Attachment 8

Water Quality and Other Expected Benefits

East Contra Costa County
Proposition 84 Round 1 Implementation Grant Proposal

ATTACHMENT 8 –
WATER QUALITY AND OTHER EXPECTED BENEFITS

This attachment describes the water quality and other expected benefits provided by the projects included within this proposal. In accordance with the PSP, the following details are provided for each of the projects:

- ✓ Narrative discussion of the estimates of without-project physical conditions
- ✓ Narrative discussion of the estimates of with-project physical conditions
- ✓ Description of methods used to estimate without- and with-project conditions
- ✓ Description of potential other benefits
- ✓ Description of the distribution of local, regional, and statewide benefits
- ✓ Identification of beneficiaries
- ✓ When benefits will be received
- ✓ Uncertainty of benefits
- ✓ Description of any adverse effects

Overview of Water Quality and Other Expected Benefits

This Proposal is expected to generate a wide variety of water quality and other benefits at the local, regional, and statewide levels. Expected water quality and other benefits to be generated by this proposal include the following.

Water Quality Benefits

This Proposal will provide a variety of water quality benefits, including the following.

- **Improved Delivered Water Quality**: The ***East County Water Conservation Program*** will improve the aesthetic quality of delivered water by eliminating inflow contamination. In addition, the ***Phase 2 Contra Costa Canal Levee Elimination and Flood Protection Project*** *will* improve delivered water quality by preventing saline groundwater from seeping into Contra Costa Canal supplies.
- **Enhanced Source Water Quality Protection / Improvement**: The ***Drainage Area 55 – West Antioch Creek Channel Improvements Project*** and the ***Upper Sand Creek Basin Project*** will reduce water quality impacts to adjacent waterbodies by eliminating chronic flooding problems. The ***Watershed Protection & Habitat Restoration Project*** will protect headwater streams in perpetuity, preventing potential impacts from development that may otherwise occur.
- **Reduced Risk to Public Health:** By preventing chronic flooding that currently plagues a disadvantaged community, the ***Drainage Area 55 – West Antioch Creek Channel Improvements Project*** will eliminate the public health risk posed by waterborne pathogens and contaminants found in degraded urban flood waters. In addition, the ***East County Water Conservation Program*** will reduce the risk of public health posed by inflow contamination in the distribution system of potable supply by completing leak detection and repair and eliminating potential inflow issues. In addition, the ***Phase 2 Contra Costa Levee Elimination and Flood Protection Project*** will enhance public health protection by reducing the risk of cancer associated with disinfection byproduct formation.
- **Reduced Pollution from Dry-Weather Irrigation Runoff**: The ***East County Water Conservation Program*** will reduce pollution from dry-weather irrigation runoff by eliminating over-watering for retrofitted systems. Reduced runoff that will result from this project will, in turn, reduce areas of ponded water in gutters and local retention basins, which will lessen problems with mosquitoes in the area. Reduced runoff will reduce loading of fertilizers and pesticides that have been applied to the landscapes, along with other pollutants including pathogens, coliform bacteria and salts.

Other Expected Benefits

Other benefits expected to be generated by Proposal implementation are summarized below.

- **Reduced CO_2 Emissions**: The ***East County Water Conservation Program***, the ***East County Water Meter Installation Program***, the ***Brentwood Non-Potable Water Distribution Project***, and the ***Pittsburg Recycled Water Pipeline Rehabilitation Project*** will result in reduced carbon emissions. In total, the Proposal will reduce CO_2 emissions by 6,063 metric tons over the life of the Proposal.
- **Reduced Stress on the Sacramento-San Joaquin Bay Delta**: By reducing water demands on the Delta, the ***East County Water Conservation Program***, the ***East County Water Meter Installation Program***, the ***Brentwood Non-Potable Water Distribution Project***, the ***Pittsburg Recycled Water Pipeline Rehabilitation Project***, and the ***Phase 2 Contra Costa Canal Levee Elimination***

and Flood Protection Project will all reduce stress on the sensitive Delta environment. The ***East County Water Conservation Program*** and ***East County Water Meter Installation Programs*** will also reduce demand on the local groundwater basin by reducing DWD service area demands.

- **Enhanced Public Safety**: In the past 15 years, there have been at least 3 documented drowning along the Contra Costa Canal. The ***Phase 2 Contra Costa Canal Levee Elimination and Flood Protection Project*** will reduce the potential for drowning along the affected stretch of the canal. In addition, the project will prevent potential levee breaches which could endanger the public and cause property damage.
- **Reduced Street Maintenance Requirements**: The ***East County Water Conservation Program*** will reduce street maintenance costs by reducing the amount of dry-weather runoff to streets in the participating agencies' service areas. The project will reduce ponding on streets and minimize the effect of moisture in creating potholes and cracks, which make up a significant portion of street maintenance costs.
- **Reduced Wastewater Treatment Needs**: The ***East County Water Conservation Program*** and the ***East County Water Meter Installation Program*** will reduce wastewater treatment needs by reducing the quantity of indoor water utilized.
- **Reductions in Fertilizer Usage**: The ***Brentwood Nonpotable Water Distribution System Project*** and the ***Pittsburg Recycled Water Pipeline Rehabilitation Project*** will reduce fertilizer use. This will result in avoided costs, as well as a reduction in fertilizer loading

Specific benefits have been identified, and where possible, quantified for each project in the Proposal. Detailed descriptions of project-specific water quality and other expected benefits are provided in the following sections.

Task 1 – East County Water Conservation Program

The following sections present a quantitative and qualitative analysis of project costs and water supply benefits. Table 16 has been completed, and is included at the end of this section.

Overview

The East Contra Costa County Water Conservation Program will implement water conservation programs designed to reduce per capita water use and reduce distribution system pipeline water losses. This program combines the conservation efforts of Diablo Water District (DWD) and the City of Brentwood.

The Diablo Water District portion of the program has two components:

- High Efficiency Toilet (HET) Rebates: Currently DWD customers are able to secure rebates from DWD's wholesale provider Contra Costa Water District (CCWD) that help cover the cost of purchasing HETs. This new rebate will cover the installation costs for 490 HETs.
- Leak Detection and Repair: DWD will perform a leak detection survey of approximately seven miles of pipe. Over that span, it is anticipated that approximately ten leaking service saddles and five leaking valves will be located and repaired.

The City of Brentwood's portion of the program will retrofit 7,500 residential irrigation systems with weather-based irrigation controllers (WBICs). These systems allow for more accurate, customized irrigation through the use of real time evapotranspiration (ET) and weather information

This project will reduce water demands and system water losses, preserving current potable supplies and reducing stress on the Delta. Table 1.1 provides an overview of the costs and benefits presented in Attachment 7 and 8. Water Quality and Other Expected benefits are discussed in more detail in the remainder of this attachment, and a complete discussion of Water Supply benefits is provided in Attachment 7.

The proposed project will provide a range of water quality and other benefits. By reducing reliance on Delta water, the project will avoid 2,021 metric tons (MT) of CO_2 emissions over the 25-year life of the project. The derivation of this estimate is shown in Table 16 at the conclusion of this section. Additionally, the reduced reliance on CCWD water will provide ecological benefits to the San Francisco Bay Delta system.

Table 1.1. Benefit-Cost Analysis Overview

	Present Value
Costs – Total Capital and O&M	$3,002,527
Monetized Benefits	
Water Supply Benefits	
Avoided Purchased Water Costs	$5,991,417
Total Monetized Benefits	$5,991,417

Quantified Benefits	
Other Benefits	
Reduced CO_2 Emissions	2,021 Metric Tons
	Qualitative indicator*
Qualitative Benefit or Cost	
Water Supply Benefits	
Improved Water Supply Reliability	+
Improved Operational Flexibility	+
Water Quality Benefits and Other Benefits	
Reduced risk to public health	+
Improved aesthetic quality of delivered tap water	+
Reduced Pollution from Dry Weather Runoff	+
Reduced Stress on the Bay Delta	+
Reduced Street Maintenance Costs	+
Avoided Wastewater Treatment Costs	+

O&M = Operations and Maintenance

CO_2 = carbon dioxide

* Direction and magnitude of effect on net benefits:
+ = Likely to increase net benefits relative to quantified estimates.
++ = Likely to increase net benefits significantly.
– = Likely to decrease benefits.
– – = Likely to decrease net benefits significantly.
U = Uncertain, could be + or –.

Description of Without-Project Conditions

The proposed project will improve water use efficiency and reduce distribution system losses, resulting in reductions in Delta water use and groundwater pumping. Without the project, continued use of these supplies results in significant energy use and carbon emissions, which will continue unabated without this project.

Without the High Efficiency Toilet (HET) Rebate Program, Diablo Water District (DWD) will continue to utilize Delta supplies purchased from Contra Costa Water District (CCWD) and local groundwater to meet demand for 490 toilets that currently use between 3.5 and 5.0 gallons per flush (gpf). These toilets are well below industry standards for water use efficiency, and use between 2.7 and 3.9 times the water of HETs. This high level of water demand per toilet also generates more flow to the wastewater treatment plant, requiring treatment. Without the project, Ironhouse Sanitation District (ISD) will continue to receive and treat larger volumes of wastewater due to these toilets.

Without the Leak Detection and Repair Program, DWD will continue to use Delta supplies and groundwater to meet a higher overall demand due to distribution system losses. Over the seven miles of

distribution system pipeline proposed for inspection, it is anticipated that ten leaking service saddles and five leaking values will be replaced. The current leaks put the distribution system at risk of inflow contamination. Inflow contamination threatens the safety and aesthetic quality of this potable supply. Without transmission line inspection and repair, DWD will continue to operate a distribution system that increases the risk to public health from contaminants entering the distribution system through water main leaks and diminishes the aesthetic quality of delivered water.

Without the SMART (ET) Irrigation Controller Conversion Program, the City of Brentwood will continue to provide a mix of Delta supplies from CCWD and East Contra Costa Irrigation District (ECCID) to meet the irrigation demands of the 7,500 residential sites proposed for irrigation efficiency improvements. Without these improvements, residential irrigation systems will continue to use 21% more water annually. This additional water use will increase the amount irrigation-based runoff.

In addition, without the project, runoff from over-watered landscapes in the City of Brentwood will continue to pond in streets and gutters and run to local retention basins. Stagnant water in these areas can be difficult to drain and can contributes to mosquito problems. The runoff contains fertilizers and pesticides that have been applied to the landscapes, along with other pollutants including salts, pathogens, and bacteria. The runoff eventually drains to the San Joaquin River, which leads to Suisun Bay and the Sacramento-San Joaquin Delta. Specific constituents of concern include chlorides and mercury.

Description of Expected Water Quality and Other Benefits (With-Project Conditions)

This project is expected to create a variety of water quality and other benefits, including avoided CO_2 emissions, reduced risk to public health, avoided wastewater treatment costs, avoided street maintenance costs and other ecological and aesthetic benefits.

Water Quality Benefits

Water quality benefits expected to accrue from project implementation include reduced risk to public health, improved aesthetics of delivered water, and reduced pollution from dry-weather irrigation runoff, as described below.

Reduced Risk to Public Health

Over the two-year implementation period, the Leak Detection and Repair Program will perform a leak detection survey of approximately seven miles of pipe. It is anticipated that DWD will find and repair approximately ten leaking service saddles and five leaking valves. The repair of these transmission pipes will reduce inflow contamination in the distribution system of potable supply. Water distribution system deficiencies have become an important cause of waterborne disease outbreaks (WBDO). According to an article from the Journal of Water and Health, water distribution system deficiencies were responsible for more than 50% of all WBDO reported in during 2001 – 2002. Additionally, from 1991 to 2000 water distribution system deficiencies caused almost 25% of all WBDOs (Craun et. al, 2006). Thus, reducing inflow contamination provides a reduced risk to public health. In addition, by eliminating the future need for emergency repairs, the project will eliminate the public health risk that can be associated with microbial contamination during such repair operations.

Improved Aesthetic Quality of Delivered Water

The Leak Detection and Repair Program will improve the aesthetic quality of delivered water by reducing inflow contamination in the distribution system of potable supply through current leaks or future emergency repairs of failed infrastructure. As previously noted, inflow contamination poses a serious risk to public health. It also results in a significant reduction in the aesthetic quality of drinking water. Reducing inflow contamination will make the water taste better.

Reduced Pollution from Dry-Weather Irrigation Runoff

Over the five-year implementation period, the SMART (ET) Irrigation Controller Conversion Program will retrofit approximately 7,500 residential irrigation systems. This program will improve irrigation system efficiency, resulting in water savings and a reduction in irrigation based runoff. Runoff from landscape irrigation is a significant source of nonpoint source pollution in urban environments. The use of WBICs will reduce runoff from landscapes that are overwatered and/or have a significant amount of overspray onto sidewalks, driveways, streets, and other hard surfaces due to poor design and/or maintenance. This will reduce the resulting dry-weather irrigation runoff, which carries fertilizers, pesticides, and other pollutants into the storm drain system and/or into local creeks and rivers. According to a study conducted by the Municipal Water District of Orange County and the Irvine Ranch Water District (MWDOC and IRWD, 2004), the installation of WBICs reduced runoff by 50% compared to post-intervention runoff and 71% compared to a control group. The study also noted that a reduction in the volume of runoff did not increase the concentration of pollutants in the runoff. This means that the reduction in total pollutants transported through runoff will likely be possible through a reduction in total runoff.

Reduced runoff that will result from this project will, in turn, reduce areas of ponded water in gutters and local retention basins, which will lessen problems with mosquitoes in the area. Reduced runoff will reduce loading of fertilizers and pesticides that have been applied to the landscapes, along with other pollutants including pathogens, coliform bacteria and salts.

Other Benefits

Other expected benefits of project implementation include reduced street maintenance costs, reduced CO_2 emissions, avoided wastewater treatment costs, and reduced stress on the Delta, as described below.

Reduced Street Maintenance Costs

The Brentwood SMART (ET) Irrigation Controller Conversion Program will reduce street maintenance costs by reducing the amount of dry-weather runoff to streets in the participating agencies' service areas. The project will reduce ponding on streets and minimize the effect of moisture in creating potholes and cracks, which make up a significant portion of street maintenance costs.

Reduced CO2 Emissions

By offsetting Delta water with locally-produced water, the project will avoid emissions of the greenhouse gas CO_2 generated by the production of energy required to transport water from the Delta (via CCWD) to DWD and the City of Brentwood.

DWD estimates that it requires 0.728 MWh to treat and deliver one AF of water from the Delta. Further, for every MWh of electricity used, 0.222 MT of CO_2 are emitted. Thus, every AF of Delta water generates approximately 0.162 MT of CO_2 (0.0.728 MWh/AF multiplied by 0.222 MT/MWh). By avoiding the use of

1,723 AF of Delta water over the assumed 25-year project life by DWD, the project will avoid emission of over 279 metric tons of CO_2.

DWD estimates that it requires 0.510 MWh to treat and deliver one AF of groundwater. For every MWh of electricity used to pump groundwater, 0.222 MT of CO_2 are emitted. Thus every AF of groundwater generates approximately 0.114 MT of CO_2 (0.510 MWh/AF multiplied by 0.222 MT/MWh). By avoiding the use of 355 AF of groundwater over the assumed ten-year project life, the project will avoid emissions of over 40 metric tons of CO_2.

The City of Brentwood does not have specific data on the amount of energy (and associated carbon emissions) required to import water from the Delta (via CCWD). However, this information is available for the DWD. For this analysis, it is assumed that the energy required to transport water to City of Brentwood customers is the same as that required to transport water to DWD customers. Based on this assumption, by avoiding the use of 10,500 AF of Delta water over the assumed ten-year project life, the Brentwood project will avoid emissions of over 1,701 metric tons of CO_2.

In total, this project will avoid the use of 12,577 AF of water and will avoid emissions of 2,021 metric tons of CO_2.

Avoided Wastewater Treatment Costs

Over the two-year implementation period, DWD's High Efficiency Toilet Program will replace 490 toilets. These new toilets will improve water use efficiency substantially, replacing 3.5 –5.0 gpf toilets with 1.28 gpf HETs. The use of HETs will reduce the volume of wastewater deliveries by 2.22 gpf to 3.72 gpf per toilet, or 1,088 gpf to 1823 gpf system wide. This volumetric reduction will result in avoided wastewater treatment costs to Ironhouse Sanitation District.

Reduced Stress on the Sacramento-San Joaquin Bay Delta

By reducing the use of Delta water, this project will augment in-stream flows in the Delta, or offset other diversions that may otherwise reduce flows. Reduced demands on Delta supplies also will help reduce the overall salinity of the Delta and improve Delta habitat.

Project Beneficiaries and Distribution of Benefits

The proposed project includes a full range of beneficiaries, as summarized in Table 1.2. At the local level, Diablo Water District and its customers will benefit from the reduced risk to public health and the improved aesthetic quality of their drinking water. Ironhouse Sanitation District will benefit from the reduction in wastewater attributed to the HET program. The City of Brentwood will benefit from a reduction in dry weather irrigation runoff, and the associated reduction in street maintenance costs. Regional and statewide ecological and air quality benefits will also result from reduced stress in the Sacramento-San Joaquin Bay Delta, and reduced GHG emissions due to reduced reliance on Delta water.

Table 1.2. Project Beneficiaries Summary

Local	**Regional**	*Statewide*
Diablo Water District. Ironhouse Sanitation District, City of Brentwood	Reduced CO_2 emissions	***Sacramento-San Joaquin Bay-Delta***

Timing of Benefits

The DWD portion of this program will be implemented over a one-year period, beginning in July of 2011 and ending in July of 2013. A water savings lifespan of 25 years has been identified for the high efficiency toilets, and transmission line leak detection and repair. Project benefits are expected to extend over 26 years, which allows for phase-in implementation over the first two years and a phase-out of benefits at the end of the project.

The City of Brentwood portion of this program will be implemented over a five-year period, beginning in 2011 and ending in 2015. A water savings lifespan of 25 years has been identified for the weather based irrigation controllers. Project benefits are expected to extend over 14 years, which allows for a phase-in implementation over the first 5 years, and phase out of benefits at the end of the project

Summary of Qualitative Benefits

The proposed project will provide a range of qualitative benefits. These benefits include the reduced risk to public health and improved aesthetic potable water quality due to DWD transmission line repairs. The installation of high efficiency toilets will result in avoided wastewater treatment costs for Ironhouse Sanitation District. Reductions in dry weather runoff pollution and street maintenance costs result from improving irrigation efficiency in the City of Brentwood. An overview of the qualitative benefits is provided in Table 1.3.

Table 1.3. Qualitative Benefits Summary – Water Quality and Other Benefits

Benefit	**Qualitative Indicator**
Reduced Risk to Public Health	+
Improved Aesthetic Quality of Delivered Water	+
Reduced Pollution from Dry Weather Runoff	+
Reduced Street Maintenance Costs	+
Avoided Wastewater Treatment Costs	+
Reduced Stress on the San Francisco Bay Delta	+

Uncertainty of Benefits

This analysis of costs and benefits is based on available data and some assumptions. As a result, there may be some omissions, uncertainties, and possible biases. In most cases, omissions lead to a downward bias in benefits. These issues are listed in Table 1.4.

Table 1.4. Omissions, Biases, and Uncertainties, and Their Effect on the Project

Benefit or Cost Category	**Likely Impact on Net Benefits***	*Comment*
Reduced Pollution from Dry Weather Runoff	+	Lifetime of WBICs is assumed to be 10 years. A review of the marketplace showed that WBIC lifetime could be 15 years (U.S. EPA, 2009). If the longer WBIC lifetime applies then the reduction in pollution from dry season runoff could be greater.

Table 1.4. Omissions, Biases, and Uncertainties, and Their Effect on the Project

Benefit or Cost Category	Likely Impact on Net Benefits*	*Comment*
Reduced Street Maintenance Costs	+	Lifetime of WBICs is assumed to be 10 years. A review of the marketplace showed that WBIC lifetime could be 15 years (U.S. EPA, 2009). If the longer WBIC lifetime applies then the reduction in street maintenance costs could be greater.

*Direction and magnitude of effect on net benefits:
+ = Likely to increase net benefits relative to quantified estimates.
++ = Likely to increase net benefits significantly.
- = Likely to decrease benefits.
-- = Likely to decrease net benefits significantly.
U = Uncertain, could be + or -.

Potential Adverse Effects

Potential adverse effects of this project are expected to be limited to temporary construction impacts associated with leak repair.

Documents Supporting Benefits Analysis

The following documents were used to develop the cost and benefit analyses described in this section:

- City of Brentwood. 2005 Urban Water Management Plan. Prepared for: City of Brentwood Department of Public Works. Prepared by: Brown and Caldwell, January 2006.
- Craun, Michael F., Gunther F. Craun, Rebecca L. Calderon, and Michael J. Beach. "Waterborne outbreaks reported in the United States." Journal of Water and Health 4.2 (2006): 19-30. Web. 15 Dec 2010. <http://courses.washington.edu/h2owaste/group1.pdf>.
- Diablo Water District. Diablo Water District Well Utilization Project, Final Environmental Impact Report. December 2008. Print.
- US EPA 2009. EPA WaterSense Draft Specification for Weather-Based Irrigation Controllers. Draft Version 1. November 19. Available: http://www.epa.gov/WaterSense/docs/controller_draftspec508.pdf. Accessed November 30, 2010.
- MWDOC and IRWD. The Residential Runoff Reduction Study. Municipal Water District of Orange County and Irvine Ranch Water District. July, 2004.

Economic Benefit Tables

The quantifiable water quality and other benefits generated by this project are summarized in Table 16. As shown in this table, the project will reduce carbon emissions by approximately 2,021 metric tons of CO_2 equivalents over the project life.

Table 16: Water Quality and Other Expected Benefits
Task #1: East County Water Conservation Program

(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)
Year	Type of Benefit	Measure of Benefit (Units)	Without Project	With Project	Change Resulting from Project (e) – (d)	Unit $ Value	Annual $ Value (f) x (g)	Discount Factor	Discounted Benefits (h) x (i)
2009	Avoided CO2 - DWD Delta Water	Metric Ton	0	0.0	0.0	N/A	N/A	N/A	N/A
	Avoided CO2 - Brentwood Delta Water	Metric Ton	0	0.0	0.0	N/A	N/A	N/A	N/A
	Avoided CO2 - DWD Groundwater	Metric Ton	0	0.0	0.0	N/A	N/A	N/A	N/A
2010	Avoided CO2 - DWD Delta Water	Metric Ton	0	0.0	0.0	N/A	N/A	N/A	N/A
	Avoided CO2 - Brentwood Delta Water	Metric Ton	0	0.0	0.0	N/A	N/A	N/A	N/A
	Avoided CO2 - DWD Groundwater	Metric Ton	0	0.0	0.0	N/A	N/A	N/A	N/A
2011	Avoided CO2 - DWD Delta Water	Metric Ton	0	7.3	7.3	N/A	N/A	N/A	N/A
	Avoided CO2 - Brentwood Delta Water	Metric Ton	0	34.0	34.0	N/A	N/A	N/A	N/A
	Avoided CO2 - DWD Groundwater	Metric Ton	0	1.1	1.1	N/A	N/A	N/A	N/A
2012	Avoided CO2 - DWD Delta Water	Metric Ton	0	11.0	11.0	N/A	N/A	N/A	N/A
	Avoided CO2 - Brentwood Delta Water	Metric Ton	0	68.0	68.0	N/A	N/A	N/A	N/A
	Avoided CO2 - DWD Groundwater	Metric Ton	0	1.6	1.6	N/A	N/A	N/A	N/A
2013	Avoided CO2 -	Metric Ton	0	11.0	11.0	N/A	N/A	N/A	N/A

Table 16: Water Quality and Other Expected Benefits
Task #1: East County Water Conservation Program

(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)
Year	Type of Benefit	Measure of Benefit (Units)	Without Project	With Project	Change Resulting from Project (e) – (d)	Unit $ Value	Annual $ Value (f) x (g)	Discount Factor	Discounted Benefits (h) x (i)
	DWD Delta Water								
	Avoided CO2 - Brentwood Delta Water	Metric Ton	0	102.1	102.1	N/A	N/A	N/A	N/A
	Avoided CO2 - DWD Groundwater	Metric Ton	0	1.6	1.6	N/A	N/A	N/A	N/A
2014	Avoided CO2 - DWD Delta Water	Metric Ton	0	11.0	11.0	N/A	N/A	N/A	N/A
	Avoided CO2 - Brentwood Delta Water	Metric Ton	0	136.1	136.1	N/A	N/A	N/A	N/A
	Avoided CO2 - DWD Groundwater	Metric Ton	0	1.6	1.6	N/A	N/A	N/A	N/A
2015	Avoided CO2 - DWD Delta Water	Metric Ton	0	11.0	11.0	N/A	N/A	N/A	N/A
	Avoided CO2 - Brentwood Delta Water	Metric Ton	0	170.1	170.1	N/A	N/A	N/A	N/A
	Avoided CO2 - DWD Groundwater	Metric Ton	0	1.6	1.6	N/A	N/A	N/A	N/A
2016	Avoided CO2 - DWD Delta Water	Metric Ton	0	11.0	11.0	N/A	N/A	N/A	N/A
	Avoided CO2 - Brentwood Delta Water	Metric Ton	0	170.1	170.1	N/A	N/A	N/A	N/A
	Avoided CO2 - DWD Groundwater	Metric Ton	0	1.6	1.6	N/A	N/A	N/A	N/A
2017	Avoided CO2 - DWD Delta Water	Metric Ton	0	11.0	11.0	N/A	N/A	N/A	N/A

Table 16: Water Quality and Other Expected Benefits
Task #1: East County Water Conservation Program

(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)
Year	Type of Benefit	Measure of Benefit (Units)	Without Project	With Project	Change Resulting from Project (e) – (d)	Unit $ Value	Annual $ Value (f) x (g)	Discount Factor	Discounted Benefits (h) x (i)
	Avoided CO2 - Brentwood Delta Water	Metric Ton	0	170.1	170.1	N/A	N/A	N/A	N/A
	Avoided CO2 - DWD Groundwater	Metric Ton	0	1.6	1.6	N/A	N/A	N/A	N/A
2018	Avoided CO2 - DWD Delta Water	Metric Ton	0	11.0	11.0	N/A	N/A	N/A	N/A
	Avoided CO2 - Brentwood Delta Water	Metric Ton	0	170.1	170.1	N/A	N/A	N/A	N/A
	Avoided CO2 - DWD Groundwater	Metric Ton	0	1.6	1.6	N/A	N/A	N/A	N/A
2019	Avoided CO2 - DWD Delta Water	Metric Ton	0	11.0	11.0	N/A	N/A	N/A	N/A
	Avoided CO2 - Brentwood Delta Water	Metric Ton	0	170.1	170.1	N/A	N/A	N/A	N/A
	Avoided CO2 - DWD Groundwater	Metric Ton	0	1.6	1.6	N/A	N/A	N/A	N/A
2020	Avoided CO2 - DWD Delta Water	Metric Ton	0	11.0	11.0	N/A	N/A	N/A	N/A
	Avoided CO2 - Brentwood Delta Water	Metric Ton	0	170.1	170.1	N/A	N/A	N/A	N/A
	Avoided CO2 - DWD Groundwater	Metric Ton	0	1.6	1.6	N/A	N/A	N/A	N/A
2021	Avoided CO2 - DWD Delta Water	Metric Ton	0	11.0	11.0	N/A	N/A	N/A	N/A
	Avoided CO2 - Brentwood	Metric Ton	0	136.1	136.1	N/A	N/A	N/A	N/A

Table 16: Water Quality and Other Expected Benefits
Task #1: East County Water Conservation Program

(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)
Year	Type of Benefit	Measure of Benefit (Units)	Without Project	With Project	Change Resulting from Project (e) – (d)	Unit $ Value	Annual $ Value (f) x (g)	Discount Factor	Discounted Benefits (h) x (i)
	Delta Water								
	Avoided CO2 - DWD Groundwater	Metric Ton	0	1.6	1.6	N/A	N/A	N/A	N/A
2022	Avoided CO2 - DWD Delta Water	Metric Ton	0	11.0	11.0	N/A	N/A	N/A	N/A
	Avoided CO2 - Brentwood Delta Water	Metric Ton	0	102.1	102.1	N/A	N/A	N/A	N/A
	Avoided CO2 - DWD Groundwater	Metric Ton	0	1.6	1.6	N/A	N/A	N/A	N/A
2023	Avoided CO2 - DWD Delta Water	Metric Ton	0	11.0	11.0	N/A	N/A	N/A	N/A
	Avoided CO2 - Brentwood Delta Water	Metric Ton	0	68.0	68.0	N/A	N/A	N/A	N/A
	Avoided CO2 - DWD Groundwater	Metric Ton	0	1.6	1.6	N/A	N/A	N/A	N/A
2024	Avoided CO2 - DWD Delta Water	Metric Ton	0	11.0	11.0	N/A	N/A	N/A	N/A
	Avoided CO2 - Brentwood Delta Water	Metric Ton	0	34.0	34.0	N/A	N/A	N/A	N/A
	Avoided CO2 - DWD Groundwater	Metric Ton	0	1.6	1.6	N/A	N/A	N/A	N/A
2025	Avoided CO2 - DWD Delta Water	Metric Ton	0	11.0	11.0	N/A	N/A	N/A	N/A
	Avoided CO2 - DWD Groundwater	Metric Ton	0	1.6	1.6	N/A	N/A	N/A	N/A
2026	Avoided CO2 -	Metric Ton	0	11.0	11.0	N/A	N/A	N/A	N/A

Table 16: Water Quality and Other Expected Benefits
Task #1: East County Water Conservation Program

(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)
Year	Type of Benefit	Measure of Benefit (Units)	Without Project	With Project	Change Resulting from Project (e) – (d)	Unit $ Value	Annual $ Value (f) x (g)	Discount Factor	Discounted Benefits (h) x (i)
	DWD Delta Water								
	Avoided CO2 - DWD Groundwater	Metric Ton	0	1.6	1.6	N/A	N/A	N/A	N/A
2027	Avoided CO2 - DWD Delta Water	Metric Ton	0	11.0	11.0	N/A	N/A	N/A	N/A
	Avoided CO2 - DWD Groundwater	Metric Ton	0	1.6	1.6	N/A	N/A	N/A	N/A
2028	Avoided CO2 - DWD Delta Water	Metric Ton	0	11.0	11.0	N/A	N/A	N/A	N/A
	Avoided CO2 - DWD Groundwater	Metric Ton	0	1.6	1.6	N/A	N/A	N/A	N/A
2029	Avoided CO2 - DWD Delta Water	Metric Ton	0	11.0	11.0	N/A	N/A	N/A	N/A
	Avoided CO2 - DWD Groundwater	Metric Ton	0	1.6	1.6	N/A	N/A	N/A	N/A
2030	Avoided CO2 - DWD Delta Water	Metric Ton	0	11.0	11.0	N/A	N/A	N/A	N/A
	Avoided CO2 - DWD Groundwater	Metric Ton	0	1.6	1.6	N/A	N/A	N/A	N/A
2031	Avoided CO2 - DWD Delta Water	Metric Ton	0	11.0	11.0	N/A	N/A	N/A	N/A
	Avoided CO2 - DWD Groundwater	Metric Ton	0	1.6	1.6	N/A	N/A	N/A	N/A
2032	Avoided CO2 - DWD Delta Water	Metric Ton	0	11.0	11.0	N/A	N/A	N/A	N/A

Table 16: Water Quality and Other Expected Benefits
Task #1: East County Water Conservation Program

(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)
Year	**Type of Benefit**	**Measure of Benefit (Units)**	**Without Project**	**With Project**	**Change Resulting from Project (e) – (d)**	**Unit $ Value**	**Annual $ Value (f) x (g)**	**Discount Factor**	**Discounted Benefits (h) x (i)**
	Avoided CO2 - DWD Groundwater	Metric Ton	0	1.6	1.6	N/A	N/A	N/A	N/A
2033	Avoided CO2 - DWD Delta Water	Metric Ton	0	11.0	11.0	N/A	N/A	N/A	N/A
	Avoided CO2 - DWD Groundwater	Metric Ton	0	1.6	1.6	N/A	N/A	N/A	N/A
2034	Avoided CO2 - DWD Delta Water	Metric Ton	0	11.0	11.0	N/A	N/A	N/A	N/A
	Avoided CO2 - DWD Groundwater	Metric Ton	0	1.6	1.6	N/A	N/A	N/A	N/A
2035	Avoided CO2 - DWD Delta Water	Metric Ton	0	11.0	11.0	N/A	N/A	N/A	N/A
	Avoided CO2 - DWD Groundwater	Metric Ton	0	1.6	1.6	N/A	N/A	N/A	N/A
2036	Avoided CO2 - DWD Delta Water	Metric Ton	0	7.3	7.3	N/A	N/A	N/A	N/A
	Avoided CO2 - DWD Groundwater	Metric Ton	0	1.1	1.1	N/A	N/A	N/A	N/A
Project Life	10 & 25 Years				2021			…	N/A
Total Present Value of Discounted Benefits Based on Unit Value (Sum of the values in Column (j) for all Benefits shown in table)									N/A

Comments:
These avoided metric tons of CO_2 are based on the following rates: Avoided groundwater saves 0.114 metric tons CO_2e per acre foot; avoided raw Delta water saves 0.162 metric tons CO_2e per acre foot.
All costs are in 2009 dollars.

Task 2 – East County Water Meter Installation Program

The following sections present a quantitative and qualitative analysis of project costs and water supply benefits. Table 16 has been completed, and is included at the end of this section.

Overview

The East Contra Costa County Water Meter Installation Program will install 216 water meters on services that are currently unmetered. The Project is needed in order to meet the requirements of AB 1420, which requires all urban water users be metered. This project combines the metering efforts of DWD and CCWD.

The DWD portion of the program will install 110 small meters in the Knightsen and Willow Park Marina area of the District. The CCWD portion of the program will install 106 meters, ranging in size from 2" to 8", on currently unmetered landscape customers.

It is anticipated that water use will decrease by at least 20% once the meters are installed and billing is based on water usage. The reduction in demand will preserve current supplies and reduce stress on the Delta system and demands on the local groundwater basin. Table 2.1 provides an overview of the costs and benefits presented in Attachments 7 and 8. Water Quality and Other Expected benefits are discussed in more detail in the remainder of this attachment, and a complete discussion of Water Supply benefits is provided in Attachment 7.

The proposed project will provide a range of water quality and other benefits. By reducing reliance the use of groundwater and untreated Delta water, the project will avoid 213 MT of CO_2 emissions over the 25-year project life. Decreased groundwater pumping as a result of the project will reduce demands on the groundwater basin. Additionally, the reduced reliance Delta water will provide ecological benefits to the Bay-Delta system.

Table 2.1. Benefit-Cost Analysis Overview

	Present Value
Costs – Total Capital and O&M	$670,861
Monetized Benefits	
Water Supply Benefits	
Avoided Delta Water Costs	$850,288
Total Monetized Benefits	$850,288
Quantified Benefits	
Other Benefits	
Reduced CO_2 Emissions	213 Metric Tons

Table 2.1. Benefit-Cost Analysis Overview

	Present Value
Qualitative Benefit or Cost	Qualitative indicator*
Water Supply Benefits	
Improved Water Supply Reliability	+
Effectively Implement a Water Loss Control Program	++
Improved Operational Flexibility	+
Water Quality Benefits and Other Benefits	
Reduced Stress on the DWD Groundwater Basin	+
Reduced Stress on the Bay-Delta	+

O&M = Operations and Maintenance

CO_2 = carbon dioxide

* Direction and magnitude of effect on net benefits:
+ = Likely to increase net benefits relative to quantified estimates.
++ = Likely to increase net benefits significantly.
– = Likely to decrease benefits.
– – = Likely to decrease net benefits significantly.
U = Uncertain, could be + or –.

Description of Without-Project Conditions

The proposed project will improve water use efficiency through the installation of water meters. The project will avoid the use of DWD groundwater and untreated CCWD Delta water. Use of this water contributes to significant energy use and carbon emissions, which will continue unabated without this project.

Without the installation of 110 new meters in the DWD service area, groundwater demand will remain 10.2 AF per year higher than with this project. This higher level of demand would continue to place demands on the local groundwater basin. Similarly, without the installation of 106 new meters in the CCWD service area, demand for untreated Delta water will remain 135.4 AF higher that with this project. This higher level of demand would increase the stress put on the Delta system.

Description of Expected Water Quality and Other Benefits (With-Project Conditions)

This project is expected to create a variety of other expected benefits, including reductions in CO_2 emissions and reduced demands on the local groundwater basin and stress on the Bay-Delta system.

Water Quality Benefits

No direct water quality benefits are expected from this project. However, these projects will result in reduced demands for Delta supplies. Reduced demands on Delta supplies may help reduce the overall salinity of the Delta.

Other Benefits

Other benefits expected from this project include avoided CO_2 emissions, reduced demands on the DWD groundwater basin, and reduced stress on the Bay-Delta system, as described below.

Reduced CO2 Emissions

By avoiding the use of groundwater and untreated Delta water, this project will avoid emissions of CO_2 (a greenhouse gas) generated by the production of energy required to for DWD to pump and treat groundwater and CCWD to transport water to customers.

DWD estimates that it requires 0.510 MWh to treat and deliver one AF of groundwater. For every MWh of electricity used to pump groundwater, 0.222 MT of CO_2 are emitted. Thus, every AF of groundwater generates approximately 0.114 MT of CO_2 (0.510 MWh/AF multiplied by 0.222 MT/MWh). By avoiding the use of 255 AF of groundwater over the assumed ten-year project life, the project will avoid emissions of over 29 metric tons of CO_2.

CCWD estimates that delivery of every AF of untreated Delta water generates approximately 0.0544 MT of CO_2. By avoiding the use of 3,385 AF of untreated Delta water over the assumed 25-year life, the project will avoid more than 184 metric tons of CO_2.

In total, this project will avoid the use of 3,640 AF of water and will avoid emissions of 213 metric tons of CO_2, as shown in Table 16.

Reduced Demands on the Groundwater Basin

This project will reduce the total annual amount of groundwater extracted from the basin. The 255 AF of groundwater that will be avoided over the life of the project will allow increased flexibility in future groundwater management planning. The groundwater basin is not currently considered to be stressed, but groundwater may make up a greater portion of overall supply in the future.

Reduced Stress on the Bay-Delta System

By reducing the use of raw Delta water from CCWD, this project will augment in-stream flows in the Delta, or offset other diversions that may otherwise reduce flows. Reduced demands on Delta supplies also will help reduce the overall salinity of the Delta and improve Delta habitat.

Project Beneficiaries and Distribution of Benefits

The proposed project includes the full range of beneficiaries, as summarized in Table 2.2. At the local level, Diablo Water District will benefit from the reduced demands on the groundwater basin due to avoided groundwater pumping. Regional and statewide ecological and air quality benefits include reduced stress on the Bay-Delta system due avoided CCWD Delta supplies, and reduced carbon emissions due to reduced Delta and groundwater pumping.

Table 2.2. Project Beneficiaries Summary

Local	**Regional**	*Statewide*
Diablo Water District	CCWD and its raw water customers Region-wide carbon emissions reductions	***Sacramento-San Joaquin Bay-Delta*** ***Statewide reduction in carbon emissions***

Timing of Benefits

The DWD portion of this program will be implemented over a one-year period, beginning in September of 2011 and ending in September of 2012. A water savings lifespan of 25 years has been identified for water meters. Project benefits are expected to extend over 26 years, which allows for the phase-in and a phase-out of benefits.

The annual reduction in carbon emissions from this project is a function of annual water savings and the carbon intensity of DWD supplies. To calculate water savings by year, it was assumed that the program will be implemented across the 12-month timeframe from September 1, 2011 through September 30, 2012. This results in a ramp-up period where approximately 25% of project benefits are realized in 2011 (3-months of the 12-month total), and all the benefits are realized in 2012. Due to the 25-year lifetime, benefits phase out between 2036 and 2037.

The CCWD portion of this program will be implemented over a two-year period, beginning in July 2011 and ending in July 2013. As with DWD 25 years has been identified for water meters. Project benefits are expected to extend over 27 years, which allows for the phase-in and phase-out of benefits.

The annual reduction in carbon emissions from this project is a function of annual water savings and the carbon intensity of raw CCWD Delta water. To calculate water savings by year, it is assumed that the program will be implemented across the 24-month timeframe from July 1, 2011 and June 30, 2013. This results in ramp up period where 25% of the benefits are realized in 2011 (6-months out of the 24-month total), 75% in 2012 (12-months out of the 24-month total, plus the benefits from 2011), and all the benefits are realized in 2013. Due to the 25-year lifetime, benefits phase out between 2036 and 2038.

Summary of Qualitative Benefits

The proposed project will provide multiple qualitative benefits. Decreased groundwater use that results from this project will reduce stress on the groundwater basin. Additionally, the reduced reliance Delta water will provide ecological benefits to the Sacramento – San Joaquin Bay-Delta.

Table 2.3. Qualitative Benefits Summary – Water Quality and Other Benefits

Benefit	Qualitative Indicator
Reduced Stress on the DWD Groundwater Basin	+
Reduced Stress on the Bay-Delta	+

Uncertainty of Benefits

This analysis of costs and benefits is based on available data and some assumptions. As a result, there may be some omissions, uncertainties, and possible biases. In this analysis, the main uncertainty is associated with the quantity of avoided CO_2 emissions. This issue is listed in Table 2.4.

Table 2.4. Omissions, Biases, and Uncertainties, and Their Effect on the Project

Benefit or Cost Category	Likely Impact on Net Benefits*	*Comment*
Reduced CO_2 Emissions	U	The avoided carbon emissions associated with this project are directly related to the energy required to treat and transport water. Where DWD and CCWD get their energy is important in determining the carbon intensity of their water. If their future energy supplies are more or less carbon intensive, avoided emissions will change.

*Direction and magnitude of effect on net benefits:
+ = Likely to increase net benefits relative to quantified estimates.
++ = Likely to increase net benefits significantly.
- = Likely to decrease benefits.
-- = Likely to decrease net benefits significantly.
U = Uncertain, could be + or -.

Potential Adverse Effects

No adverse effects are expected from project implementation.

Documents Supporting Benefits Analysis

The following documents were used to develop the cost and benefit analyses described in this section:

- Diablo Water District. Diablo Water District Well Utilization Project, Final Environmental Impact Report. December 2008. Print.
- M36 Water Audits and Loss Control Programs. 3rd ed. Denver, CO: American Water Works Association, 2009. Print.
- Raucher, R.S., J. Henderson, and J. Rice. 2006. An Economic Framework for Evaluating the Benefits and Costs of Water Reuse. WateReuse Foundation. Arlington, VA.

Economic Benefit Tables

The quantifiable water quality and other benefits generated by this project are summarized in Table 16. As shown in this table, the project will reduce carbon emissions by approximately 213 metric tons of CO_2 equivalents over the project life.

Table 16: Water Quality and Other Expected Benefits
Task #2: East County Water Meter Installation Program

(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)
Year	Type of Benefit	Measure of Benefit (Units)	Without Project	With Project	Change Resulting from Project (e) – (d)	Unit $ Value	Annual $ Value (f) x (g)	Discount Factor	Discounted Benefits (h) x (i)
2009	Avoided CO2 - DWD Groundwater	Metric Ton	0.0	0.0	0.0			1.00	N/A
	Avoided CO2 - CCWD Delta Water	Metric Ton	0.0	0.0	0.0			1.00	N/A
2010	Avoided CO2 - DWD Groundwater	Metric Ton	0.0	0.0	0.0			0.94	N/A
	Avoided CO2 - CCWD Delta Water	Metric Ton	0.0	0.0	0.0			0.94	N/A
2011	Avoided CO2 - DWD Groundwater	Metric Ton	0.0	0.3	0.3			0.89	N/A
	Avoided CO2 - CCWD Delta Water	Metric Ton	0.0	1.8	1.8			0.89	N/A
2012	Avoided CO2 - DWD Groundwater	Metric Ton	0.0	1.2	1.2			0.84	N/A
	Avoided CO2 - CCWD Delta Water	Metric Ton	0.0	5.5	5.5			0.84	N/A
2013	Avoided CO2 - DWD Groundwater	Metric Ton	0.0	1.2	1.2			0.79	N/A
	Avoided CO2 - CCWD Delta Water	Metric Ton	0.0	7.4	7.4			0.79	N/A
2014	Avoided CO2 - DWD Groundwater	Metric Ton	0.0	1.2	1.2			0.75	N/A
	Avoided CO2 - CCWD Delta Water	Metric Ton	0.0	7.4	7.4			0.75	N/A
2015	Avoided CO2 - DWD Groundwater	Metric Ton	0.0	1.2	1.2			0.71	N/A
	Avoided CO2 - CCWD Delta Water	Metric Ton	0.0	7.4	7.4			0.71	N/A
2016	Avoided CO2 - DWD Groundwater	Metric Ton	0.0	1.2	1.2			0.67	N/A
	Avoided CO2 - CCWD Delta Water	Metric Ton	0.0	7.4	7.4			0.67	N/A
2017	Avoided CO2 - DWD Groundwater	Metric Ton	0.0	1.2	1.2			0.63	N/A
	Avoided CO2 - CCWD Delta Water	Metric Ton	0.0	7.4	7.4			0.63	N/A
2018	Avoided CO2 -	Metric	0.0	1.2	1.2			0.59	N/A

Table 16: Water Quality and Other Expected Benefits
Task #2: East County Water Meter Installation Program

(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)
Year	Type of Benefit	Measure of Benefit (Units)	Without Project	With Project	Change Resulting from Project (e) – (d)	Unit $ Value	Annual $ Value (f) x (g)	Discount Factor	Discounted Benefits (h) x (i)
	DWD Groundwater	Ton							
	Avoided CO2 - CCWD Delta Water	Metric Ton	0.0	7.4	7.4			0.59	N/A
2019	Avoided CO2 - DWD Groundwater	Metric Ton	0.0	1.2	1.2			0.56	N/A
	Avoided CO2 - CCWD Delta Water	Metric Ton	0.0	7.4	7.4			0.56	N/A
2020	Avoided CO2 - DWD Groundwater	Metric Ton	0.0	1.2	1.2			0.53	N/A
	Avoided CO2 - CCWD Delta Water	Metric Ton	0.0	7.4	7.4			0.53	N/A
2021	Avoided CO2 - DWD Groundwater	Metric Ton	0.0	1.2	1.2			0.50	N/A
	Avoided CO2 - CCWD Delta Water	Metric Ton	0.0	7.4	7.4			0.50	N/A
2022	Avoided CO2 - DWD Groundwater	Metric Ton	0.0	1.2	1.2			0.47	N/A
	Avoided CO2 - CCWD Delta Water	Metric Ton	0.0	7.4	7.4			0.47	N/A
2023	Avoided CO2 - DWD Groundwater	Metric Ton	0.0	1.2	1.2			0.44	N/A
	Avoided CO2 - CCWD Delta Water	Metric Ton	0.0	7.4	7.4			0.44	N/A
2024	Avoided CO2 - DWD Groundwater	Metric Ton	0.0	1.2	1.2			0.42	N/A
	Avoided CO2 - CCWD Delta Water	Metric Ton	0.0	7.4	7.4			0.42	N/A
2025	Avoided CO2 - DWD Groundwater	Metric Ton	0.0	1.2	1.2			0.39	N/A
	Avoided CO2 - CCWD Delta Water	Metric Ton	0.0	7.4	7.4			0.39	N/A
2026	Avoided CO2 - DWD Groundwater	Metric Ton	0.0	1.2	1.2			0.37	N/A
	Avoided CO2 - CCWD Delta Water	Metric Ton	0.0	7.4	7.4			0.37	N/A
2027	Avoided CO2 - DWD Groundwater	Metric Ton	0.0	1.2	1.2			0.35	N/A
	Avoided CO2 -	Metric	0.0	7.4	7.4			0.35	N/A

Table 16: Water Quality and Other Expected Benefits
Task #2: East County Water Meter Installation Program

(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)
Year	Type of Benefit	Measure of Benefit (Units)	Without Project	With Project	Change Resulting from Project (e) – (d)	Unit $ Value	Annual $ Value (f) x (g)	Discount Factor	Discounted Benefits (h) x (i)
	CCWD Delta Water	Ton							
2028	Avoided CO2 - DWD Groundwater	Metric Ton	0.0	1.2	1.2			0.33	N/A
	Avoided CO2 - CCWD Delta Water	Metric Ton	0.0	7.4	7.4			0.33	N/A
2029	Avoided CO2 - DWD Groundwater	Metric Ton	0.0	1.2	1.2			0.31	N/A
	Avoided CO2 - CCWD Delta Water	Metric Ton	0.0	7.4	7.4			0.31	N/A
2030	Avoided CO2 - DWD Groundwater	Metric Ton	0.0	1.2	1.2			0.29	N/A
	Avoided CO2 - CCWD Delta Water	Metric Ton	0.0	7.4	7.4			0.29	N/A
2031	Avoided CO2 - DWD Groundwater	Metric Ton	0.0	1.2	1.2			0.28	N/A
	Avoided CO2 - CCWD Delta Water	Metric Ton	0.0	7.4	7.4			0.28	N/A
2032	Avoided CO2 - DWD Groundwater	Metric Ton	0.0	1.2	1.2			0.26	N/A
	Avoided CO2 - CCWD Delta Water	Metric Ton	0.0	7.4	7.4			0.26	N/A
2033	Avoided CO2 - DWD Groundwater	Metric Ton	0.0	1.2	1.2			0.25	N/A
	Avoided CO2 - CCWD Delta Water	Metric Ton	0.0	7.4	7.4			0.25	N/A
2034	Avoided CO2 - DWD Groundwater	Metric Ton	0.0	1.2	1.2			0.23	N/A
	Avoided CO2 - CCWD Delta Water	Metric Ton	0.0	7.4	7.4			0.23	N/A
2035	Avoided CO2 - DWD Groundwater	Metric Ton	0.0	1.2	1.2			0.22	N/A
	Avoided CO2 - CCWD Delta Water	Metric Ton	0.0	7.4	7.4			0.22	N/A
2036	Avoided CO2 - DWD Groundwater	Metric Ton	0.0	0.9	0.9			0.21	N/A
	Avoided CO2 - CCWD Delta Water	Metric Ton	0.0	5.5	5.5			0.21	N/A
2037	Avoided CO2 -	Metric	0.0	0.0	0.0			0.20	N/A

Table 16: Water Quality and Other Expected Benefits
Task #2: East County Water Meter Installation Program

(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)
Year	**Type of Benefit**	**Measure of Benefit (Units)**	**Without Project**	**With Project**	**Change Resulting from Project (e) – (d)**	**Unit $ Value**	**Annual $ Value (f) x (g)**	**Discount Factor**	**Discounted Benefits (h) x (i)**
	DWD Groundwater	Ton							
	Avoided CO2 - CCWD Delta Water	Metric Ton	0.0	1.8	1.8			0.20	N/A
Proj. Life	25 Years				213			…	N/A
Total Present Value of Discounted Benefits Based on Unit Value									N/A
(Sum of the values in Column (j) for all Benefits shown in table)									

Comments:
These avoided metric tons of CO_2 are based on the following rates: Avoided groundwater saves 0.114 metric tons CO_2e per acre foot; avoided raw Delta water saves 0.162 metric tons CO_2e per acre foot.
All costs are in 2009 dollars.

Task 3 – Brentwood Non-Potable Water Supply Project

The following sections present a quantitative and qualitative analysis of project costs and water supply benefits. Table 16 has been completed, and is included at the end of this section.

Overview

The Non-Potable Water Supply Project is a recycled water project being implemented by the City of Brentwood. The project involves the installation of a 12-inch non-potable water main that will provide 88 AFY for landscape irrigation. The pipeline will be approximately 9,400 feet in length, and will connect to the City's existing non-potable water distribution system.

The recycled water pipeline will provide irrigation water for about 29 acres of municipal landscape currently irrigated with potable water. The City owns 11 of these 29 acres and the East Bay Municipal Utility District (EBMUD) owns the remaining 18. The City maintains and uses EBMUD's 18 acres under an existing licensing agreement.

A summary of all benefits and costs of the project are provided in Table 3.1. Water Quality and Other Expected benefits are discussed in more detail in the remainder of this attachment, and a complete discussion of Water Supply benefits is provided in Attachment 7.

As a result of the project, the City will save $64,861 in fertilizer costs. By reducing reliance on Delta water, the project will also avoid 391 MT of CO_2 emissions over its' 50-year useful life. The project will also result in improved surface water quality in Marsh Creek and improved water quality and ecological benefits in Suisun Bay and Sacramento-San Joaquin Delta.

Table 3.1. Benefit-Cost Analysis Overview

	Present Value
Costs – Total Capital and O&M	$1,761,480
Monetizable Benefits	
Water Supply Benefits	
Avoided Potable Water Supply Costs	$1,275,421
Water Quality and Other Benefits	
Avoided fertilizer costs	$64,861
Total Monetized Benefits	$1,405,143
Qualitative Benefit or Cost	**Qualitative indicator***
Water Supply Benefits	
Increased Water Supply Reliability for City of Brentwood customers	+
Improved Operational Flexibility for Contra Costa Water District	+

Table 3.1. Benefit-Cost Analysis Overview

	Present Value
Water Quality and Other Benefits	
Improved Surface Water Quality	+
Reduced CO2 Emissions	+
Reduced Stress on the Delta	+

O&M = Operations and Maintenance

* Direction and magnitude of effect on net benefits:
+ = Likely to increase net benefits relative to quantified estimates.
++ = Likely to increase net benefits significantly.
– = Likely to decrease benefits.
– – = Likely to decrease net benefits significantly.
U = Uncertain, could be + or –.

Description of Without-Project Conditions

Without the project, 88 AFY of tertiary-treated effluent produced at City's wastewater treatment plant (WWTP) would not be put to beneficial use, and would be discharged directly to Marsh Creek, which leads to Suisun Bay and the Sacramento-San Joaquin Delta. Beneficial uses in Marsh Creek include: warm freshwater habitat, wildlife habitat, preservation of rare, threatened, or endangered species, contact water recreation, and noncontact water recreation.

Although Brentwood expects to remain in compliance with water quality regulations if the effluent from the WWTP is discharged to Marsh Creek, discharges would incrementally contribute to further surface water quality degradation via increased salt loading into Marsh Creek, Suisun Bay, and the Delta.

The use of Delta water will also require more energy than the use of recycled water. Thus, without the project, CO_2 emissions will be greater than with project implementation. In addition, when potable water is used for irrigation, irrigators must apply additional fertilizer because the potable water does not key fertilizing constituents that are common in recycled water (e.g., nitrogen, phosphorus and potassium). This will result in increased costs for the City.

Description of Expected Water Quality and Other Benefits (With-Project Conditions)

This project is expected to create a variety of water quality and other benefits, including avoided pipeline repair costs, avoided fertilizer costs, avoided CO_2 emissions, improved surface water quality, and other ecological, aesthetic, and recreational benefits. These benefits are described below.

Water Quality Benefits

If the effluent from City's WWTP is not put to beneficial use, it will be discharged directly to Marsh Creek, which leads to Suisun Bay and the Sacramento-San Joaquin Delta. Beneficial uses in Marsh Creek include: warm water habitat, preservation of rare and endangered species, wildlife habitat, water contact recreation, and noncontact water recreation. Although Brentwood would remain in compliance with water quality regulations if the effluent from the WWTP is discharged to Marsh Creek, discharges would incrementally contribute to further surface water quality degradation via increased salt loading

(i.e., chloride) to Marsh Creek, Suisun Bay, and the Delta. As a result, this project is expected to provide water quality improvements to Marsh Creek.

Other Benefits

Other benefits expected from project implementation include avoided fertilizer costs, reduced CO_2 emissions, and reduced stress on the Sacramento-San Joaquin Delta.

Avoided Fertilizer Costs

Fertilizing compounds commonly contained in recycled water are typically not found in high concentrations in potable water (e.g., nitrogen, phosphorous, potassium). Thus, the use of recycled water for irrigation will be expected to reduce fertilizer costs for the 29 acres of irrigated land affected by the project.

Specific nutrient data for the recycled water produced at the Brentwood WWTP is not available. For this analysis, it is assumed that recycled water produced at the Brentwood WWTP is similar in quality to the recycled water that is produced at the City of Pittsburg WWTP, also located in East County, and for which data is available. This recycled water contains 95 lbs of nitrogen per AF, 0.2 lbs of phosphorous per AF, and 17 lbs of potassium per AF. The commercial value of these concentrations of fertilizing compounds amounts to $41.32, $0.36, and $14.01 per AF of recycled water (Asano, 1981). Thus, for every AF of the recycled water used in lieu of potable water, the park and the golf course will avoid a total of $55.69 in fertilizer costs. For the 88 AF of recycled water applied each year in-lieu of Delta water (beginning in 2023), avoided fertilizer costs will be about $4,900 (2009 USD). Over the lifetime of the project, total present value avoided fertilizer costs will amount to $64,861.

Reduced CO2 Emissions

By offsetting Delta water demands, the project will avoid emissions of CO_2 (a greenhouse gas) generated by the production of energy required to transport water from the Delta (via CCWD) to the City of Brentwood.

Specific data on the amount of energy (and associated carbon emissions) required to import water from the Delta (via CCWD) to the City of Brentwood is not available. However, this information is available for the Diablo Water District (DWD), also located in East County. For this analysis, it is assumed that the energy required to transport water to DWD customers is approximately equal to that required to deliver Delta water to customers within the City of Brentwood.

DWD estimates that it requires 0.728 MWh to treat and deliver one AF of water from the Delta to DWD customers. Further, for every MWh of electricity used to import water, 0.222 metric tons (MT) of CO_2 are emitted. Thus, every AF of Delta water generates approximately 0.162 MT of CO_2 (0.728 MWh/AF multiplied by 0.222 MT/MWh). By avoiding the use of 4,400 AF of Delta water over the assumed project life (88 AFY), the project will avoid emission of over 712 MT of CO_2.

Avoided carbon emissions will be offset to some extent by the energy required to pump and treat recycled water. Again, specific data is not available for this project. However, based on data provided by the Delta Diablo Sanitation District (DDSD) for the Pittsburg Recycled Water Pipeline Rehabilitation Project (Task 4), approximately 0.328 MWh are required to produce and distribute recycled water within the DDSD service area. Using the same CO_2 emissions rate of 0.222 MT/MWh for every AF of recycled water delivered, 0.073 MT of CO_2 are emitted (0.328 MWh/AF multiplied by 0.222 MT/MWh). Over the

lifetime of the project, total CO_2 emissions associated with recycled water production and distribution will amount to 321 MT. Thus, with the project, net avoided carbon emissions will be 391 MT.

Reduced Stress on the Sacramento-San Joaquin Delta

By reducing the use of Delta water, this project will augment in-stream flows in the Delta, or offset other diversions that may otherwise reduce flows. Reduced demands on Delta supplies also will help reduce the overall salinity of the Delta and improve Delta habitat.

Project Beneficiaries and Distribution of Benefits

The proposed project includes the full range of beneficiaries, as is summarized in Table 3.2. At the local level, the City will benefit from avoided fertilizer costs and improved water quality in New Marsh Creek. Regional and statewide ecological and air quality benefits include reduced stress/ecological improvements in the Sacramento-San Joaquin Delta and reduced GHG emissions due to reduced reliance on Delta water.

Table 3.2. Project Beneficiaries Summary

Local	Regional	*Statewide*
City of Brentwood	Reduced CO2 emissions	***Sacramento-San Joaquin Delta***

Timing of Benefits

Construction of the new pipeline will be completed in 2012 and will come online in 2013. For this analysis, a 50-year useful project life is assumed, thus benefits and costs are calculated through 2062 (50 years after the project comes online).

Summary of Qualitative Benefits

The proposed project will provide qualitative benefits including improved surface water quality in Marsh Creek and improved water quality and ecological benefits in Suisun Bay and Sacramento-San Joaquin Delta. These benefits are summarized in Table 3.3.

Table 3.3. Qualitative Benefits Summary – Water Quality and Other Benefits

Benefit	Qualitative Indicator
Improved Surface Water Quality	+
Reduced CO2 Emissions	+
Reduced Stress on the Delta	+

Uncertainty of Benefits

This analysis of costs and benefits is based on available data and some assumptions. As a result, there may be some omissions, uncertainties, and possible biases. These issues are listed in Table 3.4.

Table 4. Omissions, Biases, and Uncertainties, and Their Effect on the Project

Benefit or Cost Category	Likely Impact on Net Benefits*	*Comment*
Avoided fertilizer costs	U	The analysis of avoided fertilizer costs is based on data for recycled water from the City of Pittsburg WWTP because similar data for the Brentwood WWTP was unavailable. If nutrient levels in the recycled water produced at Brentwood WWTP are higher or lower than assumed, this would change the value of avoided fertilizer costs.
Avoided CO2 emissions	U	The analysis of avoided CO2 emissions is based on data regarding energy use from DDSD and DWD. Energy use and emissions data specific to the City of Brentwood may increase or decrease avoided emissions.

*Direction and magnitude of effect on net benefits:
+ = Likely to increase net benefits relative to quantified estimates.
++ = Likely to increase net benefits significantly.
– = Likely to decrease benefits.
—— = Likely to decrease net benefits significantly.
U = Uncertain, could be + or -.

Potential Adverse Effects

Adverse effects of this project are expected to be limited to temporary construction impacts.

Documents Supporting Benefits Analysis

The following documents were used to develop the cost and benefit analyses described in this section:

- City of Brentwood. 2005 Urban Water Management Plan. Prepared for: City of Brentwood Department of Public Works. Prepared by: Brown and Caldwell, January 2006.
- Diablo Water District. Diablo Water District Well Utilization Project, Final Environmental Impact Report. December 2008. Print.
- Asano, T. 1981. Evaluation of Agricultural Irrigation Projects Using Reclaimed Water. Agreement 8-179-215-2. Office of Water Recycling. California State Water Resources Control Board, Sacramento.

Economic Benefit Tables

The quantifiable water quality and other benefits generated by this project are summarized in Table 16. As shown in this table, the project will reduce carbon emissions by approximately 391 metric tons of CO_2 equivalents over the project life. Additionally, the project will avoid $64,861 in fertilizer purchases.

Table 16: Water Quality and Other Expected Benefits
Task #3: Brentwood Nonpotable Water Distribution System Project

(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)
Year	Type of Benefit	Measure of Benefit (Units)	Without Project	With Project	Change Resulting from Project (e) – (d)	Unit $ Value	Annual $ Value (f) x (g)	Discount Factor	Discounted Benefits (h) x (i)
2009								1.00	
2010								0.94	
2011								0.89	
2012								0.84	
2013	Avoided fertilizer use	lbs of fertilizer	0	12,489	12,489	$0.39	$4,900	0.79	$3,881
	Avoided CO2 emissions	MT of CO_2	0	7.8	7.8			0.79	$0
2014	Avoided fertilizer use	lbs of fertilizer	0	12,489	12,489	$0.39	$4,900	0.75	$3,661
	Avoided CO2 emissions	MT of CO_2	0	7.8	7.8			0.75	$0
2015	Avoided fertilizer use	lbs of fertilizer	0	12,489	12,489	$0.39	$4,900	0.71	$3,455
	Avoided CO2 emissions	MT of CO_2	0	7.8	7.8			0.71	$0
2016	Avoided fertilizer use	lbs of fertilizer	0	12,489	12,489	$0.39	$4,900	0.67	$3,259
	Avoided CO2 emissions	MT of CO_2	0	7.8	7.8			0.67	$0
2017	Avoided fertilizer use	lbs of fertilizer	0	12,489	12,489	$0.39	$4,900	0.63	$3,073
	Avoided CO2 emissions	MT of CO_2	0	7.8	7.8			0.63	$0
2018	Avoided fertilizer use	lbs of fertilizer	0	12,489	12,489	$0.39	$4,900	0.59	$2,901
	Avoided CO2 emissions	MT of CO_2	0	7.8	7.8			0.59	$0
2019	Avoided fertilizer use	lbs of fertilizer	0	12,489	12,489	$0.39	$4,900	0.56	$2,734
	Avoided CO2 emissions	MT of CO_2	0	7.8	7.8			0.56	$0
2020	Avoided fertilizer use	lbs of fertilizer	0	12,489	12,489	$0.39	$4,900	0.53	$2,582
	Avoided CO2 emissions	MT of CO_2	0	7.8	7.8			0.53	$0
2021	Avoided	lbs of	0	12,489	12,489	$0.39	$4,900	0.50	$2,435

Table 16: Water Quality and Other Expected Benefits
Task #3: Brentwood Nonpotable Water Distribution System Project

(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)
Year	Type of Benefit	Measure of Benefit (Units)	Without Project	With Project	Change Resulting from Project (e) – (d)	Unit $ Value	Annual $ Value (f) x (g)	Discount Factor	Discounted Benefits (h) x (i)
	fertilizer use	fertilizer							
	Avoided CO2 emissions	MT of CO_2	0	7.8	7.8			0.50	$0
2022	Avoided fertilizer use	lbs of fertilizer	0	12,489	12,489	$0.39	$4,900	0.47	$2,298
	Avoided CO2 emissions	MT of CO_2	0	7.8	7.8			0.47	$0
2023	Avoided fertilizer use	lbs of fertilizer	0	12,489	12,489	$0.39	$4,900	0.44	$2,166
	Avoided CO2 emissions	MT of CO_2	0	7.8	7.8			0.44	$0
2024	Avoided fertilizer use	lbs of fertilizer	0	12,489	12,489	$0.39	$4,900	0.42	$2,043
	Avoided CO2 emissions	MT of CO_2	0	7.8	7.8			0.42	$0
2025	Avoided fertilizer use	lbs of fertilizer	0	12,489	12,489	$0.39	$4,900	0.39	$1,931
	Avoided CO2 emissions	MT of CO_2	0	7.8	7.8			0.39	$0
2026	Avoided fertilizer use	lbs of fertilizer	0	12,489	12,489	$0.39	$4,900	0.37	$1,818
	Avoided CO2 emissions	MT of CO_2	0	7.8	7.8			0.37	$0
2027	Avoided fertilizer use	lbs of fertilizer	0	12,489	12,489	$0.39	$4,900	0.35	$1,715
	Avoided CO2 emissions	MT of CO_2	0	7.8	7.8			0.35	$0
2028	Avoided fertilizer use	lbs of fertilizer	0	12,489	12,489	$0.39	$4,900	0.33	$1,622
	Avoided CO2 emissions	MT of CO_2	0	7.8	7.8			0.33	$0
2029	Avoided fertilizer use	lbs of fertilizer	0	12,489	12,489	$0.39	$4,900	0.31	$1,529
	Avoided CO2 emissions	MT of CO_2	0	7.8	7.8			0.31	$0
2030	Avoided fertilizer use	lbs of fertilizer	0	12,489	12,489	$0.39	$4,900	0.29	$1,441
	Avoided CO2	MT of	0	7.8	7.8			0.29	$0

Table 16: Water Quality and Other Expected Benefits
Task #3: Brentwood Nonpotable Water Distribution System Project

(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)
Year	Type of Benefit	Measure of Benefit (Units)	Without Project	With Project	Change Resulting from Project (e) – (d)	Unit $ Value	Annual $ Value (f) x (g)	Discount Factor	Discounted Benefits (h) x (i)
	emissions	CO_2							
2031	Avoided fertilizer use	lbs of fertilizer	0	12,489	12,489	$0.39	$4,900	0.28	$1,362
	Avoided CO2 emissions	MT of CO_2	0	7.8	7.8			0.28	$0
2032	Avoided fertilizer use	lbs of fertilizer	0	12,489	12,489	$0.39	$4,900	0.26	$1,284
	Avoided CO2 emissions	MT of CO_2	0	7.8	7.8			0.26	$0
2033	Avoided fertilizer use	lbs of fertilizer	0	12,489	12,489	$0.39	$4,900	0.25	$1,210
	Avoided CO2 emissions	MT of CO_2	0	7.8	7.8			0.25	$0
2034	Avoided fertilizer use	lbs of fertilizer	0	12,489	12,489	$0.39	$4,900	0.23	$1,142
	Avoided CO2 emissions	MT of CO_2	0	7.8	7.8			0.23	$0
2035	Avoided fertilizer use	lbs of fertilizer	0	12,489	12,489	$0.39	$4,900	0.22	$1,078
	Avoided CO2 emissions	MT of CO_2	0	7.8	7.8			0.22	$0
2036	Avoided fertilizer use	lbs of fertilizer	0	12,489	12,489	$0.39	$4,900	0.21	$1,014
	Avoided CO2 emissions	MT of CO_2	0	7.8	7.8			0.21	$0
2037	Avoided fertilizer use	lbs of fertilizer	0	12,489	12,489	$0.39	$4,900	0.20	$960
	Avoided CO2 emissions	MT of CO_2	0	7.8	7.8			0.20	$0
2038	Avoided fertilizer use	lbs of fertilizer	0	12,489	12,489	$0.39	$4,900	0.19	$907
	Avoided CO2 emissions	MT of CO_2	0	7.8	7.8			0.19	$0
2039	Avoided fertilizer use	lbs of fertilizer	0	12,489	12,489	$0.39	$4,900	0.17	$853
	Avoided CO2 emissions	MT of CO_2	0	7.8	7.8			0.17	$0
2040	Avoided	lbs of	0	12,489	12,489	$0.39	$4,900	0.16	$804

Table 16: Water Quality and Other Expected Benefits
Task #3: Brentwood Nonpotable Water Distribution System Project

(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)
Year	Type of Benefit	Measure of Benefit (Units)	Without Project	With Project	Change Resulting from Project (e) – (d)	Unit $ Value	Annual $ Value (f) x (g)	Discount Factor	Discounted Benefits (h) x (i)
	fertilizer use	fertilizer							
	Avoided CO2 emissions	MT of CO_2	0	7.8	7.8			0.16	$0
2041	Avoided fertilizer use	lbs of fertilizer	0	12,489	12,489	$0.39	$4,900	0.16	$760
	Avoided CO2 emissions	MT of CO_2	0	7.8	7.8			0.16	$0
2042	Avoided fertilizer use	lbs of fertilizer	0	12,489	12,489	$0.39	$4,900	0.15	$715
	Avoided CO2 emissions	MT of CO_2	0	7.8	7.8			0.15	$0
2043	Avoided fertilizer use	lbs of fertilizer	0	12,489	12,489	$0.39	$4,900	0.14	$676
	Avoided CO2 emissions	MT of CO_2	0	7.8	7.8			0.14	$0
2044	Avoided fertilizer use	lbs of fertilizer	0	12,489	12,489	$0.39	$4,900	0.13	$637
	Avoided CO2 emissions	MT of CO_2	0	7.8	7.8			0.13	$0
2045	Avoided fertilizer use	lbs of fertilizer	0	12,489	12,489	$0.39	$4,900	0.12	$603
	Avoided CO2 emissions	MT of CO_2	0	7.8	7.8			0.12	$0
2046	Avoided fertilizer use	lbs of fertilizer	0	12,489	12,489	$0.39	$4,900	0.12	$568
	Avoided CO2 emissions	MT of CO_2	0	7.8	7.8			0.12	$0
2047	Avoided fertilizer use	lbs of fertilizer	0	12,489	12,489	$0.39	$4,900	0.11	$534
	Avoided CO2 emissions	MT of CO_2	0	7.8	7.8			0.11	$0
2048	Avoided fertilizer use	lbs of fertilizer	0	12,489	12,489	$0.39	$4,900	0.10	$505
	Avoided CO2 emissions	MT of CO_2	0	7.8	7.8			0.10	$0
2049	Avoided fertilizer use	lbs of fertilizer	0	12,489	12,489	$0.39	$4,900	0.10	$475
	Avoided CO2	MT of	0	7.8	7.8			0.10	$0

Table 16: Water Quality and Other Expected Benefits
Task #3: Brentwood Nonpotable Water Distribution System Project

(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)
Year	Type of Benefit	Measure of Benefit (Units)	Without Project	With Project	Change Resulting from Project (e) – (d)	Unit $ Value	Annual $ Value (f) x (g)	Discount Factor	Discounted Benefits (h) x (i)
	emissions	CO_2							
2050	Avoided fertilizer use	lbs of fertilizer	0	12,489	12,489	$0.39	$4,900	0.09	$451
	Avoided CO2 emissions	MT of CO_2	0	7.8	7.8			0.09	$0
2051	Avoided fertilizer use	lbs of fertilizer	0	12,489	12,489	$0.39	$4,900	0.09	$426
	Avoided CO2 emissions	MT of CO_2	0	7.8	7.8			0.09	$0
2052	Avoided fertilizer use	lbs of fertilizer	0	12,489	12,489	$0.39	$4,900	0.08	$402
	Avoided CO2 emissions	MT of CO_2	0	7.8	7.8			0.08	$0
2053	Avoided fertilizer use	lbs of fertilizer	0	12,489	12,489	$0.39	$4,900	0.08	$377
	Avoided CO2 emissions	MT of CO_2	0	7.8	7.8			0.08	$0
2054	Avoided fertilizer use	lbs of fertilizer	0	12,489	12,489	$0.39	$4,900	0.07	$358
	Avoided CO2 emissions	MT of CO_2	0	7.8	7.8			0.07	$0
2055	Avoided fertilizer use	lbs of fertilizer	0	12,489	12,489	$0.39	$4,900	0.07	$338
	Avoided CO2 emissions	MT of CO_2	0	7.8	7.8			0.07	$0
2056	Avoided fertilizer use	lbs of fertilizer	0	12,489	12,489	$0.39	$4,900	0.07	$319
	Avoided CO2 emissions	MT of CO_2	0	7.8	7.8			0.07	$0
2057	Avoided fertilizer use	lbs of fertilizer	0	12,489	12,489	$0.39	$4,900	0.06	$299
	Avoided CO2 emissions	MT of CO_2	0	7.8	7.8			0.06	$0
2058	Avoided fertilizer use	lbs of fertilizer	0	12,489	12,489	$0.39	$4,900	0.06	$284
	Avoided CO2 emissions	MT of CO_2	0	7.8	7.8			0.06	$0
2059	Avoided	lbs of	0	12,489	12,489	$0.39	$4,900	0.05	$265

Table 16: Water Quality and Other Expected Benefits
Task #3: Brentwood Nonpotable Water Distribution System Project

(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)
Year	**Type of Benefit**	**Measure of Benefit (Units)**	**Without Project**	**With Project**	**Change Resulting from Project (e) – (d)**	**Unit $ Value**	**Annual $ Value (f) x (g)**	**Discount Factor**	**Discounted Benefits (h) x (i)**
	fertilizer use	fertilizer							
	Avoided CO2 emissions	MT of CO_2	0	7.8	7.8			0.05	$0
2060	Avoided fertilizer use	lbs of fertilizer	0	12,489	12,489	$0.39	$4,900	0.05	$250
	Avoided CO2 emissions	MT of CO_2	0	7.8	7.8			0.05	$0
2061	Avoided fertilizer use	lbs of fertilizer	0	12,489	12,489	$0.39	$4,900	0.05	$235
	Avoided CO2 emissions	MT of CO_2	0	7.8	7.8			0.05	$0
2062	Avoided fertilizer use	lbs of fertilizer	0	12,489	12,489	$0.39	$4,900	0.05	$225
	Avoided CO2 emissions	MT of CO_2	0	7.8	7.8			0.05	$0
Proj. Life	50 Years								
Total Present Value of Discounted Benefits Based on Unit Value (Sum of the values in Column (j) for all Benefits shown in table)									**$64,861**

Comments:
All costs are in 2009 dollars.

Task 4 – Pittsburg Recycled Water Pipeline Rehabilitation Project

The following sections present a quantitative and qualitative analysis of project costs and water supply benefits. Table 16 has been completed, and is included at the end of this section.

Overview

The Pittsburg Recycled Water Pipeline Rehabilitation Project is a recycled water improvement project being administered by Delta Diablo Sanitation District (DDSD), in partnership with the City of Pittsburg. The project involves the rehabilitation of approximately 5,240 feet of 20-inch and 30-inch asbestos cement (AC) recycled water pipeline. The existing recycled water main, which was previously converted from a raw water pipeline, delivers approximately 526 acre-feet per year (AFY) of Title 22 disinfected recycled water to Stoneman Park and Delta View Golf Course (DVGC) in the City of Pittsburg. The pipeline is over 35 years old, has experienced failures, and will likely not be able to withstand increased operating pressures that will be needed as the DDSD service area expands.

A summary of all benefits and costs of the project are provided in Table 4.1. Water Quality and Other Expected benefits are discussed in more detail in the remainder of this attachment, and a complete discussion of Water Supply benefits is provided in Attachment 7.

The proposed project will provide a range of both water quality and other benefits. Rehabilitation of the pipeline will result in $28,250 in avoided pipeline repair costs from 2013 through 2022. Without the project, the pipeline is assumed to fail completely in 2023. At this time, Stoneman Park and the Delta View Golf Course (DVGC) would begin to rely on Delta water. With the use of potable water for irrigation, recycled water customers would need to spend an additional $206,700 on fertilizer. By reducing reliance on Delta water, the project will also avoid 1,872 MT of CO_2 emissions over its' 50-year useful life.

Additional qualitative benefits from the proposed project include improved surface water quality in New York Slough, improved water quality and ecological benefits in Suisun Bay and Sacramento-San Joaquin Delta, and improved aesthetics and recreational opportunities at Stoneman Park and DVGC.

Table 4.1. Benefit-Cost Analysis Overview

	Present Value
Costs – Total Capital Costs	$1,278,750
Monetizable Benefits	
Water Supply Benefits	
Avoided Delta Water Supply Costs	$4,732,853
Water Quality and Other Benefits	
Avoided pipeline maintenance and repair costs	$28,250
Avoided fertilizer costs	$206,705
Total Monetized Benefits	$4,967,808

Table 4.1. Benefit-Cost Analysis Overview

	Present Value
Qualitative Benefit or Cost	**Qualitative indicator***
Water Supply Benefits	
Increased Water Supply Reliability for City of Pittsburg customers	++
Improved Operational Flexibility for the City of Pittsburg	+
Water Quality and Other Benefits	
Improved Surface Water Quality	+
Reduced CO_2 Emissions	+
Recreational and Aesthetic Benefits	+
Reduced Stress on the Delta	+

O&M = Operations and Maintenance

* Direction and magnitude of effect on net benefits:
+ = Likely to increase net benefits relative to quantified estimates.
++ = Likely to increase net benefits significantly.
– = Likely to decrease benefits.
– – = Likely to decrease net benefits significantly.
U = Uncertain, could be + or –.

Description of Without-Project Conditions

The proposed project will ensure the continued delivery of 526 AFY of recycled water to Stoneman Park and DVGC in the City of Pittsburg. Without the project, the existing recycled water conveyance pipeline will continue to fail and DDSD will continue to incur pipeline maintenance and repair costs. Eventually, the pipeline will fail completely (i.e., it will be beyond repair). If DDSD is not able to replace the existing pipeline, Stoneman Park and DVGC will be forced to rely on potable water (Delta supplies purchased from CCWD) for irrigation.

If the effluent from DDSD's WWTP is not put to beneficial use, it will be discharged directly to New York Slough, which leads to Suisun Bay and the Sacramento-San Joaquin Delta. Beneficial uses in New York Slough included in the revised Basin Plan are: commercial and sport fishing, estuarine habitat, fish migration, preservation of rare and endangered species, wildlife habitat, water contact recreation, noncontact water recreation, and navigation. Although DDSD expects to remain in compliance with water quality regulations if the effluent from the WWTP is discharged to New York Slough, discharges would incrementally contribute to further surface water quality degradation in New York Slough, Suisun Bay, and the Delta. Specific constituents of concerns include chlorides and mercury.

The use of Delta water will also require more energy than the use of recycled water. Thus, without the project, CO_2 emissions will continue to be greater than they would be with project implementation. In addition, when potable water is used for irrigation, irrigators must apply additional fertilizer because the potable water does not contain high concentrations of key fertilizing constituents that are common in recycled water (e.g., nitrogen, phosphorus and potassium). This will result in increased costs to Stoneman Park and DVGC. Finally, recycled water is a relatively drought-resistant supply. Thus, if the pipe is rehabilitated, Stoneman Park and the golf course will be able to irrigate fully despite potable

water shortages. This will contribute to improved aesthetics (i.e., due to green lawns) and improved recreational opportunities at both the park and the golf course.

Description of Expected Water Quality and Other Benefits (With-Project Conditions)

This project is expected to create a variety of water quality and other benefits, including improved water quality in New York Slough; reduced pipeline repair costs; avoided fertilizer purchases; avoided CO_2 emissions; reduced stress on the Sacramento-San Joaquin Delta; and other ecological, aesthetic, and recreational benefits, as described below.

Water Quality Benefits

If the effluent from DDSD's wastewater treatment plant is not put to beneficial use, it will be discharged directly to New York Slough, which leads to Suisun Bay and the Sacramento-San Joaquin Delta. Beneficial uses in New York Slough (included in the revised Basin Plan) are: commercial and sport fishing, estuarine habitat, fish migration, preservation of rare and endangered species, wildlife habitat, water contact recreation, noncontact water recreation, and navigation. Although DDSD expects to remain in compliance with water quality regulations if the effluent from the WWTP is discharged to New York Slough, discharges would incrementally contribute to further surface water quality degradation in New York Slough, Suisun Bay, and the Delta. Specific constituents of concerns include chlorides and mercury.

Other Benefits

The proposed project will provide a range of water quality and other benefits, including avoided pipeline repair costs, avoided fertilizer costs, avoided CO2 emissions, and other ecological, aesthetic, and recreational benefits.

Avoided Pipeline Repair Costs

As described in Attachment 7, for this analysis it is assumed that without rehabilitation, the existing pipeline will fail completely by 2023 (50-years after it was constructed). Prior to 2023, there may also be breaks in the line; however, it is assumed that DDSD will continue to repair the pipeline between through 2022, before it fails completely.

It is difficult to predict when (or if) the pipeline will break prior to 2023. In addition, the cost of repairing different types of breaks varies; thus, it is difficult to know how much it will cost DDSD to repair the pipeline for a given incident. To account for these uncertainties, common risk management principles are applied to the benefit-cost analysis.

First, the average number of breaks per mile of pipeline was determined, based on data from a 1993 Canadian study of water main breaks for different pipe materials (National Research Council Canada, 1995). The study estimates that the average failure rate for AC pipelines is 5.8 breaks per 100km per year (or 5.8 breaks per 62.1 miles). For the existing pipeline, which is less than a mile long, this equates to an average of about 0.093 breaks per year, or 1 break every 11 years. Thus, over an 11 period, there is a 9% chance (1 break divided by 11 years) that there will be a break in the pipeline in any given year.

To determine avoided pipeline repair costs each year from 2013 (when the project comes online) through 2022 (when the pipe is assumed to fail completely), the estimated cost of a given break is multiplied by the probability that a break will occur. This leaves open the possibility that the pipeline will not break prior to 2023.

As noted above, there is limited data on the cost of an average break. However, in 2005, the City of Pittsburg experienced a break that cost about $40,000 to repair. This was a fairly low-cost repair as it occurred at an easily accessible portion of the pipeline. If DDSD were to experience a more significant failure where the pipeline is not easily accessible (i.e., where the pipeline crosses under Highway 4), costs would be as much as 10 to 100 times higher. In calculating the weighted average cost of a break in the pipeline, we assume that the portion of the pipe under the bridge is about 150 lf, or 3% of the 5,240 lf of total pipeline, and if the pipe breaks anywhere but under the bridge the repair cost will be $40,000 as opposed to a conservative 10 times that amount ($400,000) for a break under the bridge. Thus, the weighted average cost is approximately $50,800 (0.03*$400,000 + (1-0.03)*$40,000). From 2013 through 2022, the total present value avoided costs for pipeline repair amount to $28,250.

Avoided Fertilizer Costs

In absence of the project, Stoneman Park and DVGC will begin using potable water (Delta water purchased from CCWD) for irrigation beginning in 2023. At this time, the park and the golf course will also need to begin applying additional fertilizer, as fertilizing compounds commonly contained in recycled water are typically not found in high concentrations in potable water (e.g., nitrogen, phosphorous, potassium).

The recycled water that is currently provided to Stoneman Park and DVGC contains 95 lbs of nitrogen per AF, 0.2 lbs of phosphorous per AF, and 17 lbs of potassium per AF. The commercial value of these concentrations of fertilizing compounds amounts to $41.32, $0.36, and $14.01 per AF of recycled water (Asano, 1981). Thus, for every AF of the recycled water used in lieu of potable water, the park and the golf course will avoid a total of $55.69 in fertilizer costs. For the 526 AF of recycled water applied each year in-lieu of Delta water (beginning in 2023), avoided fertilizer costs will be about $29,290. Over the lifetime of the project, total present value avoided fertilizer costs will amount to $206,705.

Reduced CO_2 Emissions

By offsetting Delta water demands with locally produced water, the project will avoid emissions of CO_2 (a greenhouse gas) generated by the production of energy required to transport water from the Delta (via CCWD) to the City of Pittsburg.

DDSD does not have specific data on the amount of energy (and associated carbon emissions) required to import water from the Delta (via CCWD) to the City of Pittsburg. However, this information is available for DWD. For this analysis, it is assumed that the energy required to transport water to DWD customers is approximately equal to that required to deliver Delta water to customers within the City of Pittsburg.

DWD estimates that it requires 0.728 MWh to treat and deliver one AF of water from the Delta. Further, for every MWh of electricity used to import water, 0.222 MT of CO_2 are emitted. Thus, every AF of Delta water generates approximately 0.162 MT of CO_2 (0.728 MWh/AF multiplied by 0.222 MT/MWh). By avoiding the use of 21,040 AF of Delta water over the assumed project life (526 AFY beginning in 2023), the project will avoid emission of over 3,408 metric tons of CO_2.

Avoided carbon emissions will be offset to some extent by the energy required to pump and treat recycled water. Based on data provided by DDSD, 0.328 MWh are required to produce and distribute recycled water within the District. Using the same CO_2 emissions rate of 0.222 MT/MWh for every AF of recycled water delivered to Stoneman Park and the DVGC, 0.073 MT of CO_2 are emitted (0.328 MWh/AF multiplied by 0.222 MT/MWh). Over the lifetime of the project (beginning in 2023 when the use of

recycled water will offset the use of Delta water), total CO_2 emissions associated with recycled water production and distribution will amount to 1,536 MT. Thus, with the project, net avoided carbon emissions will be 1,872 MT.

Reduced Stress on the Sacramento-San Joaquin Delta

By offsetting Delta supplies, this project will augment in-stream flows in the Delta, or offset other diversions that may otherwise reduce flows. Reduced demands on Delta supplies also will help reduce the overall salinity of the Delta and improve Delta habitat.

Increased Recreational and Aesthetic Benefits at Stoneman Park and DVGC

With the availability of recycled water, Stoneman Park and DVGC will not be subject to water supply shortages during droughts. Thus, they will be able to maintain consistent irrigation, and turf grass at the park and golf course will not be subject to the adverse effects of drought, such as thinning and browning. This will result in improved aesthetics and recreational opportunities, especially compared to parks and golf courses reliant on potable water.

Without more extensive data, the benefits of improved aesthetics and recreation are difficult to quantify. However, it is known that about 45,000 rounds of golf are played at DVGC on an annual basis. Annual revenue at the course is approximately $900,000. If the golf course experienced adverse impacts due to potable water supply shortages, some of these revenues to the golf courses (and to the City) may be lost. For example, golfers may choose to spend their money at courses in nearby towns that irrigate with recycled water because they are able to stay green during drought periods.

Project Beneficiaries and Distribution of Benefits

The proposed project includes the full range of beneficiaries, as is summarized in Table 4.2. At the local level, recycled water customers will benefit from avoided fertilizer costs, and the City of Pittsburg will benefit from avoided pipeline repair costs, improved water quality in New York Slough, and improved aesthetics and recreation at the park and golf course. Regional and statewide ecological and air quality benefits include reduced stress/ecological improvements in the Sacramento-San Joaquin Delta and reduced GHG emissions due to reduced reliance on Delta water.

Table 4.2. Project Beneficiaries Summary

Local	**Regional**	*Statewide*
City of Pittsburg Stoneman Park DVGC	Reduced CO_2 emissions	***Sacramento-San Joaquin Delta***

Timing of Benefits

DDSD expects to complete the Pipeline Rehabilitation Project in 2012. Thus, benefits are assumed to begin to accrue in 2013. For this analysis, a 50-year useful project life is assumed for the project. Thus, benefits are calculated through 2062.

To calculate avoided pipeline repair costs, it is assumed that the existing pipeline also has a useful life of 50 years, and will last through 2022. Prior to that time, it is assumed that DDSD will continue to repair breaks that occur in the pipeline. Thus, benefits associated with avoided pipeline repair costs accrue starting in 2013, through 2022, prior to the expected failure of the existing pipeline.

Summary of Qualitative Benefits

Qualitative benefits from the proposed project include improved surface water quality in New York Slough, improved water quality and ecological benefits in Suisun Bay and Sacramento-San Joaquin Delta, and improved aesthetics and recreational opportunities at Stoneman Park and DVGC. These benefits are summarized in Table 4.3.

Table 4.3. Qualitative Benefits Summary – Water Quality and Other Benefits

Benefit	Qualitative Indicator
Improved Surface Water Quality	+
Reduced CO2 Emissions	+
Recreational and Aesthetic Benefits	+
Reduced Stress on the Delta	+

Uncertainty of Benefits

This analysis of costs and benefits is based on available data and some assumptions. As a result, there may be some omissions, uncertainties, and possible biases. These issues are listed in Table 4.4.

Table 4.4. Omissions, Biases, and Uncertainties, and Their Effect on the Project

Benefit or Cost Category	Likely Impact on Net Benefits*	*Comment*
Avoided pipeline repair costs	+	Given the age of the existing pipeline, it is likely that the rate of failure would be higher than 9%. Thus, DDSD would expend more money repairing it.
Avoided pipeline repair costs	U	The pipeline may completely fail prior to 2023, or may remain functioning for awhile after 2023. If the pipeline fails later than 2023, avoided Delta water costs would be lower because they would be incurred later, and for less time. Alternatively, if the pipeline fails earlier than 2023, avoided Delta water supply costs would be greater over the life of the project.

*Direction and magnitude of effect on net benefits:
+ = Likely to increase net benefits relative to quantified estimates.
++ = Likely to increase net benefits significantly.
– = Likely to decrease benefits.
—— = Likely to decrease net benefits significantly.
U = Uncertain, could be + or -.

Potential Adverse Effects

Adverse impacts associated with this project are expected to be limited to temporary construction-related impacts.

Documents Supporting Benefits Analysis

The following documents were used to develop the cost and benefit analyses described in this section:

- Asano, T. 1981. Evaluation of Agricultural Irrigation Projects Using Reclaimed Water. Agreement 8-179-215-2. Office of Water Recycling. California State Water Resources Control Board, Sacramento.
- National Research Council Canada, 1995: A-7019.1 Final: Water Mains Break Data on Different Pipe Materials for 1992 and 1993.
- Diablo Water District. Diablo Water District Well Utilization Project, Final Environmental Impact Report. December 2008. Print.

Economic Benefit Tables

The quantifiable water quality and other benefits generated by this project are summarized in Table 16. As shown in this table, the project will reduce carbon emissions by approximately 1,872 metric tons of CO_2 equivalents over the project life. In addition, the project will save approximately $206,705 in avoided fertilizer purchases and approximately $28,250 in avoided pipeline repair costs, for a total of $234,955 in monetized benefits.

Table 16: Water Quality and Other Expected Benefits
Task #4: Pittsburg Recycled Water Pipeline Rehabilitation Project

(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)
Year	Type of Benefit	Measure of Benefit (Units)	Without Project	With Project	Change Resulting from Project (e) – (d)	Unit $ Value	Annual $ Value (f) x (g)	Discount Factor	Discounted Benefits (h) x (i)
2009								1.00	
2010								0.94	
2011								0.89	
2012								0.84	
2013	Avoided pipeline repair costs	Average # breaks per year	0.090	0	0.090	$50,800	$4,572	0.79	$3,621
2014	Avoided pipeline repair costs	Average # breaks per year	0.090	0	0.090	$50,800	$4,572	0.75	$3,415
2015	Avoided pipeline repair costs	Average # breaks per year	0.090	0	0.090	$50,800	$4,572	0.71	$3,223
2016	Avoided pipeline repair costs	Average # breaks per year	0.090	0	0.090	$50,800	$4,572	0.67	$3,040
2017	Avoided pipeline repair costs	Average # breaks per year	0.090	0	0.090	$50,800	$4,572	0.63	$2,867
2018	Avoided pipeline repair costs	Average # breaks per year	0.090	0	0.090	$50,800	$4,572	0.59	$2,707
2019	Avoided pipeline repair costs	Average # breaks per year	0.090	0	0.090	$50,800	$4,572	0.56	$2,551
2020	Avoided pipeline repair costs	Average # breaks per year	0.090	0	0.090	$50,800	$4,572	0.53	$2,409
2021	Avoided pipeline repair costs	Average # breaks per year	0.090	0	0.090	$50,800	$4,572	0.50	$2,272
2022	Avoided pipeline repair costs	Average # breaks per year	0.090	0	0.090	$50,800	$4,572	0.47	$2,144
2023	Avoided fertilizer use	lbs of fertilizer	0	74,651	74,651	$0.39	$29,291	0.44	$12,946
	Reduced CO2	MT of	0	47	47		$0	0.44	$0

Table 16: Water Quality and Other Expected Benefits
Task #4: Pittsburg Recycled Water Pipeline Rehabilitation Project

(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)
Year	Type of Benefit	Measure of Benefit (Units)	Without Project	With Project	Change Resulting from Project (e) – (d)	Unit $ Value	Annual $ Value (f) x (g)	Discount Factor	Discounted Benefits (h) x (i)
	Emissions	CO_2							
2024	Avoided fertilizer use	lbs of fertilizer	0	74,651	74,651	$0.39	$29,291	0.42	$12,214
	Reduced CO2 Emissions	MT of CO_2	0	47	47		$0	0.42	$0
2025	Avoided fertilizer use	lbs of fertilizer	0	74,651	74,651	$0.39	$29,291	0.39	$11,541
	Reduced CO2 Emissions	MT of CO_2	0	47	47		$0	0.39	$0
2026	Avoided fertilizer use	lbs of fertilizer	0	74,651	74,651	$0.39	$29,291	0.37	$10,867
	Reduced CO2 Emissions	MT of CO_2	0	47	47		$0	0.37	$0
2027	Avoided fertilizer use	lbs of fertilizer	0	74,651	74,651	$0.39	$29,291	0.35	$10,252
	Reduced CO2 Emissions	MT of CO_2	0	47	47		$0	0.35	$0
2028	Avoided fertilizer use	lbs of fertilizer	0	74,651	74,651	$0.39	$29,291	0.33	$9,695
	Reduced CO2 Emissions	MT of CO_2	0	47	47		$0	0.33	$0
2029	Avoided fertilizer use	lbs of fertilizer	0	74,651	74,651	$0.39	$29,291	0.31	$9,139
	Reduced CO2 Emissions	MT of CO_2	0	47	47		$0	0.31	$0
2030	Avoided fertilizer use	lbs of fertilizer	0	74,651	74,651	$0.39	$29,291	0.29	$8,611
	Reduced CO2 Emissions	MT of CO_2	0	47	47		$0	0.29	$0
2031	Avoided fertilizer use	lbs of fertilizer	0	74,651	74,651	$0.39	$29,291	0.28	$8,143
	Reduced CO2 Emissions	MT of CO_2	0	47	47		$0	0.28	$0
2032	Avoided fertilizer use	lbs of fertilizer	0	74,651	74,651	$0.39	$29,291	0.26	$7,674
	Reduced CO2 Emissions	MT of CO_2	0	47	47		$0	0.26	$0
2033	Avoided	lbs of	0	74,651	74,651	$0.39	$29,291	0.25	$7,235

Table 16: Water Quality and Other Expected Benefits
Task #4: Pittsburg Recycled Water Pipeline Rehabilitation Project

(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)
Year	Type of Benefit	Measure of Benefit (Units)	Without Project	With Project	Change Resulting from Project (e) – (d)	Unit $ Value	Annual $ Value (f) x (g)	Discount Factor	Discounted Benefits (h) x (i)
	fertilizer use	fertilizer							
	Reduced CO2 Emissions	MT of CO_2	0	47	47		$0	0.25	$0
2034	Avoided fertilizer use	lbs of fertilizer	0	74,651	74,651	$0.39	$29,291	0.23	$6,825
	Avoided fertilizer use	MT of CO_2	0	47	47		$0	0.23	$0
2035	Reduced CO2 Emissions	lbs of fertilizer	0	74,651	74,651	$0.39	$29,291	0.22	$6,444
	Avoided fertilizer use	MT of CO_2	0	47	47		$0	0.22	$0
2036	Reduced CO2 Emissions	lbs of fertilizer	0	74,651	74,651	$0.39	$29,291	0.21	$6,063
	Avoided fertilizer use	MT of CO_2	0	47	47		$0	0.21	$0
2037	Reduced CO2 Emissions	lbs of fertilizer	0	74,651	74,651	$0.39	$29,291	0.20	$5,741
	Avoided fertilizer use	MT of CO_2	0	47	47		$0	0.20	$0
2038	Reduced CO2 Emissions	lbs of fertilizer	0	74,651	74,651	$0.39	$29,291	0.19	$5,419
	Avoided fertilizer use	MT of CO_2	0	47	47		$0	0.19	$0
2039	Reduced CO2 Emissions	lbs of fertilizer	0	74,651	74,651	$0.39	$29,291	0.17	$5,097
	Avoided fertilizer use	MT of CO_2	0	47	47		$0	0.17	$0
2040	Reduced CO2 Emissions	lbs of fertilizer	0	74,651	74,651	$0.39	$29,291	0.16	$4,804
	Avoided fertilizer use	MT of CO_2	0	47	47		$0	0.16	$0
2041	Reduced CO2 Emissions	lbs of fertilizer	0	74,651	74,651	$0.39	$29,291	0.16	$4,540
	Avoided fertilizer use	MT of CO_2	0	47	47		$0	0.16	$0
2042	Reduced CO2 Emissions	lbs of fertilizer	0	74,651	74,651	$0.39	$29,291	0.15	$4,276
	Avoided	MT of	0	47	47		$0	0.15	$0

Table 16: Water Quality and Other Expected Benefits
Task #4: Pittsburg Recycled Water Pipeline Rehabilitation Project

(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)
Year	Type of Benefit	Measure of Benefit (Units)	Without Project	With Project	Change Resulting from Project (e) – (d)	Unit $ Value	Annual $ Value (f) x (g)	Discount Factor	Discounted Benefits (h) x (i)
	fertilizer use	CO_2							
2043	Reduced CO2 Emissions	lbs of fertilizer	0	74,651	74,651	$0.39	$29,291	0.14	$4,042
	Avoided fertilizer use	MT of CO_2	0	47	47		$0	0.14	$0
2044	Reduced CO2 Emissions	lbs of fertilizer	0	74,651	74,651	$0.39	$29,291	0.13	$3,808
	Avoided fertilizer use	MT of CO_2	0	47	47		$0	0.13	$0
2045	Reduced CO2 Emissions	lbs of fertilizer	0	74,651	74,651	$0.39	$29,291	0.12	$3,603
	Avoided fertilizer use	MT of CO_2	0	47	47		$0	0.12	$0
2046	Avoided fertilizer use	lbs of fertilizer	0	74,651	74,651	$0.39	$29,291	0.12	$3,398
	Reduced CO2 Emissions	MT of CO_2	0	47	47		$0	0.12	$0
2047	Avoided fertilizer use	lbs of fertilizer	0	74,651	74,651	$0.39	$29,291	0.11	$3,193
	Reduced CO2 Emissions	MT of CO_2	0	47	47		$0	0.11	$0
2048	Avoided fertilizer use	lbs of fertilizer	0	74,651	74,651	$0.39	$29,291	0.10	$3,017
	Reduced CO2 Emissions	MT of CO_2	0	47	47		$0	0.10	$0
2049	Avoided fertilizer use	lbs of fertilizer	0	74,651	74,651	$0.39	$29,291	0.10	$2,841
	Reduced CO2 Emissions	MT of CO_2	0	47	47		$0	0.10	$0
2050	Avoided fertilizer use	lbs of fertilizer	0	74,651	74,651	$0.39	$29,291	0.09	$2,695
	Reduced CO2 Emissions	MT of CO_2	0	47	47		$0	0.09	$0
2051	Avoided fertilizer use	lbs of fertilizer	0	74,651	74,651	$0.39	$29,291	0.09	$2,548
	Reduced CO2 Emissions	MT of CO_2	0	47	47		$0	0.09	$0
2052	Avoided	lbs of	0	74,651	74,651	$0.39	$29,291	0.08	$2,402

Table 16: Water Quality and Other Expected Benefits
Task #4: Pittsburg Recycled Water Pipeline Rehabilitation Project

(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)
Year	Type of Benefit	Measure of Benefit (Units)	Without Project	With Project	Change Resulting from Project (e) – (d)	Unit $ Value	Annual $ Value (f) x (g)	Discount Factor	Discounted Benefits (h) x (i)
	fertilizer use	fertilizer							
	Reduced CO2 Emissions	MT of CO_2	0	47	47		$0	0.08	$0
2053	Avoided fertilizer use	lbs of fertilizer	0	74,651	74,651	$0.39	$29,291	0.08	$2,255
	Reduced CO2 Emissions	MT of CO_2	0	47	47		$0	0.08	$0
2054	Avoided fertilizer use	lbs of fertilizer	0	74,651	74,651	$0.39	$29,291	0.07	$2,138
	Reduced CO2 Emissions	MT of CO_2	0	47	47		$0	0.07	$0
2055	Avoided fertilizer use	lbs of fertilizer	0	74,651	74,651	$0.39	$29,291	0.07	$2,021
	Reduced CO2 Emissions	MT of CO_2	0	47	47		$0	0.07	$0
2056	Avoided fertilizer use	lbs of fertilizer	0	74,651	74,651	$0.39	$29,291	0.07	$1,904
	Reduced CO2 Emissions	MT of CO_2	0	47	47		$0	0.07	$0
2057	Avoided fertilizer use	lbs of fertilizer	0	74,651	74,651	$0.39	$29,291	0.06	$1,787
	Reduced CO2 Emissions	MT of CO_2	0	47	47		$0	0.06	$0
2058	Avoided fertilizer use	lbs of fertilizer	0	74,651	74,651	$0.39	$29,291	0.06	$1,699
	Reduced CO2 Emissions	MT of CO_2	0	47	47		$0	0.06	$0
2059	Avoided fertilizer use	lbs of fertilizer	0	74,651	74,651	$0.39	$29,291	0.05	$1,582
	Reduced CO2 Emissions	MT of CO_2	0	47	47		$0	0.05	$0
2060	Avoided fertilizer use	lbs of fertilizer	0	74,651	74,651	$0.39	$29,291	0.05	$1,494
	Reduced CO2 Emissions	MT of CO_2	0	47	47		$0	0.05	$0
2061	Avoided fertilizer use	lbs of fertilizer	0	74,651	74,651	$0.39	$29,291	0.05	$1,406
	Reduced CO2	MT of	0	47	47		$0	0.05	$0

Table 16: Water Quality and Other Expected Benefits
Task #4: Pittsburg Recycled Water Pipeline Rehabilitation Project

(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)
Year	**Type of Benefit**	**Measure of Benefit (Units)**	**Without Project**	**With Project**	**Change Resulting from Project (e) – (d)**	**Unit $ Value**	**Annual $ Value (f) x (g)**	**Discount Factor**	**Discounted Benefits (h) x (i)**
	Emissions	CO_2							
2062	Avoided fertilizer use	lbs of fertilizer	0	74,651	74,651	$0.39	$29,291	0.05	$1,347
	Reduced CO2 Emissions	MT of CO_2	0	47	47		$0	0.05	$0
Proj. Life	50 Years								
Total Present Value of Discounted Benefits Based on Unit Value (Sum of the values in Column (j) for all Benefits shown in table)									**$234,955**
Comments: All costs are in 2009 dollars.									

Task 5 – Phase 2 Contra Costa Canal Levee Elimination and Flood Protection Project

The following sections present a quantitative and qualitative analysis of project costs and water supply benefits. Table 16 has been completed, and is included at the end of this section.

Overview

The full CCWD Canal Levee Elimination and Flood Protection Project will replace the 21,000 feet of unlined Contra Costa Canal with a pipeline to improve source water quality available to CCWD by preventing intrusion of poor quality groundwater; eliminate up to eight miles of aging canal embankments that were not intended to provide flood protection (though they are currently relied upon for that purpose), and improve security and public safety by preventing access to the open water canal. This project is Phase 2 of the full project, which includes replacing approximately 400 feet of the canal with a pipeline and eliminating associated canal embankments. Phase 2 also includes a crossing of Marsh Creek.

It is important to note that the specific project submitted in this proposal, and evaluated in this Attachment, reflects a key portion of the greater canal levee elimination project (including the crossing of Marsh Creek), but not the entire 21,000 feet of anticipated pipeline installation to replace all of the existing canal. To evaluate benefits, we estimated (as feasible) the value of the benefits for the entire canal replacement project (because the benefits accrue from the entire project being completed), and then attributed a portion of those aggregate benefits to the specific portion of the pipeline that would be developed under this project. This specific project reflects 4.2% of the total $96 M canal replacement budget; therefore we assigned 4.2% of the overall project benefits to this specific portion of the project.

A summary of all benefits and costs of the project are provided in Table 5.1. Water Quality and Other Expected benefits are discussed in more detail in the remainder of this attachment, a complete discussion of Water Supply benefits is provided in Attachment 7, and a discussion of flood damage reduction benefits is provided in Attachment 9.

Table 5.1. Benefit-Cost Analysis Overview

	Present Value
Costs – Total Capital and O&M	$3,489,542
Monetizable Benefits	
Water Supply Benefits	
Avoided releases from SWP and CVP reservoirs	$1,146,091
Water for additional CCWD reservoir storage	$185,696
Value of avoided losses in water revenues	$452,633
Water Quality and Other Benefits	
Public safety – reduced drowning risk	$812,419
Reduced energy use (water pumping/blending)	$150,878
Reduced levels of DBPs in drinking water	$877,412

Table 5.1. Benefit-Cost Analysis Overview

	Present Value
Flood Damage Reduction	
Reduced levee failure flood damages	$13,823
Value of avoided levee breach repairs	$58,886
Total Monetized Benefits	$3,697,838
Qualitative Benefit or Cost	**Qualitative indicator***
Water Supply Benefits	
Increased Water Supply Reliability for CCWD retail and wholesale customers	++
Improved Operational Flexibility for Contra Costa Water District	++
Increased operational flexibility and added water storage (reduced water quality-driven releases) for SWP and CVP	++
Reduced stress on Bay-Delta water supplies	+
Water Quality and Other Benefits	
Enabled completion of Dutch Slough project (significant ecologic and other benefits)	++
Improved Water Quality for CCWD customers (beyond DBPs)	+
Reduced energy demands and CO2 Emissions (less pumping)	+
Reduced fish loss (including special status species)	+
Increased security (intentional or accidental contamination/disruption) of CCWD water supply	+

O&M = Operations and Maintenance

* Direction and magnitude of effect on net benefits:
+ = Likely to increase net benefits relative to quantified estimates.
++ = Likely to increase net benefits significantly.
– = Likely to decrease benefits.
– – = Likely to decrease net benefits significantly.
U = Uncertain, could be + or –.

Description of Without-Project Conditions

This project will replace four miles of unlined canal with a buried pipeline and eliminate the levees on either side of the canal. This will improve water quality at the intake downstream, eliminate flooding hazards, eliminate predation and entrainment of fish in the canal, eliminate the public safety hazard of an open canal in a residential area, and ensure compatibility with adjacent land use, including habitat restoration. Additionally, replacing the unlined canal will reduce seepage loss, reducing upstream reservoir withdrawals. This project is closely tied to the Dutch Slough Habitat Restoration Project. This canal improvement project must be completed prior to the Dutch Slough project to avoid degradation of water quality.

Without the project, CCWD will continue to rely on a long stretch of open, unlined canal in order to convey water to its intake at Pumping Plant 1 (PP1), also referred to as the Rock Slough Intake. Water quality at the intake would continue to be degraded due to seepage into the canal from groundwater. Higher salinity water seepage into the canal has been identified as the primary source of water quality degradation to PP1. Residential area runoff from the increasingly developed adjacent areas could also pose new challenges to water quality in the canal.

Additionally, the Dutch Slough Habitat Restoration Project, which will inundate adjacent properties, will exacerbate the existing seepage problem. Consequently, this very important ecologic restoration project cannot be implemented until the open canal is replaced with a pipeline.

In addition, without the project, the canal would continue to pose a flooding and public safety threat to the adjacent land area which has become increasingly residential. The levees that contain the canal were not designed for flood protection, yet they are currently used for this purpose.

Overall this project will provide significant benefits at the local, regional, and state level through improved water supply reliability, and regional improvements in water quality. By reducing seepage into the canal, this project will improve both water supply and water quality for CCWD, the State Water Project (SWP), and the Central Valley Project (CVP). It also will enable a significant Delta restoration project to proceed.

Description of Expected Water Quality and Other Benefits (With-Project Conditions)

This project is expected to create a variety of water quality and other benefits, including the following.

Water Quality Benefits

The primary water quality benefit expected from this project is a reduction in disinfection byproduct formation, and associated public health protection. With completion of the project, water at PP1 will have lower bromide levels, which is transformed into bromate during ozonation at CCWD's Randall Bold Treatment Plant. Bromate is suspected of contributing to kidney and thyroid cancer in humans. The federal maximum contaminant level (MCL) for bromate is 10 ug/L, and the excess cancer risk at the MCL is 2 in 100,000 (US EPA, 2003). The average bromate level in CCWD finished water currently is 2 to 16 ug/L. As bromate is presumed to have a linear no-threshold dose-response relationship, the only risk-free level of exposure to bromate is zero. Thus, any project that reduces the potential level of bromate in drinking water is providing positive reduction in risk of cancer to those who drink that water (US EPA, 2003).

The drinking water unit cancer risk for bromate is equal to 2 * 10^{-5} per ug/L; for water at the MCL concentration of 10 ug/L, this corresponds to 2 in 100,000. Therefore, if 200,000 people receive water with bromate at the MCL, then lifetime excess risk of cancer implies that, statistically, the number of people in the exposed group that would get cancer from the water is projected to be 4 (2 in 100,000, times 200,000 people). If an action reduces bromate levels by only 1 ug/L, then 0.4 of these statistically anticipated excess cancer cases would be avoided (a 10% reduction in exposure levels yields a 10% reduction in risk). Bromides are expected to be reduced by 2 – 5 % with a corresponding reduction in bromate of 2 – 4%.

Within the range of current bromate levels from 2 to 16 ug/L, bromate levels average 6.5 ug/L. The average bromate level is used to calculate public health benefits from reduced bromate levels. The relationship between bromate risk and concentration is linear, so risk at 6.5 ug/L will equal 65% of the risk at the MCL, or 1.3 x 10-5 per ug/L. Multiplying this risk level by the number of households served (178,571) and the average number of people per household in the area (3.1) provides the estimate of the excess lifetime cancer cases expected under baseline: 7.2. This project will reduce bromate levels by an average of 3%, so we assume bromate levels will drop to 6.3 ug/L. Therefore, this project would result in 0.216 fewer cancer cases per year.

In its Stage 2 Disinfectant and Disinfectant By-Products Rule, the U.S. EPA estimates the value of a statistical life (VSL) at approximately $7.1 million, adjusted to 2005 dollars. More recently, EPA has updated its best estimate for VSL to $7.0 million (in 2006 dollars, but based on projected 2010 income levels) (US EPA 2008). Here we use the $7.0 million VSL figure as a reasonable approximation for 2009 dollars. The VSL estimates are based on meta-analyses of the "wage-risk" literature, which involves estimating the tradeoff individuals are willing to pay between risk and higher income based on salary differentials between occupations with differing risk levels.

Based on the excess cancer cases avoided for this project and the US EPA-sanctioned estimate of the value of a statistical life, this project would provide approximately $1.51 million in benefits from avoided cancer cases annually (0.216 cancer cases avoided per year, times $7 million per avoided cancer case). As shown in Table 16, the present value of this benefit amounts to $20.9 million for the entire canal and levee elimination project. Assigning the 4.2% share of the total benefit attributable to the portion of the pipeline project covered by this specific component of the overall project, the present value benefits amount to roughly $877,412.

Other Benefits

Other benefits expected from project implementation include completion of the Dutch Slough project, reduced energy usage, reduced carbon footprint, improved public safety and reduced fish loss. These benefits are discussed below.

Enabling Completion of the Dutch Slough Restoration Project

Encasing the unlined canal is a critical step for the completion of the Dutch Slough Restoration Project, a tidal wetland restoration site just north of the canal. The Dutch Slough Habitat Restoration Project cannot move forward as planned until the Canal is replaced by a pipeline through this area.

The Dutch Slough Tidal Marsh Restoration Project is a critical early action to improve the ecosystem health of the Sacramento-San Joaquin Delta, a point highlighted by Governor Schwarzenegger in a July 2007 statement and its inclusion in the Interim Delta Plan. The completion of the legislatively-mandated (SBX7-1 Section 85085) Dutch Slough Tidal Marsh Restoration project is dependent on the construction

of the canal replacement pipeline adjacent to the Dutch Slough Restoration site. As specified in Mitigation term 3.1.1-5 of the Dutch Slough EIR Mitigation Monitoring and Reporting Program, "To avoid potential negative impacts to water quality within the Contra Costa Canal from groundwater intrusion, breaching of the Dutch Slough project site will not commence until encasement of the Canal south of the site is complete."

The Dutch Slough Tidal Marsh Restoration Project, in the City of Oakley, is situated at a location and elevation which offer the only opportunity for an immediate and major tidal marsh restoration and research program in the western Delta. The 1,200 acre site is currently used as pasture, but has the potential for restoring over six miles of shoreline and a mosaic of tidal, riparian, and upland habitats. The resulting restored habitats will provide enhanced western Delta habitat for fish and wildlife. The unique site topography which is relatively unsubsided provides for immediate restoration of intertidal dendritic channels favored by native fish including threatened spring run Chinook salmon, endangered winter run Chinook salmon, and Sacramento splittail. The habitat restoration in the upland sites will allow for the development of riparian forest and shaded riverine habitats.

Because it will restore natural hydrology and increase nutrients in the Delta's aquatic food chain, the project is expected to provide important benefits to the larger Delta ecosystem. Numerous planning processes, including the Delta Vision Strategic Plan, the CALFED Ecosystem Restoration Plan, and the Bay Delta Conservation Plan, have identified restoring tidal marsh as integral to restoring the health of the Bay-Delta Ecosystem.

This highly important Delta ecosystem restoration project is dependent on the completion of the proposed project. Further, as part of its completed mitigation for the canal encasement, CCWD acquired wetland and upland habitat land (suitable for special status species including the burrowing owl and giant garter snake) at Holland tract. Overall, CCWD has acquired 47 acres of wetland and 98 acres of upland habitat.

Clearly, there are appreciable ecosystem-related benefits associated with completion of the canal encasement project. However, we have not attempted to assign a monetary value to this benefit.

Reduced Energy Use to Meet Water Quality Targets for CCWD Finished Waters

Improved water quality at the intake will enable CCWD to meet its finished water quality goals with less pumping and blending of its supplies. This is anticipated to result in a savings of $200,000 per year in energy costs for the utility.

An additional annual operating cost that would be avoided with this project is the elimination of the need to use aquatic pesticides. Absent the project, these pesticides would continue to be used as needed to control algae and other aquatic plants in the canal, at a cost of $60,000 per year.

Combining these two operating expenses, the energy and pesticide cost savings associated with this project amount to $260,000 per year. As shown in Table 12, the present value of this benefit amounts to $3.6 million for the entire canal and levee elimination project. Assigning the 4.2% share of these total benefits that are attributable to the portion of the pipeline project covered by this specific component of the overall project, the present value benefits amount to about $150,878.

Reduced Carbon Footprint

CCWD estimates that the energy savings derived from pipeline-related improvements to water quality will amount to over 1700 MWH per year. This energy savings is associated with a reduction in CO_2 emissions of 497.5 metric tons per year. Over the 75-year life of the pipeline, this amounts to a reduction in the CCWD carbon footprint of over 37,300 metric tons. Over 1,566 of these metric tons of reduced carbon emissions (4.2%) can be attributed to the portion of the pipeline addressed by this specific project. No monetized values are associated with this reduction in CCWD's carbon footprint.

Security and Public Safety

Currently, the open canal presents a risk for drowning or other accidents. This is of particular concern because the area is being developed rapidly for residential use, with up to 8,000 homes planned for the area and 25,000 residents. Enclosing the canal will completely eliminate this risk.

Newspaper accounts indicate that at least three people have drowned in the canal since 1995. That past history indicates a risk of 3 fatalities in 15 years, or an average risk of 20% (3/15) for a drowning to occur in any given year. Enclosing the canal in a pipeline will eliminate this risk. Applying the generally accepted USEPA estimate of $7 million per VSL as the value of reducing risks of premature death, the annual risk reduction benefit of the project amounts to $1.4 million per year (0.2 times $7 million). As shown in Table 16, the present value of this benefit amounts to $19.34 million for the entire canal encasement project. Assigning the 4.2% share of these total benefits that are attributable to the portion of the full project covered by this specific component, the present value benefits amount to about $812,419.

In addition, the open canal is highly vulnerable to intentional and unintentional contamination, and poses a security risk to the utility, its customers, and adjacent residents. This vulnerability is likely to increase as development increases in the area. Enclosing the canal will eliminate this security risk. No monetary value has been assigned to the reduced security risk.

Reduced Fish Loss

Fish entrainment and predation are recognized issues in the unlined Canal. Historically pumping and the tides could draw fish into the canal. Once in the canal, a study of predation conducted by DFG in the mid-1990s estimated the predation rate to be as high as 80%. The Rock Slough Fish screen meets approach velocity criteria for smelt and salmon, providing protection from impingement and entrainment. The canal replacement combined with the Rock Slough Fish screen will eliminate predation in the canal and entrainment at PP1.

Additionally, absent the project, aquatic pesticides would continue to be used as needed to control algae and other aquatic plants. The project will eliminate the need to add these pesticides into the sensitive Bay-Delta environment.

The potentially high value of reduced takes of special status fish, and of reduced introduction of herbicides in the near-Delta waters are not assigned monetary values in this analysis. However, these non-monetized benefits could nonetheless be of considerable value.

Project Beneficiaries and Distribution of Benefits

In terms of water quality and other benefits, the Contra Costa Canal Levee Elimination and Flood Protection Project will benefit stakeholders at the local, regional, and state level, as is summarized in Table 5.2. At the local level, CCWD will benefit from improved operational flexibility.

This project not only benefits CCWD but also many state and federal interests. The completion of the legislatively mandated (SBX7-1 Section 85085) Dutch Slough Tidal Marsh Restoration project is dependent on the encasement of the Contra Costa Canal adjacent to the Dutch Slough Restoration site. This will provide appreciable ecological benefits to the Delta and all state-wide stakeholders with an interest in the Delta's health.

Table 5.2. Project Beneficiaries Summary

Local	Regional	*Statewide*
CCWD and its retail customers Residents living in lands adjacent to the existing canal.	Contra Costa Water District's wholesale customers, especially those relying on raw water (all of which relies on the Canal)	***Stakeholders with interest in Bay-Delta water supplies, fisheries, and general ecologic well-being***

Timing of Benefits

Construction of the new pipeline will be completed in 2012 and will come online in 2013. For this analysis, a 75-year useful project life is assumed, thus benefits and costs are calculated through 2087 (75 years after the project comes online).

Summary of Qualitative Benefits

Qualitative benefits from the proposed project include enables completion of the Dutch Slough project, improved water quality for CCWD customers, reduced energy demands and CO_2 emissions, reduced fish loss, and increased security. These benefits are summarized in Table 5.3.

Table 5.3. Qualitative Benefits Summary – Water Quality and Other Benefits

Benefit	Qualitative Indicator
Water Quality and Other Benefits	
Enabled completion of Dutch Slough project (significant ecologic and other benefits)	++
Improved Water Quality for CCWD customers (beyond DBPs)	+
Reduced energy demands and CO2 Emissions (less pumping)	+
Reduced fish loss (including special status species)	+
Increased security (intentional or accidental contamination/disruption) of CCWD water supply	+

Uncertainty of Benefits

This analysis of costs and benefits is based on available data and some assumptions. As a result, there may be some omissions, uncertainties, and possible biases. In most cases, omissions lead to a downward

bias in benefits: the project is expected to be much more beneficial than the subset of benefits that can be monetized would indicate. Several of these issues are listed in Table 5.3.

Table 5.3. Omissions, Biases, and Uncertainties, and Their Effect on the Project

Benefit or Cost Category	Likely Impact on Net Benefits*	*Comment*
Value of enabling completion of Dutch Slough restoration project	++	The Dutch Slough restoration project is expected to generate considerable ecologic and other benefits to the Delta system. The project cannot move forward without completion of the pipeline. No monetized estimates of the value of the completing this restoration project are included in our empirical estimates of benefits. Therefore, the total benefits are likely to be understated.
Reduced cancer risk from reduced bromate concentrations	U	The amount by which bromide in source waters will be reduced, and the amount of bromate reduction realized in tap waters, is uncertain. There also are uncertainties regarding the quantified cancer risk assessment and valuation of the avoided cases using VSL. In addition, there may be other DBP reductions associated with the improved source water quality that are omitted from the benefits analysis.
Project costs	U	The calculation of the present value of costs is a function of the timing of capital outlays and a number of other factors and conditions. Changes in these variables will change the estimate of costs.

*Direction and magnitude of effect on net benefits:
+ = Likely to increase net benefits relative to quantified estimates.
++ = Likely to increase net benefits significantly.
– = Likely to decrease benefits.
– – = Likely to decrease net benefits significantly.
U = Uncertain, could be + or –.

Potential Adverse Effects

Potential adverse impacts from this project are expected to be limited to temporary construction impacts.

Documents Supporting Benefits Analysis

The following documents were used to develop the cost and benefit analyses described in this section:

- Newspaper and CCWD Board Meeting minutes: accounts of drownings (http://articles.sfgate.com/1995-09-28/news/17815737_1_dive-team-sheriff-s-department-contra-costa-canal, http://www.ccwater.com/atwork/minutes.asp?action=view&bmmID=214, http://www.allvoices.com/news/5278964/s/48951268-body-found-in-coco-county-canal-died-by-drowning, accessed 12/28/2010)

- US EPA, 2008. BenMAP, the Environmental Benefits Mapping and Analysis Program. Office of Air Planning and Standards. Available: http://www.epa.gov/air/benmap/download.html.
- US EPA, 2003. National Primary Drinking Water Regulations: Stage 2 Disinfectants and Disinfection Byproducts Rule; Proposed Rule. 40 CFR Parts 141,142, and 143, August 18.

Economic Benefit Tables

The quantifiable water quality and other benefits generated by this project are summarized in Table 16. As shown in this table, the full project provides present value water quality and other expected benefits totaling $43.83 M. The portion attributable to this project is approximately 4.2 percent of the total project benefit, or $1.84 M.

Table 16: Water Quality and Other Expected Benefits
Task #5: Phase 2 Contra Costa Canal Levee Elimination and Flood Protection Project

(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)
Year	Type of Benefit	Measure of Benefit (Units)	Without Project	With Project	Change from Project (e) – (d)	Unit $ Value	Annual $ Value (f) x (g)	Discount Factor	Discounted Benefits (h) x (i)
2009								1.00	$0
2010								0.94	$0
2011								0.89	$0
2012								0.84	$0
2013	Avoided drownings	Risk (%)	20%	0%	20%	$7,000,000	$1,400,000	0.79	$1,108,931
	Treatment Energy and Herbicide Savings	Risk (%)	100%	0%	100%	$260,000	$260,000	0.79	$205,944
	Avoided bromate	Risk (%)	22%	0%	22%	$7,000,000	$1,512,000	0.79	$1,197,646
2014	Avoided drownings	Risk (%)	20%	0%	20%	$7,000,000	$1,400,000	0.75	$1,046,161
	Treatment Energy and Herbicide Savings	Risk (%)	100%	0%	100%	$260,000	$260,000	0.75	$194,287
	Avoided bromate	Risk (%)	22%	0%	22%	$7,000,000	$1,512,000	0.75	$1,129,854
2015	Avoided drownings	Risk (%)	20%	0%	20%	$7,000,000	$1,400,000	0.70	$986,945
	Treatment Energy and Herbicide Savings	Risk (%)	100%	0%	100%	$260,000	$260,000	0.70	$183,290
	Avoided bromate	Risk (%)	22%	0%	22%	$7,000,000	$1,512,000	0.70	$1,065,900
2016	Avoided drownings	Risk (%)	20%	0%	20%	$7,000,000	$1,400,000	0.67	$931,080
	Treatment Energy and Herbicide Savings	Risk (%)	100%	0%	100%	$260,000	$260,000	0.67	$172,915
	Avoided bromate	Risk (%)	22%	0%	22%	$7,000,000	$1,512,000	0.67	$1,005,566
2017	Avoided drownings	Risk (%)	20%	0%	20%	$7,000,000	$1,400,000	0.63	$878,377

Table 16: Water Quality and Other Expected Benefits
Task #5: Phase 2 Contra Costa Canal Levee Elimination and Flood Protection Project

(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)
Year	Type of Benefit	Measure of Benefit (Units)	Without Project	With Project	Change from Project (e) – (d)	Unit $ Value	Annual $ Value (f) x (g)	Discount Factor	Discounted Benefits (h) x (i)
	Treatment Energy and Herbicide Savings	Risk (%)	100%	0%	100%	$260,000	$260,000	0.63	$163,127
	Avoided bromate	Risk (%)	22%	0%	22%	$7,000,000	$1,512,000	0.63	$948,648
2018	Avoided drownings	Risk (%)	20%	0%	20%	$7,000,000	$1,400,000	0.59	$828,658
	Treatment Energy and Herbicide Savings	Risk (%)	100%	0%	100%	$260,000	$260,000	0.59	$153,894
	Avoided bromate	Risk (%)	22%	0%	22%	$7,000,000	$1,512,000	0.59	$894,950
2019	Avoided drownings	Risk (%)	20%	0%	20%	$7,000,000	$1,400,000	0.56	$781,753
	Treatment Energy and Herbicide Savings	Risk (%)	100%	0%	100%	$260,000	$260,000	0.56	$145,183
	Avoided bromate	Risk (%)	22%	0%	22%	$7,000,000	$1,512,000	0.56	$844,293
2020	Avoided drownings	Risk (%)	20%	0%	20%	$7,000,000	$1,400,000	0.53	$737,503
	Treatment Energy and Herbicide Savings	Risk (%)	100%	0%	100%	$260,000	$260,000	0.53	$136,965
	Avoided bromate	Risk (%)	22%	0%	22%	$7,000,000	$1,512,000	0.53	$796,503
2021	Avoided drownings	Risk (%)	20%	0%	20%	$7,000,000	$1,400,000	0.50	$695,757
	Treatment Energy and Herbicide Savings	Risk (%)	100%	0%	100%	$260,000	$260,000	0.50	$129,212
	Avoided bromate	Risk (%)	22%	0%	22%	$7,000,000	$1,512,000	0.50	$751,418
2022	Avoided	Risk (%)	20%	0%	20%	$7,000,000	$1,400,000	0.47	$656,375

Table 16: Water Quality and Other Expected Benefits
Task #5: Phase 2 Contra Costa Canal Levee Elimination and Flood Protection Project

(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)
Year	Type of Benefit	Measure of Benefit (Units)	Without Project	With Project	Change from Project (e) – (d)	Unit $ Value	Annual $ Value (f) x (g)	Discount Factor	Discounted Benefits (h) x (i)
	drownings								
	Treatment Energy and Herbicide Savings	Risk (%)	100%	0%	100%	$260,000	$260,000	0.47	$121,898
	Avoided bromate	Risk (%)	22%	0%	22%	$7,000,000	$1,512,000	0.47	$708,885
2023	Avoided drownings	Risk (%)	20%	0%	20%	$7,000,000	$1,400,000	0.44	$619,221
	Treatment Energy and Herbicide Savings	Risk (%)	100%	0%	100%	$260,000	$260,000	0.44	$114,998
	Avoided bromate	Risk (%)	22%	0%	22%	$7,000,000	$1,512,000	0.44	$668,759
2024	Avoided drownings	Risk (%)	20%	0%	20%	$7,000,000	$1,400,000	0.42	$584,171
	Treatment Energy and Herbicide Savings	Risk (%)	100%	0%	100%	$260,000	$260,000	0.42	$108,489
	Avoided bromate	Risk (%)	22%	0%	22%	$7,000,000	$1,512,000	0.42	$630,905
2025	Avoided drownings	Risk (%)	20%	0%	20%	$7,000,000	$1,400,000	0.39	$551,105
	Treatment Energy and Herbicide Savings	Risk (%)	100%	0%	100%	$260,000	$260,000	0.39	$102,348
	Avoided bromate	Risk (%)	22%	0%	22%	$7,000,000	$1,512,000	0.39	$595,193
2026	Avoided drownings	Risk (%)	20%	0%	20%	$7,000,000	$1,400,000	0.37	$519,910
	Treatment Energy and Herbicide Savings	Risk (%)	100%	0%	100%	$260,000	$260,000	0.37	$96,555
	Avoided bromate	Risk (%)	22%	0%	22%	$7,000,000	$1,512,000	0.37	$561,503

Table 16: Water Quality and Other Expected Benefits
Task #5: Phase 2 Contra Costa Canal Levee Elimination and Flood Protection Project

(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)
Year	Type of Benefit	Measure of Benefit (Units)	Without Project	With Project	Change from Project (e) – (d)	Unit $ Value	Annual $ Value (f) x (g)	Discount Factor	Discounted Benefits (h) x (i)
2027	Avoided drownings	Risk (%)	20%	0%	20%	$7,000,000	$1,400,000	0.35	$490,481
	Treatment Energy and Herbicide Savings	Risk (%)	100%	0%	100%	$260,000	$260,000	0.35	$91,089
	Avoided bromate	Risk (%)	22%	0%	22%	$7,000,000	$1,512,000	0.35	$529,720
2028	Avoided drownings	Risk (%)	20%	0%	20%	$7,000,000	$1,400,000	0.33	$462,718
	Treatment Energy and Herbicide Savings	Risk (%)	100%	0%	100%	$260,000	$260,000	0.33	$85,933
	Avoided bromate	Risk (%)	22%	0%	22%	$7,000,000	$1,512,000	0.33	$499,736
2029	Avoided drownings	Risk (%)	20%	0%	20%	$7,000,000	$1,400,000	0.31	$436,527
	Treatment Energy and Herbicide Savings	Risk (%)	100%	0%	100%	$260,000	$260,000	0.31	$81,069
	Avoided bromate	Risk (%)	22%	0%	22%	$7,000,000	$1,512,000	0.31	$471,449
2030	Avoided drownings	Risk (%)	20%	0%	20%	$7,000,000	$1,400,000	0.29	$411,818
	Treatment Energy and Herbicide Savings	Risk (%)	100%	0%	100%	$260,000	$260,000	0.29	$76,480
	Avoided bromate	Risk (%)	22%	0%	22%	$7,000,000	$1,512,000	0.29	$444,763
2031	Avoided drownings	Risk (%)	20%	0%	20%	$7,000,000	$1,400,000	0.28	$388,507
	Treatment Energy and Herbicide Savings	Risk (%)	100%	0%	100%	$260,000	$260,000	0.28	$72,151
	Avoided	Risk (%)	22%	0%	22%	$7,000,000	$1,512,000	0.28	$419,588

Table 16: Water Quality and Other Expected Benefits
Task #5: Phase 2 Contra Costa Canal Levee Elimination and Flood Protection Project

(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)
Year	Type of Benefit	Measure of Benefit (Units)	Without Project	With Project	Change from Project (e) – (d)	Unit $ Value	Annual $ Value (f) x (g)	Discount Factor	Discounted Benefits (h) x (i)
	bromate								
2032	Avoided drownings	Risk (%)	20%	0%	20%	$7,000,000	$1,400,000	0.26	$366,516
	Treatment Energy and Herbicide Savings	Risk (%)	100%	0%	100%	$260,000	$260,000	0.26	$68,067
	Avoided bromate	Risk (%)	22%	0%	22%	$7,000,000	$1,512,000	0.26	$395,837
2033	Avoided drownings	Risk (%)	20%	0%	20%	$7,000,000	$1,400,000	0.25	$345,770
	Treatment Energy and Herbicide Savings	Risk (%)	100%	0%	100%	$260,000	$260,000	0.25	$64,214
	Avoided bromate	Risk (%)	22%	0%	22%	$7,000,000	$1,512,000	0.25	$373,432
2034	Avoided drownings	Risk (%)	20%	0%	20%	$7,000,000	$1,400,000	0.23	$326,198
	Treatment Energy and Herbicide Savings	Risk (%)	100%	0%	100%	$260,000	$260,000	0.23	$60,580
	Avoided bromate	Risk (%)	22%	0%	22%	$7,000,000	$1,512,000	0.23	$352,294
2035	Avoided drownings	Risk (%)	20%	0%	20%	$7,000,000	$1,400,000	0.22	$307,734
	Treatment Energy and Herbicide Savings	Risk (%)	100%	0%	100%	$260,000	$260,000	0.22	$57,151
	Avoided bromate	Risk (%)	22%	0%	22%	$7,000,000	$1,512,000	0.22	$332,353
2036	Avoided drownings	Risk (%)	20%	0%	20%	$7,000,000	$1,400,000	0.21	$290,315
	Treatment Energy and Herbicide Savings	Risk (%)	100%	0%	100%	$260,000	$260,000	0.21	$53,916

Table 16: Water Quality and Other Expected Benefits
Task #5: Phase 2 Contra Costa Canal Levee Elimination and Flood Protection Project

(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)
Year	Type of Benefit	Measure of Benefit (Units)	Without Project	With Project	Change from Project (e) – (d)	Unit $ Value	Annual $ Value (f) x (g)	Discount Factor	Discounted Benefits (h) x (i)
	Avoided bromate	Risk (%)	22%	0%	22%	$7,000,000	$1,512,000	0.21	$313,540
2037	Avoided drownings	Risk (%)	20%	0%	20%	$7,000,000	$1,400,000	0.20	$273,882
	Treatment Energy and Herbicide Savings	Risk (%)	100%	0%	100%	$260,000	$260,000	0.20	$50,864
	Avoided bromate	Risk (%)	22%	0%	22%	$7,000,000	$1,512,000	0.20	$295,793
2038	Avoided drownings	Risk (%)	20%	0%	20%	$7,000,000	$1,400,000	0.18	$258,379
	Treatment Energy and Herbicide Savings	Risk (%)	100%	0%	100%	$260,000	$260,000	0.18	$47,985
	Avoided bromate	Risk (%)	22%	0%	22%	$7,000,000	$1,512,000	0.18	$279,050
2039	Avoided drownings	Risk (%)	20%	0%	20%	$7,000,000	$1,400,000	0.17	$243,754
	Treatment Energy and Herbicide Savings	Risk (%)	100%	0%	100%	$260,000	$260,000	0.17	$45,269
	Avoided bromate	Risk (%)	22%	0%	22%	$7,000,000	$1,512,000	0.17	$263,255
2040	Avoided drownings	Risk (%)	20%	0%	20%	$7,000,000	$1,400,000	0.16	$229,957
	Treatment Energy and Herbicide Savings	Risk (%)	100%	0%	100%	$260,000	$260,000	0.16	$42,706
	Avoided bromate	Risk (%)	22%	0%	22%	$7,000,000	$1,512,000	0.16	$248,353
2041	Avoided drownings	Risk (%)	20%	0%	20%	$7,000,000	$1,400,000	0.15	$216,940
	Treatment Energy and Herbicide	Risk (%)	100%	0%	100%	$260,000	$260,000	0.15	$40,289

Table 16: Water Quality and Other Expected Benefits
Task #5: Phase 2 Contra Costa Canal Levee Elimination and Flood Protection Project

(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)
Year	Type of Benefit	Measure of Benefit (Units)	Without Project	With Project	Change from Project (e) – (d)	Unit $ Value	Annual $ Value (f) x (g)	Discount Factor	Discounted Benefits (h) x (i)
	Savings								
	Avoided bromate	Risk (%)	22%	0%	22%	$7,000,000	$1,512,000	0.15	$234,296
2042	Avoided drownings	Risk (%)	20%	0%	20%	$7,000,000	$1,400,000	0.15	$204,661
	Treatment Energy and Herbicide Savings	Risk (%)	100%	0%	100%	$260,000	$260,000	0.15	$38,008
	Avoided bromate	Risk (%)	22%	0%	22%	$7,000,000	$1,512,000	0.15	$221,034
2043	Avoided drownings	Risk (%)	20%	0%	20%	$7,000,000	$1,400,000	0.14	$193,076
	Treatment Energy and Herbicide Savings	Risk (%)	100%	0%	100%	$260,000	$260,000	0.14	$35,857
	Avoided bromate	Risk (%)	22%	0%	22%	$7,000,000	$1,512,000	0.14	$208,522
2044	Avoided drownings	Risk (%)	20%	0%	20%	$7,000,000	$1,400,000	0.13	$182,147
	Treatment Energy and Herbicide Savings	Risk (%)	100%	0%	100%	$260,000	$260,000	0.13	$33,827
	Avoided bromate	Risk (%)	22%	0%	22%	$7,000,000	$1,512,000	0.13	$196,719
2045	Avoided drownings	Risk (%)	20%	0%	20%	$7,000,000	$1,400,000	0.12	$171,837
	Treatment Energy and Herbicide Savings	Risk (%)	100%	0%	100%	$260,000	$260,000	0.12	$31,913
	Avoided bromate	Risk (%)	22%	0%	22%	$7,000,000	$1,512,000	0.12	$185,584
2046	Avoided drownings	Risk (%)	20%	0%	20%	$7,000,000	$1,400,000	0.12	$162,110
	Treatment Energy and	Risk (%)	100%	0%	100%	$260,000	$260,000	0.12	$30,106

Table 16: Water Quality and Other Expected Benefits
Task #5: Phase 2 Contra Costa Canal Levee Elimination and Flood Protection Project

(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)
Year	Type of Benefit	Measure of Benefit (Units)	Without Project	With Project	Change from Project (e) – (d)	Unit $ Value	Annual $ Value (f) x (g)	Discount Factor	Discounted Benefits (h) x (i)
	Herbicide Savings								
	Avoided bromate	Risk (%)	22%	0%	22%	$7,000,000	$1,512,000	0.12	$175,079
2047	Avoided drownings	Risk (%)	20%	0%	20%	$7,000,000	$1,400,000	0.11	$152,934
	Treatment Energy and Herbicide Savings	Risk (%)	100%	0%	100%	$260,000	$260,000	0.11	$28,402
	Avoided bromate	Risk (%)	22%	0%	22%	$7,000,000	$1,512,000	0.11	$165,169
2048	Avoided drownings	Risk (%)	20%	0%	20%	$7,000,000	$1,400,000	0.10	$144,278
	Treatment Energy and Herbicide Savings	Risk (%)	100%	0%	100%	$260,000	$260,000	0.10	$26,794
	Avoided bromate	Risk (%)	22%	0%	22%	$7,000,000	$1,512,000	0.10	$155,820
2049	Avoided drownings	Risk (%)	20%	0%	20%	$7,000,000	$1,400,000	0.10	$136,111
	Treatment Energy and Herbicide Savings	Risk (%)	100%	0%	100%	$260,000	$260,000	0.10	$25,278
	Avoided bromate	Risk (%)	22%	0%	22%	$7,000,000	$1,512,000	0.10	$147,000
2050	Avoided drownings	Risk (%)	20%	0%	20%	$7,000,000	$1,400,000	0.09	$128,407
	Treatment Energy and Herbicide Savings	Risk (%)	100%	0%	100%	$260,000	$260,000	0.09	$23,847
	Avoided bromate	Risk (%)	22%	0%	22%	$7,000,000	$1,512,000	0.09	$138,679
2051	Avoided drownings	Risk (%)	20%	0%	20%	$7,000,000	$1,400,000	0.09	$121,138
	Treatment	Risk (%)	100%	0%	100%	$260,000	$260,000	0.09	$22,497

Table 16: Water Quality and Other Expected Benefits
Task #5: Phase 2 Contra Costa Canal Levee Elimination and Flood Protection Project

(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)
Year	Type of Benefit	Measure of Benefit (Units)	Without Project	With Project	Change from Project (e) – (d)	Unit $ Value	Annual $ Value (f) x (g)	Discount Factor	Discounted Benefits (h) x (i)
	Energy and Herbicide Savings								
	Avoided bromate	Risk (%)	22%	0%	22%	$7,000,000	$1,512,000	0.09	$130,829
2052	Avoided drownings	Risk (%)	20%	0%	20%	$7,000,000	$1,400,000	0.08	$114,281
	Treatment Energy and Herbicide Savings	Risk (%)	100%	0%	100%	$260,000	$260,000	0.08	$21,224
	Avoided bromate	Risk (%)	22%	0%	22%	$7,000,000	$1,512,000	0.08	$123,424
2053	Avoided drownings	Risk (%)	20%	0%	20%	$7,000,000	$1,400,000	0.08	$107,813
	Treatment Energy and Herbicide Savings	Risk (%)	100%	0%	100%	$260,000	$260,000	0.08	$20,022
	Avoided bromate	Risk (%)	22%	0%	22%	$7,000,000	$1,512,000	0.08	$116,438
2054	Avoided drownings	Risk (%)	20%	0%	20%	$7,000,000	$1,400,000	0.07	$101,710
	Treatment Energy and Herbicide Savings	Risk (%)	100%	0%	100%	$260,000	$260,000	0.07	$18,889
	Avoided bromate	Risk (%)	22%	0%	22%	$7,000,000	$1,512,000	0.07	$109,847
2055	Avoided drownings	Risk (%)	20%	0%	20%	$7,000,000	$1,400,000	0.07	$95,953
	Treatment Energy and Herbicide Savings	Risk (%)	100%	0%	100%	$260,000	$260,000	0.07	$17,820
	Avoided bromate	Risk (%)	22%	0%	22%	$7,000,000	$1,512,000	0.07	$103,629
2056	Avoided drownings	Risk (%)	20%	0%	20%	$7,000,000	$1,400,000	0.06	$90,522

Table 16: Water Quality and Other Expected Benefits
Task #5: Phase 2 Contra Costa Canal Levee Elimination and Flood Protection Project

(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)
Year	Type of Benefit	Measure of Benefit (Units)	Without Project	With Project	Change from Project (e) – (d)	Unit $ Value	Annual $ Value (f) x (g)	Discount Factor	Discounted Benefits (h) x (i)
	Treatment Energy and Herbicide Savings	Risk (%)	100%	0%	100%	$260,000	$260,000	0.06	$16,811
	Avoided bromate	Risk (%)	22%	0%	22%	$7,000,000	$1,512,000	0.06	$97,763
2057	Avoided drownings	Risk (%)	20%	0%	20%	$7,000,000	$1,400,000	0.06	$85,398
	Treatment Energy and Herbicide Savings	Risk (%)	100%	0%	100%	$260,000	$260,000	0.06	$15,860
	Avoided bromate	Risk (%)	22%	0%	22%	$7,000,000	$1,512,000	0.06	$92,230
2058	Avoided drownings	Risk (%)	20%	0%	20%	$7,000,000	$1,400,000	0.06	$80,564
	Treatment Energy and Herbicide Savings	Risk (%)	100%	0%	100%	$260,000	$260,000	0.06	$14,962
	Avoided bromate	Risk (%)	22%	0%	22%	$7,000,000	$1,512,000	0.06	$87,009
2059	Avoided drownings	Risk (%)	20%	0%	20%	$7,000,000	$1,400,000	0.05	$76,004
	Treatment Energy and Herbicide Savings	Risk (%)	100%	0%	100%	$260,000	$260,000	0.05	$14,115
	Avoided bromate	Risk (%)	22%	0%	22%	$7,000,000	$1,512,000	0.05	$82,084
2060	Avoided drownings	Risk (%)	20%	0%	20%	$7,000,000	$1,400,000	0.05	$71,702
	Treatment Energy and Herbicide Savings	Risk (%)	100%	0%	100%	$260,000	$260,000	0.05	$13,316
	Avoided bromate	Risk (%)	22%	0%	22%	$7,000,000	$1,512,000	0.05	$77,438
2061	Avoided	Risk (%)	20%	0%	20%	$7,000,000	$1,400,000	0.05	$67,643

Table 16: Water Quality and Other Expected Benefits
Task #5: Phase 2 Contra Costa Canal Levee Elimination and Flood Protection Project

(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)
Year	Type of Benefit	Measure of Benefit (Units)	Without Project	With Project	Change from Project (e) – (d)	Unit $ Value	Annual $ Value (f) x (g)	Discount Factor	Discounted Benefits (h) x (i)
	drownings								
	Treatment Energy and Herbicide Savings	Risk (%)	100%	0%	100%	$260,000	$260,000	0.05	$12,562
	Avoided bromate	Risk (%)	22%	0%	22%	$7,000,000	$1,512,000	0.05	$73,054
2062	Avoided drownings	Risk (%)	20%	0%	20%	$7,000,000	$1,400,000	0.05	$63,814
	Treatment Energy and Herbicide Savings	Risk (%)	100%	0%	100%	$260,000	$260,000	0.05	$11,851
	Avoided bromate	Risk (%)	22%	0%	22%	$7,000,000	$1,512,000	0.05	$68,919
2063	Avoided drownings	Risk (%)	20%	0%	20%	$7,000,000	$1,400,000	0.04	$60,202
	Treatment Energy and Herbicide Savings	Risk (%)	100%	0%	100%	$260,000	$260,000	0.04	$11,180
	Avoided bromate	Risk (%)	22%	0%	22%	$7,000,000	$1,512,000	0.04	$65,018
2064	Avoided drownings	Risk (%)	20%	0%	20%	$7,000,000	$1,400,000	0.04	$56,794
	Treatment Energy and Herbicide Savings	Risk (%)	100%	0%	100%	$260,000	$260,000	0.04	$10,548
	Avoided bromate	Risk (%)	22%	0%	22%	$7,000,000	$1,512,000	0.04	$61,338
2065	Avoided drownings	Risk (%)	20%	0%	20%	$7,000,000	$1,400,000	0.04	$53,580
	Treatment Energy and Herbicide Savings	Risk (%)	100%	0%	100%	$260,000	$260,000	0.04	$9,950
	Avoided bromate	Risk (%)	22%	0%	22%	$7,000,000	$1,512,000	0.04	$57,866

Table 16: Water Quality and Other Expected Benefits
Task #5: Phase 2 Contra Costa Canal Levee Elimination and Flood Protection Project

(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)
Year	Type of Benefit	Measure of Benefit (Units)	Without Project	With Project	Change from Project (e) – (d)	Unit $ Value	Annual $ Value (f) x (g)	Discount Factor	Discounted Benefits (h) x (i)
2066	Avoided drownings	Risk (%)	20%	0%	20%	$7,000,000	$1,400,000	0.04	$50,547
	Treatment Energy and Herbicide Savings	Risk (%)	100%	0%	100%	$260,000	$260,000	0.04	$9,387
	Avoided bromate	Risk (%)	22%	0%	22%	$7,000,000	$1,512,000	0.04	$54,591
2067	Avoided drownings	Risk (%)	20%	0%	20%	$7,000,000	$1,400,000	0.03	$47,686
	Treatment Energy and Herbicide Savings	Risk (%)	100%	0%	100%	$260,000	$260,000	0.03	$8,856
	Avoided bromate	Risk (%)	22%	0%	22%	$7,000,000	$1,512,000	0.03	$51,501
2068	Avoided drownings	Risk (%)	20%	0%	20%	$7,000,000	$1,400,000	0.03	$44,986
	Treatment Energy and Herbicide Savings	Risk (%)	100%	0%	100%	$260,000	$260,000	0.03	$8,355
	Avoided bromate	Risk (%)	22%	0%	22%	$7,000,000	$1,512,000	0.03	$48,585
2069	Avoided drownings	Risk (%)	20%	0%	20%	$7,000,000	$1,400,000	0.03	$42,440
	Treatment Energy and Herbicide Savings	Risk (%)	100%	0%	100%	$260,000	$260,000	0.03	$7,882
	Avoided bromate	Risk (%)	22%	0%	22%	$7,000,000	$1,512,000	0.03	$45,835
2070	Avoided drownings	Risk (%)	20%	0%	20%	$7,000,000	$1,400,000	0.03	$40,038
	Treatment Energy and Herbicide Savings	Risk (%)	100%	0%	100%	$260,000	$260,000	0.03	$7,436
	Avoided	Risk (%)	22%	0%	22%	$7,000,000	$1,512,000	0.03	$43,241

Table 16: Water Quality and Other Expected Benefits
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(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)
Year	Type of Benefit	Measure of Benefit (Units)	Without Project	With Project	Change from Project (e) – (d)	Unit $ Value	Annual $ Value (f) x (g)	Discount Factor	Discounted Benefits (h) x (i)
	bromate								
2071	Avoided drownings	Risk (%)	20%	0%	20%	$7,000,000	$1,400,000	0.03	$37,772
	Treatment Energy and Herbicide Savings	Risk (%)	100%	0%	100%	$260,000	$260,000	0.03	$7,015
	Avoided bromate	Risk (%)	22%	0%	22%	$7,000,000	$1,512,000	0.03	$40,793
2072	Avoided drownings	Risk (%)	20%	0%	20%	$7,000,000	$1,400,000	0.03	$35,634
	Treatment Energy and Herbicide Savings	Risk (%)	100%	0%	100%	$260,000	$260,000	0.03	$6,618
	Avoided bromate	Risk (%)	22%	0%	22%	$7,000,000	$1,512,000	0.03	$38,484
2073	Avoided drownings	Risk (%)	20%	0%	20%	$7,000,000	$1,400,000	0.02	$33,617
	Treatment Energy and Herbicide Savings	Risk (%)	100%	0%	100%	$260,000	$260,000	0.02	$6,243
	Avoided bromate	Risk (%)	22%	0%	22%	$7,000,000	$1,512,000	0.02	$36,306
2074	Avoided drownings	Risk (%)	20%	0%	20%	$7,000,000	$1,400,000	0.02	$31,714
	Treatment Energy and Herbicide Savings	Risk (%)	100%	0%	100%	$260,000	$260,000	0.02	$5,890
	Avoided bromate	Risk (%)	22%	0%	22%	$7,000,000	$1,512,000	0.02	$34,251
2075	Avoided drownings	Risk (%)	20%	0%	20%	$7,000,000	$1,400,000	0.02	$29,919
	Treatment Energy and Herbicide Savings	Risk (%)	100%	0%	100%	$260,000	$260,000	0.02	$5,556

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(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)
Year	Type of Benefit	Measure of Benefit (Units)	Without Project	With Project	Change from Project (e) – (d)	Unit $ Value	Annual $ Value (f) x (g)	Discount Factor	Discounted Benefits (h) x (i)
	Avoided bromate	Risk (%)	22%	0%	22%	$7,000,000	$1,512,000	0.02	$32,312
2076	Avoided drownings	Risk (%)	20%	0%	20%	$7,000,000	$1,400,000	0.02	$28,225
	Treatment Energy and Herbicide Savings	Risk (%)	100%	0%	100%	$260,000	$260,000	0.02	$5,242
	Avoided bromate	Risk (%)	22%	0%	22%	$7,000,000	$1,512,000	0.02	$30,483
2077	Avoided drownings	Risk (%)	20%	0%	20%	$7,000,000	$1,400,000	0.02	$26,627
	Treatment Energy and Herbicide Savings	Risk (%)	100%	0%	100%	$260,000	$260,000	0.02	$4,945
	Avoided bromate	Risk (%)	22%	0%	22%	$7,000,000	$1,512,000	0.02	$28,758
2078	Avoided drownings	Risk (%)	20%	0%	20%	$7,000,000	$1,400,000	0.02	$25,120
	Treatment Energy and Herbicide Savings	Risk (%)	100%	0%	100%	$260,000	$260,000	0.02	$4,665
	Avoided bromate	Risk (%)	22%	0%	22%	$7,000,000	$1,512,000	0.02	$27,130
2079	Avoided drownings	Risk (%)	20%	0%	20%	$7,000,000	$1,400,000	0.02	$23,698
	Treatment Energy and Herbicide Savings	Risk (%)	100%	0%	100%	$260,000	$260,000	0.02	$4,401
	Avoided bromate	Risk (%)	22%	0%	22%	$7,000,000	$1,512,000	0.02	$25,594
2080	Avoided drownings	Risk (%)	20%	0%	20%	$7,000,000	$1,400,000	0.02	$22,357
	Treatment Energy and Herbicide	Risk (%)	100%	0%	100%	$260,000	$260,000	0.02	$4,152

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Year	Type of Benefit	Measure of Benefit (Units)	Without Project	With Project	Change from Project (e) – (d)	Unit $ Value	Annual $ Value (f) x (g)	Discount Factor	Discounted Benefits (h) x (i)
	Savings								
	Avoided bromate	Risk (%)	22%	0%	22%	$7,000,000	$1,512,000	0.02	$24,145
2081	Avoided drownings	Risk (%)	20%	0%	20%	$7,000,000	$1,400,000	0.02	$21,091
	Treatment Energy and Herbicide Savings	Risk (%)	100%	0%	100%	$260,000	$260,000	0.02	$3,917
	Avoided bromate	Risk (%)	22%	0%	22%	$7,000,000	$1,512,000	0.02	$22,779
2082	Avoided drownings	Risk (%)	20%	0%	20%	$7,000,000	$1,400,000	0.01	$19,898
	Treatment Energy and Herbicide Savings	Risk (%)	100%	0%	100%	$260,000	$260,000	0.01	$3,695
	Avoided bromate	Risk (%)	22%	0%	22%	$7,000,000	$1,512,000	0.01	$21,489
2083	Avoided drownings	Risk (%)	20%	0%	20%	$7,000,000	$1,400,000	0.01	$18,771
	Treatment Energy and Herbicide Savings	Risk (%)	100%	0%	100%	$260,000	$260,000	0.01	$3,486
	Avoided bromate	Risk (%)	22%	0%	22%	$7,000,000	$1,512,000	0.01	$20,273
2084	Avoided drownings	Risk (%)	20%	0%	20%	$7,000,000	$1,400,000	0.01	$17,709
	Treatment Energy and Herbicide Savings	Risk (%)	100%	0%	100%	$260,000	$260,000	0.01	$3,289
	Avoided bromate	Risk (%)	22%	0%	22%	$7,000,000	$1,512,000	0.01	$19,125
2085	Avoided drownings	Risk (%)	20%	0%	20%	$7,000,000	$1,400,000	0.01	$16,706
	Treatment Energy and	Risk (%)	100%	0%	100%	$260,000	$260,000	0.01	$3,103

Table 16: Water Quality and Other Expected Benefits
Task #5: Phase 2 Contra Costa Canal Levee Elimination and Flood Protection Project

(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)
Year	**Type of Benefit**	**Measure of Benefit (Units)**	**Without Project**	**With Project**	**Change from Project (e) – (d)**	**Unit $ Value**	**Annual $ Value (f) x (g)**	**Discount Factor**	**Discounted Benefits (h) x (i)**
	Herbicide Savings								
	Avoided bromate	Risk (%)	22%	0%	22%	$7,000,000	$1,512,000	0.01	$18,043
2086	Avoided drownings	Risk (%)	20%	0%	20%	$7,000,000	$1,400,000	0.01	$15,761
	Treatment Energy and Herbicide Savings	Risk (%)	100%	0%	100%	$260,000	$260,000	0.01	$2,927
	Avoided bromate	Risk (%)	22%	0%	22%	$7,000,000	$1,512,000	0.01	$17,022
2087	Avoided drownings	Risk (%)	20%	0%	20%	$7,000,000	$1,400,000	0.01	$14,869
	Treatment Energy and Herbicide Savings	Risk (%)	100%	0%	100%	$260,000	$260,000	0.01	$2,761
	Avoided bromate	Risk (%)	22%	0%	22%	$7,000,000	$1,512,000	0.01	$16,058
Proj. Life	75 Years							…	
								Total Present Value of Discounted Costs (Sum of Column (i))	**$43,826,406**
								Transfer to Table 20, column (c), Exhibit F: Proposal Costs and Benefits Summaries	

Comments:
Present value is for the full canal encasement project. This project is responsible for approximately 4/96 = 4.2 percent of full project benefits, or $1,840,709.
All costs are in 2009 dollars.

Task 6 – Drainage Area 55 - West Antioch Creek Channel Improvement Project

The following sections present a quantitative and qualitative analysis of project costs and water supply benefits. Table 16 has been completed, and is included at the end of this section.

Overview

This project will install three 14 feet by 7 feet Caltrans Standard Box Culverts spanning 620 feet of West Antioch Creek. These box culverts will increase the storm water capacity of the creek, replacing an inadequate concrete trapezoidal ditch and arch culverts. This installation will provide a 25-year level of flood protection to commercial and multi-family properties adjacent to the channel and within a Disadvantaged Community Area by addressing a 650' gap that exists between channel improvements made by the Contra Costa County Flood Control & Water Conservation District in 1993 and the earthen channel on the Antioch Fairgrounds property.

A summary of all benefits and costs of the project are provided in Table 6.1. Water Quality and Other Expected benefits are discussed in more detail in the remainder of this attachment, and a complete discussion of flood protection benefits is provided in Attachment 9.

Table 6.1. Benefit-Cost Analysis Overview

	Present Value
Costs – Total Capital and O&M	$4,922,559
Monetizable Benefits	
Flood Control Benefits: Avoided losses in property damages, Avoided clean-up costs, Avoided traffic delays due to key road inundation (FRAM)	$8,409,721
Total Monetized Benefits	$8,409,721
Qualitative Benefit or Cost	**Qualitative indicator***
Water Quality and Other Benefits	
Improved Public Health Protection	++
Improved Surface Water Quality	++
Avoided Loss of Recreation	++
Reduced Street Maintenance Costs	++
Flood Benefit	
Avoided Emergency Response Costs	++

O&M = Operations and Maintenance
* Direction and magnitude of effect on net benefits:
+ = Likely to increase net benefits relative to quantified estimates.
++ = Likely to increase net benefits significantly.
– = Likely to decrease benefits.
– – = Likely to decrease net benefits significantly.
U = Uncertain, could be + or –.

Description of Without-Project Conditions

Without the project, annual flooding events will continue to plague this disadvantaged community. This area currently experiences two to three floods annually, causing damage to local buildings and infrastructure. Additionally, during the flooding events considerable loss of function occurs. Local businesses are inaccessible, resulting in loss of revenue. The Pittsburg-Antioch Highway, which serves as a major transportation artery to and from East Contra Costa County, is often forced to close during these events.

Considerable emergency response costs are incurred during these relatively frequent events. These costs are related to emergency flood response, security provision and flood clean-up. These floods also result in the loss of the ability to provide the community with essential city services due to impacts to the City's Maintenance and Service Center. The flooding levels and associated damages increase in more severe events, such as a 25-year storm.

The three box culverts will be able to pass approximately ten times more stormwater than the existing system. In addition to the flood benefits resulting from this expanded capacity, a significant reduction in flood-related water quality impairment will occur. During flooding events, water breeches the channel bank and travels through this DAC, collecting and depositing surface debris (trash, vegetation, etc.), pollutants (oil, pesticides, fertilizers, etc.), and pathogenic microorganisms. Direct contact with polluted flood waters through wound infections, dermatitis, conjunctivitis, and ear, nose and throat infections poses a significant risk of infection. One epidemic-forming disease that may be contracted from body contact with flood waters is leptospirosis, a bacterial disease, which may be transmitted through contact of the skin or mucous membranes with contaminated water, damp soil or vegetation or mud contaminated with rodent urine. Ingestion of flood waters or of water contaminated with flood waters poses a risk of severe infection. For communities plagued by chronic flooding, avoiding contact with flood waters may be impossible. Without the project, this disadvantaged community will continue to experience frequent flooding, and will continue to be regularly exposed to the real and immediate public health risks posed by degraded flood water quality.

In addition to water quality impacts to the local community, Delta water quality will continue to be impacted in the absence of this project. When these impaired floodwaters recede, debris and pollutants make their way back into West Antioch Creek, which flows into the Sacramento – San Joaquin Bay – Delta upstream of New York Slough. Additional debris and pollutants are left behind, either to be cleaned by the DAC or absorbed into the local environment. Without this project, these flood related water quality concerns will persist.

Description of Expected Water Quality and Other Benefits (With-Project Conditions)

This project is expected to create a variety of water quality and other benefits, including improved surface water quality, improved public health protection, avoided loss of recreation, and reduced street maintenance costs.

Water Quality Benefits

Implementation of this project will reduce flood-related debris and pollutant loading in West Antioch Creek. West Antioch Creek flows directly into New York Slough, which leads to Suisun Bay and the Sacramento-San Joaquin Delta. Beneficial uses in New York Slough (included in the revised Basin Plan) are: commercial and sport fishing, estuarine habitat, fish migration, preservation of rare and endangered species, wildlife habitat, water contact recreation, non-contact water recreation, and navigation. Flood-related loading would incrementally contribute to further surface water quality degradation in New York Slough, Suisun Bay, and the Delta. Specific constituents of concerns include chlorides and mercury.

In addition to improving surface water quality in the Delta, the project will improve public health protection by eliminating exposure to degraded flood waters. Currently, this community experiences moderate to severe flooding two to three times per year. According to the World Health Organization (WHO), there is an increased risk of infection of water-borne diseases when direct contact occurs with polluted flood waters through wound infections, dermatitis, conjunctivitis, and ear, nose and throat infections. One epidemic-forming disease that may be contracted from body contact with flood waters is leptospirosis, a bacterial disease. Leptospirosis may be transmitted through contact of the skin or mucous membranes with contaminated water, damp soil or vegetation or mud contaminated with rodent urine. Flooding following rainfall assists in spreading the organism due to the proliferation of rodents which shed large amounts of leptospires in their urine. Leptospirosis outbreaks have occurred throughout the world, with a recent (2007) outbreak on a college campus in Oahu, HI following a flood event.

Ingestion of flood waters or of water contaminated with flood waters can cause a host of infections, ranging from mild to severe. A well-known example of disease outbreak following drinking water contamination occurred in Walkerton, Ontario in 2000 in which seven people died after consuming drinking water contaminated with E. Coli. In 1999, a dormitory sewage pit on County Fairgrounds in New York caused a major outbreak of waterborne disease, killing two people and hospitalizing 71 others.

The risk of infection posed by contacting and / or ingesting flood waters is severe. For communities plagued by chronic flooding, avoiding contact with flood waters may be impossible. This project will protect this disadvantaged community from floods up to the 25-year event, all but removing the real and immediate public health risks posed by degraded flood water quality.

Other Benefits

Other benefits of this project include avoided loss of recreation and reduced street maintenance costs.

Avoided Loss of Recreation

Flooding often results in the closure of the Contra Costa County Fairgrounds, the Antioch Little League Complex and Prosserville Park. Implementation of this project will reduce the frequency of closure at these facilities, and the associated loss of recreation.

Reduced Street Maintenance Costs

As floodwaters recede, a significant volume is left behind in temporary ponds. The project will reduce ponding on streets and minimize the effect of moisture in creating potholes and cracks, which make up a significant portion of street maintenance costs.

Project Beneficiaries and Distribution of Benefits

The proposed project includes the full range of beneficiaries, as summarized in Table 6.2. At the local level, the disadvantaged community members that live and work in the area will benefit from the improved surface water quality and public health protection as well as the reduced risk of flood-related damage. At the regional level, the City of Antioch and its residents will benefit due to the reduced emergency response and clean-up costs, and reduced loss of function. Statewide, the Sacramento – San Joaquin Bay-Delta will benefit from reduced floodwater related trash and pollutant loading.

Table 6.2. Project Beneficiaries Summary

Local	**Regional**	*Statewide*
Residents and workers in this DAC within the City of Antioch	City of Antioch	***Bay-Delta***

Timing of Benefits

Installation of the culverts will be completed by 2013. For this analysis, a 50-year useful project life is assumed, thus benefits and costs are calculated through 2063 (50 years after the project comes online).

Summary of Qualitative Benefits

The proposed project will provide a range of both water quality and other benefits. Reducing the frequency of flood events in this DAC will result in improved public health protection and improved surface water quality in West Antioch Creek and the Sacramento-San Joaquin Delta. Additional qualitative benefits from the proposed project include the avoided loss of recreation at facilities that must close during flood events, and reduced street maintenance costs from flood-related ponding and moisture. These qualitative benefits are listed in Table 6.3.

Table 6.3. Qualitative Benefits Summary – Water Quality and Other Benefits

Benefit	**Qualitative Indicator**
Improved Public Health Protection	++
Improved Surface Water Quality	++
Avoided Loss of Recreation	++
Reduced Street Maintenance Costs	++

Uncertainty of Benefits

This analysis of costs and benefits is based on available data and some assumptions. As a result, there may be some omissions, uncertainties, and possible biases. In most cases, omissions lead to a downward bias in benefits. These issues are listed in Table 6.4.

Table 6.4 Omissions, Biases, and Uncertainties, and Their Effect on the Project

Benefit or Cost Category	Likely Impact on Net Benefits*	*Comment*
Improved Surface Water Quality	U	Quantification of water quality impairments that result from flooding is not available. The improvements in surface water quality will likely vary depending on the severity of flooding.
Avoided Loss of Recreation	+	Additional recreation may be lost due to flooding. For example, recreation that occurs in street areas (bike riding, running and other sports) will be loss during flooding events.

*Direction and magnitude of effect on net benefits:
+ = Likely to increase net benefits relative to quantified estimates.
++ = Likely to increase net benefits significantly.
- = Likely to decrease benefits.
-- = Likely to decrease net benefits significantly.
U = Uncertain, could be + or -.

Potential Adverse Effects

Adverse effects caused by this project are expected to be limited to temporary construction impacts.

Documents Supporting Benefits Analysis

The following references were used to develop the cost and benefit analyses described in this section:

- Personal communication with Phil Harrington, Director of Capital Improvements/Water Rights, City of Antioch (12/16/2010).
- State of California. *San Francisco Bay Basin Water Quality Control Plan (Basin Plan)*. Oakland, CA: RWQCB, 2007. Web. 24 Dec 2010.

Economic Benefit Tables

No water quality and other benefits generated by this project have been quantified; as a result, Table 16 has been excluded.

Table 16: Water Quality and Other Expected Benefits
Task #6: Drainage Area 55 – West Antioch Creek Channel Improvements Project

NOT APPLICABLE

Task 7 – Upper Sand Creek Basin

The following sections present a quantitative and qualitative analysis of project costs and water supply benefits. Table 16 has been completed, and is included at the end of this section.

Overview

The primary purpose of the Upper Sand Creek Basin (USCB) project is to prevent flooding along the lower reach of Marsh Creek between Sand Creek and the Marsh Creek outfall into the Sacramento-San Joaquin River at Big Break, in Oakley. The regional goal for USCB is to significantly reduce peak flows from Sand Creek into Marsh Creek, thereby reducing the flood-related risks and damages associated with a variety of storm frequency/severity events. It will also improve water quality in these receiving waters, by capturing sediment and other nonpoint source pollution carried by storm events.

In addition, the USCB project will create 5.3 acres of riparian habitat, including 0.9 acres of perennial wetlands and 4.3 acres of seasonal wetlands. These wetlands provide valuable habitat for special status species, and are considered quality habitats for raptor, western pond turtles, burrowing owls, the California Tiger Salamander and Red Legged frog.

The project was designed to provide recreation benefits by creating a 62.5 acre open space park. The City of Antioch has plans to construct a regional sports park in this area and the site has been laid out to accommodate a number of sports fields that can be used for soccer, football, and baseball/softball.

Finally, the project will provide several water quality benefits, by attenuating peak stormwater flows, thereby reducing streambed scour and erosion and reducing sedimentation. The project also involves installation of trash capture devices that will help protect against the degradation of surface water quality in Sand Creek, Marsh Creek and eventually the San Joaquin River and Delta.

A summary of all benefits and costs of the project are provided in Table 7.1. Water Quality and Other Expected benefits are discussed in more detail in the remainder of this attachment, and a complete discussion of flood protection benefits is provided in Attachment 7.

Table 7.1. Benefit-Cost Analysis Overview

	Present Value
Costs – Total Capital and O&M	$11.74 M
Monetizable Benefits	
Flood Control Benefits: Avoided losses in property damages (FRAM)	$27.9 M
Total Monetized Benefits	$ 27. 9 M
Qualitative Benefit or Cost	Qualitative indicator*
Avoided traffic delays due to key road inundation	+
Avoided emergency response costs during floods	+

Table 7.1. Benefit-Cost Analysis Overview

	Present Value
Water Quality and Other Benefits	
Improved Surface Water Quality	+
Improved riparian habitat	+
Recreational and Aesthetic Benefits	+
Increased Housing Values Near New Park Acreage	+
Avoided Permitting Costs	+

O&M = Operations and Maintenance

* Direction and magnitude of effect on net benefits:
+ = Likely to increase net benefits relative to quantified estimates.
++ = Likely to increase net benefits significantly.
– = Likely to decrease benefits.
– – = Likely to decrease net benefits significantly.
U = Uncertain, could be + or –.

Description of Without-Project Conditions

Between Upper Sand Creek Basin and its confluence with Marsh Creek, the Sand Creek channel provides little to no flood protection from relatively minor storms. Lower Sand Creek Basin, an existing interim off-line basin, is located within this downstream reach, and will be built-out to its ultimate capacity subsequent to the completion of Upper Sand Creek Basin. Downstream of Lower Sand Creek Basin, Sand Creek enters into Marsh Creek, which has engineered banks designed to protect adjacent areas from flooding up to a 50-year event.

The area at risk covers over 10,000 acres, and includes residential developments (nearly 2000 homes), as well as over 250 commercial, industrial and institutional buildings, agricultural lands, and numerous important roads (including Highway 4) and bridges. Property tax assessment records indicate the value of existing properties in the 100-year floodplain of these creeks amounts to $759 million. These tax assessment figures are likely to understate the true market value of these properties, and do not include the value of contents and other personal property that may also be at risk in these neighborhoods. Approximately 15% of the properties at risk are located along the area at risk from flooding from Sand Creek ($112.4 million at risk = 15% of $749 million), and the remaining 85% of the at risk property values ($636.7 million = 85% of $749 million) are located in the areas subject to flooding from March Creek.

Without the project, the properties along the Sand Creek portion of the watershed will be at risk of frequent flooding from a wide range of storm events. High stormwater flow increases streambed scour and stream bank erosion, resulting in increased sedimentation. Without the reduction in peak flows that will result from this project, increased sediment and pollutant loading with continue unabated.

This project will also install trash capture devices. Without this project, storm related trash loading will continue to degrade surface water quality in Sand Creek, Marsh Creek and eventually the San Joaquin River and Delta.

The basin construction plan includes the creation of wetlands, riparian habitat, stream channel and open space. These areas provide valuable habitat for special species, recreation opportunities for community members, and improve adjacent property values. Without the project these benefits will not be realized.

Description of Expected Water Quality and Other Benefits (With-Project Conditions)

This project is expected to create a variety of water quality and other benefits, including improved surface water quality, improved riparian habitat, and additional recreational and aesthetic benefits. These benefits are described below.

Water Quality Benefits

The primary water quality benefit expected from this project is improved surface water quality, resulting from decreased flooding. This project will reduce both peak pollutant loading and trash loading.

Reduction in Peak Loadings

Water Quality improvements will occur as a result of decreases in loadings due to the reduction in maximum peak flow in Sand Creek generated by a 100-year, 12 hour storm from 2,818 cfs to 131 cfs. Scouring and stream bank erosion will be reduced. This will reduce sediment loading of downstream reaches of Sand Creek, Marsh Creek and eventually the San Joaquin River and Delta.

Reduction in Trash Loadings to the Creeks and Delta

Trash loadings into the Sand Creek and Marsh Creek and then into the San Joaquin River and the Delta will be reduced due to trash capture devices.

Other Benefits

Other benefits expected from project implementation include habitat restoration, recreation, increased housing values near the new park acreage, and avoided permitting costs,

Improved Riparian Habitat

The project will create 0.93 acres of perennial wetlands and 4.36 acres of seasonal wetlands. These wetlands will provide valuable habitat for special status species, and is considered quality habitat for raptors, western pond turtle, burrowing owl and others. Special status species include the California Tiger Salamander and Red Legged Frog. The addition of0.6 acres of riparian habitat and 3,612 feet of stream channel will support a suite of native plants and exhibit enhanced functions for wildlife. Current conditions are considered to be of highly degraded biological value.

Recreational and Aesthetic Benefits

A 62.5-acre open space park will be created. The City of Antioch has plans for construction of a sports park in this area. The bottom of the basin has been laid out to accommodate a number of sports fields that can be used for soccer, football, and baseball/softball, and the basin design was configured so that this sports park may be constructed without significant earthmoving. The construction of the sports park is in the conceptual state and there is currently no target date for construction

Increased Housing Values Near New Park Acreage

Parcels adjacent to the Basin are slated for housing developments, and with construction of Basin setting aside 62 acres for use as open space and sports park, increased housing values are anticipated. Economic research has shown that greenbelts and open space in or surrounding residential areas can have significant positive impact on housing values, but impact on property values varies greatly

depending on the types of park. For parks that are closer to unimproved open space, rather than parks with recreation development such as ball fields, value increases in the range of 5 to 10% are most common.

Avoided Permitting Costs

The District will minimize HCP fees by mitigating on site via the construction of the restoration area. If the Basin were not built, the District would have to either raise the levees or widen the channel of Marsh Creek. Environmental restoration costs for raising levees or widening the channel are much greater due to the length of channel that would be impacted. Construction of the basin has a much lower environmental impact and required mitigation.

Project Beneficiaries and Distribution of Benefits

The proposed project includes the full range of beneficiaries, as summarized in Table 7.2. At the local level, communities along Upper Sand Creek and Marsh Creek in the Cities of Brentwood and Oakley will have significant reductions in 100-year flood impacts, and in the quantity of trash deposited during flooding. At the regional level, native species, including special status species such as the Red Legged Frog and California Tiger Salamander, will benefit from increased and improved natural habitat. As the project will minimize the flooding of major roads in the area, the entire population of the two cities will benefit. The project will also benefit the City of Antioch, as Antioch has planned a sports park for the basin. At the statewide level, the Sacramento – San Joaquin Bay – Delta will benefit from reduced flood related sedimentation and trash loading.

Table 7.2. Project Beneficiaries Summary

Local	**Regional**	*Statewide*
Communities along Upper Sand Creek and Marsh Creek in the City of Brentwood	Cities of Oakley and Brentwood City of Antioch Native Species, including the Red Legged Frog and California Tiger Salamander	***Bay-Delta***

Timing of Benefits

Construction of the expanded detention basin will be completed in 2015. For this analysis, a 50-year useful project life is assumed, thus benefits and costs are calculated through 2065 (50 years after the project comes online). Antioch's sports park will be built at some later date when funds become available.

Summary of Qualitative Benefits

Qualitative benefits from the proposed project include improved water quality in Marsh Creek and the Delta, restored habitat and preservation of open space, increased recreational access, and minimized environmental disturbance. These benefits are summarized in Table 7.3.

Table 7.3. Qualitative Benefits Summary – Water Quality and Other Benefits

Benefit	Qualitative Indicator
Avoided traffic delays due to key road inundation	+
Avoided emergency response costs during floods	+
Water Quality and Other Benefits	
Improved Surface Water Quality	+
Improved riparian habitat	+
Recreational and Aesthetic Benefits	+
Increased Housing Values Near New Park Acreage	+
Avoided Permitting Costs	+

Uncertainty of Benefits

This analysis of costs and benefits is based on available data and some assumptions. As a result, there may be some omissions, uncertainties, and possible biases. In this analysis, the main uncertainties are associated with improved surface water quality. In this case, the omission leads to a downward bias in benefits, as described in Table 7.4.

Table 7.4. Omissions, Biases, and Uncertainties, and Their Effect on the Project

Benefit or Cost Category	Likely Impact on Net Benefits*	*Comment*
Improved Surface Water Quality	+	The habitat restoration area may also serve as a bio-filter, reducing pollutant concentrations downstream.
Reduced flood impacts	++	In any given year, the probability that a 100-year storm occurs is 1%. This 1% probability of significant damage to Brentwood and Oakley is mitigated with the construction of Upper Sand Creek Basin.

*Direction and magnitude of effect on net benefits:
+ = Likely to increase net benefits relative to quantified estimates.
++ = Likely to increase net benefits significantly.
- = Likely to decrease benefits.
-- = Likely to decrease net benefits significantly.
U = Uncertain, could be + or -.

Potential Adverse Effects

Adverse effects associated with this project are expected to be limited to temporary construction impacts.

Documents Supporting Benefits Analysis

The following documents were used to develop the cost and benefit analyses described in this section:

- Personal communication with Carl Roner, Associate Civil Engineer, Contra Costa Flood Protection and Water Conservation District (12/16/10).
- Crompton, John L. "The impact of parks on property values: empirical evidence from the past two decades in the United States." *Managing Leisure* 10. (2005): 203-218. Web. 28 Dec 2010. <http://www.rpts.tamu.edu/faculty/crompton/Crompton/Articles/4.1.pdf>.

Economic Benefit Tables

No water quality and other benefits generated by this project have been quantified; as a result, Table 16 has been excluded.

Table 16: Water Quality and Other Expected Benefits
Task #7: Upper Sand Creek Basin

NOT APPLICABLE

Task 8 – Watershed Protection and Restoration

The following sections present a quantitative and qualitative analysis of project costs and water supply benefits. Table 16 has also been completed, and is included at the end of this section.

Overview

This project will fund a portion of the HCP Habitat and Watershed Protection/Restoration Project. The project involves acquiring a parcel of land between 200 and 500 acres in the northwest corner of the IRWMP area, restoring habitat, and creating wetlands in a region rich in natural resources and home to the headwaters to many small creeks. The project will contribute to the creation of a habitat corridor from the Concord Naval Weapons Station to the Black Diamond Mines Regional Preserve, protect valuable species habitat and source waters, and create two acres of additional wetlands. This project is designed to achieve the following objectives:

- Mitigate source water degradation due to development
- Provide comprehensive regional species protection
- Create new wetland habitat
- Contribute to species recovery

Protected and restored habitats will include annual grassland, oak savannah, oak woodland, chaparral, riparian vegetation and streams, permanent wetland, and seasonal wetlands.

In a 2002 Biological Opinion, the US Fish and Wildlife Service (FWS) required CCWD to develop a successful regional HCP as a condition for exercising its full water right. Without successful completion of the HCP, CCWD will not be permitted to increase its Delta withdrawals from 148,000 AFY to 195,000 AFY. This project is a portion of the HCP and is therefore a component of a project that is necessary for the CCWD to receive the additional 47,000 AFY of supply contingent upon successful implementation of the regional HCP. The full HCP will permanently conserve approximately 30,000 acres of land; as such, this project represents approximately one percent of the total HCP.

Table 8.1 below provides an overview of the overall benefit-cost outcomes with a summary of the benefits and costs for this project. Water Quality and Other Expected benefits are discussed in more detail in the remainder of this attachment, and a complete discussion of Water Supply benefits is provided in Attachment 7.

Monetized benefits estimated for this project accrue from CCWD's ability to exercise its full Delta water right, increasing its withdrawals from 148,000 AFY to 195,000 AFY on successful implementation of the SCP. Although this specific project is not sufficient for the increased allotment, it represents approximately one percent of the necessary project. As such, monetized water supply benefits are based on one percent of the total increase in withdrawals, with a present value of $1.99 M.

The total present value cost of the project over its 50-year lifetime is estimated to be $1,606,290. When the non-monetized benefits related to water quality improvements, habitat restoration (including habitat for threatened and endangered species), increased recreation, increased residential property values adjacent to new parks, and avoided permitting costs are included, the value of benefits for this project will significantly exceed the monetized benefits alone.

Table 8.1. Benefit-Cost Analysis Overview

	Present Value
Costs – Total Capital and O&M	$1,606,290
Monetized Benefits	
Water Supply Benefits	
WS Benefit – Avoided Alternative Supply	$1,986,452
	Qualitative indicator*
Qualitative Benefits	
Water Quality Benefits	
Water quality improvements due to source water protection	+
Other Benefits	
Habitat Restoration	++
Threatened and endangered species	++
Recreation	+
Increased housing values	+
Avoided Permitting Costs	++

O&M = Operations and Maintenance
* Direction and magnitude of effect on net benefits:
+ = Likely to increase net benefits relative to quantified estimates.
++ = Likely to increase net benefits significantly.
– = Likely to decrease benefits.
– – = Likely to decrease net benefits significantly.
U = Uncertain, could be + or –.

Description of Without-Project Conditions

The following conditions are expected to persist in the absence of the project:

- CCWD may have difficulty obtaining USFW and BLM permission for withdrawal of its full Bay-Delta water allocations.
- Matching funds from USFWS, the East Bay Regional Park District Measure WW Funds Local Assistance Grant, and CA Department of Fish and Game may be lost.
- Without the project, new regional growth will affect a variety of important natural habitats, causing more disruption than has already occurred in the watersheds. Key habitat will continue

to be threatened, affecting special status species including CA Tiger Salamander and Red Legged Frog. Source water would not be protected, threatening downstream users and habitat.

- Development of a wildlife and recreation corridor will potentially not occur and threatened and special status species populations will continue to decline.

Description of Expected Water Quality and Other Benefits (With-Project Conditions)

This project is expected to create a variety of water quality and other benefits, including the following.

Water Quality Benefits

The area to be preserved contains the headwaters of many small creeks. By protecting these lands in perpetuity from future development (the proposed purchase area borders highly urbanized lands) water quality is protected from increased loadings of total dissolved solids (TDS) and other pollutants.

The HCP allows the community to stay ahead of detrimental water quality impacts by addressing the ecosystem as a whole, mitigating potential impacts, and protecting watersheds before significant impacts occur.

Other Benefits

Other benefits resulting from project implementation will include habitat preservation and restoration, including preservation and restoration of threatened and endangered species habitats; increased housing values for homes adjacent to new parks; recreation; and avoided costs related to preparing and implementing a comprehensive plan.

Habitat Restoration

This project will acquire and enhance sensitive habitat. In addition, two acres of wetlands will be created. In addition to special status species, this area is considered quality habitat for raptors, western pond turtle, burrowing owl and others. The properties for acquisition have the highest density of suitable breeding habitat for Red Legged Frogs and California Tiger Salamanders in the area. The property is close to existing protected lands, and connects an emerging preserve system.

Threatened and Endangered Species

Over 150 special status species either occur in the area already, or the habitat would be suitable for these species in the future. Some of the existing species include the San Joaquin kit fox, Alameda whip snake, CA tiger salamander, and CA red-legged frog.

Recreation

This purchase will assist in creating a corridor trail system to connect Mount Diablo to the Black Diamond Mines Regional Preserve. All lands acquired become part of the California Park District and will be managed in the future for recreation. Until the park district has the funds to open the lands to the general public (i.e. remove hazards, develop trails and fund staffing), Conservancy and EBRPD staff will provide opportunities for supervised public access when appropriate. Past acquisitions that are in land bank status have had groups such as the California Plant Society lead field trips to identify threatened and endangered flora.

Increased Housing Values Near New Park Acreage

Economic research has shown that greenbelts and open space in or surrounding residential areas can have significant positive impact on housing values, but impact on property values varies greatly depending on the types of park. For parks that are closer to unimproved open space (as opposed to parks with recreation development such as ball fields), value increases in the range of 5 to 10% are most common.

Avoided Permitting Costs

By developing a comprehensive regional plan, the HCP provides a coordinated means of issuing natural resource permits instead of going through permitting for each project. This will reduce the uncertainty currently associated with obtaining permits and reduce agency and landowner permitting costs. This, in turn, will make more funds available for infrastructure projects or resource conservation.

With a regional HCP, individual landowners and developers are no longer required to provide individual mitigation plans and activities to receive a permit. This allows the permit process to proceed more quickly and efficiently and, as a result of the mitigations being managed by mitigation experts, usually results in more cohesive and effective mitigation installations.

Project Beneficiaries and Distribution of Benefits

This project will provide local and regional benefits by preserving habitat and other ecosystem services. It will also benefit local governments interested in infrastructure improvement by reducing permitting costs for these projects. Finally, it will benefit local landowners in the area by providing economic incentives to preserve their land. The Bay-Delta water quality will be increase slightly by the protection of source waters.

Table 8.2. Project Beneficiaries Summary

Local	**Regional**	*Statewide*
CCWD	Other users in watershed	
Home builders & Developers	Species	
Local Cities	Habitat	
Contra Costa County	Regulatory agencies – DFG, USFWS	***Bay-Delta***
Local communities	(removes regulatory burden by streamlining permit process)	

Timing of Benefits

This project will involve land purchase, and protection of that land in perpetuity. The benefits of protecting this land will begin accruing immediately upon acquisition and will amplify as other property in the region is assembled into a larger regional preserve system.

Summary of Qualitative Benefits

This project will preserve and restore habitat for numerous special status species, provide recreation opportunities, and facilitate permitting, thus streamlining the permitting process and reducing permitting costs for future projects. These benefits have been assessed qualitatively and are summarized below.

Table 8.3. Qualitative Benefits Summary – Water Quality and Other Benefits

Benefit	Qualitative Indicator
Water Quality – Source water protection	+
Threatened and endangered species	++
Recreation	+
Increased residential property values adjacent to new parks	+
Avoided permitting costs & delays	++

Uncertainty of Benefits

This analysis of costs and benefits is based on available data and some assumptions. As a result, there may be some omissions, uncertainties, and possible biases. In this analysis, the main uncertainties are associated with avoided permitting costs. These issues are listed in Table 8.4.

Table 8.4. Omissions, Biases, and Uncertainties, and Their Effect on the Project

Benefit or Cost Category	Likely Impact on Net Benefits*	*Comment*
Avoided permitting costs	++	It is uncertain exactly how much this project will save in permitting costs for individual projects. However, program-level permitting has been shown to be significantly less expensive than obtaining permits for individual projects. A wide range of stakeholders have been involved in the development of this plan including members of the regulated community such as: Home Builders, Farm Bureau, Public Works Departments, Caltrans, landowners and others.

*Direction and magnitude of effect on net benefits:
+ = Likely to increase net benefits relative to quantified estimates.
++ = Likely to increase net benefits significantly.
- = Likely to decrease benefits.
-- = Likely to decrease net benefits significantly.
U = Uncertain, could be + or -.

Potential Adverse Effects

No potential adverse effects from this project have been identified. All land will only be purchased from willing sellers. Take from wetlands construction will be small to nil.

Documents Supporting Benefits Analysis

The following documents were used to develop the cost and benefit analyses described in this section:

- East Contra Costa County Habitat Conservation Plan / Natural Community Conservation Plan

Economic Benefit Tables

The water quality and other benefits generated by this project cannot be physically quantified. As a result, Table 16 has not been completed for this project.

Table 16: Water Quality and Other Expected Benefits
Task #8: Watershed Protection and Restoration

NOT APPLICABLE