significant items to note with regard to constructing that slope into the canal. First, the berm would need to be placed as rock in order to keep it from eroding and washing away. Secondly, the impact to the navigation channel would need to be investigated. A draw depth and width of canal needs to be maintained for traffic on the canal. In addition, the flow area would be reduced by the fill placed in the canal which could alter the hydraulic response to even frequently seen rainfall events. The reduced flow area could cause higher water surface elevations or increase velocities for a given event.

6.6.5 Recommendations

[USACE-PRO]

7. Design References, Criteria, and Information Summary

7.1 Design References

The alternatives investigations and analyses for this task order were based on information provided by the USACE-PRO from previous design memoranda (DM), reports, and construction drawings in addition to USACE-PRO regulations available at http://www.mvn.usace.army.mil/publicatons. The information provided by USACE-PRO included:

- "East of Harvey Canal Hurricane Protection Project, Design Memorandum No. 2 East and West of Algiers Canal, Volumes 1 and 2", dated January 1999.
- "Sample Results and Final Site Inspection Report, Algiers Landfill" submitted by Norwood Land Co. to the Louisiana Department of Environmental Quality (LA DEQ) dated September 12, 1997.
- Drawings: "Hurricane Protection Project, Algiers Canal Levee Enlargement, East Side Belle Chase Highway to Algiers Lock", dated August, 2004.
- "Elevations for Design of Hurricane Protection Levees and Structures, Lake Pontchartrain and Vicinity Hurricane Protection Project; West Bank and Vicinity Hurricane Protection Project", USACE-PRO MVN, October 9, 2007.
- "Vertical Datum Report – East Jefferson Polder", USACE-PRO MVN, January 2008.

7.2 Assumptions and Input Data

In addition to the specific design criteria and input data detailed in this section below, the following major assumptions were used in completion of the report analyses:

- Tie-ins to the existing walls at Algiers Lock, Belle Chase Pump Station No. 2, and New Orleans Sewerage and Water Board Pump Station No. 11 were not evaluated.
- One soil's reach was used as a "worst reach" for refinement of the earthen and structural alternatives.
- ROW extents were determined for 2057 design elevations of levees plus overbuild.
- Costs were determined for levee alternatives using 2007 design elevation plus interim lifts to attain 2057 design elevation plus overbuild.
- Costs were determined for T-wall alternatives using 2057 design elevation.
- Spencer's Method was not used for unreinforced levee section.

- T-wall alternatives were evaluated at the Orleans Parish Landfill area with no known disturbance to the assumed limits of landfill material.
- Existing survey base files were provided in raw text format. The survey information matched an existing DTM surface being used on the Sector Gate South Project; therefore, the previously created DTM was used on this project. As a result, the survey data was used to identify utilities and features not included in other base files.
- As-built drawings were provided by USACE-PRO which identified topography features including landscaping and utilities. Information from these as-builts were copied into the plan and compared/corrected to match the provided survey.
- USACE-PRO baseline information was obtained from the Sector Gate South Project Inroads alignment files. This alignment was established from the Algiers main loop traverse provided by USACE-PRO.

7.3 Field Data Collection

7.3.1 Site Reconnaissance

A site reconnaissance was conducted on April 30, 2008. The field visit enabled the team to view the present conditions of the existing protection and note any physical features to augment the alternatives investigations. Visible facilities were identified that could possibly impact alternative recommendations and future construction and provided an initial assessment of facility relocation issues.

7.3.2 Survey Data

Existing baseline, topographic, hydrographic and ROW data was provided by USACE-PRO for the extent of the project area. As part of this task order, additional survey data was collected for the perimeter of the Orleans Parish Landfill that included cross sections every 600 feet perpendicular to the landfill perimeter.

Surveys conform to the requirements stated in Section 9 of the latest version of the “Hurricane and Storm Damage Risk Reduction System Design Guidelines”. This includes identifying a minimum of three (3) permanent benchmarks (new or existing) on design and construction drawings for all flood control projects. The benchmarks were established relative to existing NAVD88 controls established by the National Geodetic Survey (NGS), using either conventional differential leveling and / or the latest NGS – approved differential Global Positioning System (GPS) network observations, with appropriate corrections to the local hydraulic design surface. Prior to and during actual construction stake out, these primary reference marks shall be

verified externally and internally and field records of these survey verifications shall be permanently archived. A complete re-evaluation of the vertical datum shall be conducted at each scheduled periodic inspection. The survey report and ITR have been completed and are shown in Appendix G.

7.3.3 Borings and Testing

Existing soil borings and Cone Penetrometer Tests (CPTs) were obtained by others and provided by USACE-PRO for the development of this report. The above mentioned borings and CPTs were taken every 1,000 feet for centerline borings, every 2,000 feet for landside and floodside toe borings and every 1,000 feet for CPTs.

7.3.4 Identification of Potential Relocations

An initial assessment of facility relocation issues was obtained during the site reconnaissance of April 30, 2008. Potential relocations are detailed in Section 9.

7.4 Subsurface and Groundwater Conditions

Beneath the existing levees, the project site is characterized by Holocene Aged soils that overlie Pleistocene Age soils. The Holocene Age soils consist of swamp/marsh, deltaic plain, and nearshore Gulf depositional units. Groundwater elevation was estimated based on canal water.

7.5 Hydraulic Design Criteria and Information

Hydraulic information relating to the design of proposed levee improvements was provided by the USACE-PRO. The purpose of this project is to perform feasibility-level design for alternative methods of raising the existing hurricane protection to 100-year (one percent chance of occurring in any year) levels between Highway 23 and the Algiers Lock. The 2007 Still Water Level (SWL) was provided as elevation 9.0 feet NAVD88 corresponding to a top of levee elevation of 10.5 feet NAVD88. The SWL given for the 2057 condition was elevation 11.0 feet NAVD88 with a corresponding top of structure and levee elevation of 14.0 feet NAVD88.

Table 1 – Project 1% Design Elevations (NAVD 88)

Segment	Location	Type	SWL		Design Elevation	
			2007	2057	2007	2057
WBV-48.2	Highway 23 to Algiers Lock, East Side of Algiers Canal	Levee	9.0		10.5	
		Levee, Floodwall		11.0		14.0

7.5.1 Modeling and Design Elevations

The source of the hydraulic elevations in this report is the USACE-PRO MVN, October 9, 2007 report: Elevations for Design of Hurricane Protection Levees and Structures, Lake Pontchartrain and Vicinity Hurricane Protection Project; West Bank and Vicinity Hurricane Protection Project, and subsequent addenda. All elevations are in feet NAVD88 2004.65.

The HSDRRS included features that provide protection from a hurricane event that would produce a one percent exceedance surge elevation and associated waves. Hydraulic modeling and analyses performed to calculate the surge elevation and wave characteristics are described in the October 9, 2007 report.

After construction is complete, the HSDRRS will meet the hydraulic requirements for levee certification, as documented in the draft Engineering Technical Letter (ETL), Engineering and Design, Certification of Levee Systems, for the National Flood Insurance Program (NFIP).

The hydraulic elevations presented in this report should be considered initial elevations. Additional, more thorough engineering investigations may follow to determine final construction elevations.

This report considers different configurations of levees and structures that may have different design elevations. The selected alternative may have effects on design elevations in adjacent contract reaches. To assure continuity of design methodology, consistency of designs across contract reaches, and provide close quality management, final design elevations utilized throughout the New Orleans area will be reviewed by the New Orleans District Engineering Division Chief of Hydraulics and Hydrologic Branch.

7.5.2 Future Analysis

As noted in the October 9, 2007 report, in the future, subsidence and sea level rise will affect elevations required for levee certification, and an analysis was performed to project the effect of these parameters on future surge elevations and wave characteristics. The New Orleans District will perform regular reassessments of these and other hydrologic parameters to assure the effectiveness of the system in the future years. The system will undergo a reassessment after major events, significant changes in design and analysis methodologies, or no less than every 10 years.

7.5.3 Gages

There is no gaging station in the vicinity of the contract reach. During the design phase, gaging requirements will be established and gage(s) will be installed. The gage(s) will be used for determining the tidal datum local mean sea level (LMSL) prior to construction. Additional temporary gage(s) may be required depending on vertical accuracy requirements. The gage(s) can also be used to monitor future hydrologic conditions in the area. The datum of the gage(s) has been established to comply with criteria contained in the Vertical Control Requirements for Engineering, Design, Construction, and Operation of Flood Control, Shore Protection, Hurricane Protection, and Navigation Projects (Engineering Division Policy Memo No. 2).

The relationship between NAVD88 2004.65 and LMSL for the gage(s) will be re-evaluated and reviewed by the National Oceanographic and Atmospheric Administration (NOAA) every 5 years (or more frequently if warranted based upon rate of subsidence).

The “Vertical Datum Report” for the East Jefferson Polder contains specific information on the gage network and the relationship between LMSL and NAVD 88 2004.65 for the project area.

7.6 Geotechnical / Civil Design Criteria and Information

This section presents the geotechnical assumptions and design criteria used to perform geotechnical analyses of the structures outlined above. The following design criteria provided by USACE-PRO serve as a guideline for this report:

- Hurricane and Storm Damage System Design Guidelines (Interim, October 2007).
- April 25, 2008 Memorandum for Commander Mississippi Valley Division (CEMVDRB/Mr. Rogers), 1400 Walnut Street, Vicksburg, MS 39181, Subject: Hurricane Protect System Slope Stability Design Criteria.

In addition to above guidelines, following publications were referred to for the geotechnical design:

- EM 1110-2-1902, Slope Stability, October 2003.
- EM 1110-1-1904, Settlement Analysis, September 1990.
- EM 1110-2-2906, Design of Pile Foundations, January 1991.
- EM 1110-2-1913, Design and Construction of Levees, April 2000.
- EM 1110-2-1901, Seepage Analysis and Control for Dams, April 1993.
- ETL 1110-2-569, Design Guidelines for Levee Under seepage, May 2005.
- DIVR 1110-1-400, Soil Mechanic Data, December 1998.

Computer software used:

- SLOPE/W Version 2007 by Geo-Slope International for slope stability using Spencer's Method (Geo-Studio Version 7.10 Build 4143)
- "Stability with Uplift" for Slope Stability using MVD Method of Planes.
- SEEP/W Version 2007 by Geo-Slope International (Geo-Studio Version 7.10 Build 4143)
- "Computer Program for Determining Induced Stresses and Consolidations Settlements (CSETT)" for Settlement Analysis

Civil plans follow the AE/C CADD Standard Manual Release 3.0, with further guidance from the Mississippi Valley Division Release 3.0 (March 2007).

All CADD files are in Bentley Microstation version 2004. Civil design was accomplished through the use of Bentley InRoads 2004.

Example calculations provided by USACE-PRO:

- Lake Pontchartrain, Louisiana and Vicinity, High Level Plan, Design Memorandum No. 18 – General Design, St. Charles Parish North of Airline Highway, Appendix D, Volume II, Geotechnical Design Calculations section was used as reference for geotextile design associated with the reinforced levee section.

A complete geotechnical analysis will be performed on the selected alternative during the preparation of P & S. This analysis will conform to the guidelines included in the latest version of the "Hurricane and Storm Damage and Risk Reduction System Design Guidelines". We do not expect this further design work to affect the selection of the preferred alternative.

7.6.1 Levee Embankment Design

Using subsurface information provided by the USACE-PRO, shear lines and unit weights lines were developed and used in levee embankment design. A

representative cross section was selected for the design analysis. In addition to stability analysis, settlement analyses were completed to develop a construction lift schedule to maintain the design elevation over the life of the project.

7.6.2 Stability Design Criteria

The stability of the proposed levee and structures were determined using the USACE-PRO Mississippi Valley Division (MVD) Method of Planes (MOP) "Stability with Uplift" program. The stability of the flood protection systems was analyzed for three different water elevations corresponding to: (1) Still Water Level (2057) (2) Top Of Levee (2057) and (3) Low Water (Flood Side) (El. -1.0 feet).

Earthen levee sections were analyzed using the shear strength and unit weights developed for the shear lines. The stability analyses of the T-Walls and Railroad Swing Gate Structures utilized shear strength values that were factored by the required design factor of safety (FoS) from the SOW to determine unbalanced forces.

Minimum geotextile tensile strength requirements were calculated using the MOP output utilizing the specified FoS for reinforced levees. Run-out lengths were calculated from the tensile strength and adhesion values calculated from cohesion values of the levee material.

The locations of the most critical passive wedges for the T-Walls and Railroad Swing Gate Structure were searched while fixing the active wedge at the heel of the structure base until the lowest FoS was obtained for each stratum. The locations of the most critical active and passive wedges for earthen levees were determined using engineering judgment and trial and error process. In both cases, the minimum length of the central block was limited to the width of the structure base or 0.7 H, whichever was greater. The term "H" is defined as vertical distance between failure surface and intersection of active wedge with ground surface. If unbalanced forces were present, they were then determined by subtracting the resisting forces from the driving forces. If the water level is above the ground surface, a free water force has to be eliminated from the driving force on the active side of the structure and from the resisting force on the passive side of the structure. If the driving force is greater than the resisting force after adjusting the MOP's output driving forces and resisting forces for the free water forces, then an unbalanced load exists.

Slope stability using Spencer's Block search method with Geo-Slope's SLOPE/W was performed on the 3 most critical layers and was used for comparison purposes only in accordance with the SOW. In general, Spencer's method considers both shear and a constant normal interslice forces, and satisfies both moment and force equilibrium. For

the block search, wedge-shaped failure surfaces were generated using force and moment equilibrium.

Reinforced levee sections were analyzed using the spatial variation add-in provided by USACE-PRO which generally increased the FoS and reduced the required geotextile tensile strength. The tensile strength values calculated using the add-in were more consistent with values generated from the MOP program using the same FoS.

For T-Wall analysis, if the FoS obtained was lower than the required FoS for the given design case, a horizontal line load was applied midway between the ground surface and the failure surface at the foundation heel. The unbalanced load was then obtained by trial and error process until the required FoS was obtained.
Table 2 presents the summary of FoS used for this report.

Table 2: Slope Stability Minimum Factors of Safety (FoS)

UNREINFORCED LEVEE EMBANKMENT DESIGN		
	Method of Planes	**Spencer's Method**
Still Water Level (2057)	1.40	N/A
Top of Levee (2057)	1.30	N/A
Low Water (Floodside) (-1.0)	1.35	N/A
GEOTEXTILE REINFORCED LEVEE EMBANKMENT DESIGN		
	Method of Planes	**Spencer's Method**
Still Water Level (2057)	1.40	1.50
Top of Levee (2057)	1.30	1.40
Low Water (Floodside) (-1.0)	1.35	1.40
T-WALL DESIGN		
	Method of Planes	**Spencer's Method**
Still Water Level (2057)	N/A	1.50
Top of Levee (2057)	1.30	1.40
Low Water (Floodside) (-1.0)	1.35	1.40

7.6.3 Pile Foundation

Design of pile foundations was completed in general accordance with USACE-PRO Manual, EM 1110-2-2906, Design of Pile Foundations, January 1991. Allowable

compressive pile capacities and allowable uplift capacity curves were generated using electronic spreadsheets and checked using hand calculations. If unbalanced loads were present from the stability analysis, pile capacity was neglected above the critical failure surface. The critical failure surface was considered to be the plane at the elevation that results in the greatest unbalanced load. Contribution due to end bearing was neglected for layers where the undrained shear strength was less than 1,000 psf. Factors of safety (FoS) of 3.0 for the Q-case and 1.5 for the S-case (long-term) were assumed. The more critical pile length of two cases was considered for design. For purposes of this EAR Cost Estimate, a FoS of 2.0 with pile load tests was not considered. Steel 14x89 H-piles were considered as part of this EAR Cost Estimate.

Per New Orleans District recommendations, vertical effective stress in the subsurface foundation was limited to 3500 psf for determining both the undrained and drained pile capacity curves.

Pile reactions resulting from the critical loading conditions were determined using Ensoft's GROUP, Version 7 computer software. Axial forces, vertical and horizontal displacements, and maximum shear forces were determined using the subsurface conditions defined by the shear line.

For the case where unbalanced loads were encountered, allowable shear loads on the pile at the critical surface were determined using Ensoft's LPILE computer software. Hand calculations were also performed to determine that the number of piles per row was adequate to resist flow through from the unbalanced loads, as well as the ability of the soil to resist shear failure between pile rows as a result of unbalanced loads. The maximum unbalanced load was applied to the piles as a distributed lateral load from the pile cap to the critical surface.

7.6.4 Floodwalls

Floodwalls were analyzed in accordance with section 5 of the HSDRS Design Guidelines.

7.6.5 Lateral Earth Pressure

At-rest soil pressures were used to design retaining wall structures. Per NOD recommendations, at-rest lateral earth pressure coefficients of 0.8 and 0.5 were used for clay backfill and sand backfill, respectively.

7.6.6 Bearing Capacity

A FoS of 3.0 is recommended for use in shallow foundation design.

7.6.7 Seepage

The seepage or piping FoS_{piping} is the ratio of the critical hydraulic gradient divided by the upward or exit gradient, as shown in Equation 1. The critical hydraulic gradient (i_{crit}) is defined as the gradient required to induce piping or a quick condition (boils or heaving) of the protected side top stratum. The critical hydraulic gradient is the ratio of the buoyant unit weight of the soil and the unit weight of water, as shown by Equation 2. The exit gradient i_{ex} is the change in total head at the critical exit block divided by the length of the flow path across the critical exit block. The seepage FoS_{piping} was calculated at the critical exit block, which is typically the shortest equal potential head drop for the shortest flow path as viewed from a typical flow net diagram.

$$FoS_{piping} = \frac{i_{crit}}{i_{ex}} \qquad (1)$$

$$i_{crit} = \frac{\gamma_s -}{\gamma_w} \qquad (2)$$

Seepage below and through the cross sections was analyzed using the computer program SEEP/W. SEEP/W is a two-dimensional finite element model commonly used to model unconfined and confined seepage problems, including groundwater movement and pore water pressure distribution within porous materials such as soil and rock. A flow net was developed using the finite element model and the FoS_{piping} was calculated using the above equations. A minimum design FoS_{piping} of 1.6 for fat clays was considered for design.

7.6.8 Settlement

Settlement was calculated using the computer program CSETT which allows build events to be added at specific time during the design lift of the project. Consolidation properties were interpolated from consolidation test data provided by USACE-PRO as well as empirical correlations of index properties. In addition to consolidation settlement, 10 percent settlement of newly placed levee material was also considered in the analysis in accordance with EM 1110-2-1913, Design and Construction of Levees, April 2000.

The design elevation is assumed to follow a straight line projection during the design period with an initial elevation of 10.5 feet at time zero and an elevation of 14 feet at time 50 years. Lift thickness and time periods were selected to maintain a top of levee elevation above the projected design elevation over the 50 year life of the project.

7.6.9 Geotextiles

Minimum geotextile tensile strength requirements were calculated using the MOP output utilizing the specified FoS for reinforced levees. Run-out lengths were calculated from the tensile strength and adhesion values calculated from cohesion values of the levee material. The maximum geotextile tensile strength necessary to achieve the required FoS for the reinforced conditions with and without utility crossings was determined to calculate the FoS for the remaining models.

7.7 Structural Design Criteria and Information

The structural design criteria used for the design of the reinforced concrete T-wall beneath the Woodland Highway 407 Bridge is summarized in Table 3 below.

Table 3 Structural Design Criteria

Algiers Woodland Highway 407 Bridge Flood Wall Structural Design Guidelines					
No.	**Item**	**Value**		**Source**	
PHYSICAL PARAMETERS					
1	Datum Shift	NGVD29 - 0.5' = NAVD88		HSDRRS 3/16/07 pg. 6	
2	Proposed wall top EL	14.0 (2057)		SOW pg. 7	
3	Wall base grade EL	-2.0 (+/-)		Survey 04/08	(awaiting drawings)
4	Wall length	3100' – 22648'		Survey 04/08	
5	Structural Superiority	add 2' min.	**(NOT)**	HSDRRS 10/04/07 pg. 1-23	
4	Wall thickness	24" min.		HSDRRS 10/04/07 pg. 5-12	
5	Wall thickness	48" max.		HSDRRS 10/04/07 pg. 5-11	
6	Cover	4" min. (24" & >)		HSDRRS 10/04/07 pg. 5-12	
7	Temperature steel	0.0028*Ag (1/2 e.f.)		HSDRRS 10/04/07 pg. 5-12	
8	Expansion joints	40' to 60'		HSDRRS 10/04/07 pg. 5-3	
LOADS					
9	Still water level	11.0 (2057)		SOW pg. 18	
10	Wave run-up	3'		Calculated	
11	Wind speed	130 mph (3 sec.)		ASCE-7 pg. 34	
12	Wind pressure	50 psf min.		HSDRRS 10/04/07 pg. 5-14	
13	Boat impact load	100 kip		HSDRRS 10/04/07 pg. 5-26	
14	Boat impact length	5' + 45 deg. of depth		HSDRRS 10/04/07 pg. 5-23	
No.	**Item**	**Value**		**Source**	

MATERIAL PROPERTIES							
15	Concrete f'c		4000 psi		HSDRRS 10/04/07 pg. 5-11		
16	Rebar fy		60 ksi		HSDRRS 10/04/07 pg. 5-11		
17	Load factor		1.7 (DL & LL)		HSDRRS 10/04/07 pg. 5-11		
18	Hydraulic factor		1.3 (additional)		HSDRRS 10/04/07 pg. 5-11		
19	Water unit weight		64 pcf		HSDRRS 10/04/07 pg. 5-13		
20	Concrete unit weight		150 pcf		HSDRRS 10/04/07 pg. 5-13		
21	Sand unit weight		120 pcf		HSDRRS 10/04/07 pg. 5-13		
22	At rest pressure (Ko)		0.5 (sand)		HSDRRS 10/04/07 pg. 5-13		

Structural calculations provided in Appendix C illustrate the application of these design criteria, as well as the means and methods used in the concrete design. EM-1110-2-2705, “Structural Design of Closure Structures for Local Protection Projects” is also cited for reference.

A complete structural analysis will be performed on the selected alternative during the preparation of P&S. This analysis will conform to the guidelines included in the latest version of the “Hurricane and Storm Damage and Risk Reduction System Design Guidelines”. We do not expect this further design work to affect the selection of the preferred alternative.

7.8 Mechanical and Electrical Design Criteria and Information

Not applicable.

7.9 Relocations - Utilities Design Criteria and Information

A complete utilities and facilities relocation analysis will be performed on the selected alternative during the preparation of P&S. This analysis will conform to the guidelines included in the latest version of the “Hurricane and Storm Damage and Risk Reduction System Design Guidelines”. We do not expect this further design work to affect the selection of the preferred alternative.

7.10 Borrow Requirements

The borrow area location and typical pit details are shown on Sheet 42 in Appendix A. The borrow area is located to the southwest of the project near the intersection of Bayou Barriere and the W.P.A. Canal. It is located north of several existing pits and one future pit to be used by others. The borrow area is within a 25 mile haul distance and the contractor would be able to use the existing crossing over the W.P.A. Canal to bring in excavation equipment. Using an estimated allowable 20 feet deep pit with 4H:1V side slopes, the footprint of the borrow area could be large enough to provide the maximum borrow needed for the project based upon chosen alternatives for each reach. Refer to the cost estimate for quantities of the required fill material for the project.

7.11 Armoring

Armoring will be provided for critical areas of the Hurricane and Storm Damage Risk Reduction System (HSDRRS) features described in this report. The design criteria determining the overtopping rates and armoring methods are still under investigation. Therefore, a detailed description of the armoring for the features in this report is not available. This work will continue in parallel with other pre-award activities until complete.

The Armoring Team is tasked to provide research and planning for the use of armoring against erosion and scour on the protected side of selected critical portions of levees and floodwalls in the HSDRRS. These critical areas include: transition points (where levees and floodwalls transition into any hardened feature such as other levees, floodwalls, pump stations, etc.), utility pipeline crossings, floodwall protected side slopes, and earthen levees that are exposed to wave and surge overtopping during a 500-year hurricane storm event. The Armoring Team will be guiding the design PDT in this process by providing an Armoring Manual for design guidance and criteria. This manual will be the basis for decisions on what should be armored and how armoring should take place.

The Armoring Team defines resiliency as the capacity of the levee/floodwall to resist, without catastrophic failure, overtopping (wave and surge) caused by a storm which is greater than the design event. A Resilience Team has been formed to validate the Armoring Team's initial focus. USACE Engineering Division is leading the Resiliency effort to certify the practicality and applicability of using the 500 year storm event for armoring. The armoring methods to be implemented in the final design are anticipated to provide erosion protection such that the structure will be resilient to the 500-year event, or more defined as the ability of the structure to provide protection during events greater that the design event without catastrophic failure.

The following armoring methods are under consideration and the appropriate combination of methods will be applied throughout the earthen levee projects included in the HSDRRS:

- ACB – Articulated Concrete Blocks
- ACB/TRM – The physical conditions or hydraulic parameters are such that small modifications could allow a reduction to a TRM (Turf Reinforcement Mattress)
- TRM
- TRM/Grass – The physical conditions or hydraulic parameters are such that small modifications could allow a reduction to a surface with good grass cover only
- Good grass cover

The armoring required for floodwalls will be a hybrid of materials to accomplish the required level of armoring. For instance, the interim floodwall repairs curtailed the concrete splash pads midway down the levee slope. The Armoring Team suggests that these pads be extended down the entire slope of the levee and be curtained at the toe in order to eliminate a transition in a critical part of the levee section.

Transitions have been a significant part of the Armoring Team's effort to date. The transitions from structures to floodwalls to sheetpiles are being addressed with detailed design drawings and will be forwarded to the individual design PDTs to aid them in their site-specific designs.

Pipeline crossings are being identified by the Relocations Section in USACE. The Armoring Team is reviewing their detail drawings and requirements to include armoring features. These drawings will need ITR and should be forwarded to those utility owners that are ultimately responsible for the work.

8. Real Estate – Right-of-Way Requirements

New Orleans and Gulf Railroad Gate Structure and Floodwall at Highway 23

The proposed construction for this reach of the project requires no new permanent ROW to be acquired. However, areas will be required for staging and turnaround of equipment coming to and off of the existing levee. In order to prevent the need to stop railroad traffic for any extended period of time, access would be needed from both sides. Access from an existing roadway to the south and construction easement between Highway 23 and the railroad is shown on the Right of Way plan in Appendix A. Access from the east to a construction area east of the railroad tracks is also shown for this purpose. The total area required near the railroad gate is about 1.41 acres.

Highway 23 to Orleans Parish Landfill

The proposed construction for this reach will require additional permanent ROW to be acquired for all alternatives except for the T-wall. The proposed ROW was developed by offsetting the construction limits of the proposed alignments by 15-foot, as instructed by the provided USACE-PRO standard. That offset was then evaluated to eliminate the curves and reduce the number of minor increases in width produced. Ultimately, when an area needed to be increased in width to maintain the 15 foot distance, a 90-degree turn was inserted to bump it out for a short distance. That would carry for a reasonable distance until the next 90-degree turn could be logically placed. So, the resulting ROW is set a minimum of 15 feet from the construction limits. Some areas may exhibit a distance of up to about 30 feet of additional width. The golf course and several businesses (noted on the Sheets) would require ROW takes for the earthen levee alternatives. The total required ROW for the unreinforced earthen levee option would be about 29.61 acres. The total required ROW for the reinforced earthen levee option would be reduced to about 8.93 acres.

For all alternatives, the same construction easement proposed for access and turnaround in the railroad gate structure reach of the project would be utilized. The location is shown on the ROW plan sheets. The Belle Chasse Pump Station 2 property could also be used for access and staging.

Orleans Parish Landfill

The proposed Option 1 at the Orleans Parish Landfill reach requires no new permanent ROW to be acquired. However, access, staging, and turnaround for equipment would need to be accomplished by acquiring a construction easement encompassing the existing road along the west side of the landfill area. This area is shown on the ROW sheet in Appendix A and totals about 0.50 acres.

The alignment Option 2 around the landfill would go through private land its entire length. It essentially cuts off access to the land with the T-wall, and therefore would require a gate or complete purchase of the land. A gate anywhere along the proposed wall could be a safety hazard and liability with respect to the integrity of the protection system. Also, the land could be inundated for lengths of time when the existing levee is breached in high water situations. Therefore, purchasing the entire area between the proposed T-wall and existing levee would be necessary. The general ROW line established on the outside of the wall is based on a 15 foot minimum offset from the construction limit. However, on the east side along the tree line, the line was moved out to the Parish section line. While that does add an additional area to the ROW requirements, it provides access for tree removal and construction. The total permanent ROW required for this option would be about 42.27 acres of land. As with the Option 1 alternative, a construction easement would be required for access, staging, and turnaround during construction of the project reach (0.46 acres). Refer to the ROW sheets for visualization of the discussed requirements.

Orleans Parish Landfill to Woodland Highway Bridge

The proposed construction for this reach will require additional permanent ROW to be acquired for all alternatives except for the T-wall. The proposed ROW was developed by offsetting the construction limits of the proposed alignments by 15-feet, as instructed by the provided USACE-PRO standard. As this left a fairly rectangular ROW parcel, there was no need to make adjustments to the offset. The total permanent ROW required for the unreinforced and reinforced earthen levee alternatives would be 3.32 acres and 1.6 acres, respectively. For all alternatives, the permanent easements or construction easements necessary for the Orleans Parish Landfill reach and the Beneath Woodland Highway Bridge reach would allow for staging and turnaround of equipment.

Beneath Woodland Highway Bridge

The proposed construction for this reach of the project requires no new permanent ROW to be acquired. Staging area and turnaround for equipment can be achieved within the existing ROW by the bridge and the temporary construction access required for the Woodland Highway Bridge to Algiers Lock reach of the project. Refer to the ROW plans for access to the project reach from the New Orleans Sewerage and Water Board Pump Station or north of the Woodland Highway 407 Bridge.

Woodland Highway Bridge to Algiers Lock

The proposed construction for this reach will require additional permanent ROW to be acquired for all alternatives. The proposed ROW was developed by offsetting the construction limits of the proposed alignments by 15-foot, as instructed by the provided USACE-PRO standard. That offset was then evaluated to eliminate the curves and reduce the number of minor increases in width produced. Ultimately, when an area needed to be increased in width to maintain the 15-foot distance, a 90-degree turn was inserted to bump it out for a short distance. That would carry for a reasonable distance until the next 90-degree turn could be logically placed. So, the resulting ROW is set a minimum of 15 feet from the construction limits. Some areas may exhibit a distance of up to about 25 feet of additional width. Permanent ROW requirements for the unreinforced earthen levee and reinforced earthen levee alternatives would be 17.93 acres and 4.71 acres, respectively. The requirement for the T-wall would be much less at a total of 0.11 acres.

For all alternatives, construction access and staging would be handled by acquiring construction easement to the north side of the highway bridge. The total easement area is about 3.60 acres. Construction staging could also take place on the pump station property on the south side of the station.

Summary by Alternative

Table 4 summarizes the additional ROW area that needs to be acquired by Real Estate for the various alternatives.

Table 4 – Additional Right-of-Way Required by Alternative

No.	Alternative	Additional ROW Required (acres)		
		Protected Side	Flood Side	Total
1	Unreinforced Levee Enlargement	50.86	0	50.86
2	Reinforced Levee Enlargement	15.24	0	15.24
3	Reinforced T-wall	0.11	0	0.11
4	Swing Gate at New Orleans and Gulf Railroad	0	0	0
5	T-wall beneath Woodland Highway Bridge	0	0	0
6	Floodward Alignment T-wall at Orleans Parish Landfill	0	0	0
7	Landward Alignment T-wall at Orleans Landfill	3.68	0	3.68

9. Relocations

Relocations of utilities and facilities are summarized below as per each alternative investigated.

<u>All earthen levee enlargement, unreinforced</u>

A review of pre-Hurricane Katrina surveys provided by the USACE-PRO and field verification indicates that the following utilities will require relocation:

Table 5 – Utility Relocations - All earthen levee enlargement, unreinforced

Utility Description	Station	Orientation	Owner
Overhead Powerline (414 feet long)	583+30	Crossing	Entergy
Waterline (178 feet long)	583+67	Crossing	SWBNOLA
Overhead Powerline (414 feet long)	583+75	Crossing	Entergy
Waterline (185 feet long)	600+70	Crossing	SWBNOLA
Overhead Powerline (414 feet long)	630+65	Crossing	Entergy
Overhead Powerline (414 feet long)	631+32	Crossing	Entergy
Waterline (189 feet long)	673+55	Crossing	SWBNOLA
Sewerline (199 feet long)	754+25	Crossing	SWBNOLA

A review of pre-Hurricane Katrina surveys provided by the USACE-PRO and field verification indicates that the following facilities will require relocation:

Table 6 – Facility Relocations - All earthen levee enlargement, unreinforced

Facility Description	Station
Pond	581+25
Transmission Tower	583+22
Chainlink Fence (200 feet long, parallel)	585+98 to 587+98
Pond	627+20
Transmission Tower	631+51
Concrete Dock	656+64
Wood Dock	657+01
Metal Building	660+47
Chainlink Fence (405 feet long, parallel)	659+35 to 663+40

Facility Description	Station
Concrete Pads	666+15
Building	666+66
Transformer Building	666+99
Chainlink Fence (77 feet long, parallel)	667+98 to 668+75
Steel Grid	668+40
Chainlink Fence (417 feet long, parallel/crossing)	669+74 to 672+99
Chainlink Fence (198 feet long, parallel/crossing)	710+44 to 710+94
Radio Tower	710+69
Chainlink Fence (645 feet long, parallel/crossing)	713+10 to 715+33
Chainlink Fence (200 feet long, crossing)	750+99 to 751+28
Chainlink Fence (173 feet long, parallel/crossing)	768+16 to 768+90

<u>All earthen levee enlargement, reinforced with geotextile</u>

A review of pre-Hurricane Katrina surveys provided by the USACE-PRO and field verification indicates that the following utilities will require relocation:

Table 7 – Utility Relocations - All earthen levee enlargement, reinforced with geotextile

Utility Description	Station	Orientation	Owner
Overhead Powerline (138 feet long)	583+30	Crossing	Entergy
Waterline (136 feet long)	583+67	Crossing	SWBNOLA
Overhead Powerline (138 feet long)	583+75	Crossing	Entergy
Waterline (145 feet long)	600+70	Crossing	SWBNOLA
Overhead Powerline (147 feet long)	630+65	Crossing	Entergy
Overhead Powerline (147 feet long)	631+32	Crossing	Entergy
Waterline (114 feet long)	673+55	Crossing	SWBNOLA
Sewerline (77 feet long)	754+25	Crossing	SWBNOLA

A review of pre-Hurricane Katrina surveys provided by the USACE-PRO and field verification indicates that the following facilities will require relocation:

Table 8 – Facility Relocations - All earthen levee enlargement, reinforced with geotextile

Facility Description	Station
Pond	581+25
Transmission Tower	583+22
Pond	627+20
Transmission Tower	631+51
Metal Building	660+47
Concrete Pads	666+15
Building	666+66
Transformer Building	666+99
Chainlink Fence (354 feet long, parallel/crossing)	669+95 to 672+99
Chainlink Fence (198 feet long, parallel/crossing)	710+44 to 710+94
Radio Tower	710+69
Chainlink Fence (120 feet long, parallel/crossing)	713+10 to 713+72
Chainlink Fence (282 feet long, parallel/crossing)	713+72 to 715+33
Chainlink Fence (71 feet long, crossing)	751+28
Chainlink Fence (118 feet long, parallel/crossing)	768+16 to 768+90

<u>Reinforced concrete T-wall at the existing protected side levee toe</u>

A review of pre-Hurricane Katrina surveys provided by the USACE-PRO and field verification indicates that the following utilities will require relocation:

Table 9 – Utility Relocations - Reinforced concrete T-wall at the existing protected side levee toe

Utility Description	Station	Orientation	Owner
Overhead Powerline (31 feet long)	583+30	Crossing	Entergy
Overhead Powerline (31 feet long)	583+75	Crossing	Entergy
Waterline (29 feet long)	583+67	Crossing	SWBNOLA
Waterline (33 feet long)	600+70	Crossing	SWBNOLA
Overhead Powerline (31 feet long)	630+65	Crossing	Entergy
Overhead Powerline (31 feet long)	631+32	Crossing	Entergy

Utility Description	Station	Orientation	Owner
Waterline (25 feet long)	673+55	Crossing	SWBNOLA
Sewer line (31 feet long)	754+25	Crossing	SWBNOLA

A review of pre-Hurricane Katrina surveys provided by the USACE-PRO and field verification indicates that the following facilities will require relocation:

Table 10 – Facility Relocations - Reinforced concrete T-wall at the existing protected side levee toe

Facility Description	Station
Metal Building	660+47
Concrete Pads	666+15
Transformer Building	666+99
Chainlink Fence (191 feet long, parallel/crossing)	713+72 to 715+33
Chainlink Fence (44 feet long, parallel/crossing)	751+00 to 751+27
Chainlink Fence (48 feet long, parallel/crossing)	768+16 to 768+90

Swing gate at the New Orleans and Gulf Railroad tracks

A review of pre-Hurricane Katrina surveys provided by the USACE-PRO and field verification indicates that the following utilities will require relocation:

Table 11 – Utility Relocations - Swing Gate at the New Orleans and Gulf Railroad tracks

Utility Description	Station	Orientation	Owner
Power Pole	574+84	Point	Entergy
Power Pole	574+85	Point	Entergy

A review of pre-Hurricane Katrina surveys provided by the USACE-PRO and field verification indicates that there are no facilities that need to be relocated based on this alternative.

Structural alternative beneath the Woodland Highway Bridge

A review of pre-Hurricane Katrina surveys provided by the USACE-PRO and field verification indicates that there are no utilities and facilities that will require relocation.

Floodward alignment of T-wall at the Orleans Parish Landfill

There are no utility relocations associated with this alternative.

A review of pre-Hurricane Katrina surveys provided by the USACE-PRO and field verification indicates that the following facilities will require relocation:

Table 12 – Facility Relocations - Floodward alignment of T-wall at the Orleans Parish Landfill

Facility Description	Station
Concrete Slab	681+07
Concrete Slab	681+52

Landward alignment of T-wall adjacent to Woodland Highway at the Orleans Parish Landfill

A review of pre-Hurricane Katrina surveys provided by the USACE-PRO and field verification indicates that the following utilities will require relocation:

Table 13 – Utility Relocations - Landward alignment of T-wall adjacent to Woodland Highway at the Orleans Parish Landfill

Utility Description	Station	Orientation	Owner
Overhead Powerline (34 feet long)	2+61 to 2+95	Parallel	Entergy
Power Pole	2+95	Point	Entergy
Overheard Powerline (77 feet long)	2+95 to 3+71	Parallel	Entergy
Power Pole	3+71	Point	Entergy
Overhead Powerline (83 feet long)	4+49 to 5+32	Parallel	Entergy
Power Pole	5+32	Point	Entergy
Overhead Powerline (94 feet long)	5+32 to 6+26	Parallel	Entergy
Power Pole	6+26	Point	Entergy
Overhead Powerline (82 feet long)	6+26 to 7+08	Parallel	Entergy
Power Pole	7+08	Point	Entergy
Overhead Powerline (66 feet long)	7+08 to 7+74	Parallel	Entergy
Power Pole	7+74	Point	Entergy
Overhead Powerline (37 feet long)	7+74 to 8+09	Parallel	Entergy
Power Pole	8+09	Point	Entergy
Overhead Powerline (109 feet long)	8+09 to 9+37	Parallel	Entergy

Utility Description	Station	Orientation	Owner
Power Pole	9+37	Point	Entergy
Overhead Powerline (415 feet long)	9+37 to 13+52	Parallel	Entergy
Power Pole	13+52	Point	Entergy
Overhead Powerline (419 feet long)	13+52 to 17+63	Parallel	Entergy

A review of pre-Hurricane Katrina surveys provided by the USACE-PRO and field verification indicates that the following facilities will require relocation:

Table 14 – Facility Relocations - Landward alignment of T-wall adjacent to Woodland Highway at the Orleans Parish Landfill

Facility Description	Station
Utility Box	7+75
Transformer	8+00

10. Environmental Evaluation

10.1 Environmental Considerations

The Algiers Lock levee and floodwall system is owned, operated, and maintained by the USACE-PRO. The existing levee/floodwall system has a length of approximately 19,000 linear feet. In general, the floodside of the levee and floodwalls is immediately bordered by natural wetlands and open water. Alternately, the protected side is bordered by bottomland forests, a golf course, landfill, and open grass fields depending on the reach being analyzed.

Marsh, estuarine, and open water habitats are found on the floodside of the levee and floodwalls thus providing valuable spawning, nursery, feeding, and migration/mobility habitats for an array of fish and other aquatic species. Wetland types range from emergent and semi-emergent to scrub-shrub.

Bottomland forests provide critical habitat for many species of waterfowl. A diverse array of species including cypress, tupelo, tallow, and sugarberry (hackberry), and a variety of oaks are present within the bottomland forests along this project reach which furnish habitats for terrestrial species of songbirds and small mammals.

There are 5 species listed by the US Fish and Wildlife Service (USFWS) as threatened or endangered that could potentially inhabit or utilize the project area. Special status

species that could inhabit or utilize the project area are: pallid sturgeon (*Sciaphirhynchus albus*), gulf sturgeon (*Acipenser oxyrhinchus desotoi*), kemp's ridley sea turtle (*Lepidochelys kempii*), brown pelican (*Pelecanus occidentalis*), and loggerhead sea turtle (*Caretta caretta*).

Orleans Parish Landfill is located along the project reach and has been recognized as a potential hazard producing constituent. The landfill has been buried and capped. Flood protection measures proposed within the landfill area have been designed to completely avoid the landfill thus eliminating potential impacts that could occur if the cap were pierced or broken.

10.2 Potential Impacts

In order to minimize impacts to high value wetlands, alignments were either kept within the existing ROW, shifted (wherever possible) to the protected side of the existing alignment, or the use of alternative means of protection (i.e., T-walls). These assumptions were incorporated into the civil layout and analysis which avoided impacts to both wetland areas and the Orleans Parish landfill. An alternative alignment was analyzed for the landfill area which would induce 3.68 acres of protected side impacts. These impacts are not anticipated to affect the landfill but to bordering habitat.

10.3 Cultural Resources

A cultural resources survey of the areas within the construction footprint has not yet been awarded or begun. No impacts to cultural resources are anticipated within the project area.

11. Cost Engineering and Construction Scheduling

11.1 Quantities and Cost Estimate for each Alternative (Consistent Method)

A cost estimate contingency of 25 percent was applied to each of the seven alternatives as required by this task order. The design team discussed each alternative and developed enough material and acreage quantities to generate a level of certainty +/- 25%. The amount and quality of the available data (geotechnical, survey, and plans) that were used in the analyses was sufficient for this level of certainty with the following exceptions:

For all of the reaches, there was limited existing plan and survey information. Assumptions regarding the existing surface grade were based on East Levee Plan and Profile plates, dated July 1998, by the USACE-PRO. These plates were all pre-Katrina.

Limited subsurface information was available at the time of report to be used for this EAR. Thirty-nine borings and 31 CPTs were used to model the cross sections, develop shear lines, and determine other soil properties. As stated in earlier sections, soil properties and profiles can change over distances. Therefore, the results of the analysis and design sections were typical. In summary, it is the design team's opinion that a 25 percent cost estimating contingency is appropriate for this report.

11.2 Cost Estimate

The investigation of the alternatives was performed to a preliminary design level. All calculations were completed to determine the feasibility of the respective alternatives and were based on engineering judgment and available design criteria. The structural control components were sized and plates developed to determine a general layout and preliminary cost of construction.

Preliminary quantities and cost estimates for each alternative were developed for each alternative under investigation. In addition, separate costs were developed for Reaches 2, 4, and 6. These reaches include Alternatives 1, 2, and 3. Applicable line items for each alternative were developed and evaluated based on their relevance to the design, materials, necessary construction activities, ROW management, utility relocation and operation and maintenance costs. Unit costs for each item were developed from 2008 cost estimates generated for the Plaquemines Non-Federal Levee EAR. These unit costs were developed based on experience with other projects, review of previously generated unit costs by USACE-PRO, and/or furnished by USACE-PRO. These unit costs should be quite similar to the unit costs associated with the project. Unit cost for riprap placement (unreinforced levee) and some of the utilities were developed using R.S. Means©. Cost for installation of dolphins was obtained from a local contractor. Quantities for each item were developed and provided by project design engineers.

For the levee, it was assumed that the construction would occur over several construction sequences. Two types of levees were considered, unreinforced and reinforced. For the unreinforced levee (Alternative 1, Reaches 2, 4, and 6), it was assumed that new soil would be placed over the existing material. For geotechnical considerations, it was assumed that the levee would be constructed to exceed 2007 standards (10.5 feet North American Vertical Datum [NAVD]) on year 0. It was also assumed that the levee design standard would increase in a linear fashion to a 2057 standard of 14.0 feet. The geotechnical evaluation assumed that construction of the levee would occur on years 0, 3, 15, and 35. The cost estimates assumed construction in Years 0, 3, 15, and 35. Per the geotechnical preliminary design, construction in each of these years allowed for overbuild and settlement to obtain the design standards. For the unreinforced levee, the construction seasons were the

same. The reinforced levee assumed that the existing levee would be removed, including an additional 2 feet below grade to allow for placement of geotextile material. The estimates allowed for placement of two layers of geotextile per the geotechnical design. Costs for dewatering were included in the reinforced levee construction. The levee construction assumed overbuild to compensate for settlement. Soil estimates were evaluated using geotechnical design and ROW constraints.

The reinforced levee assumed that the existing levee would be scarified and a geotextile fabric would be placed at two feet below grade and another layer at grade. The original material would be re-used as part of the levee improvement. The cost estimates included 3 percent inflation for future year construction. Operation and maintenance costs were also calculated based on a percentage of capital construction costs. Common construction components were applied such as clearing and grubbing, silt fencing, and drains. No soil mixing was assumed. Real estate acquisition was assumed for the cost estimates. Acreages were developed as part of the ROW evaluation. It was assumed that the cost per acre is $65,000. The cost for dolphins is approximately $110,000 based on a contractor estimate (Boh Brothers). The summary of costs is shown in Table 15.

11.3 Construction Durations

For the levee construction, it was assumed that approximately 5,000 cubic yards (CY) of soil could be placed and compacted per day. It was assumed that the soil would be hauled from a local source (within 20 miles) and approximately 500 trucks per day would deliver approximately 18 CY of soil each. The soil would be placed in 1 foot or ½-foot lifts and in-place compaction would account for approximately 11 CY per truck load (66% reduction in volume). For the reinforced levee, limited dewatering will likely be necessary, but with no real impact to the production schedule. The levee would be constructed in increments to provide for flood protection during construction. For the T-walls, it was assumed that pile installation would be the critical time constraint. Two pile driving rigs could operate simultaneously and install piles approximately 120-feet per hour each for the construction production rate of 240 feet/hour. The project schedule assumes time allowed for scoping, geotechnical investigation, 35%, 65%, 95%, and 100% design. It also accounts for permitting, real estate acquisition, procuring a contractor, and construction. Based on costs, the recommended alternative is the reinforced levee for Reaches 2, 4, and 6 and constructing a T-wall on floodward alignment of the landfill. The project schedule to construct the reinforced levee (Alternative 2) and the floodside T-wall along the landfill (Alternative 6) is shown in Appendix D. The construction schedule was adjusted for a six-day work week.

Summary of Preliminary Costs - 25% Contingency

Life Cycle (Net Present Cost) to 2057; 3 percent inflation

Alternative 1 - All earthen levee enlargement, unreinforced
-Reach 2 Hwy 23 to the Landfill

	Total (2008 dollars)	25% Contingency	Total W/ Contingency	Net Present Value (3% Inflation)
Overbuild in Year 0 to achieve 2007 Design Standard	$24,132,662	$6,033,166	$30,165,828	**$30,165,828**
Overbuild in Year 3 (2008 Dollars)	$3,345,505	$836,376	$4,181,881	**$3,826,421**
Overbuild in Year 15 (2008 Dollars)	$4,201,285	$1,050,321	$5,251,606	**$3,371,531**
Overbuild in Year 35 (2008 Dollars)	$3,184,175	$796,044	$3,980,219	**$1,412,978**
Annual Operations &Maintenance - 50 years	$482,653	$120,663	$603,317	**$15,523,335**
Life Cycle Cost - Net Present Value over 50 years				**$54,300,093**

Alternative 1 - All earthen levee enlargement, unreinforced
-Reach 4 Landfill to the Woodland Bridge

	Total (2008 dollars)	25% Contingency	Total W/ Contingency	Net Present Value (3% Inflation)
Overbuild in Year 0 to achieve 2007 Design Standard	$2,461,637	$615,409	$3,077,046	**$3,077,046**
Overbuild in Year 3 (2008 Dollars)	$609,823	$152,456	$762,278	**$697,484**
Overbuild in Year 15 (2008 Dollars)	$685,405	$171,351	$856,756	**$550,037**
Overbuild in Year 35 (2008 Dollars)	$595,577	$148,894	$744,471	**$264,287**
Annual Operations &Maintenance - 50 years	$49,233	$12,308	$61,541	**$1,583,448**
Life Cycle Cost - Net Present Value over 50 years				**$6,172,302**

Alternative 1 - All earthen levee enlargement, unreinforced
-Reach 6 Woodland Bridge to Algiers Lock

	Total (2008 dollars)	25% Contingency	Total W/ Contingency	Net Present Value (3% Inflation)
Overbuild in Year 0 to achieve 2007 Design Standard	$10,834,896	$2,708,724	$13,543,620	**$13,543,620**
Overbuild in Year 3 (2008 Dollars)	$1,614,823	$403,706	$2,018,529	**$1,846,954**
Overbuild in Year 15 (2008 Dollars)	$1,977,025	$494,256	$2,471,281	**$1,586,563**
Overbuild in Year 35 (2008 Dollars)	$1,546,551	$386,638	$1,933,189	**$686,282**
Annual Operations &Maintenance - 50 years	$212,449	$53,112	$265,561	**$6,832,889**
Life Cycle Cost - Net Present Value over 50 years				**$24,496,307**

Alternative 2 - All earthen levee enlargement, reinforced with geotextile
-Reach 2 Hwy 23 to the Landfill

	Total (2008 dollars)	25% Contingency	Total W/ Contingency	Net Present Value (3% Inflation)
Overbuild in Year 0 to achieve 2007 Design Standard	$15,172,182	$3,793,046	$18,965,228	**$18,965,228**
Overbuild in Year 3 (2008 Dollars)	$4,686,601	$1,171,650	$5,858,251	**$5,360,300**
Overbuild in Year 15 (2008 Dollars)	$3,723,721	$930,930	$4,654,651	**$2,988,286**
Overbuild in Year 35 (2008 Dollars)	$4,221,923	$1,055,481	$5,277,404	**$1,873,478**
Annual Operations &Maintenance - 50 years	$303,444	$75,861	$379,305	**$9,759,506**
Life Cycle Cost - Net Present Value over 50 years				**$38,946,798**

Alternative 2 - All earthen levee enlargement, reinforced with geotextile
-Reach 4 Landfill to the Woodland Bridge

	Total (2008 dollars)	25% Contingency	Total W/ Contingency	Net Present Value (3% Inflation)
Overbuild in Year 0 to achieve 2007 Design Standard	$2,238,061	$559,515	$2,797,576	**$2,797,576**
Overbuild in Year 3 (2008 Dollars)	$728,245	$182,061	$910,306	**$832,930**
Overbuild in Year 15 (2008 Dollars)	$643,245	$160,811	$804,056	**$516,204**
Overbuild in Year 35 (2008 Dollars)	$687,207	$171,802	$859,008	**$304,948**
Annual Operations &Maintenance - 50 years	$44,761	$11,190	$55,952	**$1,439,632**
Life Cycle Cost - Net Present Value over 50 years				**$5,891,289**

Alternative 2 - All earthen levee enlargement, reinforced with geotextile
-Reach 6 Woodland Bridge to Algiers Lock

	Total (2008 dollars)	25% Contingency	Total W/ Contingency	Net Present Value (3% Inflation)
Overbuild in Year 0 to achieve 2007 Design Standard	$6,764,812	$1,691,203	$8,456,015	**$8,456,015**
Overbuild in Year 3 (2008 Dollars)	$2,182,419	$545,605	$2,728,024	**$2,496,142**
Overbuild in Year 15 (2008 Dollars)	$1,774,895	$443,724	$2,218,619	**$1,424,353**
Overbuild in Year 35 (2008 Dollars)	$1,985,763	$496,441	$2,482,204	**$881,182**
Annual Operations &Maintenance - 50 years	$135,296	$33,824	$169,120	**$4,351,465**
Life Cycle Cost - Net Present Value over 50 years				**$17,609,158**

Alternative 3 - Reinforced concrete T-wall at the existing land side levee toe
-Reach 2 Hwy 23 to the Landfill

	Total (2008 dollars)	25% Contingency	Total W/ Contingency	Net Present Value (3% Inflation)
Year 0 Capital Cost	$94,494,273	$23,623,568	$118,117,841	**$118,117,841**
Annual Operations &Maintenance - 50 years	$472,471	$118,118	$590,589	**$15,195,860**
Life Cycle Cost - Net Present Value over 50 years				**$133,313,702**

Alternative 3 - Reinforced concrete T-wall at the existing land side levee toe
-Reach 4 Landfill to the Woodland Bridge

	Total (2008 dollars)	25% Contingency	Total W/ Contingency	Net Present Value (3% Inflation)
Year 0 Capital Cost	$8,599,302	$2,149,825	$10,749,127	**$10,749,127**
Annual Operations &Maintenance - 50 years	$42,997	$10,749	$53,746	**$1,382,875**
Life Cycle Cost - Net Present Value over 50 years				**$12,132,002**

Alternative 3 - Reinforced concrete T-wall at the existing land side levee toe
-Reach 6 Woodland Bridge to Algiers Lock

	Total (2008 dollars)	25% Contingency	Total W/ Contingency	Net Present Value (3% Inflation)
Year 0 Capital Cost	$40,114,778	$10,028,695	$50,143,473	**$50,143,473**
Annual Operations &Maintenance - 50 years	$200,574	$50,143	$250,717	**$6,450,958**
Life Cycle Cost - Net Present Value over 50 years				**$56,594,430**

Alternative 4 - 18' wide railroad swing gate across the N.O. and Gulf Railroad tracks
-Reach 1

	Total (2008 dollars)	25% Contingency	Total W/ Contingency	Net Present Value (3% Inflation)
Year 0 Capital Cost	$4,920,000	$1,230,000	$6,150,000	**$6,150,000**
Annual Operations &Maintenance - 50 years	$24,600	$6,150	$30,750	**$791,198**
Life Cycle Cost - Net Present Value over 50 years				**$6,941,198**

Alternative 5 - Structural alternative underneath the Woodland Hwy Bridge
-Reach 5

	Total (2008 dollars)	25% Contingency	Total W/ Contingency	Net Present Value (3% Inflation)
Year 0 Capital Cost	$2,153,990	$538,497	$2,692,487	**$2,692,487**
Annual Operations &Maintenance - 50 years	$10,770	$2,692	$13,462	**$346,388**
Life Cycle Cost - Net Present Value over 50 years				**$3,038,875**

Alternative 6 - Floodward alignment of a T-Wall at the site of the abandoned landfill in Orleans Parish
-Reach 3

	Total (2008 dollars)	25% Contingency	Total W/ Contingency	Net Present Value (3% Inflation)
Year 0 Capital Cost	$35,641,348	$8,910,337	$44,551,685	**$44,551,685**
Annual Operations &Maintenance - 50 years	$257,188	$64,297	$321,486	**$8,271,824**
Life Cycle Cost - Net Present Value over 50 years				**$52,823,509**

Alternative 7 - A landward alignment of a T-wall at the site of the abandoned landfill in Orleans Parish
-Reach 3

	Total (2008 dollars)	25% Contingency	Total W/ Contingency	Net Present Value (3% Inflation)
Year 0 Capital Cost	$36,787,599	$9,196,900	$45,984,499	**$45,984,499**
Annual Operations &Maintenance - 50 years	$367,876	$91,969	$459,845	**$11,831,812**
Life Cycle Cost - Net Present Value over 50 years				**$57,816,311**

12. Quality Implementation

Quality management activities for engineering design tasks will be performed under the guidance of "Design Quality Control Plan" (DQCP) except where superseded by USACE-PRO requirements. These activities will assist Bioengineering ARCADIS, LLC in providing quality deliverables aligned with the Government's needs and task order requirements which will, in turn, help ensure effective execution of the construction phases. Engineering design quality control activities will focus on assignment of appropriately qualified and experienced personnel, adequate project planning and monitoring, review and checking of work, and use of appropriate design tools. Procedures for controlling investigation or study activities will also be implemented to ensure efficiency, cost effectiveness, coordination with design objectives, and reliability of data collected, preservation of worker safety, and proper recording and reporting formats.

12.1 Quality Control Plan

The DQCP for this project was submitted to the USACE-PRO on April 23, 2008. The document detailed the measures to be undertaken to provide effective quality control throughout the performance of the work. Specifically, the DQCP discussed the services necessary to complete all tasks described in the Scope of Work and to ensure that the work performed would meet the agreed-upon requirements of the USACE-PRO. It presented the measures being taken by the Joint Venture AE to provide effective quality control throughout the performance of the work. Among the key elements of the plan were the identification of the Project Delivery and Independent Technical Review team members, the discipline and professional engineer registration numbers for team members, listing of tasks and a milestone schedule, and general quality management procedures.

12.2 Independent Technical Review (ITR)

Independent Technical Review is a continual process with a formal review to be completed with the 95 percent submittal and coordinated with the Project Delivery Team (PDT). The ITR team consists of three experienced engineers: one civil, one structural, and one geotechnical, who were not involved in the performance of the work and who are not involved in the development of the contract services. The DrChecks review tool will be used by both the ITR team and PDT in the formal review. All comments will give a clear statement of the concern, the basis of the concern, and, when appropriate, the actions necessary to resolve the concern. The PDT will evaluate and respond to all comments. Responses will state clearly the concurrence or non-

concurrence with the comment. Concurrences will include what the corrective action was and where and when it was taken. Non-concurrences will include an explanation or proposed alternative. All comments will be evaluated and closed (agreed upon) by the ITR team before the Statement of Technical Review is compiled.

13. Schedule

13.1 Proposed Schedule

The proposed schedule summarizes the time required for design and construction of the preferred alternative for each of the reaches. As mentioned above, the preferred alternative is construction of a reinforced levee along reaches 2, 4, and 6 and constructing a T-wall along the floodward alignment of the landfill. The schedule is based on a notice to proceed date of January 1, 2009 (design only). A January 2009 notice to proceed (NTP) is assumed because it allows for geotechnical testing and negotiations.

Approximately 2 months are scheduled for geotechnical testing. Final design (including geotechnical testing) will require approximately 10 months and will be submitted in September 2009. Construction of the levee and T-wall along the existing alignment will commence in January 2010, and is slated for final acceptance in November 2010. The schedule depicts a 30-day lag time between the commencement of the pile driving crew and actual T-wall installation.

This report assumes real estate acquisition and any demolition before the piles are driven for the T-wall structure. All work should be completed prior to the 2011 hurricane season.

14. Recommendations

[USACE-PRO]

15. Operation and Maintenance Requirements and Costs

Annual operation and maintenance (O & M) costs were estimated using a percentage of the capital construction cost. It was assumed that O & M for the levee would be approximately 2percent of the capital cost. This would supply monies for repair, mowing, etc. For the walls, it was assumed that O & M would cost approximately ½ percent of the capital cost to maintain the structures. The costs were annualized for 50 years at an inflation rate of 3percent. Net present or life cycle costs were then calculated. The summary of costs is shown in Appendix E.

Appendix A

Civil / Structural Plates

Appendix B

Geotechnical Report Appendix

(Not Required for 95% Submittal)

Appendix C

Engineering Appendix

Appendix D

Construction Duration Appendix

Appendix E

Quantity and Cost Estimate Appendix

Appendix F

Photographs

Appendix G

Survey Report