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DHCCP DESIGN STANDARDS
Volume 2
Facility-Specific Design Guidelines

Delta Habitat Conservation and Conveyance Program (DHCCP)

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LIMITATIONS

The Department of Water Resources has prepared and issued these Facility Engineering Guides to promote consistency and compatibility between DHCCP projects and inform Design Consultants of DWR preferences on certain issues. These Facility Engineering Guides are not intended to supersede or abrogate the primary responsibility of each individual Design Consultant to produce a design product that complies with the terms of the applicable design agreement and standards of professional care and performance within the State of California. In the event a Design Consultant disagrees with any provision of these Facility Engineering Guides, the Design Consultant should advise the DHCCP Engineering Manager and reach consensus on an appropriate resolution of the disagreement.

Note: The ultimate purpose of these guidelines is stated above. This initial submittal was prepared to gather facility specific design criteria for use in preparation of the EIR/EIS and will be modified continuously throughout the program.

Note: Standard Details and Specifications will be presented as separate volumes in the future.

Tables

BDCP	Bay Delta Conservation Plan
CDFG	California Department of Fish & Game
cfs	cubic feet per second
CLSM	Controlled low strength material
cm/s	Centimeters per second
CVP	Central Valley Project
cy	cubic yard
DHCCP	Delta Habitat Conservation and Conveyance Program
DWR	State of California Department of Water Resources
EPBMs	Earth pressure balance machines
EIR/EIS	Environmental Impact Report / Environmental Impact Statement
FEMA	Federal Emergency Management Agency
FFTT	Fish Facilities Technical Team
FS	Factor of safety
ft	foot, feet
ft/s	feet per second
H	horizontal, height
H&H	Hydrology and hydraulics
H:V	Horizontal to vertical
JOC	Joint Operations Center
MHHW	Mean higher high water
MLLW	Mean lower low water
mm	Millimeter
NOAA	National Oceanic and Atmospheric Administration
O&M	Operation & maintenance
pcf	pounds per cubic foot
psf	pounds per square foot
psi	pounds per square inch
RCCP	Reinforced Concrete Cylinder Pipe
SB	Soil-bentonite
SCADA	Supervisory Control and Data Acquisition
SCB	Soil-cement-bentonite
SWP	State Water Project
TBD	To be determined

TBM	Tunnel boring machine
TDF	Through Delta Facility
TM	Technical Memorandum
USACE	US Army Corps of Engineers
USFWS	United States Fish & Wildlife Service
V	vertical
W	width
WSE	water surface elevation

1.0 INTAKE FACILITIES

In support of the DHCCP conveyance options, this chapter presents design criteria for fish screened intakes associated with diversion of raw water from natural watercourses within the Delta. The purpose of this section is to present the basic criteria for design of intake facilities for use in conceptual design and in the Program's EIR/EIS. The design criteria herein are from the sources cited.

1.1 Fish Protection

Diverting raw water from the Delta has the potential of adversely affecting survival conditions of certain aquatic species, particularly threatened and endangered fish species. Because Delta waters support a number of state and federally listed fisheries, a method of diverting water without negatively affecting fish populations is an essential requirement of the DHCCP. The object of protective intake facilities is to minimize "take", or entrainment and impingement, of at-risk fish species from points of diversion in which these species reside or occupy.

The most common form of preventative technology used to date is termed a positive exclusion barrier, or fish screen. Although alternative methods such as physical guidance and behavioral devices have been studied since the 1960's (i.e. guidance louvers, lights, acoustics, temperature devices, chemicals, electric fields, bubble curtains), they are considered experimental technologies. These alternative approaches have proven unreliable and seldom exhibit efficiencies above sixty percent (Congress, 1995), whereas screens offer much greater efficiencies upwards of ninety percent (Nordlund, 1997).

Under the BDCP a consortium of industry leaders and regulatory agency officials, termed the Fish Facilities Technical Team (FFTT), was assembled to define best available practices and technologies for protecting listed species from entrainment and impingement. An array of various intake configurations and technologies have been evaluated which provide reliable and protective diversion operations.

The criteria presented herein represent the collective opinion and determinations of the FFTT, as well as assimilation of current regulatory agency criteria for fish screening. Recommendations will continue to evolve pending further studies and analyses.

1.2 EIR/EIS Design Criteria

Table 1-1 summarizes the general EIR/EIS design criteria for fish screened intake facilities including:

- Biological Criteria.
- Hydraulic Criteria.
- Mechanical Criteria.
- Structural Criteria.
- Electrical and I&C Criteria.
- Operational Criteria.
- Environmental Issues.

Table 1-1 Fish Screening / Intake Structure Design Criteria

Design Factor	Criteria
Category: Biological	
Target Fish Species and Life Stages	
Delta Smelt	Juvenile/Adult
Longfin Smelt	Juvenile/Adult
Green Sturgeon	Not Specifically Addressed
White Sturgeon	Not Specifically Addressed
Sacramento Splittail	Not Specifically Addressed
Steelhead	Fry/Adult
Spring-run Chinook Salmon	Fry/Adult
Winter-run Chinook Salmon	Fry/Adult
Fall-run and Late Fall-run Chinook Salmon	Fry/Adult
Spatial Distribution	
Delta Smelt	TBD
Longfin Smelt	TBD
Green Sturgeon	TBD
White Sturgeon	TBD
Sacramento Splittail	TBD
Steelhead	TBD
Spring-run Chinook Salmon	TBD
Winter-run Chinook Salmon	TBD
Fall-run and Late Fall-run Chinook Salmon	TBD
Temporal Distribution	
Delta Smelt	TBD
Longfin Smelt	TBD
Green Sturgeon	TBD
White Sturgeon	TBD
Sacramento Splittail	TBD
Steelhead	TBD
Spring-run Chinook Salmon	TBD
Winter-run Chinook Salmon	TBD
Fall-run and Late Fall-run Chinook Salmon	TBD
Predation	Minimize extent of in-channel structures that otherwise encourages aquatic and avian loitering and predation opportunity
Category: Hydraulic	
Maximum Diversion Capacity	
Thru Delta:	
North Delta	4,000 cfs
Clifton Court	15,000 cfs
Isolated West	15,000 cfs
Isolated East	15,000 cfs
Dual Conveyance	5,000 cfs

Number of Diversions	Three to Ten (FFTT, 2008)
Diversion Locations	From Sacramento to Walnut Grove and at North End of Clifton Court Forebay and at the San Joaquin River
Approach Velocity	Delta Smelt: 0.20 fps (USFWS) Salmonids: 0.33 fps (CDFG/NOAA)
Sweeping Velocity	Ambient, run-of-river (FFTT, 2008)
Exposure Time	15 minutes (CDFG, 2000)
Screen Area Contingency	10-percent $A_{surface} = 110\% \times \frac{Q_{max}(cfs)}{0.33(fps)}$ *or* $= 110\% \times \frac{Q_{max}(cfs)}{0.20(fps)}$
Screen Submergence	1-foot at rated flow allowance
Screen Elevation	3-feet minimum above river bottom
Flood Impacts	Produce no water surface profile impacts that encroach within USACE minimum freeboard

Category: Mechanical

Screen Cleaning	Traveling brush capable of one cleaning cycle every five minutes (CDFG, 2000)
Flow Control Baffles	Produce uniform approach velocity distribution across screen bank with less than 10-percent hot spots
Configuration or Type	Flat plate
Screen Type and Material	Slotted, Wedge wire Type 304 stainless steel
Screen Opening Size	1.75 mm or 0.0689 inches
Screen Porosity	40-percent minimum
Anti-Fouling	Isolation, dewatering, removal, and tin/copper or silcon/teflon-based epoxy
Intake Sediment Management	Passive system, intake bay hopper bottoms, 4.0 ft/s conduit transport velocity, isolatable bays (bulkhead inserts), elevated invert
Downstream Sediment Management	Mechanical removal, chain-and-flight rake system or other, 50% grit removal efficiency, removable spoil container
Cathodic Protection	Impressed current or sacrificial anode

Category: Structural

Structure Placement	In-river in straight sections of river 500-feet minimum upstream or downstream of horizontal bend
Intake Separation	One-half mile minimum, one mile preferred
Stability	Overturning SF=1.5 Sliding Resistance SF=1.5 Bearing Capacity SF=2.5

	Uplift/Buoyancy SF=1.5
	Seepage Control/Hydraulic Cut-Off
	Slope Stability – Critical Failure Surface
Foundation Requirements	Combination end-bearing/friction piles; depth, size, and spacing to be determined by structural and geotechnical engineers
Allowable Settlement	TBD
Load Cases	At-rest earth pressure
	Dead
	Live
	Wind
	Thermal
	Debris
	Full hydrostatic
	Surcharge
	Seismic (Critical Structures): Per USACEEM1110-2-6053
	Hydrodynamic
	Screen – 10' hydrostatic
Load Combinations and Factors	Concrete: Per USACE 1110-2-2104 Steel: Per USACE 1110-2-2105
Capacity	Flexure
	Shear
	Deflection
	Crack Control
	Anchorage
	Torsion
Debris Protection	Log boom and deflector assemblies per DWR Equipment Guidelines or pertinent specifications
Navigation	Conform to USACE criteria

<u>Category: Electrical and I&C</u>

Power Supply	Source and loads to be determined
Alarms	Equipment and condition alarms to be determined
Measurement	Flow, stage, differential, water quality

<u>Category: Operational</u>

Diversion Sequencing	TBD
Diversion Correlation to River Flow	TBD
Flow Adjustment	TBD

<u>Category: Environmental</u>

Cofferdams or excavation in-river Sequencing	TBD
Noise and vibration from pile driving	TBD

1.3 References

1. DFG Fish Screen Criteria, 2000

   http://www.dfg.ca.gov/fish/Resources/Projects/Engin/Engin_ScreenCriteria.asp

2. NMFS Fish Screen Criteria, 1997

   http://swr.nmfs.noaa.gov/hcd/fishscrn.pdf

3. NMFS Fish Screen Criteria, 1995

   http://www.ser.org/sernw/pdf/NOAA_fish_screen_guidance.pdf

4. Bureau of Reclamation Water Resources Technical Publication - Fish Protection at Water Diversions - A Guide for Planning and Designing Fish Exclusion Facilities, April 2006

   Note: Fish Screen Chapter: Chapter IV. Positive Barrier Screens

   http://www.usbr.gov/pmts/hydraulics_lab/pubs/manuals/fishprotection/index.html

5. Fish Screening and Fish Passage Analysis of the CALFED Bay-Delta Program, Phase II Delta Conveyance Alternatives, July, 1997
6. Debris Rack: Debris Capture and Fish Passage; March, 2008 (DWR Technical Memorandum)

   http://baydeltaoffice.water.ca.gov/ndelta/fishery/documents/DWR_memo_031008_UCD_TDF_Debris%20rack%20study.pdf

7. A Pilot Study on the Bio-fouling Resistance of 304 and 316 Stainless Steels and Copper Nickel Metal; July 2005 (A DWR Study Report)

   http://baydeltaoffice.water.ca.gov/ndelta/fishery/documents/BiofoulingStudyFinal.pdf

8. Fish Passage Technologies: Protection at Hydropower Facilities, Congress' Office of Technology Assessment; September, 1995
9. NMFS Anadromous Salmonid Passage Facility Design; NOAA, February 2008
10. Designing Fish Screens for Fish Protection at Water Diversions, Bryan Nordlund (NMFS); May, 1997
11. Conceptual Proposal for Screening Water Diversion Facilities along the Sacramento River; DWR, August 2008

2.0 CONVEYANCE PIPELINES

The purpose of this chapter is to present design criteria sufficient for EIR/EIS conceptual design support for the conveyance pipelines between the intake pumping plants and the canal (the "Intake Pipelines"). The design criteria are from the sources cited.

2.1 Pipeline Capacity

An evaluation study of the optimum configuration of number of conduits and conduit size was carried out. Based on the study, the optimum size pipeline would be 16-ft diameter with a design flow capacity of 1,500 cfs per pipeline for the ICF East and West, and for the Dual conveyance facility. Based on the same study, the optimum size pipeline would be 14-ft diameter with a design flow capacity of 1,000 cfs per pipeline for the Through Delta facility.

2.2 EIR/EIS Design Criteria

Table 2-1 summarizes the EIR/EIS design criteria for the intake pipelines, which includes the following categories:

- Hydraulic Design
- Structural Design
- Civil Design
- Environmental Issues

2.3 References

1. "Delta Alternative Conveyance", DWR, December 2007.
2. "Peripheral Canal, Preliminary Design Report", DWR, July 1973.
3. "Delta Risk Management Strategy, Building Block 1.7: Isolated Conveyance Facility", URS.
4. "Aqueduct Design Criteria", DWR, September 1997.
5. Conveyance Engineering Report, Chapter 8.0 Pipeline Conveyance System East, DWR, March 2009
6. Conveyance Engineering Report, Chapter 8.0 Pipeline Conveyance System West, DWR, March 2009
7. Conveyance Engineering Report, Chapter 8.0 Pipeline Conveyance System Dual, DWR, March 2009
8. Conveyance Engineering Report, Chapter 8.0 Pipeline Conveyance System Through, DWR, March 2009

Table 2-1 Intake Pipelines Design Criteria

Design Factor	Criteria
Category: Hydraulic Design	
Shape	Circular
Sediment Deposition	Utilize high flow on intermediate basis to flush sediments
Losses:	
The hydraulic analysis was performed using the general form of Manning's equation for large diameter conduits, where: Q = flow, cfs D = inside diameter of pipe, ft n = Manning's roughness coefficient L = length, ft	$H_f = \frac{4.66L}{D^{\frac{16}{3}}}(Qn)^2$
Wall Friction – Manning's roughness coefficient "n"	n = 0.013
Other Losses	TBD
Transition Structures	
Pumping Plant to Pipeline	Transition structure to achieve a reduction in flow velocity and minimize energy losses
Pipeline to Canal	Transition structure to achieve a reduction of flow velocity from the pipes to the canal in order to avoid erosion of the canal embankment. Isolation of the pipes from the canal is achieved by means of radial gates installed at transition structures.
Intermediate Pumping Plant to Canal (afterbay)	Transition structure to achieve a reduction of flow velocity from the intermediate pumping plant discharge pipes to the canal in order to avoid erosion of the canal embankment. Isolation of the intermediate pumping plants discharge pipes from the canal is achieved by means of radial gates.
Horizontal and Vertical Curves	Long Radius
Pipe Slope	Minimum Slope: 0.001 ft/ft
Velocity	Maximum: 7.5 ft/s Minimum: 1.5 ft/s
Surge Analysis	Analyzed at pumping plant power failure conditions with all pumps operating. Use slow closing isolation devices.
Category: Structural Design	
Geotechnical Considerations	
Expected Trench Conditions	Flood plain deposits consisting of clayey soils with various amounts of sand and silt. Groundwater varies from a few feet to 6-8 ft below ground surface.

	Trench bottom shall be stable material free from soil pumping and soft soils or organic rich soils (peat) with low bearing strength.
Bedding Types	The pipe bedding material may be concrete, slurry, imported granular material, native material or a combination there-of
Backfill Types	For circular steel pipe, granular embedment to pipeline centerline. For circular concrete pipe, embedment up to 1/6 pipe O.D., embedment shall be crushed rock or pea gravel coarse aggregate size number 7 (13 to 4.75) placed in 6 inch layers and compacted to 95% maximum density per ASTM D1557. The remaining backfill material may be concrete, slurry, imported granular material, native material or a combination there-of. Saturated sand and high plastic clays CH, MH and OH will not be allowed for backfill material.
Soil Modulus E’	TBD
Special Supports, Pile-Supported	As-needed; TBD
Geofabrics	TBD
Trench Width (with dewatering)	
Conduit Type I Width (permanent easement)	290 ft
Conduit Type II Width (permanent easement)	360 ft
Pipeline Materials	
Steel Pipe	AWWA C200
Reinforced Concrete Cylinder Pipe (RCCP)	AWWA C300
Circular Cast-in-Place Concrete Pipe	ACI 301 and ACI 350-06
External Loads	
Dead Loads	Prism load Marston load Unit weight of soil - TBD USBR Engineering Monograph No. 6, Stress Analysis of Concrete Pipe
Live Loads	Standard highway loadings (HS-20) or railroad loadings (E-80)
Seismic	TBD
Groundwater Uplift	The pipe shall be designed to resist external pressure and uplift from groundwater. When such conditions exist, various techniques to prevent pipe flotation will be investigated such as anchoring pipelines with concrete ballasts.
Vacuum Pressure	Vacuum pressure shall be as determined by surge analyses or by sudden unintentional draining of pipelines

Internal Pressure	
Design Pressure Range	7 psi to 30 psi
Test Pressure	The sum of design plus surge pressure
Surge Pressure	A surge analysis will be performed during final design
Wall Thickness	The design procedure to determine wall thickness shall consider the following conditions: • Handling and installation • External loads • Internal working pressure • Internal surge pressure • Internal vacuum • External hydrostatic • Horizontal deflection • Longitudinal thrust forces caused by changes in alignment • Longitudinal forces resulting from changes in temperature • Combined stress (hoop and longitudinal) The pipe wall thickness selected shall be the greater of the thicknesses computed for the loading conditions listed above.
Joints	
Steel Pipe	Flanged, lap-welded slip, and butt strap
RCCP	Carnegie
Circular Cast-in-Place Concrete Pipe or Other Cast-in-Place options	Wall to slab joints will be keyed where applicable and water stops will be provided at all construction joints
Deflection Criteria	Beveled Joint Limitations Bends and Fittings Dimensions Pipe layout to accommodate 1. Pulled pipe joints 2. Beveled ends (steel pipe) 3. Mitered ends (steel pipe) 4. Fittings as required to meet curvature and offsets
Specials, Bends and Fittings	
Steel Pipe	Steel fittings shall comply with ANSI/AWWA C208 Flanges shall comply with ANSI/AWWA C207
RCCP	Fittings and specials shall be Steel Pipe (see above)
Circular Cast-in-Place Concrete Pipe and Other Cast-in-Place Options	Custom design as required
Appurtenances and Structures	
Vacuum Relief / Air Release	
Location	At high points and at all transition structures

Type	Large diameter standpipe
Blowoffs / Pipe Drain Stations	
Configuration	Custom design as required
Size	TBD
Locations	Installed at low points in the conveyance pipeline system to facilitate draining for inspection and maintenance
Access Structures / Assemblies	
Size / Configuration	Access provisions will be provided at each transition structure. Additional access will be custom design, TBD
Protective Coatings and Linings - Steel Pipe	
Coating	Hot applied coal tar enamel
Lining	Cement Mortar field applied
Cathodic Protection	
System Type	Impressed current
Insulating Joints	TBD
Pipe Joint Bonding Joints	TBD
Monitoring Stations Joints	TBD
Protective Coatings and Linings – RCCP or Cast-in-Place	
Coating	None
Lining	None
Thrust Restraint	TBD
Category: Civil Design	
Flood Protection	See Flood Protection TM
Utility Coordination	TBD through GIS
Separation Requirements	
Horizontal	TBD
Vertical	TBD
Cover Requirements*	
▾ 16 ft Steel Pipes	16 ft
▾ 16 ft RCCP or Cast-in-Place Pipes	10 ft
▾ 14 ft Steel Pipes	14 ft
▾ 14 ft RCCP or Cast-in-Place Pipes	8 ft
<u>* Cover Requirements are minimum depths of undisturbed soil and do not account for farming practice requirements or wind erosion effects.</u>	
Traffic Control and Temporary Access	
Temporary Crossings and Access	Where allowed by the governing agency, roadway crossing will be constructed by open-cut trench construction methods. Local access to homes and businesses will be

	maintained by detours, or temporary pavement. Where open cut trench construction is not allowed, the roadway crossing will be by trenchless construction.
Maximum Open Trench Length	TBD
Special Crossings	TBD
Safety	Open trench areas will have temporary fencing and barricades to limit public access and prevent entrapment of wildlife / livestock in the trench excavations

Category: Environmental Criteria/Issues

Groundwater Disposal Volume – TBD Quality – TBD Duration – TBD	Dewatering facility terminations will have velocity dissipation facilities such as rock, or grouted riprap to reduce the velocity / energy and minimize erosion. Temporary above grade pipeline will be provided for discharge. If discharge into waterway, rip rap protection of levees may be required. If NPDES discharge requirements require, treatment prior to disposal will provided.
Air Quality	
Nos. of Equipment & Duration - TBD	Diesel powered equipment will be used for excavation
Construction Visual Impact & Dust	Excavated material will initially be sidecast and stockpiled along the pipeline alignment within the construction easement.
Traffic / Offsite Impacts	
No. of Truck Trips - TBD	Surplus excavated material will be stockpiled along the trench for temporary disposal. If not used subsequently for backfilling, excess material will be hauled away for reuse or disposal offsite
Air Quality – Dust	
Dust control measures during construction will conform to all federal, state, and local requirements Duration - TBD	Sediment tracked onto public streets will be removed (such as by street sweeping) to prevent impact on a watercourse and dust generation
Visual Impact After the construction is complete, the alignment will be re-contoured.	Erosion control measure for slopes will include surface roughening, finish grading, followed by seeding. Paved areas disturbed by construction will be re-paved.

3.0 CANALS

The purpose of this chapter is to present design criteria sufficient for EIR/EIS design support for the conveyance option facilities. The design criteria are from the sources cited.

3.1 Canal Capacity

The main conveyance canals may ultimately be designed for the 15,000 cfs, 10,000 cfs and 5,000 cfs capacities identified. Other capacities being evaluated include 8,000 cfs (Through Delta, south end to Clifton Court Forebay) and 4,000 cfs (Through Delta, intake). Criteria presented below are for the 15,000 cfs option. However, assuming all canals are unlined, identical cross-sections will be used as described in Table 3-1.

3.2 EIR/EIS Design Criteria

Table 3-1 summarizes the EIR/EIS design criteria for DHCCP canals and includes the following categories:

- Hydraulic Design
- Analysis Criteria an Considerations
- Canal Embankment Design
- Operational Considerations
- Construction and Environmental Issues.

3.3 References

1. "Delta Alternative Conveyance", DWR, December 2007.
2. "Peripheral Canal, Preliminary Design Report", DWR, July 1973.
3. "Delta Risk Management Strategy, Building Block 1.7: Isolated Conveyance Facility", URS.
4. "Aqueduct Design Criteria", DWR, September 1997.
5. "Technical Memorandum: Flood Elevations and Protection", DHCCPa Team, January 2009.

Table 3-1 Canal Design Criteria

Design Factor	Criteria
Category: Hydraulic Design	
Cross-Sectional Geometry (wetted perimeter)	The cross-sections may be adjusted at bridge crossings (due to piers in the water) to maintain the same cross sectional area, limit bridge length, and prevent erosion.
Shape	Trapezoidal
Side Slope, normally submerged	3H:1V(1) (2) (3)
Side Slope, varying water levels	3H:1V
Bottom Width	
Bottom width (15,000 cfs)	340 ft
Depth	
Depth	23.5 ft (3)
Sediment Deposition	See Pumping Plant Design Criteria for Sediment Removal.
Cross-Sectional Geometry (above wetted perimeter)	
Freeboard	To protect against transient waves from canal operations
Freeboard within canal	3 ft(3)
Side Slope	
Side Slope above maximum WSE	3H:1V (1) Determined by soil type
Friction Factor	
For Unlined Canal (Earth Lining), Manning's "n"	0.025(1) (2) Include 5% contingency for future changes in "n"
Erosion Protection, Manning's "n"	Hydraulic analysis used n= 0.03. This is conservative, assuming some growth
Bed Slope	Approx. 1V:10,000H (1) - may vary
Limiting Velocities	
Upper limit to prevent erosion	2.5 ft/s (1) (2)
Lower limit to prevent sediment deposition	Sedimentation will occur when canal is not delivering water (still-water condition). See Pumping Plant Design Criteria for Sediment Control.
Other Losses	
Bridge Pier	See Bridge Design Criteria
Horizontal Bend - Minimum Radius	2500 feet TBD: May be less, since velocity is low (check headloss).
Other Considerations	Hydraulic Checks at siphons, tunnels and to break up long pools.

Category: Analysis Criteria and Considerations

Seepage	A seepage analysis will be performed. Seepage control may involve a cut off wall, liner or other measure(s).
Drainage	Drainage for the islands will be altered by the canal and levees. Potential remedies include: 1. Drainage channels along the toe of slope of the levees and around the ends of the levees and over the siphons. 2. New drainage pumping facilities. 3. Culverts beneath the canal (Canal may be too deep).
Slope Stability	Slope stability analyses will be performed to confirm slope stability. Conditions could include end-of-construction, long-term operation, and sudden drawdown. Minimum required factors of safety (F.S.) (to be confirmed): 1. End-of construction: F.S. = 1.3 2. Long-term: F.S. = 1.4 – 1.5 3. Rapid drawdown: F.S. = 1.1 – 1.2 4. Design flood: F.S. = 1.3
Seismic Design	Based on probabilistic seismic hazard analysis (PSHA), design earthquake will be 200-year event (to be confirmed). Fault crossings – TBD from maps of active fault zones. Liquefaction potential – TBD from geotechnical investigation. Seismically-induced deformations will be estimated to evaluate canal embankment performance. Selected dynamic response analysis of the embankments will be required to calculate time histories of seismic-induced inertial force acting on the critical sliding masses. For the design earthquake, seismic canal embankment deformations should generally be less than 1 foot (TBD); depends on pattern of deformations. Seismic triggers to close gates to isolate pools - TBD

Category: Canal Embankment Design

Flood Protection: See Flood Protection Design Criteria	Cross drainage allowed: Culverts, Overchutes, Drain Inlets Includes sea level rise.
Cross-sectional geometry:	
Canal Embankment Crest Elevation	Based on 200-year flood event, plus wind -wave runup plus residual freeboard
Canal Embankment Top Width	20 feet and 24 feet for secondary and primary access, respectively.
Side Slope	
Side Slope, outboard sides	3H:1V [(3)] (to be confirmed)

Category: Operational Considerations	
Controlled volume	Water will be held in the canal by check gates.
Controlled flow	Flow may be controlled from pool to pool by the check gates.
Load rejection	Gates (checks) will maintain water depth in canals within +/-1 ft of the target depth (23.5 ft in the 15,000 cfs standard canal). No rejection other than to forebays.
Sediment removal	Sediment removed at intake pumping plants. Within canal, sediment removal is not planned on a regular basis (to be confirmed).
Drawdown	Variability in water surface elevation
(TBD) feet per day (maximum)	More of a factor for lined canals (2 feet per day for California Aqueduct).
Pumps	Pumps may be used to control flow. Placement of pumps will impact embankment height, invert cut, and subsequently costs. For an eastern alignment, pumps have been considered at the upstream end, middle and downstream end. More than one location may be required.
Category: Construction and Environmental Issues	
Seepage	A seepage analysis will be performed
Embankment Foundation Excavation / Treatment	Constructability, cost and other factors will be evaluated whether to remove and replace peat and other unacceptable soils, or to treat such soils in situ.
Evaporation	0.70 x pan evaporation for large canals(4)
Habitat Restoration	Some habitat restoration may be possible in areas made unusable between the canal and existing levees. Possible riparian zone at 8:1 slope (TBD)
Borrow Areas	Borrow areas to provide appropriate soils for canal embankment construction to be located.
Moving Draglines over Sloughs	Draglines will need to be moved over sloughs using temporary bridges or culverts.
Spoils	Disposal of spoils may be made into existing islands, borrow areas or alongside the embankment. The latter will widen the footprint.
Dewatering During Construction	Draglines may be used for canal excavation below the water table without dewatering. If dewatering required for other activities, disposal of groundwater, effect on farmland, and effect on adjacent structures from dewatering induced settlement may have to be determined.

4.0 SIPHONS

The purpose of this chapter is to present design criteria sufficient for EIR/EIS design support for the conveyance option facilities. The design criteria are from the sources cited.

4.1 Siphon Capacity

Siphons may ultimately be designed for capacities ranging up to 15,000 cfs. Criteria presented below are for the 15,000 cfs option.

4.2 EIR/EIS Design Criteria

Table 4-1 summarizes the EIR/EIS design criteria for DHCCP siphons and includes the following categories:

- Hydraulic Design
- Structural Design
- Civil Design
- Operational Considerations
- Environmental Issues
- Construction Issues

4.3 References

1. "Delta Alternative Conveyance", DWR, December 2007.
2. "Peripheral Canal, Preliminary Design Report", DWR, July 1973.
3. "Delta Risk Management Strategy, Building Block 1.7: Isolated Conveyance Facility", URS
4. "Aqueduct Design Criteria", DWR, September 1997.

Table 4-1 Siphon Design Criteria

Design Factor	Criteria
Category: Hydraulic Design	
Cross-Sectional Geometry	
Shape	Rectangular at inlet/outlet; square at middle(1)
Number of Barrels	Four(1)
Inlet/Outlet Dimensions	W x H: 26 ft x24 ft (1)
Barrel Dimensions	W x H: 26 ft x26 ft (1)
Sediment Deposition	Controlled through periodic flushing utilizing reduced number of barrels.
Losses	
Wall Friction	Manning's n=0.013 (full conduit, cast in place segments, conservative)
Transitions	TBD by hydraulic analysis
Bends	TBD by hydraulic analysis
Barrel Slope	TBD; depends on site
Limiting Velocities	8-9 ft/s inside siphon (1)
Category: Structural Design	
Concrete Structures	
Concrete strength	4,000 psi 28-day strength
Earthwork	Criteria TBD
Scour in Drainage Facility	To account for future scouring, an approximate margin of 15 feet will be provided between the siphon top and minimum bed elevation of the slough
Groundwater	TBD
Sediment in water	See pumping plant design criteria
Slope Stability	Slope stability analyses will be performed; criteria TBD
Seismic Design	Fault crossings - TBD Liquefaction potential – TBD Seismic triggers to close gates to isolate pools?
Category: Civil Design	
Flood Protection	See Flood Protection Design Criteria
Inlet/Gate Structure	Four reinforced concrete bays with wing walls, apron, piers, access bridge, stop logs, radial gates, and floating boom(1)
Gates	
Number	Four (1)
Size	33 ft high x 26 ft wide (1)
Outlet Structure	Four reinforced concrete bays with wing

		walls, apron, piers, access bridge, and stop logs[1]
	Cross-Sectional Geometry of Levee	Refer to Canal Criteria
	Safety	Log booms, fencing
Category: Operational Design		
	Controlled volume – gates in water?	Radial gates used to maintain constant upstream water surface elevation
Category: Environmental Criteria / Issues		
	Construction phasing	TBD
	Groundwater control / disposal	TBD
	Spoils disposal	TBD
	Protection of riparian / aquatic habitat	TBD
Category: Construction Issues		
	In-the-wet	TBD
	Cut and cover	TBD
	Redirected Instream flows	TBD

5.0 TUNNELS

The purpose of this chapter is to present design criteria sufficient for preliminary design support for the DHCCP tunnels.

5.1 Tunnel Capacity

Tunnels may ultimately be designed for capacities ranging up to 15,000 cfs. Criteria presented below are for the 15,000 cfs option.

5.2 EIR/EIS Design Criteria

Table 5-1 summarizes the general EIR/EIS design criteria for DHCCP tunnels including:

- Operational
- Geometry
- Anticipated Ground Conditions and Anticipated Ground Behavior
- Seismicity
- Line and Grade Control
- Alignment
- Construction Method for Tunnels
- Tunnel Initial Support
- Tunnel Final Lining (Pipeline Materials)
- Launch and Retrieval of Tunneling Equipment
- Settlement and Heave Tolerances
- Protection of Adjacent Structures and Property
- Work Areas/Equipment Layout Requirements
- Transport/Disposal and Potential Reuse of Excavated Materials
- Ground Improvement
- Operations and Maintenance Requirements
- Tunnel Gas Classification
- Permitting
- Shafts

It is assumed that DHCCP tunnels will flow under pressure and not open channel conditions. In addition, geotechnical investigations are discussed and presented elsewhere and are only referred to herein.

5.3 References

1. Peck, R.B. 1969, Deep Excavations and Tunneling in Soft Ground, Proc 7th Int Conference Soil Mech & Foundation Eng, Mexico City.
2. Terzaghi, K 1950, Geologic Aspects of Soft Ground Tunneling, in “Applied Sedimentology”, P.D. Trask (ed), Wiley, New York.
3. Heuer, R.F., 1974, Important Ground Parameters in Soft Ground Tunneling, Proc Subsurface Exploration for Underground Excavation and Heavy Construction, ASCE.

Table 5-1 Tunnels Design Criteria

Design Factor	Criteria
Category: Operational	
Design Flows Internal pressures **Transient pressures**	All barrels operating? One barrel empty? Allowable head losses? Geometry of elbows, minimum radius
Filling and Emptying	TBD
Sediment trap	TBD
Category: Geometry	
Internal Finished Diameter of Tunnels	The tunnels are assumed to be 27 feet in internal finished diameter. This diameter depends on hydraulic considerations defined elsewhere.
Excavated Diameter of Tunnels	Based on the required inside diameter, the outside excavated diameter will need to be determined after structural analysis and design of the segmental lining. Flexibility should be provided to allow the Contractor to size the excavation.
Number of (Parallel) Tunnels	It is assumed that 3 parallel tunnels will be required. Design should evaluate whether 3 tunnels is the most cost efficient configuration (as opposed to two larger tunnels, or 4 or more smaller tunnels).
Lateral Spacing of Tunnels	Enough space between parallel tunnels will be required so that construction of one tunnel does not overload the parallel adjacent tunnel(s). For planning purposes, a minimum spacing of 2 (external) tunnel diameters should be assumed between parallel tunnels. Analysis will need to be performed to determine the minimum spacing that should be adhered to during design.
Cover Required Over Tunnels	Cover over the tunnels should be evaluated for the shallowest locations of the tunnels. The minimum required depth of cover will need to be determined. There will need to be enough cover to prevent hydrofracture of the ground due to earth pressure balance tunneling.
Depth of Tunnels (Plan and Profile)	Plan and profile will need to be determined for the tunnels. This will be dependent upon the geotechnical conditions. For planning, the deep tunnels are assumed to be approximately between 160 to 200 feet deep. No geotechnical data is currently available at the depth of the tunnels. Conservatively the tunnels are assumed to be horizontal. If ground conditions allow, they will be shallower at the portals (shafts).

Category: Anticipated Ground Conditions and Anticipated Ground Behavior

Sources of Geologic and Geotechnical Data	A literature review of available published reports and references, including maps containing geologic and seismic information by the State of California, will need to be performed.
Geotechnical Investigations	Geotechnical investigations will be conducted along the tunnel alignments. The design criteria for geotechnical investigation are presented elsewhere.
Anticipated Ground Behavior	Ground conditions will need to be evaluated and grouped into reaches along the tunnel where ground conditions are generally similar. Ground behavior will need to be evaluated and discussed in accordance with the General Categories of Ground Behavior for Soft Ground Tunnels, as presented by Terzaghi, 1950 and modified by Heuer, 1974. This classification system is commonly referred to as the "Tunnelmans Ground Classification" and includes the following categories of ground behavior: firm ground, raveling ground, squeezing ground, running ground, flowing ground, and swelling ground. This classification is well recognized by Contractors and is useful in determining means and methods for shaft construction and tunnel excavation.
Groundwater Control	Groundwater control during construction is essential in order to avoid catastrophic flooding of the tunnel. Grouting or ground improvement may be required. Adequate geotechnical and groundwater data are essential for effective use of a tunnel boring machine.

Category: Seismicity

Alquist Priolo Fault Zone	It is not anticipated that the tunnels will be constructed within an Alquist Priolo Fault Zone
Fault Crossing	Any fault crossings or potential fault crossings need to be identified.
Earthquake Magnitude for Design	Ground motions need to be defined and the earthquake magnitude for design of the facilities needs to be determined.

Category: Line and Grade Control

Design criteria are required for line and grade control and correction.	Deviations in line and grade should not affect the hydraulics of the system or cause deformation of the segmental lining that could affect its structural performance. Corrections to line and grade should be made gradually and the maximum allowable correction for returning to the specified line and grade if the

tunnel is off needs to be determined.

Category: Alignment

Surface Consideration

Generally, alignment appears to be in essentially unoccupied terrain or farmland. Essentially the more surface working area available at the top of working shafts, the more economical and efficient the construction operations will be.

Tunnel Considerations

In order to facilitate tunneling activities and economy tunnel alignment should be as straight as possible. Curves, though possible, come at an additional price and risk which should be avoided if possible.

The minimum radius of curvature needs to be evaluated during preliminary design. This is dependent on the segment design and the diameter of the tunnel as well as the TBM itself. Short radius curves that are less than 250 to 500 feet in diameter are typically not constructable. A change in alignment during tunneling is typically only possible at a shaft location.

Category: Construction Method for Tunnels

Earth Pressure Balance Tunneling Machines or Slurry Tunneling Machines

Earth pressure balance machines (EPBMs) are anticipated for construction of the DHCCP tunnels based on the depth and anticipated ground conditions and groundwater elevation.

The chosen construction methods must be capable of excavating through the anticipated soil conditions and counterbalancing the anticipated earth and groundwater pressures.

Slurry tunneling machines can be considered and evaluated for shallower tunnel crossings.

Work Shafts

The construction shafts need to be sized to facilitate expected operations.

The main drive, or excavation, shaft will need area for the following:

- Equipment – cranes, loaders, trucks (shipping), conveyors, materials processing, water treatment facilities, electrical facilities, air compressors
- Offices and shops
- Muck (excavation) storage either temporary and/or permanent
- Lay down storage of ventilation piping, track materials, segments (both short and long term needs), and other materials used on a daily mining basis.
- Utility services, particularly electric power, water, sanitary, telephone
- Other

Shafts for Access, Ventilation, and other usage might range in areas of an acre plus or minus

Retrieval and secondary working shaft will have a lesser need for working area but would be expected to have the room for:

- Equipment – Crane, Forks, Loader, special facilities such as grout plants with materials storage, shotcrete facilities, possible water control and treatment facilities
- Trailers for offices and safety
- Lay down area for temporary usage.

Other shafts would include smaller drilled or hand excavated excavations for providing ventilation and safety access of personnel. These types of shafts may, or may not, become a permanent feature of the finished system. Surface area needed would generally be minimal and be sufficient for the excavating equipment and follow on provisions for providing access and ventilation.

Category: Tunnel Initial Support

The required tunnel initial support is based on the external groundwater loads and internal pressures. Bolted and gasketed pre-cast concrete segments are likely to be the only type of tunnel initial support that is feasible for these tunnels.

Allowable initial support methods for tunneling will be determined and included in the Specifications. Bolted and Gasketed Pre-Cast Concrete Segments are assumed at this point. Bolted and gasketed pre-cast concrete segments are typically made up of 6 pieces that form a ring. These pieces are bolted together at the circumferential and longitudinal joints.

Loads

Based on the geotechnical and groundwater conditions present at the site, loads will be developed for the Contractor to use to design the initial tunnel support. Design of the initial support will be the responsibility of the Contractor and should be based on the loads presented in the Construction contract documents.

Loading Cases

Ground loads

Groundwater loads

Construction

Operation

Seismic

Transient

Deformed lining case

Category: Tunnel Final Lining (Pipeline Materials)

Based on flow, velocity and pressures.

Category: Launch and Retrieval of Tunneling Equipment

The tunnel boring machines will be launched at the main construction work shafts.

Size of the construction shafts and ground stabilization of construction work shafts will be left up to the contractor for determination.

Ground Improvement for ground stabilization will be required outside of the construction work shafts to avoid ground loss and groundwater inflows into the construction work shafts during launch or retrieval of the tunnel boring machines.	Ground improvement will be required in the contract documents. Flexibility should be provided to the contractor in order to facilitate his chosen design of the shaft(s).

Category: Settlement and Heave Tolerances

Approach: The allowable ground movements (settlement/heave) for tunneling operations will need to be determined during design and provided in the Specifications	Estimates of the amount of surface settlement that could occur due to tunneling operations will need to be made during design and an evaluation will need to be performed to evaluate the potential impacts on surface structures and any underground utilities. The settlement pattern that typically develops above a soft ground tunnel is a trough-shaped depression resembling an inverted bell curve with the maximum settlement occurring above the tunnel centerline (Peck, 1969). Facility and property owners typically do not set maximum allowable settlements, but do require that their facilities are not damaged by settlements.

Category: Protection of Adjacent Structures and Property

Approach: A survey of all structures and property along or adjacent to the alignment will need to be performed and any property that needs to be protected will need to be identified.	A program of geotechnical instrumentation and monitoring will need to be developed and included in the plans and specifications in order to help evaluate the settlements induced by the tunneling activities. Maximum allowable settlement thresholds should be determined and included in the contract documents.

Category: Work Areas/Equipment Layout Requirements

Approach: Staging areas are required near work shafts to provide space for construction equipment, material storage, fabrication, materials handling and muck removal and disposal. Support facilities such as office trailers, change houses, and sanitation facilities will also be necessary.	The temporary construction easements will need to accommodate required work areas and equipment layout for the selected tunneling construction methods.

Category: Transport, Disposal and Potential Re-Use of Excavated Materials

Transport of Excavated Materials	Acceptable truck haul routes will need to be evaluated and determined. The number of total truck trips and number of truck trips per day should be estimated during preliminary design. In some cases, it may be necessary to upgrade or repair haul routes if the access roads are not able to withstand the anticipated truck traffic.
Traffic Control Plans	Traffic control plans will be required as part of the construction contract documents.
Disposal Sites	All excavated materials will need to be contained and removed from the construction site. If there is enough layout and construction staging area, some amount of stockpiling and spreading of excavated materials can occur on site. Potential disposal sites will need to be located and evaluated. Disposal sites that can accept the excavated material need to be located and evaluated to determine the volumes that

they could potentially accept.

Potential Reuse of Excavated Materials

The potential for reuse of excavated materials needs to be investigated. The spoils will be wet and plasticized when they emerge from the tunnel and will need to be spread and dried before they could be reused. Potential reuse options could include spreading the material over agricultural fields, levee embankment reinforcement, elevated fills for developments and some for backfill of construction shafts.

Category: Ground Improvement

Protection of Existing Structures

If predicted settlements are anticipated to damage structures or property it may be necessary to use ground improvement to protect these structures or facilities. Various procedures are available, but perhaps jet grouting or chemical grouting might be a preferable choice.

Shaft Support

Shaft excavation can pose extreme risks in alluvial materials, particularly if the materials are saturated. Without having the particular geology available for close review, stabilization might take place by:

- Jet grouting
- Concrete secant pile construction
- Freezing
- Sinking large diameter caissons.
- Other

Tunnel Support

Essentially the contractor will rely on the equipment manufacturer and his geotechnical engineer / geologist to determine the better methods for implementing tunnel support.

Launch and Retrieval of Tunneling Machines

EPBTM launching, any TBM launching, will require excavation of a tail tunnel which would be meticulously mined by hand and small equipment. This operation can be quite involved and costly, but necessary.

Retrieval would not be expected to pose significant concerns.

Category: Operations and Maintenance Requirements

Number of Access Shafts

The number of permanent access shafts and the number of access shafts required for construction will need to be determined.

Typically the number of permanent facility access shafts is determined by the operations and maintenance personnel working for the owner of the facility. The access shafts will facilitate entering the tunnels for emergency inspection and repairs or other operational functions.

The number of construction access shafts will also be a function of ventilation and access requirements during construction. Cal OSHA may have specific requirements for access and ventilation during construction.

Inspection of Tunnels

Dependent on requirements of the owner of the facility.

Maintenance and Operation Dewatering of Tunnels

Dependent on requirements of the owner of the facility.

Category: Tunnel Gas Classification

Approach: For all tunnels constructed in California, it is required to obtain a tunnel gas classification from Cal OSHA.

It is anticipated that Cal OSHA will give these tunnels a classification of gassy or extra hazardous due to the natural gas wells existing along the alignment. We understand that natural gas wells exist in the area and there are old natural gas fields along the alignment. The geotechnical investigation program will need to investigate these wells and determine if it is anticipated that gas will be anticipated in the tunnel excavation during construction. This affects the constructability of the project.

A tunnel gas classification of gassy or extra hazardous will require specialized tunneling equipment that is MSHA approved, gas detection equipment on the tunneling boring machines, automatic shutoff of the equipment if gas is detected, fireproof construction equipment and other special requirements that Cal OSHA will impose to provide safe work conditions during tunneling. Presence of gas or extra-hazardous conditions can adversely impact the construction schedule and cause unanticipated delays.

Category: Permitting

Approach: All permitting requirements need to be determined.

Permits are typically needed when a tunnel crosses beneath highways, railroads, levees or rivers. Permitting agencies can include the US Army Corps of Engineers, California Department of Fish and Game, US Fish and Wildlife and the Regional Water Quality Control Board in addition to the Cal OSHA Mining and Tunneling Unit (for the Tunnel Gas Classification).

Category: Shafts

Developing Loads

Lateral earth pressures, groundwater pressures and surcharge pressures are required for design of shaft excavation support systems.

Bottom Stability

Groundwater Control

Ground Support

Final Lining

Surface Excavation

Shafts Sizing

The geometry and sizing of the shafts will be determined by the contractor to efficiently perform their work.

Selecting Feasible Shaft Construction Methods

Slurry Walls, Caissons, and Secant Pile shafts are all feasible construction methods for shafts. During preliminary design, appropriate shaft construction methods will need to be evaluated. Allowable shaft construction methods should be included in the project specifications.

Groundwater Control Systems

Groundwater control systems will need to be provided to ensure a dry and stable excavation. Bottom stability of the excavation will need to be evaluated.

Launch and Retrieval of Tunneling Machines

The shafts will need to be designed to launch and retrieve the tunneling machines. Ground improvement outside of the shaft will be required to avoid loss of ground and groundwater inflows during launching and retrieval of the machines.

Category: Construction Contract Documents

Plans

Specification

Geotechnical Data Report

Geotechnical Baseline Report

6.0 PUMPING PLANTS

The purpose of this chapter is to present design criteria sufficient for EIR/EIS design support for the conveyance option facilities. The design criteria are from the sources cited.

6.1 Pumping Plants Capacity

Pumping plants may ultimately be designed for the 15,000 cfs, 10,000 cfs, 5,000 cfs and 100 cfs capacities identified. Criteria presented below are for the 15,000 cfs, intermediate pumping plant options.

6.2 EIR/EIS Design Criteria

Table 6-1 summarizes the general EIR/EIS design criteria for DHCCP pumping plants and includes the following categories:

- Site Civil
- Pumping Equipment
- Piping and Valves
- Auxiliary Equipment
- Sedimentation Basins
- Solids Pumping Station
- Electrical
- Controls and Communications
- Structural
- Architectural
- Mechanical
- Security
- Fire Protection
- Cathodic Protection
- Environmental

6.3 References

1. "Technical Memorandum: Flood Elevations and Protection", DHCCPa Team, January 2009.

Table 6-1 Pumping Plant Design Criteria

Design Factor	Criteria
Category: Site Civil Design	
Access Roads	
Regulatory Agency or Code	USACE EM-3-1110-130 thru 132? AASHTO? County Standards for driveway entrance?
Roadway Widths	• Two-way traffic - Minimum 24 feet. • Two-way traffic with parking on one side - 28-feet. • Two-way traffic with parking on two sides - 32 feet. • One-way - 12 feet with provisions for turnaround. • Provide 4-ft minimum shoulder. • Maximum 3% roadway slope. • Provide 1/8- to 1/4-inch per foot of pavement cross slope.

Other Design Considerations:

- Two-way roads will not be dead-ended unless a cul-de-sac is provided.
- One-way roads will include provisions for turn around.
- Backing up of vehicles should be avoided and, where necessary, be minimized to less than 100 feet. Minimum curb turning radius should be 25 feet.
- Buildings will be accessible to fire trucks by roads that have a minimum unobstructed width of 20 feet and that have a vertical clearance of 13.5 feet.
- Roads will extend to within 150 feet of all portions of the exterior walls of the first story.
- Road design criteria and layout will be reviewed with the local Fire Marshal to identify special requirements and configurations that may be dictated by the enforcing Fire Department.
- Directional and traffic signs and markings shall be provided for all one-way roads and to direct traffic to key buildings (like Operations and Administration Building).
- Minimum turning paths shall be in accordance with the table below.
- Hammerhead turning configurations will be avoided.
- Ramps will be provided to sidewalks, similar to typical handicap ramps, to allow electrical carts to use sidewalks.
- All streets will have a minimum vertical clearance of 13.5 feet.
- Surface street design will conform to the local agency requirements and recommendations included in the geotechnical investigations.

TYPICAL CAR AND TRUCK DIMENSIONS[(a) (b)]

	WheelBase (ft)	Front Overhang (ft)	Rear Overhang (ft)	Overall Length (ft)	Overall Width (ft)	Height (ft)
Passenger Car	11	3	5	19	7	--
Single Unit Truck	20	4	6	30	8.5	13.5
Single Unit Bus	25	7	8	40	8.5	13.5

(a) From "A Policy on Design of Urban Highways and Arterial Streets," American Association of State Highway and Transportation Officials.

(b) Minimum path of left front wheel/minimum path of rear wheel.

Parking

- Parking for employees and visitors will be located near the Building.
- Automobile parking stalls will use the minimum criteria indicated in the table below. Parking for the disabled shall be provided in accordance with local requirements.

Regulatory Agency or Code TBD

PARKING STALL DIMENSIONS

Angle (deg)	Width, Stall (ft)	Depth, Stall (ft)	Width, Single Aisle, (ft)	Width, Double Aisle,(ft)
90	10	18	47	65
60	10	16	43	61
45	10	13	37	54

Grading

- Grading will be designed in accordance with applicable standards and recommendations of the geotechnical report. Where conflict exists between the code or ordinance and the geotechnical report, the more stringent requirements shall be adopted. In addition to the above requirements, the following guidelines shall also be incorporated:
- The intake pumping plant operating floor elevation will be based on the flood protection criteria(1).
- The intermediate, emergency turnout, SJRT, and VC pumping plants operating floor elevation will be based on the design embankment flood protection for the highest elevation of the floodplain including island and tidal flooding water surface elevation plus wind-wave runup and 3 feet of freeboard.
- Overall grading for the entire site shall be conservative and allow flexibility to allow future modifications to the site without future designs exceeding minimum design slopes.
- Minimum slopes for drainage in landscaped areas should be 1 percent; minimum cross slopes for paved areas should be 2 percent with catch basins and storm sewers located throughout the paved area; minimum slopes in concrete gutters should be 0.7 percent.
- Grading shall be designed to minimize the need for cross gutters or ribbon gutters (gutters across large paved areas).
- Maximum cross slope in areas between streets and structures should be 4 percent. Maximum ramp grades should be 10 percent, as long as line of sight is not impaired. Maximum road grades shall be 7 percent where heavy truck traffic is expected on a routine basis. Short reaches of 10 to 12 percent grades may be allowed under special circumstances.
- Maximum cut and fill slopes will conform to the recommendations of the geotechnical report. In landscaped areas where grass will need to be mowed, the maximum slope should be 3:1, horizontal to vertical.
- Temporary excavation slopes will conform to recommendations of the geotechnical report.
- Access ramps for the handicapped will be provided where required and shall be in accordance with state and local standards.
- Finished grades at structures, slabs and buildings should be 4 inches below floor or slab elevation, unless vehicular access is required.
- Finished grades around open water retaining structures shall be at least 3.5 feet below the top of the wall; otherwise handrails must be provided on top of the wall for safety.
- Grading design shall incorporate contours. Control points for staking during construction should be located by coordinates, or dimensions from permanent structures. Spot elevations alone, without contours; do not provide adequate information.

Drainage

- The design shall be in accordance with the following guidelines:
- Design criteria and methods for calculating drainage runoff, sizing underground piping, slotted drains, open channels, ditches, and appurtenances will conform to Caltrans Standards.
- To avoid redesign and conflict, the drainage design will be incorporated into the site layout decision process during the initial phases of the design.
- Sheet flow and flow lines shall be directed away from areas of frequent pedestrian traffic (walkways) and yard activities. Culverts will be provided where collected drainage must cross walkways. Drainage will be directed away from structures and buildings and away from the top of cut and fill slopes.
- Where drainage is collected into an underground system, inlet structures shall be designed so that ponding does not occur.
- Curbs as edges on asphalt concrete paved road should be considered to allow run-off from the road to sheet flow into landscaped or grass areas. Concrete curbs and/or headers (redwood, creosote rail, etc.) serve as a mowing strip and help to control the finished grade of the AC pavement. Width of the curb will be 6 inches.
- Drainage in the improved portions of the site will be handled by inlet structures and underground storm drains. All storm drains shall be a minimum of 8-inch diameter. All inlet openings will be a minimum 4 square feet.
- Storm drains will be daylighted to ditches or connected to an off-site drain system. On-site detention basins will be designed so that storm water will not be detained more than a few days.
- The drainage system will be designed for minimal maintenance.
- Drainage runoff shall be calculated in accordance with industry accepted methods.

Pavement

Pavement design will conform to the following criteria:

- The R value for the subgrade soils under the pavement will be determined by the geotechnical report.
- Plant access roads, where routine truck service is required, will be designed with a maximum traffic index of 7.0. Other plant access roads shall be designed with a maximum traffic index of 5.5.
- Design life for the pavement will be 20 years.
- Concrete pavement may be used in lieu of asphalt pavement. Concrete paving will be used in areas where truck parking is anticipated. Concrete pavement will also be used in areas where asphalt paving is incompatible with the materials handling requirements for the area.
- Pedestrian walkways between structures and buildings shall be of concrete with a minimum width of 5 feet and minimum nominal thickness of 6 inches.
- Vertical curves shall be provided at grade breaks to provide a smooth riding surface.
- Profiles for plant roads shall be provided where control of grade is critical and/or vertical curves are required. At a minimum, profiles shall show stations, existing grade, vertical curves, horizontal curves, and final grade.
- Coordinates and/or dimensions shall be provided for grading control points, top or bottom of slope with the rate of slope, and other control points to provide sufficient staking to control the contractor's tolerances for grading.

Regulatory Agency or Code	TBD

Yard Piping

Yard piping is all pipes, vaults and conduit buried outside of buildings.

The following table lists piping abbreviations and recommended materials. All piping will be designed to withstand internal pressure, surge pressure and external loads. Large diameter piping may require special structural design consideration. Corrosion protection will be provided in accordance with recommendations contained in the geotechnical report.

YARD PIPING

System	Service	Size and Material
BLD	Building Drain	Exposed, ¼" to 1-1/2", galvanized steel; >1-1/2", ABS pipe. Buried to 5 ft of structure, ABS pipe
PW	Potable Water	½" to 4", PVC; 6" to -24", ductile; >24", steel
E	Electrical Conduit	Exposed, except corrosive, C1D1; direct contact with earth or concrete, RGS; direct bury, PVC-RGS; concrete encased, PVC.
FPW	Fire Protection Water	All sizes, ductile
IRR	Irrigation	All sizes, PVC
NPW	Non Potable Water	½" to 4", PVC; 6" to 24", ductile; >24", steel
RD	Roof Drain	Galvanized steel pipe
SAN	Sanitary Sewer	ABS pipe or concrete
SD	Storm Drain	Concrete

Water Piping

Water piping (potable and non-potable) will conform to the following general criteria:

- The water system should be designed as a loop to minimize dead ends, increase reliability, and reduce the size of piping. Isolation valves shall be provided at all tee fittings (one on each downstream pipe).
- A 10-foot horizontal separation should be maintained between potable water lines, and sewer or process lines. Where a 10-foot separation cannot be provided, special piping and encasement requirements may apply. Comply with state and local requirements.

Regulatory Agency or Code: TBD

Sanitary Sewers

Sanitary sewer will be provided to receive all non-storm drainage, including wastewater from rest room, floor drains, equipment drains, and sump pump. Sanitary sewer shall be discharged into a public sewer, a holding tank, or a septic tank.

Gravity Lines

The following guidelines will be used:

- Manholes or cleanouts will be provided at each change in grade and direction. Manholes will be used for sanitary lines 8 inches or larger. Manholes will be spaced at a maximum of 400 feet.
- Capacity of gravity sewers will be determined using Manning's Equation. The value of "n" in the Manning formula is assumed to be constant for pipes flowing partly full or completely full. An "n" value of 0.013 should be used as an average

coefficient for all sizes and types of pipe material. This value is slightly conservative and compensates for offset joints, poor alignment, grade settlement, and the effect of slime and grease buildup and sediment deposits in sewers.

- Gravity sewers, 18 inches in diameter and larger, should be designed so that at peak flow the liquid surface does not exceed 3/4 of the pipe diameter. Gravity sewers less than 18 inches in diameter should be designed so that at peak flow the liquid surface does not exceed 2/3 of the pipe diameter.
- To ensure an adequate cleansing velocity, the minimum velocity should be 2.5 feet per second (ft/s) under all flow conditions. Flow will be kept below supercritical velocity. Hydraulic jumps will not be permitted. Maximum velocity will be below 8 ft/s.
- Under normal conditions, the minimum depth of the crown of pipe will be no less than 3 feet.

Regulatory Agency or Code — TBD What is water supply?

Pressure Lines

- The Darcy-Weisbach equation will be used in the design of pressure sewer lines.

  $H=f(L/D)(V^2/2g)$

  f - Friction factor, a dimensionless number, is a function of pipe roughness and the Reynold's number.

  H - Headloss, ft of liquid.

  L - Length of pipe, ft.

  D - Pipe diameter.

  V - velocity, ft/s
- Force main velocity should be in the range of 6 to 8 ft/s at design flow. The velocity at minimum flow will be at least 2.0 ft/s.
- Force mains will be designed so that no point in the vertical alignment is located above the energy grade line. If high points in the alignment of force mains are unavoidable, gas relief and vacuum valves shall be installed.

Storm Sewer

The design of the storm system will be based on the Stormwater Management Plan.

Regulatory Agency or Code — TBD

Valves

The following table lists valve types for yard piping applications. Vaults will be provided for valve operation.

VALVE TYPES

Service	Size	Type
Water (Potable or Nonpotable)	≤2" >2" >12"	Gate Gate or Butterfly Butterfly
Raw Sewage	All	Eccentric Plug, Knife Gate or Ball

Fire Protection

- Fire protection shall conform to the requirements of the National Fire Protection Association, and local Fire Marshal requirements. In addition, the following guidelines will be followed:
- Fire protection shall be provided from the potable water system.
- Where possible, plant fire protection shall be from a piping loop provided around the perimeter of the Pumping Plant. The system shall be able to provide a minimum of 3,000 gallons per minute (gpm) at a residual pressure of 20 pounds per square inch (psi) throughout the system. Actual flow requirements will be confirmed with the Agency. Water tank required?
- Fire hydrants shall meet local government standards. Fire hydrants shall have at least one 2-1/2-inch port.
- Fire hydrant spacing shall be in conformance with the rules and ordinances of local government. As a general rule, a fire hydrant provides 300-foot radius coverage for structures.
- Fire hydrants shall be placed at points with fire truck access. Access to fire hydrants shall be such that when a pumper truck is parked next to a hydrant, the truck does not block access to the remaining portion of the site. Hydrants should be readily visible to fire department personnel.
- Fire hydrants, vulnerable to vehicular damage, shall be provided with crash posts.

Fences

Access to the perimeter of all facilities will be provided to serve as a security buffer and to allow easy visual examination of the pumping plant.

Provide security fence along the property line and access control gates to the PP. Security fencing will be a minimum of 6 feet high. Fencing must be set back from the property line to keep the fence from encroaching on other property.

Pumping Equipment

The following table provides pump selection criteria.

Pump Selection Guide

Pumping Application	Pump Type	Pump Drive	Minimum Passage Size
Process Water	Volute mixed flow pumps with vertical shaft or low/medium head vertical mixed/axial flow column pumps	Constant Speed and/or variable speed	½”

Sump Pump	Vertical submersible centrifugal pumps	Constant Speed	2”

- The number and size of pumps will be selected based on the calculated range of pump operations to provide operational flexibility. The number of pumps provided shall be able to deliver maximum design flow with one largest unit out of service. Smaller pumps may also be provided to provide operational flexibility.
- Provide adequate horizontal and vertical spacing between pumps to allow removal of commonly replaced/serviced items.
- All mechanical equipment, and control cabinets will be mounted on a nominal 4-inch high, reinforced concrete base, restrained to withstand all static, dynamic, hydraulic, wind and seismic loads. Equipment not requiring vibration isolation devices will be bolted to the foundation, anchored and restrained to withstand all static, dynamic, hydraulic, wind and seismic loads.
- Pumping plant suction inlets for volute pumps and vertical column pumps based on Hi Standards for rectangular intake and formed suction intakes.

Regulatory Agency or Code USACE EM-2-3105?

Category: Piping and Valves

Piping

- Steel pipes shall be used for all raw water piping inside and outside the pumping plant.
- Raw water piping inside the building, non-buried, shall have interior lining and exterior coating suitable for the application.
- Buried and/or concrete encased raw water piping shall have interior lining and cement mortar coating.
- Provide dismantling joints near pumps and valves.

Valves

- Hydraulic or electrically actuated butterfly valves shall be used for pump isolation.
- Provide valve pits of adequate clearance for access maintenance of valves and make adequate drainage provisions for vaults.

The following table lists the type of valves to be used on various piping system inside the pumping plant.

VALVE TYPES

Service	Size	Type
Water (Potable or Nonpotable)	≤2"	Gate
	>2"	Gate or Butterfly
	>12"	Butterfly
Sump Pump Discharge	All	Gate
Compressed Air System	All	Ball

Category: Auxiliary Equipment

Trashracks

Provide trash racks and automatic cleaning rakes at entrance to pump suction.

Isolation Stop Logs	Provide stop logs for isolation of pumps.
Compressed Air System	Provide compressed air system for lowering water level below impellers
Sump Pumps	Provide rail mounted submersible pumps for dewatering of all valve pits

Category: Sedimentation Basins

Sedimentation Basin Capacity	Each basin is designed to accept a flow of 500 cfs. At each intake pumping plant location multiple basins are used in series to deliver the pumping plant capacity of either 2,000 cfs or 3,000 cfs.

Design Criteria

Design Factor	Criteria
Category: Hydraulic Design	
Cross-Sectional Geometry	
Shape	Rectangular
Number of Basins	4 Basins, 2,000 cfs pumping plant 6 Basins, 3,000 cfs pumping plant
Basin Dimensions (int.)	L x W x H: 120 ft x 40 ft x 55 ft
Losses	
Wall Friction	TBD by hydraulic analysis
Transitions	TBD by hydraulic analysis
Typical Channel Velocity	0.49 ft/s
Typical retention time (at avg w.l; 500 cfs)	4.2 mins
Category: Civil Design	
Flood Protection	See Flood Elevations and Protection(1)
Gate Structure	Stainless steel rising weir gates, mechanically actuated.
Gates	
Number	2
Size	25 ft high x 11 ft wide
Category: Operational Design	
Controlled depth	Weir gates used for control flow depth Min. water depth 24.5ft Max. water depth 48.5ft
Controlled flow	Pump speed used for control
Category: Geotechnical	
Excavation	35 ft below existing GL
Fill	Approx. 32ft
Foundation	Mat slab foundation supported on piles

Solids Scraper System

Each sedimentation basin would have a mechanical sediment removal system. The system would collect and siphon off the settled solids into the solids pumping station located at the downstream end of the basins. There are multiple options noted for solids removal, which include MRI's vacuum sludge collector system and Envirex Chain & Scraper sludge collector system. Currently the drawings show the MRI system based on general criteria. All materials are stainless steel. This system may vary with the Fish Facilities as the solids collection system will be handling a higher volume of solids. A more detailed description of the systems can be obtained as the design progresses.

Category: Solids Lagoons

Design Criteria

Design Factor	Criteria
Category: Hydraulic Design	
Cross-Sectional Geometry	
Shape	Rectangular
Number of Lagoons	3
Lagoon Dimensions	Top L x Top W x Depth: 165 ft x 86 ft x 10 ft
Average Daily Mass of Solids	133,000 lb/d
Maximum Daily Mass of Solids	253,000 lb/d
Yearly Accumulated Volume	486,000 cu ft
Category: Civil Design	
Flood Protection	See Flood Elevations and Protection(1)
Actuator	1 per lagoon
Discharge Pipe	TBD
Return Flow Location	Upstream and downstream of Sedimentation basins via valved connection
Category: Operational Design	
Truck Bed Load Size	30 cu yd
Number of Truck Loads / Year	600
Solids Particle Size	0.125mm – 1.6 mm
Category: Geotechnical	
Excavation	15 ft below future ground surface
Foundation	Mat slab foundation

Category: Solids Pumping Station

Flood Protection	See Flood Elevations and Protection(1)
Gate Structure	Stainless steel rising weir gates, mechanically actuated.
Control Valves	
Number	3
Size	25 ft high x 11 ft wide

Category: Mechanical	
Pump Type	Progressive Cavity
Number of Pumps	3
Medium	Sediment 1-2% solids
Minimum Passage Size	2”
Category: Operational Design	
Pump Operation	Duty/Assist/Standby
Flow Control	Pump speed used for control
Category: Geotechnical	
Excavation	40 ft below future GL
Foundation	Mat slab foundation supported on piles

**Throughput of the Intake Pumping Plant, volume of water transferred during solids pumping and other assumed data will be refined as the design progresses.

Category: Electrical

General

- Voltage rating for the motors above 500HP shall be 4160V or 6.6kV.
- Power Transformers and distribution transformers shall be sized based on the load calculations.
- Power transformers shall be installed in 69kV substations
- MV Metal-Clad switchgear shall be installed to feed power supply for pump motors and distribution transformers.
- Control voltage for MV switchgear shall be 125V dc.
- 600V MCC shall be provided for feeding auxiliary supply.
- Variable Frequency Drives shall be provided for all Intake pump motors
- Fire alarm system shall be provided for the pumping plants.
- Lightning protection for the buildings shall be provided.
- Lighting for the plant shall be provided in compliance with IES
- 2007 California Electrical Code

Category: Controls and Communications

- Communications to the Pumping Plant should support (this needs further coordination with DWR)

- o SCADA and Controls
- o Site Security (TBD)
- o Telephone (TBD)
- o IT Connections (TBD)

- Communications to the site should be coordinated with the overall communications design, and generally should be provided by fiber optics.
- Communications should be provided between the Pumping Plant, related conveyance sites as required, Area Control Center for the Field Division (TBD), and the Joint Operations Center (JOC).

Category: Structural

Foundations	Reinforced concrete mat founded on deep pile foundations. Type of pile and method of installation TBD.
Subterranean Walls	Reinforced concrete retaining walls.
Slabs & Elevated Operating Floors	Reinforced concrete, slabs, beams & columns.
Building	Steel framed structure with clear span across pump operating floor. Metal panel cladding is used at the walls and roof. Lateral force resisting frames are provide in the transverse direction and braced frames are provided in the longitudinal direction. Traveling bridge crane is supported from the interior building columns and used for the maintenance and repair of pumps and motors.
Reference Building Code	2007 California Building Code
Geotechnical Report	TBD

Category: Architectural

TBD

2007 California Building Code

Category: Mechanical

Hydraulic Power Units and Hydraulic Valve Actuators	One hydraulic power unit consisting of a hydraulic oil tank, one electrically operated duty pump, one electrically operated standby pump and one manually operated standby pump will be provided at each pumping plant. Other accessories like filters, directional control valves, isolation valves, hydraulic piping etc. will be part of the system. Hydraulic piping will be stainless steel. The system will be designed for an operating pressure of 1500 psi. For each valve, sufficient number of accumulators will be installed adjacent to the valve to facilitate

operation of the valve for a full cycle even during a power failure. Accumulators will be bladder type pre-charged with Nitrogen.

Depending on the torque requirements, single acting or double acting hydraulic actuators will be provided.

Electric Valve Actuators

Electric valve actuators will be suitable for 480 V/60Hz/3 Phase power supply.

Category: Mechanical Building Systems

General

Mechanical building systems will conform to the requirements of the State of California Title 24, the CA Mechanical Code and other applicable codes and will include heating, ventilating and air conditioning (HVAC), plumbing, and fire protection systems.

Plumbing Systems

Plumbing systems will be provided for the various areas of the pumping plant. Roof drains, where needed, will discharge to splashblocks at grade; floor drains and mechanical equipment drains will be provided with gravity drainage to a plant drainage sump equipped with duplex sump pumps. The sump pumps will discharge to a wastewater holding tank. Restroom fixtures will be provided with sanitary gravity drainage to a wastewater holding tank. Oil rooms will be provided with separate sumps. A potable water supply system will be provided for the welfare facilities and any safety showers if required. If available, a potable water supply will be taken from the nearest clean water conveyance system. If not available, a self-contained water filtration and treatment system will be included. The availability of potable and non-potable water sources will be determined during detailed design. Raw water downstream of strainers will be evaluated for use in a non-potable water system serving hose faucets, and water cooled condensing units for electrical equipment and HVAC hydronic cooling systems.

HVAC

The various areas of the pumping plant will be provided with HVAC systems to maintain desired temperatures for equipment protection and human comfort, and to ensure adequate ventilation (Table 7.2). Natural ventilation will be used for cooling where feasible; fans, louvers, and ductwork will provide additional capacity. Packaged or central type air cooled direct expansion refrigerant systems will be used for air conditioning where necessary; water cooled air conditioning equipment will be used where feasible. Air conditioning systems will include economizer components to utilize outdoor air for cooling. Heating will be provided by electric unit heaters and heat pumps.

Room Type	Summer Design Temp (°F)	Winter Design Temp (°F)	Cooling System Type	Heating System Type
Mechanical Process & Equipment Rooms	104	55	100% Outside Air	Electric Unit Heaters
Electrical Rooms	90	55	Air Conditioner	Electric Unit Heaters
Control Room, Restroom	78	72	Heat Pump	Heat Pump

Category: Security

General

Provide anti-terrorist security system and linked to SCADA system. Video Cameras.

Category: Fire Protection

General

Fire suppression systems will be provided as required by the authority having jurisdiction. Carbon dioxide and clean agent fire suppression systems will be evaluated for the pump motors, electrical rooms and oil storage rooms if required.

Category: Cathodic Protection

General

- All buried piping shall be protected with cathodic protection system.
- Insulation joints shall be provided to electrically isolate buried piping and reinforcing steel.

Category: Environmental Criteria / Issues

Pile driving TBD

Dewatering TBD

7.0 FOREBAYS

The purpose of this chapter is to present design criteria sufficient for EIR/EIS design support for the DHCCP facilities. The design criteria are from the sources cited.

There is a forebay required for each of the three conveyance options that involve construction of an entirely new conveyance system (ICF East, ICF West, and DCF). In addition to providing steady and uniform flow to the Banks and Jones Pumping Plants, this forebay would provide storage to allow flexible operation of the system of new upstream pumping plants and the existing Banks and Jones Pumping Plants so as to meet operational, environmental and maintenance requirements while minimizing electrical power costs.

7.1 Forebay Capacity

Forebay capacity is dependent on the canal design flow (15,000 cfs for the two isolated conveyance alignments) and how it is to be used including:

- How the river intake pumping plants deliver water into the conveyance system, i.e. whether they will be operated to match the tidal cycle, operated at a steady rate throughout the day, or operated at reduce rates during periods of the day with the highest power costs (on-peak) and at higher rates during off-peak periods.
- The degree that the canal system itself can be used for storage. The canal system is divided into a series of gated pools that can potentially be drawn upon to assist in regulation of the overall system.
- How the export pumping plants will be operated, i.e. operated at a steady rate throughout the day or operated at reduced rates during periods of the day with highest power costs (on-peak) and increased pumping during off-peak periods.

7.2 EIR/EIS Design Criteria

Table 7-1 summarizes the general feasibility design criteria for the DHCCP forebays and includes the following categories:

- Operational Considerations
- Size
- Hydraulic Design Criteria
- Geometry
- Embankment Design Criteria
- Environmental Criteria/Issues
- Security, Health and Safety

7.3 References

1. "Isolated Conveyance Facility East Option Description Report", DHCCPa Team, Revision 1, December 30, 2008.
2. "Isolated Conveyance Facility West Option Description Report", DHCCPb Team, Revision 1, December 30, 2008.
3. "Technical Memorandum: Flood Elevations and Protection", DHCCPc Team, January 2009.

4. "Design Criteria – DHCCP Setback Levees", DHCCPd Team, February 2009.
5. "Delta Alternative Conveyance", DWR, December 2007.
6. "Delta Risk Management Strategy, Building Block 1.7: Isolated Conveyance Facility", URS.
7. "Aqueduct Design Criteria", DWR, September 1997.
8. "Guidelines for Design of Intakes for Hydroelectric Plants", ASCE, 1995.

Table 7-1 Forebay Design Criteria

Design Factor	Criteria
Category: Operational Design Criteria	
Design Flows for Conveyance	
Maximum	15,000 cfs
Inlet Control	
Location	Installed at inlet to the forebay
Type	Radial gates
Outlet Control	
Location	Installed at each outlet of the forebay where necessary to isolate from Clifton Court Forebay and Old River
Type	Radial gates that seat in either direction
Drawdown: variability in water surface elevation (includes variability with respect to time)	
Max Drawdown per hour	2 feet
Max Drawdown per day	7 feet
Monitoring	Water level monitoring equipment
Seismic	
Seismic triggers to close gates to isolate pools?	TBD
Inflows	15,000 cfs
Outflows	
Maximum to Banks Pumping Plant	10,300 cfs
Maximum to Jones Pumping Plant	4,600 cfs
Minimum Water Surface Elevation	0.5 feet NAVD 88
Bypass Requirements	Existing water rights to Byron-Bethany Irrigation District
Other Special Facilities	Radial gate control structures at existing approach canals to Banks and Jones Pumping Plants where necessary to isolate from Clifton Court Forebay and Old River
Category: Size	
Surface Area for Storage	620 acres
Active Storage Capacity	4,300 acre-feet
Operating Range	7.0 feet (+0.5 to +7.5 feet NAVD 88)

Category: Hydraulic Design Criteria	
Freeboard	
Wind Setup	Modified Zuider Zee formula, USACE 1976 Design Wind Speed – TBD Wind direction – TBD
Wave Runup	USACE 1976 (Combined wind wave 2.5 feet, DHCCPc 2009)
Load Rejection/Acceptance Wave	Pumping Plant - loss of power or on initial startup (TBD)
Design Storm/Flooding	Exterior embankment subject to flood flows (13.8 feet, DHCCPc 2009)
Sea Level Rise	Yes, additional 3.1 feet at Banks Pumping Plant (DHCCPc 2009)
Residual Freeboard	3 feet
Category: Sedimentation	
Sediment Load	
Residual Depth	3 feet after 50 years
Anticipated Depth of Sedimentation	7.5 feet after 50 years
Through-Basin Velocity	TBD
Sediment Removal	
Type of Equipment?	Dredge
Frequency of Dredging	Periodic – approximately once every 10 years along main approach, General Dredging of entire basin only required at end of 50 years
Dispose of Dredged Material	Location - TBD
Category: Embankment Design	
Topographical Constraints	
ICF East and DCF	Clifton Court Forebay embankments, Old River levees, existing Jones Pumping Plant approach canal embankments, UPRR and Byron Highway
ICF West	Italian Slough levees, power lines, UPRR and Byron Highway
DSOD Jurisdictional?	Yes
Evacuation Requirement	TBD
Seismic Design	
Design Basis Earthquake (DBE)	Refer to Seismic Criteria
Other Seismic Considerations	TBD
Foundation Objectives	
Embankment Material	
Limitations On Use Of Locally Available Material	TBD
Zoning/Filter-Drain Requirements	TBD
Slope Stability	Refer to Setback Levees Design Criteria (DHCCPd 2009)
Factor Of Safety For Steady State Max Normal Pool	TBD
Factor Of Safety For Max Surcharge Pool	TBD
Factor Of Safety For Rapid Drawdown	TBD

Interior Side Slope, Cut	TBD (Assume 3H:1V in initial layout)
Interior Side Slope, Fill	TBD (Assume 3H:1V in initial layout)
Exterior Side Slope, Cut	TBD (Assume 3H:1V in initial layout)
Exterior Side Slope, Fill	TBD (Assume 3H:1V in initial layout)
Lining	
Inboard Slope Protection	Riprap protection over full operating range
Outboard Slope Protection	Refer to canal design criteria
Category: Environmental Criteria/Issues	
Flood Protection	See Flood Protection criteria - protection from inflow and potential damage from forebay breech (DHCCPc 2009)
Category: Security, Health and Safety	
Fencing	TBD
Signage	TBD
Locks	TBD
Lighting	TBD

8.0 SETBACK LEVEES

The purpose of this chapter is to present design criteria sufficient for EIR/EIS design support for the conveyance option facilities.

8.1 Levee and Channel Configurations

Generally, setback levees will be used along the through-Delta portion of the Through Delta Facility conveyance option and parts of the through-Delta component of the Dual Facility conveyance option. Setback levees may also be used at a few additional locations to provide flooding protection to specific facilities. For the through-Delta portion of the conveyances, several different cross-sectional configurations of the channel are planned. Criteria outlined in the following section generally apply to each type of setback levee, except as otherwise noted.

8.2 EIR/EIS Design Criteria

The following table summarizes the EIR/EIS design criteria for DHCCP setback levees and includes the following categories:

- Levee Geometry
- Material Properties
- Foundation Improvement
- Geotechnical Analysis
- Environmental/Cultural Considerations
- Existing Infrastructure
- Construction

Table 8-1 Setback Levee EIR/EIS Design Criteria

Design Factor	Criteria
Category: Levee Geometry	
Levee Height	
Design flood-stage elevation with respect to inundation on waterside of levee	Elevations in accordance with those provided in the DHCCP Flood Elevation and Protection TM (January 2009). The DHCCP Flood Elevation and Protection TM (January 2009) identifies multiple potential flooding sources, each with an associated WSE, and identifies the WSE that controls design.
Design flood-stage elevation with respect to inundation on landside of levee	Elevations in accordance with those provided in the DHCCP Flood Elevation and Protection TM (January 2009). The DHCCP Flood Elevation and Protection TM (January 2009) identifies multiple potential flooding sources, each with an associated WSE, and identifies the WSE that controls design.

Table 8-1 Setback Levee EIR/EIS Design Criteria

Design Factor	Criteria
Required freeboard on waterside of levee	Freeboard in accordance with that described in the DHCCP Flood Elevation and Protection TM (January 2009). The DHCCP Flood Elevation and Protection TM (January 2009) defines separately levee height that is freeboard (3 feet) and levee height that is for wave run-up (5 feet).
Required freeboard on landside of levee	Freeboard in accordance with that described in the DHCCP Flood Elevation and Protection TM (January 2009). The DHCCP Flood Elevation and Protection TM (January 2009) defines separately levee height that is freeboard (3 feet) and levee height that is for wave run-up (5 feet).
Additional levee height to maintain design crest elevation to account for regional subsidence and project-induced settlement	Levee height must be increased to accommodate elevation loss at crest expected from subsidence and settlement. Analysis of subsidence and settlement, and allowable amounts, are provided under geotechnical analysis criteria, below.
Levee Crest	
Crest width	Minimum 20 feet, except at turnarounds, etc., requiring greater width. At some locations, the crest may need to be widened for turnarounds, access ramps, etc., or to accommodate a permanent paved roadway; additional width must accommodate road, any shoulder or safety barrier requirements, and additional width for sideslope of roadway baserock and pavement section (where the roadway section is raised above levee structural fill elevation).
Crest crown/cross-slope angle	3% cross-slope downward toward waterside over full width of crest; except where a public roadway is situated along the crest, where design criteria will be set on a case-by-case basis. Public roadway design criteria for cross-slopes/super-elevation at curves (speed-dependent) will necessitate site-specific design at such locations.
Levee Slopes	
Waterside slope angles for structural levee prism (engineered embankment fill)	Minimum slope (i.e., maximum steepness of slope) angle 3:1 (H:V). Additional material that may be placed on the slope for habitat reasons is not considered engineered embankment fill.
Landside slope angles for structural levee prism (engineered embankment fill)	Minimum slope (i.e., maximum steepness of slope) angle 3:1 (H:V). Additional material that may be placed on the slope for habitat reasons is not considered engineered embankment fill.

Table 8-1 Setback Levee EIR/EIS Design Criteria

Design Factor	Criteria
Landside compound slope configurations	Compound slopes may be used with a lower slope portion being flatter than an adjoining upper slope portion, and connected by a simple grade-break/hinge-line; grade-break for compound slopes to be set at (nominally) elevation of waterside MHHW elevation; no landside mid-slope benches, except as created by roadway ramps that obliquely traverse the slope to connect from toe to crest. Compound slopes are expected to be used where 3:1 (H:V) slopes do not meet stability criteria.
Levee Toe Right-Of-Way	
Excavation and trenching	Minimum 50-feet-wide right-of-way zone (adjacent to the toe of the levee), within which no permanently exposed excavation/ditch or temporary excavation/trench that is backfilled with granular material (e.g., utility trench bedding, roadway baserock) may extend >1 foot deep, and minimum 100-feet-wide right-of-way zone (adjacent to the toe of the levee), within which no permanently exposed excavation/ditch or temporary excavation/trench that is backfilled with granular material may extend >3 feet deep.
Above-grade surcharge	Minimum 50-feet-wide right-of-way zone (adjacent to the toe of the levee), within which no fill or other surcharging structure may cause a loss of ground elevation of >1 foot.
Levee Embankment Zones	
Structural levee prism fill boundaries (engineered embankment fill)	Minimum 10 feet wide at top of structural fill. Where rip-rap armoring, bedding, or similar materials are on the slope face, these materials may be embedded into the slope, but must not reduce the lateral section of the structural levee prism fill to less than the required minimum width value of 10 feet at the top.
Waterside slope armoring zone dimensions	Full height of waterside slope; thickness/width in accordance with calculations for wave action and flow-induced tractive forces.
Landside slope armoring zone dimensions	From current waterside mean lower low water elevation up to future mean higher high water elevation plus wave run-up; thickness/width in accordance with calculations for wave action.
Levee crest roadway dimensions	Section may be embedded/ recessed into structural levee prism (engineered embankment fill) for paved road; for unpaved road, section must be on top of structural levee prism fill, with a maximum of 1.5 feet on top of the structural levee prism fill.
Waterside on-slope supplemental fill dimensions/limits	Outside the geometric limits of any structural levee prism fill or armoring (i.e., not within the geometric limits of engineered embankment materials). For various configurations, supplemental fill may be placed on levee slopes for habitat purposes; for some configurations, supplemental fill may be placed over armoring.

Table 8-1 Setback Levee EIR/EIS Design Criteria

Design Factor	Criteria
Landside on-slope supplemental fill dimensions/limits	Outside the geometric limits of any structural levee prism fill or armoring (i.e., not within the geometric limits of engineered embankment materials). For various configurations, supplemental fill may be placed on levee slopes for habitat purposes; for some configurations, supplemental fill may be placed over armoring.
Toe-drain/chimney-drain locations and dimensions	Dimensions based on permeability and flow requirements; blanket/ horizontal drains minimum 1.5 feet thick, extending from landside toe into levee a distance equal to 2 times the levee height; vertical/inclined drains minimum thickness/width of 3 feet, extending up to 200-year WSE. Toe drains or chimney drains may be used for certain levee configurations.
Levee penetrations	No penetrations underneath levee; through the levee, bottom of penetration (including bedding) above the elevation of the design WSE + freeboard (not above design WSE + freeboard + wave run-up). The DHCCP Flood Elevation and Protection TM (January 2009) identifies multiple potential flooding sources, each with an associated WSE, and identifies the WSE that controls design; the TM defines separately levee height that is freeboard (3 feet) and levee height that is for wave run-up (5 feet).
Other internal zoning	Not currently planned, except as associated with filter requirements for drains.
Levee Freeboard Extension	
Freeboard wall (T-wall, I-wall) locations/dimensions	Not currently planned.
Freeboard dike locations/dimensions	Not currently planned.
Levee Alignment	
Alignment centerline/setback offset distance from existing levee	Minimum setback distance and curvature determined by H&H.
Plan curvature of levee alignment	Minimum setback distance and curvature determined by H&H. Levee curvature design may also need to account for levee-top roadway curvature requirements.
Levee tie-in to improved existing levee	Designed to meet geotechnical analysis performance criteria (for DHCCP levees).
Levee tie-in to unimproved existing levee	Not designed to meet geotechnical analysis performance criteria.
Levee tie-in to operable barrier	Designed to meet geotechnical analysis performance criteria.
Category: Material Properties	
Structural Levee Prism Fill	

Table 8-1 Setback Levee EIR/EIS Design Criteria

Design Factor	Criteria
Material types/classifications	≥30% passing No. 200 sieve; Liquid Limit ≤45 and Plasticity Index ≤15; no organic content or other deleterious material.
Placement/compaction requirements	Loose lift thickness ≤ 8 inches; ≥90% relative compaction and moisture content at or above optimum per ASTM D1557.
Slope Armor	
Waterside armoring material types/classifications	Size in accordance with calculations for wave action and flow-induced tractive forces.
Landside armoring material types/classifications	Size in accordance with calculations for wave action; at locations adjacent to terminal ends of new canals (i.e., over new culvert siphons), also size in accordance with calculations for flow-induced tractive forces from flows between levee and embankment confining terminal end of canal.
Levee-Top Fill	
Levee crest roadway fill types/classifications	In accordance with DWR roadway standards; where applicable, also in accordance with Department of Transportation standards.
Road fill placement/compaction requirements	In accordance with DWR roadway standards; where applicable, also in accordance with Department of Transportation standards.
General fill types/classifications	Not currently planned.
General fill placement/compaction requirements	Not currently planned.
Supplemental Fill	
Waterside supplemental fill material types/classifications	Wet unit weight ≤110 pcf.
Waterside supplemental fill placement/compaction requirements	Nominally horizontal lifts across entire fill area, with loose lift thickness ≤ 24 inches.
Landside supplemental fill material types/classifications	Wet unit weight ≤130 pcf; material must be workable and able to be compacted. Relatively weak/soft soils may be used, but the material must be capable of being worked, placed, and compacted by typical earth-work operations; pure peat is not allowed on the landside slopes.
Landside supplemental fill placement/compaction requirements	Loose lift thickness ≤ 12 inches; ≥85% relative compaction and moisture content at or above optimum per ASTM D1557.
Toe Drain/Chimney Drain	
Material types/classifications	In accordance with USACE EM1110-2-1913 Appendix D.
Placement/compaction requirements	In accordance with USACE EM1110-2-1913 Appendix D.
Freeboard Extension	

Table 8-1 Setback Levee EIR/EIS Design Criteria

Design Factor	Criteria
Freeboard wall materials	Not currently planned.
Freeboard wall placement requirements	Not currently planned.
Freeboard dike materials	Not currently planned.
Freeboard dike placement requirements	Not currently planned.
Category: Foundation Improvements	
Removal and Replacement	
Overexcavation depths and widths	Overexcavation 5 feet deep; excavation bottom width delimited by 3:1 (H:V) projection down and outward from levee toe (at original ground surface elevation); excavation bottom width exception: where a surficial clay blanket ≤5 feet thick is present at the landside toe, excavation bottom width shall extend 100 feet beyond the levee toe; excavation backcut side-slopes 1.5:1 (H:V).
Backfill materials and placement	Same criteria as for structural levee prism fill.
In-Situ Ground Improvement	
Improvement type/methodology	Various methods allowable, including soil mixing (by augers), grouting (by injection), vibro-compaction/replacement, and rammed aggregate. Types to be selected will depend on effectiveness/reliability within various soil types of achieving increased soil stiffness, increased soil strength, and/or decreased soil permeability; types dependent also on other factors and restrictions, such as risk associated with adjacent existing levee conditions or consideration of groundwater conditions and potential impacts.
Improvement depth and width	Minimum depth to bottom of moderately to significantly compressible soils; width equal to and coincident with levee width toe-to-toe (at original ground surface elevation). Improvement depth may need to target/extend to and through depths of weak or highly permeable layers.
Additive materials and placement requirements	Various materials allowable, including soils/aggregates, cement, and non-toxic chemicals, selected and placed in accordance with methodology selected.
Cut-Off Wall	
Cut-off wall type/methodology	Soil-bentonite (SB) slurry wall. Soil-cement-bentonite (SCB) slurry wall not included due to likely deformation of soil profile.
Cut-off wall depths	Depths to be designed as fully penetrating (through permeable layers of concern).
Additive materials and placement requirement	In accordance with method.
Category: Geotechnical Analysis	

Table 8-1 Setback Levee EIR/EIS Design Criteria

Design Factor	Criteria
Subsidence and Project-Induced Settlement	
Allowable elevation loss at levee crest due to combined effects of subsidence and project-induced settlement	2.5 feet within 50 years.
Subsidence analysis parameters	For crest height, account for amount equal to 25% of total predicted subsidence. Not including amount of subsidence due to loss of soil from ground surface (e.g., wind-loss, oxidation), but estimating amount due to compression of soil profile from withdrawal/loss of soil gas and/or groundwater.
Settlement analysis parameters	Refer to Table 1-2. Need to consider consolidation-type settlement and any other non-immediate (i.e., elastic) sources from levee fill, supplemental fill, new groundwater elevations, new surface water conditions, etc.
Seepage	
Through-seepage limits	Seepage exiting on the landside slope-face is not allowed.
Under-seepage exit gradient	Maximum allowable exit gradient of 0.5 at the landside toe.
Seepage analysis parameters	Refer to Table 1-2.
Analysis and boundary condition constraints	Seepage analyses should be performed without any supplemental fill (e.g., for habitat restoration) on the levee slopes or on the existing ground surface; refer to Table 1-3 for water surface elevations corresponding to various analysis conditions; agricultural drainage channels should be included along the margin of the levee toe right-of-way (10 feet deep, consideration of empty and of full of water). Topographic conditions should account for allowable excavations within right-of-way.
Slope Stability	
Waterside and landside factors of safety (FS)	Long-term static FS ≥ 1.5; End-of-construction FS ≥ 1.3; Rapid drawdown FS ≥ 1.2; Rapid flood-stage rise FS ≥ 1.4.
Waterside and landside post-seismic deformation	Value of upper limit of range of estimates of deformation ≤ 3 feet.
Stability analysis parameters	Refer to Table 1-2 and to the DHCCP Seismic Design Criteria TM (December 2008).

Table 8-1 Setback Levee EIR/EIS Design Criteria

Design Factor	Criteria
Analysis and boundary condition constraints	Stability analyses should be performed without any supplemental fill (e.g., for habitat restoration) on the slope being analyzed or on the existing ground surface adjacent to that slope, but with supplemental fill on the opposite-side slope; refer to Table 1-3 for water surface elevations corresponding to various analysis conditions; drainage channels should be included along the margin of the levee toe right-of-way (10 feet deep, consideration of empty and of full of water); slip surface depth (thickness of widest part of slide mass) ≥ 3 feet. Undrained strength parameters should be used for low permeability soils and effective strength parameters should be used for free-draining materials, except that for long-term static analyses effective strength parameters should be used for all materials except normally consolidated clays.

Category: Environmental/Cultural Considerations	
Slope Landscaping	Design of waterside slope landscaping between crests of setback and existing levees.
Habitat Restoration	Description of methods to create new habitat and preserve existing habitat.
Cultural Impacts	Description of methods to avoid known cultural locations
Category: Existing Infrastructure	
Levee Penetrations	Guidelines for replacing existing levee penetrations
Utility Crossings	Construction concerns for disruption to existing utilities
Bridges	Realignment of existing bridges
Roadways	Realignment of existing roadways
Railroads	Realignment of existing railroads
Hydraulic Structures	Placement and redesign of new and existing structures
Category: Construction	
Borrow Sources	Locations of suitable fill material
Spoil Storage and Removal	Locations of temporary and final storage of over-excavated and other spoil soils.
Fill Stockpiles	Locations of construction site fill material
Haul Routes	Mapping of trucking routes
Staging Areas	Locations and sizes of construction staging areas along levee alignment
Dewatering	TBD

Table 8-2 Setback Levee EIR/EIS Design Analysis Parameters

Material	Unit Weight (pcf)	Compressibility		Permeability		Strength				
		C_c	C_α / C_c	K_h (cm/s)	K_h / k_v	ϕ'	c' (psf)	ϕ	c (psf)	S_u (psf)
New levee fill	125	Note 1	-	1x10-4	4	30	0	18	500	-
New foundation fill	125	Note 1	-	1x10-4	4	30	0	18	500	-
New internal drain/filter	130	-	-	1x10-2	1	34	0	-	-	-
New landside supplemental fill	125	-	-	-	-	26	0	18	100	-
New waterside supplemental fill	110	-	-	-	-	22	0	17	100	-
Existing levee fill	115	0.4 to 0.6	0.04	1x10-3	4	26	0	-	-	-
Native clay	115	0.2 to 0.5	0.05	1x10-5	10	26	0	18	400	-
Native silt	115			1x10-4	10	28	0	-	-	-
Native sand	120			1x10-3	4	30	0	-	-	-
Native peat, organic soil	70	1.5 to 4	0.08	1x10-4	10	26	0	18	140	135+0.21□ v′
Liquefied sand or gravel	120	-	-	-	-	-	-	-	-	250
Soil treated by grouting or mixing	125	Note 2	-	1x10-5	10	36	0	-	-	-
Soil treated by rammed or vibrated aggregate	120	Note 2	-	1x10-4	100	34	0	-	-	-

Note 1: Estimate magnitude of compression as percentage of total fill height using 1 to 2 percent.
Note 2: Estimate magnitude of compression as percentage of total improvement depth using 1 to 2 percent.

Table 8-3 Setback Levee EIR/EIS Design Analysis Water Surfaces

Analysis Case	Water Surface for Analysis		Comments
	Waterside	Landside	
Static condition	MHHW	Ground surface*	*at levee toe
Seismic condition	MHHW	Ground surface*	*at levee toe
Rapid flood-rise condition on waterside	MHHW for antecedent steady-state, 200yr for flood-rise level	Ground surface*	*at levee toe
Rapid flood-rise condition on landside	MHHW for antecedent steady-state, 200yr for flood-rise level	Ground surface* for antecedent steady-state, 200yr for flood-rise level	*at levee toe
Rapid drawdown condition, both sides	*Case 1:* 200yr flood for steady-state, MLLW for drawdown level *Case 2:* MHHW for steady-state, MLLW for drawdown level	*Case 1:* 200yr flood for steady-state, MLLW for drawdown level *Case 2:* MHHW for steady-state, ground surface* for drawdown level	*Case 1:* Drop occurs to same level on each side *Case 2:* *at levee toe

9.0 OPERABLE BARRIERS

The purpose of this chapter is to present the design criteria sufficient for EIR/EIS design support for the DHCCP facilities. The design criteria are from the sources cited.

9.1 Operable Barrier Design Criteria

The primary design functions of the Operable Barriers and the proposed improvements for the river channels in areas where barriers are proposed for the DHCCP include: (1) meeting the goals for conservation and habitat restoration of covered species; (2) enhancing the water supply reliability and water quality; (3) improving the conditions for fish habitat and migrating fish in the south Sacramento-San Joaquin River Delta; (4) maintaining adequate water levels and quality for south Delta agricultural deliveries; and (5) improving operational flexibilities of the SWP and CVP.

The inflatable bottom-hinged flow control gate is considered the most suitable type of gate for this application. The inflatable bottom-hinged gate uses a modular design and consists primarily of individual steel panel and inflatable air bladder and control system. The design allows the gate panels to be installed and operated individually and collectively on a common air supply system. The gates can be set at number of positions between fully raised and fully lowered as assisted by the air bladder and compressed air supplied and regulated by the control system.

The locations for the Operable Barriers currently identified have included locations at Middle River, Grand Line Canal, Old River, Head of Old River, Connection Slough, and Woodward Canal.

9.2 EIR/EIS Design Criteria

Table 9-1 summarizes the general EIR/EIS design criteria for Operable Barriers of DHCCP facilities including:

- Site Conditions and Considerations
- Hydraulic Criteria
- Structural Criteria
- Mechanical Criteria
- Electrical and I&C Criteria
- Construction Considerations.

Table 9-1 Operable Barriers

Design Factor	Criteria
Category: Site Conditions and Considerations	
Existing Levees	
Conditions and Stability	TBD
Improvement Requirements	TBD
Structural Tie-In with Barrier Structure	TBD
Accessibility	
Construction Access by Land or Water	TBD
Positioning and Stationing of Construction Equipment during Erection and Installation for Equipment and Structures	TBD
Improve or Provide Construction Access Road	TBD
Site Restrictions	
Environmental and Biological Sensitive and Restrictive Areas	TBD
Existing Road Widening and Upgrading	TBD
Construction Duration	TBD
Noise Restriction	TBD
Category: Hydraulic	
Width and Configuration of Channel	
Flow Diversion	TBD
Number of Gates	TBD
Subgrade Improvement and Leveling	TBD
Seepage Cut-off	TBD
Foundation Work	TBD
Flow Velocity	
Increase Velocity Due to Flow Restrictions During Construction	TBD
Bank Erosion Protection due to Increased Flow Velocity	TBD
Depth of Channel	
Backfill to Raise River Bottom for Uneven Subgrade for Barrier Structure Location	TBD
Different Gate Panel Heights to Accommodate Subgrade Elevation Differential	TBD
Category: Structural	
Inflatable Gate	
Load Conditions and Operational Position for Gate Panels	TBD
Stability	
Seepage Cutoff	TBD
Bearing Capacity	TBD
Sliding Stability	TBD
Overturning Stability	TBD
Static Load Conditions	TBD

Seismic Load Conditions	TBD
Category: Mechanical	
Piping	
Air Supply Line	TBD
Flow Control System	TBD
Corrosion Protection	
Coatings	TBD
Cathodic Protection	TBD
Control Valves	
Design Characteristics	TBD
Abrasion and Turbulent Flows	TBD
Compressor	
Air and Lubrication Systems	TBD
Capacity	TBD
Design Features	TBD
Category: Electrical and I&C	
Programmable Control	
Control Inflating and Venting of Air for Inflatable Bladders	TBD
Pneumatic Water Level Controller as Backup	TBD
Control Gauges and Panel	TBD
Flow Measurement and Monitoring	
Discharge Flows	TBD
Water Elevations	TBD
Differential Water Elevations	TBD
Water Quality	TBD
Category: Construction	
In-The-Wet Method	
Prefabrication and Pre-Assembly	TBD
Underwater Inspection	TBD
QA/QC and Testing	TBD
Conventional Cast-In- Place with Cofferdam	
Stage Construction	TBD
Sheetpile Wall Enclosure Up to Half of Channel Width	TBD
Dewatering and Construction in The Dry	TBD

10.0 BRIDGES

The purpose of this chapter is to present design criteria and basic design guidelines for bridges and approach roadways crossing the canals sufficient for EIR/EIS design support for the conveyance option facilities.

10.1 EIR/EIS Design Criteria

Table 10-1 summarizes the general planning and design approach for both roadway and railroad bridges that will ultimately need to cross the various surface canals:

- Bridge Type, Location and Alignment
- Bridge Design Criteria
- Environmental Issues.

Table 10-1 Bridge Design Criteria

Design Factor	Criteria
Category: Bridge Type, Location, Alignment	
Bridge Type	
At Roadway Crossings	To be determined on case by case basis. General types to consider include cast-in-place concrete bridge, precast concrete girder bridge, or steel girder bridge (less likely). All will have concrete decks.
At Railroad Crossings	Pre-cast concrete girders or steel girders. RR prefers simple span "repairable" bridges of relatively short spans for easy repair. May be entirely negotiable for this application. Consider steel girder bridges for relative light weight and ability to raise and lower them much more easily than concrete bridges
Bridge Location	
At Roadway Crossings	See Project Descriptions
At Railroad Crossings	See Project Descriptions
At Private Roadways or Driveways	Focus has been on restoring existing public access. Private ROW impacts and access not likely to be widely considered given property rights uncertainties at this stage.
Other Considerations	Eliminating certain crossings will be considered on a case by case basis if reasonable alternative routes to nearby crossings exist and traffic demand allows. A single conveniently located bridge on new alignment could be introduced to compensate for the elimination of two nearby crossings. In addition, currently unforeseen bridges may become necessary to accommodate access across severed property.
Bridge Alignment	
At Roadways Intersected by Proposed Canal	Bridge alignment to preferably be built on existing roadway alignment unless existing alignment is

substandard. Traffic will need to be detoured away from bridge site entirely or onto a local temporary detour around and adjacent to bridge site. Most roadways are on tangent alignments at the proposed crossings. Preference is to build bridges on existing alignments to maintain tangent facility where practical.

At Existing Bridges to be Replaced to Accommodate Proposed Waterway Improvements

New replacement bridges and approach roadways will follow new alignments that are offset from existing as necessary to construct while maintaining traffic on existing bridges. This assumes detouring off existing roadway alignments is not feasible. These conditions occur at existing crossings for the Thru Delta Facility where setback levees require bridge replacements.

At Railroads

Siphoning under existing active tracks is a preferred option where hydraulically feasible to avoid considerable cost of new and/or temporary railroad facilities. Where new railroad bridges are required across proposed canals, bridges will preferably follow existing alignments with temporary shooflys built. Railroad companies resist introducing new curved alignments. Where existing railroad bridges need to be replaced, new alignments should be introduced where practical so that service on live tracks can be maintained during construction.

Category: Bridge Design Criteria

Span Configurations

At Roadway Crossings

In general bridge spans should be kept to a maximum length of approximately 145 feet to accommodate a precast girder bridge type option.

At Railroad Crossings

In general railroad bridge spans may be shorter than roadway spans for operational reasons dictated by RR. Span lengths shall comply where possible with railroad company standard bridge plans.

Cross-Sectional Geometry

At Roadway Crossings

- State Highways (SR 4, SR 12)
- County Roads
- Secondary Roads
- Local Roads, driveways, etc

Use Caltrans Highway Design Manual for State Highways and AASHTO criteria for particular road classification.

Generally, bridge widths shall match approach roadway width (traveled way + shoulders + pedestrian/bicycle + safety features). Most roads qualify as rural collector or local rural roads.

At Railroad Crossings

SPRR =Single Track

BNSF = Double Track

AREMA criteria shall be used for railroad bridges and all related track work in addition to the criteria and requirements particular to each railroad company.

Single track = 18’ type *

Double track = 38’ wide bridge type *

* extra width for RR maintenance vehicles to cross bridge may be required

Bridge Length

At Roadway Crossings	Generally from approx top of levee to top of levee
At Railroad Crossings	RR bridges may need to extend beyond levee to allow levee maintenance road to pass under bridge behind levee. Railroad poses strong resistance to introducing new at-grade crossings. Gradual grade change criteria could result in long bridges depending on site conditions.
Bridge Piers	
At Roadway Crossings	For hydraulic pier, walls will be preferred substructure. (Approximately 2.5 –ft thick normal to flow).
At Railroad Crossings	Same as for roadways
Levee Maintenance Road Continuity	
At Roadway Crossings	Levee maintenance roads will need to cross the roadways at the ends of bridge approach guard railing. In addition, the right turn radius from a new road onto DWR operating road shall comply with the provisions of the truck and bus turning template in the Caltrans Highway Design Manual for 80 ft long vehicle.
At Railroad Crossings	Levee maintenance roads will generally be restricted from crossing tracks. The RR bridges can have span(s) beyond the levee allowing maintenance roads to descend the back of the levee to pass underneath the approach spans where practical.
Design Standards	
At Roadway Crossings	Current version AASHTO LRFD Bridge Design Specifications with California Amendments adopted by Caltrans and all pertinent Caltrans bridge design manuals including the Seismic Design Criteria; DWR Encroachment Permit Guidelines; California Code of Regulations, title 23, division 1, chapter 1, article 8, section 128; pertinent USACE guidelines for the hydraulic and in-channel requirements; bridge owner's design criteria. AASHTO Geometric Design of Highways and Streets (2004) to be used for approach roadway and bridge width determination of non-state roads. State bridges and roadways shall comply with Caltrans Highway Design Manual.
At Railroad Crossings	AREMA Design Specifications

Category: Environmental Criteria / Issues

- Primary environmental issues for bridges will be temporary traffic disruption during construction and impacts due to realignments and shooflys required to build the bridges while maintaining traffic on the facilities.
- High profile roadways may be a visual issue and increase noise due to traffic being raised. Bridge architecture and landscape architecture TBD.

Approach fills may at places exceed 20 feet in height relative to surrounding land and can have a relatively large footprint some of which often extends beyond canal ROW corridor.

11.0 PROJECT CONTROLS DESIGN & INTEGRATION

The purpose of this chapter is to present design criteria sufficient for EIR/EIS design support for the DHCCP control and communications systems.

11.1 Control Systems EIR/EIS Design Criteria

Table 11-1 summarizes the general planning and design approach for DHCCP control systems and includes the following categories:

- Functional Design Criteria
- Control System Design Criteria

11.2 Communications Systems EIR/EIS Design Criteria

Table 11-2 summarizes the EIR/EIS design criteria for DHCCP communications systems and includes the following categories:

- Functional Design Criteria
- Fiber Optic Cable
- Ducts for Fiber Optic Cable
- Radio Systems

Table 11-1 Control Systems Design Criteria

Design Factor	Criteria
Category: Control Systems Design Criteria	
Functional Design Criteria	
Compatibility	Compatible with the existing DWR State Water Project (SWP) Control System.
Redundancy	TBD
Control System Equipment Power	TBD
Instrumentation Power	TBD
Seismic Design	Control System equipment will withstand earthquakes per the Seismic Criteria.
Control System Cabinets	The following criteria apply to enclosure ratings for cabinets: • NEMA 12 for dry indoor locations. • NEMA 4 for damp and wet locations. • NEMA 4x for corrosive environments.
Security	TBD
System Clock	GPS-based clock at each Pumping Plant. IRIG-B and Network Time Protocol compatible. Utilized for PLCs, HMIs, and Protective Relays.
PLCs/RTUs	
Type	Compatible with the existing DWR State Water Project (SWP) PLCs/RTUs.
Note: Additional Design Criteria to be included in the July Submittal.	

Table 11-2 Communications Systems Design Criteria

Design Factor	Criteria
Category: Communications Systems Design Criteria	
Functional Design Criteria	
Application Support	The communications systems will support the following applications: • DHCCP Control Systems • DHCCP Telephone System • CalISO Monitoring at Pumping Plants • Other applications such as power monitoring systems, protective relays, administrative networks, etc.
Compatibility	Compatible with the existing DWR State Water Project (SWP) Communications System.
Redundancy	Redundant communications from the JOC and Area Control Center (TBD) to each site.

Communications Equipment Power	The following criteria apply to electrical power for communications equipment:
	• Each DHCCP site will be equipped with a dedicated power supply and distribution system to serve communications equipment.
	• Electrical power will be -48 volt DC.
	• Typical systems will include:
	  • Battery Chargers, redundant
	  • Batteries
	  • Power Distribution Panel
	  • Load Shed Panel
	  • Alarm Monitoring
	• Battery systems will be designed to supply the load for a minimum of eight (8) hours following loss of primary power.

Seismic Design	Communications equipment will withstand earthquakes per the Seismic Criteria.
Communications Cabinets	The following criteria apply to enclosure ratings for communications cabinets: • NEMA 12 for dry indoor locations. • NEMA 4 for damp and wet locations. • NEMA 4x for corrosive environments.
Security	TBD
System Clock	Stratum-1 clocks with satellite uplink located at two independent sites to sync Stratum 3e clocks at the sites. These are clocks dedicated for the communications systems.

Fiber Optic Cable

Cable Redundancy	Redundant fiber optic cables will be installed along each segment of the new conveyance system. Where possible, this will be accomplished by providing separate conduit systems on each side of the conveyance system. A separate entrance will be provided into each facility for each cable to provide route diversity.
Cable Characteristics	
Optical Mode	Singlemode
Fiber Count	48 fibers per cable
Cable Construction	Loose tube cable with non-gel water barrier; central strength member consisting of electrically non-conductive material.
Cable Splicing	Splices shall be minimized, and shall use the fusion method. Cables shall be spliced in fiber termination panels located in the communications cabinet at each pumping plant and siphon. Wayside splices shall be encased in watertight cases. Splices shall not be done in tunnels. Where midspan splices are required along tunnel segments, conduits will be installed to bring the cables to pull boxes near the surface, if feasible, where splices will be made.
Cable Terminations	

Connector Type	TBD
Fiber Termination Panels	Fiber termination panels, with splice area and cable patching area, shall be installed at each site on the fiber optic cable backbone where communication circuits are dropped. Although not all fibers will be terminated at each site where communication circuits are dropped, all fibers shall be run into the termination panels and either spliced through or terminated.

Ducts for Fiber Optic Cable

General	All fiber optic cables will be installed within conduits and innerducts. These conduits shall be dedicated for use by fiber optic cables only. Cables will not be directly buried.
Spare Ducts	A minimum of one spare conduit and/or innerduct, as applicable, shall be provided along the complete length of the conveyance system, including runs into facilities. A pull rope will be installed in each spare innerduct.
Duct Type – along pipelines, canals, levees	A combination of polyvinyl chloride (PVC) conduit with high density polyethylene (HDPE) innerduct will be installed for all underground segments along pipelines, levees and canals. • PVC conduit will be x.x inches in diameter with a Schedule 80 rating. • Two [or three] HDPE innerducts will be installed in each PVC conduit. • HDPE innerduct rating - TBD. • The fiber optic cable will be installed in one of the innerducts.
Duct Type – along Tunnels	Fiber optic cables in tunnels will be installed in high density polyethylene (HDPE) ducts. The following requirements apply: • One HDPE duct will be installed in each tunnel barrel. • HDPE innerduct will carry a SDR9 rating. • Support brackets for the HDPE duct will be anchored in the wall of the tunnel.
Conduit and Innerduct Installation	The following installation requirements apply: • Field sweeps of conduit and innerduct shall have a minimum bending radius of 36 inches. • An electronic marking tape will be laid above the conduits and innerducts in all buried segments for future detection.
Pull Boxes (Hand Holes)	The following criteria apply to pull boxes (hand holes): • The maximum spacing between pull boxes will be 1500 feet. • Pull boxes will be installed at each 90 degree change in the conduit route. • Pull boxes will be located to prevent the total change in direction of the fiber optic

cable raceway between pulling points to exceed 180 degrees.

- Pull boxes not in fenced-in locations will be buried following installation of fiber optic cable with a nominal depth at the pull box cover of 24 inches.
- An electronic marking ball will be laid in each buried pull box for future detection.
- Pull box covers will have an H-20 traffic load rating.
- Watertight plugs will be installed in open conduits and innerducts entering each pull box.

Radio Systems

Radio System Equipment

The following criteria apply to radio systems:

- Radios will be utilized to communicate with sites not on the fiber optic cable backbone and where it is not practicable to run lateral fiber optic cable segments off the backbone (such as to operable barriers).
- Radio antennas will be installed on the DHCCP facility structures, such as pumping plant buildings, where practicable.
- Monopoles will be installed where dedicated antenna mounting structures are required.

12.0 HYDRAULIC & SURGE ANALYSIS

To be added for July 2009 submittal

13.0 ELECTRICAL POWER SUPPLY & ENERGY STUDY

The purpose of this chapter is to present design criteria and basic design guidelines for the electric power supply system sufficient for EIR/EIS design support for the conveyance option facilities.

13.1 EIR/EIS Design Criteria

Table 13-1 summarizes the general planning and design approach for the electrical transmission lines and substations needed to deliver power to all conveyance option facilities:

Table 13-1 Electric Power Supply Design Criteria

Design Factor	Criteria
Category: General Design Criteria	
Interconnection Line	Single 230 kV transmission line between utility substation and project main 230 kV substation
Subtransmission Line	Single 69 kV transmission lines between main 69 kV substation and various intakes and intermediate pumping plants. Line sized to supply full load demand to facilities
Power Transformers	Provide multiple power transformers sized to ensure full operation with one transformer out of service. Transformer tap settings, voltage ratings and set points shall be coordinated with utility to control reactive flows and voltage profiles.
Substation Configuration	Use main bus-transfer bus configuration to connect four or more elements to minimize circuit breaker count. Use ring bus configuration for 3 element substation.
Circuit Breakers	Utilize circuit breakers with sufficient interrupting capability to satisfactorily interrupt maximum expected short circuit duty and DC offset
System Protection and Control Schemes	Shall be coordinated to provide for safety, equipment protection and isolation of faulted components during abnormal conditions
Insulation Coordination	Power system equipment will be selected to withstand voltage stresses associated with expected operational voltages.
Station Grounding	Each substation must have a ground grid that is solidly connected to all metallic structures and other non-energized metallic equipment. The grid shall limit ground potential gradients to such voltage an current levels that will not endanger the safety of person or damage equipment in or immediately adjacent to the substation facility during normal and short circuit conditions.
Power Factor Considerations	Facilities shall be operated so as to not place an undue burden on either project or utility to supply or absorb reactive power

Metering and Telecommunications	Metering equipment will be installed at the point of connection between project and utility. Metering equipment shall include solid state metering for each revenue meter installed. Communications systems will be compatible with the utility, and provide reliable communication media for remote access, SCADA and voice communications functions
Transmission Line Rating	Transmission lines shall meet good utility practices and design standards. These design standards will include operating voltage, ampacity, insulation coordination, structure design and short circuit duty.
Substation Facility Ratings	Electrical equipment shall be designed to carry full continuous transient current ratings of the facilities. All components shall be designed, constructed and energized per NESC, NEC, ANSI and IEEE standards.
SCADA	Provide SCADA capability to enable full remote operation of entire project, and monitoring of all critical operating parameters

Category: Main 230 kV Substation

Power Transformers	Provide two full sized 230/69 kV power transformers
Substation Configuration	Three element ring bus configuration

Category: 69 kV Substations

Power Transformers	Provide multiple power transformers sized to supply full connected load with a single transformer out of service
Substation Configuration	Use main bus-operating bus configuration with substation bays for incoming power source, outbound transmission line(s), and pumping plant (intake or intermediate pumping plant) power transformers
Subtransmission Lines	Subtransmission (69 kV) transmission lines will connect the main 69 kV substation to the intake and other pumping plants. Lines will generally follow the alignment, and be constructed within the project right of way

Category: 12 kV Distribution System

Source Transformers	69/12 kV transformers will be installed at various 69 kV substations to provide source for the 12 kV distribution system
Distribution Lines	Where possible, 12 kV distribution lines will be constructed as underbuilt on the 69 kV subtransmission poles
Distribution Transformers	12 kV distribution transformers will supply 120/240/480 volt power for communications, control, and operation at various locations and control structures. Distribution transformers will be located

adjacent to the distribution line, and near the load location.

14.0 CONSTRUCTION & CONTRACTING PLAN

To be added for July 2009 submittal.