Appendix D
Engineering and Cost Summary

CCWD Alternative Intake Project, California
Special Study Report

Prepared by

Bureau of Reclamation
Mid-Pacific Region

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ABBREVIATIONS AND ACRONYMS

AIP	Alternative Intake Project
CCWD	Contra Costa Water District
AWWA	American Water Works Association
CDFG	California Department of Fish and Game
CEQA	California Environmental Equality Act
cfs	cubic feet per-second
CCI	cost construction index
CVPIA	Central Valley Project Improvement Act
Delta	Sacramento-San Joaquin Delta
EIR	Environmental Impact Report
EIS	Environmental Impact Statement
hp	horsepower
IDC	interest during construction
kWh	kilowatt-hour
Mg/L	milligram per liter
NEPA	National Environmental Policy Act
NMFS	National Marine Fisheries Service
O&M	operations and maintenance
PG&E	Pacific Gas and Electric
psi	pounds per square inch
RCCP	reinforced concrete cylinder pipe
Reclamation	United States Department of the Interior, Bureau of Reclamation
RO	reverse osmosis
SR	State Route
TDH	total dynamic head
TDS	total dissolved solids
TWSA	treated water service area
USFWS	United States Fish and Wildlife Service
WAPA	Western Area Power Authority
WSP	welded steel pipe
WTP	water treatment plant

Chapter 1 Introduction

The Alternative Intake Project (AIP) is a water quality project for Contra Costa Water District (CCWD) that could also provide fisheries protection and emergency water supply benefits. The project would relocate some of CCWD's existing Sacramento-San Joaquin Delta (Delta) diversions to obtain better source water quality. The United States Department of the Interior, Bureau of Reclamation (Reclamation), is the lead agency for National Environmental Policy Act (NEPA) compliance, and CCWD is the lead agency for California Environmental Equality Act (CEQA) compliance for the AIP.

Background

In 2004, Reclamation was authorized to expend funds "for design and construction of the relocation of drinking water intake facilities to in-Delta water users" with passage of the CALFED Bay-Delta Authorization Act, Public Law 108-361. In January 2005, a Notice of Preparation for the AIP was released and a Notice of Intent was published in the Federal Register (Vol. 70, No. 15, pp. 2557-2558). Public scoping meetings and an informal consultation with Federal and State resources agencies were held in spring 2005. The draft Environmental Impact Statement/Environmental Impact Report (EIR/EIS) for the AIP was released for public comments in May 2006, and the final EIR/EIS was released in October 2006 and approved by CCWD on November 15, 2006.

In October 2006, Reclamation initiated this Special Study Report to develop Plan Formulation and Economics Evaluation chapters and complete a Federal Decision Document for the AIP. The primary purpose of this Special Study Report is to describe the formulation of alternatives to meet Federal planning objectives, and identify a most likely preferred plan for further development.

Purpose and Scope of Appendix

This Engineering and Cost Summary Appendix presents information related to appraisal-level designs and costs for the formulated alternative plans described in the AIP Special Study Report. Feasibility-level designs and costs are presented only for the identified most likely preferred alternative, while appraisal-level designs and costs are presented for the other analyzed alternatives. The appendix also presents the engineering design criteria used in developing designs for the physical elements of each alternative plan.

Information Reviewed

Previous reports and studies reviewed in preparation of this appendix include the following:

- AIP EIR/EIS (Reclamation and CCWD, 2006).
- AIP Preliminary Engineering Report (CCWD, 2006a)
- AIP Predesign Cost Estimates Report (CCWD, 2006b)

Organization of the Appendix

Following this introduction chapter, the Engineering and Cost Summary Appendix is organized as follows:

Chapter 2 briefly describes the alternative plans considered for the AIP.

Chapter 3 describes design considerations and criteria for the major physical features of the alternative plans.

Chapter 4 documents preliminary designs and feasibility-level cost estimates for Alternative Plan 1.

Chapter 5 documents conceptual designs and appraisal-level cost estimates for Alternative Plan 2.

Chapter 6 documents conceptual designs and appraisal-level cost estimates for Alternative Plan 3.

Chapter 7 summarizes the findings of this appendix.

Chapter 8 lists the sources used to compile this appendix.

Chapter 2
Alternative Plans

This chapter briefly describes alternative plans considered for the AIP. It also provides a review of the project setting.

Project Overview

CCWD obtains its water supply exclusively from the Delta and delivers treated and raw (untreated) water to approximately 500,000 people in central and eastern Contra Costa County. CCWD's existing facilities and operations span eastern Contra Costa County, and include Delta water intakes, untreated water distribution and pumping facilities, reservoirs, water treatment plants (WTP), and treated water distribution facilities. CCWD maintains three Delta intakes: Old River near State Route (SR) 4, Rock Slough, and Mallard Slough. CCWD's major water storage facility is Los Vaqueros Reservoir, with 100,000 acre-feet of storage. CCWD operates three much smaller reservoirs: Martinez and Contra Loma (owned by Reclamation) and Mallard (owned by CCWD), with a combined usable storage of about 4,030 acre-feet. CCWD treats water at the Bollman WTP and Randall-Bold WTP.

All of CCWD's intakes are subject to variations in water quality caused by salinity intrusion, Delta hydrodynamics, and discharges into the Delta and its tributary streams from both point and nonpoint sources. The Old River intake is used most frequently because it has the best quality water and fish screens. Rock Slough is used as CCWD's secondary option for diversion, and relatively minor diversions are made from Mallard Slough in most years because salinity levels are frequently high at this intake. CCWD operates its intake facilities based on a long-term goal of delivering water with chloride concentrations of 65 milligrams per liter (mg/L) or less to its customers, given physical limitations of the existing infrastructure, and consistent with environmental regulations and permit conditions. Water from the Mallard Slough intake exceeds this value throughout most of the year, and water from the Old River and Rock Slough intakes exceeds this value during periods of low Delta inflows, generally from July until January. Consequently, CCWD meets its delivered chloride goal by using high quality water from Los Vaqueros Reservoir to blend with Delta water when Delta chloride concentrations are above 65 mg/L. Los Vaqueros Reservoir is filled using the Old River intake during periods when water quality is high in the Delta, generally January through June.

The AIP evaluates a new point of diversion and rediversion at a new intake on Victoria Canal under Reclamation and CCWD's water rights. The AIP would allow CCWD to divert higher quality water than is currently available at CCWD's Rock Slough and Old River intakes during certain periods of the year, while not increasing the amount of water pumped from the Delta (either rate or annual quantity). The AIP would help maintain water quality levels for CCWD customers, especially during drought periods. It could also provide fisheries protection and emergency water supply benefits.

Study Area

The study area for this project is the Delta, in San Joaquin and Contra Costa counties. The study area encompasses CCWD's service area and the surrounding area, including some of the central and south Delta (Figure 2-1).

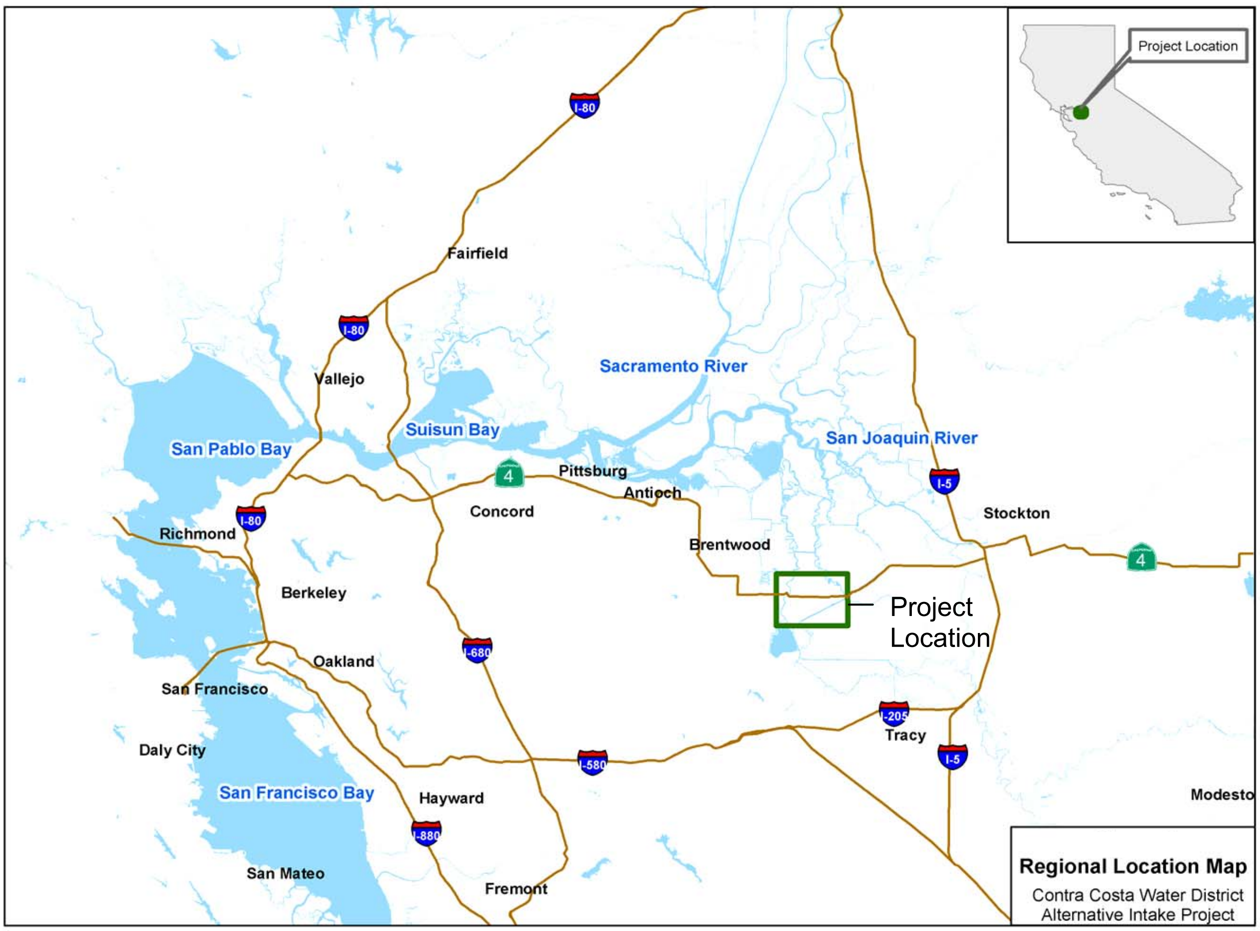

Figure 2-1. Study Area Regional Map

Alternative Plans

This section describes a set of four alternative plans that were formulated and retained for further development based on the screened resources management measures discussed in Chapter 3 of the AIP Special Study Report. These plans include the No-Action Plan (i.e., future without-project) and three action alternative plans, 1 through 3. It should be noted that this appendix does not provide any engineering or cost information for the No-Action Plan.

No-Action Plan

Under the No-Action Plan (i.e., future without-project condition), CCWD would continue to operate and maintain its existing facilities to maximize delivered water quality consistent with applicable environmental regulations and permit conditions. To meet the projected future levels of demand (2020 water demand levels), the No-Action Plan would include expanding the Old River pump station capacity to 320 cubic feet per second (cfs) consistent with the CCWD Future Water Supply Implementation EIR (CCWD, 1998). This appendix does not provide engineering or cost information for this expansion because it represents baseline conditions for the AIP.

Alternative Plan 1

Plan 1 has been selected as the most likely preferred plan, and would preserve CCWD's existing intakes and add a new intake location on Victoria Canal. The new Victoria Canal intake would protect and improve delivered water quality for CCWD customers by enabling CCWD to relocate some of its existing diversions at the Old River intake to Victoria Canal. This Delta location has the advantage of having better source water quality at certain times of the year than is currently available at Old River. Victoria Canal receives its flows from the Middle River.

Alternative Plan 2

Plan 2 would include constructing a desalination treatment plant to reduce salinity and to improve the quality of supplies delivered to the Bollman WTP. It would also reduce overall demand on the Rock Slough unscreened intake by increasing diversion through the screened Mallard Slough intake. The plan would require expansion of the existing Mallard Slough intake and pump station. This expansion would serve the demands of the treated water service area (TWSA) customers currently served by the Bollman WTP. It would also reduce overall demands on the Contra Costa Canal, such that the canal would primarily serve CCWD's untreated-water customers.

Alternative Plan 3

Plan 3 would relocate the existing CCWD Rock Slough intake to a new location on the Middle River. This location is opposite Bacon Island and would offer better water quality than from the Rock Slough intake. The plan would involve building a new screened intake and pump station on the Middle River that would feed CCWD's existing Pumping Plant No. 1 through a pipeline to the

Contra Costa Canal entrance. To eliminate potential water quality deterioration in the Contra Costa Canal sections between Pumping Plant No. 1 and the canal entrance, this plan assumes that the Contra Costa Canal Encasement Project would be implemented and is part of the No-Action Plan. The new screened intake would contribute to an overall reduction in fish mortality rates compared to the current unscreened intake on Rock Slough.

Chapter 3
Design Criteria

This chapter describes design considerations and criteria for the major physical features of the alternative plans. Major physical features of the alternative plans include levee improvement work, fish screens, pumping plants, conveyance elements, and a reverse osmosis desalination facility. Design criteria for these major physical elements of the alternative plans are described below.

Levee Design Criteria

Levee improvements would be required under Plan 1 and Plan 3 to support construction of the new Delta intakes because these proposed intakes would encroach on existing levees. Depending on site-specific conditions and layouts, levee reinforcement, modification, and/or relocation may be required.

New levee construction would use well-graded, compactable clayey material, which would be obtained from an on-site borrow area or off-site sources to be identified during final design. Soils in the Delta often include a significant amount of peat, which is a highly compressible organic matter. Compression and consolidation of peat deposits would begin immediately as new loads are placed, and would continue over several years. Therefore, all peat and other unsuitable soils should be excavated and removed from the levee site. This excavated material could be disposed of by partially filling the excavated borrow areas. To further reduce the amount of postconstruction settlement at levee sites, several techniques can be used that include preloading, installing wick drains, or installing stone columns directly beneath the setback levees.

Protection of the water side slope of a levee is required in order to withstand the erosion forces of waves and stream currents. Riprap is the most commonly used method of slope protection because of its relative ease of handling, stockpiling, placement, and maintenance. Where levee slopes are composed of erodible granular soils or fine-grained soils of low plasticity, a bedding layer of sand and gravel or plastic filter cloth should be provided beneath the riprap.

Underseepage in pervious foundations beneath levees may result in excessive hydrostatic pressures beneath an impervious top stratum on the land side, causing sand boils, and piping beneath the levee itself. Principal seepage control measures for foundation underseepage are cutoff trenches, water side impervious blankets, land side seepage berms, pervious toe trenches, and pressure relief wells. Appropriate underseepage control measures should be evaluated during the geotechnical evaluation of levee sites.

Fish Screen Design Criteria

Fish screens are designed to provide a positive barrier to prevent entrainment of juvenile and adult fish in the intakes. Fish screens also reduce entrainment of debris and sediment in the system. Design of intakes in the Delta is governed primarily by fish protection and geotechnical considerations. The criteria described below are based primarily on established resource agency fish screen design requirements, design criteria used for the existing Old River intake, and design criteria developed for the new Victoria Canal intake (Plan 1) and documented in the predesign report (CCWD, 2006a).

Intake structure design would follow the requirements of the United States Fish and Wildlife Service (USFWS), National Marine Fisheries Service (NMFS), and California Department of Fish and Game (CDFG). These agencies have specific requirements, summarized in Table 3-1, for screening to exclude fish from entrainment and impingement at water intakes. Species that must be protected include winter-run Chinook salmon, spring-run Chinook salmon, steelhead, delta smelt, and Sacramento splittail, all of which have been listed as endangered or threatened species under the Federal and/or California Endangered Species Acts. Other species of fish would also be protected.

Table 3-1. Federal and State Fish Screen Requirements

Item	Value	Source
General		
Approach Velocity	0.2 fps maximum (based on delta Smelt)	USFWS
Sweeping Velocity	To be determined on a case-by-case basis	CDFG, NMFS
Porosity	27% minimum	CDFG, NMFS
Screen Exposure Duration	15-minute maximum	CDFG
Opening Size		
Round	3/32-inch maximum	CDFG, NMFS
Square (diagonal)	3/32-inch maximum	CDFG, NMFS
Slotted	1.75 mm maximum	CDFG, NMFS
Cleaning Frequency	12 cleanings per hour minimum	CDFG

Key:
CDFG = California Department of Fish and Game
fps = feet per second
mm = millimeter
NMFS = National Marine Fisheries Service
USFWS = United States Fish and Wildlife Service

In flowing water, requirements are set for the sweeping velocity past the screens and maximum exposure time to the screens (Table 3-1). However, at many Delta locations, sweeping velocities are influenced by the tidal cycle, pumping rates at other diversions in the area, and inflows to the Delta, resulting in high variability in sweeping velocities. Therefore, specific requirements for sweeping velocity are not currently published by the resources agencies, but need to be developed on a case-by-case basis.

As part of the fish screen design, a cleaning mechanism would be required to address debris buildup and biological growth on the screens. An automated screen cleaning system is typically needed to conform to the requirements of Federal and State agencies. A brush-type, or air or water burst-type, cleaning system may be used. Other operation and maintenance (O&M) considerations for the fish screen include (1) preventing mud buildup behind the screens, (2) providing access to the screens, baffles, and cleaner from the deck of the intake structure, (3) a crane to assist in removing the screen panels, (4) spare screen panels for replacement of damaged screens, and (5) stop logs to help with the repair and/or replacement of screen panels.

Pump Station Design Criteria

Design of pump stations for project alternatives is assumed to be similar to the design of the existing Old River pump station. The configuration of the pump station is such that the intake structure is part of the pump station structure. Pump intake designs should follow Hydraulic Institute standards. The function of the pump intake is to supply an evenly distributed flow of water to the suction line of each pump, and provide for adequate submergence or net positive suction head to prevent vortexing and cavitation. A physical model study of the pump intakes and pump cans may also be considered.

The pump stations would use vertical turbine pumps in a wet well, similar to the existing pump station at Old River. Selection of the number, type, and size of pumps used for each pump station is based on the ability to deliver full capacity under all flow conditions. Use of constant speed pumps and/or variable frequency drive motors would depend on the need to provide flexible delivery capacities. Discharge piping for each pump includes a check valve and isolation valve prior to connection to the discharge header.

The intake/pump station structure would be constructed of cast-in-place concrete, supported by piles driven to a depth to resist lateral, overturning, and gravity forces on the structure. The structure would support the pumps, fish screens, and cleaning system on the water side of the facility. The pump station would have sediment control systems that would reduce the amount of silting in the pump bays and approach to the pumps.

Friction losses for the pumping plant discharge piping (plant losses) would include losses in the pump column, pump discharge piping, and discharge header, and losses for check valves, pump control valves, and fittings for the assumed typical layout. Preliminary estimates for losses were developed based on a typical piping layout for the pumping plants. The hydraulic analysis would be refined during final design after a more detailed plan and profile are developed. The analysis would include detailed minor loss calculations for fittings shown in the pipeline plan and profile sheets. This analysis would also include system performance at startup (considering higher C-factors for new pipe) to evaluate pump operation at startup and to size bypass lines required for initial filling of the system.

The hydraulic criteria summarized in Table 3-2 were used to calculate pipeline and pump station head losses, to size pumps and motors, and to determine appropriate pipeline pressure ratings. Pipeline head losses were calculated using the Hazen-Williams equations.

Table 3-2. Pump Station Hydraulic Design Criteria

Description	Criterion
Hazen-Williams Coefficient, C	C = 140
Maximum Allowable Minor Losses	8% of pipeline friction losses
Minimum Pump Efficiency	85%
Minimum Motor Efficiency	90%
Maximum Velocity for Pump Discharge Header	11 feet per second
Pump Column Maximum Head Loss	5 feet/100 feet
Pump Column Minimum Velocity	4 feet per second

Surge Protection

Surge protection would be required at each pump station to protect the pump station and transmission facilities from transient pressures associated with sudden changes in pumping or hydraulic conditions in the pipelines. The limiting condition for the design of surge protection facilities is often loss of power, which causes a sudden shutdown of the pumps, resulting in transient passive waves traveling through the pipeline to the pumps. Pressure vessel surge tanks may be used to mitigate the effects of pressure waves. Detailed surge analysis would be conducted during final design to determine the appropriate surge control devices and strategy.

Electrical Requirements

Electrical power for new facilities would be delivered by new high voltage transmission lines connected to one of two utility systems, based on proximity. The two utilities in the area are Western Area Power Authority (WAPA) and Pacific Gas and Electric (PG&E). A step-down transformer substation would be required to reduce transmission-level (high) voltage to required service-level voltage to the new pump stations.

Instrumentation for the pumping station would support a fully automated operation at the station. The pump station would be operated similarly to the existing Old River pump station, which is normally operated remotely from the Bollman WTP. CCWD personnel sequentially start the pumps at the Old River pump station to initiate diversion from the Old River. The number of pumps operating at any given time depends on CCWD's flow requirements and diversion strategy. When the pump station is taken off-line, the pumps are turned off and the wet well remains flooded.

Pipeline Design Criteria

The hydraulic analysis of major conveyance system components was completed using the Hazen-Williams equation for friction losses in pipelines. Two different types of pipe were used in this evaluation: reinforced concrete cylinder pipe (American Water Works Association (AWWA) C300)) and welded steel pipe (AWWA C200). These two material types were selected for installation based on their ability to meet the project’s pressure requirements, vertical loading capability, corrosion resistance, pipe jacking capacity, flexibility with fittings and connections, ability to resist thrust, and performance during seismic events. Both pipe types are considered suitable as conveyance options; the cost of each is contingent on market conditions and pricing at time of bidding.

Based on AWWA Manual M-11 for design of steel pipelines, a Hazen-Williams C-factor of 140 was used for the hydraulic analysis of the pipeline systems. This value considers long-term lining deterioration, slime buildup, etc. For the reinforced cylindrical concrete pipes a Hazen-Williams C-factor of 120 was used for the hydraulic analysis of the pipeline systems.

For pipe joints, either steel spigot and bell rings with a rubber gasket (AWWA C300-86) or welded joints (AWWA C200-89) would be used. Pressure class of pipe would be 300 pounds per square inch (psi) maximum working pressure.

Minor losses were estimated to be 8 percent of the friction losses calculated for each segment of pipeline. This value for minor losses was based on preliminary hydraulic calculations of minor losses for an assumed alignment of each of the pipelines, including fittings such as bends and valves.

Reverse Osmosis Desalination Design Criteria

Desalination is a water treatment process used to remove salts, other dissolved minerals, and organic constituents from brackish water or seawater. The two most common desalination processes are reverse osmosis (RO) and electrodialysis/electrodialysis reversal. RO was selected as the basis for the project concept because it is more cost effective for the high-end range of total dissolved solids (TDS) concentrations typical of the Delta source, which can be generally categorized as brackish water in the vicinity of the Mallard Slough intake.

To develop a conceptual process design for the proposed desalination facility, a FILMTEC BW30-440i membrane element from Dow Chemical Company (Figure 3-2) was selected based on feed water salinity, feed water fouling tendency, required rejection, and energy requirements. This membrane element provides the high surface area necessary to handle high flow under the proposed plans (Table 3-3). The FILMTEC BW30-440i element, with a surface area of 440 square feet, is typically arranged in pressure vessels that contain 6 membrane elements. To achieve the desired system recovery and permeate water quality, the pressure vessels are typically arranged in serial stages. The number of stages is defined by the quality of the raw water and the desired characteristics of the finished water.

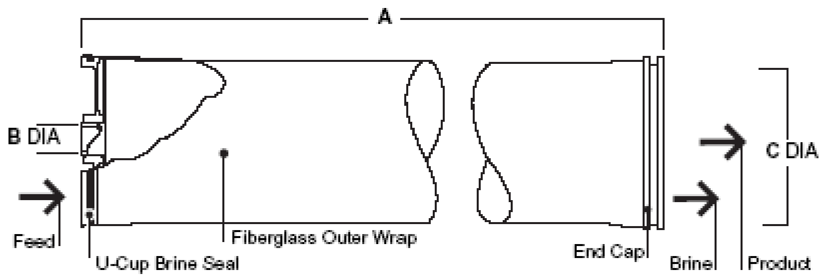

Figure 3-2. Schematic for FILMTEC Membrane

Table 3-3. Product Specifications for FILMTEC Membrane BW30-440i

Feature	***Value***
Membrane Type	Thin-Film Composite
Dimensions (refer to Figure D-2)	40" (A) × 7.9" (B) × 1.125" (C)
Nominal Active Area	440 sq. ft.
Product Water Flow Rate*	10,500 gpd
Stabilized Salt Rejection*	99.5%
Single-Element Recovery	15%
Operating Limits	
Maximum Feed Flow	85 gpm
Maximum Operating Pressure	600 psi
Maximum Operating Temperature	113 °F
Maximum Feed Silt Density Index	SDI 5
Maximum Feed Turbidity	1 NTU
Free Chlorine Tolerance	< 0.1 ppm
pH Range, Continuous Operation	2 – 11
pH Range, Short-Term Cleaning (30 min)	1 – 12

Notes:
[1] Refer to Figure D-2 in this appendix.
[2] Permeate flow and salt rejection based on 2,000 ppm NaCl, 225 psi, 77 °F, pH 8 and 15% recovery.

Key:
" = inches
°F = degrees Fahrenheit
gpd = gallons per day
gpm = gallons per minute
min = minutes
NaCl = sodium chloride
NTU = nephelometric turbidity units
ppm = parts per million
sq. ft. = square feet

Chapter 4
Plan 1 Designs and Cost

This chapter documents the feasibility-level designs and cost estimate for Alternative Plan 1. Plan 1 would add a new intake on Victoria Canal, which would connect to the existing Old River conveyance system.

Victoria Canal Intake

Plan 1 would include a new, screened water intake and pump station located along the lower third of Victoria Canal on Victoria Island in the central Delta. A new pipeline would extend from the new intake directly across Victoria Island and the Old River, and tie into CCWD's existing Old River conveyance system on Byron Tract. Figure 4-1 is a conceptual depiction of the proposed intake location on Victoria Canal and the potential direct pipeline route to CCWD's existing Old River facilities. The specific footprint of the proposed intake, pump station, and conveyance pipeline, with some surface appurtenances, would be determined during final design based on various factors, including the results of geotechnical data collection, environmental constraints, and landowner negotiations.

Fish Screen

The new intake on Victoria Canal would include a fish screen that would provide a positive barrier against entrainment of fish and debris into the wet well/pump bays. The intake structure would consist of a reinforced concrete structure with side retaining walls, suction pipes, and a fish screen open to Victoria Canal, supported on concrete columns (see Figure 4-2). The facility would be designed to meet fish screening requirements in the Delta. It would be cleaned regularly with a mechanical cleaning system. A pump station would lift water from the new intake and convey it through the pipeline system and to the existing Old River c system on Byron Tract.

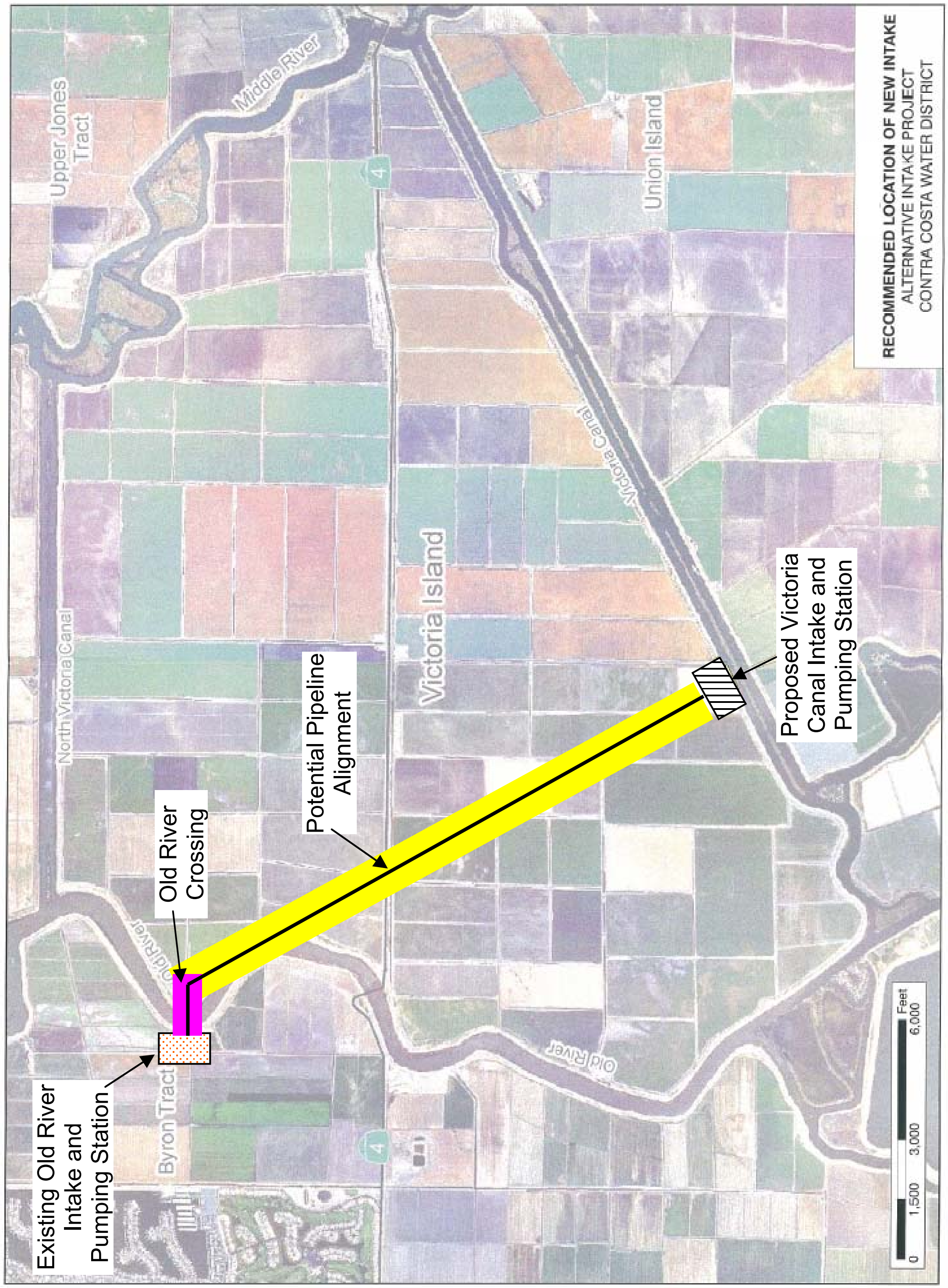

Figure 4-1. Plan 1 – Conceptual Location of the Proposed Victoria Canal Intake and Direct Pipeline to Old River Intake

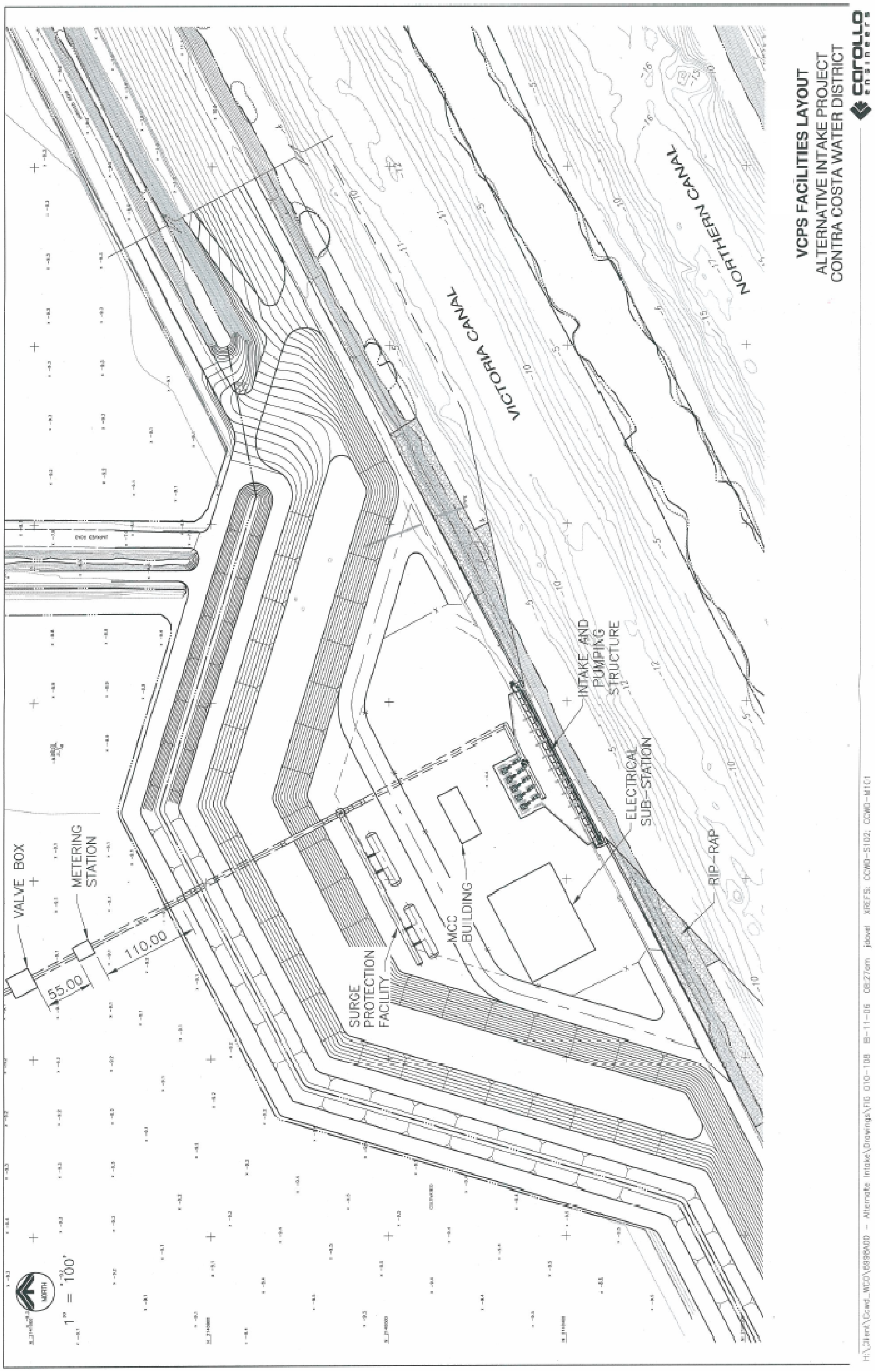

Figure 4-2. Plan 1 – Plan View of the Proposed Victoria Canal Intake and Pumping Station

Pump Station

The pump station layout and concept includes vertical turbine pumps mounted on a concrete deck above individual pump bays separated by baffle walls. Flow is directed from a trapezoidal screen area to the pump bells. The pumps would discharge through a header into a common pipeline that connects to the Old River pump station. Figure 4-3 shows the layout of the proposed pump station site. The pump station configuration includes a total of five high lift pumps, each with a capacity of 50 cfs. Three pumps would be rated at 4,000 horsepower (hp), while the other two would be rated at 2,250 hp. This arrangement of pumps would provide the flexibility to efficiently move water at both high and low water levels in the Victoria Canal. Discharge piping for each pump has a check valve and isolation valve configuration prior to connection to the discharge header. The pump discharge header and transmission main piping would be configured to slope back, where possible, to the pump station for ease of pipeline dewatering. Dewatering of the remaining pipeline would be through blow-off valves located at identified low points.

The intake/pump station structure would be constructed of cast-in-place concrete, supported by piles driven to a depth to resist lateral, overturning, and gravity forces on the structure. The structure would support the pumps, fish screens, flow baffles, and cleaning system on the river side of the facility (refer to Figure 4-3). The pump station would have sedimentation systems that would reduce the amount of silting of the pump bays and the approach to the pumps. Minimum submergence requirements were evaluated for the depth of the structure based on the low water surface elevation presented.

Power Supply

The proposed intake site is in an unimproved area with no electric utilities. A new power substation would be constructed on site. Power transmission lines would be extended to the intake site on Victoria Island. Power supply to the facility would be transmitted through the distribution system from a combination of available sources, which may include PG&E and/or WAPA. Potential corridors for power lines would be the same as for the pipeline, although the pipeline and power lines may not be on the same alignment. A new transmission line about 3.75 miles long would be required to provide electric power to the proposed Victoria Canal intake.

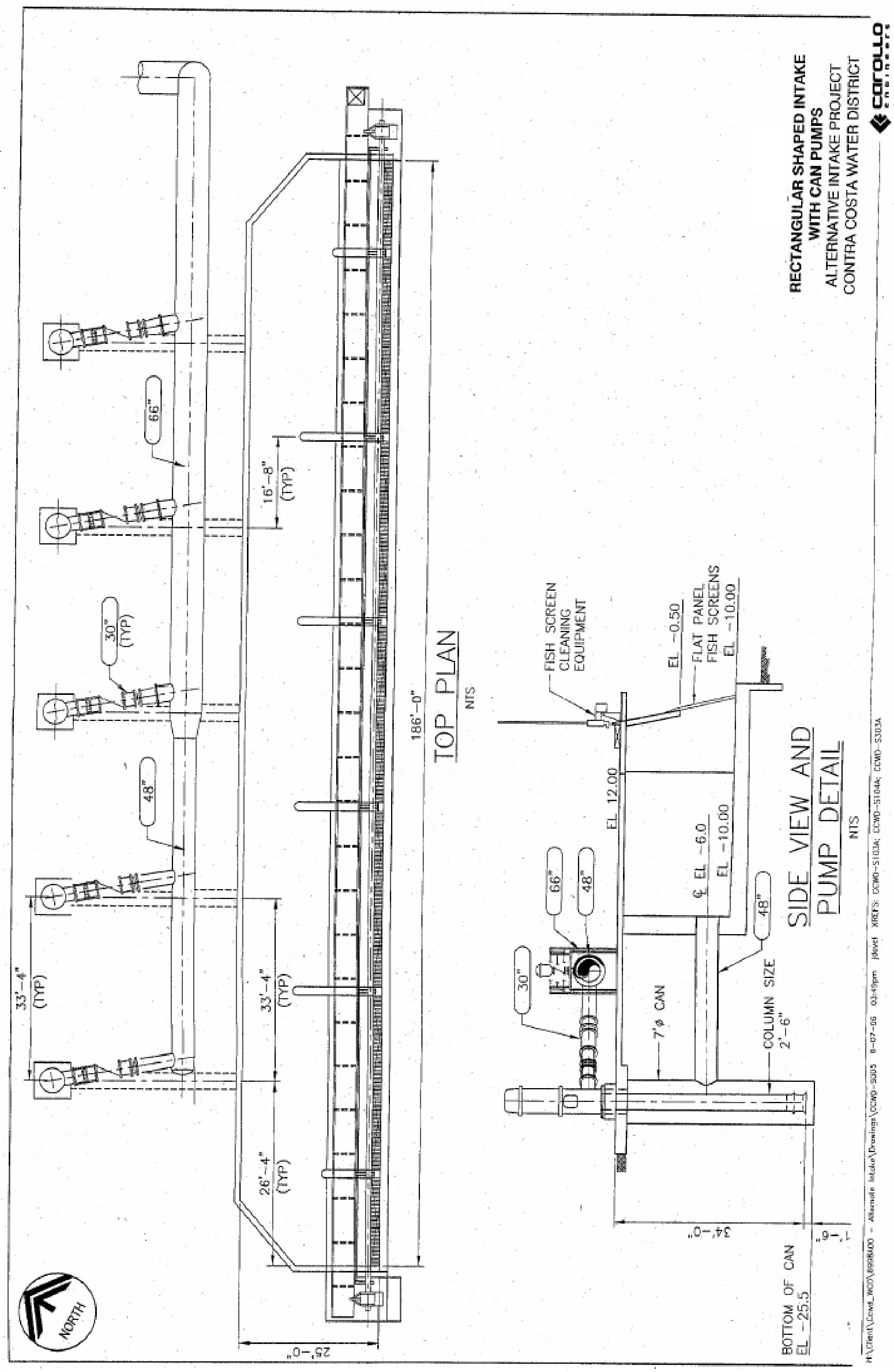

Figure 4-3. Plan 1 – Proposed Victoria Canal Pump Station and Fish Screens

Conveyance

The new conveyance pipeline would cross Victoria Island, constructed below grade within a trench, from the new intake and pump facility on Victoria Canal to the Old River levee. Figure 4-1 shows the potential alignment for direct and indirect pipeline options. For this analysis, the direct alignment is assumed. The pipeline, which would be approximately 12,000 to 14,000 feet long, would be sized to accommodate a flow rate of up to 250 cfs, using a pipe diameter of approximately 6 feet. Pipeline features such as air release blow-offs, control valves, cathodic protection test stations, and access hatches would be installed in vaults or on pads above ground along the pipeline route. Existing irrigation and drainage ditches that potentially could be affected by the pipeline routing would be siphoned under, rerouted, crossed over, or replaced, based on considerations of both farming operations and construction costs.

As mentioned, the new conveyance pipeline would be constructed across Victoria Island using a conventional open trench design. Because the conveyance pipeline would likely be installed below the groundwater table, the trench (Figure 4-4) would be designed to provide enough earthen cover over the pipe to counter any buoyant forces that may occur. In addition, a significant dewatering effort would be required during pipeline construction, which would be accomplished using dewatering wells. The pipeline would be buried in a trench that would be excavated to maintain a minimum cover of 5 feet over the pipeline.

Old River Crossing

The crossing of the Old River would be achieved through microtunneling at an elevation that would avoid unconsolidated soils and provide sufficient protection for the pipeline. A large pit would be excavated on Byron Tract, west of the existing levee and a similar pit would be excavated on Victoria Island. One pit would operate as a launching pit while the other would act as a receiving pit. Once the new pipe is in place, concrete access vaults would be constructed within both the launching and receiving pits, prior to backfilling of the pits. Figure 4-5 shows a cross section of the proposed Old River crossing for the Victoria Canal pipeline.

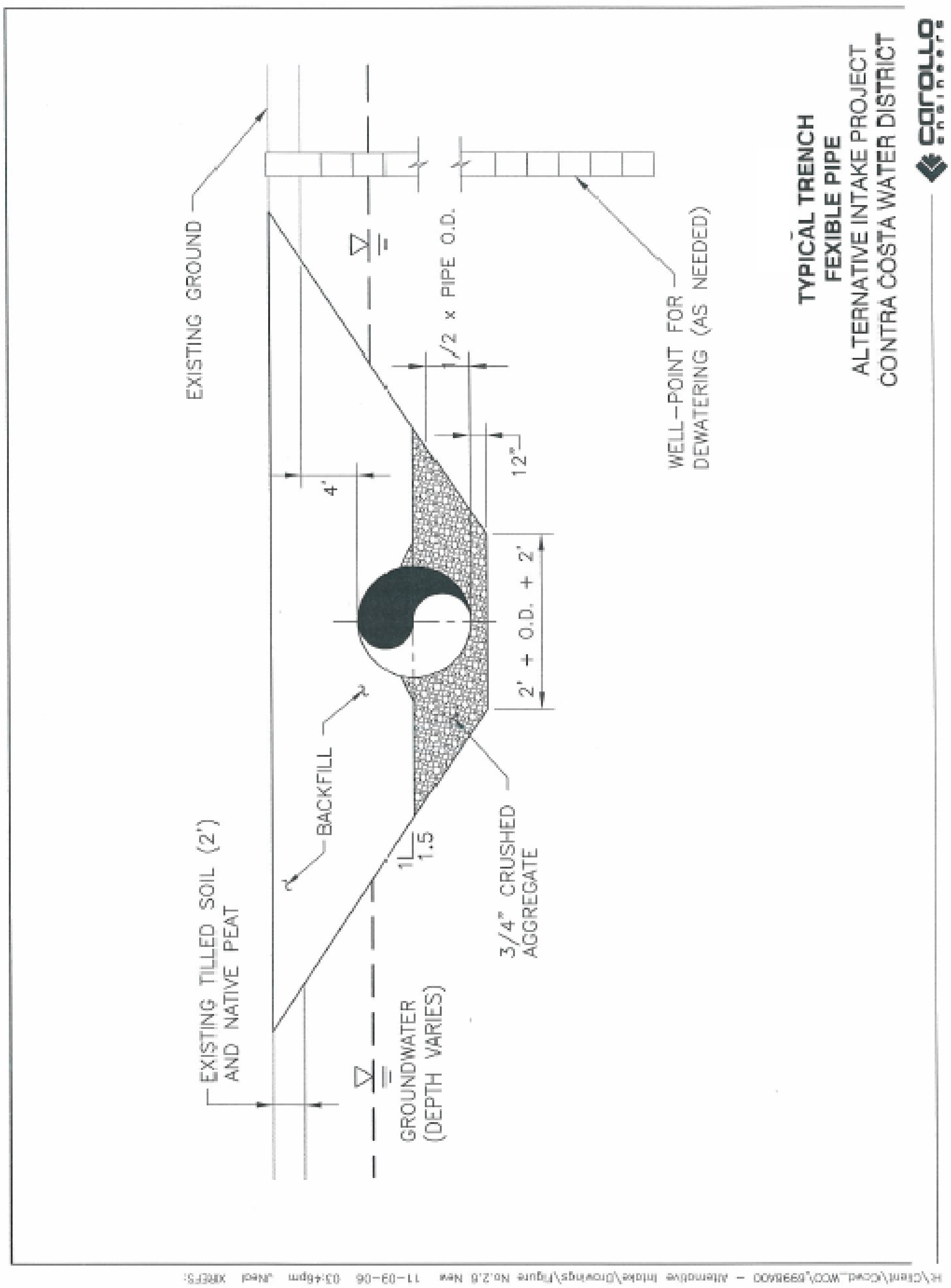

Figure 4-4. Typical Open Trench Design for Pipeline Construction

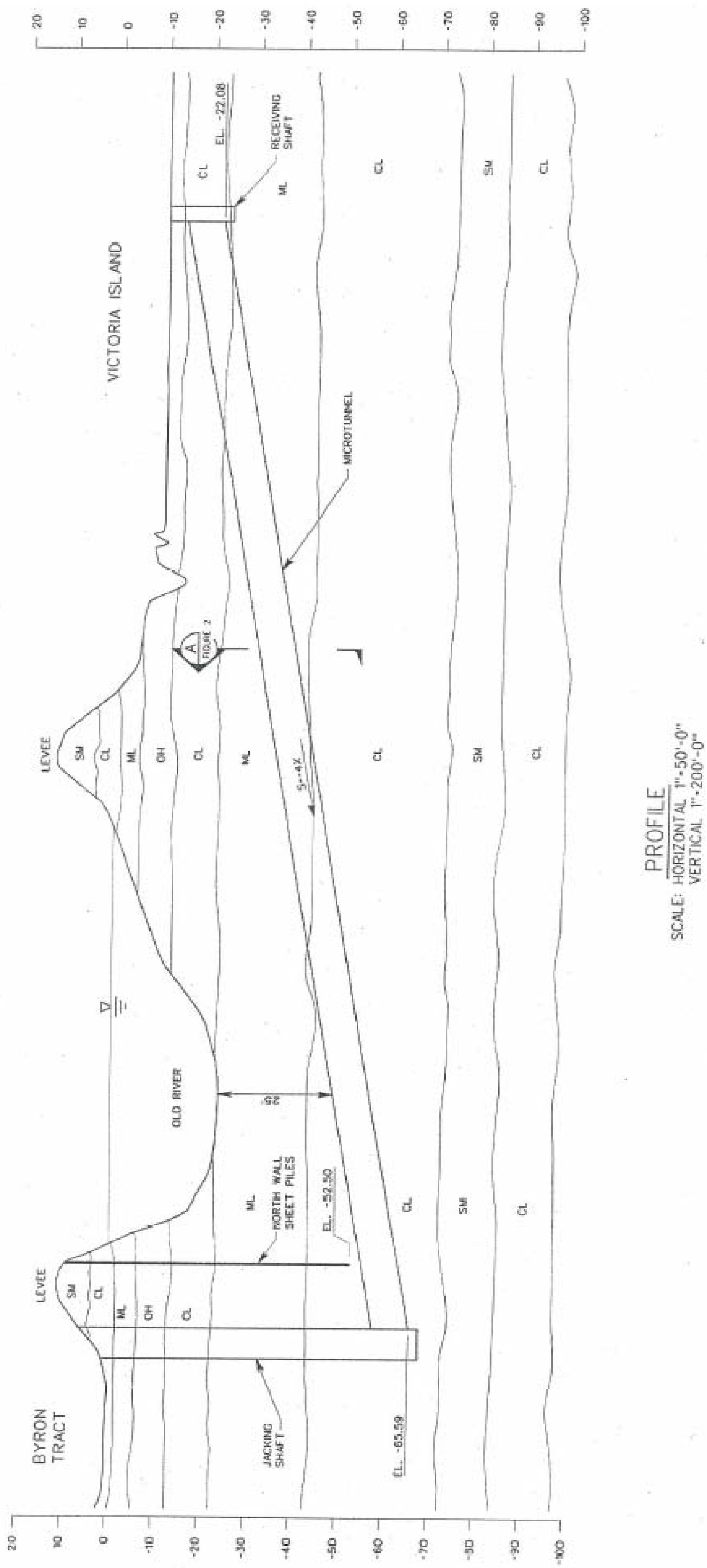

Figure 4-5. Plan 1 – Old River Crossing for Victoria Canal Pipeline

Tie-in to Old River Conveyance System

The conveyance pipeline from the new Victoria Canal intake would connect into the existing Old River conveyance system (Figure 4-6). A potential tie-in approach is to connect to the Old River pump station wet well/ forebay through a direct sidewall connection. The existing Old River pump station has two 72-inch-diameter pipe "stub-outs" in the sidewall of its wet well. This proposed connection would conform to Hydraulic Institute standards related to turbulence, eddies, and vortices that could compromise pump operations. A small-scale model may be required to identify and correct any potential adverse flow patterns resulting from the proposed sidewall connection.

Levee Improvements

The existing levee would be reinforced and reconfigured to serve as the engineered soil platform for the proposed intake/pump station facilities and to allow installation of the new intake structure. Figure 4-7 shows the proposed levee modifications. The approximate footprint area of the levee improvements (i.e., measured at the base of the side slopes) would be 250 to 300 feet wide by 1,000 to 1,200 feet long. Approximately 6 to 8 acres at the intake site would be removed from agricultural use by the proposed levee modifications.

Levee construction would require approximately 140,000 to 170,000 cubic yards of fill material. The top of the reconfigured levee would be surfaced with aggregate base to maintain vehicular traffic during rain events. A ramp would allow access to the pump station and ancillary buildings. Slope protection (i.e., riprap) would be installed on the water side of the levee for up to 400 to 500 feet on each side of the intake structure.

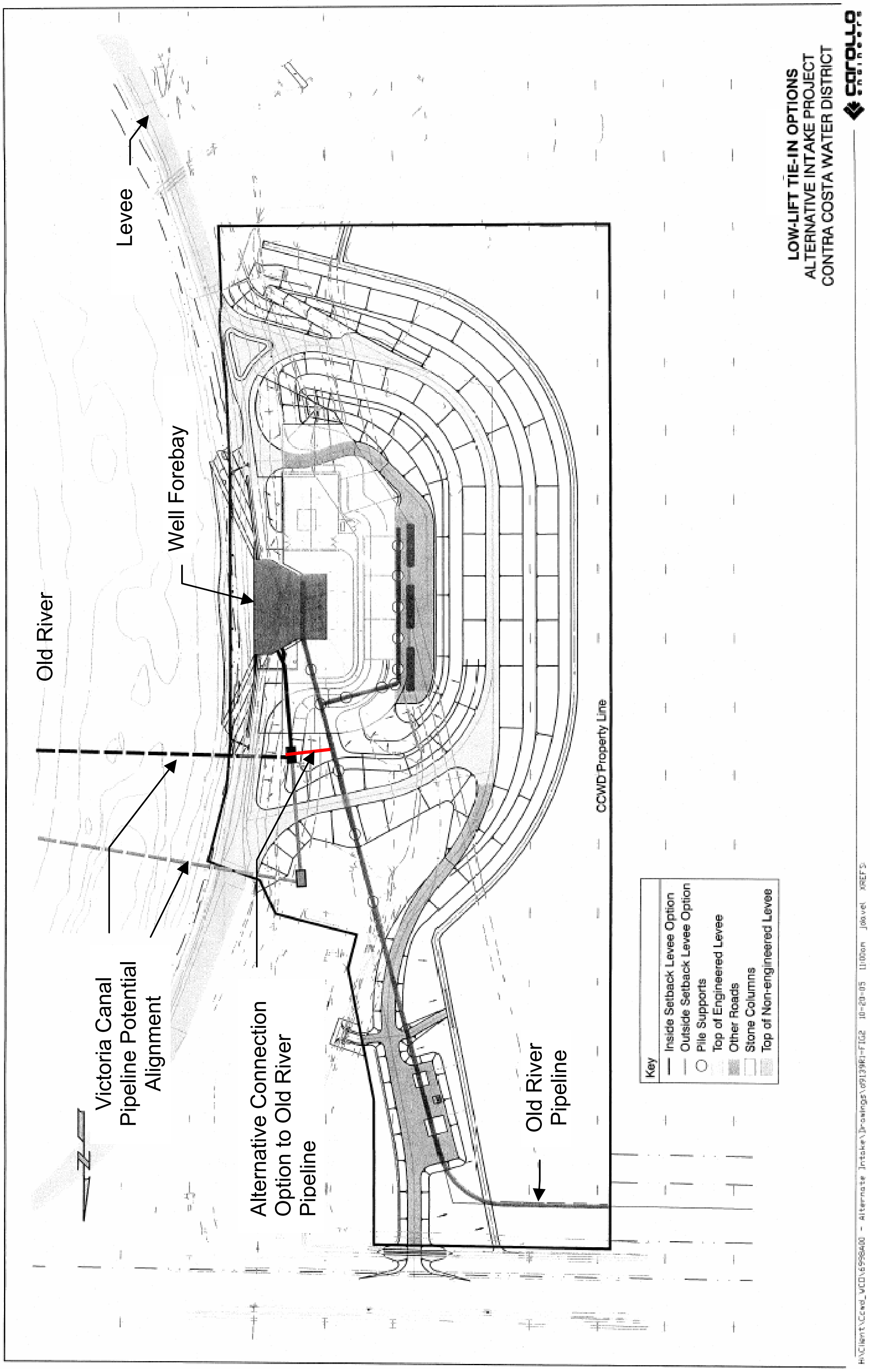

Figure 4-6. Plan 1 – Old River Crossing for Victoria Canal Pipeline

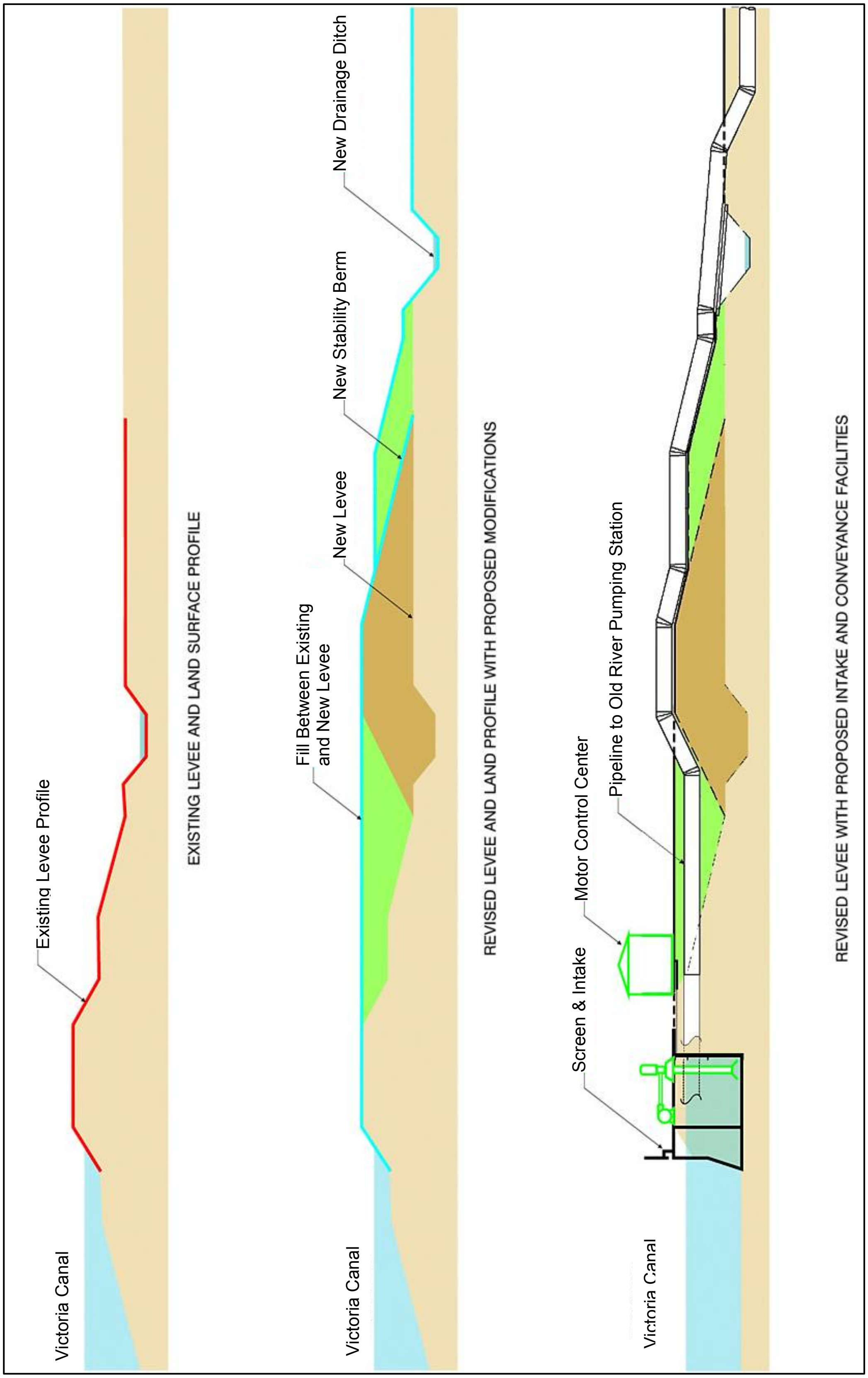

Figure 4-7. Plan 1 – Conceptual Cross-Sections of Proposed Levee Modifications and Proposed Intake and Conveyance Facilities

Electric Power Usage

Power usage for Plan 1 is calculated in terms of the net additional energy consumption for pumping compared to that of the No-Action Plan. Changes in operation under Plan 1, compared to the No-Action Plan, would include the new pump station at Victoria Canal, which would pump water to the existing Old River conveyance system. Changes in operation would also include some reduction of pumping from the Old River and Rock Slough intakes. The combined operations of the Old River and new Victoria Canal intakes would result in increased pumping at the Los Vaqueros Reservoir transfer facility. Plan 1 would not result in changes to operations of Mallard Slough intake. Figure 4-8 summarizes the net changes in energy use for CCWD major pumping facilities.

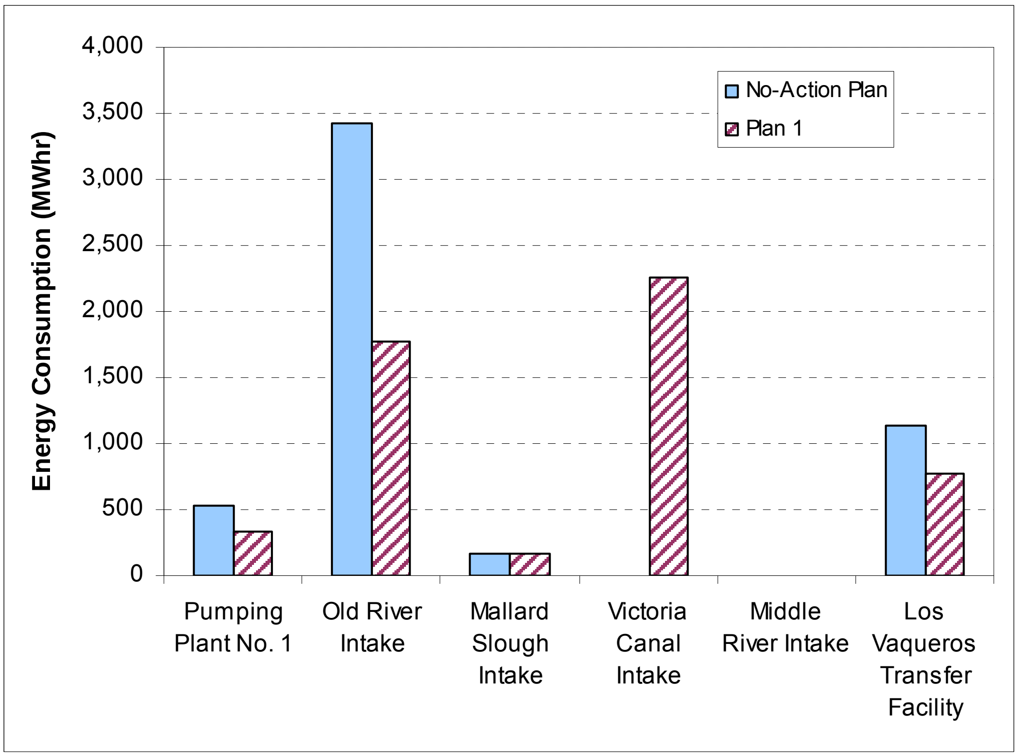

Figure 4-8. Net Energy Consumption for Pumping for Plan 1 Compared to the No-Action Plan

Cost Estimates

CCWD developed cost estimates for Plan 1 (CCWD, 2006b) as part of its pre- and detailed engineering design of the Victoria Canal intake. Table 4-1 summarizes base construction costs for Plan 1 physical elements. To provide equitable means for comparing the costs of the three alternative plans for the AIP, an appraisal-level cost estimate was developed. The cost estimate for Plan 1 was developed using Reclamation cost factors for appraisal-level cost estimates. Table 4-2 documents appraisal-level cost estimate for Plan 1. Table 4-3 shows the annualized total project costs under Plan 1, which also include O&M and replacement costs over the 40-year life of the project.

Since Plan 1 has been identified as the most likely preferred alternative, a feasibility-level cost estimate is required for that alternative. To reflect feasibility-level, or better, cost estimates, the predesign cost estimates developed by CCWD for the AIP (CCWD, 2006b) were used to develop a preliminary cost allocation for the most likely preferred alternative. These cost estimates were developed recently (2006) to accompany the preliminary engineering report (CCWD, 2006a) that provides the basis for the final design, which is currently under way. Cost factors employed by CCWD in the predesign cost estimate were not adjusted because they reflect more detailed analysis of the likely project costs. Feasibility-level or better cost estimates of the most likely preferred plan are summarized in Table 4-4 and Table 4-5. Note that the base construction cost (total field costs) in Table 4-4 matches the total field cost in Table 4-2 .This is because both the appraisal- and feasibility-level cost estimates used the same information, developed in the predesign report for the AIP (CCWD, 2006b).

Table 4-1. Estimate of Base Construction Cost for Plan 1

Cost Component	Size		Quantity		Unit Cost		Cost	Comments
Screened Intake and Pump Station								
Intake and Pump Station	250	cfs	1		$10,574,600	$	$10,574,600	Carollo Tech. Memo No. 1[1]
Electrical Substation	69	kVA	1		$1,558,400	$	$1,558,400	Carollo Tech. Memo No. 1[1]
Metering Station			1		$204,000	$	$204,000	Carollo Tech. Memo No. 1[1]
Isolation Valve Box			1		$422,000	$	$422,000	Carollo Tech. Memo No. 1[1]
						Subtotal	**$12,759,000**	
Levee Improvements			1		$6,901,000		**$6,901,000**	Carollo Tech. Memo No. 1[1]
Power Supply - Transmission Lines			20,000	LF	$75	$/LF	**$1,500,000**	Carollo Tech. Memo No. 1[1]
Raw Water Conveyance	66	inch	11,000	LF	$1,309	$/LF	**$14,400,000**	Carollo Tech. Memo No. 1[1]
Tie-ins to Existing Conveyance			1		$200,000	$	**$200,000**	Carollo Tech. Memo No. 1[1]
Wide Channel Crossing - Microtunneling	78	inch	1,100	LF	$10,836	$/LF	**$11,920,000**	Carollo Tech. Memo No. 1[1]
Total Field Cost (base construction cost)							**$47,680,000**	

Notes:
[1] CCWD AIP Technical Memorandum No. 1 Pre-design Cost Estimate Draft, Carollo Engineers, August 2006 (CCWD, 2006b)
Key:
cfs = cubic feet per second
kVA = kilovolt-ampere
LF = lineal foot

Table 4-2. Appraisal-Level Cost Estimate for Plan 1

Cost Component	Size		Quantity		Unit Cost		Cost	Comments
Total Field Cost (base construction cost)							$47,680,000	Table 4-1
Unlisted Items			1		15%		$7,152,000	Reclamation guide for appraisal cost estimate
						Subtotal	$54,832,000	
Construction Contingency			1		25%		$13,708,000	Reclamation guide for appraisal cost estimate
Total First Cost (total construction cost)							$68,540,000	
Indirect Costs - Engineering, Admin, Legal			1		25%	of First Cost	$17,135,000	Reclamation guide for appraisal cost estimate
						Subtotal	$85,675,000	
Interest During Construction (IDC)			1		7.5%	of First Cost	$6,430,000	Federal interest rate 4 ⅞, 3 years construction
Land Acquisition - Easement							$-	Not included – under negotiation
Land Acquisition – Fee Title	1		8	acres	$250,000	$/acre	$2,000,000	
Total Implementation Cost							$94,110,000	

Table 4-3. Appraisal-Level Annualized Cost Estimate for Plan 1

Cost Component	Quantity		Unit Cost		Cost	Comments
Equivalent Annual Implementation Cost over 40 Years					$5,400,000	Table 4-2, Federal interest rate 4 ⅞ %
Annual O&M of Conveyance Pipeline	1		0.5%	of First Cost	$190,612	Reclamation guide for O&M costs
Annual O&M of Intake and Pump Station	1		1.0%	of First Cost	$161,009	Reclamation guide for O&M costs
Annual O&M of Power Supply Facilities	1		0.8%	of First Cost	$35,172	Reclamation guide for O&M costs
				Subtotal	$390,000	
Power Cost for Pumping (Net Additional Use)[1]	39,376	kWh	$0.10	$ per kWh	$10,000	
				Subtotal	$10,000	
Total Annual O&M Cost					$400,000	
Annualized Replacement Cost					$-	Assumes 40-year life cycle
Equivalent Annual Project Cost over 40 Years					$5,800,000	

Notes:
[1] Net additional power usage compared to the No-Action Plan
Key: kWh = kilowatts per hour O&M = operations and maintenance

Table 4-4. Feasibility-Level Cost for Plan 1

Cost Component	Size		Quantity		Unit Cost		Cost	Comments
Total Field Cost (base construction cost)							$47,680,000	Table 4-1
Construction Contingency			1		20%		$9,540,000	Carollo Tech. Memo No. 1[1]
First Cost (total construction cost)							$57,220,000	
General Conditions			1		10%	of First Cost	$5,720,000	Carollo Tech. Memo No. 1[1]
						Subtotal	$62,940,000	
General Contractor Overhead and Profit			1		10%		$6,294,000	Carollo Tech. Memo No. 1[1]
						Subtotal	$69,230,000	
Escalation to Midpoint of Construction			1				$10,870,000	Carollo Tech. Memo No. 1[1]
Indirect Costs - Engineering, Admin, Legal			1				$18,800,000	Carollo Tech. Memo No. 1[1]
Sales Tax			1			of First Cost	$2,360,000	8.25% on 50% of Project Construction Cost[a]
Land Acquisition – Easement								Not included – under negotiation
Land Acquisition – Fee Title	1		8	acres	$250,000	$/acre	$2,000,000	
Total Implementation Cost							$103,260,000	

Notes: [1] CCWD AIP Technical Memorandum No. 1 Pre-design Cost Estimate Draft, Carollo Engineers, August 2006

Table 4-5. Feasibility-Level Annualized Cost for Plan 1

Cost Component	Quantity		Unit Cost		Cost	Comments
Equivalent Annual Implementation Cost over 40 Years					$5,910,000	Table 4-4, Federal interest rate 4 ⅞ %
Annual O&M of Conveyance Pipeline	1		0.5%	of First Cost	$190,612	Reclamation guide for O&M costs
Annual O&M of Intake and Pump Station	1		1.0%	of First Cost	$161,009	Reclamation guide for O&M costs
Annual O&M of Power Supply Facilities	1		0.8%	of First Cost	$35,172	Reclamation guide for O&M costs
				Subtotal	$390,000	
Power Cost for Pumping (Net Additional Use)[1]	39,376	kWh	$0.10	$ per kWh	$10,000	
Total Annual O&M Cost					$400,000	
Annualized Replacement Cost					$-	Assumes 40-year life cycle
Equivalent Annual Project Cost over 40 Years					$6,310,000	

Notes:
[1] Net additional power usage compared to the No-Action Plan

Key: kWh = kilowatts per hour O&M = operations and maintenance

Chapter 5
Plan 2 Conceptual Designs and Cost

This chapter documents the conceptual designs and appraisal-level cost estimates for Alternative Plan 2. Under Plan 2, a desalination treatment process would be installed at the Bollman WTP to reduce salinity and improve the quality of Mallard Slough diversions. The plan would also require the expansion of the existing Mallard Slough intake and pump station, and a treatment capacity expansion for the Bollman WTP to accommodate increased deliveries from the plant. The other major facilities associated with Plan 2 would be an untreated-water conveyance pipeline from the intake/pump plant to the Bollman WTP, and a brine concentrate discharge pipeline from the plant to Suisun Bay.

Mallard Slough Intake Expansion

The existing Mallard Slough intake is located at the southern end of a dredged channel due west of Mallard Slough. The Mallard Slough intake is only operated seasonally when its water quality is high. This water is then generally blended with Contra Costa Canal water, such that overall water quality is maintained within the specific range of the target chloride value. Because of the intake's proximity to San Francisco Bay, the water quality constituents of concern are typically sodium and chloride.

Mallard Slough Intake

Plan 2 would require expansion of the existing Mallard Slough intake and pump station from its current capacity of 60 cfs to a capacity of approximately 132 cfs. The expansion of the intake and pump station would be within the existing CCWD property boundary. The new pump station and supporting structure would be constructed similar to the existing pump station. The facility would include a screened intake with an automatic cleaning system, additional pumps, and associated electrical system upgrades. The fish screen design would match the existing screen design and would meet required flow velocity limitations established by the resources agencies. The intake would be equipped with flat plate fish screens that contain an alloy to inhibit algal growth, thereby improving screen O&M.

Conveyance

A new 48-inch-diameter pipeline would be constructed to convey the additional flow (approximately 72 cfs) from the expanded Mallard Slough intake to the desalination plant that would be constructed at the Bollman WTP site. The new pipeline would consist of an 8,000-foot-long, 36-inch-diameter welded steel pipeline. It would connect the expanded pump station to the Contra Costa Canal while maintaining the existing pipeline connection to Mallard Reservoir for redundancy. The new conveyance pipeline would run parallel to the existing pipeline up to the Contra Costa Canal (Figure 5-1), at which point it would transition westward in an alignment parallel to that of the canal to its terminus at the Bollman WTP site. The entire untreated-water conveyance pipeline (approximately 40,000 feet) would be located within CCWD easements and rights-of-way.

Desalination Plant

Plan 2 would include a new RO desalination plant constructed on vacant land within the boundaries of the existing Bollman WTP site in Concord, California (see Figure 5-2). The major components of the existing Bollman WTP include Mallard Reservoir, where untreated water from the Contra Costa Canal is stored, facilities for pretreatment, ozonation, filtration, chemical addition processes, and treated water storage. The following is a brief description of the new desalination plant, and its integration into the existing process:

- Untreated water would be conveyed from the Mallard Slough intake in the new 48-inch-diameter conveyance pipeline directly to the existing raw water pump station that feeds the Bollman WTP. Mixing in Mallard Reservoir would be avoided to prevent dilution of salinity levels that would reduce the efficiency of the RO process.

- Pretreatment would be provided through the existing conventional treatment facilities at the Bollman WTP. The current rated capacity of the existing treatment facilities is 75 mgd. The plant can also produce a slightly increased capacity of 82 mgd as a pretreatment step for subsequent RO membrane processes.

- Desalination treatment would occur in a new building constructed in a currently vacant area on the Bollman WTP property. The building would house the RO membranes, piping, booster pumps, filters, and chemicals, and space for offices, storage, and instrumentation. The brackish water desalination system would process up to 82 mgd of untreated water to produce approximately 70 mgd of treated water.

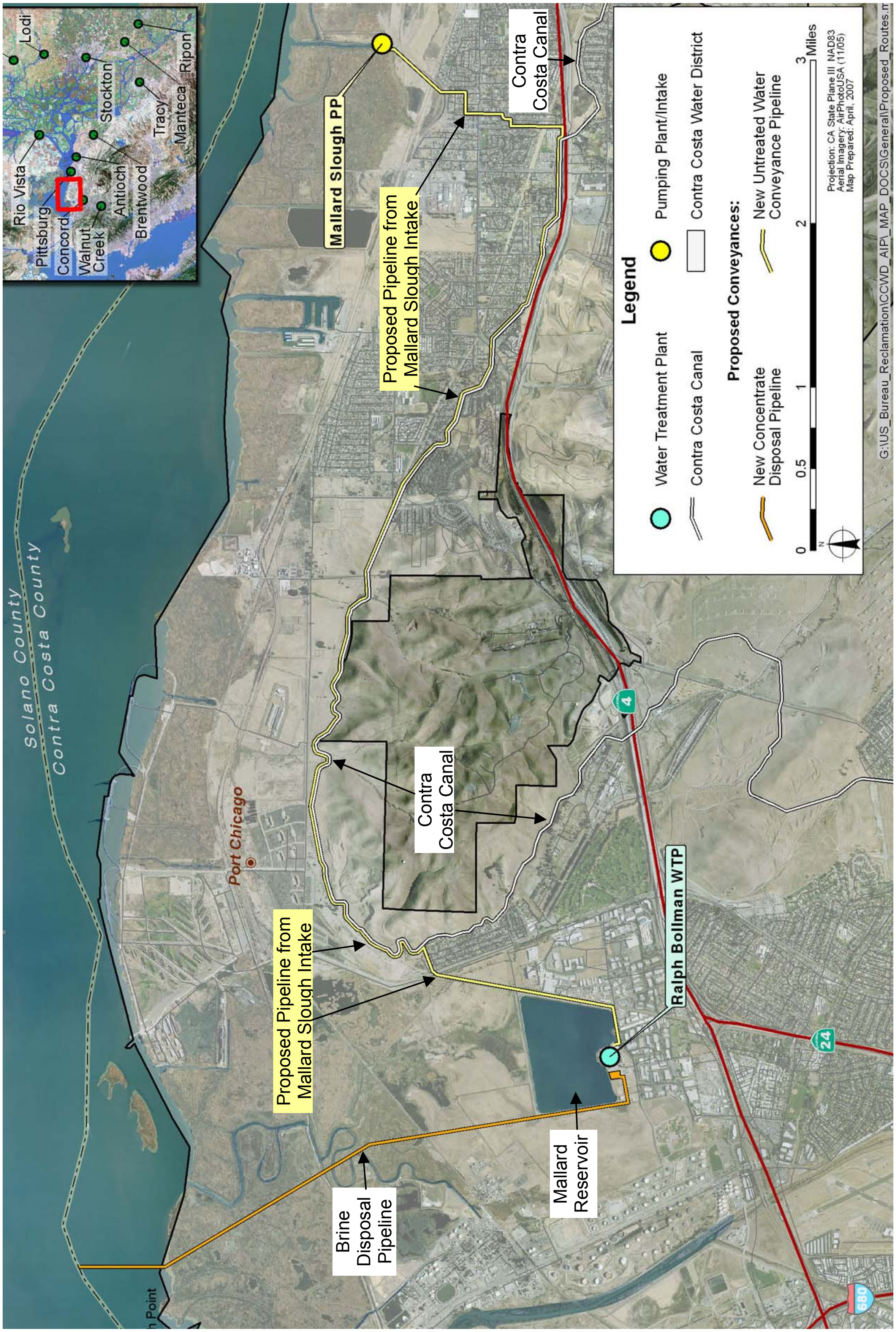

Figure 5-1. Untreated Water and Concentrate Disposal Conveyance

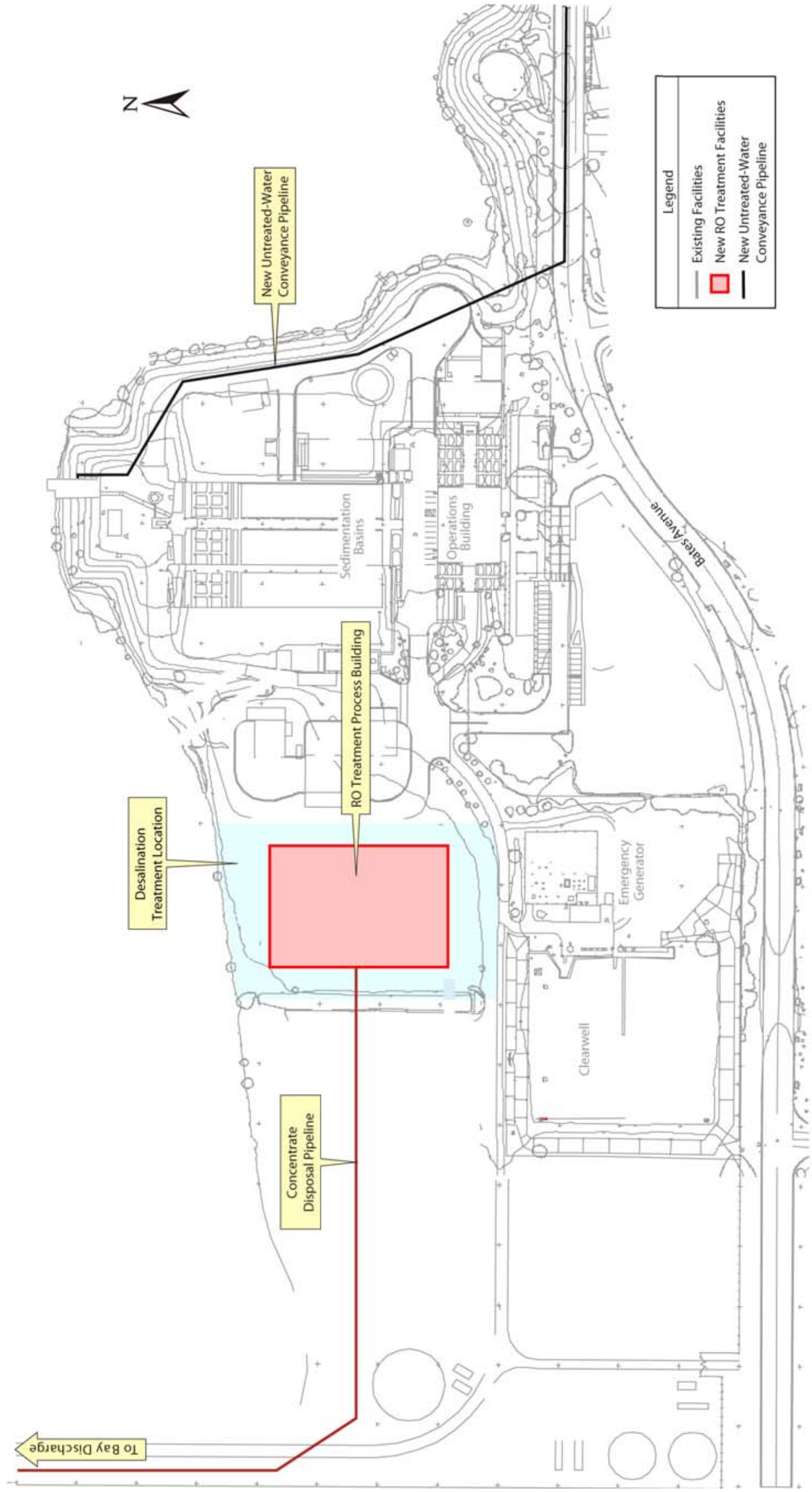

Figure 5-2. Plan 2 – Location of the Proposed Desalination Treatment Plant at Bollman WTP Site

- The finished water from the RO process would be blended and chemically conditioned for pH and alkalinity adjustment (i.e., lime and carbon dioxide addition). This posttreatment process would be necessary to achieve an improved mineral balance with increased hardness to protect the distribution system against corrosion. Distribution of desalinated water to CCWD's treated water customers would be via CCWD's existing distribution system.

- CCWD currently discharges waste solids (i.e., suspended solids and pretreatment flocculant solids) off site to a lagoon-type storage system for drying and disposal, located at the Central Contra Costa Sanitation District treatment facility. No capacity upgrades to the solids handling systems would be anticipated because of the proposed modification to the treatment plant.

Conceptual Design of Reverse Osmosis Membrane System

RO for water desalination is the process of forcing water from a region of high dissolved solids concentration through a semipermeable membrane to a region of low dissolved solids concentration by applying pressure in excess of the osmotic pressure. The membranes used for RO have a dense barrier layer in the polymer matrix where most separation occurs. This process requires that a high pressure be exerted on the high concentration side of the membrane, usually 250 to 400 psi for brackish water, and 600 to 1,000 psi for seawater.

A typical RO treatment system includes a set of membrane elements, housed in pressure vessels. With a high pressure pump, feed water is continuously pumped to the pressure vessels. Within the membrane elements, the feed water would be split into a low-saline and/or purified product (permeate) and a high saline or concentrated brine (concentrate or reject). A flow regulating valve controls the percentage of feed water going to the concentrate stream, and the permeate, which would be obtained from the feed. A RO treatment system also includes a clean-in-place system that handles the cleaning of the membranes.

The recovery (ratio of permeate to feed) of an RO system for brackish water is typically about 70 to 85 percent, with an upper limit of 90 percent. In seawater desalination, the upper limit for recovery is 50 percent, which is dictated by the osmotic pressure of the concentrate stream that approaches the physical pressure limit of membrane elements. Water quality in the vicinity of Mallard Slough intake has an average TDS of 2,140 mg/L, which is within the brackish water range.

Based on a preliminary review of water quality data for untreated water and applications of RO treatment for similar source waters, a value of up to 85 percent recovery of permeate water (i.e., desalted product water) has been assumed for the purposes of this project concept. The remaining 15 percent would be discharged as concentrate byproduct. Actual values of permeate recovery may be lower by 5 to 10 percent, and would need to be confirmed prior to final design with bench and/or pilot-scale testing. Figure 5-3 shows estimated feed, permeate, and concentrate flows for the proposed desalination treatment. Table 5-1 shows the projected water quality constituent values in the untreated feed water, bypass/blending stream, permeate, and concentrate byproduct stream.

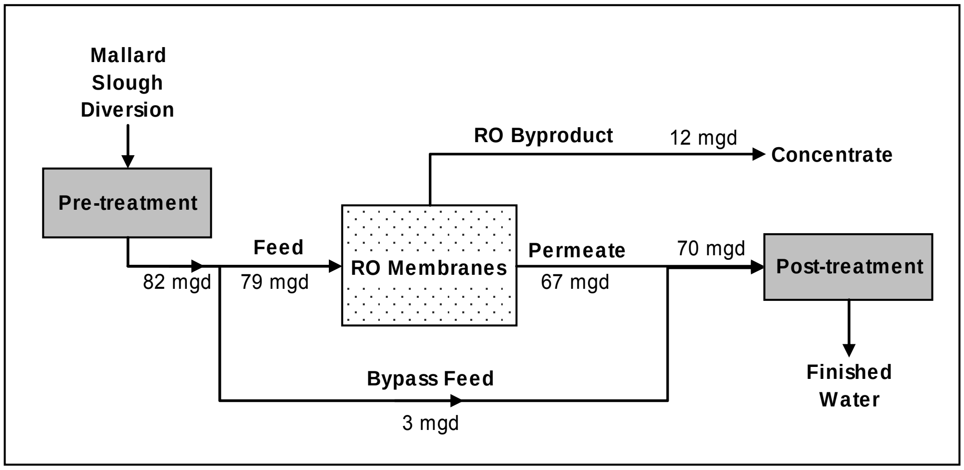

Figure 5-3. Projected Reverse Osmosis Treatment Maximum Flow Rates

FILMTEC Membrane Element

To develop a conceptual process design for the proposed desalination facility, the FILMTEC BW30-440i membrane element from Dow Chemical Company was selected based on feed water salinity, feed water fouling tendency, and required rejection and energy requirements. The FILMTEC BW30-440i element, with a surface area of 440 square feet, is typically arranged in pressure vessels that contain 6 membrane elements. To achieve the desired system recovery and permeate water quality, the pressure vessels would also be arranged in stages. The number of stages defines how many pressure vessels in series the feed would pass through until it exits the system and is discharged as concentrate. Figure 5-4 shows the conceptual process design, including the number of stages, for the proposed RO membrane treatment for Mallard Slough brackish water. The conceptual process design shows a three-stage RO treatment process, with total of 1,692 six-element pressure vessels, which corresponds to a total active surface area of 4,466,667 square feet (Table 5-2). Design parameters for the conceptual RO treatment process are summarized in Table 5-3. It should be noted that selection of the arrangement of vessels in Figure 5-4 and Table D-5 is such that the feed flow rate for vessels in the first stage and the concentrate flow rate per vessel of the last stage would meet maximum and minimum flow requirements, respectively.

Desalination treatment would occur in a new building measuring approximately 80,000t to 100,000 square feet, which would be constructed in a currently vacant area on the Bollman WTP property (see Figure 5-2). The building would house the RO membranes, piping, booster pumps, filters, and chemicals, and space for offices, storage, and instrumentation.

Table 5-1. Projected Water Quality Constituent Concentrations for Desalination

Parameter	Unit	Feed Water[1]	RO Permeate	Finished Water[2]	RO Byproduct
Chloride	mg/L	776	25	65	6,200
Sodium	mg/L	595	17	45	3,870
TDS	mg/L	2140	50	150	13,348
Potassium	mg/L	20	0.7	2	130
Magnesium	mg/L	80	0.5	4	522
Calcium	mg/L	35	0.2	23	233
Alkalinity	mg/L	61	4	63	510
Nitrate	mg/L	1.6	0.3	0.3	8.5
Sulfate	mg/L	152	1.7	14	1,660
Silica	mg/L	17	0.3	1.0	110
Phosphate	mg/L	0.3	-	< 0.1	2.0
Hardness	mg/L as $CaCO_3$	295	2.7	75	2,850
pH		7.67	6.4	8.1	8.4
Ammonia	mg/L	0.1	-	< 0.1	< 0.7
TOC	mg/L	2.7	-	< 0.5	< 18
CCPP[3]	mg/L as $CaCO_3$			5.0	
Larson Ratio[4]				1.5	

Notes:

[1] Mallard Slough average water quality 1996–2000 (Bay Area Regional Desalination Project Pre-Feasibility Study Final Report, URS Corporation and Boyle Engineering, 2003).

[2] Posttreatment includes chemical treatment and blending conventionally treated water at a ratio of 17% nondesalinated water to total finished water. Chemical treatment includes 50 mg/L of carbonic acid, 45 mg/L lime, and 2.5 mg/L of sodium hypochlorite.

[3] Calcium carbonate precipitation potential. Used to assess corrosivity of finished water. Should be within the range of 4–10 mg/L as $CaCO_3$.

[4] Used to assess corrosivity of finished water with respect to chlorides and sulfate. Should be less than 5.

Key:
$CaCO_3$ = calcium carbonate
mg/L = milligrams per liter
RO = reverse osmosis
TDS = total dissolved solids
TOC = total organic carbon

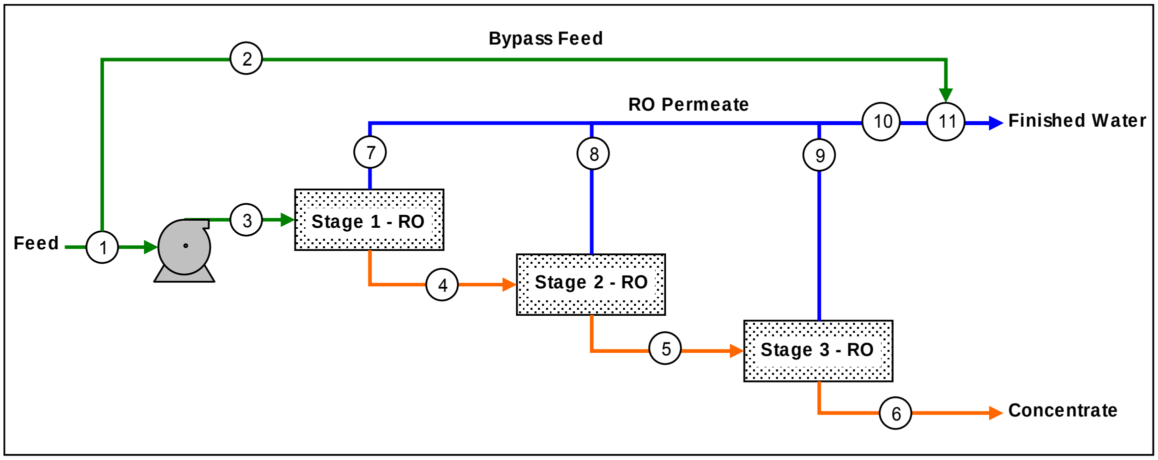

Figure 5-4. Conceptual Process Design for RO Membrane System

Table 5-2. Conceptual Design for RO Membrane System

Feature	Stage 1	Stage 2	Stage 3
RO Membrane Element Type	FILMTEC BW30-440i		
No. of Elements	5,583	2,979	1,589
No. of Pressure Vessels	931	496	265
Total Active Surface Area (ft^2)	2,456,575	1,310,734	699,358

Key:
ft^2 = square feet
RO = reverse osmosis

Table 5-3. Conceptual Process Design Parameters for RO Membrane System

RO Stream[1]	No.[2]	Flow (gpm)	Flow (mgd)	Recovery[3]	TDS (ppm)	Salt Rejection[3]	Pressure (psi)
Feed	1	57,000	82	-	2,140	-	-
	2	2,100	3	-	2,140	-	-
	3	54,900	79	-	2,140	-	260
Byproduct	4	21,900	31.5	-	5,349	-	230
	5	12,400	18	-	9,385	-	205
	6	8,300	12	-	13,858	-	175
Permeate	7	33,000	47.5	60%	11	99.5%	-
	8	9,500	14	43%	80	98.5%	-
	9	4,100	6	33%	328	96.5%	-
Finished Water	10	46,600	67	-	53	-	-
	11	48,700	70	-	143	-	-

Notes:
[1] Design is based on FILMTEC BW30-440i membrane elements from Dow Chemical Company.
[2] Refer to Figure 5-4
[3] Assumed values based on membrane specifications and typical performance of similar RO systems.

Key:
gpm = gallons per minute
mgd = million gallons per day
ppm = parts per million
psi = pounds per square inch
RO = reverse osmosis

Concentrate Disposal Pipeline

Disposal of the concentrated brine (concentrate) produced in the RO process can be achieved through blending with treated wastewater effluent prior to discharge through a new pipeline to Suisun Bay. Blending the concentrate with wastewater is a potentially viable option, as the CCWD Bollman WTP site is near the Central Contra Costa Sanitation District wastewater treatment facilities. Prior to disposal, concentrate byproduct from the RO units would pass through an energy recovery turbine to maximize energy efficiency of the system.

The disposal facilities would include a new pump station, with a capacity of approximately 12 mgd, and pipeline approximately 14,000 to 15,000 feet long that would convey the concentrate byproduct to Suisun Bay (Figure 5-1). The pipeline includes an outfall diffuser located approximately 2,000 feet from the shoreline, in Contra Costa County, and at a water depth of 50 to 75 feet. It would be designed with nozzle-type ports for velocity and dispersion mixing of the concentrate in sufficient rates to meet dilution standards.

Power Usage

Desalination is an energy-intensive water treatment method. Energy is the largest single variable cost for a desalination plant, varying from one-third to more than one-half the cost of produced water (Chaudhry, 2003). For example, Semiat (2000) reports that electrical energy use accounts for 44 percent of the typical water costs of an RO plant, with the remainder from other O&M expenses and fixed charges (i.e., capital amortization).[1]

The energy requirements for RO depend directly on the concentration of salts in the feed water and, to a lesser extent, on the temperature of the feed water. Because no heating or phase change is necessary for RO, the major use of energy is for pressurizing the feed water. As a result, RO facilities are most economical for desalinating brackish water, and the product water increases in cost as the salt content of the source water increases. Actual energy requirements for desalination vary widely depending on project specifics. For example, a seawater desalination plant, under investigation by the Municipal Water District of Orange County, requires approximately 5,500 kilowatt-hour (kWh)/acre-foot. On the other hand, desalination of brackish groundwater at the Chino Desalter Facility requires approximately 1,700 kWh/acre-foot.[2]

For the proposed desalination treatment at the Bollman WTP, an estimated energy use of 3,000 kWh/acre-foot is assumed. This estimate is based on the average salt concentration of Mallard Slough water supply, compared to that of seawater and brackish groundwater. It should be noted that this approximate

[1] Cohen, R., G. Wolff, and B. Nelson. 2004. Energy down the drain: The Hidden Costs of California's Water Supply. Natural Resources Defense Council.
[2] Cooley H., P. Gleick, and G. Wolff. 2006. Desalination, with a Grain of Salt: A California Perspective. Pacific Institute.

estimate does not evaluate in detail the actual pressure requirements, the use of variable drive pumps to optimize energy use, energy capture and recycling, or other energy efficiency best practices.

Pumping power usage for Plan 2 is calculated in terms of the net additional energy consumption for pumping Delta water compared to that of the No-Action Plan. Changes in operation under Plan 2, compared to the No-Action Plan, would include expanding the Mallard Slough intake diversion. Changes in operation would also include some reduction of pumping from the Old River intake, and consequently in Los Vaqueros Reservoir transfer facility, as well as some reductions at the Rock Slough intake. Figure 5-5 summarizes the net changes in energy use for CCWD major pumping facilities.

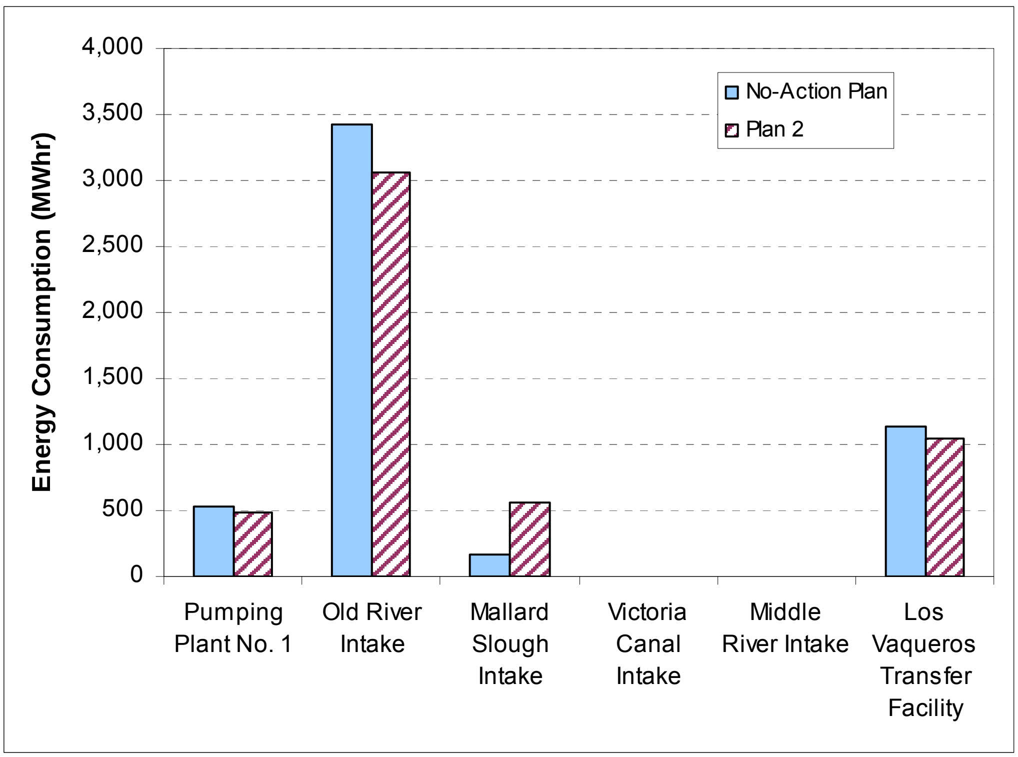

Figure 5-5. Pumping Energy Consumption for Plan 2 Compared to the No-Action Plan

Cost Estimates

Cost estimates developed for Plan 2 components are at the appraisal-level, per Reclamation guidance, and are primarily used to compare alternative plans. They are not intended to be at the feasibility-level required to request project authorization or appropriations for construction. Table 5-4 documents appraisal-level cost estimates for Plan 2. Table 5-5 shows the annualized total project costs under Plan 2, which also include O&M and replacement costs over the 40-year life of the project.

Table 5-4. Appraisal-Level Cost Estimate for Plan 2

Cost Component	Size		Quantity		Unit Cost		Cost	Comments
Screened Intake and Pump Station								
Intake and Pump Station	72	cfs	1		$8,837,500	$/cfs	$8,837,500	MWH estimate - cost curve
Electrical Substation	-	kVA	-		$-	$	$-	
Metering Station			1		$204,000		$204,000	Carollo's Tech Memo No. 1[1]
Isolation Valve Box			1		$422,000		$422,000	Carollo's Tech Memo No. 1[1]
						Subtotal	**$9,463,500**	
Power Supply - Transmission Lines			-	LF	$-	$/LF	**$-**	Power available at current intake site
Raw Water Conveyance	42	Inch	40,000	LF	$650	$/LF	**$26,000,000**	MWH Estimate -
Tie-ins to Existing Conveyance		Inch	-		$-	$	**$-**	
Wide Channel Crossing – Microtunneling		inch	-	LF	$-	$/LF/inch	**$-**	
Desalination Facilities	82	mgd	1		$2,500,000	$/mgd	**$205,000,000**	MWH Estimate -70 mgd output, RO, cost curve
Concentrate Discharge Pump Station	12	mgd	1		$275,000		**$3,300,000**	MWH Estimate -60' total head, cost curve
Concentrate Discharge Pipeline	24	Inch	15,000	LF	$360	$/LF	**$5,400,000**	MWH Estimate -24" C200, CML, 4' cover, no rock
Concentrate Discharge Outfall	24	Inch	2,000	LF	$600	$/LF	**$1,200,000**	MWH Estimate -24" C200, CML, water placement
Total Field Cost (base construction cost)							**$250,363,500**	
Unlisted Items			1		15%		$37,554,525	Reclamation guide for appraisal cost estimate
						Subtotal	**$287,918,025**	
Construction Contingency			1		25%		**$71,979,506**	Reclamation guide for appraisal cost estimate
Total First Cost (total construction cost)							**$359,897,531**	
Indirect Costs - Engineering, Admin, Legal			1		25%		$89,974,383	Reclamation guide for appraisal cost estimate
						Subtotal	**$449,871,914**	
Interest During Construction (IDC)			1		7.5%		**$33,750,000**	Federal interest rate 4 ⅞, 3 years construction
Land Acquisition – Easement			0	acres	$250,000	$/acre	**$-**	
Land Acquisition – Fee Title			0	acres	$250,000	$/acre	**$-**	
Total Implementation Cost							**$483,630,000**	

Notes: [1] CCWD AIP Technical Memorandum No. 1 Pre-design Cost Estimate Draft, Carollo Engineers, August 2006

Key: ' = foot; " = inches; cfs = cubic feet per second; CML = cement mortar lining; kVA = kilovolt-ampere; LF = lineal feet; mgd = million gallons per day; MWH = MWH Americas, Inc.

Table 5-5. Appraisal-Level Annualized Cost Estimate for Plan 2

Cost Component	Size		Quantity		Unit Cost		Cost	Comments
Equivalent Annual Implementation Cost over 40 Years							**$33,170,000**	Table 5-4, Federal interest rate 4 ⅞ %
Annual O&M of Conveyance Pipeline			1		0.5%	of First Cost	$225,688	Reclamation guide for O&M costs
Annual O&M of Intake and Pump Station			1		1.0%	of First Cost	$136,038	Reclamation guide for O&M costs
Annual O&M of Desalination Plant			1		1.0%	of First Cost	$2,946,875	Reclamation guide for O&M costs
Annual O&M of Power Supply Facilities			1		0.8%	of First Cost	$-	Reclamation guide for O&M costs
						Subtotal	**$3,310,000**	
Power Cost for Pumping (net additional use)			-119,156	kWh	$ 0.10	$ per kWh	$(11,916)	
Power Cost for Desalination	3,000	kWh/AF	9,400	AF	$ 0.10	$ per kWh	$5,820,000	
						Subtotal	**$5,810,000**	
Total Annual O&M Cost							$9,120,000	
Replacement Cost for Desalination Plant			1		35%	of First Cost	$103,140,625	Assumes 7-year life cycle
Annualized Replacement Cost							$11,780,000	Assumes 40-year life cycle for major components
Equivalent Annual Project Cost over 40 Years							**$54,070,000**	

Key:
AF = acre-feet
kWh = 1000 watts per hour
O&M = operations and maintenance

Chapter 6
Plan 3 Conceptual Designs and Cost

This chapter documents the conceptual designs and cost estimates for Alternative Plan 3. Under Plan 3, the existing CCWD Rock Slough intake would move to a new location on the Middle River that provides better water quality. The new intake would tie into the Contra Cost Canal at its entrance near Rock Slough.

Middle River Intake

Plan 3 would move the existing CCWD Rock Slough intake to a new location on the Middle River, opposite Bacon Island, that provides better water quality. The location of the intake would be west of the City of Stockton, approximately 6 miles north of SR 4 along Bacon Island Road on the west levee of the Middle River (see Figure 6-1). The plan would involve building a new screened intake and pump station on Middle River that would feed CCWD's existing Pumping Plant No. 1 through a pipeline to the Contra Costa Canal entrance. To eliminate potential water quality deterioration in the Contra Costa Canal sections between Pumping Plant No. 1 and the canal entrance, this plan assumes that the Contra Costa Canal Encasement Project would be implemented and is part of the No-Action Plan. The new screened intake would contribute to overall reduction in fish mortality rates compared to the current unscreened intake on Rock Slough.

The stretch of river considered for the location of the intake is north of the confluence of Empire Cut to the Middle River. Two distinct locations were considered at bends in the Middle River along approximately 3,000 feet of the west bank. These locations were targeted to take advantage of favorable river flow characteristics combined with terrain conducive to construction of the conveyance pipeline (see Figure 6-2).

Potential Middle River Intake Site

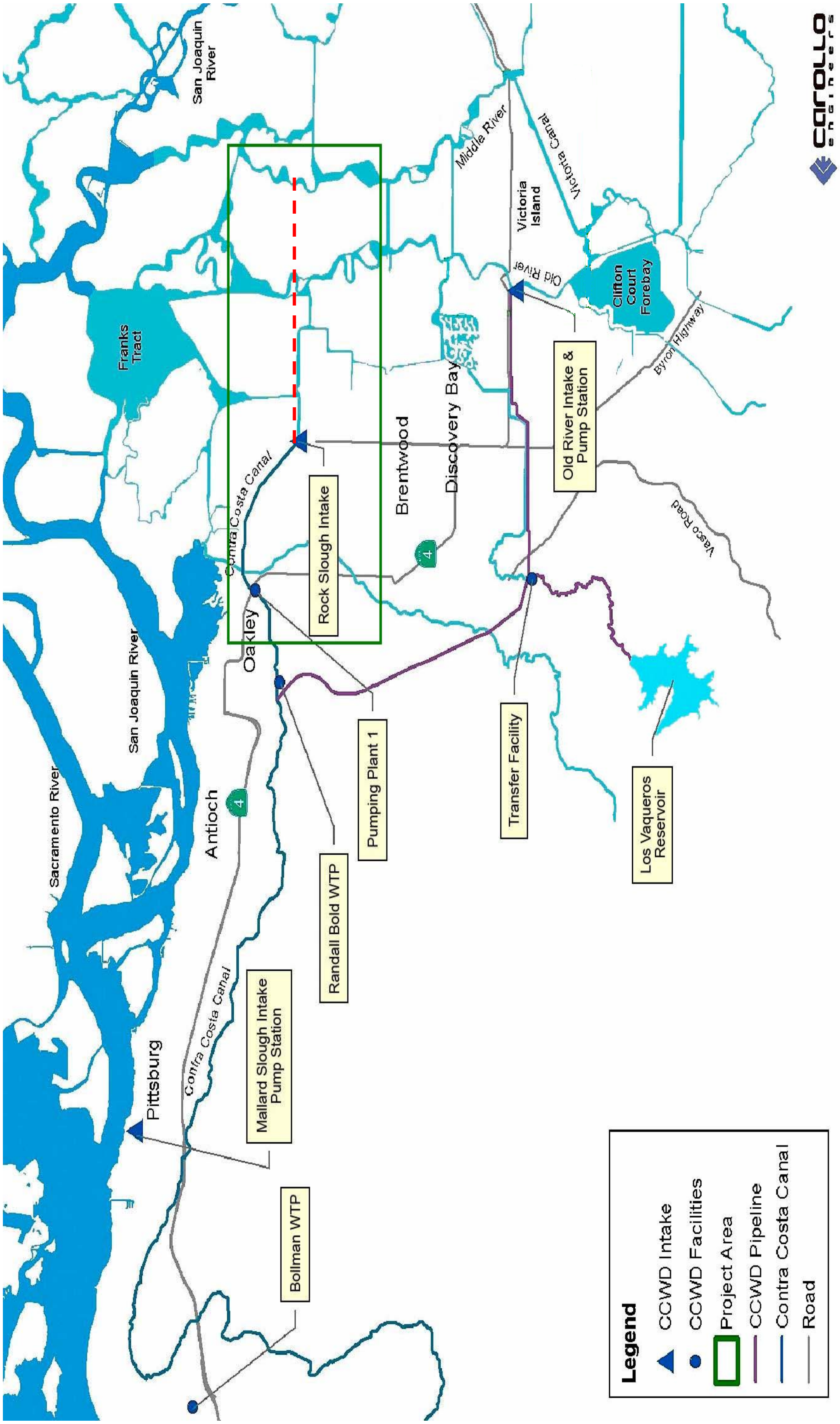

Figure 6-1. Plan 3 – Regional Map of the Proposed Middle River Intake Project

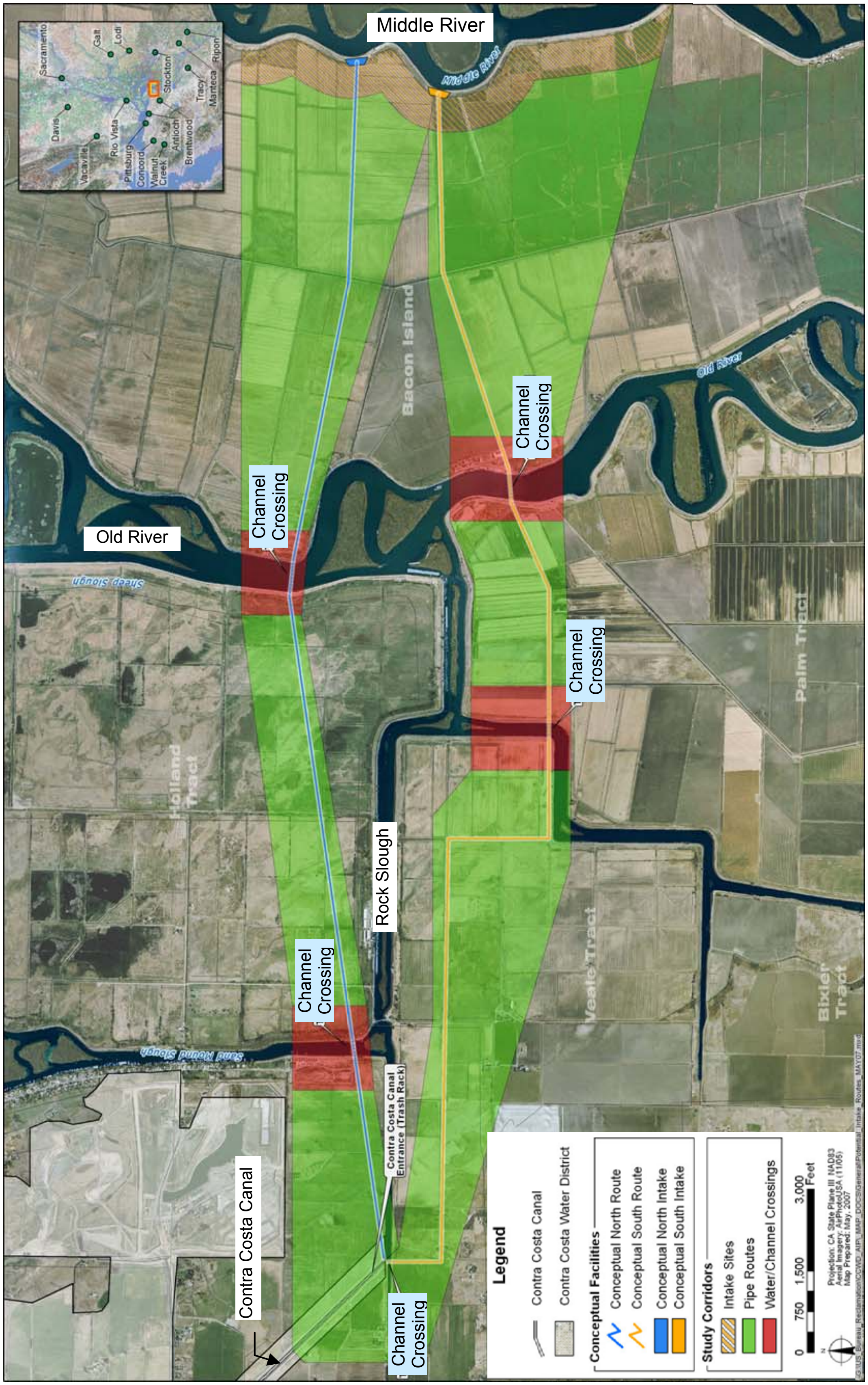

Figure 6-2. Plan 3 – Potential Pipeline Alignment for the Middle River Intake

The intake design would follow the same parameters used in the design for the project located on the Victoria Canal (Plan 1). One significant difference relates to the overall capacity of the intake and pump station, which for this alternative would be 340 cfs.

The intake would be a fully screened facility to prevent harm to aquatic species, in compliance with the Central Valley Project improvement Act (CVPIA). The approach velocity to the screen is assumed to require compliance with 0.2 fps to prevent impingement of delta smelt. Bathymetric information for the Middle River at both proposed intake locations was unavailable at the time of this evaluation. The depth of the Middle River (-21.7 feet) is known but detailed elevations near the bank have not been established. For the purpose of this study, cross-sectional information is assumed to be similar to Victoria Canal.

Two design options were evaluated for the intake, including a deep screen with an effective depth of 12 feet and a shallow screen with an 8-foot effective depth of screen. The effective depth of screen is contingent on the cross section of the river and the varying water surface elevations. Design of an intake requires that a reliable water surface elevation is used for the pump station to be operational during all river conditions. Refer to Table 6-1 below for parameters used for the intake conceptual design. The screen design for this location is also assumed to be a flat panel rectangular wedge-wire, similar to the Old River pump station designs.

Table 6-1. Plan 4 - Conceptual Intake Design Parameters

Parameter	Design Criteria	
	Option A Deep Screen	Option B Shallow Screen
Design Flow (cfs)	340	340
Approach Velocity (fps)	0.2	0.2
Required Effective Screen Area (ft²)	1,700	1,700
Design minimum water surface elev. (feet)	-2.0	-2.0
Screen invert elevation (feet)	-14.0	-10.0
Screen width (feet)	177	238
Screen height (feet)	12.0	8.0
Screen panel area (ft²)	2,125	1,904
Number of screen panels	19	24
Screen slot opening sizes (mm)	1.75	1.75
Total intake length (feet)	205.5	277.5
Screen area provided to area required ratio ($A_{provided}/A_{required}$)	1.25	1.12

Key:
cfs = cubic feet per second
ft² = square feet
fps = feet per second
mm = millimeter

Pump Station

The pump station layout and concept is vertical turbine pumps mounted on a concrete deck above individual pump bays separated by baffle walls. Flow is directed from a trapezoidal screen area to the pump bells. The pump station configuration includes a total of five pumps, each with a capacity of 68 cfs at 110 feet of total dynamic head (TDH). Discharge piping for each pump has a check valve and isolation valve configuration prior to connection to the discharge header.

The inlet/pump station structure would be constructed of cast-in-place concrete, supported by piles driven to a depth to resist lateral, overturning, and gravity forces on the structure. The structure would support the pumps, fish screens, and cleaning system on the river side of the facility. The pump station would have adequate sediment control systems that would reduce the amount of silting in the pump bays and the approach to the pumps. Minimum submergence requirements were evaluated for the depth of the structure based on the low water surface elevation presented.

Power Supply

Currently, no electric utilities are present at the proposed intake site. A new power substation would be constructed on site. Power transmission lines would be extended to the intake site on Bacon Island. The potential electric distribution system for connection includes PG&E and WAPA. Power supply to the facility would be transmitted through the distribution system from a combination of available sources, which may include PG&E and/or Reclamation's CVP. Potential corridors for power lines would be the same as for the pipeline, although the pipeline and power lines may not be on the same alignment. Based on preliminary review of area electric grids, a new transmission line about 5 miles in length would be required to provide electric power to the proposed Middle River intake.

Conveyance

Several pipeline alignments were evaluated for conveyance of the raw water to the tie-in point at Rock Slough. Two alignments were taken further in terms of development for conveyance of Middle River water and are shown in Figure 6-2.

The northern alignment would be the shortest or most direct route from the intake to the tie-in point at Rock Slough. This alignment would be approximately 29,400 feet long with waterway crossings at the Old River and Mound Slough. The waterway crossings would be tunneled with a total of approximately 1,660 feet of specialized construction.

The southern alignment would be a longer pipeline route, beginning at an intake location ¼ mile south of the Plan 1 intake location. This pipeline placement would be within roadways and located at the back of property lot lines in order to limit the amount of impact and cost of land acquisition and right of way procurement. The total length of this alternative would be 33,560 feet, with nearly 60 percent located in a defined roadway. This alternative has three tunneled crossings (1,800 feet), one at the Old River, and two at Rock Slough (Figure 6-1).

Plan 3 includes conveyance of raw water by pressure pipe from the Middle River to the connection point to the CCWD Canal at Rock Slough. Criteria used for sizing discharge piping, valves, and header pipes are as shown below:

- Single diameter transmission main would have a capacity of 340 cfs.
- Line velocity less than 11 fps requires a 78-inch pipe.
- Pipe materials include welded steel pipe (WSP), and reinforced concrete cylinder pipe (RCCP).
- Pipe joints would be AWWA Standard C200-86 for WSP and AWWA Standard C300-89 for RCCP.
- Poor soils would require conventional open cut trenching with lay back of trench walls.
- Groundwater is within a few feet of the ground surface.
- Depth of burial varies between 4 to 8 feet.
- General soil conditions are similar to Victoria Canal.
- Impressed current cathodic protection would be used for full length of pipeline

The design approach for the raw water transmission main is assumed to follow standard practice of the industry. Pipeline features such as air release, control valves, cathodic protection test stations, and access hatches would be installed in vaults or on pads above ground along the pipeline route. Pipe crossings of existing irrigation and drainage ditches would be developed based on discussions with landowners and consideration of both farming operations and construction costs. Channel crossings, including of the Old River, and potentially Sand Mound Slough or Werner Dredger Cut, would be accomplished though microtunneling.

Tie-in to Contra Costa Canal

The proposed pipeline from the Middle River intake would terminate with a connection to the Contra Costa Canal (Figure 6-2). This connection would be designed to the requirements and specific details of the Contra Costa Canal Encasement project, which involves replacement of an open channel with a pipeline. The Contra Costa Canal project is an effort to control water quality deterioration in the Contra Costa Canal between Pumping Plant No. 1 and the entrance.

Canal encasement would hydraulically isolate water supplies in the canal by replacing the unlined and porous open canal with a leak-proof pipeline. Two large 10-foot-inside-diameter pipes with a total capacity 350 cfs are planned for construction in the existing canal cross section of Reclamation's 300-foot canal right-of-way. Small portions of the pipeline could also be constructed beneath the canal berms.

Figure 6-3 shows a preliminary layout of the head works of the encased Contra Costa Canal. The proposed 78-inch-diameter pipeline carrying raw water from the Middle River intake would connect into the encased canal at the section shown in Figure 6-2.

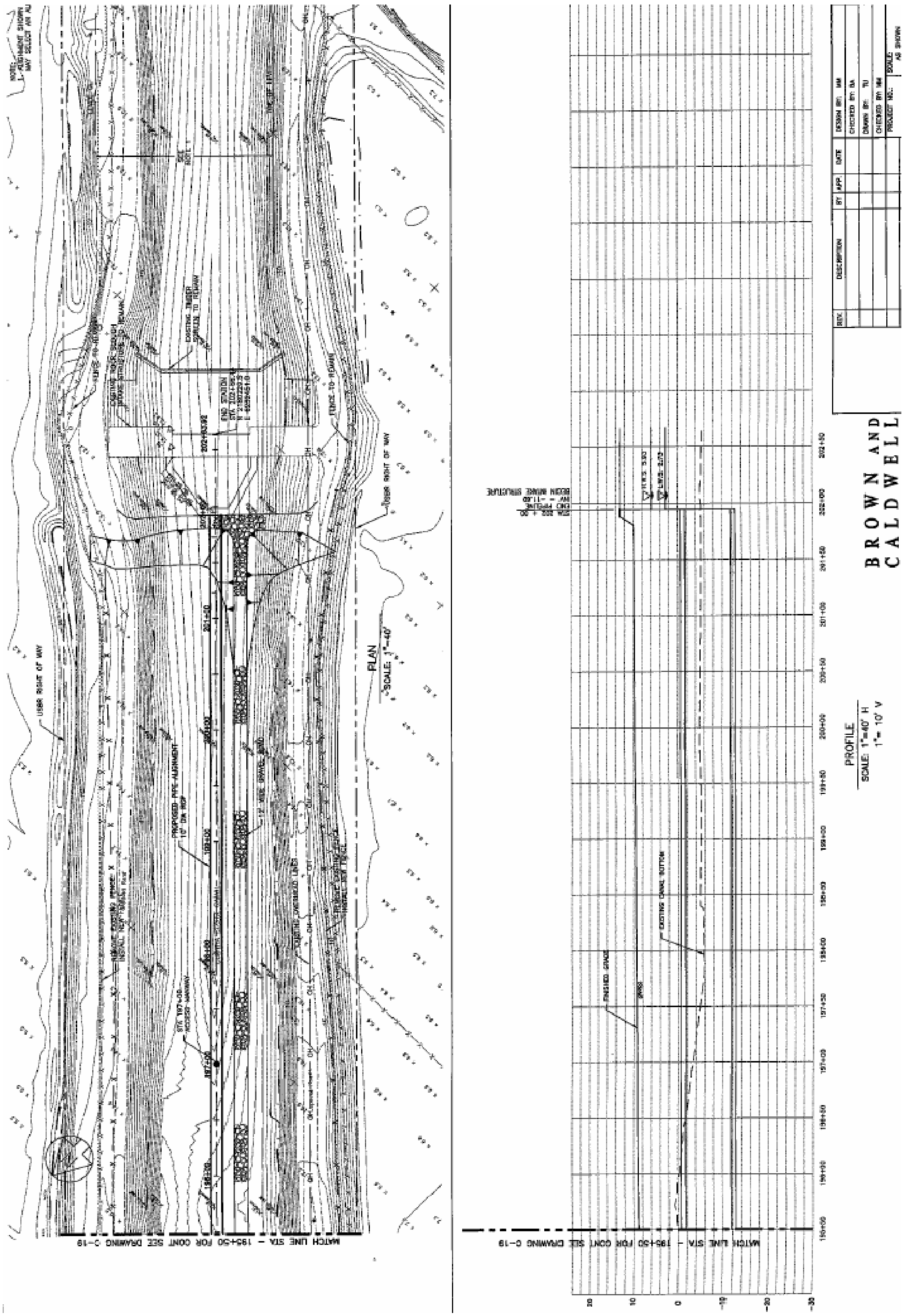

Figure 6-3. Plan 3 – Proposed Profile for the Contra Costa Canal Encasement Project

Levee Improvements

The existing levee and levee road (Bacon Island Road) on Bacon Island would be reinforced and reconfigured to serve as the engineered soil platform for the proposed intake/pump station facilities, and to allow installation of the new intake structure. Conceptually, these levee modifications could be similar to those described for Victoria Island levees under Plan 1 (Figure 4-7). As part of these modifications, a new setback levee would be constructed that would be used to reroute Bacon Island Road, which currently runs on top of the existing levee on Bacon Island. A ramp would be provided to allow access to the pump station and ancillary buildings. Slope protection (i.e., riprap) would be installed on the water side of the new levee on each side of the intake structure for 400 to 500 feet. The footprint of the area required for the new intake and associated levee improvements would be approximately 6 to 10 acres. The overall site layout would be similar to that of Victoria Canal intake, under Plan 1 (refer to Figure 4-2).

Electric Power Usage

Power usage for Plan 3 is calculated in terms of net additional energy consumption for pumping compared to that of the No-Action Plan. Changes in operation under Plan 3, compared to the No-Action Plan, would include introducing the new pump station at the Middle River, which would pump water to the entrance of Contra Costa Canal. Changes in operation would also include some reduction of pumping from the Old River intake, and consequently in the Los Vaqueros Reservoir transfer facility. Plan 3 would not result in changes to operations of Mallard Slough intake. Figure 6-4 summarizes the net changes in energy use for CCWD major pumping facilities.

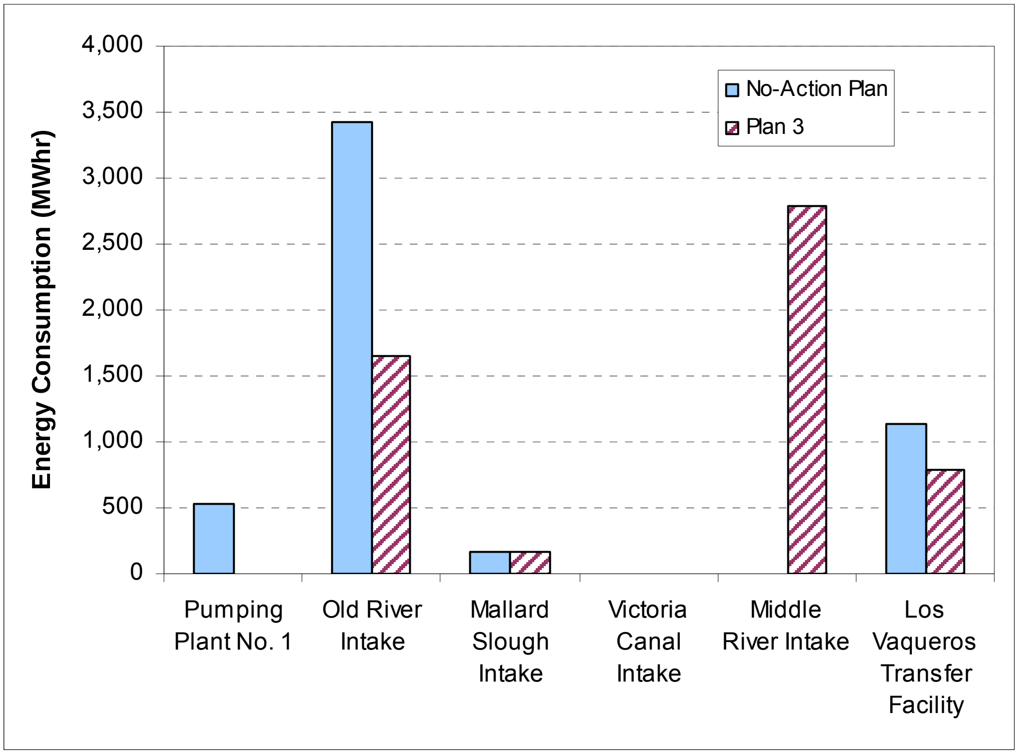

Figure 6-4. Pumping Energy Consumption for Plan 3 Compared to the No-Action Plan

Cost Estimates

Cost estimates developed for Plan 3 components are at the appraisal level (per Reclamation guidance) and are primarily used to compare alternative plans. They are not intended to be at the feasibility level required to request project authorization or appropriations for construction. The cost estimate was developed for the northern pipeline alignment, which would be the shortest and more direct alignment. Table 6-2 documents appraisal-level cost estimates for Plan 3. Table 6-3 shows the annualized total project costs under Plan 3, which also include O&M and replacement costs over the 40-year life of the project. The cost estimates for Plan 3 are developed in a manner consistent with the appraisal-level cost estimates developed for Plan 1 (Victoria Canal intake) to facilitate comparison between the two alternative plans.

Table 6-2. Appraisal-Level Cost Estimate for Plan 3

Cost Component	Size		Quantity		Unit Cost		Cost	Comments
Screened Intake and Pump Station								
Intake, Pump Station	340	cfs	1		$14,835,000	$/cfs	$14,835,000	MWH estimate – cost curve
Electrical Substation	69	kVA	1		$1,558,400	$	$1,558,400	Carollo Tech Memo No. 1[1]
Metering Station			1		$204,000	$	$204,000	Carollo Tech Memo No. 1[1]
Isolation Valve Box			1		$422,000	$	$422,000	Carollo Tech Memo No. 1[1]
						Subtotal	**$17,020,000**	
Levee Improvements			1		$6,901,000		**$6,901,000**	Carollo Tech Memo No. 1[1]
Power Supply - Transmission Lines			26,400	LF	$75	$/LF	**$1,980,000**	Carollo Tech Memo No. 1[1]
Raw Water Conveyance	78	inch	30,000	LF	$1,547	$/LF	**$46,420,000**	Carollo Tech Memo[1] Scaled up for the larger diam.
Tie-ins to Existing Conveyance			1		$200,000	$	**$200,000**	Carollo Tech Memo No. 1[1]
Wide Channel Crossing - Microtunneling	90	inch	2,000	LF	$13,545	$/LF	**$27,100,000**	Carollo Tech Memo[1] Scaled up for the larger diam.
Total Field Cost (base construction cost)							**$99,621,000**	
Unlisted Items			1		15%		$14,943,150	Reclamation guide for appraisal cost estimate
						Subtotal	**$114,564,150**	
Construction Contingency			1		25%		**$28,641,038**	Reclamation guide for appraisal cost estimate
Total First Cost (total construction cost)							**$143,210,000**	
Indirect Costs - Engineering, Admin, Legal			1		25%		$35,802,500	Reclamation guide for appraisal cost estimate
						Subtotal	**$179,012,500**	
Interest During Construction (IDC)			1		7.5%		**$13,430,000**	Federal interest rate 4 ⅞, 3 years construction
Land Acquisition - Easement	1		-	acres	-	$/acre		
Land Acquisition - in Fee	1		10	acres	$250,000	$/acre	**$2,500,000**	
Total Implementation Cost							**$194,950,000**	

Notes:
[1] CCWD AIP Technical Memorandum No. 1 Pre-design Cost Estimate Draft, Carollo Engineers, August 2006

Key:
cfs = cubic feet per second
kVA = kilovolt-ampere
LF = lineal feet
MWH = MWH Americas, Inc.

Table 6-3. Appraisal-Level Annualized Cost Estimate for Plan 3

Cost Component	Size		Unit Cost		Cost	Comments
Equivalent Annual Implementation Cost over 40 Years					$11,170,000	Table 6-2, Federal interest rate 4 ⅞ %
Annual O&M of Conveyance Pipeline	1		0.5%	of First Cost	$528,425	Reclamation guide for O&M costs
Annual O&M of Intake and Pump Station	1		1.0%	of First Cost	$244,663	Reclamation guide for O&M costs
Annual O&M of Desalination Plant	1		1.0%	of First Cost	$-	Reclamation guide for O&M costs
Annual O&M of Power Supply Facilities	1		0.8%	of First Cost	$22,770	Reclamation guide for O&M costs
				Subtotal	$800,000	
Power Cost for Pumping (net additional use)	135,559	kWh	$0.10	$per kWh	$13,556	
Power Cost for Desalination					$-	
				Subtotal	$20,000	
Total Annual O&M Cost					$820,000	
Replacement Cost for Desalination Plant	1		35%	of First Cost	$-	
Annualized Replacement Cost					$-	Assumes 40-year life cycle for major components
Equivalent Annual Project Cost over 40 Years					**$11,990,000**	

Key:
kWh = kilowatts-hour
O&M -= operations and maintenance

Chapter 7
Summary of Findings

This chapter summarized the findings of this document. Major physical features of the alternative plans are summarized in Table 7-1.

Table 7-1. Physical Features Summary for the Alternative Plans

Physical Features	Description		
	Plan 1	**Plan 2**	**Plan 3**
Screened Intake [1]	1,250 ft² effective screen area	350 ft² effective screen area	1,700 ft² effective screen area
Raw Water Pump Station	250 cfs, 316 feet total head	72 cfs, 188 feet total head	340 cfs, 354 feet total head
Power Supply	20,000 feet of transmission lines	-	26,400 feet of transmission lines
Levee Improvements [2]	1,200 feet of levees	-	1,200 feet of levees
Raw Water Conveyance [3]	14,000 feet, 66-inch-diameter	40,000 feet, 42-inch diameter	30,000 feet, 78-inch-diameter
Wide Channel Crossings [4]	1,100 feet, 78-inch-diameter	-	2,000 feet, 90-inch-diameter
Desalination Facilities [5]	-	70 mgd RO filtering facility	-
Desalination Concentrate Discharge Pump Station	-	12 mgd (18 cfs), 100 feet total head	-
Desalination Concentrate Discharge Pipeline	-	15,000 feet, 24-inch-diameter	-
Desalination Concentrate Discharge Offshore Outfall	-	2,000 feet, 24-inch-diameter	-
Land	6 to 8 acres	None required	8 to 10 acres

Notes:
[1] Flat panel rectangular wedge-wire fish screen, including a cleaning mechanism (similar to the Old River intake's fish screen design). Effective screen area is based on diversion capacity and desirable approach velocity of 0.2 feet per second.
[2] Levee improvements include relocating and reinforcing existing levees.
[3] Material for conveyance pipeline would be either reinforced concrete cylinder pipe or welded steel pipe. Pipeline construction method would be conventional open trench.
[4] Channel crossings would be achieved using microtunneling.
[5] Pretreatment and posttreatment and solids handling for the desalination plant would be provided through existing facilities at the Bollman WTP.

Key:
- = Not Applicable
cfs = cubic feet per second
ft² = square feet
mgd = millions gallon per day
RO = reverse osmosis
WTP = water treatment plant

Summary of Plan Cost

Design and costs for alternative plans are based primarily on the predesign cost estimate developed for Plan 1 (CCWD, 2006b) and appraisal-level cost estimates developed for the Los Vaqueros Reservoir Expansion Investigation (Reclamation, 2006). Unit costs were updated to 2006 prices using the Engineering News Record construction cost index (CCI) for the San Francisco Region. Per Reclamation guidance for appraisal-level cost, the total construction cost includes 15 percent for unlisted items and an additional 25 percent contingency. To obtain an estimate of total implementation cost, 25 percent was added to the total field cost to account for engineering design, construction inspection, administrative, and legal costs.

Interest during construction (IDC), which accounts for costs incurred during the construction period, is computed using the Federal discount rate of 4 ⅞ percent from the construction start date to the beginning of the period of analysis, and assuming a construction duration of 3 years. IDC is applied to total field cost (including unlisted items and contingencies, but excluding engineering design, inspection, administrative, and legal costs). IDC was calculated based on 2006 construction dollars.

Project costs for the three alternatives evaluated in this report are summarized in Table 7-2. Feasibility-level or better cost estimates for Plan 1 developed by CCWD are summarized in Table 7-3.

Table 7-2. Summary of Alternative Plans Appraisal-Level Costs

Component	Cost Estimate ($millions)[1]		
	Plan 1	**Plan 2**	**Plan 3**
Screened Intake and Pump Station	$12.76	$9.46	$17.02
Levee Improvements	$6.90	$-	$6.90
Power Supply (transmission lines)	$1.50	$-	$1.98
Raw Water Conveyance	$14.60	$26.00	$46.62
Wide Channel Crossing (microtunneling)	$11.92	$-	$27.10
Desalination Facilities	$-	$205.00	$-
Concentrate Discharge Pump Station	$-	$3.30	$-
Concentrate Discharge Pipeline	$-	$5.40	$-
Concentrate Discharge Outfall	$-	$1.20	$-
Total Field Cost (base construction cost)	**$47.68**	**$250.36**	**$99.62**
Unlisted Items @ 15%	$7.15	$37.55	$14.94
Subtotal	$54.83	$287.92	$114.56
Construction Contingency @ 25%	$13.71	$71.98	$28.64
Total First Cost (total construction cost)	**$68.54**	**$359.90**	**$143.21**
Indirect Costs @ 25 %[2]	$17.13	$89.97	$35.80
Subtotal	$85.67	$449.87	$179.01
Interest During Construction (IDC)[3]	$6.43	$33.75	$13.43
Land Acquisition[4]	$2.00	$-	$2.50
Total Implementation Cost	**$94.11**	**$483.63**	**$194.95**
	Annual Cost ($millions/year)		
Annualized Implementation Cost over 40 Years	**$5.40**	**$33.17**	**$11.17**
Annual O&M[5]	$0.39	$3.31	$0.80
Annual Net Additional Energy Cost[6]	$0.01	$5.81	$0.02
Annualized Replacement Cost[7]	$-	$11.78	$-
Annualized Project Cost over 40 Years	**$5.80**	**$54.07**	**$11.99**

Notes:

[1] Appraisal-level cost estimates are in 2006 dollars, and are based on predesign cost estimates developed by CCWD for Plan 1 (Victoria Canal intake). Costs do not specifically include environmental mitigation.

[2] Indirect costs include engineering, administrative, and legal fees.

[3] Interest during construction is based on an assumed construction period of 3 years.

[4] Land acquisition costs do not include long-term or temporary construction easements.

[5] Annual O&M factors are 0.5 percent for pipelines, 1.0 percent for intake facilities and pump station, 1.0 percent for desalination plant, and 0.8 percent for power supply facilities.

[6] Net additional energy costs are the incremental energy costs above the project costs for the No-Action Plan (i.e., future without-project condition).

[7] Annualized replacement costs are calculated for components with assumed life cycles of less than 40 years. Only the reverse osmosis desalination treatment components have a life cycle of less than 40 years (7-year life cycle is assumed in this analysis).

Key:
- = Not Applicable
CCWD = Contra Costa Water District
O&M = operation and maintenance

Table 7-3. Feasibility-Level or Better Cost Estimate for the Most Likely Preferred Plan

Component	Cost ($millions)[1]
Total Field Cost (base construction cost)[2]	**$47.68**
Construction Contingency @20%	$9.54
Total Construction Cost	**$57.22**
General Conditions @10%[3]	$5.72
Subtotal	*$62.94*
General Contractor Overhead and Profit @10%	$6.29
Subtotal	*$69.23*
Escalation to Midpoint of Construction[4]	$10.87
Subtotal	*$80.10*
Engineering, Legal, and Administrative[5]	$18.80
Sales Tax (8.25% on 50% of Project Construction Cost)	$2.36
Land Acquisition – Fee Title for 8 acres	$2.00
Total Implementation Cost	**$103.26**
	Annual Cost ($millions/year)
Equivalent Annual Implementation Cost over 40 Years	**$5.91**
Annual O&M[6]	$0.39
Annual Additional Energy Cost[7]	$0.01
Annualized Replacement Cost[8]	$-
Equivalent Annual Project Cost over 40 Years	**$6.31**

Notes:

[1] Feasibility-level or better cost estimates are in 2006 dollars.

[2] Costs are from the predesign cost estimates developed by CCWD for the AIP.

[3] General conditions include mobilization/demobilization, bonds and insurance, and other project startup and temporary facilities.

[4] Projected escalation of construction material based on recent historical trends. It assumes an 8 percent annual escalation in costs calculated to midconstruction period.

[5] Reflects actual planning costs, contracted design work, and project construction management expenses. Estimates also include CCWD labor and administrative cost.

[6] Annual O&M factors are 0.5 percent for pipelines, 1.0 percent for intake facilities and pumping station, 1.0 percent for desalination plant, and 0.8 percent for power supply facilities.

[7] Net additional energy costs are the incremental energy costs above the project costs for the No-Action Plan (i.e., future without-project condition).

[8] Annualized replacement costs are calculated for components with assumed life cycles of less than 40 years. Only the reverse osmosis desalination treatment components have a life cycle of less than 40 years (7-year life cycle is assumed in this analysis).

Chapter 8 References

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