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Appendix 3F
Intake Location Analysis

3F.1 Introduction

The purpose of this appendix is to describe the process(es) and steps utilized to identify and refine potential new intake locations for analysis in the Bay Delta Conservation Plan (BDCP)/California WaterFix Environmental Impact Report/Environmental Impact Statement (EIR/EIS). The identification of potential intake locations was accomplished through an iterative process involving engineers and resource experts most familiar with existing facility operations, river hydrology, and the biological resources in the Delta. This process included convening a Fish Facilities Technical Team, conducting a Value Planning Study, and participating in numerous collaborative meetings with technical staff from the various agencies and consultants collaborating in the BDCP process to discuss evolving information.

Currently, the coequal goals of the BDCP are restoring the Delta ecosystem while at the same time securing a reliable water supply. This objective is also the policy of the State of California, as reflected in the 2009 legislation commonly referred to as the Delta Reform Act¹. The California Department of Water Resources (DWR) and United States Bureau of Reclamation (Reclamation) are jointly seeking to protect at-risk fish species either through improving existing diversion facilities and/or by building new diversion facilities with state-of-the-art fish screening capabilities.

Since the 1970s, several variations of new diversion facilities have been suggested and/or evaluated to address these issues. As technologies and criteria have evolved and data have been collected over past decades, diversion concepts have developed accordingly. For the BDCP, two general approaches have been proposed to date for diverting and screening water conveyed through the Delta. First, the addition of diversion facilities further north on the Sacramento River has been evaluated. In the alternative, the BDCP has considered use of the existing consolidated diversion at Clifton Court Forebay with the inclusion of improvements that address BDCP objectives relating to species concerns and reliability of water supply.

3F.2 Sacramento River Diversion Facilities

One option for improving survival conditions for delta fisheries is to withdraw water from the Sacramento River upstream of the aquatic habitats most favorable to at-risk fish species. By adding new points of diversion to the northern limits of the legal Delta, it is expected the threat to vulnerable species can be significantly decreased. For example, implementing new points of diversion on the Sacramento River could help avoid intake exposure for smelt species. Through the DHCCP and BDCP processes, several conveyance options using new points of diversion have been evaluated, each including improved means of fish protection. These evaluations have indicated that when new Sacramento River facilities are operated in tandem with the existing South Delta pumps, the flexibility of Central Valley Project and State Water Project operations can be increased to allow

¹ Sacramento-San Joaquin Delta Reform Act of 2009, SBX7 1.

operators to divert water from Northern or Southern facilities in response to the needs of various life stages of affected species as they move in and out of the Delta.

3F.3 Fish Facilities Technical Team (FFTT) 2008 Proposal

In 2008, the BDCP brought together State and federal regulatory agency and industry experts as the Fish Facilities Technical Team (FFTT) and charged them with developing, analyzing and proposing concepts on fish screen technologies and facilities for intake facilities with a maximum diversion capacity of 15,000 cubic feet per second (cfs) as part of an isolated conveyance system. The focus of the FFTT was to provide the BDCP Conveyance Workgroup with initial direction and recommendations regarding location, composition and arrangement of fish protective diversion facilities.

The FFTT provided its recommendations in an August 2008 draft report *Conceptual Proposal for Screening Water Diversion Facilities along the Sacramento River*. The FFTT developed several intake concepts that would suit the conveyance options being explored under the BDCP. It is important to note that the FFTT intake concepts were developed strictly looking at the requirements of diverting water from the river and not how the water would be conveyed beyond the levees bordering the river. Thus, existing land use, infrastructure constraints, and other criteria were not included for consideration during the initial FFTT evaluation. Further, the FFTT was directed by the Conveyance Workgroup to focus on a reach of the Sacramento River between the City of Sacramento and Walnut Grove for locating fish screen intake facilities.² Based on the review of available information, the team identified twelve potentially suitable locations, identified as locations A-L (see Figure 3F-1), for placing a diversion facility. Based on the selected locations and various screening techniques available the FFTT proposed four intake concepts.

² *Conceptual Proposal for Screen Water Diversion Facilities along the Sacramento River*, p. 9, (FFTT/BDCP August 2008). Northern locations were recommended to reduce the exposure of delta smelt, longfin smelt and other estuarine species. (FFTT 2008, page 5)

The FFTT proposed intake concepts included the following³:

Diversion Concept	Facility Type/Location	Number and Capacity
A	Combined In-River (Dual) and On-Bank Intakes at Cross-Section Locations C (Freeport), F (Hood), and H (Courtland)	Three sites at 5,000 cfs each
B	Series of Cylindrical Screens at Locations from A (Sacramento) to L (Walnut Grove)	Ten sites with fifteen screens per site for a maximum of 1,500 cfs per site
C	Combined In-River (Dual) and On-Bank Intakes at Cross-Section Locations from A (Sacramento) to L (Walnut Grove)	Ten sites at 1,500 cfs each
D	Combined In-River (Dual) and Cylindrical Screens at Cross-Section Locations from A (Sacramento) to L (Walnut Grove)	Ten sites at 1,500 cfs each

Key elements that were considered by the FFTT when identifying potential intake concepts included river bathymetry, hydraulics, temporal and spatial distribution of salmonid and smelt species, opportunities to minimize predation, sediment management, flood control, and navigational impacts. Several key conclusions relative to intake locations were:

- Intakes should be located as far north as possible to minimize encroachment on Delta smelt habitat. This approach also improves sweeping velocities at intakes as a result of muted tidal backwater effects⁴.
- Intakes should be located within straight reaches of the river to avoid complex flow patterns, scour, and sediment issues associated with river bends.
- Existing riparian habitat should be avoided.

3F.4 Value Planning Study Team

Recognizing that other factors play a role in constraining options and contributing to feasible intake location choices, a Value Planning Study Team (VPS Team) was assembled to assist in further defining intake locations and configurations. The VPS Team completed a Value Planning Study (VPS) to further evaluate potential intake schemes considering factors beyond the limits of the river boundaries. The VPS Team was comprised primarily of independent participants spanning a broad cross-section of technical disciplines (including civil engineers, mechanical engineers, and biologists), met for a week-long workshop that included a half-day tour of proposed intake locations to provide the team with perspective on existing conditions and constraints to intake siting. Three members of the FFTT were included on the VPS Team to maintain continuity and information transfer. The VPS was developed to analyze potential options considering operational flexibility, maintainability, community impacts, conveyance requirements, economics, and infrastructure

³ *North Delta Intakes Facilities for the Draft EIR/S*. Table 3.1 FFTT Proposed Diversion Concepts. (11-30-2010 Draft).

⁴ Although intake locations were recommended to be as far north as possible they must also be sufficiently downstream from the SRCSD discharge for water quality considerations and also south of the confluence of the Sacramento and American Rivers for flow considerations.

impacts, among other considerations. A list of roughly forty intake concepts was developed for the east and west conveyance routes, with varying capacities, locations and technologies. Ultimately, twenty-three options were advanced for comparison, addressing both east and west conveyance alignments along with an additional eight options specific to the west alignment only and including in-river, near-bank, and on-bank screen configurations. Eight performance factors were applied:

- Operational flexibility
- Maintainability
- Constructability/construction ease
- Fish protection/fish benefits
- Landowner and community impacts
- River impacts
- Safety
- Security

The VPS Team produced a list of feasible intake concepts as well as performance factors and approximate costs by which to compare the options. A criteria and evaluation matrix was developed as a decision support tool to compare the performance of a series of concepts using a weighted list of characteristics or factors (California Department of Water Resources 2009a). Selection of Intake Locations for EIR/EIS Analysis

Based on what was analyzed by the FFTT and the VPS Team, initial intake locations were selected for evaluation by the BDCP lead agencies. Subsequent to the FFTT and VPS Team efforts, more in-depth evaluations were conducted to select the appropriate number of intakes and a preferred arrangement of locations that would meet a variety of criteria, such as fish protection, land use impacts, impacts to terrestrial species habitat, river geomorphology, hydraulics, and use of best available intake technology. This decision making process served as the basis for defining intake facility locations for evaluation in the Draft EIR/EIS. These evaluations led to the identification of five separate intake facilities, each with a maximum diversion capacity of 3,000 cfs, to be located between Freeport and Courtland.

In January 2009, a subset of Lead-Agency staff held meetings to refine locations of intake sites for all conveyance alignment options according to various environmental and land impact factors. A collaborative process was used to adjust intake sites in an attempt to minimize impacts. Available geographic information system (GIS) datasets used included:

- Property boundaries/parcel lines
- Rare species habitat zones
- Existing points of diversion on the Sacramento River
- Existing Land Use
- Wetland delineation
- River cross-sections
- United States Fish and Wildlife Service (USFWS) fish trapping data
- Ground level surveillance

A site tour was also conducted in coordination with lead agency staff to give participants a view of the physical setting and existing site conditions at the various potential intake locations. This trip was instrumental in providing first hand perspective on the somewhat typical site conditions that exist for all of the intake locations.

Intake locations were differentiated by an evaluation of exposure of special status fish species to the intake screens, acreage of special status terrestrial species impacted by the intake locations, and acreages of land where existing uses would be changed by intake facilities. Physical locations identified by the FFTT were adjusted to minimize landside impacts. The result of this process and the respective adjustments are reflected in Figure 3F-2.

After the refinement of the intake locations, discussions were held with lead agency representatives and BDCP/DHCCP in December of 2009 to develop key design and environmental factors that could be used to screen intake location options. The primary purpose of the screening process was to determine a smaller set of potential intake locations. Key factors that were decided upon were:

- Individual points of diversion should be limited based on FFTT and VPS study results.
- Omit options exclusively involving cylindrical screen technology due to design limitations.⁵
- Use a single screening technology rather than multiple technologies based on O&M challenges⁶.
- Eliminate options involving ten intakes because of the increase in community and species impacts.
- Eliminate options involving six intakes because they are similar to and represented by options with five intakes.
- Eliminate intake options at the southern end of the study reach due to tidal influence, higher probability of Delta smelt abundance, and potential impacts on natural flow in Sutter and Steamboat Sloughs.

The result, after applying these factors in several iterations, was a set of five potential intake combinations.⁷

3F.4.1 Conceptual Engineering Report Concept Planning Conclusions

Next, based on the process outlined above, Lead Agency staff selected initial intake locations for the East and West preliminary intake sites based on analysis prepared in a conceptual engineering report (CER). The CER recommended five 3,000 cfs capacity intakes. Locations A (west of the Pocket Area), B (south boundary of the Pocket Area), D (southern east-west leg of the Freeport Bend), F (just downstream of Hood), and G (between Hood and Courtland) were selected for the western

⁵ Cylindrical screens consist of a series of dual screens (see ATO CER, Appendix B [DWR 2010a]). The space between the dual screens has the potential to provide opportunity and area for use by predatory species. Drawbacks to this screen configuration also include the number of moving parts and hydraulic components, exposure to impact damage from debris/bed load, single source manufacturing, and potential for producing structures in the watercourse which supports predation.

⁶ The use of a uniform (single) screen technology for all of the intake facilities has advantages including uniformity of design, exchangeable parts, uniform training for operations and maintenance employees and consolidation of operations and maintenance activities.

⁷ *Proposed North Delta Intake Facilities for the Draft EIR/S*, Table 3.4 & Figure 3.6, p. 3-21 (DWR 2010b).

isolated conveyance facility; and locations B, D, E (due east of Clarksburg), F, and G were chosen for the eastern isolated conveyance facility. For the Through-Delta conveyance alignment, two 2,000 cfs intakes were selected at locations F and G.

Location C (due west of Freeport) was eliminated due to its proximity to an existing intake at Freeport and its location about 0.5 miles south of the existing Sacramento Regional County Sanitation District (Sacramento Regional) treatment plant outfall. Intake locations E and E1 were eliminated from consideration for the west conveyance option because of their proximity to an existing community. Intake location B is as far north as an intake can be for the eastern isolated conveyance facility without substantially impacting urban development in Sacramento.

Locations D and E were preferred for the eastern isolated conveyance facility because they are located at the north end of the study reach and because water from these two intakes and an intake at location B can be transported to an eastern conveyance facility with a minimum of land use disturbance. Intake locations F and G were preferred, for both alignments, because they can also be joined to a single canal to move the water from all five intakes to a conveyance facility with a minimum of land use disturbance and impacts to terrestrial habitat.

Additionally, existing conditions and preliminary impact analyses were conducted in support of the EIR/EIS. This information was available to the lead and responsible agencies to further refine intake locations during their formulation of EIR/EIS alternatives and review of preliminary impact analysis results.

In September 2009, representatives of the EIR/EIS lead and responsible agencies took a site tour and recorded their field observations and recommendations for intake locations. The purposes of the tour were as follows: to incorporate updated information from the administrative draft EIR/EIS document and draft alternatives development analysis, along with recommendations based on the professional judgment of agency representatives; to confirm the relative suitability of currently proposed intake sites; to make recommendations for adjustments, if needed; and to provide supporting rationales excluding certain areas from further consideration due to their less favorable characteristics.

As a result of the field visit, several intake locations were shifted slightly to avoid existing easements, riparian habitat restoration activities, towns/communities, established monitoring locations, and high-value land uses. Understanding the iterative nature of the intake siting process, alternate intake locations were also recommended in the event that, based on follow-up engineering investigations, one of the other recommended intake locations was determined to be less favorable.

3F.4.2 Consideration of Intake Locations Downstream of Sutter and Steamboat Sloughs

Additional modeling was conducted in late 2009 to simulate operation of the proposed five intake locations. This effort further informed the DHCCP team and the EIR/EIS consulting team on how the intakes might be operated (e.g., comparing an operational scenario where all intakes would be pumping simultaneously with a scenario where intakes would be activated using top to bottom – that is, north to south – sequencing and how the Delta hydraulics would be affected). The modeling effort also raised questions related to fish exposure to the intakes and possible scenarios to provide additional biological protection through avoidance.

1 In 2009 and 2010, the fish agencies requested additional hydrologic and operational information to
2 determine (i) whether biological protection could be increased by locating all of the intakes
3 upstream of the confluence of the Sacramento River with Sutter and Steamboat sloughs or (ii)
4 whether two intakes located downstream of the sloughs would provide additional protection under
5 certain operating conditions. The rationale for identifying potential intake locations downstream of
6 Sutter and Steamboat sloughs was based on the assumption that some proportion of the population
7 of emigrating juvenile salmonids and smelt that emigrate through or generally use the distributaries
8 during regular seasonal movements would avoid exposure to the intakes downstream of the
9 distributaries. Current information suggests that roughly 25–30% of the Sacramento River flow may
10 enter Steamboat and Sutter sloughs. If fish are diverted at the same ratio, then 25–30% of the
11 migrating anadromous salmonids could experience exposure to only 3 screens, as opposed to 5. Fish
12 that avoid exposure to intakes are not subjected to “take” associated with increased predation
13 related to the presence of intake structures, and entrainment or impingement related to operations.
14 However, increased tidal influence of downstream intake locations could result in multiple
15 exposures to the same intake with tidal reverse flows. Likewise, intakes located downstream of the
16 sloughs and thus deeper into the tidally influenced reaches of the Delta could result in reduced
17 water quality for diversions, a condition that could worsen in the future with climate change and sea
18 level rise. Additionally, there is a potential for reduced water diversions due to diversion operation
19 sweeping velocity constraints from increased tidal influence of the farther downstream intake
20 locations.

21 The BDCP consulting team also conducted investigations on intake locations below the sloughs and
22 their respective effects on these distributaries’ tidal reverse flow/emigration durations. The intent
23 was to determine, if possible, what effect intakes located downstream of the sloughs would have on
24 1) the absolute flows and relative proportion of flows entering Sutter Slough, Steamboat Slough, and
25 mainstem Sacramento River, 2) increased tidal influence at these locations, 3) hydrologic
26 interactions between downstream intakes and Georgiana Slough or the Delta Cross Channel, and 4)
27 the potential for any such interactions to result in adverse effects on covered fish species, habitat
28 quality, and water quality.

29 Between 2009 and 2011 several meetings between the Lead Agency group and the DHCCP team
30 resulted in recommended adjustments to the proposed intake locations. Due to community
31 opposition expressed during scoping meetings, construction impacts in an overly constrained
32 conveyance corridor, historic building conflicts, and the precedent set by the Freeport Diversion EIR
33 (a 300 cfs intake across the river from the Pocket Area was determined not a reasonable and
34 prudent alternative), the Lead Agency group recommended relocation of the northernmost intakes.
35 Locations downstream of Sutter and Steamboat Sloughs were discussed, and additional analysis was
36 conducted by the BDCP consulting team that discouraged downstream locations to minimize tidal
37 influence effects on operation, maximize positive outbound sweeping velocities, minimize
38 encroachment on Delta smelt habitat, and avoid producing reverse flows in the sloughs. General
39 recommendations from the FFTT to provide approximately 1-mile separation between intakes, to
40 locate intakes on straight reaches of the river as far north as possible, and to locate the furthest
41 north intake a few miles downstream of the Sacramento regional effluent discharge remained intact.
42 However, the process did result in adjusting physical locations of intake sites between Sacramento
43 and Walnut Grove from those identified in the FFTT study, including the elimination of one
44 particular site due to prohibitive existing features and conditions.

45 The BDCP consulting team presented its recommendations regarding the upstream versus
46 downstream intake locations to the BDCP Steering Committee on January 20, 2010. In support of

1 locating all five intakes upstream of Sutter Slough, the team cited reduced probability of bi-
 2 directional tidal flows and improved sweeping velocities with greater river flows further upstream
 3 (less flow diverted to sloughs), which could reduce exposure time to intake screens. The team also
 4 suggested that locating intakes further upstream would reduce the future effects of sea level rise
 5 and salinity intrusion on export operations and protection of fish. Intakes located further upstream
 6 would be less likely to entrain organic material and food produced in the Cache Slough region.

7 Locating intakes downstream of Sutter Slough could result in reduced exposure of juvenile
 8 salmonids and other covered fish produced upstream because some proportion of the fish would
 9 migrate downstream through the sloughs and thus not be exposed to the two downstream intake
 10 structures. However, downstream locations could increase delta smelt and longfin smelt exposure to
 11 the screens, an increase that could be exacerbated over time by sea level rise. Locating two intakes
 12 downstream would also lengthen the distance the intakes are spread along the Sacramento River,
 13 providing increased refuge areas between structures, but the increased probability of bi-directional
 14 tidal flows would increase exposure duration for the two downstream intakes. The BDCP consulting
 15 team also pointed out that revisions to the bypass criteria would be needed to account for flows
 16 entering Sutter and Steamboat sloughs; and these bypass flows and diversion rates would be
 17 complex to model. Based on a consideration of the pros and cons of the two alternative intake
 18 location configurations, the BDCP consulting team recommended that all five intake structures be
 19 located in the Sacramento River in the reach upstream of the confluence with Sutter Slough.

20 However, the potential intake locations downstream of the sloughs continued to interest the
 21 fisheries agencies. An interagency conceptual discussion of the relationship of the intake locations to
 22 smelt and salmonid distribution and exposure to the intakes resulted in a calculation of smelt and
 23 salmonid exposures under the two configurations. The primary concern of the location of the
 24 intakes respective to the smelt population distribution in the diversion planning reach is to avoid
 25 smelt egg and larval life stage exposure to the intakes in which entrainment or impingement could
 26 occur. Presumably, since the egg and larva are free floating, the smelt losses would be proportionate
 27 to the rate of exposure and the proportion of diversion flows to the tributary flows at the time of
 28 exposure. The rationale for placing the intakes as far upstream as feasible for smelt distribution is
 29 that the portions of the smelt population in this reach that reproduce downstream of the intake
 30 locations would not be exposed to the intakes, or in cases of fish produced from the middle portion
 31 of the reach, smelt egg and larva would be exposed to a reduced number of intakes. Using collected
 32 fish/station data from the planning reach, the downstream configuration resulted in a calculated
 33 23% increase in smelt screen exposures while the downstream configuration resulted in a
 34 calculated 16% decrease in salmonid screen exposures.

35 **3F.5 Refinement of Intake Locations for EIR/EIS** 36 **Analysis**

37 Previously the FFTT identified 12 sites as possible intake locations extending from north of Freeport
 38 to Sutter Slough. Further effort refined the intake sites proposed by the FFTT. Site visits, scoping
 39 comments, and land use considerations prompted the EIR/EIS consulting team to adjust its original
 40 five proposed sites. In developing proposed sites for the intakes, the following general
 41 considerations were used:

- Position them as far upstream as practical to best avoid encroachment on potential Delta smelt habitat and to minimize probability of smelt exposure;
- Position them as far upstream as practical to best avoid tidal influence and to achieve the greatest opportunity for positive outbound flows with ambient sweeping velocities minimizing fish exposure duration;
- Site intakes to avoid highest concentration of fish in the water column, found to be toward the outside radius of a bend per United States Geological Survey “Clarksburg Bend” pilot experiment conducted in 2005–2006;
- Locate intakes upstream of Steamboat and Sutter Sloughs to avoid producing unnatural reverse flows in the sloughs, prolonging emigration of salmonids entering these waterways, and increasing exposure to predation by circulating young fish back and forth past aquatic and avian predators;
- Maintain a one-mile buffer distance between intake facilities to provide for fish resting and redistribution within the river section;
- Minimize visual and noise disturbance, as well as construction-related impacts, to land owners, residents, and commercial areas;
- Avoid/Minimize displacing land owners and residents;
- Avoid known areas with high concentration of cultural and historic resources;
- Preserve riparian habitat whenever possible and minimize impacts to special status terrestrial species and high value habitats;
- Avoid placing intakes where hydraulic conflicts with existing facilities could occur; and
- When possible, use sites where levee stability is compromised and requires eventual repair even without new intakes (the thought being that, because intake construction requires movement of existing levees, long-term cost savings could be achieved by using intake construction as an opportunity to strengthen levees already in need of strengthening).

The proposed five intake structure locations were reviewed by the Lead Agency group and its Anadromous Fisheries Mini-Effects Team, the BDCP Steering Committee, and the National Marine Fisheries Service. The Anadromous Fisheries Mini-Effects Team analyzed the proposed locations and identified a concern that the intake structures would potentially attract predatory fish and increase the vulnerability to predation mortality of juvenile salmonids and other covered fish species. To offer alternate pathways to migrating salmonids and other fish, it was again proposed to locate one or more intakes downstream of the junctions with Sutter and Steamboat sloughs. The EIR/EIS consulting team recognized the need to include downstream intakes in the range of alternatives evaluated in the EIR/EIS.

3F.6 Lead Agency Suggested Locations

In May 2010, the Lead Agency group guiding development of the EIR/EIS suggested that five specific site locations north of Sutter and Steamboat sloughs and two site locations south of the sloughs be moved forward for analysis, with each site capable of diverting 3,000 cfs from the Sacramento River. Meanwhile, the DWR engineering team obtained bathymetric data for the entire river reach and

1 began evaluating the proposed site locations for appropriate river geometry, resulting in suggested
2 alternative sites for several of the intake locations.

3 In July 2010, the BDCP Steering Committee received a presentation entitled, “Evaluation of North
4 Delta Intake Locations,” which addressed potential optional intake locations, including intakes both
5 upstream and downstream from the five proposed intake locations suggested by the EIR/EIS
6 consulting team. Key findings from the presentation were:

- 7 • All configurations analyzed, within the reach upstream of the Sacramento-American River
8 confluence to downstream of Sutter and Steamboat Slough, appear to have similar salinity levels
9 at the intakes.
- 10 • Diversion capability appears insensitive to the intake configurations analyzed.
- 11 • Operations and operational preference are more important than location of the intakes for
12 effects on tidal dynamics.
- 13 • Intake locations primarily influence exposure risk and to a lesser extent migration pathways.

14 This presentation indicated that locating two intakes south of Sutter and Steamboat Sloughs may
15 provide a significant benefit to out-migrating smolts. This benefit was based in part on the results of
16 a one dimensional particle tracking model that indicated that about half the particles moved down
17 Sutter and Steamboat Sloughs and the other half moved past Walnut Grove. Since smelt larvae are
18 much more likely than salmonids to be entrained through a screen, the possible benefits associated
19 with avoiding the lower intakes might provide an overall greater benefit for these alternative intake
20 locations. However, it was noted that fish do not necessarily behave like particles and the actual
21 percentage of downstream migrants entering these sloughs is uncertain. Assumptions may also be
22 affected by where the fish are during low versus high flows in the river. For example, fish may be
23 more bank-oriented during low flows, while they may be more center-oriented with higher flows or
24 with changes in turbidity. Juvenile salmonid emigration behavior and habitat preference may in turn
25 be a function of whether fish are wild or are produced by a hatchery, as hatchery fish may be more
26 bank-oriented due to feeding patterns at the hatcheries.

27 An acoustic tracking study conducted by David Vogel (2008) monitored large (107 mm to 181 mm
28 smolt sized) juvenile Chinook salmon as they emigrated through this region of the Delta. Vogel
29 reported that 26% of tagged smolts entered Sutter and Steamboat Sloughs during a series of
30 releases in December, and 37% entered the sloughs during January releases. It is problematic to try
31 to interpret these data to estimate how smaller fish such as larval delta smelt or fry sized salmonids
32 might behave at these channel junctions, as these smaller fish would have much weaker swimming
33 abilities than the larger fish used in Vogel’s study.

34 **3F.7 Further DWR Studies**

35 In late 2010 DWR contributed two reports summarizing studies and analysis relevant to selection of
36 intake locations. The first, *Two Dimensional Hydraulic Modeling Studies of DHCCP Intakes*⁸,
37 summarized preliminary two dimensional hydraulic modeling results of the Sacramento River
38 section covering the proposed intake sites for the DHCCP. The objective of these modeling studies
39 was to quantify the near-field impacts of the proposed intake technologies on Sacramento River

⁸ *Proposed North Delta Intake Facilities for the Draft EIR/S, Appendix G (DWR 11-30-2010).*

hydraulics. This study concluded that based on the two dimensional modeling runs, both in-river type intakes (with and without setback levees) would have severe adverse impacts on channel hydraulics. The on-bank intakes, however, were found to have minimal impacts on the river hydraulics and were viable alternatives for the DHCCP program.

In response to the bathymetric study, DWR Division of Engineering (DOE) prepared a report entitled *Evaluation of DHCCP Proposed Intake Locations* to reevaluate the locations of the proposed DHCCP intakes. A total of 17 locations along the Sacramento River between Freeport and Steamboat Slough were included in DOE's study: five sites recommended by the DHCCP Conceptual Engineering Reports from November 2009 (California Department of Water Resources 2009b), five sites recommended by the DHCCP from *Technical Memorandum 3 Recommended Delta Intake Facilities for the Draft EIR/S (Draft)* (California Department of Water Resources 2010c), and seven sites chosen by DOE based on the new bathymetric study data. The sites were named Intake Site 1 (IS-1) through IS-17, from the most northern site to the most southern site. All of these sites also satisfied recommendations made by the FFTT's first report for proposed intake locations. All seventeen of the sites were evaluated using aerial maps, land use maps, recently collected bathymetry data, river cross-sections, and water surface elevations at the 99% exceedance level. The sites were then analyzed and compared based on the following criteria:

- Location on the east or the west bank of the Sacramento River
- Impact to existing structures, businesses, historical interests and current use of the land,
- The potential for deposit of sediments at the face of the intake fish screens, and
- Potential encroachment into the river cross-section and corresponding water depth, and preliminary screen height and intake facility length estimates.

After evaluating all seventeen potential sites, the report identified two preferred combinations of five intake locations. One set of five was all on the east bank of the river and north of Courtland. A second set allowed for flexibility in locating the intakes on the east or west bank.

3F.8 Reconvening the Fish Facilities Technical Team

Based on new information produced and gathered during the efforts described above, as well as discussions occurring in various other working groups (such as the Bypass Subgroup, the Habitat and Restoration Technical Team, and the Anadromous Fish Team), the FFTT was reconvened to revisit its initial recommendations. In January 2011, a formal charge was given to the FFTT by the EIR/EIS five agency group, made up of representatives from DWR, California Department of Fish and Game (CDFG), Reclamation, USFWS, and the National Marine Fisheries Service (NMFS). A series of meetings were conducted to address the issues as assigned in the formal charge and to draft a technical memorandum of the team's recommendations and rationale (BDCP Fish Facilities Technical Team 2011).

Among other tasks, the FFTT was charged with:

- Reviewing new information developed since the last FFTT meetings held in 2008, including the Separate Analysis presented to the BDCP Steering Committee in January 2010 and any construction cost estimations for the separate configurations provided in the Separate Analysis conducted by the BDCP consulting team;

- Reviewing additional information and studies generated since the FFTT last convened; and
- Based on those reviews, to consider any adjustments to its previous recommendations regarding locations, individual size, and configuration of intakes for the benefit of listed and unlisted fish or for water quality.

In considering any options for intakes, the FFTT was instructed to consider changes in flood potential (both local and regional), preliminary costs, and constructability for a total 15,000 cfs diversion capacity. To aid in the analysis of additional intake locations south of Sutter/Steamboat Sloughs, the FFTT asked DWR to provide Sacramento River bathymetric plots between the sloughs and Walnut Grove. The team looked at the bathymetric plots as well as some cross sections of two locations in the reach that were more than a mile apart and had a river bottom of about -22 feet mean sea level (MSL). The FFTT agreed that optional intake locations south of Sutter/Steamboat Sloughs should be reviewed.

Additional recommendations from the FFTT in 2011 include:

- Locate diversion structures up against the bank of the river rather than out in the channel.
- Locate intakes downstream of the town of Freeport due to public scoping comments received in March 2009 citing construction impacts in an overly constrained conveyance corridor, historic building conflicts, and the precedent set by the Freeport Regional Water Project EIR indicating that intakes in the Pocket area would produce significant impacts.
- Target approximately 1-mile of separation between intakes, though closer spacing may be acceptable to assure that each location meets the critical siting conditions (e.g., adequate river depth and bank geometry).
- Locate intakes within straight reaches of the river or mild outside bends to avoid complex flow patterns, sedimentation, and excessive scour.
- Locate the furthest upstream intake downstream of where complete mixing is reported to occur with effluent discharge from the Sacramento Regional Wastewater Treatment Facility.

The FFTT reviewed bathymetric data for both the EIR/EIS locations and the several additional locations identified by the DWR engineering team which were potentially better suited for a diversion facility due to water depth and river curvature. The additional intake locations evaluated by the FFTT included the original EIR/EIS Sites 1 through 5, the Alternate Sites 1 through 5 as refined by DWR for the FFTT, and the two sites below Steamboat Slough, FFTT Sites 6 and 7.

During the process, it was discovered that conflicting coordinates and facility footprints existed for intakes 1-5. An initial set of GPS coordinates had been developed for the 2010 DHCCP Conceptual Engineering Reports (CER). After the release of the CER, DWR developed revised coordinates largely reflecting the change from “in-river” to “on-bank” intake fish screen technologies and data from the new bathymetric survey. The differences between the two efforts can be seen on Table 1. For the two locations furthest upstream, intakes 1 and 2, the alterations were minimal in comparison to the initial coordinates identified in the CER process. However, the locations for intakes 3, 4, and 5 differed appreciably, which prompted the FFTT to recommend a field visit to those alternative intake sites with agency and consultant staff knowledgeable in the biology, engineering, botany, community/land use, and hydrology for the area.

Table 1. Potential North Delta Intake Site Location Coordinates Comparison

Site	Location	EIR/EIS Sites	DWR/DHCCP Alternative Sites	Offset from EIR/EIS Site
1	Latitude	38.43411	38.434058	270' Downstream
	Longitude	-121.51855	-121.519510	
2	Latitude	38.405342	38.405542	70' Upstream
	Longitude	-121.514319	-121.514390	
3	Latitude	38.374924	38.383023	3,730' Upstream
	Longitude	-121.523036	-121.517813	
4	Latitude	38.355213	38.362588	3,650' Upstream
	Longitude	-121.527962	-121.519945	
5	Latitude	38.345037	38.349777	4,780' Upstream
	Longitude	-121.548789	-121.533840	
6	Latitude	38.296029		
	Longitude	-121.565009		
7	Latitude	38.281036		
	Longitude	-121.546916		

All of the intake sites are located on the left bank looking down stream with a near-bank bed elevation of approximately -15 feet or greater. Sites on or just below an outside bend in the river are preferable. It is anticipated that these sites will be deeper, have higher sweeping flow velocities, and be less subject to sedimentation. Conversely, it is anticipated that sites on or just below the inside of a river bend will be shallower, have slower sweeping flow velocities, and be more susceptible to sedimentation.

As part of its charge, the FFTT revisited accumulated information relative to locating intakes south of Steamboat and Sutter sloughs. These continued discussions centered around the potential effects on Sacramento River spawning delta smelt from having intakes further south. The FFTT was also uncertain of the potential effects to salmonids from placing intakes below Steamboat and Sutter Sloughs. As previously described, the use of particle tracking modeling indicates about half the particles move down the sloughs; however, fish do not necessarily behave like particles and the actual percentage of downstream migrants entering these sloughs is uncertain. The FFTT echoed previous concerns about slower flow velocities past these lower intakes as fish traveling past these intakes could be negatively affected by slower velocities. However, the proposed operational criteria under development by the DHCCP would have these lower intakes operating only during relatively high flow periods, and they would be required to shut down any time sweeping velocities were not meeting the minimum deemed to be safe for juvenile salmonids and adult delta smelt.

Concern was also raised for green sturgeon at all of the intakes, regardless of their location relative to the sloughs. Juvenile sturgeon (along with the other covered fish species) may face higher predation due to the presence of the structures alone (regardless of their operations). The interface between the fish screen facility and the river bottom will need to be evaluated to minimize impacts to sturgeon. The FFTT agreed that more information was needed to determine the potential effects for each of the covered species from placing structures below the sloughs, and recommended that the EIR/EIS evaluate the option to site intakes below Steamboat and Sutter Sloughs.

3F.9 Five-Agency Recommendations for BDCP Intakes 1–7

In December of 2011, technical staff representing the five lead agencies, along with consultant staff, participated in an additional site visit to the proposed intake locations and met to review selection criteria. This meeting resulted in recommendations to management for the siting of intakes 1–7 for the BDCP effects analysis (Figure 3F-3) (California Department of Water Resources 2011a). This group used the following criteria in determining their recommendations:

- Minimize impacts to aquatic and terrestrial species,
- Maintain a diversion structure's functionality,
- Provide adequate river depth (bed elevations from LIDAR and bathymetry data),
- Provide adequate sweeping flows (positioning along the river),
- Maintain flood neutrality, and
- Minimize impacts to land use and community.

Their final recommendations were as follows:

- Intake 1 – Use of CER 1 (or EIR 1)
- Intake 2 – Use of CER 2 (or EIR 2)
- Intake 3 – Use of Alt 3
- Intake 4 – Locate intake in between Alt 4 and CER 4
- Intake 5 – Use of Alt 5
- Intakes 6 and 7 – Use locations for 6 and 7 developed by the FFTT

3F.10 Phased Construction

Based on potential impacts to salmonids from large screened diversions, such as those considered in the BDCP, the National Marine Fisheries Services (NMFS) proposed phased construction of the intakes to reduce uncertainty surrounding the impacts of simultaneous construction. In response DWR, prepared a white paper evaluating the impacts to the costs, schedule and deliveries if phased construction was implemented. This paper concluded that phased construction as proposed by NMFS would increase the construction duration from 7.25 years to about 17.5–20.5 years. The construction cost would increase from approximately \$12.068 billion to \$13.29–14.236 billion (California Department of Water Resources 2011b).

In addition, on October 12, 2011, DWR held a Phased Construction Workshop held to address the uncertainties associated with the construction and operation of the five proposed intakes along the Sacramento River between Freeport and Courtland. The objective of this workshop was to better define the scope and schedule of a phased approach for construction to be included as a potential alternative in the EIR/S. Based on a series of assumptions regarding intake locations, intake capacity, size and location of the Forebay, six phasing scenarios were proposed. However, the EIR/S

evaluates construction of all intakes regardless of phasing in order to support the total impact in the analysis.

3F.11 Intake Locations Analyzed in the EIR/EIS

The intake locations evaluated in the EIR/EIS reflect the ongoing and iterative process between the environmental and the engineering teams and represent a reasonable range of alternative intake locations, including intake locations downstream of Sutter and Steamboat sloughs to evaluate potential effects on covered fish species. Figures 3-2, 3-4, and 3-6 in EIR/EIS Chapter 3, *Description of Alternatives*, show the seven intake locations for the tunnel, east, and west alignments respectively, as analyzed in the EIR/EIS.

At the June 20, 2012, BDCP public meeting, it was announced that the proposed project would consist of three 3,000 cfs (total of 9,000 cfs) diversion intakes along the eastern bank of the mainstem Sacramento River. The 7 intake locations under evaluation in the EIR/S could be located between Clarksburg and Walnut Grove. As the description for the proposed project was modified to reduce the maximum north Delta diversion capacity from 15,000 cfs to 9,000 cfs, the number of required intakes was reduced from five to three. In general, there has been a preference to locate sites as far north on the Sacramento River to reduce the area of overlap between delta smelt and direct exposure to the intake screens. However, salmonids emigrating along the mainstem Sacramento River would encounter some or all of the intakes proposed for construction, unless they travel downstream through the Yolo Bypass or Sutter and Steamboat Sloughs. Shorter screen lengths have been desirable to reduce the exposure time for fish swimming past the front of a screen. All intake locations would be located at least one mile apart as recommended by the FFTT to provide rests or breaks for fish passing multiple screens. Potential intake locations upstream of Scribner's bend were eliminated from consideration, due to the concern of proximity to a wastewater treatment plant located a few miles upstream.

Current Lead Agency discussions have narrowed down the locations of the three intakes to include intakes 2, 3, and 5 for analysis under the proposed project. Intake 2 is the second most northern intake location site of the seven sites under consideration and is located towards the middle of a gentle outside river bend with shallower depths than other intake locations under consideration. Therefore the shallower depths will require a longer screen length. However, intake 2 would have reduced costs when compared to the costs associated with Intake 1 due to its closer proximity to the intermediate forebay (IF) located near Hood. And, as discussed below, Intake 2 would create fewer potential impacts to nearby sandhill crane populations, compared with Intake 1. Intake 3 is located on the outer bend at the downstream end of a curve nearing the community of Hood. Deep bed elevations resulting in shorter screen lengths at Intake 3 make it a stronger candidate than Intake 4. Both intakes 3 and 5 bookend the community, but avoid many of the structures that Intake 4 would directly impact within the small community. For these reasons Intakes 2, 3, and 5 will move forward for analysis under the proposed project. The footprint for Intake 5 overlaps with the tip of Snodgrass Slough that serves as habitat for both aquatic and terrestrial species. There is also a natural gas field nearby that will need to be further examined in the process. However, the locations of Intakes 2, 3, and 5 being in close proximity for tunneling to the IF have made these locations a priority for consideration.

Intake locations not moving forward for analysis in the proposed project include Intakes 1, 4, 6, and 7, though they will be addressed in connection with other EIR/EIS alternatives. Those locations have

1 suitable attributes for placement of an intake; however, they did not make it as being the top three
 2 sites under analysis for the proposed project. Intake 1 is the most northern located site of the seven
 3 sites under consideration. Intake 1 is considered to have one of the shortest screen lengths of those
 4 under consideration, due to deep river bed elevations that occur along the toe of the bank, which
 5 have the potential to minimize impacts aquatic species. In contrast, project features such as
 6 transmission lines, borrow/spoil/reusable tunnel material areas, and intake facility footprints are in
 7 close proximity to an existing greater sandhill crane roost site located just east of the Intake 1
 8 location. Although cranes have been known to adapt over time to loud noises and other
 9 disturbances, the potential for constant utility, maintenance, and operation of Intake 1 could result
 10 in nest abandonment by the cranes which could cause stress to an already limited overwintering
 11 population of cranes that use the central Delta. The EIR/S alternatives evaluation will provide a
 12 comparison of potential effects associated with each intake location which should identify related
 13 aquatic and terrestrial impacts. Intake 1 is also the furthest away from the IF, therefore being the
 14 most costly of the seven locations. The footprint for Intake 4 encroaches upon parts of the developed
 15 area, where it would be expected to have a greater impact to the community than the other
 16 surrounding intake locations. Also, a natural gas field is close to the footprint for Intake 4 that would
 17 require further examination if the site was chosen.

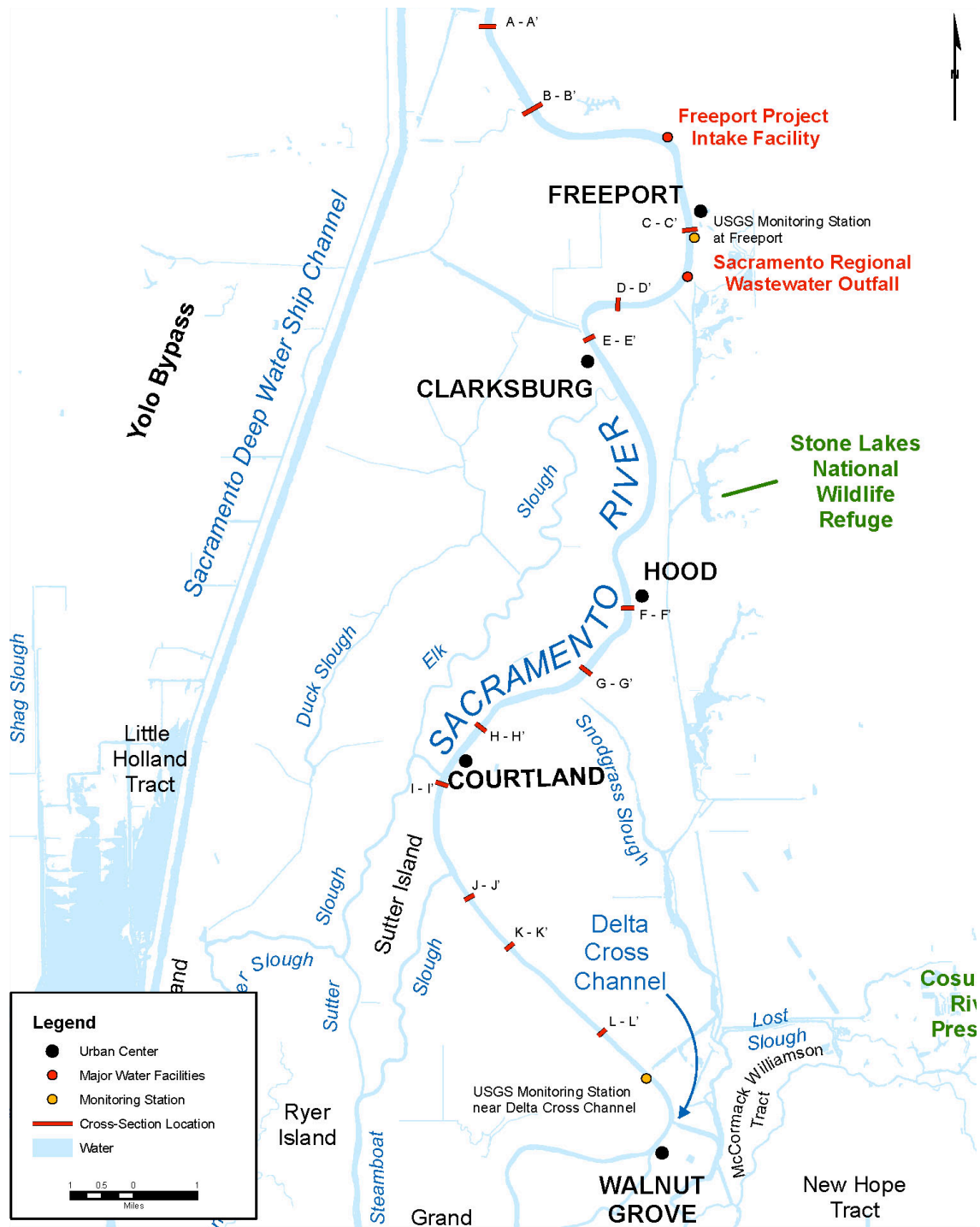
18 The alternate configuration of the North Delta intakes that includes intakes 6 and 7 was derived by
 19 the agencies as a way to potentially reduce exposure of outmigrants to increased entrainment,
 20 impingement, predation, and any other adverse effects associated with the intakes. The reduction in
 21 exposure was hypothesized to result from a portion of the downstream-migrating juvenile fish
 22 population entering Sutter and Steamboat sloughs (i.e., an alternative migration pathway) rather
 23 than staying in the mainstem Sacramento River. Because Intakes 6 and 7 would be located
 24 downstream of Sutter and Steamboat sloughs, the fish that migrate down Sutter and Steamboat
 25 sloughs would not pass these intakes and, therefore, would not be exposed to any adverse effects
 26 from these two intakes. Because intake location could influence the hydrodynamics of Delta
 27 channels, particle tracking was used to determine whether the configuration of intakes would
 28 potentially affect migration pathways for migratory species. This analysis assumed that
 29 outmigrating fish behaved as passive, neutrally buoyant particles, which is not likely true for most
 30 species, although fish generally follow flow patterns. For this analysis, particles were inserted just
 31 downstream of the American River confluence on the Sacramento River.

32 Results indicate that the percentage of particles that would travel into either Sutter and Steamboat
 33 sloughs or the Delta Cross Channel and Georgiana Slough differs very little between diversions from
 34 intakes 1, 2, 3, 4 and 5 and intakes 1, 2, 3, 6, and 7. Based on these results, it was concluded that the
 35 probability of fish migrating into these alternative pathways was independent of the location of
 36 proposed intakes between Intake Sites 4 and 5 and Intake Sites 6 and 7. It was further concluded,
 37 moreover, that the use of Intakes 6 and 7 could create a series of tradeoffs rather than just benefits
 38 for affected species. Moving the intakes would provide a benefit to those outmigrating species that
 39 would use Sutter and Steamboat sloughs as an alternative migration pathway because exposure to
 40 these two intakes would be reduced, although overall benefits are small (0% to 6% increase in
 41 overall survival). At times, survival of individuals in Sutter and Steamboat sloughs is lower than that
 42 in the mainstem Sacramento River. For those individuals that stay in the mainstem Sacramento
 43 River, increased effects of tidal conditions on river hydrodynamics near Intake Sites 6 and 7 (e.g.,
 44 reduced downstream velocity under flood tide conditions that could contribute to increased
 45 duration of exposure or multiple exposures to intakes) would increase the exposure to these

intakes. Moving the intakes to Sites 6 and 7 would increase exposure risk of delta and longfin smelt to the intakes, particularly in the future with sea level rise.

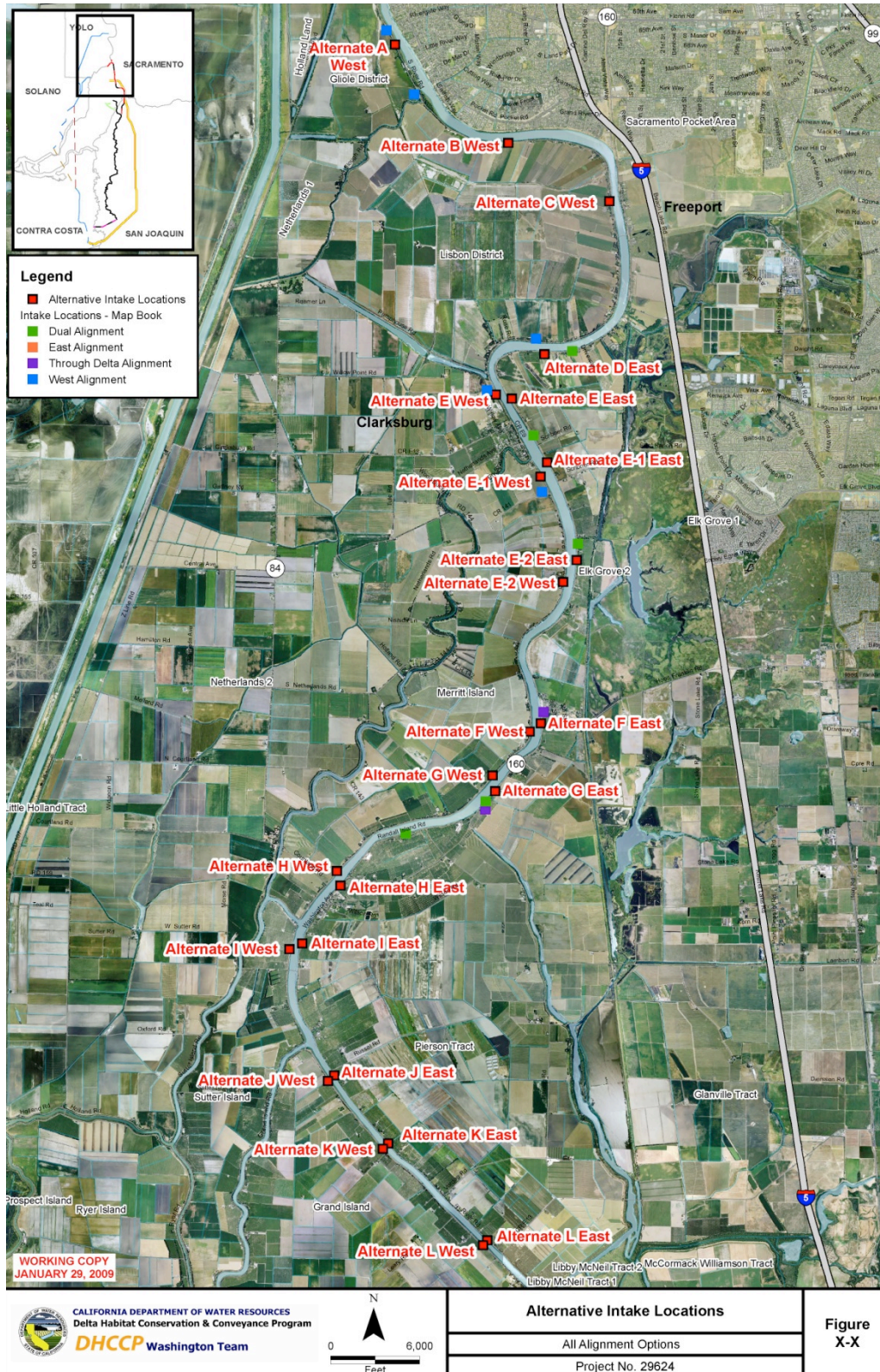
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Source: California Department of Water Resources 2010:3-4

Figure 3F-1
Sacramento River Cross-Section Analysis



Source: Figure 3.5, p. 3-18 (DWR 11-30-2010).

Figure 3F-2
Alternative Intake Locations

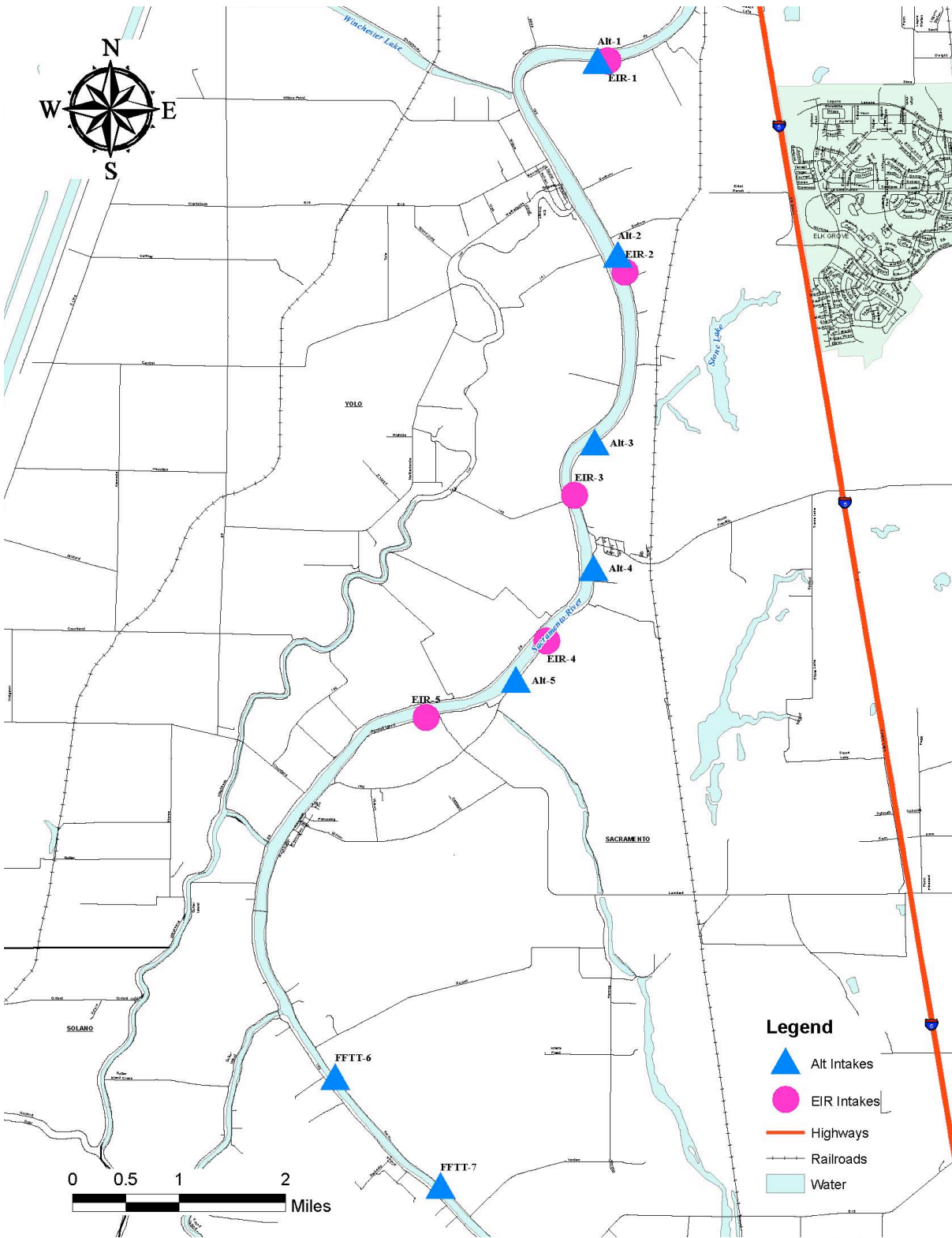


Figure 3F-3
Potential North Delta Intake Locations
Reviewed by the FFTT in 2011