RECLAMATION
Managing Water in the West

Hydraulic Laboratory Technical Memorandum PAP-1034

Concept Level Design of Additional Fish Holding Tanks

Tracy Fish Collection Facility

U.S. Department of the Interior
Bureau of Reclamation
Technical Service Center
Hydraulic Investigations and Laboratory Services Group
Denver, Colorado

May 2011

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Concept Level Design of Additional Fish Holding Tanks

Tracy Fish Collection Facility

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5/20/2011

Peer Review: Joshua D. Mortensen — Date
Hydraulic Engineer, Hydraulic Investigations and Laboratory Services Group, 86-68460

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Background

Recently, Tracy Fish Collection Facility (TFCF) personnel requested that the Bureau of Reclamation's (BOR) Technical Service Center (TSC) develop a preliminary design for additional fish holding tanks to be used in conjunction with the existing facility. The request originated from Action IV.4.1 of the Biological Opinion (BO) and Conference Opinion (CO) issued by the National Marine Fisheries Service (NMFS) in 2009. The objective of Action IV.4.1 is to "implement specific measures to reduce pre-screen loss and improve screening efficiency at Federal facilities." To achieve this objective NMFS required that TFCF undertake a series of actions to reduce pre-screen loss and improve screening efficiency which includes action 1b:

> *"By March 31, 2011, Reclamation shall complete studies for the re-design of the secondary channel to enhance the efficiency of screening, fish survival, and reduction of predation within the secondary channel structure and report study findings to NMFS. NMFS shall review study findings and if changes are deemed feasible, Reclamation shall initiate the implementation of the study findings by January 31, 2012."*

The design of additional holding tanks is intended to contribute to the above action by improving salvage efficiencies after fish pass from the secondary channel into the holding tanks. Currently, the existing holding tanks are able to hold approximately 150,000 fish per tank. However, the existing facility design only allows active fish collection from one tank at a time. When tanks are not actively collecting fish, but are used for short term storage of fish, water quality is diminished due to the lack of fresh water.

During a three year study from 2000 to 2003 a detailed count was conducted which indicated that the TFCF salvages an average 18,000 fish per day. This value is easily salvaged within the capabilities of the current facility. Unfortunately fish do not equally distribute themselves as they enter the facility. At times fish can swarm the facility in mass, preventing continuous salvage operations and forcing facility shut downs. Table 1 contains a summary of several times salvage operations have been compromised due to large volumes of fish. When these large volumes of fish enter the facility the fish lift bucket weight limitations are exceeded, partial salvage from the holding tanks is impossible and the incoming fish exceed those leaving in the salvage trucks.

Table 1 - Dates large quantities of fish have entered the TFCF

Date:	Species:	Approximate Daily Count
6/7/2006	Sacramento Splittail	1,000,000
6/20/2006	Common Carp	11,000,000
10/11/2008	Threadfin Shad	4,000,000

In addition to times when the current facility is overwhelmed by mass numbers of fish, several facility renovations are expected to increase the everyday salvage numbers. Some of these renovations include:

- Trash rack cleaner (Completed)
- Traveling screens will replace the louvers in the secondary channel (2013)
- Traveling screens will replace the louvers in the primary channel (future)
- Wemco-Hidrostal pump installation and new secondary (future)

All these completed and upcoming renovations have the potential to increase the numbers of fish that enter the holding tanks. To ensure that salvage efficiency remains high for these renovations, additional holding tanks are required. The remainder of this report summarizes the concept level design of additional holding tanks at the Tracy Fish Collection Facility.

Design Criteria

Preliminary design criteria were provided to the TSC from TFCF personnel to ensure that additional holding tanks meet the needs of the facility. Preliminary design criteria provided include:

- Tank Requirement:
    - Capacity: 4 million fish
    - Size: fit into existing infrastructure and available space
    - Finish: smooth and white (to visualize fish)
    - Density: 20 fish per gallon (5.28/liter)
- Fish Characteristics:
    - Size: 10 g each
    - Species: Threadfin Shad, American Shad, Splittail, Common Carp
    - Oxygen Use: 300 mgO_2/kg per hour
- Oxygen Requirements:

- Maintain ≥ 7 ppm dissolved oxygen effluent (DO_{out})
- If dissolved oxygen influent (DO_{in}) is ≤ 7 ppm maintain DO_{out} = DO_{in}
- Supplemental oxygen required when DO_{out} is below 7 ppm

- Fish Removal:
  - Maintain flow during drawdown to minimize damage to aquatic species

Oxygen Calculations

In order to evaluate the dissolved oxygen (DO) concentrations in the tank several assumptions were made. First, it was assumed that when fish enter the tank they will be equally distributed throughout the tank. This assumption is inaccurate considering that many types of fish will congregate or school together, however the assumption is appropriate for determining the total oxygen used throughout a holding tank. Second, it was assumed that the fish consume a constant amount of oxygen throughout the day (300 mg O_2/kg per hour). Since these tanks are being designed for short-term fish holding, no feeding will take place which simplifies the oxygen consumption rate of fish. Setting the oxygen consumption to a constant value allows the level of dissolved oxygen in the tank's effluent to be solved using Equation 1.

$$DO_{out} = DO_{in} - \frac{r_{DO,fish}}{Q} \quad (1)$$

where:

- DO_{out} = the amount of dissolved oxygen leaving the tank (ppm)
- DO_{in} = the amount of dissolved oxygen entering the tank (ppm)
- Q = the flow rate of water entering the tank (L/hr)
- $r_{\mathrm{DO,fish}}$ = the hourly consumption of oxygen used by the fish (mg DO per hour)

$r_{\mathrm{DO,fish}}$ can be calculated Using Equation 2:

$$r_{DO,fish} = V_{tank} \times r_{fish} \times a_{DO} \quad (2)$$

where:

- V_{tank} = the volume of the tank in liters (L),
- r_{fish} = the density of the fish in the tank measured in kg fish per liter (kgfish/L)
- a_{DO} = the average oxygen consumption rate of the fish in mg O_2 used per kg of fish per hour (mgO_2/kg fish per hour).

When the levels of DO_{out} require additional oxygen, the amount of supplemental oxygen needed (DO_{add}) can be calculated with Equation 3.

$$DO_{add} = DO_{req} - DO_{out} \tag{3}$$

where:

- DO_{req} = the amount of dissolved oxygen required at the outlet (ppm).

Simply converting DO_{add} from ppm to L/hr and compensating for diffuser efficiency with Equation 4 allows the supplemental aeration needed in L/hr to be designed.

$$DO_{L/hr} = \frac{DO_{add} \times Q}{\rho_{DO} \times e_{dif}} \tag{4}$$

where:

- $DO_{L/hr}$ = the supplemental oxygen needed (L/hr)
- ρ_{DO} = the density of 90% pure oxygen (assume 1330 mg/L @ 20°C)
- e_{dif} = the efficiency of the oxygen diffuser

Using the above formulas the size and oxygen use for the additional holding tank were determined. As the tank increased in size, the amount of flow required to maintain DO above 7 ppm also increased, which made sizing the tank to meet all requirements difficult.

Additional Holding Tank – Concept Level Design

A compromise between available space, size, inflow and velocity was used to determine the proposed raceway type design for the additional holding tank at the TFCF. Several other designs were considered but were not carried into concept designs because they did not meet basic design requirements.

Tank dimensions:

Figure 1 provides an isometric view of the proposed raceway type holding tank. The tank is 100-ft long, 10-ft wide and 6-ft deep (Figure 6 in Appendix B). An operating water depth of 5-ft leaves 1-ft of freeboard on all sides. Two 10-ft by 6-ft traveling fish screens at the downstream end of the additional holding tank will allow flow to exit from either side into 15-ft long, 5-ft wide and 6-ft deep channels with overshot gates to control the water depth. A 20-ft wide, 5-ft long and 7.5-ft deep collection basin downstream of overshot gates will guide the water through a 36-in discharge pipe back into the Delta Mendota canal adjacent to the existing secondary velocity control (VC) pump discharge.

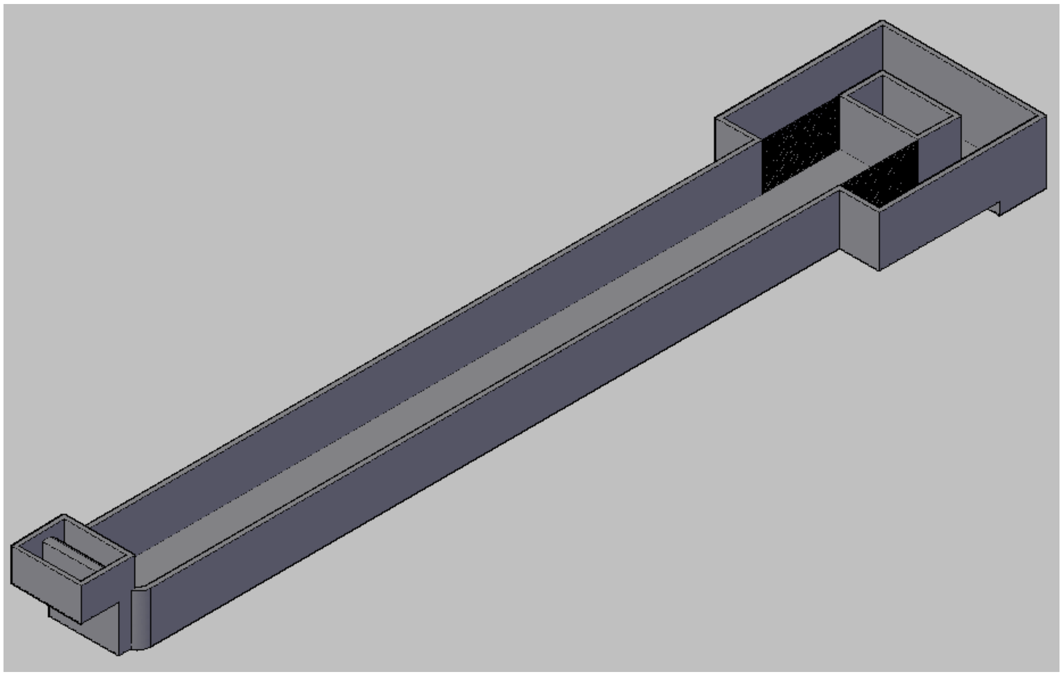


Figure 1 - Isometric view of the additional holding tank at TFCF

Tank flow:

The 5,000 ft^3 tank will be supplied with a maximum of 30 ft^3/sec of water from 2 sources, a 10 ft^3/sec fish influent line and a 20 ft^3/sec supplemental fresh water supply. Channel depths will be maintained such that 0.60 ft/sec will not be exceeded when fish are present.

Fish Influent –
The 10 ft^3/sec fish influent line will connect to the 20-in influent pipe supplying fish and water to the existing holding tanks. A 16-in Wemco-Hidrostal fish pump (Figure 7 and Figure 8 Section C-C in Appendix B), will allow tank operation even when water levels in the secondary are at a minimum. Fish influent will pass from the secondary bypass through the pump and enter the bottom of the holding tank at an angle of 45 degrees to horizontal by means of a 16-in smooth walled pipe. A fixed flapper gate will be installed at the end of the influent discharge to prevent fish from swimming back down the pipe when no influent is supplied.

Fresh Water –
The 20 ft^3/sec supplemental fresh water supply will be pumped from the secondary VC pump discharge collection basin to the upstream end of the new holding tank (Figure 7 and Figure 8 in Appendix B). Fresh water will pass

through a downflow contactor which is intended to aerate the fresh water to 90 percent DO saturation.

Outflow –

Flow will exit either side of the downstream end of the tank through 10-ft by 6-ft traveling fish screens. The screens have been sized to meet NMFS approach velocity guidelines for delta smelt with a normal operating approach velocity of 0.2 ft/sec. The screens will separate the main tank from two 15-ft long, 5-ft wide and 6-ft deep secondary channels with overshot gates at the downstream end. The overshot gates will be automated to maintain a set water surface elevation in the tank. Downstream of the overshot gates a 36-in diameter pipe will be used to convey the effluent back to the Delta Mendota Canal adjacent to the existing VC pump discharge (Figure 7 in Appendix B).

Tank location:

Figure 2 provides a site overview of the proposed location for the additional holding tank over an image of the TFCF grounds. The additional holding tank will be located where the old biology trailer and adjacent storage building are currently located (Figure 7 in Appendix B). These buildings will be torn down and the top of the tank will be set at the existing ground surface elevation of 14 feet. The location of piping in Figure 7 (Appendix B) is subject to change corresponding to existing utilities and other piping.

Figure 2 - Location for the proposed additional holding tank at TFCF

Holding Density:

Design guidelines suggest that the additional holding tank be able to hold 4 million fish for up to 2 weeks time and/or use the available space. Space limitations prevailed, which prevent this large quantity of fish from being accommodated within the proposed tank. However, as designed the 5,000 ft^3 holding tank will be able to hold 750,000 fish assuming 10 gram fish at 20 fish per gallon. If, at a later time, more space becomes available for use, multiple additional tanks of the same design can be added to accommodate larger numbers of fish.

Oxygen Addition:

Using the previously defined Equations 1-4 and assuming the maximum recommended holding density (750,000, 10 gram fish) with oxygen consumption rate of 300 mgO_2 per kg of fish per hour, approximately 2.2 million mgO_2 will be consumed by the fish each hour. Historically it has been recorded that DO levels entering the facility have dropped below 5.0 ppm during the hot summer months. Using 5.0 ppm as a worst case influent scenario and 20 ft^3/sec flow through the holding tank, the following options to maintain 7 ppm effluent were considered:

Option 1 – Pure Oxygen Addition

Increasing dissolved oxygen by means of injecting pure oxygen through micro-pore airstones will require 336 standard ft^3/hr (158 L/m) of oxygen. Commercially available airstone specifications vary, but approximately 14 square feet of contact area will be required to diffuse the necessary oxygen assuming 50 percent diffusion efficiency. That means 72 6-in diameter air stones will be required to supply oxygen to the tank. Supply of the oxygen will be transferred from a pressure swing adsorption (PSA) or similar oxygen generation unit to the air stones with compressed air. 336 standard ft^3/hr PSA units are available commercially and range from $36,000-$80,000 intial cost with additional annual maintenance fees.

Option 2 – Downflow Contactor

Another option for adding oxygen to the additional holding tank is to use a downflow contactor. Instead of using pure oxygen injection, DO is increased by a natural method. Clean supply water that is pumped into the holding tank will enter a head box and pass over a broad crested weir forming an impinging jet which will enter a sized column of water where bubbles will transfer oxygen to the surrounding water. Water leaving the contactor will enter the upstream end of the tank with oxygen saturation levels approaching 90 percent. Figure 3 provides an isometric view of the downflow contactor. Flow is from top left to bottom right.

To ensure that a downflow contactor would adequately raise DO levels, researchers constructed a 1 ft sectional model (Figure 4) at the TSC's Hydraulic

Laboratory in Denver, CO. The model includes a head box, weir, adjustable column separator and a discharge pool. The column separator was adjustable so that the proper column volume could be sized to allow sufficiently high oxygen transfer. Flows were passed into the head box where oxygen levels were measured, passed through the column (contactor) and into the discharge pool (holding tank) where oxygen levels were measured again. Although high inflow DO levels were present during the testing, the column width was sized to increase DO from 6.94 to 7.34 ppm which was from 94 to 99% saturation. Oxygen measurements were taken with a YSI 85 water quality probe. Considering that tests were conducted in Denver CO which is approximately 5200 feet higher in elevation than the TFCF, it is recommended that further testing be performed at the TFCF to ensure proper operation and adequate DO increase.

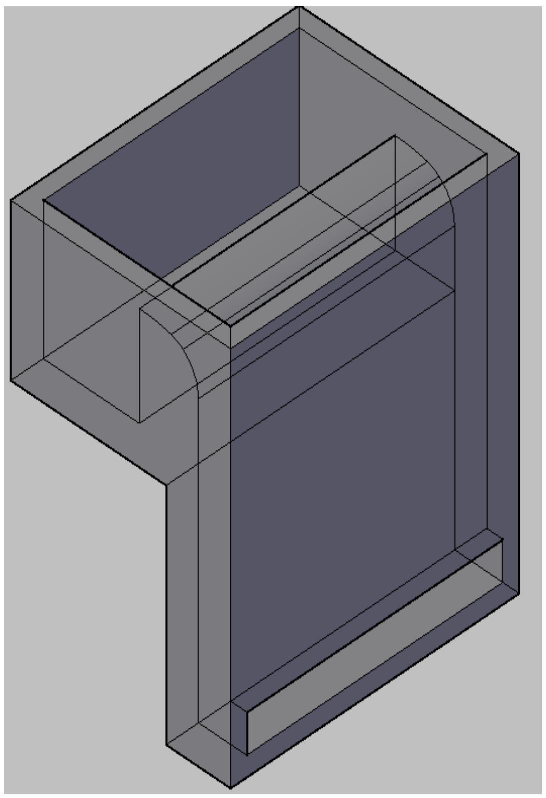


Figure 3 - Isometric view of downflow contactor

Figure 4 - Laboratory testing of downflow contactor

Fish Removal:

A crowder will be used to concentrate fish towards the downstream end of the holding tank. During the crowding, constant flow through the system will be maintained to minimize stress on the fish. Once crowded, a Transvac style vacuum pump (Figure 5) will be used to remove fish from the tank directly into the fish haul truck. To ensure that the vacuum would not injure fish during removal the TSC performed laboratory tests to determine survival efficiencies. During tests a Transvac pump was used to transfer fish approximately 15 feet higher than their original holding. 96 hour survival was measured at 99% and 97% for rainbow trout and threadfin shad.

Figure 5 - Transvac vacuum pump

Debris:

As debris is a constant concern at the TFCF, several features will prevent excessive debris buildup in the additional holding tank. It is planned that in 2013 traveling screens will replace the secondary louvers. It is anticipated that this renovation will remove a large portion of debris before it enters either the existing or the new additional holding tank. As an extra measure of protection, the traveling screens at the additional holding tank exit will prevent excess debris from accumulating.

Predator Removal:

As currently designed, no predator removal is planned in the additional holding tanks. However, if predators become an issue, an active separator could be easily incorporated into the design to remove large predators.

Costs:

Appraisal level cost estimates were performed by TSC cost estimators in July of 2010. Since those cost estimates were performed, more detailed information became available regarding the costs of the traveling screens which increased to $60,000 each. In addition, costs associated with excavating around existing infrastructure and utility lines were not taken into account. For these reasons the total cost estimate presented in Appendix A should be increased to approximately $2.5M. As cost estimates are only at the appraisal level, design changes, increased unit costs, or change in infrastructure could significantly change the cost of this project.

Conclusion:

As part of meeting the NMFS Biological Opinion, TFCF personnel requested that the TSC develop concept level designs to improve screening efficiency and fish survival while reducing predation in the secondary channel. As projects develop that will meet these requirements it is expected that more fish will be collected in the existing holding tanks. The current capacity of the existing holding tanks is limited, which prevent salvage when fish enter the facility in large quantities. As fish entering the holding tanks increase it will be necessary to provide a means that will allow safe and efficient salvage of fish. As a result it is recommended that an addition holding tank be constructed at the TFCF. As proposed, the new tank will be a flow through type holding tank similar to a fish hatchery raceway. The tank will be 10-ft wide, 6-ft deep and 100-ft long. This will allow approximately 750,000 fish to be safely held for short periods of time in the tank to facilitate distributed salvage. Water will enter from 2 sources, a fish influent line and a fresh water supply. It is recommended that oxygen levels in the tank be increased by using a downflow contactor instead of air stones. Some of the benefits of the proposed holding tank include:

- Hold fish 2 weeks or longer if feeders are added
- Can operate in conjunction or independent of:
  - Existing operations
  - New pumped secondary (Study of Fish Pump System)
- 5 feet water depth with 20 ft^3/sec of continuous oxygenated water
  - Increased water quality improves salvage efficiency
  - Possible visualization of fish in holding tank
- Can incorporate an active separator to reduce predation
- Fish will be crowded and removed with a Transvac type pump
- Can salvage a portion of the fish at a time

APPENDIX A
COST ESTIMATE WORKSHEETS

FEATURE: TRACY FISH FACILITY - DESIGN ACCT NO. 4 86-68460, Hydraulic Investigations and Laboratory Services Group Tracy Fish Collection Facility New Short Term Holding Tank	**PROJECT:** Central Valley Project - California
	WOID: TRRN4 — **ESTIMATE LEVEL:** Appraisal
	REGION: MP — **UNIT PRICE LEVEL:** Jul - 10
	FILE: U:\0001 ESTIMATES\Tracy Fish Fac - Fish Pump System\Estimate\[Tracy FF-Short Term Storage Tank_Appraisal_Aug 2010.xls]Tank - Sht 3 of 3 - Summary

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		General Sitework					
	1	*Clearing of 2 buildings is required*		1	LS	$17,500.00	$17,500.00
		Diversion and Dewatering					
	2	*Groundwater is at or 2' above excavation*		1	LS	$150,000.00	$150,000.00
		Excavation					
		Assume common material stockpiled for reuse and backfill					
		Assume rock material stockpiled for reuse and backfill					
		Stockpiles will be located within 1/2 mile of site					
	3	Excavation for Short Term Holding Tank	86-68460	1,250	yd3	$30.00	$37,500.00
	4	Excavation for Hidrostal pump vault	86-68460	300	yd3	$30.00	$9,000.00
	5	Common Excavation for piping	86-68460	1,000	yd3	$50.00	$50,000.00
		Note: Items 3 and 4 Unit Prices includes placing and compacting backfill for structures (approximately 33% of excavated quantity assumed)					
		Note: Item 5 Unit Price includes placing and compacting backfill for pipe trench.					
		Concrete Work					
		Furnish, form and place reinforced concrete					
		Assume 8" thick walls					
		Assume 9" thick floors					
		Assume water stops at all joints					
	6	Tank walls and floors	86-86460	100	yd3	$1,250.00	$125,000.00
	7	Pump vault walls and floors	86-86460	25	yd3	$1,250.00	$31,250.00
	8	Pump pad	86-86460	1	yd3	$1,250.00	$1,250.00
	9	16" Hole drilled through 12" concrete wall	86-86460	2	ea	$500.00	$1,000.00
	10	Furnish and install waterstop	86-86460	800	lin ft	$20.00	$16,000.00
		SUBTOTAL THIS SHEET	1				**$438,500.00**

QUANTITIES		PRICES	
BY Bryan Heiner	**CHECKED** Josh Mortensen	**BY** T. Hanke	**CHECKED**
DATE PREPARED 08/17/10	**PEER REVIEW / DATE** Josh Mortensen / 08/17/10	**DATE PREPARED** 09/10/10	**PEER REVIEW / DATE** DCO 9/10/10

FEATURE:	PROJECT:			
TRACY FISH FACILITY - DESIGN ACCT NO. 4 86-68460, Hydraulic Investigations and Laboratory Services Group	Central Valley Project - California			
Tracy Fish Collection Facility	WOID: TRRN4	ESTIMATE LEVEL:	Appraisal	
	REGION: MP	UNIT PRICE LEVEL:	Jul - 10	
New Short Term Holding Tank	FILE: U:\0001 ESTIMATES\Tracy Fish Fac - Fish Pump System\Estimate\[Tracy FF-Short Term Storage Tank_Appraisal_Aug 2010.xls]Tank - Sht 3 of 3 - Summary			

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		Piping					
		Assume welded joint connections					
		Assume welded steel with lining					
	11	36" dia, pipe thickness = 0.25"	86-68460	400	lin ft	$300.00	$120,000.00
	12	36" dia, 90 degree short radius elbow = 0.25"	86-68460	1	ea	$2,500.00	$2,500.00
	13	16" dia, pipe thickness = 0.25"	86-68460	300	lin ft	$150.00	$45,000.00
	14	16" dia gate valve with auto control	86-68460	3	ea	$20,000.00	$60,000.00
	15	16" dia 90 degree long radius elbow	86-68460	6	ea	$800.00	$4,800.00
	16	16" dia 45 degree long radius elbow	86-68460	1	ea	$400.00	$400.00
	17	20" X 16" pipe reducer, thickness 0.25"	86-68460	1	ea	$1,750.00	$1,750.00
		Miscellaneous					
	18	10' X 6' automated fish crowder	86-68460	1	ea	$90,000.00	$90,000.00
	19	10' X 6' fish screens	86-68460	2	ea	$22,000.00	$44,000.00
	20	5' X 6' automated overshot weir/gate	86-68460	2	ea	$80,000.00	$160,000.00
	21	Install Government-furnished Wemco-Hidrostal pump	86-68460	1	ea	$30,000.00	$30,000.00
	22	Furnish and install sump pump for fish pump vault					
		Allocation for sump pump	86-68460	1	LS	$4,000.00	$4,000.00
	23	Furnish and install fresh water pump (20 cfs)					
		Allocation for fresh water pump	86-68460	1	LS	$185,000.00	$185,000.00
	24	Electrical Work					
		Assume necessary electric access already on site					
		Allocation for electrical work	86-68460	1	LS	$100,000.00	$100,000.00
		SUBTOTAL THIS SHEET	2				**$847,450.00**

QUANTITIES		PRICES	
BY Bryan Heiner	**CHECKED** Josh Mortensen	**BY** T. Hanke	**CHECKED** D. K
DATE PREPARED 08/17/10	**PEER REVIEW / DATE** Josh Mortensen / 08/17/10	**DATE PREPARED** 09/10/10	**PEER REVIEW / DATE** DCD 9/10/10

FEATURE:	PROJECT:			
TRACY FISH FACILITY - DESIGN ACCT NO. 4 86-68460, Hydraulic Investigations and Laboratory Services Group Tracy Fish Collection Facility New Short Term Holding Tank	Central Valley Project - California			
	WOID:	TRRN4	ESTIMATE LEVEL:	Appraisal
	REGION:	MP	UNIT PRICE LEVEL:	Jul - 10
	FILE:	U:\0001 ESTIMATES\Tracy Fish Fac - Fish Pump System\Estimate\[Tracy FF-Short Term Storage Tank_Appraisal_Aug 2010.xls]Tank - Sht 3 of 3 - Summary		

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
	Summary -						
		Subtotal Sheet 1					$438,500.00
		Subtotal Sheet 2					$847,450.00
		Subtotal 1					$1,285,950.00
		Mobilization	5%	+/-			$64,000.00
		Subtotal 2 = Subtotal 1 + Mobilization					$1,349,950.00
		Design Contingencies	15%	+/-			$200,050.00
		Subtotal 3 = Subtotal 2 + Design Contingencies					$1,550,000.00
		Allowance for Procurement Strategies (APS)	0.0%	+/-			$0.00
		Type of solicitation assumed is: Full and open sealed bic competition					
		Subtotal 4 = Subtotal 3 + APS					$1,550,000.00
		CONTRACT COST					$1,550,000.00
		Construction Contingencies	25%	+/-			$400,000.00
		FIELD COST					$1,950,000.00

Ref.: For appropriate use and terminology, see Reclamation Manual, Directives and Standards FAC; 09-01, 09-02 and 09-03.

QUANTITIES		PRICES	
BY Bryan Heiner	CHECKED Josh Mortensen	BY T. Hanke	CHECKED DKL
DATE PREPARED 08/17/10	PEER REVIEW / DATE Josh Mortensen / 08/17/10	DATE PREPARED 09/10/10	PEER REVIEW / DATE DCD 9/10/10

BUREAU OF RECLAMATION **ESTIMATE WORKSHEET** SHEET _1_ OF _1_

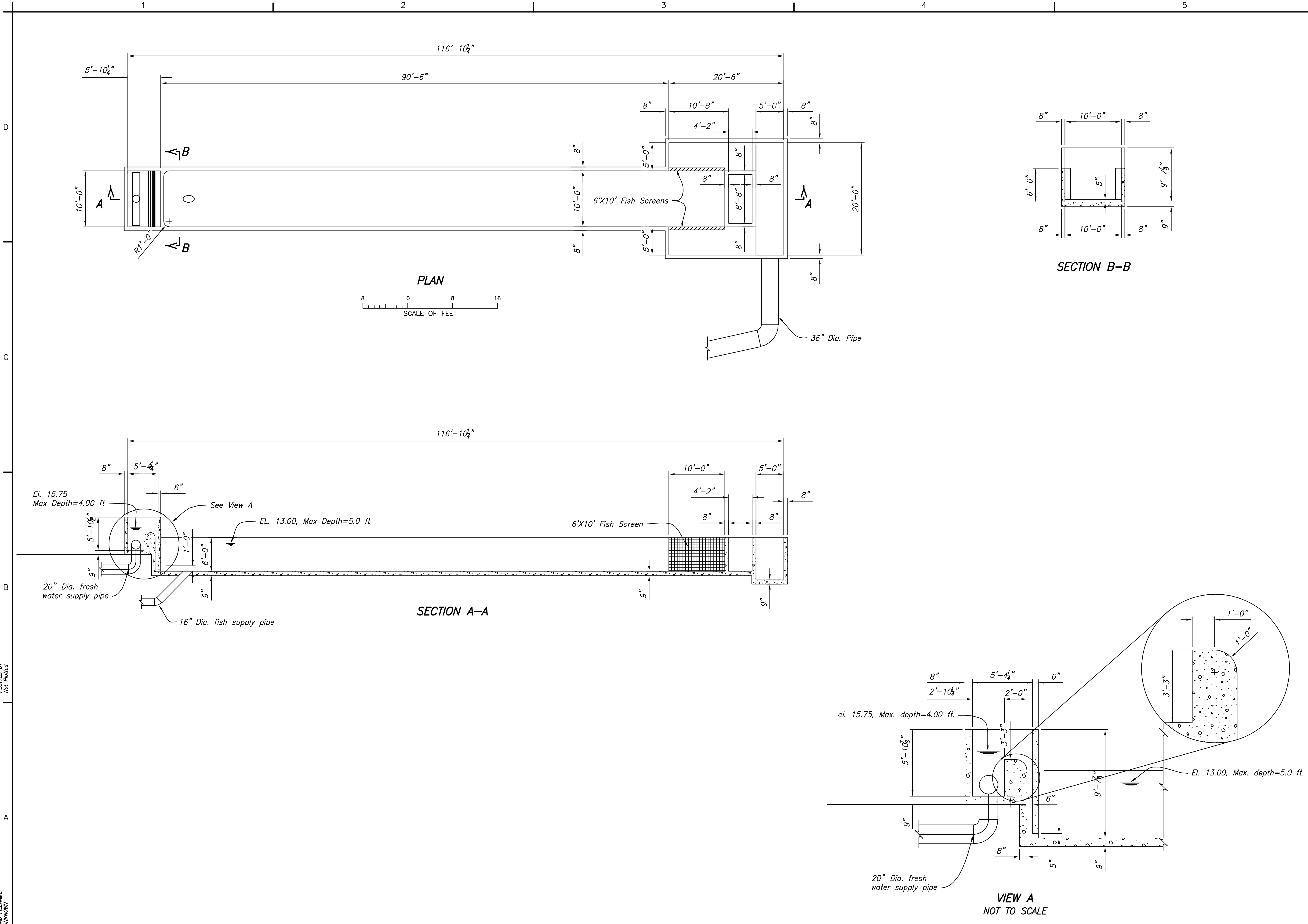
FEATURE: Holding Tank Pump - Pumping Unit Equipment (20 cfs Total Flow)	**PROJECT:** Tracy Fish Collection Facility New Holding Tank Pumping Unit
	WOID: TRRNR **ESTIMATE LEVEL:** Feasibility
	REGION: MP **UNIT PRICE LEVEL:**
	FILE: C:\Documents and Settings\bheiner\Local Settings\Temporary Internet Files\Content.Outlook\3NB7LLJE\[Tracy FF-Short Term Storage Tank_Appraisal_Aug 2010 - TO B HEINER ON 04 19 11.xls]Tank - Sht 3 of 3 - Summary

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		FURNISH AND INSTALL THE FOLLOWING:					
		PUMP	86-68420	3,500	lbs		
	1	1- Cascade Pump Model 20 MF vertical turbine					
		mixed-flow pump, single stage, 880 rpm,					
		Rated 9,000 gpm (20 cfs) pump @ 23' TDH,					
		product lube line shaft, 15' long - 20" dia.					
		column pipe assembly & discharge head,					
		(3,500 lbs)					
		- cast iron bowl w/ bronze impellers					
		- stainless steel shafts (bottom, line, top)					
		- fabricated-steel, below-deck discharge head					
		- pump vibration limits at Hydraulic Institute Stds					
		- non-witnessed certified pump shop test					
		- pump shop testing with job motor					
		MOTOR	86-68420	2,400	lbs		
	2	1- Vertical, TEFC, 50-degree C motor, 75 hp,					
		900 rpm, solid shaft, Premium Efficiency,					
		480V/3Ph/60Hz					
		(2,400 lbs)					
		SUBTOTAL THIS SHEET					

QUANTITIES		PRICES	
BY R. Zelenka	CHECKED	BY	CHECKED
DATE PREPARED 08/12/10	PEER REVIEW / DATE	DATE PREPARED	PEER REVIEW / DATE

No costs were completed for this worksheet due to a delay in receiving the information; line item 23 on page 2 of the previous worksheet is a lump sum estimate for this sheet.

APPENDIX B
DESIGN DRAWINGS



RECLAMATION
Managing Water in the West

ALWAYS THINK SAFETY

U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

CENTRAL VALLEY PROJECT – CALIFORNIA
DELTA DIVERSION – DELTA-MENDOTA INTAKE CANAL

FISH COLLECTING FACILITIES
HOLDING TANKS

NEW ADDITIONAL HOLDING TANKS
PLAN, SECTIONS & DIMENSIONS

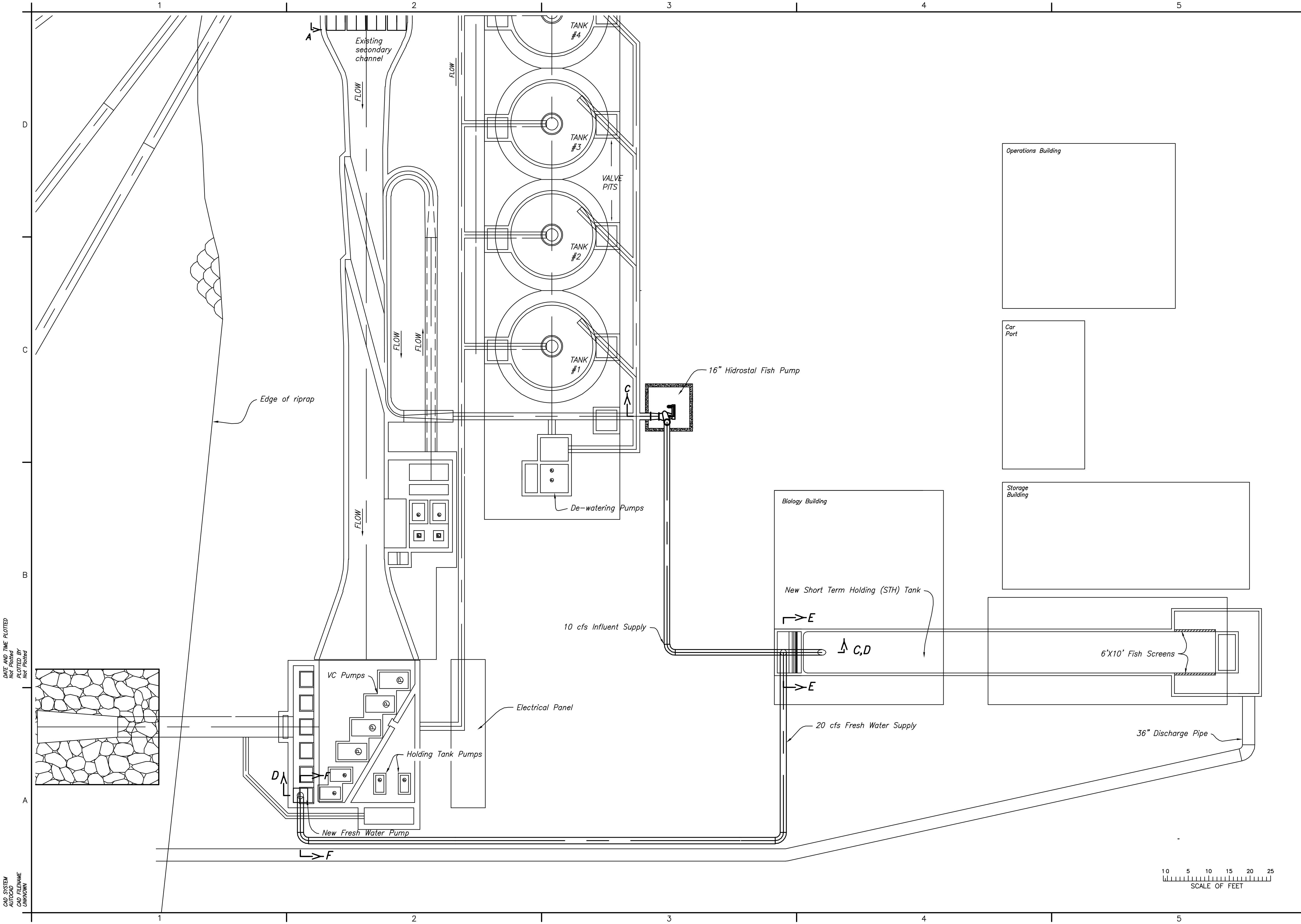
DESIGNED Bryan J. Heiner
DRAWN Bryan J. Heiner
CHECKED
TECH. APPR. NAME – TITLE
APPROVED PEER REVIEWER – NAME – TITLE
DENVER, COLORADO

Figure 6

SHEET 1 OF 1

DATE AND TIME PLOTTED Not Plotted
PLOTTED BY Not Plotted

CAD SYSTEM AUTOCAD
CAD FILENAME UNKNOWN



RECLAMATION
Managing Water in the West

ALWAYS THINK SAFETY

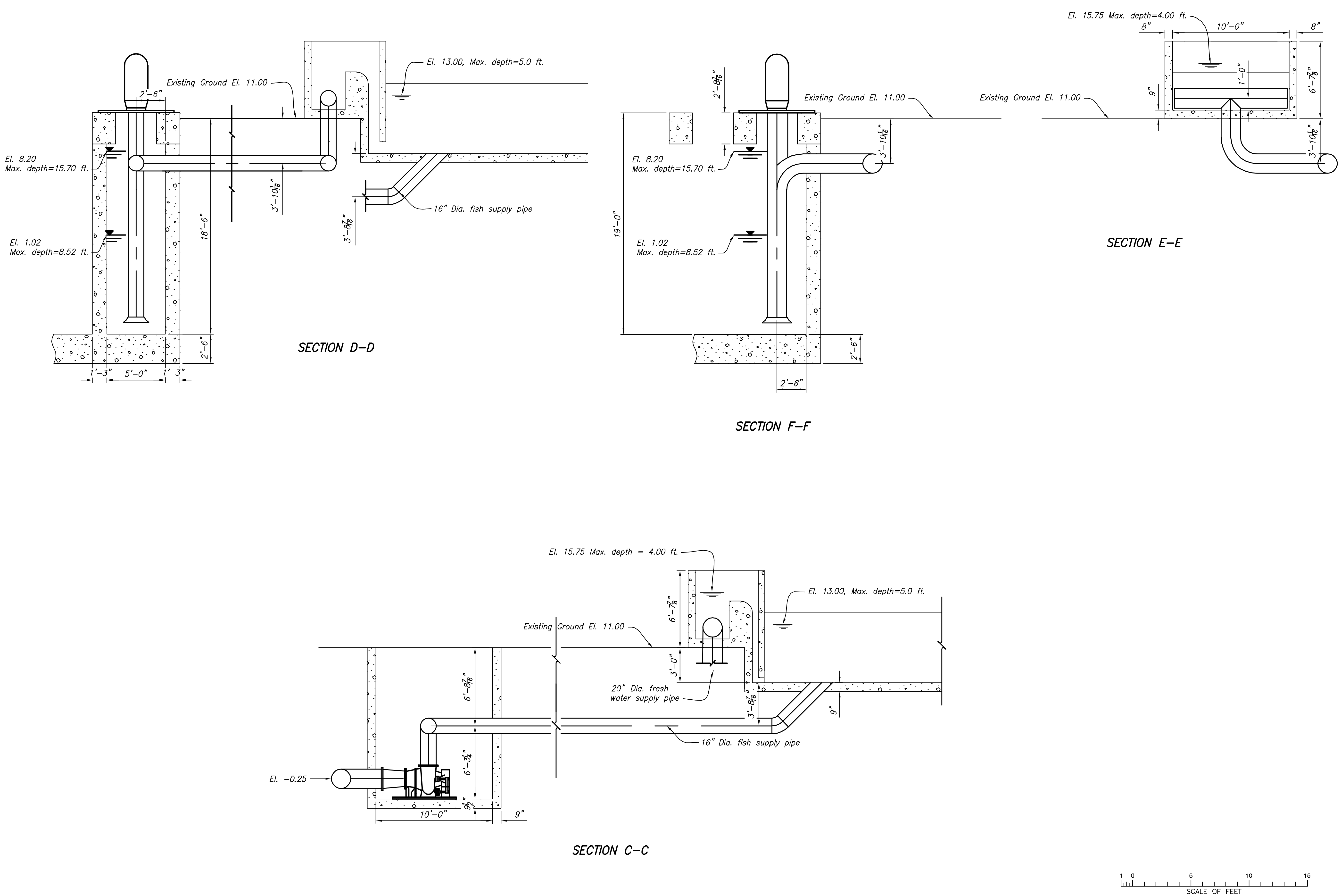
U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
CENTRAL VALLEY PROJECT – CALIFORNIA
DELTA DIVERSION – DELTA-MENDOTA INTAKE CANAL

FISH COLLECTING FACILITIES
HOLDING TANKS
NEW ADDITIONAL HOLDING TANKS
GENERAL PLAN – LAYOUT

DESIGNED Bryan J. Heiner
DRAWN Bryan J. Heiner
CHECKED
TECH. APPR. NAME – TITLE
APPROVED PEER REVIEWER – NAME – TITLE
DENVER, COLORADO

Figure 7

SHEET 1 OF 2



RECLAMATION
Managing Water in the West

ALWAYS THINK SAFETY

U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
CENTRAL VALLEY PROJECT - CALIFORNIA
DELTA DIVERSION - DELTA-MENDOTA INTAKE CANAL
FISH COLLECTING FACILITIES
HOLDING TANKS
NEW ADDITIONAL HOLDING TANKS
GENERAL PLAN - SECTIONS

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DENVER, COLORADO

Figure 8

SHEET 2 OF 2