Appendix B

U.S. FISH AND WILDLIFE SERVICE COORDINATION LETTERS AND REPORT

Coordination Letters

United States Department of the Interior

FISH AND WILDLIFE SERVICE
646 Cajundome Blvd.
Suite 400
Lafayette, Louisiana 70506

DEPT. OF NATURAL RESOURCES

OCT 2 ? 2008

OFFICE OF THE SECRETARY

October 15, 2008

Mr. Scott Angelle, Secretary
Louisiana Department of Natural Resources
Office of Coastal Protection and Restoration
Post Office Box 44487
Baton Rouge, Louisiana 70804

Dear Mr. Angelle:

The U.S. Fish and Wildlife Service (Service) has reviewed the State of Louisiana, Office of Coastal Protection and Restoration's (OCPR) Draft Interim Feasibility Study (Interim Report) for the "Amite River Diversion Canal Modification, Louisiana Coastal Area, Project and Program Support." The Amite River Diversion Canal Modification project was identified in the 2004, Louisiana Coastal Area Ecosystem Restoration Study (LCA Plan) as a near-term critical restoration project, and the purpose of the interim report is to identify changes in the study area, confirm project justification, and describe a path forward to complete a subsequent feasibility study by December 2010. The Interim Report has been prepared under the provisions of the Water Resources Development Act of 2007 and satisfies the requirements of the Secretary of the Army to submit a decision document for that project to Congress by December 31, 2008. The Service submits the following technical assistance in accordance with the Endangered Species Act (ESA) of 1973 (87 Stat. 884, as amended; 16 U.S.C. 1531 et seq.), the Bald and Golden Eagle Protection Act (BGEPA) (54 Stat. 250, as amended, 16 U.S.C. 668a-d), the Migratory Bird Treaty Act (MBTA) (40 Stat. 755, as amended; 16 U.S.C. 703 et seq.), and the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661 et seq.).

The interim report is well written, provides a good description of the existing conditions and the need for the project, and identifies potential problems and opportunities to be addressed in the subsequent feasibility report. Material excavated during the construction of the Amite River Diversion Canal, a 10.6-mile-long federal flood control canal, was deposited along the canal sides further disrupting the natural hydrologic regime of the swamp complex. Working with two other near-term critical features of the LCA Plan (i.e., the Hope Canal and the Convent/Blind River diversion projects), this project will help restore Mississippi River water, sediment, and nutrients flows into the swamp habitat. Efforts to gap the spoil bank and restore some hydrology in the study area have been implemented as compensatory mitigation for a proposed waterfront development expansion project (reference Corps Permit # MVN 2006-1355 CZ). That project constructed two gaps along the southern spoil bank. The Amite River Diversion Canal Modification project is evaluating the construction of upwards of ten gaps which

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would be strategically placed based on hydrologic modeling and geotechnical investigations to ensure the greatest ecological benefits. The Service recommends that avoidance and minimization of impacts to forested habitat be considered when determining alternative locations for gaps.

Federally listed as an endangered species, West Indian manatees (*Trichechus manatus*) occasionally enter Lakes Pontchartrain and Maurepas, and associated coastal waters and streams during the summer months (i.e., June through September). Manatee occurrences appear to be increasing, and they have been regularly reported in the Amite, Blind, Tchefuncte, and Tickfaw Rivers, and in canals within the adjacent coastal marshes of Louisiana. They have also been occasionally observed elsewhere along the Louisiana Gulf coast. The manatee has declined in numbers due to collisions with boats and barges, entrapment in flood control structures, poaching, habitat loss, and pollution. Cold weather and outbreaks of red tide may also adversely affect these animals. Should the proposed project involve activity in the aquatic environment in those areas during summer months, further consultation with this office will be necessary.

The Gulf sturgeon (Acipenser oxyrhynchus desotoi), federally listed as a threatened species, is an anadromous fish that occurs in many rivers, streams, and estuarine waters along the northern Gulf coast between the Mississippi River and the Suwannee River, Florida. In Louisiana, Gulf sturgeon have been reported at Rigolets Pass, rivers and lakes of the Lake Pontchartrain basin, and adjacent estuarine areas. Spawning occurs in coastal rivers between late winter and early spring (i.e., March to May). Adults and sub-adults may be found in those rivers and streams until November, and in estuarine or marine waters during the remainder of the year. Sturgeon less than two years old appear to remain in riverine habitats and estuarine areas throughout the year, rather than migrate to marine waters. Habitat alterations such as those caused by water control structures that limit and prevent spawning, poor water quality, and over-fishing have negatively affected this species.

On March 19, 2003, the Service and the National Marine Fisheries Service (NMFS) published a final rule in the Federal Register (Volume 68, No. 53) designating critical habitat for the Gulf sturgeon in Louisiana, Mississippi, Alabama, and Florida. Portions of the Pearl and Bogue Chitto Rivers, Lake Pontchartrain east of the Lake Pontchartrain Causeway, all of Little Lake, The Rigolets, Lake St. Catherine, and Lake Borgne within Louisiana were included in that designation. While sturgeon have been documented in project area waterways, these waterways are not designated critical habitat.

The project-area forested wetlands may provide nesting habitat for the bald eagle (*Haliaeetus leucocephalus*), which was officially removed from the List of Endangered and Threatened Species on August 8, 2007. Bald eagles nest in Louisiana from October through mid-May. Eagles typically nest in mature trees (e.g., bald cypress, sycamore, willow, etc.) near fresh to intermediate marshes or open water in the southeastern Parishes. Areas with high numbers of nests include the Lake Verret Basin south to Houma, the marsh/ridge complex south of Houma to Bayou Vista, the north shore of Lake Pontchartrain, and the Lake Salvador area. Eagles also winter, and infrequently nest, in mature pine trees near large lakes in central and northern Louisiana. Major threats to this species include habitat alteration, human disturbance, and environmental contaminants (i.e., organochlorine pesticides and lead).

Breeding bald eagles occupy "territories" that they will typically defend against intrusion by other eagles, and that they likely return to each year. A territory may include one or more alternate nests that are built and maintained by the eagles, but which may not be used for nesting in a given year. Potential nest trees within a nesting territory may, therefore, provide important alternative bald eagle nest sites. In forested areas, bald eagles often select the tallest trees with limbs strong enough to support a nest that may weigh more than 1,000 pounds. Nest sites typically include at least one perch with a clear view of the water or area where the eagles usually forage. Shoreline trees or snags located near large waterbodies provide the visibility and accessibility needed to locate aquatic prey. Bald eagles are vulnerable to disturbance during courtship, nest building, egg laying, incubation, and brooding. Disturbance during this critical period may lead to nest abandonment, cracked and chilled eggs, and exposure of small young to the elements. Human activity near a nest late in the nesting cycle may also cause flightless birds to jump from the nest tree, thus reducing their chance of survival.

Although the bald eagle has been removed from the List of Endangered and Threatened Species, it continues to be protected under the MBTA and the BGEPA. The Service developed the National Bald Eagle Management (NBEM) Guidelines to provide landowners, land managers, and others with information and recommendations to minimize potential project impacts to bald eagles, particularly where such impacts may constitute "disturbance," which is prohibited by the BGEPA. A copy of the NBEM Guidelines is available at: <http://www.fws.gov/southeast/es/baldeagle/NationalBaldEagleManagementGuidelines.pdf>. Those guidelines recommend: (1) maintaining a specified distance between the activity and the nest (buffer area); (2) maintaining natural areas (preferably forested) between the activity and nest trees (landscape buffers); and (3) avoiding certain activities during the breeding season. On-site personnel should be informed of the possible presence of nesting bald eagles within the project boundary, and should identify, avoid, and immediately report any such nests to this office. If a bald eagle nest is discovered within or adjacent to the proposed project area, then an evaluation must be performed to determine whether the project is likely to disturb nesting bald eagles. That evaluation may be conducted on-line at: http://www.fws.gov/southeast/es/baldeagle. Following completion of the evaluation, that website will provide a determination of whether additional consultation is necessary. The Division of Migratory Birds for the Southeast Region of the Service (phone: 404/679-7051, e-mail: SEmigratorybirds@fws.gov) has the lead role in conducting such consultations. Should you need further assistance interpreting the guidelines or performing an on-line project evaluation, please contact this office.

The proposed study area is known to support colonial nesting waterbirds. Colonies may be present that are not currently listed in the database maintained by the Louisiana Department of Wildlife and Fisheries (LDWF). That database is updated primarily by monitoring the colony sites that were previously surveyed during the 1980s. Until a new, comprehensive coast-wide survey is conducted to determine the location of newly-established nesting colonies, we recommend that a qualified biologist inspect the proposed work site for the presence of undocumented nesting colonies during the nesting season. To minimize disturbance to colonies containing nesting wading birds (i.e., herons, egrets, night-herons, ibis, and roseate spoonbills), anhingas, and/or cormorants, all activity occurring within 1,000 feet of a rookery should be restricted to the non-nesting period (i.e., September 1 through February 15, exact dates may vary

within this window depending on species present). In addition, we recommend that on-site contract personnel be informed of the need to identify colonial nesting birds and their nests, and should avoid affecting them during the breeding season.

As you are aware, the Maurepas Swamp Wildlife Management Area (WMA) is located adjacent to the southwestern boundary of the study area along the Petite Amite River. Please contact the LDWF, Region 7 Office (225/765-2360), for further information regarding any additional permits that may be required to perform work on that WMA.

We look forward to assisting the OCPR and the U.S. Army Corps of Engineers in the documentation of existing conditions, development of alternatives, and assessment of effects of project alternatives on Federal trust resources during the subsequent feasibility study. Should you have any questions regarding our comments, please contact Angela Trahan (337/291-3137) of this office.

Sincerely,

James F. Boggs
Supervisor
Louisiana Field Office

cc: Corps of Engineers, New Orleans, LA (Attn: Susan Hennington)
NMFS, Baton Rouge, LA
EPA, Baton Rouge, LA
LDWF, Baton Rouge, LA
LDWF, Region 7 Office, Baton Rouge, LA
LDNR, CMD, Baton Rouge, LA

United States Department of the Interior

FISH AND WILDLIFE SERVICE
646 Cajundome Blvd.
Suite 400
Lafayette, Louisiana 70506

January 20, 2009

Colonel Alvin B. Lee
District Engineer
U.S. Army Corps of Engineers
Post Office Box 60267
New Orleans, Louisiana 70160-0267

Dear Colonel Lee:

The U.S. Fish and Wildlife Service (Service) has reviewed the Department of the Army, Corps of Engineers (Corps), Notice of Intent (NOI) to prepare a Draft Supplemental Environmental Impact Statement (SEIS) for the Louisiana Coastal Area (LCA) – Louisiana, Amite River Diversion Canal Modification Feasibility Study. The NOI was published in the Federal Register (Volume 73, No. 246, pg. 78340) on December 22, 2008 (Department of Interior No. ER 09/25). The LCA Program was authorized by the Water Resources Development Act of 2007, and this SEIS will be tiered off the programmatic EIS (LCA – Louisiana, Ecosystem Restoration study, November 2004) for that program. The Service submits the following comments in accordance with the National Environmental Policy Act of 1969 (83 Stat. 852, as amended; 42 U.S.C. 4321 et seq.), the Migratory Bird Treaty Act (MBTA, 40 Stat. 755, as amended; 16 U.S.C. 703 et seq.), the Bald and Golden Eagle Protection Act (BGEPA) (54 Stat. 250, as amended, 16 U.S.C. 668a-d), the Endangered Species Act (ESA) of 1973 (87 Stat. 884, as amended; 16 U.S.C. 1531 et seq.), and the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661 et seq.). These comments were also provided to the State of Louisiana in an October 15, 2008, letter.

Material excavated during the construction of the Amite River Diversion Canal, a 10.6-mile-long federal flood control canal, was deposited along the canal sides further disrupting the natural hydrologic regime of the swamp complex. Working with two other near-term critical features of the LCA Program (i.e., the Hope Canal and the Convent/Blind River diversion projects), this project will help restore Mississippi River water, sediment, and nutrients flows into the swamp habitat. Efforts to gap the spoil bank and restore some hydrology in the study area have been implemented as compensatory mitigation for a proposed waterfront development expansion project (reference Corps Permit # MVN 2006-1355 CZ). That project constructed two gaps along the southern spoil bank. The Amite River Diversion Canal Modification project is evaluating the construction of upwards of ten gaps which would be strategically placed based on hydrologic modeling and geotechnical investigations to ensure the greatest ecological benefits. The Service recommends that avoidance and minimization of impacts to forested habitat be considered when determining alternative locations for gaps.

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Breeding bald eagles occupy "territories" that they will typically defend against intrusion by other eagles, and that they likely return to each year. A territory may include one or more alternate nests that are built and maintained by the eagles, but which may not be used for nesting in a given year. Potential nest trees within a nesting territory may, therefore, provide important

alternative bald eagle nest sites. In forested areas, bald eagles often select the tallest trees with limbs strong enough to support a nest that may weigh more than 1,000 pounds. Nest sites typically include at least one perch with a clear view of the water or area where the eagles usually forage. Shoreline trees or snags located near large waterbodies provide the visibility and accessibility needed to locate aquatic prey. Bald eagles are vulnerable to disturbance during courtship, nest building, egg laying, incubation, and brooding. Disturbance during this critical period may lead to nest abandonment, cracked and chilled eggs, and exposure of small young to the elements. Human activity near a nest late in the nesting cycle may also cause flightless birds to jump from the nest tree, thus reducing their chance of survival.

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As you are aware, the Maurepas Swamp Wildlife Management Area (WMA) is located adjacent to the southwestern boundary of the study area along the Petite Amite River. Please contact the LDWF, Region 7 Office (225/765-2360), for further information regarding any additional permits that may be required to perform work on that WMA.

The President's Council on Environmental Quality defined the term "mitigation" in the National Environmental Policy Act regulations to include: (a) avoiding the impact altogether by not taking a certain action or parts of an action; (b) minimizing impacts by limiting the degree or magnitude of the action and its implementation; (c) rectifying the impact by repairing, rehabilitating, or restoring the affected environment; (d) reducing or eliminating the impact over time by preservation and maintenance operations during the life of the action; and (e) compensating for the impact by replacing or providing substitute resources or environments.

The Service's Mitigation Policy (Federal Register Volume 46, No. 15, January 23, 1981) supports and adopts this definition of mitigation and considers its specific elements to represent the desirable sequence of steps in the mitigation planning process. That policy identifies four resource categories that are used to insure that the level of mitigation recommended by Service biologists will be consistent with the fish and wildlife resource values involved. Considering the high value for fish and wildlife and the relative scarcity of the forested wetlands, those wetlands have been designated Resource Category 2 habitats. The mitigation goal for habitats in this resource category is no net loss of in-kind habitat value. Detailed mitigation needs will be evaluated during the feasibility stage.

We look forward to assisting the Corps in the documentation of existing conditions, development of alternatives, and assessment of effects of project alternatives on Federal trust resources during the subsequent feasibility study. Should you have any questions regarding our comments, please contact Angela Trahan (337/291-3137) of this office.

Sincerely,

for James F. Boggs
Supervisor
Louisiana Field Office

cc: DOI, OEPC, Washington, D.C. (Attn.: Loretta Sutton)
DOI, OEPC, Albuquerque, NM (Attn.: Steven Spencer)
FWS, BAP & HC (ERT), Arlington, VA (Attn.: Stephanie Nash)
FWS, Atlanta, GA (Attn.: Richard Warner)
EPA, Dallas, TX
NMFS, Baton Rouge, LA
Corps, New Orleans, LA (Attn.: Mr. Bill Klein, CEMVN-PM-RS)
LDWF, Region 7 Office, Baton Rouge, LA
LDWF, Baton Rouge, LA (Attn.: Kyle Balkum)
LDWF, Natural Heritage Program, Baton Rouge, LA
OCPR, Baton Rouge, LA

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United States Department of the Interior

OFFICE OF THE SECRETARY
Office of Environmental Policy and Compliance
1001 Indian School Road NW, Suite 348
Albuquerque, New Mexico 87104

ER 10/479
File 9043.1

June 29, 2010

Joan Exnicios
Chief, Environmental Planning & Compliance Branch
New Orleans District
U.S. Army Corps of Engineers
PO Box 60267
New Orleans, Louisiana 70160-0267

Subject: Draft Supplemental Environmental Impact Statement (DSEIS) for Amite River Diversion Canal (ARDC) Modification Element of the Section 7006(E)(3) Ecosystem Restoration Project, Feasibility Study, Louisiana Coastal Area (LCA), Ascension and Livingston Parishes, LA

Dear Ms. Exnicios:

The U.S. Department of the Interior has reviewed the subject document and offers the following comments in accordance with provisions of the National Environmental Policy Act (NEPA) of 1969 (83 Stat. 852; 42 U.S.C. 4321 et seq.), the Fish and Wildlife Coordination Act (FWCA, 48 Stat. 401, as amended; 16 U.S.C. 661 et seq.), and the Endangered Species Act of 1973 (87 Stat. 884, as amended, 16 U.S.C. 1531 et seq.).

General Comments on the DSEIS

The DSEIS provides a good description of fish and wildlife resources within the study area, the purpose and need for the proposed action, program objectives, critical needs and opportunities, and potential risks and uncertainties. Given the substantial adverse impacts to the project area wetlands and their associated fish and wildlife resources that are expected to occur under future-without-project conditions, the U.S. Fish and Wildlife Service strongly supports authorization and implementation of the ARDC project, as it would improve environmental conditions through the creation and/or restoration of swamp habitats. Specifically, the LCA-ARDC project is designed to establish hydrologic connectivity between the ARDC and the western Maurepas Swamp. That connectivity would allow the swamp to drain during seasonal low-flow conditions in the Amite River, and thereby, promote the germination and survival of bald cypress (and other tree species) seedlings. In addition, nutrients and sediments would be introduced from the ARDC into the swamp during flood events and from runoff during localized rainfall events.

Nutrients and sediment delivered to the swamp would improve biological productivity and reduce the chances of further habitat degradation and swamp loss via conversion to open water.

The FWS's Lafayette Field Office supports implementation of the proposed project and provided the following fish and wildlife recommendations in our April 2010 Draft FWCA Report:

1. If authorized funding limits for this project are increased the FWS recommends that Alterative 39 be reconsidered as the potential future Tentatively Selected Plan (TSP).

2. If a proposed project feature is changed significantly or is not implemented within one year of the Endangered Species Act consultation letter, we recommend that the Corps reinitiate coordination with our office to ensure that the proposed project would not adversely affect any federally listed threatened or endangered species or their critical habitat.

3. Avoid adverse impacts to bald eagle nesting locations and wading bird colonies through careful design of project features and timing of construction. A qualified biologist should inspect the proposed work site for the presence of undocumented wading bird nesting colonies and bald eagles during the nesting season (i.e., February 16 through October 31 for wading bird nesting colonies, and October through mid-May for bald eagles).

4. To minimize disturbance to colonies containing nesting wading birds (i.e., herons, egrets, night-herons, ibis, and roseate spoonbills), anhingas, and/or cormorants, all activity occurring within 1,000 feet of a rookery should be restricted to the non-nesting period (i.e., September 1 through February 15, exact dates may vary within this window depending on species present). In addition, we recommend that on-site contract personnel be informed of the need to identify colonial nesting birds and their nests, and should avoid affecting them during the breeding season.

5. Because bald eagles are known to nest within the proposed study area, we recommend that an evaluation be performed to determine whether the project is likely to disturb nesting bald eagles. That evaluation may be conducted on-line at: http://www.fws.gov/southeast/es/baldeagle. Following completion of the evaluation, that website will provide a determination of whether additional consultation is necessary and those results should be forwarded to this office.

6. Land clearing associated with project features should be conducted during the fall or winter to minimize impacts to nesting migratory birds, when practicable.

7. Further detailed planning of project features (e.g., Design Documentation Report, Engineering Documentation Report, Plans and Specifications, or other similar documents) should be coordinated with the FWS and other State and Federal natural resource agencies, and shall be provided an opportunity to review and submit recommendations on all the work addressed in those reports.

8. A report documenting the status of implementation, maintenance and adaptive management measures should be prepared every 3 years by the managing agency and provided to the Corps, the FWS, National Marine Fisheries Service, U.S. Environmental Protection Agency, Louisiana Department of Natural Resources, Office of Coastal Protection and Restoration, and the Louisiana Department of Wildlife and Fisheries. That report should also describe future management activities, and identify any proposed changes to the existing management plan.

Specific comments on the SEIS

Page ES-xv, ES.10 Conclusions and Recommendations, Paragraph 1, Sentence 1 – This sentence should read ". . . includes the creation of three conveyance channels. . ."

Page 3-9, Table 3.1 Evaluation of Hydrologic Subunits, SE-2 Description – This section states that although the swamps within SE-2 are hydrologically connected to the Blind River, this area would benefit from additional freshwater, nutrients, and sediments, as well as flushing of severe saltwater intrusion events. The FWS recommends describing why such benefits are not currently being realized (from the existing hydrologic connection to the Blind River) and how additional benefits would be derived from connecting the area to the ARDC.

Page 3-16, Table 3.2 Management Measures Considered with Screening Results, CS-01 Clearing and Snagging of Bayou Chene Blanc NE-1/NW-2 – The screening result identified does not address clearing and snagging activities, but rather dredging activities. The FWS, therefore, recommends revising accordingly.

Page 3-72, Section 3.7 Plan Selection – Tentatively Selected Plan – Table 3.11 depicts the Project Delivery Team's (PDT) ranking of the Final Array of Alternatives. Because the PDT ranked Alternatives 39, 36, and 38 higher than Alternative 33, we recommend justifying why Alternative 33 was selected as the TSP over those higher ranked alternatives.

Page 3-90, Performance Measures for Monitoring, Performance Measure 2b: Number of cypress and tupelo saplings – Both cypress and tupelo are shade intolerant. The desired outcome should be revised to accurately depict the limits of this performance measure. Performance of this measure is dependent on achieving historic hydrologic patterns (extended dry periods) in the swamp and would be more probable in areas that allow sufficient light (i.e., deteriorated swamp habitats that are converting to marsh/open water). Conversely, achievement of this measure is unlikely in healthier portions of the project area.

Page 4-2, Section 4.1.2 Climate, Paragraph 2, Sentence 6 – This sentence should read "Minimum and maximum annual rainfall values for Reserve were reported as 34.1 and 84.3 inches, respectively."

Page 5-1, Section 5.0 Environmental Consequences – The FWS recommends addressing direct, indirect, and cumulative impacts of the proposed project to the bald eagle and colonial nesting wading birds in this section. In addition, we recommend including a discussion on how potential adverse impacts to those species will be avoided.

Comments on the BA

The Gulf sturgeon is an anadromous fish that occurs in many coastal rivers and streams and estuarine waters from the Atchafalaya River to the Suwanee River, Florida. In Louisiana, Gulf sturgeon have been reported at Rigolets Pass, and rivers and lakes of the Lake Pontchartrain basin and adjacent estuarine areas. The proposed project does not occur within Gulf sturgeon critical habitat and that species has not been reported within the ARDC. Furthermore, while there may be minor impacts to Gulf sturgeon prey species those impacts are expected to be insignificant since only a small fraction of the total ARDC water bottom would be impacted. Thus, the FWS's Louisiana Field Office concurs with your determination that the proposed activity is not likely to adversely affect the Gulf sturgeon or its critical habitat.

Federally listed as endangered, West Indian manatees (*Trichechus manatus*) occasionally enter Lakes Pontchartrain and Maurepas, including their associated coastal waters and streams, during the summer months. Manatees, within Louisiana, have also been reported in the Amite, Blind, Tchefuncte, and Tickfaw Rivers, and in canals within the adjacent coastal marshes, they have also been occasionally observed elsewhere along the Louisiana coast. According to your BA, all contract personnel associated with the project would be informed of the potential presence of manatees and the need to avoid collisions with manatees. Temporary signs would be posted prior to and during all construction/dredging activities to remind personnel to be observant for manatees during active construction/dredging operations or within vessel movement zones (i.e., work area). In addition, siltation barriers, if used, would be made of material in which manatees cannot become entangled, and would be properly secured and monitored. If a manatee is sighted within 100 yards of the active work zone, special operating conditions would be implemented, including: no operation of moving equipment within 50 feet of a manatee; all vessels would operate at no wake/idle speeds within 100 yards of the work area; and siltation barriers, if used, would be re-secured and monitored. Once the manatee has left the 100-yard buffer zone around the work area on its own accord, special operating conditions are no longer necessary, but careful observations would be resumed. Accordingly, the FWS's Louisiana Field Office concurs with your determination that the proposed work is not likely to adversely affect the West Indian manatee.

No further endangered species consultation will be required for this project unless there are changes in the scope or location of the work, or construction has not been initiated within 1 year. If the work has not been initiated within 1 year, follow-up consultation should be accomplished with the FWS's Louisiana Field Office prior to making expenditures for construction.

We appreciate the opportunity to provide comments on the subject document. If your staff has additional questions regarding our comments, please contact FWS's Lafayette Field Office Karen Soileau at (337) 291-3132.

Sincerely,

Stephen R. Spencer
Regional Environmental Officer

cc: U.S. Environmental Protection Agency, Dallas, TX
Attn: Barbara Keeler
NOAA's National Marine Fisheries Service, Baton Rouge, LA
Attn: Mr. Richard Hartman
Louisiana Department of Wildlife and Fisheries, Baton Rouge, LA
Attn: Mr. Kyle Balkum
Louisiana Department of Wildlife and Fisheries, Natural Heritage Program, Baton Rouge, LA
Louisiana Office of Coastal Protection and Restoration, Baton Rouge, LA
Attn: Renee Sanders

Coordination Act Report

United States Department of the Interior

FISH AND WILDLIFE SERVICE
646 Cajundome Blvd.
Suite 400
Lafayette, Louisiana 70506

April 12, 2010

Colonel Alvin B. Lee
District Commander
U.S. Army Corps of Engineers
Post Office Box 60267
New Orleans, Louisiana 70160-0267

Dear Colonel Lee

Please reference the "Louisiana Coastal Area – Amite River Diversion Canal Modification Element of the Section 7006(E)(3) Ecosystem Restoration Projects Study". This report contains a description of existing fish and wildlife resources in the project area, discusses future with-project and future without-project habitat conditions, identifies fish and wildlife-related impacts, and provides project recommendations. This document does not constitute the report of the Secretary of the Interior as required by Section 2(b) of the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661 et seq.). The Service is coordinating with National Marine Fisheries and the Louisiana Department of Wildlife and Fisheries; their comments will be incorporated into the final report.

We appreciate the cooperation of your staff on this study. Should your staff have any questions regarding the enclosed report, please have them contact Ms. Karen Soileau (337/291-3132) of this office.

Sincerely,

James F. Boggs
Supervisor
Louisiana Field Office

Attachment

cc: EPA, Dallas, TX
National Marine Fisheries Service, Baton Rouge, LA
LA Dept. of Wildlife and Fisheries, Baton Rouge, LA
Office of Coastal Protection and Restoration, Baton Rouge, LA
GEC, Baton Rouge, LA

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DRAFT
FISH AND WILDLIFE COORDINATION ACT REPORT

ON

LOUISIANA COASTAL AREA - AMITE RIVER DIVERSION CANAL MODIFICATION ELEMENT OF THE SECTION 7006(E)(3) ECOSYSTEM RESTORATION PROJECTS STUDY

Submitted To
New Orleans District
U.S. Army Corps of Engineers
and
Office of Coastal Protection and Restoartion

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Ecological Services
Lafayette, Louisiana

April 2010

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INTRODUCTION

The Louisiana Coastal Area – Amite River Diversion Canal (LCA-ARDC) Modification Integrated Feasibility Report and Environmental Impact Statement (EIS) was prepared by the U.S. Army Corps of Engineers (USACE), New Orleans District, in partnership with the Louisiana Office of Coastal Protection and Restoration, under the authority of Title VII of the Water Resources Development Act (WRDA) of 2007. This authorization was recommended by the Chief of Engineer's Report, dated January 31, 2005. That report recommended projects and features in the interest of hurricane protection, prevention of salt water intrusion, preservation of fish and wildlife, prevention of erosion, and related water resources purposes. One recommended project was the modification of the ARDC.

The LCA-ARDC project is designed to establish hydrologic connectivity between the ARDC and the western Maurepas Swamp. That connectivity would allow the swamp to drain during seasonal low-flow conditions in the Amite River, and thereby, promote the germination and survival of bald cypress (and other tree species) seedlings. In addition, nutrients and sediments would be introduced from the ARDC into the swamp during flood events and from runoff during localized rainfall events. Nutrients and sediment delivered to the swamp would improve biological productivity and reduce the chances of further habitat degradation and swamp loss via conversion to open water.

This draft report contains a description of existing fish and wildlife resources in the project area, discusses future with-project (FWP) and future without-project (FWOP) habitat conditions, identifies fish and wildlife-related impacts, and provides recommendations to improve the proposed restoration measures. When finalized, this report will be submitted in fulfillment of the requirements of the Fish and Wildlife Coordination Act (FWCA; 48 Stat. 401, as amended; 16 U.S.C. 661 et seq.), and will constitute the report of the Secretary of the Interior as required by Section 2(b) of that Act. This draft FWCA Report is being provided to the Louisiana Department of Wildlife and Fisheries (LDWF) and the National Marine Fisheries Service (NMFS); their comments will be incorporated into the final report.

DESCRIPTION OF THE STUDY AREA

In the 1950s, the USACE, in an effort to relieve flooding along the upper Amite River, constructed the ARDC in order to facilitate the flow of water from the Amite River to Lake Maurepas. The 10 mile long canal is 350 feet wide and was dug to a depth of -25 feet. The LCA-ARDC study area (Figure 1) is located in LCA Subprovince 1 (USACE 2004) and is situated along the ARDC in Ascension and Livingston parishes, in the vicinity of Head of Island, Louisiana. The study area is bounded to the north by the old channel of the Amite River, Old River, Chinquapin Canal and Bayou Chene Blanc; to the east by the Blind River; to the south by the Petite Amite River and the New River Canal; and to the west by the Sevario Canal, Ascension Parish flood protection levees, and the Laurel Ridge Canal.

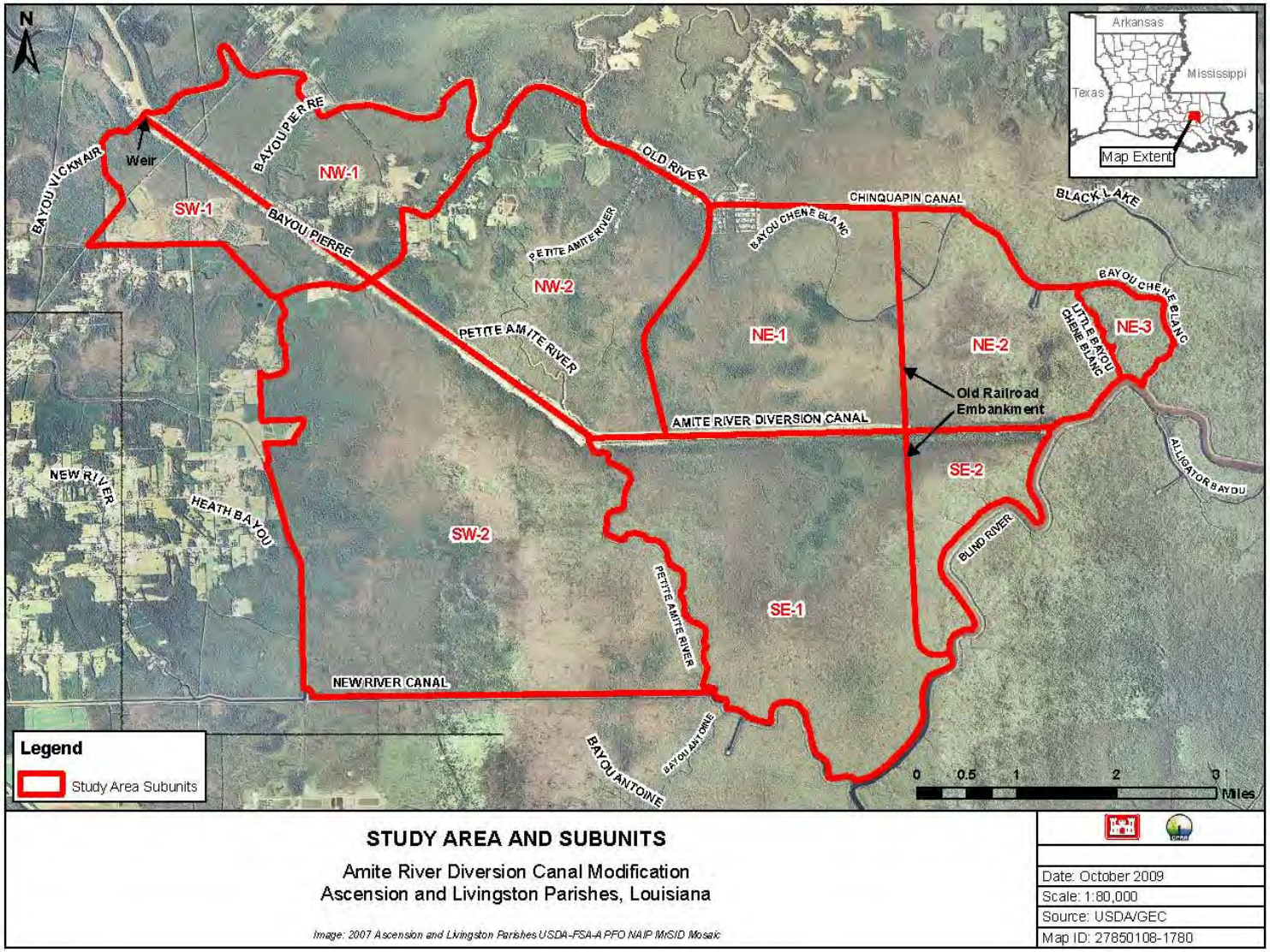
Historically, hydrologic conditions within the LCA-ARDC study area were dominated in the

north and west by the Amite River, in the south by overbank flow from the Mississippi River, and in the east by tidal influence from Lake Maurepas. Periodic flooding of the Amite River and/or Mississippi River resulted in the inundation of the study area. Flooding occurred annually, with peak water elevations in the spring or early summer. As floodwaters receded, surface waters in the study area were conveyed eastward via sheet flow to Bayou Chene Blanc or Blind River, then to Lake Maurepas.

The construction of flood control projects within the LCA-ARDC study area, primarily the ARDC component of the Amite River and Tributaries (AR&T) project, together with other land use practices, such as land development and logging, have significantly altered the hydrologic regime of the study area. River channelization and levee construction reduced overbank flooding in the study area, which in turn reduced the influx of floodwaters bearing high volumes of nutrients and sediment that are essential for biomass production and soil accretion. In addition, the placement of dredged material as berms along either side of the ARDC disrupted sheet flow within the LCA-ARDC study area and formed topographic high points (ridges) that prevented the drainage of bald cypress-tupelo swamps into the ARDC during low surface flow intervals (USACE 2004). This activity, in conjunction with other activities, such as construction of the railroad grade that traverses the eastern study area from north to south, permanently impounded bald cypress-tupelo swamp habitat within the study area. Those impoundments have contributed to decreased water quality and increased cypress and tupelo seedling mortality, which has resulted in increased habitat conversion from cypress swamp to open water.

Impoundment is particularly pronounced within the eastern portion of the LCA-ARDC study area, i.e., NE-1 and NE-2 (Figure 1). Specifically, during a recent study, water levels within the swamp habitat along the left descending bank of the ARDC never receded below 2.2 feet above mean sea level (msl), although canal water levels receded below that level (Shaffer *et al.,* 2006). Swamp impoundment is not as evident within the western portion of the LCA-ARDC study area. Installation of drainage culverts, construction of several gaps in the dredge material berms, and the confluence of Bayou Pierre with the ARDC in that area provide for hydrologic exchange between the diversion canal and the adjacent swamps.

Subsidence and salinity increases have also contributed to swamp ecosystem degradation in the LCA-ARDC study area. Land elevations decrease from subsidence, which may be caused by compaction, oxidation, and consolidation of sediments, faulting, groundwater depletion, or decreased organic deposition as a result of decreased vegetation biomass production; while land elevations increase as a result of sediment accretion, from direct sediment input from riverine sources or from organic vegetation deposition. The soil characteristics of the western Maurepas Swamp indicate a lack of riverine influence as evidenced by high soil organic matter content and low bulk density values (DeLaune et al. 1979, Hatton 1983, Messina and Conner 1998). Consequently, soil building within the Maurepas Swamp is almost exclusively a result of organic productivity (Shaffer et al. 2001, 2003, 2006, Rybczyk et al. 2002, Roberts 1985). In the swamps adjacent to the ARDC, productivity is substantially depressed compared to normal conditions (Coastal Wetlands Planning, Protection and Restoration Act [CWPPRA] Task Force



STUDY AREA AND SUBUNITS

Amite River Diversion Canal Modification
Ascension and Livingston Parishes, Louisiana

Image: 2007 Ascension and Livingston Parishes USDA-FSA-APFO NAIP MrSID Mosaic

Date: October 2009
Scale: 1:80,000
Source: USDA/GEC
Map ID: 27850108-1780

Figure 1. Study Area and Subunits

2002). Subsidence in the LCA-ARDC study area and vicinity is classified as intermediate, at about 1.1-2.0 feet per century (LCA 2004). With minimal soil building and moderately high subsidence, there has been a net lowering of ground surface elevation, doubling flood frequency over the last four decades (Thompson 2000), so that the swamps are now persistently flooded.

Saltwater intrusion has increased in this general area, partly due to net subsidence and the lack of riverine freshwater inputs. Salinities as low as three parts per thousand (ppt) can reduce growth of both bald cypress and water tupelo saplings (Pezeshki et al. 1990). Salinity, combined with flooding stress, can substantially reduce bald cypress growth. Consequently, salinity significantly contributes to swamp deterioration, particularly combined with stressors such as flooding and herbivory.

Storm surges from Lake Maurepas caused by tropical cyclones also exert a stochastic but severe stress on the swamp habitat through salinity spikes in swamp surface waters. Dredged material berms prevent higher salinity water from being flushed out of the system (CWPPRA Task Force 2002). Storm surge waters remain in the impounded swamps of the LCA-ARDC study area cumulatively increasing salinities in impounded waters and soils.

FISH AND WILDLIFE RESOURCES

The purpose of this section is to describe the principal fish and wildlife resources of the study area, and to establish their significance. Several key habitat types are described, followed by qualitative descriptions of important fish and wildlife.

Major Habitat Types

Cypress/Tupelo Swamps

The LCA-ARDC study area contains approximately 27,984 acres; the majority of which is dominated by bald cypress/tupelo swamp habitat. About 18,204 acres of that habitat type are presently impounded to various extents within the study area; that persistent flooding has resulted in the impairment of cypress/tupelo seedling establishment/regeneration (CWPPRA Task Force 2002). Cypress/tupelo regenerates well when the seedbed is moist but not flooded during the time period of seed germination and seedling establishment. Cypress/tupelo seeds cannot germinate in standing water, and seedlings must grow tall enough during dry periods for their crowns to extend above the water surface to survive flooding during the growing season. Excessive flooding will reduce regeneration even though overstory trees may still be thriving. Ultimately, the lack of regeneration due to prolonged inundation will eliminate forest cover, resulting in the conversion of swamp habitat to open water over time (CWPPRA Task Force 2002). In addition, saltwater intrusion from storm events has stressed the swamp habitat along the Blind River.

Cypress swamps in the project area provide substantial fish and wildlife values. Wildlife species typical of cypress swamps include green tree frog, bullfrog, mud and musk turtles, American alligator, various species of water snakes, anhinga, barred owl, northern parula, great blue heron, great egret, white ibis, and mink. Often surrounding backwater lakes, these areas also provide

essential habitat for aquatic species when inundated.

In addition to bald cypress and water tupelo, Drummond red maple, green ash, and various oak species are also found in the cypress/tupelo swamp habitat within the LCA-ARDC study area, with Drummond red maple and green ash comprising sub-dominant midstory species (Conner and Day 1976; Hoeppner 2008; Shaffer et al. 2003). Scrub species, including black willow, wax myrtle, and common buttonbush are sporadically present, particularly in areas with diminished canopy cover caused by impaired health or mortality of overstory species. Shrub-scrub swamps provide important nesting habitat for colonial wading birds as well as various species of aquatic wildlife.

Bottomland Hardwoods

Bottomland hardwoods are present along several ridge remnants that run through the LCA-ARDC study area. These ridges are mostly near the mid-point of the east-west stretch of the ARDC. Dominant tree species in those areas include Drummond red maple, green ash, laurel oak, water oak, sweet gum, sugarberry, American elm, and Chinese tallow. The areas between the ridges and the swamp show a transition in species including green ash, Drummond red maple, black willow, bald cypress, and water tupelo. Wax myrtle, rough-leaf dogwood, black willow, Chinese tallow, Chinese privet, yaupon, and deciduous holly typically dominate the shrub stratum. Vines such as poison ivy, greenbriars, pepper vine, and trumpet creeper are present. In addition, an old railroad grade and several earthen levees run through the LCA-ARDC study area with similar habitats.

Bottomland hardwood forests typically provide high wildlife habitat values to a variety of species, including amphibians such as the Gulf coast toad and Cope's gray tree frog; reptiles such as the copperhead and green anole; many species of birds, including wood duck, barred owl, pileated woodpecker, red-shouldered hawk, Acadian flycatcher, Swainson's Warbler and northern parula; and mammals including white-tailed deer, swamp rabbit, gray fox, bobcat, raccoon, opossum, and squirrels. In addition to terrestrial wildlife, many species of fish utilize flooded bottomland hardwoods as well; some species are specifically adapted for spawning in these backwater flood plains.

Open Water

Open water areas are distributed throughout the LCA-ARDC study area and include the ARDC; the Amite, Petite Amite, and Blind Rivers; Bayous Pierre and Chene Blanc; and the Choupique Canal. Submerged aquatic vegetation communities within the LCA-ARDC study area are largely confined to areas of higher flow. This includes natural waterways and natural cuts into the swamp interior. Shallow water habitats within the LCA-ARDC study area that have insufficient flow have become choked with floating vegetation, greatly limiting light penetration within the water column.

In their *2006 Water Quality Integrated Report*, the Louisiana Department of Environmental Quality indicated that water within the study area supports the designated standards for primary and secondary contact recreation, but does not support those standards for fish and wildlife

propagation. Suspected sources of impairment include mercury, total phosphorus, chloride, excessive nutrient levels, siltation, and low levels of dissolved oxygen.

Fresh Marsh

There are approximately 249 acres of fresh marsh within the LCA-ARDC study area. Shaffer et al. (2003) have shown that many of the marshes within the Maurepas Swamp exist as a transitional habitat as swamps are converting to open water areas over time. Those swamp habitats are being replaced by marsh and open water due to a number of factors including salt water intrusion (associated with hurricanes and rising sea levels), altered hydrology, impoundments, subsidence, and herbivory (Keddy et al. 2007).

Developed Areas

Developed areas comprise approximately 281 acres within the LCA-ARDC study area. Urban areas are primarily confined to the dredged material berms lining the ARDC adjacent to LA-22, and the right descending bank of the Amite River in the northwestern portion of the LCA-ARDC study area. Barren lands make up a small percentage of the LCA-ARDC study area and may include strip mines, quarries, and gravel pits. Agricultural croplands or grasslands make up approximately 469 acres of the LCA-ARDC study area and appear to be restricted to livestock pasture. These pastures are located in isolated pockets along the lower Amite River and LA-22 in the western portion of the study area.

Fishery Resources

Construction of the ARDC and dredged material berms have impeded exchange of organisms and water between the swamp and the ARDC. Accordingly, the study area is expected to provide low- to moderate-value habitat for some recreationally important fishes and shellfishes. Freshwater sport fishes likely present include white crappie, bluegill, warmouth, channel catfish, and blue catfish. Other fishes likely present include yellow bullhead, freshwater drum, bowfin, carp, buffaloes, and gars. In addition, the waterbodies and wetlands of the LCA-ARDC study area provide nursery and foraging habitats supportive of a variety of fishery species, some of which may serve as prey for other fish species.

Lantz (1970) sampled fish within the Amite River; primarily freshwater species were collected, although a few transient marine species were also collected or reported. Species collected included blue catfish, gizzard shad, spotted gar, freshwater drum, channel catfish, striped mullet, and largemouth bass. Laiche (1980) also sampled fish within the Amite River. The most abundant species collected were blacktail shiner, bullhead minnow, mosquitofish, longear sunfish, mimic shiner, blackstripe topminnow, bluegill, and longnose shiner.

Watson et al. (1981) collected 57 species of fish in the Blind River, including 43 freshwater species, 12 estuarine species, and two diadromous species. The authors suggested the confluence of the ARDC was a point of separation between the upper and lower reaches of Blind River. The lower Blind River had the greatest species diversity, primarily due to the presence of estuarine species. The low concentrations of dissolved oxygen above the ARDC could be an important

limiting factor in the distribution of fish.

Aquatic and wetland habitats in the LCA-ARDC study area also provide foraging and nursery habitat for a few economically important marine fishery species that use freshwater habitats in this area. The species expected to be found in the LCA-ARDC study area include striped mullet and Gulf menhaden.

Wildlife Resources

The coastal marshes and forested wetlands of the Lake Pontchartrain Basin have been identified by the North American Waterfowl Management Plan (NAWMP), Gulf Coast Joint Venture (GCLV): Mississippi River Coastal Wetlands Initiative as a key waterfowl wintering area. The Gulf Coast is the terminus of the Central and Mississippi Flyways and is therefore one of the most important waterfowl areas in North America, providing both wintering and migration habitat for significant numbers of the continental duck and goose populations that use both flyways. The Mississippi River Coastal Wetlands Initiative area is dominated by coastal marsh, forested swamps, and seasonally flooded bottomland hardwoods that provide habitat for several species of wintering waterfowl. Wood ducks are the primary waterfowl species in forested wetlands, while other ducks (e.g., mallard, American widgeon, gadwall, blue- and green-winged teal, Northern shovelers, ring-necked ducks, and lesser scaup) use those forested habitats to a lesser degree.

Strategies to achieve the goals and objectives of the GCJV include but are not limited to: 1) maintaining the existing functions and values of those habitats and preventing additional losses and degradation of those wetlands and 2) modifying existing dredged material berms and canals to restore hydrology (Wilson et al. 2002). Numerous other game birds are present in or adjacent to the study area, including American coot, rails, gallinules, common snipe, and American woodcock. Non-game bird species also utilize the study area marshes, including least bittern, pied-billed grebe, black-necked stilt, American avocet, killdeer, black-bellied plover, willet, and various species of sandpipers, gulls, and terns. The study area supports many resident and transient hawks and owls including red-shouldered hawk, barn owl, common screech owl, great horned owl, and barred owl. Winter residents include red-tailed hawk, northern harrier, and American kestrel, while the Mississippi kite, swallow-tailed kite and broad-winged hawk are common summer residents. In addition, the project area supports many species of resident and migratory passerine birds. Some neo-tropical migrants that are currently experiencing a population decline (e.g., white-eyed vireo, northern parula) are dependent on large forested acreage to successfully reproduce. Also, present are cuckoos, swifts, hummingbirds, nighthawks, woodpeckers, and the belted kingfisher.

Invasive Species

Within the LCA-ARDC study area invasive mammal species present include nutria and feral hogs. Invasive plant species present within that area include: water hyacinth, alligator weed, hydrilla, common salvinia, giant salvinia, variable-leaf milfoil, Chinese tallow, and Chinese privet. Those species displace native aquatics and degrade water and/or habitat quality. In addition, Chinese tallow is tolerant to flooding and salt stress and can establish self-replacing

monocultures that provide less foraging value to migrating birds and interrupt the natural succession of woody species (Louisiana Coastal Protection and Restoration 2008).

Threatened and Endangered Species

West Indian Manatee

Federally listed as an endangered species, West Indian manatees (*Trichechus manatus*) occasionally enter Lakes Pontchartrain and Maurepas, and associated coastal waters and streams during the summer months (i.e., June through September). Manatee occurrences appear to be increasing, and they have been regularly reported in the Amite, Blind, Tchefuncte, and Tickfaw Rivers, and in canals within the adjacent coastal marshes of Louisiana. The manatee has declined in numbers due to collisions with boats and barges, entrapment in flood control structures, poaching, habitat loss, and pollution. Cold weather and outbreaks of red tide may also adversely affect these animals.

All contract personnel associated with the project should be informed of the potential presence of manatees and the need to avoid collisions with manatees, which are protected under the Marine Mammal Protection Act of 1972 and the Endangered Species Act of 1973. All construction personnel are responsible for observing water-related activities for the presence of manatee(s). Temporary signs should be posted prior to and during all construction/dredging activities to remind personnel to be observant for manatees during active construction/dredging operations or within vessel movement zones (i.e., work area), and at least one sign should be placed where it is visible to the vessel operator. Siltation barriers, if used, should be made of material in which manatees could not become entangled, and should be properly secured and monitored. If a manatee is sighted within 100 yards of the active work zone, special operating conditions should be implemented, including: no operation of moving equipment within 50 feet of a manatee; all vessels should operate at no wake/idle speeds within 100 yards of the work area; and siltation barriers, if used, should be re-secured and monitored. Once the manatee has left the 100-yard buffer zone around the work area on its own accord, special operating conditions are no longer necessary, but careful observations would be resumed. Any manatee sighting should be immediately reported to the Service's Lafayette, Louisiana Field Office (337/291-3100) and the Louisiana Department of Wildlife and Fisheries, Natural Heritage Program (225/765-2821).

Gulf Sturgeon

The Gulf sturgeon (*Acipenser oxyrhynchus desotoi*), federally listed as a threatened species, is an anadromous fish that occurs in many rivers, streams, and estuarine waters along the northern Gulf coast between the Mississippi River and the Suwannee River, Florida. In Louisiana, Gulf sturgeon have been reported at Rigolets Pass, rivers and lakes of the Lake Pontchartrain basin, and adjacent estuarine areas. Spawning occurs in coastal rivers between late winter and early spring (i.e., March to May). Adults and sub-adults may be found in those rivers and streams until November, and in estuarine or marine waters during the remainder of the year. Sturgeon less than two years old appear to remain in riverine habitats and estuarine areas throughout the year, rather than migrate to marine waters. Habitat alterations such as those caused by water control structures that limit and prevent spawning, poor water quality, and over-fishing have

negatively affected this species.

On March 19, 2003, the Service and the National Marine Fisheries Service (NMFS) published a final rule in the Federal Register (Volume 68, No. 53) designating critical habitat for the Gulf sturgeon in Louisiana, Mississippi, Alabama, and Florida. The proposed project, however, does not occur within nor would it impact designated Gulf sturgeon critical habitat.

The Corps is responsible for determining whether the selected alternative is likely (or not likely) to adversely affect any listed species and/or critical habitat, and for requesting the Service's concurrence with that determination. If the Corps determines, and the Service concurs, that the selected alternative is likely to adversely affect listed species and/or critical habitat, a request for formal consultation in accordance with Section 7 of the ESA should be submitted to the Service. That request should also include the Corps' rationale supporting their determination.

Species of Special Interest

Bald Eagle

The project-area forested wetlands provide nesting habitat for the bald eagle (*Haliaeetus leucocephalus*), which was officially removed from the List of Endangered and Threatened Species on August 8, 2007. There is one active bald eagle nest that is known to exist within the proposed project area, however, other nests may be present that are not currently listed in the database maintained by the Louisiana Department of Wildlife and Fisheries.

Bald eagles nest in Louisiana from October through mid-May. Eagles typically nest in mature trees (e.g., bald cypress, sycamore, willow, etc.) near fresh to intermediate marshes or open water in the southeastern Parishes. Areas with high numbers of nests include the north shore of Lake Pontchartrain and the Lake Salvador area. Major threats to this species include habitat alteration, human disturbance, and environmental contaminants (i.e., organochlorine pesticides and lead).

Breeding bald eagles occupy "territories" that they will typically defend against intrusion by other eagles, and that they likely return to each year. A territory may include one or more alternate nests that are built and maintained by the eagles, but which may not be used for nesting in a given year. Potential nest trees within a nesting territory may, therefore, provide important alternative bald eagle nest sites. Bald eagles are vulnerable to disturbance during courtship, nest building, egg laying, incubation, and brooding. Disturbance during this critical period may lead to nest abandonment, cracked and chilled eggs, and exposure of small young to the elements. Human activity near a nest late in the nesting cycle may also cause flightless birds to jump from the nest tree, thus reducing their chance of survival.

Although the bald eagle has been removed from the List of Endangered and Threatened Species, it continues to be protected under the MBTA and the Bald and Golden Eagle Protection Act (BGEPA). The Service developed the National Bald Eagle Management (NBEM) Guidelines to provide landowners, land managers, and others with information and recommendations to minimize potential project impacts to bald eagles, particularly where such impacts may

constitute "disturbance," which is prohibited by the BGEPA. A copy of the NBEM Guidelines is available at:
http://www.fws.gov/southeast/es/baldeagle/NationalBaldEagleManagementGuidelines.pdf.
Those guidelines recommend: (1) maintaining a specified distance between the activity and the nest (buffer area); (2) maintaining natural areas (preferably forested) between the activity and nest trees (landscape buffers); and (3) avoiding certain activities during the breeding season. On-site personnel should be informed of the possible presence of nesting bald eagles within the project boundary, and should identify, avoid, and immediately report any such nests to this office. If a bald eagle nest is discovered within or adjacent to the proposed project area, then an evaluation must be performed to determine whether the project is likely to disturb nesting bald eagles. That evaluation may be conducted on-line at:
http://www.fws.gov/southeast/es/baldeagle. Following completion of the evaluation, that website will provide a determination of whether additional consultation is necessary. A copy of that determination should be provided to this office.

Colonial Nesting Birds

The proposed project would be located in an area where colonial nesting waterbirds may be present. Colonies may be present that are not currently listed in the database maintained by the Louisiana Department of Wildlife and Fisheries. That database is updated primarily by monitoring the colony sites that were previously surveyed during the 1980s. Until a new, comprehensive coast-wide survey is conducted to determine the location of newly-established nesting colonies, we recommend that a qualified biologist inspect the proposed work site for the presence of undocumented nesting colonies during the nesting season. To minimize disturbance to colonial nesting birds, the following restriction on activity should be observed:

> For colonies containing nesting wading birds (i.e., herons, egrets, night-herons, ibis, and roseate spoonbills), anhingas, and/or cormorants, all activity occurring within 1,000 feet of a rookery should be restricted to the non-nesting period (i.e., September 1 through February 15, exact dates may vary within this window depending on species present).

In addition, we recommend that on-site contract personnel be informed of the need to identify colonial nesting birds and their nests, and should avoid affecting them during the breeding season.

Refuges and Wildlife Management Areas

There are no U.S. Fish and Wildlife Service National Wildlife Refuges located within the LCA-ARDC study area. A portion of the state-operated Maurepas Swamp Wildlife Management Area is located within that study area. Please contact the Louisiana Department of Wildlife and Fisheries in Baton Rouge, Louisiana, (225/765-2360) for their comments regarding potential project impacts to this area.

EVALUATION METHODOLOGY

Evaluation of project-related impacts on fish and wildlife resources was aided by use of the

Wetland Value Assessment (WVA) methodology developed for the evaluation of proposed CWPPRA projects (Louisiana Coastal Wetlands Conservation and Restoration Task Force [LCWCRTF] 2006). The WVA methodology is similar to the Service's Habitat Evaluation Procedures (HEP), in that habitat quality and quantity are measured for baseline conditions and predicted for future without-project (FWOP) and future with-project (FWP) conditions. Separate habitat assessment models were used, including the Swamp and Bottomland Hardwood Community Models. Instead of the species-based approach of HEP, each model utilizes an assemblage of variables considered important to the suitability of a given habitat type for supporting a diversity of fish and wildlife species. As with HEP, these models allow a numeric comparison of each future condition and provide a combined quantitative and qualitative estimate of project-related impacts to fish and wildlife resources.

The WVA models operate under the assumption that optimal conditions for fish and wildlife habitat within a given coastal wetland type can be characterized, and that existing or predicted conditions can be compared to that optimum to provide an index of habitat quality. Habitat quality is estimated and expressed through the use of a mathematical model developed specifically for each habitat type. Each model consists of: 1) a list of variables that are considered important in characterizing fish and wildlife habitat; 2) a Suitability Index graph for each variable, which defines the assumed relationship between habitat quality (Suitability Indices) and different variable values; and 3) a mathematical formula that combines the Suitability Indices for each variable into a single value for wetland habitat quality, termed the Habitat Suitability Index (HSI).

The WVA methodology was initially developed in 1991 by the CWPPRA Environmental Work Group (LCWCRTF 2006). Initially, emergent marsh habitat models were developed for fresh, intermediate, brackish and saline marsh types. Subsequently, models were also developed for swamps, barrier islands, barrier headlands, and coastal forested ridges. The habitat variable-habitat suitability relationships within the WVA models have not been verified by field experiments or validated through a rigorous scientific process. However, the variables were originally derived from HEP suitability indices taken from species models for species found in that habitat type. It should also be noted that some aspects of the WVA have been defined by policy and/or functional considerations of CWPPRA. However, habitat variable-habitat suitability relationships are, in most cases, supported by scientific literature and research findings. In other cases, best professional judgment by a team of fisheries biologists, wildlife biologists, ecologists, and university scientists may have been used to determine certain habitat variable-habitat suitability relationships. In addition, the WVA models have undergone a refinement process and habitat variable-habitat suitability relationships, HSIs, and other model aspects are periodically modified as more information becomes available regarding coastal fish and wildlife habitat suitability, coastal processes, and the efficacy of restoration projects being evaluated.

The WVA models assess the suitability of each habitat type for providing resting, foraging, breeding, and nursery habitat to a diverse assemblage of fish and wildlife species. This standardized, multi-species, habitat-based methodology facilitates the assessment of project-induced impacts on fish and wildlife resources. The CWPPRA swamp WVA model used consists of four variables: 1) stand structure; 2) stand maturity; 3) water regime; and 4) mean

high salinity during the growing season. The bottomland hardwood WVA model consists of seven variables: 1) tree species association; 2) stand maturity; 3) understory/midstory; 4) hydrology; 5) size of contiguous forested area; 6) suitability and traversability of surrounding land uses; and 7) disturbance.

Using the WVA methodology, impact assessments were conducted by the Habitat Evaluation Team (HET), which included representatives from the Service, the Corps, Office of Coastal Protection and Restoration, GEC, Southeast Louisiana University, and Taylor Engineering. To assess impacts the HET used habitat information collected during June and July 2009 field inspections, surveys, expert opinions, knowledge of the area, experience with similar projects, Digital Ortho-quarter Quadrangle aerial photographs (DOQQ), and hydraulics and hydrology modeling information.

Those elements were used in conjunction with the above-discussed mathematical models to compute an HSI value for each target year (TY). Target years identified within the LCA-ARDC WVA model runs include: TY0, TY1, TY10, TY25, and TY50.

The product of an HSI and the acreage of available habitat for a given target year is known as the Habitat Unit (HU). The HU is the basic unit for measuring project effects on fish and wildlife habitat. Future HUs change according to changes in habitat quality and/or quantity. Results are annualized over the project life to determine the Average Annual Habitat Units (AAHUs) available for each habitat type.

The seven alternatives within the LCA-ARDC Final Array were evaluated: Alternative 33 (NE-1/NE-2), Alternative 34 (SE-1/SE-2), Alternative 35 (SE-1), Alternative 36 (NE-1/NE-2, SE-1/SE-2), Alternative 37 (SE-1/SE-2, SE-1), Alternative 38 (NE-1/NE-2, SE-1), and Alternative 39 (NE-1/NE-2, SE-1/SE-2 – All Subunits Combined). Prior to running the WVA analysis, the benefit areas associated with each alternative were designated as either primary impact areas or secondary impact areas. For purposes of the WVA, the Service assumed that the primary impact areas would receive the most benefits from freshwater flows, nutrients, and sediments, while the secondary impact areas would receive lesser benefits.

Subsequent to the mapping of primary and secondary impact areas for each alternative, WVAs were run for each habitat type (i.e., degraded swamp/fresh marsh, 10 years to convert to marsh, 20-30 years to convert to marsh, and 30-50 years to convert to marsh) present within those areas. Once benefits were calculated, adverse temporary and permanent impacts to swamp and bottomland hardwood habitats associated with construction of the bank openings, conveyance channels, and dredged material placement were calculated. The change in AAHUs for each FWP scenario, compared to FWOP project conditions, provides a measure of anticipated impacts. A net gain in AAHUs indicates that the project is beneficial to the habitat being evaluated; a net loss of AAHUs indicates that the project is damaging to that habitat type.

The WVA initial analysis was completed on the primary and secondary impact areas for all alternatives under the low sea level rise (SLR) scenario. As requested by the Corps, additional WVAs were later run to quantify impacts under the intermediate and high SLR scenarios for the Tentatively Selected Plan and the National Ecosystem Restoration Plan. A combined total of

168 WVA evaluations were completed.

The Project Information Sheet (including assumptions used by the HET) and the WVA summary sheet for the LCA-ARDC project are presented in Appendix A and B, respectively. The complete WVA analysis can be obtained from the Service's Lafayette, Louisiana Ecological Services Office upon request.

FUTURE WITHOUT-PROJECT FISH AND WILDLIFE RESOURCES

Under future without-project conditions, the current problems associated with altered hydrology are expected to continue. The swamp habitat surrounding the ARDC will likely continue to degrade, resulting in the eventual conversion from a freshwater swamp to open water. The lack of hydrologic connectivity would result in the continued impoundment of the project-area swamp, with an associated reduction in canopy cover, degradation of water quality, and transition of swamp habitat to marsh, with the eventual conversion to open-water habitat. Storm surges from tropical cyclone events would increase salinity levels and the frequency of saltwater inundation is expected to increase with relative sea level rise (RSLR).

The lack of freshwater, sediments, and nutrients would continue to reduce tree vigor and growth, increase tree mortality, increase the presence of invasive species, and reduce ecological functions. In addition, the assumed RSLR, would exacerbate swamp degradation in the future.

The anticipated conversion of swamp habitats to marsh and open water would result in the loss of wetland values and functions. While the Service recognizes the ecological importance of freshwater marshes, most of the marshes present within the LCA-ARDC study area are present as a transitional habitat, as swamps convert to open water, and are the result of habitat deterioration and conversion, rather than healthy swamp/marsh interfaces. Keddy et al. (2007) reports that the vast majority of the Maurepas Swamp is typical of swamps identified as either nutrient poor and stagnant or near-continuously flooded. Flood durations in the Maurepas Swamp have doubled, on average, over the past half-century (Thomson et al. 2002). The flooding and impoundment within the study area prevents seed germination and recruitment and, as a result, swamps are converting to marsh and open water.

Keddy et al. (2007) identify priority actions for habitat restoration within the Maurepas Swamp. One such recommendation addresses the re-establishment of sheet flow via removal or gapping of dredged material berms and road and railroad beds. They explain that sheet flow (or shallow water flow over the surface of the soil) was, most likely, the principle way in which water and nutrients moved through this system. Now, however, the presence of man-made hydrologic barriers impedes sheet flow. Canals decrease overbank flooding and accelerate the flow of water, sediment, and nutrients out of the area, while dredged material berms and other such man-made features block sheet flow. Implementation of the proposed project would restore an historic ecosystem and increase the fish and wildlife habitat values of the project area.

DESCRIPTION OF NATIONAL ECOSYSTEM RESTORATION PLAN

Alternative 39 (Figure 2) has been identified as the NER and the best plan for ecosystem

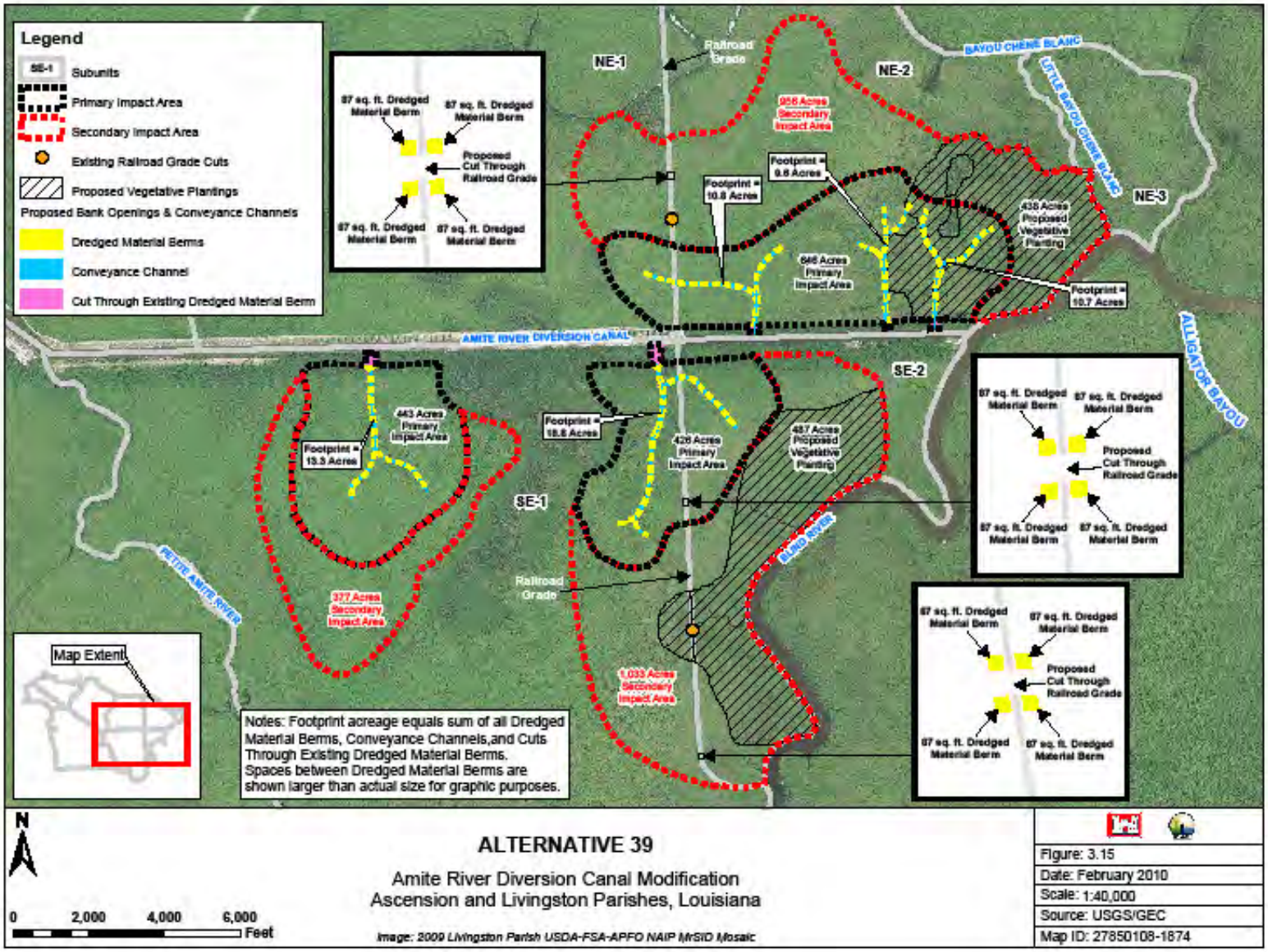


Figure 2. Alternative 39

restoration in the study area. That plan includes three areas for restoration in the final array, including two that have a critical need, and have begun converting from swamp to marsh, and a third less critical area that is expected to begin conversion in the next 20-30 years. Due to funding limitations and the risk of losing authorization, however, Alternative 39 has not been designated as the tentatively selected plan (TSP).

Features of Alternative 39 include:

- Three dredged material bank openings and three bifurcated conveyance channels in the north bank of the ARDC in NE-2 with the westernmost cut in the north bank of the ARDC also extending through the railroad grade into NE-1 to add connectivity between NE-1 and NE-2.
- One dredged material bank opening and one bifurcated conveyance channel in the south bank of the ARDC in SE-1 with the conveyance channel extending through the railroad grade into SE-1 to add connectivity between SE-1 and SE-2, and the ARDC.
- One opening and one conveyance channel in the south bank of the ARDC in SE-1.
- Dredged material (9.9 acres) from the bank openings and the conveyance channel would be sidecast on both sides of the proposed channel. Gaps would be left in the disposal berms so sheet flow is not reduced.
- Three cuts would be created in the railroad grade to improve sheet flow. One cut would be approximately 0.9 miles north of the ARDC. The second cut would be approximately 0.9 miles south of the ARDC. The third cut would be approximately two miles south of the ARDC.
- Vegetative plantings of bottomland hardwood/swamp tree species on 9.9 acres of dredged material berms.
- Vegetative plantings of swamp tree species within 925 acres of the swamp floor.

All excavation through the dredged material berms, as well as the conveyance channels through the swamp, were designed to mimic natural, existing cuts within the study area, which have been determined to be self-maintaining. Several existing channels were surveyed for depth, dimension, and profile.

The material dredged from the existing berms would be placed along the swamp-side of the excavated cut as new bottomland hardwood habitat. All material dredged during construction of the conveyance channels would be placed along the channels, with gaps included, to allow sufficient sheet flow to be conveyed from the swamp.

EVALUATION OF NATIONAL ECOSYSTEM RESTORATION PLAN

Alternative 39 includes all of the most critical areas within the Maurepas Swamp basin, establishes the greatest amount of hydrologic connectivity of all of the alternatives, is cost-effective while providing the most benefits, and is a best-buy plan. Accordingly, the Service fully supports Alternative 39 as the NER plan and believes it best represents the long term restoration need for the area.

The WVA evaluations conducted on all alternatives within the final array show that the highest

net benefits to fish and wildlife habitats occur with implementation of Alternative 39. Specifically, the WVA analysis indicates that the NER for the LAC-ARDC project would result in net gains of 1,602, 1,516, and 1,452 AAHUs under the low, intermediate, and high SLR scenarios, respectively.

Swamp habitat for fish and wildlife species would be restored, mimicking as closely as possible, conditions which occurred historically in the area. Implementation of Alternative 39 would restore the hydrologic connectivity between NE-1, NE-2, SE-1, and SE-2 within the ARDC. That alternative would improve the hydrologic connectivity between the ARDC and approximately 3,881 acres in both the primary and secondary impact areas, restore approximately 290 acres of swamp, and create approximately 9.9 acres of upland habitat from dredged material placement. Restored hydrologic connections would: 1) increase the nutrient and sediment input to approximately 1,515 acres within the primary impact area, 2) increase acreage of high-quality swamp habitats used by fish and wildlife for shelter, nesting, feeding, roosting, cover, nursery, and other life requirements, and 3) increase vegetative growth and productivity. In addition, when compared to the future without project scenario, implementation of this alternative would significantly reduce the likelihood of 3,881 acres of existing swamp habitat converting to marsh and eventual open water habitat over the life of the project.

DESCRIPTION OF TENTATIVELY SELECTED PLAN

Because the NER plan (Alternative 39) cannot be constructed within the currently authorized cost cap, Alternative 33 (Figure 3) was chosen as the TSP.

Alternative 33 includes:

- Three dredged material bank openings and three bifurcated conveyance channels in the north bank of the ARDC in NE-2 with the westernmost channel in the north bank of the ARDC also extending through the railroad grade into NE-1 to add connectivity between NE-1, NE-2, and the ARDC.
- Dredged material (5.0 acres) from the bank openings and the conveyance channel would be sidecast on both sides of the proposed channel. Gaps will be left in the disposal berms so sheet flow is not reduced.
- One cut would be created in the railroad grade approximately 0.9 miles north of the ARDC to improve sheet flow.
- Vegetative plantings of bottomland hardwood/freshwater swamp tree species on 5.0 acres of dredged material berms.
- Vegetative plantings of freshwater swamp tree species within 438 acres of the swamp floor.

All excavation through the dredged material berms, as well as the conveyance channels through the swamp, were designed to mimic natural, existing cuts within the study area, which have been determined to be self-maintaining. Several existing channels were surveyed for depth, dimension, and profile.

The material dredged from the existing berms would be placed along the swamp-side of the

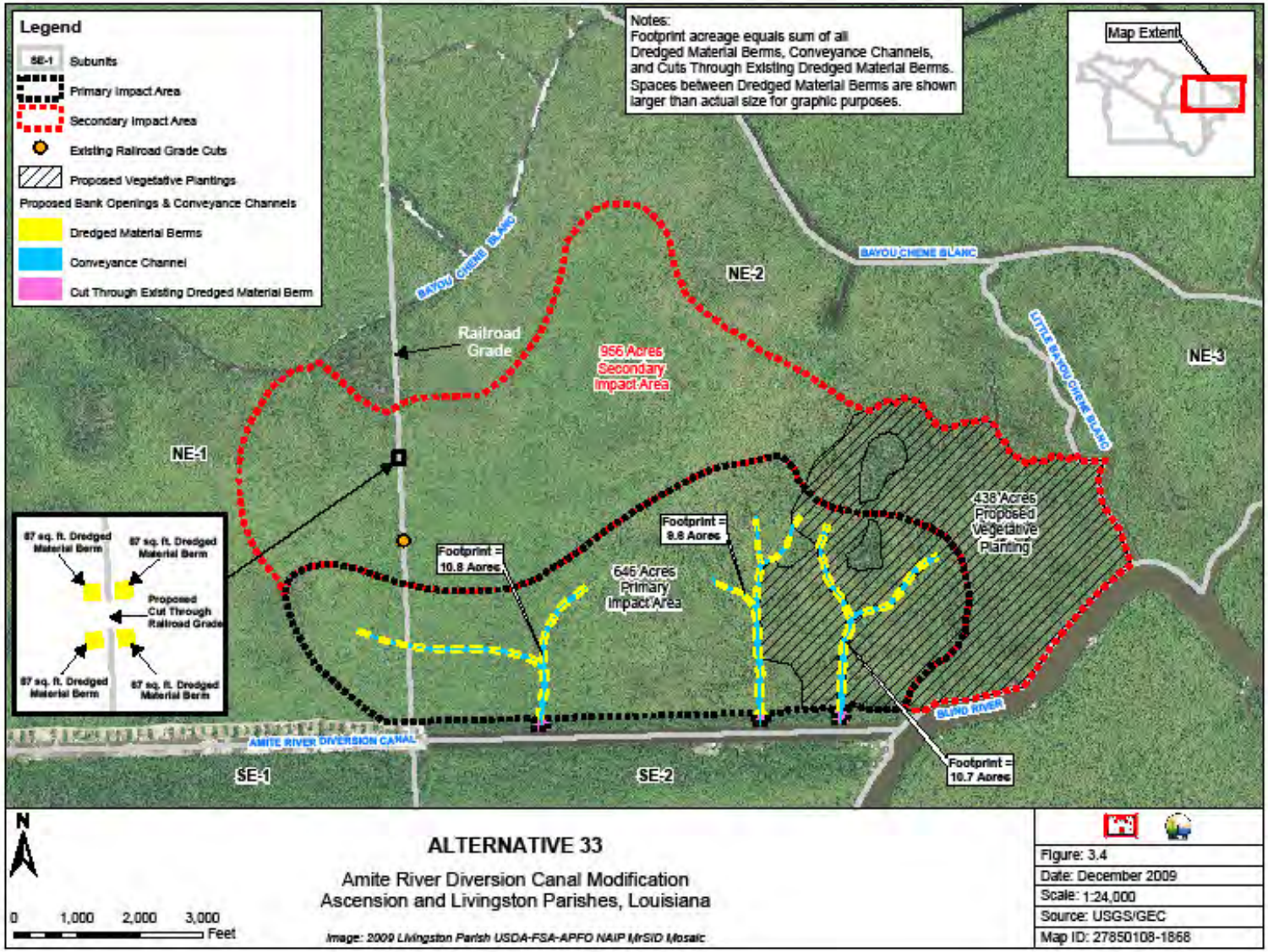


Figure 3. Alternative 33

excavated cut as new bottomland hardwood habitat. All material dredged during construction of the conveyance channels would be placed along the channels, with gaps included, to allow sufficient sheet flow to be conveyed from the swamp.

EVALUATION OF TENTATIVELY SELECTED PLAN

Alternative 33 addresses the most-highly degraded portion of the study area (NE-2), is considered cost effective, and can be implemented within the current cost cap. Implementation of that alternative, however, would not address the restoration needs within SE-1 and SE-2. Implementation of Alternative 33 would, therefore, result in similar benefits as expected under Alternative 39, but to a lesser degree. Specifically, Alternative 33 would improve the hydrologic connectivity between the ARDC and approximately 1,602 acres in both the primary and secondary impact areas, restore approximately 144 acres of swamp, and create approximately 5.0 acres of upland habitat from dredged material placement. The WVA analysis indicates that the TSP for the LAC-ARDC project would result in net gains of 679, 640, and 610 AAHUs under the low, intermediate, and high SLR scenarios, respectively.

FISH AND WILDLIFE CONSERVATION AND MITIGATION MEASURES

Swamp habitats are considered by the Service to be aquatic resources of national importance due to their increasing scarcity and high habitat value for fish and wildlife within Federal trusteeship (i.e., migratory waterfowl, wading birds, other migratory birds, threatened and endangered species, and interjurisdictional fisheries). Because of the Services' close coordination with the USACE on this project, and because the project is expected to have an overall benefit to the LCA-ARDC study area, the Service has no conservation measures to offer at this time.

SERVICE POSITION AND RECOMMENDATIONS

The TSP will benefit the fish and wildlife resources of the LCA-ARDC area by providing freshwater, nutrients, and sediments to the study area thus facilitating sediment deposition, increase organic production, increase biological productivity, and reduce conversion of swamp habitat to open water. Approximately 679 AAHUs and 1,602 net acres of swamp habitats would benefit by the proposed project at the end of the project life. The Service supports implementation of Alternative 33 provided the following fish and wildlife recommendations are implemented concurrently with project implementation:

1. If authorized funding limits for this project are increased the Service recommends that Alterative 39 be reconsidered as the potential future TSP.

2. If a proposed project feature is changed significantly or is not implemented within one year of the Endangered Species Act consultation letter, we recommend that the Corps reinitiate coordination with our office to ensure that the proposed project would not adversely affect any Federally listed threatened or endangered species or their critical habitat.

3. Avoid adverse impacts to bald eagle nesting locations and wading bird colonies through

careful design of project features and timing of construction. A qualified biologist should inspect the proposed work site for the presence of undocumented wading bird nesting colonies and bald eagles during the nesting season (i.e., February 16 through October 31 for wading bird nesting colonies, and October through mid-May for bald eagles).

4. To minimize disturbance to colonies containing nesting wading birds (i.e., herons, egrets, night-herons, ibis, and roseate spoonbills), anhingas, and/or cormorants, all activity occurring within 1,000 feet of a rookery should be restricted to the non-nesting period (i.e., September 1 through February 15, exact dates may vary within this window depending on species present). In addition, we recommend that on-site contract personnel be informed of the need to identify colonial nesting birds and their nests, and should avoid affecting them during the breeding season.

5. Because bald eagles are known to nest within the proposed study area, we recommend that an evaluation be performed to determine whether the project is likely to disturb nesting bald eagles. That evaluation may be conducted on-line at: http://www.fws.gov/southeast/es/baldeagle. Following completion of the evaluation, that website will provide a determination of whether additional consultation is necessary and those results should be forwarded to this office.

6. Land clearing associated with project features should be conducted during the fall or winter to minimize impacts to nesting migratory birds, when practicable.

7. Further detailed planning of project features (e.g., Design Documentation Report, Engineering Documentation Report, Plans and Specifications, or other similar documents) should be coordinated with the Service and other State and Federal natural resource agencies, and shall be provided an opportunity to review and submit recommendations on the all work addressed in those reports.

8. A report documenting the status of implementation, maintenance and adaptive management measures should be prepared every three years by the managing agency and provided to the Corps, the Service, National Marine Fisheries Service, U.S. Environmental Protection Agency, Louisiana Department of Natural Resources, Office of Coastal Protection and Restoration, and the Louisiana Department of Wildlife and Fisheries. That report should also describe future management activities, and identify any proposed changes to the existing management plan.

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APPENDIX A

PROJECT INFORMATION SHEET WITH ASSUMPTIONS FOR LCA-ARDC

Wetland Value Assessment Project Information Sheet
December 2009

Project Name: Louisiana Coastal Area Amite River Diversion Canal (LCA ARDC) Modification project

Project Type(s): Swamp restoration, hydrologic restoration, and vegetative planting

Sponsoring Agency: U.S. Army Corps of Engineers (USACE) and Louisiana Department of Natural Resources

Preparer of Wetland Value Assessment (WVA) information sheet: Karen Soileau
Information found in this project information sheet was obtained primarily from the Draft Feasibility Report appendix (CPE 2005 and 2007).

Project Area: The project area is situated along the Amite River Diversion Canal (ARDC) in Ascension and Livingston Parishes, in the vicinity of Head of Island, Louisiana. The project area is focused around the impaired bald cypress-tupelo swamp stands adjacent to the ARDC, extending northward and southward of the canal in the western portion of the Maurepas Swamp, located within the Pontchartrain Basin.

Project area boundaries were developed and delineated based on hydrologic features of the area suspected of being influenced by the LCA ARDC Modification project. For planning purposes, the project area was further divided into nine sub-areas. Those sub-areas are defined by topographic high points (e.g., dredged material berms, relict railroad grade, road embankments) or natural and artificial channels (e.g., rivers, canals) that would serve to impede or intercept hydrologic flows.

Problem: The project area includes the ARDC, a 10.6-mile-long flood control channel between the Amite and Blind Rivers. Dredged material excavated during channel construction was deposited in dredged material berms on either side of the canal. The construction of the ARDC and its associated dredged material berms, and the resulting impoundment, channelization, surge-related saltwater intrusion, and the loss of freshwater, sediments, and nutrients from the Amite River have all caused significant adverse impacts to the area, resulting in poor swamp health and ecosystem degradation in the western Maurepas Swamp.

Goal: The goal of the LCA ARDC Modification project is to reverse the trend of degradation in the western portion of the Maurepas Swamp, so as to contribute toward achieving and sustaining a coastal ecosystem that can support and protect the environment, economy, and culture of southern Louisiana and thus the Nation.

Objectives:

- Increase hydrologic connectivity between the degraded swamp and bottomland hardwood habitats within the study area and the ARDC by increasing the exchange of freshwater, sediments, and nutrients over the 50-year period of analysis.
- Reduce habitat conversion of swamp to open water within the study area over the 50-year period of analysis.
- Facilitate natural hydrologic cycle within the study area over the 50-year period of analysis by reducing impoundment in degraded swamp and bottomland hardwood habitats adjacent to the ARDC to improve tree productivity and seedling germination.
- Improve fish and wildlife habitat within the study area over the 50-year period of analysis.

Project Features:

1. Freshwater Reintroduction – Restoring processes that input freshwater, nutrients, and sediments are essential for establishing sustainable coastal swamp systems. The implementation of freshwater reintroduction measures that establish hydrologic connectivity between study area waterbodies and the adjacent swamp habitat could nourish existing swamp habitat to increase productivity and restore areas that have converted to freshwater marsh or open water, reintroduce sediments and nutrients throughout the ecosystem, and allow aquatic organisms access to previously unavailable habitats. The benefits that such reintroductions produce increase over time and continue as long as the reintroduction is operated and maintained. Additionally, freshwater reintroductions can be adaptively managed to respond to environmental changes and optimize benefits.

2. Habitat Restoration – The majority of the Maurepas Swamp is stressed as a result of hydrologic alteration and seems to be on a trajectory of slow degradation leading to a gradual conversion to marsh and open water (Hoeppner *et al.*, 2007). Without restoration, the factors and processes that are contributing to stress and deterioration of the swamps in the vicinity of the ARDC would continue and would result in loss of the swamp, with succession to open water. The wetland loss rates for the Coast 2050 Amite/Blind Rivers mapping unit (which contains the study area) for 1974-90 were estimated by the Corps to be 0.83 percent per year for swamp habitat, and 0.02 percent per year for fresh marsh. Based on these rates, approximately 50 percent of swamp and 1.2 percent of fresh marsh would be lost within 60 years (Coastal Wetlands Planning, Protection, and Restoration Act [CWPPRA] Task Force, 2002). Additionally, the Corps determined that, based on the low tree density, degraded condition, and expectation for mortality, the majority of swamp habitat within the study area would degrade to less than 33 percent canopy cover within 20 years (USACE, 2004). Under the continued influence of these conditions, tree mortality would continue to increase and tree density would continue to decline, until most swamp habitat in the vicinity of the ARDC converts to fresh marsh. Monitoring studies conducted for the CWPPRA Priority Project List 12 (PPL 12) proposal indicated that conversion of bald cypress-tupelo swamp to fresh marsh is already occurring in the study area,

particularly north of the ARDC in subunit NE-2 (CWPPRA Task Force, 2002). Additionally, the monitoring results indicate that many areas of fresh marsh in the greater southern Maurepas Swamp have converted to fragile spikerush flotant, which is particularly susceptible to nutrient starvation and fragmentation. Consequently, it is expected that the vast majority of swamp habitat adjacent to the ARDC would convert to open water rather than stable marsh habitat without implementation of the proposed project.

LOW SEA LEVEL RISE SCENARIO ASSUMPTIONS

Primary Impact Areas

- ***Fresh Marsh*** – The Swamp Model was chosen for this area over the Fresh Marsh Model, even though there is less than a 33 percent canopy cover, because the area provides functions and values more closely associated with a swamp than a fresh marsh.

Variable 1: Stand Structure

Both *Future* *With* and *Future* *Without* *Project*
Target Year 0 –

This information was gathered during a July 30, 2009, field assessment. It was the consensus of the group that there is less than 33 percent overstory closure. [Class 1]

Future *Without* *Project*
Target Years 1 – 50 –

Continued degradation of the area is anticipated under the future without project scenario. Because of the low tree density and degraded condition, the area is expected to remain a Class 1.

Future *With* *Project*
Target Year 1 –

Because of the minimal time lapse since project construction (i.e., 1 year), we predicted that the stand structure would remain a Class 1.

Future *With* *Project*
Target Year 10 –

The combined effects of increased deposition of fine-grained sediment, increased nutrient loading, increased freshwater flows, reduced salinities, seasonally-lower water levels, and vegetative planting should improve habitat conditions within the area. However, cypress trees planted at TY1 would be 11 years old. In Louisiana, the height of cypress at 10 years of age is, on average, 17 feet (U.S. Department of Agriculture [USDA] 1980). Therefore, because there were no tree species within the midstory at TY 0 and because planted cypress trees would not be old enough yet to be considered a component of the overstory, we anticipate the stand structure would remain a Class 1.

Future With Project
Target Year 25 –

The combined effects of increased deposition of fine-grained sediment, increased nutrient loading, increased freshwater flows, reduced salinities, seasonally-lower water levels, and vegetative planting should improve habitat conditions within the area. In addition, planted cypress trees are expected to be over 31 feet at age 26 (USDA 1980) and would, therefore, be considered a component of the overstory. Accordingly, we anticipate an overstory closure of 50 -75 percent with a midstory or herbaceous cover greater than 33 percent. [Class 4]

Future With Project
Target Year 50 –

The combined effects of increased deposition of fine-grained sediment, increased nutrient loading, increased freshwater flows, reduced salinities, seasonally-lower water levels, and vegetative planting should continue to improve habitat conditions within the area. Accordingly, we anticipate an overstory closure of greater than or equal to 75 percent with either a midstory cover or herbaceous cover greater than 33 percent. [Class 6]

Variable 2: Stand Maturity

Both *Future* *With* and *Future* *Without* *Project*
Target Year 0 –

This information was gathered during a July 30, 2009, field assessment. Those estimates, based on existing habitat conditions, were consistent with those found by Bernard Wood (Research Assistant Southeastern Louisiana University) through direct measurement of project area trees. His diameter at breast height (dbh) estimate, for all tree species combined, was between 6.5 and 8.25 inches, as compared to our average of 6.3 inches determined during our Wetland Value Assessment (WVA) data collection field assessment. Although our estimate is on the lower end of the range determined by Mr. Wood, because the subject area represents some of the more degraded habitat we feel that this estimate is representative of existing habitat conditions. Basal area was estimated based on information gathered during the aforementioned field visit and data collected by Southeast Louisiana University over the past 10 years.

Future *Without* *Project*
Target Years 1 – 50 –

Values based on information presented in the PPL 12 WVA. Mean dbh for each species was estimated as the mean existing dbh plus the existing mean annual growth rate times X number of years (growth rate: cypress = .11 inches per year tupelo et al = .08 inches per year). Basal area was again estimated utilizing data collected by Southeast Louisiana University and percent composition of canopy trees was estimated based on best professional judgment. Within the PPL 12 WVA it was assumed that 50 percent of the tupelo et al would die over 20 years, but that actual mortality of cypress would be minimal. Over the 50 year project life, we assume that 75 percent of the tupelo et al would die with minimal cypress mortality. In addition, we assume that minimal regeneration would occur over 50 years based on the degraded habitat conditions and lack of tree species at TY 0 in the understory. Subsequently, under the future

without project scenario, basal areas decreased from time year 0 to 50.

Future With Project

Target Years 1 – 50 –

Values based on information presented in the PPL 12 WVA. Under the future with project scenario, construction of the gaps is expected to stimulate productivity and growth of cypress and tupelo. We assume that the primary impact areas would receive the most benefits from freshwater flows, nutrients, and sediments; thus, those areas should see the greatest increase in growth. These assumptions are similar to those by Hamilton and Shaffer (2001) for the Maurepas Diversion Project. Results of studies by John Day in wetlands receiving secondary treated sewage suggest that introduction of nutrients as well as sediments from river water could stimulate production by 3-5 fold (Hamilton and Shaffer 2001). Comparison of productivity in swamps that are either managed, have more favorable hydrology, and/or are receiving nutrient enrichment suggest that the existing level of productivity in Maurepas are ½ to ¼ of average values. As a conservative projection, we assume growth rates to be 167% of current growth in the primary impact areas, which is the same assumption used in the PPL 12 WVA. Percent composition of cypress trees in the canopy was increased over the 50 years to mimic conditions in healthier portions of the project area. Basal area was estimated by a bottomland hardwood growth/basal area calculator developed by the United States Forest Service (Putnam et al. 1960).

Variable 3: Water Regime

Both *Future With* and *Future Without Project*

Target Year 0 –

At present the Maurepas Swamp within this portion of the project area are permanently flooded and have no flow/exchange.

Future Without Project

Target Years 1 – 50 –

Continued degradation of the area is expected under the future without project scenario and we anticipate the project area to remain permanently flooded with no flow/exchange.

Future With Project
Target Years 1 – 50 –

We assume that the portions of the proposed project within the primary impact area would receive the highest amount of direct benefits from construction of the gaps and should experience a substantial increase in substrate accretion and nutrient input. In addition, being in the immediate area of the proposed gaps we assume that this area would receive a high level of flow-exchange. We, therefore, anticipate a seasonal flood duration with high flow/exchange.

Variable 4: Mean High Salinity During the Growing Season

Both *Future With* and *Future Without Project*
Target Year 0 –

Value based on information presented in the PPL 12 WVA. Specifically, for the Maurepas Diversion Project it was estimated that typical high salinity during the growing season would be about 1.4 ppt. Because the LCA ARDC Modification project is further from the lake (i.e., further from the source of saltwater intrusion) the CWPPRA Environmental Work Group assumed a lower mean high salinity in this area and adopted 1.2 ppt for the PPL 12 WVA.

Future Without Project
Target Years 1 – 50 –

Subsidence is expected to continue within the project area over time under the future without project scenario. We, therefore, assume that the ability for saltwater to intrude further and/or more frequently into the project area swamps would likewise increase. Because the subject area is impounded with no flow/exchange we expect the

salinity to increase over time. Thus, we assumed that mean high salinity during the growing season to increase to 1.4 ppt over 50 years.

Future With Project
Target Years 1 – 50 –

Values based on information presented in the PPL 12 WVA. Specifically, the proposed project was designed to allow for freshwater to be introduced into the swamp when water elevations in the ARDC are higher than in the swamp, which is expected to occur frequently. This frequent introduction of freshwater into the system from the ARDC is expected to result in a mean high salinity reduction for the first 10 years (i.e., 0.9 ppt from TY 1-10). Because of the anticipated increase in sea level rise over time, however, we assume an increase in mean high salinities of 1.0 and 1.2 ppt for TY 25 and 50, respectively.

- ***10 Years to Marsh***

Variable 1: Stand Structure

Both *Future With* and *Future Without Project*
Target Year 0 –

This information was gathered during a July 30, 2009, field assessment. Those estimates, based on existing habitat conditions, were consistent with those found by Bernard Wood (Research Assistant Southeastern Louisiana University). Specifically, total canopy cover is estimated to be approximately 35 percent with an approximate midstory cover of 17 percent. [Class 2]

Future Without Project
Target Year 1 –

Because of the minimal time lapse since TY0, we predicted that the stand structure would remain a Class 2.

Future Without Project
Target Years 10 – 50 –

Continued degradation of the area is anticipated under the future without project scenario. Because of the low tree density and degraded condition, we downgraded the variable to a Class 1.

Future With Project
Target Year 1 –

Because of the minimal time lapse since project construction (i.e., 1 year), we predicted that the stand structure would remain a Class 2.

Future With Project
Target Year 10 –

The combined effects of increased deposition of fine-grained sediment, increased nutrient loading, increased freshwater flows, reduced salinities, seasonally-lower water levels, and vegetative planting should improve habitat conditions within the area. While the majority cypress trees in the project area (planted at TY1) would be 11 years old, and would not be old enough yet to be considered a component of the overstory, other midstory tree species present at TY 0 (i.e., red maple, green ash, and water tupelo) would become a component of the overstory at TY 10. In addition, because construction of the gaps is designed to allow for drainage of the area during ARDC low flow events, seedling germination, establishment, and survival is expected to increase. Thus, we anticipate an overstory canopy closure between 33 and 50 percent and greater than a 33 percent midstory or herbaceous cover. [Class 3]

Future With Project
Target Years 25 – 50 –

The combined effects of increased deposition of fine-grained sediment, increased nutrient loading, increased freshwater flows, reduced salinities, seasonally-lower water levels, and vegetative planting should improve habitat conditions within the area. In addition, planted cypress trees are expected to be over 31 feet at age 26 (USDA 1980)

and would, therefore, be considered a component of the overstory. Because construction of the gaps is designed to allow for drainage of the area during ARDC low flow events, seedling germination, establishment, and survival is expected to increase. Thus, we anticipate an overstory canopy closure equal to or greater than 75 percent with a herbaceous cover greater than 33 percent. [Class 6]

Variable 2: Stand Maturity

Both *Future* *With* and *Future* *Without* *Project*
Target Year 0 –

This information was gathered during a July 30, 2009, field assessment. Those estimates, based on existing habitat conditions, were consistent with those found by Bernard Wood (Research Assistant Southeastern Louisiana University) through direct measurement of project area trees. His dbh estimate, for all tree species combined, was between 6.5 and 8.25 inches, as compared to our average of 7.2 inches determined during our WVA data collection field assessment. Basal area was estimated based on information gathered during the aforementioned field visit and data collected by Southeast Louisiana University over the past 10 years.

Future *Without* *Project*
Target Years 1 – 50 –

Values based on information presented in the PPL 12 WVA. Mean dbh for each species was estimated as the mean existing dbh plus the existing mean annual growth rate times X number of years (growth rate: cypress = .11 inches per year tupelo et al = .08 inches per year). Basal area was again estimated by a bottomland hardwood growth/basal area calculator developed by the United States Forest Service (Putnam et al. 1960) and percent composition of canopy trees was estimated based on best professional judgment. Within the PPL 12 WVA it was assumed that 50 percent of the tupelo et al would die over 20 years, but that actual mortality of cypress would be minimal. Over the 50

year project life, we assume that 75 percent of the tupelo et al would die with minimal cypress mortality. In addition, we assume that minimal regeneration would occur over 50 years based on the degraded habitat conditions. Subsequently, under the future without project scenario, basal areas decreased from time year 0 to 50.

Future With Project
Target Years 1 – 50 –

Values based on information presented in the PPL 12 WVA. Under the future with project scenario, construction of the gaps is expected to stimulate productivity and growth of cypress and tupelo. We assume that the high benefit areas would receive the most benefits from freshwater flows, nutrients, and sediments; thus, those areas should see the greatest increase in growth. These assumptions are similar to those by Hamilton and Shaffer (2001) for the Maurepas Diversion Project. Results of studies by John Day in wetlands receiving secondary treated sewage suggest that introduction of nutrients as well as sediments from river water could stimulate production by 3-5 fold (Hamilton and Shaffer 2001). Comparison of productivity in swamps that are either managed, have more favorable hydrology, and/or are receiving nutrient enrichment suggest that the existing level of productivity in Maurepas are ½ to ¼ of average values. As a conservative projection, we assume growth rates to be 167% of current growth in the primary impact areas, which is the same assumption used in the PPL 12 WVA. Percent composition of cypress trees was adjusted over the 50 years to mimic conditions in healthier portions of the project area. Basal area was estimated by a bottomland hardwood growth/basal area calculator developed by the United States Forest Service (Putnam et al. 1960).

Variable 3: Water Regime

Both *Future With* and *Future Without Project*
Target Year 0 –

At present the Maurepas Swamp within the project

area are semi-permanently flooded and have low flow/exchange.

Future Without Project
Target Years 1 – 50 –

Continued degradation of the area is expected under the future without project scenario. Because the area has some level of flow/exchange (albeit low), we anticipate the area to remain semi-permanently flooded over 50 years.

Future With Project
Target Years 1 – 50 –

We assume that the portions of the proposed project within the primary impact area would receive the highest amount of direct benefits from construction of the gaps and should experience a substantial increase in substrate accretion and nutrient input. In addition, being in the immediate area of the proposed gaps we assume that this area would receive a high level of flow-exchange. We, therefore, anticipate a seasonal flood duration with high flow/exchange.

Variable 4: Mean High Salinity During the Growing Season

Both *Future With* and *Future Without Project*
Target Year 0 –

Value based on information presented in the PPL 12 WVA. Specifically, for the Maurepas Diversion Project it was estimated that typical high salinity during the growing season would be about 1.4 ppt. Because the LCA ARDC Modification project is further from the lake (i.e., further from the source of saltwater intrusion) the CWPPRA Environmental Work Group assumed a lower mean high salinity in this area and adopted 1.2 ppt for the PPL 12 WVA.

Future Without Project
Target Years 1 – 50 –

Values based on information presented in the PPL 12 WVA. Specifically, subsidence is expected to

continue within the project area over time under the future without project scenario. We, therefore, assume that the ability for saltwater to intrude further and/or more frequently into the project area swamps would likewise increase. Thus, we assumed that mean high salinity during the growing season to increase to 1.4 ppt over 50 years.

Future With Project
Target Years 1 – 50 –

Values based on information presented in the PPL 12 WVA. Specifically, the proposed project was designed to allow for freshwater to be introduced into the swamp when water elevations in the ARDC are higher than in the swamp, which is expected to occur frequently. This frequent introduction of freshwater into the system from the ARDC is expected to result in a mean high salinity reduction for the first 10 years (i.e., 0.9 ppt from TY 1-10). Because of the anticipated increase in sea level rise over time, however, we assume an increase in mean high salinities of 1.0 and 1.2 ppt for TY 25 and 50, respectively.

- ***20 - 30 Years to Marsh***

Variable 1: Stand Structure

Both *Future With* and *Future Without Project*
Target Year 0 –

This information was gathered during a July 30, 2009, field assessment. Those estimates, based on existing habitat conditions, were consistent with those found by Bernard Wood (Research Assistant Southeastern Louisiana University). Specifically, total canopy cover is estimated to be approximately 60 percent with an approximate midstory cover of approximately 35 percent. [Class 4]

Future Without Project
Target Year 1 –

Because of the minimal time lapse since TY0, we predicted that the stand structure would remain a

Class 4.

Future Without Project
Target Years 10 – 50 –

Continued degradation of the area is anticipated under the future without project scenario. Because of this, we assumed that overstory closure would be reduced to less than 50 percent by TY10 (Class 2) and less than 33 percent by TY25 (Class 1).

Future With Project
Target Year 1 –

Because of the minimal time lapse since project construction (i.e., 1 year), we predicted that the stand structure would remain a Class 4.

Future With Project
Target Year 10 –

The combined effects of increased deposition of fine-grained sediment, increased nutrient loading, increased freshwater flows, reduced salinities, seasonally-lower water levels, and vegetative planting should improve habitat conditions over time within the area. In addition, because construction of the gaps is designed to allow for drainage of the area during ARDC low flow events, seedling germination, establishment, and survival is expected to increase. We do not, however, anticipate a significant change in stand structure in this area over 10 years. Therefore, we predicted stand structure would remain a Class 4.

Future With Project
Target Years 25 – 50 –

The combined effects of increased deposition of fine-grained sediment, increased nutrient loading, increased freshwater flows, reduced salinities, seasonally-lower water levels, and vegetative planting should improve habitat conditions within the area over time. Because construction of the gaps is designed to allow for drainage of the area during ARDC low flow events, seedling

germination, establishment, and survival is expected to increase. Thus, we anticipate an overstory canopy closure equal to or greater than 75 percent with a herbaceous cover or midstory cover greater than 33 percent. [Class 6]

Variable 2: Stand Maturity

Both *Future* *With* and *Future* *Without* *Project*
Target Year 0 –

This information was gathered during a July 30, 2009, field assessment. Those estimates, based on existing habitat conditions, were consistent with those found by Bernard Wood (Research Assistant Southeastern Louisiana University) through direct measurement of project area trees. His dbh estimate, for all tree species combined, was between 6.5 and 8.25 inches, as compared to our average of 7.9 inches determined during our WVA data collection field assessment. Basal area was estimated based on information gathered during the aforementioned field visit and data collected by Southeast Louisiana University over the past 10 years.

Future *Without* *Project*
Target Years 1 – 50 –

Values based on information presented in the PPL 12 WVA. Mean dbh for each species was estimated as the mean existing dbh plus the existing mean annual growth rate times X number of years (growth rate: cypress = .11 inches per year tupelo et al = .08 inches per year). Basal area was estimated based on data collected by Southeast Louisiana University over the past 10 years and percent composition of canopy trees was estimated based on best professional judgment. Within the PPL 12 WVA it was assumed that 50 percent of the tupelo et al would die over 20 years, but that actual mortality of cypress would be minimal. Over the 50 year project life, we assume that 75 percent of the tupelo et al would die with minimal cypress mortality occurring within the 10 year to marsh habitat type. Because habitat quality and conditions

are higher in the 20 year to marsh habitat type, as compared to the 10 year to marsh habitat type, we assume that tupelo mortality would occur, but at a slower rate. Therefore, we predict that 50 percent of the tupelo et al would die over the 50 year project life. Subsequently, under the future without project scenario, basal areas decreased from time year 0 to 50.

Future With Project

Target Years 1 – 50 –

Values based on information presented in the PPL 12 WVA. Under the future with project scenario, construction of the gaps is expected to stimulate productivity and growth of cypress and tupelo. We assume that the primary impact areas would receive the most benefits from freshwater flows, nutrients, and sediments; thus, those areas should see the greatest increase in growth. These assumptions are similar to those by Hamilton and Shaffer (2001) for the Maurepas Diversion Project. Results of studies by John Day in wetlands receiving secondary treated sewage suggest that introduction of nutrients as well as sediments from river water could stimulate production by 3-5 fold (Hamilton and Shaffer 2001). Comparison of productivity in swamps that are either managed, have more favorable hydrology, and/or are receiving nutrient enrichment suggest that the existing level of productivity in Maurepas are ½ to ¼ of average values. As a conservative projection, we assume growth rates to be 167% of current growth in the high benefit areas, which is the same assumption used in the PPL 12 WVA. Percent composition of cypress trees was adjusted over the 50 years to mimic conditions in healthier portions of the project area. Basal area was estimated by a bottomland hardwood growth/basal area calculator developed by the United States Forest Service (Putnam et al. 1960).

Variable 3: Water Regime

Both *Future With* and *Future Without Project*

Target Year 0 –

At present the Maurepas Swamp within the project area are semi-permanently flooded and have low flow/exchange.

Future Without Project
Target Years 1 – 50 –

Continued degradation of the area is expected under the future without project scenario. Because the area has some level of flow/exchange (albeit low), we anticipate the area to remain semi-permanently flooded over 50 years.

Future With Project
Target Years 1 – 50 –

We assume that the portions of the proposed project within the primary impact area would receive the highest amount of direct benefits from construction of the gaps and should experience a substantial increase in substrate accretion and nutrient input. In addition, being in the immediate area of the proposed gaps we assume that this area would receive a high level of flow-exchange. We, therefore, anticipate a seasonal flood duration with high flow/exchange.

Variable 4: Mean High Salinity During the Growing Season

Both *Future With* and *Future Without Project*
Target Year 0 –

Value based on information presented in the PPL 12 WVA. Specifically, for the Maurepas Diversion Project it was estimated that typical high salinity during the growing season would be about 1.4 ppt. Because the LCA ARDC Modification project is further from the lake (i.e., further from the source of saltwater intrusion) the CWPPRA Environmental Work Group assumed a lower mean high salinity in this area and adopted 1.2 ppt for the PPL 12 WVA.

Future Without Project
Target Years 1 – 50 –

Values based on information presented in the PPL 12 WVA. Specifically, subsidence is expected to continue within the project area over time under the future without project scenario. We, therefore, assume that the ability for saltwater to intrude further and/or more frequently into the project area swamps would likewise increase. Thus, we assumed that mean high salinity during the growing season to increase to 1.4 ppt over 50 years.

Future With Project
Target Years 1 – 50 –

Values based on information presented in the PPL 12 WVA. Specifically, the proposed project was designed to allow for freshwater to be introduced into the swamp when water elevations in the ARDC are higher than in the swamp, which is expected to occur frequently. This frequent introduction of freshwater into the system from the ARDC is expected to result in a mean high salinity reduction for the first 10 years (i.e., 0.9 parts per thousand [ppt] from TY 1-10). Because of the anticipated increase in sea level rise over time, however, we assume an increase in mean high salinities of 1.0 and 1.2 ppt for TY 25 and 50, respectively.

- ***30 -50 Years to Marsh***

Variable 1: Stand Structure

Both *Future With* and *Future Without Project*
Target Year 0 –

This information was provided by Bernard Wood (Research Assistant Southeastern Louisiana University). Specifically, total canopy cover is estimated to be between 50 and 75 percent with a midstory cover greater than 33 percent or a herbaceous cover greater than 33 percent. [Class 4]

Future Without Project
Target Year 1 –

Because of the minimal time lapse since TY0, we predicted that the stand structure would remain a

Class 4.

Future Without Project
Target Years 10 – 50 –

Continued degradation of the area is anticipated under the future without project scenario. Because of this, we assumed that overstory closure would be reduced to less than 50 percent by TY25 (Class 3) and less than 33 percent by TY50 (Class 1).

Future With Project
Target Year 1 –

Because of the minimal time lapse since project construction (i.e., 1 year), we predicted that the stand structure would remain a Class 4.

Future With Project
Target Year 10 –

The combined effects of increased deposition of fine-grained sediment, increased nutrient loading, increased freshwater flows, reduced salinities, seasonally-lower water levels, and vegetative planting should improve habitat conditions over time within the area. In addition, because construction of the gaps is designed to allow for drainage of the area during ARDC low flow events, seedling germination, establishment, and survival is expected to increase. We do not, however, anticipate a significant change in stand structure in this area over 10 years. Therefore, we predicted stand structure would remain a Class 4.

Future With Project
Target Years 25 – 50 –

The combined effects of increased deposition of fine-grained sediment, increased nutrient loading, increased freshwater flows, reduced salinities, seasonally-lower water levels, and vegetative planting should improve habitat conditions within the area over time. Because construction of the gaps is designed to allow for drainage of the area during ARDC low flow events, seedling

germination, establishment, and survival is expected to increase. Thus, we anticipate an overstory canopy closure equal to or greater than 75 percent with a herbaceous cover or midstory cover greater than 33 percent. [Class 6]

Variable 2: Stand Maturity

Both *Future* *With* and *Future* *Without* *Project*
Target Year 0 –

This information was provided by Bernard Wood through direct measurement of project area trees.

Future *Without* *Project*
Target Years 1 – 50 –

Values based on information provided by Bernard Wood. Mean dbh for each species was estimated as the mean existing dbh plus the existing mean annual growth rate times X number of years (growth rate: cypress = .15 inches per year tupelo et al = .10 inches per year). Basal area was estimated based on data collected by Southeast Louisiana University over the past 10 years and percent composition of canopy trees was estimated based on best professional judgment. Within the PPL 12 WVA it was assumed that 50 percent of the tupelo et al would die over 20 years, but that actual mortality of cypress would be minimal. Over the 50 year project life, we assume that 75 percent of the tupelo et al would die with minimal cypress mortality occurring within the 10 year to marsh habitat type. Because habitat quality and conditions are higher in the 30 - 50 year to marsh habitat type, as compared to the 10 year to marsh habitat type, we assume that tupelo mortality would occur, but at a slower rate. Therefore, we predict that 50 percent of the tupelo et al would die over the 50 year project life. Subsequently, under the future without project scenario basal areas decrease slightly from time year 0 to 25 and decrease significantly between time year 25 and 50 due to the projected loss of canopy cover.

Future *With* *Project*

Target Years 1 – 50 –

Values based on information presented in the PPL 12 WVA and information provided by Mr. Bernard Wood. Under the future with project scenario, construction of the gaps is expected to stimulate productivity and growth of cypress and tupelo. We assume that the primary impact areas would receive the most benefits from freshwater flows, nutrients, and sediments; thus, those areas should see the greatest increase in growth. These assumptions are similar to those by Hamilton and Shaffer (2001) for the Maurepas Diversion Project. Results of studies by John Day in wetlands receiving secondary treated sewage suggest that introduction of nutrients as well as sediments from river water could stimulate production by 3-5 fold (Hamilton and Shaffer 2001). Comparison of productivity in swamps that are either managed, have more favorable hydrology, and/or are receiving nutrient enrichment suggest that the existing level of productivity in Maurepas are ½ to ¼ of average values. As a conservative projection, we assume growth rates to be 167% of current growth in the high benefit areas, which is the same assumption used in the PPL 12 WVA. Percent composition of cypress trees was adjusted over the 50 years to mimic conditions in healthier portions of the project area. Basal area was estimated by a bottomland hardwood growth/basal area calculator developed by the United States Forest Service (Putnam et al. 1960).

Variable 3: Water Regime

Both *Future* *With* and *Future* *Without* *Project*
Target Year 0 –

At present the Maurepas Swamp within the project area are temporarily flooded and have low flow/exchange.

Future *Without* *Project*
Target Years 1 – 50 –

Continued degradation of the area is expected under

the future without project scenario. Because the area has some level of flow/exchange (albeit low), we anticipate the area to remain temporarily flooded over 50 years.

Future With Project
Target Years 1 – 50 –

We assume that the portions of the proposed project within the primary impact area would receive the highest amount of direct benefits from construction of the gaps and should experience a substantial increase in substrate accretion and nutrient input. In addition, being in the immediate area of the proposed gaps we assume that this area would receive a high level of flow-exchange. We, therefore, anticipate a seasonal flood duration with high flow/exchange.

Variable 4: Mean High Salinity During the Growing Season

Both *Future With* and *Future Without Project*
Target Year 0 –

Value based on information presented in the PPL 12 WVA. Specifically, for the Maurepas Diversion Project it was estimated that typical high salinity during the growing season would be about 1.4 ppt. Because the LCA ARDC Modification project is further from the lake (i.e., further from the source of saltwater intrusion) the CWPPRA Environmental Work Group assumed a lower mean high salinity in this area and adopted 1.2 ppt for the PPL 12 WVA.

Future Without Project
Target Years 1 – 50 –

Values based on information presented in the PPL 12 WVA. Specifically, subsidence is expected to continue within the project area over time under the future without project scenario. We, therefore, assume that the ability for saltwater to intrude further and/or more frequently into the project area swamps would likewise increase. Thus, we assumed that mean high salinity during the growing season to increase to 1.4 ppt over 50 years.

Future With Project
Target Years 1 – 50 –

Values based on information presented in the PPL 12 WVA. Specifically, the proposed project was designed to allow for freshwater to be introduced into the swamp when water elevations in the ARDC are higher than in the swamp, which is expected to occur frequently. This frequent introduction of freshwater into the system from the ARDC is expected to result in a mean high salinity reduction for the first 10 years (i.e., 0.9 ppt from TY 1-10). Because of the anticipated increase in sea level rise over time, however, we assume an increase in mean high salinities of 1.0 and 1.2 ppt for TY 25 and 50, respectively.

Secondary Impact Areas

- ***Fresh Marsh*** – The Swamp Model was chosen for this area over the Fresh Marsh Model, even though there is less than a 33 percent canopy cover, because the area provides functions and values more closely associated with a swamp than a fresh marsh.

Variable 1: Stand Structure

Both *Future With* and *Future Without Project*
Target Year 0 –

This information was gathered during a July 30, 2009, field assessment. It was the consensus of the group that there is less than 33 percent overstory closure. [Class 1]

Future Without Project
Target Years 1 – 50 –

Continued degradation of the area is anticipated under the future without project scenario. Because of the low tree density and degraded condition, the area is expected to remain a Class 1.

Future With Project
Target Year 1 –

Because of the minimal time lapse since project construction (i.e., 1 year), we predicted that the stand structure would remain a Class 1.

Future With Project
Target Year 10 –

The combined effects of increased deposition of fine-grained sediment, increased nutrient loading, increased freshwater flows, reduced salinities, seasonally-lower water levels, and vegetative planting should improve habitat conditions within the area. However, cypress trees planted at TY1 would be 11 years old. In Louisiana, the height of cypress at 10 years of age is, on average, 17 feet (USDA 1980). Therefore, because there were no tree species within the midstory at TY 0 and because planted cypress trees would not be old enough yet to be considered a component of the overstory, we anticipate the stand structure would remain a Class 1.

Future With Project
Target Year 25 –

The combined effects of increased deposition of fine-grained sediment, increased nutrient loading, increased freshwater flows, reduced salinities, seasonally-lower water levels, and vegetative planting should improve habitat conditions within the area. In addition, planted cypress trees are expected to be over 31 feet at age 26 (USDA 1980) and would, therefore, be considered a component of the overstory. Accordingly, we anticipate an overstory closure of 50 -75 percent with a midstory or herbaceous cover greater than 33 percent. [Class 4]

Future With Project
Target Year 50 –

The combined effects of increased deposition of fine-grained sediment, increased nutrient loading, increased freshwater flows, reduced salinities, seasonally-lower water levels, and vegetative

planting should continue to improve habitat conditions within the area. Accordingly, we anticipate an overstory closure of greater than or equal to 75 percent with either a midstory cover or herbaceous cover greater than 33 percent. [Class 6]

Variable 2: Stand Maturity

Both *Future* *With* and *Future* *Without* *Project*
Target Year 0 –

This information was gathered during a July 30, 2009, field assessment. Those estimates, based on existing habitat conditions, were consistent with those found by Bernard Wood (Research Assistant Southeastern Louisiana University) through direct measurement of project area trees. His dbh estimate, for all tree species combined, was between 6.5 and 8.25 inches, as compared to our average of 6.3 inches determined during our WVA data collection field assessment. Although our estimate is on the lower end of the range determined by Mr. Wood, because the subject area represents some of the more degraded habitat we feel that this estimate is representative of existing habitat conditions. Basal area was estimated based on information gathered during the aforementioned field visit and data collected by Southeast Louisiana University over the past 10 years.

Future *Without* *Project*
Target Years 1 – 50 –

Values based on information presented in the PPL 12 WVA. Mean dbh for each species was estimated as the mean existing dbh plus the existing mean annual growth rate times X number of years (growth rate: cypress = .11 inches per year tupelo et al = .08 inches per year). Basal area was again estimated by a bottomland hardwood growth/basal area calculator developed by the United States Forest Service (Putnam et al. 1960) and percent composition of canopy trees was estimated based on best professional judgment. Within the PPL 12 WVA it was assumed that 50 percent of the tupelo et al would die over 20 years, but that actual

mortality of cypress would be minimal. Over the 50 year project life, we assume that 75 percent of the tupelo et al would die with minimal cypress mortality. In addition, we assume that minimal regeneration would occur over 50 years based on the degraded habitat conditions and lack of tree species at TY 0 in the understory. Subsequently, under the future without project scenario, basal areas decreased from time year 0 to 50.

Future With Project

Target Years 1 – 50 –

Values based on information presented in the PPL 12 WVA. Under the future with project scenario, construction of the gaps is expected to stimulate productivity and growth of cypress and tupelo. We assume that the secondary impact areas would receive the benefits from freshwater flows, nutrients, and sediments; however, to a lesser extent than the primary impact areas. These assumptions are similar to those by Hamilton and Shaffer (2001) for the Maurepas Diversion Project. Results of studies by John Day in wetlands receiving secondary treated sewage suggest that introduction of nutrients as well as sediments from river water could stimulate production by 3-5 fold (Hamilton and Shaffer 2001). Comparison of productivity in swamps that are either managed, have more favorable hydrology, and/or are receiving nutrient enrichment suggest that the existing level of productivity in Maurepas are ½ to ¼ of average values. As a conservative projection, we assume growth rates to be 129% of current growth in the secondary impact areas, which is the same assumption used in the PPL 12 WVA. Percent composition of cypress trees was adjusted over the 50 years to mimic conditions in healthier portions of the project area. Basal area was estimated by a bottomland hardwood growth/basal area calculator developed by the United States Forest Service (Putnam et al. 1960) and is assumed to result in similar conditions as the 155 acre fresh marsh high benefit area since vegetated plantings are proposed.

Variable 3: Water Regime

Both *Future* *With* and *Future* *Without* *Project*
Target Year 0 –

At present the Maurepas Swamp within this portion of the project area are semi-permanently flooded and have low flow/exchange.

Future *Without* *Project*
Target Years 1 – 50 –

Continued degradation of the area is expected under the future without project scenario. Because the area has some level of flow/exchange (albeit low), we anticipate the area to remain semi-permanently flooded over 50 years.

Future *With* *Project*
Target Years 1 – 50 –

We assume that the portions of the proposed project within the secondary impact areas are expected to see direct benefits from construction of the gaps, and should experience an increase in substrate accretion and nutrient input, however, to a lesser extent than the primary impact areas. Being located further from the proposed gaps than the primary impact areas, we assume that the secondary impact areas would also experience some level of improvement in flooding duration due to improved drainage of the swamp, however, not to the extent of the primary impact areas. We, therefore, anticipate a semi-permanent flood duration with moderate flow/exchange.

Variable 4: Mean High Salinity During the Growing Season

Both *Future* *With* and *Future* *Without* *Project*
Target Year 0 –

Value based on information presented in the PPL 12 WVA. Specifically, for the Maurepas Diversion Project it was estimated that typical high salinity during the growing season would be about 1.4 ppt. Because the ARDC project is further from the lake (i.e., further from the source of saltwater intrusion)

the CWPPRA Environmental Work Group assumed a lower mean high salinity in this area and adopted 1.2 ppt for the PPL 12 WVA.

Future Without Project
Target Years 1 – 50 –

Values based on information presented in the PPL 12 WVA. Specifically, subsidence is expected to continue within the project area over time under the future without project scenario. We, therefore, assume that the ability for saltwater to intrude further and/or more frequently into the project area swamps would likewise increase. Thus, we assumed that mean high salinity during the growing season would increase to 1.4 ppt over 50 years.

Future With Project
Target Years 1 – 50 –

Values based on information presented in the PPL 12 WVA. Specifically, the proposed project was designed to allow for freshwater to be introduced into the swamp when water elevations in the ARDC are higher than in the swamp, which is anticipated to occur frequently. This frequent introduction of freshwater into the system from the ARDC is expected to result in a mean high salinity reduction. However, because the secondary impact areas are located further from the gaps than the primary impact areas and because the volume of water would be spread over a larger area we assumed that mean high salinity benefits would be less in those areas (1.0 ppt for TY 1 and 10). In addition, because of the anticipated increase in sea level rise over time, we assume an increase in mean high salinities of 1.1 and 1.3 ppt for TY 25 and 50, respectively.

- ***10 Years to Marsh***

Variable 1: Stand Structure

Both *Future With* and *Future Without Project*
Target Year 0 –

This information was gathered during a July 30, 2009, field assessment. Those estimates, based on existing habitat conditions, were consistent with those found by Bernard Wood (Research Assistant Southeastern Louisiana University). Specifically, total canopy cover is estimated to be approximately 35 percent with an approximate midstory cover of 17 percent. [Class 2]

Future Without Project
Target Year 1 –

Because of the minimal time lapse since TY0, we predicted that the stand structure would remain a Class 2.

Future Without Project
Target Years 10 – 50 –

Continued degradation of the area is anticipated under the future without project scenario. Because of the low tree density and degraded condition, we downgraded the variable to a Class 1.

Future With Project
Target Year 1 –

Because of the minimal time lapse since project construction (i.e., 1 year), we predicted that the stand structure would remain a Class 2.

Future With Project
Target Year 10 –

The combined effects of increased deposition of fine-grained sediment, increased nutrient loading, increased freshwater flows, reduced salinities, seasonally-lower water levels, and vegetative planting should improve habitat conditions within the area. While the majority cypress trees in the project area (planted at TY1) would be 11 years old, and would not be old enough yet to be considered a component of the overstory, other midstory tree species present at TY 0 (i.e., red maple, green ash, and water tupelo) would become a component of the overstory at TY 10. In addition, because

construction of the gaps is designed to allow for drainage of the area during ARDC low flow events, seedling germination, establishment, and survival is expected to increase. Thus, we anticipate an overstory canopy closure between 33 and 50 percent and greater than a 33 percent midstory or herbaceous cover. [Class 3]

Future With Project
Target Years 25 – 50 –

The combined effects of increased deposition of fine-grained sediment, increased nutrient loading, increased freshwater flows, reduced salinities, seasonally-lower water levels, and vegetative planting should improve habitat conditions within the area. In addition, planted cypress trees are expected to be over 31 feet at age 26 (USDA 1980) and would, therefore, be considered a component of the overstory. Because construction of the gaps is designed to allow for drainage of the area during ARDC low flow events, seedling germination, establishment, and survival is expected to increase. Thus, we anticipate an overstory canopy closure equal to or greater than 75 percent with a herbaceous cover greater than 33 percent. [Class 6]

Variable 2: Stand Maturity

Both *Future With* and *Future Without Project*
Target Year 0 –

This information was gathered during a July 30, 2009, field assessment. Those estimates, based on existing habitat conditions, were consistent with those found by Bernard Wood (Research Assistant Southeastern Louisiana University) through direct measurement of project area trees. His dbh estimate, for all tree species combined, was between 6.5 and 8.25 inches, as compared to our average of 7.2 inches determined during our WVA data collection field assessment. Basal area was estimated based on information gathered during the aforementioned field visit and data collected by Southeast Louisiana University over the past 10 years.

Future <u>Without</u> Project

Target Years 1 – 50 –

Values based on information presented in the PPL 12 WVA. Mean dbh for each species was estimated as the mean existing dbh plus the existing mean annual growth rate times X number of years (growth rate: cypress = .11 inches per year tupelo et al = .08 inches per year). Basal area was again estimated by a bottomland hardwood growth/basal area calculator developed by the United States Forest Service (Putnam et al. 1960) and percent composition of canopy trees was estimated based on best professional judgment. Within the PPL 12 WVA it was assumed that 50 percent of the tupelo et al would die over 20 years, but that actual mortality of cypress would be minimal. Over the 50 year project life, we assume that 75 percent of the tupelo et al would die with minimal cypress mortality. In addition, we assume that minimal regeneration would occur over 50 years based on the degraded habitat conditions. Subsequently, under the future without project scenario, basal areas decreased from time year 0 to 50.

Future <u>With</u> Project

Target Years 1 – 50 –

Values based on information presented in the PPL 12 WVA. Under the future with project scenario, construction of the gaps is expected to stimulate productivity and growth of cypress and tupelo. We assume that the secondary impact areas would receive the benefits from freshwater flows, nutrients, and sediments; however, to a lesser extent than the primary impact areas. These assumptions are similar to those by Hamilton and Shaffer (2001) for the Maurepas Diversion Project. Results of studies by John Day in wetlands receiving secondary treated sewage suggest that introduction of nutrients as well as sediments from river water could stimulate production by 3-5 fold (Hamilton and Shaffer 2001). Comparison of productivity in swamps that are either managed, have more favorable hydrology, and/or are receiving nutrient

enrichment suggest that the existing level of productivity in Maurepas are ½ to ¼ of average values. As a conservative projection, we assume growth rates to be 129% of current growth in the secondary impact areas, which is the same assumption used in the PPL 12 WVA. Percent composition of cypress trees was adjusted over the 50 years to mimic conditions in healthier portions of the project area. Basal area was estimated by a bottomland hardwood growth/basal area calculator developed by the United States Forest Service (Putnam et al. 1960).

Variable 3: Water Regime

Both *Future With* and *Future Without Project*
Target Year 0 –

At present the Maurepas Swamp within the project area are semi-permanently flooded and have low flow/exchange.

Future Without Project
Target Years 1 – 50 –

Continued degradation of the area is expected under the future without project scenario. Because the area has some level of flow/exchange (albeit low), we anticipate the area to remain semi-permanently flooded over 50 years.

Future With Project
Target Years 1 – 50 –

We assume that the portions of the proposed project within the secondary impact areas are expected to see direct benefits from construction of the gaps, and should experience an increase in substrate accretion and nutrient input, however, to a lesser extent than the primary impact areas. Being located further from the proposed gaps than the primary impact areas, we assume that the secondary impact areas would also experience some level of improvement in flooding duration due to improved drainage of the swamp, however, not to the extent of the primary impact areas. We, therefore,

anticipate a semi-permanent flood duration with moderate flow/exchange.

Variable 4: Mean High Salinity During the Growing Season

Both *Future* *With* and *Future* *Without* *Project*
Target Year 0 –

Value based on information presented in the PPL 12 WVA. Specifically, for the Maurepas Diversion Project it was estimated that typical high salinity during the growing season would be about 1.4 ppt. Because the LCA ARDC Modification project is further from the lake (i.e., further from the source of saltwater intrusion) the CWPPRA Environmental Work Group assumed a lower mean high salinity in this area and adopted 1.2 ppt for the PPL 12 WVA.

Future *Without* *Project*
Target Years 1 – 50 –

Values based on information presented in the PPL 12 WVA. Specifically, subsidence is expected to continue within the project area over time under the future without project scenario. We, therefore, assume that the ability for saltwater to intrude further and/or more frequently into the project area swamps would likewise increase. Thus, we assumed that mean high salinity during the growing season would increase to 1.4 ppt over 50 years.

Future *With* *Project*
Target Years 1 – 50 –

Values based on information presented in the PPL 12 WVA. Specifically, the proposed project was designed to allow for freshwater to be introduced into the swamp when water elevations in the ARDC are higher than in the swamp, which is anticipated to occur frequently. This frequent introduction of freshwater into the system from the ARDC is expected to result in a mean high salinity reduction. However, because the secondary impact areas are located further from the gaps than the primary impact areas and because the volume of water would be spread over a larger area we assumed that

mean high salinity benefits would be less in those areas (1.0 ppt for TY 1 and 10). In addition, because of the anticipated increase in sea level rise over time, we assume an increase in mean high salinities of 1.1 and 1.3 ppt for TY 25 and 50, respectively.

- ***20 - 30 Years to Marsh***

Variable 1: Stand Structure

Both *Future* *With* and *Future* *Without* *Project*
Target Year 0 –

This information was gathered during a July 30, 2009, field assessment. Those estimates, based on existing habitat conditions, were consistent with those found by Bernard Wood (Research Assistant Southeastern Louisiana University). Specifically, total canopy cover is estimated to be approximately 60 percent with an approximate midstory cover of approximately 35 percent. [Class 4]

Future *Without* *Project*
Target Year 1 –

Because of the minimal time lapse since TY0, we predicted that the stand structure would remain a Class 4.

Future *Without* *Project*
Target Years 10 – 50 –

Continued degradation of the area is anticipated under the future without project scenario. Because of this, we assumed that overstory closure would be reduced to less than 50 percent by TY10 (Class 2) and less than 33 percent by TY25 (Class 1).

Future *With* *Project*
Target Year 1 –

Because of the minimal time lapse since project construction (i.e., 1 year), we predicted that the stand structure would remain a Class 4.

Future With Project
Target Year 10 –

The combined effects of increased deposition of fine-grained sediment, increased nutrient loading, increased freshwater flows, reduced salinities, seasonally-lower water levels, and vegetative planting should improve habitat conditions over time within the area. In addition, because construction of the gaps is designed to allow for drainage of the area during ARDC low flow events, seedling germination, establishment, and survival is expected to increase. We do not, however, anticipate a significant change in stand structure in this area over 10 years. Therefore, we predicted stand structure would remain a Class 4.

Future With Project
Target Years 25 – 50 –

The combined effects of increased deposition of fine-grained sediment, increased nutrient loading, increased freshwater flows, reduced salinities, seasonally-lower water levels, and vegetative planting should improve habitat conditions within the area over time. Because construction of the gaps is designed to allow for drainage of the area during ARDC low flow events, seedling germination, establishment, and survival is expected to increase. Thus, we anticipate an overstory canopy closure equal to or greater than 75 percent with a herbaceous cover or midstory cover greater than 33 percent. [Class 6]

Variable 2: Stand Maturity

Both *Future With* and *Future Without Project*
Target Year 0 –

This information was gathered during a July 30, 2009, field assessment. Those estimates, based on existing habitat conditions, were consistent with those found by Bernard Wood (Research Assistant Southeastern Louisiana University) through direct measurement of project area trees. His dbh estimate, for all tree species combined, was between

6.5 and 8.25 inches, as compared to our average of 7.9 inches determined during our WVA data collection field assessment. Basal area was estimated based on information gathered during the aforementioned field visit and data collected by Southeast Louisiana University over the past 10 years.

Future Without Project

Target Years 1 – 50 –

Values based on information presented in the PPL 12 WVA. Mean dbh for each species was estimated as the mean existing dbh plus the existing mean annual growth rate times X number of years (growth rate: cypress = .11 inches per year tupelo et al = .08 inches per year). Basal area was again estimated by a bottomland hardwood growth/basal area calculator developed by the United States Forest Service (Putnam et al. 1960) and percent composition of canopy trees was estimated based on best professional judgment. Within the PPL 12 WVA it was assumed that 50 percent of the tupelo et al would die over 20 years, but that actual mortality of cypress would be minimal. Over the 50 year project life, we assume that 75 percent of the tupelo et al would die with minimal cypress mortality occurring within the 10 year to marsh habitat type. Because habitat quality and conditions are higher in the 20 year to marsh habitat type, as compared to the 10 year to marsh habitat type, we assume that tupelo mortality would occur, but at a slower rate. Therefore, we predict that 50 percent of the tupelo et al would die over the 50 year project life. Subsequently, under the future without project scenario, basal areas decrease from time year 0 to 50.

Future With Project

Target Years 1 – 50 –

Values based on information presented in the PPL 12 WVA. Under the future with project scenario, construction of the gaps is expected to stimulate productivity and growth of cypress and tupelo. We assume that the secondary impact areas would

receive benefits from freshwater flows, nutrients, and sediments; however, to a lesser extent than the primary impact areas. These assumptions are similar to those by Hamilton and Shaffer (2001) for the Maurepas Diversion Project. Results of studies by John Day in wetlands receiving secondary treated sewage suggest that introduction of nutrients as well as sediments from river water could stimulate production by 3-5 fold (Hamilton and Shaffer 2001). Comparison of productivity in swamps that are either managed, have more favorable hydrology, and/or are receiving nutrient enrichment suggest that the existing level of productivity in Maurepas are ½ to ¼ of average values. As a conservative projection, we assume growth rates to be 129% of current growth in the secondary impact areas, which is the same assumption used in the PPL 12 WVA. Percent composition of cypress trees was adjusted over the 50 years to mimic conditions in healthier portions of the project area. Basal area was estimated by a bottomland hardwood growth/basal area calculator developed by the United States Forest Service (Putnam et al. 1960).

Variable 3: Water Regime

Both *Future* *With* and *Future* *Without* *Project*
Target Year 0 –

At present the Maurepas Swamp within the project area are semi-permanently flooded and have low flow/exchange.

Future *Without* *Project*
Target Years 1 – 50 –

Continued degradation of the area is expected under the future without project scenario. Because the area has some level of flow/exchange (albeit low), we anticipate the area to remain semi-permanently flooded over 50 years.

Future *With* *Project*
Target Years 1 – 50 –

We assume that the portions of the proposed project within the secondary impact areas are expected to see direct benefits from construction of the gaps, and should experience an increase in substrate accretion and nutrient input, however, to a lesser extent than the primary impact areas. Being located further from the proposed gaps than the primary impact areas, we assume that the secondary impact areas would also experience some level of improvement in flooding duration due to improved drainage of the swamp, however, not to the extent of the primary impact areas. We, therefore, anticipate a semi-permanent flood duration with moderate flow/exchange.

Variable 4: Mean High Salinity During the Growing Season

Both *Future With* and *Future Without Project*
Target Year 0 –

Value based on information presented in the PPL 12 WVA. Specifically, for the Maurepas Diversion Project it was estimated that typical high salinity during the growing season would be about 1.4 ppt. Because the LCA ARDC Modification project is further from the lake (i.e., further from the source of saltwater intrusion) the CWPPRA Environmental Work Group assumed a lower mean high salinity in this area and adopted 1.2 ppt for the PPL 12 WVA.

Future Without Project
Target Years 1 – 50 –

Values based on information presented in the PPL 12 WVA. Specifically, subsidence is expected to continue within the project area over time under the future without project scenario. We, therefore, assume that the ability for saltwater to intrude further and/or more frequently into the project area swamps would likewise increase. Thus, we assumed that mean high salinity during the growing season would increase to 1.4 ppt over 50 years.

Future With Project
Target Years 1 – 50 –

Values based on information presented in the PPL 12 WVA. Specifically, the proposed project was designed to allow for freshwater to be introduced into the swamp when water elevations in the ARDC are higher than in the swamp, which is anticipated to occur frequently. This frequent introduction of freshwater into the system from the ARDC is expected to result in a mean high salinity reduction. However, because the secondary impact areas are located further from the gaps than the primary impact areas and because the volume of water would be spread over a larger area we assumed that mean high salinity benefits would be less in those areas (1.0 ppt for TY 1 and 10). In addition, because of the anticipated increase in sea level rise over time, we assume an increase in mean high salinities of 1.1 and 1.3 ppt for TY 25 and 50, respectively.

- ***30 -50 Years to Marsh***

Variable 1: Stand Structure

Both *Future* *With* and *Future* *Without* *Project*
Target Year 0 –

This information was provided by Bernard Wood (Research Assistant Southeastern Louisiana University). Specifically, total canopy cover is estimated to be between 50 and 75 percent with a midstory cover greater than 33 percent or a herbaceous cover greater than 33 percent. [Class 4]

Future *Without* *Project*
Target Year 1 –

Because of the minimal time lapse since TY0, we predicted that the stand structure would remain a Class 4.

Future *Without* *Project*
Target Years 10 – 50 –

Degradation of the area is anticipated under the future without project scenario. Because of this, we assumed that overstory closure would be reduced to

less than 50 percent by TY25 (Class 3) and less than 33 percent by TY50 (Class 1).

Future <u>With</u> Project
Target Year 1 –

Because of the minimal time lapse since project construction (i.e., 1 year), we predicted that the stand structure would remain a Class 4.

Future <u>With</u> Project
Target Year 10 –

The combined effects of increased deposition of fine-grained sediment, increased nutrient loading, increased freshwater flows, reduced salinities, seasonally-lower water levels, and vegetative planting should improve habitat conditions over time within the area. In addition, because construction of the gaps is designed to allow for drainage of the area during ARDC low flow events, seedling germination, establishment, and survival is expected to increase. We do not, however, anticipate a significant change in stand structure in this area over 10 years. Therefore, we predicted stand structure would remain a Class 4.

Future <u>With</u> Project
Target Years 25 – 50 –

The combined effects of increased deposition of fine-grained sediment, increased nutrient loading, increased freshwater flows, reduced salinities, seasonally-lower water levels, and vegetative planting should improve habitat conditions within the area over time. Because construction of the gaps is designed to allow for drainage of the area during ARDC low flow events, seedling germination, establishment, and survival is expected to increase. Thus, we anticipate an overstory canopy closure equal to or greater than 75 percent with a herbaceous cover or midstory cover greater than 33 percent. [Class 6]

Variable 2: Stand Maturity

Both *Future* *With* and *Future* *Without* *Project*
Target Year 0 –

This information was provided by Bernard Wood through direct measurement of project area trees.

Future *Without* *Project*
Target Years 1 – 50 –

Values based on information provided by Bernard Wood. Mean dbh for each species was estimated as the mean existing dbh plus the existing mean annual growth rate times X number of years (growth rate: cypress = .15 inches per year tupelo et al = .10 inches per year). Basal area was estimated based on data collected by Southeast Louisiana University over the past 10 years and percent composition of canopy trees was estimated based on best professional judgment. Within the PPL 12 WVA it was assumed that 50 percent of the tupelo et al would die over 20 years, but that actual mortality of cypress would be minimal. Over the 50 year project life, we assume that 75 percent of the tupelo et al would die with minimal cypress mortality occurring within the 10 year to marsh habitat type. Because habitat quality and conditions are higher in the 30 - 50 year to marsh habitat type, as compared to the 10 year to marsh habitat type, we assume that tupelo mortality would occur, but at a slower rate. Therefore, we predict that 50 percent of the tupelo et al would die over the 50 year project life. Subsequently, under the future without project scenario basal areas decrease slightly from time year 0 to 25 and decrease significantly between time year 25 and 50 due to the projected loss of canopy cover.

Future *With* *Project*
Target Years 1 – 50 –

Values based on information presented in the PPL 12 WVA. Under the future with project scenario, construction of the gaps is expected to stimulate productivity and growth of cypress and tupelo. We assume that the secondary impact areas would receive benefits from freshwater flows, nutrients,

and sediments; however, to a lesser extent than the primary impact areas. These assumptions are similar to those by Hamilton and Shaffer (2001) for the Maurepas Diversion Project. Results of studies by John Day in wetlands receiving secondary treated sewage suggest that introduction of nutrients as well as sediments from river water could stimulate production by 3-5 fold (Hamilton and Shaffer 2001). Comparison of productivity in swamps that are either managed, have more favorable hydrology, and/or are receiving nutrient enrichment suggest that the existing level of productivity in Maurepas are ½ to ¼ of average values. As a conservative projection, we assume growth rates to be 129% of current growth in the secondary impact areas, which is the same assumption used in the PPL 12 WVA. Percent composition of cypress trees was adjusted over the 50 years to mimic conditions in healthier portions of the project area. Basal area was estimated by a bottomland hardwood growth/basal area calculator developed by the United States Forest Service (Putnam et al. 1960).

Variable 3: Water Regime

Both *Future With* and *Future Without Project*
Target Year 0 –

At present the Maurepas Swamp within the project area are temporarily flooded and have low flow/exchange.

Future Without Project
Target Years 1 – 50 –

Degradation of the area is expected under the future without project scenario. Because the area has some level of flow/exchange (albeit low), we anticipate the area to remain temporarily flooded over 50 years.

Future With Project
Target Years 1 – 50 –

We assume that the portions of the proposed project

within the secondary impact areas are expected to see direct benefits from construction of the gaps, and should experience an increase in substrate accretion and nutrient input, however, to a lesser extent than the primary impact areas. Being located further from the proposed gaps than the primary impact areas, we assume that the secondary impact areas would also experience some level of improvement in flooding duration due to improved drainage of the swamp, however, not to the extent of the primary impact areas. We, therefore, anticipate a temporary flood duration with moderate flow/exchange.

Variable 4: Mean High Salinity During the Growing Season

Both *Future* *With* and *Future* *Without* *Project*
Target Year 0 –

Value based on information presented in the PPL 12 WVA. Specifically, for the Maurepas Diversion Project it was estimated that typical high salinity during the growing season would be about 1.4 ppt. Because the LCA ARDC Modification project is further from the lake (i.e., further from the source of saltwater intrusion) the CWPPRA Environmental Work Group assumed a lower mean high salinity in this area and adopted 1.2 ppt for the PPL 12 WVA.

Future *Without* *Project*
Target Years 1 – 50 –

Values based on information presented in the PPL 12 WVA. Specifically, subsidence is expected to continue within the project area over time under the future without project scenario. We, therefore, assume that the ability for saltwater to intrude further and/or more frequently into the project area swamps would likewise increase. Thus, we assumed that mean high salinity during the growing season would increase to 1.4 ppt over 50 years.

Future *With* *Project*
Target Years 1 – 50 –

Values based on information presented in the PPL

12 WVA. Specifically, the proposed project was designed to allow for freshwater to be introduced into the swamp when water elevations in the ARDC are higher than in the swamp, which is anticipated to occur frequently. This frequent introduction of freshwater into the system from the ARDC is expected to result in a mean high salinity reduction. However, because the secondary impact areas are located further from the gaps than the primary impact areas and because the volume of water would be spread over a larger area we assumed that mean high salinity benefits would be less in those areas (1.0 ppt for TY 1 and 10). In addition, because of the anticipated increase in sea level rise over time, we assume an increase in mean high salinities of 1.1 and 1.3 ppt for TY 25 and 50, respectively.

APPENDIX B

WVA SUMMARY SHEET FOR LCA-ARDC

Low SLR

Alternative 33

• Fresh Marsh Primary Impact Area	=	70.88	AAHUs	3544.07	CHUs
• 10 Years to Marsh Primary Impact Area	=	35.22	AAHUs	1761.12	CHUs
• 10 Years to Marsh Secondary Impact Area	=	73.46	AAHUs	3673.10	CHUs
• 20-30 Years to Marsh Primary Impact Area	=	189.49	AAHUs	9474.31	CHUs
• 20-30 Years to Marsh Secondary Impact Area	=	252.42	AAHUs	12621.00	CHUs
• 30-50 Years to Marsh Primary Impact Area	=	27.29	AAHUs	1364.40	CHUs
• 30-50 Years to Marsh Secondary Impact Area	=	40.02	AAHUs	2001.13	CHUs
• Spoil Bank Permanent Impacts	=	-0.55	AAHUs	-27.60	CHUs
• Spoil Bank Temporary Impacts	=	-0.23	AAHUs	-11.38	CHUs
• Fresh Marsh Permanent Impacts	=	-1.33	AAHUs	-66.42	CHUs
• 10 Years to Marsh Permanent Impacts	=	-0.71	AAHUs	-35.53	CHUs
• 20-30 Years to Marsh Permanent Impacts	=	-4.70	AAHUs	-235.12	CHUs
• 30-50 Years to Marsh Permanent Impacts	=	-1.80	AAHUs	-89.89	CHUs
TOTAL	►	**679.46**	**AAHUs**	**33973.18**	**CHUs**

Alternative 34

• Fresh Marsh Secondary Impact Area	=	46.79	AAHUs	2339.32	CHUs
• 10 Years to Marsh Primary Impact Area	=	38.96	AAHUs	1948.18	CHUs
• 10 Years to Marsh Secondary Impact Area	=	293.72	AAHUs	14686.10	CHUs
• 20-30 Years to Marsh Primary Impact Area	=	81.28	AAHUs	4063.86	CHUs
• 20-30 Years to Marsh Secondary Impact Area	=	59.83	AAHUs	2991.75	CHUs
• 30-50 Years to Marsh Primary Impact Area	=	67.25	AAHUs	3362.63	CHUs
• 30-50 Years to Marsh Secondary Impact Area	=	9.38	AAHUs	469.23	CHUs
• Spoil Bank Permanent Impacts	=	-0.62	AAHUs	-31.05	CHUs
• Spoil Bank Temporary Impacts	=	-0.32	AAHUs	-15.81	CHUs
• 10 Years to Marsh Permanent Impacts	=	-0.28	AAHUs	-14.21	CHUs
• 20-30 Years to Marsh Permanent Impacts	=	-1.67	AAHUs	-83.60	CHUs
• 30-50 Years to Marsh Permanent Impacts	=	-5.75	AAHUs	-287.66	CHUs
TOTAL	►	**588.58**	**AAHUs**	**29428.75**	**CHUs**

Alternative 35

• 20-30 Years to Marsh Primary Impact Area	=	143.92	AAHUs	7196.09	CHUs
• 20-30 Years to Marsh Secondary Impact Area	=	110.98	AAHUs	5548.85	CHUs
• 30-50 Years to Marsh Primary Impact Area	=	58.05	AAHUs	2902.27	CHUs
• 30-50 Years to Marsh Secondary Impact Area	=	26.00	AAHUs	1299.80	CHUs
• Spoil Bank Permanent Impacts	=	-0.41	AAHUs	-20.70	CHUs
• Spoil Bank Temporary Impacts	=	-0.23	AAHUs	-11.38	CHUs
• 20-30 Years to Marsh Permanent Impacts	=	-2.54	AAHUs	-127.14	CHUs
• 30-50 Years to Marsh Permanent Impacts	=	-2.16	AAHUs	-107.87	CHUs
TOTAL	►	**333.60**	**AAHUs**	**16679.91**	**CHUs**

Alternative 36

• Fresh Marsh Primary Impact Area	=	70.88	AAHUs	3544.07	CHUs
• Fresh Marsh Secondary Impact Area	=	46.79	AAHUs	2339.32	CHUs
• 10 Years to Marsh Primary Impact Area	=	74.19	AAHUs	3709.30	CHUs
• 10 Years to Marsh Secondary Impact Area	=	367.18	AAHUs	18359.20	CHUs
• 20-30 Years to Marsh Primary Impact Area	=	270.76	AAHUs	13538.17	CHUs
• 20-30 Years to Marsh Secondary Impact Area	=	312.25	AAHUs	15612.74	CHUs
• 30-50 Years to Marsh Primary Impact Area	=	94.54	AAHUs	4727.03	CHUs
• 30-50 Years to Marsh Secondary Impact Area	=	49.41	AAHUs	2470.36	CHUs
• Spoil Bank Permanent Impacts	=	-1.17	AAHUs	-58.65	CHUs
• Spoil Bank Temporary Impacts	=	-0.54	AAHUs	-27.19	CHUs
• Fresh Marsh Permanent Impacts	=	-1.33	AAHUs	-66.42	CHUs
• 10 Years to Marsh Permanent Impacts	=	-0.99	AAHUs	-49.74	CHUs
• 20-30 Years to Marsh Permanent Impacts	=	-6.37	AAHUs	-318.72	CHUs
• 30-50 Years to Marsh Permanent Impacts	=	-7.55	AAHUs	-377.55	CHUs
TOTAL	►	**1268.04**	**AAHUs**	**63401.93**	**CHUs**

Alternative 37

• Fresh Marsh Secondary Impact Area	=	46.79	AAHUs	2339.32	CHUs
• 10 Years to Marsh Primary Impact Area	=	38.96	AAHUs	1948.18	CHUs
• 10 Years to Marsh Secondary Impact Area	=	293.72	AAHUs	14686.10	CHUs
• 20-30 Years to Marsh Primary Impact Area	=	225.20	AAHUs	11259.95	CHUs
• 20-30 Years to Marsh Secondary Impact Area	=	170.81	AAHUs	8540.60	CHUs
• 30-50 Years to Marsh Primary Impact Area	=	125.30	AAHUs	6264.90	CHUs
• 30-50 Years to Marsh Secondary Impact Area	=	35.38	AAHUs	1769.03	CHUs
• Spoil Bank Permanent Impacts	=	-1.03	AAHUs	-51.75	CHUs
• Spoil Bank Temporary Impacts	=	-0.54	AAHUs	-27.19	CHUs
• 10 Years to Marsh Permanent Impacts	=	-0.28	AAHUs	-14.21	CHUs
• 20-30 Years to Marsh Permanent Impacts	=	-4.21	AAHUs	-210.74	CHUs
• 30-50 Years to Marsh Permanent Impacts	=	-7.91	AAHUs	-395.53	CHUs
TOTAL	►	**922.17**	**AAHUs**	**46108.66**	**CHUs**

Alternative 38

• Fresh Marsh Primary Impact Area	=	70.88	AAHUs	3544.07	CHUs
• 10 Years to Marsh Primary Impact Area	=	35.22	AAHUs	1761.12	CHUs
• 10 Years to Marsh Secondary Impact Area	=	73.46	AAHUs	3673.10	CHUs
• 20-30 Years to Marsh Primary Impact Area	=	333.41	AAHUs	16670.40	CHUs
• 20-30 Years to Marsh Secondary Impact Area	=	363.40	AAHUs	18169.85	CHUs
• 30-50 Years to Marsh Primary Impact Area	=	85.33	AAHUs	4266.67	CHUs
• 30-50 Years to Marsh Secondary Impact Area	=	66.02	AAHUs	3300.93	CHUs
• Spoil Bank Permanent Impacts	=	-0.97	AAHUs	-48.30	CHUs
• Spoil Bank Temporary Impacts	=	-0.46	AAHUs	-22.76	CHUs
• Fresh Marsh Permanent Impacts	=	-1.33	AAHUs	-66.42	CHUs
• 10 Years to Marsh Permanent Impacts	=	-0.71	AAHUs	-35.53	CHUs
• 20-30 Years to Marsh Permanent Impacts	=	-7.25	AAHUs	-362.26	CHUs
• 30-50 Years to Marsh Permanent Impacts	=	-3.96	AAHUs	-197.76	CHUs
TOTAL	►	**1013.06**	**AAHUs**	**50653.09**	**CHUs**

Alternative 39

• Fresh Marsh Primary Impact Area	=	70.88	AAHUs	3544.07	CHUs
• Fresh Marsh Secondary Impact Area	=	46.79	AAHUs	2339.32	CHUs
• 10 Years to Marsh Primary Impact Area	=	74.19	AAHUs	3709.30	CHUs
• 10 Years to Marsh Secondary Impact Area	=	367.18	AAHUs	18359.20	CHUs
• 20-30 Years to Marsh Primary Impact Area	=	414.69	AAHUs	20734.26	CHUs
• 20-30 Years to Marsh Secondary Impact Area	=	423.23	AAHUs	21161.60	CHUs
• 30-50 Years to Marsh Primary Impact Area	=	152.59	AAHUs	7629.30	CHUs
• 30-50 Years to Marsh Secondary Impact Area	=	75.40	AAHUs	3770.16	CHUs
• Spoil Bank Permanent Impacts	=	-1.59	AAHUs	-79.35	CHUs
• Spoil Bank Temporary Impacts	=	-0.77	AAHUs	-38.57	CHUs
• Fresh Marsh Permanent Impacts	=	-1.33	AAHUs	-66.42	CHUs
• 10 Years to Marsh Permanent Impacts	=	-0.99	AAHUs	-49.74	CHUs
• 20-30 Years to Marsh Permanent Impacts	=	-8.92	AAHUs	-445.86	CHUs
• 30-50 Years to Marsh Permanent Impacts	=	-9.71	AAHUs	-485.42	CHUs
TOTAL	►	**1601.64**	**AAHUs**	**80081.84**	**CHUs**

Intermediate SLR

Alternative 33

• Fresh Marsh Primary Impact Area	=	66.75	AAHUs	3337.67	CHUs
• 10 Years to Marsh Primary Impact Area	=	34.54	AAHUs	1726.93	CHUs
• 10 Years to Marsh Secondary Impact Area	=	67.45	AAHUs	3372.29	CHUs
• 20-30 Years to Marsh Primary Impact Area	=	183.48	AAHUs	9174.00	CHUs
• 20-30 Years to Marsh Secondary Impact Area	=	232.49	AAHUs	11624.65	CHUs
• 30-50 Years to Marsh Primary Impact Area	=	26.58	AAHUs	1329.14	CHUs
• 30-50 Years to Marsh Secondary Impact Area	=	37.91	AAHUs	1895.65	CHUs
• Spoil Bank Permanent Impacts	=	-0.55	AAHUs	-27.60	CHUs
• Spoil Bank Temporary Impacts	=	-0.23	AAHUs	-11.38	CHUs
• Fresh Marsh Permanent Impacts	=	-1.32	AAHUs	-66.22	CHUs
• 10 Years to Marsh Permanent Impacts	=	-0.66	AAHUs	-32.80	CHUs
• 20-30 Years to Marsh Permanent Impacts	=	-4.37	AAHUs	-218.27	CHUs
• 30-50 Years to Marsh Permanent Impacts	=	-1.76	AAHUs	-88.17	CHUs
TOTAL	►	**640.32**	**AAHUs**	**32015.90**	**CHUs**

Alternative 36

• Fresh Marsh Primary Impact Area	=	66.75	AAHUs	3337.67	CHUs
• Fresh Marsh Secondary Impact Area	=	42.53	AAHUs	2126.41	CHUs
• 10 Years to Marsh Primary Impact Area	=	72.75	AAHUs	3637.31	CHUs
• 10 Years to Marsh Secondary Impact Area	=	337.11	AAHUs	16855.69	CHUs
• 20-30 Years to Marsh Primary Impact Area	=	262.18	AAHUs	13109.05	CHUs
• 20-30 Years to Marsh Secondary Impact Area	=	287.60	AAHUs	19491.03	CHUs
• 30-50 Years to Marsh Primary Impact Area	=	92.10	AAHUs	4604.86	CHUs
• 30-50 Years to Marsh Secondary Impact Area	=	46.80	AAHUs	2340.15	CHUs
• Spoil Bank Permanent Impacts	=	-1.17	AAHUs	-58.65	CHUs
• Spoil Bank Temporary Impacts	=	-0.54	AAHUs	-27.19	CHUs
• Fresh Marsh Permanent Impacts	=	-1.32	AAHUs	-66.22	CHUs
• 10 Years to Marsh Permanent Impacts	=	-0.92	AAHUs	-45.92	CHUs
• 20-30 Years to Marsh Permanent Impacts	=	-5.92	AAHUs	-295.88	CHUs
• 30-50 Years to Marsh Permanent Impacts	=	-7.41	AAHUs	-370.31	CHUs
TOTAL	►	**1190.54**	**AAHUs**	**64638.00**	**CHUs**

Alternative 39

• Fresh Marsh Primary Impact Area	=	66.75	AAHUs	3337.67	CHUs
• Fresh Marsh Secondary Impact Area	=	42.53	AAHUs	2126.41	CHUs
• 10 Years to Marsh Primary Impact Area	=	72.75	AAHUs	3637.31	CHUs
• 10 Years to Marsh Secondary Impact Area	=	337.11	AAHUs	16855.69	CHUs
• 20-30 Years to Marsh Primary Impact Area	=	408.90	AAHUs	20444.99	CHUs
• 20-30 Years to Marsh Secondary Impact Area	=	389.82	AAHUs	19491.03	CHUs
• 30-50 Years to Marsh Primary Impact Area	=	148.64	AAHUs	7432.12	CHUs
• 30-50 Years to Marsh Secondary Impact Area	=	71.43	AAHUs	3571.43	CHUs
• Spoil Bank Permanent Impacts	=	-1.59	AAHUs	-79.35	CHUs
• Spoil Bank Temporary Impacts	=	-0.77	AAHUs	-38.57	CHUs
• Fresh Marsh Permanent Impacts	=	-1.32	AAHUs	-66.22	CHUs
• 10 Years to Marsh Permanent Impacts	=	-0.92	AAHUs	-45.92	CHUs
• 20-30 Years to Marsh Permanent Impacts	=	-8.28	AAHUs	-413.90	CHUs
• 30-50 Years to Marsh Permanent Impacts	=	-9.52	AAHUs	-476.11	CHUs
TOTAL	►	**1515.53**	**AAHUs**	**75776.57**	**CHUs**

High SLR

Alternative 33

• Fresh Marsh Primary Impact Area	=	58.99	AAHUs	2949.66	CHUs
• 10 Years to Marsh Primary Impact Area	=	31.57	AAHUs	1578.35	CHUs
• 10 Years to Marsh Secondary Impact Area	=	67.08	AAHUs	3354.07	CHUs
• 20-30 Years to Marsh Primary Impact Area	=	170.56	AAHUs	8528.05	CHUs
• 20-30 Years to Marsh Secondary Impact Area	=	226.61	AAHUs	11330.35	CHUs
• 30-50 Years to Marsh Primary Impact Area	=	26.42	AAHUs	1320.83	CHUs
• 30-50 Years to Marsh Secondary Impact Area	=	37.46	AAHUs	1873.22	CHUs
• Spoil Bank Permanent Impacts	=	-0.55	AAHUs	-27.60	CHUs
• Spoil Bank Temporary Impacts	=	-0.23	AAHUs	-11.38	CHUs
• Fresh Marsh Permanent Impacts	=	-1.30	AAHUs	-64.90	CHUs
• 10 Years to Marsh Permanent Impacts	=	-0.62	AAHUs	-31.24	CHUs
• 20-30 Years to Marsh Permanent Impacts	=	-4.16	AAHUs	-207.75	CHUs
• 30-50 Years to Marsh Permanent Impacts	=	-1.63	AAHUs	-81.71	CHUs
TOTAL	►	**610.20**	**AAHUs**	**30509.94**	**CHUs**

Alternative 36

• Fresh Marsh Primary Impact Area	=	58.99	AAHUs	2949.66	CHUs
• Fresh Marsh Secondary Impact Area	=	40.91	AAHUs	2045.66	CHUs
• 10 Years to Marsh Primary Impact Area	=	66.49	AAHUs	3324.36	CHUs
• 10 Years to Marsh Secondary Impact Area	=	335.10	AAHUs	16754.90	CHUs
• 20-30 Years to Marsh Primary Impact Area	=	243.72	AAHUs	12186.02	CHUs
• 20-30 Years to Marsh Secondary Impact Area	=	280.32	AAHUs	14016.16	CHUs
• 30-50 Years to Marsh Primary Impact Area	=	91.52	AAHUs	4576.08	CHUs
• 30-50 Years to Marsh Secondary Impact Area	=	46.25	AAHUs	2312.45	CHUs
• Spoil Bank Permanent Impacts	=	-1.17	AAHUs	-58.65	CHUs
• Spoil Bank Temporary Impacts	=	-0.54	AAHUs	-27.19	CHUs
• Fresh Marsh Permanent Impacts	=	-1.30	AAHUs	-64.90	CHUs
• 10 Years to Marsh Permanent Impacts	=	-0.87	AAHUs	-43.74	CHUs
• 20-30 Years to Marsh Permanent Impacts	=	-5.63	AAHUs	-281.62	CHUs
• 30-50 Years to Marsh Permanent Impacts	=	-6.86	AAHUs	-343.16	CHUs
TOTAL	►	**1146.92**	**AAHUs**	**57346.02**	**CHUs**

Alternative 39

• Fresh Marsh Primary Impact Area	=	58.99	AAHUs	2949.66	CHUs
• Fresh Marsh Secondary Impact Area	=	40.91	AAHUs	2045.66	CHUs
• 10 Years to Marsh Primary Impact Area	=	66.49	AAHUs	3324.36	CHUs
• 10 Years to Marsh Secondary Impact Area	=	335.10	AAHUs	16754.90	CHUs
• 20-30 Years to Marsh Primary Impact Area	=	373.27	AAHUs	18663.39	CHUs
• 20-30 Years to Marsh Secondary Impact Area	=	379.95	AAHUs	18997.57	CHUs
• 30-50 Years to Marsh Primary Impact Area	=	147.71	AAHUs	7385.67	CHUs
• 30-50 Years to Marsh Secondary Impact Area	=	70.58	AAHUs	3529.16	CHUs
• Spoil Bank Permanent Impacts	=	-1.59	AAHUs	-79.35	CHUs
• Spoil Bank Temporary Impacts	=	-0.77	AAHUs	-38.57	CHUs
• Fresh Marsh Permanent Impacts	=	-1.30	AAHUs	-64.90	CHUs
• 10 Years to Marsh Permanent Impacts	=	-0.87	AAHUs	-43.74	CHUs
• 20-30 Years to Marsh Permanent Impacts	=	-7.88	AAHUs	-393.96	CHUs
• 30-50 Years to Marsh Permanent Impacts	=	-8.82	AAHUs	-441.21	CHUs
TOTAL	►	**1451.77**	**AAHUs**	**72588.63**	**CHUs**

United States Department of the Interior

FISH AND WILDLIFE SERVICE
646 Cajundome Blvd.
Suite 400
Lafayette, Louisiana 70506

September 2, 2010

Colonel Edward R. Fleming
District Commander
U.S. Army Corps of Engineers
Post Office Box 60267
New Orleans, Louisiana 70160-0267

Dear Colonel Fleming:

Enclosed is the Final Fish and Wildlife Coordination Act Report on the Louisiana Coastal Area – Amite River Diversion Canal Modification Element of the Section 7006(E)(3) Ecosystem Restoration Projects Study. Copies of the draft report were provided to the National Marine Fisheries Service and the Louisiana Department of Wildlife and Fisheries for their review and their comments were incorporated into the final report. This report is transmitted pursuant the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661 et seq.) and constitutes the report of the Secretary of the Interior as required by Section 2(b) of that Act.

We appreciate the cooperation of your staff on this study. Should your staff have any questions regarding the enclosed report, please have them contact Ms. Karen Soileau (337/291-3132) of this office.

Sincerely,

James F. Boggs
Supervisor
Louisiana Field Office

Enclosure

cc: EPA, Dallas, TX
National Marine Fisheries Service, Baton Rouge, LA
LA Dept. of Wildlife and Fisheries, Baton Rouge, LA
Office of Coastal Protection and Restoration, Baton Rouge, LA
GEC, Baton Rouge, LA

TAKE PRIDE IN AMERICA

United States Department of the Interior

FISH AND WILDLIFE SERVICE
646 Cajundome Blvd.
Suite 400
Lafayette, Louisiana 70506

September 2, 2010

Robert J. Barham
Secretary
Louisiana Department of Wildlife and Fisheries
Post Office Box 98000
Baton Rouge, Louisiana 70898-9000

Dear Mr. Barham:

Enclosed, for your records, is the Final Fish and Wildlife Coordination Act Report on the Louisiana Coastal Area – Amite River Diversion Canal Modification Element of the Section 7006(E)(3) Ecosystem Restoration Projects Study. This report was prepared under the authority of the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661 et seq.) and constitutes the report of the Secretary of the Interior as required by Section 2(b) of that Act.

We appreciate the cooperation of your staff on this study. Should your staff have any questions regarding the enclosed report, please have them contact Karen Soileau (337/291-3132) of this office.

Sincerely,

James F. Boggs
Supervisor
Louisiana Field Office

Enclosure

TAKE PRIDE IN AMERICA

United States Department of the Interior

FISH AND WILDLIFE SERVICE
646 Cajundome Blvd.
Suite 400
Lafayette, Louisiana 70506

September 2, 2010

Mr. Richard Hartman
Branch Chief
Habitat Conservation Division
National Marine Fisheries Service
c/o Louisiana State University
Baton Rouge, Louisiana 70803-7535

Dear Mr. Hartman:

Enclosed, for your records, is the Final Fish and Wildlife Coordination Act Report on the Louisiana Coastal Area – Amite River Diversion Canal Modification Element of the Section 7006(E)(3) Ecosystem Restoration Projects Study. Your agencies comments were incorporated into this final report. This report was prepared under the authority of the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661 et seq.) and constitutes the report of the Secretary of the Interior as required by Section 2(b) of that Act.

We appreciate the cooperation of your staff on this study. Should your staff have any questions regarding the enclosed report, please have them contact Karen Soileau (337/291-3132) of this office.

Sincerely,

James F. Boggs
Supervisor
Louisiana Field Office

Enclosure

TAKE PRIDE IN AMERICA

Fish and Wildlife Coordination Act Report

Louisiana Coastal Area (LCA)
Amite River Diversion Canal Modification
Ascension and Livingston Parishes, Louisiana

Submitted To
New Orleans District
U.S. Army Corps of Engineers
and
Office of Coastal Protection and Restoration

Prepared by
Karen Soileau
Fish and Wildlife Biologist
U.S. Fish and Wildlife Service
Ecological Services
Lafayette, Louisiana

September 2010

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INTRODUCTION

The Louisiana Coastal Area – Amite River Diversion Canal (LCA-ARDC) Modification Integrated Feasibility Report and Environmental Impact Statement (EIS) was prepared by the U.S. Army Corps of Engineers (USACE), New Orleans District, in partnership with the Louisiana Office of Coastal Protection and Restoration, under the authority of Title VII of the Water Resources Development Act (WRDA) of 2007. This authorization was recommended by the Chief of Engineer's Report, dated January 31, 2005. That report recommended projects and features in the interest of hurricane protection, prevention of salt water intrusion, preservation of fish and wildlife, prevention of erosion, and related water resources purposes. One recommended project was the modification of the ARDC.

The LCA-ARDC project is designed to establish hydrologic connectivity between the ARDC and the western Maurepas Swamp. That connectivity would allow the swamp to drain during seasonal low-flow conditions in the Amite River, and thereby, promote the germination and survival of bald cypress (and other tree species) seedlings. In addition, nutrients and sediments would be introduced from the ARDC into the swamp during flood events and from runoff during localized rainfall events. Nutrients and sediment delivered to the swamp would improve biological productivity and reduce the chances of further habitat degradation and swamp loss via conversion to open water.

This draft report contains a description of existing fish and wildlife resources in the project area, discusses future with-project (FWP) and future without-project (FWOP) habitat conditions, identifies fish and wildlife-related impacts, and provides recommendations to improve the proposed restoration measures. Copies of the draft report were provided to the National Marine Fisheries Service and the Louisiana Department of Wildlife and Fisheries for their review and their comments were incorporated into the final report. This report is transmitted pursuant the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661 et seq.) and constitutes the report of the Secretary of the Interior as required by Section 2(b) of that Act.

DESCRIPTION OF THE STUDY AREA

In the 1950s, the USACE, in an effort to relieve flooding along the upper Amite River, constructed the ARDC in order to facilitate the flow of water from the Amite River to Lake Maurepas. The 10 mile long canal is 350 feet wide and was dug to a depth of -25 feet. The LCA-ARDC study area (Figure 1) is located in LCA Subprovince 1 (USACE 2004) and is situated along the ARDC in Ascension and Livingston Parishes, in the vicinity of Head of Island, Louisiana. The study area is bounded to the north by the old channel of the Amite River, Old River, Chinquapin Canal and Bayou Chene Blanc; to the east by the Blind River; to the south by the Petite Amite River and the New River Canal; and to the west by the Sevario Canal, Ascension Parish flood protection levees, and the Laurel Ridge Canal.

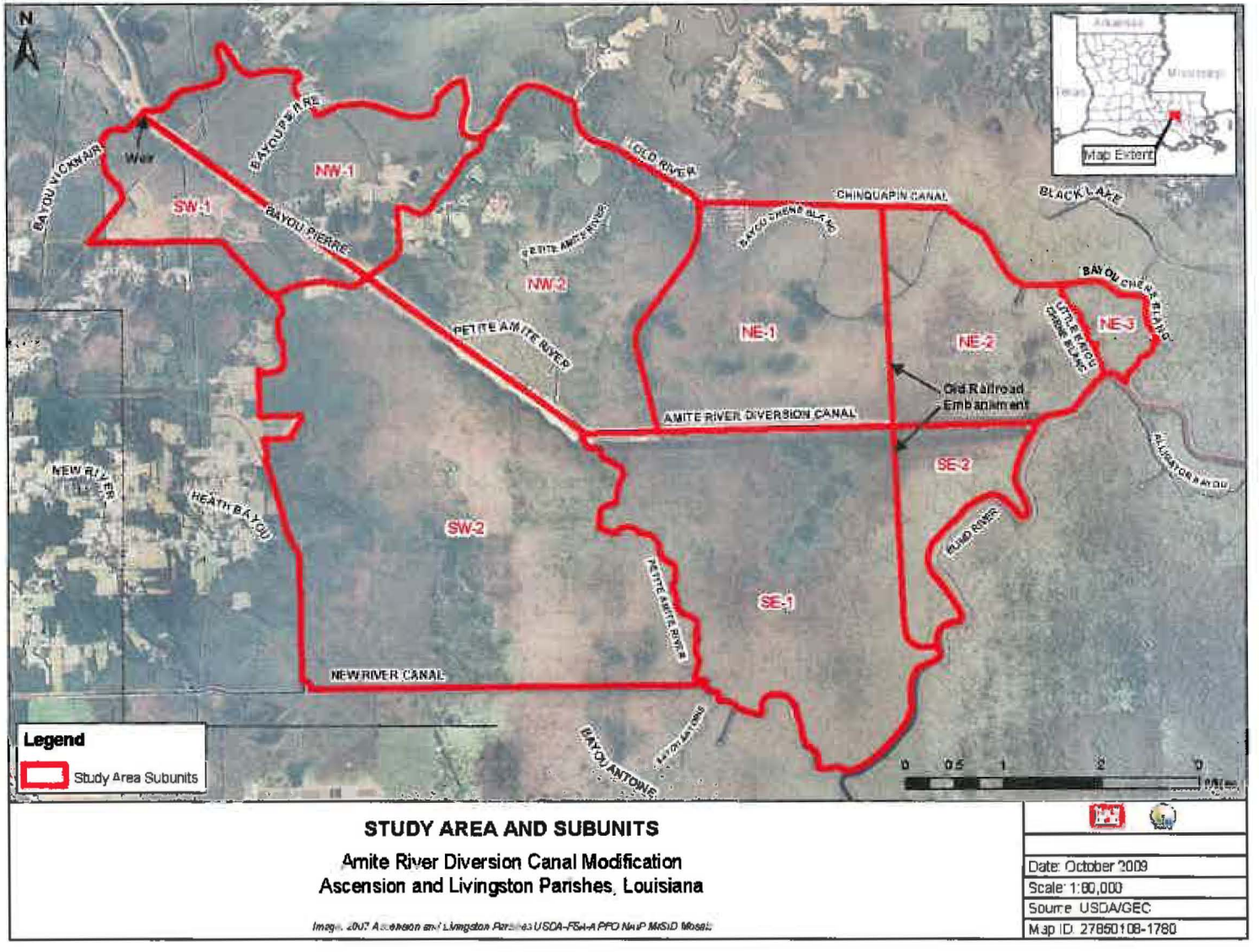
Historically, hydrologic conditions within the LCA-ARDC study area were dominated in the north and west by the Amite River, in the south by overbank flow from the Mississippi River,

and in the east by tidal influence from Lake Maurepas. Periodic flooding of the Amite River and/or Mississippi River resulted in the inundation of the study area. Flooding occurred annually, with peak water elevations in the spring or early summer. As floodwaters receded, surface waters in the study area were conveyed eastward via sheet flow to Bayou Chene Blanc or Blind River, then to Lake Maurepas.

The construction of flood control projects within the LCA-ARDC study area, primarily the ARDC component of the Amite River and Tributaries (AR&T) project, together with other land use practices, such as land development and logging, have significantly altered the hydrologic regime of the study area. River channelization and levee construction reduced overbank flooding in the study area, which in turn reduced the influx of floodwaters bearing high volumes of nutrients and sediment that are essential for biomass production and soil accretion. In addition, the placement of dredged material as berms along either side of the ARDC disrupted sheet flow within the LCA-ARDC study area and formed topographic high points (ridges) that prevented the drainage of bald cypress-tupelo swamps into the ARDC during low surface flow intervals (USACE 2004). This activity, in conjunction with other activities, such as construction of the railroad grade that traverses the eastern study area from north to south, permanently impounded bald cypress-tupelo swamp habitat within the study area. Those impoundments have contributed to decreased water quality and increased cypress and tupelo seedling mortality, which has resulted in increased habitat conversion from cypress swamp to open water.

Impoundment is particularly pronounced within the eastern portion of the LCA-ARDC study area, i.e., NE-1 and NE-2 (Figure 1). Specifically, during a recent study, water levels within the swamp habitat along the left descending bank of the ARDC never receded below 2.2 feet above mean sea level (msl), although canal water levels receded below that level (Shaffer *et al.,* 2006). Swamp impoundment is not as evident within the western portion of the LCA-ARDC study area. Installation of drainage culverts, construction of several gaps in the dredge material berms, and the confluence of Bayou Pierre with the ARDC in that area provide for hydrologic exchange between the diversion canal and the adjacent swamps.

Subsidence and salinity increases have also contributed to swamp ecosystem degradation in the LCA-ARDC study area. Land elevations decrease from subsidence, which may be caused by compaction, oxidation, and consolidation of sediments, faulting, groundwater depletion, or decreased organic deposition as a result of decreased vegetation biomass production; while land elevations increase as a result of sediment accretion, from direct sediment input from riverine sources or from organic vegetation deposition. The soil characteristics of the western Maurepas Swamp indicate a lack of riverine influence as evidenced by high soil organic matter content and low bulk density values (DeLaune et al. 1979, Hatton 1983, Messina and Conner 1998). Consequently, soil building within the Maurepas Swamp is almost exclusively a result of organic productivity (Shaffer et al. 2001, 2003, 2006, Rybczyk et al. 2002, Roberts 1985). In the swamps adjacent to the ARDC, productivity is substantially depressed compared to normal conditions (Coastal Wetlands Planning, Protection and Restoration Act [CWPPRA] Task Force



STUDY AREA AND SUBUNITS

Amite River Diversion Canal Modification
Ascension and Livingston Parishes, Louisiana

Date: October 2009
Scale: 1:60,000
Source: USDA/GEC
Map ID: 27850108-1780

Figure 1. Study Area and Subunits

2002). Subsidence in the LCA-ARDC study area and vicinity is classified as intermediate, at about 1.1-2.0 feet per century (LCA 2004). With minimal soil building and moderately high subsidence, there has been a net lowering of ground surface elevation, doubling flood frequency over the last four decades (Thompson 2000), so that the swamps are now persistently flooded.

Saltwater intrusion has increased in this general area, partly due to net subsidence and the lack of riverine freshwater inputs. Salinities as low as three parts per thousand (ppt) can reduce growth of both bald cypress and water tupelo saplings (Pezeshki et al. 1990). Salinity, combined with flooding stress, can substantially reduce bald cypress growth. Consequently, salinity significantly contributes to swamp deterioration, particularly combined with stressors such as flooding and herbivory.

Storm surges from Lake Maurepas caused by tropical cyclones also exert a stochastic but severe stress on the swamp habitat through salinity spikes in swamp surface waters. Dredged material berms prevent higher salinity water from being flushed out of the system (CWPPRA Task Force 2002). Storm surge waters remain in the impounded swamps of the LCA-ARDC study area cumulatively increasing salinities in impounded waters and soils.

FISH AND WILDLIFE RESOURCES

The purpose of this section is to describe the principal fish and wildlife resources of the study area, and to establish their significance. Several key habitat types are described, followed by qualitative descriptions of important fish and wildlife.

Major Habitat Types

Cypress/Tupelo Swamps

The LCA-ARDC study area contains approximately 27,984 acres; the majority of which is dominated by bald cypress/tupelo swamp habitat. About 18,204 acres of that habitat type are presently impounded to various extents within the study area; that persistent flooding has resulted in the impairment of cypress/tupelo seedling establishment/regeneration (CWPPRA Task Force 2002). Cypress/tupelo regenerates well when the seedbed is moist but not flooded during the time period of seed germination and seedling establishment. Cypress/tupelo seeds cannot germinate in standing water, and seedlings must grow tall enough during dry periods for their crowns to extend above the water surface to survive flooding during the growing season. Excessive flooding will reduce regeneration even though overstory trees may still be thriving. Ultimately, the lack of regeneration due to prolonged inundation will eliminate forest cover, resulting in the conversion of swamp habitat to open water over time (CWPPRA Task Force 2002). In addition, saltwater intrusion from storm events has stressed the swamp habitat along the Blind River.

Cypress swamps in the project area provide substantial fish and wildlife values. Wildlife species typical of cypress swamps include green tree frog, bullfrog, mud and musk turtles, American alligator, various species of water snakes, anhinga, barred owl, northern parula, great blue heron, great egret, white ibis, and mink. Often surrounding backwater lakes, these areas also provide

essential habitat for aquatic species when inundated.

In addition to bald cypress and water tupelo, Drummond red maple, green ash, and various oak species are also found in the cypress/tupelo swamp habitat within the LCA-ARDC study area, with Drummond red maple and green ash comprising sub-dominant midstory species (Conner and Day 1976; Hoeppner 2008; Shaffer et al. 2003). Scrub species, including black willow, wax myrtle, and common buttonbush are sporadically present, particularly in areas with diminished canopy cover caused by impaired health or mortality of overstory species. Shrub-scrub swamps provide important nesting habitat for colonial wading birds as well as various species of aquatic wildlife.

Bottomland Hardwoods

Bottomland hardwoods are present along several ridge remnants that run through the LCA-ARDC study area. These ridges are mostly near the mid-point of the east-west stretch of the ARDC. Dominant tree species in those areas include Drummond red maple, green ash, laurel oak, water oak, sweet gum, sugarberry, American elm, and Chinese tallow. The areas between the ridges and the swamp show a transition in species including green ash, Drummond red maple, black willow, bald cypress, and water tupelo. Wax myrtle, rough-leaf dogwood, black willow, Chinese tallow, Chinese privet, yaupon, and deciduous holly typically dominate the shrub stratum. Vines such as poison ivy, greenbriars, pepper vine, and trumpet creeper are present. In addition, an old railroad grade and several earthen levees run through the LCA-ARDC study area with similar habitats.

Bottomland hardwood forests typically provide high wildlife habitat values to a variety of species, including amphibians such as the Gulf coast toad and Cope's gray tree frog; reptiles such as the copperhead and green anole; many species of birds, including wood duck, barred owl, pileated woodpecker, red-shouldered hawk, Acadian flycatcher, Swainson's Warbler and northern parula; and mammals including white-tailed deer, swamp rabbit, gray fox, bobcat, raccoon, opossum, and squirrels. In addition to terrestrial wildlife, many species of fish utilize flooded bottomland hardwoods as well; some species are specifically adapted for spawning in these backwater flood plains.

Open Water

Open water areas are distributed throughout the LCA-ARDC study area and include the ARDC; the Amite, Petite Amite, and Blind Rivers; Bayous Pierre and Chene Blanc; and the Choupique Canal. Submerged aquatic vegetation communities within the LCA-ARDC study area are largely confined to areas of higher flow. This includes natural waterways and natural cuts into the swamp interior. Shallow water habitats within the LCA-ARDC study area that have insufficient flow have become choked with floating vegetation, greatly limiting light penetration within the water column.

In their *2006 Water Quality Integrated Report*, the Louisiana Department of Environmental Quality indicated that water within the study area supports the designated standards for primary and secondary contact recreation, but does not support those standards for fish and wildlife

propagation. Suspected sources of impairment include mercury, total phosphorus, chloride, excessive nutrient levels, siltation, and low levels of dissolved oxygen.

Fresh Marsh

There are approximately 249 acres of fresh marsh within the LCA-ARDC study area. Shaffer et al. (2003) have shown that many of the marshes within the Maurepas Swamp exist as a transitional habitat as swamps are converting to open water areas over time. Those swamp habitats are being replaced by marsh and open water due to a number of factors including salt water intrusion (associated with hurricanes and rising sea levels), altered hydrology, impoundments, subsidence, and herbivory (Keddy et al. 2007).

Developed Areas

Developed areas comprise approximately 281 acres within the LCA-ARDC study area. Urban areas are primarily confined to the dredged material berms lining the ARDC adjacent to LA-22, and the right descending bank of the Amite River in the northwestern portion of the LCA-ARDC study area. Barren lands make up a small percentage of the LCA-ARDC study area and may include strip mines, quarries, and gravel pits. Agricultural croplands or grasslands make up approximately 469 acres of the LCA-ARDC study area and appear to be restricted to livestock pasture. These pastures are located in isolated pockets along the lower Amite River and LA-22 in the western portion of the study area.

Fishery Resources

Construction of the ARDC and dredged material berms have impeded exchange of organisms and water between the swamp and the ARDC. Accordingly, the study area is expected to provide low- to moderate-value habitat for some recreationally important fishes and shellfishes. Freshwater sport fishes likely present include white crappie, bluegill, warmouth, channel catfish, and blue catfish. Other fishes likely present include yellow bullhead, freshwater drum, bowfin, carp, buffaloes, and gars. In addition, the waterbodies and wetlands of the LCA-ARDC study area provide nursery and foraging habitats supportive of a variety of fishery species, some of which may serve as prey for other fish species.

Lantz (1970) sampled fish within the Amite River; primarily freshwater species were collected, although a few transient marine species were also collected or reported. Species collected included blue catfish, gizzard shad, spotted gar, freshwater drum, channel catfish, striped mullet, and largemouth bass. Laiche (1980) also sampled fish within the Amite River. The most abundant species collected were blacktail shiner, bullhead minnow, mosquitofish, longear sunfish, mimic shiner, blackstripe topminnow, bluegill, and longnose shiner.

Watson et al. (1981) collected 57 species of fish in the Blind River, including 43 freshwater species, 12 estuarine species, and two diadromous species. The authors suggested the confluence of the ARDC was a point of separation between the upper and lower reaches of Blind River. The lower Blind River had the greatest species diversity, primarily due to the presence of estuarine species. The low concentrations of dissolved oxygen above the ARDC could be an important

limiting factor in the distribution of fish.

Aquatic and wetland habitats in the LCA-ARDC study area also provide foraging and nursery habitat for a few economically important marine fishery species that use freshwater habitats in this area. The species expected to be found in the LCA-ARDC study area include striped mullet and Gulf menhaden.

Wildlife Resources

The coastal marshes and forested wetlands of the Lake Pontchartrain Basin have been identified by the North American Waterfowl Management Plan (NAWMP), Gulf Coast Joint Venture (GCJV): Mississippi River Coastal Wetlands Initiative as a key waterfowl wintering area. The Gulf Coast is the terminus of the Central and Mississippi Flyways and is therefore one of the most important waterfowl areas in North America, providing both wintering and migration habitat for significant numbers of the continental duck and goose populations that use both flyways. The Mississippi River Coastal Wetlands Initiative area is dominated by coastal marsh, forested swamps, and seasonally flooded bottomland hardwoods that provide habitat for several species of wintering waterfowl. Wood ducks are the primary waterfowl species in forested wetlands, while other ducks (e.g., mallard, American widgeon, gadwall, blue- and green-winged teal, Northern shovelers, ring-necked ducks, and lesser scaup) use those forested habitats to a lesser degree.

Strategies to achieve the goals and objectives of the GCJV include but are not limited to: 1) maintaining the existing functions and values of those habitats and preventing additional losses and degradation of those wetlands and 2) modifying existing spoil banks and canals to restore hydrology (Wilson et al. 2002). Numerous other game birds are present in or adjacent to the study area, including American coot, rails, gallinules, common snipe, and American woodcock. Non-game bird species also utilize the study area marshes, including least bittern, pied-billed grebe, black-necked stilt, American avocet, killdeer, black-bellied plover, willet, and various species of sandpipers, gulls, and terns. The study area supports many resident and transient hawks and owls including red-shouldered hawk, barn owl, common screech owl, great horned owl, and barred owl. Winter residents include red-tailed hawk, northern harrier, and American kestrel, while the Mississippi kite, swallow-tailed kite and broad-winged hawk are common summer residents. In addition, the project area supports many species of resident and migratory passerine birds. Some neo-tropical migrants that are currently experiencing a population decline (e.g., white-eyed vireo, northern parula) are dependent on large forested acreage to successfully reproduce. Also, present are cuckoos, swifts, hummingbirds, nighthawks, woodpeckers, and the belted kingfisher.

Invasive Species

Within the LCA-ARDC study area invasive mammal species present include nutria and feral hogs. Invasive plant species present within that area include: water hyacinth, alligator weed, hydrilla, common salvinia, giant salvinia, variable-leaf milfoil, Chinese tallow, and Chinese privet. Those species displace native aquatics and degrade water and/or habitat quality. In addition, Chinese tallow is tolerant to flooding and salt stress and can establish self-replacing

monocultures that provide less foraging value to migrating birds and interrupt the natural succession of woody species (Louisiana Coastal Protection and Restoration 2008).

Threatened and Endangered Species

West Indian Manatee

Federally listed as an endangered species, West Indian manatees (*Trichechus manatus*) occasionally enter Lakes Pontchartrain and Maurepas, and associated coastal waters and streams during the summer months (i.e., June through September). Manatee occurrences appear to be increasing, and they have been regularly reported in the Amite, Blind, Tchefuncte, and Tickfaw Rivers, and in canals within the adjacent coastal marshes of Louisiana. The manatee has declined in numbers due to collisions with boats and barges, entrapment in flood control structures, poaching, habitat loss, and pollution. Cold weather and outbreaks of red tide may also adversely affect these animals.

All contract personnel associated with the project should be informed of the potential presence of manatees and the need to avoid collisions with manatees, which are protected under the Marine Mammal Protection Act of 1972 and the Endangered Species Act of 1973. All construction personnel are responsible for observing water-related activities for the presence of manatee(s). Temporary signs should be posted prior to and during all construction/dredging activities to remind personnel to be observant for manatees during active construction/dredging operations or within vessel movement zones (i.e., work area), and at least one sign should be placed where it is visible to the vessel operator. Siltation barriers, if used, should be made of material in which manatees could not become entangled, and should be properly secured and monitored. If a manatee is sighted within 100 yards of the active work zone, special operating conditions should be implemented, including: no operation of moving equipment within 50 feet of a manatee; all vessels should operate at no wake/idle speeds within 100 yards of the work area; and siltation barriers, if used, should be re-secured and monitored. Once the manatee has left the 100-yard buffer zone around the work area on its own accord, special operating conditions are no longer necessary, but careful observations would be resumed. Any manatee sighting should be immediately reported to the Service's Lafayette, Louisiana Field Office (337/291-3100) and the Louisiana Department of Wildlife and Fisheries, Natural Heritage Program (225/765-2821).

Gulf Sturgeon

The Gulf sturgeon (*Acipenser oxyrhynchus desotoi*), federally listed as a threatened species, is an anadromous fish that occurs in many rivers, streams, and estuarine waters along the northern Gulf coast between the Mississippi River and the Suwannee River, Florida. In Louisiana, Gulf sturgeon have been reported at Rigolets Pass, rivers and lakes of the Lake Pontchartrain basin, and adjacent estuarine areas. Spawning occurs in coastal rivers between late winter and early spring (i.e., March to May). Adults and sub-adults may be found in those rivers and streams until November, and in estuarine or marine waters during the remainder of the year. Sturgeon less than two years old appear to remain in riverine habitats and estuarine areas throughout the year, rather than migrate to marine waters. Habitat alterations such as those caused by water control structures that limit and prevent spawning, poor water quality, and over-fishing have

negatively affected this species.

On March 19, 2003, the Service and the National Marine Fisheries Service (NMFS) published a final rule in the Federal Register (Volume 68, No. 53) designating critical habitat for the Gulf sturgeon in Louisiana, Mississippi, Alabama, and Florida. The proposed project, however, does not occur within nor would it impact designated Gulf sturgeon critical habitat.

The Corps is responsible for determining whether the selected alternative is likely (or not likely) to adversely affect any listed species and/or critical habitat, and for requesting the Service's concurrence with that determination. If the Corps determines, and the Service concurs, that the selected alternative is likely to adversely affect listed species and/or critical habitat, a request for formal consultation in accordance with Section 7 of the ESA should be submitted to the Service. That request should also include the Corps' rationale supporting their determination.

Species of Special Interest

Bald Eagle

The project-area forested wetlands provide nesting habitat for the bald eagle (*Haliaeetus leucocephalus*), which was officially removed from the List of Endangered and Threatened Species on August 8, 2007. There is one active bald eagle nest that is known to exist within the proposed project area, however, other nests may be present that are not currently listed in the database maintained by the Louisiana Department of Wildlife and Fisheries.

Bald eagles nest in Louisiana from October through mid-May. Eagles typically nest in mature trees (e.g., bald cypress, sycamore, willow, etc.) near fresh to intermediate marshes or open water in the southeastern Parishes. Areas with high numbers of nests include the north shore of Lake Pontchartrain and the Lake Salvador area. Major threats to this species include habitat alteration, human disturbance, and environmental contaminants (i.e., organochlorine pesticides and lead).

Breeding bald eagles occupy "territories" that they will typically defend against intrusion by other eagles, and that they likely return to each year. A territory may include one or more alternate nests that are built and maintained by the eagles, but which may not be used for nesting in a given year. Potential nest trees within a nesting territory may, therefore, provide important alternative bald eagle nest sites. Bald eagles are vulnerable to disturbance during courtship, nest building, egg laying, incubation, and brooding. Disturbance during this critical period may lead to nest abandonment, cracked and chilled eggs, and exposure of small young to the elements. Human activity near a nest late in the nesting cycle may also cause flightless birds to jump from the nest tree, thus reducing their chance of survival.

Although the bald eagle has been removed from the List of Endangered and Threatened Species, it continues to be protected under the MBTA and the Bald and Golden Eagle Protection Act (BGEPA). The Service developed the National Bald Eagle Management (NBEM) Guidelines to provide landowners, land managers, and others with information and recommendations to minimize potential project impacts to bald eagles, particularly where such impacts may

constitute "disturbance," which is prohibited by the BGEPA. A copy of the NBEM Guidelines is available at:
http://www.fws.gov/southeast/es/baldeagle/NationalBaldEagleManagementGuidelines.pdf.
Those guidelines recommend: (1) maintaining a specified distance between the activity and the nest (buffer area); (2) maintaining natural areas (preferably forested) between the activity and nest trees (landscape buffers); and (3) avoiding certain activities during the breeding season. On-site personnel should be informed of the possible presence of nesting bald eagles within the project boundary, and should identify, avoid, and immediately report any such nests to this office. If a bald eagle nest is discovered within or adjacent to the proposed project area, then an evaluation must be performed to determine whether the project is likely to disturb nesting bald eagles. That evaluation may be conducted on-line at:
http://www.fws.gov/southeast/es/baldeagle. Following completion of the evaluation, that website will provide a determination of whether additional consultation is necessary. A copy of that determination should be provided to this office.

Colonial Nesting Birds

The proposed project would be located in an area where colonial nesting waterbirds may be present. Colonies may be present that are not currently listed in the database maintained by the Louisiana Department of Wildlife and Fisheries. That database is updated primarily by monitoring the colony sites that were previously surveyed during the 1980s. Until a new, comprehensive coast-wide survey is conducted to determine the location of newly-established nesting colonies, we recommend that a qualified biologist inspect the proposed work site for the presence of undocumented nesting colonies during the nesting season. To minimize disturbance to colonial nesting birds, the following restriction on activity should be observed:

> For colonies containing nesting wading birds (i.e., herons, egrets, night-herons, ibis, and roseate spoonbills), anhingas, and/or cormorants, all activity occurring within 1,000 feet of a rookery should be restricted to the non-nesting period (i.e., September 1 through February 15, exact dates may vary within this window depending on species present).

In addition, we recommend that on-site contract personnel be informed of the need to identify colonial nesting birds and their nests, and should avoid affecting them during the breeding season.

Refuges and Wildlife Management Areas

There are no U.S. Fish and Wildlife Service National Wildlife Refuges located within the LCA-ARDC study area. A portion of the state-operated Maurepas Swamp Wildlife Management Area is located within that study area. Please contact the Louisiana Department of Wildlife and Fisheries in Baton Rouge, Louisiana, (225/765-2360) for their comments regarding potential project impacts to this area.

EVALUATION METHODOLOGY

Evaluation of project-related impacts on fish and wildlife resources was aided by use of the

Wetland Value Assessment (WVA) methodology developed for the evaluation of proposed CWPPRA projects (Louisiana Coastal Wetlands Conservation and Restoration Task Force [LCWCRTF] 2006). The WVA methodology is similar to the Service's Habitat Evaluation Procedures (HEP), in that habitat quality and quantity are measured for baseline conditions and predicted for future without-project (FWOP) and future with-project (FWP) conditions. Separate habitat assessment models were used, including the Swamp and Bottomland Hardwood Community Models. Instead of the species-based approach of HEP, each model utilizes an assemblage of variables considered important to the suitability of a given habitat type for supporting a diversity of fish and wildlife species. As with HEP, these models allow a numeric comparison of each future condition and provide a combined quantitative and qualitative estimate of project-related impacts to fish and wildlife resources.

The WVA models operate under the assumption that optimal conditions for fish and wildlife habitat within a given coastal wetland type can be characterized, and that existing or predicted conditions can be compared to that optimum to provide an index of habitat quality. Habitat quality is estimated and expressed through the use of a mathematical model developed specifically for each habitat type. Each model consists of: 1) a list of variables that are considered important in characterizing fish and wildlife habitat; 2) a Suitability Index graph for each variable, which defines the assumed relationship between habitat quality (Suitability Indices) and different variable values; and 3) a mathematical formula that combines the Suitability Indices for each variable into a single value for wetland habitat quality, termed the Habitat Suitability Index (HSI).

The WVA methodology was initially developed in 1991 by the CWPPRA Environmental Work Group (LCWCRTF 2006). Initially, emergent marsh habitat models were developed for fresh, intermediate, brackish and saline marsh types. Subsequently, models were also developed for swamps, barrier islands, barrier headlands, and coastal forested ridges. The habitat variable-habitat suitability relationships within the WVA models have not been verified by field experiments or validated through a rigorous scientific process. However, the variables were originally derived from HEP suitability indices taken from species models for species found in that habitat type. It should also be noted that some aspects of the WVA have been defined by policy and/or functional considerations of CWPPRA. However, habitat variable-habitat suitability relationships are, in most cases, supported by scientific literature and research findings. In other cases, best professional judgment by a team of fisheries biologists, wildlife biologists, ecologists, and university scientists may have been used to determine certain habitat variable-habitat suitability relationships. In addition, the WVA models have undergone a refinement process and habitat variable-habitat suitability relationships, HSIs, and other model aspects are periodically modified as more information becomes available regarding coastal fish and wildlife habitat suitability, coastal processes, and the efficacy of restoration projects being evaluated.

The WVA models assess the suitability of each habitat type for providing resting, foraging, breeding, and nursery habitat to a diverse assemblage of fish and wildlife species. This standardized, multi-species, habitat-based methodology facilitates the assessment of project-induced impacts on fish and wildlife resources. The CWPPRA swamp WVA model used consists of four variables: 1) stand structure; 2) stand maturity; 3) water regime; and 4) mean

high salinity during the growing season. The bottomland hardwood WVA model consists of seven variables: 1) tree species association; 2) stand maturity; 3) understory/midstory; 4) hydrology; 5) size of contiguous forested area; 6) suitability and traversability of surrounding land uses; and 7) disturbance.

Using the WVA methodology, impact assessments were conducted by the Habitat Evaluation Team (HET), which included representatives from the Service, the Corps, Office of Coastal Protection and Restoration, GEC, Southeast Louisiana University, and Taylor Engineering. To assess impacts the HET used habitat information collected during June and July 2009 field inspections, surveys, expert opinions, knowledge of the area, experience with similar projects, Digital Ortho-quarter Quadrangle aerial photographs (DOQQ), and hydraulics and hydrology modeling information.

Those elements were used in conjunction with the above-discussed mathematical models to compute an HSI value for each target year (TY). Target years identified within the LCA-ARDC WVA model runs include: TY0, TY1, TY10, TY25, and TY50.

The product of an HSI and the acreage of available habitat for a given target year is known as the Habitat Unit (HU). The HU is the basic unit for measuring project effects on fish and wildlife habitat. Future HUs change according to changes in habitat quality and/or quantity. Results are annualized over the project life to determine the Average Annual Habitat Units (AAHUs) available for each habitat type.

The seven alternatives within the LCA-ARDC Final Array were evaluated: Alternative 33 (NE-1/NE-2), Alternative 34 (SE-1/SE-2), Alternative 35 (SE-1), Alternative 36 (NE-1/NE-2, SE-1/SE-2), Alternative 37 (SE-1/SE-2, SE-1), Alternative 38 (NE-1/NE-2, SE-1), and Alternative 39 (NE-1/NE-2, SE-1/SE-2 – All Subunits Combined). Prior to running the WVA analysis, the benefit areas associated with each alternative were designated as either primary impact areas or secondary impact areas. For purposes of the WVA, the Service assumed that the primary impact areas would receive the most benefits from freshwater flows, nutrients, and sediments, while the secondary impact areas would receive lesser benefits.

Subsequent to the mapping of primary and secondary impact areas for each alternative, WVAs were run for each habitat type (i.e., degraded swamp/fresh marsh, 10 years to convert to marsh, 20-30 years to convert to marsh, and 30-50 years to convert to marsh) present within those areas. Once benefits were calculated, adverse temporary and permanent impacts to swamp and bottomland hardwood habitats associated with construction of the bank openings, conveyance channels, and dredged material placement were calculated. The change in AAHUs for each FWP scenario, compared to FWOP project conditions, provides a measure of anticipated impacts. A net gain in AAHUs indicates that the project is beneficial to the habitat being evaluated; a net loss of AAHUs indicates that the project is damaging to that habitat type.

The WVA initial analysis was completed on the primary and secondary impact areas for all alternatives under the low sea level rise (SLR) scenario. As requested by the Corps, additional WVAs were later run to quantify impacts under the intermediate and high SLR scenarios for the Tentatively Selected Plan and the National Ecosystem Restoration Plan. A combined total of

168 WVA evaluations were completed.

The Project Information Sheet (including assumptions used by the HET) and the WVA summary sheet for the LCA-ARDC project are presented in Appendix A and B, respectively. The complete WVA analysis can be obtained from the Service's Lafayette, Louisiana Ecological Services Office upon request.

FUTURE WITHOUT-PROJECT FISH AND WILDLIFE RESOURCES

Under future without-project conditions, the current problems associated with altered hydrology are expected to continue. The swamp habitat surrounding the ARDC will likely continue to degrade, resulting in the eventual conversion from a freshwater swamp to open water. The lack of hydrologic connectivity would result in the continued impoundment of the project-area swamp, with an associated reduction in canopy cover, degradation of water quality, and transition of swamp habitat to marsh, with the eventual conversion to open-water habitat. Storm surges from tropical cyclone events would increase salinity levels and the frequency of saltwater inundation is expected to increase with relative sea level rise (RSLR).

The lack of freshwater, sediments, and nutrients would continue to reduce tree vigor and growth, increase tree mortality, increase the presence of invasive species, and reduce ecological functions. In addition, the assumed RSLR, would exacerbate swamp degradation in the future.

The anticipated conversion of swamp habitats to marsh and open water would result in the loss of wetland values and functions. While the Service recognizes the ecological importance of freshwater marshes, most of the marshes present within the LCA-ARDC study area are present as a transitional habitat, as swamps convert to open water, and are the result of habitat deterioration and conversion, rather than healthy swamp/marsh interfaces. Keddy et al. (2007) reports that the vast majority of the Maurepas Swamp is typical of swamps identified as either nutrient poor and stagnant or near-continuously flooded. Flood durations in the Maurepas Swamp have doubled, on average, over the past half-century (Thomson et al. 2002). The flooding and impoundment within the study area prevents seed germination and recruitment and, as a result, swamps are converting to marsh and open water.

Keddy et al. (2007) identify priority actions for habitat restoration within the Maurepas Swamp. One such recommendation addresses the re-establishment of sheet flow via removal or gapping of spoil banks and road and railroad beds. They explain that sheet flow (or shallow water flow over the surface of the soil) was, most likely, the principle way in which water and nutrients moved through this system. Now, however, the presence of man-made hydrologic barriers impedes sheet flow. Canals decrease overbank flooding and accelerate the flow of water, sediment, and nutrients out of the area, while spoil banks and other such man-made features block sheet flow. Implementation of the proposed project would restore an historic ecosystem and increase the fish and wildlife habitat values of the project area.

DESCRIPTION OF NATIONAL ECOSYSTEM RESTORATION PLAN

Alternative 39 (Figure 2) has been identified as the NER and the best plan for ecosystem

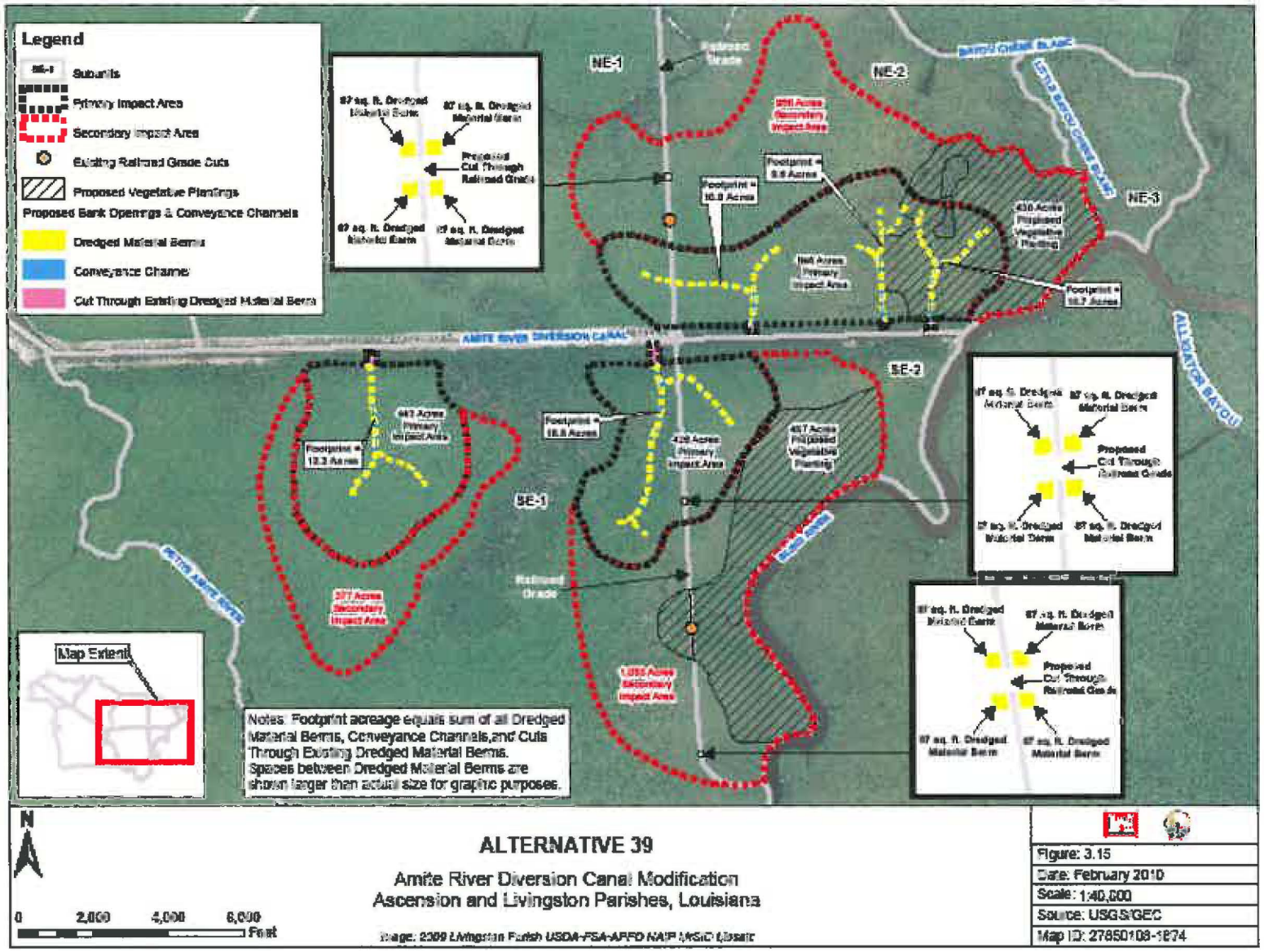


Figure 2. Alternative 39

restoration in the study area. That plan includes three areas for restoration in the final array, including two that have a critical need, and have begun converting from swamp to marsh, and a third less critical area that is expected to begin conversion in the next 20-30 years. Due to funding limitations and the risk of losing authorization, however, Alternative 39 has not been designated as the tentatively selected plan (TSP).

Features of Alternative 39 include:

- Three dredged material bank openings and three bifurcated conveyance channels in the north bank of the ARDC in NE-2 with the westernmost cut in the north bank of the ARDC also extending through the railroad grade into NE-1 to add connectivity between NE-1 and NE-2.
- One dredged material bank opening and one bifurcated conveyance channel in the south bank of the ARDC in SE-1 with the conveyance channel extending through the railroad grade into SE-1 to add connectivity between SE-1 and SE-2, and the ARDC.
- One opening and one conveyance channel in the south bank of the ARDC in SE-1.
- Dredged material (9.9 acres) from the bank openings and the conveyance channel would be sidecast on both sides of the proposed channel. Gaps would be left in the disposal berms so sheet flow is not reduced.
- Three cuts would be created in the railroad grade to improve sheet flow. One cut would be approximately 0.9 miles north of the ARDC. The second cut would be approximately 0.9 miles south of the ARDC. The third cut would be approximately two miles south of the ARDC.
- Vegetative plantings of bottomland hardwood/swamp tree species on 9.9 acres of dredged material berms.
- Vegetative plantings of swamp tree species within 925 acres of the swamp floor.

All excavation through the dredged material berms, as well as the conveyance channels through the swamp, were designed to mimic natural, existing cuts within the study area, which have been determined to be self-maintaining. Several existing channels were surveyed for depth, dimension, and profile.

The material dredged from the existing berms would be placed along the swamp-side of the excavated cut as new bottomland hardwood habitat. All material dredged during construction of the conveyance channels would be placed along the channels, with gaps included, to allow sufficient sheet flow to be conveyed from the swamp.

EVALUATION OF NATIONAL ECOSYSTEM RESTORATION PLAN

Alternative 39 includes all of the most critical areas within the Maurepas Swamp basin, establishes the greatest amount of hydrologic connectivity of all of the alternatives, is cost-effective while providing the most benefits, and is a best-buy plan. Accordingly, the Service fully supports Alternative 39 as the NER plan and believes it best represents the long term restoration need for the area.

The WVA evaluations conducted on all alternatives within the final array show that the highest

net benefits to fish and wildlife habitats occur with implementation of Alternative 39. Specifically, the WVA analysis indicates that the NER for the LAC-ARDC project would result in net gains of 1,602, 1,516, and 1,452 AAHUs under the low, intermediate, and high SLR scenarios, respectively.

Swamp habitat for fish and wildlife species would be restored, mimicking as closely as possible, conditions which occurred historically in the area. Implementation of Alternative 39 would restore the hydrologic connectivity between NE-1, NE-2, SE-1, and SE-2 within the ARDC. That alternative would improve the hydrologic connectivity between the ARDC and approximately 3,881 acres in both the primary and secondary impact areas, restore approximately 290 acres of swamp, and create approximately 9.9 acres of upland habitat from dredged material placement. Restored hydrologic connections would: 1) increase the nutrient and sediment input to approximately 1,515 acres within the primary impact area, 2) increase acreage of high-quality swamp habitats used by fish and wildlife for shelter, nesting, feeding, roosting, cover, nursery, and other life requirements, and 3) increase vegetative growth and productivity. In addition, when compared to the future without project scenario, implementation of this alternative would significantly reduce the likelihood of 3,881 acres of existing swamp habitat converting to marsh and eventual open water habitat over the life of the project.

DESCRIPTION OF TENTATIVELY SELECTED PLAN

Because the NER plan (Alternative 39) cannot be constructed within the currently authorized cost cap, Alternative 33 (Figure 3) was chosen as the TSP.

Alternative 33 includes:

- Three dredged material bank openings and three bifurcated conveyance channels in the north bank of the ARDC in NE-2 with the westernmost channel in the north bank of the ARDC also extending through the railroad grade into NE-1 to add connectivity between NE-1, NE-2, and the ARDC.
- Dredged material (5.0 acres) from the bank openings and the conveyance channel would be sidecast on both sides of the proposed channel. Gaps will be left in the disposal berms so sheet flow is not reduced.
- One cut would be created in the railroad grade approximately 0.9 miles north of the ARDC to improve sheet flow.
- Vegetative plantings of bottomland hardwood/freshwater swamp tree species on 5.0 acres of dredged material berms.
- Vegetative plantings of freshwater swamp tree species within 438 acres of the swamp floor.

All excavation through the dredged material berms, as well as the conveyance channels through the swamp, were designed to mimic natural, existing cuts within the study area, which have been determined to be self-maintaining. Several existing channels were surveyed for depth, dimension, and profile.

The material dredged from the existing berms would be placed along the swamp-side of the

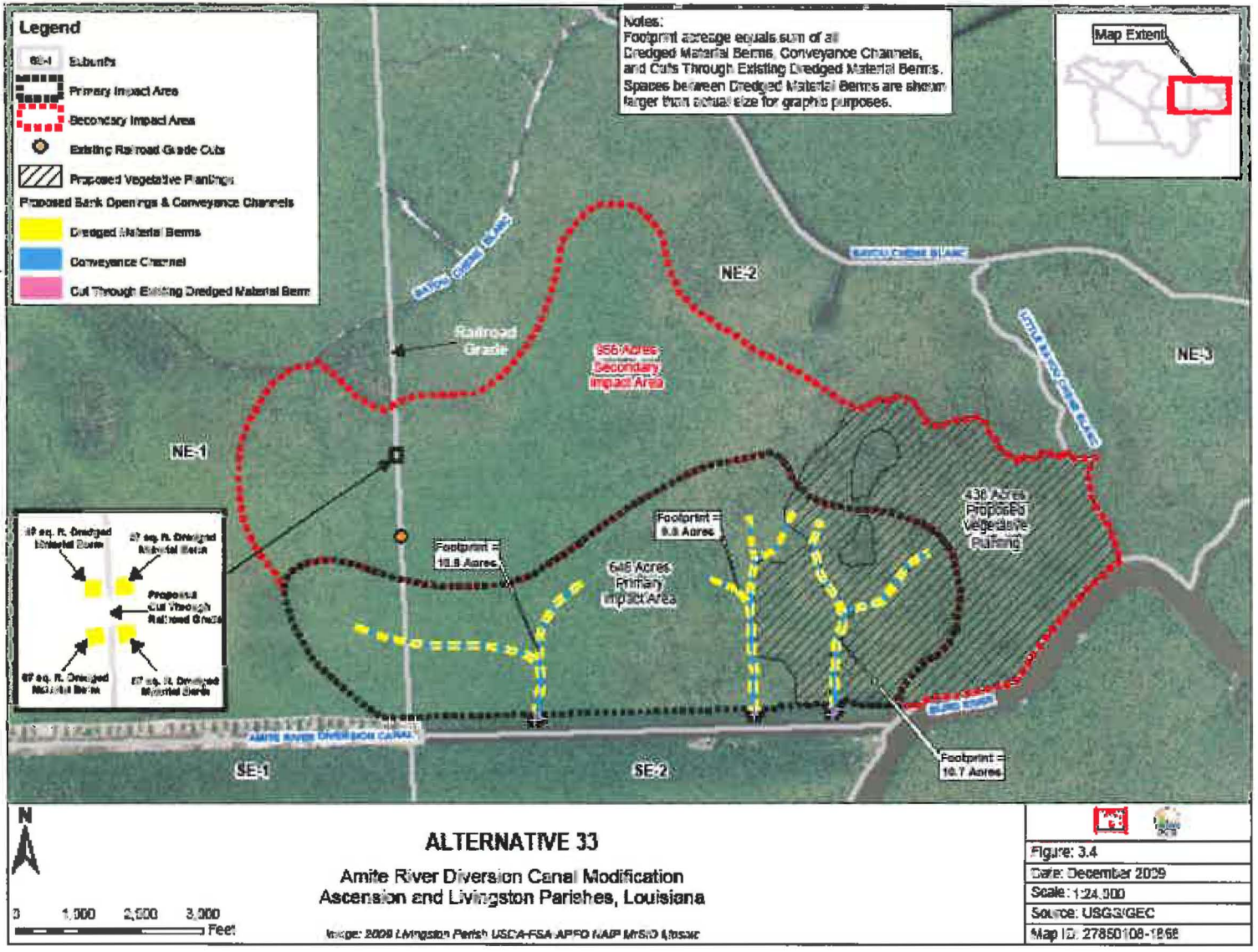


Figure 3. Alternative 33

excavated cut as new bottomland hardwood habitat. All material dredged during construction of the conveyance channels would be placed along the channels, with gaps included, to allow sufficient sheet flow to be conveyed from the swamp.

EVALUATION OF TENTATIVELY SELECTED PLAN

Alternative 33 addresses the most-highly degraded portion of the study area (NE-2), is considered cost effective, and can be implemented within the current cost cap. Implementation of that alternative, however, would not address the restoration needs within SE-1 and SE-2. Implementation of Alternative 33 would, therefore, result in similar benefits as expected under Alternative 39, but to a lesser degree. Specifically, Alternative 33 would improve the hydrologic connectivity between the ARDC and approximately 1,602 acres in both the primary and secondary impact areas, restore approximately 144 acres of swamp, and create approximately 5.0 acres of upland habitat from dredged material placement. The WVA analysis indicates that the TSP for the LAC-ARDC project would result in net gains of 679, 640, and 610 AAHUs under the low, intermediate, and high SLR scenarios, respectively.

FISH AND WILDLIFE CONSERVATION AND MITIGATION MEASURES

Swamp habitats are considered by the Service to be aquatic resources of national importance due to their increasing scarcity and high habitat value for fish and wildlife within Federal trusteeship (i.e., migratory waterfowl, wading birds, other migratory birds, threatened and endangered species, and interjurisdictional fisheries). Because of the Services' close coordination with the USACE on this project, and because the project is expected to have an overall benefit to the LCA-ARDC study area, the Service has no conservation measures to offer at this time.

SERVICE POSITION AND RECOMMENDATIONS

The TSP will benefit the fish and wildlife resources of the LCA-ARDC area by providing freshwater, nutrients, and sediments to the study area thus facilitating sediment deposition, increase organic production, increase biological productivity, and reduce conversion of swamp habitat to open water. Approximately 679 AAHUs and 1,602 net acres of swamp habitats would benefit by the proposed project at the end of the project life. The Service supports implementation of Alternative 33 provided the following fish and wildlife recommendations are implemented concurrently with project implementation:

1. If authorized funding limits for this project are increased the Service recommends that Alterative 39 be reconsidered as the potential future TSP.

2. Prioritize those measures that are contained in the NER plan that are not included within the TSP based on cost-effectiveness. In addition, advertise the most cost-effective measures in the NER plan that are missing from the TSP as additive alternates if funds for this project are authorized by Congress and the project is advertised for construction bids.

3. If a proposed project feature is changed significantly or is not implemented within one

year of the Endangered Species Act consultation letter, we recommend that the Corps reinitiate coordination with our office to ensure that the proposed project would not adversely affect any Federally listed threatened or endangered species or their critical habitat.

4. Avoid adverse impacts to bald eagle nesting locations and wading bird colonies through careful design of project features and timing of construction. A qualified biologist should inspect the proposed work site for the presence of undocumented wading bird nesting colonies and bald eagles during the nesting season (i.e., February 16 through October 31 for wading bird nesting colonies, and October through mid-May for bald eagles).

5. To minimize disturbance to colonies containing nesting wading birds (i.e., herons, egrets, night-herons, ibis, and roseate spoonbills), anhingas, and/or cormorants, all activity occurring within 1,000 feet of a rookery should be restricted to the non-nesting period (i.e., September 1 through February 15, exact dates may vary within this window depending on species present). In addition, we recommend that on-site contract personnel be informed of the need to identify colonial nesting birds and their nests, and should avoid affecting them during the breeding season.

6. Because bald eagles are known to nest within the proposed study area, we recommend that an evaluation be performed to determine whether the project is likely to disturb nesting bald eagles. That evaluation may be conducted on-line at: http://www.fws.gov/southeast/es/baldeagle. Following completion of the evaluation, that website will provide a determination of whether additional consultation is necessary and those results should be forwarded to this office.

7. Land clearing associated with project features should be conducted during the fall or winter to minimize impacts to nesting migratory birds, when practicable.

8. Further detailed planning of project features (e.g., Design Documentation Report, Engineering Documentation Report, Plans and Specifications, or other similar documents) should be coordinated with the Service and other State and Federal natural resource agencies, and shall be provided an opportunity to review and submit recommendations on the all work addressed in those reports.

9. A report documenting the status of implementation, maintenance and adaptive management measures should be prepared every three years by the managing agency and provided to the Corps, the Service, National Marine Fisheries Service, U.S. Environmental Protection Agency, Louisiana Department of Natural Resources, Office of Coastal Protection and Restoration, and the Louisiana Department of Wildlife and Fisheries. That report should also describe future management activities, and identify any proposed changes to the existing management plan.

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APPENDIX A

PROJECT INFORMATION SHEET WITH ASSUMPTIONS FOR LCA-ARDC

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Wetland Value Assessment Project Information Sheet
December 2009

Draft

Project Name: Louisiana Coastal Area – Amite River Diversion Canal (ARDC) Modification

Project Type(s): Swamp restoration, hydrologic restoration, and vegetative planting

Sponsoring Agency: U.S. Army Corps of Engineers (Corps) and Louisiana Department of Natural Resources

Preparer of Wetland Value Assessment (WVA) information sheet: Karen Soileau
Information found in this project information sheet was obtained primarily from the Draft Feasibility Report appendix (CPE 2005 and 2007).

Project Area: The project area is situated along the ARDC in Ascension and Livingston Parishes, in the vicinity of Head of Island, Louisiana. The project area is focused around the impaired baldcypress-tupelo swamp stands adjacent to the ARDC, extending northward and southward of the canal in the western portion of the Maurepas Swamp, located within the Pontchartrain Basin.

Project area boundaries were developed and delineated based on hydrologic features of the area suspected of being influenced by the Amite River Diversion Canal Modification Project. For planning purposes, the project area was further divided into nine sub-areas. Those sub-areas are defined by topographic high points (e.g., spoil banks, relict railroad grade, road embankments) or natural and artificial channels (e.g., rivers, canals) that would serve to impede or intercept hydrologic flows.

Problem: The project are includes the ARDC, a 10.6-mile-long flood control channel between the Amite and Blind Rivers. Dredged material excavated during channel construction was deposited in spoil banks on either side of the canal. The construction of the ARDC and its associated spoil banks, and the resulting impoundment, channelization, surge-related saltwater intrusion, and the loss of freshwater, sediments, and nutrients from the Amite River have all caused significant adverse impacts to the area, resulting in poor swamp health and ecosystem degradation in the western Maurepas Swamp.

Goal: The goal of the ARDC Modification Project is to reverse the trend of degradation in the western portion of the Maurepas Swamp, so as to contribute toward achieving and sustaining a coastal ecosystem that can support and protect the environment, economy, and culture of southern Louisiana and thus the Nation.

Objectives:

1. Increase hydrologic connectivity between the degraded swamp and bottomland hardwood habitats within the study area and the ARDC by increasing the

exchange of freshwater, sediments and nutrients over the 50-year period of analysis.

2. Reduce habitat conversion of swamp to open water within the study area over the 50-year period of analysis.

3. Facilitate natural hydrologic cycles within the study area over the 50- year period of analysis by reducing impoundment in degraded swamp and bottomland hardwood habitats adjacent to the ARDC to improve tree productivity and seedling germination.

4. Improve fish and wildlife habitat within the study area of the 50-year period of analysis.

Project Features:

1. Freshwater Reintroduction – Restoring processes that input freshwater, nutrients, and sediments are essential for establishing sustainable coastal swamp systems. The implementation of freshwater reintroduction measures that establish hydrologic connectivity between study area waterbodies and the adjacent swamp habitat could nourish existing swamp habitat to increase productivity and restore areas that have converted to freshwater marsh or open water, reintroduce sediments and nutrients throughout the ecosystem, and allow aquatic organisms access to previously unavailable habitats. The benefits that such reintroductions produce increase over time and continue as long as the reintroduction is operated and maintained. Additionally, freshwater reintroductions can be adaptively managed to respond to environmental changes and optimize benefits.

2. Habitat Restoration – The majority of the Maurepas swamp is stressed as a result of hydrologic alteration and seems to be on a trajectory of slow degradation leading to a gradual conversion to marsh and open water (Hoeppner et al. 2007). Without restoration, the factors and processes that are contributing to stress and deterioration of the swamps in the vicinity of the ARDC will continue and will result in loss of the swamp, with succession to open water. The wetland loss rates for the Coast 2050 Amite/Blind Rivers mapping unit (which contains the study area) for 1974-90 were estimated by the Corps to be 0.83 percent per year for swamp habitat, and 0.02 percent per year for fresh marsh. Based on these rates, approximately 50 percent of swamp and 1.2 percent of fresh marsh will be lost within 60 years (CWPPRA Task Force 2002). Additionally, the Corps determined that, based on the low tree density, degraded condition, and expectation for mortality, the majority of swamp habitat within the study area will degrade to less than 33 percent canopy cover within 20 years (U.S. Army Corps of Engineers 2004). Under the continued influence of these conditions, tree mortality will continue to increase and tree density will continue to decline, until most swamp habitat in the vicinity of the ARDC converts to fresh marsh. Monitoring studies conducted for the CWPPRA PPL 12 proposal indicated that conversion of baldcypress-tupelo swamp to fresh marsh is already occurring in

the study area, particularly north of the ARDC in subunit NE-2 (CWPPRA Task Force, 2002). Additionally, the monitoring results indicate that many areas of fresh marsh in the greater southern Maurepas Swamp have converted to fragile spikerush flotant, which is particularly susceptible to nutrient starvation and fragmentation. Consequently, it is expected that the vast majority of swamp habitat adjacent to the ARDC would convert to open water rather than stable marsh habitat without implementation of the proposed project.

LOW SEA LEVEL RISE SCENARIO ASSUMPTIONS

Primary Impact Areas

- ***Fresh Marsh*** – The Swamp Model was chosen for this area over the Fresh Marsh Model, even though there is less than a 33 percent canopy cover, because the area provides functions and values more closely associated with a swamp than a fresh marsh.

Variable 1: Stand Structure

Both *Future With* and *Future Without Project*
Target Year 0 –

This information was gathered during a July 30, 2009, field assessment. It was the consensus of the group that there is less than 33 percent overstory closure. [Class 1]

Future Without Project
Target Years 1 – 50 –

Continued degradation of the area is anticipated under the future without project scenario. Because of the low tree density and degraded condition, the area is expected to remain a Class 1.

Future With Project
Target Year 1 –

Because of the minimal time lapse since project construction (i.e., 1 year), we predicted that the stand structure would remain a Class 1.

Future With Project
Target Year 10 –

The combined effects of increased deposition of fine-grained sediment, increased nutrient loading, increased freshwater flows, reduced salinities, seasonally-lower water levels, and vegetative planting should improve habitat conditions within the area. However, cypress trees planted at TY1 would be 11 years old. In Louisiana, the height of cypress at 10 years of age is, on average, 17 feet (USDA 1980). Therefore, because there were no tree species within the midstory at TY 0 and because planted cypress trees would not be old enough yet to be considered a component of the overstory, we anticipate the stand structure would remain a Class 1.

Future With Project
Target Year 25 –

The combined effects of increased deposition of fine-grained sediment, increased nutrient loading, increased freshwater flows, reduced salinities, seasonally-lower water levels, and vegetative planting should improve habitat conditions within the area. In addition, planted cypress trees are expected to be over 31 feet at age 26 (USDA 1980) and would, therefore, be considered a component of the overstory. Accordingly, we anticipate an overstory closure of 50 -75 percent with a midstory or herbaceous cover greater than 33 percent. [Class 4]

Future With Project
Target Year 50 –

The combined effects of increased deposition of fine-grained sediment, increased nutrient loading, increased freshwater flows, reduced salinities, seasonally-lower water levels, and vegetative planting should continue to improve habitat conditions within the area. Accordingly, we anticipate an overstory closure of greater than or equal to 75 percent with either a midstory cover or herbaceous cover greater than 33 percent. [Class 6]

Variable 2: Stand Maturity

Both *Future With* and *Future Without Project*
Target Year 0 –

This information was gathered during a July 30, 2009, field assessment. Those estimates, based on existing habitat conditions, were consistent with those found by Bernard Wood (Research Assistant Southeastern Louisiana University) through direct measurement of project area trees. His dbh estimate, for all tree species combined, was between 6.5 and 8.25 inches, as compared to our average of 6.3 inches determined during our WVA data collection field assessment. Although our estimate is on the lower end of the range determined by Mr. Wood, because the subject area represents some of the more degraded habitat we feel that this estimate is representative of existing habitat conditions. Basal area was estimated based on information gathered during the aforementioned field visit and data collected by Southeast Louisiana University over the past 10 years.

Future Without Project
Target Years 1 – 50 –

Values based on information presented in the PPL 12 WVA. Mean dbh for each species was estimated as the mean existing dbh plus the existing mean annual growth rate times X number of years (growth rate: cypress = 0.11 inches per year ; tupelo et al = 0.08 inches per year). Basal area was again estimated utilizing data collected by Southeast Louisiana University and percent composition of canopy trees was estimated based on best professional judgment. Within the PPL 12 WVA it was assumed that 50 percent of the tupelo et al would die over 20 years, but that actual mortality of cypress would be minimal. Over the 50 year project life, we assume that 75 percent of the tupelo et al would die with minimal cypress mortality. In addition, we assume that minimal regeneration would occur over 50 years based on the degraded habitat conditions and lack of tree species at TY 0 in the understory. Subsequently, under the future without project scenario, basal areas decreased from

target year 0 to 50.

Future <u>With</u> Project
Target Years 1 – 50 –

Values based on information presented in the PPL 12 WVA. Under the future with project scenario, construction of the gaps is expected to stimulate productivity and growth of cypress and tupelo. We assume that the primary impact areas will receive the most benefits from freshwater flows, nutrients, and sediments; thus, those areas should see the greatest increase in growth. These assumptions are similar to those by Hamilton and Shaffer (2001) for the Maurepas Diversion Project. Results of studies by John Day in wetlands receiving secondary treated sewage suggest that introduction of nutrients as well as sediments from river water could stimulate production by 3-5 fold (Hamilton and Shaffer 2001). Comparison of productivity in swamps that are either managed, have more favorable hydrology, and/or are receiving nutrient enrichment suggest that the existing level of productivity in Maurepas are ½ to ¼ of average values. As a conservative projection, we assume growth rates to be 167% of current growth in the primary impact areas, which is the same assumption used in the PPL 12 WVA. Percent composition of cypress trees in the canopy was increased over the 50 years to mimic conditions in healthier portions of the project area. Basal area was estimated by using bottomland hardwood growth/basal area rates developed by the United States Forest Service (Putnam et al. 1960).

Variable 3: Water Regime

Both *Future <u>With</u>* and *Future <u>Without</u> Project*
Target Year 0 –

At present the Maurepas swamps within this portion of the project area are permanently flooded and have no flow/exchange.

Future <u>Without</u> Project
Target Years 1 – 50 –

Continued degradation of the area is expected under the future without project scenario and we anticipate the project area to remain permanently flooded with no flow/exchange.

Future With Project
Target Years 1 – 50 –

We assume that the portions of the proposed project within the primary impact area will receive the highest amount of direct benefits from construction of the gaps and should experience a substantial increase in substrate accretion and nutrient input. In addition, being in the immediate area of the proposed gaps we assume that this area will receive a high level of flow-exchange. We, therefore, anticipate a seasonal flood duration with high flow/exchange.

Variable 4: Mean High Salinity During the Growing Season

Both *Future With* and *Future Without Project*
Target Year 0 –

Value based on information presented in the PPL 12 WVA. Specifically, for the Maurepas Diversion Project it was estimated that typical high salinity during the growing season would be about 1.4 ppt. Because the ARDC project is further from the lake (i.e., further from the source of saltwater intrusion) the CWPPRA Environmental Work Group assumed a lower mean high salinity in this area and adopted 1.2 ppt for the PPL 12 WVA.

Future Without Project
Target Years 1 – 50 –

Subsidence is expected to continue within the project area over time under the future without project scenario. We, therefore, assume that the ability for saltwater to intrude further and/or more frequently into the project area swamps will likewise increase. Because the subject area is impounded with no flow/exchange we expect the salinity to increase over time. Thus, we assumed

that mean high salinity during the growing season to increase to 1.4 ppt over 50 years.

Future With Project
Target Years 1 – 50 –

Values based on information presented in the PPL 12 WVA. Specifically, the proposed project was designed to allow for freshwater to be introduced into the swamp when water elevations in the ARDC are higher than in the swamp, which is expected to occur frequently. This frequent introduction of freshwater into the system from the ARDC is expected to result in a mean high salinity reduction for the first 10 years (i.e., 0.9 parts per thousand [ppt] from TY 1-10). Because of the anticipated increase in sea level rise over time, however, we assume an increase in mean high salinities of 1.0 and 1.2 ppt for TY 25 and 50, respectively.

- ***10 Years to Marsh***

Variable 1: Stand Structure

Both *Future With* and *Future Without Project*
Target Year 0 –

This information was gathered during a July 30, 2009, field assessment. Those estimates, based on existing habitat conditions, were consistent with those found by Bernard Wood (Research Assistant Southeastern Louisiana University). Specifically, total canopy cover is estimated to be approximately 35 percent with an approximate midstory cover of 17 percent. [Class 2]

Future Without Project
Target Year 1 –

Because of the minimal time lapse since TY0, we predicted that the stand structure would remain a Class 2.

Future Without Project
Target Years 10 – 50 –

Continued degradation of the area is anticipated under the future without project scenario. Because of the low tree density and degraded condition, we downgraded the variable to a Class 1.

Future <u>With</u> Project
Target Year 1 –

Because of the minimal time lapse since project construction (i.e., 1 year), we predicted that the stand structure would remain a Class 2.

Future <u>With</u> Project
Target Year 10 –

The combined effects of increased deposition of fine-grained sediment, increased nutrient loading, increased freshwater flows, reduced salinities, seasonally-lower water levels, and vegetative planting should improve habitat conditions within the area. While the majority cypress trees in the project area (planted at TY1) would be 11 years old, and would not be old enough yet to be considered a component of the overstory, other midstory tree species present at TY 0 (i.e., red maple, green ash, and water tupelo) would become a component of the overstory at TY 10. In addition, because construction of the gaps is designed to allow for drainage of the area during ARDC low flow events, seedling germination, establishment, and survival is expected to increase. Thus, we anticipate an overstory canopy closure between 33 and 50 percent and greater than a 33 percent midstory or herbaceous cover. [Class 3]

Future <u>With</u> Project
Target Years 25 – 50 –

The combined effects of increased deposition of fine-grained sediment, increased nutrient loading, increased freshwater flows, reduced salinities, seasonally-lower water levels, and vegetative planting should improve habitat conditions within the area. In addition, planted cypress trees are expected to be over 31 feet at age 26 (USDA 1980) and would, therefore, be considered a component of

the overstory. Because construction of the gaps is designed to allow for drainage of the area during ARDC low flow events, seedling germination, establishment, and survival is expected to increase. Thus, we anticipate an overstory canopy closure equal to or greater than 75 percent with a herbaceous cover greater than 33 percent. [Class 6]

Variable 2: Stand Maturity

Both *Future With* and *Future Without Project*
Target Year 0 –

This information was gathered during a July 30, 2009, field assessment. Those estimates, based on existing habitat conditions, were consistent with those found by Bernard Wood (Research Assistant Southeastern Louisiana University) through direct measurement of project area trees. His dbh estimate, for all tree species combined, was between 6.5 and 8.25 inches, as compared to our average of 7.2 inches determined during our WVA data collection field assessment. Basal area was estimated based on information gathered during the aforementioned field visit and data collected by Southeast Louisiana University over the past 10 years.

Future Without Project
Target Years 1 – 50 –

Values based on information presented in the PPL 12 WVA. Mean dbh for each species was estimated as the mean existing dbh plus the existing mean annual growth rate times X number of years (growth rate: cypress = 0.11 inches per year; tupelo et al = 0.08 inches per year). Basal area was again estimated by using bottomland hardwood growth/basal area rates developed by the United States Forest Service (Putnam et al. 1960) and percent composition of canopy trees was estimated based on best professional judgment. Within the PPL 12 WVA it was assumed that 50 percent of the tupelo et al would die over 20 years, but that actual mortality of cypress would be minimal. Over the 50 year project life, we assume that 75 percent of the

tupelo et al would die with minimal cypress mortality. In addition, we assume that minimal regeneration would occur over 50 years based on the degraded habitat conditions. Subsequently, under the future without project scenario, basal areas decreased from target year 0 to 50.

Future With Project
Target Years 1 – 50 –

Values based on information presented in the PPL 12 WVA. Under the future with project scenario, construction of the gaps is expected to stimulate productivity and growth of cypress and tupelo. We assume that the high benefit areas will receive the most benefits from freshwater flows, nutrients, and sediments; thus, those areas should see the greatest increase in growth. These assumptions are similar to those by Hamilton and Shaffer (2001) for the Maurepas Diversion Project. Results of studies by John Day in wetlands receiving secondary treated sewage suggest that introduction of nutrients as well as sediments from river water could stimulate production by 3-5 fold (Hamilton and Shaffer 2001). Comparison of productivity in swamps that are either managed, have more favorable hydrology, and/or are receiving nutrient enrichment suggest that the existing level of productivity in Maurepas are ½ to ¼ of average values. As a conservative projection, we assume growth rates to be 167% of current growth in the primary impact areas, which is the same assumption used in the PPL 12 WVA. Percent composition of cypress trees was adjusted over the 50 years to mimic conditions in healthier portions of the project area. Basal area was estimated by using bottomland hardwood growth/basal area rates developed by the United States Forest Service (Putnam et al. 1960).

Variable 3: Water Regime

Both *Future With* and *Future Without Project*
Target Year 0 –

At present the Maurepas swamps within the project area are semi-permanently flooded and have low

flow/exchange.

Future Without Project
Target Years 1 – 50 –

Continued degradation of the area is expected under the future without project scenario. Because the area has some level of flow/exchange (albeit low), we anticipate the area to remain semi-permanently flooded over 50 years.

Future With Project
Target Years 1 – 50 –

We assume that the portions of the proposed project within the primary impact area will receive the highest amount of direct benefits from construction of the gaps and should experience a substantial increase in substrate accretion and nutrient input. In addition, being in the immediate area of the proposed gaps we assume that this area will receive a high level of flow-exchange. We, therefore, anticipate a seasonal flood duration with high flow/exchange.

Variable 4: Mean High Salinity During the Growing Season

Both *Future With* and *Future Without Project*
Target Year 0 –

Value based on information presented in the PPL 12 WVA. Specifically, for the Maurepas Diversion Project it was estimated that typical high salinity during the growing season would be about 1.4 ppt. Because the ARDC project is further from the lake (i.e., further from the source of saltwater intrusion) the CWPPRA Environmental Work Group assumed a lower mean high salinity in this area and adopted 1.2 ppt for the PPL 12 WVA.

Future Without Project
Target Years 1 – 50 –

Values based on information presented in the PPL 12 WVA. Specifically, subsidence is expected to continue within the project area over time under the

future without project scenario. We, therefore, assume that the ability for saltwater to intrude further and/or more frequently into the project area swamps will likewise increase. Thus, we assumed that mean high salinity during the growing season to increase to 1.4 ppt over 50 years.

Future With Project
Target Years 1 – 50 –

Values based on information presented in the PPL 12 WVA. Specifically, the proposed project was designed to allow for freshwater to be introduced into the swamp when water elevations in the ARDC are higher than in the swamp, which is expected to occur frequently. This frequent introduction of freshwater into the system from the ARDC is expected to result in a mean high salinity reduction for the first 10 years (i.e., 0.9 ppt from TY 1-10). Because of the anticipated increase in sea level rise over time, however, we assume an increase in mean high salinities of 1.0 and 1.2 ppt for TY 25 and 50, respectively.

- ***20 - 30 Years to Marsh***

Variable 1: Stand Structure

Both *Future With* and *Future Without Project*
Target Year 0 –

This information was gathered during a July 30, 2009, field assessment. Those estimates, based on existing habitat conditions, were consistent with those found by Bernard Wood (Research Assistant Southeastern Louisiana University). Specifically, total canopy cover is estimated to be approximately 60 percent with an approximate midstory cover of approximately 35 percent. [Class 4]

Future Without Project
Target Year 1 –

Because of the minimal time lapse since TY0, we predicted that the stand structure would remain a Class 4.

Future Without Project
Target Years 10 – 50 –

Continued degradation of the area is anticipated under the future without project scenario. Because of this, we assumed that overstory closure would be reduced to less than 50 percent by TY10 (Class 2) and less than 33 percent by TY25 (Class 1).

Future With Project
Target Year 1 –

Because of the minimal time lapse since project construction (i.e., 1 year), we predicted that the stand structure would remain a Class 4.

Future With Project
Target Year 10 –

The combined effects of increased deposition of fine-grained sediment, increased nutrient loading, increased freshwater flows, reduced salinities, seasonally-lower water levels, and vegetative planting should improve habitat conditions over time within the area. In addition, because construction of the gaps is designed to allow for drainage of the area during ARDC low flow events, seedling germination, establishment, and survival is expected to increase. We do not, however, anticipate a significant change in stand structure in this area over 10 years. Therefore, we predicted stand structure would remain a Class 4.

Future With Project
Target Years 25 – 50 –

The combined effects of increased deposition of fine-grained sediment, increased nutrient loading, increased freshwater flows, reduced salinities, seasonally-lower water levels, and vegetative planting should improve habitat conditions within the area over time. Because construction of the gaps is designed to allow for drainage of the area during ARDC low flow events, seedling germination, establishment, and survival is expected

to increase. Thus, we anticipate an overstory canopy closure equal to or greater than 75 percent with a herbaceous cover or midstory cover greater than 33 percent. [Class 6]

Variable 2: Stand Maturity

Both *Future With* and *Future Without Project*
Target Year 0 –

This information was gathered during a July 30, 2009, field assessment. Those estimates, based on existing habitat conditions, were consistent with those found by Bernard Wood (Research Assistant Southeastern Louisiana University) through direct measurement of project area trees. His dbh estimate, for all tree species combined, was between 6.5 and 8.25 inches, as compared to our average of 7.9 inches determined during our WVA data collection field assessment. Basal area was estimated based on information gathered during the aforementioned field visit and data collected by Southeast Louisiana University over the past 10 years.

Future Without Project
Target Years 1 – 50 –

Values based on information presented in the PPL 12 WVA. Mean dbh for each species was estimated as the mean existing dbh plus the existing mean annual growth rate times X number of years (growth rate: cypress = 0.11 inches per year; tupelo et al = 0.08 inches per year). Basal area was estimated based on data collected by Southeast Louisiana University over the past 10 years and percent composition of canopy trees was estimated based on best professional judgment. Within the PPL 12 WVA it was assumed that 50 percent of the tupelo et al would die over 20 years, but that actual mortality of cypress would be minimal. Over the 50 year project life, we assume that 75 percent of the tupelo et al would die with minimal cypress mortality occurring within the 10 year to marsh habitat type. Because habitat quality and conditions are higher in the 20 year to marsh habitat type, as

compared to the 10 year to marsh habitat type, we assume that tupelo mortality would occur, but at a slower rate. Therefore, we predict that 50 percent of the tupelo et al would die over the 50 year project life. Subsequently, under the future without project scenario, basal areas decreased from target year 0 to 50.

Future With Project

Target Years 1 – 50 –

Values based on information presented in the PPL 12 WVA. Under the future with project scenario, construction of the gaps is expected to stimulate productivity and growth of cypress and tupelo. We assume that the primary impact areas will receive the most benefits from freshwater flows, nutrients, and sediments; thus, those areas should see the greatest increase in growth. These assumptions are similar to those by Hamilton and Shaffer (2001) for the Maurepas Diversion Project. Results of studies by John Day in wetlands receiving secondary treated sewage suggest that introduction of nutrients as well as sediments from river water could stimulate production by 3-5 fold (Hamilton and Shaffer 2001). Comparison of productivity in swamps that are either managed, have more favorable hydrology, and/or are receiving nutrient enrichment suggest that the existing level of productivity in Maurepas are ½ to ¼ of average values. As a conservative projection, we assume growth rates to be 167% of current growth in the high benefit areas, which is the same assumption used in the PPL 12 WVA. Percent composition of cypress trees was adjusted over the 50 years to mimic conditions in healthier portions of the project area. Basal area was estimated by a bottomland hardwood growth/basal area calculator developed by the United States Forest Service (Putnam et al. 1960).

Variable 3: Water Regime

Both *Future With* and *Future Without Project*

Target Year 0 –

At present the Maurepas swamps within the project area are semi-permanently flooded and have low flow/exchange.

Future Without Project
Target Years 1 – 50 –

Continued degradation of the area is expected under the future without project scenario. Because the area has some level of flow/exchange (albeit low), we anticipate the area to remain semi-permanently flooded over 50 years.

Future With Project
Target Years 1 – 50 –

We assume that the portions of the proposed project within the primary impact area will receive the highest amount of direct benefits from construction of the gaps and should experience a substantial increase in substrate accretion and nutrient input. In addition, being in the immediate area of the proposed gaps we assume that this area will receive a high level of flow-exchange. We, therefore, anticipate a seasonal flood duration with high flow/exchange.

Variable 4: Mean High Salinity During the Growing Season

Both *Future With* and *Future Without Project*
Target Year 0 –

Value based on information presented in the PPL 12 WVA. Specifically, for the Maurepas Diversion Project it was estimated that typical high salinity during the growing season would be about 1.4 ppt. Because the ARDC project is further from the lake (i.e., further from the source of saltwater intrusion) the CWPPRA Environmental Work Group assumed a lower mean high salinity in this area and adopted 1.2 ppt for the PPL 12 WVA.

Future Without Project
Target Years 1 – 50 –

Values based on information presented in the PPL

12 WVA. Specifically, subsidence is expected to continue within the project area over time under the future without project scenario. We, therefore, assume that the ability for saltwater to intrude further and/or more frequently into the project area swamps will likewise increase. Thus, we assumed that mean high salinity during the growing season to increase to 1.4 ppt over 50 years.

Future With Project
Target Years 1 – 50 –

Values based on information presented in the PPL 12 WVA. Specifically, the proposed project was designed to allow for freshwater to be introduced into the swamp when water elevations in the ARDC are higher than in the swamp, which is expected to occur frequently. This frequent introduction of freshwater into the system from the ARDC is expected to result in a mean high salinity reduction for the first 10 years (i.e., 0.9 ppt from TY 1-10). Because of the anticipated increase in sea level rise over time, however, we assume an increase in mean high salinities of 1.0 and 1.2 ppt for TY 25 and 50, respectively.

- ***30 -50 Years to Marsh***

Variable 1: Stand Structure

Both *Future With* and *Future Without Project*
Target Year 0 –

This information was provided by Bernard Wood (Research Assistant Southeastern Louisiana University). Specifically, total canopy cover is estimated to be between 50 and 75 percent with a midstory cover greater than 33 percent or a herbaceous cover greater than 33 percent. [Class 4]

Future Without Project
Target Year 1 –

Because of the minimal time lapse since TY0, we predicted that the stand structure would remain a Class 4.

Future Without Project
Target Years 10 – 50 –

Continued degradation of the area is anticipated under the future without project scenario. Because of this, we assumed that overstory closure would be reduced to less than 50 percent by TY25 (Class 3) and less than 33 percent by TY50 (Class 1).

Future With Project
Target Year 1 –

Because of the minimal time lapse since project construction (i.e., 1 year), we predicted that the stand structure would remain a Class 4.

Future With Project
Target Year 10 –

The combined effects of increased deposition of fine-grained sediment, increased nutrient loading, increased freshwater flows, reduced salinities, seasonally-lower water levels, and vegetative planting should improve habitat conditions over time within the area. In addition, because construction of the gaps is designed to allow for drainage of the area during ARDC low flow events, seedling germination, establishment, and survival is expected to increase. We do not, however, anticipate a significant change in stand structure in this area over 10 years. Therefore, we predicted stand structure would remain a Class 4.

Future With Project
Target Years 25 – 50 –

The combined effects of increased deposition of fine-grained sediment, increased nutrient loading, increased freshwater flows, reduced salinities, seasonally-lower water levels, and vegetative planting should improve habitat conditions within the area over time. Because construction of the gaps is designed to allow for drainage of the area during ARDC low flow events, seedling germination, establishment, and survival is expected

to increase. Thus, we anticipate an overstory canopy closure equal to or greater than 75 percent with a herbaceous cover or midstory cover greater than 33 percent. [Class 6]

Variable 2: Stand Maturity

Both *Future With* and *Future Without Project*
Target Year 0 –

This information was provided by Bernard Wood through direct measurement of project area trees.

Future Without Project
Target Years 1 – 50 –

Values based on information provided by Bernard Wood. Mean dbh for each species was estimated as the mean existing dbh plus the existing mean annual growth rate times X number of years (growth rate: cypress = 0.15 inches per year; tupelo et al = 0.10 inches per year). Basal area was estimated based on data collected by Southeast Louisiana University over the past 10 years and percent composition of canopy trees was estimated based on best professional judgment. Within the PPL 12 WVA it was assumed that 50 percent of the tupelo et al would die over 20 years, but that actual mortality of cypress would be minimal. Over the 50 year project life, we assume that 75 percent of the tupelo et al would die with minimal cypress mortality occurring within the 10 year to marsh habitat type. Because habitat quality and conditions are higher in the 30 - 50 year to marsh habitat type, as compared to the 10 year to marsh habitat type, we assume that tupelo mortality would occur, but at a slower rate. Therefore, we predict that 50 percent of the tupelo et al would die over the 50 year project life. Subsequently, under the future without project scenario basal areas decrease slightly from target year 0 to 25 and decrease significantly between target year 25 and 50 due to the projected loss of canopy cover.

Future With Project
Target Years 1 – 50 –

Values based on information presented in the PPL 12 WVA and information provided by Mr. Bernard Wood. Under the future with project scenario, construction of the gaps is expected to stimulate productivity and growth of cypress and tupelo. We assume that the primary impact areas will receive the most benefits from freshwater flows, nutrients, and sediments; thus, those areas should see the greatest increase in growth. These assumptions are similar to those by Hamilton and Shaffer (2001) for the Maurepas Diversion Project. Results of studies by John Day in wetlands receiving secondary treated sewage suggest that introduction of nutrients as well as sediments from river water could stimulate production by 3-5 fold (Hamilton and Shaffer 2001). Comparison of productivity in swamps that are either managed, have more favorable hydrology, and/or are receiving nutrient enrichment suggest that the existing level of productivity in Maurepas are ½ to ¼ of average values. As a conservative projection, we assume growth rates to be 167% of current growth in the high benefit areas, which is the same assumption used in the PPL 12 WVA. Percent composition of cypress trees was adjusted over the 50 years to mimic conditions in healthier portions of the project area. Basal area was estimated by using bottomland hardwood growth/basal area rates developed by the United States Forest Service (Putnam et al. 1960).

Variable 3: Water Regime

Both *Future With* and *Future Without Project*
Target Year 0 –

At present the Maurepas swamps within the project area are temporarily flooded and have low flow/exchange.

Future Without Project
Target Years 1 – 50 –

Continued degradation of the area is expected under the future without project scenario. Because the area has some level of flow/exchange (albeit low),

we anticipate the area to remain temporarily flooded over 50 years.

Future With Project
Target Years 1 – 50 –

We assume that the portions of the proposed project within the primary impact area will receive the highest amount of direct benefits from construction of the gaps and should experience a substantial increase in substrate accretion and nutrient input. In addition, being in the immediate area of the proposed gaps we assume that this area will receive a high level of flow-exchange. We, therefore, anticipate a seasonal flood duration with high flow/exchange.

Variable 4: Mean High Salinity During the Growing Season

Both *Future With* and *Future Without Project*
Target Year 0 –

Value based on information presented in the PPL 12 WVA. Specifically, for the Maurepas Diversion Project it was estimated that typical high salinity during the growing season would be about 1.4 ppt. Because the ARDC project is further from the lake (i.e., further from the source of saltwater intrusion) the CWPPRA Environmental Work Group assumed a lower mean high salinity in this area and adopted 1.2 ppt for the PPL 12 WVA.

Future Without Project
Target Years 1 – 50 –

Values based on information presented in the PPL 12 WVA. Specifically, subsidence is expected to continue within the project area over time under the future without project scenario. We, therefore, assume that the ability for saltwater to intrude further and/or more frequently into the project area swamps will likewise increase. Thus, we assumed that mean high salinity during the growing season to increase to 1.4 ppt over 50 years.

Future With Project

Target Years 1 – 50 –

Values based on information presented in the PPL 12 WVA. Specifically, the proposed project was designed to allow for freshwater to be introduced into the swamp when water elevations in the ARDC are higher than in the swamp, which is expected to occur frequently. This frequent introduction of freshwater into the system from the ARDC is expected to result in a mean high salinity reduction for the first 10 years (i.e., 0.9 ppt from TY 1-10). Because of the anticipated increase in sea level rise over time, however, we assume an increase in mean high salinities of 1.0 and 1.2 ppt for TY 25 and 50, respectively.

Secondary Impact Areas

- ***Fresh Marsh*** – The Swamp Model was chosen for this area over the Fresh Marsh Model, even though there is less than a 33 percent canopy cover, because the area provides functions and values more closely associated with a swamp than a fresh marsh.

Variable 1: Stand Structure

Both *Future* *With* and *Future* *Without* *Project*
Target Year 0 –

This information was gathered during a July 30, 2009, field assessment. It was the consensus of the group that there is less than 33 percent overstory closure. [Class 1]

Future *Without* *Project*
Target Years 1 – 50 –

Continued degradation of the area is anticipated under the future without project scenario. Because of the low tree density and degraded condition, the area is expected to remain a Class 1.

Future *With* *Project*
Target Year 1 –

Because of the minimal time lapse since project

construction (i.e., 1 year), we predicted that the stand structure would remain a Class 1.

Future With Project
Target Year 10 –

The combined effects of increased deposition of fine-grained sediment, increased nutrient loading, increased freshwater flows, reduced salinities, seasonally-lower water levels, and vegetative planting should improve habitat conditions within the area. However, cypress trees planted at TY1 would be 11 years old. In Louisiana, the height of cypress at 10 years of age is, on average, 17 feet (USDA 1980). Therefore, because there were no tree species within the midstory at TY 0 and because planted cypress trees would not be old enough yet to be considered a component of the overstory, we anticipate the stand structure would remain a Class 1.

Future With Project
Target Year 25 –

The combined effects of increased deposition of fine-grained sediment, increased nutrient loading, increased freshwater flows, reduced salinities, seasonally-lower water levels, and vegetative planting should improve habitat conditions within the area. In addition, planted cypress trees are expected to be over 31 feet at age 26 (USDA 1980) and would, therefore, be considered a component of the overstory. Accordingly, we anticipate an overstory closure of 50 -75 percent with a midstory or herbaceous cover greater than 33 percent. [Class 4]

Future With Project
Target Year 50 –

The combined effects of increased deposition of fine-grained sediment, increased nutrient loading, increased freshwater flows, reduced salinities, seasonally-lower water levels, and vegetative planting should continue to improve habitat conditions within the area. Accordingly, we

anticipate an overstory closure of greater than or equal to 75 percent with either a midstory cover or herbaceous cover greater than 33 percent. [Class 6]

Variable 2: Stand Maturity

Both *Future* *With* and *Future* *Without* *Project*
Target Year 0 –

This information was gathered during a July 30, 2009, field assessment. Those estimates, based on existing habitat conditions, were consistent with those found by Bernard Wood (Research Assistant Southeastern Louisiana University) through direct measurement of project area trees. His dbh estimate, for all tree species combined, was between 6.5 and 8.25 inches, as compared to our average of 6.3 inches determined during our WVA data collection field assessment. Although our estimate is on the lower end of the range determined by Mr. Wood, because the subject area represents some of the more degraded habitat we feel that this estimate is representative of existing habitat conditions. Basal area was estimated based on information gathered during the aforementioned field visit and data collected by Southeast Louisiana University over the past 10 years.

Future *Without* *Project*
Target Years 1 – 50 –

Values based on information presented in the PPL 12 WVA. Mean dbh for each species was estimated as the mean existing dbh plus the existing mean annual growth rate times X number of years (growth rate: cypress = 0.11 inches per year; tupelo et al = 0.08 inches per year). Basal area was again estimated by using bottomland hardwood growth/basal area rates developed by the United States Forest Service (Putnam et al. 1960) and percent composition of canopy trees was estimated based on best professional judgment. Within the PPL 12 WVA it was assumed that 50 percent of the tupelo et al would die over 20 years, but that actual mortality of cypress would be minimal. Over the 50 year project life, we assume that 75 percent of the

tupelo et al would die with minimal cypress mortality. In addition, we assume that minimal regeneration would occur over 50 years based on the degraded habitat conditions and lack of tree species at TY 0 in the understory. Subsequently, under the future without project scenario, basal areas decreased from target year 0 to 50.

Future With Project

Target Years 1 – 50 –

Values based on information presented in the PPL 12 WVA. Under the future with project scenario, construction of the gaps is expected to stimulate productivity and growth of cypress and tupelo. We assume that the secondary impact areas will receive the benefits from freshwater flows, nutrients, and sediments; however, to a lesser extent than the primary impact areas. These assumptions are similar to those by Hamilton and Shaffer (2001) for the Maurepas Diversion Project. Results of studies by John Day in wetlands receiving secondary treated sewage suggest that introduction of nutrients as well as sediments from river water could stimulate production by 3-5 fold (Hamilton and Shaffer 2001). Comparison of productivity in swamps that are either managed, have more favorable hydrology, and/or are receiving nutrient enrichment suggest that the existing level of productivity in Maurepas are ½ to ¼ of average values. As a conservative projection, we assume growth rates to be 129% of current growth in the secondary impact areas, which is the same assumption used in the PPL 12 WVA. Percent composition of cypress trees was adjusted over the 50 years to mimic conditions in healthier portions of the project area. Basal area was estimated by using bottomland hardwood growth/basal area rates developed by the United States Forest Service (Putnam et al. 1960) and is assumed to result in similar conditions as the 155 acre fresh marsh high benefit area since vegetated plantings are proposed.

Variable 3: Water Regime

Both *Future With* and *Future Without Project*

Target Year 0 –

At present the Maurepas swamps within this portion of the project area are semi-permanently flooded and have low flow/exchange.

Future Without Project
Target Years 1 – 50 –

Continued degradation of the area is expected under the future without project scenario. Because the area has some level of flow/exchange (albeit low), we anticipate the area to remain semi-permanently flooded over 50 years.

Future With Project
Target Years 1 – 50 –

We assume that the portions of the proposed project within the secondary impact areas are expected to see direct benefits from construction of the gaps, and should experience an increase in substrate accretion and nutrient input, however, to a lesser extent than the primary impact areas. Being located further from the proposed gaps than the primary impact areas, we assume that the secondary impact areas will also experience some level of improvement in flooding duration due to improved drainage of the swamp, however, not to the extent of the primary impact areas. We, therefore, anticipate a semi-permanent flood duration with moderate flow/exchange.

Variable 4: Mean High Salinity During the Growing Season

Both *Future With* and *Future Without Project*
Target Year 0 –

Value based on information presented in the PPL 12 WVA. Specifically, for the Maurepas Diversion Project it was estimated that typical high salinity during the growing season would be about 1.4 ppt. Because the ARDC project is further from the lake (i.e., further from the source of saltwater intrusion) the CWPPRA Environmental Work Group assumed a lower mean high salinity in this area and adopted

1.2 ppt for the PPL 12 WVA.

Future Without Project
Target Years 1 – 50 –

Values based on information presented in the PPL 12 WVA. Specifically, subsidence is expected to continue within the project area over time under the future without project scenario. We, therefore, assume that the ability for saltwater to intrude further and/or more frequently into the project area swamps will likewise increase. Thus, we assumed that mean high salinity during the growing season would increase to 1.4 ppt over 50 years.

Future With Project
Target Years 1 – 50 –

Values based on information presented in the PPL 12 WVA. Specifically, the proposed project was designed to allow for freshwater to be introduced into the swamp when water elevations in the ARDC are higher than in the swamp, which is anticipated to occur frequently. This frequent introduction of freshwater into the system from the ARDC is expected to result in a mean high salinity reduction. However, because the secondary impact areas are located further from the gaps than the primary impact areas and because the volume of water would be spread over a larger area we assumed that mean high salinity benefits would be less in those areas (1.0 ppt for TY 1 and 10). In addition, because of the anticipated increase in sea level rise over time, we assume an increase in mean high salinities of 1.1 and 1.3 ppt for TY 25 and 50, respectively.

- ***10 Years to Marsh***

Variable 1: Stand Structure

Both *Future With* and *Future Without Project*
Target Year 0 –

This information was gathered during a July 30, 2009, field assessment. Those estimates, based on

existing habitat conditions, were consistent with those found by Bernard Wood (Research Assistant Southeastern Louisiana University). Specifically, total canopy cover is estimated to be approximately 35 percent with an approximate midstory cover of 17 percent. [Class 2]

Future Without Project
Target Year 1 –

Because of the minimal time lapse since TY0, we predicted that the stand structure would remain a Class 2.

Future Without Project
Target Years 10 – 50 –

Continued degradation of the area is anticipated under the future without project scenario. Because of the low tree density and degraded condition, we downgraded the variable to a Class 1.

Future With Project
Target Year 1 –

Because of the minimal time lapse since project construction (i.e., 1 year), we predicted that the stand structure would remain a Class 2.

Future With Project
Target Year 10 –

The combined effects of increased deposition of fine-grained sediment, increased nutrient loading, increased freshwater flows, reduced salinities, seasonally-lower water levels, and vegetative planting should improve habitat conditions within the area. While the majority cypress trees in the project area (planted at TY1) would be 11 years old, and would not be old enough yet to be considered a component of the overstory, other midstory tree species present at TY 0 (i.e., red maple, green ash, and water tupelo) would become a component of the overstory at TY 10. In addition, because construction of the gaps is designed to allow for drainage of the area during ARDC low flow events,

seedling germination, establishment, and survival is expected to increase. Thus, we anticipate an overstory canopy closure between 33 and 50 percent and greater than a 33 percent midstory or herbaceous cover. [Class 3]

Future With Project
Target Years 25 – 50 –

The combined effects of increased deposition of fine-grained sediment, increased nutrient loading, increased freshwater flows, reduced salinities, seasonally-lower water levels, and vegetative planting should improve habitat conditions within the area. In addition, planted cypress trees are expected to be over 31 feet at age 26 (USDA 1980) and would, therefore, be considered a component of the overstory. Because construction of the gaps is designed to allow for drainage of the area during ARDC low flow events, seedling germination, establishment, and survival is expected to increase. Thus, we anticipate an overstory canopy closure equal to or greater than 75 percent with a herbaceous cover greater than 33 percent. [Class 6]

Variable 2: Stand Maturity

Both *Future With* and *Future Without Project*
Target Year 0 –

This information was gathered during a July 30, 2009, field assessment. Those estimates, based on existing habitat conditions, were consistent with those found by Bernard Wood (Research Assistant Southeastern Louisiana University) through direct measurement of project area trees. His dbh estimate, for all tree species combined, was between 6.5 and 8.25 inches, as compared to our average of 7.2 inches determined during our WVA data collection field assessment. Basal area was estimated based on information gathered during the aforementioned field visit and data collected by Southeast Louisiana University over the past 10 years.

Future Without Project

Target Years 1 – 50 –

Values based on information presented in the PPL 12 WVA. Mean dbh for each species was estimated as the mean existing dbh plus the existing mean annual growth rate times X number of years (growth rate: cypress = 0.11 inches per year; tupelo et al = 0.08 inches per year). Basal area was again estimated by a bottomland hardwood growth/basal area calculator developed by the United States Forest Service (Putnam et al. 1960) and percent composition of canopy trees was estimated based on best professional judgment. Within the PPL 12 WVA it was assumed that 50 percent of the tupelo et al would die over 20 years, but that actual mortality of cypress would be minimal. Over the 50 year project life, we assume that 75 percent of the tupelo et al would die with minimal cypress mortality. In addition, we assume that minimal regeneration would occur over 50 years based on the degraded habitat conditions. Subsequently, under the future without project scenario, basal areas decreased from target year 0 to 50.

Future With Project

Target Years 1 – 50 –

Values based on information presented in the PPL 12 WVA. Under the future with project scenario, construction of the gaps is expected to stimulate productivity and growth of cypress and tupelo. We assume that the secondary impact areas will receive the benefits from freshwater flows, nutrients, and sediments; however, to a lesser extent than the primary impact areas. These assumptions are similar to those by Hamilton and Shaffer (2001) for the Maurepas Diversion Project. Results of studies by John Day in wetlands receiving secondary treated sewage suggest that introduction of nutrients as well as sediments from river water could stimulate production by 3-5 fold (Hamilton and Shaffer 2001). Comparison of productivity in swamps that are either managed, have more favorable hydrology, and/or are receiving nutrient enrichment suggest that the existing level of productivity in Maurepas are ½ to ¼ of average

values. As a conservative projection, we assume growth rates to be 129% of current growth in the secondary impact areas, which is the same assumption used in the PPL 12 WVA. Percent composition of cypress trees was adjusted over the 50 years to mimic conditions in healthier portions of the project area. Basal area was estimated by using bottomland hardwood growth/basal area rates developed by the United States Forest Service (Putnam et al. 1960).

Variable 3: Water Regime

Both *Future With* and *Future Without Project*
Target Year 0 –

At present the Maurepas swamps within the project area are semi-permanently flooded and have low flow/exchange.

Future Without Project
Target Years 1 – 50 –

Continued degradation of the area is expected under the future without project scenario. Because the area has some level of flow/exchange (albeit low), we anticipate the area to remain semi-permanently flooded over 50 years.

Future With Project
Target Years 1 – 50 –

We assume that the portions of the proposed project within the secondary impact areas are expected to see direct benefits from construction of the gaps, and should experience an increase in substrate accretion and nutrient input, however, to a lesser extent than the primary impact areas. Being located further from the proposed gaps than the primary impact areas, we assume that the secondary impact areas will also experience some level of improvement in flooding duration due to improved drainage of the swamp, however, not to the extent of the primary impact areas. We, therefore, anticipate a semi-permanent flood duration with moderate flow/exchange.

Variable 4: Mean High Salinity During the Growing Season

Both *Future With* and *Future Without Project*
Target Year 0 –

Value based on information presented in the PPL 12 WVA. Specifically, for the Maurepas Diversion Project it was estimated that typical high salinity during the growing season would be about 1.4 ppt. Because the ARDC project is further from the lake (i.e., further from the source of saltwater intrusion) the CWPPRA Environmental Work Group assumed a lower mean high salinity in this area and adopted 1.2 ppt for the PPL 12 WVA.

Future Without Project
Target Years 1 – 50 –

Values based on information presented in the PPL 12 WVA. Specifically, subsidence is expected to continue within the project area over time under the future without project scenario. We, therefore, assume that the ability for saltwater to intrude further and/or more frequently into the project area swamps will likewise increase. Thus, we assumed that mean high salinity during the growing season would increase to 1.4 ppt over 50 years.

Future With Project
Target Years 1 – 50 –

Values based on information presented in the PPL 12 WVA. Specifically, the proposed project was designed to allow for freshwater to be introduced into the swamp when water elevations in the ARDC are higher than in the swamp, which is anticipated to occur frequently. This frequent introduction of freshwater into the system from the ARDC is expected to result in a mean high salinity reduction. However, because the secondary impact areas are located further from the gaps than the primary impact areas and because the volume of water would be spread over a larger area we assumed that mean high salinity benefits would be less in those areas (1.0 ppt for TY 1 and 10). In addition,

because of the anticipated increase in sea level rise over time, we assume an increase in mean high salinities of 1.1 and 1.3 ppt for TY 25 and 50, respectively.

- ***20 - 30 Years to Marsh***

Variable 1: Stand Structure

Both *Future* *With* and *Future* *Without* *Project*
Target Year 0 –

This information was gathered during a July 30, 2009, field assessment. Those estimates, based on existing habitat conditions, were consistent with those found by Bernard Wood (Research Assistant Southeastern Louisiana University). Specifically, total canopy cover is estimated to be approximately 60 percent with an approximate midstory cover of approximately 35 percent. [Class 4]

Future *Without* *Project*
Target Year 1 –

Because of the minimal time lapse since TY0, we predicted that the stand structure would remain a Class 4.

Future *Without* *Project*
Target Years 10 – 50 –

Continued degradation of the area is anticipated under the future without project scenario. Because of this, we assumed that overstory closure would be reduced to less than 50 percent by TY10 (Class 2) and less than 33 percent by TY25 (Class 1).

Future *With* *Project*
Target Year 1 –

Because of the minimal time lapse since project construction (i.e., 1 year), we predicted that the stand structure would remain a Class 4.

Future *With* *Project*
Target Year 10 –

The combined effects of increased deposition of fine-grained sediment, increased nutrient loading, increased freshwater flows, reduced salinities, seasonally-lower water levels, and vegetative planting should improve habitat conditions over time within the area. In addition, because construction of the gaps is designed to allow for drainage of the area during ARDC low flow events, seedling germination, establishment, and survival is expected to increase. We do not, however, anticipate a significant change in stand structure in this area over 10 years. Therefore, we predicted stand structure would remain a Class 4.

Future With Project
Target Years 25 – 50 –

The combined effects of increased deposition of fine-grained sediment, increased nutrient loading, increased freshwater flows, reduced salinities, seasonally-lower water levels, and vegetative planting should improve habitat conditions within the area over time. Because construction of the gaps is designed to allow for drainage of the area during ARDC low flow events, seedling germination, establishment, and survival is expected to increase. Thus, we anticipate an overstory canopy closure equal to or greater than 75 percent with a herbaceous cover or midstory cover greater than 33 percent. [Class 6]

Variable 2: Stand Maturity

Both *Future With* and *Future Without Project*
Target Year 0 –

This information was gathered during a July 30, 2009, field assessment. Those estimates, based on existing habitat conditions, were consistent with those found by Bernard Wood (Research Assistant Southeastern Louisiana University) through direct measurement of project area trees. His dbh estimate, for all tree species combined, was between 6.5 and 8.25 inches, as compared to our average of 7.9 inches determined during our WVA data

collection field assessment. Basal area was estimated based on information gathered during the aforementioned field visit and data collected by Southeast Louisiana University over the past 10 years.

Future Without Project

Target Years 1 – 50 –

Values based on information presented in the PPL 12 WVA. Mean dbh for each species was estimated as the mean existing dbh plus the existing mean annual growth rate times X number of years (growth rate: cypress = 0.11 inches per year; tupelo et al = 0.08 inches per year). Basal area was again estimated by a bottomland hardwood growth/basal area calculator developed by the United States Forest Service (Putnam et al. 1960) and percent composition of canopy trees was estimated based on best professional judgment. Within the PPL 12 WVA it was assumed that 50 percent of the tupelo et al would die over 20 years, but that actual mortality of cypress would be minimal. Over the 50 year project life, we assume that 75 percent of the tupelo et al would die with minimal cypress mortality occurring within the 10 year to marsh habitat type. Because habitat quality and conditions are higher in the 20 year to marsh habitat type, as compared to the 10 year to marsh habitat type, we assume that tupelo mortality would occur, but at a slower rate. Therefore, we predict that 50 percent of the tupelo et al would die over the 50 year project life. Subsequently, under the future without project scenario, basal areas decrease from target year 0 to 50.

Future With Project

Target Years 1 – 50 –

Values based on information presented in the PPL 12 WVA. Under the future with project scenario, construction of the gaps is expected to stimulate productivity and growth of cypress and tupelo. We assume that the secondary impact areas will receive benefits from freshwater flows, nutrients, and sediments; however, to a lesser extent than the

primary impact areas. These assumptions are similar to those by Hamilton and Shaffer (2001) for the Maurepas Diversion Project. Results of studies by John Day in wetlands receiving secondary treated sewage suggest that introduction of nutrients as well as sediments from river water could stimulate production by 3-5 fold (Hamilton and Shaffer 2001). Comparison of productivity in swamps that are either managed, have more favorable hydrology, and/or are receiving nutrient enrichment suggest that the existing level of productivity in Maurepas are ½ to ¼ of average values. As a conservative projection, we assume growth rates to be 129% of current growth in the secondary impact areas, which is the same assumption used in the PPL 12 WVA. Percent composition of cypress trees was adjusted over the 50 years to mimic conditions in healthier portions of the project area. Basal area was estimated by using bottomland hardwood growth/basal area rates developed by the United States Forest Service (Putnam et al. 1960).

Variable 3: Water Regime

Both *Future With* and *Future Without Project*
Target Year 0 –

At present the Maurepas swamps within the project area are semi-permanently flooded and have low flow/exchange.

Future Without Project
Target Years 1 – 50 –

Continued degradation of the area is expected under the future without project scenario. Because the area has some level of flow/exchange (albeit low), we anticipate the area to remain semi-permanently flooded over 50 years.

Future With Project
Target Years 1 – 50 –

We assume that the portions of the proposed project within the secondary impact areas are expected to

see direct benefits from construction of the gaps, and should experience an increase in substrate accretion and nutrient input, however, to a lesser extent than the primary impact areas. Being located further from the proposed gaps than the primary impact areas, we assume that the secondary impact areas will also experience some level of improvement in flooding duration due to improved drainage of the swamp, however, not to the extent of the primary impact areas. We, therefore, anticipate a semi-permanent flood duration with moderate flow/exchange.

Variable 4: Mean High Salinity During the Growing Season

Both *Future With* and *Future Without Project*
Target Year 0 –

Value based on information presented in the PPL 12 WVA. Specifically, for the Maurepas Diversion Project it was estimated that typical high salinity during the growing season would be about 1.4 ppt. Because the ARDC project is further from the lake (i.e., further from the source of saltwater intrusion) the CWPPRA Environmental Work Group assumed a lower mean high salinity in this area and adopted 1.2 ppt for the PPL 12 WVA.

Future Without Project
Target Years 1 – 50 –

Values based on information presented in the PPL 12 WVA. Specifically, subsidence is expected to continue within the project area over time under the future without project scenario. We, therefore, assume that the ability for saltwater to intrude further and/or more frequently into the project area swamps will likewise increase. Thus, we assumed that mean high salinity during the growing season would increase to 1.4 ppt over 50 years.

Future With Project
Target Years 1 – 50 –

Values based on information presented in the PPL 12 WVA. Specifically, the proposed project was

designed to allow for freshwater to be introduced into the swamp when water elevations in the ARDC are higher than in the swamp, which is anticipated to occur frequently. This frequent introduction of freshwater into the system from the ARDC is expected to result in a mean high salinity reduction. However, because the secondary impact areas are located further from the gaps than the primary impact areas and because the volume of water would be spread over a larger area we assumed that mean high salinity benefits would be less in those areas (1.0 ppt for TY 1 and 10). In addition, because of the anticipated increase in sea level rise over time, we assume an increase in mean high salinities of 1.1 and 1.3 ppt for TY 25 and 50, respectively.

- ***30 -50 Years to Marsh***

Variable 1: Stand Structure

Both *Future With* and *Future Without Project*
Target Year 0 –

This information was provided by Bernard Wood (Research Assistant Southeastern Louisiana University). Specifically, total canopy cover is estimated to be between 50 and 75 percent with a midstory cover greater than 33 percent or a herbaceous cover greater than 33 percent. [Class 4]

Future Without Project
Target Year 1 –

Because of the minimal time lapse since TY0, we predicted that the stand structure would remain a Class 4.

Future Without Project
Target Years 10 – 50 –

Degradation of the area is anticipated under the future without project scenario. Because of this, we assumed that overstory closure would be reduced to less than 50 percent by TY25 (Class 3) and less than 33 percent by TY50 (Class 1).

Future *With* *Project*
Target Year 1 –

Because of the minimal time lapse since project construction (i.e., 1 year), we predicted that the stand structure would remain a Class 4.

Future *With* *Project*
Target Year 10 –

The combined effects of increased deposition of fine-grained sediment, increased nutrient loading, increased freshwater flows, reduced salinities, seasonally-lower water levels, and vegetative planting should improve habitat conditions over time within the area. In addition, because construction of the gaps is designed to allow for drainage of the area during ARDC low flow events, seedling germination, establishment, and survival is expected to increase. We do not, however, anticipate a significant change in stand structure in this area over 10 years. Therefore, we predicted stand structure would remain a Class 4.

Future *With* *Project*
Target Years 25 – 50 –

The combined effects of increased deposition of fine-grained sediment, increased nutrient loading, increased freshwater flows, reduced salinities, seasonally-lower water levels, and vegetative planting should improve habitat conditions within the area over time. Because construction of the gaps is designed to allow for drainage of the area during ARDC low flow events, seedling germination, establishment, and survival is expected to increase. Thus, we anticipate an overstory canopy closure equal to or greater than 75 percent with a herbaceous cover or midstory cover greater than 33 percent. [Class 6]

Variable 2: Stand Maturity

Both *Future* *With* and *Future* *Without* *Project*
Target Year 0 –

This information was provided by Bernard Wood through direct measurement of project area trees.

Future Without Project

Target Years 1 – 50 –

Values based on information provided by Bernard Wood. Mean dbh for each species was estimated as the mean existing dbh plus the existing mean annual growth rate times X number of years (growth rate: cypress = 0.15 inches per year; tupelo et al = 0.10 inches per year). Basal area was estimated based on data collected by Southeast Louisiana University over the past 10 years and percent composition of canopy trees was estimated based on best professional judgment. Within the PPL 12 WVA it was assumed that 50 percent of the tupelo et al would die over 20 years, but that actual mortality of cypress would be minimal. Over the 50 year project life, we assume that 75 percent of the tupelo et al would die with minimal cypress mortality occurring within the 10 year to marsh habitat type. Because habitat quality and conditions are higher in the 30 - 50 year to marsh habitat type, as compared to the 10 year to marsh habitat type, we assume that tupelo mortality would occur, but at a slower rate. Therefore, we predict that 50 percent of the tupelo et al would die over the 50 year project life. Subsequently, under the future without project scenario basal areas decrease slightly from target year 0 to 25 and decrease significantly between target year 25 and 50 due to the projected loss of canopy cover.

Future With Project

Target Years 1 – 50 –

Values based on information presented in the PPL 12 WVA. Under the future with project scenario, construction of the gaps is expected to stimulate productivity and growth of cypress and tupelo. We assume that the secondary impact areas will receive benefits from freshwater flows, nutrients, and sediments; however, to a lesser extent than the primary impact areas. These assumptions are

similar to those by Hamilton and Shaffer (2001) for the Maurepas Diversion Project. Results of studies by John Day in wetlands receiving secondary treated sewage suggest that introduction of nutrients as well as sediments from river water could stimulate production by 3-5 fold (Hamilton and Shaffer 2001). Comparison of productivity in swamps that are either managed, have more favorable hydrology, and/or are receiving nutrient enrichment suggest that the existing level of productivity in Maurepas are ½ to ¼ of average values. As a conservative projection, we assume growth rates to be 129% of current growth in the secondary impact areas, which is the same assumption used in the PPL 12 WVA. Percent composition of cypress trees was adjusted over the 50 years to mimic conditions in healthier portions of the project area. Basal area was estimated by using bottomland hardwood growth/basal area rates developed by the United States Forest Service (Putnam et al. 1960).

Variable 3: Water Regime

Both *Future With* and *Future Without Project*
Target Year 0 –

At present the Maurepas swamps within the project area are temporarily flooded and have low flow/exchange.

Future Without Project
Target Years 1 – 50 –

Degradation of the area is expected under the future without project scenario. Because the area has some level of flow/exchange (albeit low), we anticipate the area to remain temporarily flooded over 50 years.

Future With Project
Target Years 1 – 50 –

We assume that the portions of the proposed project within the secondary impact areas are expected to see direct benefits from construction of the gaps,

and should experience an increase in substrate accretion and nutrient input, however, to a lesser extent than the primary impact areas. Being located further from the proposed gaps than the primary impact areas, we assume that the secondary impact areas will also experience some level of improvement in flooding duration due to improved drainage of the swamp, however, not to the extent of the primary impact areas. We, therefore, anticipate a temporary flood duration with moderate flow/exchange.

Variable 4: Mean High Salinity During the Growing Season

Both *Future With* and *Future Without Project*
Target Year 0 –

Value based on information presented in the PPL 12 WVA. Specifically, for the Maurepas Diversion Project it was estimated that typical high salinity during the growing season would be about 1.4 ppt. Because the ARDC project is further from the lake (i.e., further from the source of saltwater intrusion) the CWPPRA Environmental Work Group assumed a lower mean high salinity in this area and adopted 1.2 ppt for the PPL 12 WVA.

Future Without Project
Target Years 1 – 50 –

Values based on information presented in the PPL 12 WVA. Specifically, subsidence is expected to continue within the project area over time under the future without project scenario. We, therefore, assume that the ability for saltwater to intrude further and/or more frequently into the project area swamps will likewise increase. Thus, we assumed that mean high salinity during the growing season would increase to 1.4 ppt over 50 years.

Future With Project
Target Years 1 – 50 –

Values based on information presented in the PPL 12 WVA. Specifically, the proposed project was designed to allow for freshwater to be introduced

into the swamp when water elevations in the ARDC are higher than in the swamp, which is anticipated to occur frequently. This frequent introduction of freshwater into the system from the ARDC is expected to result in a mean high salinity reduction. However, because the secondary impact areas are located further from the gaps than the primary impact areas and because the volume of water would be spread over a larger area we assumed that mean high salinity benefits would be less in those areas (1.0 ppt for TY 1 and 10). In addition, because of the anticipated increase in sea level rise over time, we assume an increase in mean high salinities of 1.1 and 1.3 ppt for TY 25 and 50, respectively.

INTERMEDIATE AND HIGH SEA LEVEL RISE SCENARIO ASSUMPTIONS

Variable 1: Stand Structure

No anticipated changes to this variable (i.e., same projections as low sea level rise scenario).

Variable 2: Stand Maturity

No anticipated changes to this variable (i.e., same projections as low sea level rise scenario).

Variable 3: Water Regime

The following information was provided by George Hudson of Taylor Engineering.

RATE OF RSLR	RSLR @ 50 YEARS	WITHOUT PROJECT YEARS TO PERMANENT INUNDATION	WITH PROJECT YEARS TO PERMANENT INUNDATION	WITH PROJECT WITH 8 MM/YR ACCRETION YEARS TO PERMANENT INUNDATION
Low Rate	1.5 feet	14 years	40 years	150 years
Intermediate Rate	1.9 feet	12.5 years	31 years	58 years
High Rate	3.2 feet	8 years	17 years	26 years

Variable 4: Mean High Salinity During the Growing Season

The study area is normally dominated by the fresh headwater flow of the Amite River, with some additional freshwater input from the Blind River. This area also has episodic salinity pulses from tropical storms and extreme droughts, such as the drought of 1998-2000.

As RSLR occurs, the isohalines will migrate toward the study area, but still will be hindered somewhat by the freshwater input. As sea level rises [such as in the low (1.5 feet in 50 years) to medium (1.9 feet in 50 years) estimates], the tropical events and droughts will allow for increased saltwater intrusion into the area. The spikes will be higher and there will be more volume of saltwater entering the study area. As sea level continues to increase [as for the high (3.2 feet in 50 years)] this saltwater intrusion will increase, likely curvilinearly, perhaps exponentially.

The salinity (V4) term in the Swamp WVA accounts for the impact of salinity on the estimate of health for the system. V4 is the mean average high salinity, basically the average of the top 33% of the readings. As salinity increases due to RSLR, the spikes and volume of salt water will increase. However, due to the domination of the fresh water in the Amite and Blind Rivers, this area will still likely be fresh during normal conditions, even with the high estimate of RSLR. Therefore, even if the top 10% of the readings are higher, the next 23% (rest of the 33%) would likely be about the same. Thus, there would be some "watering down" of the spikes for the WVA evaluation. The key to this logic is the freshwater input of the 2,200 square miles of the Blind River and Amite River watersheds. For the FWP, the connectivity and the normal freshwater input that follows a tropical event would improve conditions by flushing the salt water out of the system, rather than letting it linger and increase soil salinities.

The WVA Team developed estimates for the V4 Salinity term for the low (1.5 ft) RSLR estimate (see the following table). Using this as a basis, a relationship between salinity increase and RSLR was determined. For the low FWOP, the Team determined that the V4 term would go from 1.2 to 1.4 ppt with a RSLR increase of 1.5 feet. We assume a linear increase in RSLR, thus the estimates for the WVA years (1, 10, and 25) are simply estimated by dividing the 50-year estimate by the appropriate year. The estimate of 0.133 ppt per foot of RSLR [(1.4-1.2)/1.5] was developed from the low estimate.

For the medium RSLR estimate, a 0.133 ppt per foot of RSLR was applied to the estimate of RSLR.

For year 50 in the high RSLR estimate, the estimate was doubled to 0.266 ppt per foot of RSLR. The reason for this increase is that when the sea level increases to about the 1.5-1.9 foot range, the saltwater intrusion would be much more pronounced as the increase would be curvilinear or even exponential. Likely, the 1.0 ppt isohaline may be very close to the study area in Lake Maurepas, even during normal conditions.

The FWP for both medium and high RSLR was estimated based on the FWOP and WVA Technical discussions.

Salinity estimates for three RSLR senarios, as based on Low RSLR.

	Low RSLR				Med RSLR				High RSLR			
		V4 Salinity				V4 Salinity				V4 Salinity		
Year		FWOP	FWP			FWOP	FWP			FWOP	FWP	
	RSLR		Primary Impact Area	Secondary Impact Area	RSLR		Primary Impact Area	Secondary Impact Area	RSLR		Primary Impact Area	Secondary Impact Area
0	0.00	1.20	1.20	1.20	0.00	1.20	1.20	1.20	0.00	1.20	1.20	1.20
1	0.03	1.20	0.90	1.00	0.04	1.21	0.90	1.00	0.06	1.21	0.90	1.00
10	0.30	1.20	0.90	1.00	0.38	1.25	0.90	1.00	0.64	1.29	0.90	1.00
25	0.75	1.30	1.00	1.10	0.95	1.33	1.00	1.10	1.60	1.41	1.20	1.30
50	1.50	1.40	1.20	1.30	1.90	1.45	1.20	1.30	3.20	2.05	1.80	1.90

FWOP

Low	Determined in WVA Technical Meetings
Medium	0.2 PPT / 1.5 ft RSLR = 0.133 ppt / foot of RSLR
High	Double rate from from year 25 to year 50 on High SLR - 0.266 ppt increase per foot of RSLR.

FWP

LOW	Determined in WVA Technical Meetings
Medium	Estimated Based on FWOP and WVA Technical Meetings
High	Estimated Based on FWOP and WVA Technical Meetings

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APPENDIX B

WVA SUMMARY SHEET FOR LCA-ARDC

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Amite River Diversion Canal Modification
WVA Summary

Low SLR

Alternative 33

• Fresh Marsh Primary Impact Area	=	70.88	AAHUs	3544.07	CHUs
• 10 Years to Marsh Primary Impact Area	=	35.22	AAHUs	1761.12	CHUs
• 10 Years to Marsh Secondary Impact Area	=	73.46	AAHUs	3673.10	CHUs
• 20-30 Years to Marsh Primary Impact Area	=	189.49	AAHUs	9474.31	CHUs
• 20-30 Years to Marsh Secondary Impact Area	=	252.42	AAHUs	12621.00	CHUs
• 30-50 Years to Marsh Primary Impact Area	=	27.29	AAHUs	1364.40	CHUs
• 30-50 Years to Marsh Secondary Impact Area	=	40.02	AAHUs	2001.13	CHUs
• Spoil Bank Permanent Impacts	=	-0.55	AAHUs	-27.60	CHUs
• Spoil Bank Temporary Impacts	=	-0.23	AAHUs	-11.38	CHUs
• Fresh Marsh Permanent Impacts	=	-1.73	AAHUs	-86.42	CHUs
• 10 Years to Marsh Permanent Impacts	=	-0.71	AAHUs	-35.53	CHUs
• 20-30 Years to Marsh Permanent Impacts	=	-4.70	AAHUs	-235.12	CHUs
• 30-50 Years to Marsh Permanent Impacts	=	-1.80	AAHUs	-89.89	CHUs
TOTAL	►	**679.46**	**AAHUs**	**33973.18**	**CHUs**

Alternative 34

• Fresh Marsh Secondary Impact Area	=	46.79	AAHUs	2339.32	CHUs
• 10 Years to Marsh Primary Impact Area	=	38.96	AAHUs	1948.18	CHUs
• 10 Years to Marsh Secondary Impact Area	=	293.72	AAHUs	14683.10	CHUs
• 20-30 Years to Marsh Primary Impact Area	=	81.25	AAHUs	4063.76	CHUs
• 20-30 Years to Marsh Secondary Impact Area	=	59.83	AAHUs	2991.75	CHUs
• 30-50 Years to Marsh Primary Impact Area	=	67.25	AAHUs	3362.63	CHUs
• 30-50 Years to Marsh Secondary Impact Area	=	9.25	AAHUs	462.23	CHUs
• Spoil Bank Permanent Impacts	=	-0.62	AAHUs	-31.05	CHUs
• Spoil Bank Temporary Impacts	=	-0.32	AAHUs	-15.81	CHUs
• 10 Years to Marsh Permanent Impacts	=	-0.28	AAHUs	-14.21	CHUs
• 20-30 Years to Marsh Permanent Impacts	=	-1.87	AAHUs	-93.60	CHUs
• 30-50 Years to Marsh Permanent Impacts	=	-5.75	AAHUs	-287.66	CHUs
TOTAL	►	**588.58**	**AAHUs**	**29428.75**	**CHUs**

Alternative 35

• 20-30 Years to Marsh Primary Impact Area	=	143.92	AAHUs	7196.09	CHUs
• 20-30 Years to Marsh Secondary Impact Area	=	110.96	AAHUs	5548.65	CHUs
• 30-50 Years to Marsh Primary Impact Area	=	58.05	AAHUs	2902.27	CHUs
• 30-50 Years to Marsh Secondary Impact Area	=	26.00	AAHUs	1299.80	CHUs
• Spoil Bank Permanent Impacts	=	-0.41	AAHUs	-20.70	CHUs
• Spoil Bank Temporary Impacts	=	-0.23	AAHUs	-11.38	CHUs
• 20-30 Years to Marsh Permanent Impacts	=	-2.54	AAHUs	-127.14	CHUs
• 30-50 Years to Marsh Permanent Impacts	=	-2.16	AAHUs	-107.87	CHUs
TOTAL	►	**333.60**	**AAHUs**	**16679.91**	**CHUs**

Alternative 36

• Fresh Marsh Primary Impact Area	=	70.63	AAHUs	3544.07	CHUs
• Fresh Marsh Secondary Impact Area	=	46.79	AAHUs	2339.32	CHUs
• 10 Years to Marsh Primary Impact Area	=	74.19	AAHUs	3709.30	CHUs
• 10 Years to Marsh Secondary Impact Area	=	367.18	AAHUs	18359.20	CHUs
• 20-30 Years to Marsh Primary Impact Area	=	270.75	AAHUs	13538.17	CHUs
• 20-30 Years to Marsh Secondary Impact Area	=	312.25	AAHUs	15612.74	CHUs
• 30-50 Years to Marsh Primary Impact Area	=	94.54	AAHUs	4727.03	CHUs
• 30-50 Years to Marsh Secondary Impact Area	=	49.41	AAHUs	2470.36	CHUs
• Spoil Bank Permanent Impacts	=	-1.17	AAHUs	-58.65	CHUs
• Spoil Bank Temporary Impacts	=	-0.54	AAHUs	-27.19	CHUs
• Fresh Marsh Permanent Impacts	=	-1.33	AAHUs	-66.42	CHUs
• 10 Years to Marsh Permanent Impacts	=	-0.99	AAHUs	-49.74	CHUs
• 20-30 Years to Marsh Permanent Impacts	=	-6.37	AAHUs	-317.72	CHUs
• 30-50 Years to Marsh Permanent Impacts	=	-7.55	AAHUs	-377.55	CHUs
TOTAL	►	**1268.04**	**AAHUs**	**63401.93**	**CHUs**

Alternative 37

• Fresh Marsh Secondary Impact Area	=	46.79	AAHUs	2339.32	CHUs
• 10 Years to Marsh Primary Impact Area	=	38.96	AAHUs	1948.18	CHUs
• 10 Years to Marsh Secondary Impact Area	=	293.72	AAHUs	14686.10	CHUs
• 20-30 Years to Marsh Primary Impact Area	=	225.20	AAHUs	11259.95	CHUs
• 20-30 Years to Marsh Secondary Impact Area	=	170.81	AAHUs	8540.60	CHUs
• 30-50 Years to Marsh Primary Impact Area	=	125.30	AAHUs	6264.90	CHUs
• 30-50 Years to Marsh Secondary Impact Area	=	35.38	AAHUs	1769.03	CHUs
• Spoil Bank Permanent Impacts	=	-1.03	AAHUs	-51.75	CHUs
• Spoil Bank Temporary Impacts	=	-0.54	AAHUs	-27.19	CHUs
• 10 Years to Marsh Permanent Impacts	=	-0.28	AAHUs	-14.21	CHUs
• 20-30 Years to Marsh Permanent Impacts	=	-4.21	AAHUs	-210.51	CHUs
• 30-50 Years to Marsh Permanent Impacts	=	-7.91	AAHUs	-395.53	CHUs
TOTAL	►	**922.17**	**AAHUs**	**46108.66**	**CHUs**

Alternative 38

• Fresh Marsh Primary Impact Area	=	70.88	AAHUs	3544.07	CHUs
• 10 Years to Marsh Primary Impact Area	=	35.22	AAHUs	1761.12	CHUs
• 10 Years to Marsh Secondary Impact Area	=	73.46	AAHUs	3673.10	CHUs
• 20-30 Years to Marsh Primary Impact Area	=	333.41	AAHUs	16670.40	CHUs
• 20-30 Years to Marsh Secondary Impact Area	=	363.40	AAHUs	18169.85	CHUs
• 30-50 Years to Marsh Primary Impact Area	=	85.33	AAHUs	4266.67	CHUs
• 30-50 Years to Marsh Secondary Impact Area	=	66.02	AAHUs	3300.93	CHUs
• Spoil Bank Permanent Impacts	=	-0.97	AAHUs	-48.30	CHUs
• Spoil Bank Temporary Impacts	=	-0.46	AAHUs	-22.76	CHUs
• Fresh Marsh Permanent Impacts	=	-1.33	AAHUs	-66.42	CHUs
• 10 Years to Marsh Permanent Impacts	=	-0.71	AAHUs	-35.53	CHUs
• 20-30 Years to Marsh Permanent Impacts	=	-7.25	AAHUs	-362.26	CHUs
• 30-50 Years to Marsh Permanent Impacts	=	-3.96	AAHUs	-197.76	CHUs
TOTAL	►	**1013.06**	**AAHUs**	**50653.09**	**CHUs**

Alternative 39

• Fresh Marsh Primary Impact Area	=	70.88	AAHUs	3544.07	CHUs
• Fresh Marsh Secondary Impact Area	=	46.79	AAHUs	2339.32	CHUs
• 10 Years to Marsh Primary Impact Area	=	74.19	AAHUs	3709.30	CHUs
• 10 Years to Marsh Secondary Impact Area	=	367.18	AAHUs	18359.20	CHUs
• 20-30 Years to Marsh Primary Impact Area	=	414.69	AAHUs	20734.25	CHUs
• 20-30 Years to Marsh Secondary Impact Area	=	423.23	AAHUs	21161.50	CHUs
• 30-50 Years to Marsh Primary Impact Area	=	152.59	AAHUs	7629.30	CHUs
• 30-50 Years to Marsh Secondary Impact Area	=	75.40	AAHUs	3770.16	CHUs
• Spoil Bank Permanent Impacts	=	-1.59	AAHUs	-79.35	CHUs
• Spoil Bank Temporary Impacts	=	-0.77	AAHUs	-38.57	CHUs
• Fresh Marsh Permanent Impacts	=	-1.33	AAHUs	-66.42	CHUs
• 10 Years to Marsh Permanent Impacts	=	-0.99	AAHUs	-49.74	CHUs
• 20-30 Years to Marsh Permanent Impacts	=	-8.92	AAHUs	-445.86	CHUs
• 30-50 Years to Marsh Permanent Impacts	=	-9.71	AAHUs	-485.42	CHUs
TOTAL	►	**1601.64**	**AAHUs**	**80081.84**	**CHUs**

Intermediate SLR

Alternative 33

• Fresh Marsh Primary Impact Area	=	66.75	AAHUs	3337.67	CHUs
• 10 Years to Marsh Primary Impact Area	=	34.54	AAHUs	1726.53	CHUs
• 10 Years to Marsh Secondary Impact Area	=	67.45	AAHUs	3372.29	CHUs
• 20-30 Years to Marsh Primary Impact Area	=	182.48	AAHUs	9124.00	CHUs
• 20-30 Years to Marsh Secondary Impact Area	=	232.59	AAHUs	11624.65	CHUs
• 30-50 Years to Marsh Primary Impact Area	=	26.58	AAHUs	1329.14	CHUs
• 30-50 Years to Marsh Secondary Impact Area	=	37.91	AAHUs	1895.65	CHUs
• Spoil Bank Permanent Impacts	=	-0.55	AAHUs	-27.60	CHUs
• Spoil Bank Temporary Impacts	=	-0.23	AAHUs	-11.38	CHUs
• Fresh Marsh Permanent Impacts	=	-1.32	AAHUs	-66.22	CHUs
• 10 Years to Marsh Permanent Impacts	=	-0.65	AAHUs	-32.50	CHUs
• 20-30 Years to Marsh Permanent Impacts	=	-4.37	AAHUs	-218.27	CHUs
• 30-50 Years to Marsh Permanent Impacts	=	-1.76	AAHUs	-88.17	CHUs
TOTAL	►	**640.32**	**AAHUs**	**32015.90**	**CHUs**

Alternative 36

• Fresh Marsh Primary Impact Area	=	66.75	AAHUs	3337.67	CHUs
• Fresh Marsh Secondary Impact Area	=	42.53	AAHUs	2126.41	CHUs
• 10 Years to Marsh Primary Impact Area	=	72.75	AAHUs	3637.31	CHUs
• 10 Years to Marsh Secondary Impact Area	=	337.11	AAHUs	16855.59	CHUs
• 20-30 Years to Marsh Primary Impact Area	=	262.18	AAHUs	13109.05	CHUs
• 20-30 Years to Marsh Secondary Impact Area	=	267.60	AAHUs	13491.03	CHUs
• 30-50 Years to Marsh Primary Impact Area	=	92.10	AAHUs	4604.86	CHUs
• 30-50 Years to Marsh Secondary Impact Area	=	46.80	AAHUs	2340.15	CHUs
• Spoil Bank Permanent Impacts	=	-1.17	AAHUs	-58.65	CHUs
• Spoil Bank Temporary Impacts	=	-0.54	AAHUs	-27.19	CHUs
• Fresh Marsh Permanent Impacts	=	-1.32	AAHUs	-66.22	CHUs
• 10 Years to Marsh Permanent Impacts	=	-0.92	AAHUs	-45.92	CHUs
• 20-30 Years to Marsh Permanent Impacts	=	-5.92	AAHUs	-295.88	CHUs
• 30-50 Years to Marsh Permanent Impacts	=	-7.41	AAHUs	-370.31	CHUs
TOTAL	►	**1190.64**	**AAHUs**	**64638.00**	**CHUs**

Alternative 39

• Fresh Marsh Primary Impact Area	=	66.75	AAHUs	3337.67	CHUs
• Fresh Marsh Secondary Impact Area	=	42.53	AAHUs	2126.41	CHUs
• 10 Years to Marsh Primary Impact Area	=	72.75	AAHUs	3637.31	CHUs
• 10 Years to Marsh Secondary Impact Area	=	337.11	AAHUs	16855.59	CHUs
• 20-30 Years to Marsh Primary Impact Area	=	408.90	AAHUs	20444.99	CHUs
• 20-30 Years to Marsh Secondary Impact Area	=	373.82	AAHUs	19491.03	CHUs
• 30-50 Years to Marsh Primary Impact Area	=	148.64	AAHUs	7432.12	CHUs
• 30-50 Years to Marsh Secondary Impact Area	=	71.43	AAHUs	3571.43	CHUs
• Spoil Bank Permanent Impacts	=	-1.59	AAHUs	-79.35	CHUs
• Spoil Bank Temporary Impacts	=	-0.77	AAHUs	-38.57	CHUs
• Fresh Marsh Permanent Impacts	=	-1.32	AAHUs	-66.22	CHUs
• 10 Years to Marsh Permanent Impacts	=	-0.92	AAHUs	-45.92	CHUs
• 20-30 Years to Marsh Permanent Impacts	=	-8.28	AAHUs	-413.90	CHUs
• 30-50 Years to Marsh Permanent Impacts	=	-9.52	AAHUs	-476.11	CHUs
TOTAL	►	**1515.53**	**AAHUs**	**75776.57**	**CHUs**

High SLR

Alternative 33

• Fresh Marsh Primary Impact Area	=	58.99	AAHUs	2949.66	CHUs
• 10 Years to Marsh Primary Impact Area	=	31.57	AAHUs	1578.35	CHUs
• 10 Years to Marsh Secondary Impact Area	=	67.08	AAHUs	3354.07	CHUs
• 20-30 Years to Marsh Primary Impact Area	=	170.56	AAHUs	8528.05	CHUs
• 20-30 Years to Marsh Secondary Impact Area	=	226.61	AAHUs	11330.35	CHUs
• 30-50 Years to Marsh Primary Impact Area	=	26.42	AAHUs	1320.83	CHUs
• 30-50 Years to Marsh Secondary Impact Area	=	37.46	AAHUs	1873.22	CHUs
• Spoil Bank Permanent Impacts	=	-0.55	AAHUs	-27.60	CHUs
• Spoil Bank Temporary Impacts	=	-0.23	AAHUs	-11.38	CHUs
• Fresh Marsh Permanent Impacts	=	-1.30	AAHUs	-64.90	CHUs
• 10 Years to Marsh Permanent Impacts	=	-0.62	AAHUs	-31.24	CHUs
• 20-30 Years to Marsh Permanent Impacts	=	-4.16	AAHUs	-207.75	CHUs
• 30-50 Years to Marsh Permanent Impacts	=	-1.63	AAHUs	-81.71	CHUs
TOTAL	►	**610.20**	**AAHUs**	**30509.94**	**CHUs**

Alternative 36

• Fresh Marsh Primary Impact Area	=	58.99	AAHUs	2949.66	CHUs
• Fresh Marsh Secondary Impact Area	=	40.91	AAHUs	2045.66	CHUs
• 10 Years to Marsh Primary Impact Area	=	66.49	AAHUs	3324.36	CHUs
• 10 Years to Marsh Secondary Impact Area	=	335.10	AAHUs	16754.90	CHUs
• 20-30 Years to Marsh Primary Impact Area	=	243.72	AAHUs	12186.02	CHUs
• 20-30 Years to Marsh Secondary Impact Area	=	280.32	AAHUs	14016.16	CHUs
• 30-50 Years to Marsh Primary Impact Area	=	91.52	AAHUs	4576.08	CHUs
• 30-50 Years to Marsh Secondary Impact Area	=	46.25	AAHUs	2312.45	CHUs
• Spoil Bank Permanent Impacts	=	-1.17	AAHUs	-58.65	CHUs
• Spoil Bank Temporary Impacts	=	-0.54	AAHUs	-27.19	CHUs
• Fresh Marsh Permanent Impacts	=	-1.30	AAHUs	-64.90	CHUs
• 10 Years to Marsh Permanent Impacts	=	-0.87	AAHUs	-43.74	CHUs
• 20-30 Years to Marsh Permanent Impacts	=	-5.63	AAHUs	-281.62	CHUs
• 30-50 Years to Marsh Permanent Impacts	=	-6.86	AAHUs	-343.15	CHUs
TOTAL	►	**1146.92**	**AAHUs**	**57346.02**	**CHUs**

Alternative 39

• Fresh Marsh Primary Impact Area	=	58.99	AAHUs	2949.66	CHUs
• Fresh Marsh Secondary Impact Area	=	40.91	AAHUs	2045.66	CHUs
• 10 Years to Marsh Primary Impact Area	=	66.49	AAHUs	3324.36	CHUs
• 10 Years to Marsh Secondary Impact Area	=	335.10	AAHUs	16754.90	CHUs
• 20-30 Years to Marsh Primary Impact Area	=	373.27	AAHUs	18663.39	CHUs
• 20-30 Years to Marsh Secondary Impact Area	=	378.85	AAHUs	18927.57	CHUs
• 30-50 Years to Marsh Primary Impact Area	=	147.71	AAHUs	7385.57	CHUs
• 30-50 Years to Marsh Secondary Impact Area	=	70.58	AAHUs	3529.16	CHUs
• Spoil Bank Permanent Impacts	=	-1.59	AAHUs	-79.35	CHUs
• Spoil Bank Temporary Impacts	=	-0.77	AAHUs	-38.57	CHUs
• Fresh Marsh Permanent Impacts	=	-1.30	AAHUs	-64.90	CHUs
• 10 Years to Marsh Permanent Impacts	=	-0.87	AAHUs	-43.74	CHUs
• 20-30 Years to Marsh Permanent Impacts	=	-7.88	AAHUs	-393.96	CHUs
• 30-50 Years to Marsh Permanent Impacts	=	-8.82	AAHUs	-441.21	CHUs
TOTAL	►	**1451.77**	**AAHUs**	**72588.63**	**CHUs**

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