

WESTSIDE CREEKS ECOSYSTEM RESTORATION

*Appendix D: Cost Effectiveness-Incremental Cost
Analysis*

COST EFFECTIVENESS AND INCREMENTAL COST ANALYSIS (CE/ICA) APPENDIX

INTRODUCTION

Comparing benefits and costs for ecosystem restoration provides a challenge to planners and decision makers because benefits and costs are not measured in the same units. Environmental restoration benefits can be measured in habitat units or some other physical unit, while costs are measured in dollars. Therefore benefits and costs cannot be directly compared. Two analyses are conducted to help planners and decision makers identify plans for implementation, though the analyses themselves do not identify a single ideal plan. These two techniques are cost effectiveness and incremental cost analysis. Use of these techniques are described in the *Economic and Environmental Principles and Guidelines for Water and Related Land Resource Implementation Studies* (U.S. Water Resources Council 1983).

Cost effectiveness compares the annual costs and benefits of plans under consideration to identify the least cost plan alternative for each possible level of environmental output, and for any level of investment, the maximum level of output is identified.

Incremental cost analysis of the cost effective plans is conducted to reveal changes in costs as output levels are increased. Results from both analyses are presented graphically to help planners and decision makers select plans. For each of the best buy plans identified through incremental cost analysis, an “is it worth it?” analysis is then conducted for each incremental measure or plan to justify the incremental cost per unit of output to arrive at a recommended plan.

For this study, the environmental output is the avian community unit, which is derived from the product of an Avian Index of Biotic Integrity (AIBI) and a measure’s acreage. The development of the AIBI is discussed in detail in the environmental technical appendix.

MEASURES AND PLANS

Measures were formulated incrementally for each of the four creeks. These measures included riparian meadows, construction of a natural design pilot channel inclusive of instream structures to restore pool-riffle-run sequences, riparian woody vegetation plantings in the riparian meadow, slackwater features, and on Martinez Creek, wetlands. A brief description of each measure follows:

Riparian Meadow (RM): The change from non-native herbaceous vegetation to a restored native riparian meadow would be a hydraulically neutral action, and can be implemented as a standalone alternative.

Restoration of the riparian meadow would partially address the restoration objective for the WSC by providing some increased vertical structure diversity in the riparian habitat, some increased insect (primary producer) biomass production, and some increased allochthonous material input to the aquatic habitat. The increase in allochthonous materials and temperature reduction from

limited shading would provide some limited improvement in dissolved oxygen levels for the aquatic environment.

Cost components for establishment of a native riparian meadow include:

- removal of top six inches of existing soil to remove the non-native seed bank,
- ripping to a depth of 12-18 inches to reduce compaction and provide an acceptable strata for deep root growth,
- incorporation of compost material into the top 2-4 inches to promote germination and sustained growth,
- planting a diverse mix of native riparian meadow seeds, and
- provisions for short-term watering to aid in quick establishment of ground cover of the exposed floodway slopes.

Pilot Channel (PC): The pilot channel management measure would support the ecosystem restoration objective by addressing the problems associated with the increased bed slope and loss of aquatic habitat structure and function.

The amount of ground disturbance from the excavation to construct the pilot channel would require re-establishment of a large portion of the slope vegetation. For this reason, the pilot channel management measure was not considered as a stand-alone management measure, but rather implementable only in combination with the riparian meadow management measure.

Specifically, the pilot channel management measure would mimic the ecological functions of the channel forming process through construction of a pilot channel sized to carry the channel forming flow and the use of in-stream structures which flattens the bed slope during channel forming events thereby balancing movement of sediment through the system. The in-stream structures will restore pool-riffle complexes and support appropriate substrate deposition for pool and riffle habitats. Further, the pilot channel management measure, primarily through the pool/riffle habitats, will allow some slackwater micro habitat formation. The riffles will assist with dissolved oxygen levels, and increased pool depths will provide aquatic locations as high temperature refugia. Properly functioning riffles and pools are important primary producer habitats, serving as breeding, brooding, and foraging grounds for a diverse list of benthic organisms, aquatic insects, and fish. Pools support the aquatic functional need for allochthonous material inputs through providing a low velocity location where these materials fall-out of the velocity stream and begin the decaying process to return energy to the system.

Cost components for establishment of the pilot channel include:

- excavation to accommodate the pilot channel and initial pool depths, and construct riffle structures,
- grading to form the pilot channel and transition to existing floodway slopes,
- rock constructed riffle structures,
- armoring, and
- utility relocation.

Riparian Woody Vegetation (RWV) (30, 70): The riparian woody vegetation management measure would support the ecosystem restoration objective by addressing the problems of lack of aquatic shading, reduced allochthonous material inputs, lack of stratification of vertical structure, lack of terrestrial shading, and lack of soft and hard mast diversity.

A well developed, age and species diverse woody riparian habitat provides numerous ecological benefits to the riparian and aquatic components of the riverine system which are requirements for

many migratory birds. The habits of different species of birds for things like foraging, resting, and defense can range from upper-canopy, mid-canopy, shrub, to leaf-layer, and that is just based on vertical and horizontal stratification. A well developed and sustaining riparian woodland provides each of these layers and supports the feeding, resting, and defensive requirements for a great number of birds. Woody vegetation provides an important source of allochthonous material to the aquatic environment through leaf drop to small and large woody debris. These allochthonous inputs add energy to the aquatic system required by the organisms lowest on the primary producer scale; these organisms are at the true base of the system and are required in large sustained numbers of individuals to ensure there is adequate energy surplus at each trophic level to feed the next higher level through to the primary consumers.

Cost components for the establishment of the RWV include:

- spot treatment herbicide to remove herbaceous competition in the immediate area around the seedling,
- purchase of seedlings in a diverse mix of native riparian shrubs and trees,
- planting of seedlings, and
- provisions for short term watering to aid in quick establishment.

Consistent with the study constraints, implementation of the RWV would require an increase in hydraulic capacity within the floodway to accommodate the increased hydraulic roughness of RWV. Implementation of the pilot channel management measure would gain some hydraulic capacity through the required excavation to implement that management measure. Therefore, it was determined that implementation of the RWV management measure would be implemented only in combination with the pilot channel management measure.

Slackwater (SW): The slackwater management measure would support the ecosystem restoration objective by an important micro-habitat component of the aquatic ecosystem.

Natural channel forming processes create areas, generally along the bank margins, where the velocity is slower. These are generally small areas, but they pay big benefits to the aquatic system. Slackwater habitats serve as velocity refugia for many aquatic organisms to rest and forage. Due to the slower velocities, allochthonous materials tend to congregate and pack in these areas, and therefore slackwaters are generally locations with high energy for the lower aquatic organisms. The aquatic food chain of primary producers through to primary consumer is supported at a micro level in slackwater habitats. These are the locations provide easy hunting and foraging for primary consumers due to the small area – high population effect of these habitats.

Cost components for the establishment of slackwater include:

- minor excavation,
- minor grading,
- armoring

Implementation of the slackwater management measure would require mobilization of equipment and staging sites for each location. Since the pilot channel is continuous and requires multiple staging sites, significant cost reduction for this management measure would be experienced by combining the slackwater work with the pilot channel work. Furthermore, the slackwater areas would remain difficult to maintain without the installation of the pilot channel addressing sediment transport. Therefore, slackwater would only be implemented in combination with the pilot channel.

Wetland (WL): The wetland management measure would support the ecosystem restoration objective by addressing the loss of aquatic habitat structure and function.

The management measure would restore uniquely productive microhabitats through the accumulation of organic materials.

Cost components for the establishment of wetland include:

- real estate acquisition,
- excavation,
- grading,
- armoring,
- planting a diverse mixture of wetland vegetation, and
- provisions for short term actions to aide in establishment.

Implementation of the wetland management measure would require ensuring a consistent, if intermittent, source of water. The nearest source is Martinez, but modifications to the existing channel would be required. Operation and maintenance of a wetland area would be labor intensive without a balanced sediment transport system. For this reason the team determined the wetland management measure would only be implemented in combination with the pilot channel management measure.

Of these measures, only riparian meadows were considered as a stand-alone measure. Riparian meadows is a prerequisite for the pilot channel, and the pilot channel a pre-requisite for riparian woody vegetation, slackwater, and the wetland. For the woody vegetation measure, two scales were considered: 30 stems per acre in all areas identified for woody vegetation planting and a combination of 70 stems in locations where the impact on water surface elevations were neutral and 30 stems per acre in the remaining areas identified for woody vegetation. Table 1 presents a list of measure combinations (fully formed plans) for each of the four creeks.

Table 1. List of Plans by Creek

Stream	Plans
San Pedro Creek	Riparian Meadow
	Riparian Meadow + Pilot Channel
	Riparian Meadow + Pilot Channel + Riparian Woody Vegetation (30 stems per acre)
	Riparian Meadow + Pilot Channel + Riparian Woody Vegetation (70 stems per acre)
	Riparian Meadow + Pilot Channel + Slackwater
	Riparian Meadow + Pilot Channel + Riparian Woody Vegetation (30 stems per acre) + Slackwater
	Riparian Meadow + Pilot Channel + Riparian Woody Vegetation (70 stems per acre) + Slackwater
Alazán Creek	Riparian Meadow
	Riparian Meadow + Pilot Channel
	Riparian Meadow + Pilot Channel + Riparian Woody Vegetation (30 stems per acre)
	Riparian Meadow + Pilot Channel + Riparian Woody Vegetation (70 stems per acre)
	Riparian Meadow + Pilot Channel + Slackwater
	Riparian Meadow + Pilot Channel + Riparian Woody Vegetation (30 stems per acre) + Slackwater
	Riparian Meadow + Pilot Channel + Riparian Woody Vegetation (70 stems per acre) + Slackwater
Martinez Creek	Riparian Meadow
	Riparian Meadow + Pilot Channel
	Riparian Meadow + Pilot Channel + Riparian Woody Vegetation (30 stems per acre)
	Riparian Meadow + Pilot Channel + Riparian Woody Vegetation (70 stems per acre)
	Riparian Meadow + Pilot Channel + Slackwater
	Riparian Meadow + Pilot Channel + Wetland
	Riparian Meadow + Pilot Channel + Slackwater + Wetland
	Riparian Meadow + Pilot Channel + Riparian Woody Vegetation (30 stems per acre) + Slackwater

Stream	Plans
	Riparian Meadow + Pilot Channel + Riparian Woody Vegetation (70 stems per acre) + Slackwater Riparian Meadow + Pilot Channel + Riparian Woody Vegetation (30 stems per acre) + Wetlands Riparian Meadow + Pilot Channel + Riparian Woody Vegetation (70 stems per acre) + Wetlands Riparian Meadow + Pilot Channel + Riparian Woody Vegetation (30 stems per acre) + Slackwater + Wetlands Riparian Meadow + Pilot Channel + Riparian Woody Vegetation (30 stems per acre) + Slackwater + Wetlands
Apache Creek	Riparian Meadow Riparian Meadow + Pilot Channel Riparian Meadow + Pilot Channel + Riparian Woody Vegetation (30 stems per acre) Riparian Meadow + Pilot Channel + Riparian Woody Vegetation (70 stems per acre) Riparian Meadow + Pilot Channel + Slackwater Riparian Meadow + Pilot Channel + Riparian Woody Vegetation (30 stems per acre) + Slackwater Riparian Meadow + Pilot Channel + Riparian Woody Vegetation (70 stems per acre) + Slackwater

ANNUALIZED AVIAN COMMUNITY UNITS AND COSTS

EXISTING AND FUTURE WITHOUT-PROJECT AVIAN COMMUNITY UNITS

In order to determine benefits of an environmental restoration plan, future with-project environmental outputs are compared to future without-project outputs. The difference between the two represents the benefits from project implementation. For this study, future without-project conditions are assumed to be the same as existing conditions, given the existing habitat quality and that the area is completely built up. The future without-project avian community units are shown in Table 2.

Table 2. Future Without-Project Avian Community Units

Stream	Plans	Future Without Project		
		Avian IBI	Acres	Avian Community Unit
San Pedro Creek	Riparian Meadow	0.91368	67.35	61.53655
	Riparian Meadow + Pilot Channel	0.91368	67.35	61.53655
	Riparian Meadow + Pilot Channel + Woody Vegetation (30 stems per acre)	0.91368	67.35	61.53655
	Riparian Meadow + Pilot Channel + Woody Vegetation (70 stems per acre)	0.91368	67.35	61.53655
	Riparian Meadow + Pilot Channel + Slackwater	0.91368	67.35	61.53655
	Riparian Meadow + Pilot Channel + Woody Vegetation (30 stems per acre) + Slackwater	0.91368	67.35	61.53655
	Riparian Meadow + Pilot Channel + Woody Vegetation (70 stems per acre) + Slackwater	0.91368	67.35	61.53655
Alazán Creek	Riparian Meadow	0.91949	70.35	64.68619
	Riparian Meadow + Pilot Channel	0.91949	70.35	64.68619
	Riparian Meadow + Pilot Channel + Woody Vegetation (30 stems per acre)	0.91949	70.35	64.68619
	Riparian Meadow + Pilot Channel + Woody Vegetation (70 stems per acre)	0.91949	70.35	64.68619
	Riparian Meadow + Pilot Channel + Slackwater	0.91949	70.35	64.68619
	Riparian Meadow + Pilot Channel + Woody Vegetation (30 stems per acre) + Slackwater	0.91949	70.35	64.68619
	Riparian Meadow + Pilot Channel + Woody Vegetation (70 stems per acre) + Slackwater	0.91949	70.35	64.68619

Stream	Plans	Future Without Project		
		Avian IBI	Acres	Avian Community Unit
	Riparian Meadow + Pilot Channel + Woody Vegetation (70 stems per acre) + Slackwater	0.91949	70.35	64.68619
Martinez Creek	Riparian Meadow	0.92020	50.56	46.52511
	Riparian Meadow + Pilot Channel	0.92020	50.56	46.52511
	Riparian Meadow + Pilot Channel + Woody Vegetation (30 stems per acre)	0.92020	50.56	46.52511
	Riparian Meadow + Pilot Channel + Woody Vegetation (70 stems per acre)	0.92020	50.56	46.52511
	Riparian Meadow + Pilot Channel + Slackwater	0.92020	50.56	46.52511
	Riparian Meadow + Pilot Channel + Wetland	0.92020	50.56	46.52511
	Riparian Meadow + Pilot Channel + Slackwater + Wetland	0.92020	50.56	46.52511
	Riparian Meadow + Pilot Channel + Woody Vegetation (30 stems per acre) + Slackwater	0.92020	50.56	46.52511
	Riparian Meadow + Pilot Channel + Woody Vegetation (70 stems per acre) + Slackwater	0.92020	50.56	46.52511
	Riparian Meadow + Pilot Channel + Woody Vegetation (30 stems per acre) + Wetlands	0.92020	50.56	46.52511
	Riparian Meadow + Pilot Channel + Woody Vegetation (70 stems per acre) + Wetlands	0.92020	50.56	46.52511
	Riparian Meadow + Pilot Channel + Woody Vegetation (30 stems per acre) + Slackwater+Wetlands	0.92020	50.56	46.52511
	Riparian Meadow + Pilot Channel + Woody Vegetation (70 stems per acre) + Slackwater+Wetlands	0.92020	50.56	46.52511
	Apache Creek	Riparian Meadow	0.93985	34.02
Riparian Meadow + Pilot Channel		0.93985	34.02	31.97356
Riparian Meadow + Pilot Channel + Woody Vegetation (30 stems per acre)		0.93985	34.02	31.97356
Riparian Meadow + Pilot Channel + Woody Vegetation (70 stems per acre)		0.93985	34.02	31.97356
Riparian Meadow + Pilot Channel + Slackwater		0.93985	34.02	31.97356
Riparian Meadow + Pilot Channel + Woody Vegetation (30 stems per acre) + Slackwater		0.93985	34.02	31.97356
Riparian Meadow + Pilot Channel + Woody Vegetation (70 stems per acre) + Slackwater		0.93985	34.02	31.97356
Riparian Meadow + Pilot Channel + Woody Vegetation (70 stems per acre) + Slackwater		0.93985	34.02	31.97356

FUTURE WITH-PROJECT

ENVIRONMENTAL OUTPUTS

For comparison of measures, both environmental outputs and costs are converted to annual averages, or annualized. For the avian community units, an Avian IBI was first developed for each measure over a period of 75 years, with indexes estimated for 1 year following construction; 15 years following construction, 25 years following construction, 50 years following construction and 75 years following construction. A period of 75 years was chosen to allow the maturing of the riparian woody vegetation so that full benefits can be captured. The respective AIBIs were then multiplied by acreage to get the Avian Community Units for each measure in each of the reference years. Tables 3 through 7 show the calculation of these Avian Community Units. Using the annualizer module in the IWR Planning Suite software, these environmental outputs were annualized. Table 8 shows the data entered into the annualizer module and the resulting average annual avian community units for each measure. In performing the annualization, linear interpolation was used for the calculation.

Table 3. Calculation of Total Avian Community Units for Year 1

Stream	Plan	Non Woody Vegetation Avian IBI (Riparian Meadow, Pilot Channel, Slackwater)	Non Woody Vegetation Acres	Non Woody Vegetation Avian Community Units	Avian IBI for 30 Stems per Acre	Total Acreage for 30 Stems per Acre	Avian Community Units for 30 Stems per Acre	Avian IBI for 70 Stems per Acre	Acreage for 70 Stems per Acre	Avian Community Units for 70 Stems per Acre	Avian IBI for Wetlands	Acreage for Wetlands	Avian Community Units for Wetlands	Total Avian Community Units
San Pedro Creek	Riparian Meadow	1.11	67.35	74.77										74.77
	Riparian Meadow + Pilot Channel	1.16	67.35	78.18										78.18
	Riparian Meadow + Pilot Channel + Woody Vegetation (30 stems per acre)	1.16	50.24	58.32	1.16	17.11	19.86							78.18
	Riparian Meadow + Pilot Channel + Woody Vegetation (70 stems per acre)	1.16	50.24	58.32	1.16	9.14	10.61	1.16	7.97	9.25				78.18
	Riparian Meadow + Pilot Channel + Slackwater	1.21	67.35	81.59										81.59
	Riparian Meadow + Pilot Channel + Woody Vegetation (30 stems per acre) + Slackwater	1.21	50.24	60.9	1.21	17.11	20.73							81.59
	Riparian Meadow + Pilot Channel + Woody Vegetation (70 stems per acre) + Slackwater	1.21	50.24	60.9	1.21	9.14	11.07	1.21	7.97	9.66				81.59
Alazán Creek	Riparian Meadow	1.15	70.35	80.82										80.82
	Riparian Meadow + Pilot Channel	1.20	70.35	84.39										84.39
	Riparian Meadow + Pilot Channel + Woody Vegetation (30 stems per acre)	1.20	58.02	69.60	1.20	12.33	14.79							84.39
	Riparian Meadow + Pilot Channel + Woody Vegetation (70 stems per acre)	1.20	58.02	69.60	1.20	7.86	9.42	1.20	4.47	5.36				84.39
	Riparian Meadow + Pilot Channel + Slackwater	1.25	70.35	87.95										87.95
	Riparian Meadow + Pilot Channel + Woody Vegetation (30 stems per acre) + Slackwater	1.25	58.02	72.54	1.25	12.33	15.41							87.95
	Riparian Meadow + Pilot Channel + Woody Vegetation (70 stems per acre) + Slackwater	1.25	58.02	72.54	1.25	7.86	9.83	1.25	4.47	5.59				87.95
Martínez Creek	Riparian Meadow	1.15	50.56	58.08										58.08
	Riparian Meadow + Pilot Channel	1.20	50.56	60.64										60.64
	Riparian Meadow + Pilot Channel + Woody Vegetation (30 stems per acre)	1.20	41.77	50.10	1.20	8.79	10.54							60.64

Stream	Plan	Non Woody Vegetation Avian IBI (Riparian Meadow, Pilot Channel, Slackwater)	Non Woody Vegetation Acres	Non Woody Vegetation Avian Community Units	Avian IBI for 30 Stems per Acre	Total Acreage for 30 Stems per Acre	Avian Community Units for 30 Stems per Acre	Avian IBI for 70 Stems per Acre	Acreage for 70 Stems per Acre	Avian Community Units for 70 Stems per Acre	Avian IBI for Wetlands	Acreage for Wetlands	Avian Community Units for Wetlands	Total Avian Community Units
	Riparian Meadow + Pilot Channel + Woody Vegetation (70 stems per acre)	1.20	41.77	50.10	1.20	5.03	6.03	1.20	3.76	4.51				60.64
	Riparian Meadow + Pilot Channel + Slackwater	1.25	50.56	63.20										63.20
	Riparian Meadow + Pilot Channel + Wetland	1.20	50.56	60.64							1.45	5.20	7.54	68.18
	Riparian Meadow + Pilot Channel + Slackwater + Wetland	1.25	50.56	63.20							1.45	5.20	7.54	70.74
	Riparian Meadow + Pilot Channel + Woody Vegetation (30 stems per acre) + Slackwater	1.25	41.77	52.21	1.25	8.79	10.99							63.20
	Riparian Meadow + Pilot Channel + Woody Vegetation (70 stems per acre) + Slackwater	1.25	41.77	52.21	1.25	5.03	6.29	1.25	3.76	4.70				63.20
	Riparian Meadow + Pilot Channel + Woody Vegetation (30 stems per acre) + Wetlands	1.20	41.77	50.10	1.20	8.79	10.54			0.00	1.45	5.20	7.54	68.18
	Riparian Meadow + Pilot Channel + Woody Vegetation (70 stems per acre) + Wetlands	1.20	41.77	50.10	1.20	5.03	6.03	1.20	3.76	4.51	1.45	5.20	7.54	68.18
	Riparian Meadow + Pilot Channel + Woody Vegetation (30 stems per acre) + Slackwater+Wetlands	1.25	41.77	52.21	1.25	8.79	10.99			0.00	1.45	5.20	7.54	70.74
	Riparian Meadow + Pilot Channel + Woody Vegetation (70 stems per acre) + Slackwater+Wetlands	1.25	41.77	52.21	1.25	5.03	6.29	1.25	3.76	4.70	1.45	5.20	7.54	70.74
Apache Creek	Riparian Meadow	1.09	34.02	37.20										37.20
	Riparian Meadow + Pilot Channel	1.11	34.02	37.73										37.73
	Riparian Meadow + Pilot Channel + Woody Vegetation (30 stems per acre)	1.11	27.22	30.19	1.11	6.80	7.54							37.73
	Riparian Meadow + Pilot Channel + Woody Vegetation (70 stems per acre)	1.11	27.22	30.19	1.11	2.00	2.22	1.11	4.80	5.32				37.73
	Riparian Meadow + Pilot Channel + Slackwater	1.13	34.02	38.27										38.27
	Riparian Meadow + Pilot Channel + Woody Vegetation (30 stems per acre) + Slackwater	1.13	27.22	30.62	1.13	6.80	7.65							38.27
	Riparian Meadow + Pilot Channel + Woody Vegetation (70 stems per acre) + Slackwater	1.13	27.22	30.62	1.13	2.00	2.25	1.13	4.80	5.40				38.27

Table 4. Calculation of Total Avian Community Units for Year 15

Stream	Plan	Non Woody Vegetation Avian IBI (Riparian Meadow, Pilot Channel, Slackwater)	Non Woody Vegetation Acres	Non Woody Vegetation Avian Community Units	Avian IBI for 30 Stems per Acre	Total Acreage for 30 Stems per Acre	Avian Community Units for 30 Stems per Acre	Avian IBI for 70 Stems per Acre	Acreage for 70 Stems per Acre	Avian Community Units for 70 Stems per Acre	Avian IBI for Wetlands	Acreage for Wetlands	Avian Community Units for Wetlands	Total Avian Community Units
San Pedro Creek	Riparian Meadow	1.11	67.35	74.77										74.77
	Riparian Meadow + Pilot Channel	1.16	67.35	78.18										78.18
	Riparian Meadow + Pilot Channel + Woody Vegetation (30 stems per acre)	1.16	50.24	58.31	1.65	17.11	28.17							86.49
	Riparian Meadow + Pilot Channel + Woody Vegetation (70 stems per acre)	1.16	50.24	58.31	1.65	9.14	15.04	2.00	7.97	15.95				89.31
	Riparian Meadow + Pilot Channel + Slackwater	1.21	67.35	81.59										81.59
	Riparian Meadow + Pilot Channel + Woody Vegetation (30 stems per acre) + Slackwater	1.21	50.24	60.86	1.70	17.11	29.04							89.90
	Riparian Meadow + Pilot Channel + Woody Vegetation (70 stems per acre) + Slackwater	1.21	50.24	60.86	1.70	9.14	15.51	2.05	7.97	16.35				92.73
Alazán Creek	Riparian Meadow	1.15	70.35	80.82										80.82
	Riparian Meadow + Pilot Channel	1.20	70.35	84.39										84.38
	Riparian Meadow + Pilot Channel + Woody Vegetation (30 stems per acre)	1.20	58.02	69.60	1.69	12.33	20.78							90.38
	Riparian Meadow + Pilot Channel + Woody Vegetation (70 stems per acre)	1.20	58.02	69.60	1.69	7.86	13.25	2.04	4.47	9.12				91.96
	Riparian Meadow + Pilot Channel + Slackwater	1.25	70.35	87.95										87.95
	Riparian Meadow + Pilot Channel + Woody Vegetation (30 stems per acre) + Slackwater	1.25	58.02	72.54	1.74	12.33	21.40							93.94
	Riparian Meadow + Pilot Channel + Woody Vegetation (70 stems per acre) + Slackwater	1.25	58.02	72.54	1.74	7.86	13.64	2.04	4.47	9.12				95.30
Martínez Creek	Riparian Meadow	1.15	50.56	58.08										58.08
	Riparian Meadow + Pilot Channel	1.20	50.56	60.64										60.64
	Riparian Meadow + Pilot Channel + Woody Vegetation (30 stems per acre)	1.20	41.77	50.09	1.69	8.79	14.81							64.91
	Riparian Meadow + Pilot Channel + Woody Vegetation (70 stems per acre)	1.20	41.77	50.09	1.69	5.03	8.48	2.04	3.76	7.67				66.24
	Riparian Meadow + Pilot Channel + Slackwater	1.25	50.56	63.20										63.20

Stream	Plan	Non Woody Vegetation Avian IBI (Riparian Meadow, Pilot Channel, Slackwater)	Non Woody Vegetation Acres	Non Woody Vegetation Avian Community Units	Avian IBI for 30 Stems per Acre	Total Acreage for 30 Stems per Acre	Avian Community Units for 30 Stems per Acre	Avian IBI for 70 Stems per Acre	Acreage for 70 Stems per Acre	Avian Community Units for 70 Stems per Acre	Avian IBI for Wetlands	Acreage for Wetlands	Avian Community Units for Wetlands	Total Avian Community Units
Stream	Riparian Meadow + Pilot Channel + Wetland	1.20	50.56	60.64							1.45	5.20	7.54	68.18
	Riparian Meadow + Pilot Channel + Slackwater + Wetland	1.25	50.56	63.20							1.45	5.20	7.54	70.74
	Riparian Meadow + Pilot Channel + Woody Vegetation (30 stems per acre) + Slackwater	1.25	41.77	52.21	1.74	8.79	15.26							67.47
	Riparian Meadow + Pilot Channel + Woody Vegetation (70 stems per acre) + Slackwater	1.25	41.77	52.21	1.74	5.03	8.73	2.09	3.76	7.86				68.80
	Riparian Meadow + Pilot Channel + Woody Vegetation (30 stems per acre) + Wetlands	1.20	41.77	50.09	1.69	8.79	14.81				1.45	5.20	7.54	72.44
	Riparian Meadow + Pilot Channel + Woody Vegetation (70 stems per acre) + Wetlands	1.20	41.77	50.09	1.69	5.03	8.48	2.04	3.76	7.67	1.45	5.20	7.54	73.78
	Riparian Meadow + Pilot Channel + Woody Vegetation (30 stems per acre) + Slackwater+Wetlands	1.25	41.77	52.21	1.74	8.79	15.26				1.45	5.20	7.54	75.01
	Riparian Meadow + Pilot Channel + Woody Vegetation (70 stems per acre) + Slackwater+Wetlands	1.25	41.77	52.21	1.74	5.03	8.73	2.09	3.76	7.86	1.45	5.20	7.54	76.34
Apache Creek	Riparian Meadow	1.09	34.02	37.20										37.20
	Riparian Meadow + Pilot Channel	1.11	34.02	37.73										37.73
	Riparian Meadow + Pilot Channel + Woody Vegetation (30 stems per acre)	1.11	27.22	30.19	1.59	6.80	10.85							41.04
	Riparian Meadow + Pilot Channel + Woody Vegetation 70 stems per acre)	1.11	27.22	30.19	1.59	2.00	3.19	1.95	4.80	9.36				42.74
	Riparian Meadow + Pilot Channel + Slackwater	1.13	34.02	38.27										38.27
	Riparian Meadow + Pilot Channel + Woody Vegetation (30 stems per acre) + Slackwater	1.13	27.22	30.63	1.61	6.80	10.95							41.58
Riparian Meadow + Pilot Channel + Woody Vegetation (70 stems per acre) + Slackwater	1.13	27.22	30.63	1.61	2.00	3.22	1.97	4.80	9.43				43.28	

Table 5. Calculation of Total Avian Community Units for Year 25

Stream	Plan	Non Woody Vegetation Avian IBI (Riparian Meadow, Pilot Channel, Slackwater)	Non Woody Vegetation Acres	Non Woody Vegetation Avian Community Units	Avian IBI for 30 Stems per Acre	Total Acreage for 30 Stems per Acre	Avian Community Units for 30 Stems per Acre	Avian IBI for 70 Stems per Acre	Acreage for 70 Stems per Acre	Avian Community Units for 70 Stems per Acre	Avian IBI for Wetlands	Acreage for Wetlands	Avian Community Units for Wetlands	Total Avian Community Units
San Pedro Creek	Riparian Meadow	1.11	67.35	74.77										74.77
	Riparian Meadow + Pilot Channel	1.16	67.35	78.18										78.18
	Riparian Meadow + Pilot Channel + Woody Vegetation (30 stems per acre)	1.16	50.24	58.32	2.01	17.11	34.35							92.67
	Riparian Meadow + Pilot Channel + Woody Vegetation (70 stems per acre)	1.16	50.24	58.32	2.01	9.14	18.35	2.48	7.97	19.77				96.44
	Riparian Meadow + Pilot Channel + Slackwater	1.21	67.35	81.59										81.59
	Riparian Meadow + Pilot Channel + Woody Vegetation (30 stems per acre) + Slackwater	1.21	50.24	60.86	2.06	17.11	35.21							96.08
	Riparian Meadow + Pilot Channel + Woody Vegetation (70 stems per acre) + Slackwater	1.21	50.24	60.86	2.06	9.14	18.81	2.53	7.97	20.17				99.85
Alazán Creek	Riparian Meadow	1.15	70.35	80.82										80.82
	Riparian Meadow + Pilot Channel	1.20	70.35	84.39										84.39
	Riparian Meadow + Pilot Channel + Woody Vegetation (30 stems per acre)	1.20	58.02	69.59	2.05	12.33	25.23							94.83
	Riparian Meadow + Pilot Channel + Woody Vegetation (70 stems per acre)	1.20	58.02	69.59	2.05	7.86	16.08	2.52	4.47	11.26				96.94
	Riparian Meadow + Pilot Channel + Slackwater	1.25	70.35	87.95										87.95
	Riparian Meadow + Pilot Channel + Woody Vegetation (30 stems per acre) + Slackwater	1.25	58.02	72.54	2.10	12.33	25.86							98.39
	Riparian Meadow + Pilot Channel + Woody Vegetation (70 stems per acre) + Slackwater	1.25	58.02	72.54	2.10	5.86	16.48	2.57	4.47	11.49				100.50
Martínez Creek	Riparian Meadow	1.15	50.56	58.08										58.08
	Riparian Meadow + Pilot Channel	1.20	50.56	60.64										60.64
	Riparian Meadow + Pilot Channel + Woody Vegetation (30 stems per acre)	1.20	41.77	50.10	2.05	8.79	17.98							68.08
	Riparian Meadow + Pilot Channel + Woody Vegetation (70 stems per acre)	1.20	41.77	50.10	2.05	5.03	10.29	2.52	3.76	9.47				69.86
	Riparian Meadow + Pilot Channel + Slackwater	1.25	50.56	63.20										63.20

Stream	Plan	Non Woody Vegetation Avian IBI (Riparian Meadow, Pilot Channel, Slackwater)	Non Woody Vegetation Acres	Non Woody Vegetation Avian Community Units	Avian IBI for 30 Stems per Acre	Total Acreage for 30 Stems per Acre	Avian Community Units for 30 Stems per Acre	Avian IBI for 70 Stems per Acre	Acreage for 70 Stems per Acre	Avian Community Units for 70 Stems per Acre	Avian IBI for Wetlands	Acreage for Wetlands	Avian Community Units for Wetlands	Total Avian Community Units
Stream	Riparian Meadow + Pilot Channel + Wetland	1.20	50.56	60.64							1.45	5.20	7.54	68.17
	Riparian Meadow + Pilot Channel + Slackwater + Wetland	1.25	50.56	63.20							1.45	5.20	7.54	70.74
	Riparian Meadow + Pilot Channel + Woody Vegetation (30 stems per acre) + Slackwater	1.25	41.77	52.21	2.10	8.79	18.43							70.65
	Riparian Meadow + Pilot Channel + Woody Vegetation (70 stems per acre) + Slackwater	1.25	41.77	52.21	2.10	5.03	10.55	2.57	3.76	9.66				72.42
	Riparian Meadow + Pilot Channel + Woody Vegetation (30 stems per acre) + Wetlands	1.20	41.77	50.09	2.05	8.79	17.99				1.45	5.20	7.54	75.62
	Riparian Meadow + Pilot Channel + Woody Vegetation (70 stems per acre) + Wetlands	1.20	41.77	50.09	2.05	5.03	10.29	2.52	3.76	9.47	1.45	5.20	7.54	77.40
	Riparian Meadow + Pilot Channel + Woody Vegetation (30 stems per acre) + Slackwater+Wetlands	1.25	41.77	52.21	2.10	8.79	18.43				1.45	5.20	7.54	78.18
	Riparian Meadow + Pilot Channel + Woody Vegetation (70 stems per acre) + Slackwater+Wetlands	1.25	41.77	52.21	2.10	5.03	10.55	2.57	3.76	9.66	1.45	5.20	7.54	79.96
Apache Creek	Riparian Meadow	1.09	34.02	37.20										37.20
	Riparian Meadow + Pilot Channel	1.11	34.02	37.73										37.73
	Riparian Meadow + Pilot Channel + Woody Vegetation (30 stems per acre)	1.11	27.22	30.19	1.96	6.80	13.30							43.49
	Riparian Meadow + Pilot Channel + Woody Vegetation (70 stems per acre)	1.11	27.22	30.19	1.96	2.00	3.91	2.43	4.80	11.66				45.76
	Riparian Meadow + Pilot Channel + Slackwater	1.13	34.02	38.27										38.27
	Riparian Meadow + Pilot Channel + Woody Vegetation (30 stems per acre) + Slackwater	1.13	27.22	30.62	1.97	6.80	13.41							44.03
	Riparian Meadow + Pilot Channel + Woody Vegetation (70 stems per acre) + Slackwater	1.13	27.22	30.62	1.97	2.00	3.94	2.44	4.80	11.73				46.30

Table 6. Calculation of Total Avian Community Units for Year 50

Stream	Plan	Non Woody Vegetation Avian IBI (Riparian Meadow, Pilot Channel, Slackwater)	Non Woody Vegetation Acres	Non Woody Vegetation Avian Community Units	Avian IBI for 30 Stems per Acre	Total Acreage for 30 Stems per Acre	Avian Community Units for 30 Stems per Acre	Avian IBI for 70 Stems per Acre	Acreage for 70 Stems per Acre	Avian Community Units for 70 Stems per Acre	Avian IBI for Wetlands	Acreage for Wetlands	Avian Community Units for Wetlands	Total Avian Community Units
San Pedro Creek	Riparian Meadow	1.11	67.35	74.77										74.77
	Riparian Meadow + Pilot Channel	1.16	67.35	78.18										78.18
	Riparian Meadow + Pilot Channel + Woody Vegetation (30 stems per acre)	1.16	50.24	58.32	2.48	17.11	42.44							100.76
	Riparian Meadow + Pilot Channel + Woody Vegetation (70 stems per acre)	1.16	50.24	58.32	2.48	9.14	22.67	3.02	7.97	24.03				105.02
	Riparian Meadow + Pilot Channel + Slackwater	1.21	67.35	81.59										81.59
	Riparian Meadow + Pilot Channel + Woody Vegetation (30 stems per acre) + Slackwater	1.21	50.24	60.86	2.53	17.11	43.31							104.17
	Riparian Meadow + Pilot Channel + Woody Vegetation (70 stems per acre) + Slackwater	1.21	50.24	60.86	2.53	9.14	23.13	3.07	7.97	24.44				108.43
Alazán Creek	Riparian Meadow	1.15	70.35	80.82										80.82
	Riparian Meadow + Pilot Channel	1.20	70.35	84.39										84.39
	Riparian Meadow + Pilot Channel + Woody Vegetation (30 stems per acre)	1.20	58.02	69.60	2.52	12.33	31.06							100.66
	Riparian Meadow + Pilot Channel + Woody Vegetation (70 stems per acre)	1.20	58.02	69.60	2.52	7.86	19.80	3.05	4.47	13.65				103.05
	Riparian Meadow + Pilot Channel + Slackwater	1.25	70.35	87.95										87.95
	Riparian Meadow + Pilot Channel + Woody Vegetation (30 stems per acre) + Slackwater	1.25	58.02	72.54	2.57	12.33	31.69							104.22
	Riparian Meadow + Pilot Channel + Woody Vegetation (70 stems per acre) + Slackwater	1.25	58.02	72.54	2.57	7.86	20.20	3.10	4.47	13.88				106.61
Martínez Creek	Riparian Meadow	1.15	50.56	58.08										58.08
	Riparian Meadow + Pilot Channel	1.20	50.56	60.64										60.64
	Riparian Meadow + Pilot Channel + Woody Vegetation (30 stems per acre)	1.20	41.77	50.10	2.52	8.79	22.14							72.24
	Riparian Meadow + Pilot Channel + Woody Vegetation (70 stems per acre)	1.20	41.77	50.10	2.52	5.03	12.67	3.05	3.76	11.48				74.25
	Riparian Meadow + Pilot Channel + Slackwater	1.25	50.56	63.20										63.20
	Riparian Meadow + Pilot Channel + Wetland	1.20	50.56	60.64							1.45	5.20	7.54	68.18
	Riparian Meadow + Pilot Channel + Slackwater + Wetland	1.25	50.56	63.20							1.45	5.20	7.54	70.74
	Riparian Meadow + Pilot Channel + Woody Vegetation (30 stems per acre) + Slackwater	1.25	41.77	52.21	2.57	8.79	22.59							74.80
Riparian Meadow + Pilot Channel + Woody Vegetation (70 stems per acre) + Slackwater	1.25	41.77	52.21	2.57	5.03	12.93	3.10	3.76	11.67				76.81	

Stream	Plan	Non Woody Vegetation Avian IBI (Riparian Meadow, Pilot Channel, Slackwater)	Non Woody Vegetation Acres	Non Woody Vegetation Avian Community Units	Avian IBI for 30 Stems per Acre	Total Acreage for 30 Stems per Acre	Avian Community Units for 30 Stems per Acre	Avian IBI for 70 Stems per Acre	Acreage for 70 Stems per Acre	Avian Community Units for 70 Stems per Acre	Avian IBI for Wetlands	Acreage for Wetlands	Avian Community Units for Wetlands	Total Avian Community Units
	Riparian Meadow + Pilot Channel + Woody Vegetation (30 stems per acre) + Wetlands	1.20	41.77	50.10	2.52	8.79	22.14				1.45	5.20	7.54	79.78
	Riparian Meadow + Pilot Channel + Woody Vegetation (70 stems per acre) + Wetlands	1.20	41.77	50.10	2.52	5.03	12.67	3.05	3.76	11.48	1.45	5.20	7.54	81.79
	Riparian Meadow + Pilot Channel + Woody Vegetation (30 stems per acre) + Slackwater+Wetlands	1.25	41.77	52.21	2.57	8.79	22.59				1.45	5.20	7.54	82.33
	Riparian Meadow + Pilot Channel + Woody Vegetation (70 stems per acre) + Slackwater+Wetlands	1.25	41.77	52.21	2.57	5.03	12.93	3.10	3.76	11.67	1.45	5.20	7.54	84.35
Apache Creek	Riparian Meadow	1.09	34.02	37.20										37.20
	Riparian Meadow + Pilot Channel	1.11	34.02	37.73										37.73
	Riparian Meadow + Pilot Channel + Woody Vegetation (30 stems per acre)	1.11	27.22	30.19	2.43	6.82	16.52							46.71
	Riparian Meadow + Pilot Channel + Woody Vegetation (70 stems per acre)	1.11	27.22	30.19	2.43	2.00	4.86	2.96	4.80	14.23				49.28
	Riparian Meadow + Pilot Channel + Slackwater	1.13	34.02	38.27										38.27
	Riparian Meadow + Pilot Channel + Woody Vegetation (30 stems per acre) + Slackwater	1.13	27.22	30.62	2.44	6.82	16.62							47.24
	Riparian Meadow + Pilot Channel + Woody Vegetation (70 stems per acre) + Slackwater	1.13	27.22	30.62	2.44	2.00	4.89	2.98	4.80	14.30				49.82

Table 7. Calculation of Total Avian Community Units for Year 75

Stream	Plan	Non Woody Vegetation Avian IBI (Riparian Meadow, Pilot Channel, Slackwater)	Non Woody Vegetation Acres	Non Woody Vegetation Avian Community Units	Avian IBI for 30 Stems per Acre	Total Acreage for 30 Stems per Acre	Avian Community Units for 30 Stems per Acre	Avian IBI for 70 Stems per Acre	Acreage for 70 Stems per Acre	Avian Community Units for 70 Stems per Acre	Avian IBI for Wetlands	Acreage for Wetlands	Avian Community Units for Wetlands	Total Avian Community Units
San Pedro Creek	Riparian Meadow	1.11	67.35	74.77										74.77
	Riparian Meadow + Pilot Channel	1.16	67.35	78.18										78.18
	Riparian Meadow + Pilot Channel + Woody Vegetation (30 stems per acre)	1.16	50.24	58.32	2.48	17.11	42.44							100.76
	Riparian Meadow + Pilot Channel + Woody Vegetation (70 stems per acre)	1.16	50.24	58.32	2.48	9.14	22.67	3.02	7.97	24.03				105.02
	Riparian Meadow + Pilot Channel + Slackwater	1.21	67.35	81.59										81.59
	Riparian Meadow + Pilot Channel + Woody Vegetation (30 stems per acre) + Slackwater	1.21	50.24	60.86	2.53	17.11	43.31							104.17
	Riparian Meadow + Pilot Channel + Woody Vegetation (70 stems per acre) + Slackwater	1.21	50.24	60.86	2.53	9.14	23.13	3.07	7.97	24.44				108.43
Alazán Creek	Riparian Meadow	1.15	70.35	80.82										80.82
	Riparian Meadow + Pilot Channel	1.20	70.35	84.39										84.39
	Riparian Meadow + Pilot Channel + Woody Vegetation (30 stems per acre)	1.20	58.02	69.60	2.52	12.33	31.06							100.66
	Riparian Meadow + Pilot Channel + Woody Vegetation (70 stems per acre)	1.20	58.02	69.60	2.52	7.86	19.80	3.05	4.47	13.65				103.05
	Riparian Meadow + Pilot Channel + Slackwater	1.25	70.35	87.95										87.95
	Riparian Meadow + Pilot Channel + Woody Vegetation (30 stems per acre) + Slackwater	1.25	58.02	72.54	2.57	12.33	31.69							104.22
	Riparian Meadow + Pilot Channel + Woody Vegetation (70 stems per acre) + Slackwater	1.25	58.02	72.54	2.57	7.86	20.20	3.10	4.47	13.88				106.61
Martinez Creek	Riparian Meadow	1.15	50.56	58.08										58.08
	Riparian Meadow + Pilot Channel	1.20	50.56	60.64										60.64
	Riparian Meadow + Pilot Channel + Woody Vegetation (30 stems per acre)	1.20	41.77	50.09	2.52	8.79	22.14							72.24
	Riparian Meadow + Pilot Channel + Woody Vegetation (70 stems per acre)	1.20	41.77	50.09	2.52	5.03	12.67	3.05	3.76	11.48				74.25
	Riparian Meadow + Pilot Channel + Slackwater	1.25	50.56	63.20										63.20
	Riparian Meadow + Pilot Channel + Wetland	1.20	50.56	60.64							1.45	5.20	7.54	68.18

Stream	Plan	Non Woody Vegetation Avian IBI (Riparian Meadow, Pilot Channel, Slackwater)	Non Woody Vegetation Acres	Non Woody Vegetation Avian Community Units	Avian IBI for 30 Stems per Acre	Total Acreage for 30 Stems per Acre	Avian Community Units for 30 Stems per Acre	Avian IBI for 70 Stems per Acre	Acreage for 70 Stems per Acre	Avian Community Units for 70 Stems per Acre	Avian IBI for Wetlands	Acreage for Wetlands	Avian Community Units for Wetlands	Total Avian Community Units
	Riparian Meadow + Pilot Channel + Slackwater + Wetland	1.25	50.56	63.20							1.45	5.20	7.54	70.74
	Riparian Meadow + Pilot Channel + Woody Vegetation (30 stems per acre) + Slackwater	1.25	41.77	52.21	2.57	8.79	22.59							74.80
	Riparian Meadow + Pilot Channel + Woody Vegetation (70 stems per acre) + Slackwater	1.25	41.77	52.21	2.57	5.03	12.93	3.10	3.76	11.67				76.81
	Riparian Meadow + Pilot Channel + Woody Vegetation (30 stems per acre) + Wetlands	1.20	41.77	50.09	2.52	8.79	22.14				1.45	5.20	7.54	79.78
	Riparian Meadow + Pilot Channel + Woody Vegetation (70 stems per acre) + Wetlands	1.20	41.77	50.09	2.52	5.03	12.67	3.05	3.76	11.48	1.45	5.20	7.54	81.79
	Riparian Meadow + Pilot Channel + Woody Vegetation (30 stems per acre) + Slackwater+Wetlands	1.25	41.77	52.21	2.57	8.79	22.59				1.45	5.20	7.54	82.34
	Riparian Meadow + Pilot Channel + Woody Vegetation (70 stems per acre) + Slackwater+Wetlands	1.25	41.77	52.21	2.57	5.03	12.93	3.10	3.76	11.67	1.45	5.20	7.54	84.35
Apache Creek	Riparian Meadow	1.09	34.02	37.20										37.20
	Riparian Meadow + Pilot Channel	1.11	34.02	37.73										37.73
	Riparian Meadow + Pilot Channel + Woody Vegetation (30 stems per acre)	1.11	27.22	30.19	2.43	6.80	16.52							46.71
	Riparian Meadow + Pilot Channel + Woody Vegetation (70 stems per acre)	1.11	27.22	30.19	2.43	2.00	4.86	2.96	4.80	14.23				49.28
	Riparian Meadow + Pilot Channel + Slackwater	1.13	34.02	38.27										38.27
	Riparian Meadow + Pilot Channel + Woody Vegetation (30 stems per acre) + Slackwater	1.13	27.22	30.62	2.44	6.80	16.62							47.25
	Riparian Meadow + Pilot Channel + Woody Vegetation (70 stems per acre) + Slackwater	1.13	27.22	30.62	2.44	2.00	4.89	2.98	4.80	14.30				49.82

Table 8. Average Annual ABI

Stream	Measure	Year						Average Annual Avian Community Units
		0	1	15	25	50	75	
San Pedro Creek	Riparian Meadow	61.54	74.77	74.77	74.77	74.77	74.77	74.27
	Riparian Meadow + Pilot Channel	61.54	78.18	78.18	78.18	78.18	78.18	77.66
	Riparian Meadow + Pilot Channel + Woody Vegetation (30 stems per acre)	61.54	78.18	86.49	92.67	100.76	100.76	93.66
	Riparian Meadow + Pilot Channel + Woody Vegetation (70 stems per acre)	61.54	78.18	89.32	96.44	105.02	105.02	97.12
	Riparian Meadow + Pilot Channel + Slackwater	61.54	81.59	81.59	81.59	81.59	81.59	81.05
	Riparian Meadow + Pilot Channel + Woody Vegetation (30 stems per acre) + Slackwater	61.54	81.59	89.90	96.08	104.17	104.17	97.05
	Riparian Meadow + Pilot Channel + Woody Vegetation (70 stems per acre) + Slackwater	61.54	81.59	92.73	99.85	108.43	108.43	100.51
	Alazán Creek	Riparian Meadow	64.69	80.82	80.82	80.82	80.82	80.82
Riparian Meadow + Pilot Channel		64.69	84.39	84.39	84.39	84.39	84.39	83.83
Riparian Meadow + Pilot Channel + Woody Vegetation (30 stems per acre)		64.69	84.39	90.38	94.83	100.66	100.66	95.35
Riparian Meadow + Pilot Channel + Woody Vegetation (70 stems per acre)		64.69	84.39	91.96	96.94	103.05	103.05	97.30
Riparian Meadow + Pilot Channel + Slackwater		64.69	87.95	87.95	87.95	87.95	87.95	87.36
Riparian Meadow + Pilot Channel + Woody Vegetation (30 stems per acre) + Slackwater		64.69	87.95	93.94	98.39	104.22	104.22	98.89
Riparian Meadow + Pilot Channel + Woody Vegetation (70 stems per acre) + Slackwater		64.69	87.95	95.30	100.50	106.61	106.61	100.80
Martinez Creek		Riparian Meadow	46.53	58.08	58.08	58.08	58.08	58.08
	Riparian Meadow + Pilot Channel	46.53	60.64	60.64	60.64	60.64	60.64	60.24
	Riparian Meadow + Pilot Channel + Woody Vegetation (30 stems per acre)	46.53	60.64	64.91	68.08	72.24	72.24	68.46
	Riparian Meadow + Pilot Channel + Woody Vegetation (70 stems per acre)	46.53	60.64	66.24	69.86	74.25	74.25	70.09
	Riparian Meadow + Pilot Channel + Slackwater	46.53	63.20	63.20	63.20	63.20	63.20	62.78
	Riparian Meadow + Pilot Channel + Wetland	46.53	68.18	68.18	68.18	68.18	68.18	67.73
	Riparian Meadow + Pilot Channel + Slackwater + Wetland	46.53	70.74	70.74	70.74	70.74	70.74	70.27
	Riparian Meadow + Pilot Channel + Woody Vegetation (30 stems per acre) + Slackwater	46.53	63.20	67.47	70.65	74.80	74.80	71.00
	Riparian Meadow + Pilot Channel + Woody Vegetation (70 stems per acre) + Slackwater	46.53	63.20	68.80	72.42	76.81	76.81	72.63
	Riparian Meadow + Pilot Channel + Woody Vegetation (30 stems per acre) + Wetlands	46.53	68.18	72.45	75.62	79.78	79.78	75.94
	Riparian Meadow + Pilot Channel + Woody Vegetation (70 stems per acre) + Wetlands	46.53	68.18	73.78	77.40	81.79	81.79	77.58
	Riparian Meadow + Pilot Channel + Woody Vegetation (30 stems per acre) + Slackwater+Wetlands	46.53	70.74	75.01	78.18	82.34	82.34	78.49
	Riparian Meadow + Pilot Channel + Woody Vegetation (70 stems per acre) + Slackwater+Wetlands	46.53	70.74	76.34	79.96	84.35	84.35	80.12
	Apache Creek	Riparian Meadow	31.97	37.20	37.20	37.20	37.20	37.20
Riparian Meadow + Pilot Channel		31.97	37.73	37.73	37.73	37.73	37.73	37.48
Riparian Meadow + Pilot Channel + Woody Vegetation (30 stems per acre)		31.97	37.73	41.04	43.49	46.71	46.71	43.84
Riparian Meadow + Pilot Channel + Woody Vegetation (70 stems per acre)		31.97	37.73	42.74	45.76	49.28	49.28	45.93
Riparian Meadow + Pilot Channel + Slackwater		31.97	38.27	38.27	38.27	38.27	38.27	38.02
Riparian Meadow + Pilot Channel + Woody Vegetation (30 stems per acre) + Slackwater		31.97	38.27	41.58	44.03	47.25	47.25	44.38
Riparian Meadow + Pilot Channel + Woody Vegetation (70 stems per acre) + Slackwater		31.97	38.27	43.28	46.30	49.82	49.82	46.46

Environmental restoration benefits are calculated by subtracting the future without-project avian community units from the with-project average annual avian community units. The resulting benefits are then used, along with annual costs, to identify cost effective plans and perform incremental cost analysis. The calculation of benefits (outputs) are shown in Table 9.

COSTS

Annual costs were calculated using the annualizer in IWR Planning Suite. A period of analysis of 75 years was used, along with a federal discount rate of 3.75% (per EGM13-01 dated 27 OCT 2012), and a construction time of 18 months. Prices are expressed in October 2012 dollars. Since all plans are expected to have similar annual operation and maintenance costs and monitoring costs, the values would not affect plan formulation or selection, and were not included in the analysis. First costs were developed the cost engineering section, including contingencies. Details of the development of costs can be found in the Cost Engineering Appendix. Table 10 provides first costs, interest during construction, and average annual costs for the measure combinations. First costs ranged from \$2.3 million (\$93,000 annual cost) for riparian meadow only in Apache Creek to \$17.9 million (\$736,000 annual cost) for riparian meadow, pilot channel, slackwater, wetlands, and 70/30 trees per acre in Martinez Creek.

Table 9. Calculation of Benefits (Output)

Stream	Plan	Future Without Project			Future With Project			
		Avian IBI	Acres	Avian Community Unit	Acres	Average Annual Avian Community Unit	Benefits Average Annual Avian Community Units (Output)	
San Pedro Creek	Riparian Meadow	0.913683	67.35	61.53655	67.35	74.27136	12.73481	
	Riparian Meadow + Pilot Channel	0.913683	67.35	61.53655	67.35	77.65872	16.12217	
	Riparian Meadow + Pilot Channel + Woody Vegetation (30 stems per acre)	0.913683	67.35	61.53655	67.35	93.65845	32.1219	
	Riparian Meadow + Pilot Channel + Woody Vegetation (70 stems per acre)	0.913683	67.35	61.53655	67.35	97.12074	35.58419	
	Riparian Meadow + Pilot Channel + Slackwater	0.913683	67.35	61.53655	67.35	81.04609	19.50954	
	Riparian Meadow + Pilot Channel + Woody Vegetation (30 stems per acre) + Slackwater	0.913683	67.35	61.53655	67.35	97.04702	35.51047	
	Riparian Meadow + Pilot Channel + Woody Vegetation (70 stems per acre) + Slackwater	0.913683	67.35	61.53655	67.35	100.5093	38.97276	
	Alazán Creek	Riparian Meadow	0.919491	70.35	64.68619	70.35	80.28135	15.59516
Riparian Meadow + Pilot Channel		0.919491	70.35	64.68619	70.35	83.82717	19.14098	
Riparian Meadow + Pilot Channel + Woody Vegetation (30 stems per acre)		0.919491	70.35	64.68619	70.35	95.35475	30.66856	
Riparian Meadow + Pilot Channel + Woody Vegetation (70 stems per acre)		0.919491	70.35	64.68619	70.35	97.29697	32.61078	
Riparian Meadow + Pilot Channel + Slackwater		0.919491	70.35	64.68619	70.35	87.36366	22.67746	
Riparian Meadow + Pilot Channel + Woody Vegetation (30 stems per acre) + Slackwater		0.919491	70.35	64.68619	70.35	98.89363	34.20744	
Riparian Meadow + Pilot Channel + Woody Vegetation (70 stems per acre) + Slackwater		0.919491	70.35	64.68619	70.35	100.799	36.11277	
Martinez Creek		Riparian Meadow	0.920196	50.56	46.52511	50.56	57.69275	11.16764
	Riparian Meadow + Pilot Channel	0.920196	50.56	46.52511	50.56	60.23575	13.71064	
	Riparian Meadow + Pilot Channel + Woody Vegetation (30 stems per acre)	0.920196	50.56	46.52511	50.56	68.45646	21.93135	
	Riparian Meadow + Pilot Channel + Woody Vegetation (70 stems per acre)	0.920196	50.56	46.52511	50.56	70.08925	23.56414	
	Riparian Meadow + Pilot Channel + Slackwater	0.920196	50.56	46.52511	50.56	62.77875	16.25364	
	Riparian Meadow + Pilot Channel + Wetland	0.920196	50.56	46.52511	55.76	67.72526	21.20015	
	Riparian Meadow + Pilot Channel + Slackwater + Wetland	0.920196	50.56	46.52511	55.76	70.26826	23.74315	
	Riparian Meadow + Pilot Channel + Woody Vegetation (30 stems per acre) + Slackwater	0.920196	50.56	46.52511	50.56	70.99986	24.47475	
	Riparian Meadow + Pilot Channel + Woody Vegetation (70 stems per acre) + Slackwater	0.920196	50.56	46.52511	50.56	72.63278	26.10767	
	Riparian Meadow + Pilot Channel + Woody Vegetation (30 stems per acre) + Wetlands	0.920196	50.56	46.52511	55.76	75.9433	29.41819	
	Riparian Meadow + Pilot Channel + Woody Vegetation (70 stems per acre) + Wetlands	0.920196	50.56	46.52511	55.76	77.57538	31.05027	
	Riparian Meadow + Pilot Channel + Woody Vegetation (30 stems per acre) + Slackwater+Wetlands	0.920196	50.56	46.52511	55.76	78.48657	31.96146	
	Riparian Meadow + Pilot Channel + Woody Vegetation (70 stems per acre) + Slackwater+Wetlands	0.920196	50.56	46.52511	55.76	80.12042	33.59531	
	Apache Creek	Riparian Meadow	0.939846	34.02	31.97356	34.02	36.92178	4.948216
		Riparian Meadow + Pilot Channel	0.939846	34.02	31.97356	34.02	37.47876	5.505194
Riparian Meadow + Pilot Channel + Woody Vegetation (30 stems per acre)		0.939846	34.02	31.97356	34.02	43.84279	11.86922	
Riparian Meadow + Pilot Channel + Woody Vegetation (70 stems per acre)		0.939846	34.02	31.97356	34.02	45.92924	13.95568	
Riparian Meadow + Pilot Channel + Slackwater		0.939846	34.02	31.97356	34.02	38.01507	6.041507	
Riparian Meadow + Pilot Channel + Woody Vegetation (30 stems per acre) + Slackwater		0.939846	34.02	31.97356	34.02	44.37816	12.4046	
Riparian Meadow + Pilot Channel + Woody Vegetation (70 stems per acre) + Slackwater		0.939846	34.02	31.97356	34.02	46.46449	14.49093	

Table 10. First Costs and Annual Costs (October 2012 dollars, 75 year period of analysis, 3.75% discount rate, 18 month construction period)

Stream	Plan	First Cost	Interest During Construction	Investment Cost	Annual Interest	Annual Principle	Total Annual Costs
San Pedro Creek	Riparian Meadow	\$5,602,146	\$148,734	\$5,750,880	\$215,658	\$14,555	\$230,213
	Riparian Meadow + Pilot Channel	13,510,677	358,702	13,869,379	520,102	35,103	555,205
	Riparian Meadow + Pilot Channel + Woody Vegetation (30 stems per acre)	13,557,982	359,958	13,917,940	521,923	35,226	557,149
	Riparian Meadow + Pilot Channel + Woody Vegetation (70 stems per acre)	13,588,627	360,772	13,949,399	523,102	35,306	558,408
	Riparian Meadow + Pilot Channel + Slackwater	13,952,155	370,423	14,322,578	537,097	36,250	573,347
	Riparian Meadow + Pilot Channel + Woody Vegetation (30 stems per acre) + Slackwater	13,999,460	371,679	14,371,139	538,918	36,373	575,291
	Riparian Meadow + Pilot Channel + Woody Vegetation (70 stems per acre) + Slackwater	14,030,105	372,493	14,402,598	540,097	36,453	576,550
Alazán Creek	Riparian Meadow	5,840,873	155,073	5,995,946	224,848	15,176	240,024
	Riparian Meadow + Pilot Channel	14,968,729	397,413	15,366,142	576,230	38,892	615,122
	Riparian Meadow + Pilot Channel + Woody Vegetation (30 stems per acre)	15,002,253	398,303	15,400,556	577,521	38,979	616,500
	Riparian Meadow + Pilot Channel + Woody Vegetation (70 stems per acre)	15,017,421	398,706	15,416,127	578,105	39,018	617,123
	Riparian Meadow + Pilot Channel + Slackwater	15,407,899	409,073	15,816,972	593,136	40,033	633,169
	Riparian Meadow + Pilot Channel + Woody Vegetaion (30 stems per acre) + Slackwater	15,441,423	409,963	15,851,386	594,427	40,120	634,547
	Riparian Meadow + Pilot Channel + Woody Vegetation (70 stems per acre) + Slackwater	15,456,591	410,366	15,866,957	595,011	40,159	635,170
Martinez Creek	Riparian Meadow	4,210,779	111,794	4,322,573	162,096	10,940	173,037
	Riparian Meadow + Pilot Channel	16,199,039	430,077	16,629,116	623,592	42,088	665,680
	Riparian Meadow + Pilot Channel + Woody Vegetation (30 stems per acre)	16,228,382	430,856	16,659,238	624,721	42,165	666,886
	Riparian Meadow + Pilot Channel + Woody Vegetation (70 stems per acre)	16,246,542	431,338	16,677,880	625,421	42,212	667,632
	Riparian Meadow + Pilot Channel + Slackwater	16,310,494	433,036	16,743,530	627,882	42,378	670,260

	Riparian Meadow + Pilot Channel + Wetland	17,743,650	471,086	18,214,736	683,053	46,101	729,154
	Riparian Meadow + Pilot Channel + Slackwater + Wetland	17,855,105	474,045	18,329,150	687,343	46,391	733,734
	Riparian Meadow + Pilot Channel + Woody Vegetation (30 stems per acre) + Slackwater	16,339,837	433,815	16,773,652	629,012	42,454	671,466
	Riparian Meadow + Pilot Channel + Woody Vegetation (70 stems per acre) + Slackwater	16,357,997	434,297	16,792,294	629,711	42,501	672,212
	Riparian Meadow + Pilot Channel + Woody Vegetation (30 stems per acre) + Wetlands	17,772,993	471,865	18,244,858	684,182	46,178	730,360
	Riparian Meadow + Pilot Channel + Woody Vegetation (70 stems per acre) + Wetlands	17,791,153	472,347	18,263,500	684,881	46,225	731,106
	Riparian Meadow + Pilot Channel + Woody Vegetation (30 stems per acre) + Slackwater+Wetlands	17,884,448	474,824	18,359,272	688,473	46,467	734,940
	Riparian Meadow + Pilot Channel + Woody Vegetation (70 stems per acre) + Slackwater+Wetlands	17,902,608	475,306	18,377,914	689,172	46,515	735,686
Apache Creek	Riparian Meadow	2,262,528	60,069	2,322,597	87,097	5,878	92,976
	Riparian Meadow + Pilot Channel	5,122,882	136,010	5,258,892	197,208	13,310	210,519
	Riparian Meadow + Pilot Channel + Woody Vegetation (30 stems per acre)	5,152,302	136,791	5,289,093	198,341	13,387	211,728
	Riparian Meadow + Pilot Channel + Woody Vegetation (70 stems per acre)	5,171,069	137,290	5,308,359	199,063	13,435	212,499
	Riparian Meadow + Pilot Channel + Slackwater	5,262,602	139,720	5,402,322	202,587	13,673	216,260
	Riparian Meadow + Pilot Channel + Woody Vegetation (30 stems per acre) + Slackwater	5,292,022	140,501	5,432,523	203,720	13,750	217,469
	Riparian Meadow + Pilot Channel + Woody Vegetation (70 stems per acre) + Slackwater	5,310,789	140,999	5,451,788	204,442	13,798	218,241

COST EFFECTIVENESS AND INCREMENTAL COST ANALYSIS

To conduct the cost CE/ICA analysis, environmental restoration benefits (increase in with-project average annual avian community units) and annual costs (expressed in thousands of dollars) were entered into IWR Planning Suite. This data is presented in Table 11. Using the 34 measures, the plan generator in the software was used to create all possible combinations of the measures. This resulted in 7,168 plans.

Table 11. Inputs for IWR Planning Suite CEICA Analysis

Stream	Measure	Average Annual Avian Community Benefit (Output)	Average Annual Costs (\$1,000)
San Pedro Creek	Riparian Meadow	12.73481	\$230.213
	Riparian Meadow + Pilot Channel	16.12217	555.205
	Riparian Meadow + Pilot Channel + Woody Vegetation (30 stems per acre)	32.12190	557.149
	Riparian Meadow + Pilot Channel + Woody Vegetation (70 stems per acre)	35.58419	558.408
	Riparian Meadow + Pilot Channel + Slackwater	19.50954	573.347
	Riparian Meadow + Pilot Channel + Woody Vegetation (30 stems per acre) + Slackwater	35.51047	575.291
	Riparian Meadow + Pilot Channel + Woody Vegetation (70 stems per acre) + Slackwater	38.97276	576.550
Alazán Creek	Riparian Meadow	15.59516	240.024
	Riparian Meadow + Pilot Channel	19.14098	615.122
	Riparian Meadow + Pilot Channel + Woody Vegetation (30 stems per acre)	30.66856	616.500
	Riparian Meadow + Pilot Channel + Woody Vegetation (70 stems per acre)	32.61078	617.123
	Riparian Meadow + Pilot Channel + Slackwater	22.67746	633.169
	Riparian Meadow + Pilot Channel + Woody Vegetation (30 stems per acre) + Slackwater	34.20744	634.547
	Riparian Meadow + Pilot Channel + Woody Vegetation (70 stems per acre) + Slackwater	36.11277	635.170
Martinez Creek	Riparian Meadow	11.16764	173.037
	Riparian Meadow + Pilot Channel	13.71064	665.680
	Riparian Meadow + Pilot Channel + Woody Vegetation (30 stems per acre)	21.93135	666.886
	Riparian Meadow + Pilot Channel + Woody Vegetation (70 stems per acre)	23.56414	667.632
	Riparian Meadow + Pilot Channel + Slackwater	16.25364	670.260
	Riparian Meadow + Pilot Channel + Wetland	21.20015	729.154
	Riparian Meadow + Pilot Channel + Slackwater + Wetland	23.74315	733.734
	Riparian Meadow + Pilot Channel + Woody Vegetation (30 stems per acre) + Slackwater	24.47475	671.466
	Riparian Meadow + Pilot Channel + Woody Vegetation (70 stems per acre) + Slackwater	26.10767	672.212
	Riparian Meadow + Pilot Channel + Woody Vegetation (30 stems per acre) + Wetlands	29.41819	730.360
	Riparian Meadow + Pilot Channel + Woody Vegetation (70 stems per acre) + Wetlands	31.05027	731.106
	Riparian Meadow + Pilot Channel + Woody Vegetation (30 stems per acre) + Slackwater+Wetlands	31.96146	734.940

Stream	Measure	Average Annual Avian Community Benefit (Output)	Average Annual Costs (\$1,000)
Apache Creek	Riparian Meadow + Pilot Channel + Woody Vegetation (70 stems per acre) + Slackwater+Wetlands	33.59531	735.686
	Riparian Meadow	4.94822	92.976
	Riparian Meadow + Pilot Channel	5.50519	210.519
	Riparian Meadow + Pilot Channel + Woody Vegetation (30 stems per acre)	11.86922	211.728
	Riparian Meadow + Pilot Channel + Woody Vegetation (70 stems per acre)	13.95568	212.499
	Riparian Meadow + Pilot Channel + Slackwater	6.04151	216.260
	Riparian Meadow + Pilot Channel + Woody Vegetation (30 stems per acre) + Slackwater	12.40460	217.469
	Riparian Meadow + Pilot Channel + Woody Vegetation (70 stems per acre) + Slackwater	14.49093	218.241

COST EFFECTIVENESS

Using the generated plans, their costs and benefits, a cost effective analysis was performed using the IWR Planning Suite Software. Of the 7,168 plans, 96 cost effective alternatives (including no action) were identified. From the cost effective alternatives, 7 (including the no action plan) were identified as “Best Buy” plans. The results of the analysis is shown graphically in Figure 1.

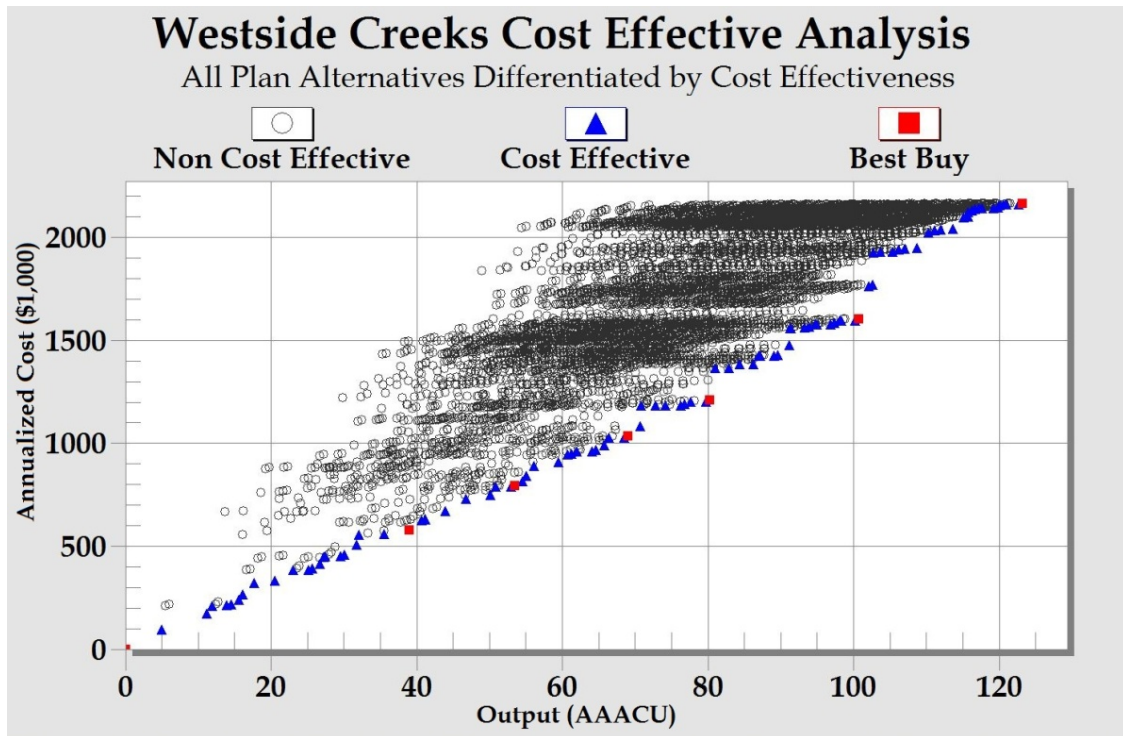


Figure 1. Cost Effective Results

INCREMENTAL COST ANALYSIS

Through incremental cost analysis, six action plans were identified as best buy plans. Those plans are:

- Alternative 2: Riparian meadow, pilot channel, riparian woody vegetation, and slackwater in San Pedro Creek.
- Alternative 3: Alternative 2 plus riparian meadow, pilot channel, riparian woody vegetation, and slackwater in Apache Creek.
- Alternative 4: Alternative 3 plus riparian meadow in Alazán Creek.
- Alternative 5: Alternative 4 plus riparian meadow in Martinez Creek
- Alternative 6: Alternative 5 plus pilot channel, riparian woody vegetation, and slackwater in Alazán Creek
- Alternative 7: Alternative 6 plus pilot channel, riparian woody vegetation, slackwater, and wetlands in Martinez Creek

Figure 2 presents the six “action” plans resulting from the incremental cost analysis showing the incremental average annual cost per incremental output and the environmental output (measured in AAACUs) for each alternative.

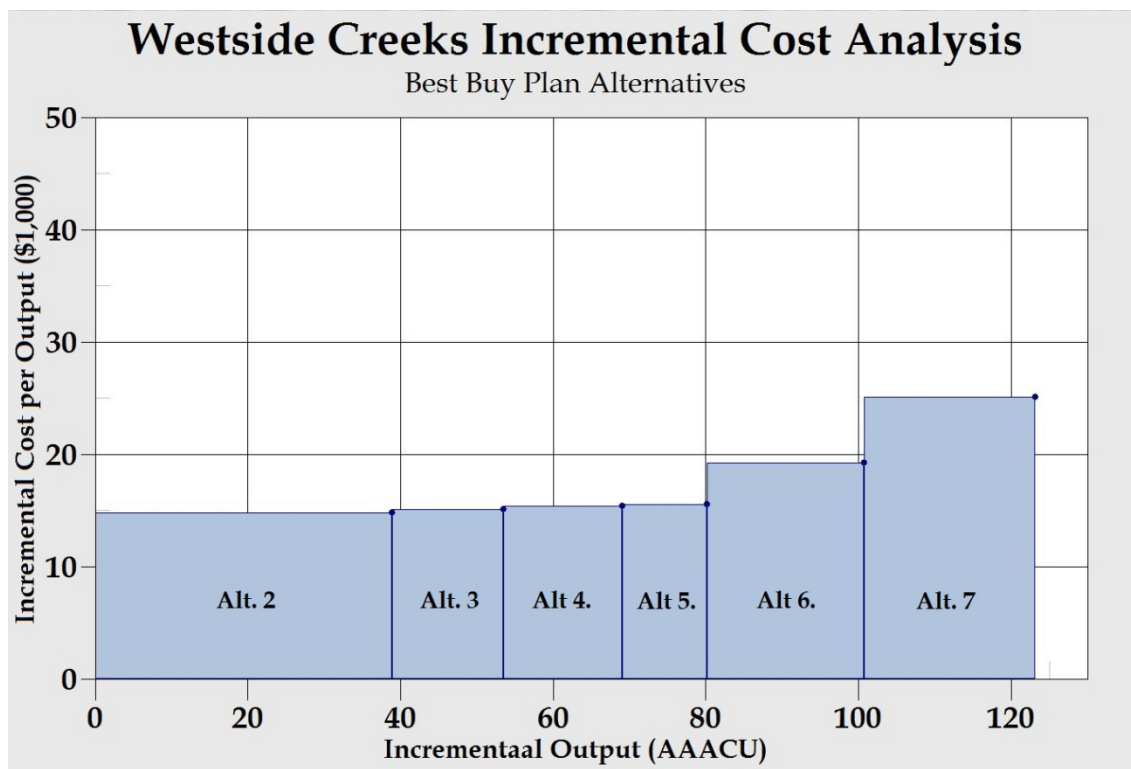


Figure 2. Incremental Cost and Output Results

Table 12 presents the incremental cost and outputs generated by the IWR Planning Suite

Table 12. Incremental Cost of Best Buy Plan Combinations

Alt.	Increment Added	Output (Avian Community Unit)	Annual Cost (\$1,000)	Average Annual Cost (\$1,000 / ACU)	Incremental Cost (\$1,000)	Incremental Output (Avian Community Unit)	Incremental Cost Per Incremental Output
1	No Action Plan on All Creeks	0	0				
2	San Pedro – Pilot Channel, Slackwater, 70/30 Woody Stems/Acre	38.97	\$576.55	\$14.7937	\$576.5500	38.9728	\$14.7937
3	Alternate 2 + Apache - Pilot Channel, Slackwater, 70/30 Woody Stems/Acre	53.46	794.79	14.8660	218.2410	14.4909	15.0605
4	Alternate 3 + Alazán Creek Riparian Meadow	69.06	1,034.82	14.9845	240.0240	15.5952	15.3909
5	Alternative 4 +Martinez Creek Riparian Meadow	80.23	1,207.85	15.0555	173.0370	11.1676	15.4945
6	Alternate 5 + Alazán Creek Pilot Channel, Slackwater, 70/30 Woody Stems/Acre	100.74	1,603.00	15.9116	395.1460	20.5176	19.2589
7	Alternate 6 + Martinez Creek Pilot Channel, Slackwater, Wetlands, 70/30 Woody Stems/Acre	123.17	2,165.65	17.5823	562.6490	22.4277	25.0873

Alternative 2 has increases the AAACUs by 39 units over the no action plan with an incremental cost per incremental output of \$15,000. The alternative's first cost is \$14 million, with an average annual cost of \$577 thousand.

Alternative 3 creates a total AAACU of 53 units, an increase of 14 over alternative 2. However, the incremental cost per incremental output remains at \$15,000, indicating no increases in costs for the last AAACU added over alternative 2. The first cost of alternative 3 is \$19 million, an increase of \$5 million from alternative 2. The average annual cost for the alternative 3 is \$795 thousand, an increase of 218 thousand from alternative 2.

Alternative 4 creates a total AAACU of 69 units over the no action plan, an increase of 16 AAACUs over alternative 3. The incremental cost per incremental output remains at \$15,000, indicating no increase in cost for the last AAACU added. The first cost of the alternative is \$25 million, an increase of \$6 million over alternative 3. The average annual cost is \$1 million, an increase of \$240 thousand over alternative 3.

Alternative 5 creates a total of 80 AAAACUs above the no action plan, which is an increase of 11 AACUs over alternative 4. The incremental cost per incremental output remains at \$15,000, indicating no increase in cost for the last unit of habitat added. The first cost is \$29 million, an increase of \$4 million over alternative 4. The average annual cost is \$1.2 million, an increase of \$200 thousand over alternative 4.

Alternative 6 creates a total of 101 AAACUs above the no action plan, and an increase of 21 AAACUs above alternative 5. With alternative 6, there is an increase in the incremental cost per incremental output to \$19 thousand, indicating the cost of the last added unit of habitat is greater than prior alternatives. The alternative's first cost is \$39 million, a \$10 million increase over alternative 5. The average annual cost is \$1.6 million, an increase of \$400 thousand over alternative 5.

Alternative 7 creates a total of 123 AAACUs above the no action plan, and an increase of 22 AAACUs over alternative 6. The incremental cost per incremental output is \$25 thousand, an increase of \$6 thousand over alternative 6, showing the last added ACCCU has an increasing

cost. The first cost is \$53 million, an increase of \$14 million over alternative 6. The average annual cost is \$2.2 million, an increase of \$600 thousand over alternative 6.

With the best buy plans identified and their incremental costs per incremental output calculated, each plan must be evaluated through an “Is It Worth It” analysis to make the case that each successive alternative is worth its incremental cost when compared to its incremental and total AAACU. Since the costs and AAACUs are measured in different units, this analysis is more qualitative than empirical. The “Is It Worth It” analysis for this study is presented in the plan formulation section of the main report.