Appendix K

ECONOMICS AND BENEFITS

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SECTION 1

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 <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 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* <u>*With*</u> and *Future* <u>*Without*</u> *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 <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 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 <u>Without</u> 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 <u>With</u> 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 <u>With</u>* and *Future <u>Without</u> 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 <u>Without</u> 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 <u>Without</u> 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 <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 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 <u>Without</u> 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 <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 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 <u>Without</u> 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 <u>With</u> 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 <u>With</u>* and *Future <u>Without</u> 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 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 <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 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 <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 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* <u>*With*</u> and *Future* <u>*Without*</u> *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 <u>*Without*</u> *Project*
Target Year 1 –

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

Future <u>*Without*</u> *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 = .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 <u>With</u>* and *Future <u>Without</u> 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 <u>Without</u> 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 <u>With</u> 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.

Low RSLR

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 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 RSLR

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 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 RSLR
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 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**

WVA Data

Figure 1 depicts the acreages utilized as input for the WVA model. These acreages represent each habitat type (20-30 years to marsh, marsh, etc.) separated out into the primary and secondary impact areas for the final array of alternatives.

Figures 2 – 6 depict the construction footprint in acres for the bifurcated conveyance channels implemented within the final array of alternatives.

Primary and Secondary Impact Areas

The primary and secondary impact areas for the final array of alternatives were developed after examining existing conveyance channels found within the study area. These channels are considered to be in a state of hydrologic equilibrium due to the lack of sediment buildup observed, when compared to other channels found within the same general area. The benefit areas for the proposed conveyance channels were developed by observing the dimensions and configurations of the drainage areas found along these existing channels.

The primary impact area would have more flow exchange and therefore more sediments and nutrients than the secondary impact area. The volume of water, which transports sediments and nutrients, is dependent on the duration of high stages in the ARDC. During the short duration of high stages in the ARDC, the benefits may be limited to the primary impact area. During normal hydrologic cycles, the primary impact area would receive a higher flow exchange than the secondary impact area.

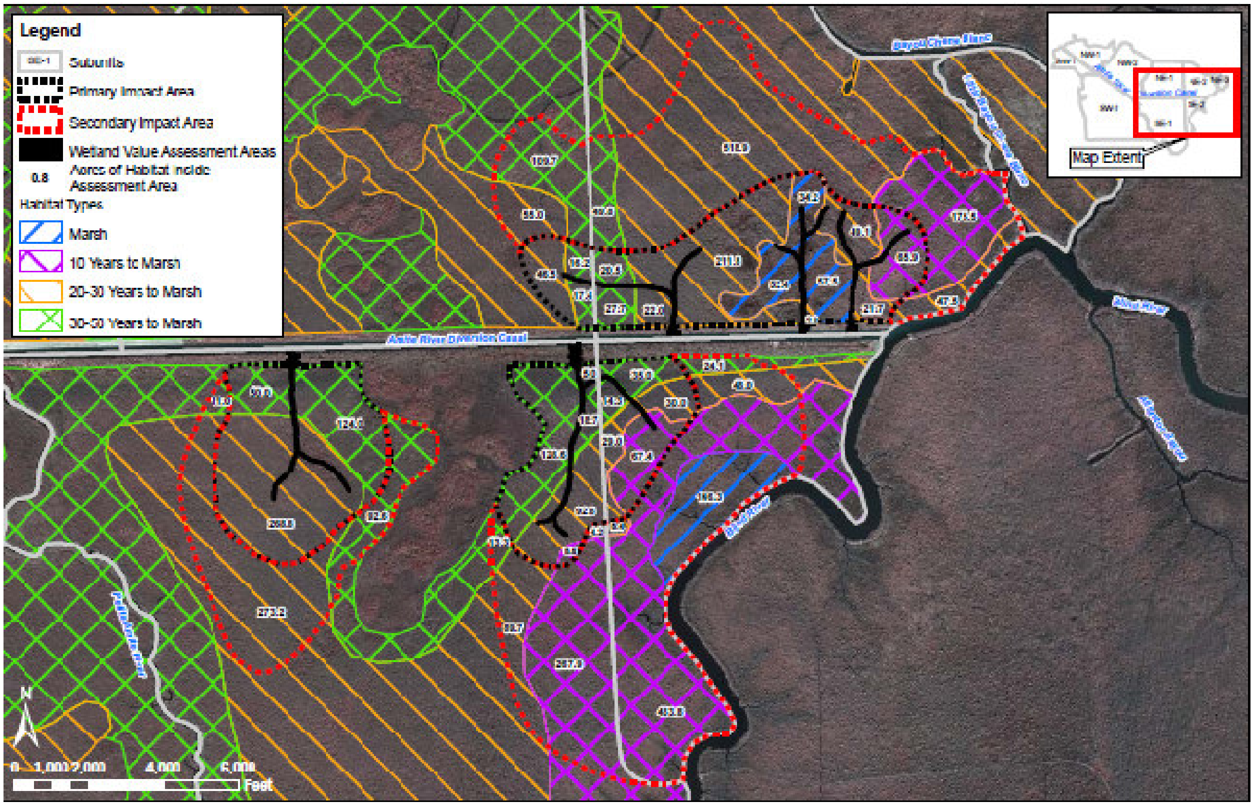


Figure 1. Input Acreages for WVA Model

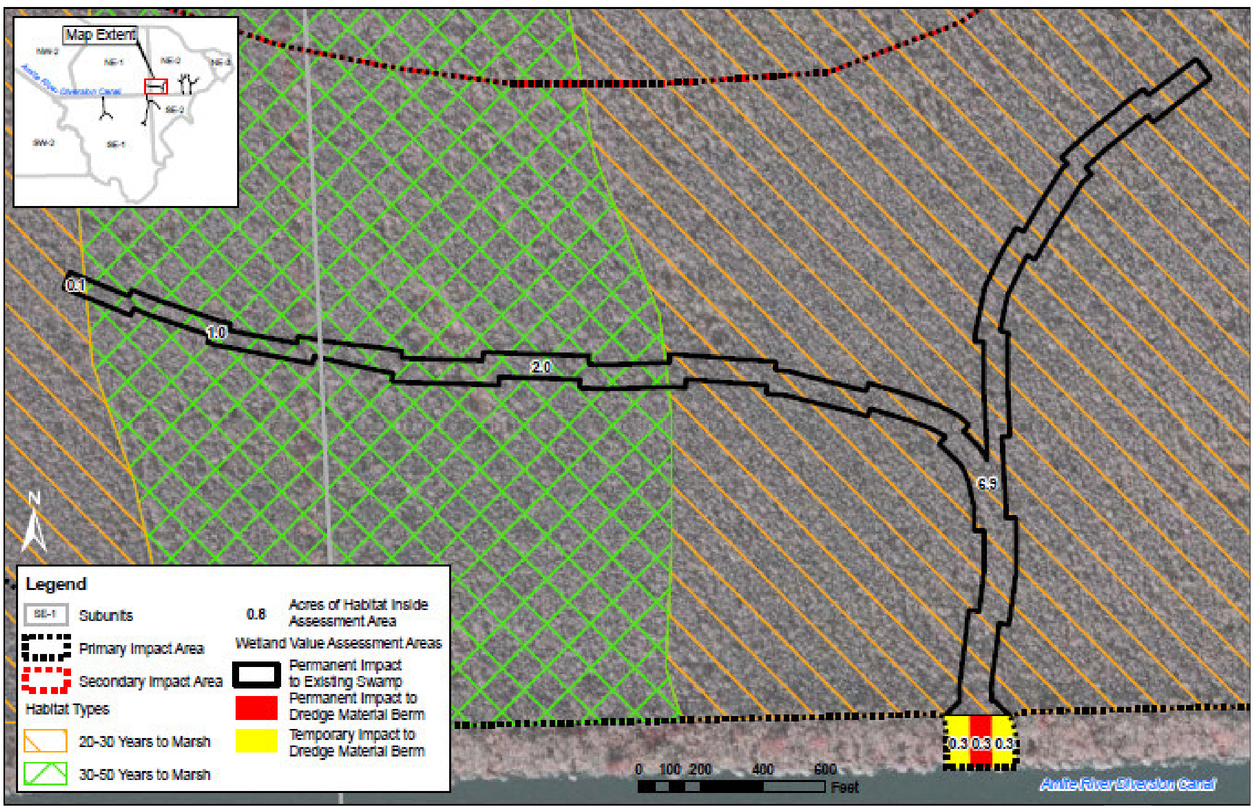


Figure 2. WVA Acreages for Alternative 33 Cut A

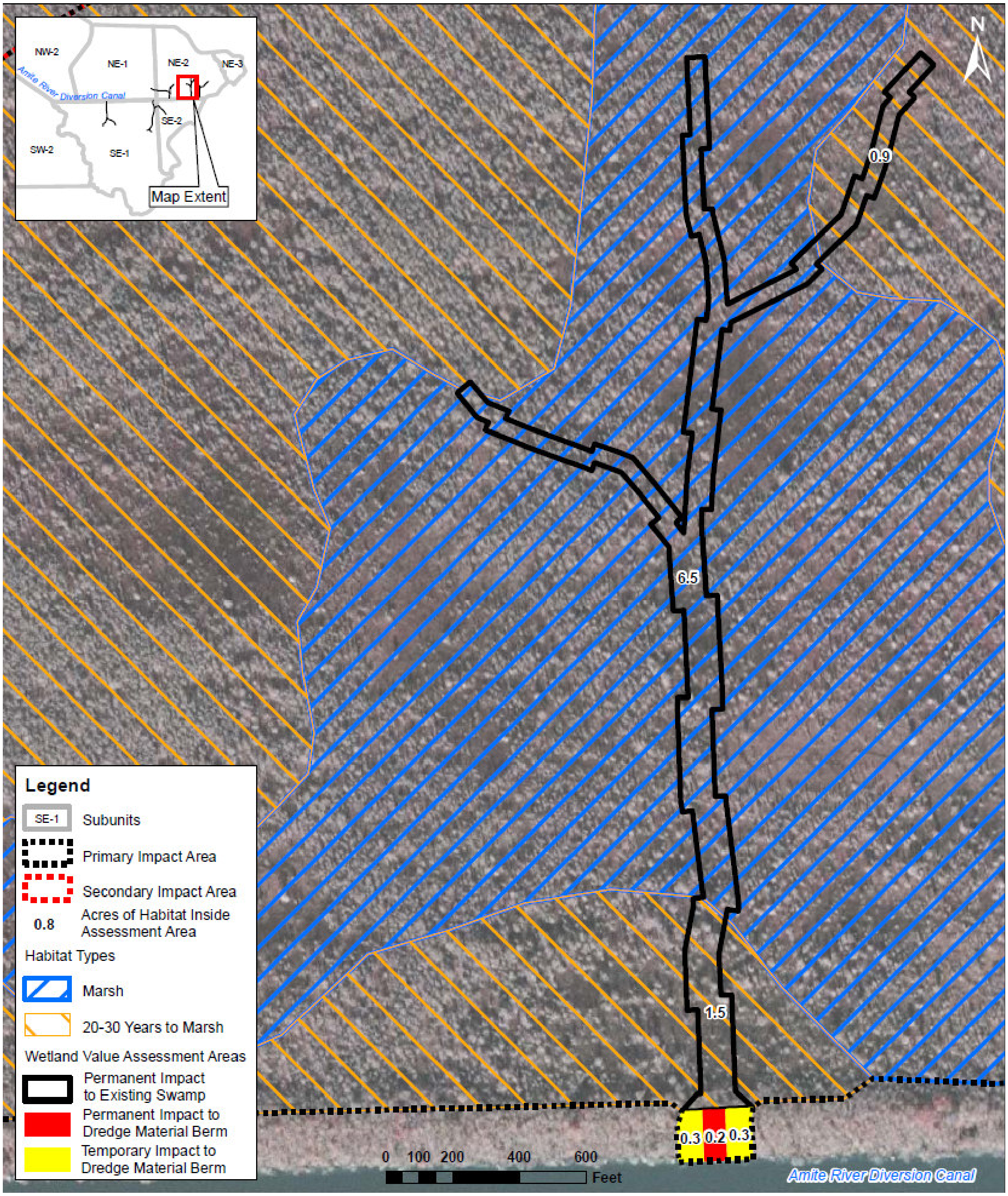


Figure 3. WVA Acreages for Alternative 33 Cut B

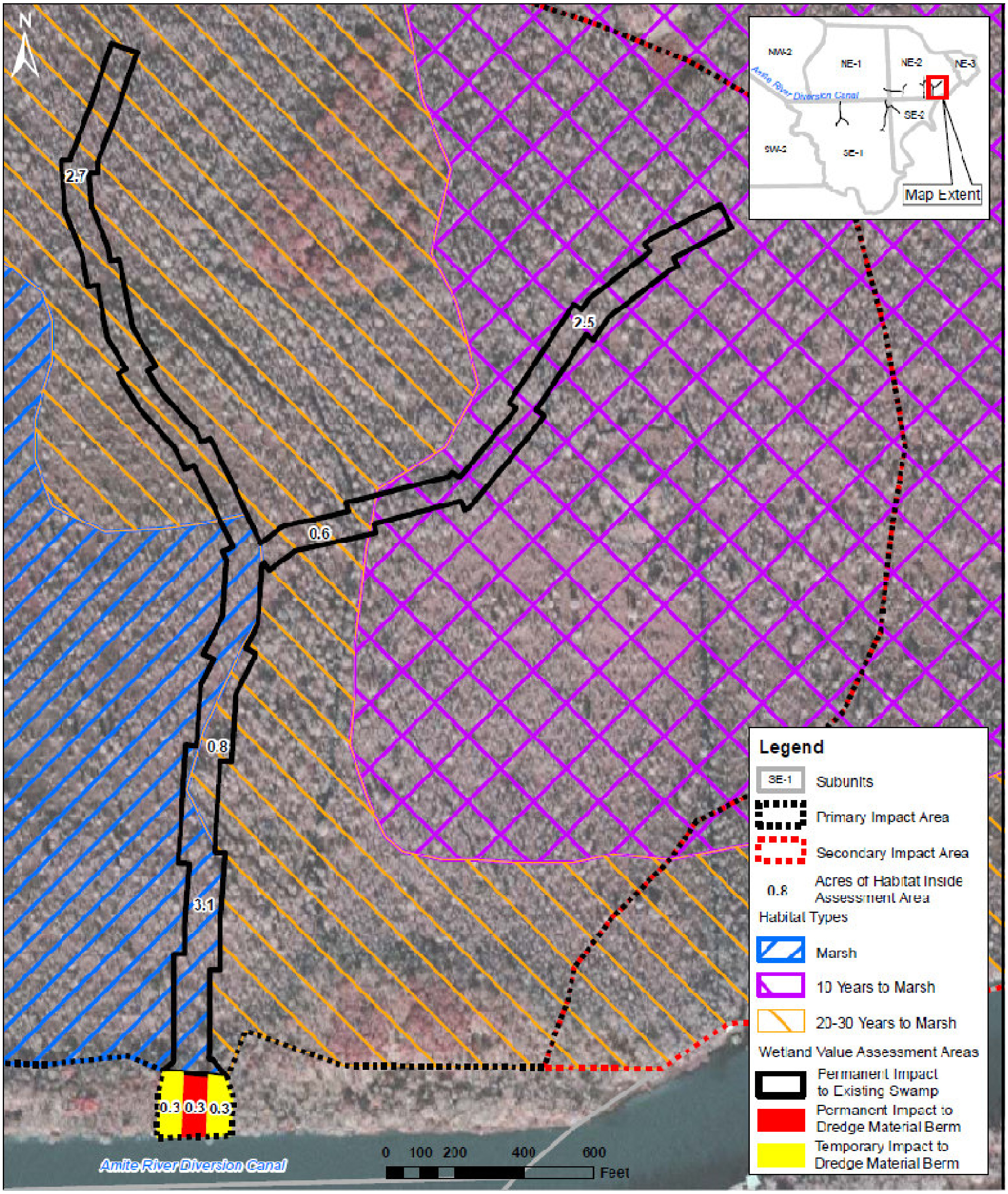


Figure 4. WVA Acreages for Alternative 33 Cut C

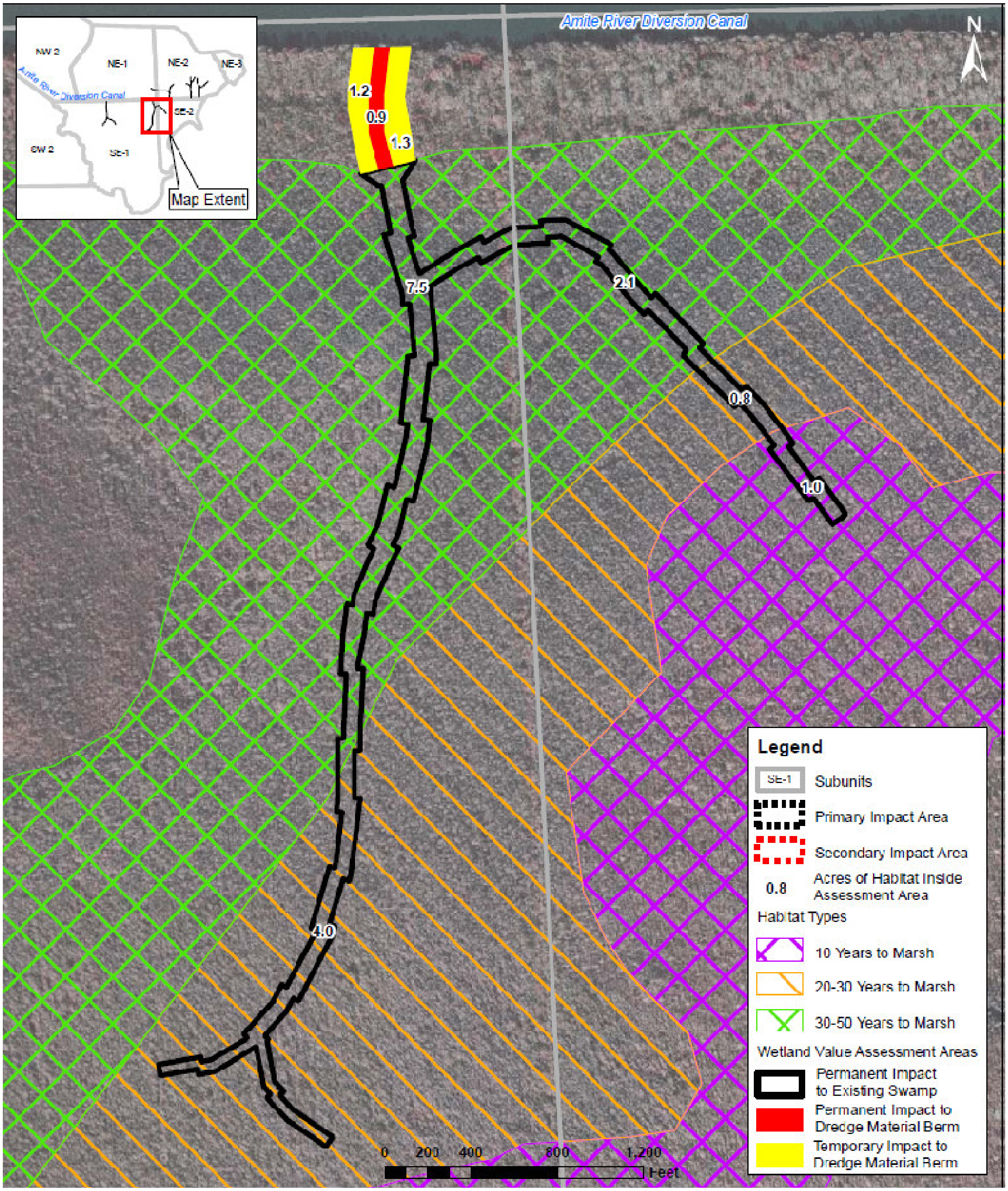


Figure 5. WVA Acreages for Alternative 34

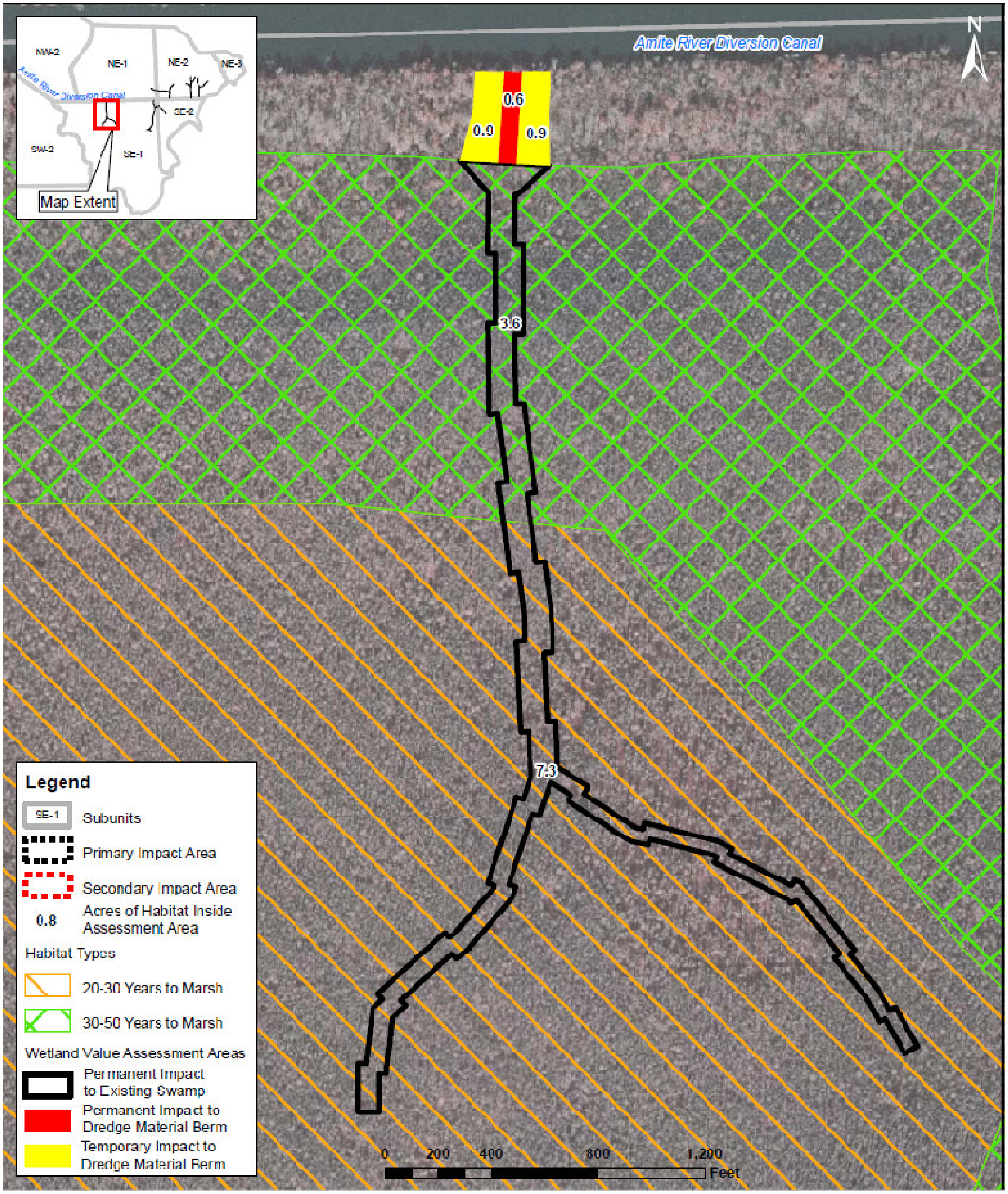
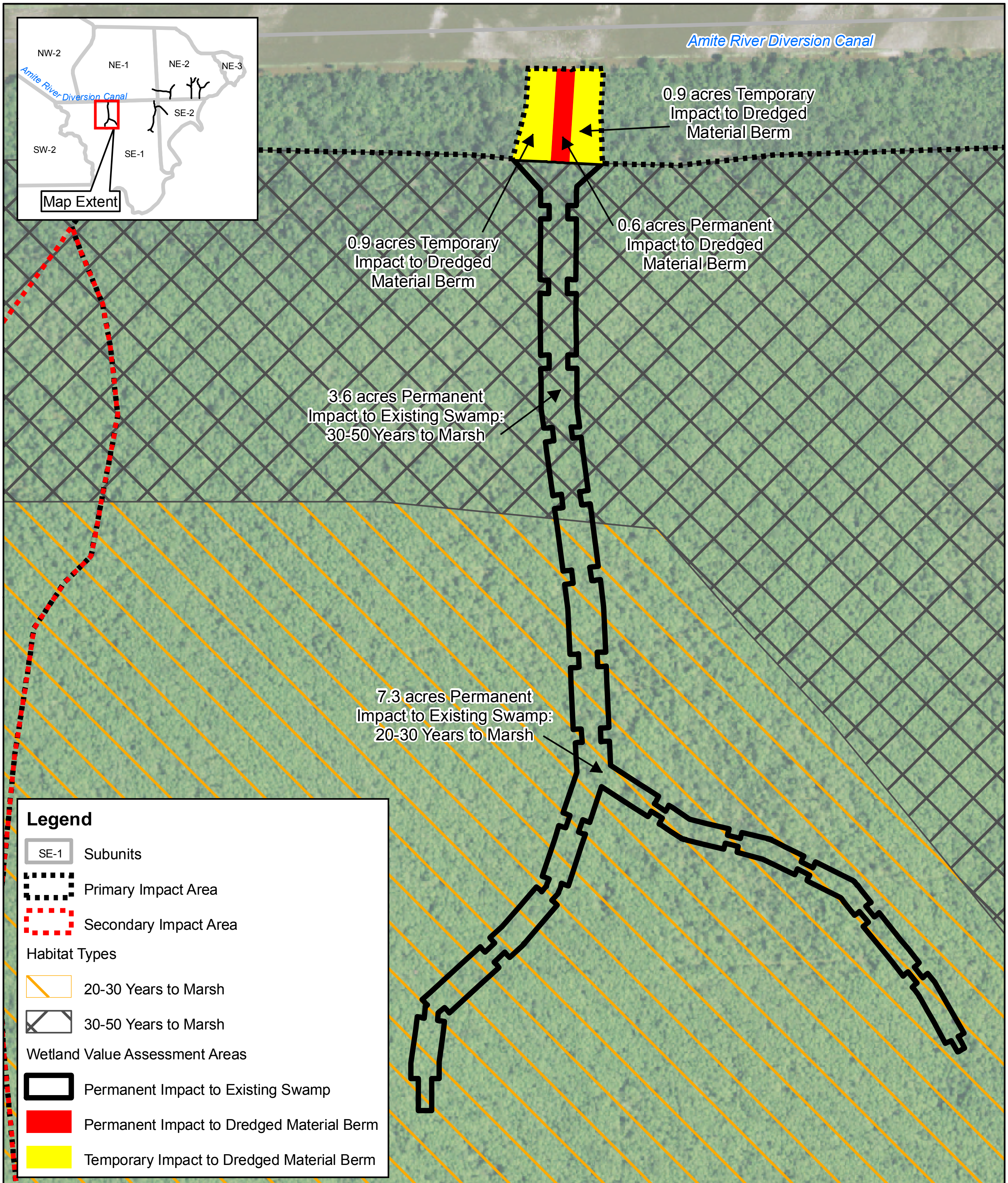


Figure 6. WVA Acreages for Alternative 35



WETLAND VALUE ASSESSMENT AREAS FOR ALTERNATIVE 35

Amite River Diversion Canal Modification
Ascension and Livingston Parishes, Louisiana

Image: 2009 Livingston Parish USDA-FSA-APFO NAIP MrSID Mosaic

Figure: 6
Date: February 2010
Scale: 1:6,000
Source: USGS/GEC
Map ID: 27850108-1859

Summary of acreages for each alternative by habitat type used in the WVA and benefits analysis

	Construction Area									Benefits Area										
	Dredged Material Berm			Existing Swamp (Permanent)						Primary Impact Area					Secondary Impact Area					
Alternative	Permanent	Temporary	Sub Total	Marsh	10 Years to Marsh	20-30 Years to Marsh	30-50 Years to Marsh	Sub Total	Total	Existing Marsh	10 Years to Marsh	20-30 Years to Marsh	30-50 Years to Marsh	Sub Total	Existing Marsh	10 Years to Marsh	20-30 Years to Marsh	30-50 Years to Marsh	Sub Total	Total for Benefits Areas
33 Cut A	0.3	0.6	0.9	0.0	0.0	7.0	3.0	10.0	11.8											
33 Cut B	0.2	0.6	0.8	6.5	0.0	2.4	0.0	8.9	10.5											
33 Cut C	0.3	0.6	0.9	3.1	2.5	4.1	0.0	9.7	11.5											
33	0.8	1.8	2.6	9.6	2.5	13.5	3.0	28.6	**31.2**	144.1	65.9	353.9	81.8	**645.7**	0.0	175.5	621.4	159.5	**956.4**	**1,602.1**
34	0.9	2.5	3.4	0.0	1.0	4.8	9.6	15.4	**18.8**	0.0	72.9	151.8	201.6	**426.3**	146.3	701.7	147.3	37.4	**1,032.7**	**1,459.0**
35	0.6	1.8	2.4	0.0	0.0	7.3	3.6	10.9	**13.3**	0.0	0.0	268.8	174.0	**442.8**	0.0	0.0	273.2	103.6	**376.8**	**819.6**
36	1.7	4.3	6.0	9.6	3.5	18.3	12.6	44.0	**50.0**	144.1	138.8	505.7	283.4	**1,072.0**	146.3	877.2	768.7	196.9	**1,989.1**	**3,061.1**
37	1.5	4.3	5.8	0.0	1.0	12.1	13.2	26.3	**32.1**	0.0	72.9	420.6	375.6	**869.1**	146.3	701.7	420.5	141.0	**1,409.5**	**2,278.6**
38	1.4	3.6	5.0	9.6	2.5	20.8	6.6	39.5	**44.5**	144.1	65.9	622.7	255.8	**1,088.5**	0.0	175.5	894.6	263.1	**1,333.2**	**2,421.7**
39	2.3	6.1	8.4	9.6	3.5	25.6	16.2	54.9	**63.3**	144.1	138.8	774.5	457.4	**1,514.8**	146.3	877.2	1,041.9	300.5	**2,365.9**	**3,880.7**

WVA Model Certification--Comments and Responses

1. **Starting the SI curves for all variables at 0.1 is problematic because even habitat with no ecological value appears to have some ecological value.** The WVA swamp model has only two graphs. One of them, V2 - Stand Maturity, has a zero intercept. The other, Salinity, does not. However, McKay and Fischenich (1) did a sensitivity analysis on the Barataria Barrier Shoreline WVA. Their study showed that the application of the zero slope intercept instead of 0.1 as in the model did not affect the relative rankings of any of the alternatives. The same is likely to be true for the ARDC Modification project.

3. **The number of target years should be increased to improve the predictive ability of the models given that changes are often non-linear.** For the LCA ARDC Modification project, different alternatives were analyzed using target years depending upon various assumptions such as the health of the vegetation relative to similar vegetation in the swamp outside of the project area as reflected in the habitat classification map (20-30 years to marsh, 30-50 years to marsh, and >50 years to marsh). The target years (TY) used for the LCA ARDC Modification project were TY0, TY1, TY20, TY30, and TY 50.

For the WVA Certification, additional text has been provided in the Procedural Manual to guide users on the selection of target years. A table has been added summarizing, by project type, the use of specific target years to reflect aspects of project evolution. Suggestions have been made for ensuring the justification for the selection of target years is added to the Project Information Sheet.

4. **In the spreadsheet for the marsh model, open water and emergent marsh AAHUs are incorrectly combined and should be added rather than taking the arithmetic mean.** The marsh models were not used in the LCA ARDC Modification project.

6. **Sea level is an important driver and relative sea level rise and climate change should be included in the models.** For the LCA ARDC Modification project, relative sea level and subsidence were accounted for in the land loss rates calculated for each project area. Data in the literature indicated that the rate of accretion will offset sea level rise and subsidence. The hydrologic modeling that was used to evaluate WVA metrics for the ARDC used the intermediate rate of sea level rise.

For WVA Certification, a new section ‘Climate Change’ has been added to the Procedural Manual to provide guidance on how to consider sea-level rise and other climate change effects in the evaluation. Suggestions have been made to document in the Project Information Sheet how these factors are considered in the evaluation.

10. For some model variables, policy decisions appear to supersede the biology of the relationships for developing the Suitability Index (SI) curves. This comment referred to a problem that the reviewers had with the marsh models. The marsh models were not used in the LCA ARDC Modification project.

11. The spreadsheets for the models as created are likely to lead to errors in maintenance and use. The United States Fish and Wildlife Service (USFWS) Habitat Evaluation Team (HET) member for the LCA ARDC Modification project is experienced in the use of WVA spreadsheets. To ensure that "% cover" and "class," as well as other spreadsheet numbers were entered correctly, the spreadsheet entries have been and will be reviewed by several members of the HET (e.g., agency representatives).

For WVA Certification, the spreadsheets have been corrected as Battelle suggested to correct calculation errors, improve the spreadsheet user interface, and decrease the likelihood of user errors.

12. Several inaccuracies were identified in the model spreadsheets that should be corrected. As explained above, the USFWS HET member is experienced in the use of WVA spreadsheets and the HET reviewed all spreadsheets. According to model developers, the spreadsheet works correctly for the Swamp WVA V2.

For WVA Certification, the spreadsheets have been corrected as Battelle suggested to correct calculation and specification errors.

15. The WVA method should be expanded to handle risk and uncertainty in areas exposed to episodic events. Risk and uncertainty are already incorporated into the WVA model used for the LCA ARDC Modification project. Risk and uncertainty are also addressed in Section 3.8 of the Integrated Feasibility Study and Draft Supplemental Environmental Impact Statement (DSEIS) and include hydrologic, environmental, and construction and economic uncertainties.

For WVA Certification, suggestions have been made to add a section to the Project Information Sheet to describe how risk and uncertainty are considered in the evaluation.

16. The WVA method should be updated, taking into account new GIS data, LIDAR, and other new data sources as well as model formats/presentation (visualization tools, HGM). The WVA model used for the LCA ARDC Modification project included the use of the most recent imagery and land loss data available from the (U.S. Geological Survey) USGS as well as the most appropriate historic imagery to determine land loss and habitat conversion. The habitat classification map was developed by scientists with the most knowledge about the condition of wetlands in Maurepas Swamp in conjunction with the most recent available imagery from the USGS.

For WVA Certification, the Procedural Manual has been updated to reflect current use and to provide appropriate guidance on available data sources.

18. The use of the geometric mean may be more appropriate than the arithmetic mean to derive some HSIs. Provide scientific basis for the decision. The WVA Swamp Model used for the LCA ARDC Modification project uses a geometric mean to derive HSIs.

SECTION 2

LOUISIANA COASTAL AREA
AMITE RIVER DIVERSION CANAL MODIFICATION
INTEGRATED FEASIBILITY STUDY AND
ENVIRONMENTAL IMPACT STATEMENT

IWR CE/ICA ANALYSIS

ECONOMICS APPENDIX
APPENDIX K

Cost Effective and Incremental Cost Analyses

Introduction

For environmental planning, where traditional benefit-cost analysis is not possible because costs and benefits are expressed in different units, two analytical methods are used to assist Corps planners in the decision process. First, cost effectiveness analysis is conducted to ensure that the least cost solution is identified for each possible level of environmental output. Subsequent incremental cost analysis of the cost effective solutions is conducted to reveal changes in costs for increasing levels of environmental outputs. In the absence of a common measurement unit for comparing the non-monetary benefits with the monetary costs of environmental plans, cost effectiveness and incremental cost analysis are valuable tools to assist in decision making.

It is important to keep in mind that the most useful information developed by these two methods is what it tells decision makers about the relative relationships among solutions – that one would likely produce greater output than another, or one is likely to be more costly than another – rather than the specific numbers that are calculated. Furthermore, these analyses would usually not lead, and are not intended to lead, to a single best solution (as in economic cost-benefit analysis); however, they would improve the quality of decision making by ensuring that a rational, supportable approach is used in considering and selecting alternative methods to produce environmental outputs.

The cost-effectiveness and incremental cost analyses are performed with the Institute of Water Resources IWR-Plan software. This software takes the annualized costs, as determined by a preliminary cost estimate, and the annualized benefits (Average Annual Habitat Units) (AAHUs), as determined by the Wetland Value Assessment (WVA) model, for each of the alternatives in the final array, including the No-Action Alternative. From this data, an analysis of cost-effectiveness and incremental cost is run between each alternative, at which point the software determines if any of the alternatives are determined to be cost-effective. A cost-effective alternative is one which produces the greater benefits (AAHUs) with the same cost as other alternatives. From this analysis, a frontier is formed on the cost benefit plot (Figure 1). Anything above this frontier is considered cost-effective. Additionally, an incremental cost analysis is run between each of the alternatives included in the IWR Planning Suite analysis. The incremental cost analysis compares the differential in cost and benefits (the slope of the line connecting two alternatives on the cost/benefit plot) for each alternative to the alternatives with similar cost and benefit characteristics. The alternatives which exhibit comparably greater differentials are characterized as a Best Buy. A Best Buy represents the alternatives with maximized incremental benefit to cost increase when compared to the previous incremental benefit and cost comparison.

Amite River Diversion Canal Modification

This study evaluated several alternatives designed to restore freshwater swamp habitat within the western Maurepas Swamp, which is recognized as a vital national resource.

The intent is to restore the degraded areas within the study area by restoring hydrologic connectivity, increasing nutrient and sediment input into the areas of impact and to promote the healthy regeneration of cypress/tupelo swamp habitat. In this analysis, eight environmental restoration alternatives are being evaluated. These alternatives include the No-Action Alternative, along with Alternatives 33 through 39. Alternatives 33, 34, and 35 are considered stand-alone alternatives, while Alternatives 36 through 39 are combinations of the aforementioned stand-alone alternatives. Therefore, the final array represents all possible combinations of Alternatives 33, 34, and 35. It should also be noted that, based on feedback from Dr. Gary Shaffer of the University of Southeastern Louisiana, vegetative plantings are considered a critical component of the restoration process. Therefore, vegetative plantings were included in all alternatives proposed in the most-highly degraded areas in the study area (Alternative 33 and 34). Table K.1 displays the expected environmental outputs in terms of average annual habitat units, the annualized costs for each restoration alternative, and the annualized cost per AAHU. Average annual costs (reflecting 2008 price levels) were calculated using the Federal discount rate of 4.375 percent and assuming a 50-year period of analysis.

Table 1. Cost and Benefit Breakdown for Final Array of Alternatives

Alternative	Acres of Benefit	AAHUs	Total Construction Cost	Annualized Cost**	Annualized Cost/AAHU
35*	820	334	$1,090,000	$61,000	$180
38*	2,422	1,013	$4,550,000	$236,000	$230
37	2,279	922	$4,210,000	$217,000	$240
39*	3,881	1,602	$7,700,000	$394,000	$250
36	3,061	1,268	$6,870,000	$352,000	$280
33	1,602	679	$3,780,000	$197,000	$290
34	1,459	589	$3,370,000	$174,000	$300

*Best Buy

** Discount Rate of 4.375% used over six-year construction period

IWR Results

The results of the IWR-Plan Software Suite analysis determined that all eight of the restoration alternatives are considered cost-effective (Table 2). In addition, the No-Action Alternative, Alternative 35, Alternative 38, and Alternative 39 were designated as Best Buys. By default, the No-Action Alternative and the alternative with the maximum output (Alternative 39) are considered Best Buys by the IWR-Plan Software Suite. Therefore, it is evident that there is not a significant difference in the incremental cost to incremental benefit ratio between the other six restoration alternatives. Figure 1 represents the cost-effective frontier of the eight proposed restoration alternatives. Figure 2 depicts a plot of annualized costs vs. annualized benefits for all eight alternatives analyzed.

Table 2. IWR Results

Alternative	Annualized Cost	Output (AAHUs)	Cost Effective?
No Action Plan	$0	0	Best Buy
35	$61,000	334	Best Buy
34	$174,000	589	Yes
33	$197,000	679	Yes
37	$217,000	922	Yes
38	$236,000	1013	Best Buy
36	$351,000	1268	Yes
39	$394,000	1602	Best Buy

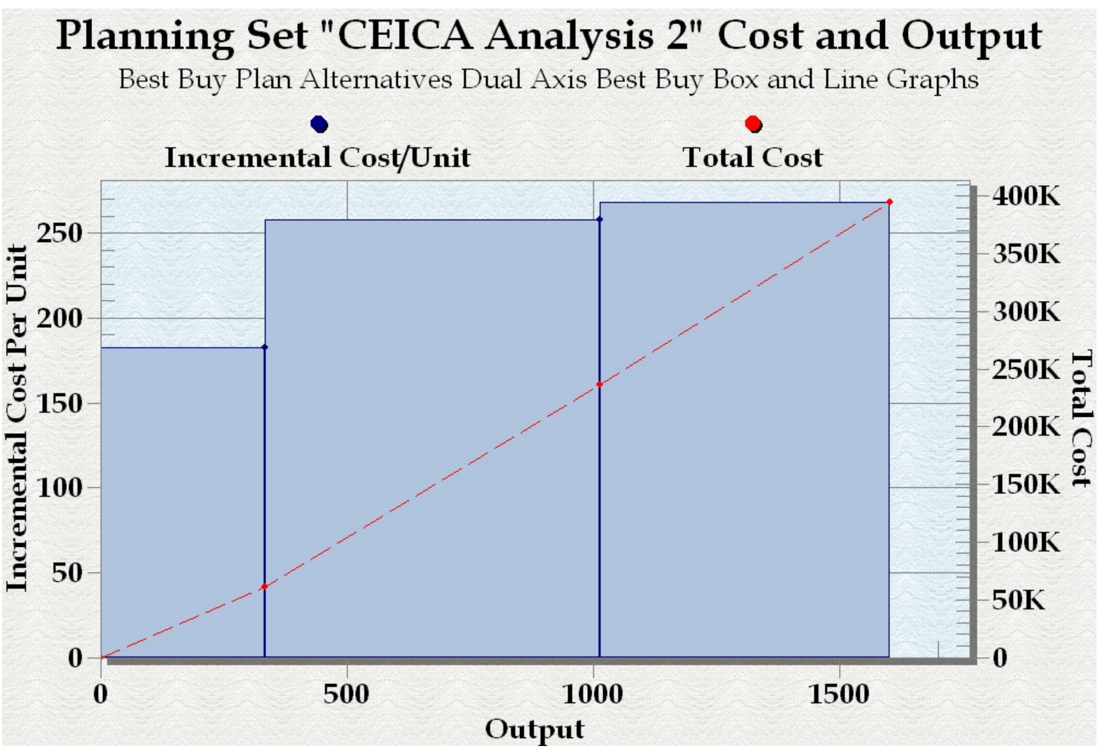


Figure 1. Cost-Effective Frontier

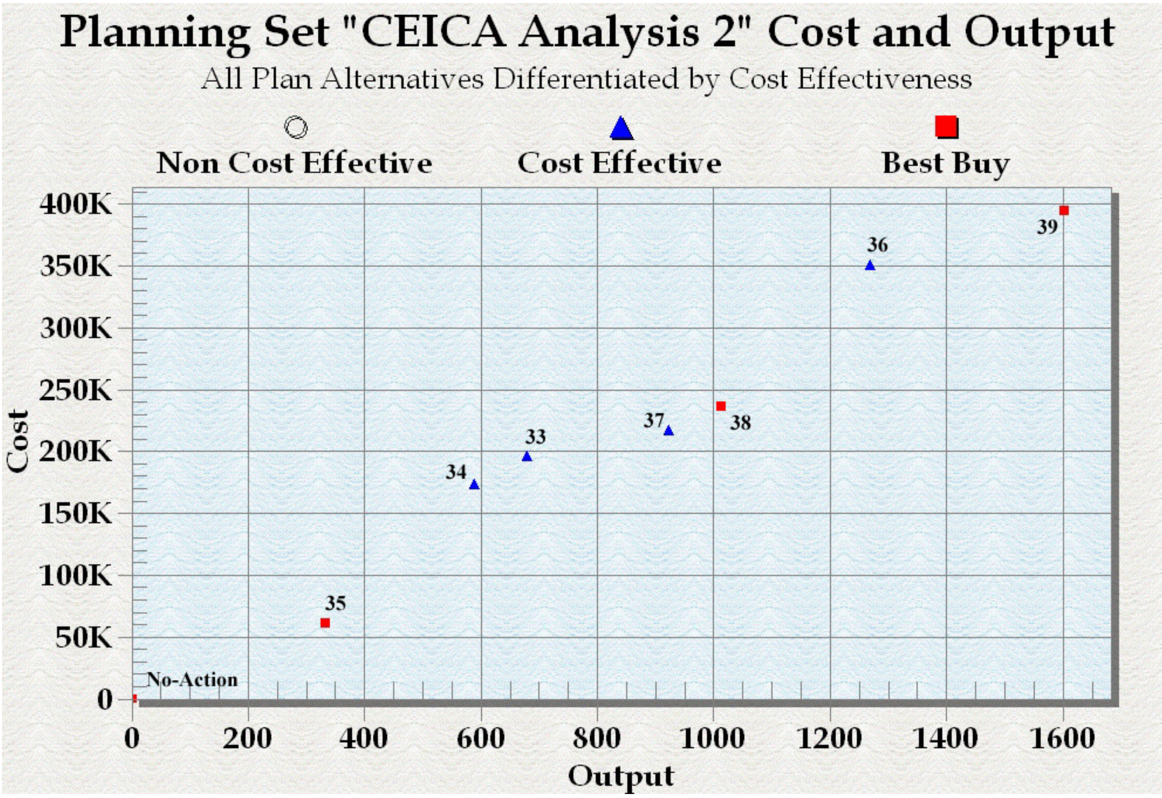


Figure 2. Benefit vs. Cost Plot

Background of CE/ICA Analysis

The following analysis is based on an Environmental Studies report produced by the US Army Corps of Engineers entitled, "Cost Effectiveness Analysis for Environmental Planning: Nine Easy Steps." The analysis was started at Step 4 (since the Array of Alternatives has already been determined) as directed by the document.

Step 4: None of the alternatives have the same output; therefore they are **All Cost Efficient**.

Step 5: All are Cost Effective

Table 1: Step 5 – Cost Effective Solutions

Alternative	Output (AAHUs)	Annualized Cost (AAC)	Cost Effective?
No-Action	0	$0	Yes
35	334	$60,956	Yes
34	589	$173,671	Yes
33	679	$196,686	Yes
37	922	$217,220	Yes
38	1013	$236,293	Yes
36	1268	$351,365	Yes
39	1602	$394,171	Yes

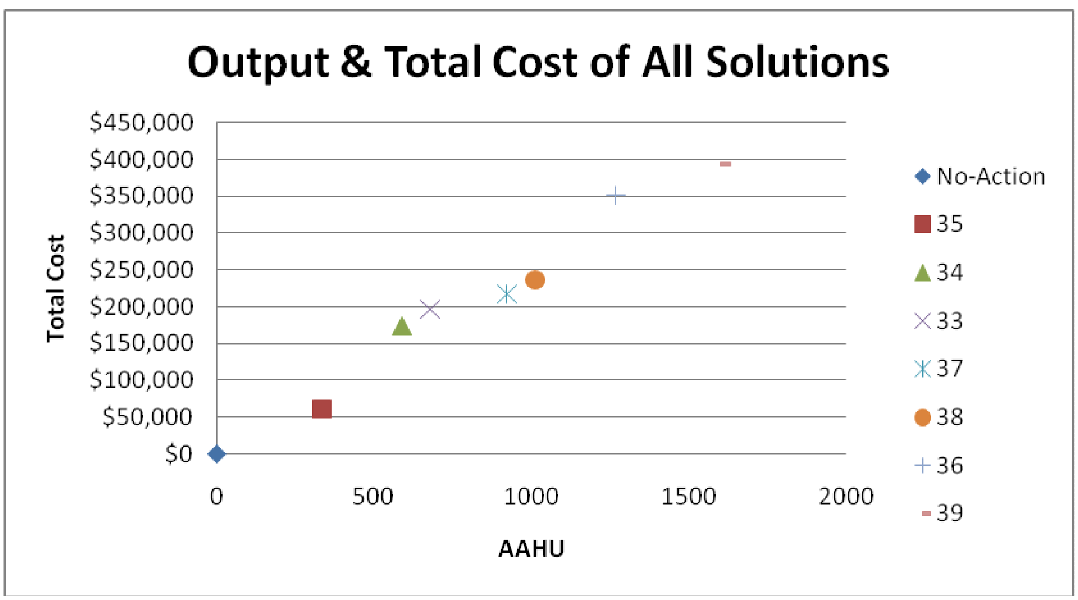


Figure 1: Step 5 – Cost Effective Solutions

Step 6: Calculate Average Costs

Table 2: Step 6 – Average Costs

Alternative	Output (AAHUs)	Annualized Cost (AAC)	AAC/AAHU	
No-Action	0	$0	$0	← Dropped from Further Analysis
35	334	$60,956	$182.50	← Lowest Average Cost
34	589	$173,671	$294.86	
33	679	$196,686	$289.67	
37	922	$217,220	$235.60	
38	1013	$236,293	$233.26	
36	1268	$351,365	$277.10	
39	1602	$394,171	$246.05	

Step 7: Average Costs for Additional Output

Table 3: Step 7A – First Recalculation

Alternative	Output (AAHUs)	Additional Output (AAHU)	Annualized Cost	Average Cost for Additional Output
35	334	0	$60,956	---
34	589	255	$173,671	$442
33	679	345	$196,686	$393
37	922	588	$217,220	$266
38	1013	679	$236,293	$258
36	1268	934	$351,365	$311
39	1602	1268	$394,171	$263

Table 4: Step 7B – Second Recalculation

Alternative	Output (AAHUs)	Additional Output (AAHU)	Annualized Cost	Average Cost for Additional Output
38	1013	0	$236,293	---
36	1268	255	$351,365	$451
39	1602	589	$394,171	$268

Table 5: Step 7C – Summary of Results

Average Cost for Additional Output			
Alternative	**Original**	**Step 7A**	**Step 7B**
No-Action	-		
35	$183	---	
34	$295	$442	
33	$290	$393	
37	$236	$266	
38	$233	$258	---
36	$277	$311	451.26275
39	$246	$263	268.04414

Table 6: Step 7D – Solutions with Lowest Average Costs for Additional Output

Alternative	Output (AAHUs)	Annualized Cost
No-Action	0	$0
35	334	$60,956
38	1013	$236,293
39	1602	$394,171

<u>**Step 8:**</u> Calculate Incremental Costs

Table 7: Step 8A –Incremental Costs

Alternative	Output (AAHUs)	Annualized Cost	Additional Output (AAHU)	Additional Annualized Cost	Incremental Cost ($ per AAHU)
No-Action	0	$0	---	---	---
35	334	$60,956	334	$60,956	$183
38	1013	$236,293	679	$175,337	$258
39	1602	$394,171	589	$157,878	$268

Table 8: Step 8B – Solutions with Lowest Average Costs for Additional Output

Alternative	Output (AAHUs)	Annualized Cost	Incremental Cost ($ per AAHU)
No-Action	0	$0	---
35	334	$60,956	$183
38	1013	$236,293	$233
39	1602	$394,171	$246

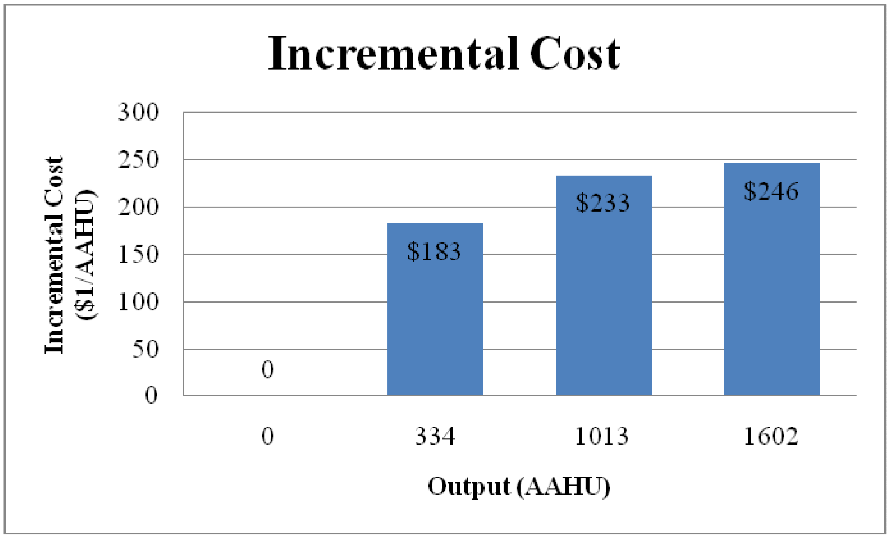


Figure 2: Step 8 – Incremental Cost

Step 9: Comparison and Justification of Successive Incremental Outputs and Costs

Table 9: Step 9 – Justification

Alternative	Output (AAHUs)	Annualized Cost	Additional Output (AAHU)	Additional Annualized Cost	Incremental Cost ($ per AAHU)	Justified? Worth It?
No-Action	0	$0	---	---	---	
35	334	$60,956	334	$60,956	$183	Yes
38	1013	$236,293	679	$175,337	$258	Yes
39	1602	$394,171	589	$157,878	$268	Yes