Attachment 9: Economic Analysis – Flood Damage Reduction Costs and Benefits

Overview

The projects in the American River Basin (ARB) Integrated Regional Water Management (IRWM) Implementation Grant Proposal represent the region's current priorities and present a suite of projects that best contribute to meeting regional planning objectives. Overall, these projects can be grouped into three key categories that describe the regional linkages of the Proposal: Water Supply Reliability/Conjunctive Use, Efficient Water Use and Reuse, and Floodplain and Environmental Restoration, Protection and Improvement

Contained herein are five projects that focus on floodplain and environmental restoration, protection and improvement. These projects are summarized below:

- The **Antelope Creek Water Efficiency and Flood Control Improvement Project** (Project 5) is a multi-benefit project being proposed by the Placer County Flood Control and Water Conservation District and Placer County Water Agency (PCWA). The benefits of this project are so varied that this project could, in fact, fall under the Water Supply Reliability/ Conjunctive Use category, as well as the Efficient Water Use and Reuse category. It will consist of concrete gunite lining along PCWA's Antelope Canal, as well as an on-channel flood control weir along Antelope Creek. The project will meet multiple planning objectives by increasing flood protection, improving water supply and water quality, restoring local ecosystems and expanding an existing public recreation corridor. This project has high internal synergy as the reduced sedimentation from lining the canal will improve channel capacity to assist in the flood control measures of the project. The idea for this project spawned from participation in the ARB IRWM effort.
- The **Secret Ravine Fish Passage Improvement Project** (Project 2) restores natural channel and floodplain function and increases channel capacity, ensuring access during low-flow conditions to approximately 10 miles of potential spawning and rearing habitat upstream of the project site. The project will improve flood management by removing flow restricting barrier and reconnecting channel to the floodplain and also increase aquatic habitat available for salmonid spawning within the Dry Creek Watershed.
- The **Lower American River Mile 0.5R Aquatic and Riparian Enhancement** (Project 12) has been developed to increase the frequency of flooded habitat available for fish in the American and Sacramento Rivers during spring and winter, and to provide improved habitat for birds and other wildlife species. These enhancements will be achieved by lowering and re-grading the over-steepened river bank at the site and improving the quality of the upland habitat on the adjacent elevated floodplain. By widening the inundated area at river mile 0.5 of the lower American River and increasing flooded area, this project relieves flood flows in downstream areas.

- Similarly, the **Lower Cosumnes River Floodplain Restoration Project** (Project 13) improves riparian forest habitat and juvenile salmon rearing habitat by restoring historic floodplain hydrodynamics and riparian forest ecosystems. Additionally, this project is expected to ameliorate the impacts from low flood stage events by reconnecting the River to the floodplain and adding about 10% to the overall Cosumnes River floodplain, thereby increasing the floodplain's holding capacity, attenuating flood peak, and reducing water velocity.
- And finally, the **Sleepy Hollow Detention Basin Retrofit** (Project 15) will modify an existing flood detention basin in the Laguna Creek Watershed using low impact development techniques to create a multi-functional water resource feature, improving water quality and providing habitat for birds and aquatic animals. The desired outcome of intercepting flows will be a reduction of the 100-year water surface elevation in the basin.

Of these projects, one is expressly designed to provide flood damage reduction benefits in support of the region's stormwater and floodplain management objective to "provide the highest practicable level of achieving flood control and stormwater quality in the region." This project, the Antelope Creek Water Efficiency and Flood Control project, is the focus of this attachment. Flood control-related benefits, as they apply to the other projects referenced below have been addressed qualitatively in Attachment 8, Water Supply and Other Benefits.

Project 5: Antelope Creek Water Efficiency and Flood Control Improvement Project

Project Description

The Antelope Creek Water Efficiency and Flood Control Project (Project) site is located adjacent to Interstate 80, north of Atlantic Street on Antelope Creek in the City of Roseville. The proposed project concept is to construct two in-channel embankments and/or weirs spanning the main channel with culverts that have capacity for low to moderate flows. The embankments and/or weirs will detain higher flows to reduce peak flow rates downstream from the Project site. The locations of the structures are just upstream of the railroad bridge and Atlantic Street, at an existing bike path culvert, just downstream from Roseville Parkway. The Project is currently at a conceptual design stage, and the detailed designs will be developed at a later date. This evaluation assumes that arch structures would be used for the culverts to provide a natural stream bottom and that the embankment/weir at the bike path location would replace an existing culvert with one with more capacity. The structures would be designed to be overtopped in flood events.

The purpose of the Project is to reduce peak flows downstream from the Project site. The Project is separated into two phases: Phase 1 involves construction of a new structure near Atlantic Street, and Phase 2 involves replacement of the existing bike path crossing with a flow control structure that would improve low flow conveyance and increase the volume impounded before being overtopped. Figure 1 through Figure 3 illustrates the locations and a conceptual layout of the proposed weir/embankments.

The structure near Atlantic Street was modeled as a 10- to 12-foot high embankment on the floodplain with a Conspan Arch culvert with a span of 32 feet and a rise of 7.5 feet. The second weir will replace the existing bike bridge, raising the bridge deck about four to six feet. An embankment or wall will tie in the crest of the new structure to existing ground to limit overtopping to the desired area. The model assumed that the two existing 6.5-foot diameter culverts will be replaced with a Conspan Arch with a span of 20 feet and a rise of seven feet.

Figure 1: Proposed Project Location

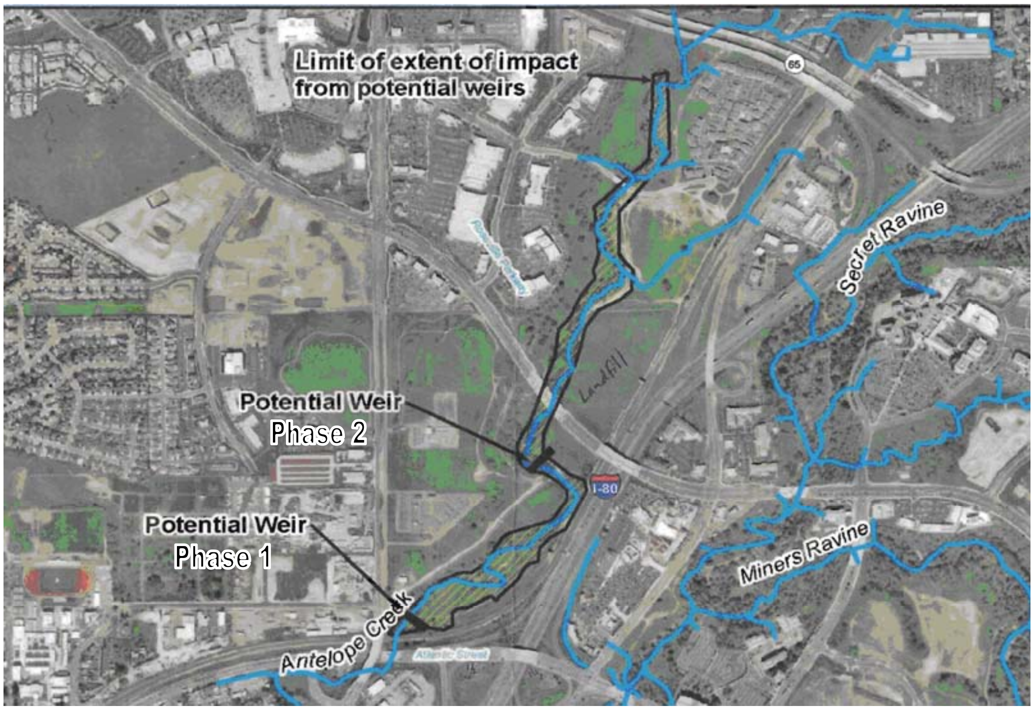
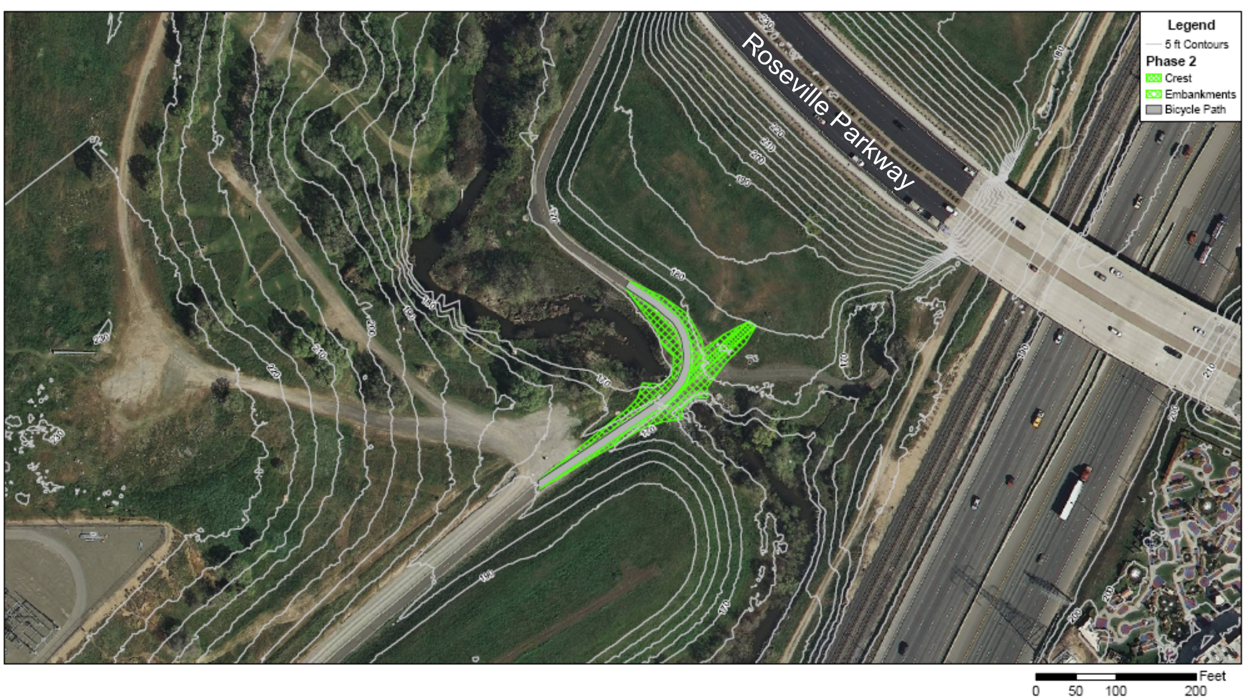


Figure 2: Conceptual Layout of Phase 1 - Construction of a New Structure near Atlantic Street

Figure 3: Conceptual Layout of Phase 2 - Replacement of the Existing Bike Path Crossing Downstream from Roseville Parkway



Costs

As documented in Attachment 4, the budgetary estimate for this Project is $1,667,227. Included in the Project budget are the initial costs associated with Project implementation. The full costs of implementing Phase 1 are included in the budget. Some of the costs associated with Phase 2 are also captured in the budget because certain administrative, engineering and environmental tasks (e.g. environmental documentation preparation) required for implementation of Phase 1 also apply to the Phase 2 project and those costs are not easily separated between the two phases.

Table 1 augments the costs presented in Attachment 4 with projected future operations, maintenance and replacement costs. Whereas Attachment 4 focuses on costs that are eligible for reimbursement under the Proposition 84 Integrated Regional Water Management Implementation Grant Program, this attachment describes the economic costs that will be incurred to accomplish full implementation of the Project (both Phases 1 and 2) and achieve the stated benefits. The total present value of the Phase 1 Project costs is $1,331,903 and is based on a 50-year project life cycle, which is consistent with the life cycle assumed in the flood damage reduction benefit analysis.

Table 1: Annual Cost of Project (referenced as Table 17 in Exhibit E of the Proposition 84 Implementation Grant PSP)

Annual Cost of Project Project: Antelope Creek Water Efficiency and Flood Control Project									
	Initial Costs	Operations and Maintenance Costs (1)						Discounting Calculations	
	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)
YEAR	Grand Total cost From Attachment 4 Project 5 (row (i), column (d))	Admin	Operation	Maintenance	Replacement	Other	Total Costs (a) +...+ (f)	Discount Factor	Discounted Costs (g) x (h)
2009							$0	1.000	$0
2010							$0	0.943	$0
2011	$24,907						$24,907	0.890	$22,167
2012	$218,950						$218,950	0.840	$183,918
2013	$694,223						$694,223	0.792	$549,825
2014	$729,147			$1,250	$1,250		$731,647	0.747	$546,540
2015				$1,250	$1,250		$2,500	0.705	$1,763
2016				$1,250	$1,250		$2,500	0.665	$1,663
2017				$1,250	$1,250		$2,500	0.627	$1,568
2018				$1,250	$1,250		$2,500	0.592	$1,480
2019				$1,250	$1,250		$2,500	0.558	$1,395
2020				$1,250	$1,250		$2,500	0.527	$1,318
2021				$1,250	$1,250		$2,500	0.497	$1,243
2022				$1,250	$1,250		$2,500	0.469	$1,173
2023				$1,250	$1,250		$2,500	0.442	$1,105
2024				$1,250	$1,250		$2,500	0.417	$1,043
2025				$1,250	$1,250		$2,500	0.394	$985
2026				$1,250	$1,250		$2,500	0.371	$928
2027				$1,250	$1,250		$2,500	0.350	$875
2028				$1,250	$1,250		$2,500	0.331	$828
2029				$1,250	$1,250		$2,500	0.312	$780
2030				$1,250	$1,250		$2,500	0.294	$735
2031				$1,250	$1,250		$2,500	0.278	$695
2032				$1,250	$1,250		$2,500	0.262	$655

Annual Cost of Project Project: Antelope Creek Water Efficiency and Flood Control Project								
	Initial Costs	Operations and Maintenance Costs (1)					Discounting Calculations	
	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)
YEAR	Grand Total cost From Attachment 4 Project 5 (row (i), column (d))	Admin	Operation	Maintenance	Replacement	Other	Total Costs (a) +...+ (f)	Discount Factor	Discounted Costs (g) x (h)
2033				$1,250	$1,250		$2,500.00	0.247	$618
2034				$1,250	$1,250		$2,500.00	0.233	$583
2035				$1,250	$1,250		$2,500.00	0.220	$550
2036				$1,250	$1,250		$2,500.00	0.207	$518
2037				$1,250	$1,250		$2,500.00	0.196	$490
2038				$1,250	$1,250		$2,500.00	0.185	$463
2039				$1,250	$1,250		$2,500.00	0.174	$435
2040				$1,250	$1,250		$2,500.00	0.164	$410
2041				$1,250	$1,250		$2,500.00	0.155	$388
2042				$1,250	$1,250		$2,500.00	0.146	$365
2043				$1,250	$1,250		$2,500.00	0.138	$345
2044				$1,250	$1,250		$2,500.00	0.130	$325
2045				$1,250	$1,250		$2,500.00	0.123	$308
2046				$1,250	$1,250		$2,500.00	0.116	$290
2047				$1,250	$1,250		$2,500.00	0.109	$273
2048				$1,250	$1,250		$2,500.00	0.103	$258
2049				$1,250	$1,250		$2,500.00	0.097	$243
2050				$1,250	$1,250		$2,500.00	0.092	$230
2051				$1,250	$1,250		$2,500.00	0.087	$218
2052				$1,250	$1,250		$2,500.00	0.082	$205
2053				$1,250	$1,250		$2,500.00	0.077	$193
2054				$1,250	$1,250		$2,500.00	0.073	$183
2055				$1,250	$1,250		$2,500.00	0.069	$173
2056				$1,250	$1,250		$2,500.00	0.065	$163
2057				$1,250	$1,250		$2,500.00	0.061	$153
2058				$1,250	$1,250		$2,500.00	0.058	$145

Annual Cost of Project

Project: Antelope Creek Water Efficiency and Flood Control Project

	Initial Costs	Operations and Maintenance Costs (1)						Discounting Calculations	
	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)
YEAR	Grand Total cost From Attachment 4 Project 5 (row (i), column (d))	Admin	Operation	Maintenance	Replacement	Other	Total Costs (a) +...+ (f)	Discount Factor	Discounted Costs (g) x (h)
2059				$1,250	$1,250		$2,500.00	0.054	$136
2060				$1,250	$1,250		$2,500.00	0.051	$128
2061				$1,250	$1,250		$2,500.00	0.048	$121
2062				$1,250	$1,250		$2,500.00	0.046	$114
2063				$1,250	$1,250		$2,500.00	0.043	$108
2064				$1,250	$1,250		$2,500.00	0.041	$101
Total Present Value of Discounted Costs (Sum of Column (i))									$1,331,903

Comments:
Both the water efficiency and flood control improvements that will be implemented are passive projects that do not have regular administrative or operational costs.

Maintenance and replacement costs for are included because the ALERT-type stream level and precipitation gauges that will be installed as part of the flood control improvements will require periodic maintenance and replacement. The National Weather Service's Weather Service Hydrology Handbook No. 2 notes that maintenance and life-cycle replacement costs each run around 10% of capital investment per year. For these calculations, 5% of the capital investment associated with the gauges is attributed to maintenance and the other 5% to replacement.

The "Without Project" Baseline

Antelope Creek is a perennial creek draining the northeast portion of the Dry Creek watershed. The mainstem is approximately 9.5 miles long and the watershed area is 21.4 square miles. The Antelope Creek system is composed of approximately 12.4 miles of intermittent tributaries in addition to the main tributary, Clover Valley Creek. The Aitken Reservoir is located within the Antelope Creek sub-watershed.

Antelope Creek and Miners Ravine combine with Clover Valley Creek and Secret Ravine, respectively, near Interstate 80 and Atlantic Street in Roseville to form Dry Creek. Cirby Creek, made up of the combination of Cirby and Linda Creeks and Strap Ravine, joins Dry Creek just upstream of Riverside Avenue in Roseville. Downstream of Roseville, just downstream of Elverta Road, Dry Creek branches into North Dry Creek and Dry Creek and forms Cherry Island in the Rio Linda area. Without the proposed project, the City of Roseville and unincorporated areas of Placer County will continue to be repeatedly damaged areas during storm events as a result of bank overtopping.

Flood Damage Reduction Benefits

This section describes the Flood Damage Reduction Analysis (FDRA) that was completed for the Project and presents the Expected Annual Damage (EAD) benefits that would result from the completion of the Project.

Hydrology and Hydraulic Analysis

Detailed hydrology and hydraulic models were developed for the 2010 update to the *Dry Creek Watershed Flood Control Study* (Plan Update). Hydrology models were developed for various levels of build-out in the Dry Creek watershed. This analysis used the 2007 existing conditions hydrology. As stipulated in Exhibit E (page 56, note 1) of the *Proposal Solicitation Package, Integrated Regional Water Management, Proposition 84, Implementation Round 1* (DWR, August 2010), both Without Project and With Project conditions are assessed based on existing conditions hydrology.

The Plan Update hydrology uses cloudburst centering per the Placer County Flood Control and Water Conservation District's (District's) hydrology procedures. The centerings are based on various locations and angle combinations. The Plan Update identified seven critical storm centerings that produced nearly all peak flows at key locations throughout the watershed. Three of the critical storm centerings, centered at locations in the Antelope Creek and Secret Ravine watersheds, produce the maximum peak flows at locations downstream from the Project site. The three critical storm centerings are AC5I at 0°, SE40M at 30°, and SE40N at 0°. Details related to the hydrology are available in the Plan Update.

An extensive unsteady-state HEC-RAS model was created for the Plan Update using existing models. The existing conditions HEC-RAS geometry that includes the District's Miners Ravine Off-Channel Detention Basin was used as the basis for the baseline (Without Project) conditions for this analysis. The model datum is NGVD 29. Maximum peak stages and maximum peak flows for each of the three centerings for the 10-year, 25-year, 50-year, and 100-year flow conditions were generated for the Without Project flow conditions, Project Phase 1 flow conditions, and Project Phase 2 flow conditions. Project Phase 2 flow conditions reflect both Phase 1 and Phase 2 being complete. For each recurrence interval and Project condition scenario, the maximum peak stage produced by the maximum of the three critical centerings was tabulated for use in the FDRA.

Table 2 lists peak stages at five example locations on Dry Creek, downstream of the Project site for each of the five recurrence intervals for the Without Project, Phase 1, and Phase 2 flow conditions.

Table 2: Maximum peak flood stage at sample locations for various scenarios

Without Project					
Recurrence Interval		10	25	50	100
Location	HEC-RAS River Station	Peak Stage (ft)	Peak Stage (ft)	Peak Stage (ft)	Peak Stage (ft)
Near Bernice Avenue	81041.20	145.2	147.1	148.4	150.0
Royer Park	77943	136.9	139.9	140.9	142.0
Near Earl Avenue	74433.10	131.1	133.2	134.4	135.3
Near Riverside Avenue	73756.6	129.7	131.7	132.8	133.4
Vernon Street	70071.60	124.0	126.1	127.2	129.2
Near Billy Mitchell Blvd	52140	93.9	95.7	96.5	97.3
Phase 1					
Recurrence Interval		10	25	50	100
Location	HEC-RAS River Station	Peak Stage (ft)	Peak Stage (ft)	Peak Stage (ft)	Peak Stage (ft)
Near Bernice Avenue	81041.20	145.1	147.0	148.2	149.8
Royer Park	77943	136.8	139.5	140.7	141.8
Near Earl Avenue	74433.10	131.0	133.1	134.3	135.1
Near Riverside Avenue	73756.6	129.6	131.6	132.7	133.3
Vernon Street	70071.60	124.0	126.0	127.1	129.1
Near Billy Mitchell Blvd	52140	93.9	95.6	96.5	97.2
Phase 2					
Recurrence Interval		10	25	50	100
Location	HEC-RAS River Station	Peak Stage (ft)	Peak Stage (ft)	Peak Stage (ft)	Peak Stage (ft)
Near Bernice Avenue	81041.20	145.0	146.8	148.0	149.6
Royer Park	77943	136.7	139.2	140.6	141.4
Near Earl Avenue	74433.10	130.9	133.0	134.2	135.0
Near Riverside Avenue	73756.6	129.6	131.5	132.6	133.2
Vernon Street	70071.60	123.9	125.9	126.9	129.1
Near Billy Mitchell Blvd	52140	93.9	95.6	96.4	97.1

Due to its proximity to locations of flood prone properties, Dry Creek at Vernon Street became, and continues to be used as, a reference location for flood impacts in the Dry Creek watershed. Figure 4 and Figure 5 illustrate the location of flood prone properties that could benefit from the proposed project, and Vernon Street at Dry Creek. Figure 6 presents the 100-year flow hydrographs for the existing conditions, Phase 1, and Phase 2 scenarios for the SE40N° 0 centering that generates maximum peak flow rates at Vernon Street. The maximum peak flow rate is reduced by about 530 cubic feet per second (cfs) following completion of Phase 1 and by about 1,000 cfs following completion of Phase 2.

Figure 4: Dry Creek Watershed Groups and Flood Prone Properties with Potential Benefits

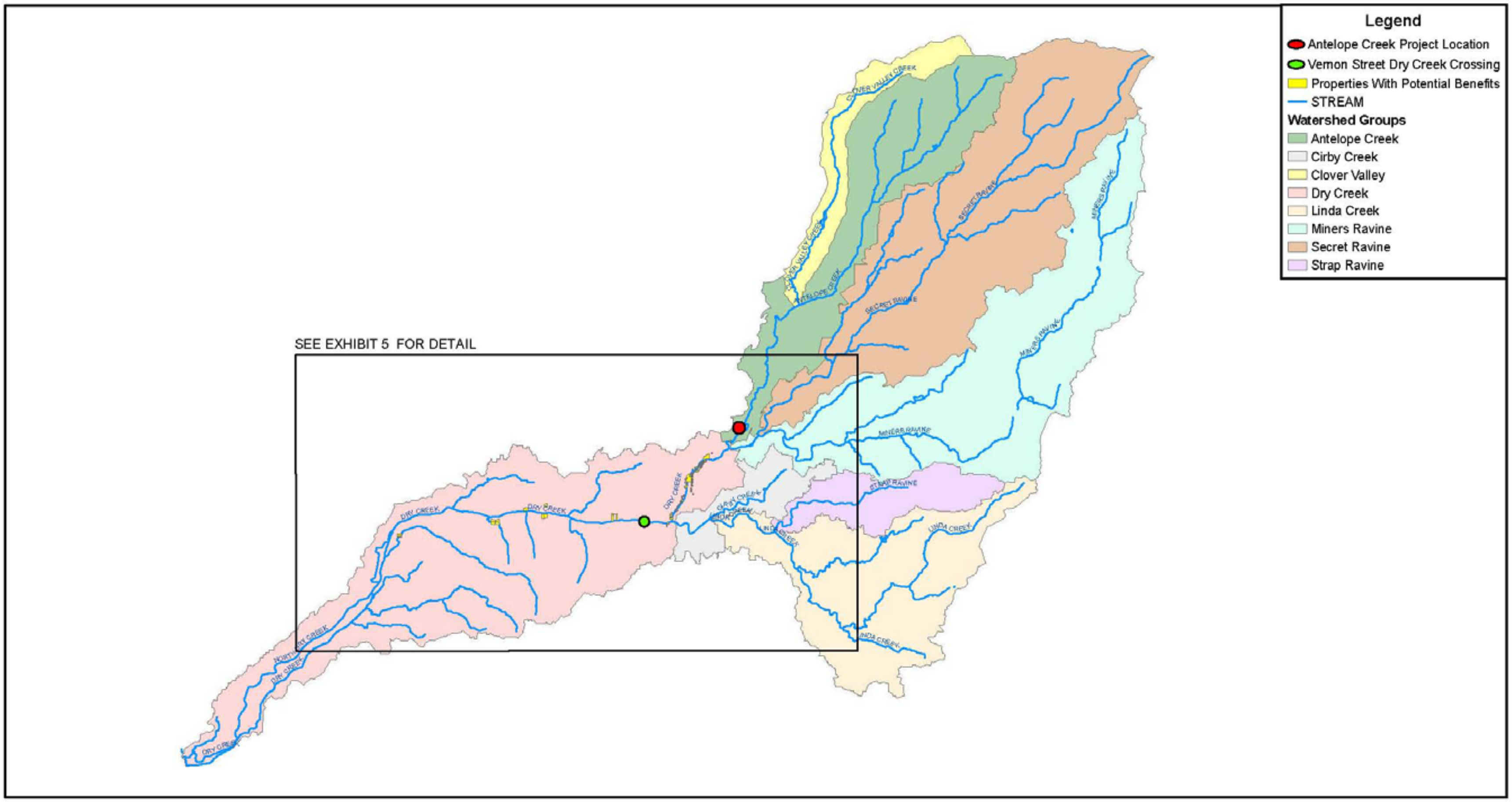


Figure 5: Detail of Project Area and Flood Prone Properties with Potential Benefits

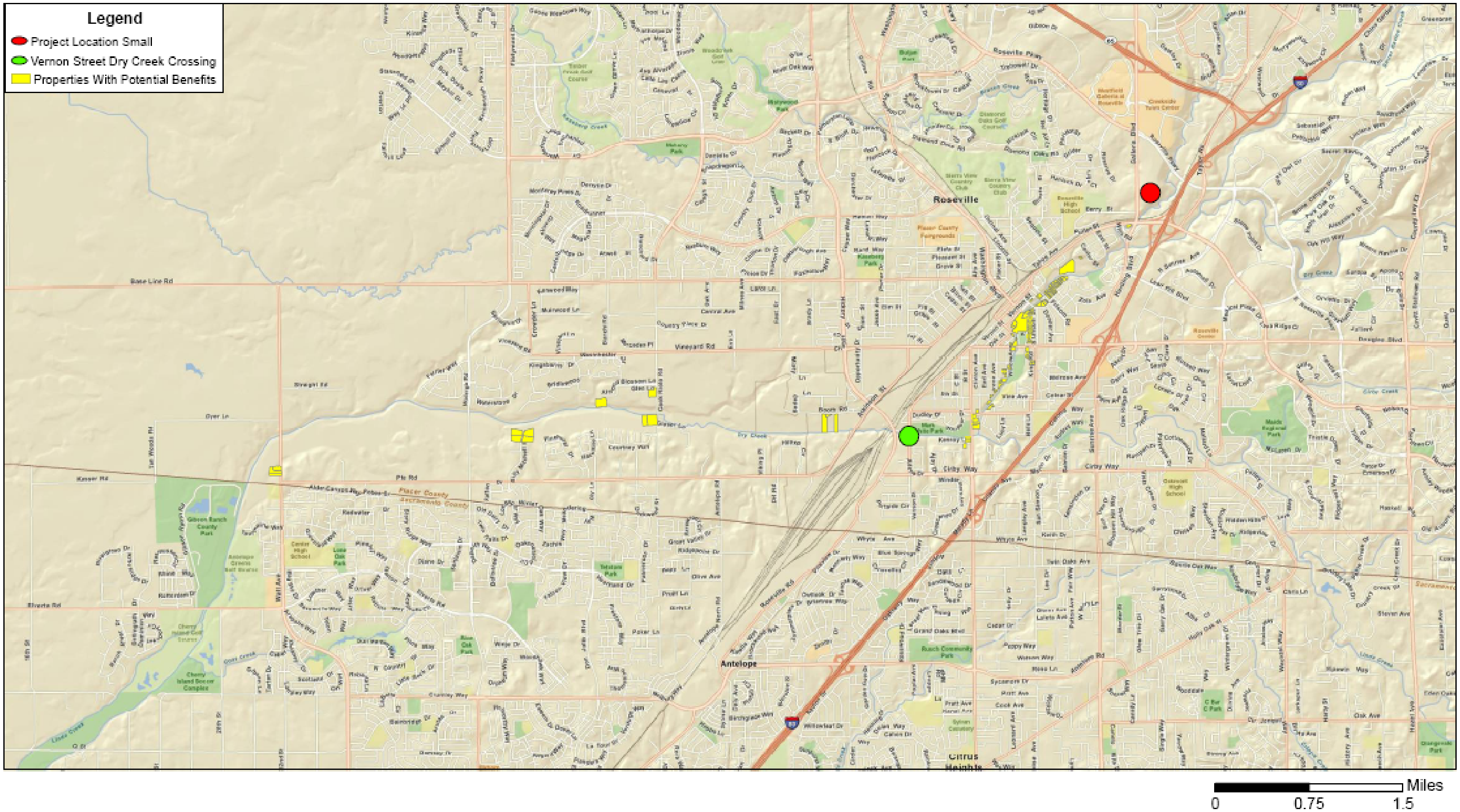
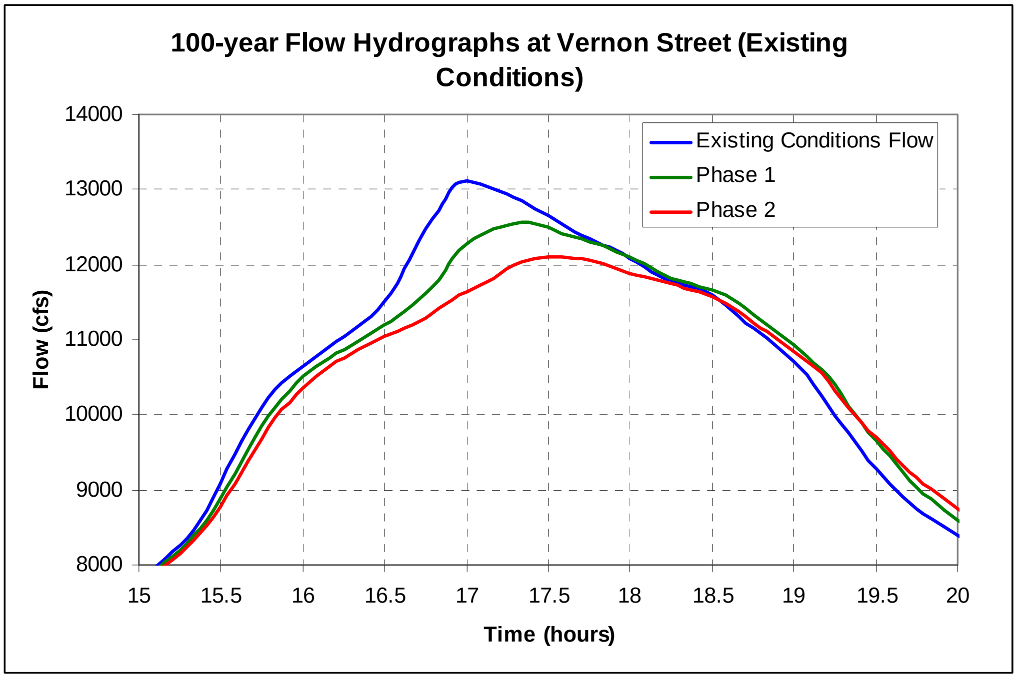


Figure 6: Flow Hydrographs for Vernon Street.



Flood Prone Properties

Information about parcels that have experienced flood damage was provided by the District and included separate databases for parcels within the City of Roseville and for parcels in unincorporated Placer County. The Placer County database contains high water marks for the 1995 flood event and flood depths for the 1983, 1986, and 1995 flood events. The District also provided 2008 LiDAR data (from the California Department of Water Resources [DWR]) in NAVD 88. By using the databases provided by the District and the LiDAR data, a total of 128 flood prone parcels were identified downstream of the Project.

Finished floor or lowest living area elevations were available for most parcels from the City of Roseville and Placer County flood prone parcel databases. Finished floor elevations were estimated from 2008 LiDAR and converted to the model datum for elevations were not available in the databases. Google Earth street view was also used to determine if finished floor elevations appeared to be close to ground elevations or if structures were raised. Finished floor elevations for 13 parcels were estimated in this manner.

The building size was also available from the databases for most buildings. For 21 buildings without an available building size, an estimate was obtained from Zillow.com, which acquires building size from publicly available records. For properties where the building size could not be acquired, the size was estimated using aerial imagery.

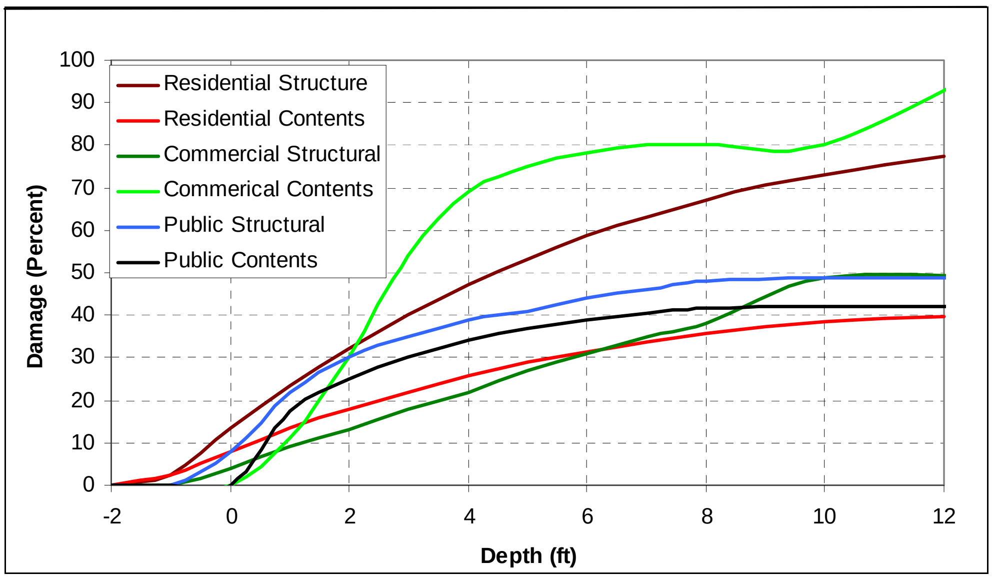
The database from the City of Roseville listed an estimated 1997 property value of $83.90 per square foot for living space and $22.10 per square foot for garage space. For the 2010 estimate, the property values were estimated to be $130 per square foot of living space and $30 per square foot of garage space.

Flood Damage Analysis

The flood damage analysis (FDA) was completed using HEC-FDA, a computer program developed by the US Army Corps of Engineers (USACE). HEC-FDA uses the stage and discharge data produced in HEC-RAS and structure information to develop damage-stage relationships and combines the damage-stage functions with discharge-exceedance probability and stage-discharge relationships. The model then applies a Monte Carlo simulation process to compute expected annual damage while accounting for uncertainty (See HEC-FDA User's Manual).

Depth damage curves published by both USACE and FEMA were used in the FDA (See USACE Economic Guidance Memorandum—EGM 04-01, *Generic Depth-Damage Relationships*, October 2003). The depth damage curves for residential, commercial, and public buildings are presented in Figure 7. All residential buildings are assumed to be 1-story without a basement.

Figure 7: Depth vs. Damage Curves



The structure value to content value ratio was assumed to be 0.50 for residential, commercial, and public buildings. Contents of structures may include equipment, furnishings, raw materials, and commercial inventory. A factor of plus or minus 0.25 feet was applied to the 100-year stage data to account for uncertainty.

HEC-FDA produced an expected annual damage results based on the structural damage curves and flood model described in this memo. The EAD based on structural damage only is presented in Table 3.

Table 3: Expected Annual Damage based on structural damage curves

Scenario	Expected Annual Damage	Expected Annual Damage Reduced
Without Project	$ 101,000	--
Phase 1	$ 97,000	$ 4,000
Phase 2	$ 89,000	$ 12,000

The event damage for structural damage only for the 2-, 10-, 25-, 50-, and 100-year recurrence intervals is presented in Table 4.

Table 4: Event Damage for Structural Damage Only
(referenced as Table 18 in Exhibit E of the Proposition 84 Implementation Grant PSP)

Hydrologic Event	Event Probability	Event Damage Without Project	Event Damage With Project Phase 1	Phase 1 Event Benefit	Event Damage With Project Phase 2	Phase 2 Event Benefit
10-year	0.10	$179,000	$176,000	$3,000	$172,000	$7,000
25-year	0.04	$745,000	$718,000	$27,000	$656,000	$89,000
50-year	0.02	$1,689,000	$1,679,000	$10,000	$1,527,000	$162,000
100-year	0.01	$2,505,000	$2,415,000	$90,000	$2,202,000	$303,000

Figure 8 presents the loss-probability curves. The expected annual damage reduction is the area between the curves.

Figure 8: Loss vs. Probability Curves

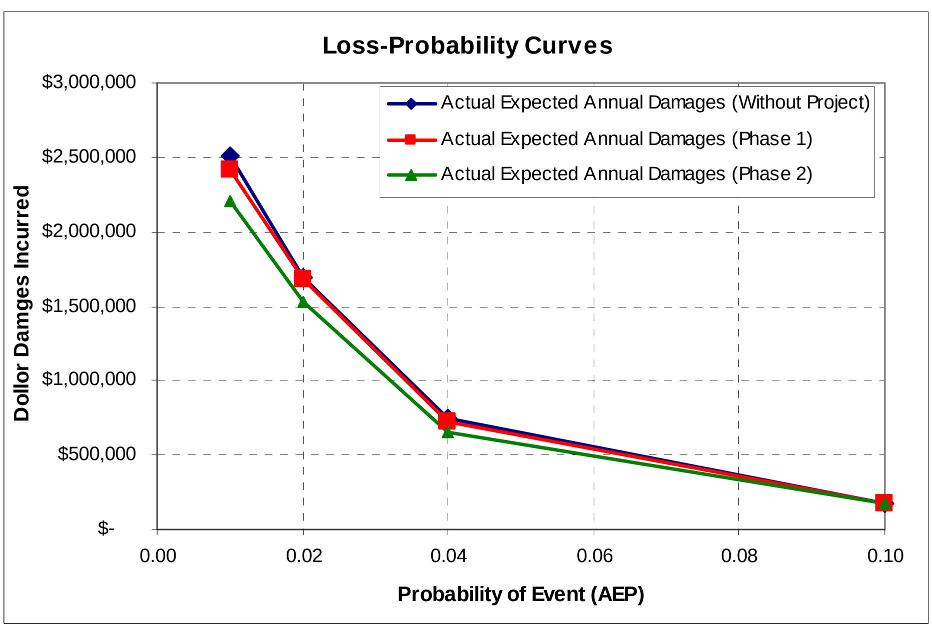


Table 5 presents the present value of future benefits of the Project, assuming an analysis period of 50 years with a 6% discount rate, consistent with DWR standard practice. The results are presented in the following section.

Table 5: Present Value of Expected Annual Damage Benefits (structural damage only)
(referenced as Table 19 in Exhibit E of the Proposition 84 Implementation Grant PSP)

Expected Annual Damage Without Project	$101,000
Expected Annual Damage with Phase 1	$97,000
Expected Damage Benefit	$4,000
Expected Annual Damage with Phase 1+2	$89,000
Expected Damage Benefit	$12,000
Present Value Coefficient	15.76
Present Value of Future Benefits (Phase 1)	***$64,000***
Present Value of Future Benefits (Phase 2)	***$190,000***

Adjustments to Flood Damage Analysis Results

Several adjustments were made to the EAD values to account for various non-building damages, such as clean-up and other non-structural costs that can be considered to be proportional to structural damage. Some of the additional adjustment factors were taken from DWR *Flood Rapid Assessment Model (F-RAM) Development*, (November 2008). These adjustments include:

- **Vehicle damage:** Street flooding can cause vehicle damage as flood waters rise above the vehicle floorboards. There is a used car lot on Riverside Avenue that has the potential for flood damage, and other vehicles would likely be damaged in the event of a flood. A small reduction in peak flood stage in a given event could cause a major reduction in automobile damage if flows remain below automobile floorboards. Assuming 100 vehicles would be damaged during a 100-year flood event with the vehicles experiencing 30% damage, and assuming an average vehicle value of $10,000, an estimate of $300,000 in vehicle damage may be expected for the 100-year flow event. This represents 12% of the estimated 100-year event structural damage.
- **Roadway inundation damage***:* A value of $30,000 per mile of inundated minor road is assumed in F-RAM. Using a conservative assumption of two miles of inundated minor roads (in the areas that would receive benefit from the Project) for the 100-year flood event, about $60,000 of damage to minor roads is expected. This is about 2% of the estimated 100-year event structural damage and damage reduction benefit can be assumed to be proportional to structural damage reduction benefit.

- **Bridge overtopping***:* Seven bridges are overtopped in the existing condition 100-year flood event downstream from the Project. While the Project does not prevent any of these bridges to be overtopped in the existing conditions 100-year flood event, the height of overtopping may be reduced. Also, the new Cook Riolo Road bridge is not indicated as being overtopped in the existing condition 100-year flood event, but the Plan Update does indicate that it would be overtopped in the 100-year flood event based on unmitigated build-out in the Dry Creek watershed. The Project may prevent the bridge from being overtopped for the 100-year build-out conditions, however, this study is based on existing hydrology and no bridge-related damage reduction was included for Cook Riolo Road. Furthermore, the benefit due to reduced overtopping of the other bridges is assumed to be negligible.
- **Other Factors:** Costs related to other factors include: emergency response services, loss of business income, temporary relocation, transportation system disruptions, loss of public services, damage to landscaping, and damage to other infrastructure such as sewer and power are not included in the structural damage estimates. Based on F-RAM documentation, indirect damages can be estimated as 25% of the direct damages to residential and commercial structures.

Factors for non-structural damage indicate that total damage can be expected to be at least 37% higher than structural damage based on property damage alone, not including loss of business to commercial and industrial enterprises, costs of flooding disruption to utilities (gas, electricity, water, sewerage, telecommunications and postal services), and costs imposed on public services, such as education and health services. To provide a reasonable comprehensive estimate for the flood reduction benefit of the project, the EAD for each scenario was increased by 50%. Table 6 presents the EAD adjusted by 50% to account for non-structural and indirect damages.

Table 6: Expected Annual Damage Adjusted for Non-Structural Factors

Scenario	Expected Annual Damage	Expected Annual Damage Reduced
Without Project	$ 151,000	--
Phase 1	$ 145,000	$ 6,000
Phase 2	$ 134,000	$ 17,000

Table 7 presents the present value of future benefits of the Project, assuming an analysis period of 50 years with a 6% discount rate, consistent with DWR standard practice.

Table 7: Expected Annual Damage Adjusted to Include Non-Structural Factors
(referenced as Table 19 in Exhibit E of the Proposition 84 Implementation Grant PSP)

Expected Annual Damage Without Project	$151,000
Expected Annual Damage with Phase 1	$145,000
Expected Damage Benefit	$6,000
Expected Annual Damage with Phase 2	$134,000
Expected Damage Benefit	$17,000
Present Value Coefficient	15.76
Present Value of Future Benefits (Phase 1)	***$95,000***
Present Value of Future Benefits (Phase 2)	***$268,000***

Conclusion

Even though Phases 1 and 2 of the Project would provide a significant flow reduction in a 100-year storm event, this reduction corresponds to only a relatively small (less than one-half foot) reduction in peak flood stage at key locations. Based on the HEC-FDA results, multiplied by 1.5 to account for non-structural and indirect damages, the present value of the expected benefit of Phase 1 is $95,000 and the expected benefit of the complete Project with Phase 2 is $268,000.

Though these results alone do not provide justification for the cost of the proposed project, other factors, such as increased benefit of other potential future regional projects and reducing measures necessary to provide 100-year protection to properties help justify the cost. Additionally, there are few potentially feasible regional flood reduction projects in the Dry Creek watershed, and the Antelope Creek Project was identified as being the most cost effective of the options available. Finally, the Project includes additional benefits besides flood reduction; these benefits which also help to justify the cost are presented in Attachment 7.

Supporting Documentation

The following supporting documents are included in this attachment:

- *Antelope Creek Water Efficiency and Flood Control Project Flood Damage Reduction Analysis* (RBF Consulting, December 28, 2010)
- *Miners Ravine Off-Channel Detention Basin Facility Mitigation Monitoring Plan* (Placer County Flood Control and Water Conservation District, January 2006)
- *Draft Update to the Dry Creek Watershed Flood Control Plan* (Placer County Flood Control and Water Conservation District, November 2010) - See separately bound document