APPENDIX K

BENEFIT COST - INCREMENTAL COST ANALYSIS

TERREBONNE BASIN BARRIER SHORELINE RESTORATION
FINAL FEASIBILITY REPORT

APPENDIX K - BENEFIT COST - INCREMENTAL COST ANALYSIS

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

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):

TY1	TY5	TY10	TY20	TY30	TY40	TY50
235	253	266	255	260	248	23

$$\text{Weighted Average Calculation} = \left[\frac{(TY1 + TY5)}{2}\right]\left(\frac{\#\text{ of years}}{\text{between TY/49}}\right) + \left[\frac{(TY5 + TY10)}{2}\right]\left(\frac{\#\ of\ years}{\text{between TY/49}}\right) + \left[\frac{(TY10 + TY20)}{2}\right]\left(\frac{\#\ of\ years}{\text{between TY/49}}\right)$$
$$+ \left[\frac{(TY20 + TY30)}{2}\right]\left(\frac{\#\ of\ years}{\text{between TY/49}}\right) + \left[\frac{(TY30 + TY40)}{2}\right]\left(\frac{\#\ of\ years}{\text{between TY/49}}\right) + \left[\frac{(TY40 + TY50)}{2}\right]\left(\frac{\#\ of\ years}{\text{between TY/49}}\right) = \left[\frac{(235 + 253)}{2}\right]\left(\frac{4}{49}\right)$$
$$+ \left[\frac{(253 + 266)}{2}\right]\left(\frac{5}{49}\right) + \left[\frac{(266 + 255)}{2}\right]\left(\frac{10}{49}\right) + \left[\frac{(255 + 260)}{2}\right]\left(\frac{10}{49}\right) + \left[\frac{(260 + 248)}{2}\right]\left(\frac{10}{49}\right) + \left[\frac{(248 + 23)}{2}\right]\left(\frac{10}{49}\right) = 231\ \text{Acres}$$

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

Plan	Habitat Type	Target Year (TY)								
		TY0	TY1	TY5	TY10	TY20	TY30	TY40	TY50	Weighted Average
A	Dune	0	0	0	0	0	0	0	0	0
	Supratidal	51	51	30	10	3	0	0	0	7
	Intertidal	188	184	161	137	76	55	0	0	70
B	Dune	0	45	33	15	1	0	0	0	7
	Supratidal	51	226	194	162	150	83	25	0	105
	Intertidal	188	235	253	266	255	260	248	23	231
C	Dune	0	50	38	22	8	0	0	0	11
	Supratidal	51	291	215	192	174	110	62	4	132
	Intertidal	188	237	300	301	295	306	277	223	285
D	Dune	0	60	45	25	14	0	0	0	13
	Supratidal	51	460	445	231	210	120	67	29	179
	Intertidal	188	122	146	339	335	341	307	263	298
E	Dune	0	63	50	29	20	0	0	0	16
	Supratidal	51	688	675	657	630	144	72	51	368
	Intertidal	188	39	39	40	39	478	457	425	253

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

Plan	Habitat Type	Target Year (TY)								
		TY0	TY1	TY5	TY10	TY20	TY30	TY40	TY50	Weighted Average
A	Dune	0	0	0	0	0	0	0	0	0
	Supratidal	51	51	30	10	3	0	0	0	7
	Intertidal	188	184	161	137	76	55	0	0	70
B	Dune	0	45	33	15	6	0	0	0	8
	Supratidal	51	226	198	163	173	112	62	0	123
	Intertidal	188	237	254	267	254	264	259	38	236
C	Dune	0	50	38	22	8	0	0	0	11
	Supratidal	51	292	219	193	200	142	92	14	152
	Intertidal	188	239	302	303	297	307	300	262	295
D	Dune	0	60	45	25	14	0	0	0	13
	Supratidal	51	461	449	232	220	158	96	34	196
	Intertidal	188	122	148	340	352	336	339	307	312
E	Dune	0	63	50	28	20	0	0	0	15
	Supratidal	51	689	679	658	656	188	109	68	393
	Intertidal	188	39	40	40	40	467	489	472	263

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

Plan	Habitat Type	Target Year (TY)								
		TY0	TY1	TY5	TY10	TY20	TY30	TY40	TY50	Weighted Average
A	Dune	0	0	0	0	0	0	0	0	0
	Supratidal	51	51	30	10	3	0	0	0	7
	Intertidal	188	184	161	137	76	55	0	0	70
B	Dune	0	45	33	15	3	0	0	0	8
	Supratidal	51	226	198	165	170	107	36	0	117
	Intertidal	188	237	254	267	254	264	279	34	240
C	Dune	0	50	38	22	8	0	0	0	11
	Supratidal	51	291	218	194	194	137	86	12	148
	Intertidal	188	238	302	302	296	307	300	258	294
D	Dune	0	60	45	25	14	0	0	0	13
	Supratidal	51	460	448	232	218	156	93	34	194
	Intertidal	188	122	147	341	348	332	329	303	308
E	Dune	0	63	50	29	20	0	0	0	16
	Supratidal	51	688	678	659	650	182	106	66	389
	Intertidal	188	38	39	40	39	466	486	468	261

Table K1-4. Summary of Habitat Acres for Whiskey Island Restoration Plans

Plan	Habitat Type	Target Year (TY)								
		TY0	TY1	TY5	TY10	TY20	TY30	TY40	TY50	Weighted Average
A	Dune	0	0	0	0	0	0	0	0	0
	Supratidal	377	367	40	4	0	0	0	0	19
	Intertidal	443	436	692	616	468	375	0	0	271
B	Dune	0	57	53	0	0	0	0	0	7
	Supratidal	377	614	220	164	0	0	0	0	70
	Intertidal	443	509	830	801	786	594	410	276	613
C	Dune	0	65	61	57	0	0	0	0	17
	Supratidal	377	830	328	223	84	0	0	0	115
	Intertidal	443	377	808	828	847	717	472	363	669
D	Dune	0	69	65	61	0	0	0	0	18
	Supratidal	377	917	533	288	167	1	0	0	165
	Intertidal	443	376	690	850	854	785	521	355	686
E	Dune	0	80	76	71	0	0	0	0	21
	Supratidal	377	1323	1127	1039	938	259	75	0	576
	Intertidal	443	250	376	379	375	875	782	475	566

Table K1-5. Summary of Habitat Acres for Trinity Island Restoration Plans

Plan	Habitat Type	Target Year (TY)								
		TY0	TY1	TY5	TY10	TY20	TY30	TY40	TY50	Weighted Average
A	Dune	39	32	4	3	0	0	0	0	2
	Supratidal	232	206	137	52	3	1	0	0	30
	Intertidal	311	326	327	245	72	19	0	0	99
B	Dune	39	126	92	23	0	0	0	0	17
	Supratidal	232	338	237	208	43	0	0	0	76
	Intertidal	311	569	626	629	627	460	279	33	459
C	Dune	39	129	122	67	0	0	0	0	27
	Supratidal	232	456	316	270	190	4	0	0	129
	Intertidal	311	564	632	635	594	561	380	199	512
D	Dune	39	126	116	102	0	0	0	0	31
	Supratidal	232	1072	1004	351	324	124	0	0	281
	Intertidal	311	72	73	642	578	577	501	298	476
E	Dune	39	123	115	107	0	0	0	0	32
	Supratidal	232	1399	1329	1237	1157	422	217	32	738
	Intertidal	311	67	66	67	69	608	618	593	344

Table K1-6. Summary of Habitat Acres for East Island Restoration Plans

Plan	Habitat Type	Target Year (TY)								
		TY0	TY1	TY5	TY10	TY20	TY30	TY40	TY50	Weighted Average
A	Dune	35	23	5	4	0	0	0	0	2
	Supratidal	178	176	86	46	6	0	0	0	23
	Intertidal	71	59	110	101	58	16	0	0	43
B	Dune	35	88	59	18	0	0	0	0	12
	Supratidal	178	229	165	140	33	0	0	0	53
	Intertidal	71	362	404	405	401	290	171	46	294
C	Dune	35	89	81	50	0	0	0	0	19
	Supratidal	178	296	213	175	122	2	0	0	84
	Intertidal	71	372	410	412	388	360	242	122	330
D	Dune	35	84	74	67	0	0	0	0	20
	Supratidal	178	718	674	231	208	73	0	0	184
	Intertidal	71	33	34	418	377	382	314	192	307
E	Dune	35	77	75	69	0	0	0	0	20
	Supratidal	178	950	898	837	770	273	139	17	492
	Intertidal	71	33	33	34	39	402	402	379	220

Table K1-7. Summary of Habitat Acres for Wine Island Restoration Plans

Plan	Habitat Type	Target Year (TY)								
		TY0	TY1	TY5	TY10	TY20	TY30	TY40	TY50	Weighted Average
A	Dune	1	0	0	0	0	0	0	0	0
	Supratidal	5	5	2	2	0	0	0	0	1
	Intertidal	6	7	6	5	3	1	0	0	3
B	Dune	1	12	11	10	0	0	0	0	3
	Supratidal	5	97	75	61	47	13	0	0	32
	Intertidal	6	97	109	109	106	111	96	5	95
C	Dune	1	13	12	11	0	0	0	0	3
	Supratidal	5	109	90	76	64	29	2	0	44
	Intertidal	6	117	125	126	122	129	128	9	114
D	Dune	1	12	11	10	9	0	0	0	5
	Supratidal	5	118	98	85	62	38	10	0	49
	Intertidal	6	140	149	150	146	150	151	7	134
E	Dune	1	11	10	9	8	0	0	0	4
	Supratidal	5	338	328	314	288	76	47	0	176
	Intertidal	6	17	17	17	17	210	210	229	117
Ring	Dune	1	15	12	4	0	0	0	0	2
	Supratidal	5	11	8	6	3	1	0	0	3
	Intertidal	6	3	4	4	3	3	2	1	3

Table K1-8. Summary of Habitat Acres for Timbalier Island Restoration Plans

Plan	Habitat Type	Target Year (TY)								
		TY0	TY1	TY5	TY10	TY20	TY30	TY40	TY50	Weighted Average
A	Dune	57	53	31	8	0	0	0	0	6
	Supratidal	549	529	266	286	93	18	1	0	113
	Intertidal	374	373	541	392	289	149	37	2	222
B	Dune	57	155	130	13	0	0	0	0	20
	Supratidal	549	748	566	524	236	38	1	0	219
	Intertidal	374	726	811	822	829	695	450	175	651
C	Dune	57	193	160	130	0	0	0	0	42
	Supratidal	549	1550	630	496	438	134	3	0	314
	Intertidal	374	85	916	933	826	833	644	373	738
D	Dune	57	191	161	136	0	0	0	0	43
	Supratidal	549	1761	1668	600	499	187	4	0	457
	Intertidal	374	83	88	1041	978	994	843	571	804
E	Dune	57	215	183	160	0	0	0	0	50
	Supratidal	549	2346	2257	2130	1996	629	330	53	1238
	Intertidal	374	69	71	74	76	1148	1123	1088	611

Table K1-9. Summary of Habitat Acres for East Timbalier Island Restoration Plans

Plan	Habitat Type	Target Year (TY)								
		TY0	TY1	TY5	TY10	TY20	TY30	TY40	TY50	Weighted Average
A	Dune	7	1	1	0	0	0	0	0	0
	Supratidal	129	74	60	46	9	2	1	0	18
	Intertidal	173	133	140	111	98	49	17	4	69
B	Dune	7	63	58	54	0	0	0	0	16
	Supratidal	129	314	240	199	175	70	7	0	117
	Intertidal	173	452	476	474	456	459	405	7	405
C	Dune	7	86	67	62	0	0	0	0	19
	Supratidal	129	972	327	238	158	52	7	0	150
	Intertidal	173	71	702	714	664	587	552	496	595
D	Dune	7	93	71	66	0	0	0	0	20
	Supratidal	129	1077	1062	351	359	256	157	56	358
	Intertidal	173	60	72	734	673	682	676	670	604
E	Dune	7	120	83	78	0	0	0	0	24
	Supratidal	129	1641	1617	1587	1556	444	192	244	931
	Intertidal	173	99	91	86	71	1086	1227	1066	621

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

Plan	Habitat Acres				
	Dune & Supratidal Subtotal	Intertidal	Intertidal Adjusted*	Grand Total Adjusted	**IWR Program Input**
A	7	70	85	92	**0**
B	112	231	281	393	**301**
C	143	285	347	489	**397**
D	192	298	362	554	**462**
E	384	253	308	692	**599**

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

Table K1-11. IWR Acres for Raccoon Island Restoration Plans with Breakwaters

Plan	Habitat Acres				
	Dune & Supratidal Subtotal	Intertidal	Intertidal Adjusted*	Grand Total Adjusted	**IWR Program Input**
A	7	70	85	92	**0**
B	131	236	287	418	**326**
C	162	295	358	520	**428**
D	209	312	378	587	**495**
E	408	263	319	727	**635**

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

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

Plan	Habitat Acres				
	Dune & Supratidal Subtotal	Intertidal	Intertidal Adjusted*	Grand Total Adjusted	**IWR Program Input**
A	7	70	85	92	**0**
B	124	240	291	416	**324**
C	159	294	357	516	**424**
D	207	308	374	581	**489**
E	405	261	317	722	**630**

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

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

Plan	Habitat Acres				
	Dune & Supratidal Subtotal	Intertidal	Intertidal Adjusted*	Grand Total Adjusted	**IWR Program Input**
A	19	271	329	348	**0**
B	77	613	744	822	**474**
C	132	669	812	944	**596**
D	183	686	833	1015	**667**
E	597	566	687	1284	**936**

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

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

Plan	Habitat Acres				
	Dune & Supratidal Subtotal	Intertidal	Intertidal Adjusted*	Grand Total Adjusted	**IWR Program Input**
A	32	99	121	153	**0**
B	93	459	558	651	**498**
C	155	512	622	777	**625**
D	313	476	578	891	**738**
E	770	344	417	1187	**1035**

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

Table K1-15. IWR Acres for East Island Restoration Plans

Plan	Habitat Acres				
	Dune & Supratidal Subtotal	Intertidal	Intertidal Adjusted*	Grand Total Adjusted	**IWR Program Input**
A	25	43	52	78	**0**
B	64	294	357	422	**344**
C	102	330	401	503	**426**
D	205	307	373	577	**500**
E	513	220	267	780	**703**

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

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

Plan	Habitat Acres				
	Dune & Supratidal Subtotal	Intertidal	Intertidal Adjusted*	Grand Total Adjusted	**IWR Program Input**
A	1	3	4	4	**0**
B	35	95	116	151	**147**
C	47	114	138	185	**181**
D	54	134	163	217	**213**
E	180	117	142	323	**319**
Ring	5	3	3	9	**5**

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

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

Plan	Habitat Acres				
	Dune & Supratidal Subtotal	Intertidal	Intertidal Adjusted*	Grand Total Adjusted	**IWR Program Input**
A	119	222	269	388	**0**
B	239	651	790	1029	**641**
C	357	738	897	1253	**865**
D	501	804	976	1477	**1088**
E	1288	611	741	2029	**1641**

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

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

Plan	Habitat Acres				
	Dune & Supratidal Subtotal	Intertidal	Intertidal Adjusted*	Grand Total Adjusted	**IWR Program Input**
A	18	69	84	102	**0**
B	133	405	492	624	**523**
C	169	595	723	892	**791**
D	379	604	734	1112	**1011**
E	955	621	754	1709	**1607**

*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 K1-19. IWR Input

Island (# of Scales)	Scale #	Description	Cost, ($1,000)	Net Acres
Raccoon (13)	0	Plan A	0	0
	1	Plan B	54,400	301
	2	Plan C	58,300	397
	3	Plan D	64,100	462
	4	Plan E	81,100	599
	5	Plan B with BW	58,100	326
	6	Plan C with BW	62,000	428
	7	Plan D with BW	67,800	495
	8	Plan E with BW	84,800	635
	9	Plan B with TG	56,600	324
	10	Plan C with TG	60,600	424
	11	Plan D with TG	66,400	489
	12	Plan E with TG	83,400	630
Whiskey (5)	0	Plan A	0	0
	1	Plan B	63,500	474
	2	Plan C	73,900	596
	3	Plan D	84,500	667
	4	Plan E	124,000	936
Trinity (5)	0	Plan A	0	0
	1	Plan B	67,100	498
	2	Plan C	77,600	625
	3	Plan D	93,400	738

Island (# of Scales)	Scale #	Description	Cost, ($1,000)	Net Acres
	4	Plan E	136,700	1035
East (5)	0	Plan A	0	0
	1	Plan B	56,500	344
	2	Plan C	62,400	426
	3	Plan D	72,600	500
	4	Plan E	102,300	703
Wine (6)	0	Plan A	0	0
	1	Plan B	42,500	147
	2	Plan C	43,900	181
	3	Plan D	45,800	213
	4	Plan E	51,500	318
	5	Ring*	16,400	5
Timbalier (5)	0	Plan A	0	0
	1	Plan B	83,400	641
	2	Plan C	97,400	865
	3	Plan D	113,000	1088
	4	Plan E	168,000	1641
East Timbalier (5)	0	Plan A	0	0
	1	Plan B	144,000	523
	2	Plan C	180,000	791
	3	Plan D	229,000	1011
	4	Plan E	375,000	1607

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.

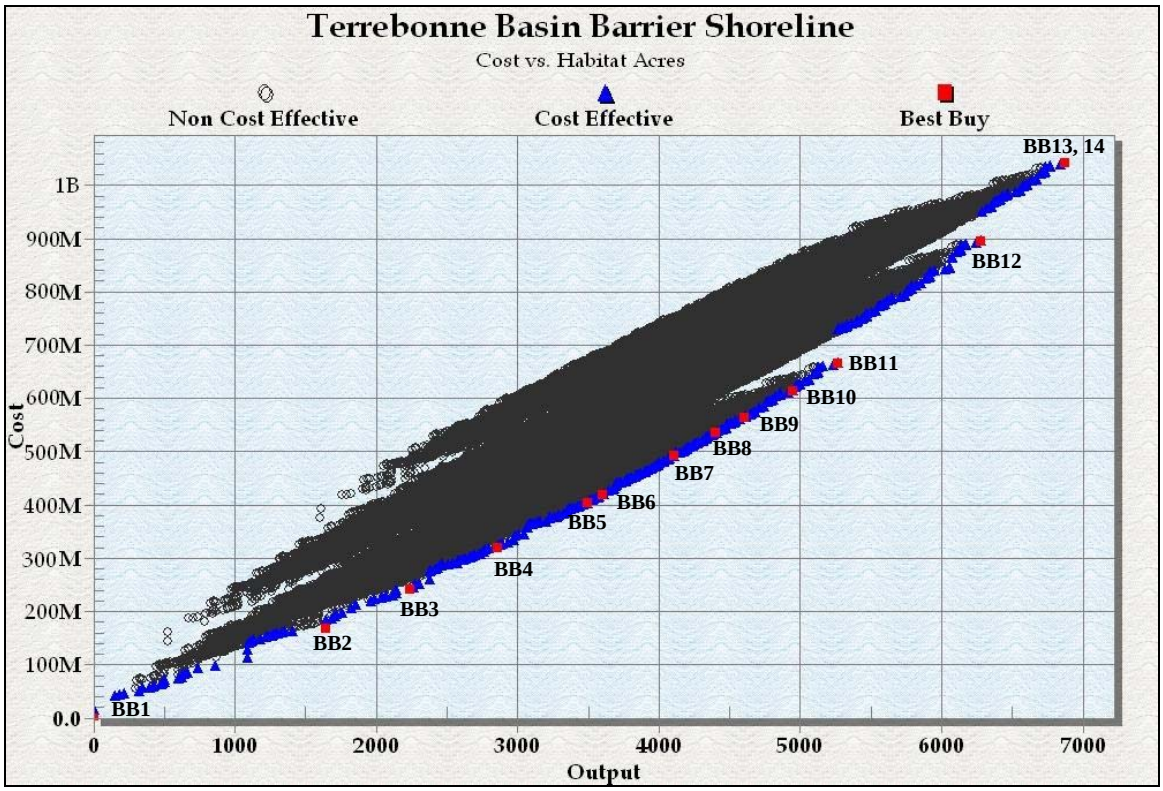

Figure K1-1. Results of IWR Iteration 1

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 K2-1. Summary of Intermediate Array of Restoration Plans

Alternative		Category	Net AAHU	Preliminary Cost* ($)	Annualized Cost** ($)	Annualized Cost per AAHU ($/ AAHU)	Description
1	No Action (Plan A)	No Action	0	0	0	0	This alternative does not include any restoration.
2	Timbalier (Plan E)	Best Buy	871	170,000,000	8,710,000	10,000	Restoration of Timbalier Island to its minimal geomorphologic form and ecologic function along with 25 years of advanced fill.
3	Whiskey (Plan C) / Timbalier (Plan E)	Best Buy	1,250	247,000,000	12,640,000	10,120	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.
4	Whiskey (Plan C) / Trinity (Plan C) / Timbalier (Plan E)	Best Buy	1,637	329,000,000	16,820,000	10,280	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.
5	Raccoon with TG (Plan E) / Whiskey (Plan C) / Trinity (Plan C) / Timbalier (Plan E)	Best Buy	2,063	408,000,000	20,830,000	10,100	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.
6	Raccoon (Plan B) / Whiskey (Plan B) / Trinity (Plan B)	Max # of Islands Constructible with Cleared Sediment Sources	785	177,000,000	9,040,000	11,510	Restoration of Raccoon, Whiskey, and Trinity Islands, all to their minimal geomorphologic form and ecologic function.
7	Raccoon with BW (Plan B) / Whiskey (Plan B) / Trinity (Plan B)	Max # of Islands Constructible with Cleared Sediment Sources	808	182,000,000	9,280,000	11,490	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.
8	Raccoon with TG (Plan B) / Whiskey (Plan B) / Trinity (Plan B)	Max # of Islands Constructible with Cleared Sediment	801	180,000,000	9,190,000	11,470	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.

Alternative		Category	Net AAHU	Preliminary Cost* ($)	Annualized Cost** ($)	Annualized Cost per AAHU ($/ AAHU)	Description
		Sources					
9	Raccoon (Plan B) / Whiskey (Plan B) / Timbalier (Plan B)	Max # of Islands Constructible with Cleared Sediment Sources	890	199,000,000	10,160,000	11,420	Restoration of Raccoon, Whiskey, and Timbalier Islands, all to their minimal geomorphologic form and ecologic function.
10	Raccoon (Plan B) / Trinity (Plan B) / East (Plan B) / Whisky (Plan B) / Timbalier (Plan B) / East Timbalier (Plan B) / Wine w/ Monkey (Plan B)	System-wide Barrier Island Restoration	1,842	439,000,000	22,420,000	12,170	Restoration of Raccoon, Whiskey, Trinity, East, Wine, Timbalier, and East Timbalier Islands, all to their minimal geomorphologic form and ecologic function.

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.

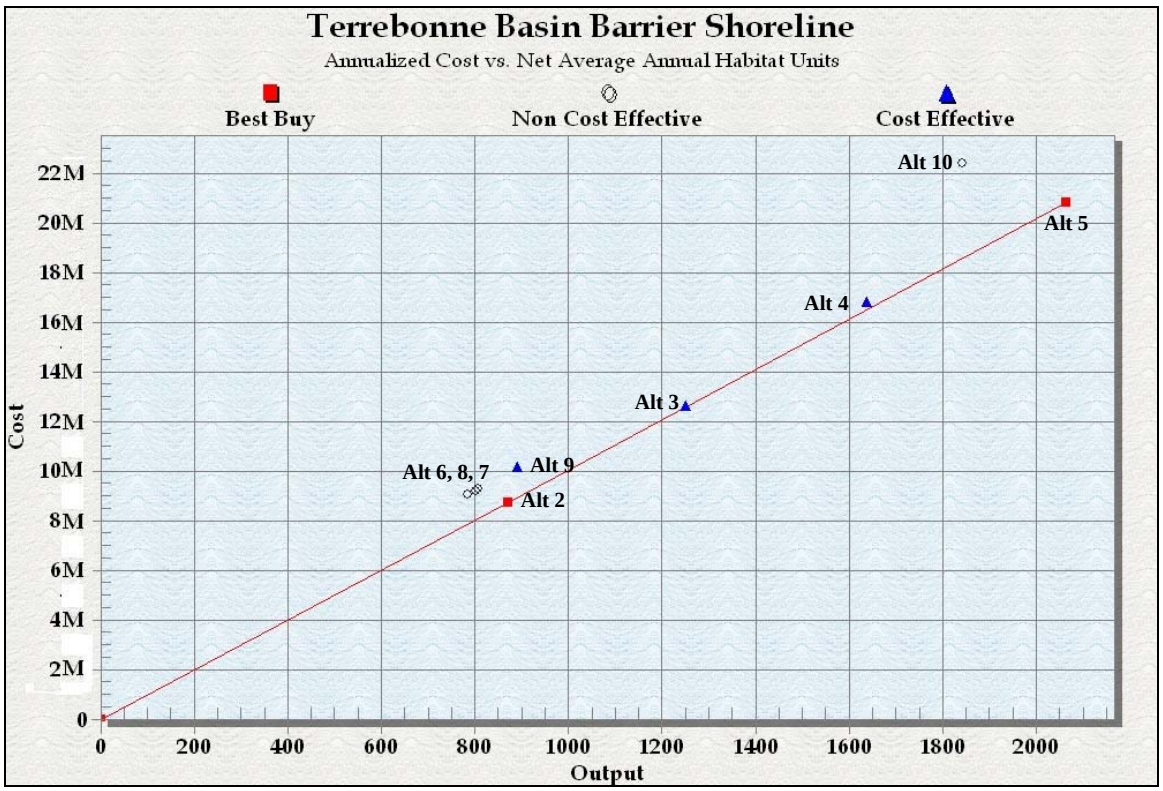

Figure K3-1. Results of IWR Iteration 2 Using the Intermediate Array of Alternatives

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 K3-1. Cost Effective Alternatives

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

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 K3-2. Incremental Cost Analysis

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

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.

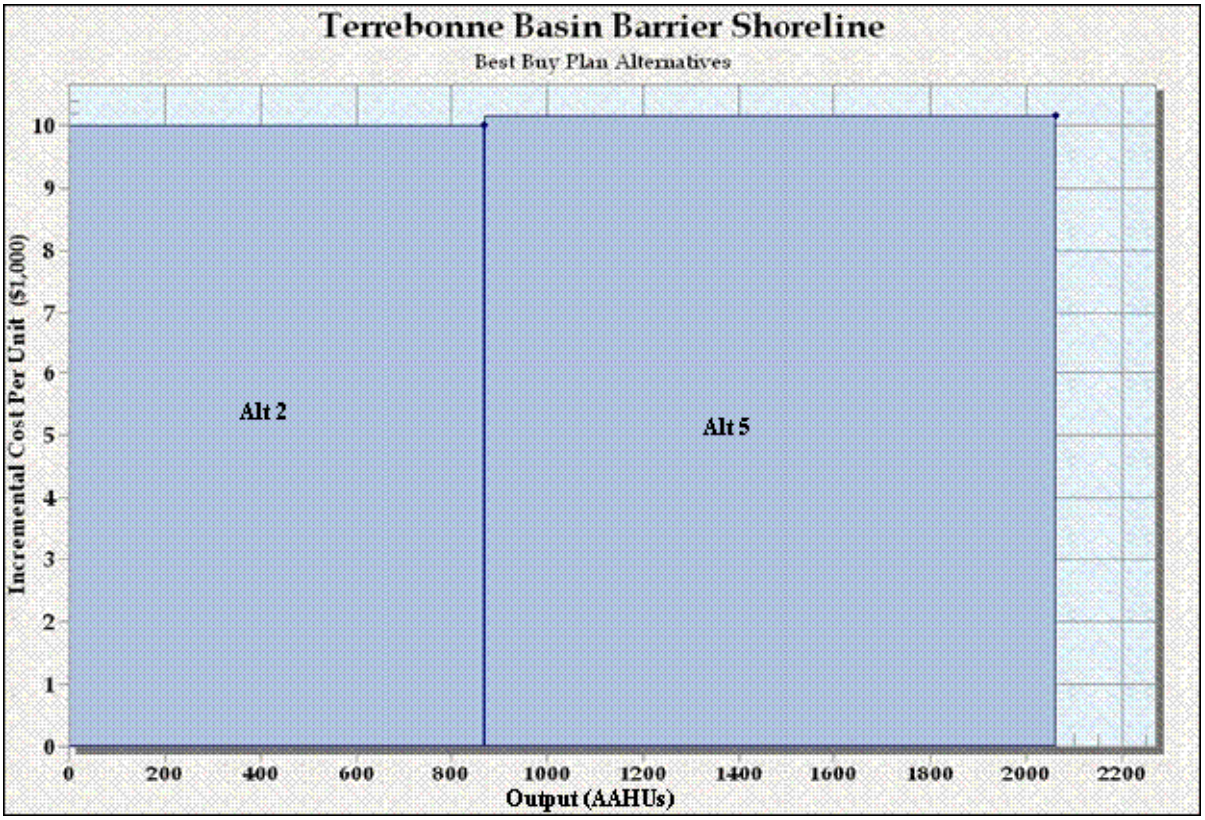

Figure K3-2. Incremental Cost and Output for the Best Buy Plans.

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

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

Table K4-2. NER Plan Marsh Fill Design Parameters

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

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

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

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

presented in the Integrated Feasibility Study and Final Environmental Impact Statement Report, Section 3.

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 K4-4. Whiskey Island Plan C: Island Acres and Beach Dimensions Summary

Target Year	TY0	TY1	TY5	TY10	TY15	TY20	TY25	TY30	TY40	TY50
Dune Acres	0	65	61	57	2	0	0	0	0	0
Supratidal Acres	377	830	328	223	162	84	4	0	0	0
Intertidal Acres	443	377	808	828	855	847	837	717	472	363
Beach Length, ft	11200	19800	19800	19800	19800	16500	3100	0	0	0
Beach Width, ft	1466[1]	1826	722	491	356	222	56	0	0	0

[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

Target Year	TY0	TY1	TY5	TY10	TY20	TY21	TY30	TY40	TY41	TY50
Dune Acres	0	65	61	57	0	65	57	0	65	57
Supratidal Acres	377	830	328	223	84	496[1]	223	84	496[1]	223
Intertidal Acres	443	377	808	828	847	834	717	472	461	363
Beach Length, ft	11200	19800	19800	19800	16500	19800	19800	16500	19800	19800
Beach Width, ft	1466[2]	1826	722	491	222	1091	491	222	1091	491

[1] Plan C Supratidal Beach = 412 Acres (these supratidal acres are part of renourishment), Plan C Supratidal Marsh = 418 Acres (these supratidal acres are not part of renourishment).

[2] Includes CWPPRA TE-50 project.

Table K4-6. Whiskey Island RA2: Island Acres and Beach Dimensions Summary

Target Year	TY0	TY1	TY5	TY10	TY20	TY21	TY30	TY40	TY41	TY50
Dune Acres	0	65	61	57	0	65	57	0	57	0
Supratidal Acres	377	830	328	223	84	496[1]	223	84	387[2]	164
Intertidal Acres	443	377	808	828	847	834	717	472	461	363
Beach Length, ft	11200	19800	19800	19800	16500	19800	19800	16500	19600	19600
Beach Width, ft	1466[3]	1826	722	491	222	1091	491	222	860	364

[1] Plan C Supratidal Beach = 412 Acres (these supratidal acres are part of renourishment),
Plan C Supratidal Marsh = 418 Acres (these supratidal acres are not part of renourishment).
[2] Plan B Supratidal Beach = 303 Acres (these supratidal acres are part of renourishment),
Plan B Supratidal Marsh = 311 Acres (these supratidal acres are not part of renourishment).
[3] Includes CWPPRA TE-50 project.

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

Target Year	TY0	TY1	TY5	TY10	TY15	TY16	TY20	TY30	TY31	TY40	TY50
Dune Acres	0	65	61	57	2	59	53	27	84	0	0
Supratidal Acres	377	830	328	223	162	465[1]	304	82	385	164	0
Intertidal Acres	443	377	808	828	855	853	847	717	693	472	363
Beach Length, ft	11200	19800	19800	19800	19800	19600	19600	19600	19600	19600	0
Beach Width, ft	1466[2]	1826	722	491	356	1033	676	180	856	364	0

[1] Plan B Supratidal Beach = 303 Acres (these supratidal acres are part of renourishment),
Plan B Supratidal Marsh = 311 Acres (these supratidal acres are not part of renourishment).
[2] 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.

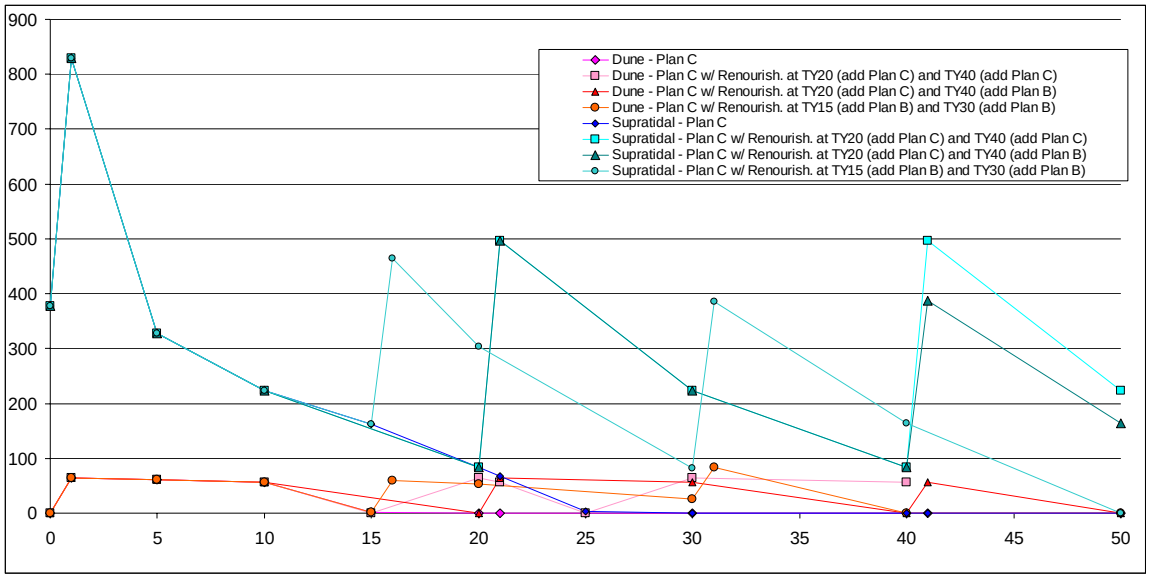

Figure K4-1. Graphical Summary of Dune and Beach Acres Associated with Initial Restoration Plan C and Three Renourishment Alternatives on Whiskey Island.

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

Target Year	TY0	TY1	TY5	TY10	TY15	TY20	TY25	TY30	TY40	TY50
Dune Acres	39	129	122	67	34	0	0	0	0	0
Supratidal Acres	232	456	316	270	230	190	90	4	0	0
Intertidal Acres	311	564	632	635	615	594	597	561	380	199
Beach Length, ft	22600	24000	24000	24000	24000	24000	22400	4100	0	0
Beach Width, ft	447	828	574	490	417	345	175	42	0	0

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

Target Year	TY0	TY1	TY5	TY10	TY15	TY20	TY25	TY26	TY30	TY40	TY50
Dune Acres	39	129	122	67	34	0	0	129	122	34	0
Supratidal Acres	232	456	316	270	230	190	90	496[1]	320	230	90
Intertidal Acres	311	564	632	635	615	594	597	590	561	380	199
Beach Length, ft	22600	24000	24000	24000	24000	24000	22400	24000	24000	24000	22400
Beach Width, ft	447	828	574	490	417	345	175	900	581	417	175

[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.

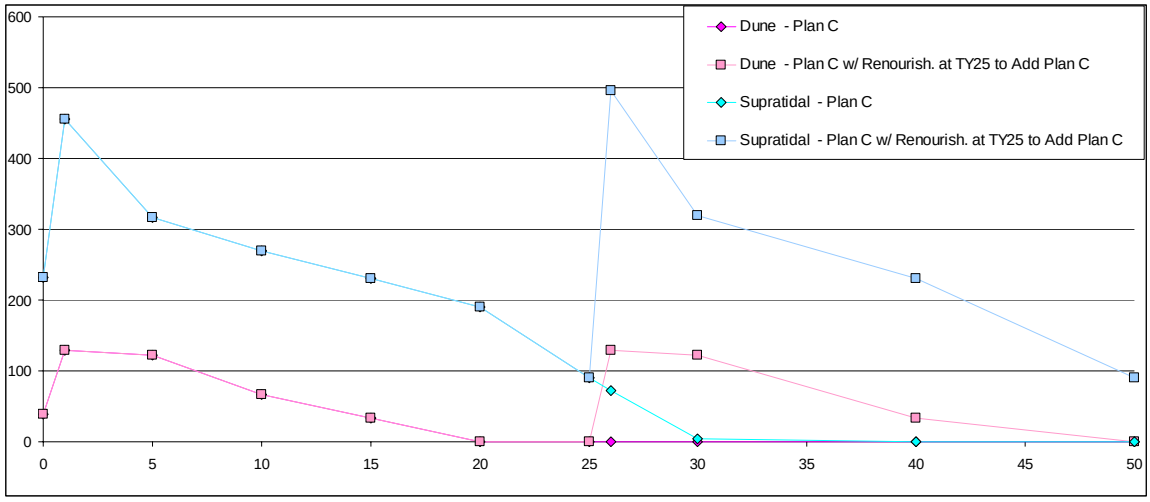

Figure K4-2. Graphical Summary of Dune and Beach Acres Associated with Initial Restoration Plan C and Recommended Renourishment Scenario on Trinity Island.

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 geomorphologic form for the remaining 20 years of analysis.

Table K4-10. Raccoon Island Plan E with Terminal Groin: Island Acres and Beach Dimensions Summary

Target Year	TY0	TY1	TY5	TY10	TY20	TY30	TY40	TY50
Dune Acres	0	63	50	29	20	0	0	0
Supratidal Acres	51	688	678	659	650	182	106	66
Intertidal Acres	188	38	39	40	39	466	486	468
Beach Length, ft	8200	15300	15300	15300	15300	15300	7000	5400
Beach Width, ft	271	1959	1930	1876	1851	518	660	532

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

Target Year	TY0	TY1	TY5	TY10	TY20	TY30	TY31	TY40	TY50
Dune Acres	0	63	50	29	20	0	45	15	3
Supratidal Acres	51	688	678	659	650	182	204[1]	165	170
Intertidal Acres	188	38	39	40	39	466	468	486	468
Beach Length, ft	8200	15300	15300	15300	15300	15300	14900	14900	14900
Beach Width, ft	271	1959	1930	1876	1851	518	596	482	497

[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

Target Year	TY0	TY1	TY5	TY10	TY20	TY30	TY31	TY40	TY50
Dune Acres	0	63	50	29	20	0	45	15	3
Supratidal Acres	51	688	678	659	650	182	386[1]	271	236
Intertidal Acres	188	38	39	40	39	466	468	486	468
Beach Length, ft	8200	15300	15300	15300	15300	15300	14900	14900	14900
Beach Width, ft	271	1959	1930	1876	1851	518	1128	792	690

[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.

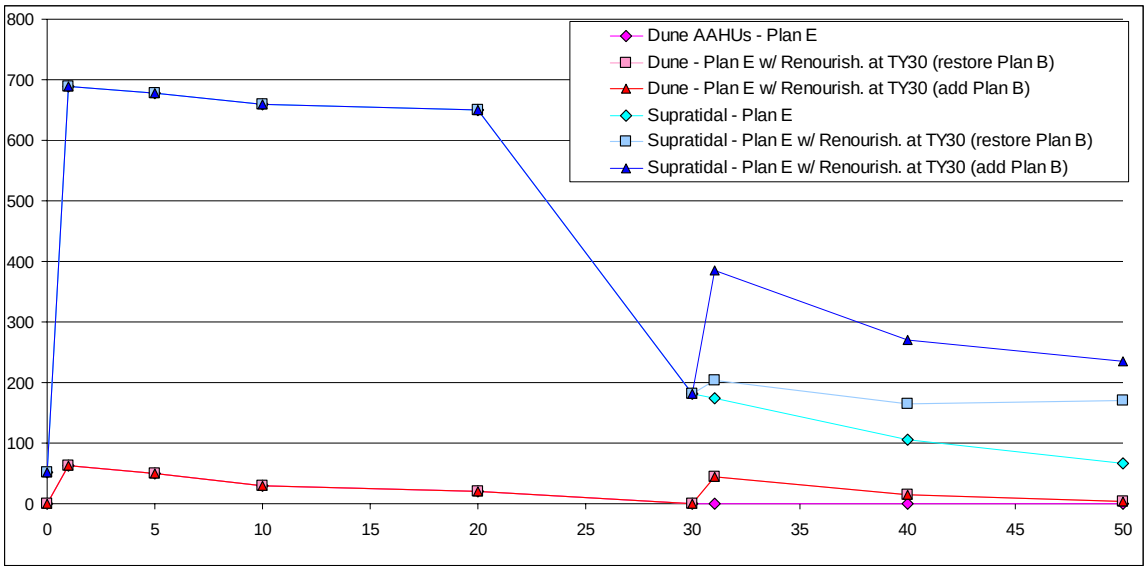

Figure K4-3. Graphical Summary of Dune and Beach Acres Associated with Initial Restoration Plan E and Two Renourishment Alternatives on Raccoon Island.

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 that 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 Summary

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

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

Target Year	TY0	TY1	TY5	TY10	TY20	TY30	TY31	TY40	TY50
Dune Acres	57	215	183	160	0	0	155	13	0
Supratidal Acres	549	2346	2257	2130	1996	629	667[1]	524	236
Intertidal Acres	374	69	71	74	76	1148	1146	1123	1088
Beach Length, ft	35600	39100	39100	39100	39100	37700	35400	39100	39100
Beach Width, ft	672	2614	2514	2373	2224	727	821	584	263

[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

Target Year	TY0	TY1	TY5	TY10	TY20	TY30	TY31	TY40	TY50
Dune Acres	57	215	183	160	0	0	155	13	0
Supratidal Acres	549	2346	2257	2130	1996	629	1296[1]	854	289
Intertidal Acres	374	69	71	74	76	1148	1146	1123	1088
Beach Length, ft	35600	39100	39100	39100	39100	37700	35400	39100	39100
Beach Width, ft	672	2614	2514	2373	2224	727	1595	951	322

[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.

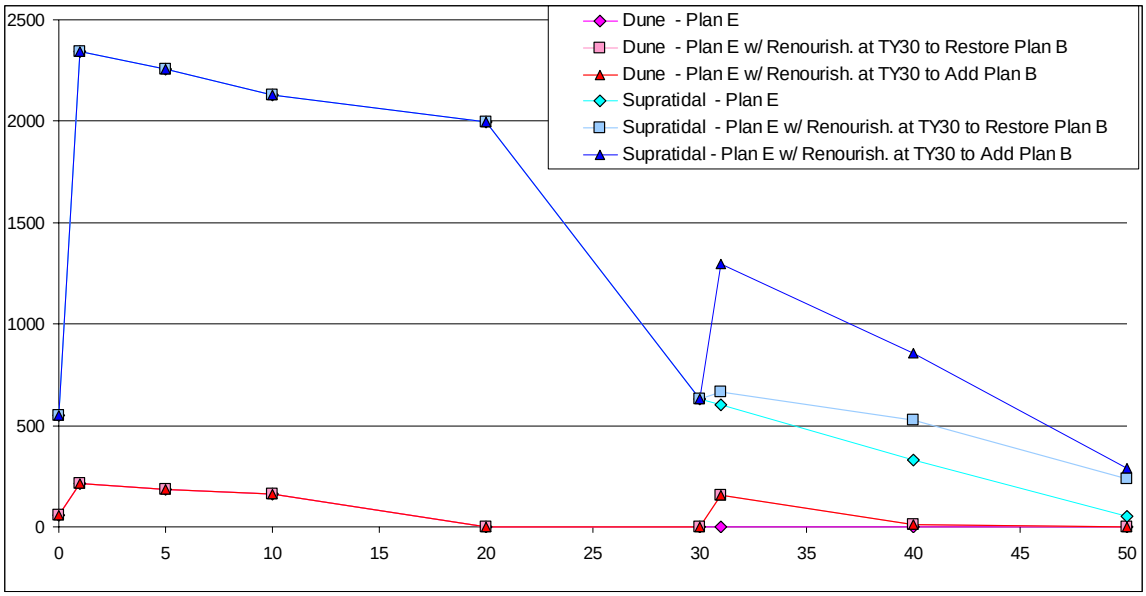

Figure K4-4. Graphical Summary of Dune and Beach Acres Associated with Initial Restoration Plan E and Two Renourishment Alternatives on Timbalier Island.

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

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

[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

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

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 K5-1. Summary of Extended Array of Restoration Plans

Alternative		Category	Net AAHU	Preliminary Cost* ($)	Annualized Cost** ($)	Annualized Cost per AAHU ($/AAHU)	Description
1	No Action (Plan A)	No Action	0	0	0	0	This alternative does not include any restoration.
2	Timbalier (Plan E)	Best Buy	871	170,000,000	8,710,000	10,000	Restoration of Timbalier Island to its minimal geomorphologic form and ecologic function along with 25 years of advanced fill.
3	Whiskey (Plan C) / Timbalier (Plan E)	Best Buy	1250	247,000,000	12,600,000	10,120	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.
4	Whiskey (Plan C) / Trinity (Plan C) / Timbalier (Plan E)	Best Buy	1637	329,000,000	16,800,000	10,280	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.
5	Raccoon with TG (Plan E) / Whiskey (Plan C) / Trinity (Plan C) / Timbalier (Plan E)	Best Buy	2063	408,000,000	20,800,000	10,100	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.
6	Raccoon (Plan B) / Whiskey (Plan B) / Trinity (Plan B)	Max # of Islands Constructible with Cleared Sediment Sources	785	177,000,000	9,040,000	11,510	Restoration of Raccoon, Whiskey, and Trinity Islands, all to their minimal geomorphologic form and ecologic function.
7	Raccoon with BW (Plan B) / Whiskey (Plan B) / Trinity (Plan B)	Max # of Islands Constructible with Cleared Sediment Sources	808	182,000,000	9,280,000	11,490	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.
8	Raccoon with TG (Plan B) / Whiskey (Plan B) / Trinity (Plan B)	Max # of Islands Constructible with Cleared Sediment Sources	801	180,000,000	9,190,000	11,470	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.

Alternative		Category	Net AAHU	Preliminary Cost* ($)	Annualized Cost** ($)	Annualized Cost per AAHU ($/AAHU)	Description
9	Raccoon (Plan B) / Whiskey (Plan B) / Timbalier (Plan B)	Max # of Islands Constructible with Cleared Sediment Sources	890	199,000,000	10,200,000	11,420	Restoration of Raccoon, Whiskey, and Timbalier Islands, all to their minimal geomorphologic form and ecologic function.
10	Raccoon (Plan B) / Trinity (Plan B) / East (Plan B) / Whisky (Plan B) / Timbalier (Plan B) / East Timbalier (Plan B) / Wine w/ Monkey (Plan B)	System-wide Barrier Island Restoration	1842	439,000,000	22,400,000	12,170	Restoration of Raccoon, Whiskey, Trinity, East, Wine, Timbalier, and East Timbalier Islands, all to their minimal geomorphologic form and ecologic function.
11	Whiskey (Plan C)	Partial NER Plan	379	79,600,000	4,070,000	10,740	Restoration of Whiskey Island to its minimal geomorphologic form and ecologic function along with 5 years of advanced fill.
12	Trinity (Plan C)	Partial NER Plan	387	81,500,000	4,160,000	10,750	Restoration of Trinity Island to its minimal geomorphologic form and ecologic function along with 5 years of advanced fill.

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

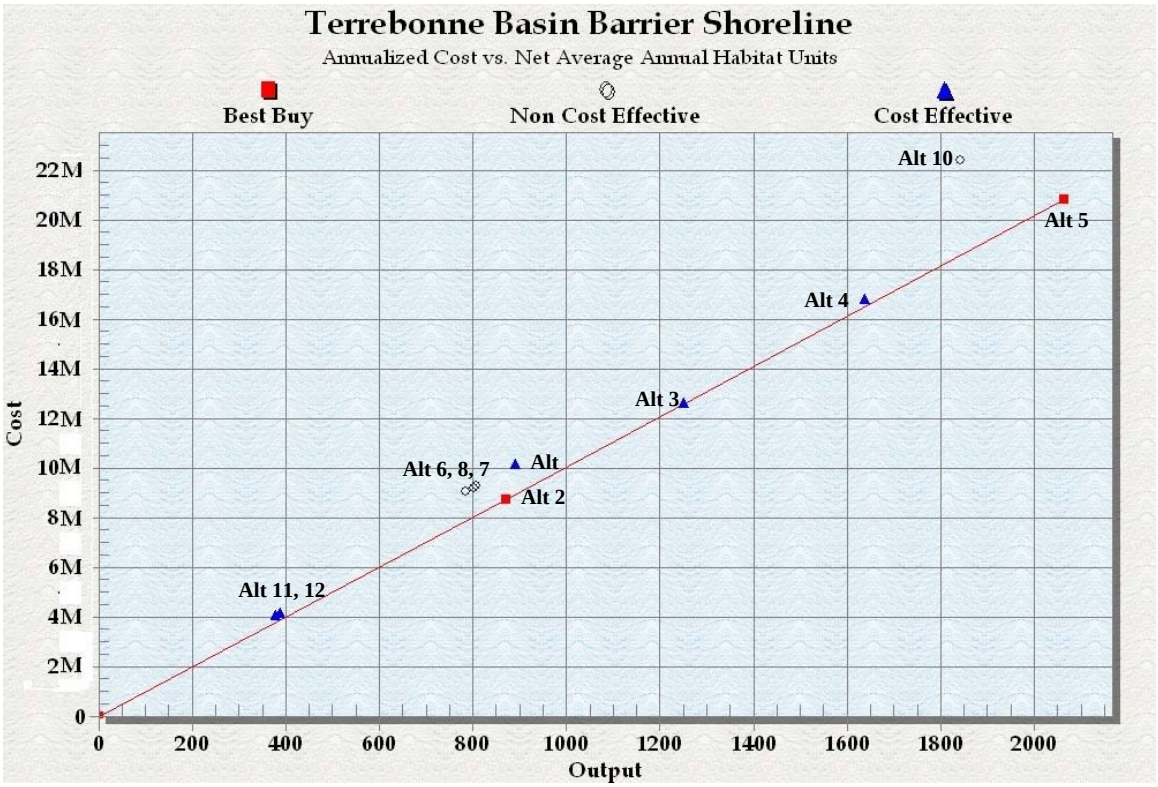

Figure K5-1. Results of IWR Analysis Using the Extended Array

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 TY 40 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

	Fill	Volume (cy)	Length (ft)	Density (cy/lf)	Dune Acres	Supratidal Acres	Intertidal Acres
Initial	Beach/Dune	8,330,000	19800	422	65[1]	830[1]	N/A
	Marsh	580,000	4,600	127	N/A	N/A	377[1]
Renour-ishment	TY20	8,330,000	19,800	422	65[2]	496[2]	834[2]
	TY40	6,330,000	19,600	323	57[3]	387[3]	461[3]

[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

	Borrow Area	Beach/Dune Cut Volume (cy)	Marsh Cut Volume (cy)
Initial	Ship Shoal Borrow Area 7	9,410,000	—
	Whiskey Island Restoration Borrow Area 3	—	928,000
Renour-ishment	Ship Shoal Borrow Area 7	16,600,000	—
	Whiskey Island Restoration Borrow Area 3	—	—

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.