APPENDIX K

BENEFIT COST - INCREMENTAL COST ANALYSIS
APPENDIX K - BENEFIT COST - INCREMENTAL COST ANALYSIS

TABLE OF CONTENTS

K1. INCREMENTAL COST ANALYSIS (IWR ANALYSIS).......................... 1-1
  K1.1 DESCRIPTION .................................................................................................... 1-1
  K1.2 RESTORATION PLANS ...................................................................................... 1-1
  K1.3 IWR SCREENING PROCESS .............................................................................. 1-2
  K1.4 IWR SCREENING RESULTS ........................................................................... 1-10

K2. INTERMEDIATE ARRAY OF ALTERNATIVES ........................................... 2-1

K3. COST EFFECTIVENESS AND INCREMENTAL COST ANALYSES ........... 3-1
  K3.1 COST EFFECTIVENESS ....................................................................................... 3-1
  K3.2 INCREMENTAL COST ANALYSIS ........................................................................ 3-2

K4. NATIONAL ECOSYSTEM RESTORATION PLAN .................................. 4-1
  K4.1 SELECTION OF THE NATIONAL ECOSYSTEM RESTORATION PLAN ........... 4-1
  K4.2 RENOURISHMENT CYCLES ............................................................................. 4-2
    K4.2.1 Whiskey Island ............................................................................................ 4-3
    K4.2.2 Trinity Island ............................................................................................... 4-6
    K4.2.3 Raccoon Island with Terminal Groin ............................................................. 4-8
    K4.2.4 Timbalier Island ......................................................................................... 4-11
  K4.3 DESCRIPTION OF NATIONAL ECOSYSTEM RESTORATION PLAN WITH
      RENOURISHMENT .............................................................................................. 4-13

K5 FIRST COMPONENT OF CONSTRUCTION .............................................. 5-1
  K4.1 SELECTION OF THE FIRST COMPONENT OF CONSTRUCTION .................... 5-1
  K4.2 RENOURISHMENT CYCLES ............................................................................. 5-4
  K4.3 DESCRIPTION OF FIRST COMPONENT OF CONSTRUCTION WITH
      RENOURISHMENT .............................................................................................. 5-4

LIST OF FIGURES

K1-1. Results of IWR Iteration 1 .............................................................................. 1-12
K3-1. Results of IWR Iteration 2 Using the Intermediate Array of Alternatives ....... 3-1
K3-2. Incremental Cost and Output for the Best Buy Plans ........................................ 3-3
K4-1. Graphical Summary of Dune and Beach Acres Associated with Initial
      Restoration Plan C and Three Renourishment Alternatives on Whiskey Island ........................................................................................................... 4-6
K4-2. Graphical Summary of Dune and Beach Acres Associated with Initial
      Restoration Plan C and Recommended Renourishment Scenario on Trinity Island ............................................................................................................. 4-8
K4-3. Graphical Summary of Dune and Beach Acres Associated with Initial
      Restoration Plan E and Two Renourishment Alternatives on Raccoon Island ................................................................................................................... 4-10
K4-4. Graphical Summary of Dune and Beach Acres Associated with Initial
      Restoration Plan E and Two Renourishment Alternatives on Timbalier Island .................................................................................................................. 4-13
K5-1. Results of IWR Run Using the Extended Array .............................................. 5-4
### LIST OF TABLES

- **K1-1.** Summary of Habitat Acres for Raccoon Island Restoration Plans ........................................ 1-3
- **K1-2.** Summary of Habitat Acres for Raccoon Island Restoration Plans with Breakwaters .......................................................... 1-3
- **K1-3.** Summary of Habitat Acres for Raccoon Island Restoration Plans with Terminal Groin .................................................. 1-4
- **K1-4.** Summary of Habitat Acres for Whiskey Island Restoration Plans ............................................... 1-4
- **K1-5.** Summary of Habitat Acres for Trinity Island Restoration Plans ................................................. 1-5
- **K1-6.** Summary of Habitat Acres for East Island Restoration Plans ...................................................... 1-5
- **K1-7.** Summary of Habitat Acres for Wine Island Restoration Plans ................................................. 1-6
- **K1-8.** Summary of Habitat Acres for Timbalier Island Restoration Plans ............................................. 1-6
- **K1-9.** Summary of Habitat Acres for East Timbalier Island Restoration Plans ............................................. 1-7
- **K1-10.** IWR Acres for Raccoon Island Restoration Plans ................................................................. 1-7
- **K1-11.** IWR Acres for Raccoon Island Restoration Plans with Breakwaters ............................................. 1-8
- **K1-12.** IWR Acres for Raccoon Island Restoration Plans with Terminal Groin ................................ 1-8
- **K1-13.** IWR Acres for Whiskey Island Restoration Plans ........................................................................... 1-8
- **K1-14.** IWR Acres for Trinity Island Restoration Plans ........................................................................... 1-8
- **K1-15.** IWR Acres for East Island Restoration Plans .............................................................................. 1-9
- **K1-16.** IWR Acres for Wine Island Restoration Plans ............................................................................. 1-9
- **K1-17.** IWR Acres for Timbalier Island Restoration Plans ........................................................................ 1-9
- **K1-18.** IWR Acres for East Timbalier Island Restoration Plans ........................................................ 1-9
- **K1-19.** IWR Input .............................................................................................................................. 1-10
- **K2-1.** Summary of Intermediate Array of Restoration Plans .................................................................. 2-3
- **K3-1.** Cost Effective Alternatives ..................................................................................................................... 3-2
- **K3-2.** Incremental Cost Analysis .................................................................................................................. 3-3
- **K4-1.** NER Plan Beach and Dune Fill Design Parameters .......................................................................... 4-2
- **K4-2.** NER Plan Marsh Fill Design Parameters .......................................................................................... 4-2
- **K4-3.** NER Plan Preliminary Assessment of Borrow Areas and Cut Volumes ............................................. 4-2
- **K4-4.** Whiskey Island Plan C: Island Acres and Beach Dimensions Summary ........................................ 4-3
- **K4-5.** Whiskey Island RA1: Island Acres and Beach Dimensions Summary ........................................... 4-4
- **K4-6.** Whiskey Island RA2: Island Acres and Beach Dimensions Summary ........................................... 4-5
- **K4-7.** Whiskey Island RA3: Island Acres and Beach Dimensions Summary ........................................... 4-5
- **K4-8.** Trinity Island Plan C: Island Acres and Beach Dimensions Summary ........................................... 4-6
- **K4-9.** Trinity Island Acres and Beach Dimensions Summary ............................................................... 4-7
- **K4-10.** Raccoon Island Plan E with Terminal Groin: Island Acres and Beach Dimensions Summary .......................................................... 4-8
- **K4-11.** Raccoon Island RA1: Island Acres and Beach Dimensions Summary ........................................... 4-9
- **K4-12.** Raccoon Island RA2: Island Acres and Beach Dimensions Summary ........................................... 4-10
- **K4-13.** Timbalier Island Plan E: Island Acres and Beach Dimensions Summary ........................................... 4-11
- **K4-14.** Timbalier Island RA1: Island Acres and Beach Dimensions Summary ........................................... 4-12
- **K4-15.** Timbalier Island RA2: Island Acres and Beach Dimensions Summary ........................................... 4-12
- **K4-16.** NER Plan Beach / Dune Fill and Marsh Fill Design Parameters .............................................. 4-14
- **K4-17.** NER Plan Borrow Areas and Cut Volumes .................................................................................. 4-14
- **K5-1.** Summary of Extended Array of Restoration Plans .......................................................................... 5-2
- **K5-2.** First Component of Construction Beach/Dune Fill and Marsh Fill Design Parameters .......................................................... 5-5
- **K5-3.** First Component of Construction Borrow Areas and Cut Volumes ...................................................... 5-5
**K1. INCREMENTAL COST ANALYSIS (IWR ANALYSIS)**

**K1.1 DESCRIPTION**

The United States Army Corps of Engineers (USACE) Institute for Water Resources (IWR) developed the IWR Planning Suite which assists with formulation and comparison of alternative plans. The IWR Planning Suite assists with plan formulation by combining solutions to planning problems and calculating the additive effects of each combination. It also assists with plan comparison by conducting a Cost Effectiveness / Incremental Cost Analysis (CE/ICA), identifying the plans which are the best financial investments - Best Buy Plans, and displaying the effects of each on a range of decision variables. The IWR Planning Suite 1.0.11.0 was used in the IWR screening process of the Louisiana Coastal Area (LCA) Terrebonne Basin Barrier Shoreline Restoration (TBBSR) Study solutions.

**K1.2 RESTORATION PLANS**

Five (5) restoration design plans, denoted by Plans A through E, were developed in Appendix L for the seven (7) Terrebonne Basin barrier islands: Raccoon, Whiskey, Trinity, East, Wine, Timbalier, and East Timbalier Islands.

Plan A is the No Action Plan, that is, no sediment is imported to restore the islands components (i.e., beach, dune, and marsh). The restoration design for Plan B provides for the minimal geomorphologic form and ecologic function on each island defined through analysis of historic planforms and elevations and storm erosion modeling such that the restored island retains this form and function after being subjected to the design storms.

Plans C through E are scalars of Plan B that investigated incremental increases in the scales of beach, dune and marsh planforms and elevations to provide plan formulators the ability to determine the optimal increment for restoration of the geomorphologic form and ecologic function of these islands. The optimal level of restoration is defined as the best balance of environmental benefits (e.g., habitat acres), constructability as constrained by available sediment volumes in identified borrow sources, and cost effectiveness. Plan C provides for the minimal geomorphologic form and ecologic function on each island along with 5 years of advanced fill. Plan D provides for the minimal geomorphologic form and ecologic function on each island along with 10 years of advanced fill. Plan E provides for the minimal geomorphologic form and ecologic function on each island along with 25 years of advanced fill.

An additional option was derived for Wine Island that included placing beach compatible sand within the existing rock revetment locally known as the Wine Island Ring. Two additional options were derived for Raccoon Island including the construction of eight additional breakwaters (BW) or construction of a terminal groin (TG) (Appendix L).
K1.3 IWR SCREENING PROCESS

Restoration design plans and measures were developed and analyzed through the plan formulation process (Integrated Feasibility Study and Final Environmental Impact Statement Report, Section 3). Because of the millions of potential alternatives comprised of island measure(s) and borrow area combinations (Appendix L), an IWR screening process was conducted to identify the most cost effective alternatives for consideration in developing the Intermediate Array of Alternatives. The input parameters for the IWR screening run included habitat acres and conceptual cost estimates (Appendix L) specific to the island measures carried through the plan formulation process.

The habitat acres were calculated based on the Wetland Value Assessment (WVA) methodology which states that the key habitat components, dune, supratidal (beach), and intertidal (marsh), combine to provide the optimum metric by which the islands should be compared (Coastal Wetlands Planning, Protection and Restoration Act (CWPPRA), 2002). The methodology projects dune (≥ 5 feet (ft) North American Vertical Datum of 1988 (NAVD 88)), supratidal (≥ 2 ft NAVD 88 and ≤ 4.9 ft NAVD 88), and intertidal (≥ 0.0 ft NAVD 88 and ≤ 1.9 ft NAVD 88) acres at specific Target Years (TYs). The PDT chose the following TYs: TY0, TY1, TY5, TY10, TY20, TY30, TY40, and TY50 along with the year of disappearance for each habitat component. Because the habitat acres constantly change due to erosion, sea level change, subsidence, overwash, and barrier island migration, weighted averages were calculated over the 50-year period of analysis for a balanced comparison of measures. An example weighted average calculation is presented below (Raccoon Island, Plan B, intertidal habitat):

<table>
<thead>
<tr>
<th>TY1</th>
<th>TY5</th>
<th>TY10</th>
<th>TY20</th>
<th>TY30</th>
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<tr>
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<td>266</td>
<td>255</td>
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<td>248</td>
<td>23</td>
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</tbody>
</table>

Weighted Average Calculation = \[
\frac{(TY1 + TY5)}{2} \left( \frac{\text{# of years between TY1} + \text{# of years between TY5}}{49} \right) + \frac{(TY5 + TY10)}{2} \left( \frac{\text{# of years between TY5} + \text{# of years between TY10}}{49} \right) + \frac{(TY10 + TY30)}{2} \left( \frac{\text{# of years between TY10} + \text{# of years between TY30}}{49} \right) + \frac{(TY30 + TY40)}{2} \left( \frac{\text{# of years between TY30} + \text{# of years between TY40}}{49} \right) + \frac{(TY40 + TY50)}{2} \left( \frac{\text{# of years between TY40} + \text{# of years between TY50}}{49} \right) + \frac{(TY10 + TY20 + TY30 + TY40 + TY50)}{5} \left( \frac{\text{# of years between TY10} + \text{# of years between TY20} + \text{# of years between TY30} + \text{# of years between TY40} + \text{# of years between TY50}}{49} \right)
\]

\[
= \frac{(235 + 253)}{2} \left( \frac{5}{49} \right) + \frac{(266 + 255)}{2} \left( \frac{10}{49} \right) + \frac{(255 + 260)}{2} \left( \frac{10}{49} \right) + \frac{(260 + 248)}{2} \left( \frac{10}{49} \right) + \frac{(248 + 23)}{2} \left( \frac{10}{49} \right) = 231 \text{ Acres}
\]

Tables K1-1 through K1-9 present habitat acres at specific TYs and weighted average acres calculated for individual islands and design plans.
### Table K1-1. Summary of Habitat Acres for Raccoon Island Restoration Plans

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### Table K1-2. Summary of Habitat Acres for Raccoon Island Restoration Plans with Breakwaters

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Table K1-3. Summary of Habitat Acres for Raccoon Island Restoration Plans with Terminal Groin

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<td>7</td>
<td>120</td>
<td>83</td>
<td>78</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
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<tr>
<td></td>
<td>Supratidal</td>
<td>129</td>
<td>1641</td>
<td>1617</td>
<td>1587</td>
<td>1556</td>
<td>444</td>
<td>192</td>
<td>244</td>
<td>931</td>
</tr>
<tr>
<td></td>
<td>Intertidal</td>
<td>173</td>
<td>99</td>
<td>91</td>
<td>86</td>
<td>71</td>
<td>1086</td>
<td>1227</td>
<td>1066</td>
<td>621</td>
</tr>
</tbody>
</table>

The weighted average habitat acres were used to compute IWR acres, i.e., acres used as input into the IWR program. Based upon the WVA methodology (CWPPRA, 2002), the intertidal habitat acres were adjusted by a weighting factor of 17/14 and combined with dune and supratidal acres to yield total adjusted habitat acres. Because the No Action Plan (Plan A) is always required to have zero acres in the IWR program, Plan A’s total adjusted habitat acres were subtracted from Plan B through Plan E’s acres to produce the final net IWR acres as presented in Tables K1-10 through K1-18.

### Table K1-10. IWR Acres for Raccoon Island Restoration Plans

<table>
<thead>
<tr>
<th>Plan</th>
<th>Dune &amp; Supratidal Subtotal</th>
<th>Intertidal</th>
<th>Intertidal Adjusted*</th>
<th>Grand Total Adjusted</th>
<th>IWR Program Input</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>7</td>
<td>70</td>
<td>85</td>
<td>92</td>
<td>0</td>
</tr>
<tr>
<td>B</td>
<td>112</td>
<td>231</td>
<td>281</td>
<td>393</td>
<td>301</td>
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<tr>
<td>C</td>
<td>143</td>
<td>285</td>
<td>347</td>
<td>489</td>
<td>397</td>
</tr>
<tr>
<td>D</td>
<td>192</td>
<td>298</td>
<td>362</td>
<td>554</td>
<td>462</td>
</tr>
<tr>
<td>E</td>
<td>384</td>
<td>253</td>
<td>308</td>
<td>692</td>
<td>599</td>
</tr>
</tbody>
</table>

*adjusted to account for WVA weighting factor of 17/14
### Table K1-11. IWR Acres for Raccoon Island Restoration Plans with Breakwaters

<table>
<thead>
<tr>
<th>Plan</th>
<th>Dune &amp; Supratidal Subtotal</th>
<th>Intertidal</th>
<th>Intertidal Adjusted*</th>
<th>Grand Total Adjusted</th>
<th>IWR Program Input</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>7</td>
<td>70</td>
<td>85</td>
<td>92</td>
<td>0</td>
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<tr>
<td>B</td>
<td>131</td>
<td>236</td>
<td>287</td>
<td>418</td>
<td>326</td>
</tr>
<tr>
<td>C</td>
<td>162</td>
<td>295</td>
<td>358</td>
<td>520</td>
<td>428</td>
</tr>
<tr>
<td>D</td>
<td>209</td>
<td>312</td>
<td>378</td>
<td>587</td>
<td>495</td>
</tr>
<tr>
<td>E</td>
<td>408</td>
<td>263</td>
<td>319</td>
<td>727</td>
<td>635</td>
</tr>
</tbody>
</table>

*adjusted to account for WVA weighting factor of 17/14

### Table K1-12. IWR Acres for Raccoon Island Restoration Plans with Terminal Groin

<table>
<thead>
<tr>
<th>Plan</th>
<th>Dune &amp; Supratidal Subtotal</th>
<th>Intertidal</th>
<th>Intertidal Adjusted*</th>
<th>Grand Total Adjusted</th>
<th>IWR Program Input</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>7</td>
<td>70</td>
<td>85</td>
<td>92</td>
<td>0</td>
</tr>
<tr>
<td>B</td>
<td>124</td>
<td>240</td>
<td>291</td>
<td>416</td>
<td>324</td>
</tr>
<tr>
<td>C</td>
<td>159</td>
<td>294</td>
<td>357</td>
<td>516</td>
<td>424</td>
</tr>
<tr>
<td>D</td>
<td>207</td>
<td>308</td>
<td>374</td>
<td>581</td>
<td>489</td>
</tr>
<tr>
<td>E</td>
<td>405</td>
<td>261</td>
<td>317</td>
<td>722</td>
<td>630</td>
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</table>

*adjusted to account for WVA weighting factor of 17/14

### Table K1-13. IWR Acres for Whiskey Island Restoration Plans

<table>
<thead>
<tr>
<th>Plan</th>
<th>Dune &amp; Supratidal Subtotal</th>
<th>Intertidal</th>
<th>Intertidal Adjusted*</th>
<th>Grand Total Adjusted</th>
<th>IWR Program Input</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>19</td>
<td>271</td>
<td>329</td>
<td>348</td>
<td>0</td>
</tr>
<tr>
<td>B</td>
<td>77</td>
<td>613</td>
<td>744</td>
<td>822</td>
<td>474</td>
</tr>
<tr>
<td>C</td>
<td>132</td>
<td>669</td>
<td>812</td>
<td>944</td>
<td>596</td>
</tr>
<tr>
<td>D</td>
<td>183</td>
<td>686</td>
<td>833</td>
<td>1015</td>
<td>667</td>
</tr>
<tr>
<td>E</td>
<td>597</td>
<td>566</td>
<td>687</td>
<td>1284</td>
<td>936</td>
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</tbody>
</table>

*adjusted to account for WVA weighting factor of 17/14

### Table K1-14. IWR Acres for Trinity Island Restoration Plans

<table>
<thead>
<tr>
<th>Plan</th>
<th>Dune &amp; Supratidal Subtotal</th>
<th>Intertidal</th>
<th>Intertidal Adjusted*</th>
<th>Grand Total Adjusted</th>
<th>IWR Program Input</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>32</td>
<td>99</td>
<td>121</td>
<td>153</td>
<td>0</td>
</tr>
<tr>
<td>B</td>
<td>93</td>
<td>459</td>
<td>558</td>
<td>651</td>
<td>498</td>
</tr>
<tr>
<td>C</td>
<td>155</td>
<td>512</td>
<td>622</td>
<td>777</td>
<td>625</td>
</tr>
<tr>
<td>D</td>
<td>313</td>
<td>476</td>
<td>578</td>
<td>891</td>
<td>738</td>
</tr>
<tr>
<td>E</td>
<td>770</td>
<td>344</td>
<td>417</td>
<td>1187</td>
<td>1035</td>
</tr>
</tbody>
</table>

*adjusted to account for WVA weighting factor of 17/14
### Table K1-15. IWR Acres for East Island Restoration Plans

<table>
<thead>
<tr>
<th>Plan</th>
<th>Dune &amp; Supratidal Subtotal</th>
<th>Intertidal</th>
<th>Intertidal Adjusted*</th>
<th>Grand Total Adjusted</th>
<th>IWR Program Input</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>25</td>
<td>43</td>
<td>52</td>
<td>78</td>
<td>0</td>
</tr>
<tr>
<td>B</td>
<td>64</td>
<td>294</td>
<td>357</td>
<td>422</td>
<td>344</td>
</tr>
<tr>
<td>C</td>
<td>102</td>
<td>330</td>
<td>401</td>
<td>503</td>
<td>426</td>
</tr>
<tr>
<td>D</td>
<td>205</td>
<td>307</td>
<td>373</td>
<td>577</td>
<td>500</td>
</tr>
<tr>
<td>E</td>
<td>513</td>
<td>220</td>
<td>267</td>
<td>780</td>
<td>703</td>
</tr>
</tbody>
</table>

*adjusted to account for WVA weighting factor of 17/14

---

### Table K1-16. IWR Acres for Wine Island Restoration Plans

<table>
<thead>
<tr>
<th>Plan</th>
<th>Dune &amp; Supratidal Subtotal</th>
<th>Intertidal</th>
<th>Intertidal Adjusted*</th>
<th>Grand Total Adjusted</th>
<th>IWR Program Input</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>1</td>
<td>3</td>
<td>4</td>
<td>4</td>
<td>0</td>
</tr>
<tr>
<td>B</td>
<td>35</td>
<td>95</td>
<td>116</td>
<td>151</td>
<td>147</td>
</tr>
<tr>
<td>C</td>
<td>47</td>
<td>114</td>
<td>138</td>
<td>185</td>
<td>181</td>
</tr>
<tr>
<td>D</td>
<td>54</td>
<td>134</td>
<td>163</td>
<td>217</td>
<td>213</td>
</tr>
<tr>
<td>E</td>
<td>180</td>
<td>117</td>
<td>142</td>
<td>323</td>
<td>319</td>
</tr>
<tr>
<td>Ring</td>
<td>5</td>
<td>3</td>
<td>3</td>
<td>9</td>
<td>5</td>
</tr>
</tbody>
</table>

*adjusted to account for WVA weighting factor of 17/14

---

### Table K1-17. IWR Acres for Timbalier Island Restoration Plans

<table>
<thead>
<tr>
<th>Plan</th>
<th>Dune &amp; Supratidal Subtotal</th>
<th>Intertidal</th>
<th>Intertidal Adjusted*</th>
<th>Grand Total Adjusted</th>
<th>IWR Program Input</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>119</td>
<td>222</td>
<td>269</td>
<td>388</td>
<td>0</td>
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<tr>
<td>B</td>
<td>239</td>
<td>651</td>
<td>790</td>
<td>1029</td>
<td>641</td>
</tr>
<tr>
<td>C</td>
<td>357</td>
<td>738</td>
<td>897</td>
<td>1253</td>
<td>865</td>
</tr>
<tr>
<td>D</td>
<td>501</td>
<td>804</td>
<td>976</td>
<td>1477</td>
<td>1088</td>
</tr>
<tr>
<td>E</td>
<td>1288</td>
<td>611</td>
<td>741</td>
<td>2029</td>
<td>1641</td>
</tr>
</tbody>
</table>

*adjusted to account for WVA weighting factor of 17/14

---

### Table K1-18. IWR Acres for East Timbalier Island Restoration Plans

<table>
<thead>
<tr>
<th>Plan</th>
<th>Dune &amp; Supratidal Subtotal</th>
<th>Intertidal</th>
<th>Intertidal Adjusted*</th>
<th>Grand Total Adjusted</th>
<th>IWR Program Input</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>18</td>
<td>69</td>
<td>84</td>
<td>102</td>
<td>0</td>
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<td>B</td>
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<td>523</td>
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<tr>
<td>C</td>
<td>169</td>
<td>595</td>
<td>723</td>
<td>892</td>
<td>791</td>
</tr>
<tr>
<td>D</td>
<td>379</td>
<td>604</td>
<td>734</td>
<td>1112</td>
<td>1011</td>
</tr>
<tr>
<td>E</td>
<td>955</td>
<td>621</td>
<td>754</td>
<td>1709</td>
<td>1607</td>
</tr>
</tbody>
</table>

*adjusted to account for WVA weighting factor of 17/14
The WVA model is presently undergoing model certification in accordance with USACE EC 1105-2-407, May 2005 Planning Models Improvement Program: Model Certification. The model has undergone external review which is documented in the July 8, 2009, Draft Model Certification Review Report for the WVA Models prepared by the Battelle Memorial Institute for the USACE, Ecosystem Planning Center of Expertise. The WVA revision documentation and spreadsheets have been submitted to the Ecosystem Center of Expertise (ECO-PCX). The ECO-PCX has reviewed the revisions and will forward a recommendation to certify the model for use in the LCA projects.

Since the WVA was still in the process of being certified, the projects using the WVA model were required to respond to specific comments related to the ongoing certification process and the use of WVA on the specific project. The specific comments and responses for the WVA as it relates to the LCA TBBSR Study can be found in Annex K-1. Based on satisfactory responses to these comments, ECO-PCX has cleared the WVA model for use in evaluating the alternatives considered in the LCA TBBSR Study.

K1.4 IWR SCREENING RESULTS

Table K1-19 summarizes the IWR input used in the IWR screening run.

<table>
<thead>
<tr>
<th>Island (# of Scales)</th>
<th>Scale #</th>
<th>Description</th>
<th>Cost, ($1,000)</th>
<th>Net Acres</th>
</tr>
</thead>
<tbody>
<tr>
<td>Raccoon (13)</td>
<td>0</td>
<td>Plan A</td>
<td>0</td>
<td>0</td>
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<tr>
<td></td>
<td>1</td>
<td>Plan B</td>
<td>54,400</td>
<td>301</td>
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<tr>
<td></td>
<td>2</td>
<td>Plan C</td>
<td>58,300</td>
<td>397</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>Plan D</td>
<td>64,100</td>
<td>462</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>Plan E</td>
<td>81,100</td>
<td>599</td>
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<td></td>
<td>5</td>
<td>Plan B with BW</td>
<td>58,100</td>
<td>326</td>
</tr>
<tr>
<td></td>
<td>6</td>
<td>Plan C with BW</td>
<td>62,000</td>
<td>428</td>
</tr>
<tr>
<td></td>
<td>7</td>
<td>Plan D with BW</td>
<td>67,800</td>
<td>495</td>
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<td></td>
<td>8</td>
<td>Plan E with BW</td>
<td>84,800</td>
<td>635</td>
</tr>
<tr>
<td></td>
<td>9</td>
<td>Plan B with TG</td>
<td>56,600</td>
<td>324</td>
</tr>
<tr>
<td></td>
<td>10</td>
<td>Plan C with TG</td>
<td>60,600</td>
<td>424</td>
</tr>
<tr>
<td></td>
<td>11</td>
<td>Plan D with TG</td>
<td>66,400</td>
<td>489</td>
</tr>
<tr>
<td></td>
<td>12</td>
<td>Plan E with TG</td>
<td>83,400</td>
<td>630</td>
</tr>
<tr>
<td>Whiskey (5)</td>
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<td>Plan A</td>
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<td>0</td>
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<td>Plan B</td>
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<td>Plan D</td>
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<td></td>
<td>3</td>
<td>Plan D</td>
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</tr>
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<td>Scale #</td>
<td>Description</td>
<td>Cost, ($1,000)</td>
<td>Net Acres</td>
</tr>
<tr>
<td>---------------------</td>
<td>---------</td>
<td>-------------</td>
<td>----------------</td>
<td>-----------</td>
</tr>
<tr>
<td>East (5)</td>
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<td>Plan A</td>
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<td>0</td>
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<td></td>
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<td>Plan B</td>
<td>56,500</td>
<td>344</td>
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<td></td>
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<td>Plan C</td>
<td>62,400</td>
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<td></td>
<td>3</td>
<td>Plan D</td>
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<td>500</td>
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<td></td>
<td>4</td>
<td>Plan E</td>
<td>102,300</td>
<td>703</td>
</tr>
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<td>Wine (6)</td>
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<td></td>
<td>3</td>
<td>Plan D</td>
<td>45,800</td>
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<td></td>
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<td>Plan E</td>
<td>51,500</td>
<td>318</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>Ring*</td>
<td>16,400</td>
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</tr>
<tr>
<td>Timbalier (5)</td>
<td>0</td>
<td>Plan A</td>
<td>0</td>
<td>0</td>
</tr>
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<td></td>
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<td>Plan B</td>
<td>83,400</td>
<td>641</td>
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</tr>
<tr>
<td></td>
<td>3</td>
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<td>113,000</td>
<td>1088</td>
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<td></td>
<td>4</td>
<td>Plan E</td>
<td>168,000</td>
<td>1641</td>
</tr>
<tr>
<td>East Timbalier (5)</td>
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<td>0</td>
</tr>
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<td>1</td>
<td>Plan B</td>
<td>144,000</td>
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<td></td>
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<td></td>
<td>3</td>
<td>Plan D</td>
<td>229,000</td>
<td>1011</td>
</tr>
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<td></td>
<td>4</td>
<td>Plan E</td>
<td>375,000</td>
<td>1607</td>
</tr>
</tbody>
</table>

BW denotes breakwaters
TG denotes Terminal Groin
* this plan includes filling the existing rock ring of Wine Island

A total of 243,750 plans were generated in IWR. It produced 360 cost effective plan alternatives ranging in conceptual cost between $0 (No Action) to $1.04 billion (Raccoon with BW, Whiskey, Trinity, East, Wine, Timbalier, and East Timbalier – all Plan E). Fourteen (14) of the cost effective plans were Best Buy Plans. Figure K1-1 presents an IWR graph which depicts all of the plans including non cost effective, cost effective and Best Buys.
Figure K1-1. Results of IWR Iteration 1

Of the 243,750 Generated Plans, 360 were Cost-Effective (blue triangles) and 14 were Best Buys (red squares).
K2. INTERMEDIATE ARRAY OF ALTERNATIVES

Based on the results of the IWR analysis presented in Section K1, five (5) Best Buy Plans were recommended for inclusion in the Intermediate Array of Alternatives presented in Table K2-1. It should be noted that because the conceptual cost estimates in the IWR screening were developed separately for individual islands and dune/beach and marsh fill components, they did not account for potential reductions due to shared mobilization/demobilization as well as other fixed costs (Appendix L). The conceptual cost estimates were subsequently refined through the reduction in redundancies for analyzing and developing alternatives to carry forward into the Intermediate Array (Appendix L).

Preliminary cost estimates were developed from the refined conceptual costs with the inclusion of preconstruction, engineering, and design, real estate, sand fencing, and vegetative plantings. For the preliminary cost estimates, the costs associated with supervision and inspection from the refined conceptual costs were revised and re-categorized for monitoring and operations and maintenance (O&M) (Appendix L). According to Section E-36c of ER 1105-2-100, all costs should be calculated in terms of present worth using the appropriate discount rate and annualized. Therefore, the preliminary costs were annualized at a discount rate of 4.375%, with a base year of 2012.

It should be noted that for Best Buy Plans 4 and 5, the volume of required marsh fill exceeds the volume of marsh sediments identified in the cleared marsh borrow areas, thus, sand borrow areas were selected to provide the additional sediment to complete the marsh fill templates. Furthermore, the WVA methodology was applied to compute Average Annual Habitat Units (AAHUs). The Habitat Units, which represent a numerical combination of quality and quantity existing at any given point in time resulting from the future without and future with project scenarios, were annualized and averaged over the 50-year period of analysis to determine AAHUs. The difference in AAHUs between two scenarios represents the net benefits attributable to the LCA TBBSR Study in terms of habitat quality and quantity. The No Action Plan A AAHUs were subtracted from Plan B through Plan E’s AAHUs to yield the net AAHUs that represent Plan B through Plan E’s net benefits compared to the No Action Plan scenario. Plan A’s net AAHUs are thus zero.

To apply a system-wide approach of restoring as many islands within the Study Area and to ensure that other alternatives that could provide effective solutions and can be constructed with cleared sediment sources, additional solutions were further analyzed. All possible minimized (Plan B) three- and four-island combinations that could be constructed with cleared sediment sources were developed. The most cost effective combinations whose refined conceptual cost estimate did not exceed the Best Buy Plans included in the Intermediate Array of Alternatives, of which there were four (4), were included in the Intermediate Array of Alternatives.

Finally, a system-wide barrier island restoration measure which would restore all seven (7) islands to their minimized design (Plan B) completed the Intermediate Array of Alternatives.
In summary, the ten (10) Intermediate Array alternatives were grouped into four (4) categories.

1) **No Action** – The No-Action Alternative assumes there would be no future barrier island restoration within the Study Area. The barrier islands will continue to be subjected to the factors and processes that are contributing to the loss of the Timbalier Islands and the Isles Dernieres and will result in a direct loss of the barrier islands to open water.

2) **“Best Buy”** – The Best Buy alternative based on the IWR screening provides the greatest increase in the value of the output variable for the least increase in the value of the cost variable. In other words, the Best Buy alternative yields the maximum habitat acres at the lowest cost per unit. If the budget falls between two “Best Buy” alternatives, the lower cost plan could be scaled-up. The “Best Buy” alternative is geared less toward the system-wide approach of restoring all of the islands and more toward restoring the island or islands that are most cost effective.

3) **Maximum number of islands constructible with cleared sediment sources** - This alternative would favor those islands where the total costs are lowest, allowing for more islands to be created using cleared sediment sources noting they may or may not be cost effective based on the IWR screening. The rationale for advancing these alternatives is based on a system wide approach of restoring as many of the islands within the Study Area as possible. The signals received from the public meetings, both scoping and Coastal Protection and Restoration Authority stakeholder, indicate a general desire to restore all of the islands in the Study Area. Concentrating restoration efforts on only one or two “cost effective” islands may well meet with public opposition, focusing on the equitability of the alternatives evaluation process.

4) **System-wide barrier island restoration** – This alternative would take a full system-wide approach to restoring the barrier islands. Each of the seven barrier islands would be restored to their minimal geomorphologic form and ecologic function. Similar to the alternatives that include the most islands that can be constructed with cleared sediment sources, this alternative may or may not be cost effective based on the IWR screening. The rationale is the same, that being; the significant stakeholder input received during plan formulation indicates a general desire to restore all of the islands in the Terrebonne Basin. It is noted that for this alternative, the volume of required marsh fill exceeds the volume of marsh sediments identified in the cleared marsh borrow areas, thus, sand borrow areas were selected to provide the additional sediment to complete the marsh fill templates.

The descriptions of the ten (10) alternatives along with their respective preliminary annualized costs and net AAHUs are summarized in Table K2-1. The cost data are presented in Appendix L. The AAHU data are presented in the Integrated Feasibility Study and Final Environmental Impact Statement Report, Section 3.
<table>
<thead>
<tr>
<th></th>
<th>Alternative</th>
<th>Category</th>
<th>Net AAHU</th>
<th>Preliminary Cost* ($)</th>
<th>Annualized Cost** ($)</th>
<th>Annualized Cost per AAHU ($)</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>No Action (Plan A)</td>
<td>No Action</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>This alternative does not include any restoration.</td>
</tr>
<tr>
<td>2</td>
<td>Timbalier (Plan E)</td>
<td>Best Buy</td>
<td>871</td>
<td>170,000,000</td>
<td>8,710,000</td>
<td>10,000</td>
<td>Restoration of Timbalier Island to its minimal geomorphologic form and ecologic function along with 25 years of advanced fill.</td>
</tr>
<tr>
<td>3</td>
<td>Whiskey (Plan C) / Timbalier (Plan E)</td>
<td>Best Buy</td>
<td>1,250</td>
<td>247,000,000</td>
<td>12,640,000</td>
<td>10,120</td>
<td>Restoration of Whiskey Island to its minimal geomorphologic form and ecologic function along with 5 years of advanced fill combined with restoration of Timbalier Island to its minimal geomorphologic form and ecologic function along with 25 years of advanced fill.</td>
</tr>
<tr>
<td>4</td>
<td>Whiskey (Plan C) / Trinity (Plan C) / Timbalier (Plan E)</td>
<td>Best Buy</td>
<td>1,637</td>
<td>329,000,000</td>
<td>16,820,000</td>
<td>10,280</td>
<td>Restoration of Whiskey and Trinity Islands to their minimal geomorphologic form and ecologic function along with 5 years of advanced fill combined with restoration of Timbalier Island to its minimal geomorphologic form and ecologic function along with 25 years of advanced fill.</td>
</tr>
<tr>
<td>5</td>
<td>Raccoon with TG (Plan E) / Whiskey (Plan C) / Trinity (Plan C) / Timbalier (Plan E)</td>
<td>Best Buy</td>
<td>2,063</td>
<td>408,000,000</td>
<td>20,830,000</td>
<td>10,100</td>
<td>Restoration of Whiskey and Trinity Islands to their minimal geomorphologic form and ecologic function along with 5 years of advanced fill combined with restoration of Raccoon and Timbalier Islands to their minimal geomorphologic form and ecologic function along with 25 years of advanced fill and construction of a terminal groin on the western end of Raccoon Island.</td>
</tr>
<tr>
<td>6</td>
<td>Raccoon (Plan B) / Whiskey (Plan B) / Trinity (Plan B)</td>
<td>Max # of Islands Constructible with Cleared Sediment Sources</td>
<td>785</td>
<td>177,000,000</td>
<td>9,040,000</td>
<td>11,510</td>
<td>Restoration of Raccoon, Whiskey, and Trinity Islands, all to their minimal geomorphologic form and ecologic function.</td>
</tr>
<tr>
<td>7</td>
<td>Raccoon with BW (Plan B) / Whiskey (Plan B) / Trinity (Plan B)</td>
<td>Max # of Islands Constructible with Cleared Sediment Sources</td>
<td>808</td>
<td>182,000,000</td>
<td>9,280,000</td>
<td>11,490</td>
<td>Restoration of Raccoon, Whiskey, and Trinity Islands, all to their minimal geomorphologic form and ecologic function, along with construction of eight additional breakwaters on the western end of Raccoon Island.</td>
</tr>
<tr>
<td>8</td>
<td>Raccoon with TG (Plan B) / Whiskey (Plan B) / Trinity (Plan B)</td>
<td>Max # of Islands Constructible with Cleared Sediment</td>
<td>801</td>
<td>180,000,000</td>
<td>9,190,000</td>
<td>11,470</td>
<td>Restoration of Raccoon, Whiskey, and Trinity Islands, all to their minimal geomorphologic form and ecologic function, along with construction of a terminal groin on the western end of Raccoon Island.</td>
</tr>
<tr>
<td>Alternative</td>
<td>Category</td>
<td>Net AAHU</td>
<td>Preliminary Cost* ($)</td>
<td>Annualized Cost** ($)</td>
<td>Annualized Cost per AAHU ($/ AAHU)</td>
<td>Description</td>
<td></td>
</tr>
<tr>
<td>-------------</td>
<td>----------</td>
<td>----------</td>
<td>------------------------</td>
<td>-----------------------</td>
<td>-------------------------------------</td>
<td>-------------</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Sources</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Raccoon (Plan B) / Whiskey (Plan B) / Timbalier (Plan B)</td>
<td>Max # of Islands Constructible with Cleared Sediment Sources</td>
<td>890</td>
<td>199,000,000</td>
<td>10,160,000</td>
<td>11,420</td>
<td>Restoration of Raccoon, Whiskey, and Timbalier Islands, all to their minimal geomorphologic form and ecologic function.</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Sources</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Raccoon (Plan B) / Trinity (Plan B) / East (Plan B) / Whisky (Plan B) / Timbalier (Plan B) / East Timbalier (Plan B) / Wine w/ Monkey (Plan B)</td>
<td>System-wide Barrier Island Restoration</td>
<td>1,842</td>
<td>439,000,000</td>
<td>22,420,000</td>
<td>12,170</td>
<td>Restoration of Raccoon, Whiskey, Trinity, East, Wine, Timbalier, and East Timbalier Islands, all to their minimal geomorphologic form and ecologic function.</td>
<td></td>
</tr>
</tbody>
</table>

BW: Breakwaters
TG: Terminal Groin
* Refined cost accounts for potential reductions due to shared mobilization/demobilization as well as other fixed costs as described in Section L9.1.4
** Preliminary costs were annualized at a discount rate of 4.375%, with a base year of 2012. The price level is 2009.
K3. COST EFFECTIVENESS AND INCREMENTAL COST ANALYSES

K3.1 COST EFFECTIVENESS

Figure K3-1 presents a graph depicting the ten (10) alternatives that comprise the Intermediate Array of Alternatives categorized as non cost effective, cost effective and Best Buy. The cost effective and Best Buy Plans are the alternatives that produce the most benefits for the same or less cost. Note that the cost effective and Best Buy Plans fall along the efficient frontier. The costs presented are preliminary costs which were annualized at a discount rate of 4.375%, with a base year of 2012. The price level is 2009.

The CE/ICA analysis revealed that Alternatives 6, 7, 8, and 10 were not cost effective when compared to the other alternatives in the Intermediate Array. Alternatives 6, 7, and 8 provide 785, 808, and 801 net AAHUs at a preliminary cost of $177,000,000, $182,000,000, and $180,000,000, respectively. However, Alternative 2 provides more benefits (871 AAHUs) for less preliminary cost ($170,000,000). Therefore, Alternatives 6, 7, and 8 are not cost effective when compared to Alternative 2. Similarly, Alternative 10 provides fewer benefits (1842 AAHUs) than Alternative 5 (2063 AAHUs) at a greater preliminary cost and was therefore not cost effective.
Although there is a general positive sloping trend between costs and outputs (i.e. benefits), the trend is not completely linear. A combination of factors contribute to this non-linearity including number of islands in the alternative, characteristics of the existing island footprints, and the extent to which the islands are being restored. For example, Alternative 2 consists of restoring Timbalier Island (the largest island in the system) using the largest island plan (Plan E). Alternatives 6, 7, and 8 will restore three smaller islands (Raccoon, Whiskey, and Trinity) using smaller island plans (Plan B). These alternatives will require three separate mobilization/demobilization events (compared to just one for Alternative 2), considerably increasing the costs per benefit. Furthermore, Timbalier Island currently has a considerable amount of sub-aerial habitat and a shallow sloping subtidal region behind the island. Therefore, the restoration plan will require relatively less material to increase its habitat value when compared to Alternatives 6, 7, and 8 which will require fill placement in deeper water.

This phenomenon can also be seen when comparing Alternative 5 to Alternative 10. Although Alternative 5 is only restoring four islands (compared to seven islands in Alternate 10), it will produce a larger amount of AAHUs. This is because the islands in Alternative 5 are being restored using larger plans (Plan E for Raccoon and Timbalier and Plan C for Whiskey and Trinity) than Alternative 10, which restores the islands to the minimum plan (Plan B). Furthermore, the additional mobilization/demobilization costs associated with a seven-island plan also increase the cost per benefit.

Table K3-1 displays the six (6) cost effective / Best Buy Plans from the Intermediate Array of Alternatives.

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
<th>Outputs (AAHU)</th>
<th>Annualized Cost ($)</th>
<th>Annualized Cost/ AAHU</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alt 1</td>
<td>No Action (Plan A)</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Alt 2</td>
<td>Timbalier (Plan E)</td>
<td>871</td>
<td>8,710,000</td>
<td>10,000</td>
</tr>
<tr>
<td>Alt 9</td>
<td>Raccoon (Plan B) / Whiskey (Plan B) / Timbalier (Plan B)</td>
<td>890</td>
<td>10,160,000</td>
<td>11,410</td>
</tr>
<tr>
<td>Alt 3</td>
<td>Whiskey (Plan C) / Timbalier (Plan E)</td>
<td>1250</td>
<td>12,640,000</td>
<td>10,120</td>
</tr>
<tr>
<td>Alt 4</td>
<td>Whiskey (Plan C) / Trinity (Plan C) / Timbalier (Plan E)</td>
<td>1637</td>
<td>16,820,000</td>
<td>10,280</td>
</tr>
<tr>
<td>Alt 5</td>
<td>Raccoon with TG (Plan E) / Whiskey (Plan C) / Trinity (Plan C) / Timbalier (Plan E)</td>
<td>2063</td>
<td>20,830,000</td>
<td>10,100</td>
</tr>
</tbody>
</table>

**K3.2 INCREMENTAL COST ANALYSIS**

The incremental cost analyses process is an iterative process. For the incremental cost analysis, the cost effective alternative plans were sorted in order of increasing output (Table K3-2). Next, the plan with the lowest average annual cost per AAHU beyond the No-Action Plan (Alternative 1) was identified and selected as the first Best Buy Plan.
The process continued, searching for the greatest increases in output for the least increases in cost. The alternatives were analyzed in all possible combinations.

<table>
<thead>
<tr>
<th>Code</th>
<th>Outputs (AAHU)</th>
<th>Total Cost ($)</th>
<th>Additional Output (AAHU)</th>
<th>Additional Costs ($)</th>
<th>Incremental Costs ($/AAHU)</th>
<th>Category</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alt 1</td>
<td>0</td>
<td>0</td>
<td>-</td>
<td>-</td>
<td>0</td>
<td>Best Buy</td>
</tr>
<tr>
<td>Alt 2</td>
<td>871</td>
<td>170,000,000</td>
<td>871</td>
<td>170,000,000</td>
<td>195,000</td>
<td>Best Buy</td>
</tr>
<tr>
<td>Alt 9</td>
<td>890</td>
<td>199,000,000</td>
<td>19</td>
<td>29,000,000</td>
<td>1,530,000</td>
<td>Cost Effective</td>
</tr>
<tr>
<td>Alt 3</td>
<td>1,250</td>
<td>247,000,000</td>
<td>360</td>
<td>48,000,000</td>
<td>133,000</td>
<td>Cost Effective</td>
</tr>
<tr>
<td>Alt 4</td>
<td>1,637</td>
<td>329,000,000</td>
<td>387</td>
<td>82,000,000</td>
<td>212,000</td>
<td>Cost Effective</td>
</tr>
<tr>
<td>Alt 5</td>
<td>2,063</td>
<td>408,000,000</td>
<td>426</td>
<td>79,000,000</td>
<td>185,000</td>
<td>Best Buy</td>
</tr>
</tbody>
</table>

A graphical representation of the incremental analysis for the Best Buy Plans excluding the No Action Plan is provided in Figure K3-1. As seen in the figure, Alternative 5 provides considerably more output for a slight increase in incremental cost.

Figure K3-2. Incremental Cost and Output for the Best Buy Plans.
As demonstrated by the CE/ICA, the incremental cost from Alternative 2 to Alternative 9 is not justifiable, thus Alternative 9 was not carried forward. Consequently, the PDT narrowed the alternative selection to create the Final Array of Alternatives:

- Alternative 1: No Action Plan;
- Alternative 2: Timbalier (Plan E);
- Alternative 3: Whiskey (Plan C)/Timbalier (Plan E);
- Alternative 4: Whiskey (Plan C)/Trinity (Plan C)/Timbalier (Plan E);
- Alternative 5: Raccoon with TG (Plan E)/Whiskey (Plan C)/Trinity (Plan C)/Timbalier (Plan E); and
- Alternative 11: Whiskey (Plan C)

In summary, these alternatives were carried forward for detailed analysis because they were all cost effective and fell along the efficient frontier curve. Alternatives 6, 7, 8, and 10 were not cost effective and therefore, not carried forward for further analysis. Alternative 9 was also removed from further analysis because the cost per AAHU was significantly (14%) higher than Alternative 2 and it fell above the efficient frontier curve. Alternative 11 was added to the Final Array because none of the alternatives in the Intermediate Array were within Water Resources Development Act (WRDA) 2007 authorization for the LCA TBBSR Study. Discussion of the development and selection of Alternative 11 is included in Section K5. Additional details are presented in the Integrated Feasibility Study and Final Environmental Impact Statement Report, Section 3.
K4. NATIONAL ECOSYSTEM RESTORATION PLAN

K4.1 SELECTION OF THE NATIONAL ECOSYSTEM RESTORATION PLAN

To develop the National Ecosystem Restoration Plan (NER) Plan, the Final Array of Alternatives identified in the previous section was used in a second IWR run. For this run, net AAHUs and annualized costs were utilized. Additional details on the screening analysis to select the NER Plan are presented in the Integrated Feasibility Study and Final Environmental Impact Statement Report, Section 3.

**Alternative 1**
This alternative is the No Action Plan. It is one of the three Best Buy alternatives. Its net AAHUs and cost are zero. The alternative was not selected as the NER Plan because the barrier islands will continue to be subjected to the factors and processes that are contributing to the eventual loss of the Timbalier Islands and the Isles Dernieres to open water.

**Alternative 2**
This alternative is Plan E on Timbalier Island. It is one of the three Best Buy alternatives. The alternative was not selected as the NER Plan because it only allows restoring one island and thus does not achieve all of the Study goals and objectives especially systematic ecosystem restoration for the whole basin. The remaining barrier islands will continue to be subjected to the factors and processes that are contributing to the eventual loss of the barrier islands to open water.

**Alternative 3**
This alternative is a combination of Plan C on Whiskey Island and Plan E on Timbalier Island. It is a cost effective alternative. The alternative was not selected as the NER Plan because it is not a Best Buy and only allows restoration of two islands.

**Alternative 4**
This alternative is a combination of Plan C’s on Whiskey and Trinity Islands and Plan E on Timbalier Island. It is a cost effective alternative and geared toward a system-wide approach. The alternative was not selected as the NER Plan because it is not a Best Buy.

**Alternative 5**
This alternative is a combination of Plan E with a TG on Raccoon Island, Plan C’s on Whiskey and Trinity Islands and Plan E on Timbalier Island. It is one of the three Best Buy alternatives, is geared toward a system-wide approach, and thus was selected as the NER Plan. It also provides considerably more output for a slight increase in incremental cost compared to the other Best Buy Plan (Alternative 2).

The design parameters for the NER Plan islands for the beach/dune fill and marsh fill are presented in Tables K4-1 and K4-2, respectively. The borrow areas identified for the NER Plan islands and the approximate required beach/dune and marsh cut volumes are
presented in Table K4-3. The borrow area and island restoration plans are presented in Annexes L-1 and L-2, respectively.

### Table K4-1. NER Plan Beach and Dune Fill Design Parameters

<table>
<thead>
<tr>
<th>Island</th>
<th>Plan</th>
<th>Volume (cy)</th>
<th>Length (ft)</th>
<th>Density (cy/lf)</th>
<th>Dune (TY 1 acres)</th>
<th>Supratidal (TY 1 acres)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Whiskey C</td>
<td>C</td>
<td>8,330,215</td>
<td>19,763</td>
<td>422</td>
<td>65</td>
<td>830</td>
</tr>
<tr>
<td>Trinity C</td>
<td>C</td>
<td>3,100,027</td>
<td>23,961</td>
<td>129</td>
<td>129</td>
<td>456</td>
</tr>
<tr>
<td>Raccoon w/ TG E</td>
<td>E</td>
<td>5,192,133</td>
<td>15,325</td>
<td>339</td>
<td>63</td>
<td>688</td>
</tr>
<tr>
<td>Timbalier E</td>
<td>E</td>
<td>10,702,818</td>
<td>39,106</td>
<td>274</td>
<td>215</td>
<td>2346</td>
</tr>
</tbody>
</table>

### Table K4-2. NER Plan Marsh Fill Design Parameters

<table>
<thead>
<tr>
<th>Island</th>
<th>Plan</th>
<th>Volume (cy)</th>
<th>Length (ft)</th>
<th>Density (cy/lf)</th>
<th>Intertidal (TY 1 acres)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Whiskey C</td>
<td>C</td>
<td>579,724</td>
<td>4,571</td>
<td>127</td>
<td>377</td>
</tr>
<tr>
<td>Trinity C</td>
<td>C</td>
<td>3,965,791</td>
<td>22,316</td>
<td>178</td>
<td>564</td>
</tr>
<tr>
<td>Raccoon w/ TG E</td>
<td>E</td>
<td>5,108,660</td>
<td>12,398</td>
<td>412</td>
<td>38</td>
</tr>
<tr>
<td>Timbalier E</td>
<td>E</td>
<td>9,073,317</td>
<td>35,433</td>
<td>256</td>
<td>69</td>
</tr>
</tbody>
</table>

### Table K4-3. NER Plan Preliminary Assessment of Borrow Areas and Cut Volumes

<table>
<thead>
<tr>
<th>Borrow Area</th>
<th>Beach/Dune Cut Volume (cy)</th>
<th>Marsh Cut Volume (cy)</th>
</tr>
</thead>
<tbody>
<tr>
<td>South Pelto Borrow Area 6</td>
<td>19,373,663</td>
<td>-</td>
</tr>
<tr>
<td>Ship Shoal Borrow Area 7</td>
<td>30,503,265</td>
<td>-</td>
</tr>
<tr>
<td>Whiskey Island Restoration Borrow Area 3</td>
<td>-</td>
<td>7,797,307</td>
</tr>
<tr>
<td>New Cut Borrow Area 4</td>
<td>-</td>
<td>2,300,000</td>
</tr>
<tr>
<td>Raccoon Island Restoration Borrow Area 5</td>
<td>-</td>
<td>2,200,000</td>
</tr>
</tbody>
</table>

The NER Plan was designed to create 2,063 net AAHUs at a preliminary opinion of cost of approximately $408,000,000. The NER Plan represents a system-wide and cost effective approach to restoring as many islands as possible within the Study Area that can be constructed with cleared sediment sources.

**K4.2 RENOURISHMENT CYCLES**

In order to maintain the NER Plan’s geomorphic form through the 50-year period of analysis, an analysis was conducted to determine the optimal renourishment cycle for each island. The criterion to provide for geomorphologic sustainability of an island was established as its “non-breaching” width. The island will not breach and lose its geomorphologic form if its beach width exceeds the amount of erosion resulting from the design storm impacts. Based on the modeling results presented in Annex L-3, of the three design storms, Katrina & Rita combined event, Gustav & Ike combined event, and a 50-year storm, the Katrina & Rita event resulted in the largest beach erosion amount of 104 ft (assuming 0.16 mm grain size) which was therefore selected as the critical non-breaching beach width. Additional details on the incremental analysis to verify the NER Plan remained cost effective with renourishment compared to the other alternatives are

K4.2.1 Whiskey Island

Table K4-4 presents Whiskey Island Plan C dune, supratidal, intertidal acres, beach length, and average beach width corresponding to several TYs. It indicates that between TY25 and TY30 Whiskey Island supratidal habitat disappears and only intertidal is sustained for the 50-year period of analysis. Thus, the island’s geomorphic form will primarily be a submerged shoal from TY30 to TY50.

<table>
<thead>
<tr>
<th>Target Year</th>
<th>TY0</th>
<th>TY1</th>
<th>TY5</th>
<th>TY10</th>
<th>TY15</th>
<th>TY20</th>
<th>TY25</th>
<th>TY30</th>
<th>TY40</th>
<th>TY50</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dune Acres</td>
<td>0</td>
<td>65</td>
<td>61</td>
<td>57</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Supratidal Acres</td>
<td>377</td>
<td>830</td>
<td>328</td>
<td>223</td>
<td>162</td>
<td>84</td>
<td>4</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Intertidal Acres</td>
<td>443</td>
<td>377</td>
<td>808</td>
<td>828</td>
<td>855</td>
<td>847</td>
<td>837</td>
<td>717</td>
<td>472</td>
<td>363</td>
</tr>
<tr>
<td>Beach Length, ft</td>
<td>11200</td>
<td>19800</td>
<td>19800</td>
<td>19800</td>
<td>19800</td>
<td>16500</td>
<td>3100</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Beach Width, ft</td>
<td>1466(^1)</td>
<td>1826</td>
<td>722</td>
<td>491</td>
<td>356</td>
<td>222</td>
<td>56</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

\(^1\) Includes CWPPRA TE-50 project.

An analysis of Whiskey Island’s length and width indicated that by TY25 the island will have breached, because its width of 56 ft is less than the critical non-breaching width of 104 ft. The island’s projected beach length at TY25, 3,100 ft, compared to 18,100 ft of beach at TY1, further confirms that Whiskey Island will have been breached between TY20 and TY25. This analysis infers that Whiskey Island has to be renourished prior to TY25.

In order to develop a minimal renourishment plan required to maintain Whiskey Island’s geomorphologic form and ecologic function for the entire 50-year period of analysis, several renourishment alternatives (RA) were considered including:

- RA1 – renourishment of beach and dune at TY20 to add Plan C and TY40 to add Plan C;
- RA2 – renourishment of beach and dune at TY20 to add Plan C and TY40 to add Plan B; and
- RA3 – renourishment of beach and dune at TY15 to add Plan B and TY30 to add Plan B.

Marsh renourishment was eliminated as the initial restoration plan provides for significant intertidal habitat throughout the 50-year period of analysis, thus its evolution over time remained the same as the initial Plan C restoration.
Below is a description of RA1, renourishment of beach and dune at TY20 to add Plan C and TY40 to add Plan C, the other two alternatives were analyzed in a similar manner. Renourishment of Whiskey Island’s beach and dune portions at TY20 to add Plan C infers retaining what is left of the island at TY20 from its initial Plan C restoration and adding the same amount of beach and dune acres developed for TY1. Further, because a portion of the initial restoration supratidal acres will convert to intertidal acres by TY20 as a result of sea level rise and subsidence, only the portion of initially supratidal acres that remains supratidal at TY20 gets added during beach renourishment.

After renourishment at TY20, beach and dune acres were evolved such that at TY40, the beach/dune acres are a summation of beach/dune acres from initial restoration of Whiskey Island that are still remaining 40 years later and beach/dune acres of the TY20 renourishment still remaining 20 years after that renourishment. The latter is equivalent to initial Plan C’s dune/beach acres at TY20.

Tables K4-5 through K4-7 present dune, supratidal, intertidal acres, beach length, and average beach width developed for the three RAs on Whiskey Island.

### Table K4-5. Whiskey Island RA1: Island Acres and Beach Dimensions Summary

<table>
<thead>
<tr>
<th>Target Year</th>
<th>TY0</th>
<th>TY1</th>
<th>TY5</th>
<th>TY10</th>
<th>TY20</th>
<th>TY21</th>
<th>TY30</th>
<th>TY40</th>
<th>TY41</th>
<th>TY50</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dune Acres</td>
<td>0</td>
<td>65</td>
<td>61</td>
<td>57</td>
<td>0</td>
<td>65</td>
<td>57</td>
<td>0</td>
<td>65</td>
<td>57</td>
</tr>
<tr>
<td>Supratidal Acres</td>
<td>377</td>
<td>830</td>
<td>328</td>
<td>223</td>
<td>84</td>
<td>496</td>
<td>223</td>
<td>84</td>
<td>496</td>
<td>223</td>
</tr>
<tr>
<td>Intertidal Acres</td>
<td>443</td>
<td>377</td>
<td>808</td>
<td>828</td>
<td>847</td>
<td>834</td>
<td>717</td>
<td>472</td>
<td>461</td>
<td>363</td>
</tr>
<tr>
<td>Beach Length, ft</td>
<td>11200</td>
<td>19800</td>
<td>19800</td>
<td>19800</td>
<td>16500</td>
<td>19800</td>
<td>19800</td>
<td>16500</td>
<td>19800</td>
<td>19800</td>
</tr>
<tr>
<td>Beach Width, ft</td>
<td>1466²</td>
<td>1826</td>
<td>722</td>
<td>491</td>
<td>222</td>
<td>1091</td>
<td>491</td>
<td>222</td>
<td>1091</td>
<td>491</td>
</tr>
</tbody>
</table>

¹ Plan C Supratidal Beach = 412 Acres (these supratidal acres are part of renourishment),
² Includes CWPPRA TE-50 project.

Plan C Supratidal Marsh = 418 Acres (these supratidal acres are not part of renourishment).
Table K4-6. Whiskey Island RA2: Island Acres and Beach Dimensions Summary

<table>
<thead>
<tr>
<th>Target Year</th>
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<th>TY5</th>
<th>TY10</th>
<th>TY20</th>
<th>TY21</th>
<th>TY30</th>
<th>TY40</th>
<th>TY41</th>
<th>TY50</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dune Acres</td>
<td>0</td>
<td>65</td>
<td>61</td>
<td>57</td>
<td>0</td>
<td>65</td>
<td>57</td>
<td>0</td>
<td>57</td>
<td>0</td>
</tr>
<tr>
<td>Supratidal Acres</td>
<td>377</td>
<td>830</td>
<td>328</td>
<td>223</td>
<td>84</td>
<td>496&lt;sup&gt;1&lt;/sup&gt;</td>
<td>223</td>
<td>84</td>
<td>387&lt;sup&gt;2&lt;/sup&gt;</td>
<td>164</td>
</tr>
<tr>
<td>Intertidal Acres</td>
<td>443</td>
<td>377</td>
<td>808</td>
<td>828</td>
<td>847</td>
<td>834</td>
<td>717</td>
<td>472</td>
<td>461</td>
<td>363</td>
</tr>
<tr>
<td>Beach Length, ft</td>
<td>11200</td>
<td>19800</td>
<td>19800</td>
<td>19800</td>
<td>16500</td>
<td>19800</td>
<td>19800</td>
<td>19800</td>
<td>19600</td>
<td>19600</td>
</tr>
<tr>
<td>Beach Width, ft</td>
<td>1466&lt;sup&gt;3&lt;/sup&gt;</td>
<td>1826</td>
<td>722</td>
<td>491</td>
<td>222</td>
<td>1091</td>
<td>491</td>
<td>222</td>
<td>860</td>
<td>364</td>
</tr>
</tbody>
</table>

<sup>1</sup> Plan C Supratidal Beach = 412 Acres (these supratidal acres are part of renourishment),  
<sup>2</sup> Plan C Supratidal Marsh = 418 Acres (these supratidal acres are not part of renourishment).  
<sup>3</sup> Includes CWPPRA TE-50 project.

Table K4-7. Whiskey Island RA3: Island Acres and Beach Dimensions Summary

<table>
<thead>
<tr>
<th>Target Year</th>
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<th>TY1</th>
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<td>57</td>
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<td>59</td>
<td>53</td>
<td>27</td>
<td>84</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Supratidal Acres</td>
<td>377</td>
<td>830</td>
<td>328</td>
<td>223</td>
<td>162</td>
<td>465&lt;sup&gt;1&lt;/sup&gt;</td>
<td>304</td>
<td>82</td>
<td>385</td>
<td>164</td>
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<tr>
<td>Intertidal Acres</td>
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<td>377</td>
<td>808</td>
<td>828</td>
<td>855</td>
<td>853</td>
<td>847</td>
<td>717</td>
<td>693</td>
<td>472</td>
<td>363</td>
</tr>
<tr>
<td>Beach Length, ft</td>
<td>11200</td>
<td>19800</td>
<td>19800</td>
<td>19800</td>
<td>19800</td>
<td>19800</td>
<td>19600</td>
<td>19600</td>
<td>19600</td>
<td>19600</td>
<td>0</td>
</tr>
<tr>
<td>Beach Width, ft</td>
<td>1466&lt;sup&gt;2&lt;/sup&gt;</td>
<td>1826</td>
<td>722</td>
<td>491</td>
<td>356</td>
<td>1033</td>
<td>676</td>
<td>180</td>
<td>856</td>
<td>364</td>
<td>0</td>
</tr>
</tbody>
</table>

<sup>1</sup> Plan B Supratidal Beach = 303 Acres (these supratidal acres are part of renourishment),  
<sup>2</sup> Plan B Supratidal Marsh = 311 Acres (these supratidal acres are not part of renourishment).  
<sup>3</sup> Includes CWPPRA TE-50 project.

Figure K4-1 presents a graphical summary of dune and beach acres associated with initial restoration Plan C and the three RAs for the 50-year period of analysis.

Based on the RA analysis, RA1 and RA2 sustain geomorphologic form throughout the period of analysis, however, RA3 does not. Because RA2 requires renourishment at TY40 in the form of adding Plan B which is smaller than Plan C added at TY40 in RA1, RA2 is a less expensive RA to implement and thus was selected.
K4.2.2 Trinity Island

Table K4-8 presents Trinity Island Plan C dune, supratidal, intertidal acres, beach length, and average beach width for a range of TYs. It indicates that between TY30 and TY40 Trinity Island supratidal habitat disappears and only intertidal is sustained for the 50-year period of analysis. Thus, the island’s geomorphic form will primarily be a submerged shoal from TY30 to TY50.

Table K4-8. Trinity Island Plan C: Island Acres and Beach Dimensions Summary

<table>
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<th>TY20</th>
<th>TY25</th>
<th>TY30</th>
<th>TY40</th>
<th>TY50</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dune Acres</td>
<td>39</td>
<td>129</td>
<td>122</td>
<td>67</td>
<td>34</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Supratidal Acres</td>
<td>232</td>
<td>456</td>
<td>316</td>
<td>270</td>
<td>230</td>
<td>190</td>
<td>90</td>
<td>4</td>
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<td>0</td>
</tr>
<tr>
<td>Intertidal Acres</td>
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<td>564</td>
<td>632</td>
<td>635</td>
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<td>594</td>
<td>597</td>
<td>561</td>
<td>380</td>
<td>199</td>
</tr>
<tr>
<td>Beach Length, ft</td>
<td>22600</td>
<td>24000</td>
<td>24000</td>
<td>24000</td>
<td>24000</td>
<td>22400</td>
<td>4100</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Beach Width, ft</td>
<td>447</td>
<td>828</td>
<td>574</td>
<td>490</td>
<td>417</td>
<td>345</td>
<td>175</td>
<td>42</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

An analysis of Trinity Island’s length and width indicated island breaching will have occurred by TY30 as only four (4) supratidal acres with a projected beach width of 42 ft, significantly less than the non-breaching beach width of 104 ft derived from the SBEACH storm impact modeling, remain. Further, as a result of breaching, the length of Trinity Island will have reduced by 83% at TY30 compared to its restored length at TY1. At TY25, the island’s beach is projected to be 175 ft wide and non-breaching which
infers that Plan C on Trinity Island will sustain geomorphologic form for 25 years and the island has to then be renourished to maintain the form for the remaining 25 years of analysis.

Because Plan B is smaller than Plan C using Plan B to renourish Trinity Island at TY25 will not be sufficient for 25 years of sustainability between TY26 and TY50 without a second renourishment event. Plans D and E are, on the other hand, larger than Plan C and will be sufficient but are more expensive to implement. Therefore, adding Plan C at TY25 is the optimal RA, thus it was selected.

Renourishment of Trinity Island’s beach and dune portions at TY25 to add Plan C infers retaining what is left of the island at TY25 from its initial Plan C restoration and adding the same amount of beach and dune acres developed for TY1. Because a portion of the initial restoration supratidal acres will convert to intertidal acres by TY25 as a result of sea level rise and subsidence, only the portion of initially supratidal acres that remains supratidal at TY25 gets added during renourishment.

After renourishment at TY25, beach and dune acres were evolved such that at TY30, the beach/dune acres are a summation of beach/dune acres from initial restoration of Trinity Island that are still remaining 30 years later and beach/dune acres of the TY25 renourishment still remaining 5 years after that renourishment. The latter is equivalent to initial Plan C’s beach/dune acres at TY5. For TY40 and TY50, the beach and dune acres were evolved in a similar manner.

Similarly to Whiskey Island, marsh renourishment on Trinity Island was eliminated as the initial restoration plan provides for significant intertidal habitat throughout the 50-year period of analysis.

Table K4-9 presents dune, supratidal, intertidal acres, beach length, and average beach width developed for the renourishment scenario on Trinity Island.

Table K4-9. Trinity Island Acres and Beach Dimensions Summary

<table>
<thead>
<tr>
<th>Target Year</th>
<th>TY0</th>
<th>TY1</th>
<th>TY5</th>
<th>TY10</th>
<th>TY15</th>
<th>TY20</th>
<th>TY25</th>
<th>TY26</th>
<th>TY30</th>
<th>TY40</th>
<th>TY50</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dune Acres</td>
<td>39</td>
<td>129</td>
<td>122</td>
<td>67</td>
<td>34</td>
<td>0</td>
<td>129</td>
<td>122</td>
<td>34</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Supratidal Acres</td>
<td>232</td>
<td>456</td>
<td>316</td>
<td>270</td>
<td>230</td>
<td>190</td>
<td>90</td>
<td>496</td>
<td>320</td>
<td>230</td>
<td>90</td>
</tr>
<tr>
<td>Intertidal Acres</td>
<td>311</td>
<td>564</td>
<td>632</td>
<td>635</td>
<td>615</td>
<td>594</td>
<td>597</td>
<td>590</td>
<td>561</td>
<td>380</td>
<td>199</td>
</tr>
<tr>
<td>Beach Length, ft</td>
<td>22600</td>
<td>24000</td>
<td>24000</td>
<td>24000</td>
<td>24000</td>
<td>22400</td>
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<td>24000</td>
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<td>22400</td>
</tr>
<tr>
<td>Beach Width, ft</td>
<td>447</td>
<td>828</td>
<td>574</td>
<td>490</td>
<td>417</td>
<td>345</td>
<td>175</td>
<td>900</td>
<td>581</td>
<td>417</td>
<td>175</td>
</tr>
</tbody>
</table>

1 Plan C Supratidal Beach = 406 Acres (these supratidal acres are part of renourishment), Plan C Supratidal Marsh = 50 Acres (these supratidal acres are not part of renourishment).
Figure K4-2 presents a graphical summary of beach and dune acres associated with initial restoration Plan C and recommended renourishment scenario for the 50-year period of analysis.

Figure K4-2. Graphical Summary of Dune and Beach Acres Associated with Initial Restoration Plan C and Recommended Renourishment Scenario on Trinity Island.

K4.2.3 Raccoon Island with Terminal Groin

Table K4-10 presents Raccoon Island Plan E with TG habitat acres and island dimensions calculated for a range of TYs. It indicates that the supratidal habitat is sustained for the 50-year period of analysis. However, an analysis of Raccoon Island’s beach dimensions indicates that the length of Raccoon Island’s beach will have reduced by 54% by TY40 and by 65% by TY50 compared to its restored length at TY1. This infers that the island has to be renourished at TY30 to maintain its geomorphic form for the remaining 20 years of analysis.

<table>
<thead>
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<th>TY5</th>
<th>TY10</th>
<th>TY20</th>
<th>TY30</th>
<th>TY40</th>
<th>TY50</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dune Acres</td>
<td>0</td>
<td>63</td>
<td>50</td>
<td>29</td>
<td>20</td>
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<td>0</td>
</tr>
<tr>
<td>Supratidal Acres</td>
<td>51</td>
<td>688</td>
<td>678</td>
<td>659</td>
<td>650</td>
<td>182</td>
<td>106</td>
<td>66</td>
</tr>
<tr>
<td>Intertidal Acres</td>
<td>188</td>
<td>38</td>
<td>39</td>
<td>40</td>
<td>39</td>
<td>466</td>
<td>486</td>
<td>468</td>
</tr>
<tr>
<td>Beach Length, ft</td>
<td>8200</td>
<td>15300</td>
<td>15300</td>
<td>15300</td>
<td>15300</td>
<td>15300</td>
<td>7000</td>
<td>5400</td>
</tr>
<tr>
<td>Beach Width, ft</td>
<td>271</td>
<td>1959</td>
<td>1930</td>
<td>1876</td>
<td>1851</td>
<td>518</td>
<td>660</td>
<td>532</td>
</tr>
</tbody>
</table>

Table K4-10. Raccoon Island Plan E with Terminal Groin: Island Acres and Beach Dimensions Summary
In order to develop a minimal renourishment plan required to maintain Raccoon Island’s geomorphologic form and ecologic function, two renourishment alternatives (RA) were considered including:

- RA1 – renourishment of beach and dune at TY30 to restore Plan B; and
- RA2 – renourishment of beach and dune at TY30 to add Plan B.

Marsh renourishment was eliminated as the initial restoration plan provides for significant intertidal habitat throughout the 50-year period of analysis, thus its evolution over time remained the same as the initial Plan E restoration.

For RA1, renourishment of beach and dune at TY30 to restore Plan B infers building Plan B on what is left of the island at TY30 from its initial Plan E restoration to create Plan B’s amount of beach and dune acres developed for TY1. Because a portion of the initial restoration supratidal acres will convert to intertidal acres by TY30 as a result of sea level rise and subsidence, only the portion of initially supratidal acres that remains supratidal at TY30 gets restored during beach renourishment.

For RA2, renourishment of beach and dune at TY30 to add Plan B infers retaining what is left of the island at TY30 from its initial Plan E restoration and adding Plan B’s amount of beach and dune acres developed for TY1. Similarly to RA1, only the portion of initially supratidal acres that remains supratidal at TY30 gets added during beach renourishment.

Tables K4-11 and K4-12 present dune, supratidal, intertidal acres, beach length, and average beach width developed for the two RAs on Raccoon Island.

Table K4-11. Raccoon Island RA1: Island Acres and Beach Dimensions Summary

<table>
<thead>
<tr>
<th>Target Year</th>
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<th>TY5</th>
<th>TY10</th>
<th>TY20</th>
<th>TY30</th>
<th>TY31</th>
<th>TY40</th>
<th>TY50</th>
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</thead>
<tbody>
<tr>
<td>Dune Acres</td>
<td>0</td>
<td>63</td>
<td>50</td>
<td>29</td>
<td>20</td>
<td>0</td>
<td>45</td>
<td>15</td>
<td>3</td>
</tr>
<tr>
<td>Supratidal Acres</td>
<td>51</td>
<td>688</td>
<td>678</td>
<td>659</td>
<td>650</td>
<td>182</td>
<td>204(^1)</td>
<td>165</td>
<td>170</td>
</tr>
<tr>
<td>Intertidal Acres</td>
<td>188</td>
<td>38</td>
<td>39</td>
<td>40</td>
<td>39</td>
<td>466</td>
<td>468</td>
<td>486</td>
<td>468</td>
</tr>
<tr>
<td>Beach Length, ft</td>
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<td>15300</td>
<td>15300</td>
<td>15300</td>
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<td>14900</td>
<td>14900</td>
</tr>
<tr>
<td>Beach Width, ft</td>
<td>271</td>
<td>1959</td>
<td>1930</td>
<td>1876</td>
<td>1851</td>
<td>518</td>
<td>596</td>
<td>482</td>
<td>497</td>
</tr>
</tbody>
</table>

\(^1\) Plan B Supratidal Beach = 204 Acres (these supratidal acres are part of renourishment),
Plan B Supratidal Marsh = 23 Acres (these supratidal acres are not part of renourishment).
### Table K4-12. Raccoon Island RA2: Island Acres and Beach Dimensions Summary

<table>
<thead>
<tr>
<th>Target Year</th>
<th>TY0</th>
<th>TY1</th>
<th>TY5</th>
<th>TY10</th>
<th>TY20</th>
<th>TY30</th>
<th>TY31</th>
<th>TY40</th>
<th>TY50</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Dune Acres</strong></td>
<td>0</td>
<td>63</td>
<td>50</td>
<td>29</td>
<td>20</td>
<td>0</td>
<td>45</td>
<td>15</td>
<td>3</td>
</tr>
<tr>
<td><strong>Supratidal Acres</strong></td>
<td>51</td>
<td>688</td>
<td>678</td>
<td>659</td>
<td>650</td>
<td>182</td>
<td>386</td>
<td>271</td>
<td>236</td>
</tr>
<tr>
<td><strong>Intertidal Acres</strong></td>
<td>188</td>
<td>38</td>
<td>39</td>
<td>40</td>
<td>39</td>
<td>466</td>
<td>468</td>
<td>486</td>
<td>468</td>
</tr>
<tr>
<td><strong>Beach Length, ft</strong></td>
<td>8200</td>
<td>15300</td>
<td>15300</td>
<td>15300</td>
<td>15300</td>
<td>14900</td>
<td>14900</td>
<td>14900</td>
<td>14900</td>
</tr>
<tr>
<td><strong>Beach Width, ft</strong></td>
<td>271</td>
<td>1959</td>
<td>1930</td>
<td>1876</td>
<td>1851</td>
<td>518</td>
<td>1128</td>
<td>792</td>
<td>690</td>
</tr>
</tbody>
</table>

1 Plan B Supratidal Beach = 204 Acres (these supratidal acres are part of renourishment), Plan B Supratidal Marsh = 23 Acres (these supratidal acres are not part of renourishment).

Figure K4-3 presents a graphical summary of beach and dune acres associated with initial restoration Plan E and the two RAs for the 50-year period of analysis.

Based on the RA analysis, both RA1 and RA2 sustain geomorphologic form throughout the period of analysis; however, RA1 requires renourishment in the form of restoring Plan B which is smaller than adding Plan B. Therefore RA1 is a less expensive RA to implement and thus was selected.

![Figure K4-3](image-url)
K4.2.4 Timbalier Island

Table K4-13 presents Timbalier Island Plan E habitat acres and island dimensions calculated for the 50-year period of analysis. It indicates that the supratidal habitat is sustained for the 50-year period of analysis. However, an analysis of Timbalier Island’s beach dimensions indicates that the width of Timbalier Island’s beach will have decreased from 406 ft TY40 to 65 ft at TY50 which is significantly less than the non-breaching width of 104 ft. This infers that the island will no longer sustain its geomorphologic form and function and will have to be renourished by TY40. However, the volumes associated with renourishment of Timbalier Island are minor compared to initial restoration. Thus, to remain cost effective, TY30 was selected to coincide with the renourishment event on Raccoon Island so the two islands could be constructed under a single mobilization.

Table K4-13. Timbalier Island Plan E: Island Acres and Beach Dimensions

<table>
<thead>
<tr>
<th>Summary</th>
<th>Target Year</th>
<th>TY0</th>
<th>TY1</th>
<th>TY5</th>
<th>TY10</th>
<th>TY20</th>
<th>TY30</th>
<th>TY40</th>
<th>TY50</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dune Acres</td>
<td>TY0</td>
<td>57</td>
<td>215</td>
<td>183</td>
<td>160</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Supratidal Acres</td>
<td>TY1</td>
<td>549</td>
<td>2346</td>
<td>2257</td>
<td>2130</td>
<td>1996</td>
<td>629</td>
<td>330</td>
<td>53</td>
</tr>
<tr>
<td>Intertidal Acres</td>
<td>TY5</td>
<td>374</td>
<td>69</td>
<td>71</td>
<td>74</td>
<td>76</td>
<td>1148</td>
<td>1123</td>
<td>1088</td>
</tr>
<tr>
<td>Beach Length, ft</td>
<td>TY10</td>
<td>35600</td>
<td>39100</td>
<td>39100</td>
<td>39100</td>
<td>39100</td>
<td>37700</td>
<td>35400</td>
<td>35400</td>
</tr>
<tr>
<td>Beach Width, ft</td>
<td>TY20</td>
<td>672</td>
<td>2614</td>
<td>2514</td>
<td>2373</td>
<td>2224</td>
<td>727</td>
<td>406</td>
<td>65</td>
</tr>
</tbody>
</table>

In order to develop a minimal renourishment plan required to maintain Timbalier Island’s geomorphologic form and ecologic function, two RAs were considered including:

- RA1 – renourishment of beach and dune at TY30 to restore Plan B; and
- RA2 – renourishment of beach and dune at TY30 to add Plan B.

Marsh renourishment was eliminated as the initial restoration plan provides for significant intertidal habitat throughout the 50-year period of analysis, thus its evolution over time remained the same as the initial Plan E restoration.

For RA1, renourishment of beach and dune at TY30 to restore Plan B infers building Plan B on what is left of the island at TY30 from its initial Plan E restoration to create Plan B’s amount of beach and dune acres developed for TY1. Because a portion of the initial restoration supratidal acres will convert to intertidal acres by TY30 as a result of sea level rise and subsidence, only the portion of initially supratidal acres that remains supratidal at TY30 gets restored during renourishment.

For RA2, renourishment of beach and dune at TY30 to add Plan B infers retaining what is left of the island at TY30 from its initial Plan E restoration and adding Plan B’s amount
of beach and dune acres developed for TY1. Similarly to RA1, only the portion of initially supratidal acres that remains supratidal at TY30 gets added during beach renourishment.

Tables K4-14 and K4-15 present dune, supratidal, intertidal acres, beach length, and average beach width developed for the two RAs on Timbalier Island.

**Table K4-14. Timbalier Island RA1: Island Acres and Beach Dimensions Summary**

<table>
<thead>
<tr>
<th>Target Year</th>
<th>TY0</th>
<th>TY1</th>
<th>TY5</th>
<th>TY10</th>
<th>TY20</th>
<th>TY30</th>
<th>TY31</th>
<th>TY40</th>
<th>TY50</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dune Acres</td>
<td>57</td>
<td>215</td>
<td>183</td>
<td>160</td>
<td>0</td>
<td>0</td>
<td>155</td>
<td>13</td>
<td>0</td>
</tr>
<tr>
<td>Supratidal Acres</td>
<td>549</td>
<td>2346</td>
<td>2257</td>
<td>2130</td>
<td>1996</td>
<td>629</td>
<td>667</td>
<td>524</td>
<td>236</td>
</tr>
<tr>
<td>Intertidal Acres</td>
<td>374</td>
<td>69</td>
<td>71</td>
<td>74</td>
<td>76</td>
<td>1148</td>
<td>1146</td>
<td>1123</td>
<td>1088</td>
</tr>
<tr>
<td>Beach Length, ft</td>
<td>35600</td>
<td>39100</td>
<td>39100</td>
<td>39100</td>
<td>37700</td>
<td>35400</td>
<td>39100</td>
<td>39100</td>
<td></td>
</tr>
<tr>
<td>Beach Width, ft</td>
<td>672</td>
<td>2614</td>
<td>2514</td>
<td>2373</td>
<td>2224</td>
<td>727</td>
<td>821</td>
<td>584</td>
<td>263</td>
</tr>
</tbody>
</table>

1 Plan B Supratidal Beach = 667 Acres (these supratidal acres are part of renourishment),
   Plan B Supratidal Marsh = 81 Acres (these supratidal acres are not part of renourishment).

**Table K4-15. Timbalier Island RA2: Island Acres and Beach Dimensions Summary**

<table>
<thead>
<tr>
<th>Target Year</th>
<th>TY0</th>
<th>TY1</th>
<th>TY5</th>
<th>TY10</th>
<th>TY20</th>
<th>TY30</th>
<th>TY31</th>
<th>TY40</th>
<th>TY50</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dune Acres</td>
<td>57</td>
<td>215</td>
<td>183</td>
<td>160</td>
<td>0</td>
<td>0</td>
<td>155</td>
<td>13</td>
<td>0</td>
</tr>
<tr>
<td>Supratidal Acres</td>
<td>549</td>
<td>2346</td>
<td>2257</td>
<td>2130</td>
<td>1996</td>
<td>629</td>
<td>1296</td>
<td>854</td>
<td>289</td>
</tr>
<tr>
<td>Intertidal Acres</td>
<td>374</td>
<td>69</td>
<td>71</td>
<td>74</td>
<td>76</td>
<td>1148</td>
<td>1146</td>
<td>1123</td>
<td>1088</td>
</tr>
<tr>
<td>Beach Length, ft</td>
<td>35600</td>
<td>39100</td>
<td>39100</td>
<td>39100</td>
<td>37700</td>
<td>35400</td>
<td>39100</td>
<td>39100</td>
<td></td>
</tr>
<tr>
<td>Beach Width, ft</td>
<td>672</td>
<td>2614</td>
<td>2514</td>
<td>2373</td>
<td>2224</td>
<td>727</td>
<td>1595</td>
<td>951</td>
<td>322</td>
</tr>
</tbody>
</table>

1 Plan B Supratidal Beach = 667 Acres (these supratidal acres are part of renourishment),
   Plan B Supratidal Marsh = 81 Acres (these supratidal acres are not part of renourishment).

Figure K4-4 presents a graphical summary of beach and dune acres associated with initial restoration Plan E and the two RAs for the 50-year period of analysis.

Based on the RA analysis, both RA1 and RA2 sustain geomorphologic form throughout the period of analysis; however, RA1 requires renourishment in the form of restoring Plan B which is smaller than adding Plan B. Therefore RA1 is a less expensive RA to implement and thus was selected.
Figure K4-4. Graphical Summary of Dune and Beach Acres Associated with Initial Restoration Plan E and Two Renourishment Alternatives on Timbalier Island.

K4.3 Description of National Ecosystem Restoration Plan with Renourishment

The iterative analyses resulted in recommending Alternative 5 with renourishment as the NER Plan. The NER Plan with renourishment consists of restoration of:

- Whiskey Island to its minimal geomorphologic form and ecologic function along with 5 years of advanced fill (Plan C) and two beach and dune renourishment events, one at TY20 to add Plan C and the other one at TY40 to add Plan B;
- Trinity Island to its minimal geomorphologic form and ecologic function along with 5 years of advanced fill (Plan C) and one renourishment of beach and dune at TY25 to add Plan C;
- Raccoon Island to its minimal geomorphologic form and ecologic function along with 25 years of advanced fill, construction of a TG on the western end, and one renourishment of beach and dune at TY30 to restore Plan B; and
- Timbalier Island to its minimal geomorphologic form and ecologic function along with 25 years of advanced fill and one renourishment of beach and dune at TY30 to restore Plan B.

The NER Plan with renourishment was designed to create 2,883 net AAHUs. The design beach/dune fill and marsh fill parameters are presented in Table K4-16. The borrow areas identified for the NER Plan with renourishment and the required approximate beach/dune and marsh cut volumes are presented in Table K4-17. Further, the borrow area and island restoration plans are presented in Annexes L-1 and L-2, respectively.
Table K4-16. NER Plan Beach / Dune Fill and Marsh Fill Design Parameters

<table>
<thead>
<tr>
<th>Fill</th>
<th>Volume (cy)</th>
<th>Length (ft)</th>
<th>Density (cy/lf)</th>
<th>Dune Acres</th>
<th>Supratidal Acres</th>
<th>Intertidal Acres</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Initial</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Beach/Dune</td>
<td>27,320,000</td>
<td>98,200</td>
<td>278</td>
<td>472^1</td>
<td>4,320^1</td>
<td>N/A</td>
</tr>
<tr>
<td>Marsh</td>
<td>18,730,000</td>
<td>74,800</td>
<td>250</td>
<td>N/A</td>
<td>N/A</td>
<td>1048^1</td>
</tr>
<tr>
<td><strong>Renourishment</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TY20</td>
<td>8,330,000</td>
<td>19,800</td>
<td>422</td>
<td>65^2</td>
<td>496^2</td>
<td>834^2</td>
</tr>
<tr>
<td>TY25</td>
<td>3,100,000</td>
<td>24,000</td>
<td>129</td>
<td>129^3</td>
<td>496^3</td>
<td>590^3</td>
</tr>
<tr>
<td>TY30</td>
<td>2,420,000</td>
<td>54,000</td>
<td>45</td>
<td>200^4</td>
<td>1,682^4</td>
<td>1,591^4</td>
</tr>
<tr>
<td>TY40</td>
<td>6,330,000</td>
<td>19,600</td>
<td>323</td>
<td>57^5</td>
<td>387^5</td>
<td>461^5</td>
</tr>
</tbody>
</table>

^1 at TY1; ^2 at TY21; ^3 at TY26; ^4 at TY31; ^5 at TY41
N/A denotes Not Applicable

Table K4-17. NER Plan Borrow Areas and Cut Volumes

<table>
<thead>
<tr>
<th>Borrow Area</th>
<th>Beach/Dune Cut Volume (cy)</th>
<th>Marsh Cut Volume (cy)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Initial</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ship Shoal Borrow Area 7</td>
<td>19,800,000</td>
<td>3,160,000</td>
</tr>
<tr>
<td>South Pelto Borrow Area 6</td>
<td>12,090,000</td>
<td>3,480,000</td>
</tr>
<tr>
<td>Whiskey Island Restoration Borrow Area 3</td>
<td>—</td>
<td>12,400,000</td>
</tr>
<tr>
<td>New Cut Borrow Area 4</td>
<td>—</td>
<td>2,500,000</td>
</tr>
<tr>
<td>Raccoon Island Restoration Borrow Area 5</td>
<td>—</td>
<td>2,400,000</td>
</tr>
<tr>
<td><strong>Renourishment</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ship Shoal Borrow Area 7</td>
<td>23,100,000</td>
<td>—</td>
</tr>
<tr>
<td>South Pelto Borrow Area 6</td>
<td>531,000</td>
<td>—</td>
</tr>
</tbody>
</table>

The Tri-Services Automated Cost Engineering System (TRACES MII Version 3.01) was used to develop the baseline LCA TBBSR Study cost for the NER Plan with renourishment. MII is the second generation of the MCASES software used as a costing tool by the USACE. The MII English Cost Book 2008, National Labor 2008 - Preliminary Draft, and the MII Equipment Region 3r 2007 libraries were linked to the project library in the development of the costs for the NER Plan with renourishment.
Based on the detailed cost estimate prepared and a contingency value determined using Crystal Ball, a fully funded cost estimate of $689,000,000 was developed for the initial restoration of the NER Plan. Utilizing the MII cost developed for the renourishment events and a contingency of 35% based on professional judgment, the O&M costs for the Raccoon Island TG at TY10 and renourishment events at TY20, TY25, TY30 and TY40 were estimated to be $1,370,000, $157,000,000, $117,000,000, $97,500,000, and $184,000,000, respectively. The opinion of probable fully funded cost for the NER Plan with renourishment is approximately $1,246,000,000. Refer to Appendix L for the detailed cost estimate.
K5. FIRST COMPONENT OF CONSTRUCTION

K5.1 SELECTION OF THE FIRST COMPONENT OF CONSTRUCTION

The NER Plan which consists of Whiskey Plan C, Trinity Plan C, Raccoon Plan E with TG, and Timbalier Plan E was selected based on the IWR analysis, it is a Best Buy that fulfills the planning objectives of the LCA TBBSR Study, and it represents a system-wide and cost effective approach of restoring as many islands within the Terrebonne Basin which can be constructed with cleared sediment sources. However, the NER Plan cannot be constructed within WRDA 2007 authorization. In order to identify plans that could be constructed within WRDA 2007 authorization, the PDT performed separate cost refinements on each island in the NER Plan using MII. The original contingency was also refined using Crystal Ball. These refinements inflated the costs of the islands, leaving Trinity Island Plan C and Whiskey Island Plan C as the only island plans that could be constructed within WRDA 2007 authorization. Consequently, a separate screening process was conducted on the two islands to select the most appropriate island to be constructed as the first component of construction.

Previous CE/ICA analysis revealed that both islands plans, when analyzed separately, were cost effective. The plans also proved to be cost effective when analyzed by running the IWR analysis on an extended array that included the original ten (10) alternatives plus the two (2) additional alternatives (Table K5-1 and Figure K5-1). Renourishment was not included in this analysis.

Although Whiskey Plan C provides slightly fewer net AAHUs than Trinity Island Plan C (379 net AAHUs vs. 387 net AAHUs), it was determined to be the first component of construction due to a number of qualitative benefits provided by the plan. For example, Whiskey Plan C was designed to avoid approximately 286 acres of existing mangroves on the island in order to minimize the ecologic impact during construction, and to protect these habitats over time by constructing the beach and dune template gulf-ward. Since the island is considered a valuable wildlife habitat (the Isles Dernieres Barrier Islands Wildlife Refuge) and the Louisiana Department of Wildlife and Fisheries is reestablishing a pelican rookery on the island, maintaining adequate areas of healthy beach, dune, and marsh is particularly important. Whiskey Plan C was also designed to complement TE-50, which is an existing CWPPRA project that was constructed in 2009. TE-50 created approximately 316 acres of intertidal back-barrier marsh between the two existing mangrove stands. Restoration of the beach and dune gulfward of TE-50 will help to protect the existing CWPPRA investment.

Whiskey Island is also the closest island to the critical marsh habitat located in the southern-most portion of Terrebonne Basin. If the island was to disappear, the marsh habitat on the mainland would be susceptible to the direct impacts of tropical storms and hurricanes.
<table>
<thead>
<tr>
<th>Alternative</th>
<th>Category</th>
<th>Net AAHU</th>
<th>Preliminary Cost* ($)</th>
<th>Annualized Cost** ($)</th>
<th>Annualized Cost per AAHU ($/AAHU)</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 No Action (Plan A)</td>
<td>No Action</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>This alternative does not include any restoration.</td>
</tr>
<tr>
<td>2 Timbalier (Plan E)</td>
<td>Best Buy</td>
<td>871</td>
<td>170,000,000</td>
<td>8,710,000</td>
<td>10,000</td>
<td>Restoration of Timbalier Island to its minimal geomorphologic form and ecologic function along with 25 years of advanced fill.</td>
</tr>
<tr>
<td>3 Whiskey (Plan C) / Timbalier (Plan E)</td>
<td>Best Buy</td>
<td>1250</td>
<td>247,000,000</td>
<td>12,600,000</td>
<td>10,120</td>
<td>Restoration of Whiskey Island to its minimal geomorphologic form and ecologic function along with 5 years of advanced fill combined with restoration of Timbalier Island to its minimal geomorphologic form and ecologic function along with 25 years of advanced fill.</td>
</tr>
<tr>
<td>4 Whiskey (Plan C) / Trinity (Plan C) / Timbalier (Plan E)</td>
<td>Best Buy</td>
<td>1637</td>
<td>329,000,000</td>
<td>16,800,000</td>
<td>10,280</td>
<td>Restoration of Whiskey and Trinity Islands to their minimal geomorphologic form and ecologic function along with 5 years of advanced fill combined with restoration of Timbalier Island to its minimal geomorphologic form and ecologic function along with 25 years of advanced fill.</td>
</tr>
<tr>
<td>5 Raccoon with TG (Plan E) / Whiskey (Plan C) / Trinity (Plan C) / Timbalier (Plan E)</td>
<td>Best Buy</td>
<td>2063</td>
<td>408,000,000</td>
<td>20,800,000</td>
<td>10,100</td>
<td>Restoration of Whiskey and Trinity Islands to their minimal geomorphologic form and ecologic function along with 5 years of advanced fill combined with restoration of Raccoon and Timbalier Islands to their minimal geomorphologic form and ecologic function along with 25 years of advanced fill and construction of a terminal groin on the western end of Raccoon Island.</td>
</tr>
<tr>
<td>6 Raccoon (Plan B) / Whiskey (Plan B) / Trinity (Plan B)</td>
<td>Max # of Islands Constructible with Cleared Sediment Sources</td>
<td>785</td>
<td>177,000,000</td>
<td>9,040,000</td>
<td>11,510</td>
<td>Restoration of Raccoon, Whiskey, and Trinity Islands, all to their minimal geomorphologic form and ecologic function.</td>
</tr>
<tr>
<td>7 Raccoon with BW (Plan B) / Whiskey (Plan B) / Trinity (Plan B)</td>
<td>Max # of Islands Constructible with Cleared Sediment Sources</td>
<td>808</td>
<td>182,000,000</td>
<td>9,280,000</td>
<td>11,490</td>
<td>Restoration of Raccoon, Whiskey, and Trinity Islands, all to their minimal geomorphologic form and ecologic function, along with construction of eight (8) additional breakwaters on the western end of Raccoon Island.</td>
</tr>
<tr>
<td>8 Raccoon with TG (Plan B) / Whiskey (Plan B) / Trinity (Plan B)</td>
<td>Max # of Islands Constructible with Cleared Sediment Sources</td>
<td>801</td>
<td>180,000,000</td>
<td>9,190,000</td>
<td>11,470</td>
<td>Restoration of Raccoon, Whiskey, and Trinity Islands, all to their minimal geomorphologic form and ecologic function, along with construction of a terminal groin on the western end of Raccoon Island.</td>
</tr>
<tr>
<td>Alternative</td>
<td>Category</td>
<td>Net AAHU</td>
<td>Preliminary Cost* ($)</td>
<td>Annualized Cost** ($)</td>
<td>Annualized Cost per AAHU ($)</td>
<td>Description</td>
</tr>
<tr>
<td>-----------------------------------------------------------------------------</td>
<td>--------------------------------------------------------------------------</td>
<td>----------</td>
<td>-----------------------</td>
<td>--------------------------</td>
<td>-----------------------------</td>
<td>----------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Raccoon (Plan B) / Whiskey (Plan B) / Timbalier (Plan B)</td>
<td>Max # of Islands Constructible with Cleared Sediment Sources</td>
<td>890</td>
<td>199,000,000</td>
<td>10,200,000</td>
<td>11,420</td>
<td>Restoration of Raccoon, Whiskey, and Timbalier Islands, all to their minimal geomorphologic form and ecologic function.</td>
</tr>
<tr>
<td>Raccoon (Plan B) / Trinity (Plan B) / East (Plan B) / Whisky (Plan B) / Timbalier (Plan B) / East Timbalier (Plan B) / Wine w/ Monkey (Plan B)</td>
<td>System-wide Barrier Island Restoration</td>
<td>1842</td>
<td>439,000,000</td>
<td>22,400,000</td>
<td>12,170</td>
<td>Restoration of Raccoon, Whiskey, Trinity, East, Wine, Timbalier, and East Timbalier Islands, all to their minimal geomorphologic form and ecologic function.</td>
</tr>
<tr>
<td>Whiskey (Plan C)</td>
<td>Partial NER Plan</td>
<td>379</td>
<td>79,600,000</td>
<td>4,070,000</td>
<td>10,740</td>
<td>Restoration of Whiskey Island to its minimal geomorphologic form and ecologic function along with 5 years of advanced fill.</td>
</tr>
<tr>
<td>Trinity (Plan C)</td>
<td>Partial NER Plan</td>
<td>387</td>
<td>81,500,000</td>
<td>4,160,000</td>
<td>10,750</td>
<td>Restoration of Trinity Island to its minimal geomorphologic form and ecologic function along with 5 years of advanced fill.</td>
</tr>
</tbody>
</table>

BW: Breakwaters  
TG: Terminal Groin  
* Refined cost accounts for potential reductions due to shared mobilization/demobilization as well as other fixed costs as described in Section L9.1.4  
** Preliminary costs were annualized at a discount rate of 4.375%, with a base year of 2012. The price level is 2009
K5.2 RENOURISHMENT CYCLE

The first component of construction consists of restoration of Whiskey Island to its minimal geomorphologic form and ecologic function along with 5 years of advanced fill. The PDT re-evaluated the feasibility of renourishment on Whiskey Island Plan C. This evaluation was conducted concurrently with that of the NER Plan (Section 4.2). Based on an iterative optimization process, the PDT determined that Whiskey Plan C would require two renourishment intervals. The first would occur at TY20 and would include the addition of the same amount of dune and supratidal beach habitat that was originally created in TY1 (i.e. add a Plan C to the template at TY20). The second renourishment interval would occur at TY40 and would include the addition of the same amount of dune and supratidal beach habitat needed to construct a Plan B template. No additional marsh material will be added.

K5.3 DESCRIPTION OF FIRST COMPONENT OF CONSTRUCTION WITH RENOURISHMENT

The iterative analyses resulted in recommending Alternative 11 with renourishment as the first component of construction. The plan consists of restoration of Whiskey Island to its minimal geomorphologic form and ecologic function along with 5 years of advanced fill (Plan C) and two renourishment events, one at TY20 to add Plan C and the other one at TY40 to add Plan B. The plan was designed to create 678 net AAHUs.
The design parameters for the first component of construction for the beach/dune fill and marsh fill are presented in Table K5-2. The borrow areas identified for the first component of construction and the required approximate beach/dune and marsh cut volumes are presented in Table K5-3. Further, the borrow area and island restoration plans are presented in Annexes L-1 and L-2, respectively.

### Table K5-2. First Component of Construction Beach / Dune Fill and Marsh Fill Design Parameters

<table>
<thead>
<tr>
<th>Fill</th>
<th>Volume (cy)</th>
<th>Length (ft)</th>
<th>Density (cy/lf)</th>
<th>Dune Acres</th>
<th>Supratidal Acres</th>
<th>Intertidal Acres</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial Beach/Dune</td>
<td>8,330,000</td>
<td>19,800</td>
<td>422</td>
<td>65(^1)</td>
<td>830(^1)</td>
<td>N/A</td>
</tr>
<tr>
<td>Initial Marsh</td>
<td>580,000</td>
<td>4,600</td>
<td>127</td>
<td>N/A</td>
<td>N/A</td>
<td>377(^1)</td>
</tr>
<tr>
<td>Renourishment TY20</td>
<td>8,330,000</td>
<td>19,800</td>
<td>422</td>
<td>65(^2)</td>
<td>496(^2)</td>
<td>834(^2)</td>
</tr>
<tr>
<td>Renourishment TY40</td>
<td>6,330,000</td>
<td>19,600</td>
<td>323</td>
<td>57(^3)</td>
<td>387(^3)</td>
<td>461(^3)</td>
</tr>
</tbody>
</table>

\(^1\) at TY1  
\(^2\) at TY21  
\(^3\) at TY41  
N/A denotes Not Applicable

### Table K5-3. First Component of Construction Borrow Areas and Cut Volumes

<table>
<thead>
<tr>
<th>Borrow Area</th>
<th>Beach/Dune Cut Volume (cy)</th>
<th>Marsh Cut Volume (cy)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial Ship Shoal Borrow Area 7</td>
<td>9,410,000</td>
<td>—</td>
</tr>
<tr>
<td>Initial Whiskey Island Restoration</td>
<td>—</td>
<td>928,000</td>
</tr>
<tr>
<td>Renourishment Ship Shoal Borrow Area 7</td>
<td>16,600,000</td>
<td>—</td>
</tr>
<tr>
<td>Renourishment Whiskey Island Restoration</td>
<td>—</td>
<td>—</td>
</tr>
</tbody>
</table>

Based on the detailed cost estimate prepared and a contingency value determined using Crystal Ball, a fully funded cost estimate of $119,000,000 was developed for the initial restoration of the first component of construction. Utilizing the MII cost developed for the renourishment events and a contingency of 35% based on professional judgment the renourishment events at TY20 and TY40 were estimated to cost $158,000,000 and $184,000,000, respectively. The opinion of probable fully funded cost for the first component of construction is approximately $461,000,000. Refer to Appendix L for the detailed cost estimate.