

**LOUISIANA COASTAL AREA  
BARATARIA BASIN BARRIER SHORELINE RESTORATION  
FINAL CONSTRUCTION REPORT  
AND  
FINAL ENVIRONMENTAL IMPACT STATEMENT**

**ECONOMICS  
APPENDIX B**

## **Cost Effective and Incremental Cost Analyses**

### **Introduction**

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

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

To perform the CE/ICA, use was made of the IWR Planning Suite Decision Support Software developed by the US Army Corps of Engineers Institute for Water Resources (IWR). IWR Planning Suite has been developed to assist with plan comparison by conducting cost effectiveness and incremental cost analyses, identifying the plans which are the best financial investments (“Best Buys”), and displaying the effects of each on a range of decision variables. The software is available via the IWR Planning Suite Internet. The latest version (1.0.11.0) has been certified for use by USACE Headquarters, meaning that it has been reviewed and certified by the appropriate Planning Center of Expertise (PCX) and represents a corporate approval that the model is sound and functional.

### **Caminada Headland and Shell Island**

This study evaluated several frameworks designed to preserve coastal habitat and functions in the Barataria Study area now recognized as a vital national resource. The intent is to save these important resources in a manner that also sustains or increases other economic resources that are the traditional focus of the Federal water resource program. In this analysis four environmental restoration alternatives are being evaluated at both locations of Caminada Headland and Shell Island. Table 1 displays the expected environmental outputs in terms of average annual habitat units along with the average annual costs for each of the restoration alternatives and no action plans. Tables 1a and 1b display the detailed cost estimates that were used to calculate the average annual estimates for each alternative referenced in Table 1. Average annual costs were

calculated using the federal discount rate of 4.0 percent and assuming a 50 year period of analysis. It should be noted that since Shell Island plans S3 and S5 have a 3 year construction schedule, as opposed to all other plans that have a 2 year construction schedule, their base years (the first year of project operation) are 1 year later than these other plans. Therefore, in order to make appropriate comparisons, the average annual estimates of plans S3 and S5 were discounted by 1 year for this purpose. Costs in Tables 1a and 1b reflect 2007 price levels but were updated to 2011 price levels for all other tables using the Civil Works Construction Cost Index (EM 1110-2-1304).

A more accurate depiction of the performance associated with each restoration alternative is displayed in Table 2. This displays the incremental outputs compared to the no action plan for each of the restoration alternatives. For example, the incremental outputs associated with the S1 alternative equals 355.9 average annual habitat units representing the difference between the 302.9 AAHU's that alternative S1 is expected to produce and the -53 AAHU's that Shell Island will lose if no action is taken.

Since each of the restoration alternatives at both Caminada Headland and Shell Island can be implemented with every alternative from the other area, the next step in this analysis is to calculate the outputs and costs of all the possible combinations of restoration alternatives. The IWR Planning model performed these calculations and the results are presented in Table 3, which show the sums of the combined measured increments for all of the possible alternatives. For example, if both restoration alternatives C5 and S1 are taken, then the overall increase in AAHU over the no action plan is estimated to be 1,954.8. This is calculated by summing the incremental AAHU's associated with C5 (1,598.9) and S1 (355.9) respectively in Table 2.

### **Cost Effective Solutions**

In cost effectiveness analysis, it is necessary to filter out plans that produce the same output level as another plan, but cost more; or cost the same amount or more than another plan, but produces less output. This CE analysis was performed by the IWR planning model and those plans that are economically inefficient have been eliminated from further analysis. As an example, the restoration alternatives labeled C6, C7, and C9 produce less output but cost more than the alternative labeled C5; consequently the alternatives C6, C7, and C9 should not be included in further analysis.

Table 4 displays the remaining levels of output for the considered measures representing the "cost effectiveness frontier." For each remaining level of output, it indicates that at least one solution is available to produce that output; and if more than one solution would produce that level of output, only the least costly solution has been retained.

### **Cost Effective and Incrementally Justified (Best Buy Plans)**

The final step in the analysis is to determine which subset of the cost effective solutions is also incrementally justified. These solutions, also known as Best Buy Plans or Best Buy Alternatives, are those plans that provide increases in benefits at the lowest average

cost (per HU). The IWR Planning model was run to make the necessary calculations producing the results shown in Table 5.

Included in Table 5 is the incremental cost per HU for each of the Best Buy plans that can be used to assist in the decision making process. Incremental cost is calculated by dividing the difference between two solution's costs by the difference between the two solution's outputs. Reviewing this table, with the incremental cost information, now allows the decision maker to make the following comparisons of alternative restoration plans and to progressively ask "Is it worth it?"

In the first comparison, the first level of additional output is 1598.9 AAHU, which could be produced at an incremental cost of \$8,418 per AAHU. If decision makers determine that 1598.9 AAHU are worth \$8,418 apiece, then they should proceed to the next level of output and repeat the questioning. In this case the next level of additional output is 783.6 AAHU, which means that an additional 783.6 AAHU could be produced at an additional incremental cost of \$14,684 per AAHU.

As noted previously, neither cost effectiveness analysis nor incremental cost analysis will tell the decision maker what choice to make. However, the information developed by both analyses will help the decision maker make a better-informed decision and, once a decision is made, they will help you to better understand its consequences in relation to your other choices.

Figure 1 shows the full range of solutions, and highlights the cost effective solutions and the incrementally justified (Best Buy) solutions. Figure 2 shows the incremental cost and output for the Best Buy plans.

**Table 1**  
**Summary of Outputs and Average Annual Costs**

**Shell Island**

<b>Name of Alternative</b>	<b>Description</b>	<b>Outputs (AAHU)</b>	<b>Average Annual Costs (\$)</b>
No Action	No Action	-53	-
S1	Two Islands with No Renourishment	302.9	7,400,433
S2	Two Islands with Renourishment	672.7	12,047,740
S3	Single Island with 10 Year Advanced Fill and No Renourishment	522.9	9,476,986
S5	Single Island with 10 Year Advanced Fill and 2 Renourishments	730.6	11,506,705

**Caminada Headland**

<b>Name of Alternative</b>	<b>Description</b>	<b>Outputs (AAHU)</b>	<b>Average Annual Costs (\$)</b>
No Action	No Action	-610.6	-
C5	Landward/Seaward Combination with Additional Marsh and Renourishment	988.3	13,459,269
C6	Landward/Seaward Combination with Additional Marsh and 1 replenishment	600.9	17,623,677
C7	Landward/Seaward Combination with Additional Marsh and 2 replenishment	639.6	21,068,033
C9	Landward/Seaward Combination with additional marsh construction and 4 replenishments	922.3	27,548,949

Notes:

- (1) 2010 Price Levels
- (2) 4 1/8 Interest Rate
- (3) AAHU - Average Annual Habitat Units

**Table 1a**  
**Caminada Headlands Detailed Cost Estimates by Alternative**  
(\$, 2007 Price Levels)

<b>Alternative 5</b>	<b>Base Year</b>	<b>Base Year</b>	<b>Present</b>	<b>Average</b>
<b>Cost Categories</b>	<b>-1</b>	<b>0</b>	<b>Value</b>	<b>Annual</b>
Construction Cost	78,475,875	78,475,875		
Contingency	15,695,175	15,695,175		
E & D (Engineering & Design)	2,004,782	2,004,782		
S & A (Supervision & Administration)	1,594,684	1,594,684		
O & M (Operations and Maintenance)	-	-		
O & M Renourishment Only	-	-		2,849,606
<b>Total</b>	97,770,516	97,770,516	199,574,065	12,339,550

<b>Alternative 6</b>	<b>Base Year</b>	<b>Base Year</b>	<b>Base Year</b>	<b>Present</b>	<b>Average</b>
<b>Cost Categories</b>	<b>-1</b>	<b>0</b>	<b>+25</b>	<b>Value</b>	<b>Annual</b>
Construction Cost	78,475,875	78,475,875	312,239,045		
Contingency	15,695,175	15,695,175	62,447,809		
E & D (Engineering & Design)	2,004,782	2,004,782	5,226,023		
S & A (Supervision & Administration)	1,594,684	1,594,684	5,284,150		
O & M (Operations and Maintenance)	-	-	-		
<b>Total</b>	97,770,516	97,770,516	385,197,027	339,793,292	16,157,508

<b>Alternative 7</b>	<b>Base Year</b>	<b>Base Year</b>	<b>Base Year</b>	<b>Base Year</b>	<b>Present</b>	<b>Average</b>
<b>Cost Categories</b>	<b>-1</b>	<b>0</b>	<b>+20</b>	<b>+40</b>	<b>Value</b>	<b>Annual</b>
Construction Cost	78,475,875	78,475,875	274,374,231	226,441,989		
Contingency	15,695,175	15,695,175	54,874,846	45,288,398		
E & D (Engineering & Design)	2,004,782	2,004,782	5,082,843	3,677,295		
S & A (Supervision & Administration)	1,594,684	1,594,684	5,069,427	3,694,468		
O & M (Operations and Maintenance)	-	-	-	-		
<b>Total</b>	97,770,516	97,770,516	339,401,348	279,102,150	406,202,215	19,315,318

<b>Alternative 9</b>	<b>Base Year</b>	<b>Present</b>	<b>Average</b>					
<b>Cost Categories</b>	<b>-1</b>	<b>0</b>	<b>+10</b>	<b>+20</b>	<b>+30</b>	<b>+40</b>	<b>Value</b>	<b>Annual</b>
Construction Cost	78,475,875	78,475,875	171,225,001	174,705,082	153,376,325	147,429,726		
Contingency	15,695,175	15,695,175	34,245,000	34,941,016	30,675,265	29,485,945		
E & D (Engineering & Design)	2,004,782	2,004,782	4,041,838	3,793,548	3,184,682	2,823,383		
S & A (Supervision & Administration)	1,594,684	1,594,684	3,426,857	3,455,191	2,995,382	2,779,051		
O & M (Operations and Maintenance)	-	-	-	-	-	-		
<b>Total</b>	97,770,516	97,770,516	212,938,696	216,894,837	190,231,654	182,518,106	531,157,508	25,257,066

Note: Present Value estimates and Average Annual estimates were calculated using the federal discount rate of 4.125 percent and a 50 year period of analysis.

**Table 1b**  
**Shell Island Detailed Cost Estimates by Alternative**  
(\$, 2007 Price Levels)

<b>Alternative 1</b>	<b>Base Year</b>	<b>Base Year</b>	<b>Present</b>	<b>Average</b>				
<b>Cost Categories</b>	<b>-1</b>	<b>0</b>	<b>Value</b>	<b>Annual</b>				
Construction Cost	52,954,800	52,954,800						
Contingency	10,590,960	10,590,960						
E & D (Engineering & Design)	3,177,288	3,177,288						
S & A (Supervision & Administration)	3,177,288	3,177,288						
O & M (Operations and Maintenance)	-	-						
<b>Total</b>	<b>69,900,336</b>	<b>69,900,336</b>	<b>142,684,061</b>	<b>6,784,768</b>				
<b>Alternative 2</b>	<b>Base Year</b>	<b>Base Year</b>	<b>Base Year</b>	<b>Base Year</b>	<b>Base Year</b>	<b>Base Year</b>	<b>Present</b>	<b>Average</b>
<b>Cost Categories</b>	<b>-1</b>	<b>0</b>	<b>+10</b>	<b>+20</b>	<b>+30</b>	<b>+40</b>	<b>Value</b>	<b>Annual</b>
Construction Cost	53,972,450	53,972,450	42,795,508	48,539,508	33,663,028	28,202,548		
Contingency	10,794,500	10,794,500	8,559,000	9,708,000	6,733,000	5,641,000		
E & D (Engineering & Design)	3,238,348	3,238,348	2,567,725	2,912,375	2,019,801	1,692,177		
S & A (Supervision & Administration)	3,238,348	3,238,348	2,567,725	2,912,375	2,019,801	1,692,177		
O & M (Operations and Maintenance)	-	-	-	-	-	-		
<b>Total</b>	<b>71,243,645</b>	<b>71,243,645</b>	<b>56,489,959</b>	<b>64,072,259</b>	<b>44,435,631</b>	<b>37,227,903</b>	<b>232,286,444</b>	<b>11,045,451</b>
<b>Alternative 3</b>	<b>Base Year</b>	<b>Base Year</b>	<b>Base Year</b>	<b>Present</b>	<b>Average</b>			
<b>Cost Categories</b>	<b>-2</b>	<b>-1</b>	<b>0</b>	<b>Value</b>	<b>Annual</b>			
Construction Cost	46,116,531	46,116,531	46,116,531					
Contingency	9,223,333	9,223,333	9,223,333					
E & D (Engineering & Design)	2,766,993	2,766,993	2,766,993					
S & A (Supervision & Administration)	2,766,993	2,766,993	2,766,993					
O & M (Operations and Maintenance)	-	-	-					
<b>Total</b>	<b>60,873,850</b>	<b>60,873,850</b>	<b>60,873,850</b>	<b>190,258,271</b>	<b>8,688,566</b>			
<b>Alternative 5</b>	<b>Base Year</b>	<b>Base Year</b>	<b>Base Year</b>	<b>Base Year</b>	<b>Base Year</b>	<b>Present</b>	<b>Average</b>	
<b>Cost Categories</b>	<b>-2</b>	<b>-1</b>	<b>0</b>	<b>+20</b>	<b>+40</b>	<b>Value</b>	<b>Annual</b>	
Construction Cost	46,116,531	46,116,531	46,116,531	48,410,344	46,849,832			
Contingency	9,223,333	9,223,333	9,223,333	9,682,000	9,370,000			
E & D (Engineering & Design)	2,766,993	2,766,993	2,766,993	2,904,617	2,810,992			
S & A (Supervision & Administration)	2,766,993	2,766,993	2,766,993	2,904,617	2,810,992			
O & M (Operations and Maintenance)	-	-	-	-	-			
<b>Total</b>	<b>60,873,850</b>	<b>60,873,850</b>	<b>60,873,850</b>	<b>63,901,578</b>	<b>61,841,815</b>	<b>231,006,533</b>	<b>10,549,426</b>	

Note: Present Value estimates and Average Annual estimates were calculated using the federal discount rate of 4.125 percent and a 50 year period of analysis.

**Table 2**  
**Incremental Outputs by Alternative**

Name of Alternative	Description	Outputs (AAHU)
S1	Two Islands with No Renourishment	355.9
S2	Two Islands with Renourishment	725.8
S3	Single Island with 10 Year Advanced Fill and No Renourishment	575.9
S5	Single Island with 10 Year Advanced Fill and 2 Renourishments	783.6
C5	Landward/Seaward Combination with Additional Marsh and Renourishment	1,598.9
C6	Landward/Seaward Combination with Additional Marsh and 1 replenishment	1,211.5
C7	Landward/Seaward Combination with Additional Marsh and 2 replenishment	1,250.2
C9	Landward/Seaward Combination with additional marsh construction and 4 replenishments	1,532.9

Notes:

- (1) 2010 Price Levels
- (2) 4 1/8 Interest Rate
- (3) AAHU - Average Annual Habitat Units

**Table 3**  
**Summary of Outputs and Average Annual Costs of All Solutions**

<b>Name of Solution</b>	<b>Description</b>	<b>Outputs (AAHU)</b>	<b>Average Annual Costs (\$)</b>
No Action	No Action	0	-
C5	Landward/Seaward Combination with Additional Marsh and Renourishment	1598.9	13,459,269
C6	Landward/Seaward Combination with Additional Marsh and 1 replenishment	1211.5	17,623,677
C7	Landward/Seaward Combination with Additional Marsh and 2 replenishment	1250.2	21,068,033
C9	Landward/Seaward Combination with additional marsh construction and 4 replenishments	1532.9	27,548,949
S1	Two Islands with No Renourishment	355.9	7,400,433
S2	Two Islands with Renourishment	725.8	12,047,740
S3	Single Island with 10 Year Advanced Fill and No Renourishment	575.9	9,476,986
S5	Single Island with 10 Year Advanced Fill and 2 Renourishments	783.6	11,506,705
C5/S1	C5 plus S1	1954.8	20,859,702
C5/S2	C5 plus S2	2324.6	25,507,009
C5/S3	C5 plus S3	2174.8	22,936,255
C5/S5	C5 plus S5	2382.5	24,965,974
C6/S1	C6 plus S1	1567.4	25,024,110
C6/S2	C6 plus S2	1937.3	29,671,417
C6/S3	C6 plus S3	1787.4	27,100,663
C6/S5	C6 plus S5	1995.4	29,130,382
C7/S1	C7 plus S1	1606.1	28,468,466
C7/S2	C7 plus S2	1976.0	33,115,773
C7/S3	C7 plus S3	1826.1	30,545,019
C7/S5	C7 plus S5	2034.1	32,574,738
C9/S1	C9 plus S1	1888.8	34,949,382
C9/S2	C9 plus S2	2258.7	39,596,689
C9/S3	C9 plus S3	2108.8	37,025,935
C9/S5	C9 plus S5	2316.8	39,055,654

Notes:

- (1) 2010 Price Levels
- (2) 4 1/8 Interest Rate
- (3) AAHU - Average Annual Habitat Units

**Table 4**  
**Cost Effective Solutions**

<b>Name of Solution</b>	<b>Description</b>	<b>Outputs (AAHU)</b>	<b>Average Annual Costs (\$)</b>
No Action	No Action	0	0
S1	Two Islands with No Renourishment	355.9	7,400,433
S3	Single Island with 10 Year Advanced Fill and No Renourishment	575.9	9,476,986
S5	Single Island with 10 Year Advanced Fill and 2 Renourishments	783.6	11,506,705
C5	Landward/Seaward Combination with Additional Marsh and Renourishment	1598.9	13,459,269
C5/S1	C5 plus S1	1954.8	20,859,702
C5/S3	C5 plus S3	2174.8	22,936,255
C5/S5	C5 plus S5	2382.5	24,965,974

Notes:

- (1) 2010 Price Levels
- (2) 4 1/8 Interest Rate
- (3) AAHU - Average Annual Habitat Units

**Table 5  
Incremental Costs**

<b>Name of Solution</b>	<b>Output (AAHU)</b>	<b>Avg. Ann. Costs (\$)</b>	<b>Additional Output (AAHU)</b>	<b>Additional Costs (\$)</b>	<b>Incremental Costs (\$ per AAHU)</b>
No Action	0	0	--	--	--
C5	1598.9	13,459,269	1598.9	13,459,269	8,418
C5/S5	2382.5	24,965,974	783.6	11,506,705	14,684

Notes:

- (1) 2010 Price Levels
- (2) 4 1/8 Interest Rate
- (3) AAHU - Average Annual Habitat Units

Lowest average cost solutions.

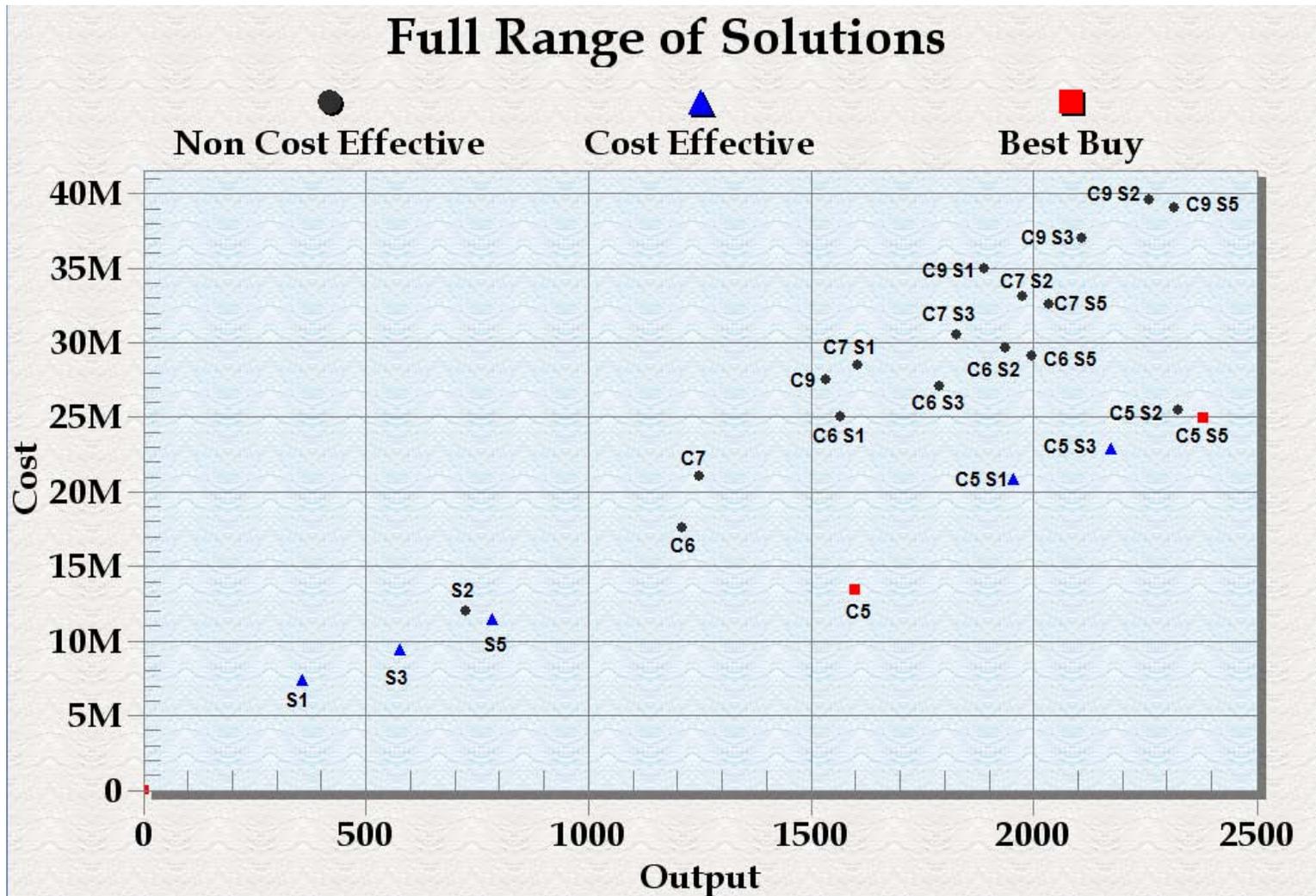


Figure 1

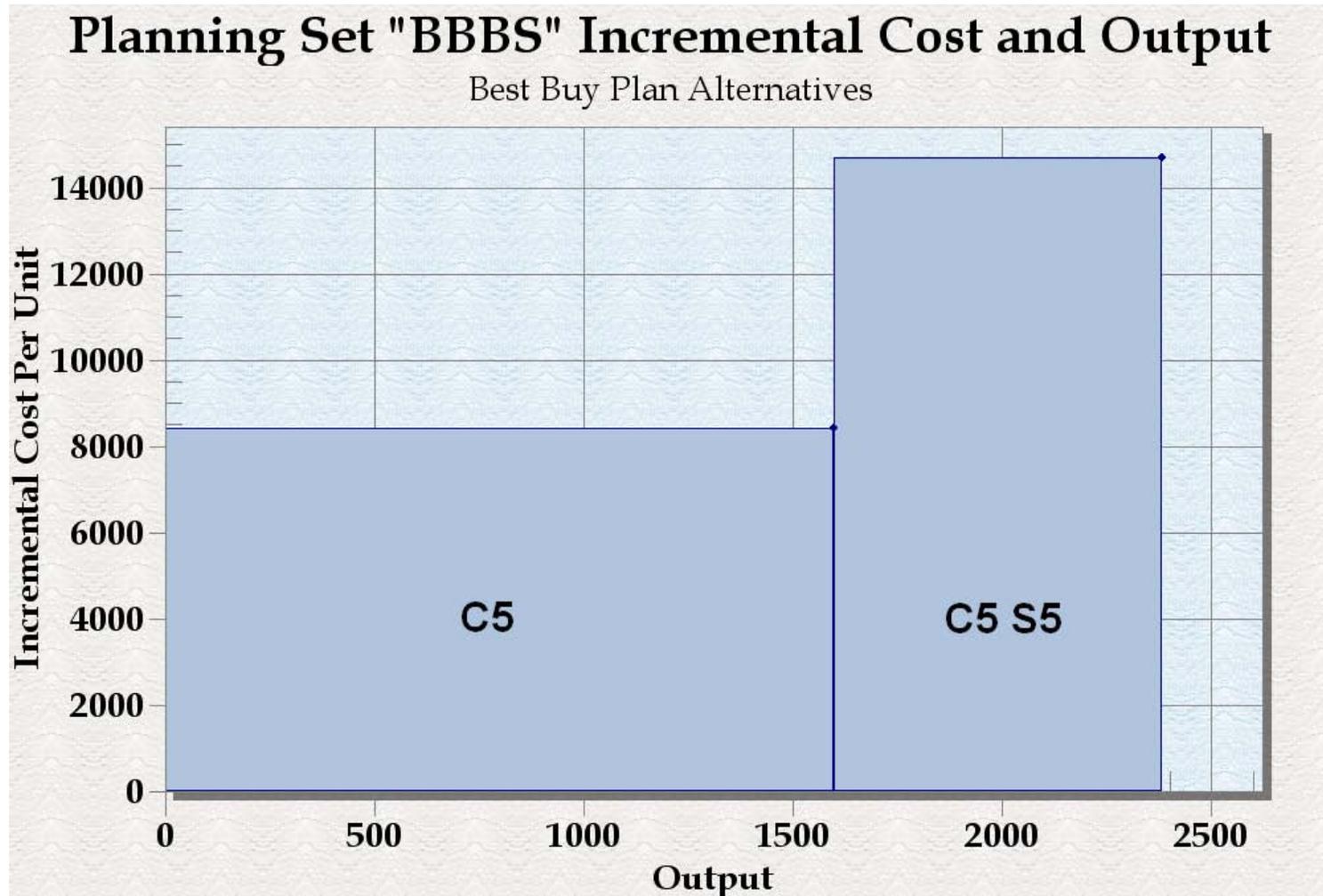


Figure 2