APPENDICES

Appendix A

Public Comments Regarding the Notice of Preparation of an Addendum

Appendix A
Public Comments Regarding Notice of Preparation of an Addendum

A notice of the preparation of this addendum was circulated for 30 days on October 9, 2015 to the State Clearinghouse and public agencies and interested stakeholders. The notice requested written comments regarding the scope of the addendum to ensure that the range of environmental issues related to the proposed project is identified and evaluated. A total of four comments were received. Table A-1 summarizes the commenting party, comment letter signatory, and date of the comment letter. The comment letters are included after the table.

Table A-1. List of Comment Letters

Agency	Comment Letter Signatory, Date
Contra Costa Water District	Leah Orloff, Water Resources Manager – November 5, 2015
Delta Stewardship Council	Cindy Messer, Deputy Executive Officer – November 2, 2015
State Clearinghouse	Scott Morgan, Director – November 10, 2015
State Lands Commission	Brian Bugsch, Chief Land Management Division – October 22, 2015

CONTRA COSTA
WATER DISTRICT

November 5, 2015

Byron Buck
State and Federal Contractors Water Agency
1121 L Street, Suite 806
Sacramento, CA 95814

Dear Mr. Buck,

The State and Federal Contractors Water Agency is proposing to prepare an addendum to the Suisun Marsh Habitat Management, Preservation, and Restoration Plan EIS/EIR to implement the Tule Red Tidal Restoration Project (proposed Project). The proposed Project would convert approximately 420 acres of existing managed wetlands to tidal habitat to benefit federal and state-listed Delta smelt, longfin smelt, and salmonids. The proposed Project would introduce full, daily tidal exchange to an existing managed marsh duck club owned by Westervelt Ecological Services and to a portion of a Grizzly Island Wildlife Area which is owned and operated by the California Department of Fish and Wildlife.

Contra Costa Water District (CCWD) has previously commented on the Suisun Marsh Habitat Management, Preservation, and Restoration Plan EIS/EIR and the Mallard Farms Habitat Conservation Bank (Attached) requesting that prior to implementing a specific project, such as the proposed Project, project proponents do the following:

- conduct a robust water quality analysis to determine potential water quality impacts in the Delta, including but not limited to changes in X2 position, changes in upstream reservoir releases made to meet water quality objectives, changes in Delta drinking water quality.
- conduct a cumulative impact analysis containing all relevant and foreseeable habitat restoration projects in the Delta
- select a site design that minimizes water quality impacts
- avoid, minimize or mitigate adverse water quality impacts to a less than significant level

The Final Suisun Marsh Habitat Management, Preservation, and Restoration Plan EIS/EIR states on page 2-19 "*as part of each site-specific tidal restoration action, project proponents will use an accurate tidal hydraulics and salinity model (e.g., the RMA Bay-Delta model or other appropriate model) to simulate the proposed action to ensure that impacts on scour, changes in tidal stage, sedimentation, salinity, and other hydraulic processes do not exceed those described in this EIS/EIR*". An accurate salinity model is necessary but the results from that modeling must be interpreted within the context of existing regulations and water supply operations to fully disclose potential project impacts.

In 2014, CCWD reached a settlement agreement with the Mallard Farms Habitat Conservation Bank guaranteeing the public release of the proprietary RMA modeling inputs and results that future restoration projects can use to identify water quality impacts on an individual and cumulative basis so that they can be mitigated to the extent necessary. The settlement agreement includes information related to the Mallard Farms Habitat Conservation Bank and the Dutch Slough Tidal Marsh Restoration Project.

CCWD requests that the addendum for the proposed Project utilizes the RMA model, and information regarding other restoration projects, to analyze potential water quality impacts on an individual and cumulative basis. We look forward to reviewing the results of the impact analyses and working with you to ensure that any water quality impacts are minimized or otherwise mitigated to a less than significant level.

Thank you for your consideration of these comments. Please call me at (925) 688-8083 or call Maureen Martin at (925) 688-8323 if you have any questions. We would be happy to meet with you to discuss water quality modeling as the proposed Project goes forward.

Sincerely,

Leah Orloff
Water Resources Manager

LO/MM:wec

Attachment

CONTRA COSTA WATER DISTRICT

1331 Concord Avenue
P.O. Box H2O
Concord, CA 94524
(925) 688-8000 FAX (925) 688-8122
www.ccwater.com

December 29, 2010

Ms. Becky Victorine
Bureau of Reclamation
2800 Cottage Way
Sacramento, CA 95825

Subject: Suisun Marsh Habitat Management, Preservation, and Restoration Plan Environmental Impact Statement/ Environmental Impact Report

Dear Ms. Victorine:

Contra Costa Water District (CCWD) appreciates the opportunity to comment on the Suisun Marsh Habitat Management, Preservation, and Restoration Plan Environmental Impact Statement/Environmental Impact Report (EIS/EIR). CCWD supports the restoration objectives outlined in the EIS/EIR and looks forward to reviewing more analyses as specific restoration sites are selected and restoration moves forward.

Although specific restoration sites were not identified in the EIS/EIR, the modeling done for the EIS/EIR shows that site selection is important when considering water quality effects in Suisun Marsh and the Delta. Based on the modeling done to date, we suggest the implementing agencies prioritize restoration sites in the northern marsh (such as Set 1 modeled) that would tend to decrease Delta salinity over sites in the southern marsh (Set 2) that would tend to increase salinity. Restoring sites in the northern portion of the Marsh first, then following with sites in the southern portion of the Marsh, as appropriate, would help ensure that water quality in the Delta and Suisun Bay is not degraded at any point in project implementation. Alternatively, the actual location of the connections of the restoration sites to adjacent channels can alter the tidal hydrodynamics in a way that avoids undesirable water quality changes.

Maintaining Delta water quality without increasing western Delta salinity can be desirable with respect to maintaining the position of X2, the two parts per thousand isohaline, which is an ecological parameter. Based on the data in this EIS/EIR, potential adverse impacts can be avoided by scheduling and appropriate implementation of projects. This should be examined as each project is implemented.

As individual restoration projects are chosen, we look forward to reviewing site-specific water quality modeling. Important components of the water quality analysis will include the following:

- Effect on X2 position;
- Effect on upstream reservoir releases made to meet water quality standards; and
- Effect on Delta drinking water quality, including changes in salinity that could "otherwise substantially degrade water quality" in the absence of standards violations (California Code of Regulations, Division 6, Chapter 3, Article 20, Appendix G).

Please call me at 925-688-8083 or call Maureen Martin at 925-688-8323 if you have any questions. We would be happy to meet with you to discuss water quality modeling as the plan goes forward.

Sincerely,

Leah Orloff
Water Resources Manager

LO/MM:cmn

cc: Ms. Cay Goude, United States Fish and Wildlife Service
Mr. Scott Wilson, Department of Fish and Game
Mr. Russ Grimes, United States Bureau of Reclamation

CONTRA COSTA
WATER DISTRICT

1331 Concord Avenue
P.O. Box H2O
Concord, CA 94524
(925) 688-8000 FAX (925) 688-8122
www.ccwater.com

December 15, 2011

James Starr
California Department of Fish and Game
4001 North Wilson Way
Stockton, CA 95205

Dear Mr. Starr: Jim,

Thank you for your Dec. 5, 2011 transmittal of the responses to Contra Costa Water District's (CCWD's) comments on the Suisun Marsh Habitat Management, Preservation, and Restoration Plan Draft Environmental Impact Statement/Environmental Impact Report (EIS/EIR). CCWD supports the restoration objectives outlined in the draft and final EIS/EIRs and looks forward to reviewing more analyses as specific restoration sites are selected and restoration moves forward.

CCWD submitted comments on the Draft EIR/EIS (December 29, 2010, L. Orloff to B. Victorine) requesting more analysis whenever a particular restoration site is chosen for implementation, to address potential water quality and water supply impacts. The Final EIR/EIS addressed CCWD's comments with Master Response 1; however, the commitments made in this response do not fully address our concerns. CCWD appreciates that the EIS/EIR states that "as part of each site-specific tidal restoration action, project proponents will use an accurate tidal hydraulics and salinity model (e.g., the RMA Bay-Delta model or other appropriate model) to simulate the proposed action to ensure that impacts on scour, changes in tidal stage, sedimentation, salinity, and other hydraulic processes do not exceed those described in this EIS/EIR". An accurate salinity model is necessary, but the results from that modeling must be interpreted within the context of existing regulations and water supply operations to fully understand the action's effects. The number of exceedences of water quality objectives is not a sufficient metric to assess the full impacts a restoration action could have on water quality, water supply, and the ecosystem. For example, X2 can be substantially moved without necessarily exceeding a water quality objective. CCWD requests a commitment for a more thorough analysis of the potential water quality impacts of each project that is selected for implementation, and for public disclosure of the results of that analysis, including the project's effects on:

- compliance with D-1641 objectives
- changes in X2 position
- changes in upstream reservoir releases needed to meet water quality objectives
- changes in salinity at Delta drinking water intakes, including increases in salinity that could "otherwise substantially degrade water quality" in the absence of standards violations (California Code of Regulations, Division 6, Chapter 3, Article 20, Appendix G).

Some specific actions (such as the Set 2 actions modeled for the EIR/EIS) will tend to increase salinity intrusion into the Delta and move X2 eastward, to the detriment of fish and drinking water quality, while others (such as Set 1) will have the opposite effect. The results of the water quality analyses should be used to insure that project implementation is staged so that there is no net increase in salinity intrusion.

CCWD requests that the commitments we describe above – to more complete water quality analysis of specific actions and to staging the projects so that there is no net water quality impact – be made in the Department of Fish and Game's CEQA findings and included as additional mitigation measures to ensure that impacts remain less than significant. The attachment to this letter contains suggested language for those findings.

Thank you for your consideration of these comments. Please call me at (925) 688-8083 or call Maureen Martin at (925) 688-8323 if you have any questions. We would be happy to meet with you to discuss water quality impacts and modeling as the plan goes forward.

Sincerely,

Leah Orloff
Water Resources Manager

LO/MM:wec

Attachment

cc: Cay Goude, USFWS
Russ Grimes, USBR
Becky Victorine, USBR

Proposed CEQA Findings and Additional Mitigation Measures
Suisun Marsh Habitat Management, Preservation, and Restoration Plan Draft
Environmental Impact Statement/Environmental Impact Report

1. Water quality analysis for each specific tidal restoration action shall include evaluation and public disclosure of the action's effect on:

   - compliance with D-1641 objectives
   - changes in X2 position
   - changes in upstream reservoir releases needed to meet water quality objectives
   - changes in salinity at Delta drinking water intakes, including increases in salinity that could "otherwise substantially degrade water quality" in the absence of standards violations (California Code of Regulations, Division 6, Chapter 3, Article 20, Appendix G).

2. The water quality analyses shall be used to stage implementation of specific actions so that their net effect does not cause a temporary or permanent increased salinity intrusion into the Delta and an eastward shift in X2.

SETTLEMENT AGREEMENT REGARDING PROPOSED MALLARD FARMS CONSERVATION BANK

This Settlement Agreement Regarding Mallard Farms Conservation Bank (Agreement) is entered into and shall become effective this 23rd day of June, 2014, between the Contra Costa Water District (CCWD) and Reclamation District 2130 (RD 2130).

RECITALS

A. In April 2013, RD 2130 issued for public review and comment an Initial Study/ Mitigated Negative Declaration for the Mallard Farms Conservation Bank (the Bank, also referred to as "the Mallard Farms Restoration project") regarding the potential environmental effects that would result from the breaching of levees on seven contiguous parcels in Suisun Marsh bordering Honker Bay, pursuant to RD 2130's obligation under the California Environmental Quality Act.

B. As described in the IS/MND, the Bank will breach the outer levees of the seven contiguous parcels at three locations with the goal of creating habitat appropriate for a wide range of wildlife, including fish species protected under U.S. Endangered Species Act and California Endangered Species Act.

C. CCWD provides drinking water to approximately 500,000 customers in northern and central Contra Costa County and relies entirely on the Delta for its supply. CCWD has made nearly $1Billion in investments in the past 15 years to protect its source water quality and thus improve the quality of the water it serves to its customers. CCWD's operations and facilities are highly sensitive to Delta salinity.

D. CCWD believes that water quality at CCWD drinking water intakes could be significantly and adversely impacted by the Bank, individually and in combination with other similar types of restoration projects planned in the vicinity.

E. On May 2, 2013, CCWD submitted a comment letter asserting that the IS/MND prepared for the Bank was inadequate because it did not contain any analysis of the Bank's potential to increase seawater intrusion into the Sacramento-San Joaquin Delta, or any analysis, disclosure, or mitigation of potentially significant water quality impacts caused by increased seawater intrusion.

F. On March 26, 2014 RD 2130 provided CCWD with results from the proprietary RMA hydrodynamic model predicting potential changes in seawater intrusion in the Sacramento-San Joaquin Delta associated with the construction of the Bank and the Dutch Slough Tidal Marsh Restoration Project.

G. In the past the lack of publicly available modeling for habitat restoration projects has prevented some habitat restoration projects from fully evaluating water quality impacts on an individual and cumulative basis; the public release of the proprietary RMA modeling inputs and results provides a foundation that future restoration projects can use to identify water quality impacts on an individual and cumulative basis so that they can be mitigated to the extent necessary.

Therefore, in consideration of the foregoing, the Parties agree as follows:

1. The Parties agree that the modeling performed to date provides the analysis requested in CCWD's May 2, 2013 comment letter and thereby satisfies the deficiencies of the IS/MND initially identified by CCWD.
2. In exchange for the performance of the obligations undertaken by RD 2130 under this Agreement, CCWD agrees to forego bringing one or more legal challenges to the sufficiency of the IS/MND.
3. RD 2130 agrees to make publicly available, without restriction as to use, the following information from the RMA modeling study of the proposed Mallard Farms Restoration project:
   a. Input (boundary condition) time series including the tidal boundary, river inflows, Delta Island Consumptive Use, and water exports for the periods simulated in the RMA modeling study (2002, 2003, 2011).
   b. RMA model result times series at Delta monitoring stations for the base condition, three Mallard Farms breach configurations, and cumulative impact simulation that included the proposed Dutch Slough Tidal Marsh Restoration Project.
   c. Bathymetric data and levee configurations (Geo-referenced x-y-z point data) for the existing condition and modeled breached conditions of the Mallard Farms Restoration project site.

   RD 2130 further agrees to allow RMA to utilize the model geometry prepared for the Mallard Farms study, including the proposed Dutch Slough Tidal Marsh Restoration Project in other studies of cumulative effects of habitat restoration projects.
4. Each party hereto hereby releases and forever discharges the other party, and its respective boards, departments, divisions, related agencies and entities, current and former officers, current and former employees, directors, principals, attorneys, agents, administrators, trustors, trustees, beneficiaries, shareholders, parent companies, partners, associates, subsidiaries, affiliates, predecessors, insurers, landowners, consultants, successors and assigns from any and all claims, including attorney's fees and costs, arising from the dispute regarding the sufficiency of the Initial Study/ Mitigated Negative Declaration for the Mallard Farms Conservation Bank.
5. The Parties understand and agree that this Agreement memorializes a

compromise of disputed claims, and that the consideration herein is not, in any manner, to be construed at any time or for any purpose, as an admission or concession about the merit or lack thereof of any Party's position concerning these claims, or as an admission of liability by either party, which liability is expressly denied and controverted.

6. This Agreement contains the entire agreement between the Parties with respect to the subject matter hereof and supersedes all prior and contemporaneous agreements, representations, and understandings of the Parties.
7. This Agreement is the product of negotiation and preparation of the Parties. Any rule of construction to the effect that any ambiguity is to be resolved against the drafting party shall not be applied to the interpretation of this Agreement.
8. The Parties have freely and voluntarily executed this Agreement and are not acting under coercion, fraud, duress, menace, economic compulsion or undue influence, or because of any supposed disparity of bargaining power; rather, the Parties are freely and voluntarily signing this Agreement for their own benefit.

By affixing his/her signature below, each of the persons signing this Agreement warrants and represents that he/she has read and understands this Agreement, that in signing on behalf of a Party he/she has full and complete authority from that Party to bind said Party to perform and comply with each and every term, obligation, condition and covenant set forth in this Agreement, and that the Party on behalf of whom he/she signs agrees to be bound by its terms.

RECLAMATION DISTRICT NO. 2130

By: ____________________
President, Board of Trustees

ATTEST:

____
District ~~Secretary~~ Treasure

APPROVED AS TO FORM:

____
David Aladjem, Attorneys for District
Reclamation District No. 2130

CONTRA COSTA WATER DISTRICT

By: ____________________
Jerry Brown, General Manager

ATTEST:

Mary A. Neher
District Secretary, Mary A. Neher

APPROVED AS TO FORM:

Carl P A Nelson 6/10/14
Carl P. A. Nelson, Attorneys for District
Contra Costa Water District

NOTICE OF SPECIAL MEETING
RECLAMATION DISTRICT NO. 2130

NOTICE IS HEREBY GIVEN that the Board of Trustees of Reclamation District No. 2130 calls a special meeting to consider the approval of a settlement agreement between Reclamation District No. 2130 and Contra Costa Water District. The special meeting is open to the public and will be held on June 6, 2014, at 10 a.m. at the following address: 4171 Suisun Valley Rd., Fairfield, California.

Any documents that are made available to the Board of Trustees before the meeting shall be available for public review, by appointment, by calling the following number: (707) 864-0681.

DATED: June 6, 2014

Steve Murariu
Secretary/Treasurer, Board of Trustees
Reclamation District No. 2130

DELTA STEWARDSHIP COUNCIL
A California State Agency

980 NINTH STREET, SUITE 1500
SACRAMENTO, CALIFORNIA 95814
HTTP://DELTACOUNCIL.CA.GOV
(916) 445-5511

November 2, 2015

Tara Beltran
State and Federal Contractors Water Agency
1121 L Street, Suite 806
Sacramento, CA 95814
tbeltran@sfcwa.org

RE: Notice of Addendum for the Tule Red Tidal Restoration Project, SCH#2003112039

Dear Ms. Tara Beltran:

Thank you for the opportunity to comment on the Notice of Addendum for the Tule Red Tidal Restoration Project to the Suisun Marsh Plan Habitat Management, Preservation, and Restoration Plan Environmental Impact Statement / Environmental Impact Report (EIS/EIR). As you know, the Delta Stewardship Council (Council) is a state agency created by the California Legislature through the Delta Reform Act of 2009 to develop and implement a legally enforceable long-term management plan for the Delta. The Delta Plan applies a common sense approach based on the best available science to achieve the coequal goals of protecting and enhancing the Delta ecosystem and providing for a more reliable water supply for California, while protecting and enhancing the unique cultural, recreational, and agricultural values of the Delta as an evolving place.

According to the Delta Reform Act, it is the state or local agency approving, funding, or carrying out the project that must determine if that project is a "covered action" subject to Delta Plan regulations, and if so, to file a certification of consistency with the Delta Plan. The Notice of Addendum lists an expected need for a consistency determination with the Delta Plan. Council staff is available for early consultation to guide the State and Federal Contractors Water Agency (SFCWA) through the consistency certification process. Below we have highlighted the regulatory policies from the Delta Plan that are most relevant to the Tule Red Project.

<u>Delta Plan Regulations</u>

Best Available Science and Adaptive Management

Delta Plan Policy **G P1** (23 CCR Section 5002) states that covered actions must document use of best available science. Best available science should be consistent with the criteria listed in the table in Appendix 1A of the Delta Plan regulations (http://deltacouncil.ca.gov/docs/appendix-1a), including relevance, inclusiveness, objectivity, transparency and openness, timeliness and peer review.

Additionally, this policy calls for ecosystem restoration projects to include adequate provisions for continued implementation of adaptive management, appropriate to the scope of the action. This requirement can be satisfied through the development of an adaptive management plan that is consistent with the framework described in Appendix 1B of the Delta Plan (http://deltacouncil.ca.gov/docs/appendix-1b), along with documentation of adequate resources to implement the proposed adaptive management process.

Staff appreciated the opportunity to meet with Byron Buck in August, along with Robert Capriola (Westervelt Ecological Services), Kim Erickson (Westervelt Ecological Services), and Ramona Swenson (Environmental Science Associates), to discuss ongoing development of the monitoring and adaptive management plan for the Tule Red Project. Adaptive Management Liaisons from the Delta Science Program are available to provide further consultation regarding documentation of use of best available science and preparation of an adaptive management plan.

Habitat Restoration

Delta Plan Policy **ER P2** (23 CCR Section 5006) states that habitat restoration must occur at appropriate elevations—using Appendix 4 of the Delta Plan regulations as a guide—and be consistent with Appendix 3 of the Delta Plan regulations, which is an excerpt from the 2011 Draft Ecosystem Restoration Program Conservation Strategy. As much of the Tule Red property is located at intertidal elevation, it is presumed to have the ability to support brackish tidal marsh habitat with associated sloughs, channels, and other open water features. The Draft Conservation Strategy states two major concerns for tidal marsh restoration: the first is the risk for this habitat to be colonized by nonnative species (e.g., invasive aquatic vegetation), which would in turn limit the benefits to native species, and the second is the potential for restoration of intertidal habitats to lead to increased methylation of mercury in sediments. We recommend analyzing both of these issues in the Addendum.

Invasive Species

Nonnative species are a major obstacle to successful restoration because they affect the survival, health, and distribution of native wildlife and plant species. Although there is little chance of eradicating most established nonnative species, management can be designed to reduce their abundance. Delta Plan Policy **ER P5** (23 CCR Section 5009) states, “The potential for new introductions of or improved habitat conditions for nonnative invasive species, striped bass, or bass must be fully considered and avoided or mitigated in a way that appropriately protects the ecosystem.”

The Tule Red property contains many acres infested by the invasive *Phragmites australis*. To the maximum extent practicable, the restoration activities at Tule Red should avoid or minimize effects that would lead to improved conditions for nonnative invasive species populations on site before relying upon mitigation measures. In the event mitigation is necessary, we recommend reviewing the mitigation measures provided in the Delta Plan Program EIR (see below for details).

Respect Local Land Use

Delta Plan Policy **DP P2** (23 CCR Section 5011) calls for habitat restoration projects to avoid or reduce conflicts with existing uses and to consider comments from local agencies and the Delta Protection Commission. We recommend the Addendum analyze how changes to the site will affect water management on the adjacent Grizzly King property and the CDFW's Grizzly Island Wildlife Area. We also recommend that the Addendum include an assessment of the regional impacts on salinity in the Suisun Marsh from the restoration project.

Mitigation Measures

Delta Plan Policy **G P1** (23 CCR Section 5002) requires that actions not exempt from CEQA and subject to Delta Plan regulations must include applicable feasible mitigation measures consistent with or more effective than those identified in the Delta Plan EIR. (These mitigation measures can be found in the Delta Plan Mitigation and Monitoring Reporting Program (MMRP) document available at http://deltacouncil.ca.gov/sites/default/files/documents/files/Agenda%20Item%206a_attach%202.pdf.) We suggest that SFCWA review the Delta Plan's MMRP and incorporate relevant mitigation measures into the final CEQA document for the Tule Red project.

One mitigation measure we specifically recommend you consider incorporating into the Addendum is the Delta Plan Program EIR's **Biological Resources Mitigation Measure 4-1**, which calls for an invasive species management plan to be developed and implemented for any projects that could lead to introduction or facilitation of invasive species establishment. The plan must ensure that invasive plant species and populations are kept below preconstruction abundance and distribution levels and be based on best available science and developed in consultation with Department of Fish and Wildlife and local experts (e.g., UC Davis, California Invasive Plant Council). This mitigation requirement also calls for the plan to include the following elements:

- Nonnative species eradication methods (if eradication is feasible)
- Nonnative species management methods
- Early detection methods
- Notification requirements
- Best management practices for preconstruction, construction, and post construction periods
- Monitoring, remedial actions and reporting requirements
- Provisions for updating the target species list over the lifetime of the project as new invasive species become potential threats to the integrity of the local ecosystems

<u>Delta Plan Recommendations</u>

The Delta Plan includes 73 recommendations, which we encourage project proponents to consider as they design and implement their projects and programs. Although these recommendations are non-regulatory in nature, progress towards their implementation will help with achieving the coequal goals in a manner that protects and enhances the unique values of the Delta. We believe that the most pertinent Delta Plan Recommendations to your proposed project are the following:

Prioritize and Implement Projects that Restore Delta Habitat

Delta Plan Recommendation **ER R2** calls for habitat restoration projects to be prioritized and implemented in the six areas designated by the Delta Plan as priority habitat restoration areas (PHRAs). One of these areas is the Suisun Marsh, where the Tule Red Duck Club property is located, and a region where ER R2 calls for significant restoration of brackish marsh to support native species. We believe that SFCWA's effort to restore tidal marsh to Tule Red will help implement ER R2, and will help to benefit multiple native species, including Delta smelt, longfin smelt, and Ridgway's rail.

Protect and Enhance Opportunities for Recreation

The Delta Plan recommends protecting and improving existing recreation opportunities while seeking ways of providing new and better coordinated opportunities. Delta Plan Recommendation **DP R11** calls for providing new and protecting existing recreational opportunities in the Delta and Suisun Marsh. Additionally, Recommendation **DP R16** states that public agencies owning land should increase opportunities, where feasible, for bank fishing, hunting, levee-top trails, and environmental education. We encourage and support SFCWA's commitment to maintain waterfowl hunting on the property after restoration.

Final Remarks

Overall, we are supportive of the plan to restore tidal marsh habitat at the Tule Red Club, located within the Suisun Marsh PHRA. We look forward to working with SFCWA on this project and providing assistance to you in filing a Delta Plan consistency certification. If you have questions, please contact Daniel Huang at Daniel.Huang@deltacouncil.ca.gov.

Sincerely,

Cindy Messer
Deputy Executive Officer
Delta Stewardship Council

STATE OF CALIFORNIA
Governor's Office of Planning and Research
State Clearinghouse and Planning Unit

Edmund G. Brown Jr.
Governor

Ken Alex
Director

November 10, 2015

RECEIVED
NOV 13 2015
By

Byron Buck
State and Federal Contractors Water Agency
1121 L Street, Suite 806
Sacramento, CA 95814

Subject: Tule Red Tidal Restoration Project
SCH#: 2003112039

Dear Byron Buck:

The State Clearinghouse submitted the above named Addendum to selected state agencies for review. The review period closed on November 9, 2015, and no state agencies submitted comments by that date. This letter acknowledges that you have complied with the State Clearinghouse review requirements for draft environmental documents, pursuant to the California Environmental Quality Act.

Please call the State Clearinghouse at (916) 445-0613 if you have any questions regarding the environmental review process. If you have a question about the above-named project, please refer to the ten-digit State Clearinghouse number when contacting this office.

Sincerely,

Scott Morgan
Director, State Clearinghouse

Document Details Report
State Clearinghouse Data Base

SCH#	**2003112039**
Project Title	Tule Red Tidal Restoration Project
Lead Agency	Fish & Game #3

Type **ADM** Addendum

Description In accordance with the CEQA, the State and Federal Contractors Water Agency is proposing to prepare an addendum to the Suisun Marsh Habitat Management, Preservation, and Restoration Plan EIS/EIR to implement the Tule Red Tidal Restoration Project (proposed project). The proposed project would convert approximately 420 acres of existing managed wetlands to tidal habitat to directly benefit federal and state-listed Delta smelt, longfin smelt, and salmonids. The proposed project would introduce full, daily tidal exchange to an existing managed marsh duck club owned by Westervelt Ecological Services and to a portion of a Grizzly Island Wildlife Area which is owned and operated by the CDFW.

Lead Agency Contact

Name Byron Buck
Agency State and Federal Contractors Water Agency
Phone 916 476 5056 ***Fax***
email
Address 1121 L Street, Suite 806
City Sacramento ***State*** CA ***Zip*** 95814

Project Location

County Solano, Contra Costa, San Joaquin
City Suisun City, Fairfield
Region
Lat / Long
Cross Streets Grizzly Island Road/HW12/HW680
Parcel No.
Township ***Range*** ***Section*** ***Base***

Proximity to:

Highways Hwy 12, 80, 680
Airports Travis AFB
Railways UPRR, Capital Corridor
Waterways Suisun Marsh, Suisun Slough, Montezume Slough, etc.
Schools No
Land Use Zoned: Marsh and Agriculture. Current land uses include duck hunting areas, open water, tidal wetlands, and other recreation.

Project Issues Economics/Jobs; Public Services; Archaeologic-Historic; Air Quality; Noise; Recreation/Parks; Aesthetic/Visual; Agricultural Land; Biological Resources; Cumulative Effects; Drainage/Absorption; Flood Plain/Flooding; Forest Land/Fire Hazard; Geologic/Seismic; Growth Inducing; Minerals; Soil Erosion/Compaction/Grading; Solid Waste; Toxic/Hazardous; Traffic/Circulation; Water Quality; Water Supply; Wetland/Riparian

Reviewing Agencies Resources Agency; Department of Conservation; Department of Fish and Wildlife, Region 3; Delta Protection Commission; Office of Historic Preservation; Department of Parks and Recreation; Central Valley Flood Protection Board; San Francisco Bay Conservation and Development Commission; Department of Water Resources; Caltrans, Division of Aeronautics; Caltrans, District 4; Air Resources Board; Regional Water Quality Control Board, Region 2; Department of Toxic Substances Control; Native American Heritage Commission; Public Utilities Commission; Delta Stewardship Council

Note: Blanks in data fields result from insufficient information provided by lead agency.

Date Received 10/09/2015 ***Start of Review*** 10/09/2015 ***End of Review*** 11/09/2015

Note: Blanks in data fields result from insufficient information provided by lead agency.

STATE OF CALIFORNIA

EDMUND G. BROWN JR., *Governor*

CALIFORNIA STATE LANDS COMMISSION
100 Howe Avenue, Suite 100-South
Sacramento, CA 95825-8202

Established in 1938

JENNIFER LUCCHESI, *Executive Officer*
(916) 574-1800 FAX (916) 574-1810
California Relay Service From TDD Phone **1-800-735-2929**
from Voice Phone **1-800-735-2922**

***Contact Phone:* (916) 574-1900**
***Contact FAX:* (916) 574-1925**

October 22, 2015

File Ref: SD-2015-07-23.2
SCH# 2003112039

Westervelt Ecological Services
Attn: Greg DeYoung
600 North Market Blvd., Suite 3
Sacramento, CA 95834

Subject: Tule Red Tidal Restoration Project, Grizzly Bay, Suisun Marsh, Solano County

Dear Mr. DeYoung:

The California State Lands Commission's staff reviewed the Notice of Addendum for the Tule Red Tidal Restoration Project to the Suisun Marsh Plan Habitat Management, Preservation, Restoration Plan EIS/EIR (SCH#2003112039), received October 9, 2015.

This is to advise that the area over which the project will extend is not subject to the Commission's current leasing or permitting requirements.

This action does not constitute, nor shall it be construed as, a waiver of any right, title, or interest by the State of California in any lands under its jurisdiction.

Should you have any questions, please contact Wendy Hall at (916) 574-0994.

Sincerely,

Brian Bugsch, Chief
Land Management Division

Appendix B
Tule Red Tidal Restoration Environmental Commitments and Mitigation Measures

Tule Red Tidal Restoration Environmental Commitments and Mitigation Measures
Air Quality Best Management Practices and Mitigation Measures
Air Quality Best Management Practices: Enhanced Control Measures and Additional Air Quality Best Management Practices The following control practices will be used to offset any air quality issues that may arise. i. Hydroseed with native or noninvasive species appropriate to that specific location or apply (nontoxic) soil stabilizers to inactive construction areas (previously graded areas inactive for 10 days or more). ii. Limit traffic speeds on unpaved roads to 15 mph. iii. Install sandbags or other erosion control measures to prevent silt runoff to public roadways. iv. Replant vegetation with native or noninvasive species appropriate to that specific location in disturbed areas as quickly as possible. v. Maintain properly tuned engines. vi. Minimize the idling time of diesel-powered construction equipment to 2 minutes. vii. Use alternative-powered (e.g., hybrid, compressed natural gas, biodiesel, electric) construction equipment. viii. Use add-on control devices such as diesel oxidation catalysts or particulate filters. ix. Require all contractors to use equipment that meets California Air Resources Board's most recent certification standard for off-road heavy-duty diesel engines.
AQ-MM-2 in SMP EIS/EIR: Reduce Construction NOX Emissions Construction activity will be limited so that construction emissions do not exceed the BAAQMD's construction threshold for NO_X. Such measures include, but are not limited to, implementing off road equipment mitigation, including installing 1st tier diesel particulate filters (DPFs), and installing diesel oxidation catalysts to reduce NOx emissions by 40%.
AQ-MM-3 in SMP EIS/EIR: Implement All Appropriate BAAQMD Mitigation Measures The following BAAQMD standard mitigation measures will be implemented where appropriate and feasible. These measures include: • Cover all haul trucks transporting soil, sand, or other loose material off-site. • Remove all visible mud or dirt track-out onto adjacent public roads. • Minimize idling times either by shutting equipment off when not in use or reducing the maximum idling time to 5 minutes (as required by the California airborne toxics control measure Title 13, Section 2485 of California Code of Regulations [CCR]). Clear signage shall be provided for construction workers at all access points. • Maintain all construction equipment in accordance with manufacturer's specifications. All equipment shall be checked by a certified mechanic and determined to be running in proper condition prior to operation. • Post a publicly visible sign with the telephone number and person to contact regarding dust complaints. This person shall respond and take corrective action within 48 hours. The Air District's phone number shall also be visible to ensure compliance with applicable regulations.
AQ-MM-4: Limit Restoration and Management Activity The overlap of restoration and management activities will be limited to the extent feasible and the equipment being used for restoration and management activities will not exceed the equipment described in Tables 3-4a-d of Chapter 3 of the Tule Red Addendum and 5.7-10 of the SMP EIS/EIR. This will ensure that construction emissions do not exceed the draft BAAQMD threshold for NOx.

Tule Red Tidal Restoration Environmental Commitments and Mitigation Measures
Standard Design Features and Construction Practices
• Stop work immediately if a conflict with a utility facility occurs and contacting the affected utility to (1) notify it of the conflict, (2) aid in coordinating repairs to the utility, and (3) coordinate to avoid additional conflicts in the field.
• Implement BMPs to minimize any disease-carrying mosquitoes and threats to public health if it is found that project components pose a threat to public health.
• Control construction equipment access and placement of fill to maintain acceptable loading based on the shear strength of the foundation material.
• Minimize degradation of wetland habitats where feasible by minimizing the disturbance footprint.
• Implement BMPs and minimization measures to minimize water quality impacts such as temporary turbidity increases. See Erosion and Sediment Control Plan below.
• Inspect all equipment for oil and fuel leaks every day prior to use. Equipment with oil or fuel leaks will not be used within 100 feet of wetlands.
• Require the construction contractor to remove all trash and construction debris after construction and to implement a revegetation plan for temporarily disturbed vegetation in the construction zones.
• Maintain waste facilities. Waste facilities include concrete wash-out facilities, chemical toilets, and hydraulic fluid containers. Waste will be removed to a proper disposal site.
Access Point/Staging Areas • Establish staging areas for equipment storage and maintenance, construction materials, fuels, lubricants, solvents, and other possible contaminants in coordination with resource agencies.
• Staging areas will have a stabilized entrance and exit and will be located at least 100 feet from bodies of water unless site-specific circumstances do not provide such a setback, in which case the maximum setback possible will be used. If an off-road site is chosen, qualified biological and cultural resources personnel will survey the selected site to verify that no sensitive resources would be disturbed by staging activities. If sensitive resources are found, an appropriate buffer zone will be staked and flagged to avoid impacts. If impacts on sensitive resources cannot be avoided, the site will not be used. An alternate site will be selected.
• Where possible, no equipment refueling or fuel storage will take place within 100 feet of a body of water. Vehicle traffic will be confined to existing roads and the proposed access route. Ingress and egress points will be clearly identified in the field using orange construction fence. Work will not be conducted outside the designated work area.
Erosion and Sediment Control Plan • Prepare and implement an erosion and sediment control plan to control short-term and long-term erosion and sedimentation effects and to restore soils and vegetation in areas affected by construction activities. The plan will include all the necessary local jurisdiction requirements regarding erosion control and will implement BMPs for erosion and sediment control as required.
• Develop an erosion control plan to ensure that during rain events construction activities do not increase the levels of erosion and sedimentation. This plan will include the use of erosion control materials (baffles, fiber rolls, or hay bales; temporary containment berms) and erosion control measures such as straw application or hydroseeding with native grasses on disturbed slopes, and floating sediment booms and/or curtains to minimize any impacts that may occur from increased mobilization of sediments.

Tule Red Tidal Restoration Environmental Commitments and Mitigation Measures
Stormwater Pollution Prevention Plan • Develop a stormwater pollution prevention plan (SWPPP) prior to construction. The objectives of the SWPPP will be to (1) identify pollutant sources associated with construction activity and project operations that may affect the quality of stormwater and (2) identify, construct, and implement stormwater pollution prevention measures to reduce pollutants in stormwater discharges during and after construction. The project proponents and/or their contractor(s) will develop and implement a spill prevention and control plan as part of the SWPPP to minimize effects of spills of hazardous, toxic, or petroleum substances during construction of the project. Implementation of this measure will comply with state and federal water quality regulations. The SWPPP will be kept on site during construction activity and during operation of the project and will be made available upon request to representatives of the Regional Water Quality Control Board (Regional Water Board). The SWPPP will include but is not limited to: a. A description of potential pollutants to stormwater from erosion. b. Management of dredged sediments and hazardous materials present on site during construction (including vehicle and equipment fuels). c. Details of how the sediment and erosion control practices comply with state and federal water quality regulations. d. A description of potential pollutants to stormwater resulting from operation of the project.
Hazardous Materials Management Plan • The SWPPP will include a hazardous materials spill plan. The plan will describe the actions that will be taken in the event of a spill. The plan also will incorporate preventive measures to be implemented (such as vehicle and equipment staging, cleaning, maintenance, and refueling) and contaminant (including fuel) management and storage. In the event of a contaminant spill, work at the site immediately will cease until the contractor has contained and mitigated the spill. The contractor will immediately prevent further contamination, notify appropriate authorities, and mitigate damage as appropriate. Adequate spill containment materials, such as oil diapers and hydrocarbon cleanup kits, will be available on site at all times. Containers for storage, transportation, and disposal of contaminated absorbent materials will be provided on the project site.
• Do not use any hazardous material in excess of reportable quantities, as specified in Title 40 Code of Federal Regulations (CFR) Part 355, Subpart J, Section 355.50, unless approved in advance by the Office of Emergency Services (OES), and will provide to the OES in the annual compliance report a list of hazardous materials contained at a project site in reportable quantities. The reporting of hazardous materials in excess of reportable quantities of Title 40 CFR Part 355 is required annually to Solano County Environmental Health Services Division as the Solano County Certified Unified Program Agency (CUPA).
Mosquito Abatement Best Management Practices
Develop a management program consistent with Marsh-wide management actions for the control of mosquitoes. If necessary, implement a sampling and treatment program for any depressions that would retain tidal water.
Noise Compliance
There are no residences or sensitive receptors near the project site; therefore, noise-reduction practices are not required.

Tule Red Tidal Restoration Environmental Commitments and Mitigation Measures
Cultural Resources
• Prior to ground-disturbing activities in restoration areas, SFCWA will conduct a cultural resources inventory of the restoration area, according to the standards cited in the SMP EIS/EIR (CUL-MM-1 and CUL-MM-5), including: · The implementing regulations for Section 106 of the NHPA (36 CFR 800.4). · The State CEQA Guidelines (14 CCR 15064.5[a]). · Archeology and Historic Preservation: Secretary of the Interior's Standards and Guidelines (48 Federal Register [FR] 44716–44742). · The Secretary of the Interior's Standards and Guidelines for Federal Agency Historic Preservation Programs Pursuant to the National Historic Preservation Act (including the Guidelines for the Treatment of Cultural Landscapes). · Applicable NRHP bulletins and National Park Service technical briefs (Andrus and Shrimpton 1997; Birnbaum 1994; McClellan et al. 1995).
• If any cultural resources are determined to be historic properties and ground-disturbing activities are found to result in adverse effects, the Corps or SFCWA will resolve the effects in accordance with Section 106 of the NHPA or CEQA, as applicable.
• If no cultural resources are identified in specific restoration areas, or identified resources are not determined to be significant, no additional cultural work is required.
• If any previously unknown historic or archeological artifacts are discovered while accomplishing the authorized work, the landowner must stop work within 100 feet of the find immediately and notify the SFCWA and the Corps. All construction personnel will leave the area. Vehicles and equipment will be left in place until a qualified archaeologist identifies a safe path out of the area. The on-site supervisor will flag or otherwise mark the location of the find and keep all traffic away from the resource. The on-site supervisor immediately will notify the lead state or federal agency of the find. The activity is not authorized until the requirements of Section 106 of the NHPA have been satisfied.
• If human remains of Native American origin are discovered during ground disturbing activities on non-federal land, SFCWA or the Corps must comply with state laws relating to the disposition of Native American burials, which fall within the jurisdiction of the Native American Heritage Commission (NAHC) (PRC 5097). If human remains are discovered or recognized in any location other than a dedicated cemetery, SFCWA or the Corps will not allow further excavation or disturbance of the site or any nearby area reasonably suspected to overlie adjacent human remains until: a. the Solano County coroner has been informed and has determined that no investigation of the cause of death is required; and b. if the remains are of Native American origin, the descendants of the deceased Native Americans have made a recommendation to the landowner or the person responsible for the excavation work for means of treating or disposing of, with appropriate dignity, the human remains and any associated grave goods as provided in PRC 5097.98; or 1. the NAHC was unable to identify a descendant or the descendant failed to make a recommendation within 48 hours after being notified by the NAHC. 2. If any previously unknown historic or archeological artifacts are discovered while accomplishing the authorized work, the landowner must stop work immediately and notify the Corps. The activity is not authorized until the requirements of Section 106 of the NHPA have been satisfied.

Tule Red Tidal Restoration Environmental Commitments and Mitigation Measures
Biological Resources **Best Management Practices** The following section outlines the best management practices (BMPs) that will be implemented to avoid or minimize impacts on biological resources. Environmental commitments, including an erosion and sediment control plan, SWPPP, hazardous materials management plan, spoils disposal plan, and environmental training content will be submitted to NMFS, USFWS, and DFW 30 days prior to commencement of construction.
General • No firearms (except for federal, state, or local law enforcement officers and security personnel) will be permitted at the project site to avoid harassment, killing, or injuring of wildlife.
• No pets will be permitted at the project site to avoid harassment, killing, or injuring of wildlife.
• Native vegetation trimmed or removed on the project site will be stockpiled during work. After construction activities, removal of temporary mats and construction-related materials, and application of native and naturalized species seed mix have been completed, stockpiled native vegetation will be reapplied over temporarily disturbed wetlands to provide temporary soil protection and as a seed source.
• Vegetation shall be removed under the supervision of a qualified biologist approved by DFW and USFWS. If a mouse of any species is observed within the areas being removed of vegetation, DFW and USFWS shall be notified. Vegetation removal may begin when no mice are observed and shall start at the edge farthest from the salt marsh or the poorest habitat and work its way toward the salt marsh or the better salt marsh habitat.
• Removal of vegetation in wetland habitat will be conducted with a qualified biological monitor present. This monitor will watch for special-status wildlife species and temporarily stop work if special-status species are encountered. Wildlife will be allowed to escape before work is resumed. Monitors with the appropriate qualifications to handle special-status species will be allowed to move special-status species to safe locations as permitted by their authorizations.
• Temporarily affected wetlands will be restored by removing construction related debris and trash. Affected areas will be seeded with a native and naturalized seed mix.
Worker Training • The Service-approved biologist will provide training to field management and construction personnel on the importance of protecting environmental resources. Communication efforts and training will take place during preconstruction meetings so that construction personnel are aware of their responsibilities and the importance of compliance.

Tule Red Tidal Restoration Environmental Commitments and Mitigation Measures
• Construction personnel will be educated on the types of sensitive resources located in the project area and the measures required to avoid impacts on these resources. Materials covered in the training program will include environmental rules and regulations for the specific project and requirements for limiting activities to the construction right-of-way and avoiding demarcated sensitive resources areas. Training seminars will educate construction supervisors and managers on: i. The need for resource avoidance and protection. ii. Construction drawing format and interpretation. iii. Staking methods to protect resources. iv. The construction process. v. Roles and responsibilities. vi. Project management structure and contacts. vii. Environmental commitments. viii. Emergency procedures.
• If new construction personnel are added to the project, the contractor will ensure the personnel receive the mandatory training before starting work. A representative will be appointed during the employee education program to be the contact for any employee or contractor who might inadvertently kill or injure a listed species or who finds a dead, injured, or entrapped individual. The representative's name and telephone number will be provided to the USFWS before the initiation of ground disturbance.
Special-Status Plant Species Protection
• Special-status plant surveys required for project-specific permit compliance will be conducted within 1 year prior to initiating construction. The purpose of these surveys will be to verify the locations of special-status plants identified in previous surveys are extant, identify any new special-status plant occurrences, and cover any portions of the project area not previously identified. The extent of mitigation of direct loss of or indirect impacts on special-status plants will be based on these survey results.
• If found, the locations of special-status plants in proposed construction areas will be recorded using a global positioning system (GPS) unit and flagged.
• Any special-status plant species observed during surveys will be reported to the Service and DFW so the observations can be added to the California Natural Diversity Database (CNDDB).
Special-Status Wildlife Species Protection • If individuals of listed wildlife species may be present and subject to potential injury or mortality from construction activities, a Service or DFW-approved biologist will conduct a preconstruction survey. If a listed wildlife species is discovered, construction activities will not begin in the immediate vicinity of the individual until the Service or DFW is contacted, depending on the species, and the individual has been allowed to leave the construction area.
• Minimum qualifications for the qualified biologist will be a 4-year college degree in biology or related field and 2 years of professional experience in the application of standard survey, capture, and handling methods for the species of concern. However, in the case of fully protected species, no capture or handling will be done.
• Any special-status mammal, bird, or other species observed during surveys will be reported to the Service and DFW so the observations can be added to the California Natural Diversity Database (CNDDB).

Tule Red Tidal Restoration Environmental Commitments and Mitigation Measures
Mammals **SMHM and Suisun Shrew** • A Service-approved biologist, with previous salt marsh harvest mouse monitoring and surveying experience, will identify suitable salt marsh habitat for the mouse and conduct preconstruction surveys for the mouse prior to project initiation.
• Vegetation will be removed from all areas (driving roads, action area, or anywhere else that vegetation could be stepped on).
• If a salt marsh harvest mouse is discovered, construction activities will cease in the immediate vicinity of the individual until the Service is contacted and the individual has been allowed to leave the construction area.
• A Service-approved biologist with previous salt marsh harvest mouse experience will be on site during construction activities occurring in wetlands. The biologist will document compliance with the project permit conditions and avoidance and conservation measures. The Service-approved biologist has the authority to stop project activities if any of the requirements associated with these measures is not being fulfilled. If the Service-approved biologist has requested work stoppage because of take of any of the listed species, the Service and DFW will be notified within 1 day by email or telephone.
• Disturbance to wetland vegetation (i.e., pickleweed [*Salicornia* spp.]) will be avoided to the extent feasible in order to reduce potential impacts on SMHM habitat. If wetland vegetation (i.e., pickleweed [*Salicornia* spp.]) cannot be avoided, it will be removed by a method approved by the USFWS and DFW. The USFWS-approved biologist will be on site to monitor all wetland vegetation removal activities.
Bats • Pre-demolition surveys would be required prior to the demolition of existing structures to ensure no bat presence. These pre-demolition surveys would be conducted by a qualified biologist, and would occur up to 3 days prior to demolition. If live bats or indications of bat use, including guano, staining, prey remains, bat carcasses are not found within the existing structures, the structures may be demolished at any time • If live bats or indications of bat use are found, the demolition of the structures would be limited to the beginning of September to the middle of October, at which time remaining bats would be evicted using appropriate protocols prior to demolition. • Windows and doors of the structures would be kept closed and sealed prior to demolition to prevent bats from inhabiting or roosting in the structures. • To the degree feasible, stored material, furnishings, wooden fixtures and debris piles in and around the buildings will be checked for bats and cleared from the area prior to demolition to improve visual survey access to potential roost spaces.
Birds • Preconstruction surveys will be performed to determine whether nesting birds, including migratory birds, raptors, and special-status bird species, are present within or immediately adjacent to the project sites and associated staging and storage areas if activities would occur during active nesting periods. Bird species using the managed wetland habitat include waterfowl, shorebirds, Suisun song sparrow, Suisun common yellowthroat, and several other resident and migratory songbirds.
• All woody and herbaceous vegetation will be removed from construction areas (earthwork areas), during the nonbreeding season (September 1–February 1) to the extent feasible, to minimize effects on nesting birds. If woody and herbaceous vegetation removal occurs during the breeding season, a qualified biologist will survey the construction area for active nests and young migratory birds immediately before removal activities.
• During the breeding season, all vegetation subject to impact will be maintained to a height of approximately 6 inches to minimize the potential for nesting.

Tule Red Tidal Restoration Environmental Commitments and Mitigation Measures
• If active nests or migratory birds are found within the boundaries of the construction area, an acceptable buffer width and appropriate measures will be developed in coordination with DFW.
• Inactive migratory bird nests (excluding raptors) located outside the construction areas will be preserved. If an inactive migratory bird nest is located in the area of effect, it will be removed before the start of the breeding season (approximately February 1).
• Impacts on great blue heron rookeries will be avoided; mature trees will not be removed, and nearby work will occur outside the nesting season.
Raptors • Preconstruction surveys will be performed before and during the raptor nesting season (bimonthly, i.e., two times per month) to identify existing nests that may be used during the nesting season.
• Raptors may nest from later winter through mid-summer; therefore, multiple nesting season surveys will performed.
• DFW will be notified of all raptor nests located during the preconstruction surveys. If a raptor nest is located within the recommended buffer, the project proponents will coordinate with DFW to determine an acceptable buffer width.
• If an active raptor nest is found outside the construction areas, a buffer zone will be developed in coordination with DFW. For special-status species, a larger buffer will be required (e.g., 0.5-mile Swainson's hawk buffer). The project proponents will coordinate with DFG prior to project implementation to determine the species-specific buffer widths.
California Clapper Rail and California Black Rail If construction activities are necessary during the breeding season, preconstruction surveys for California clapper rail and black rail will be conducted by a Service-approved biologist at and adjacent to areas of potential tidal and managed wetlands habitat for California clapper rail and black rail. The surveys will focus on potential habitat that may be disturbed by construction activities during the breeding season to ensure that these species are not nesting in these locations.
Exception: Only inspection, maintenance, research, or monitoring activities may be performed during the California clapper rail or black rail breeding season in areas within or adjacent to California clapper rail breeding habitat with approval of the USFWS and DFG under the supervision of a qualified biologist
California Least Tern No activities will be performed within 300 feet of an active least tern nest during the least tern breeding season, April 15 to August 15 (or as determined through surveys).
Exception: Only inspection, maintenance, research, or monitoring activities may be performed during the least tern breeding season in areas within or adjacent to least tern breeding habitat with approval of the Service and DFW under the supervision of a qualified biologist.
Western Pond Turtle
• Preconstruction surveys will be performed in all managed wetlands and in adjacent sloughs that provide suitable habitat for western pond turtle. If pond turtles are identified, the area will be surveyed for nesting sites, if construction activities would occur during the nesting season.
• If pond turtles are identified in managed wetlands to be breached, the ponds and associated drainages will be dewatered and, to the extent feasible, any turtles observed will be captured and released to other suitable locations within a nearby managed wetland or drainage.

Tule Red Tidal Restoration Environmental Commitments and Mitigation Measures
Fish
• The NMFS Santa Rosa Area Office must be notified by letter or email message stating the project commencement date, at least 14 days prior to implementation.
• NMFS employee(s) or any other person(s) designated by NMFS will be allowed access to the work site.
• A biologist or on-site monitor will evaluate the project site during construction to document any actions or condition that could adversely affect salmonids, green sturgeon, or their habitat. Whenever conditions are identified that could adversely affect salmonids, green sturgeon, or their habitat, in a manner not described in this opinion, NMFS shall be immediately notified by contacting biologist Daniel Logan at (707) 575-6053 or dan.logan@noaa.gov.
• Draft restoration design plans (65-90 percent design level) will be submitted to NMFS for review and written approval at least 120 days prior to initiation of construction.
• The draft restoration design plans will be submitted to: NMFS Santa Rosa Area Office Attention: Supervisor of Protected Resources Division 777 Sonoma Avenue, Room 325 Santa Rosa, California, 95404-6528
• In-water construction activities, such as levee construction and levee breaching, will occur during the in-channel work window of September 1 through November 30.
Biological Monitoring • A Service-approved biologist/environmental monitor will be responsible for monitoring implementation of the conditions in the state and federal permits (CWA Section 401, 402, and 404; ESA Section 7; Fish and Game Code Section 1602 and/or 2050; project plans [SWPPP]; and EIS/EIR mitigation measures).
• The Service-approved biologist/environmental monitor will determine the location of environmentally sensitive areas adjacent to each construction site based on mapping of existing land-cover types and special-status plant species. If such maps are not available, the biologist/environmental monitor will map and quantify the land-cover types and special-status plant populations in the proposed project footprint prior to construction.
• The biologist/environmental monitor will ensure the avoidance of all sensitive habitat areas outside direct project footprints, including patches of tidal wetland along channel banks, during dredging operations, to the extent practical.
• Plants for revegetation will come primarily from natural recruitment. Plants imported to the restoration areas will come from local stock, and to the extent possible, local nurseries. Only native or naturalized plants will be used for restoration efforts.
• To avoid construction-phase disturbance to sensitive habitats immediately adjacent to the action area, the limits of construction will be marked on the construction drawings and identified in the field.
Construction Period Restrictions Timing of restoration construction activities will depend on the type of activity, presence or absence of sensitive resources, tides, and/or water management in wetlands. In general, landside work will occur between July and September. In-water activities will be conducted during the months of August through November. Working outside this window will require additional approvals from the resource agencies. Other timing restrictions may be necessary during the hunting season, such as limiting work to days other than Saturday, Sunday, and Wednesday.

Tule Red Tidal Restoration Environmental Commitments and Mitigation Measures
Nonnative Plant Control The following measures will be included in the project construction specifications to minimize the potential for the introduction of new noxious weeds and the spread of weeds previously documented in the project area.
• Use certified, weed-free, imported erosion control materials (or rice straw in upland areas).
• Coordinate with the county agricultural commissioner and land management agencies to ensure that the appropriate BMPs are implemented.
• Educate construction supervisors and managers on weed identification and the importance of controlling and preventing the spread of noxious weeds.
• Clean equipment at designated wash stations after leaving noxious weed infestation areas.
• As feasible, treat isolated infestations of noxious weeds identified in the project area with approved eradication methods at an appropriate time to prevent further formation of seed, and destroy viable plant parts and seed.
• Minimize surface disturbance to the greatest extent possible.
• Seed all disturbed areas with native and naturalized seed mixes, as provided in the revegetation plan developed in cooperation with DFW. Mulch with certified weed-free mulch. Rice straw may be used to mulch upland areas.
• Use native, noninvasive species or nonpersistent hybrids in erosion control plantings to stabilize site conditions and prevent invasive species from colonizing.
• Restore or enhance suitable habitat areas that are occupied by, or are near and accessible to, special-status species that have been adversely affected by the permanent removal of occupied habitat areas.
Note: The Table was been prepared by Westervelt Ecological Services, LLC (WES) and reviewed by ICF. This table largely reflects the Restoration Environmental Commitments and BMPs included in the Suisun Marsh Plan EIS/EIR, the Conservation Measures included in the USFWS Biological Opinion (http://www.suisunrcd.org/documents/2013FWSSMPBO-USACE.pdf), and the Conservation Measures included in the NMFS Biological Opinion (http://www.suisunrcd.org/documents/Corps-BOR-SMPopinion3Jul2013.pdf) as modified to reflect site conditions and constraints. Where appropriate, it also references the applicable mitigation measures to the Tule Red Restoration project that were incorporated into the SMP EIS/EIR.

Appendix C
Methylmercury and Dissolved Oxygen Technical Memorandum

ROBERTSON - BRYAN, INC.
Solutions for Progress

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TECHNICAL MEMORANDUM

Date: November 18, 2015

To: Westervelt Ecological Services

From: Ben Giudice, Ph.D.; Ellen Preece, Ph.D.; Keith Whitener

Project: Tule Red

Subject: Methylmercury and Dissolved Oxygen

Background

The Tule Red Tidal Restoration Project proposes to restore tidal wetlands in Suisun Marsh to directly benefit federally- and state-listed Delta smelt, longfin smelt, and salmonids by introducing full daily tidal exchange to an existing managed marsh duck club owned by Westervelt Ecological Services (WES), and to a portion of the Grizzly Island Wildlife Area (Wildlife Area) which is owned and operated by the California Department of Fish and Wildlife (CDFW).

The Project site is located on Grizzly Island in the Suisun Marsh, in an unincorporated portion of Solano County, California. The Project site is on the eastern shoreline of Grizzly Bay, immediately adjacent to the Grizzly Island Unit of the Wildlife Area.

The area proposed to be restored to tidal influence is comprised of a crescent of land roughly 1,500 feet wide and 8,000 feet long, totaling approximately 420 acres of managed marsh habitat currently maintained as a duck club. The vast majority of the site is managed marsh, with a small amount of tidal marsh at the northern end and along the bay side margin of a natural berm. Upland habitat is along the uppermost slopes and tops of the levees along the eastern edge of the Project site.

The proposed Project would restore managed marsh habitat that is currently used for duck hunting to tidal wetlands by grading and recontouring a portion of the site to create tidal channels, tidal pannes/basins, and a habitat berm; permanently breaching the existing natural berm to reintroduce full daily tidal exchange to the site; and increasing topographic variability and habitat diversity across the site.

The project would commence in the summer of 2016, and is expected to take 2-3 construction seasons (summers) to complete, including a 1-2 year period of site stabilization (including re-vegetation) between grading/recontouring activities (Phase 1) and full tidal exposure (Phase 2 - Breach). The Project is being designed to become a naturally, self-regulating system that would not require extensive management or intervention.

The primary water quality considerations for Suisun Marsh and the Tule Red site include mercury (Hg) and methylmercury (MeHg), dissolved oxygen (DO), and to a lesser degree nutrients and salinity. WES has performed water quality monitoring of the site, including continuous data of salinity, turbidity, temperature, and DO at various locations within the project site during 2013 and 2014. Additionally, water samples were collected in December, 2013, at a single location and analyzed for Hg, MeHg, metals, ammonia, organochlorine pesticides, and polychlorinated biphenyls.

The purpose of this memo is to describe, with regards to MeHg and DO, the current conditions in Suisun Marsh, regulatory framework, data collected at Tule Red, anticipated effects of the proposed project, and a preliminary framework for proposed monitoring to be conducted as part of the project.

Mercury and Methylmercury

Mercury and Methylmercury Biogeochemistry and Effects in Suisun Marsh

Mercury occurs naturally in the environment and cycles between the atmosphere, water, and sediments. However, anthropogenic activities have increased Hg cycling. Mercury is most problematic when converted to MeHg in aquatic environments. Methylmercury is the organic, most toxic form of Hg and it easily bioaccumulates in organisms. In Suisun Marsh, like other tidal wetlands in the Bay-Delta region, there are relatively high Hg and MeHg concentrations (Henneberry et al. 2013) originating from a number of historical and existing sources. Mercury inputs to Suisun Marsh are primarily from the Sacramento-San Joaquin Delta, which has been affected by historical gold and Hg mining (Baginska 2012). Other sources include atmospheric deposition, tributary inputs, tidal exchange with Suisun Bay, wastewater treatment effluent, internally generated sources, and the coastal embayment (Tetra Tech 2013).

The biogeochemical production and cycling of MeHg is complex and depends on a number of interacting factors including: organic matter (OM), organic carbon (OC), DO, pH, sulfate, iron, temperature, salinity and available pools of Hg. Some wetlands can create ideal biogeochemical conditions for inorganic Hg (II) to methylate to MeHg since they are dominated by high OM soils, and receive a large flux of sediments, both of which are sources of dissolved organic carbon (DOC). DOC fuels microbial activity while also increasing biochemical oxygen demand (BOD) and decreasing oxidation-reduction potential in water and sediment. In reduced conditions, sulfate and iron-reducing bacteria mineralize OM, causing inorganic Hg to methylate (Marvin-DiPasquale et al. 2003). Higher temperatures and low pH can further enhance microbial activity, promoting Hg methylation (Mitchell and Gilmour 2008, Ulrich 2001 as cited in Henneberry et al. 2013). Once formed, a MeHg molecule can bioaccumulate, degrade to inorganic Hg, or be complexed with sediment OM and buried.

Suisun Marsh has several different habitats characterized by various drying/wetting regimes, including flood plains, seasonally flooded and managed wetlands, tidal marsh, and open water sloughs. Unlike tidal marshes that have natural drying and wetting cycles, managed wetlands have longer drying and wetting periods. Managed wetlands and sloughs isolated from larger water bodies can cause elevated concentrations of MeHg due to minimal mixing and prolonged drying and wetting cycles. Most managed wetlands are dry during the summer and early fall and are flooded in the fall. This prolonged drying accelerates decomposition of marsh litter, supplying large amounts of DOC and provides oxygen necessary for oxidation of Hg (0) to form reactive Hg (II). The fall flood cycle often releases water rich in OM that stimulates microbial activity and increases BOD in receiving waters, which, depending on tidal and mixing conditions, can subsequently reduce DO and promote sulfate and iron reducing bacteria. Managed wetlands are characterized by the highest level of reactive inorganic Hg (II) compared to other habitat types in Suisun Marsh and, therefore, have the highest methylation potential (Tetra Tech 2013). Due to the wetting/drying regime, MeHg in Suisun Marsh is highest during fall flood-up and stays high until it tapers off after several months of continuous inundation through each winter (Siegel et al. 2011).

Toxic effects of mercury in humans include impacts to the brain, heart, kidneys, lungs, and immune system. MeHg can cause a range of toxic effects to fish including, behavioral, neurochemical, hormonal and reproductive changes (Mela et al. 2007, Schuehammer et al. 2007). At high concentrations, MeHg exposure can result in acute toxicity and death in aquatic organisms. Since the entire diet of fish or invertebrates may be contaminated with Hg from the aquatic/wetland food web, aquatic organisms may be at a high risk of MeHg exposure (Drevnick et al. 2006). However, piscivorous fish are generally at the greatest risk for elevated dietary MeHg exposure, accumulation, and toxicity, since MeHg bio-magnifies up the food chain. Birds and mammals that eat fish are also exposed to mercury in their diet, and high levels of mercury in these animals can cause death, reduced reproduction, slower growth and development, or behavioral effects.

Only a few studies on MeHg accumulation in fish tissues have been conducted in Suisun Bay and Marsh. However, all have shown high levels of MeHg in fish (Tetra Tech 2013). Seven of eight striped bass collected from Suisun Bay had MeHg concentrations above the EPA screening level for human health (Slotton et al. 2002 as cited in Tetra Tech 2013). In Suisun Slough and Cutoff Slough, both within Suisun Marsh, elevated MeHg concentrations above EPA criteria were found in silverside tissue (Siegel et al. 2011).

Two years (2007-2008) of intensive field data were collected at two managed wetland sites in northwest Suisun Marsh and their surrounding tidal sloughs to better understand BMPs that can be utilized to reduce the occurrence of low DO and high MeHg (Siegel et al. 2011). The first year the objective was to identify baseline conditions in managed wetlands and determine physical management conditions to reduce low DO and MeHg production. In the second year, data was collected to evaluate the effectiveness of the modified management actions to improve understanding of the biogeochemical processes that drive MeHg production.

A variety of BMPs intended to help minimize low DO and reduce MeHg were identified and organized into four groups: 1) water management—initial fall flood-up period, 2) water management—fall-winter circulation period, 3) water management—spring and summer salinity and vegetation management, and 4) vegetation and soils management (Siegel et al. 2011). Some of these were developed previously and other BMPs were developed for this study. It was found that certain BMPs previously used may actually contribute to poor water quality conditions, whereas some BMPs not currently used improve water quality conditions. To improve water quality within wetlands the authors suggest using a combination of different BMPs (Siegel et al. 2011). Since each wetland is unique no one set of BMPs should be used. Instead an evaluation of conditions at each wetland should affect management choices including choosing the best combination of BMPs to improve water quality.

In contrast to managed wetlands, tidal wetlands have very little active management, but are expected to have a lower potential for MeHg formation. A more detailed discussion specific to the Tule Red

Tidal Restoration Project is included in the section below titled "Proposed Project Potential Effects on Methylmercury."

Current Regulatory Framework

Water Quality Criteria and Objectives

Criteria and screening values have been developed for Hg for the protection of human health and fish-eating wildlife in fish tissue and unfiltered water-column Hg concentrations. These include, for human health protection, fish tissue criteria of 0.3 mg/kg (USEPA 2001) and 0.17 mg/kg (OEHHA 2001), and a water criterion of 1.8 ng/L (USEPA 1995) and 50 ng/L (USEPA 2000). Also, for protection of fish-eating wildlife, fish tissue criteria of 0.1 mg/kg (mammals, USEPA 1995), 0.02 mg/kg (avian, USEPA 1995), and a water criterion of 1.3 ng/L (USEPA 1995).

The Water Quality Control Plan for the San Francisco Bay Basin (San Francisco Bay Region Basin Plan) contains water quality objectives for Hg in water and MeHg in fish as shown in **Table 1**.Suisun Marsh does not contain marine water, which is defined as salinity equal to or greater than 10 parts per thousand (ppt) 95% of the time. However, the marine objectives apply since waters with salinity between 1 and 10 ppt have the more stringent objective applied.

The San Francisco Bay Region Basin Plan lists a chronic water objective for Hg of 0.025 µg/L (ppb) (25 ng/L (ppt), 4 day average) in water, as shown in Table 1. However, this objective is somewhat outdated. For most San Francisco Bay segments, including Suisun Bay and portions of the west Delta, the chronic objective was vacated and site-specific objectives expressed as fish tissue concentrations were adopted (Baginska et al. 2012). Although the Suisun Marsh area was not reflected in these site specific objectives, this is thought to be an oversight (Baginska 2012).

There is consensus that fish tissue concentrations provide the best method to protect both humans and wildlife. Therefore, the State Water Resources Control Board is developing a set of objectives for safe amounts of MeHg in fish. These objectives will help guide restoration projects, water quality permits, and other actions to prevent Hg pollution (Baginska 2012). California Environmental Quality Act (CEQA) scoping for the objective setting process was conducted in 2012. Stakeholder outreach, focus groups, and other workshops have occurred, but the State Water Board has yet to issue staff reports on these objectives or propose specific objectives.

Table 1. Water Quality Objectives for Mercury and Methylmercury in the Water Quality Control Plan for the San Francisco Bay Basin (San Francisco Bay Region Basin Plan).

Total Hg in marine waters (>10 ppt salinity)	2.1µg/L	1 hr average
Total Hg in marine waters (<10 ppt salinity)	2.4 µg/L	1 hr average
Marine and Freshwater chronic objective	0.025 µg/L	4 day average
Protection of Human Health[1]	0.2 mg MeHg/kg fish tissue	Average wet weight concentration measured in the edible portion of trophic level 3 and trophic level 4 fish
Protection of Aquatic Organisms and Wildlife[1]	0.03 mg MeHg/kg fish tissue	Average wet weight concentration measured in whole fish 3–5 cm in length

[1] Site specific water quality objectives are for Hg in San Francisco Bay. The intent is for these objectives to be extended to Suisun Marsh.
Source: Baginska 2012

The Sacramento-San Joaquin Delta Estuary MeHg Total Maximum Daily Load (TMDL) addresses fish Hg impairment in all waterways within the legal Delta, except the westernmost portion of the Delta near Chipps Island that falls within the jurisdiction of the San Francisco Bay Regional Water Quality Control Board. Suisun Bay is within the legal jurisdiction of the San Francisco Bay Water Board and is part of the San Francisco Bay Hg TMDL. Tule Red is within Suisun Marsh, which has a TMDL for MeHg in development by the San Francisco Bay Regional Water Quality Control Board. The Suisun Marsh TMDL is thus the applicable regulatory action underway pertaining to Tule Red. However, because the Delta MeHg TMDL and San Francisco Bay Hg TMDL are already adopted and provide useful context to regional Hg and MeHg issues, these are discussed below.

Delta Methylmercury TMDL and San Francisco Bay Mercury TMDL

In 1990 the Delta was identified as impaired by Hg because fish were found to have Hg levels that posed risks to humans and wildlife. The Central Valley Regional Water Quality Control Board developed two components in its water quality attainment strategy to resolve Hg impairment in the Delta. The first component of this strategy was to establish a TMDL to reduce Hg levels in fish throughout the Delta. The concentration of MeHg present in fish tissues was selected as the target for the TMDL. The TMDL addresses Hg and MeHg, since a reduction in both sources is necessary to reduce MeHg concentrations in fish. Numeric targets were selected to protect both humans and wildlife using a method approved by the United States Environmental Protection Agency (USEPA) and Delta-specific information. The numbers were chosen based on the USEPA's California Toxics Rule criterion of 50 ng/L total recoverable Hg (USEPA 2000) and to comply with the San Francisco Bay mercury control requirements (SWRCB 2010).

Numeric targets were identified for different size fish, by both trophic level and size in mm, as shown in **Table 2**. There is also an implementation goal for unfiltered ambient water of 0.06 ng/L MeHg (CVRWQCB 2010). This is not a water quality objective, but rather a target to determine how much Delta waters must be reduced to achieve fish targets.

Table 2. Target Concentrations of Methylmercury in Fish Tissue from the Sacramento-San Joaquin Delta Methylmercury TMDL.

Trophic level and size in mm	Representative fish type	Average Target MeHg concentrations in mg/kg wet weight	For the Protection of
Trophic level 3 150-500 mm total length	American shad, black bullhead, bluegill, carp, Chinook salmon, redear sunfish, Sacramento blackfish, Sacramento sucker, and white sturgeon	≤ 0.08	Humans that consume 32/g day of commonly eaten large fish and all wildlife that consume large fish
Trophic level 4 150-500 mm total length	largemouth bass, striped bass, channel and white catfish, crappie, and Sacramento pikeminnow	≤ 0.24	Humans that consume 32/g day of commonly eaten large fish and all wildlife that consume large fish
Trophic level 2 and 3 whole fish less than 50mm total length		≤ 0.03	Wildlife that consume small fish

Source: CVRWQCB 2010

The second component of the water quality attainment strategy to resolve Hg impairment in the Delta involves implementing a control program through the Water Quality Control Plan for the Sacramento and San Joaquin River Basins (the Central Valley Region Basin Plan). The Central Valley Region Basin Plan amendments recommend site-specific fish tissue objectives for the Delta and an implementation plan to achieve these objectives. The amendments include provisions for reductions in Total Hg for tributaries that discharge Hg-contaminated sediment. Since it is expected to take several centuries to lower total Hg concentrations, the MeHg reduction strategy also focuses on interrupting the methylation cycle by: 1) identifying sources of MeHg, 2) on-site MeHg management practices, and 3) control actions for upstream Hg sources that supply the methylation sites (SWRCB 2010).

The implementation strategy is divided into Phase 1 (2008-2015) and Phase 2 (2016-2030). Phase 1 is a study period to collect data and develop management practices to control MeHg discharges. It also includes the development of upstream Hg control programs for major tributaries, development and implementation of a Hg exposure reduction program to protect humans and development of a Hg offset program. In Phase 2, dischargers would implement MeHg management practices developed in Phase 1.

San Francisco Bay Mercury TMDL

The San Francisco Bay Hg TMDL was developed in 2006 and approved by the USEPA in 2008. The TMDL has a median goal for total Hg in suspended sediment of 0.2 mg/kg (ppm), which is approximately half of the median level in 2008 (SWRCB 2008). The TMDL also set a target of 0.03 ppm MeHg in small prey fish. The TMDL discusses control measures to reduce mercury input to San Francisco Bay from upstream sources (e.g., the Delta, Suisun Bay), and assigned a load reduction of 110 kg/yr from Central Valley outflows, since these outflows were identified as one of the main sources of Hg to the San Francisco Bay (SWRCB 2008). Because of this, the MeHg TMDL for the Delta must also ensure protection of human and wildlife health in the Delta meets Central Valley load allocations identified in the San Francisco Bay Hg TMDL.

Suisun Marsh Methylmercury TMDL in Development

Suisun Marsh wetlands are listed in the 2010 Clean Water Act Section 303 (d) impaired waterbodies list as impaired by Hg, low DO, organic enrichment, nutrients and salinity. The principle source of impairment in the marsh is Hg/MeHg and low DO. The listings are more than 20 years old and the basis for the listings has never been clearly explained. However, archival information indicates placement of the wetlands on the 303(d) list was due to adverse conditions not in the wetlands, but in the adjacent sloughs (Baginska 2012). The TMDL is therefore focused on actions and measures necessary to attain water quality standards in the sloughs.

Although research has shown some wetlands are efficient sites for MeHg production, methods to reduce Hg methylation and bioaccumulation are still at the testing stage. At the same time, wetland ecosystems are being restored or are planning to be restored throughout the Bay-Delta and Suisun Marsh. Therefore, it is critical to determine the best tidal restoration guidelines and management techniques to reduce MeHg production in the future. The Suisun Marsh TMDL will establish a link between managed wetland operations, specifically the flooding and releasing of high organic content, MeHg production patterns, low DO waters from managed wetlands, and the observed acute drops in DO levels in back-end sloughs.

Mercury and Methlymercury Data from Tule Red

The Wildlife Area, which is owned and operated by CDFW, runs along the northeast side of the Tule Red site. Some of the land in the Wildlife Area is managed for duck habitat, and thus, like Tule Red, is periodically flooded and drained in the fall and winter. Some or all of this water drains out of a large outfall into the Tule Red property.

WES staff collected duplicate water samples from the CDFW outfall on 12/5/2013 that were analyzed for total Hg and MeHg. The average total Hg concentration was 5.8 ng/L, and the average total MeHg concentration was 1.07 ng/L. The total Hg concentration is within the range of Hg concentrations found in ambient waters in Grizzly Bay (1-83 ng/L, 10 ng/L median (SFEI 2015)). The MeHg concentrations are elevated above those found in the ambient waters of Grizzly Bay (0.01-0.2 ng/L (SFEI 2015)), likely due to MeHg production in the managed seasonal wetlands in the Wildlife Area. No sediment samples or fish tissue samples have been collected on the site.

While greater than ambient water concentrations in the area, concentrations of MeHg in water described above are in the range expected in managed wetlands in Suisun Marsh. CDFW collected water samples at Blacklock in Suisun Marsh and found MeHg concentrations up to 2.3 ng/L when water was collected after the levee overtopped in 2005 (CDWR 2007). However, Nurse Slough, the wetland adjoining to Blacklock, had significantly lower MeHg levels (up to 0.07 ng/L) in 2004 (CDWR 2007).

Proposed Project Potential Effects on Methylmercury

Wetlands in Suisun Marsh were historically fully tidal wetlands with a daily inflow and outflow of water based on the tidal cycle. Today, the vast majority of wetlands within Suisun Marsh are managed wetlands and their hydrology is controlled so only some water is exchanged with surrounding sloughs. Tidal wetlands are considered both sources and sinks of total Hg and MeHg. Tidal wetlands retain particulates and associated Hg but export dissolved materials (e.g., DOC). Managed wetlands and tidal wetlands have very different hydrologic cycles and vegetation types which affect wetland biogeochemistry and subsequently MeHg production. There is only limited research on MeHg flux in tidal wetlands and even less information on the effects of tidal conversion of managed wetlands. Henneberry et al. (2013) hypothesized that converting managed wetlands to tidal wetlands will reduce MeHg concentrations for two reasons: 1) conversion to tidal wetlands will reduce anthropogenic management and resulting disturbance which have been linked to low DO, high DOC and elevated MeHg exports in Suisun Marsh; and 2) a change in hydrology will cause tidal wetlands to act as pumps resulting in a decrease in spatial and temporal MeHg hotspots. Both of these changes would ameliorate low DO conditions, potentially resulting in decreased MeHg formation in slough sediments.

With restoration to tidal wetlands, sub tidal areas of Tule Red would have constant saturation of soil and the intertidal region would experience drying periods too short for significant soil oxidation. Based on improved spatial and temporal redox conditions, decreases in MeHg production and concentrations may occur within the property; however, depending on the level of MeHg production decrease, loads may remain at similar levels due to greater hydrologic exchange in the tidal versus the current managed system (Tetra Tech 2013). Converting managed wetlands to tidal systems would reduce episodic discharges of high MeHg and low DO water. Since tidal systems experience much greater flow, they act as tidal pumps, reducing constituent concentrations and MeHg formation in slough sediments. The creation of more open water areas with longer inundation of restored tidal marshes are also expected to reduce DOC supply and methylation.

Not enough information is available to fully understand or anticipate the effects on MeHg when the Tule Red site is restored to tidal conditions. Many factors associated with restoration could reduce episodic MeHg production and the low DO events associated with managed wetlands, including an alteration of biogeochemical drivers that cause MeHg production. Based on evidence from the nearby Blacklock project, tidal conversion may result in a period of heightened Hg and MeHg transport and concentrations out of the site due to flushing of accumulated material (Bachand et al. 2011 as cited in Henneberry et al. 2013). This increase may span an order of magnitude in MeHg load, however, over time, concentrations should decrease (Henneberry et al. 2013). The Blacklock data set also showed that long term MeHg concentrations declined following conversion due to higher hydrologic exchange between the marsh and surrounding slough waters (Heim et al. 2013 as cited in Hennebery et al. 2013).

One significant unknown factor is the influence of the CDFW drain water on current or future Hg and MeHg concentrations in water and sediment of Tule Red. Since wetlands in the Wildlife Area will remain managed, they are expected to continue to have elevated levels of MeHg that would continue to influence the Tule Red site. However, because natural tidal flushing will occur once the property is restored, residence time of the MeHg on site will likely decrease, resulting in less opportunity for the MeHg to enter the local food chain.

Tetra Tech (2013) hypothesized the conversion from managed wetlands to full tidal marsh would increase the tidal prism and flows, which would decrease temporal and spatial MeHg hotspots within Suisun Marsh. The Suisun Marsh Plan EIR-EIS, in its assessment of project effects on Hg and MeHg, concluded that there was no evidence to conclude that tidal restoration in the Marsh would lead to increased problems with MeHg for fish, wildlife, or consumers. That is, the assessment assumed that tidal wetland restoration in Suisun Marsh would not result in increased MeHg compared to baseline export of Hg and MeHg in sediment from managed wetlands to tidal sloughs during flood/drain activities, and that it was possible a reduction could occur.

Because MeHg production in tidal wetlands is not well understood, no management practices to decrease MeHg in tidal wetlands have been developed. A number of BMPs could be used (either separately or in combination) to help reduce MeHg production at the project site (Siegel et al. 2011). However, many of the BMPs suggested by Siegel et al. 2011 have not been fully tested, so are not guaranteed to resolve MeHg production issues.

Methylmercury Monitoring

The San Francisco Bay Regional Water Quality Control Board will likely require some level of Hg and MeHg monitoring as part of permitting that will be required for the Tule Red project. At this time, it is unknown what level of monitoring will be required, since the Suisun Marsh TMDL is still in development. Although it is important that Hg and MeHg be monitored prior to and following construction at Tule Red, because large scale conversion of managed wetlands to tidal wetlands is envisioned in Suisun Marsh, participation in a regional study would be advantageous. A regional study with uniform methodology across sites will be able to better characterize Hg and MeHg dynamics within restored areas.

To our knowledge, no such regional study has been organized within Suisun Marsh, but a regional study is underway to conduct this type of monitoring within the Delta. Under the Delta Mercury Control Program, which was established by the Delta MeHg TMDL and Basin Plan Amendment, the Department of Water Resources (DWR) and CDFW are required to develop control measures to minimize the discharge of MeHg from tidal wetlands. In order to better understand imports and exports of MeHg into tidal wetlands prior to designing and restoring extensive areas of tidal restoration, DWR and CDFW have developed a monitoring plan for Hg and MeHg in tidal wetlands. The objective of the monitoring plan is to better characterize MeHg imports and exports of tidal wetlands to determine if patterns emerge. Specific objectives include: 1) determine whether tidal wetlands are net sources or sinks of MeHg and total Hg, 2) determine if seasonal differences occur, 3) measure and calculate net yearly OC, chlorophyll *a*, and total suspended solids exports, and 4) determine if OC and MeHg concentrations are correlated. This information will be used to adjust TMDL allocations accordingly and plan for future tidal wetland restoration.

DWR plans to study 3-8 tidal wetlands. Most of the wetlands are within the Delta, but the Blacklock Tidal Marsh is within Suisun Marsh, and monitoring at this location is already underway. Each wetland is to be sampled at the mouth or mouths to calculate loads of each entire wetland. Sampling will include taking continuous flow measurements and intensely measuring dissolved and particulate MeHg and total Hg for 8-12 25 hour periods to estimate MeHg and total Hg loads over a one year period. Total suspended solids, total organic carbon and dissolved organic carbon, and chlorophyll *a* will also be collected.

Whether or not a regional study can be implemented in Suisun Marsh is unknown and will be determined following coordination with the Regional Water Board and/or other agencies on what monitoring will be required. Depending on the level of requirements, if a regional study in Suisun Marsh is not envisioned or organized, it may be possible to partner with DWR and participate in their ongoing study of tidal wetlands via cost-sharing and a memorandum of understanding that Tule Red would be included in the study. Details of this partnership or an independent monitoring study will be determined as part of permitting and/or coordination with the Regional Water Board.

Dissolved Oxygen

Background on Dissolved Oxygen in Suisun Marsh

Tidal marshes and managed wetlands are naturally rich in organic carbon, and can experience low DO due to an abundance of organic matter from the growth and subsequent decay of submerged plants and macrophytes. As these plants decay they consume oxygen and can cause low DO in the marshes or surrounding waters when marsh water is discharged or drained. In Suisun Marsh, oxygen problems can be compounded from a number of anthropogenic sources that contribute to BOD including: inputs from the Sacramento-San Joaquin Delta, Bay tidal action, and runoff from local watersheds that may contain pollutants from urban, agricultural and industrial activities, nutrient enriched effluent from the Fairfield-Suisun Wastewater Treatment Plant located in the northwest portion of the marsh, and illegal waste from boats in Suisun Marina (Tetra Tech 2013). Preliminary load estimates suggest the most significant drivers of low DO are vegetation and water management activities in the managed wetlands (Tetra Tech 2013). In addition to the various sources of oxygen consuming materials that flow into the Marsh, the geometry and hydrology of the area can create conditions to further reduce DO levels (Siegel et al 2011). Although there are areas of the Marsh where it is known that DO is poor , DO patterns are not well understood in all Suisun Marsh sloughs.

Although all sources of DOC can cause poor DO in Suisun Marsh, operations at managed wetlands may have the greatest effect on water quality (Baginska 2012), though that effect is generally episodic and associated with discharge under certain tidal conditions. As discussed previously, most wetland managers perform a series of flood-drain cycles. Water stored in the surrounding diked managed wetlands have high levels of primary productivity due to long residence time and high nutrient availability (CDFG 2008 as cited in Tetra Tech 2013). Decomposition of this OM in the ponded water causes high DOC and low DO to develop. During flood-up, pulses of hypoxic water from the wetlands can be discharged into Suisun Marsh causing significant and persistent (i.e., on the order of days to weeks) DO depressions to occur within adjoining sloughs (O'Rear and Moyle 2010, Schroeter et al. 2006 as cited by Tetra Tech 2013). Further exacerbating the problem are small or narrow sloughs that reduce potential for mixing and tidal exchange. As long as circulation rates remain low and temperatures are high, as they tend to be during early fall, DO depressions continue to occur in various locations. Whether or not low DO conditions exist following discharge events depends not just on the DO of the water discharged, but the volume and flow rate of the discharge, the volume and flow rate of receiving waters into which the discharge is mixed, the DO of the receiving water, the geometry and hydrodynamics of the receiving waters, and atmospheric conditions. It also must be noted that while there are areas of the Marsh where it is known that DO is poor, not all areas of the Marsh or all managed wetlands experience low DO problems.

Seasonal DO variations in Suisun Marsh occur with most DO depressions occurring in early summer and fall (Siegel et al. 2011). These DO depressions can cover several kilometers of slough habitat in northwestern Suisun Marsh (Schroeter and Moyle 2004 as cited in Siegel et al. 2011) and can be severe enough, especially in fall (DO <2.0 mg/l) to cause mortality of fishes, invertebrates and other organisms that use the sloughs and waterways of Suisun Marsh. DO depressions have caused multiple fish kills in Suisun Marsh since 1999 (O'Rear and Moyle 2010).

Suisun Marsh wetlands are listed in the 2010 Clean Water Act Section 303 (d) impaired waterbodies list as impaired by low DO and organic enrichment. A TMDL in development is focused on attainment of DO water quality objectives to protect aquatic life (**Table 3**). However, DO concentrations at reference sites suggest occasional low DO concentrations during fall months may fall below 5 mg/l, suggesting DO targets of 7 mg/l may not be met in fall even at reference sites (Tetra Tech 2013).

Table 3. Water Quality Objectives for Dissolved Oxygen in the Water Quality Control Plan for the San Francisco Bay Basin (San Francisco Bay Region Basin Plan).

Tidal waters in the vicinity of Suisun Marsh	>7.0 mg/L
Nontidal waters designated as cold water habitat	≥ 7.0 mg/L
Nontidal waters designated as warm water habitat	≥ 5.0 mg/L
Median DO for any three consecutive months	≥ 80% DO content at saturation

Source: SWRCB 2015

The Suisun Resource Conservation District (SRCD), CDFW, DWR, and the U.S. Bureau of Reclamation (USBR) are performing dissolved oxygen monitoring as a condition of the Regional General Permit 3 through the San Francisco Bay Regional Water Quality Control Board. This monitoring is conducted in the fall in tidal slough that have already exhibited significant low DO levels, including Peytonia Slough, Boynton Slough, lower Cordelia Slough, Goodyear Slough, and the upper reaches of Suisun Slough north of Volanti Slough. This monitoring took place in 2013, 2014, and is currently in the final stages for 2015. The monitoring is taking place at managed wetlands, upstream and downstream of major points of discharge in the tidal sloughs. The data collected as part of this monitoring will be reviewed and a report drafted this winter.

Dissolved Oxygen in Tule Red

As discussed previously, the Wildlife Area, which is owned and operated by CDFW, is managed for waterfowl habitat, and thus, like Tule Red, is periodically flooded and drained in the fall and winter. Some or all of this water drains out of a large outfall into the Tule Red property. Currently, this water can remain on the property when the tide gates are closed. When tide gates are open, the tidal action can dilute and flush this water out of the property.

As with other managed wetlands in Suisun Marsh, this drain water likely contains substantial BOD and elevated MeHg concentrations on an episodic basis, as discussed above. Dissolved oxygen monitoring was conducted from January 2013 – January 2014 using an Onset Hobo optical DO logger placed in the pool to which the CDFW drain empties.

Figures 1 and 2 show the measured DO data. During February – May 2013, very high daily and weekly fluctuations were seen. In March, April, and May, 2013, DO < 2 mg/L was common. Logger failure occurred during the second half of May and during June, 2013. Very low DO was seen again in October, 2013. The logger once again failed during part of November, 2013, but data obtained in November and December 2013, and in January 2014 also showed very low DO.

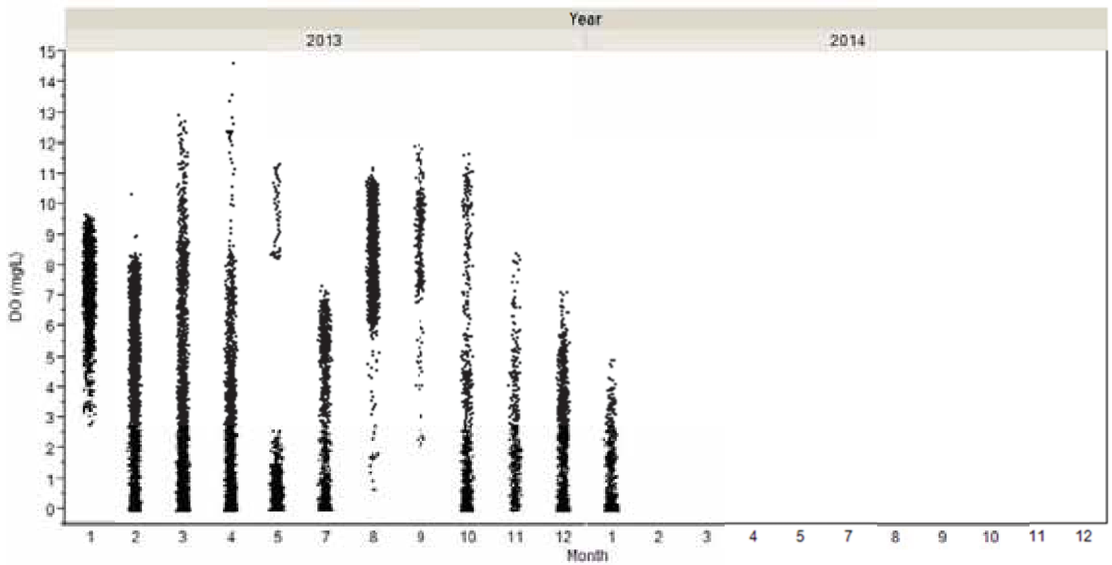

Figure 1. Dissolved oxygen data measured at Tule Red in pool to which CDFW drain empties. Note that very high daily and weekly fluctuations were measured during February – May, 2013. Logger failure occurred in May and June, 2013.

Proposed Project Effects on Dissolved Oxygen

As described above in the section titled "Proposed Project Potential Effects on Methylmercury", many factors associated with restoration could reduce episodic low DO events associated with managed wetlands. Conversion to tidal wetlands will reduce anthropogenic management and resulting disturbance which have been linked to low DO and high DOC in Suisun Marsh. Additionally, since tidal systems experience much greater flow than managed systems, they act as tidal pumps, reducing constituent concentrations in water and sediments. The creation of more open water areas with longer inundation of restored tidal marshes is expected to reduce DOC supply. Thus, the Tule Red Restoration Project is expected to reduce or eliminate the potential for discharge of low DO water from onsite managed marsh.

Nevertheless, the CDFW drain water will continue to be discharged to Tule Red. Since wetlands in the Wildlife Area will remain managed, they are expected to continue to discharge water with high BOD and low DO that could continue to influence the Tule Red site. Natural tidal flushing will occur once the property is restored, reducing residence time of the water onsite and increasing mixing and dilution. Furthermore, the proposed project includes a two-phase approach to improving the low DO problem from CDFW drain water, as discussed below.

Phase 1: Retrofit the existing outlet pipe

The potential solution utilizes the existing pipe outfall and basin and would require no additional earthwork. During the first year of construction, WES would retrofit the existing drain outlet pipe where it enters the Tule Red property with a spray aeration fitting engineered to bring the DO in the drain discharge water to within ecologically acceptable tolerances. WES would conduct continuous water quality monitoring using in situ monitors to determine the effectiveness of this measure.

Although this measure may temporarily increase DO concentrations, it is expected that the water will still contain high levels of BOD, which could subsequently lower DO downstream. Monitoring will include both DO and BOD sampling to investigate this possibility.

Phase 2: Construct a pooling area

If additional measures are required, WES would construct a new pooling area to control the discharge of the CDFW drain water into the restoration area. The new pooling area would be created downstream of the existing discharge by constructing a new road crossing and levee between the two existing levees. The levee would include a new water control structure that would allow water to be retained within the pooling area or discharged into the restoration site, depending on tides and DO content of the drain water.

As stated, Phase 2 would require construction of a road approximately 10 feet wide to connect both levees. The amount of fill associated with the road and levee is less than 0.1 acre. Construction of the road and levee is included in the permit applications.

Conclusion

As discussed above, the Tule Red Restoration Project proposes to restore tidal wetlands in Suisun Marsh by introducing full daily tidal exchange to an existing managed marsh duck club. There is no evidence to conclude that tidal restoration will lead to increased problems with MeHg for fish, wildlife, or consumers, or will increase problems associated with low DO. That is, it is expected that the project will not result in increased MeHg compared to baseline export of Hg and MeHg in sediment from the managed wetland to tidal sloughs during flood/drain activities, and it is possible a reduction could occur. Further, the project is expected to reduce or eliminate the potential for discharge of low DO water from onsite managed marsh. It is hypothesized that conversion to tidal wetlands will reduce anthropogenic management and resulting disturbance which have been linked to low DO, high DOC and elevated MeHg exports in Suisun Marsh. Further, a change in hydrology is expected to increase tidal prism and flushing and reduce residence time, and thus should result in a decrease MeHg concentrations and an increase in DO concentrations.

One significant unknown factor is the influence of the CDFW drain water on current or future Hg and MeHg concentrations in water and sediment of Tule Red. Since wetlands in the Wildlife Area will remain managed, they are expected to continue to have elevated levels of MeHg that would continue to influence the Tule Red site. However, because natural tidal flushing will occur once the property is restored, residence time of the MeHg on site will likely decrease, resulting in less opportunity for the MeHg to enter the local food chain.

The proposed project includes a two-phase approach to improving the low DO problem from CDFW drain water. These measures may increase DO concentrations, but it is expected that the water will still contain high levels of BOD, which could subsequently lower DO downstream. Monitoring will include both DO and BOD sampling to investigate this possibility.

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Appendix D.1

Salinity Modeling Analysis of the Proposed Tule Red Tidal Marsh Restoration

Salinity Modeling Analysis of the Proposed Tule Red Tidal Marsh Restoration, Grizzly Island, California
Technical Memorandum

November 2015

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Executive Summary

Numerical models for hydrodynamics and water quality transport have been applied to evaluate local and regional Impacts of the Proposed Tule Red Tidal Marsh Restoration Project (Project). The numerical model was updated to reflect the current Tule Red (July 2015) design concept with a breach of the main tidal channel located at the north end of the site. The purpose of the analysis was to evaluate the regional salinity impacts with development of the restoration project.

The tool used for the model analysis was the RMA Bay-Delta model for flow and salinity. A detailed grid representation of the Tule Red restoration design was added to the Bay-Delta model to assess the "with Project" condition.

Simulation of salt transport, using Electrical Conductivity (EC) as surrogate, was performed for the 2002- 2003 analysis period. 2002 was a dry year when western Delta water quality stations controlled water operations. 2003 was an above normal year with higher net Delta outflow. The results were evaluated for monthly averaged EC change at three western Delta locations and at south Delta Export locations. Maximum computed EC increases at the south Delta export locations were limited to +0.1% to +0.3% for the 2002 dry year. Maximum computed EC increases at Jersey Point and Emmaton in the western Delta were +0.4% and +0.3% respectively. Computed EC increased for the Mallard Island west Delta location was +0.7% for April 2002.

The 2002 and 2003 years match the analysis years performed for the "Numerical Modeling in Support of Suisun Marsh PEIR/EIS" (RMA, 2009) and permits the results from the Tule Red analysis to be evaluated in context to the water quality objectives of the Suisun Marsh Restoration Plan EIS/EIR (Reclamation, 2011). The computed salinity (EC) changes for the western Delta and export locations are consistent with the water quality objectives stated in the water quality section (sec 5.2) of the Suisun Marsh Habitat Management, Preservation, and Restoration Plan Final EIS/EIR (Reclamation, 2011). Model results from the Suisun Marsh EIR/EIS studies indicated restoration sites connecting existing marsh channels may slightly reduce salinities at Delta exports and diversions and restorations sites connect to Suisun Bay may slightly increase the salinities. Development of the Suisun Marsh restoration will include a combination of sites adjacent Suisun Bay and sites more internal to the Marsh. The small computed changes with the Tule Red restoration are well within the objectives of the Suisun Marsh Plan EIR/EIS of maintaining increases in baseline salinity well below 10%.

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Introduction

RMA previously performed a numerical modeling analysis for the 2013 preliminary restoration design. This report provides a detailed description of the numerical modeling for the Tule Red tidal restoration project for the most recent (July 2015) design plan.

Background

Tule Red is an approximately 420 acre parcel on the west edge of Grizzly Island adjacent to Suisun Bay and has a typical marshplain elevation of about 4 feet NAVD88. Planning is underway to restore the area as a tidal marsh. Numerical modeling performed as part of the Suisun Marsh Programmatic EIR/EIS and the Bay Delta Conservation Plan has shown that restoration activities in the area can impact flow and salinity both locally and regionally.

Objective

The objective of this study was to evaluate regional salinity impacts resulting from the restoration.

RMA Bay-Delta Model

The primary numerical modeling tool used for the evaluation is the RMA Bay-Delta model. The RMA Bay-Delta model is a well-established tool for analysis of hydrodynamic and water quality impacts of proposed projects in the Sacramento-San Joaquin Delta and Suisun Bay and Marsh. Most relevant to this project, the RMA Bay-Delta Model has been used extensively in the development of the Suisun Marsh Programmatic EIR/EIS (RMA, 2009) and is one of the primary tools used for the BDCP evaluation of tidal marsh restoration. The RMA Bay-Delta Model was chosen for use on these projects based on its ability to provide sufficiently accurate simulation of Delta-wide hydrodynamics and water quality transport and its ability to perform predictive simulations to evaluate the impacts of proposed tidal marsh restoration. The RMA Bay-Delta Model utilizes the RMA2 hydrodynamics and RMA11 water quality transport finite element computational engines. The finite element model formulation allows use of an unstructured computation mesh where resolution can be increased locally to represent the topographic details of a restoration site. RMA2 and RMA11 engines support combining two-dimensional depth-averaged (2D) computational elements and one-dimensional cross-sectionally averaged (1D) elements in a single mesh. In the RMA Bay-Delta Model all large channels, embayments, and tidal marsh restoration areas are represented in 2D. The model has been shown to provide accurate simulation of tidal exchange through constrictions, such as levee breaches into a restoration site, based on the breach geometry, site topography, and friction parameter (Manning's n value) estimated within a typical accepted range.

The RMA Bay-Delta Model does not directly simulate the effects of stratified flow, which would require application of a three-dimensional (3D) model. The effects of stratification are approximately incorporated into the model through calibration exercises where mixing coefficients are adjusted to best represent the observed salinity field for a historic period, or to best represent the simulated salinity field from a 3D model simulation for a proposed condition.

Electrical conductivity (µmhos/cm or µSiemens/cm), or EC, was modeled as a surrogate for salinity. Details are provided describing model boundary condition data sources and the application of boundary conditions in the model.

Model Configuration

Geometric Extents

RMA's San Francisco Bay - Sacramento–San Joaquin Delta network was developed using an in-house GIS-based graphical user interface program (RMA, 2003). Development of the grid for the Tule Red site also utilized the Janet grid generation software from smile consult GmbH. The programs allow for development of the finite element mesh over layers of bathymetry points and bathymetry grids, GIS shapefiles and aerial images.

The RMA Bay-Delta model, shown in Figure 1 extends from the Golden Gate at the west end, to the Sacramento River at the confluence with the American River, and to the San Joaquin River near Vernalis. A two-dimensional depth-averaged approximation is used to represent the San Francisco Bay, Suisun Bay region and the other open water and major channels of the Delta. The other Delta and Suisun Marsh channels and tributary streams are represented using a one-dimensional cross-sectionally averaged approximation. A Bay-Delta grid was developed with a detailed two-dimensional representation for the Tule Red site (Figure 1).

Bathymetry

Bay-Delta model bathymetry is shown in Figure 2 for the Base case. For all areas of the base model grid, the most current, best quality bathymetric data were used to set grid elevations. The model geometry was refined in Grizzly Bay using the latest Digital Elevation Model (DEM) developed by Department of Water Resources (DWR): http://baydeltaoffice.water.ca.gov/modeling/deltamodeling/modelingdata/DEM.cfm. The website also provides a figure displaying the original data sources for the most up to date Bay-Delta bathymetry data.

Project Configuration

The Tule Red model grids were developed from digital elevation models provided by Northwest Hydraulic Consultants (NHC) which included channel configuration and site marshplain elevations. NHC provided bathymetry in TIN model formats for the “as-built” and “future” conditions. The TIN model for the future condition reflects some evolution, deepening and widening of the main tidal channel. Relative to the as-built design, the future condition would be expected to have a greater tidal exchange and tidal prism due to the larger main tidal channel. We would anticipate potential salinity impacts to be greater for the future condition and thus applied the future condition elevation model to the grid development of the project site.

Figure 3 shows the conceptual design (July 2015) and the NHC future conditions elevations for the Tule Red restoration. Earlier conceptual designs breached the Tule Red site at southern or south central locations. The present design breaches the main tidal channel to Grizzly Bay at the north end of the restoration site. The recent design also includes development/construction of berms to form marsh ponds that were not in earlier concept designs. Figure 4 provides representative tidal channel cross-sections and topography sections across the berms and marsh ponds.

The dimensions of the main and smaller tidal channels are listed in Table 1. The RMA model grid explicitly represents all the smaller tidal channels of dimension of type “A” and “B” in Table 1. Only some, but not most of the small “C” channels are explicitly represented in the RMA grid due to the large number of model cells required to accurately represent these features. The smaller channels are explicitly gridded for areas of the marshplain not near channels of dimension “B” and “C”. A 3D perspective view of the RMA Bay-Delta model grid for the Tule Red site is shown in Figure 5.

Table 1 Channel dimensions for the Tule Red restoration design, from NHC future conditions 3D TIN model. Elevations are feet, NAVD88.

Feature	Description/Dimensions
Main Tidal Channel near entrance to Grizzly Bay	130 ft width @ -5 ft elevation 160 ft width @ +5 ft elevation
Main Tidal Channel	Bottom elevation ranges from -5 ft at the entrance to -2 ft at the head of channel
Tributary Tidal Channels	A: -0.5 ft at Invert, 12 ft wide at channel top. B: +2.0 ft at Invert, 8 ft wide at channel top. C: +2.5 ft at Invert, 4 ft wide at channel top

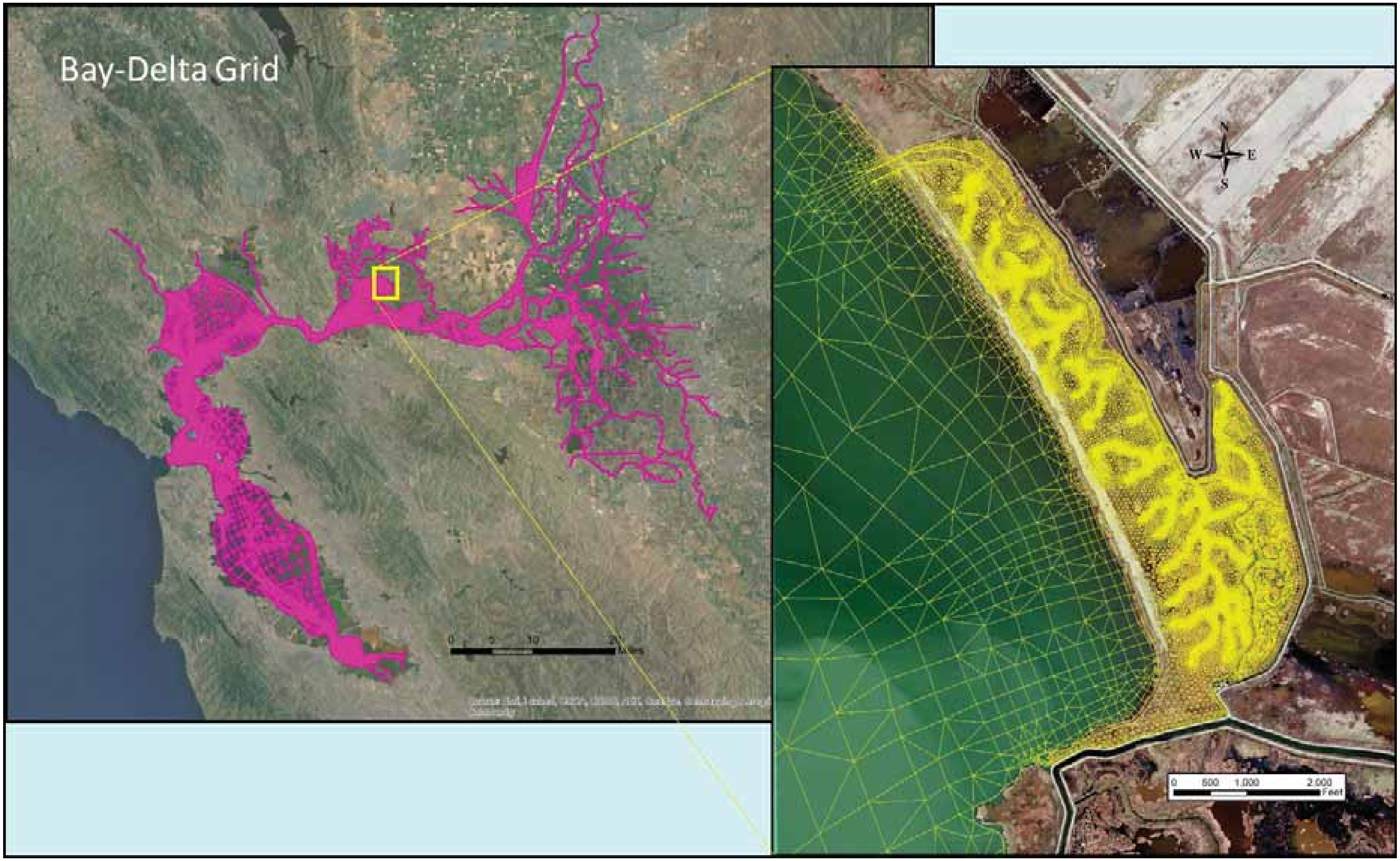

Figure 1 Numerical model network for the Bay-Delta grid and the detailed model network for the Tule Red site.

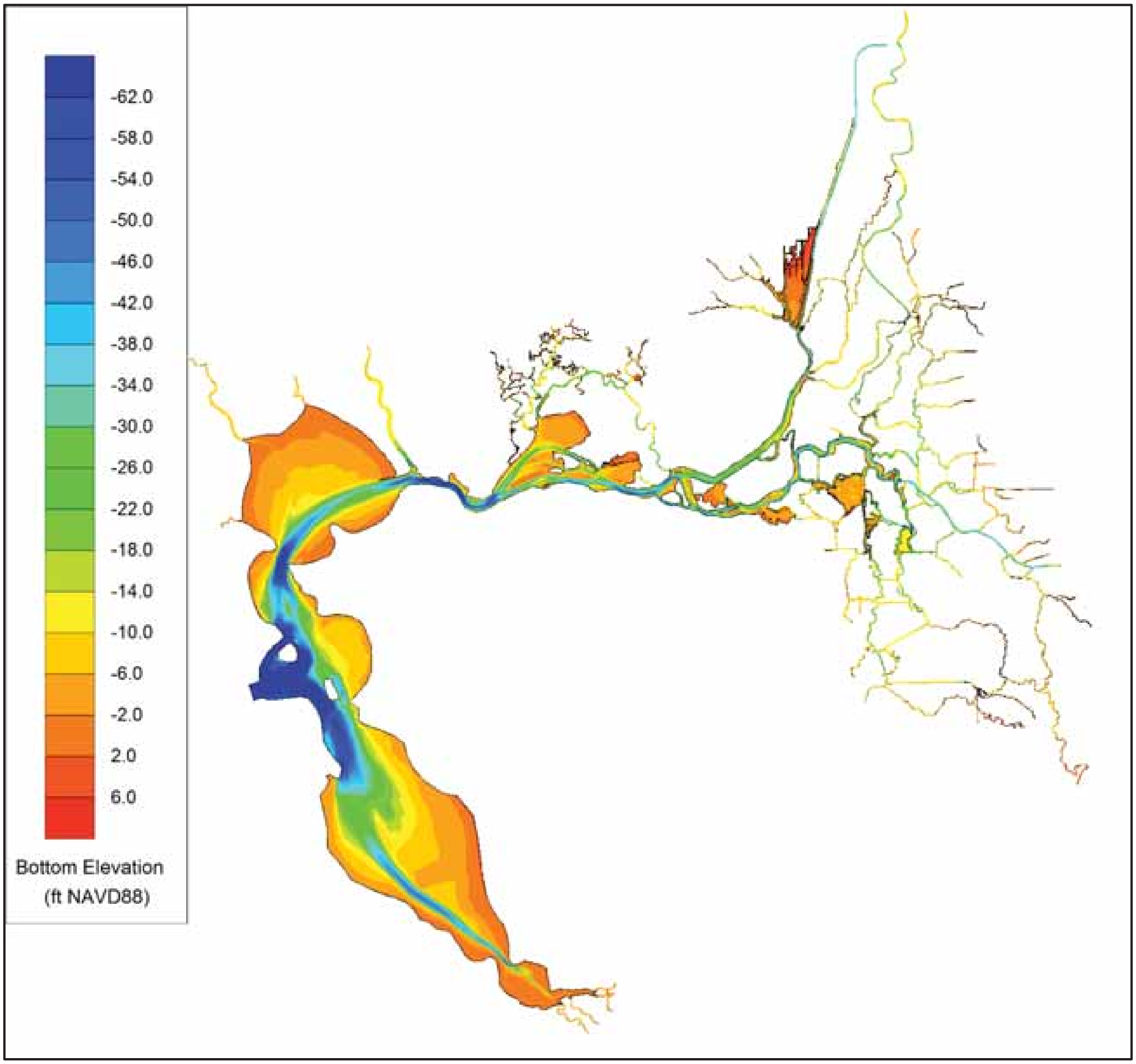

Figure 2 Base case bathymetry for the Bay-Delta model.

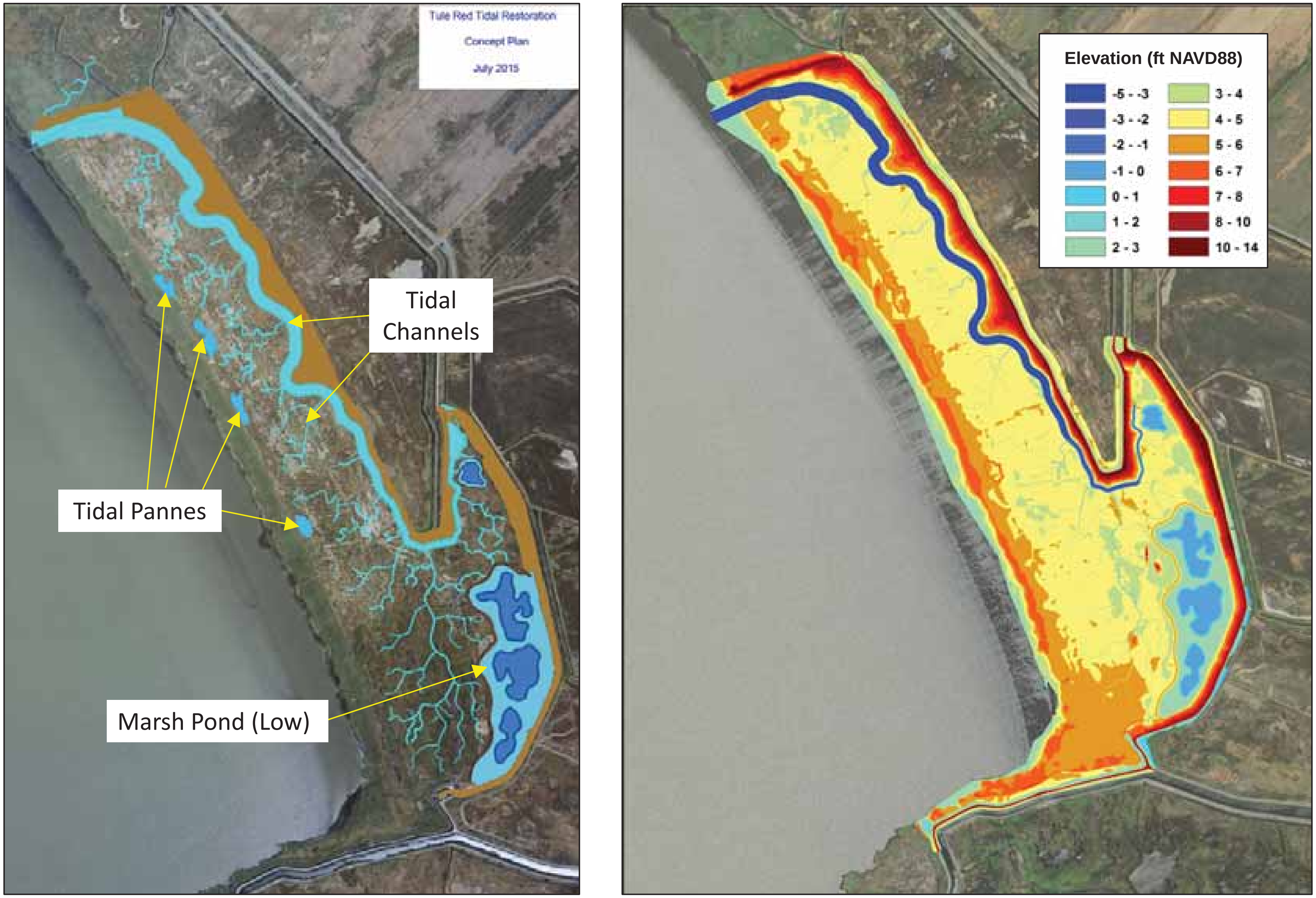

Figure 3 (left) July 2015 Tule Red Tidal Restoration Concept Plan. (right) Tule Red Restoration DEM from NHC 3D TIN model (31Aug2015 Future Condition).

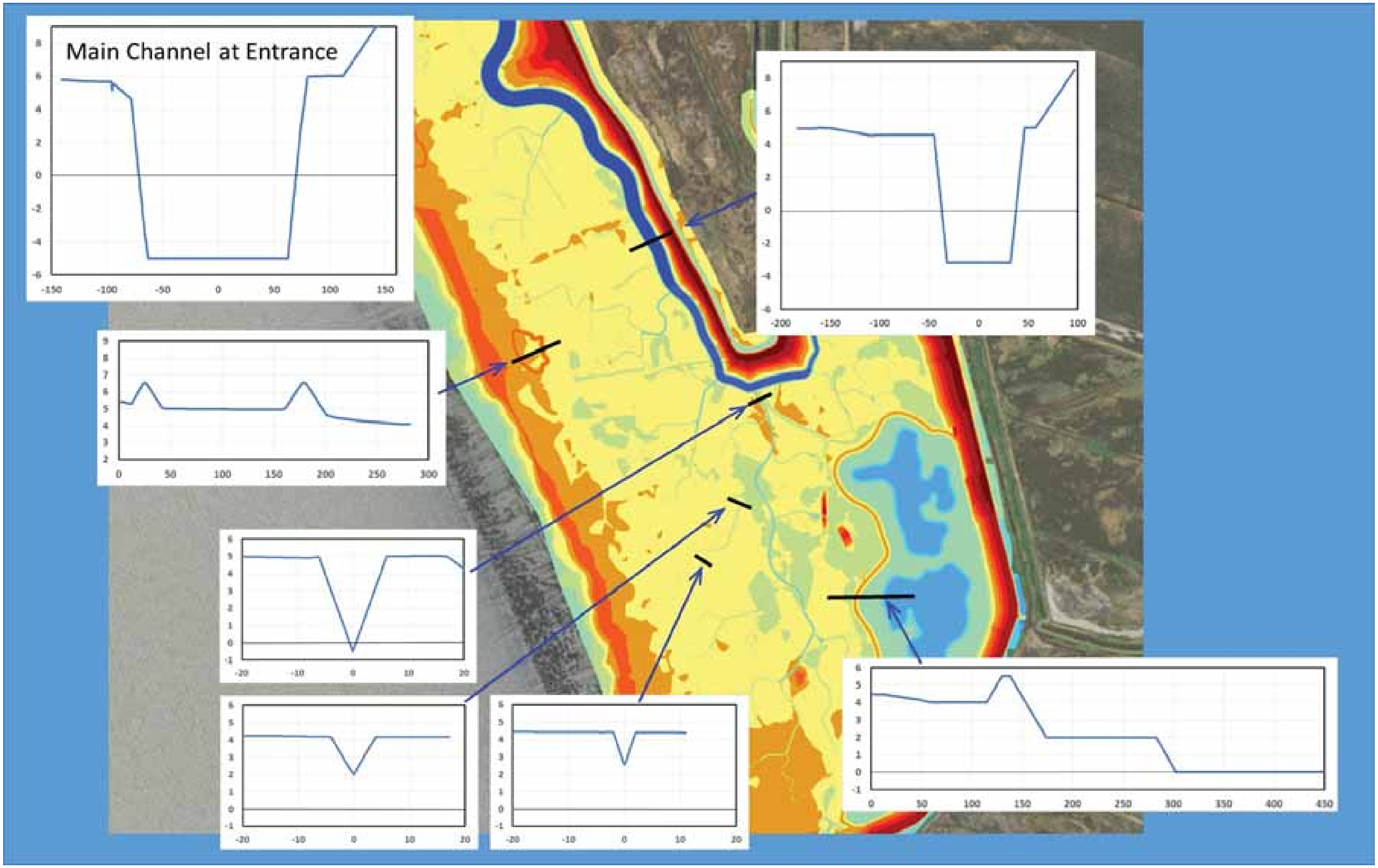

Figure 4 Selected channel cross-sections and marshplain sections of the future condition restoration design. Note the vertical to horizontal scale changes for tributary tidal channel cross-sections. Elevation is given in ft NAVD88.

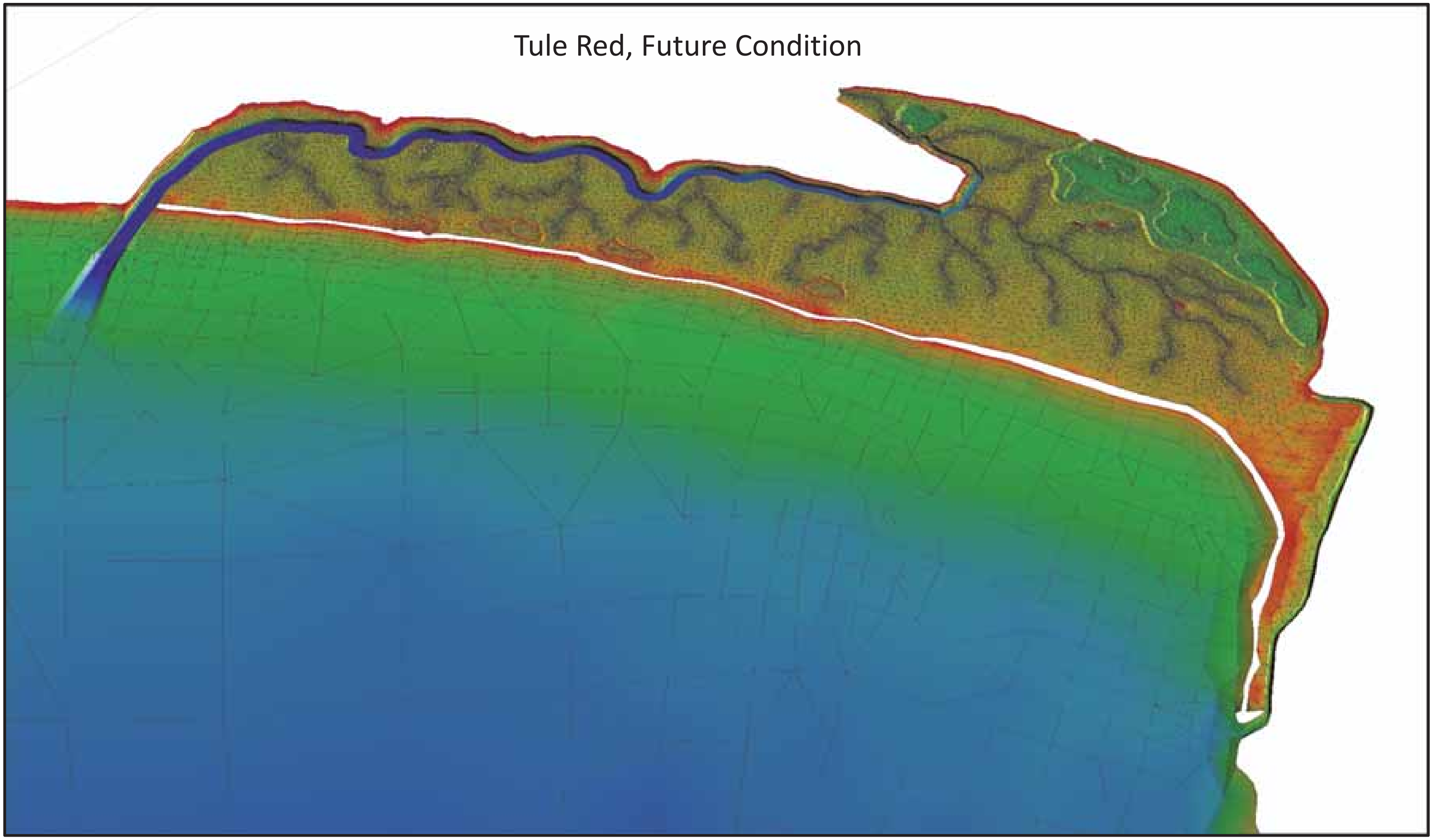

Figure 5 3D perspective view of model grid for the Tule Red tidal restoration design, future condition.

Regional Salinity Impacts Analysis

Tidal restoration around Suisun Bay and in Suisun Marsh can potentially increase modeled EC by increasing tidal prism and tidal mixing downstream of the site, and through the exchange of waters between the Bay and the restoration site (tidal trapping). Conversely, a tidal restoration may slightly dampen the tidal range upstream of the site and thus serve to slightly diminish tidal mixing further upstream towards the Delta (RMA, 2009).

For the Bay-Delta model, Electrical Conductivity (µmhos/cm or µSiemens/cm), or EC, was modeled as a surrogate for salinity. The reference to “EC” in this document is in keeping with some past conventions, and is used as a stand-in for the more precise term of Specific Conductance (SC) for the electrical conductance corrected to 25° C.

Simulation Years, 2002-2003

The hydrodynamic (RMA2) and water quality (RMA11) models were run for the January 2002 to December 2003 period. The Water Year 2002 is classified by DWR as a “dry” year type while 2003 is classified as an “above normal” hydrology for the Sacramento River system and “below normal” for the San Joaquin River system (see http://cdec.water.ca.gov/cgi-progs/iodir/wsihist). The overall monthly hydrology for the 2002 and 2003 period is characterized in the plot of the monthly averaged Net Delta Outflow (NDO) in Figure 6. In viewing the plot, the NDO for spring 2002 is notably less than the spring outflow in 2003. The observed tidally averaged EC at Martinez is plotted in Figure 7 and illustrates the general salinity trend for Suisun Bay over the simulation period.

The 2002 and 2003 years match the analysis years performed for the *Numerical Modeling in Support of Suisun Marsh PEIR/EIS* (RMA, 2009). This permits the results from the Tule Red analysis to be evaluated in context to the water quality objectives of the Suisun Marsh Restoration Plan EIS/EIR (Reclamation, 2011). A detailed presentation of the model setup and boundary conditions for the 2002-2003 period is presented in Appendix A.

Simulation Results

The salinity impacts of the Tule Red restoration are evaluated by comparing the computed Base configuration EC to the computed EC for a Tule Red restoration project. The focus of the presentation is for the 2002 dry water year where the computed impacts are somewhat more than the wetter 2003 year. Figure 8 presents a spatial comparison of the tidally averaged Base and Project EC over Suisun Bay and the western Delta for a fall period in 2002. Generally the differences between the Base and Project EC are small.

Figure 9 shows the Delta output results locations for the salinity analysis. Tidally averaged EC is plotted for 2002 for the three western Delta stations at Mallard Island (Figure 10), the Sacramento River at Emmaton (Figure 11) and the San Joaquin River at Jersey Point (Figure 12). The figures illustrate that Project computed EC visibly overlies Base condition EC. The three plots also include observed EC, and show model EC generally tracks observed EC, although model EC does underestimate observed EC for early December.

Differences between the Base and Project EC are difficult to discern from the time series plots. Project EC change from Base is tabulated for the three locations in Table 2. Increases in computed EC are small (≤ 0.4%) for the Emmaton and Jersey Point locations, and somewhat greater for the Mallard Island locations (≤ 0.7%). Tabulated monthly EC and EC change for 2002 and 2003 for the Project vs. Base are provided for all locations shown in Figure 9 in Appendix B. The tabulated monthly results for the Rock Slough and SWP water export locations are presented in Table 3. The table shows little change in computed EC with the Project, with a maximum change of +1.6 µS/cm or +0.3% at Rock Slough in August of 2002.

The above computed salinity (EC) changes for the western Delta and export locations are consistent with the water quality objectives stated in the water quality section (sec 5.2) of the *Suisun Marsh Habitat Management, Preservation, and Restoration Plan Final EIS/EIR* (Reclamation, 2011). Model results from the Suisun Marsh EIR/EIS studies indicated restoration sites connecting to existing marsh channels may slightly reduce salinities at Delta exports and diversions, and restorations sites connected to Suisun Bay may slightly increase the salinities. Development of the Suisun Marsh restoration will include a combination of sites adjacent to Suisun Bay and sites more internal to the Marsh. The small computed changes with the Tule Red restoration are well within the objectives of the Suisun Marsh Plan EIR/EIS of maintaining increases in baseline salinity well below 10%.

The computed EC results for the CCWD Rock Slough location were processed to evaluate potential changes to the D-1641 chloride compliance for the Rock Slough intake location. Details of the EC to Chloride conversion are presented in Appendix C. The D-1641 water quality objectives for the CCWD Rock Slough intake specify an overall maximum mean daily chloride limit of 250 mg/L (SWRCB, 2006). The peak computed chloride values for both Base and Project cases were 203 mg/L. In addition to the 250 mg/L overall chloride standard, the chloride concentrations are required to be less than or equal to 150 mg/L at least 165 days for the 2002 Dry year type and 190 days for 2003 Above Normal year type. Table 4 summarizes the Base condition and Project model chloride results, listing the number of calendar days within the 150 mg/L chloride limit for the two years. The table indicates for the years 2002 and 2003 the Project and the Base condition compliance are the same.

Table 6 in Appendix B presents the computed EC change for the eastern Suisun Marsh stations at Beldon's Landing and Montezuma Slough above the Salinity Control Gates. The computed EC changes with the Project are limited to ±1.0% or less from October to May. These changes are well within the 10% salinity change objective of the Suisun Marsh Restoration Plan EIS/EIR (Reclamation, 2011).

Table 2 Monthly averaged Base and Project EC for 2002, for three western Delta locations.

Month	Mallard Island			Emmaton			Jersey Point		
	Base EC (uS/cm)	EC Chng (uS/cm)	EC Chng (%)	Base EC (uS/cm)	EC Chng (uS/cm)	EC Chng (%)	Base EC (uS/cm)	EC Chng (uS/cm)	EC Chng (%)
Jan 2002	306	0.4	0.1%	176	0.0	0.0%	202	0.0	0.0%
Feb 2002	1909	5.1	0.3%	212	0.0	0.0%	247	0.1	0.0%
Mar 2002	955	4.1	0.4%	159	0.0	0.0%	208	0.1	0.0%
Apr 2002	1427	10.6	0.7%	167	0.0	0.0%	189	0.1	0.0%
May 2002	1950	11.4	0.6%	190	0.0	0.0%	235	0.0	0.0%
Jun 2002	4379	22.0	0.5%	334	0.9	0.3%	295	0.6	0.2%
Jul 2002	8018	22.7	0.3%	608	1.0	0.2%	846	3.3	0.4%
Aug 2002	9056	12.5	0.1%	761	0.3	0.0%	1214	3.5	0.3%
Sep 2002	11127	5.2	0.0%	1316	1.1	0.1%	1516	2.7	0.2%
Oct 2002	12498	-3.1	0.0%	1769	0.4	0.0%	1410	0.8	0.1%
Nov 2002	11849	-3.5	0.0%	1670	-0.6	0.0%	1375	0.5	0.0%
Dec 2002	6491	-2.4	0.0%	874	-0.7	-0.1%	943	0.4	0.0%

Table 3 Computed monthly averaged EC change for 2002-2003 at the CCWD Rock Slough intake and the SWP at the entrance to the Clifton Court Forebay gates.

CCWD, Rock Slough

Month	Base EC (uS/cm)	EC Chng (uS/cm)	EC Chng (%)
Jan 2002	431	0.1	0.0
Feb 2002	317	0.0	0.0
Mar 2002	302	0.1	0.0
Apr 2002	271	0.0	0.0
May 2002	373	0.0	0.0
Jun 2002	314	0.0	0.0
Jul 2002	364	0.7	0.2
Aug 2002	633	1.6	0.3
Sep 2002	720	1.2	0.2
Oct 2002	711	0.8	0.1
Nov 2002	685	0.1	0.0
Dec 2002	822	0.1	0.0
Jan 2003	500	0.2	0.0
Feb 2003	327	0.1	0.0
Mar 2003	266	0.0	0.0
Apr 2003	236	0.0	0.0
May 2003	356	0.0	0.0
Jun 2003	254	0.0	0.0
Jul 2003	235	0.0	0.0
Aug 2003	236	0.2	0.1
Sep 2003	360	0.4	0.1
Oct 2003	615	0.4	0.1
Nov 2003	728	0.3	0.0
Dec 2003	758	0.3	0.0

SWP, Clifton Court Intake

Month	Base EC (uS/cm)	EC Chng (uS/cm)	EC Chng (%)
Jan 2002	368	0.0	0.0
Feb 2002	331	0.0	0.0
Mar 2002	334	0.0	0.0
Apr 2002	329	0.0	0.0
May 2002	395	0.0	0.0
Jun 2002	334	0.0	0.0
Jul 2002	318	0.5	0.2
Aug 2002	483	1.1	0.2
Sep 2002	563	0.9	0.2
Oct 2002	557	0.4	0.1
Nov 2002	550	0.0	0.0
Dec 2002	583	0.0	0.0
Jan 2003	343	0.0	0.0
Feb 2003	269	0.0	0.0
Mar 2003	254	0.0	0.0
Apr 2003	320	0.0	0.0
May 2003	407	0.0	0.0
Jun 2003	214	0.0	0.0
Jul 2003	202	0.0	0.0
Aug 2003	207	0.1	0.1
Sep 2003	321	0.3	0.1
Oct 2003	507	0.3	0.1
Nov 2003	571	0.2	0.0
Dec 2003	569	0.2	0.0

Table 4 Number of days in 2002 and 2003 which computed chloride concentrations are less than or equal to 150 mg/L at the Contra Costa Canal Intake at Rock Slough.

Year	Water Year Type	D-1641 Chloride Water Quality Objective Compliance Days during Calendar Year	Number of Days with Mean Daily Chloride Conc. <= 150 mg/L	
			Base	Project
2002 [1]	Dry	165	289	289
2003 [2]	Above Normal	190	310	310

[1] Includes model results from 1-Jan-2002 through 31-Dec-2002

[2] Includes model results from 1-Jan-2003 through 31-Dec-2003

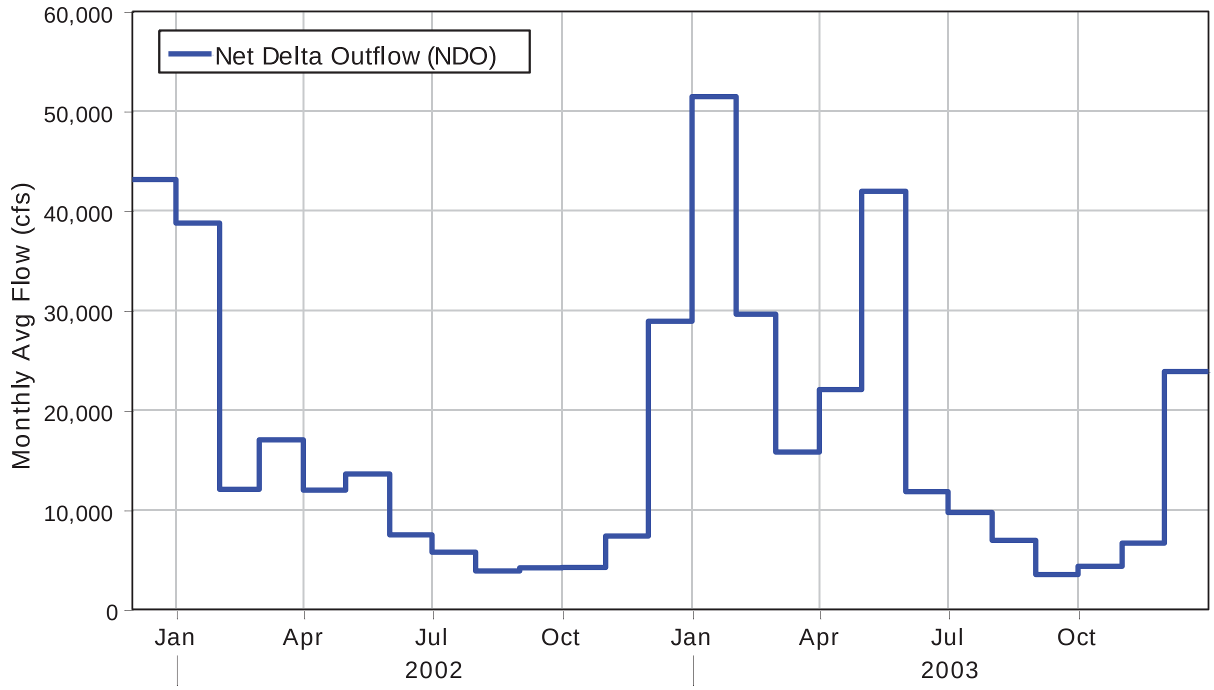

Figure 6 Net Delta Outflow (NDO) from DAYFLOW.

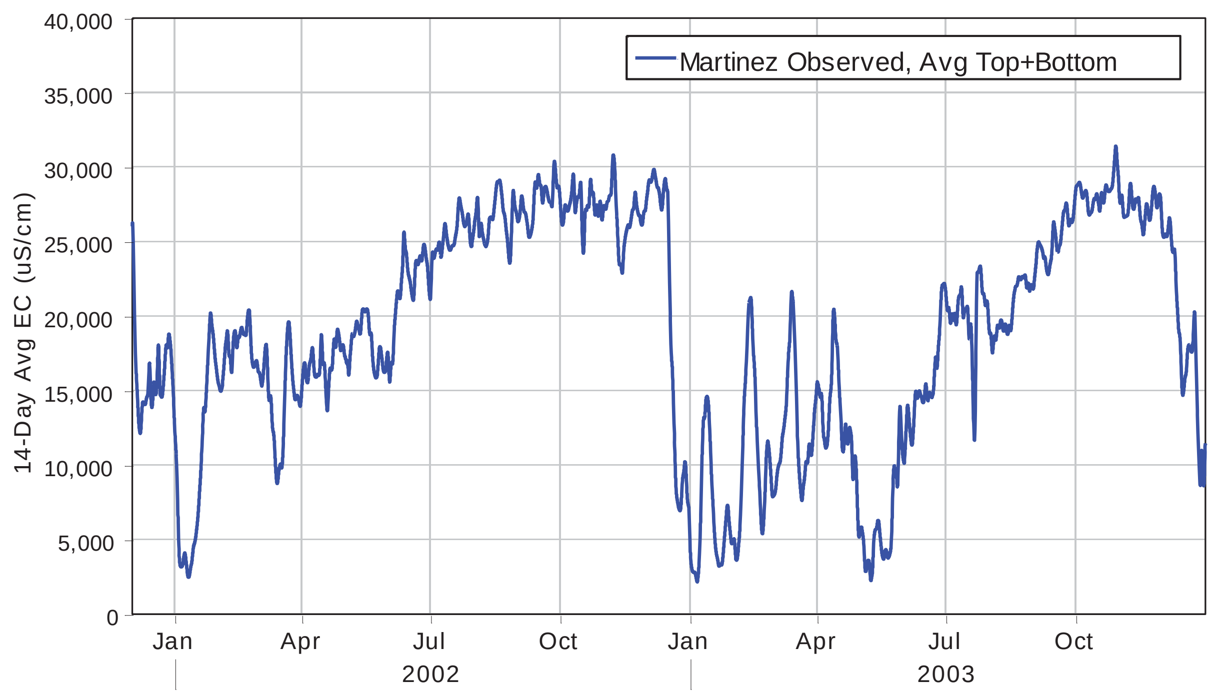

Figure 7 Observed tidally averaged EC at Martinez. Plotted value is the average of top and bottom measured EC.

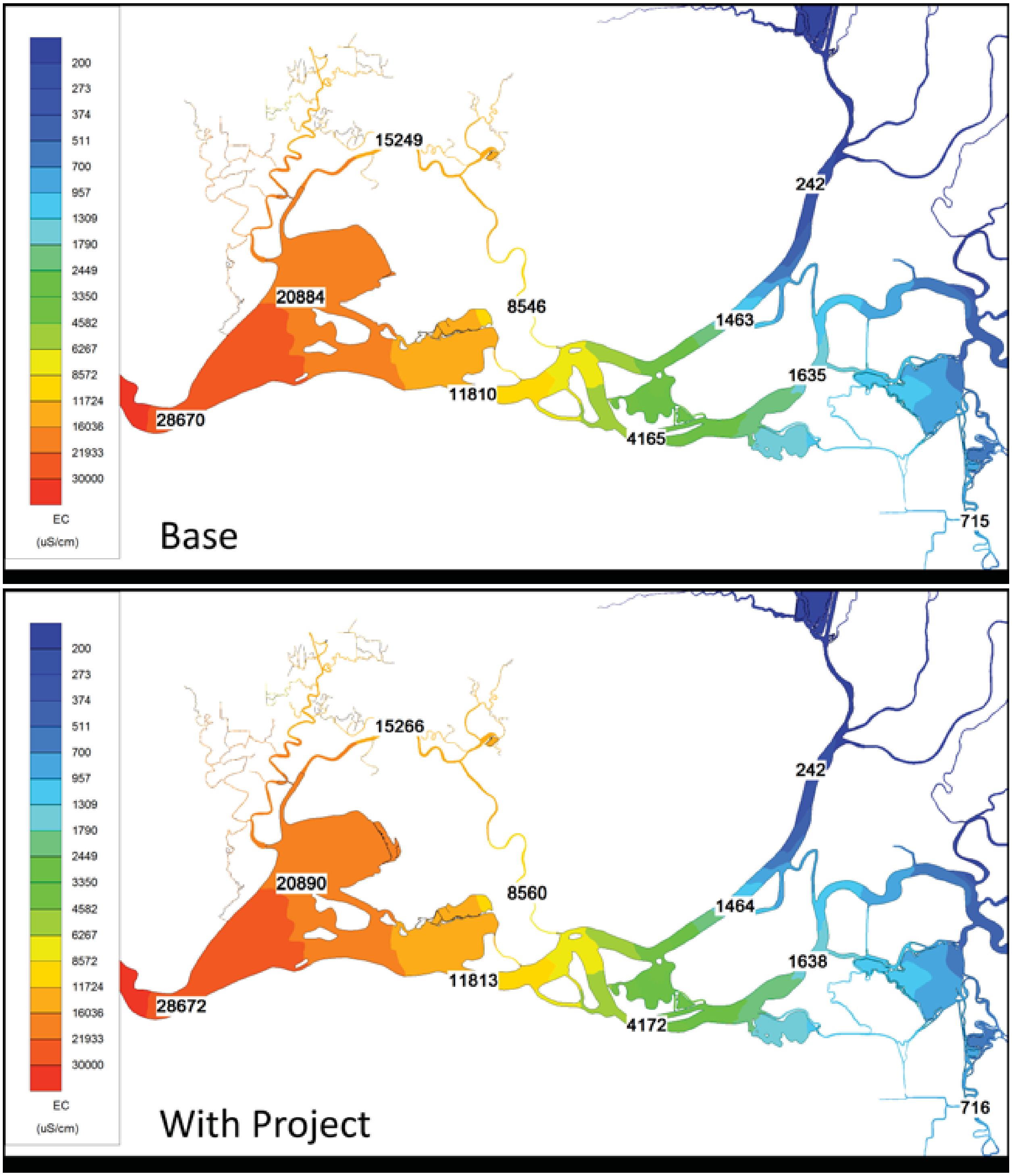

Figure 8 Contour plots of tidally averaged EC for the Base (top) and Project (bottom) configurations for September 15, 2002.

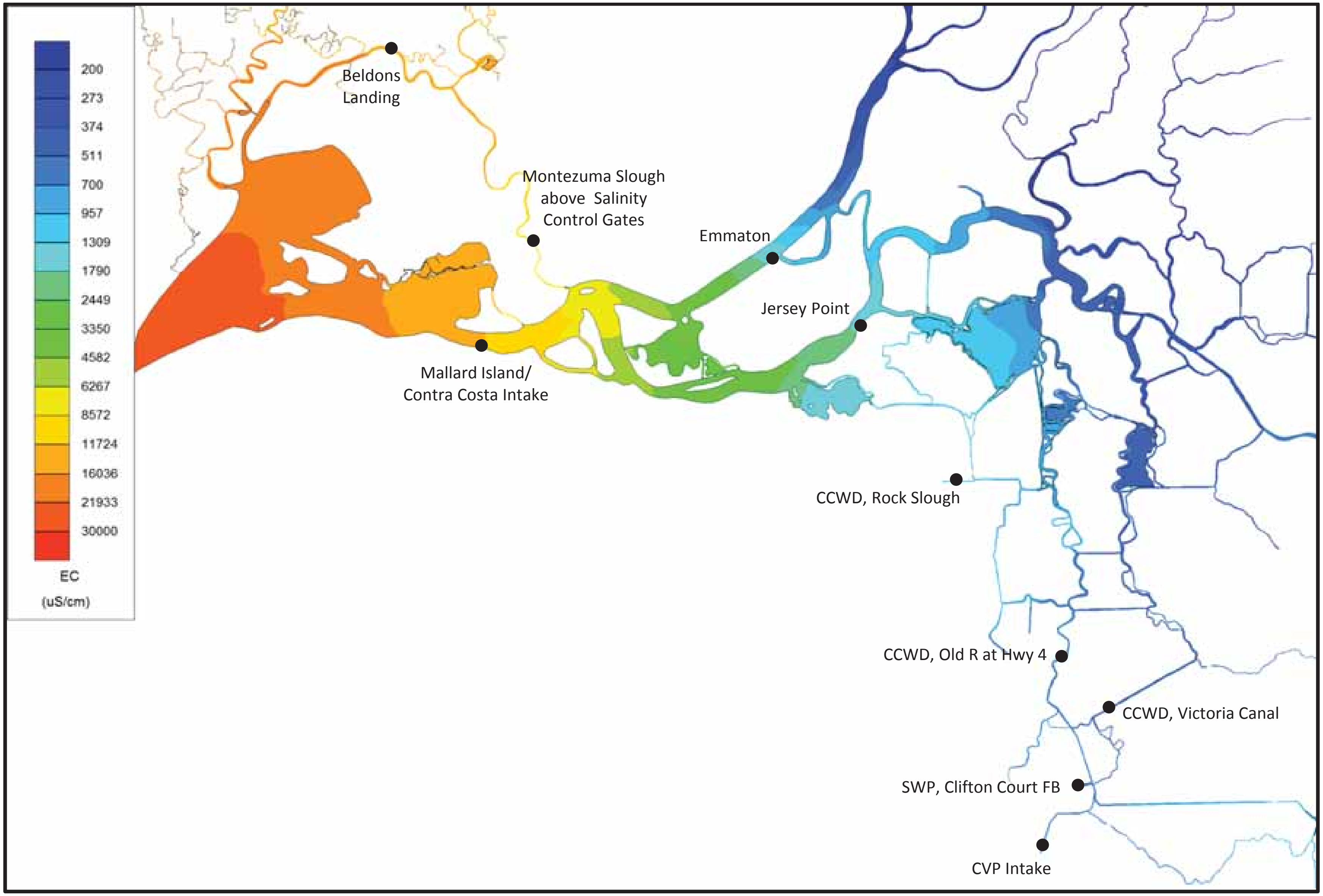

Figure 9 Station locations for output of EC plot and table results.

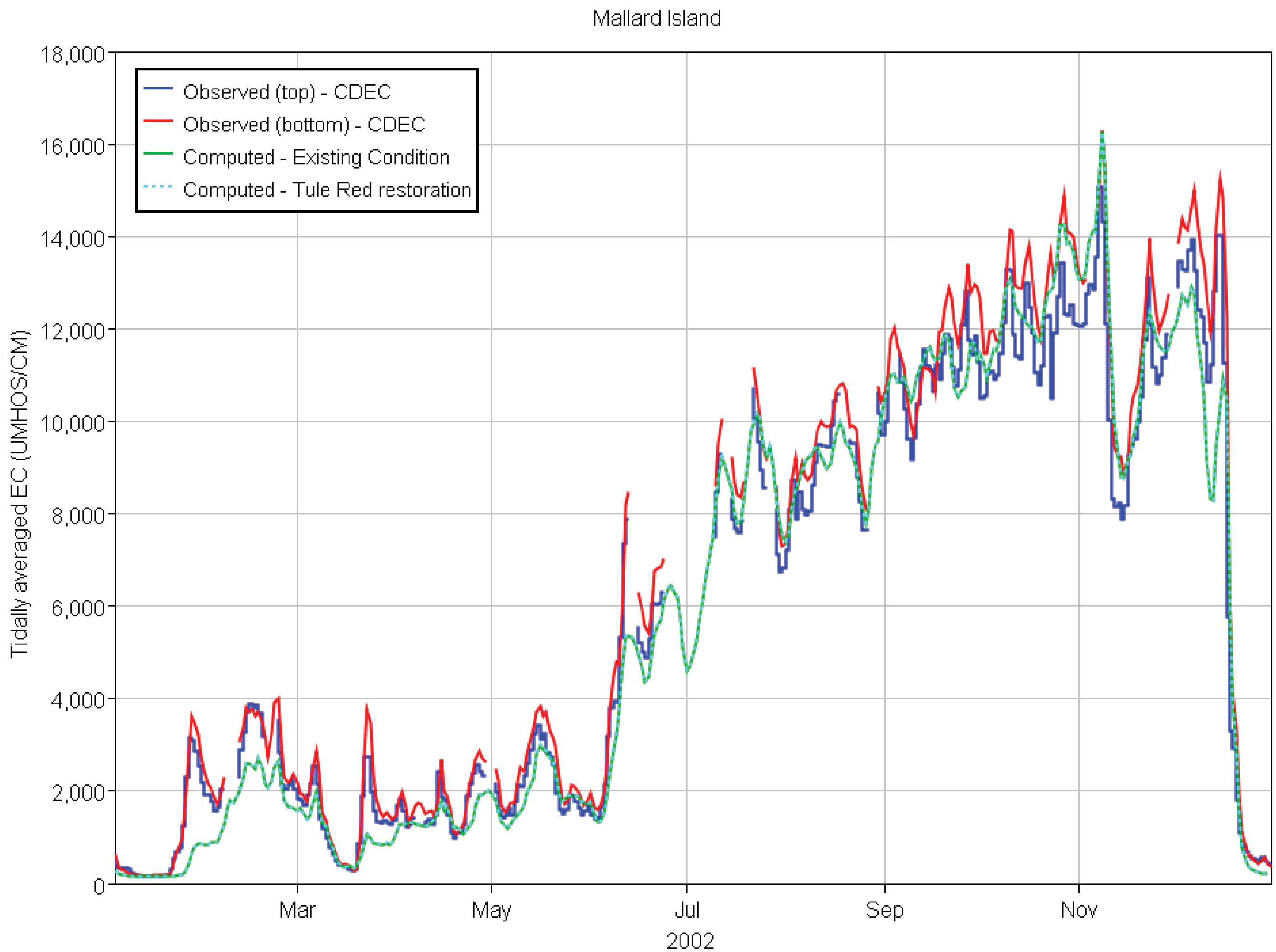

Figure 10 Comparison of tidally averaged EC for the Base and Project conditions at Mallard Island for 2002. Observed top and bottom EC are also plotted.

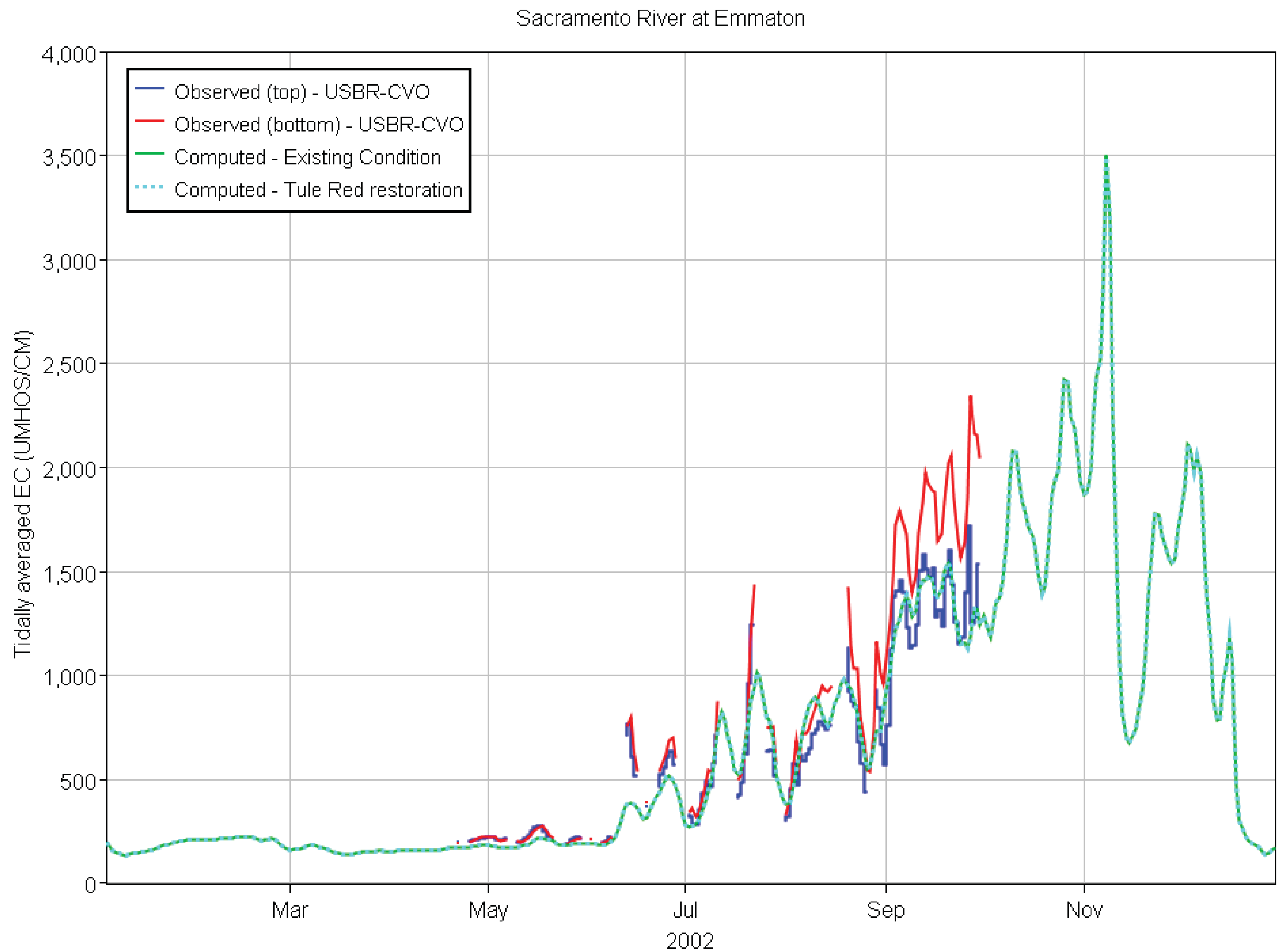

Figure 11 Comparison of tidally averaged EC for the Base and Project conditions for the Sacramento River at Emmaton for 2002. Observed top and bottom EC are also plotted.

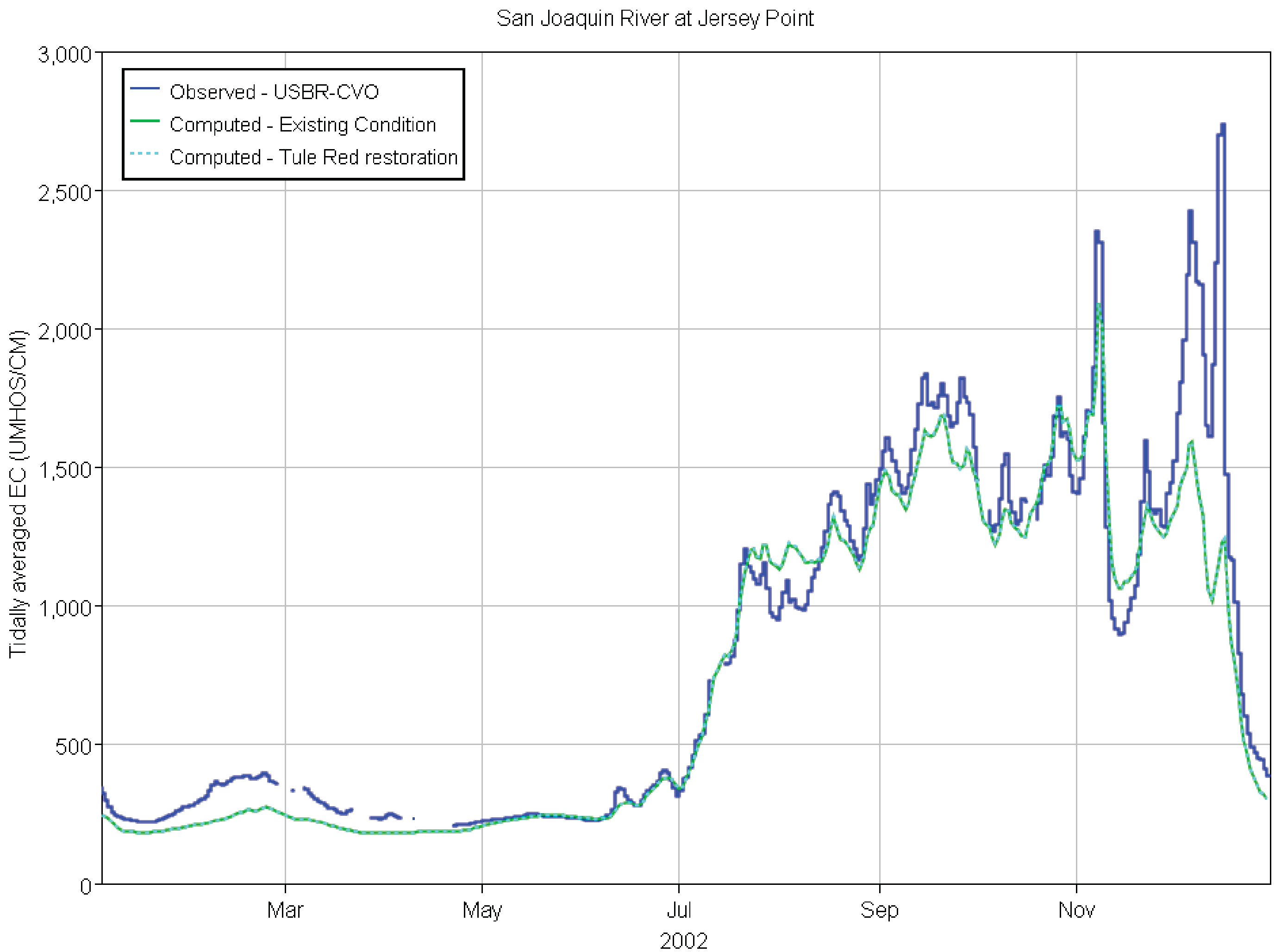

Figure 12 Comparison of tidally averaged EC for the Base and Project conditions for the San Joaquin River at Jersey Point for 2002. Observed EC is also plotted.

References

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Appendix A: Model Boundary Conditions

Overview

This appendix provides a detailed presentation of the model setup and boundary conditions for the RMA Bay-Delta model, in particular to the 2002-2003 runs for the salinity impacts analysis. Major boundary conditions for the RMA Bay-Delta model are shown in Figure 13 with further detail of all boundary conditions shown in Figure 14. Each model inflow boundary conditions requires a corresponding EC value be specified. The model boundary conditions are:

Tidal boundary at Golden Gate

The tidal boundary is set at the Golden Gate, the western boundary of the model, using observed data for the NOAA station at San Francisco. These data were smoothed and shifted to NGVD + 0.05 m. The 0.05 m shift accounts for density effects between the tidal boundary and the Project site.

Inflows, exports, precipitation, evaporation, DICU:

Sacramento River
San Joaquin River near Vernalis
Yolo Bypass
Mokelumne River
Cosumnes River
Calaveras River and other minor eastside flows
Napa River
In Suisun Marsh – Suisun Creek, Green Valley Creek, Ledgewood Creek, Laurel Creek, Fairfield Wastewater Treatment Plant (WWTP)

Delta Island Consumptive Use (DICU):

DICU flows incorporate channel depletions, infiltration, evaporation, and precipitation, as well as Delta island agricultural use. DICU flow and EC values are applied on a monthly average basis and were derived from monthly DSM2 input values (DWR, 1995).

Major Control Structures:

Delta Cross Channel gates
Suisun Marsh Salinity Control Gate (SMSCG)
South Delta Temporary Barriers

- Old River near Tracy (DMC) temporary barrier
- Old River at Head temporary barrier
- Middle River temporary barrier

- Grant Line Canal temporary barrier

Electrical Conductivity (EC):

The western EC boundary of the model, at the Golden Gate is set at 50,000 µmhos cm^{-1}, the EC of seawater. EC boundary conditions are set at all inflow boundaries.

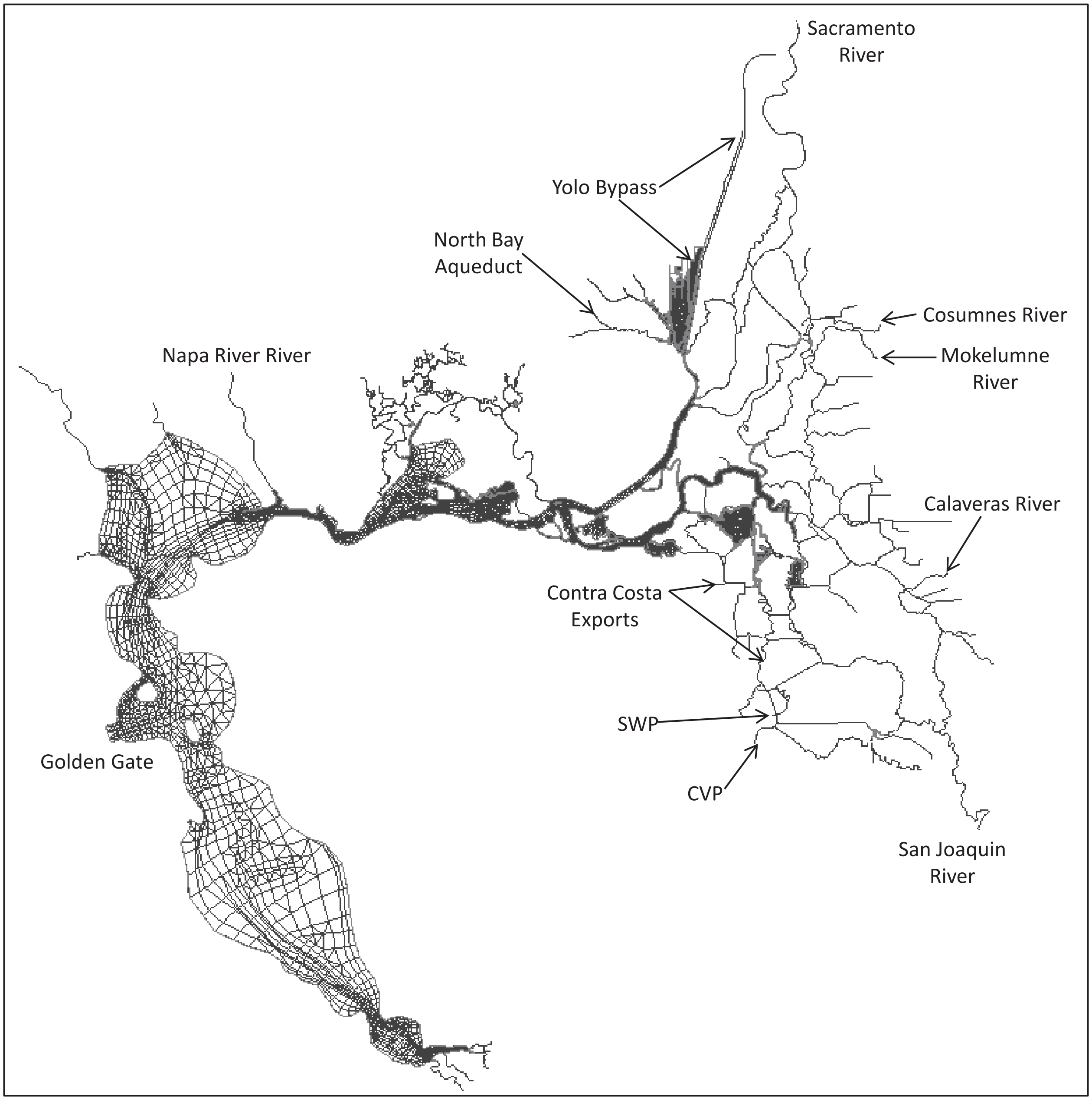

Figure 13 Major model boundary condition locations.

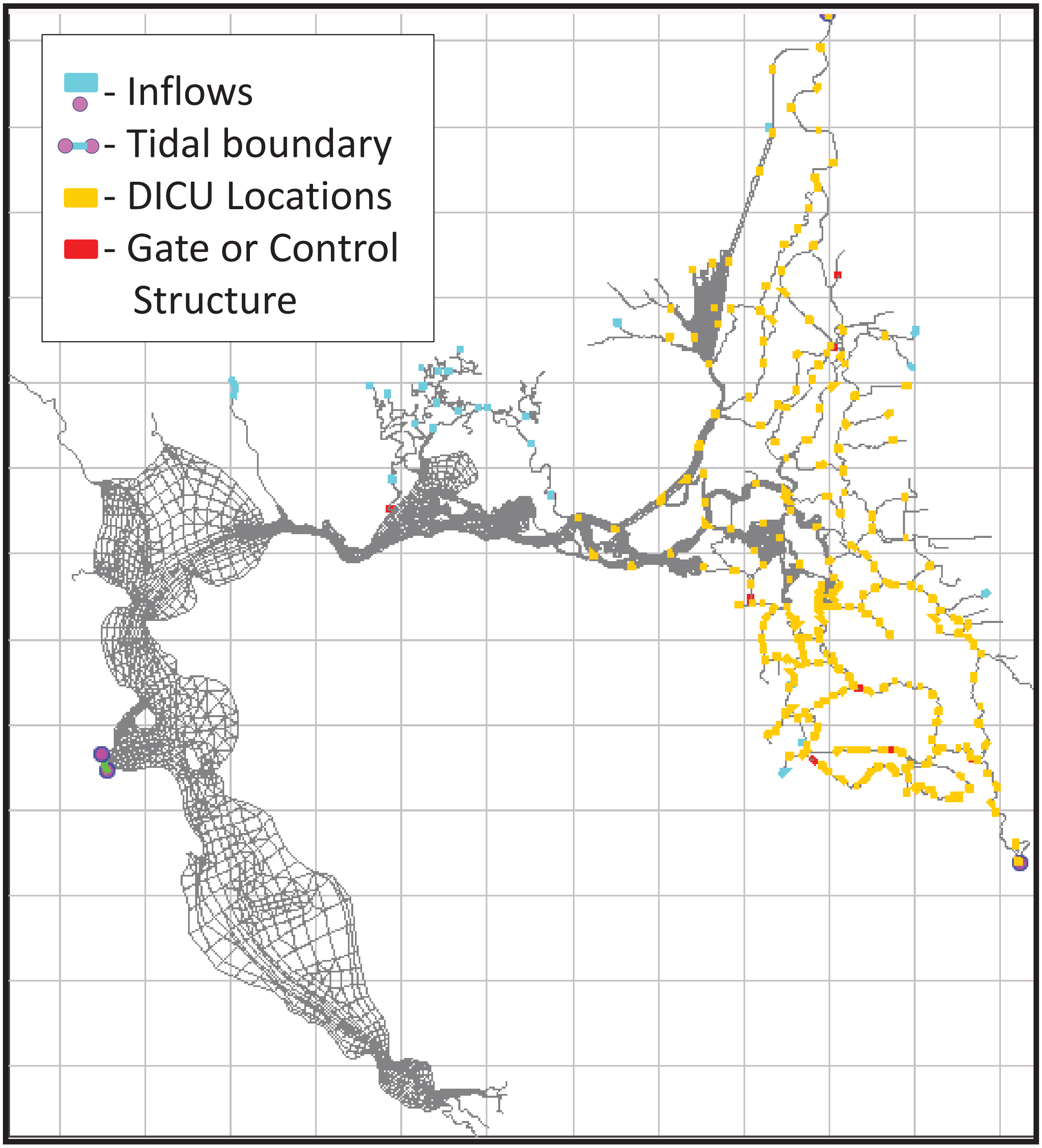

Figure 14 All model boundary condition and control structure locations.

Data Sources

The RMA Bay-Delta hydrodynamic model operation requires specification of the tidal stage at the Golden Gate and inflow and withdrawal rates at other external boundaries as shown in Figure 13. Gate and barrier operations are also included in the model. Water quality model operation requires specification of quality boundary conditions at the stage and inflow boundaries.

Boundary condition data sources include:

- CDEC: http://cdec.water.ca.gov
- DWR-DAYFLOW: http://www.water.ca.gov/dayflow/
- DWR-DES (Division of Environmental Services): http://www.water.ca.gov/environmentalservices/
- DWR-DMS (Delta Modeling Section): http://baydeltaoffice.water.ca.gov/modeling/deltamodeling/
- DWR-NCRO (North Central Region Office): http://www.cd.water.ca.gov/
- DWR-WDL (Water Data Library): http://www.water.ca.gov/waterdatalibrary/
- NOAA (National Oceanic and Atmospheric Administration): http://tidesandcurrents.noaa.gov/waterlevels
- USGS-NWIS (National Water Information System): http://waterdata.usgs.gov/nwis

DICU flows are applied on a monthly average basis for all simulation periods. These flows incorporate channel depletions, infiltration, evaporation, and precipitation, as well as Delta island agricultural use. DICU flow and EC values and were derived from monthly DSM2 input values (DWR, 1995).

Permanent gates and temporary barriers represented in the model include the Delta Cross Channel, Old River near Tracy (DMC) barrier, Old River at Head barrier, Middle River barrier, Montezuma Slough salinity control gates and Grant Line Canal barrier. Control structure locations are shown in Figure 14. The historical operation schedules for these structures are available over the Web.

Delta Cross Channel gates:
http://www.usbr.gov/mp/cvo/vungvari/Ccgates.pdf

Suisun Marsh Salinity Control Gates:
http://www.water.ca.gov/suisun/dataReports/docs/histsmscgop.pdf

South Delta Temporary Barriers
http://baydeltaoffice.water.ca.gov/sdb/tbp/web_pg/tempbar/weekly.cfm

2002-2003

Inflow, Export and EC boundary conditions for the 2002-2003 simulation period are presented in detail in the following sections.

Tide

The tidal boundary stage, plotted in Figure 15, was set using 6-minute stage data from the NOAA station at San Francisco, smoothed with a five-point moving average. The stage was shifted +0.05 m to account for density effects/density difference between the Golden Gate tidal boundary and the project site adjacent Suisun Bay.

Inflows

The major inflows into the system are from the Sacramento River, the San Joaquin River and the Yolo Bypass. The contribution from these three inflows over the 2002-2003 simulation period is Figure 17 . Figure 18 shows the flows for other inflowing rivers, the Napa River, Cosumnes River, Mokelumne River, and miscellaneous eastside flows which include Calaveras River and other minor flows. The model interpolates between the daily average flows at noon each day. Data from Dayflow (http://www.water.ca.gov/dayflow/) the IEP database (http://www.water.ca.gov/iep/products/data.cfm) and USGS (http://water.usgs.gov/osw/) were used to set these boundary conditions.

During previous work in Suisun Marsh, detailed Suisun Marsh inflows were developed for the 2002 – 2003 period. These boundary conditions were applied for the Mallard Farms simulations because they were readily available; however, it was outside the scope of this project to develop them for the other simulation periods. The 2002-2003 Suisun Marsh inflows, including Green Valley Creek, Suisun Creek, Laurel Creek, Ledgewood Creek and the Fairfield Wastewater Treatment Plant (WWTP) are plotted in Figure 19. Duck club inflows and withdrawals and marsh evaporation and precipitation were also included but are not plotted. For detailed information on development of these boundary conditions, see *Suisun Marsh Habitat Management, Preservation, and Restoration Plan, Appendix A: Numerical Modeling in Support of Suisun Marsh EIR/EIS Technical Memorandum* (U.S. Bureau of Reclamation, et al., 2011).

Exports

Delta exports applied in the model include Clifton Court (SWP), CVP, Contra Costa exports at Rock Slough and Old River intakes, and North Bay Aqueduct intake at Barker Slough. Exports are plotted for the 2002-2003 period in Figure 20 and Figure 21. Although hourly export flows are applied at the SWP, daily averages are plotted for ease of viewing. Dayflow and IEP database data are used to set daily average export flows for the CVP, North Bay Aqueduct and Contra Costa's exports.

Hourly SWP export flows for 2003 are computed using the Clifton Court gate ratings and inside and outside water levels. The flows are adjusted on a monthly basis so the total computed flow matches the monthly SWP export. For 2002, when water levels inside and outside the gates were not available, SWP exports were defined using DSM2 node 72 flow, modified to remove erroneously large flows. Further details on Clifton Court Forebay gate operations can be found in RMA's Flooded Islands Feasibility Study (RMA, 2005), and in (DWR, 2004).

EC

Time series of EC are applied to the Sacramento and San Joaquin Rivers as shown in Figure 22. The Sacramento River EC time series is also applied to Yolo Bypass inflows. The tidal boundary and all other inflows are set to constant estimated EC values as listed in Table 5.

Table 5 Constant EC boundary conditions.

Boundary	Constant EC (µmhos/cm)
Golden Gate (tidal)	50,000
Cosumnes River	120
Mokelumne River	120
Calaveras River	750
Napa River	120
All Suisun Marsh Inflows	120

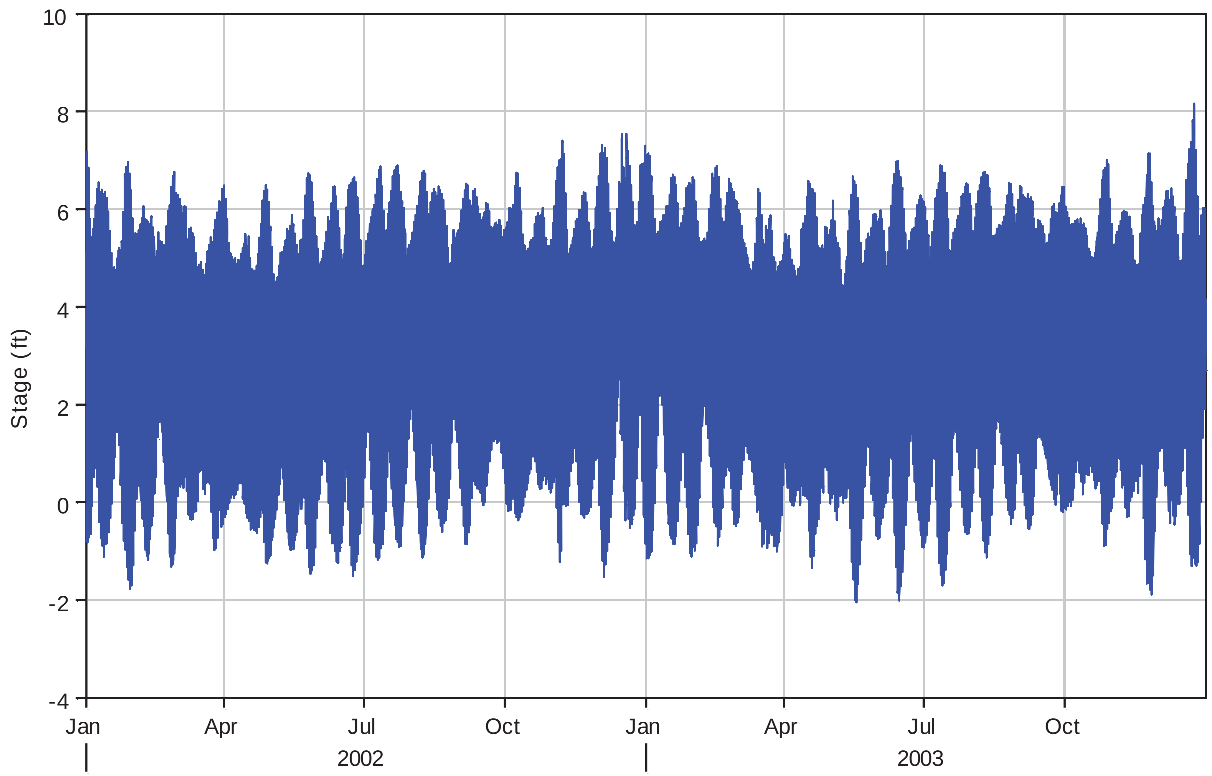

Figure 15 Smoothed NOAA San Francisco stage applied at tidal boundary for the 2002-2003 simulation period.

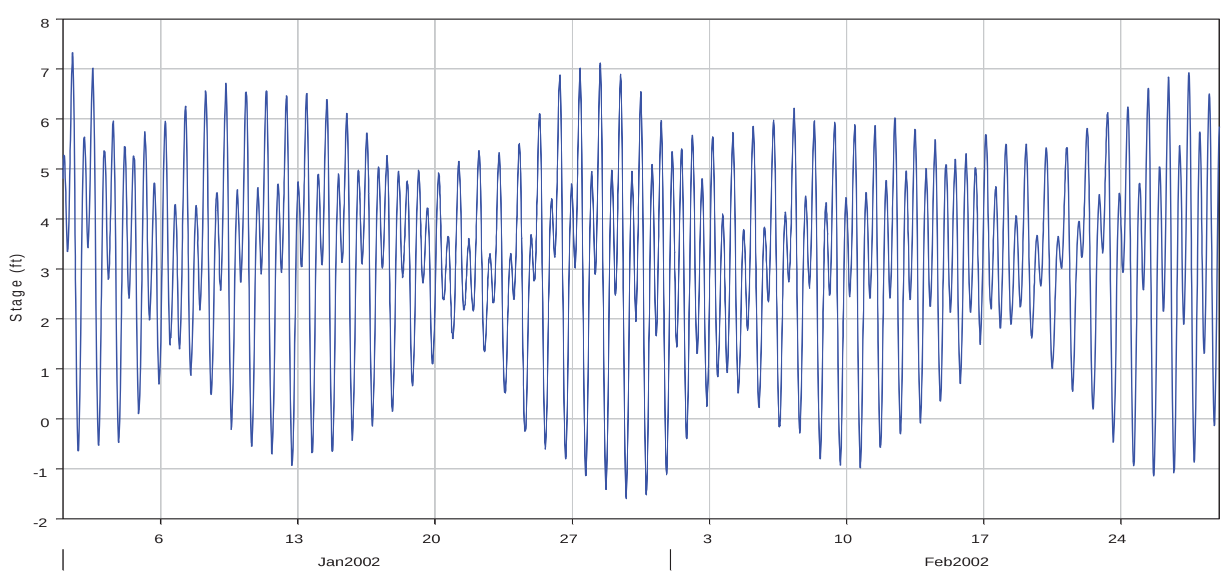

Figure 16 Tidal boundary (expanded scale), January and February, 2002.

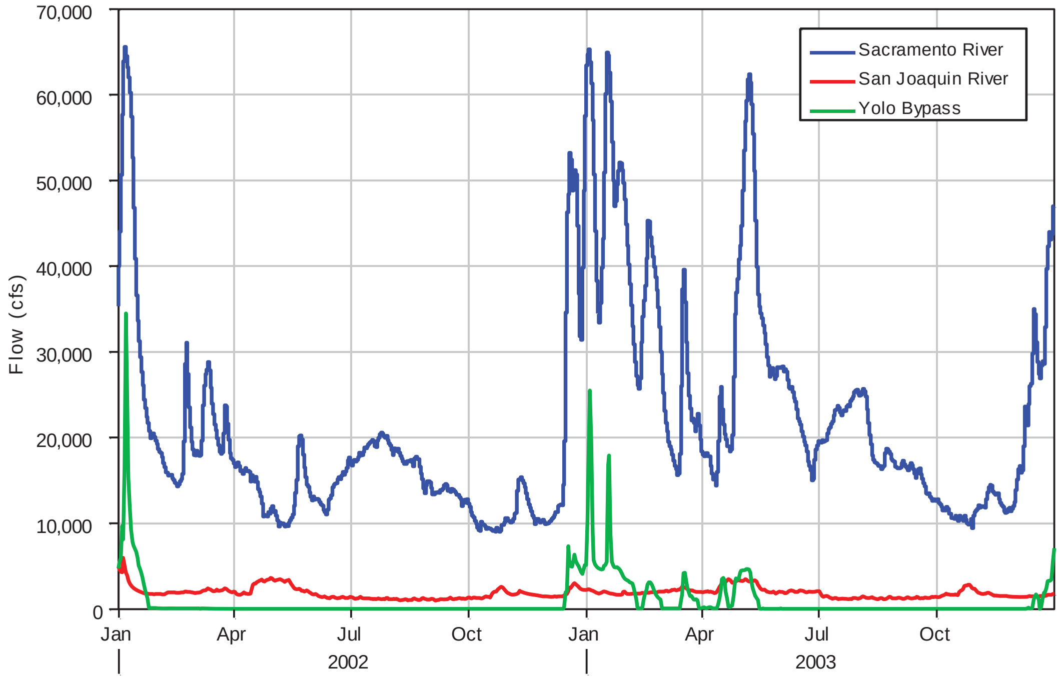

Figure 17 Sacramento River, San Joaquin River and Yolo Bypass inflow boundary conditions for the 2002-2003 simulation period

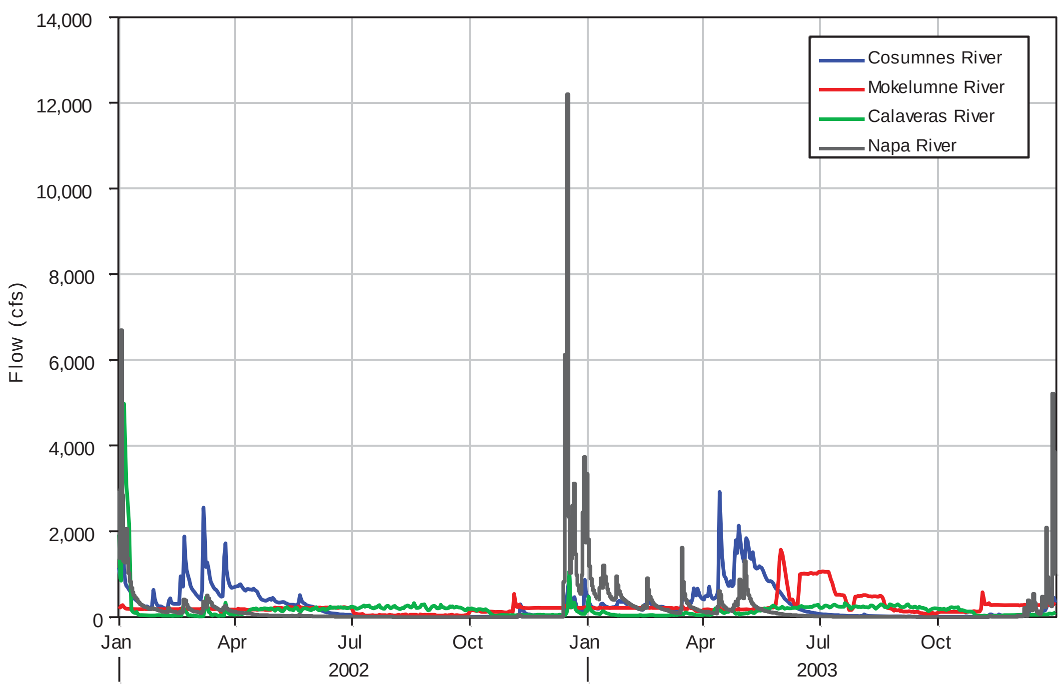

Figure 18 Cosumnes, Mokelumne, Calaveras and Napa River inflow boundary conditions for the 2002-2003 simulation period.

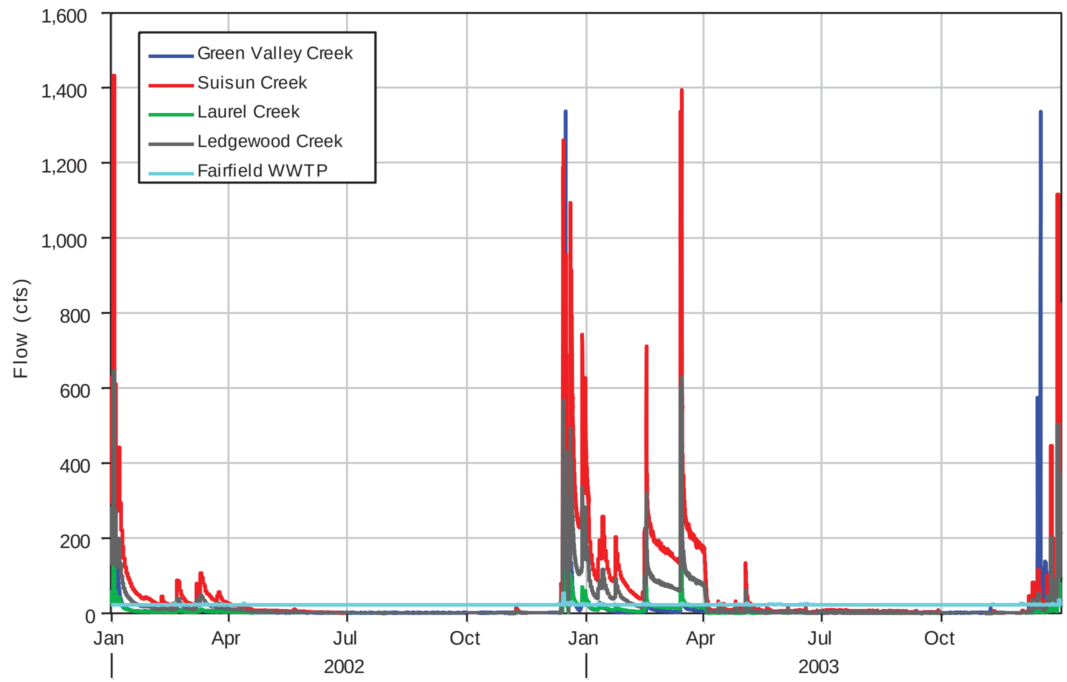

Figure 19 Suisun Marsh inflow boundary conditions for the 2002-2003 simulation period.

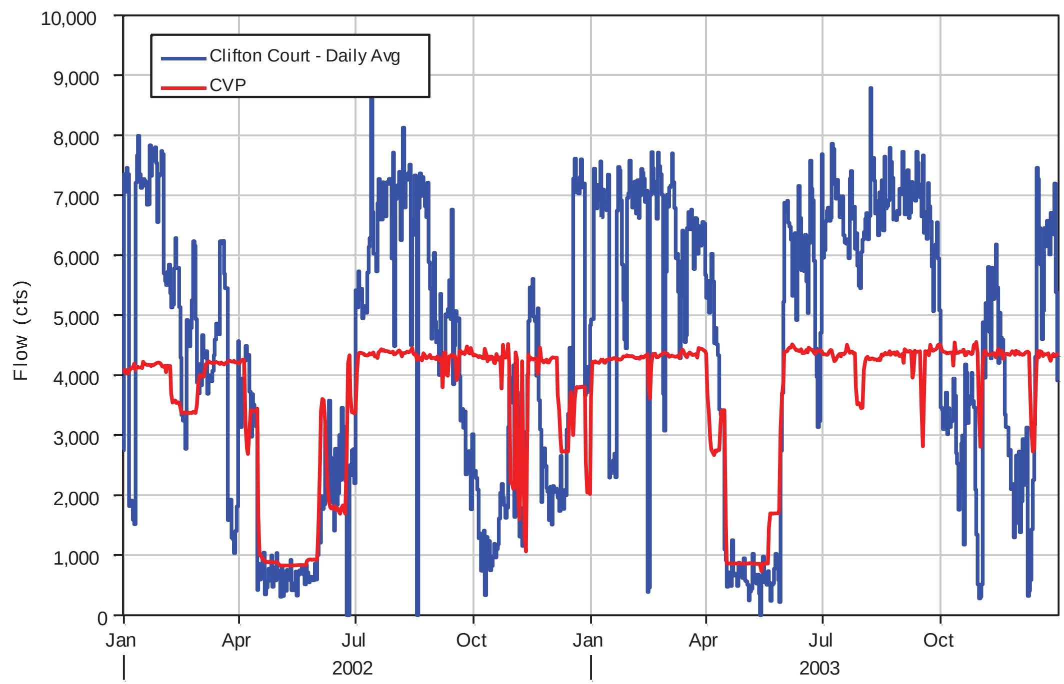

Figure 20 Clifton Court and CVP export boundary conditions for 2002-2003 simulation period.

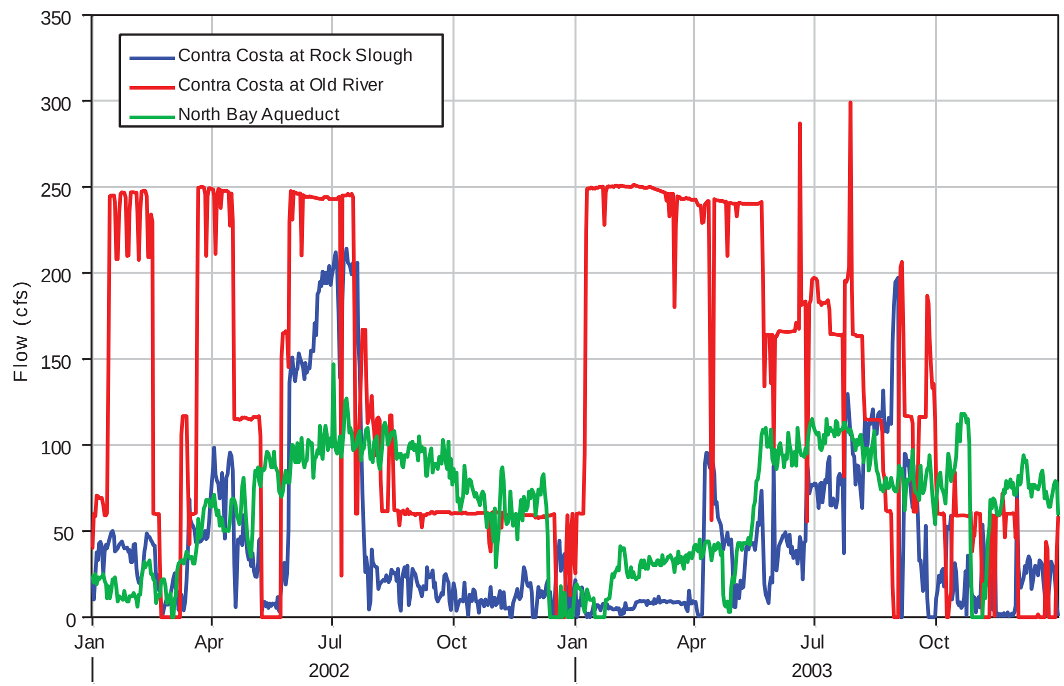

Figure 21 Contra Costa and North Bay Aqueduct export boundary conditions for 2002-2003 simulation period.

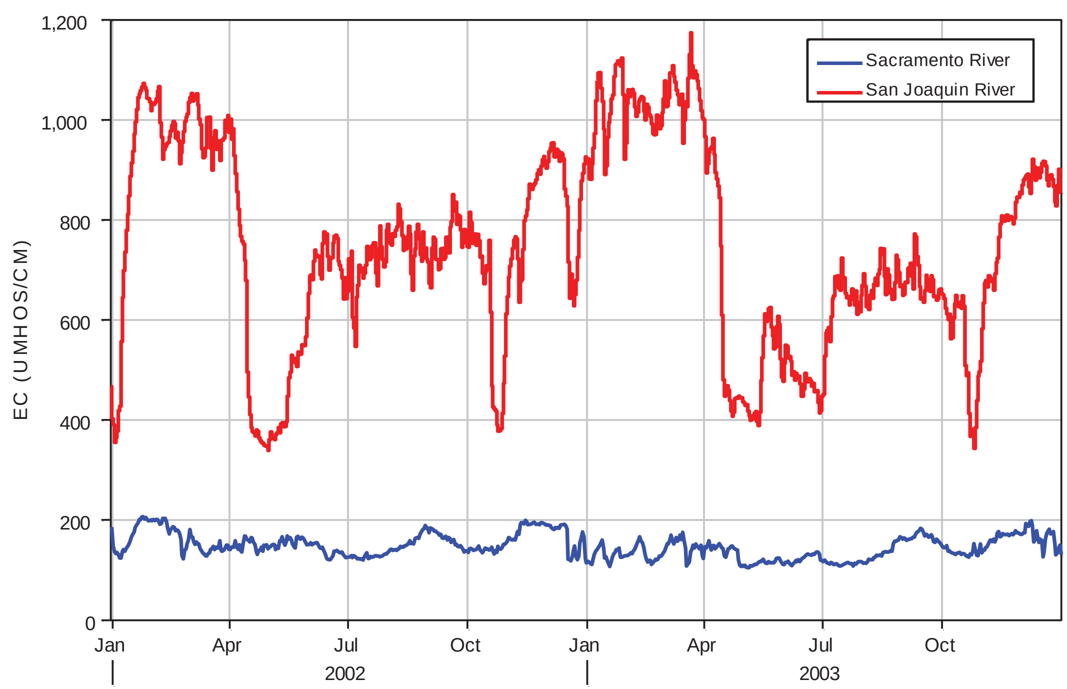

Figure 22 Sacramento and San Joaquin River EC boundary conditions for the 2002-2003 simulation period.

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Appendix B: Tables of Computed Salinity (EC) Change for Suisun Bay and Delta Locations for 2002-2003

Table 6 Computed Change from Base condition monthly averaged EC (µS/cm) for the Beldons Landing and Montezuma Slough above the Salinity Control Gates locations.

Beldons Landing

Month	Base EC (uS/cm)	EC Chng (uS/cm)	EC Chng (%)
Jan 2002	200	0.1	0.0
Feb 2002	1989	2.6	0.1
Mar 2002	2956	5.5	0.2
Apr 2002	2817	9.0	0.3
May 2002	3591	13.1	0.4
Jun 2002	5336	24.5	0.5
Jul 2002	10091	33.2	0.3
Aug 2002	13264	29.0	0.2
Sep 2002	14121	17.9	0.1
Oct 2002	12570	2.6	0.0
Nov 2002	7376	-5.1	-0.1
Dec 2002	4587	-3.2	-0.1
Jan 2003	228	0.5	0.2
Feb 2003	225	0.2	0.1
Mar 2003	1004	-1.7	-0.2
Apr 2003	1957	-9.1	-0.5
May 2003	817	-0.9	-0.1
Jun 2003	1100	3.6	0.3
Jul 2003	5171	0.3	0.0
Aug 2003	6585	12.3	0.2
Sep 2003	10132	15.6	0.2
Oct 2003	9421	15.6	0.2
Nov 2003	9986	17.9	0.2
Dec 2003	4915	10.7	0.2

Montezuma Sl above Salinity Control Gates

Month	Base EC (uS/cm)	EC Chng (uS/cm)	EC Chng (%)
Jan 2002	306	0.4	0.1
Feb 2002	1909	5.1	0.3
Mar 2002	955	4.1	0.4
Apr 2002	1427	10.6	0.7
May 2002	1950	11.4	0.6
Jun 2002	4379	22.0	0.5
Jul 2002	8018	22.7	0.3
Aug 2002	9056	12.5	0.1
Sep 2002	11127	5.2	0.0
Oct 2002	12498	-3.1	0.0
Nov 2002	11849	-3.5	0.0
Dec 2002	6491	-2.4	0.0
Jan 2003	152	0.0	0.0
Feb 2003	188	0.0	0.0
Mar 2003	562	-2.8	-0.5
Apr 2003	878	-8.6	-1.0
May 2003	141	0.1	0.1
Jun 2003	1167	2.1	0.2
Jul 2003	4126	7.2	0.2
Aug 2003	3957	9.0	0.2
Sep 2003	8231	8.6	0.1
Oct 2003	13525	26.3	0.2
Nov 2003	12071	25.0	0.2
Dec 2003	4834	10.1	0.2

Table 7 Computed Change from Base condition monthly averaged EC (µS/cm) for the Mallard Island location.

Mallard Island

Month	Base EC (uS/cm)	EC Chng (uS/cm)	EC Chng (%)
Jan 2002	306	0.4	0.1
Feb 2002	1909	5.1	0.3
Mar 2002	955	4.1	0.4
Apr 2002	1427	10.6	0.7
May 2002	1950	11.4	0.6
Jun 2002	4379	22.0	0.5
Jul 2002	8018	22.7	0.3
Aug 2002	9056	12.5	0.1
Sep 2002	11127	5.2	0.0
Oct 2002	12498	-3.1	0.0
Nov 2002	11849	-3.5	0.0
Dec 2002	6491	-2.4	0.0
Jan 2003	152	0.0	0.0
Feb 2003	188	0.0	0.0
Mar 2003	562	-2.8	-0.5
Apr 2003	878	-8.6	-1.0
May 2003	141	0.1	0.1
Jun 2003	1167	2.1	0.2
Jul 2003	4126	7.2	0.2
Aug 2003	3957	9.0	0.2
Sep 2003	8231	8.6	0.1
Oct 2003	13525	26.3	0.2
Nov 2003	12071	25.0	0.2
Dec 2003	4834	10.1	0.2

Table 8 Computed Change from Base condition monthly averaged EC (µS/cm) for the San Joaquin River at Jersey Point and the Sacramento River at Emmaton.

Jersey Point

Month	Base EC (uS/cm)	EC Chng (uS/cm)	EC Chng (%)
Jan 2002	202	0.0	0.0
Feb 2002	247	0.1	0.0
Mar 2002	208	0.1	0.0
Apr 2002	189	0.1	0.0
May 2002	235	0.0	0.0
Jun 2002	295	0.6	0.2
Jul 2002	846	3.3	0.4
Aug 2002	1214	3.5	0.3
Sep 2002	1516	2.7	0.2
Oct 2002	1410	0.8	0.1
Nov 2002	1375	0.5	0.0
Dec 2002	943	0.4	0.0
Jan 2003	179	0.0	0.0
Feb 2003	156	0.0	0.0
Mar 2003	159	0.0	0.0
Apr 2003	172	-0.1	0.0
May 2003	182	0.0	0.0
Jun 2003	153	0.0	0.0
Jul 2003	300	0.4	0.1
Aug 2003	303	0.8	0.3
Sep 2003	867	1.0	0.1
Oct 2003	1577	1.5	0.1
Nov 2003	1600	0.9	0.1
Dec 2003	893	0.4	0.0

Emmaton

Month	Base EC (uS/cm)	EC Chng (uS/cm)	EC Chng (%)
Jan 2002	176	0.0	0.0
Feb 2002	212	0.0	0.0
Mar 2002	159	0.0	0.0
Apr 2002	167	0.0	0.0
May 2002	190	0.0	0.0
Jun 2002	334	0.9	0.3
Jul 2002	608	1.0	0.2
Aug 2002	761	0.3	0.0
Sep 2002	1316	1.1	0.1
Oct 2002	1769	0.4	0.0
Nov 2002	1670	-0.6	0.0
Dec 2002	874	-0.7	-0.1
Jan 2003	142	0.0	0.0
Feb 2003	139	0.0	0.0
Mar 2003	151	0.0	0.0
Apr 2003	152	0.0	0.0
May 2003	122	0.0	0.0
Jun 2003	134	0.0	0.0
Jul 2003	210	0.1	0.0
Aug 2003	222	0.2	0.1
Sep 2003	678	-0.1	0.0
Oct 2003	1957	0.0	0.0
Nov 2003	1656	-0.3	0.0
Dec 2003	475	-0.3	-0.1

Table 9 Computed Change from Base condition monthly averaged EC (µS/cm) for the Rock Slough and Old River at Hwy 4 CCWD intake locations.

CCWD, Rock Slough

Month	Base EC (uS/cm)	EC Chng (uS/cm)	EC Chng (%)
Jan 2002	431	0.1	0.0
Feb 2002	317	0.0	0.0
Mar 2002	302	0.1	0.0
Apr 2002	271	0.0	0.0
May 2002	373	0.0	0.0
Jun 2002	314	0.0	0.0
Jul 2002	364	0.7	0.2
Aug 2002	633	1.6	0.3
Sep 2002	720	1.2	0.2
Oct 2002	711	0.8	0.1
Nov 2002	685	0.1	0.0
Dec 2002	822	0.1	0.0
Jan 2003	500	0.2	0.0
Feb 2003	327	0.1	0.0
Mar 2003	266	0.0	0.0
Apr 2003	236	0.0	0.0
May 2003	356	0.0	0.0
Jun 2003	254	0.0	0.0
Jul 2003	235	0.0	0.0
Aug 2003	236	0.2	0.1
Sep 2003	360	0.4	0.1
Oct 2003	615	0.4	0.1
Nov 2003	728	0.3	0.0
Dec 2003	758	0.3	0.0

CCWD, Old R at Hwy 4

Month	Base EC (uS/cm)	EC Chng (uS/cm)	EC Chng (%)
Jan 2002	311	0.0	0.0
Feb 2002	263	0.0	0.0
Mar 2002	268	0.0	0.0
Apr 2002	263	0.0	0.0
May 2002	361	0.0	0.0
Jun 2002	304	0.0	0.0
Jul 2002	337	0.7	0.2
Aug 2002	538	1.4	0.3
Sep 2002	631	1.0	0.2
Oct 2002	604	0.5	0.1
Nov 2002	585	0.0	0.0
Dec 2002	581	0.1	0.0
Jan 2003	272	0.0	0.0
Feb 2003	199	0.0	0.0
Mar 2003	199	0.0	0.0
Apr 2003	233	0.0	0.0
May 2003	362	0.0	0.0
Jun 2003	196	0.0	0.0
Jul 2003	198	0.0	0.0
Aug 2003	204	0.2	0.1
Sep 2003	343	0.3	0.1
Oct 2003	556	0.4	0.1
Nov 2003	634	0.3	0.0
Dec 2003	590	0.3	0.0

Table 10 Computed Change from Base condition monthly averaged EC (µS/cm) for the Victoria Canal CCWD intake location.

CCWD, Victoria Canal

Month	Base EC (uS/cm)	EC Chng (uS/cm)	EC Chng (%)
Jan 2002	390	0.0	0.0
Feb 2002	304	0.0	0.0
Mar 2002	336	0.0	0.0
Apr 2002	324	0.0	0.0
May 2002	399	0.0	0.0
Jun 2002	344	0.0	0.0
Jul 2002	272	0.2	0.1
Aug 2002	345	0.6	0.2
Sep 2002	405	0.4	0.1
Oct 2002	440	0.2	0.1
Nov 2002	425	0.0	0.0
Dec 2002	464	0.0	0.0
Jan 2003	324	0.0	0.0
Feb 2003	239	0.0	0.0
Mar 2003	255	0.0	0.0
Apr 2003	284	0.0	0.0
May 2003	421	0.0	0.0
Jun 2003	242	0.0	0.0
Jul 2003	211	0.0	0.0
Aug 2003	210	0.0	0.0
Sep 2003	278	0.1	0.0
Oct 2003	402	0.1	0.0
Nov 2003	396	0.0	0.0
Dec 2003	422	0.1	0.0

Table 11 Computed Change from Base condition monthly averaged EC (µS/cm) for the State Water Project (SWP) Clifton Court Forebay intake and the CVP intake at the Tracy Pumping Plant locations.

SWP, Clifton Court Intake

Month	Base EC (uS/cm)	EC Chng (uS/cm)	EC Chng (%)
Jan 2002	368	0.0	0.0
Feb 2002	331	0.0	0.0
Mar 2002	334	0.0	0.0
Apr 2002	329	0.0	0.0
May 2002	395	0.0	0.0
Jun 2002	334	0.0	0.0
Jul 2002	318	0.5	0.2
Aug 2002	483	1.1	0.2
Sep 2002	563	0.9	0.2
Oct 2002	557	0.4	0.1
Nov 2002	550	0.0	0.0
Dec 2002	583	0.0	0.0
Jan 2003	343	0.0	0.0
Feb 2003	269	0.0	0.0
Mar 2003	254	0.0	0.0
Apr 2003	320	0.0	0.0
May 2003	407	0.0	0.0
Jun 2003	214	0.0	0.0
Jul 2003	202	0.0	0.0
Aug 2003	207	0.1	0.1
Sep 2003	321	0.3	0.1
Oct 2003	507	0.3	0.1
Nov 2003	571	0.2	0.0
Dec 2003	569	0.2	0.0

CVP Intake

Month	Base EC (uS/cm)	EC Chng (uS/cm)	EC Chng (%)
Jan 2002	512	0.0	0.0
Feb 2002	524	0.0	0.0
Mar 2002	539	0.0	0.0
Apr 2002	438	0.0	0.0
May 2002	406	0.0	0.0
Jun 2002	381	0.0	0.0
Jul 2002	328	0.4	0.1
Aug 2002	469	0.9	0.2
Sep 2002	554	0.7	0.1
Oct 2002	553	0.4	0.1
Nov 2002	557	0.0	0.0
Dec 2002	637	0.0	0.0
Jan 2003	537	0.0	0.0
Feb 2003	490	0.0	0.0
Mar 2003	530	0.0	0.0
Apr 2003	444	0.0	0.0
May 2003	433	0.0	0.0
Jun 2003	275	0.0	0.0
Jul 2003	235	0.0	0.0
Aug 2003	258	0.1	0.0
Sep 2003	350	0.2	0.1
Oct 2003	499	0.2	0.0
Nov 2003	569	0.1	0.0
Dec 2003	621	0.1	0.0

Appendix C: EC to Chloride Conversion for the Contra Costa Water District Rock Slough Intake Location

D-1641 chloride compliance for the Contra Costa Canal Rock Slough intake location was determined by computing the mean daily value chloride concentration (mg/L) from the model computed EC results. The model results are in terms of EC (uS/cm) and need to be first converted to chloride concentration using conversion equations. The EC-chloride relation used for the current study is documented in the “Delta-Mendota Canal Recirculation Feasibility Study” (Reclamation, 2010) and which the authors applied to DSM2 (Delta Simulation Model II) model EC to derive chloride concentration at the Contra Costa Canal/Rock Slough intake. The development of the conversion equations was sourced to Contra Costa Water District personnel, and was particular to Contra Costa Canal Rock Slough intake. The EC to chloride conversion applied by the Reclamation study follows:

$$Cl = 0.285*EC - 50$$

when the DSM2 volumetric source fraction from Martinez is greater than 0.4% (seawater-influenced relationship)

$$Cl = 0.15*EC - 12$$

when the DSM2 volumetric source fraction from Martinez is less than 0.4% (nonseawater-influenced relationship)

where chloride is in mg/L and EC is measured in umhos/cm).

The RMA Delta modeling did not track the Martinez volumetric source fraction. The maximum value from the two equations was used for the final conversion value. Thus the “seawater” equation is applicable for EC values > 281 umhos/cm (chloride = 30.2 mg/L).

The model results are assessed in regards to compliance to the chloride water quality objects for the four Municipal and Industrial compliance locations:

References

Reclamation (Bureau of Reclamation). 2010. *Delta-Mendota Canal Recirculation Feasibility Study, Appendix G: Drinking Water Evaluation*. Plan Formulation Report. U.S Dept. of the Interior, Bureau of Reclamation, Mid-Pacific Region. Sacramento, California. January 2010.

Appendix D.2
Hydraulic and Geomorphic Basis of Design Report

TULE RED MARSH RESTORATION PROJECT

HYDRAULIC AND GEOMORPHIC BASIS OF DESIGN REPORT

Prepared for:

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30 November 2015

NHC Ref. No. 500059

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DISCLAIMER

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Glossary of Terms

Levee	Surround berm to prevent landward flooding (not tied to spec. frequency of flood event)
MHHW	Mean Higher High Water (The average of all higher high water heights)
MHW	Mean High Water (The average of all high water heights)
MTL	Mean Tide Level (The arithmetic mean of mean high water and mean low water)
MSL	Mean Sea Level (The arithmetic mean of hourly sea levels)
MLW	Mean Low Water (The average of all the low water heights)
MLLW	Mean Lower Low Water (The average of the lower low water heights)
Neap Tide	A tide that occurs when the difference between high tide and low tide is at its smallest
NOAA	National Oceanic and Atmospheric Administration
OCAP	
Spring Tide	A tide that occurs when the difference between high tide and low tide is at its largest

1.0 INTRODUCTION

1.1 Background and Objectives

The Tule Red Marsh Restoration Project (hereinafter Project) will restore approximately 420 acres of managed marsh in Suisun Bay to a natural unmanaged tidal marsh. The Project is being funded by the State and Federal Contractors Water Agency (SFCWA) to meet goals outlined in the State of California's Bay Delta Conservation Plan (BDCP) as well as the U.S. Fish and Wildlife Service's (USFWS) Biological Opinion (BO) issued as part of the Long-Term Operational Criteria and Plan (OCAP) for coordination of the Central Valley Project and State Water Project. The BDCP California Eco Restore program provides a goal of 9,000 acres of tidal and sub-tidal habitat restoration. The USFWS BO consults on the Delta Smelt and provides five reasonable and prudent alternatives (RPA). RPA Component 4 requires 8,000 acres of intertidal and associated subtidal habitat to be restored in the Sacramento River Delta and Suisun Marsh.

The Project also falls within the footprint of the Suisun Marsh Habitat Management, Preservation and Restoration Plan (SMP). The SMP is an interagency plan to address habitat and ecological processes, public and private land use, levee system integrity, and water quality through tidal restoration and managed wetland activities. The objectives of the SMP are to 1) restore over 5,000 acres of tidal marsh, 2) protect and enhance over 40,000 acres of managed wetland, 3) improve ecological processes and reduce stressors such as invasive species, 4) maintain waterfowl heritage and expand sporting opportunities, and 5) maintain and improve the marsh levee system integrity, and to protect water quality. In addition to restoring the managed marsh to a tidal marsh, specific project components are functional design components intended to meet the various objects of the SMP. These components are explained in detail in Chapter 3.

The key objective of the project's design is to sustainably restore natural tidal marsh processes to the Project site while meeting the objectives of the SMP. SFCWA contracted Westervelt Ecological Services (WES) to develop and implement the restoration plan. Northwest Hydraulic Consultants (NHC) is a sub-consultant to WES responsible for the hydraulic and geomorphic design of the project for meeting the ecological goals of the project. This report provides the hydraulic and geomorphic basis of design for the Tule Red Marsh Restoration Project.

1.2 Project Datum

All elevations referred to in this report are relative to the North American Vertical Datum of 1988 (NAVD88) unless otherwise stated. The National Oceanic and Atmospheric Administration (NOAA) operates the Port Chicago gage in Suisun Bay (Gage # 9415144). NOAA provides verified six minute water levels dating back to 1996 and tidal datum for the Port Chicago site. Table 1.1 provides the tidal datum relative to NAVD88.

Table 1.1: Tide elevations with respect to current datum.

Datum	Elevation Relative to NAVD88 Datum (ft)
MHHW	6.0
MHW	5.5
MTL	3.7
MSL	3.7
MLW	1.8
MLLW	1.1

1.3 Report Organization

This report is organized into six chapters. Chapter 2 of this report describes the Project site in detail. This chapter includes discussion of the origin and historic management of the project marsh, historic and on-going shoreline accretion, existing marsh elevations, soil types, and vegetation. Chapter 3 presents the conceptual marsh design. The chapter presents the hydraulic and geomorphic design objectives, as well as discussion of each of the primary concepts of the design. Chapter 4 discusses the hydraulic and geomorphic analyses used to evaluate and design the conceptual design. Chapter 5 discusses Project implementation and expected adaption of the Project over time. Chapter 6 provides references noted throughout the report.

2.0 PROJECT SITE

2.1 Project Setting

The Tule Red Marsh Restoration Project site is located on the eastern shoreline of Grizzly Bay. Grizzly Bay is an embayment in the northeast portion of Suisun Bay in the northeastern portion of the San Francisco Bay. The Sacramento-San Joaquin River Delta flows directly into Suisun Bay. The project site is in the low salinity zone where juvenile delta smelt are known to rear and mature (OCAP). Figure 2.1 shows the Project site location and its proximity to the Port Chicago tide gage.

Figure 2. 1: Tule Red project location within Suisun Bay.

The site was historically and is currently managed as the Tule Red Duck Club. The site is seasonally flooded and drained through existing artificial channels for vegetation management. Figure 2.2 shows the layout of the existing site. Human made berms and roadways separate the project site from the adjacent properties to the east. Ditches along the toe of these berms are used for flooding and draining the site. Two tide gates are used to control inflow and outflow from the site. A natural berm extends along the western shoreline edge of the property and protects the site from tidal inundation during typical high tides. King tides and high spring tides with westerly winds do overtop the outboard natural marsh berm.

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Legend

- Tide Gates
- Existing Canals
- Project Area
- Man Made Berms
- Natural Marsh Berm

DATA SOURCES:
NAIP Color Orthoimagery, 5/20/2012-5/22/2012.
Esri StreetMap, 2012.

SCALE - 1:12,000

0 500 1,000 1,500 *Feet*

Coordinate System:
NAD 1983 California State Plane Zone 2
Units: feet

Job: 5001024

Date: NOVEMBER 2015

FIGURE 2.2

Tule Red Tidal Restoration Project

Project Site Layout

ABC, P:\1500059_Tule_Red_Concept\GIS\Workmaps\Report_Figures\Figure_2-2_Project_Site_Layout.mxd

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2.2 Historic Marsh Development

Conceptualizing marsh restoration plans necessitates the analysis of existing site conditions and the historical evolution of the landscape. Anthropogenic impacts on the Suisun Marsh began in the late 1800's when the marshlands were diked and managed for agricultural purposes. Soon after, the land use changed from agricultural activities to managed wetlands for use as duck hunting clubs (DWR, 2001). An 1873 Geological Survey of California Map of the San Francisco Bay Area shows the project site was open water during this time. Figure 2.3 shows the project site with historic shorelines from published maps overlaid on a recent aerial photo. Much of the Project site developed marsh vegetation between about 1950 and 1980 and the site and its vegetation continue to expand today through shoreline accretion at a rate of about an acre per year. Historic maps of the project site are provided in Appendix A.

Table 2.1 provides the average distance per year that the shoreline has moved out into Grizzly Bay over time. Warner et al (2004) showed Grizzly Bay as a sediment sink. Sediment suspended by wind waves and tidal currents in San Pablo Bay and the Carquinez Straits are transported into Grizzly Bay's shallow embayment due to asymmetric tides and floodtide pulses. Wind waves from prevailing westerly winds help push the sediment up into the edges of the marsh vegetation. As the edge of the marsh accretes, the vegetation grows further out into the marsh moving the location of deposition seaward. The transport of sediment from the Sacramento San Joaquin Delta has decreased (Wright and Schoelhammer, 2004) in recent decades, and the rate of shoreline accretion has also decreased over these same time periods. It should be noted that although the total amount of sediment transported to Suisun Bay has decreased, estimated sediment loads from the Delta vary from 1 million to 2 million tons per year (Wright and Schoelhammer, 2004; Shvidchenko et al., 2004), which are appreciable and will continue to provide suspended sediments to the Grizzly Bay region. The effects of variation in future sediment delivery for the site's morphological evolution is discussed in Section 5.4.

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Legend

- 2012 Shoreline
- 1970s Shoreline
- 1950s Shoreline
- 1900s Shoreline (white)
- 1873 Shoreline

DATA SOURCES:
NAIP Color Orthoimagery, 5/20/2012-5/22/2012.
Esri StreetMap, 2012.

SCALE - 1:36,000
0 1,000 2,000 3,000 *Feet*

Coordinate System:
NAD 1983 California State Plane Zone 2
Units: feet

Job: 5001024

Date: NOVEMBER 2015

FIGURE 2.3

Tule Red Tidal Restoration Project

Historic Shorelines

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ABC, P:\1500059_Tule_Red_Concept\GIS\Workmaps\Report_Figures\Figure_2-3_Historic_Shorelines.mxd

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Table 2.1: Historical Rates of Shoreline Accretion

Time Period	Average Accretion Lengh (ft)	Average Annual Accretion Rate (ft/yr)	Average Annual Maximum Accretion Rate (ft/yr)
1873 – 1906-07	6,563	196	253
1906-07 – 1941	4,023	117	152
1941 – 1978-79	1,238	33	40
1978 – 2012	214	6.5	10

2.3 Existing Marsh Soils

WES contracted Hultgren-Tillis Engineers (HTE) to perform a geotechnical investigation of the soils at the Project Site. Test pits were dug at eight different locations throughout the project site. The test pits were dug about 7 to 9 feet below the existing grade, with the existing grade elevation at the test pits typically varying between 4 and 5 feet NAVD 88. The test pits showed the marsh is predominately composed of sandy silts and silty sands. Visual inspection of the excavated material did not show evidence of large episodic deposition nor appreciable accumulation of organic materials (e.g. peat or decayed vegetation). The sediments appeared to be deposited in thin horizontal horizons of less than 3 mm in thickness with generally uniform sediment characteristics.

2.4 Existing Marsh Plant Types

Existing vegetation on the Project Site includes vegetation typical of brackish marshes in Suisun Bay. The natural berm and much of the marsh plain is densely vegetated with Phragmites. Stands of native Tule are also found in the marsh plain. Native Tule and Cattail are found along the edges of the existing drainage ditches. Pickleweed is also found in several locations throughout the existing managed marsh.

2.5 Existing Marsh Elevations

WES completed topographic surveys of the site in 2013 and 2014. The topographic surveys included RTK ground surveys as well as aerial photogrammetry. Figure 2.4 shows the elevations of the existing site. The marsh plain is relatively flat, with a slight slope down from west to east. Marsh plain elevations are generally between 4 to 5 feet in elevation. The natural marsh berm is at elevation 6.5 feet, while the human made berms on the eastern edge of the site average about elevation 10. The primary drainage canals have an invert elevation at about 0 to 2 feet. The existing drainage channel bottoms are smaller than the individual pixel resolution so are not plotted on Figure 2.4

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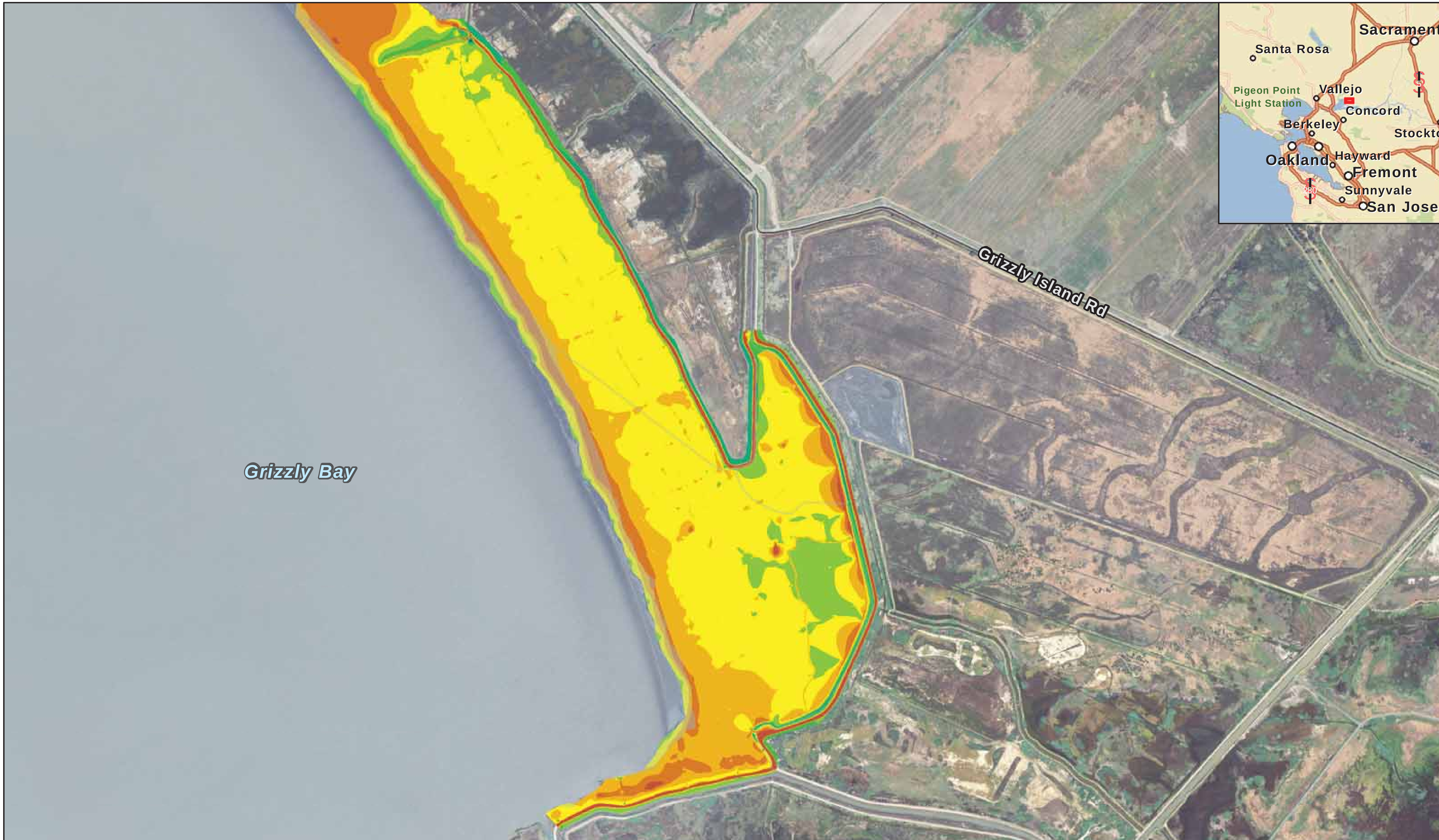

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Legend

Elevation (in NAVD88)

Below 0	2 - 3	5 - 6
0 - 1	3 - 4	6 - 7
1 - 2	4 - 5	7 +

DATA SOURCES:
NAIP Color Orthoimagery, 5/20/2012-5/22/2012.
Esri StreetMap, 2012.

SCALE - 1:12,000

0 500 1,000 Feet

Coordinate System:
NAD 1983 California State Plane Zone 2
Units: feet

Job: 5001024

NOVEMBER 2015

FIGURE 2.4

Tule Red Tidal Restoration Project

Existing Elevations

ABC, P:\500059_Tule_Red_Concept\GIS\Workmaps\Report_Figures\Figure_2-4_Existing_Elevations.mxd

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3.0 RESTORED MARSH CONCEPT

3.1 Overview

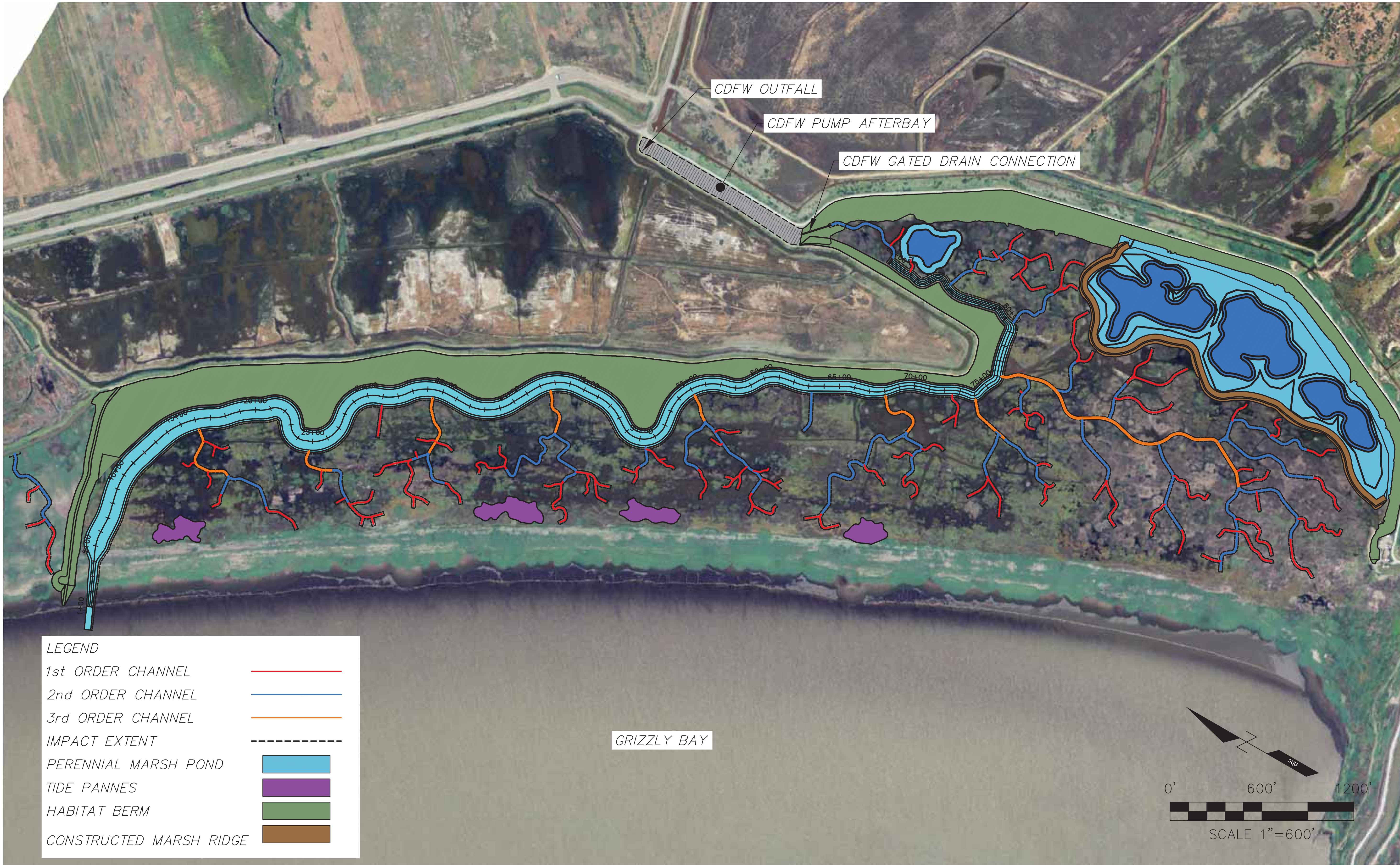
Figure 3.1 provides the conceptual site design. The proposed concept is based on a process-based design that restores full tidal exchange to the Project site. Tidal exchange is the driving process that creates and sustains tidal wetlands (Siegel et al. 2010). Key elements include inundation regime (timing, frequency, depth, duration), sedimentation processes (erosion of tidal channel boundaries, transport through tidal channels, deposition on marsh plain surfaces), and exchange of nutrients. Restoring the tidal exchange process is allows the establishment and growth of brackish marsh vegetation such that associated food web and other ecological processes occur naturally in the restored tidal marsh system.

Functional design concepts such as a habitat berm along the existing human made berm and roadway on the landward boundary of the property, as well as large ponds on the southeastern edge of the Project site are also included in the design. These functional design concepts are intended to provide opportunities for addressing objectives in the SMP and Biological Opinion for the State and Federal water projects. In addition to providing transitional upland habitat around the marsh site, the habitat berm will also improve the existing marsh levee system integrity by increasing the stability of the existing human made berm and roadway. The pond site improves ecological processes and reduces stressors from invasive species by providing adequate residence times for cultivating and rearing zooplankton. The longer residence time provided by the ponds allows sufficient time for zooplankton growth, becoming large enough to bypass the invasive overbite clam (Moyle, 2015). These and other major design components are discussed in the following sections.

3.2 Breach of Natural Marsh Ridge

The natural marsh ridge and human berms currently prevents the site from flooding and draining during typical tides. Investigation of historic maps and review of existing marshes show tidal channels entering marshes on the northeastern edges of San Pablo and Grizzly Bay typically entering marshes from backwater sloughs. Prevailing winds through much of the year come from the west and southwesterly directions and wind driven waves directly buffet these shorelines. Due to this observation and the ongoing shoreline accretion (Section 2.2 and Appendix A), the initial conceptual design considered using the existing artificial channels for flooding and draining the site. The locations of these existing channels have been been fairly stable over the past 100 years.

Odell et al (2008) provides geomorphic relationships for mature marshes in the San Francisco Bay estuary. The relationships in Odell et al (2008) show mature marshes with the Project site drainage area are typically drained by a 4th or 5th order channel with a top width of about 160 feet, and depth of about 10 feet below MHW. The existing channels within the site have top widths of about 20-30 feet, and a depth of about 4-5 feet below MHW. The discrepancy between the empirical mature marsh channel dimensions and existing channel dimensions suggests the existing channels are undersized, would provide only muted tidal exchange on the Project site, and could significantly widen and deepen if tidal fluxes were large enough to induce erosion. Due to the proximity of the existing artificial channels to the human made berms and roadways protecting the neighboring parcels, and the proximity of a water supply canal along the far side of the berm from the existing artificial channels, using the artificial channels could increase the flood risk and operations of existing infrastructure in Suisun Bay. This risk was considered unacceptable, and alternate tidal entrance channel configurations were considered.


CDFW OUTFALL
CDFW PUMP AFTERBAY
CDFW GATED DRAIN CONNECTION
LEGEND
1st ORDER CHANNEL
2nd ORDER CHANNEL
3rd ORDER CHANNEL
IMPACT EXTENT
PERENNIAL MARSH POND
TIDE PANNES
HABITAT BERM
CONSTRUCTED MARSH RIDGE
GRIZZLY BAY
0'
600'
1200'
SCALE 1"=600'

The empirical relationships also confirm the anecdotal evidence that the existing artificial channels are undersized for providing full tidal exchange on the Project site. The on-site caretaker typically opens the tide gates on multiple subsequent high tides to completely flood the site. Similarly, the caretaker opens the gates on multiple subsequent low tides to completely drain the site. Results of two-dimensional ADH modeling of this concept (Chapter 4), showed the channels were unable to provide full tidal exchange at the site. The ADH model also showed the additional tidal flux in the north channel shared with other adjacent properties would backwater neighboring properties during low tides. This would likely impair their drainage operations and this risk was considered unacceptable.

The proposed concept instead includes a breach through the natural marsh ridge directly into the bay. Numerous breach locations were evaluated through the site. The southern edge of the site is slightly lower than the northern edge of the site. The on-site caretaker noted that due to soft soils it is difficult and sometimes impossible to get maintenance equipment in this region of the site, and maintenance work in the summer of 2014 with ideal conditions (fully drained and dry marsh) still required a special amphibious excavator to perform the work. Due to constructability and maintenance access concerns (See Section 3.6), the breach was moved away from this area. Breach designs in the center of the site were also considered, but were less favorable than having a breach on the North side of the property due to a lower residence time and maintenance access concerns.

The proposed breach location is to be located on the northern edge of project site. This location minimizes required excavation across the marsh plain (minimizing construction impacts), and will have a marsh berm constructed along its edge to serve as maintenance access. The proposed inlet channel is to be excavated to a depth of -2 feet NAVD88 to inhibit the growth of vegetation within the channel. The initial channel width is 50 feet which will provide full tidal exchange immediately when constructed. The channel is expected to self-adjust to a final equilibrium width of about 160 feet and invert of -5 feet NAVD88 within 7 years after construction (Section 4.4). Shear stresses are significantly above those required to keep sediment suspended through the range of tidal exchange indicating in-channel deposition is unlikely to occur (Chapter 4).

The single northern channel inlet will provide the only hydraulic connection to the bay. The project site marsh plain is at an elevation of about 4 feet to 5 feet. Being below MHW and above MSL means the marsh plain will be flooded and drained on each high tide cycle. The volume of water required to flood the project site will result in peak flows over 1,500 cfs each time the site floods and drains. Based on the constant flushing and shear stresses computed from the hydraulic modeling, fine sediment deposition in the tidal inlet channel inlet is not expected to occur (Section 4.4). Vegetation is not evident in nearby tidal channels below about MSL and is not expected to encroach into the channel due to the depth and erosion and entrainment of sediment deposition on the tidal channel margins. Nonetheless, the project includes an access road out to the channel inlet site to provide access if unanticipated sediment deposition in the tidal inlet channel occurs.

Concerns with the stability of the breach remaining open have been expressed due to difficulties at with breach closing at Crissy Field. The Crissy field project site is located near the Golden Gate. Tidal flux into and out of the entire San Francisco Bay flows past the breach location at Crissy Field. This flux creates longshore currents which push sediment into the breach via littoral processes. The tidal flux into and out of the Crissy Field Marsh are less than 1% of the total flux pushing sediment along the shore. In contrast, the Project site is at the edge of a shallow estuary with minimal longshore currents. The tidal flux into and out of the Tule Red is the dominant flow pattern and aligned with the flux into and out of the site during the ongoing tidal fluctuations and flows.

Additional concerns with the stability of the breach remaining open have been expressed due to breach closings at projects located along Highway 37, Sonoma Creek, and the Muzzi Marsh near Corte Madera project sites in northeastern San Pablo, northern San Pablo, and northwestern San Francisco Bays, respectively. These sites were constructed into old bay muds with higher shear strengths than the more recently deposited sediments found at the Tule Red Project site. The higher shear strength reduces erosion rates of the native sediments, and duration when erosion occurs. These sites were also constructed into a higher marsh plain (elevations about 5.5 to 6 feet) without an established tidal network throughout the high marsh plain. The tidal flux is therefore limited at these sites along San Pablo Bay as the volume of water inundating the site is less due to the higher marsh plain elevation and the lack of tidal channels. The Tule Red Project is being constructed on a lower marsh plain lower than the MHW and with a fully excavated tidal network, providing significant tidal prism volume and associated tidal flux to provide flushing flows throughout the constructed tidal channel network. Results of the hydrodynamic model (Chapter 4) show shear stresses in the channel are adequate to provide erosion, and sufficiently high to inhibit deposition of fine suspended sediments on the margins of the constructed tidal channels.

3.3 Tidal Channel Network

The tidal channel network provides low resistance pathways through the densely vegetated marsh surface allowing flooding and draining with each tide cycle. Tidal networks form as a function of the tidal regime, vegetation type, sediment characteristics, and marsh elevations. The tidal channels also create pathways through the marsh plain allowing sediment to reach further out across the Project site.

A long channel from the channel inlet through the natural marsh ridge (Section3.2) was sized using empirical relationships from Odell et al (2008) and confirmed with hydrodynamic modeling. The width and depth of the channel decreased from the channel inlet to the back of the site as the contributing marsh area and tidal prism decreased. The single high order channel connection is typical of other marsh sites in Suisun Marsh (Honkers Bay, Browns Island, et al). Lower order channels (smaller distributary channels) extend from the large higher order channel and provide additional connections between the marsh plain surface and the tidal channel network.

The layout and channel density of the lower order channels is based on nearby marshes in Suisun and lower Sacramento River Delta. Low order drainages from these sites were scaled per drainage basin area using Odell et al (2008) relationships, and confirmed with reference site measurements in the Suisun Bay region. A two-dimensional hydrodynamic model was run of the final channel layout to quantify the hydraulic response of the channel layouts (Chapter 4). The model included a roughened marsh surface accounting for the establishment of the marsh vegetation with channel network throughout the marsh plain. The model was run for both typical spring and neap tides to evaluate channel stability. The results of this analysis are discussed in Chapter 4.

Various construction alternatives were evaluated for developing lower order channels off of the single high order channel. These alternatives varied from allowing full natural development of channels, to starting short lengths of low order channels to promote natural development, to more extensive excavation of tidal channels. As discussed in Chapter 4, comparison of hydrodynamic model results and existing soil information showed natural development of the low order channels would take on the order of decades. Due to the presence of Phragmites and their robust root structures currently at and near the project site, the tidal channels may not develop at all. The design will include full excavation of the tidal channels to provide additional tidal prism volume and tidal flux to provide full tidal exchange across the Project site.

3.4 Tidal Ponds and Pannes

The tidal ponds located in the southern edge of the site are a functional design component designed to increase onsite production of zooplankton. Moyle (2015) identified a preferred onsite residence time of about 14 days to allow zooplankton to reach an optimal size for foodweb production. The OCAP BO notes invasive overbite clams may colonize near marsh entrances and filter smaller copepods out of the water column, thus limiting the foodweb production and export from the marsh system. An approximate 14 day residence time allows zooplankton to grow large enough to pass the clams. Without the onsite ponds, the elevation of the marsh surface and tidal channel network is such that the majority of the site floods and drains diurnally and limits the mean residence time to about 3-9 hours.

The proposed concept includes a marsh ridge constructed up to elevation 5.5 feet NAVD88 (MHW) to create the largest pond. The marsh ridge will have gently sloping side slopes with a 10 foot top width and will be vegetated. The interior pond elevations will be excavated down to 2 feet NAVD88 in most areas, with deeper sections down to 0 feet NAVD88. The ridge will impound water behind it when tides are below 5.5 feet NAVD88, and will allow mixing of tide water when tides exceed 5.5 feet. Peak high water elevations during neap tides are only about 5.5 feet, providing some daily connection and exchange between the pond and the marsh. During spring tides, high tides reach elevations of close to 7 feet NAVD88. Assuming a reactor type model mixing model for the pond, median residence time of the ponds is computed to vary between 6 to 14 days.

A water budget was evaluated for the impounded pond following the framework of Lionberger et al. (2004). The model assumed no precipitation and peak evaporation/evapotranspiration losses of 6mm/day. The model evaluated conditions where groundwater loss occurred, and where infiltration may become minimal due to clogging of pores by microbial slimes and colloidal soils (Lionberger et al 2004). The model showed the pond was unlikely to dry during periods of low tides and high evaporation rates, and that salinity levels in the ponds would remain 1% to 15% higher than baseline conditions in Grizzly Bay. Section 4.7 provides discussion of the analysis of the residence time and water balance analyses for the ponds and tidal pannes.

Another smaller pond is also located in the southeastern corner of the project area. This pond is fed by a small channel with invert of 2.5 feet NAVD88. This pond will have a typical residence time between 15-20 hours. The purpose of this pond is to provide habitat diversity and a comparison for the larger impounded pond. The pond will be directly connected to the tides. The sedimentation rates in the pond are expected to be about 0-0.25 ft/year, thus faster than sea level rise rates. The pond may maintain its function, or gradually infill and vegetate over the next 10 years.

Tidal pannes, or alternatively categorized “mud barrens” (Mitsch and Gosseling, 1993) are located within the higher marsh plain elevations. The pannes will be surrounded by gently sloping marsh ridges with top elevations of 6.5 feet and are designed to flood only on spring tides. The tidal pannes will have a mean residence time of about a month. Due to change in duration of inundation and variability in topography nearby, as well as increased salinity levels, the pannes are intended to provide physical habitat and vegetation diversity within the marsh plain. The pannes will occasionally dry during the year, and will produce peak salinity levels about 2 to 5 times the baseline condition of Grizzly Bay.

3.5 Habitat Berm

The habitat berm surrounding the site is a functional design to meet the stipulations of the Suisun Marsh Plan (SMP). The SMP requires new levees or improvement of existing levees that will protect adjacent property owners from potential increases risk of flooding. Habitat levees that include berms that will provide protection from wind and wave action as well as provide opportunities for high marsh and upland transition habitat meet these stipulations. The habitat berms will be placed along the seaward length of existing interior levees at slopes of 10% or flatter. The habitat berms will be vegetated with native plants capable of providing erosion protection due to wind waves.

3.6 Maintenance Access

The breach though the natural marsh berm must remain open to allow full tidal exchange on the project site. Although empirical and numerical analyses indicate the breach is unlikely to close due to sediment deposition, uncertainty in design and potential unforeseen natural impediments may occur (log jams, flotsam, beaver dams, etc), which could inhibit the ability of the breach to function. A habitat/access berm is to be constructed off the edge of the existing northern berm (which runs west to east) and along the new breach channel. The habitat/access berm will allow large construction equipment access to remove unforeseen impediments from the breach channel, and to perform maintenance if necessary to keep the breach open.

4.0 HYDRAULIC AND GEOMORPHIC ANALYSES

4.1 Design Methodology

A two-step design process was used to develop the concept design discussed in Chapter 3. The first step quantified properties of existing fully tidal natural marshes. This step focused on empirical relationships, visual observations, and morphological measurements of nearby mature marshes. The results of this exercise provided a conceptual design, including channel layout and channel dimensions.

The second step of the design process incorporated the local tidal regime, vegetation, and soil properties into numerical and analytical models to test the performance of the layout derived from the first step. The objective of the second step was to determine if the concept design from the first step would provide full tidal exchange to the site, if the tidal channels would remain stable, and to quantify excavation and material placement for construction of a tidal marsh system that provides full tidal exchange. Proposed as-built designs were modeled using the two-dimensional depth averaged hydrodynamic (ADH) model. The ADH model allowed for testing the tidal channel's ability to provide full tidal exchange through the site given the local tidal characteristics adapted from Port Chicago tide records, vegetation roughness on the marsh plain, and proposed channel layout. Hydraulic shear stresses from the model were compared to sediment properties estimated to be characteristic for the Project site to ensure excavated channels were not depositional, and to determine rates of erosion if channels were not fully excavated.

This Chapter provides results of this methodology as well as other ancillary analyses used to evaluate and develop the design. The ancillary analyses include estimation of the development of low order channels across the floodplain (Section 4.6). The objective of this analysis was to determine if low order channels could naturally develop in time scales appropriate for project performance or would such tidal channels need to be excavated to provide the desired food web export processes for the restored tidal marsh. A water balance and associated residence time analysis was performed for the ponds and pannes proposed for the site (Section 4.7). The objective implementing ponds and pannes on site was to increase residence time for on-site for zooplankton development, and to address hyper-salinity and fish stranding issues within the ponds.

4.2 Empirical Marsh Relationships and Analog Sites

Odell et al (2008) provides empirical geomorphic relationships for tidal channels observed at mature marshes in the San Pablo Bay area. These relationships include channel order vs. drainage basin area, channel bifurcation ratio vs. channel order, channel width vs. drainage basin area, and channel depth vs. drainage basin area. The tidal regime, elevations, and sediment characteristics (fine sediment) of the San Pablo marshes are comparable to the project site, although the sediment deposits and tidal marshes in San Pablo bay are older and have higher cohesive strength than those that at the project site. The dominant vegetation at the two locations also vary (salt marsh vs. brackish marsh). The Odell et al (2008) relationships were verified with observations of mature marshes in Suisun Bay and the lower Sacramento River Delta and were applied to the layout of the project site. Appendix B provides a comparison of Odell et al (2008) relationships to the Honker Bay marsh located in Suisun Bay.

Odell et al (2008) provides the following relationships for channel top width, w, in feet as a function of the drainage area, A, in acres and channel depth, d, in feet as a function of top width.

$$w = 1.87A^{0.76}$$

$$d = 1.91w^{0.33}$$

An initial channel layout was developed using analog marsh sites in and around Suisun Bay. Relationships in Odell et al (2008) were then used to determine channel width and invert for tidal channels. To standardize the channel layouts for ease of construction, standard dimensions were developed for first, second, and third order channels. Table 4.1 provides the drainage area, top width, and channel depth for channels of various orders.

Table 4.1: Low Order Channel Design Dimensions

Channel Order	Drainage Area (acres)	Channel Width (feet)	Channel Invert (NAVD88 feet)
1st	1.5-4	4	2.5
2nd	4-9	8	1.5
3rd	9-15	12	0.0

4.3 Hydraulic Modeling

ADH is a numerical model developed by the U.S. Army Corps of Engineers Engineer Research and Development Center. The model is two-dimensional depth-averaged hydrodynamic model. A two-dimensional model was chosen to evaluate the distribution of flow across the relatively higher and rougher marsh surface relative to proposed marsh channels. ADH was chosen specifically as it includes a roughness boundary condition for emergent rigid vegetation for modeling flow on in inundated marshes. The model was run for both spring and neap tide conditions and provided depth and depth-averaged velocity at points throughout the project site.

The model was developed using the topographic survey data collected by WES and a 2003 NOAA bathymetric survey of Suisun Bay. Project features such as channels, ponds, and berms were added to the survey data to create a project surface. The project surface was projected onto a two-dimensional computational mesh. The computational mesh extended from about 3,000 feet offshore of the Project site to the berm along the eastern and southern edge of the Project site. Figure 4.1 shows the model extents and existing hydraulic roughness properties.

Figure 4.1: ADH model extents and material types for project conditions

ADH uses different material types assigned to areas of the computational mesh to account for spatial variability in hydraulic roughness. Hydraulic roughness is how ADH accounts for momentum loss for flow over both tidal channel surfaces and for flow over and through dense tidal marsh vegetation. The Project model used five different material properties to represent different roughness conditions in the project. The different materials are representative of different land cover and vegetation types expected on the site.

The fourth-order channel along the north and northeastern margin of the project site is to be constructed with an invert well below MLLW. The channel is expected to have a muddy, unvegetated bottom and vegetated banks. Similarly, the constant inundation of the interior of the ponds is expected to inhibit most vegetation from establishing within the ponds. The fourth-order channel, ponds, and open bay are all modeled with a Manning's n value of 0.02 indicative of the relatively low roughness for mud bottomed channels. This value is typical of low gradient tidal channels rivers with minimal vegetation or bed forms.

The marsh plain was assigned a material property that directly computes momentum loss as a function of exposed surface area and stem density of emergent vegetation. The marsh material assumes vegetation does not become fully submerged and remains rigid during tide cycles. The marsh plain at the Project site is assumed to be a mix of invasive Phragmites (*Phragmites Australias*) and native tule (*Schoenoplectus Californicus* and *Schoenoplectus Actutus*). Observation of these plants near the Project site show typical stem diameters around 0.05 feet in stands of about 15 to 20 stems per square foot. To account for additional blocked area from leaves, the material property for the marsh plain was input as assuming twenty 0.1 foot diameter stems per square foot. Similarly, the low order channels across the marsh plain would have narrow bottom widths with well vegetated banks. These channels were assigned with similar stem diameters but with a reduced stem density of 1 stems per square foot.

Observed spring and neap tide water surface elevations from the Port Chicago gage were assigned to the western boundary of the model. The temporal fluctuation of this water surface was the only external boundary condition assigned to the model. The model would be run for 3 to 4 full tidal cycles to ensure the model was adequately warmed-up. Figure 4.2 shows the boundary conditions applied for the spring and neap tide conditions.

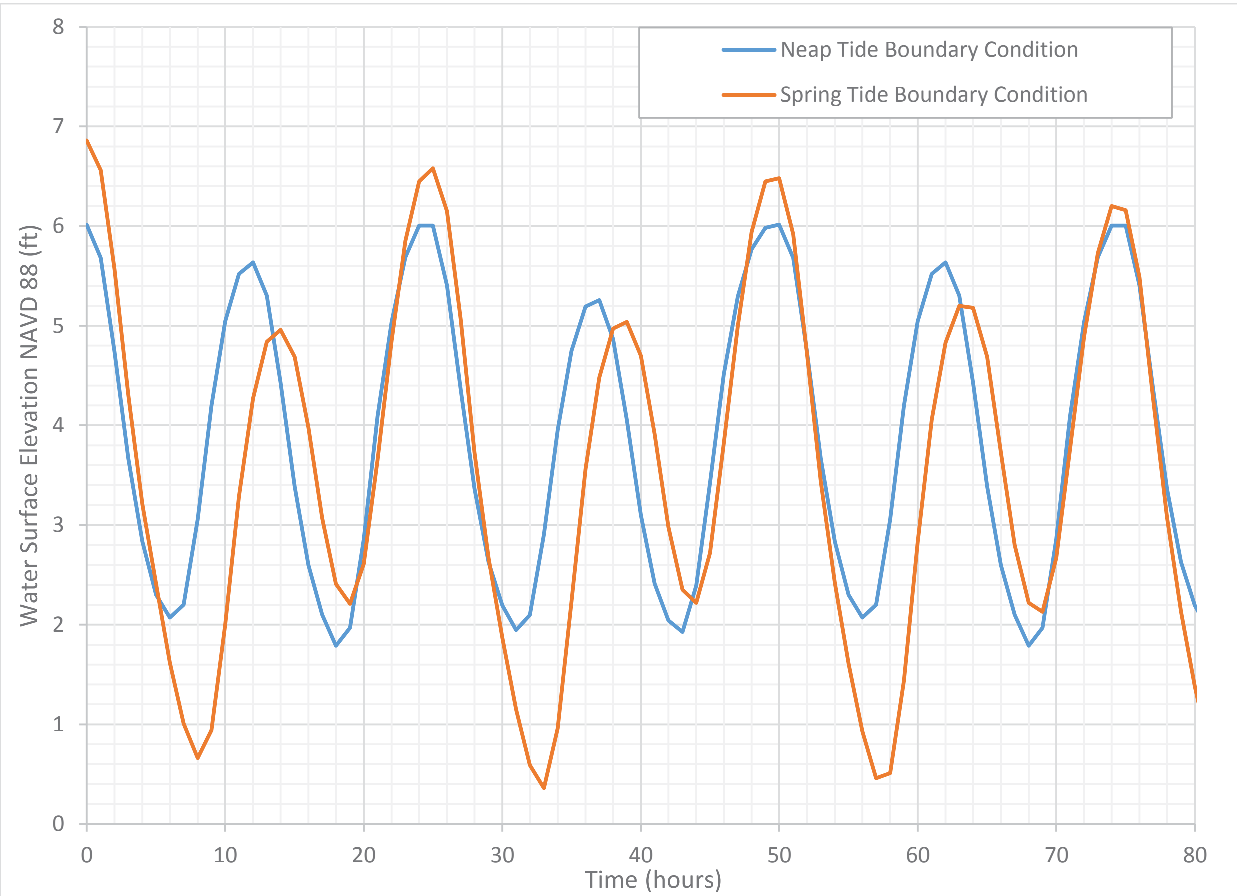


Figure 4.2: Tidal boundary conditions applied to ADH model

As discussed in Section 5.2, the initial construction of the fourth-order channel at the breach will not be constructed to its full equilibrium width as it reaches Grizzly Bay. To limit impacts and construction costs, the subtidal mud flat channel will not be excavated across the long mud flat but will instead be allowed to naturally develop through local scour processes. Figure 4.3 shows the topography for this as-built scenario. The as-built scenario is representative of the expected elevations and channel widths immediately after construction. The second scenario is representative of the site layout with all channels at equilibrium widths and depths. Figure 4.4 shows the topography used in this modeling scenario.

Figure 4.3: As-built model topography, note undersized entrance channel and no tidal mudflat channel

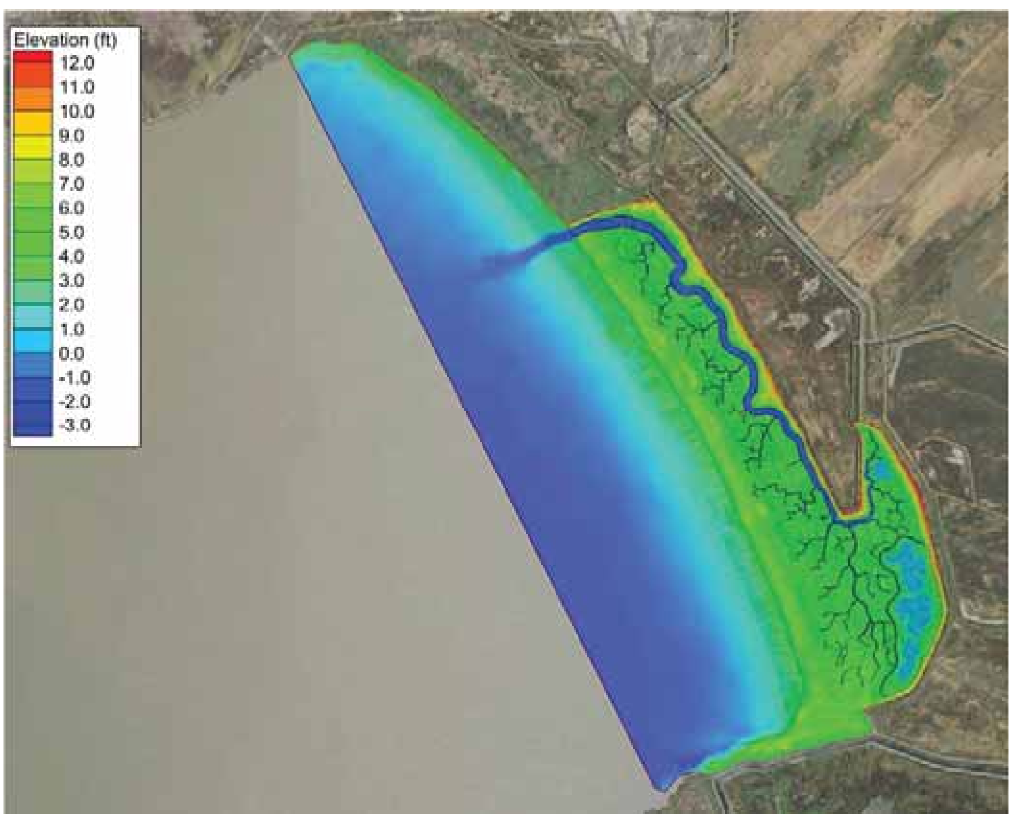


Figure 4.4: Future conditions model topography, note fully developed entrance channel and tidal mudflat channel

4.4 Hydraulic Performance

Figure 4.5 shows the water surface elevation computed from the ADH model relative to the applied boundary condition for the as-built condition. The first 10 hours of results show the model warm-up as the initial model conditions were assumed to be a constant water level. The results show the channel does not fully drain to the MLLW elevation. This is due to the existing mud flat outside of the Project area being at elevation 2 and preventing the site from fully draining. The timing and magnitude of the high tide in the breach entrance is in phase with the boundary condition. Some tidal muting is noted at the southeastern terminus of the 4th order channel where the high tide elevation is about 0.2 feet lower than the boundary condition, however the tides still rise and fall to depth adequate to flood and drain the marsh plain (approximately elevation 4-5.)

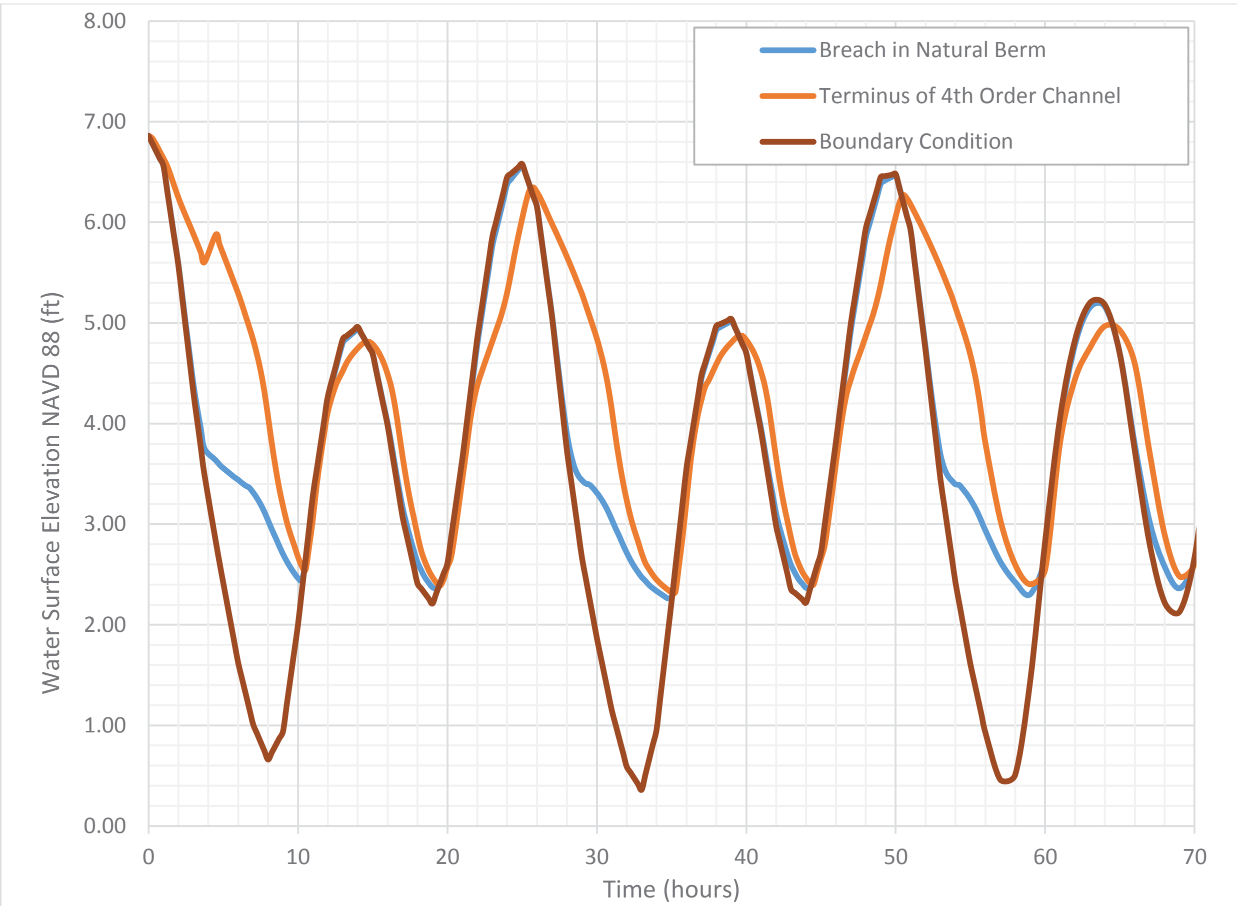


Figure 4.5: Computed water surface elevations in the 4th-order channel at the breach in the natural berm, and on the terminus of the 4th-order channel for the as-built model with spring tide boundary condition.

Figure 4.6 shows the water surface elevation outputted from the ADH model relative to the applied boundary condition for the future condition. The output shows water surface elevations in the entrance to the marsh match the applied boundary condition. The water surface elevations in the back of the marsh match the magnitude of the applied boundary condition for MHW and MLW, and are within 0.2 feet of MLLW and MHHW. The timing of when the peak high and low waters occur are delayed about an hour relative to the boundary condition, but durations of inundations of various elevations closely follow the tidal marsh conditions. The plot shows the site fully flooding and draining.

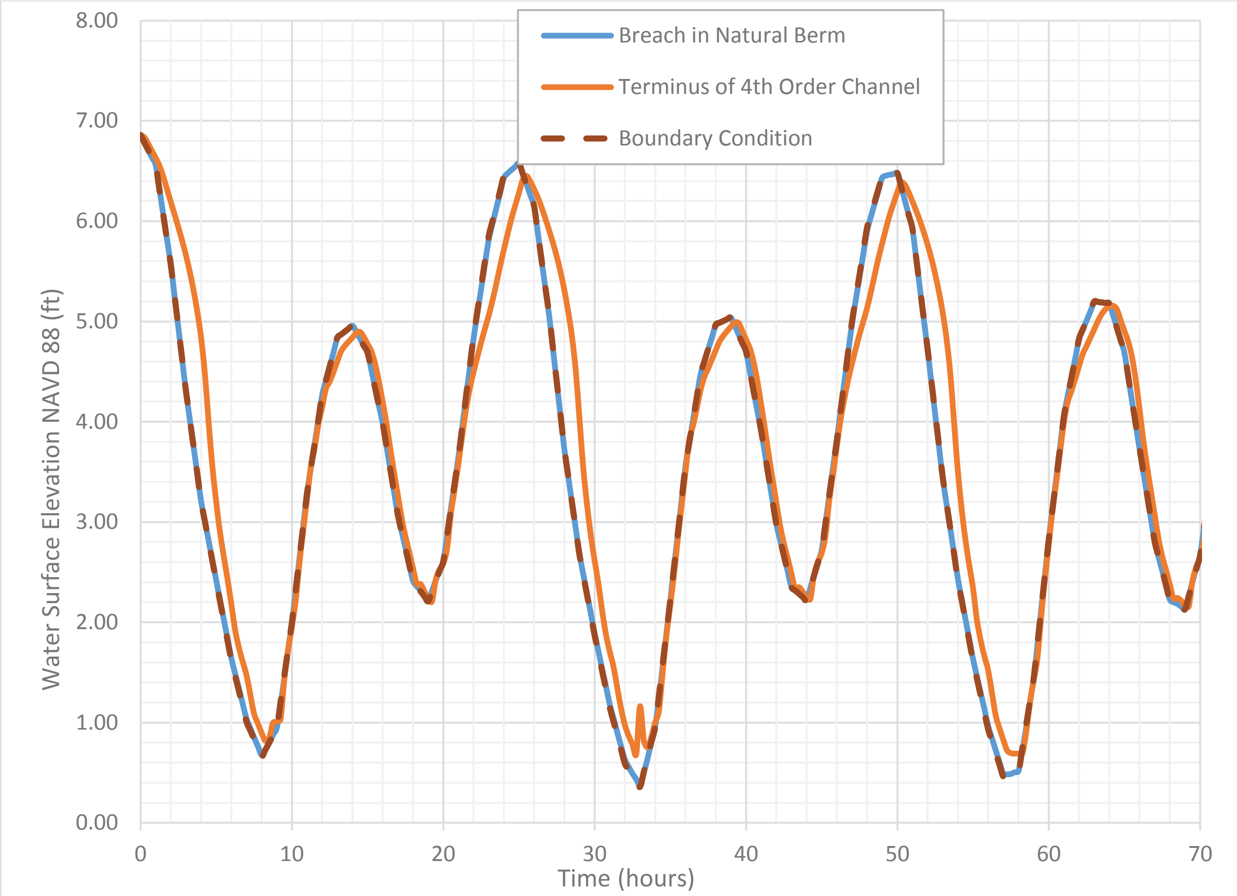


Figure 4.6: Computed water surface elevations in the 4th-order channel at the breach in the natural berm, and on the terminus of the 4th-order channel for the future condition model with spring tide boundary condition.

4.4 Channel Stability

Erosion occurs when shear stress exerted by a fluid over a channel surface exceeds the critical shear stress of the channel bed material. Tidal fluctuations flooding and draining the marsh are the driving forces of shear stress in a tidal marsh channels. As a response to this shear stress, bed material erodes from the channel bed and becomes entrained in the current. This causes the channel to become deeper with steeper side-slopes. Eventually, the channel's side-slopes will become unstable and will slough off into the channel, making the channel wider. Entrained sediment particles from the channel surface settle when their fall velocity is greater than the turbulent forces suspending the sediment particles, a process referred to as deposition. Hydraulic output from the ADH model was coupled with sediment properties to evaluate whether deposition or erosion were likely to occur in the constructed channels.

Hydraulic bed shear stress, τ, is computed as a product of water density, ρ (1.94 slug/ft^3), and the shear velocity, u_* (ft/s). Shear velocity can be computed as a function of depth-averaged velocity, u (ft/s), flow depth, H (ft), the constant acceleration due to gravity, g (32.2 ft/s^2), and skin roughness computed as a function of Manning's n value (0.020) and the Manning's constant, φ_n (1.486 for imperial units). The depth-averaged velocity and depth values were output from the ADH model.

$$\tau = \rho u_*^2$$

$$u_* = \sqrt{\frac{gn^2}{\varphi_n^2 H^{1/3}}}u$$

Shear stress and shear velocities computed with ADH were compared to critical shear stress and fall velocities of the typical marsh sediments. The Project marsh is composed of predominately silt with some sandy silt and clay present (Section 2.3). Warner et al (2004) used a critical shear stress for erosion of 0.001 psf (0.05 Pa) and settling velocity of 0.00015 ft/s (0.5 mm/s) for sediment in Grizzly Bay. These values are consistent with values typically used for non-cohesive silt particles. Inputting the fall velocity of the silt into the shear stress equation computes a critical shear stress for deposition of about $4.3(10^{-8})$ psf. Deposition is expected to occur if the shear velocity (a measure of turbulence intensity) is less than the fall velocity, or similarly if the hydraulic shear stress is less than $4.3(10^{-8})$ psf.

Figure 4.7 shows the hydraulic shear stress in the undersized section of the 4th-order channel near the breach through the natural ridge in the as-built conditions. The figure shows the hydraulic shear stress is frequently up to two orders of magnitude larger than the critical shear stress for erosion (0.001 psf) and is well above this value through much of the tidal cycle. Thus erosion is likely to occur. Since the channel is undersized relative to expected equilibrium channel size (Section 4.2), this result is reasonable and consistent with observations of tidal channel geometry in the region. Similarly, the hydraulic shear stress is rarely below the minimum shear stress where deposition is likely to occur. This indicates the entrance channel is unlikely to be depositional and will not fill in due to sediment deposition over time.

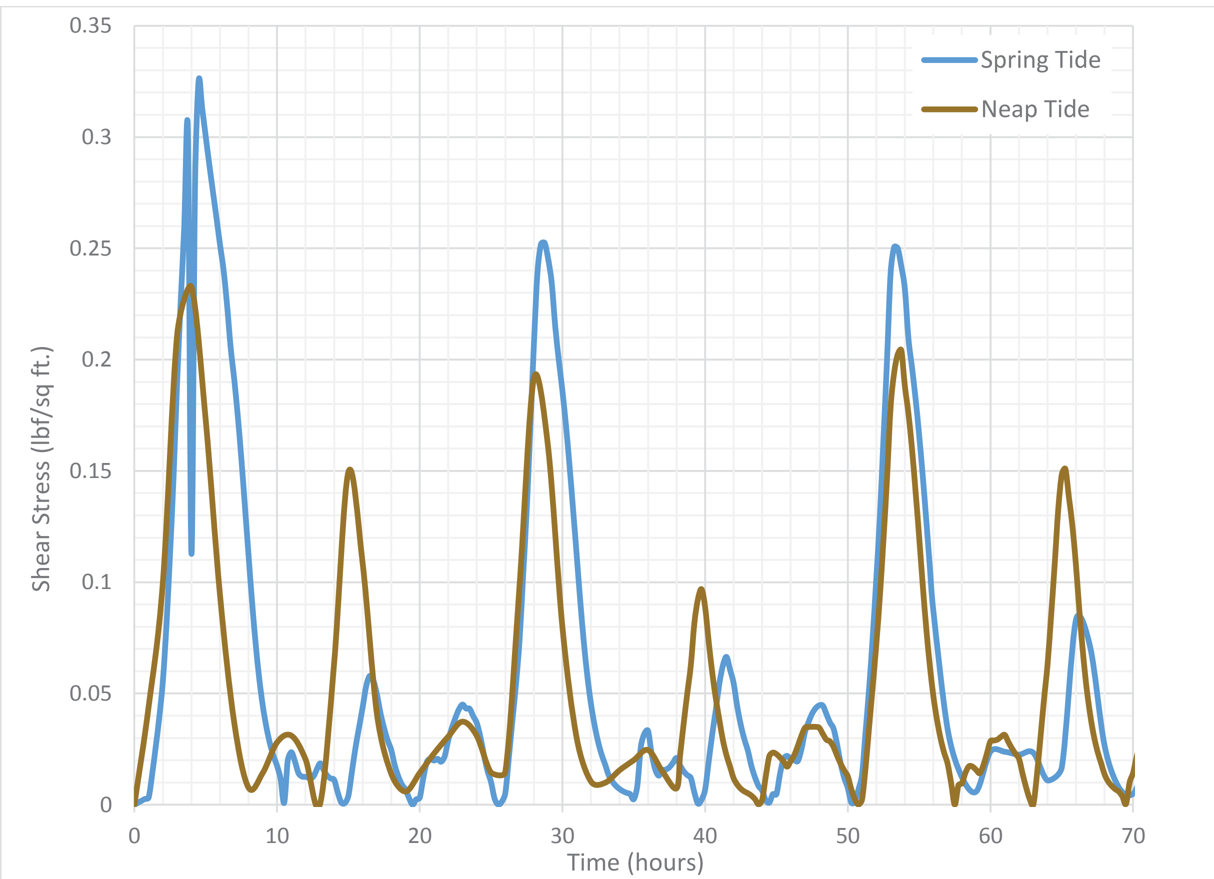


Figure 4.7: Shear stresses in the 4th order channel in under-excavated section near breach through natural marsh ridge. Note the first 10 hours are during the model warm-up.

Figure 4.8 shows the hydraulic shear stress at a point in in the 4th order channel near the center of the marsh. Unlike the section of channel at the marsh entrance, this section of channel was excavated to the expected full equilibrium size. Shear stress values are reduced from those computed for the entrance channel, however the shear stress is still greater than the critical shear stress for erosion for much of the duration of both spring and neap tide cycles. The computed shear stress is also much greater than the critical shear stress for deposition, indication the possibility of slight erosional adjustments of channel dimensions, and that this location will not experience significant depositional processes as well.

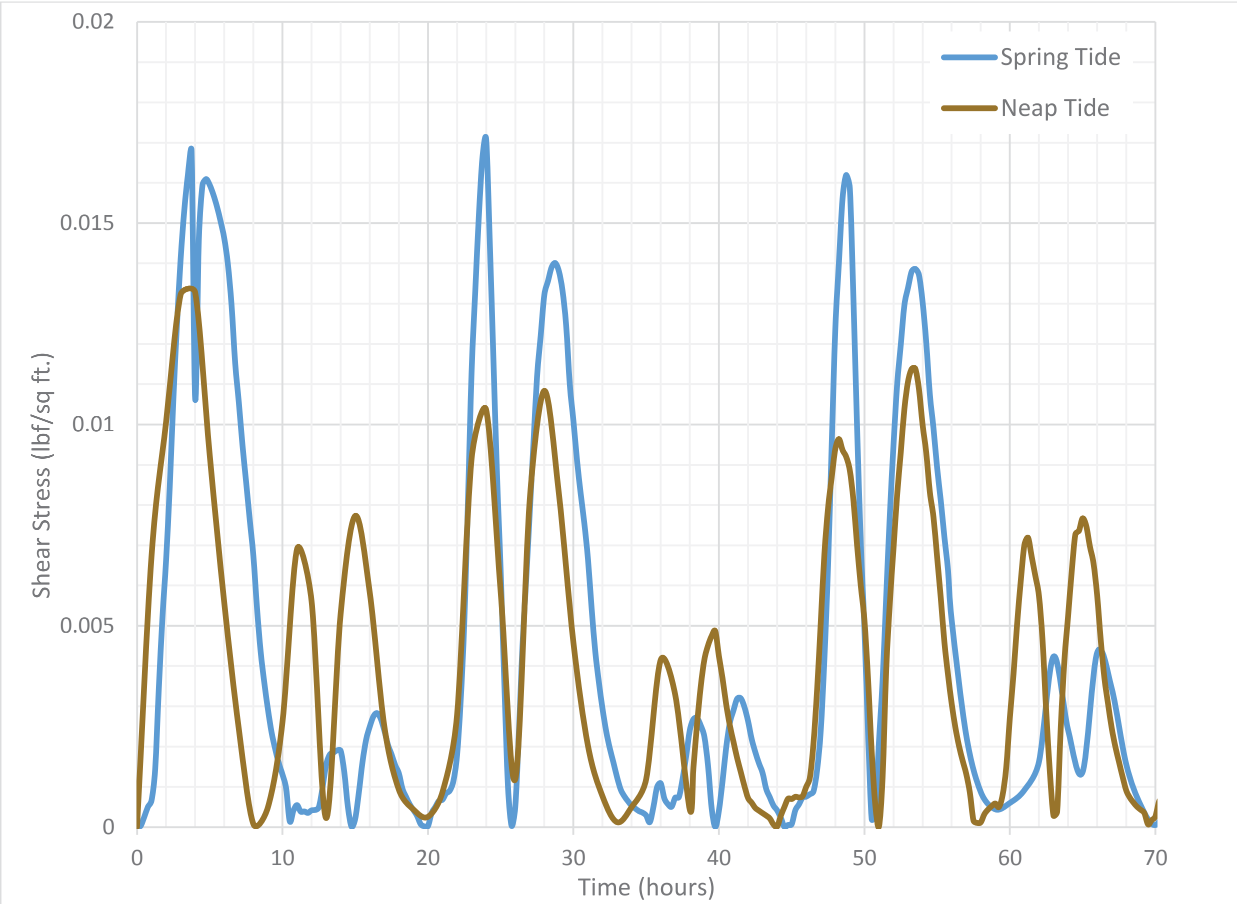


Figure 4.8: Shear stresses in the 4th order channel in a fully-excavated section of channel about halfway through the project site. Note the first 10 hours are during the model warm-up.

Figure 4.9 shows the hydraulic shear stress at point in the 4th order channel near its terminus on the eastern extent. The shear stresses are reduced relative to the previous two plots. The plot shows the shear stresses in the channel greater than or near the critical shear stress for erosion through the majority of the duration of the spring tide and neap tide simulations. The shear stresses do not fall below the threshold where deposition is expected to occur, indicating the channel is likely stable in its existing shape.

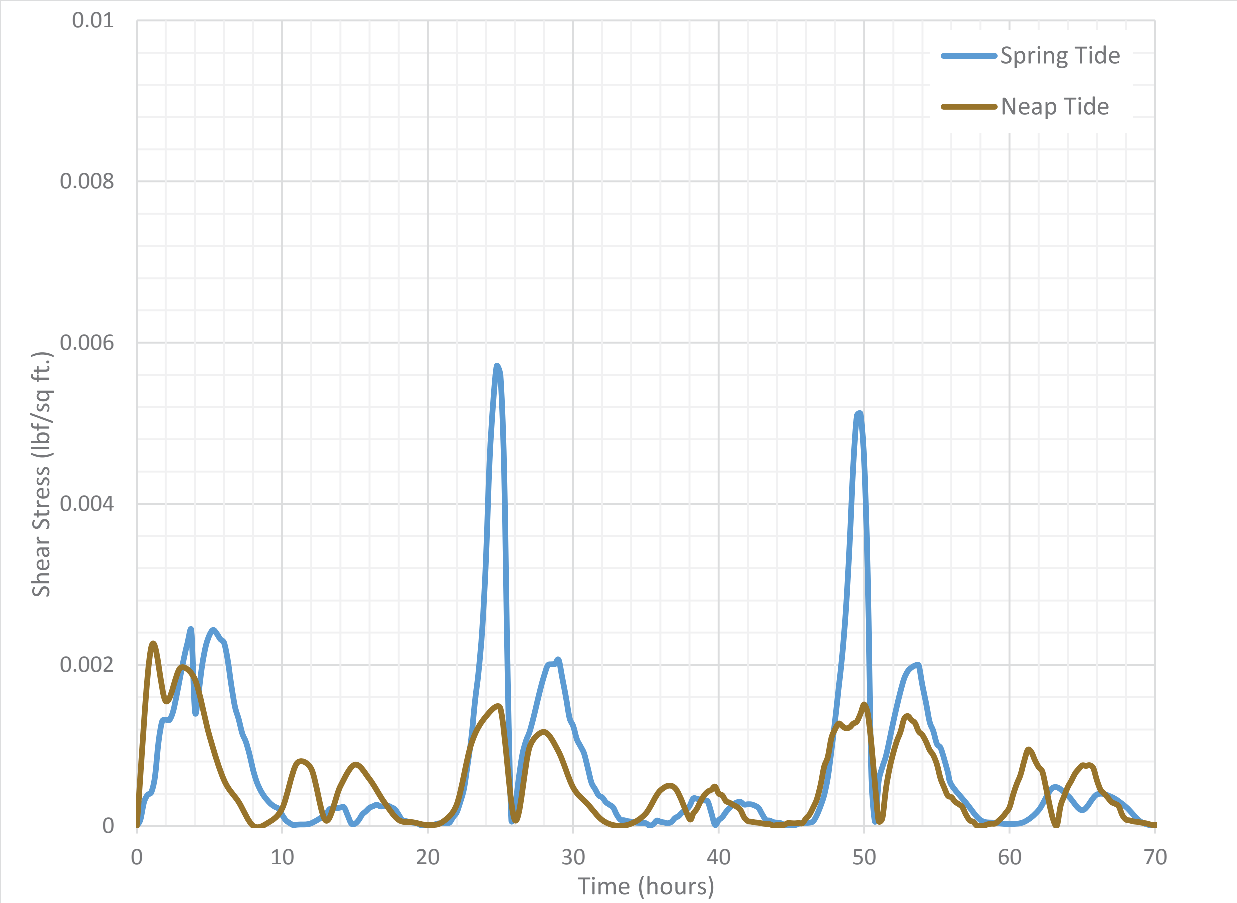


Figure 4.9: Shear stresses in the 4th order channel in a fully-excavated section of channel near the southern terminus of the 4th-order channel. Note the first 10 hours are during the model warm-up.

Computed shear stresses in the lower order channels were also computed. The shear stresses were generally less than the critical shear stress for erosion. On average, the channels were depositional about 20% of the duration during as-built conditions, and about 5% of the duration during the future conditions model. This indicates the channels may be slightly oversized and experience minor sediment deposition. Adjusting the durations used in the suspended sediment deposition calculations (Section 5.4), the channels may see between about 0.6 inches of deposition per year under as-built conditions, and about 0.2 inches per year in the future condition upon establishment of full tidal exchange through the breach entrance channel. More discussion on the potential for channel adjustment and evolution of these channels is discussed in Section 4.6.

4.5 Evolution of the Under-excavated 4th-Order Channel Section

The final section of the 4th order channel connecting the Project site to Grizzly Bay will not be constructed to full equilibrium width or depth. This final section of channel will be intentionally undersized for constructability concerns discussed in Section 5.1. The constructed channel will have a top width of 50 feet (relative to the equilibrium width of 160 feet) and only be constructed to a depth of 7 feet below the existing marsh plain (equilibrium depth is 10 feet below the marsh plain elevation). The mud flat outside of the channel will also not be excavated to initially provide a subtidal mud flat channel. Instead, the entrance to the marsh will naturally develop its final channel width and depth over time. This section provides analysis and discussion on the length of time expected before the channel reaches equilibrium.

The total mass of sediment per foot of channel was estimated by comparing the excavated and equilibrium channel cross-sections. The proposed channel area is about 250 square feet, or about 18% of the expected equilibrium channel area of 1400 square feet. Reported dry bulk densities in the region range from about 30 pcf for loosely deposited sediment on Browns Island (Ganju et al 2005) to 40 pcf for surface deposits in Grizzly Bay (Warner et al 2004). The deposits on the Project Site are mineral deposits which have settled and compacted over time and are expected to have a bulk density between about 80 pcf to 100 pcf. It is expected that about 18,000 to 23,000 tons of sediment will be eroded from the constructed channel margins through natural processes for the entrance and 4th order channel to reach its equilibrium width.

Erosion rate, E (lb/ft^2/s), is often estimated as a product of the excess shear and erosion rate constant, M (lb/ft^2/s). The excess shear is the difference between the applied shear stress and the critical shear strength, normalized by the critical shear strength.

$$E = M\left(\frac{\tau - \tau_{cr}}{\tau_{cr}}\right), \text{ for } \tau > \tau_{cr}$$

A range of erosion rate values are published based on studies in the San Francisco Bay area (Odell et al., 2008). These values range from 6(10^{-7}) lb/ft^2/s to 1(10^{-3}) lb/ft^2/s. Odell et al (2008) determined a value of 6(10^{-6}) lb/ft^2/s, while Warner et al (2004) used a value of 1.8(10^{-5}) lb/ft^2/s in Grizzly Bay, approximately twice the value identified by Odell et al. Many of the values reported in Odell et al (2008) were derived from studies in the salt marshes of San Francisco Bay which have highly cohesive and consolidated marsh soils. The Warner et al (2004) value is higher and likely indicative of the different non-cohesive and lesser consolidated materials in Grizzly Bay. It is also understood some uncertainty exists in the critical shear stress and applied shear stress for cohesive sediment transport calculations (Mehta and McAnally, 2008).

A Monte Carlo approach was used to account for the range of uncertainties in the bulk density, critical shear stress, computed shear stress, and erosion rate constant. The Monte Carlo simulation used hydraulic output from the spring and neap tide calculations. Since the computed shear stress is a function of the Manning's n value, a Manning's n value was randomly chosen from a normal distribution centered on a value of 0.02 with a standard deviation of 0.003 to compute shear stress. A temporally averaged shear stress value was computed from this time series and averaged with the chosen critical shear strength. This assumes the average shear stress at equilibrium is equivalent to the critical shear stress, and provides an average applied shear stress over the period of evolution from as-built to final channel equilibrium. The critical shear strength was chosen randomly from a normal distribution centered on a value of 0.001 psf with a standard deviation of 0.0005 psf. These values were paired with an erosion rate constant randomly chosen from a normal distribution centered on 1.8(10^{-5}) lb/ft^2/s with standard deviation of 0.5 (10^{-5}) lb/ft^2/s to determine an average erosion rate. The total mass of material to be eroded was computed by randomly selecting a bulk density from normal distribution centered on 90 pcf with a standard deviation of 5 pcf. The total mass to be eroded was divided by the erosion rate to determine a duration to equilibrium. This analysis was repeated 10,000 times to produce a data set of durations.

The analysis was run for various active channel widths. As the channel widens, the area of channel available for erosion increases. Although the analysis assumes sediment availability for erosion, the availability of sediment may be somewhat episodic as it relies on geotechnical failures such as sloughing and bank failure to widen the channel. The results of the Monte Carlo simulation were more sensitive to channel width than to changes in critical shear stress and applied shear stresses. Table 4.2 shows the durations to equilibrium using the averaged shear stresses from the as-built model runs for three bottom widths. The most representative column is the bottom width=70 feet, when then the channel area is about halfway developed, and the averaged applied shear stress is likely most representative.

Table 4.2: Results of the Monte Carlo simulation with varying channel bottom widths to determine the number of years required for the breach through the natural marsh berm to reach equilibrium.

Statistical Probability	Bottom Width=22 feet (as-built)	Bottom Width=70 feet	Bottom Width=120 feet (Expected Equilibrium)
95% Exceedance	1.0 years	0.3 years	0.2 years
Median	3.9 years	1.4 years	0.7 years
5% Exceedance	9.6 years	3.5 years	1.8 years

The Sonoma Baylands Marsh Restoration project was a similar project with an initial undersized connection to San Pablo Bay. Figure 4.10 shows the change in channel area over time after construction. The initial points on the figure were published monitoring data from PWA (2003). The final point on the graph was measured from air photos. The Sonoma Baylands project channel was cut through old, consolidated and stiff cohesive clay deposits and did not immediately provide full tidal inundation to the site. The data suggests that the erosion rate increased as the channel area increased. The increase in channel area increased the availability of channel area for erosion, as well as increased tidal flux into the site. The Sonoma Baylands project appears to have taken about 13 years to reach channel equilibrium.

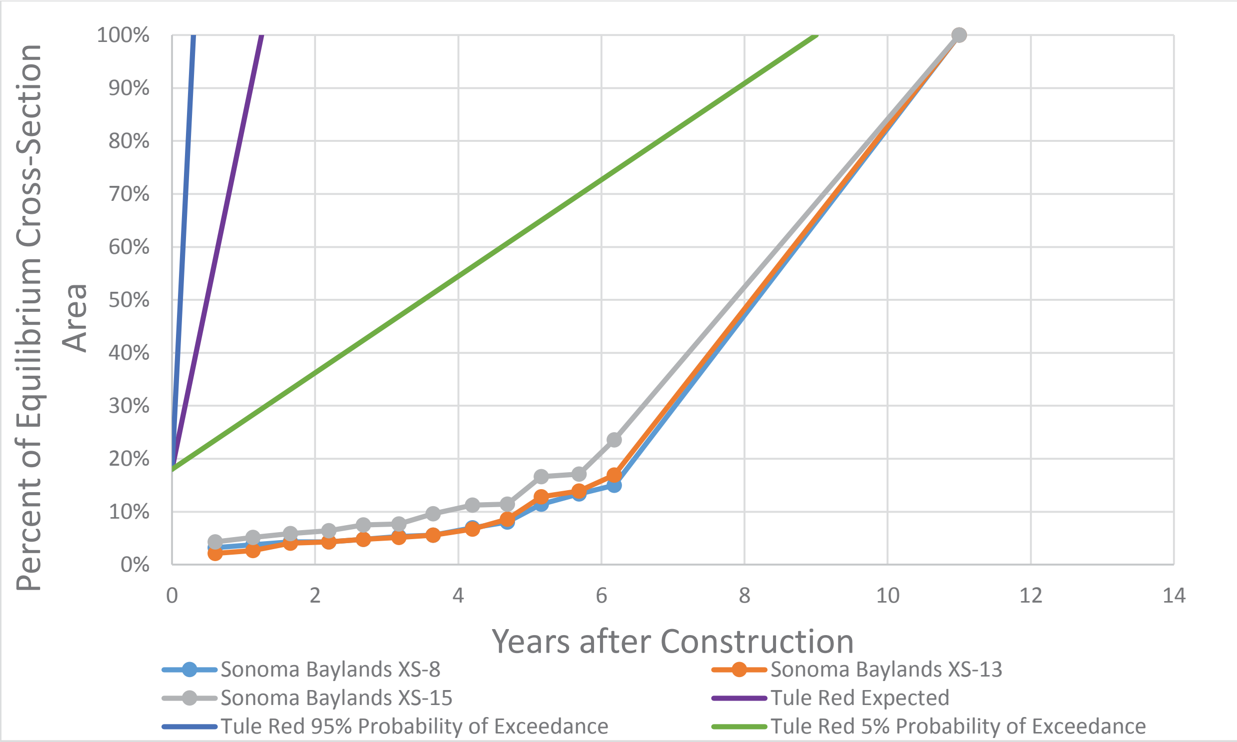


Figure 4.10: Comparison of channel evolution rates to Sonoma Baylands Project.

4.6 Tidal Channel Network Development

ADH models were run to evaluate if the tidal channel network could naturally develop. D'Alpaos et al (2007) showed that results from two-dimensional depth-averaged hydrodynamic models could be used to simulate growth of the low order channels. D'Alpaos et al (2007) used the friction slope, S_f, across the edge of the channel to determine the hydraulic shear stress. The friction slope was computed using the difference in water surface elevations in the marsh plain and channel over a distance of about 20 feet. The depth is the average depth between the marsh plain and channel.

$$\tau = \gamma H S_f$$

The shear stresses were used to compute erosion rates using similar procedures as those described in Section 4.5. Shear stresses are significantly higher than the critical shear strength. However, the duration under which the shear stress occurs is limited to the short duration when the marsh is inundated. The limited duration limits the channel extension lengths to only about 3-10 feet per year. This value also assumes vegetation does not develop at the eroding edge of the channel. Based on the elevations within the marsh, vegetation typical of low marsh habitat is expected to develop around the channel margins. The reed type vegetation (phragmites and tule) can increase the critical shear stress of the marsh plain sediments and inhibit channel growth.

Table 4.3 shows the computed channel growth lengths (increase in channel length) per year relative to other values reported in literature. As the undersized 4th-order channel evolves, the tidal flux and amount of flow passing through the lower order channels increases and increases the erosion rate. Wallace et al. (2005) evaluated channel growth rates in the Tijuana estuary. The site was less vegetated than the Project site. Similarly, D'Alpaos et al (2007) study site was in an Italian estuary with similar tide ranges to the Project site, but in coarser soil with different vegetation. The low order channels are expected to develop across about 1,000 feet of marsh. The rates shown in the Table 4.3 would require about 30 to 100 years for the lower order channel extension to occur and the marsh channel network to fully develop.

Table 4.3: Expected rate of increase in low order channel length

Increase in Channel Length (ft/yr)			
As-Built Geometry	Final Geometry	Wallace et al. (2005)	D'Alpaos et al. (2007)
3	10	4-20	10-54

4.7 Residence Time and Water Balance

The large ponds on the southern edge of the site are intended to increase the overall residence time of the site. The ponds are to be surrounded by a constructed marsh ridge with a top elevation of 5.5 feet. The marsh ridge will disconnect the ponds from the marsh when tidal elevations are less than MHW. The ridge retains water in the ponds during low tides, and limits the volume of water exchanged between the ponds and surrounding marsh during higher tides. A simple reactor based model assuming full mixing in the ponds was used to evaluate the residence times in the ponds, to ensure the ponds did not dry resulting in stranding of fish, and to ensure the pond habitat did not become hyper-saline.

The residence time for effluent leaving the ponds is based on average residence time weighted by volume for the impounded water. The relationship below shows the average residence time of water in the pond, T, at timestep i, as a function of the pond volume at the previous timestep, V_{i-1}, and pond volume at the current timestep, V_i. Pond volume lost to evaporation, E, and infiltration, I, was accounted for using constant rates. The volume of new flow coming into the pond during high tides, ΔV, was computed using a stage-volume curve for the ponds and assuming full tidal exchange on the site. For residence time calculations, negative ΔV values were set to be zero. Figure 4.11 provides water levels in the pond relative to the boundary condition computed with the ADH models.

$$T_i = \frac{(V_{i-1} - E\Delta t - I\Delta t)(T_{i-1} + \Delta t) + \Delta V\left(\frac{\Delta t}{2}\right)}{V_i}$$

$$V_i = V_{i-1} - E\Delta t - I\Delta t + \Delta V$$

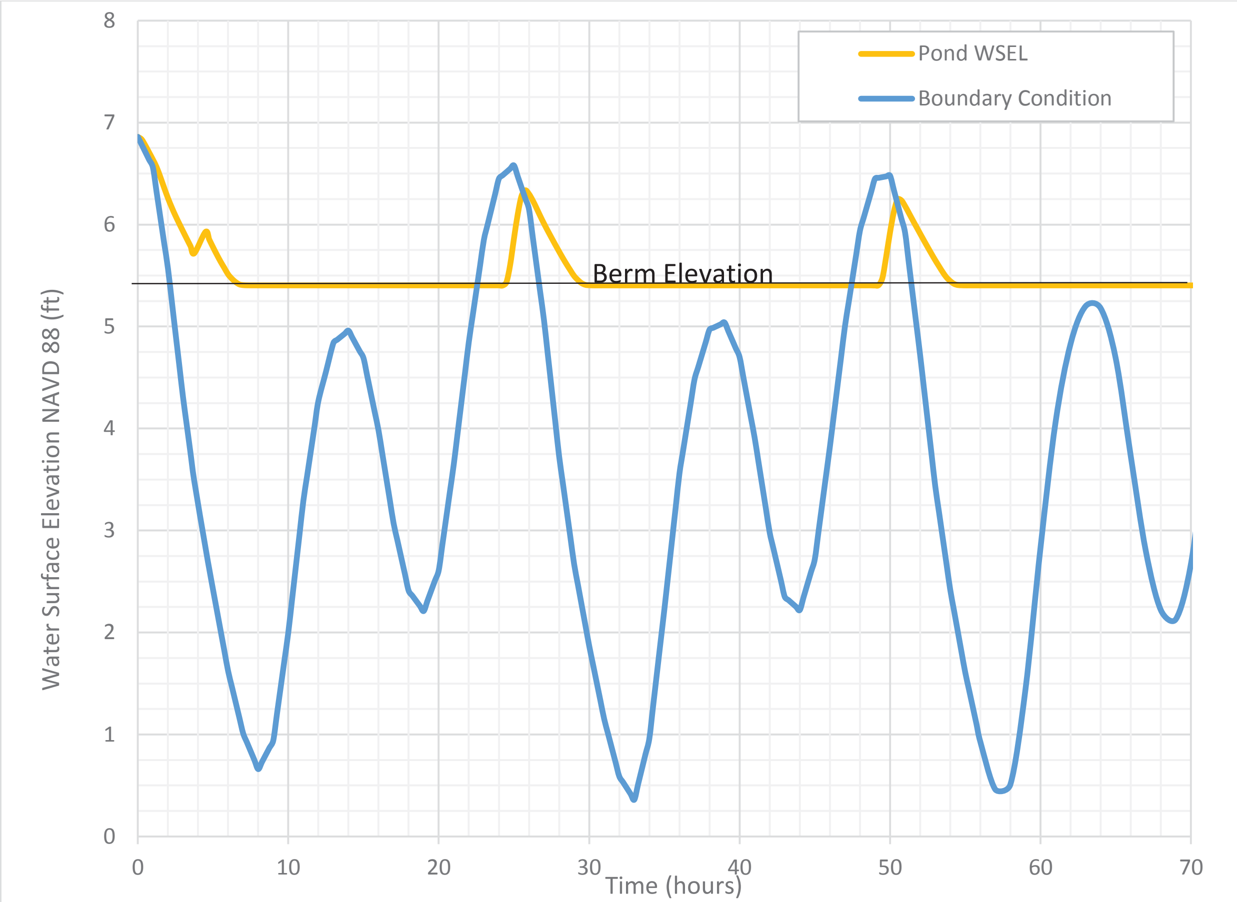


Figure 4.11: ADH computed water surface elevation within the ponds during spring tide simulation with as-built geometry.

Evaporation was accounted for assuming a constant value of 0.0008 ft/hr. This value was the peak seasonal value from Lionberger et al (2004). Lionberger (2004) also noted that infiltration becomes negligible in mature marsh ponds as the pore spaces in the pond bottom becomes clogged with microbial slimes and colloidal soil materials. This is expected to occur within the first few months after final construction is complete. Infiltration was accounted for using Darcy's law assuming a hydraulic conductivity value of 1.1 ft/hour, and by computing the head difference between the pond and the nearby marsh. The hydraulic conductivity value is indicative of clean silts.

Figure 4.12 shows the average residence time for the ponds over a simulation period from January 1, 2013 to December 31, 2014. The residence times were computed using observed hourly water surface elevations from the NOAA Port Chicago gage. The residence time of zooplankton growing in the ponds is assumed to be equivalent to the residence time of water in the ponds. Since zooplankton doesn't evaporate, nor is it expected to be lost due to infiltration, Figure 4.12 also shows residence time for simulations which don't account for evaporation or infiltration.

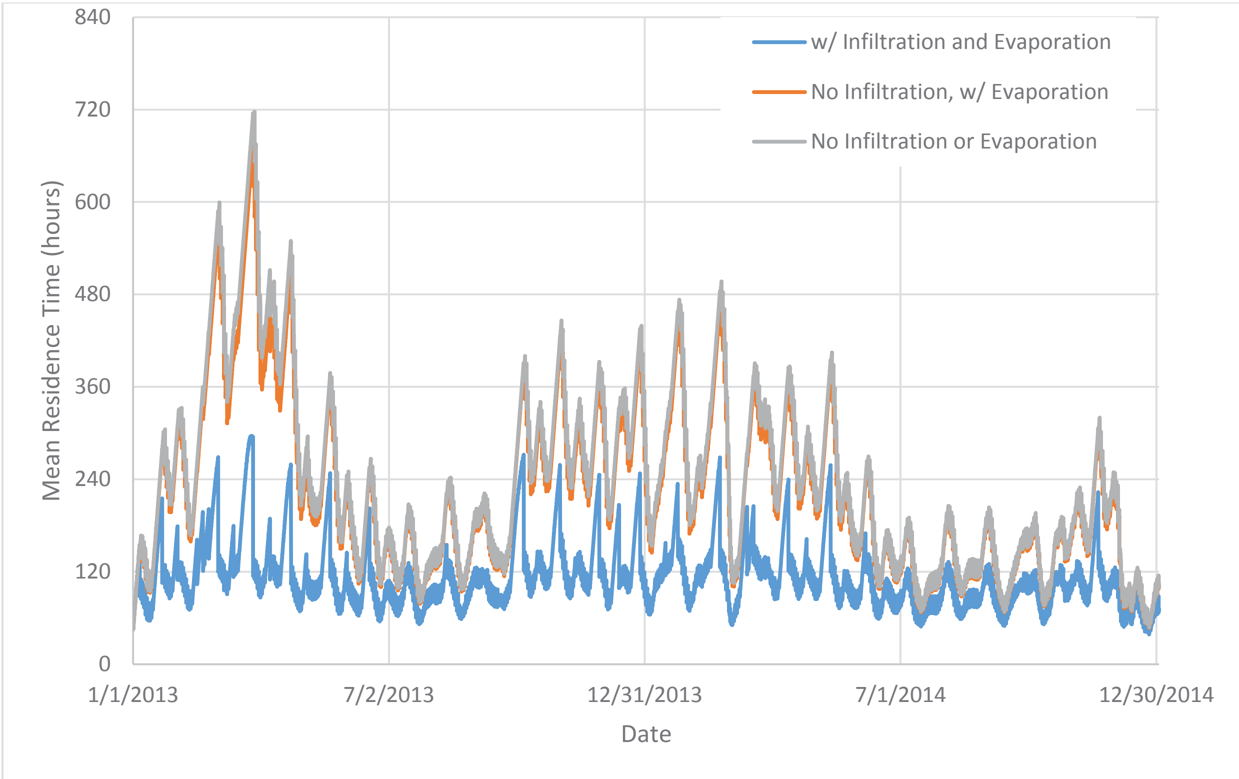


Figure 4.12: Mean residence time in ponds surrounded by marsh ridge

Table 4.4 compares the results of the three lines above. When infiltration is included, the median residence time is only about 4 days. The median residence time will almost double as the ponds age and infiltration (seepage losses) becomes negligible. The median residence time of zooplankton (excluding evaporation and infiltration) is about 9.5 days. Residence time in the ponds will generally be between 4 and 20 days.

Table 4.4: Distribution of residence times in ponds

Residence Time	Including Evaporation and Infiltration	No Infiltration	No Evaporation or Infiltration
Minimum	38 hours	45 hours	45 hours
5 Percentile	63 hours	91 hours	93 hours
Median	105 hours	202 hours	211 hours
95 Percentile	210 hours	430 hours	466 hours
Max	297 hours	677 hours	717 hours

The model assumed full mixing within the pond (i.e. no stratification). The ponds will be about 3.5 feet deep, with isolated areas up to 5.5 feet deep as measured from the surrounding marsh ridge. The windy conditions and daily temperature variation is expected to keep the relatively shallow pond well-mixed. Analysis of a two-year period from January 1, 2013 to December 31, 2014 showed the minimum depth in the ponds reached was 0.6 feet above the raised sections of pond, and 2.6 feet over the deep sections of pond. The median depth over the simulation period was 3.2 feet, with 5% and 95% exceedance values of 4 feet and 1.5 feet, respectively.

Salinity was evaluated in the ponds using results of the residence time analysis. The concentration of salinity in the pond, C, was computed as a volumetric weighted average. Loss of volume in the ponds due to evaporation and infiltration were accounted for as discussed above. Infiltration was assumed to have no impact on salinity, as salt would stay in solution during the infiltration process. However, evaporation was assumed to increase the salinity of the ponds. A constant concentration for salinity was assumed for Grizzly Bay, C_0. Figure 4.13 shows the salinity in the pond relative to this reference concentration.

$$C_i = \frac{(C_{i-1}V_{i-1}) + (C_0 \Delta V)}{V_i}$$

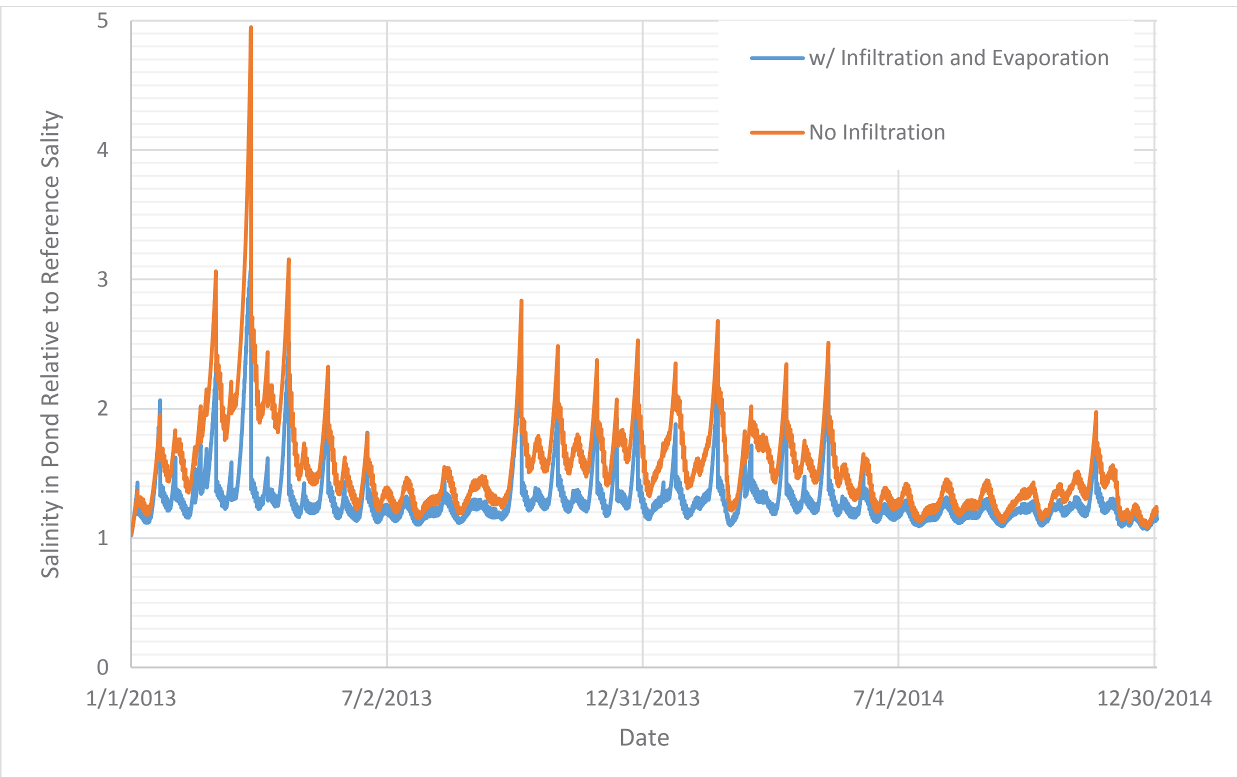


Figure 4.13: Salinity in ponds

Figure 4.13 shows salinity in the ponds is expected to be higher than that of the rest of the marsh and Grizzly Bay. The increase in salinity will be about 1.5 to 2 times that of Grizzly Bay, with occasional short durations above 3 times the Grizzly Bay salinity. The mixing of new tide water on high tides lowers the salinity in the ponds. The ponds are not expected to become hyper-saline due to this mixing.

5.0 Project Implementation

5.1 Overview

The project will be implemented in two construction phases. The first construction phase is planned to be completed in the summer of 2016. The first phase will include excavation of the lower order channels, the habitat berm, the marsh ridge, ponds, and most of the 4^{th}-order channel. The final 300 feet of the 4^{th}-order channel connecting the project site to Grizzly Bay will not be excavated. Connection to the existing tide gates will be maintained to allow management of water on the site. After construction, disturbed areas of the site will be revegetated.

The second and final phase of the construction is planned to be completed in the summer of 2018 once the vegetation onsite has established. The second phase of the construction will remove both of the existing tide gates. The habitat berm in these areas will be filled to disconnect the drainage through these existing channels. The final 300 feet of the 4^{th}-order channel will be constructed to connect the Project site to Grizzly Bay. The existing club house will be removed from the property, and the restored tidal processes will allow the site to continue to evolve naturally over time.

The project will require the excavation of about 345,000 cubic yards of soil. Of this, 315,000 cubic yards will be placed as fill to form the habitat berms and marsh ridge. The rest of the excavated soil will be side cast across the site. The project will permanently impact (through either excavation of fill placement) about 145 acres of the approximately 420 acre site.

5.2 Phase 1 Construction

The phase 1 construction will initiate early in the summer of 2016. The site will be managed to begin drying the site early in the spring. Dewatering with existing tide gates, then grubbing and stripping will be completed as the site becomes dry enough to support these activities. Earthwork activities will commence as grubbing and stripping is completed. Excavated material from the 4^{th}-order channels and ponds will be used to construct the habitat berm and new marsh ridges. Excavated material from the lower order channels will be sidecast and shaped to help create topographic diversity on the marsh plain surface, and reduce impacts from dirt hauling across the marsh plain. As excavation is completed, impacted areas will be revegetated with appropriate native marsh species.

The fourth-order channel and ponds are expected to be excavated using wheeled tractors pulling wheeled scrapers. The scrapers will place the excavated material in 3-foot lifts within the footprint of the proposed habitat berm and marsh ridge. The 3-foot lifts were recommended in the Project geotechnical investigation (Hultgren-Tillis Engineers, 2014). Finishing work on the channels and excavation of the lower order channels will be completed with tracked excavators. Habitat berms and marsh ridges will be placed assuming 0.25 feet of settlement for every vertical foot of fill placed based on recommendations in the geotechnical recommendation (Hultgrin-Tullis, 2014).

The test pits in the geotechnical investigation found groundwater at approximately elevation zero NAVD88 near the northern edge of the site, and did not find groundwater in the 9 foot deep test pits along the proposed 4^{th}-order channel alignment in the center of the site. Excavation will be kept at -2 feet and above to reduce wet excavation. The excavation will likely occur in sections to allow control of ground water within the excavated areas. Wet excavated material will be disked and dried in the footprint of the proposed habitat berm as necessary during placement. If excavated areas require draining or dewatering, the areas will be drained using pumps to direct the water onto the existing marsh plain to allow for natural infiltration away from Grizzly Bay.

The existing tide gates will be kept through the Phase 1 construction to allow drainage of potential high tides from the site. After earthwork activities are complete, the tide gates will be used to manage inundation on the site to assist with the establishment of vegetation. The on-site caretaker will continue to manage the site and maintain conditions to help promote the desired vegetation growth and establishment.

5.3 Phase 2 Construction

Phase 2 of the construction is planned to occur in the summer of 2018. Phase 2 construction will include limited earthwork onsite to account for differential settlement issues. Excavators will be used to close the connections to the existing tide gates, and the tidal gates will be removed. Large specialty marsh excavators will be required to excavate the connection of the 4^{th}-order channel to Grizzly Bay. The wet material will be side cast over the existing vegetation. The final connection will be constructed over a final low tide from the marsh out to the Grizzly Bay, with the final connection at low tide to prevent excavation in flowing water. The low tide condition will allow loose material left from the excavation to be pushed onsite during the flood tide.

5.4 Tidal Marsh Sustainability

Sustainability of tidal marshes relies on marsh accretion processes (both mineral and organic) keeping balance with sea level rise. Mineral accretion on the marsh plain requires a sustainable source of sediment and a process to bring the sediment to mash site. Warner et al (2004) provides a discussion of the processes which bring sediment into Grizzly Bay and sources of sediment. The asymmetric tidal forcing is a function of the shallow embayment being located next to the deep Suisun Bay, and the tidal regime. The floodtide pulses push sediment suspended in San Pablo and Suisun Bay back into Grizzly Bay and the Project site. The results of this process are evident in the historic ongoing shoreline accretion at this site.

The source of sediment in Suisun and San Pablo Bay is the Sacramento River Delta. Shvidchenko et al (2004) showed over 80% of the sediment inflow into the Sacramento River Delta comes for the Sacramento River watershed. Sediment yield in the Sacramento River watershed has significantly declined over the past 150 years due to the end of hydraulic mining, and due to installation of large dams throughout the watershed. NHC (2012) showed that over the past 30 years, the sediment yield out of the Sacramento River watershed has been relatively consistent, showing the watershed has adapted to these previous changes. The sediment delivery and ongoing processes currently depositing sediment along the Project shoreline are likely to continue until another large scale adjustment occurs within the Sacramento River watershed.

About 25% of the total sediment transported from the Delta through Carquinez Straights deposits in San Pablo Bay (Wegen and Jaffe, 2013). Estimated sediment loads from the Delta vary from 1 million to 2 million tons per year (Shvidchenko et al., 2004; Wright and Schoelhammer, 2004). The total mass of sediment required for mineral sediment accretion rates to match expected sea level rise rates over the next 100 years is about 2.25 million tons (3 feet of sediment overlaying a 400 acre site with 80 pcf dry bulk density). This value is less than 2.5% of the total sediment delivered to the San Francisco Bay through the delta, and less than 10% of the total sediment expected to deposit in San Pablo Bay. This conservative estimate neglects the additional bio-accretion processes that will occur on the Project site.

Krone (1987) identified the physical processes that control marsh plain accretion are dynamic, and the accretion rate is a function of the marsh plain elevation and inflowing sediment concentration. Sediment accretion occurs as suspended sediment is carried on-site during flood tides. As flows inundate the marsh plain, the sediment falls out of the water column accumulating on the marsh plain. Higher marsh elevations are inundated for shorter durations, reducing the duration over which accretion may occur relative to accretion rates on lower marsh elevations. In addition to these mineral sediment accretion process, bio accretion of decaying marsh vegetation is an important marsh accretion process, as demonstrated by Deverel et al. (2014) that greatly supplements the accretion rate, especially for higher marsh plain elevations where vegetation productivity is higher.

Marsh accretion rates from suspended sediment can be computed using a simple mass balance between sediment deposition and marsh accretion. The mass balance requires an approximate known sediment concentration, C_*, of the inflowing flood tides, a sediment concentration on the marsh plain, C, a fall velocity representative of the suspended sediment, w_s, as well as the elevation of the marsh plan, Y_m, the elevation of the tide, Y, and time, t. Warner et al (2004) showed suspended sediment concentrations in Grizzly Bay between 50 to 400 ppm and reported a fall velocity of 0.00015 ft/s. Time averaged suspended sediment concentrations were on the order of 100 to 125 ppm.

$$(Y - Y_m)\frac{dC}{dt} = -w_s C + (C_* - C)$$

Table 5.1 shows accretion rates from suspended sediment deposition for marsh elevations relative to MSL for a range of sediment concentrations. The National Resource Council (NRC, 2012) provided updated sea level rise estimates for San Francisco Bay for the years 2030, 2050, and 2100 relative to the year 2000. Assuming average rates of sea level rise between these increments provides a bench mark for comparing marsh accretion rates. If marsh accretion is greater than the sea level rise rate, the marsh elevation will increase relative to MSL. If marsh accretion is less than sea level rise rate, the marsh elevation will decrease relative to MSL. However, lower marsh plain elevations have correspondingly higher mineral sediment accretion rates, providing opportunity for marsh plain surfaces to "catch up" with the sea level rise rate. The accretion rates shown in the Table 5.1 do not account for bio accretion components of tidal marsh accretion. Deverel et al (2014) indicated that bio accretion rates can be significant for supplementing mineral accretion rates in the Delta and Suisun Bay region.

Table 5.1: Marsh accretion rates from mineral sediments (neglects bio-accretion)

	Average Accretion Rate (in/yr)						Average Rate of Sea Level Rise (inches/yr)		
Marsh Elevation (feet above MSL)	**C*=50**	**C*=75**	**C*=100**	**C*=125**	**C*=200**	**C*=400**	**2000-2030**	**2030-2050**	**2050-2100**
0	0.54	0.81	1.08	1.35	2.16	4.31	0.19	0.27	0.50
0.5	0.42	0.63	0.84	1.05	1.68	3.35			
1	0.29	0.44	0.59	0.73	1.17	2.34			
1.5	0.17	0.26	0.34	0.43	0.69	1.37			
(MWH) 2	0.08	0.12	0.16	0.20	0.33	0.65			
(MHHW) 2.5	0.03	0.04	0.05	0.06	0.10	0.21			
3	0.00	0.01	0.01	0.01	0.02	0.04			

Comparison of the accretion rates to sea level rise in Table 5.1 show the rates are comparable. Generally, accretion rates exceed sea level rise at elevations between MSL and MHW. These marsh elevations may increase relative to MSL until the accretion rate matches the sea level rise. Marsh elevations above MHW may fall relative to the rising MSL until the marsh accretion rate matches the rate of sea level rise. The accretion rates and sea level rise rates are of similar magnitude indicating that changes in marsh habitat will occur relatively slowly (over a period of 100s of years). The marsh accretion values also do not include bio-accretion which is expected to be significant, especially at the higher marsh elevations where vegetation growth and productivity is higher. The addition of bio accretion to the calculations for mineral accretions described above indicates that marsh accretion from both mineral and biological processes in the Tule Red region would be expected to keep pace with sea level rise rates in the region.

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APPENDIX A: HISTORIC MAPS OF THE PROJECT SITE

WESTERVELT ECOLOGICAL SERVICES

nhc northwest hydraulic consultants

Legend

Project Area

DATA SOURCES:
California State Geological Survey Map, 1873.
Esri StreetMap, 2012.

SCALE - 1:36,000

0 1,000 2,000 3,000 Feet

Coordinate System:
NAD 1983 California State Plane Zone 2
Units: feet

Job: 5001024

Date: NOVEMBER 2015

FIGURE A1

Tule Red Tidal Restoration Project

Project Site
Located on 1890 Map

ABC, P:\500059_Tule_Red_Concept\GIS\Workmaps\Report_Figures\Figure_A1_Project_Site_Located_on_1873_Map.mxd

WESTERVELT ECOLOGICAL SERVICES

nhc northwest hydraulic consultants

Legend

Project Area

DATA SOURCES:
USGS Topographic Map, Antioch, 1908.
NAIP Color Orthoimagery, 5/20/2012-5/22/2012.
Esri StreetMap, 2012.

SCALE - 1:36,000

0 1,000 2,000 3,000 Feet

Coordinate System:
NAD 1983 California State Plane Zone 2
Units: feet

Job: 5001024

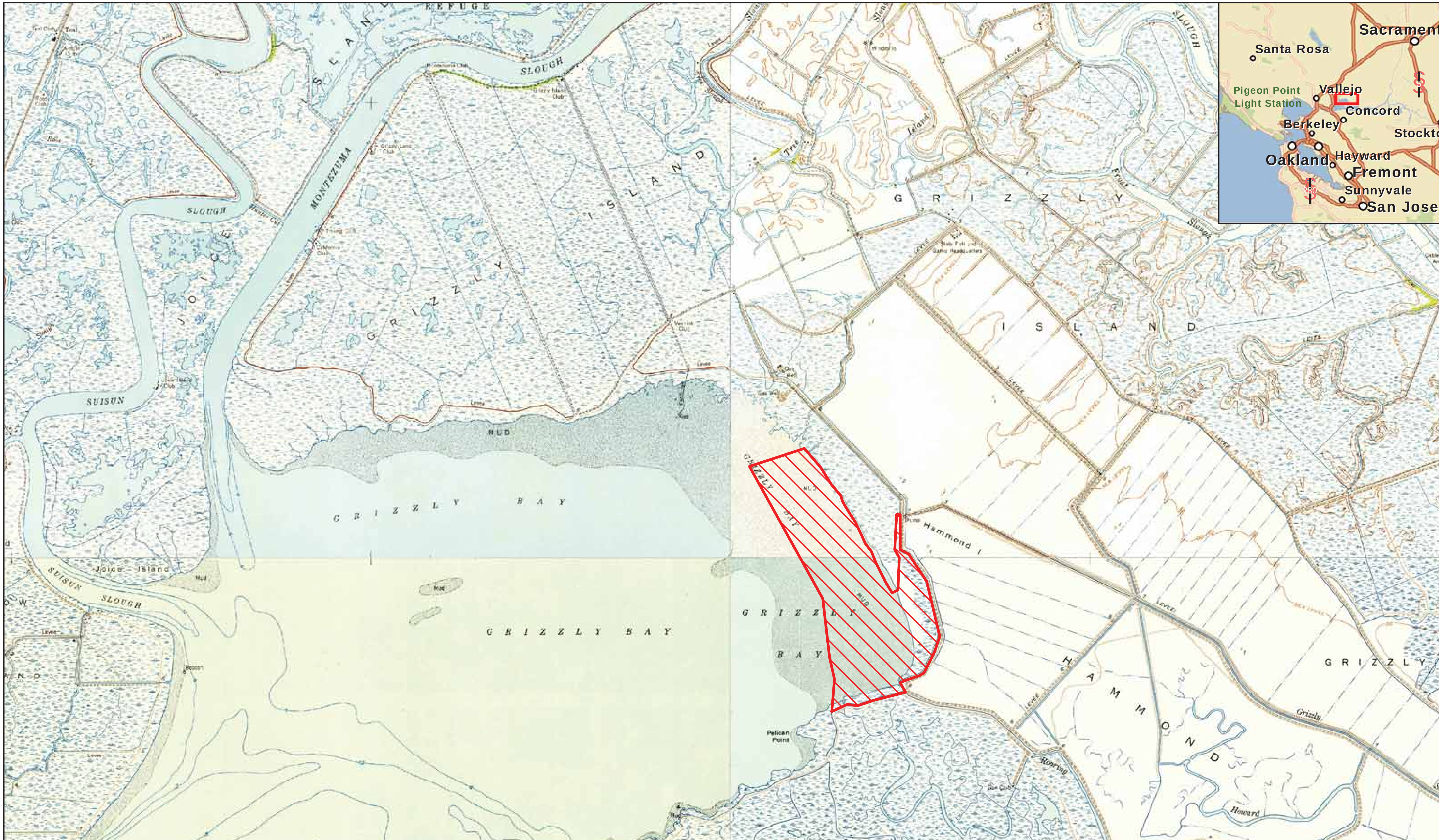
Date: NOVEMBER 2015

FIGURE A2

Tule Red Tidal Restoration Project

Project Site
Located on 1908 Map

ABC, P:\5000059_Tule_Red_Concept\GIS\Workmaps\Report_Figures\Figure_A2_Project_Site_Located_on_1908_Map.mxd



WESTERVELT ECOLOGICAL SERVICES

nhc northwest hydraulic consultants

Legend

Project Area

DATA SOURCES:
Esri StreetMap, 2012.
USGS 7.5 MinuteTopographic Maps:
Denverton, 1953; Fairfield South, 1949; Honker Bay, 1953; Port Chicago, 1951.

SCALE - 1:36,000

0 1,000 2,000 3,000 Feet

Coordinate System:
NAD 1983 California State Plane Zone 2
Units: feet

Job: 5001024

Date: NOVEMBER 2015

FIGURE A3

Tule Red Tidal Restoration Project

Project Site
Located on 1949-1953 Maps

ABC, P:\500059_Tule_Red_Concept\GIS\Workmaps\Report_Figures\Figure_A3_Project_Site_Located_on_1950s_Maps.mxd

APPENDIX B: COMPARISON OF ODELL ET AL (2008)

A site in Honker Bay, located to the south east of the Tule Red site, was chosen as a reasonable analog for comparing tidal channel characteristics proposed by Odell et al 2008 with tidal channels in the Suisun Bay and Marsh region. The site's proximity to the Tule Red site is shown in Figure B-1. The Honker Bay site is characterized by a single primary tidal channel that flows on the easterly edge of the marsh site. The shoreline of the Honker Bay site is also oriented to the in a north westerly to south easterly direction, and thus would be subject to similar wind and wind driven wave patterns as those seen at Tule Red. The Honker Bay site is also similar to the Tule Red site given the site is surrounded by human made berms for the adjacent managed marsh systems.

Figure B-1. Tule Red and Honker Bay site locations.

The Honker Bay tidal channels were digitized and their channel lengths, top of bank channel widths, and channel order were measured from digital orthophotos. The aerial photography was taken in 2014. The digitized channels, and a subset of their assigned channel order, are shown on Figure B-2.

Figure B-2. Digitized Honker Bay tidal channels and subset of channel ordering.

The digitized Honker Bay channel dimensions are compared with the channel dimensional guidance from Odell et al (2008) in Table B-1. In general, the dimensional characteristics of channel length and width between the Honker Bay site and the values obtained from relationships presented by Odell et al are reasonably consistent. The primary difference between Honker Bay characteristic and Odell et al guidance is in the bifurcation ratio, which is a measure of channel density on marsh plain surfaces. Odell et al's data was derived primarily from salt water marsh conditions, whereas Honker Bay is a brackish marsh. Channel density in brackish marsh systems is generally observed to be lower than the channel density of salt water marsh systems in the San Francisco Bay region so this difference is to be expected.

Table B-1. Comparison of tidal channel characteristics from those determined from Odell et al (2008) relationships to measured tidal channels at Honker Bay.

Parameter	Odell et al (2008)	Honker Bay Analog
Channel Order	4	4
Bifurcation Ratio	1^{st} order – 3 - 5 2^{nd} order – 3 - 6 3^{rd} order – 2 - 10 4^{th} order – 2 - 4	1^{st} order – 1 - 3 2^{nd} order – 2 - 3 3^{rd} order – 2 - 4 4^{th} order – 10
Channel Length	1^{st} order – 3ft – 180 ft 2^{nd} order – 60ft – 350 ft 3^{rd} order – 150ft – 1,000ft 4^{th} order – 300ft – 2,000ft	1^{st} – 30ft – 120ft 2^{nd} – 200ft – 380ft 3^{rd} – 250ft – 430ft 4^{th} order – 2,250ft
Main Channel Top width	40 ft	35 – 40 ft
Sinuosity	1 to 2	1.04
Channel Pattern	All	All

Appendix E
Special-Status Plant Species Surveys

ESA Biological Resources

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memorandum

date June 2, 2015

to Westervelt Ecological Services

from Rachel Brownsey, ESA

subject Tule Red Restoration Project Special-Status Plant Survey: Early Season Survey Methods and Results

Introduction

This memorandum presents the methods and results of the early season special-status plant survey at the Tule Red Restoration Project study area (study area). The study area is located along the eastern edge of Grizzly Bay within Suisun Marsh in unincorporated Solano County, CA (**Figure 1**) and is the site of a proposed tidal marsh restoration project. The early season special-status plant survey was conducted on May 19, 2015 in the the tidal emergent wetland along the margin of Grizzly Bay (**Figure 2**). The early season survey focused on evaluating habitat and surveying the tidal emergent wetland for Mason's lilaeopsis (*Lilaeopsis masonii*), Delta tule pea (*Lathyrus jepsonii* var. *jepsonii*), and Suisun marsh aster (*Symphyotrichum lentum*) – three special-status plants that begin to flower in the late-spring/early summer and occur in tidal emergent wetlands. This memorandum has been prepared to document the methods and results of the early season survey and to provide brief and succinct text that can be easily inserted into permit applications, California Environmental Quality Act (CEQA) documents, and the prospectus, as appropriate. The following sections describe the methods and results of the early season survey.

Methods

Pre-Survey Data Review

Prior to conducting the field survey, a list of special-status plants with the potential to occur within the vicinity of the study area was reviewed. Sources consulted in the preparation of the list of target plant taxa include the US Fish and Wildlife Service (USFWS) List of Federal Endangered and Threatened Species (USFWS, 2015), the California Natural Diversity Database (CNDDB) (CDFW, 2015), and the California Native Plant Society (CNPS) Online Inventory of Rare and Endangered Plants (CNPS, 2015). The Suisun Marsh Habitat Management, Preservation, and Restoration Plan EIS/EIR (U.S. Department of the Interior et al., 2011) section on special-status plants was also reviewed.

Special-Status Plant Species

For the purpose of this review, "special-status plant species" include those species afforded legal protection under the State and/or federal Endangered Species Acts or are considered sufficiently rare by the scientific community to potentially qualify for such listing. Special-status plant species include plants that fall into one or more of the following categories:

1. Species listed or proposed for listing as threatened or endangered under the federal Endangered Species Act (50 Code of Federal regulations [CFR] 17.12).

2. Species that are candidates for possible future listing as threatened or endangered under the federal Endangered Species Act (61 FR 40, February 28, 1996);

3. Species listed or proposed for listing by the State of California as threatened or endangered under the California Endangered Species Act (14 California Code of Regulations [CCR] 670.5);

4. Plants listed as rare or endangered under the California Native Plant Protection Act (California Fish and Game Code, Section 1900 et seq.);

5. Species that meet the definitions of rare and endangered under CEQA. CEQA Section 15380 provides that a plant or animal species may be treated as "rare or endangered" even if not on one of the official lists (State CEQA Guidelines, Section 15380); and

6. Plants considered to be "rare, threatened or endangered in California" according to the California Rare Plant Rank (CRPR 1A, 1B, and 2 in CNPS, 2015 as well as CRPR Rank 3 and 4[1] plant species.

A list of special-status plants that may occur at or near the study area was compiled based on data contained in the CNDDB (CDFW, 2015), the USFWS list of Federal Endangered and Threatened Species (USFWS, 2015), and the CNPS Inventory of Rare and Endangered Plants (CNPS, 2015). These plants are presented below in **Table 1** along with their habitat conditions and potential to occur in the study area.

Field Survey

On May 19, 2015 ESA botanist Rachel Brownsey and ESA wildlife biologist Julie Remp conducted a floristic survey of the tidal emergent wetland along the margin of Grizzly Bay. The tidal emergent wetland was covered on foot from the north point indicated on Figure 2 to the south boundary of the study area. The survey was floristic in nature, meaning that every plant taxon that occurred in the tidal emergent wetlands at the time of the survey was identified to the taxonomic level necessary to determine rarity and listing status. Plants not identified in the field were collected and identified in the office later in the week. All plants were identified using *The Jepson Manual: Vascular Plants of California (Second Edition)* (Baldwin et al., 2012). The special-status plant survey followed the procedures described in the California Department of Fish and Wildlife's *Protocols for Surveying and Evaluating Impacts to Special Status Native Plant Populations and Natural Communities* (CDFG, 2009).

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1 CRPR 3 plants may be analyzed under CEQA §15380 if sufficient information is available to assess potential impacts to such plants. Factors such as regional rarity vs. statewide rarity should be considered in determining whether cumulative impacts to a CRPR 4 plant are significant even if individual project impacts are not. CRPR 3 and 4 may be considered regionally significant if, e.g., the occurrence is located at the periphery of the species' range, or exhibits unusual morphology, or occurs in an unusual habitat/substrate. For these reasons, CRPR 3 and 4 plants should be included in the special-status species analysis. CRPR 3 and 4 plants are also included in the California Natural Diversity Database's (CNDDB) Special Plants, Bryophytes, and Lichens List. [Refer to the current online published list available at: http://www.dfg.ca.gov/biogeodata.].

TABLE 1
SPECIAL-STATUS PLANT SPECIES WITH POTENTIAL TO OCCUR AT THE TULE RED SITE

	Status[a]						
	Fed	State	CRPR[b]	Distribution	Preferred Habitats	Period Identifiable	Potential to Occur at Tule Red Site
Pappose tarplant *Centromadia parryi* subsp. *parryi*	-	-	IB.2	Butte, Colusa, Glenn, Lake, Napa, San Mateo, Solano, and Sonoma Counties	Valley and foothill grassland, meadows and seeps, marshes and swamps, coastal prairie: 0–1,365 feet	May–November	Possible
Saltmarsh water hemlock *Cicuta maculata* var. *bolanderi*	-	-	2.1	Contra Costa, Los Angeles, Monterey, Marin, Orange, Sacramento, Santa Barbara, San Bernardino, San Luis Obispo, Solano	Salt marshes	July-September	Unlikely, salt marsh habitat at the site is highly disturbed
Soft bird's-beak *Chloropyron molle* subsp. *molle*	E	R	1B.2	Contra Costa, Marin, Napa, Sacramento, Solano, and Sonoma Counties	Salt marshes	July–November	Unlikely, salt marsh habitat at the site is highly disturbed
Mason's lilaeopsis *Lilaeopsis masonii*	-	R	IB.1	Southern Sacramento Valley, Sacramento–San Joaquin Delta, northeast San Francisco Bay area, and Alameda, Contra Costa, Marin*, Napa, Sacramento, San Joaquin, and Solano Counties	Freshwater and intertidal marshes and streambanks in riparian scrub: generally sea level–30 feet	April–October	Likely, known to occur adjacent to the site
Delta tule pea *Lathyrus jepsonii* var. *jepsonii*	-	-	IB.2	Central Valley (especially the San Francisco Bay region) and Alameda, Contra Costa, Fresno, Marin, Napa, Sacramento, San Benito, Santa Clara, San Joaquin, and Solano Counties	Coastal and estuarine marshes: sea level–15 feet	May–June	Possible
Suisun Marsh aster *Symphyotrichum lentum*	-	-	IB.2	Sacramento–San Joaquin Delta, Suisun Marsh, Suisun Bay, and Contra Costa, Napa, Sacramento, San Joaquin, and Solano Counties	Tidal brackish and freshwater marsh: 0–10 feet	May–November	Possible
Suisun thistle *Cirsium hydrophilium* var. *hydrophilium*	E	-	1B.1	Solano County	Salt marshes	July–November	Unlikely, salt marsh habitat at the site is highly disturbed
Bearded popcorn-flower *Plagiobothrys hystriculus*	-	-	1B.1	Solano County	Valley and foothill grassland, vernal pools: 0–170 feet	April–May	Unlikely, no suitable habitat is present

ESA Biological Resources

TABLE 1
SPECIAL-STATUS PLANT SPECIES WITH POTENTIAL TO OCCUR AT THE TULE RED SITE

	Status[a]						
	Fed	**State**	**CRPR[b]**	**Distribution**	**Preferred Habitats**	**Period Identifiable**	**Potential to Occur at Tule Red Site**
Contra Costa goldfields *Lasthenia conjugens*	E	-	1B.1	Alameda, Contra Costa, Mendocino, Monterey, Marin, Napa, Santa Barbara, Santa Clara, Solano, and Sonoma Counties	Valley and foothill grassland, vernal pools, playas, and cismontane woodland: 0–1,500 feet	March–June	Unlikely, no suitable habitat is present
Carquinez goldenbush *Isocoma arguta*	-	-	1B.1	Southern Sacramento Valley, Suisun Slough, and Contra Costa and Solano Counties	Annual grassland on alkaline soils and flats: generally 3–60 feet	August–December	Unlikely, no suitable habitat is present

NOTES:

[a] **Status**

Federal
E = Endangered
– = No federal status

State
R = Listed as rare under California Native Plant Protection Act.
– = No state status

[b] **California Rare Plant Rank:**

1B.1 = Rare, threatened, or endangered in California and elsewhere; seriously threatened in California (over 80% of occurrences threatened / high degree and immediacy of threat)
1B.2 = Rare, threatened, or endangered in California and elsewhere; moderately threatened in California (20-80% occurrences threatened / moderate degree and immediacy of threat)
2B.1 = Rare, threatened, or endangered in California, but more common elsewhere; seriously threatened in California (over 80% of occurrences threatened / high degree and immediacy of threat)

SOURCE: *CDFW 2015 (CNDDB) and US Bureau of Reclamation 2011 (Final Suisun Marsh Plan EIS/EIR)*

Results

No special-status plants were observed during the early season survey. The tidal emergent wetland within the study area along the margin of Grizzly Bay supports low plant species diversity and provides little suitable habitat for the early season special-status plants Mason's lilaeopsis, Delta tule pea, and Suisun marsh aster. Dense stands of common reed at the mean high water line along the Grizzly Bay shoreline likely inhibit the establishment of California native tidal emergent wetland plants, including special-status plants. Below the mean high water line there is intense wave scour that occurs in the tule dominated areas that inhibits establishment of special-status plants. Suitable habitat for Mason's lilaeopsis, Delta tule pea, and Suisun marsh aster is found near the southern boundary of the study area where there are some low banks within the mean high water line that are more protected from wave scour because of their geographic location. This small area supports nearly twice the number of plant taxa of the tidal emergent wetland to the north and the cover of common reed (*Phragmites australis*) is less dense. California native plants in this area include low bulrush (*Isolepis cernua*), creeping sea arrow-grass (*Triglochin maritima*), and Baltic rush (*Juncus balticus*), with wooly hedge nettle (*Stachys albens*), mugwort (*Artemisia douglasiana*), and San Francisco gumplant (*Grindelia stricta*) further up the bank above the mean higher high water line.

The managed marsh was still too wet to survey in May 2015. In addition, special-status plants with potential to occur in the managed marsh such as pappose tarplant (*Centromadia parryi* subsp. *parryi*) may not have been identifiable in May 2015 due to their late summer flowering phenology.

Table 2 lists all of the plant species observed in the tidal emergent wetland during the survey. Based on the results of the survey, special-status plants are unlikely to occur in study area tidal emergent wetlands. However, it is recommended that the small area of suitable habitat at the southern end of the tidal emergent wetland along Grizzly Bay be visited again during the late season survey in August 2015. The second survey for special-status plants should be conducted in late summer once the managed marsh has dried out but before the vegetation has been mowed or disced. This second survey should be coordinated with Westervelt and the Tule Red site manager to make sure that ESA can survey the site before the vegetation is disturbed. Josh Boldt will be the ESA botanist leading the second survey effort and will be in contact to plan the late season survey.

TABLE 2
VASCULAR FLORA RECORDED FROM TIDAL EMERGENT WETLAND ALONG GRIZZLY BAY, WITHIN THE TULE RED STUDY AREA

Scientific Name	Common Name
Asteraceae	
Artemisia douglasiana	mugwort
Cotula coronopifolia	brass-buttons
Grindelia stricta	San Francisco Bay gumplant
Brassicaceae	
Lepidium latifolium	perennial pepperweed
Caryophyllaceae	
Spergula macrotheca	saltmarsh sandspurry
Chenopodiaceae	
Atriplex prostrate	fat hen
Salicornia pacifica	pickleweed
Cyperaceae	
Bolboschoenus maritimus	alkali bulrush
Isolepis cernua	low bulrush
Schoenoplectus acutus	hardstem tule
Schoenoplectus californicus	tule
Juncaceae	
Juncus balticus	Baltic rush
Juncaginaceae	
Triglochin maritima	creeping sea arrow-grass
Lamiaceae	
Stachys albens	wooly hedge nettle
Poaceae	
Phragmites australis	common reed
Polypogon monspeliensis	rabbit's foot grass
Rosaceae	
Potentilla anserina	silverweed

SOURCE: ESA, 2015

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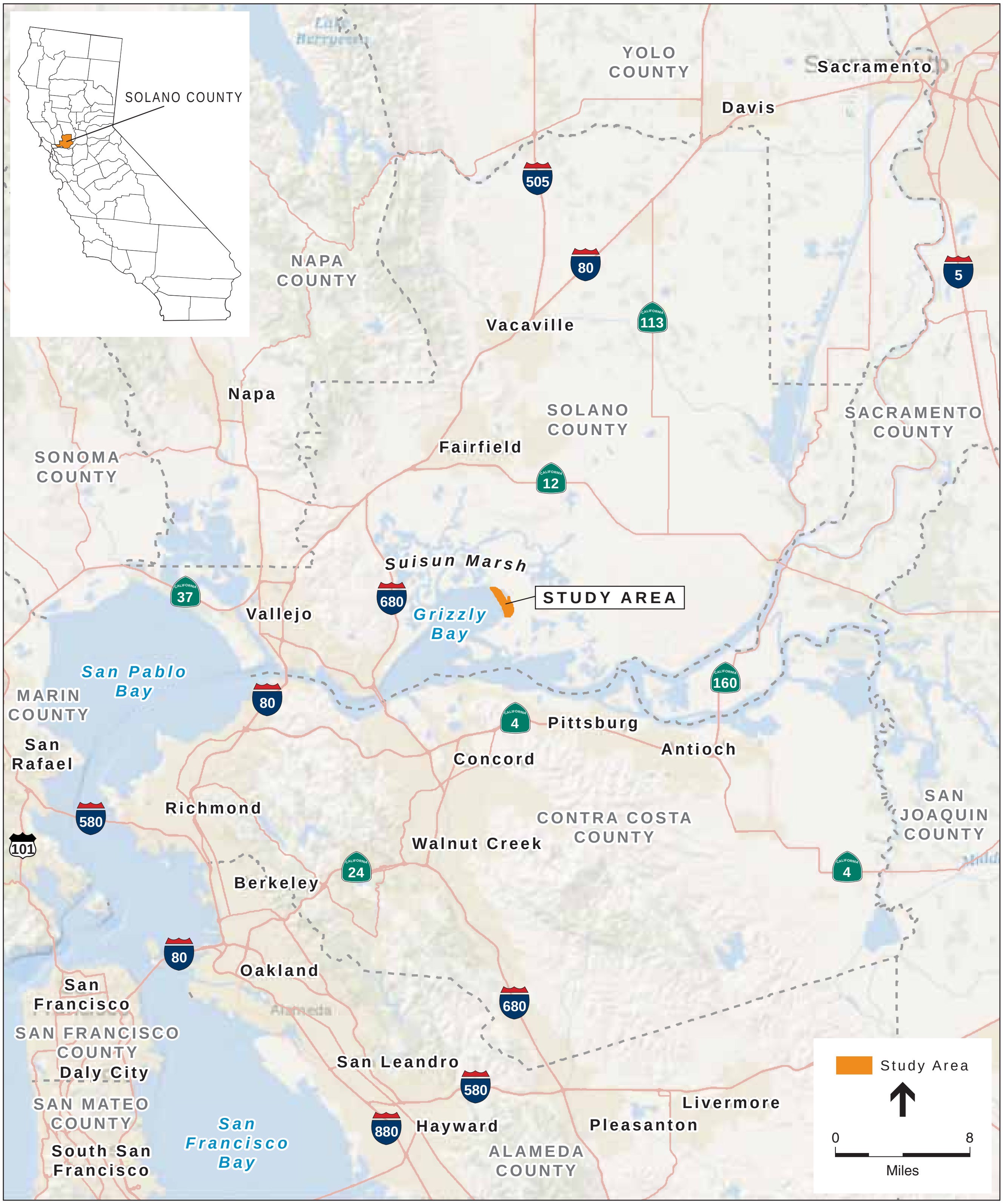

SOURCE: ESRI

Tule Red Restoration Project . 150158

Figure 1
Regional Locator

SOURCE: NAIP, 2014 (May); ESA, 2015

Tule Red Restoration Project . 150158

Figure 2

May 19, 2015 Special-Status Plant Survey Area

ESA Biological Resources

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memorandum

date August 28, 2015

to Westervelt Ecological Services

from Joshua Boldt, ESA

subject Tule Red Restoration Project Special-Status Plant Survey: Late Season Survey Methods and Results

Introduction

This memorandum presents the methods and results of the late season special-status plant survey at the Tule Red Restoration Project study area (study area). The study area is located along the eastern edge of Grizzly Bay within Suisun Marsh in unincorporated Solano County, CA (**Figure 1**) and is the site of a proposed tidal marsh restoration project. The late season special-status plant survey was conducted on August 5, 2015 in the managed marsh between the mean higher high water (MHHW) line to the west and the managed permanent channel to the east (**Figure 2**). In addition, a small area of previously surveyed suitable habitat at the southern end of the tidal emergent wetland along Grizzly Bay was visited again during the late season survey. The late season survey focused on evaluating habitat and surveying the managed marsh for papoose tarplant (*Centromadia parryi* subsp. *parryi*), saltmarsh water hemlock (*Cicuta maculata* var. *bolanderi*), soft bird's beak (*Chloropyron molle* subsp. *molle*), and Suisun thistle (*Cirsium hydrophilium* var. *hydrophilium*) – four special-status plants that begin to flower in the mid- to late-summer and occur in salt marsh habitats. The late season survey also revisited suitable tidal emergent wetland habitat for Mason's lilaeopsis (*Lilaeopsis masonii*) and Suisun marsh aster (*Symphyotrichum lentum*), , which was previously surveyed on May 19 (ESA 2015). Both of these species flower beginning in late spring continuing through summer. This memorandum has been prepared to document the methods and results of the late season survey and to provide brief and succinct text that can be easily inserted into permit applications, California Environmental Quality Act (CEQA) documents, and the prospectus, as appropriate. The following sections describe the methods and results of the early season survey.

Methods

Pre-Survey Data Review

Prior to conducting the field survey, a list of special-status plants with the potential to occur within the vicinity of the study area was reviewed. Sources consulted in the preparation of the list of target plant taxa include the U.S. Fish and Wildlife Service (USFWS) List of Federal Endangered and Threatened Species (USFWS, 2015), the California Natural Diversity Database (CNDDB) (CDFW, 2015), and the California Native Plant Society (CNPS) Online Inventory of Rare and Endangered Plants (CNPS, 2015). The Suisun Marsh Habitat Management, Preservation, and Restoration Plan EIS/EIR (U.S. Department of the Interior et al., 2011) section on special-status plants was also reviewed. The list of target plant taxa is presented below in **Table 1** along with their habitat conditions and potential to occur in the study area.

Special-Status Plant Species

For the purpose of this review, "special-status plant species" include those species afforded legal protection under the State and/or federal Endangered Species Acts or are considered sufficiently rare by the scientific community to potentially qualify for such listing. Special-status plant species include plants that fall into one or more of the following categories:

1. Species listed or proposed for listing as threatened or endangered under the federal Endangered Species Act (50 Code of Federal regulations [CFR] 17.12).

2. Species that are candidates for possible future listing as threatened or endangered under the federal Endangered Species Act (61 FR 40, February 28, 1996);

3. Species listed or proposed for listing by the State of California as threatened or endangered under the California Endangered Species Act (14 California Code of Regulations [CCR] 670.5);

4. Plants listed as rare or endangered under the California Native Plant Protection Act (California Fish and Game Code, Section 1900 et seq.);

5. Species that meet the definitions of rare and endangered under CEQA. CEQA Section 15380 provides that a plant or animal species may be treated as "rare or endangered" even if not on one of the official lists (State CEQA Guidelines, Section 15380); and

6. Plants considered to be "rare, threatened or endangered in California" according to the California Rare Plant Rank (CRPR) 1A, 1B, and 2 in CNPS, 2015 as well as CRPR Rank 3 and 4[1] plant species.

Field Survey

On August 5, 2015 ESA botanist Joshua Boldt and ESA wildlife biologist Julie Remp conducted a floristic survey of the managed marsh between the MHHW line to the west and the managed permanent channel to the east. In addition, a small area of previously surveyed suitable habitat at the southern end of the tidal emergent wetland along Grizzly Bay was re-surveyed. The managed marsh was covered on foot from the north point indicated on Figure 2 to the south boundary of the study area. The survey was floristic in nature, meaning that every plant taxon that occurred in the study area at the time of the survey was identified to the taxonomic level necessary to determine rarity and listing status. Plants not identified in the field were collected and identified in the office later in the week. All plants were identified using *The Jepson Manual: Vascular Plants of California (Second Edition)* (Baldwin et al., 2012). The special-status plant survey followed the procedures described in the California Department of Fish and Wildlife's *Protocols for Surveying and Evaluating Impacts to Special Status Native Plant Populations and Natural Communities* (CDFG, 2009).

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1 CRPR 3 plants may be analyzed under CEQA §15380 if sufficient information is available to assess potential impacts to such plants. Factors such as regional rarity vs. statewide rarity should be considered in determining whether cumulative impacts to a CRPR 4 plant are significant even if individual project impacts are not. CRPR 3 and 4 may be considered regionally significant if, e.g., the occurrence is located at the periphery of the species' range, or exhibits unusual morphology, or occurs in an unusual habitat/substrate. For these reasons, CRPR 3 and 4 plants should be included in the special-status species analysis. CRPR 3 and 4 plants are also included in the California Natural Diversity Database's (CNDDB) Special Plants, Bryophytes, and Lichens List. [Refer to the current online published list available at: http://www.dfg.ca.gov/biogeodata.].

TABLE 1
SPECIAL-STATUS PLANT SPECIES WITH POTENTIAL TO OCCUR AT THE TULE RED SITE

	Status[a]						
	Fed	**State**	**CRPR[b]**	**Distribution**	**Preferred Habitats**	**Period Identifiable**	**Potential to Occur at Tule Red Site**
Pappose tarplant *Centromadia parryi* subsp. *parryi*	-	-	IB.2	Butte, Colusa, Glenn, Lake, Napa, San Mateo, Solano, and Sonoma Counties	Valley and foothill grassland, meadows and seeps, marshes and swamps, coastal prairie: 0–1,365 feet	May–November	Possible
Saltmarsh water hemlock *Cicuta maculata* var. *bolanderi*	-	-	2.1	Contra Costa, Los Angeles, Monterey, Marin, Orange, Sacramento, Santa Barbara, San Bernardino, San Luis Obispo, Solano	Salt marshes	July-September	Unlikely, salt marsh habitat at the site is highly disturbed
Soft bird's-beak *Chloropyron molle* subsp. *molle*	E	R	1B.2	Contra Costa, Marin, Napa, Sacramento, Solano, and Sonoma Counties	Salt marshes	July–November	Unlikely, salt marsh habitat at the site is highly disturbed
Mason's lilaeopsis *Lilaeopsis masonii*	-	R	IB.1	Southern Sacramento Valley, Sacramento–San Joaquin Delta, northeast San Francisco Bay area, and Alameda, Contra Costa, Marin*, Napa, Sacramento, San Joaquin, and Solano Counties	Freshwater and intertidal marshes and streambanks in riparian scrub: generally sea level–30 feet	April–October	Likely, known to occur adjacent to the site
Delta tule pea *Lathyrus jepsonii* var. *jepsonii*	-	-	IB.2	Central Valley (especially the San Francisco Bay region) and Alameda, Contra Costa, Fresno, Marin, Napa, Sacramento, San Benito, Santa Clara, San Joaquin, and Solano Counties	Coastal and estuarine marshes: sea level–15 feet	May–June	Possible
Suisun Marsh aster *Symphyotrichum lentum*	-	-	IB.2	Sacramento–San Joaquin Delta, Suisun Marsh, Suisun Bay, and Contra Costa, Napa, Sacramento, San Joaquin, and Solano Counties	Tidal brackish and freshwater marsh: 0–10 feet	May–November	Possible
Suisun thistle *Cirsium hydrophilium* var. *hydrophilium*	E	-	1B.1	Solano County	Salt marshes	July–November	Unlikely, salt marsh habitat at the site is highly disturbed
Bearded popcorn-flower *Plagiobothrys hystriculus*	-	-	1B.1	Solano County	Valley and foothill grassland, vernal pools: 0–170 feet	April–May	Unlikely, no suitable habitat is present

TABLE 1
SPECIAL-STATUS PLANT SPECIES WITH POTENTIAL TO OCCUR AT THE TULE RED SITE

	Status[a]						
	Fed	**State**	**CRPR[b]**	**Distribution**	**Preferred Habitats**	**Period Identifiable**	**Potential to Occur at Tule Red Site**
Contra Costa goldfields *Lasthenia conjugens*	E	-	1B.1	Alameda, Contra Costa, Mendocino, Monterey, Marin, Napa, Santa Barbara, Santa Clara, Solano, and Sonoma Counties	Valley and foothill grassland, vernal pools, playas, and cismontane woodland: 0–1,500 feet	March–June	Unlikely, no suitable habitat is present
Carquinez goldenbush *Isocoma arguta*	-	-	1B.1	Southern Sacramento Valley, Suisun Slough, and Contra Costa and Solano Counties	Annual grassland on alkaline soils and flats: generally 3–60 feet	August–December	Unlikely, no suitable habitat is present

NOTES:

[a] **Status**

Federal
E = Endangered
– = No federal status

State
R = Listed as rare under California Native Plant Protection Act.
– = No state status

[b] **California Rare Plant Rank:**

1B.1 = Rare, threatened, or endangered in California and elsewhere; seriously threatened in California (over 80% of occurrences threatened / high degree and immediacy of threat)
1B.2 = Rare, threatened, or endangered in California and elsewhere; moderately threatened in California (20-80% occurrences threatened / moderate degree and immediacy of threat)
2B.1 = Rare, threatened, or endangered in California, but more common elsewhere; seriously threatened in California (over 80% of occurrences threatened / high degree and immediacy of threat)

SOURCE: *CDFW 2015 (CNDDB), USFWS 2015, CNPS 2015, and US Bureau of Reclamation 2011 (Final Suisun Marsh Plan EIS/EIR)*

Results

No special-status plants were observed during the late season survey. The managed marsh within the study area between the MHHW line to the west and the managed permanent channel to the east supports low plant species diversity and provides little suitable habitat for the late season special-status plants papoose tarplant, saltmarsh water hemlock, soft bird's beak, and Suisun thistle. The marsh has been managed as a duck club for decades. In order to make the site more suitable for ducks and for duck hunting recreation, the mosaic of emergent vegetation, open water, and channels in the managed marsh area has been carefully manipulated through water management (flooding, draining) and vegetation control (mowing, discing, and herbicide application). The site has also been managed to reduce water salinity, which facilitates the establishment of cattails. Pickleweed- and saltgrass-dominated vegetation is mowed and disced in a patchwork pattern that is evident in aerial photos taken during the late summer. Patches of tules and cattails are maintained to the greatest extent feasible, and managed seasonal channels are mowed so that they will continue to be accessible by boat in the fall when the managed marsh is again flooded. In addition, the managed marsh in the study area is now disconnected from direct tidal influence, and water levels are managed on a seasonal basis through combination flapgates. The managed marsh is completely drained in early summer to allow vegetation management, then maintained at a constant level during the fall and winter for waterfowl habitat and hunting. The disturbance to the natural vegetation communities and hydrology of the study area from these management activities makes the area unlikely to support any special-status plant species.

Suitable habitat for Suisun marsh aster and Mason's lilaeopsis (along with early season blooming species Delta tule pea [*Lathyrus jepsonii* var. *jepsonii*]) is found near the southern boundary of the study area where low banks occur within the mean high water line that are somewhat protected from wave scour because of their topographic location. This area was surveyed in May 2015 and was re-surveyed during the August 5, 2015 rare plant survey. This small area supports nearly twice the number of plant taxa of the tidal emergent wetland to the north and the cover of common reed (*Phragmites australis*) is less dense. California native plants in this area include low bulrush (*Isolepis cernua*), creeping sea arrow-grass (*Triglochin maritima*), and Baltic rush (*Juncus balticus*), with wooly hedge nettle (*Stachys albens*), mugwort (*Artemisia douglasiana*), and San Francisco gumplant (*Grindelia stricta*) further up the bank above the MHHW line. No special-status species were observed in this area.

Table 2 lists all of the plant species observed in the managed marsh and small area of suitable tidal emergent wetland during the survey. Based on the results of the survey, special-status plants are unlikely to occur in study area.

TABLE 2
VASCULAR FLORA RECORDED FROM MANAGED MARSH AND TIDAL EMERGETN WETLAND WITHIN THE TULE RED STUDY AREA

Scientific Name	Common Name
Asparagaceae	
Asparagus officinalis subsp. *officinalis*	asparagus
Asteraceae	
Artemisia douglasiana	mugwort
Baccharis pilularis	coyote brush
Cotula coronopifolia	brass-buttons
Grindelia stricta	San Francisco Bay gumplant
Jaumea carnosa	jaumea
Boraginaceae	
Heliotropium curassavicum	seaside heliotrope
Brassicaceae	
Lepidium latifolium	perennial pepperweed
Caryophyllaceae	
Spergularia macrotheca	saltmarsh sandspurry
Chenopodiaceae	
Atriplex prostrate	fat hen
Salicornia pacifica	pickleweed
Convolvulaceae	
Cuscuta salina	salt marsh dodder
Cyperaceae	
Bolboschoenus maritimus	alkali bulrush
Isolepis cernua	low bulrush
Schoenoplectus acutus	hardstem tule
Schoenoplectus californicus	tule
Frankeniaceae	
Frankenia salina	alkali-heath
Juncaceae	
Juncus balticus	Baltic rush
Juncaginaceae	
Triglochin maritima	creeping sea arrow-grass
Lamiaceae	
Stachys albens	wooly hedge nettle
Lythraceae	
Lythrum hyssopifolium	hyssop-leaf loosestrife
Poaceae	
Distichlis spicata	saltgrass
Phragmites australis	common reed

TABLE 2
VASCULAR FLORA RECORDED FROM MANAGED MARSH AND TIDAL EMERGETN WETLAND WITHIN THE TULE RED STUDY AREA

Scientific Name	**Common Name**
Polypogon monspeliensis	rabbit's foot grass
Polygonaceae	
Rumex crispus	curly dock
Rosaceae	
Potentilla anserina	silverweed
Typhaceae	
Typha angustifolia	narrow-leaved cattail

SOURCE: ESA, 2015

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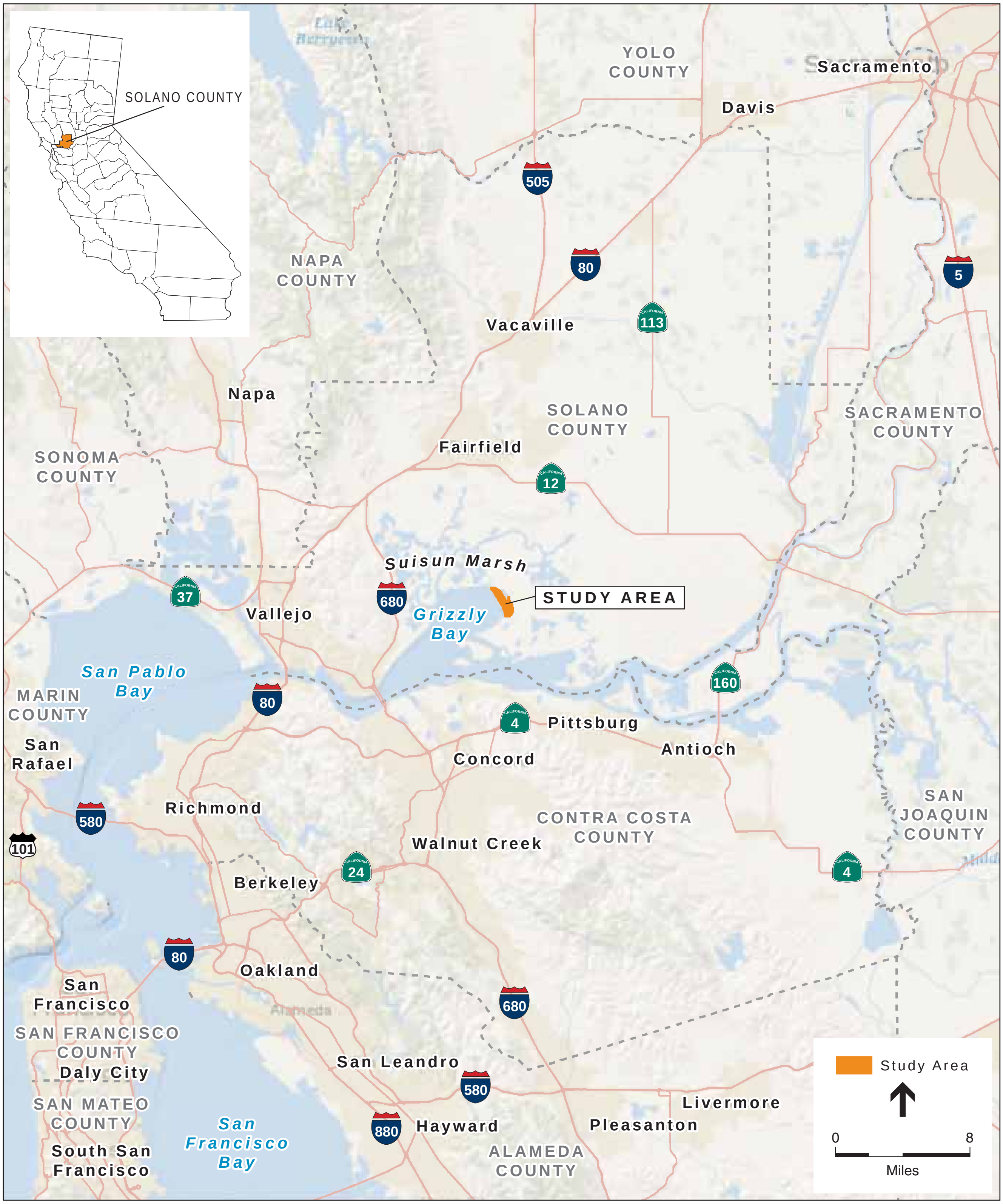

SOURCE: ESRI

Tule Red Restoration Project . 150158

Figure 1
Regional Locator

SOURCE: NAIP, 2014 (May); ESA, 2015

Tule Red Restoration Project . 150158

Figure 2
Managed Marsh Survey Area

Appendix F
Memorandum Regarding California Clapper Rail, California Black Rail, and California Least Tern

Memorandum

To: Nicole Williams, ICF
Priya Finnemore, ESA

From: Matt Gause, WES (mgause@westervelt.com)

cc: Rob Capriola, WES
Kim Erickson, WES

Date: August 26, 2015

Subject: Tule Red: California clapper rail, California black rail, and California least tern

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The Suisun Marsh Plan contains various environmental commitments regarding California clapper rail, California black rail, and California least tern. WES has been conducting field work and surveys at the Tule Red project site since purchase of the property in 2010. Numerous bird species have been observed incidental to other work; however, no California clapper rail, California black rail, or California least tern have been observed during field work conducted the last 5 years. WES has not conducted any surveys for these species following CDFW protocol; however, we do not believe these species are present at the project site for the following reasons; therefore, surveys should not be necessary to document species absence.

California Clapper Rail and California Black Rail

1. The following information about California clapper rail and California black rail is found Section 6.3, Wildlife, in the Suisun Marsh Plan.

> California clapper rails occur in tidal saline and brackish sloughs and tidal wetlands (U.S. Fish and Wildlife Service 1984) typically dominated by pickleweed and other halophytic species. Clapper rails are most often found in larger marshes and close to other large marshes and prefer marshes with established vegetative cover. Habitat that has direct tidal circulation, abundant high marsh cover, and an intricate network of tidal sloughs that provide abundant invertebrate populations is preferred. Other factors that affect rail use of tidal wetlands are inundation regime, access to high ground refugia, salinity, and vegetation communities (Conceptual Model 2010).
>
> In the study area, the California clapper rail historically has been restricted to the western, more saline portions of Suisun Marsh. The intertidal zone may provide marginal foraging habitat for California clapper rail. The low and middle tidal wetland zones may be used for foraging and refugial habitat. High tidal wetland zones provide optimal foraging, refugial, and nesting habitat. The upland transition

zone provides escape cover from high tides (Conceptual Model 2010). Nests are located in dense wetland vegetation and are constructed off the ground and above the high tide elevation. The nests typically are constructed of cordgrass or other vegetation and are capped with vegetation (Lewis and Garrison1983).

California black rails occur along tidal sloughs, brackish marsh, and tidal wetlands and typically occur in marshes dominated by pickleweed or low-growing forms of bulrush (Manolis 1978). California black rails are associated with habitat features representative of mature, well-developed marshes. Black rails most often are found in larger marshes and close to other large marshes.

California black rails require high marshes with moist soil and shallow water. Other factors that affect black rail use of tidal wetlands are inundation regime and marsh geomorphology, stable water levels that seldom flood, dense stands of low growing vegetation, and access to high-ground refugia (Conceptual Model 2010).

Diked marshes do not appear to provide suitable breeding habitat, possibly because they have lower food resource levels than tidal wetlands (Manolis 1978). California black rail nests are located in the high marsh zone and occasionally the upper limits of the middle marsh zone above the limits of tidal inundation. Nests are constructed of loosely placed vegetation concealed in dense marsh vegetation.

2. Figure 15 of the Suisun Marsh Plan identifies levees affected by California clapper rail restrictions. None of the levees on the project site or near the project site are identified as being affected by restrictions.

Based on our years of experience at the site, and our review of the California clapper rail and California black rail habitat needs, we do not believe protocol level surveys are required for the following reasons:

1. Our site is managed marsh with no direct tidal circulation and no network of tidal sloughs.
2. Our site is actively managed throughout the year. Water levels are managed at a constant level throughout the fall and winter of each year. Water levels are drawn down beginning in early February, and the marsh plain soils and vegetation will begin to dry out at the beginning of summer. Various portions of the site are mowed and disced every year in the summer and early fall.
3. Our site is on the east side of Grizzly Bay while the Suisun Marsh Plan states that California clapper rail historically has been restricted to the western, more saline portions of Suisun Marsh.

California Least Tern

1. The following information about California least tern is found Section 6.3, Wildlife, in the Suisun Marsh Plan.

(California least tern) nests consist of shallow scrapes in sand or fine substrate gravel with sparse vegetation near open water along coastal beaches and estuaries (U.S. Fish and Wildlife Service 1985).

Based on our years of experience at the site, and our review of the California least tern habitat needs, we do not believe surveys are required for the following reasons:

1. Our site is managed marsh. Although we do have sparse vegetation, we do not have any sandy areas or areas with fine gravel substrate.

2. As stated above, our site is actively managed throughout the year. Water levels are managed at a constant level throughout the fall and winter of each year. Water levels are drawn down beginning in early February, and the marsh plain soils and vegetation will begin to dry out at the beginning of summer. Various portions of the site are mowed and disced every year from July to September.

Please do not hesitate to contact me if you have any questions. I can be reached at mgause@westervelt.com or (916) 216-7953.

Appendix G
Bat Habitat Assessment Technical Memorandum

Memorandum

Date:	January 20, 2016
To:	Rob Capriola, Project Manager, Westervelt Ecological Services *Via email*
Cc:	Nicole Williams, Senior Environmental Planner
From:	Leila Harris Wildlife Biologist, ICF International
Subject:	**Results of bat habitat assessment for five buildings scheduled for demolition on Tule Red Tidal Restoration Project**

Introduction

This memo describes the results of a bat habitat assessment conducted to provide baseline information for the Tule Red Tidal Restoration Project (proposed project). This assessment evaluated the nature of potential bat habitat available in and around five buildings that are scheduled for demolition under the proposed project. This assessment was a single, daytime visit and took place in January, outside the usual active season for bats.

The study area comprises the five buildings of the Tule Red Duck Club. The buildings include one main clubhouse, an attached trailer in which the caretaker resides, and three outbuildings including a workshop, a boot shed, and a plucking shed. A figure of the buildings, generated by cultural resource review, is available in Appendix H, *Cultural Resources Report*.

Methods

Prior to the field visit, Ms. Harris reviewed California Natural Diversity Database (CNDDB) records to determine the existing level of knowledge regarding bat occurrence in the area, and examined aerial maps to obtain an overview of the surrounding habitat.

On January 7, 2016, ICF wildlife biologist Leila Harris visited the study area to determine the types of habitat available to bats and examine potential habitat for bat sign. The visit started at 13:45 and concluded at 17:30, approximately 30 minutes after sunset. The temperature was 58.4 degrees Fahrenheit at the start of the survey and 51.0 degrees Fahrenheit at the end. Skies were clear with less than 15% cloud cover and no precipitation. The air was still with occasional light breeze.

Ms. Harris assessed the interior and exterior of each building (except the interior of the caretaker's trailer and the small locked interior space within the workshop) using naked eye and/or binoculars, as appropriate, and a high powered flashlight to view interior spaces of crevices and cavities. Ms. Harris used a pole-mounted inspection mirror to look inside bird nests where accessible. Ms. Harris identified the types of potential roost structures present and where visual assessment was possible, searched for indications of bat use, including guano, staining, prey remains, bat carcasses and the presence of any live bats that might be overwintering in the study area.

During the last half hour of the survey visit, Ms. Harris operated a full spectrum bat detector and display software (miniMIC detector and SPECT'R software, Binary Acoustic Technology LLC, Tucson, Arizona) on a PC (Dell Precision M6800) to view the ultrasonic soundscape above the deck of the main clubhouse. Under ideal conditions, the miniMIC has a maximum bat detection range of 140 feet.

Results

Summary

Neither bat sign nor bats were observed during the habitat assessment. The structures available create plentiful moderate quality crevice and cavity habitat. Not all potential habitat was accessible for inspection. However, where visual examination was possible in and under the potential habitat, no guano or other sign of colonial bat activity was detected.

The focus of this visit was a roost habitat assessment, not an acoustic activity survey. Given the season, temperatures, and short duration of the acoustic detector deployment, no bat activity was expected during the 30-minute post-sunset acoustic observation. No bats were seen flying at or around sunset and no bat echolocation calls were detected. Various bat species are able to fly at temperatures significantly lower than those that occurred during the survey. However, temperatures were not ideal for bat activity, and a full-scale acoustic bat emergence survey to capture species that tend to emerge long after sunset would be of much longer duration and would occur on multiple nights to capture the sporadic activity patterns of overwintering bats.

Relevant Life History

Bats generally seek day roost locations that are protected from predators and provide appropriate temperatures for the physiological needs of the bat. These physiological needs change with season and with the reproductive status of the individual bat, leading to potential seasonal changes in roost site selection. For example, a cooler roost that is ideal for hibernation or a summertime bachelor male may not provide the temperatures needed for a heat-loving maternity colony with newborn pups.

Night roosts are sites where bats spend part of the night in between foraging bouts; these areas are often less protected from predators and the elements than day roosts, and less restricted to certain structural characteristics. They serve an important metabolic role in providing a sheltered location near foraging grounds where bats can rest and consume and digest their prey.

Different species of bats tend to be associated with different physical roost characteristics, with some species associated almost solely with cracks and crevices, others with cavern-like spaces and still others with tree foliage. Some species are flexible in their roost choices and have been found roosting both in crevices and in open cavern-like spaces. During seasonal movements, such as fall migration, bats may be found in atypical roost locations or habitats.

Vertical surfaces in close proximity to bat roosts often become peppered with guano. The surfaces directly associated with a colonial roost will often become stained with urine and body oils after long term use, and guano can build up beneath the roost location if the area is otherwise undisturbed. Invertebrate prey remains can build up under and around features used as night roosts. If there were significant, long term, colonial bat activity associated with the buildings during the active season, it would be reasonable to expect some sign of bat activity remaining in undisturbed areas. Large colonies are generally easier to detect than scattered individuals, and active bats leave more sign and tend to be easier to detect than torpid or hibernating bats.

Structural characteristics provide one aspect of bat roost habitat; temperature is another key element that is in this case, unknown. It may be that temperatures in the available roost spaces are not conducive to colonial activity in the active season. Finally, level of disturbance may also effect whether bats take up residence, and if so, which species may be present. With a caretaker on site and evidence of some level of cleaning, maintenance and activity in all buildings, the existing level of disturbance may reduce the suitability of the available roost spaces.

Bat Occurrence at Grizzly Island

The habitat surrounding the buildings is predominantly wetland, and as such could provide suitable foraging habitat for a range of bat species. The scattered trees and structures on Grizzly Island could provide day and night roost habitat for all bat species known to occur in the region.

Species confirmed to occur on Grizzly Island include the foliage-roosting western red bat (*Lasiurus blossevillii)*, for which there are both breeding and acoustic records (Pierson et al. 2006: 11; CDFW 2015) and the crevice-roosting Mexican free-tailed bat (*Tadarida brasiliensis mexicanus)*, for which there are acoustic records (Pierson et al. 2006: 35). Both species were documented during the summer. Western red bat roosts in trees and would not be expected to day roost in or on the buildings. However, Mexican free-tailed bat is often found in human structures.

The caretaker who resides on site informed Ms. Harris that he had seen only one bat in 20 years. This observation was of a dead bat of unknown species. The caretaker did not remember the time of year at which he found the bat.

Given the presence of potentially suitable habitat, and that the proposed project is within the range of many of northern California's bat species, a wider variety of species than the two confirmed in the Pierson et al. report could be expected in the study area. For general reference, Table 1 provides a list of all Northern California bat species whose ranges overlap the study area, and their associated roosting behaviors. Not all of these northern California species would be expected to occur in the Suisun Marsh, and fewer still would be expected to roost in buildings. Cliff- and tree-roosting species can be ruled out as highly unlikely, as could those species that tend to prefer xeric environments or higher elevations. Table 1 identifies those species with reasonable potential to roost in buildings in the study area at some point during the year, whether long term or as a stopover roost during seasonal movements. Given the lack of bat occurrence data specific to the study area, knowledge of bat natural history and species' ranges is used to assume potential presence in the structures.

Detailed Site Assessment Results

For all buildings, potential crevice habitat exists on both the interior and exterior of the surfaces, formed by a wide variety of structural elements, e.g., external siding, spaces formed where items are attached to vertical surfaces, and gaps between overlapping wooden beams. Potential cavity or cavern-like habitat exists in the open spaces of the buildings, particularly along ceiling beams and in corners, in open closets and above storage shelves. Additional habitat where bats might be found roosting include furnishings of the main clubhouse (within curtain folds, behind picture frames), inverted waders hanging in the boot shed, bird nests attached to all buildings, and piles of debris or other stored items both inside and outside the buildings. A space of unknown dimensions is present in what would be the attic of the clubhouse. External access to the space appeared to be possible through an unscreened slatted vent above the deck on the end of the structure.

The exterior of all buildings, and the interior of the open workshop space support bird nests, mostly the mud nests of cliff swallow (*Petrochelidon pyrrhonota*) but also likely barn swallow (*Hirundo rustica)* and black phoebe (*Sayornis nigricans*). At least three common species of bat have been found roosting in cliff swallow nests and the nests of other mud nest-building species: Mexican free-tailed bat; Yuma myotis, *Myotis yumanensis*; and big brown bat, *Eptesicus fuscus*.

The plucking shed is small and has large windows, leading to a relatively well-lit and likely thermally unstable interior, both of which may make it less desirable as a day roost. While the building appears structurally suitable for a night roost, typical signs of night roosting (guano and prey remains) were absent. The building is situated on a wooden platform over a slough. While space under the building may allow for bat roosting, it would be relatively bright during the day, and the fluctuating water levels would make this roost site unreliable. Several intact cliff swallow nests are attached to the waterside of the building, near the roof line. These nests could house small numbers of bats, though none were seen in the two nests Ms. Harris was able to view with the pole-mounted mirror.

The clubhouse is furnished and appears to be relatively well sealed. If windows were left open or other entryways were made into the building, multiple roost locations exist for crevice and cavity roosting bats. Exterior surfaces of the building contain numerous locations where individual bats could roost, such as between wooden decorative elements and outside walls, in debris piles, under loose siding material and in recessed areas or crevices formed by the deck structure and the clubhouse walls,

The boot shed contains several shelves and stored items that create limited cavity and crevice-like structures. The thermal profile of this small building may be inappropriate for maternal colonies, but use by individual roosting bats is possible.

The workshop has a high interior ceiling and appears to be left open to external access, judging from a mud nest present on the interior ceiling beam. The high ceiling could provide suitable habitat for cavern-roosting species if summer temperatures were appropriate. However, the space appears to be heavily used for storage and maintenance tasks (and therefore subject to regular disturbance). One exterior wall appears to have loosened shingles and could provide crevice habitat to single or small numbers of bats. This area could not be approached for close inspection under the shingles due to the debris piles abutting the wall.

In buildings where bats have taken up residence, whether as a night roost or an active season day roost, there is typically guano evident on floors, ledges, and particularly, on vertical surfaces. No guano was detected on any of these walls or surfaces. No staining was visible in the ceiling corners, closet corners or along crossbeams. Animal and arthropod sign was present in and on all buildings. Throughout all buildings, to varying degrees, rodent scat and spider activity were evident. Where there were bird nests, or imprints from past bird nests, there was copious associated staining. The decayed body of one unidentified rodent was in the wood stove in the living room of the main club house. Insect and arthropod remains were present in association with spider activity and the invertebrate die-offs common along windowsills. No insect and arthropod prey remains were detected that appeared consistent with day or night roosting bats. Rodent scat of at least two species was visible along the base of walls, in corners of rooms and corners of shelving.

Discussion and Limitations

The amount of material attached to surfaces and stored in and around the buildings impeded physical access to spaces below some of the potential roost structures and obscured visibility into some potential roost spaces. In examining accessible habitat similar to the obstructed areas, however, Ms. Harris detected no bats or bat sign.

Based on this habitat assessment, if bats are present, the most likely use of the site would be occasional use by scattered or isolated, non-reproductive individuals. Any number of species could be present. Individual bats roosting in or behind debris or stored items could easily remain undetected given the significant quantity of this type of material present.

The habitat assessment was conducted outside of the active season (broadly defined for the purpose of this document as spring, summer and fall) and outside the maternity season (approximately May 1 to September 15) and as such, it is impossible to confidently predict complete absence of bats without completing additional surveys during other seasons. If there were significant, long term, colonial bat activity associated with the buildings during the maternity season, it would be reasonable to expect that some sign of bat activity would remain if the areas under and around the roost(s) were undisturbed. However, scattered bats could be present in open spaces or crevices during migration. Individual, non-reproductive bats could be present during the summer. In both scenarios, these bats might leave little detectable sign.

Table 1. Northern California Bat Species by Roost Behavior

Scientific Name	Common Name	State Status[1]	Potential Use of Structures in Study Area (based on known habitat and roost associations)
Multiple Habitat Species[2]			
Antrozous pallidus	pallid bat	SSC	Potential use
Eptesicus fuscus	big brown bat		Potential use
Myotis californicus	California myotis		Potential use
Myotis ciliolabrum	western small-footed myotis		Unlikely
Myotis evotis	long-eared myotis		Unlikely
Myotis lucifugus	little brown myotis		Potential use
Myotis thysanodes	fringed myotis		Unlikely
Myotis volans	long-legged myotis		Unlikely
Myotis yumanensis	Yuma myotis		Potential use; likely
Tadarida brasiliensis	Mexican free-tailed bat		Potential use; likely
Tree-roosting species[3]			
Lasiurus blossevillii	western red bat	SSC	Highly unlikely
Lasiurus cinereus	hoary bat		Highly unlikely
Lasionycteris noctivagans	silver-haired bat		Unlikely
Cliff-roosting species[4]			
Euderma maculatum	spotted bat	SSC	Highly unlikely
Eumops perotis	western mastiff bat	SSC	Highly unlikely
Parastrellus hesperus	canyon bat		Highly unlikely
Cavern-roosting species[5]			
Corynorhinus townsendii	Townsend's big-eared bat	CESA Candidate	Potential use

Table Notes:

Roost categories from WBWG 2007 Available at: <http://wbwg.org/matrices/species-matrix/> Accessed on: January 15, 2016.

[1]SSC is Species of Special Concern (CDFW status); CESA is California Endangered Species Act. Species designated as Candidate species under CESA are under formal review for listing, during which time they received the same legal protections as if they were a fully listed species.

[2]"Multiple habitat" species are more plastic in their roost selection and have been found in a variety of roost structures, both anthropogenic (human-made) and natural. Many of these species have been found roosting both out in the open in cavern-like spaces and in narrow crevices.

[3]"Tree" species, also called migratory tree bats, are entirely or almost entirely dependent on trees for their dominant roost sites. The lasiurine bats typically roost in foliage. Silver-haired bat is associated with forests during maternity season, where their roosts are predominantly in tree hollows. This species has been found in a broader selection of roost sites during seasonal movements and during the winter, and has been found in buildings on occasion.

[4]"Cliff" species are generally found in crevices and other formations in rock, with western mastiff and spotted bat roosts associated with high cliff walls. Canyon bat does not need the height of cliffs for its roost but it is associated with rocky, often xeric environments.

[5]"Cavern" species are generally found roosting on the ceiling or wall of a cavern-like space, such as caves, abandoned mines, rooms and attics in buildings and open spaces in other anthropogenic structures. Townsend's big-eared bat life stages may include both colonial and solitary roosting behavior, depending on sex, age and reproductive status. They are not associated with crevice roosts.

Representative Photographs

Figure 1 contains representative photographs of the type of potential roosting habitat available.

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Western Bat Working Group (WBWG). 2007. Western bat species regional priority matrix. Available online: http://wbwg.org/matrices/species-matrix/. Accessed January 15, 2016.

Figure 1. Representative photos of potential habitat features and limitations.

A. <u>Main clubhouse</u>

1. Possible access to interior ventilation space. No internal survey possible. No external sign. Underside of deck and storage bays create a variety of crevice and open night roost habitat formed by wooden beams, deck structure, walls, piles of stored material, structures affixed to vertical and horizontal surfaces.

2. One example of area inaccessible to visual inspection. Clubhouse shown. Walls and roof overhangs can create crevice and night roosting habitat.

3. Furnished interior of main clubhouse, second floor. Appears well sealed.

B. <u>Plucking Shed and surrounding habitat.</u>

Interior is exposed to light and likely temperature fluctuations. Night roosting would be possible.

C. Boot Shed

1. Possible internal and external crevice and cavity habitat. Night roosting possible under roof overhang or inside building if access permitted.

Appendix G, Figure 1, Tule Red Restoration Project

2. Interior of boot shed. Crevices available between shelving and walls, join of ceiling and beams could provide roost purchase. No sign on surfaces below these spaces, no guano on walls.

D. Workshop

1. External crevice habitat and roof overhang. Extent of stored material limits access for complete visual inspection of structure. Stored material in and around buildings can shelter a variety of wildlife. Bat use of material piles not anticipated to be significant.

2. Interior workshop space. Internal cavity space at ceiling beams and corners, mud nest indicates access to interior. Staining possibly from water damage.

3. Loose shingles and other overlapping wooden structures create crevices. Flight path may be somewhat obstructed. Roof overhangs provide possible night roost habitat. Material piles limit visual inspection.

Appendix H
Cultural Resources Report

DETERMINATION OF ELIGIBILITY AND EFFECT FOR THE PROPOSED TULE RED TIDAL RESTORATION PROJECT, SOLANO COUNTY, CALIFORNIA

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(Job #15-032)

INTRODUCTION

The Tule Red Tidal Restoration Project is intended to restore tidal wetlands in the Suisun Marsh to directly benefit federally- and state-listed Delta smelt, longfin smelt, and salmonids by introducing full daily tidal exchange to an existing managed marsh duck club owned by Westervelt Ecological Services, and to a portion of the Grizzly Island Wildlife Area (Wildlife Area) which is owned and operated by the California Department of Fish and Wildlife (CDFW).

The Project site is located on Grizzly Island in the Suisun Marsh, in an unincorporated portion of Solano County, California. The Project site is on the eastern shoreline of Grizzly Bay, immediately adjacent to the Grizzly Island Unit of the Wildlife Area.

The area proposed to be restored to tidal influence is comprised of a crescent of land roughly 1,500 feet wide and 8,000 feet long, totaling approximately 420 acres of managed marsh habitat currently maintained as a duck club. The vast majority of the site is managed marsh, with a small amount of tidal marsh at the northern end and along the bay side margin of a natural berm. Upland habitat is along the uppermost slopes and tops of the levees along the eastern edge of the Project site. The Area of Potential Effect (APE) for the project is depicted on Map 1.

The proposed Project would restore managed marsh habitat that is currently used for duck hunting to tidal wetlands by grading and recontouring a portion of the site to create tidal channels, tidal pannes/basins, and a habitat berm; permanently breaching the existing natural berm to reintroduce full daily tidal exchange to the site; and increasing topographic variability and habitat diversity across the site.

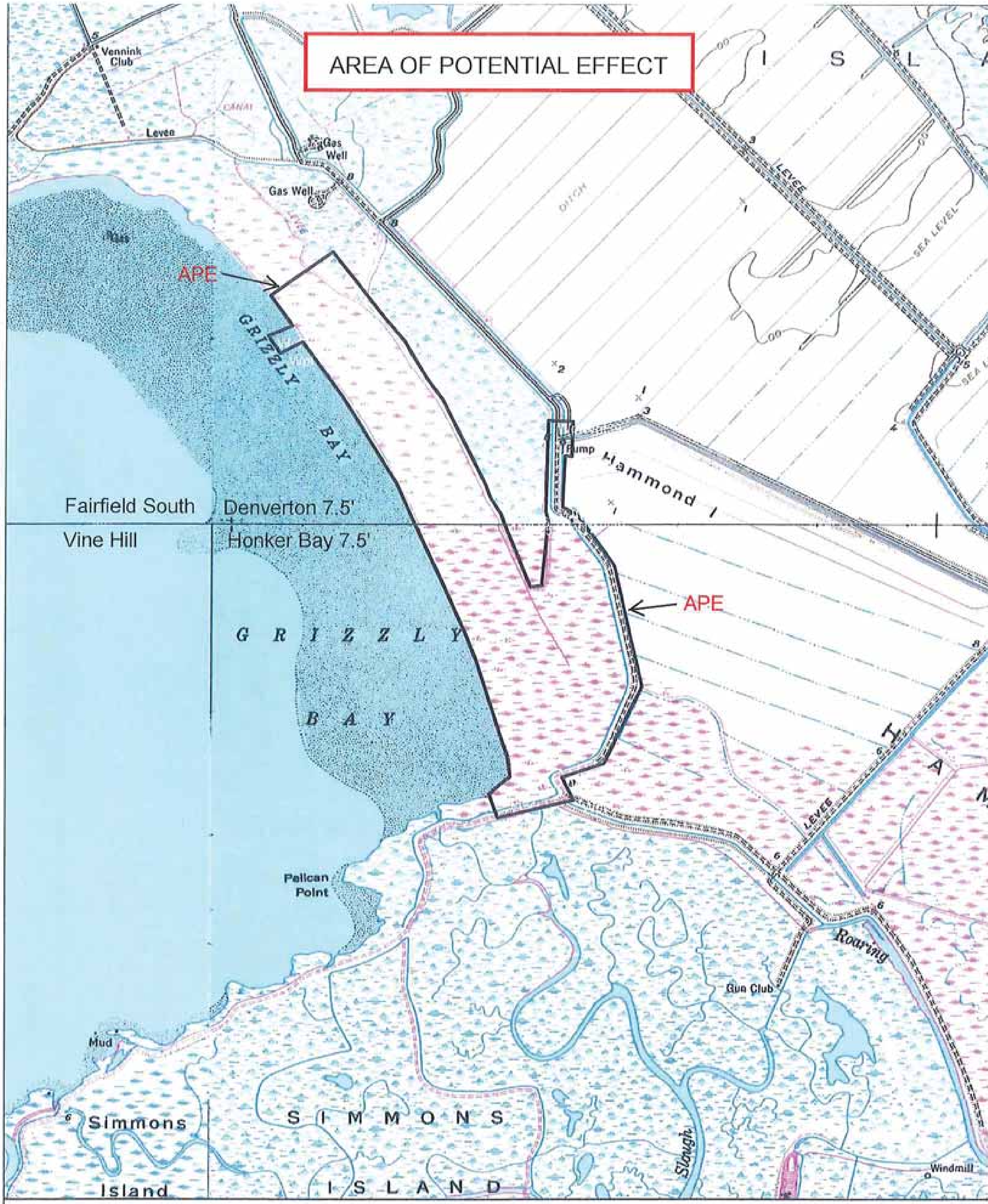
The project would commence in the summer of 2016, and is expected to take 2-3 construction seasons (summers) to complete, including a 1-2 year period of site stabilization (including re-vegetation) between grading/recontouring activities (Phase 1) and full tidal exposure (Phase 2). The Project is being designed to become a naturally, self-regulating system that would not require extensive management or intervention.

This report is concerned with the cultural resources evaluation that was conducted as part of Project. Melinda A. Peak served as the Principal Investigator for the study, with Robert Gerry, Senior Archeologist, leading the field survey team (resumes, Appendix 1).

FEDERAL REGULATORY ENVIRONMENT

The Section 106 review process is implemented using a five step procedure: 1) identification and evaluation of historic properties; 2) assessment of the effects of the undertaking on properties that are eligible for the National Register; 3) consultation with the State Historic Preservation Office (SHPO) and other agencies for the development of a memorandum of agreement (MOA) that addresses the treatment of historic properties; 4) receipt of Advisory Council on Historic Preservation comments on the MOA or results of consultation; and 5) the project implementation according to the conditions of the MOA.

The Section 106 compliance process may not consist of all the steps above, depending on the situation. For example, if identification and evaluation result in the documented conclusion that no properties included in or eligible for inclusion are present, the process ends with the identification and evaluation step.



Name: HONKER BAY
Date: 8/28/2015
Scale: 1 inch equals 2000 feet

Location: 10 589110 E 4219580 N
Caption: Tule Red Tidal Restoration Project
Area of Potential Effect

MAP 1

Decisions regarding management of cultural resources hinge on determinations of their significance (36 CFR 60.2). As part of this decision-making process the National Park Service has identified components which must be considered in the evaluation process, including:

- criteria for significance;
- historic context; and
- integrity.

Criteria for Significance

Significance of cultural resources is measured against the National Register of Historic Places (NRHP) criteria for evaluation:

The quality of significance in American history, architecture, archeology, engineering, and culture is present in districts, sites, buildings, structures, and objects that possess integrity of location, design, setting, materials, workmanship, feeling, and association, and,

(a) that are associated with events that have made a significant contribution to the broad patterns of our history; or

(b) that are associated with the lives of persons significant in our past; or

(c) that embody the distinctive characteristics of a type, period, or method of construction, or that represent the work of a master, or that possess high artistic values, or that represent a significant and distinguishable entity whose components may lack individual distinction; or

(d) that have yielded, or may be likely to yield, information important in prehistory or history (36 CFR 60.4).

Historic Context

The historic context is a narrative statement "that groups information about a series of historic properties based on a shared theme, specific time period, and geographical area." To evaluate resources in accordance with federal guidelines, these sites must be examined to determine whether they are examples of a defined "property type." The property type is a "grouping of individual properties based on shared physical or associative characteristics." Through this evaluation, each site is viewed as a representative of a class of similar properties rather than as a unique phenomenon.

A well-developed historical context helps determine the association between property types and broad patterns of American history. Once this linkage is established, each resource's potential to address specific research issues can be explicated.

Integrity

For a property to be eligible for listing in the National Register it must meet one of the criteria for significance (36 CFR 60.4 [a, b, c, or d]) and retain integrity. Integrity is defined as "the authenticity of a property's historic identity, evidenced by the survival of physical characteristics that existed during the property's historic or prehistoric period."

The following discussion is derived from National Register Bulletin 15 ("How to Apply the National Register Criteria for Evaluation").

Within the concept of integrity, there are seven aspects or qualities that define integrity in various combinations. The seven aspects are: location, design, setting, materials, workmanship, feeling, and association. To retain historic integrity, a property will possess several or usually most of these aspects. The retention of specific aspects is necessary for a property to convey this significance. Determining which of the seven aspects are important involves knowing why, where and when the property is significant.

The prescribed steps in assessing integrity are as follows:

- define the essential physical features that must be present for a property to represent its significance;

- determine whether the essential physical features are visible enough to convey their significance;

- determine whether the property needs to be compared with similar properties; and,

- determine, based on the significance and essential physical features, which aspects of integrity are particularly vital to the property being nominated and if they are present.

Ultimately, the question of integrity is answered by whether or not the property retains the identity for which it is significant.

All properties change over time. It is not necessary for a property to retain all its historic physical features or characteristics. However, the property must retain the essential physical features that enable it to convey its historic identity. The essential physical features are those features that define why a property is significant.

A property's historic significance depends on certain aspects of integrity. Determining which of the aspects is most important to a particular property requires an understanding of the property's significance and its essential physical features. For example, a property's historic significance can be related to its association with an important event, historical pattern or person. A property that is significant for its historic association is eligible for listing if it retains the essential physical features that made up its character or appearance during the period of its association with the important event, historical pattern, or person.

A property important for association with an event, historical pattern, or person ideally might retain some features of all seven aspects of integrity. Integrity of design and workmanship, however, might not be as important to the significance, and would not be relevant if the property were an archeological site. A basic integrity test for a property associated with an important event or person is whether a historical contemporary would recognize the property as it exists today. For archeological sites that are eligible under Criteria A and B, the seven aspects of integrity can be applied in much the same way as they are to buildings, structures, or objects.

In sum, the assessment of a resource's National Register eligibility hinges on meeting two conditions:

- o the site must possess the potential to be eligible for listing in the National Register under one of the evaluation criteria either individually or as a contributing element of a district based on the historic context that is established; and

- o the site must possess sufficient integrity, i.e. it must retain the qualities that make it eligible for the National Register.

For the National Register, "a district possesses a significant concentration, linkage, or continuity of. objects united historically or aesthetically by plan or physical development." The identity of a district derives from the relationship of its resources, which can be an arrangement of functionally related properties.

STATE REGULATORY ENVIRONMENT

State historic preservation regulations affecting this project include the statutes and guidelines contained in the California Environmental Quality Act (CEQA; Public Resources Code sections21083.2 and 21084.1 and sections 15064.5 and 15126.4 (b) of the CEQA Guidelines). CEQA Section 15064.5 requires that lead agencies determine whether projects may have a significant effect on archaeological and historical resources. Public Resources Code Section 21098.1 further cites: A project that may cause a substantial adverse change in the significance of an historical resource is a project that may have a significant effect on the environment.

An "historical resource" includes, but is not limited to, any object, building, structure, site, area, place, record or manuscript that is historically or archaeologically significant (Public Resources Code section 5020.1).

Advice on procedures to identify such resources, evaluate their importance, and estimate potential effects is given in several agency publications such as the series produced by the Governor's Office of Planning and Research (OPR), *CEQA and Archaeological Resources,*1994. The technical advice series produced by OPR strongly recommends that Native American concerns and the concerns of other interested persons and corporate entities, including, but not limited to, museums, historical commissions, associations and societies be solicited as part of the process of cultural resources inventory. In addition, California law protects Native American burials, skeletal remains, and associated grave goods regardless of the antiquity and provides for the sensitive treatment and disposition of those remains (California Health and Safety Code Section 7050.5, California Public Resources Codes Sections 5097.94 et al).

California Register of Historical Resources (Public Resources Code Section 5020 et seq.)

The State Historic Preservation Office (SHPO) maintains the California Register of Historical Resources (CRHR). Properties listed, or formally designated as eligible for listing, on the National Register of Historic Places are automatically listed on the CRHR, as are State Landmarks and Points of Interest. The CRHR also includes properties designated under local ordinances or identified through local historical resource surveys.

For the purposes of CEQA, an historical resource is a resource listed in, or determined eligible for listing in the California Register of Historical Resources. When a project will impact a site, it needs to be determined whether the site is an historical resource. The criteria are set forth in Section 15064.5(a)(3) of the CEQA Guidelines, and are defined as any resource that does any of the following:

A. Is associated with events that have made a significant contribution to the broad patterns of California's history and cultural heritage;

B. Is associated with the lives of persons important in our past;

C. Embodies the distinctive characteristics of a type, period, region, or method of construction, or represents the work of an important creative individual, or possesses high artistic values; or

D. Has yielded, or may be likely to yield, information important in prehistory or history.

In addition, the CEQA Guidelines, Section 15064.5(a)(4) states:

> The fact that a resource is not listed in, or determined to be eligible for listing in the California Register of Historical Resources, not included in a local register of historical resources (pursuant to section 5020.1(k) of the Public Resources Code), or identified in an historical resources survey (meeting the criteria in section 5024.1(g) of the Public Resources Code) does not preclude a lead agency from determining that the resource may be an historical resource as defined in Public Resources Code section 5020.1(j) or 5024.1.

California Health and Safety Code Sections 7050.5, 7051, And 7054

These sections collectively address the illegality of interference with human burial remains, as well as the disposition of Native American burials in archaeological sites. The law protects such remains from disturbance, vandalism, or inadvertent destruction, and establishes procedures to be implemented if Native American skeletal remains are discovered during construction of aproject, including the treatment of remains prior to, during, and after evaluation, and reburial procedures.

California Public Resources Code Section 15064.5(e)

This law addresses the disposition of Native American burials in archaeological sites and protects such remains from disturbance, vandalism, or inadvertent destruction. The section establishes procedures to be implemented if Native American skeletal remains are discovered during construction of a project and establishes the Native American Heritage Commission as the entity responsible to resolve disputes regarding the disposition of such remains.

CULTURAL HISTORY

Prehistory

Dissatisfaction with the Central California Taxonomic System, with its emphasis on widespread and presumed more-or-less coeval cultural developments, led to the now familiar system employing the terms pattern, phase, aspect, facies and other designations for related cultural expressions. The main thrust has been to recognize that certain widespread cultural developments exist, but these do not have to occur at the same time in all geographic areas or be expressed in the same way. The North Coast and northern Bay Areas were among the first to use this system (Fredrickson 1973) and accumulated archeological knowledge in this area has been reflected in development of the integrative system (Fredrickson 1984, Milliken *et al.* 2007).

At the same time detailed studies of shell bead types by Bennyhoff resulted in adjustments to previously accepted chronologies. Again, much of the change in chronological systems has involved local inception of a more widely seen pattern or aspect. This chronology based on bead typology has also seen refinements and revisions (Bennyhoff and Hughes 1984, Elsasser 1978, Groza 2002).

In the 1990s, the extensive studies and numerous reports resulting from the Los Vaqueros Reservoir Project have provided a much better understanding of archeological succession in the region than is available in most areas of California. Since this is also relevant to the current project area, a recent summary by Milliken et al. (2007) is paraphrased here.

It is presumed that the early period of prehistory reflected a material culture and way of life similar to the Borax Lake Pattern, although no good examples of this cultural expression are known in the region. If this assumption is correct, then the way of life of the earliest occupants would have been a forager strategy based on considerable population movement, probably in an annual cycle. Other interpretations are possible, however, since no sites in the area are securely dated to the period before 8,000 BC.

In the Early Holocene (or Lower Archaic) dated to 3,500 to 8,000 BC, appears to involve a generalized forager settlement pattern. This involves a great deal of mobility within a circumscribed range and exploitation of whatever foods are available. Few components of this age are known in the region, so there is relatively little detail available.

The Early Period (Middle Archaic) is dated to 500 to 3,500 BC. This marks the introduction of cut bead technology, which will be increasingly important in the economy through the rest of regional prehistory. This marks a more sedentary settlement pattern also marked by a burial pattern with ornaments as grave goods, increased trade volume and the development of large shells mounds along the bay margins.

The Lower Middle Period (Initial Upper Archaic), 500 BC to AD 430, is marked by a rather sudden shift in favored bead types. Rectangular *Olivella* beads, common over a wide area in the Early Period, disappeared altogether.

The Upper Middle Period (Late Upper Archaic), AD 430 to 1,050, another sudden and widespread change in bead typology occurred. This probably represents a collapse of the trade network established in the previous period. Many of the sites occupied in the previous period are abandoned and a new burial pattern, the Meganos complex, spreads through the East Bay region.

The Initial Late Period (Lower Emergent) is essentially an intensification of the previous period. From AD 1,050 to 1,550 the degree of complexity and artistry shown in wealth items increases, there appear to be separate burial modes for wealthy individuals in some areas and, in general, status ascription is more obvious in the archeological record

The Terminal Late Period sees a collapse in the characteristics of the cultural climax achieved in the Initial Late Period. The reasons for this are not clear. Population growth pressure, mass population movement, and diseases spreading north from the Spanish contacts farther south, have all been blamed. In any event, prehistoric society in the region was beginning to develop in new ways when the Spanish arrived.

Ethnography

Patwin territory extended approximately 90 miles north to south and 40 miles east to west along on the western side of the Sacramento River. Distinction is made between the River Patwin, who resided in large villages near the Sacramento River, especially between Colusa and Knights Landing, and the Hill Patwin, whose villages were situated in the small valleys along the lower hills of the Vaca Mountains and Coast Range, with concentrations in Long, Indian, Bear, Capay, Cortina and Napa valleys (Johnson 1978:350; Powers 1877:218). The term "Patwin" refers to the people belonging to the many small contiguous independent political entities in this area who shared linguistic and cultural similarities.

Politically, the Patwin were organized in small tribes or tribelets, each consisting of a primary village with satellite villages. Tribelets were autonomous and differed from other such units in minor cultural variations. Dialects might encompass several tribelets. Territories were vaguely defined, but included fishing and gathering areas used by the group. In each village, the leader or chief was in charge of subsistence ventures, such as hunting or gathering, and presided over ceremonies. Social and economic activities were divided among families within a village, with certain families responsible for different specialties such as trapping ducks, collecting salt, making foot drums, or performing particular dances or shamanistic rituals (Johnson 1978:354-355).

Patwin territory includes the riverine environment of tule marshes, vines and brush near the Sacramento River, the flat grasslands dotted with oak groves, and the hills and small valleys of the Coast ranges. The villages situated on low bluffs near the river were often very large; in 1848, General Bidwell estimated at least 1000 residents at *Koru*, near Colusa (Powers 1877:219). In the hills, the Patwin settled in the small valleys, particularly along Cache and Putah creeks, where large populations were reported. The plains were least hospitable; there, villages were sparse because of winter flooding and lack of reliable water sources during the dry months.

> The valley people evidently had their permanent villages on the river itself -- that is, in the marsh belt -- but appear to have left this during the dry half of the year to live on the adjacent plains, mostly by the side of tributaries. The upland people built their winter homes where the streams issue on these creeks, and in summer moved away from the main water courses into the hills or mountains (Kroeber 1925:354).

Within a village, the Patwin constructed earth-covered semi-subterranean structures. The Hill Patwin used a circular floor plan while the River Patwin favored an elliptical shape. Four types of building occurred in a predictable pattern: the ceremonial dance house was placed a short distance to the north or to the south of the village, the sudatory or sweat house was positioned to the east or west of the dance house, and the menstrual hut was built on the edge of the village, farthest from the dance house. Family dwellings could be erected anywhere within the community. Family lodges were built by one's paternal relatives while the other structures were the product of a communal effort. They used readily available materials, forming a framework of saplings, and covering the walls and roof with mud and brush (Johnson 1978:357-358; Powers 1877:220-221).

Natural resources flourished in Patwin territory. They gathered seeds and plant foods and hunted game animals on the plains, shot or netted ducks and other migratory water fowl in the thick tule marshes, and netted salmon and other fish in the rivers and streams. Some of these activities were conducted by groups or families assigned to particular resource areas by a village chief. Acorns were a staple in the Patwin diet. Two types of Valley oak and rarely, live oak acorns, were gathered at communally-owned groves (Johnson 1978:355). Common practice was to store abundant quantities of acorns in tall granaries to assure against hunger in years of poor harvest. Kroeber observed a Patwin granary more than eight feet tall and three feet in diameter (Heizer and Elsasser 1980:99). Women prepared the bitter crop by pulverizing the acorns, then leaching out the bitter tannic acid before making bread or acorn soup. At privately-owned gathering tracts on the plains,

families gathered seeds, including sunflower, alfilaria, clover, bunchgrass, wild oat and yellow-blossom. The Patwin also collected a variety of bulbs, nuts, roots and berries. These included buckeye, pine nuts, juniper berries, manzanita berries, blackberries, wild grapes, brodiaea bulbs, and tule roots. To obtain salt, the Patwin scraped off rocks that were found near Cortina, burned a grass that grew on the plains, or obtained it in trade from the neighboring Pomo (Johnson 1978:355).
King salmon, silver salmon and steelhead trout that run from the ocean to freshwater rivers and streams were an important diet item. Explorers observed Patwin fishing for salmon with a boom net in 1854 (Heizer and Elsasser 1980: Figure 37). The Patwin also caught smaller fish and collected mussels from the river bottom. They attracted wild ducks by setting out realistic decoys, then drove the fowl into large nets stretched above the marshes. Hunters also netted mud hens, geese and quail. The Suisun tribelet pursued waterfowl in tule rafts (Powers 1877:220). The Patwin hunted large game, such as tule elk, deer, antelope and bear, and took many varieties of small animals, reptiles, insects and birds either to eat or to use for ceremonial and practical materials (Johnson 1978:355).

The ceremonial life of the Patwin was centered on the Kuksu cult system, which features one or more secret societies, each with its own dances and rituals. The Kuksu cult occurs among several north central California tribes, but it was more elaborate among the Patwin who possessed three secret societies: the Kuksu, ghost and Hesi types, each with a slightly different purpose. The ghost society stressed initiation, the Kuksu emphasized curing and shamanistic functions, and the Hesi elaborated on ceremonial dance (Johnson 1978:353). In addition to ritual duties, shamans were called upon to heal the sick by applying native medicines or by sucking out the offending spiritual cause of the illness. The Patwin generally buried their dead, although the tribelets furthest south may have cremated the deceased. The Patwin near Colusa bent the body, wrapped it with strings of shell money, and covered it with an animal skin secured with ropes. They interred the corpse with material goods in a grave situated within a village or within 100 yards of a dwelling or dance house (Kroeber 1925:359-361).

History

The first written documentation of this area is in the 1776 logs of Capt. Juan Bautista de Anza. Anza, along with eleven soldiers, six muleteers and numerous servants briefly explored the Suisun Marshlands. In general, the remote location of Suisun Marsh protected the Patwin from some of the effects of the Mexican occupation of California. But disease spreading from the missionized Indians was another matter. At the start of this era, California's native population, according to the most careful and informed estimate, was approximately 310,000 (Cook 1976:43). By the end of this era, California's native population had been reduced to a figure now estimated at between 200,000 and 250,000 (Cook 1976:199),

Suisun Marsh, the largest inland marsh in the continental United States, was a vast acreage of tules, miles of sloughs and many smaller islands surrounding Grizzly Island. A patent given by Gov. William Irwin to William L. Chapman on Jan. 17, 1876, named the area “Grisly Island.” According to local legend, one summer grizzly bears migrated from Mount Diablo, crossing Suisun Bay, which was smaller than it is today, travelled across Van Sickle Island and finally came to “Grisly Island” to feed on the vegetation there. (Goerke-Shrode 2001)

Chapman leased out some areas as hunting rights to market hunters - men who hunted the ducks and geese for the San Francisco market. These men navigated the sloughs of Grizzly Island in various types of craft in search of their meal tickets. It was common in those days to use #4 shot. Unable to shoot that gauge “from the hip,” they rigged their guns to the boats so that the boat absorbed the kick of the gun. It is also said that mules were used for the same purpose - the gun rigged to the mule, which took the brunt of the recoil. (Delaplane 1996a). By 1879, some ranchers had settled in the area. Some of these entrepreneurs carried on the hunting tradition of the island by developing private duck hunting clubs. The first such hunting club to be formed was in 1879.

As early as the 1850s, white settlers came to Grizzly Island and the surrounding area to acquire land for ranching. From the beginning, building and maintaining levees and dredging the sloughs to ensure travel were of paramount importance. Hundreds of Chinese workers were brought in as a work force.

Some of the levees they constructed were made out of tule sod, cut with a tule spade into pieces of approximately 2 feet by 7 inches and then stacked like bricks. Remnants of these levees still can be found in the Suisun Marsh.

One of the larger landowners was W. J. Dutton who began to buy land on Grizzly Island in 1881 from William Chapman and others. Eventually, he owned more than 22,000 acres, which he broke into 21 parcels and leased as 1,000-acre dairy ranches to various Portuguese and Swiss-Italian dairymen.

Dutton's Landing became the center of activity at the turn of the century. Riverboats, paddle wheelers and schooners all stopped here on their way from the San Francisco Bay to Sacramento. Whatever the island produced--milk, cream, cattle, pigs, and grain--was transported from here to the more urban areas. In addition, Dutton's Landing boasted a hotel, warehouses, a slaughterhouse and a nearby creamery.

The Rush family also was well-known in the Grizzly Island area. Hiram Rush, his family and his cattle arrived in the area in 1852 from South Bend, Indiana. Rush purchased land near the Potrero hills, on the outskirts of Grizzly Island and started a cattle and horse ranch, which grew rapidly to encompass more than 5,000 acres.

Hiram's son, Benjamin F. Rush, was born at Fourteen Mile House in Sacramento County on Oct. 12, 1852. Shortly thereafter, the family came to Solano County to settle on the newly purchased Rush Ranch. After a successful career as a cattleman, he took an interest in politics. In 1904, he decided to run for the California State Senate as a Republican, representing the fifth district of Napa and Solano. He won the seat with a landslide victory over his opponent. For the next 24 years, he served as a senator (Goerke-Shrode 2001).

In the 1880s through the 1900s, the industry on Grizzly Island was pretty well given over to dairies. The market hunters who hunted ducks and geese were still in evidence, and hog hunting was a part of the local culture. The latter was deemed a necessary chore by the farmers because these beasts invaded the fields at night.

At one point, clay that was used in constructing roof tiles was mined on the island, which schooners would load up and transport to market. Another successful product for the island was the tule, which was cut and sold to Gladding McBean Pottery Works in Lincoln. The factory used the tules and island's salt grass for packing pottery. By 1900, the landing was a center of activity with a hotel, warehouses and a slaughterhouse.

The ferry was another means of transportation for residents, giving them access to Bird's Landing and Collinsville. The ferry was fairly small and could easily be pulled across the slough by hand.

Before the automobile, the trip to Suisun City was made by gasoline launch, about a two-hour trip. When the automobile came into being, travel was made via the Potrero Hills. This was a time when the island had no roads during winter months, no electricity and no phones.

The dairy business, which had been so lucrative, went into a decline during the Depression. On the other hand, duck hunting was gaining in popularity, so many ranchers took to developing duck clubs, which proved to be prosperous ventures. Today, most of the land that was once used for cattle-raising and raising grains has been turned into duck clubs or is part of a preserve.

The first harbor was constructed in 1938 at Belden's Landing. In 1947, a new harbor was dredged and Belden's expanded with a restaurant and bar. Belden's also had a boat rental business with 100 boats available for anglers and duck hunters.

The Ed Avila clan was the last family to have a dairy on Grizzly Island, but had been shut down in 1947. By 1949, the school was closed due to a lack of attendance, and the few remaining students were bused to Fairfield and Suisun. In 1948, the state of California purchased the land on Grizzly Island and created the Grizzly Island Waterfowl Management area.

In 1950, money was allocated for the Grizzly Island Bridge, and in 1960 the Montezuma Slough Bridge was completed.

The tule elk, extinct in the area since the 1860s, was reintroduced in 1977. Calves were born and the species once again flourishes on this land (Delaplane 1996a).

RESEARCH

A review of literature maintained by the Northwest Information Center (NWIC) of the California Historical Resources Information System at Sonoma State University was conducted by center staff (Appendix 2). The report, File Number 14-1588, indicated that the area had not been surveyed in the past and no resources were known within the project area. There are two recorded properties adjacent to the project area.

P-48-000987, the Grizzly King Duck Club, had been recorded in 2013, during a combined project by Far Western Anthropological Research Group, Inc., Foothill Resources, Inc. and JRP Historical Consulting LLC to record the gun clubs of the Suisun Marsh area, with an emphasis on those with standing structures (cited here as Meyer *et al.* 2013). This Duck Club borders Tule Red on the east, but the structures are not close to the Tule Red property.

P-48-000990 is the Roaring River Distribution System, a part of the "Initial Facilities" constructed in the 1970s to protect the marsh from encroaching salinity. Part of the canal that is the Roaring River Distribution System borders Tule Red on the south.

Several reports have been filed with the Information Center regarding the general project vicinity, but these involved little or no fieldwork.

CONSULTATION

The Native American Heritage Commission (NAHC) was contacted by Peak & Associates for a Sacred Lands review. Their response of June 11, 2015, indicated that no properties in the project vicinity are listed on the sacred lands file. Correspondence requesting information and/or comment and a topographic map showing the Project were sent to:

Organization	Individual
	Kesner Flores
Cortina Band of Indians	Charlie Wright, Chairperson
Yoche Dehe Wintun Nation	Leland Kinter, Chairperson
Yoche Dehe Wintun Nation	Native Cultural Renewal Committee

The Yocha Dehe replied that the project is within their aboriginal territory and that they claim authority over the Native American resources of the area. They also wish additional information on the project. This letter and other communication may be found in Appendix 3.

FIELD INSPECTION

A field reconnaissance of the Area of Potential Effect (APE) was conducted on June 25 to 27, 2015, by Peak & Associates' Senior Archeologist Robert Gerry, assisted by Michael Lawson. No evidence of prehistoric occupation or use of this area was observed. Although the land is generally heavily disturbed due to maintenance of the perennially water logged property, ground visibility is generally good due to sparse or low vegetation.

The project area was inspected by walking transects spaced at no more than 30 meters across areas of good visibility and reducing the spacing to 20 meters in areas in which visibility was somewhat impeded. Soils throughout were clearly recent alluvium from flooding episodes.

The only area of the property that could see deep excavation (up to 15 feet in depth) is the relatively small area in the northwest where a channel will be cut to break the existing natural berm and allow tidal flows back into the project area. This is an area that was part of Grizzly Bay prior to the 1850's gold rush. It is unlikely that prehistoric resources are present.

The only structures in the APE are the clubhouse and associated structures. The base of the clubhouse is the hull of a barge that was hauled in for this purpose at an unknown date. It is now covered by a two story wood superstructure providing living quarters that was constructed in 1991. The caretaker's[2] trailer is adjacent to the clubhouse as are two smaller structures for shop and storage use. There are also numerous hunting blinds on the property consisting of small cylindrical borings with metal covers. These all date to the 1990s or later.

EVALUATION

The buildings associated with the Tule Red Duck Club are not eligible for the National Register of Historic Places. It is worth noting that the survey of Suisun Marsh duck clubs (Meyer *et al.* 2013) identified 153 clubs extant in 2013, none of them were evaluated as eligible for the National Register.

For the Tule Red Duck Club, there is no known association with events that have made a significant contribution to the broad patterns of our history. The duck clubs of the Suisun Marsh area are a widespread recreational activity. The clubs have been long lasting, but have not changed or in any way contributed to the area (NRHP Criterion A).

Research on the history of the duck clubs of the region did not yield any associations with the lives of persons significant in the history of the region (Criterion B).

Construction of a two story structure based on the hulk of a barge is not a recognized architectural style in California. The construction of the duck club structure is not characteristic of any type, period, or method of construction, or that represent the work of a master, or that possess high artistic values, or that represent a significant and distinguishable entity whose components may lack individual distinction (NRHP Criterion C).

There are no archeological deposits associated with the duck club buildings. Therefore, there are no sites that have yielded, or may be likely to yield, information important in prehistory or history (NRHP Criterion D).

RECOMMENDATIONS

As a result of the identification and evaluation efforts, an agency official may find that there are no historic properties present or there are historic properties present but the undertaking will have no effect upon them as defined in Section 800.16 (i).

If the agency official finds there are historic properties that may be affected by the undertaking, the agency official shall apply the criteria of adverse effect. "An adverse effect is found when an undertaking may alter, directly or indirectly, any of the characteristics of a historic property that qualify the property for inclusion in the National Register in a manner that would diminish the integrity of the property's location, design, setting, materials, workmanship, feeling or association" (Section 800.5 (a)).

There are three possible findings:

> **Finding of no historic properties affected:** There is no effect of any kind on the historic properties.
>
> **Finding of no adverse effect:** There could be an effect, but the effect would not be harmful to the characteristics that qualify the property for inclusion in the National Register; or
>
> **Adverse effect:** There could be an effect, and that effect could diminish the integrity of such characteristics.

As no historic properties have been identified within the APE, a finding of "no historic properties affected" appears warranted in this case.

The potential for buried archaeological sites is considered low due to the heavy sedimentation that has buried older surfaces to a considerable depth. As noted above, the only area of the property that could see deep excavation (up to 15 feet in depth) is the relatively small area in the northwest where a channel will be cut to break the existing natural berm and allow tidal flows back into the project area. This is an area that was part of Grizzly Bay prior to the 1850's gold rush. It is unlikely that prehistoric resources are present. In the rest of the APE there will be minimal ground disturbance.

Federal and state laws and regulations outline the courses of action required in the event of inadvertent discoveries of cultural resources, including human remains. If cultural resources are inadvertently discovered during construction, the following measures will be required.

- The contractor immediately will cease work within 100 feet of the find. All construction personnel will leave the area. Vehicles and equipment will be left in place until a qualified archaeologist identifies a safe path out of the area. The on-site supervisor will flag or otherwise mark the location of the find and keep all traffic away from the resource. The on-site supervisor immediately will notify SFCWA (state lead agency) and Corps (federal lead agency) of the find.

- The federal lead agency is responsible for compliance with Native American Grave Protection and Repatriation Act (NAGPRA) (43 CFR 10) if inadvertent discovery of Native American remains occurs on federal lands. The federal lead agency is responsible for compliance with state laws relating to the disposition of Native American burials (Public Resources Code [PRC] 5097 and California Health and Safety Code 7050.5[b]) for human remains discoveries on non-federal lands.

- If human remains of Native American origin are discovered during ground disturbing activities on non-federal land, the lead agencies must comply with state laws relating to the disposition of Native American burials, which fall within the jurisdiction of the Native American Heritage Commission (NAHC) (PRC 5097). If human remains are discovered or recognized in any location other than a dedicated cemetery, the lead agencies will not allow further excavation or disturbance of the site or any nearby area reasonably suspected to overlie adjacent human remains until:

  a. the Solano County coroner has been informed and has determined that no investigation of the cause of death is required; and

  b. if the remains are of Native American origin, the descendants of the deceased Native Americans have made a recommendation to the landowner or the person responsible for the excavation work for means of treating or disposing of, with appropriate dignity, the human remains and any associated grave goods as provided in PRC 5097.98; or

     1. the NAHC was unable to identify a descendant or the descendant failed to make a recommendation within 48 hours after being notified by the NAHC.

     2. If any previously unknown historic or archeological artifacts are discovered while accomplishing the authorized work, the landowner must stop work immediately and notify the Corps. The activity is not authorized until the requirements of Section 106 of the NHPA have been satisfied.

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Appendix 1

Resumes

PEAK & ASSOCIATES, INC.
RESUME

MELINDA A. PEAK **January, 2015**
Senior Historian/Archeologist
3941 Park Drive, Suite 20 #329
El Dorado Hills, CA 95762
(916) 939-2405

PROFESSIONAL EXPERIENCE

Ms. Peak has served as the principal investigator on a wide range of prehistoric and historic excavations throughout California. She has directed laboratory analyses of archeological materials, including the historic period. She has also conducted a wide variety of cultural resource assessments in California, including documentary research, field survey, Native American consultation and report preparation. Ms. Peak has completed over 2,500 projects in her career, spread throughout California from Shasta County on the north to Imperial County in the south.

In addition, Ms. Peak has developed a second field of expertise in applied history, specializing in site-specific research for historic period resources. She is a registered professional historian and has completed a number of historical research projects for a wide variety of site types.

Through her education and experience, Ms. Peak meets the Secretary of Interior Standards for historian, architectural historian, prehistoric archeologist and historic archeologist.

EDUCATION

M.A. - History - California State University, Sacramento, 1989
Thesis: *The Bellevue Mine: A Historical Resources Management Site Study in Plumas and Sierra Counties, California*
B.A. - Anthropology - University of California, Berkeley

RECENT PROJECTS

Ms. Peak has had extensive experience working on coastal, lacustrine and riverine environments over the years. Some of the projects have involved identification of resources through field surveys as well as testing sites, and determining significance of resources in proposed impact areas.

Ms. Peak participated in the Pine Creek Boat Ramp Repair Project, completing historical research for the site and assisting in report preparation. A few other representative projects Ms. Peak has completed include: a field recordation and evaluation of a farm complex on Sherman Island for DWR; a survey of Lake Britton in Shasta County for Pacific Gas and Electric Company; a record search and historical map review for the Bureau of Land Management for the entire Sacramento River and a number of other existing reservoirs; the Folsom Lake Reoperation study that involved archival research to identify locations of historic and prehistoric sites inundated when the reservoir filled; and a study of river landing sites within the City of Napa for the Corps of Engineers.

Ms. Peak has completed a number of determinations of eligibility and effect documents in coordination with the Corps of Engineers for projects requiring federal permits, assessing the eligibility of a number of sites for the National Register of Historic Places. She has also completed historical research projects on a wide variety of topics for a number of projects including the Red Bluff Diversion Dam, farm complexes dating to the 1860s-1900s, bridges, an early roadhouse, Folsom Dam, Rocklin City Hall and a section of an electric railway line.

In recent years, Ms. Peak has prepared a number of cultural resource overviews and predictive models for blocks of land proposed for future development for general and specific plans. She has been able to direct a number of surveys of these areas, allowing the model to be tested.

She served as principal investigator for the multi-phase Twelve Bridges Golf Club project in Placer County. She served as liaison with the various agencies, helped prepare the historic properties treatment plan, managed the various phases of test and data recovery excavations, and completed the final report on the analysis of the test phase excavations of a number of prehistoric sites. She is currently involved as the principal investigator for the Clover Valley Lakes project adjacent to Twelve Bridges in the City of Rocklin, coordinating contacts with Native Americans, the Corps of Engineers and the Office of Historic Preservation.

Ms. Peak has served as project manager for a number of major survey and excavation projects in recent years, including the many surveys and site definition excavations for the 172-mile-long Pacific Pipeline proposed for construction in Santa Barbara, Ventura and Los Angeles counties. She also completed an archival study in the City of Los Angeles for the project. She also served as principal investigator for a major coaxial cable removal project for AT&T.

Additionally, she completed a number of small surveys, served as a construction monitor at several urban sites, and conducted emergency recovery excavations for sites found during monitoring. She has directed the excavations of several historic complexes in Sacramento, Placer and El Dorado Counties.

Ms. Peak is the author of a chapter and two sections of a published history (1999) of Sacramento County, *Sacramento: Gold Rush Legacy, Metropolitan Destiny*. She served as the consultant for a children's book on California, published by Capstone Press in 2003 in the Land of Liberty series.

Ms. Peak conducted archival research for the Fourteen Mile House, an inn on Auburn Boulevard in Citrus Heights dating to the early 1850s. She then completed the nomination of the site as a Point of Historical Interest, with approval by the State Historical Resources Commission in May 2012.

PEAK & ASSOCIATES, INC.
RESUME

ROBERT A. GERRY **January 2015**
Senior Archeologist
3941 Park Drive, Suite 20, #329
El Dorado Hills, CA 95762

PROFESSIONAL EXPERIENCE

Mr. Gerry has over thirty years of extensive experience in both the public and private sectors. He has directed all types of cultural resource-related projects, including field survey, test excavations, data recovery programs, intensive archival research and cultural resource management. He has completed archeological work in most cultural areas of California and in the western Great Basin.

EDUCATION

Graduate studies - Anthropology - California State University, Sacramento, 1972-1977
B.A. - Anthropology - University of Illinois, Chicago Circle, 1972

RECENT PROJECTS

Mr. Gerry was field director for a cultural resources survey of the Diamond Valley Project in Alpine County, California. The project involved an overview and survey of an extensive plan area, recording and evaluation of resources and presenting the results to local Native Americans and helping to conduct a field tour with them. He also directed field survey of the Van Vleck Ranch, a large property in Sacramento County being put into a conservation easement. He has conducted surveys throughout California related to low income housing development.

Mr. Gerry was field director for a cultural resources survey of about 18,640 acres within the Naval Petroleum Reserve No. 1, Kern County, California. The project employed a stratified random sampling strategy and resulted in the recording of 112 cultural resources, and preparation of a management plan. He also directed a subsequent excavation program for evaluation of significance. Additionally, he served as field director for archeological surveys on the Plumas, Stanislaus, El Dorado and Six Rivers National Forests.

He was field director and primary report writer on several linear surveys of considerable length--including the San Joaquin Valley Pipeline (157 miles) for Shell Oil, the Point Arena-Dunnigan fiber optic cable (137 miles) and the Medford, Oregon, to Redding, California fiber optic cable (151 miles), the Oregon and Idaho portions of the Spokane to Boise fiber optic cable, and the San Bernardino to San Diego fiber optic cable, for American Telephone & Telegraph Company. He also assisted on the 170 mile Pacific Pipeline survey on the southern coast of California and conducted several surveys of water pipelines in southern California: La Sierra pipeline (Riverside), Perris Valley. Pico Rivera, Temecula and San Jacinto.

Mr. Gerry supervised the cultural resources assessments and participated in all field surveys for the studies of water supply facilities for seven wildlife refuges in the Sacramento and San Joaquin Valleys. He also took a lead role in field work and report preparation for major residential developments in the Sacramento area, such as the Sunrise Douglas project and Florin Vineyard.

Mr. Gerry has developed a specialty in bridge replacement evaluations, completing five such studies in Tuolumne County, two in Santa Barbara County, two in Amador County and ten others in various areas of California.

Mr. Gerry has had extensive experience in recording mining sites in northern California and Nevada for proposed mining undertakings as well as in the course of survey for proposed subdivisions, reservoirs, and other development projects. He directed the survey of two parcels totaling 2,240 acres in the Battle Mountain Mining District in Lander County, recording a number of mining sites and features. Within the Cook Ranch Project area in El Dorado County, he completed the recordation of several gold mines and a cinnabar mine. He has completed three studies involving the American Hill Mine in Nevada City, the location where hydraulic mining began in the 1850s.

Mr. Gerry has directed test excavations for evaluation of significance at a number of sites, both historic and prehistoric. Examples include CA-NAP-261, twelve sites on Naval Petroleum Reserve No. 1, three sites on Russell Ranch in Sacramento County, a midden site near Guinda and a village known through ethnographic literature in Murphys.

His work has included an important role in working with Native American peoples. He has surveyed eight allotments and rancherias in the Pit River area, the Point Arena/Manchester Rancheria in Mendocino County, the Susanville Rancheria in Lassen County, the Rumsey Rancheria in Yolo County, and three rancherias in northwestern California. In each of these projects, he has been closely involved with Native American organizations and individuals, including a number of native people he has directed as surveyor trainees.

In the field of historical resources, Mr. Gerry has prepared site records and significance evaluations for numerous historical buildings throughout California. The bulk of these have been single family residences, but industrial, commercial and multi-family residences were also included. He has also directed excavations for evaluation of historical archeological potential and monitored construction work in areas of known historical sensitivity.

Appendix 2

Record Search

CALIFORNIA HISTORICAL RESOURCES INFORMATION SYSTEM

ALAMEDA
COLUSA
CONTRA COSTA
DEL NORTE
HUMBOLDT
LAKE
MARIN
MENDOCINO
MONTEREY
NAPA
SAN BENITO
SAN FRANCISCO
SAN MATEO
SANTA CLATA
SANTA CRUZ
SOLANO
SONOMA
YOLO

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6/9/2015 NWIC File No.: 14-1588

Robert Gerry
Peak & Associates, Inc.
3941 Park Drive, Suite 20-329
El Dorado Hills, CA 95762

re: Tule Red Tidal Marsh Restoration Project

The Northwest Information Center received your record search request for the project area referenced above, located on the Denverton & Honker Bay USGS 7.5' quads. The following reflects the results of the records search for the project area and a 1/8th mile radius:

Resources within project area:	P-48-987.
Resources within 1/8th mile radius:	P-48-990.
Reports within project area:	S-43268.
Reports within 1/8th mile radius:	None
Other Reports within records search radius:	S-848, 1784, 9462, 15529, 17835, 32596, & 33600. These reports are classified as Other Reports; reports with little or no field work or missing maps. The electronic maps do not depict study areas for these reports, however a list of these reports has been provided. In addition, you have not been charged any fees associated with these studies.

Resource Database Printout (list): ☒ enclosed ☐ not requested ☐ nothing listed

Resource Database Printout (details): ☐ enclosed ☒ not requested ☐ nothing listed

Resource Digital Database Records: ☐ enclosed ☒ not requested ☐ nothing listed

Report Database Printout (list): ☒ enclosed ☐ not requested ☐ nothing listed

Report Database Printout (details): ☐ enclosed ☒ not requested ☐ nothing listed

Report Digital Database Records: ☐ enclosed ☒ not requested ☐ nothing listed

Resource Record Copies: ☒ enclosed ☐ not requested ☐ nothing listed

Report Copies: ☐ enclosed ☒ not requested ☐ nothing listed

OHP Historic Properties Directory:	☐ enclosed	☐ not requested	☒ nothing listed
Archaeological Determinations of Eligibility:	☐ enclosed	☐ not requested	☒ nothing listed
CA Inventory of Historic Resources (1976):	☐ enclosed	☒ not requested	☐ nothing listed
Caltrans Bridge Survey:	☐ enclosed	☒ not requested	☐ nothing listed
Ethnographic Information:	☐ enclosed	☒ not requested	☐ nothing listed
Historical Literature:	☐ enclosed	☒ not requested	☐ nothing listed
Historical Maps:	☐ enclosed	☒ not requested	☐ nothing listed
Local Inventories:	☐ enclosed	☒ not requested	☐ nothing listed
GLO and/or Rancho Plat Maps:	☐ enclosed	☒ not requested	☐ nothing listed
Shipwreck Inventory:	☐ enclosed	☒ not requested	☐ nothing listed

*Notes:

-

Please forward a copy of any resulting reports from this project to the office as soon as possible. Due to the sensitive nature of archaeological site location data, we ask that you do not include resource location maps and resource location descriptions in your report if the report is for public distribution. If you have any questions regarding the results presented herein, please contact the office at the phone number listed above.

The provision of CHRIS Data via this records search response does not in any way constitute public disclosure of records otherwise exempt from disclosure under the California Public Records Act or any other law, including, but not limited to, records related to archeological site information maintained by or on behalf of, or in the possession of, the State of California, Department of Parks and Recreation, State Historic Preservation Officer, Office of Historic Preservation, or the State Historical Resources Commission.

Due to processing delays and other factors, not all of the historical resource reports and resource records that have been submitted to the Office of Historic Preservation are available via this records search. Additional information may be available through the federal, state, and local agencies that produced or paid for historical resource management work in the search area. Additionally, Native American tribes have historical resource information not in the CHRIS Inventory, and you should contact the California Native American Heritage Commission for information on local/regional tribal contacts.

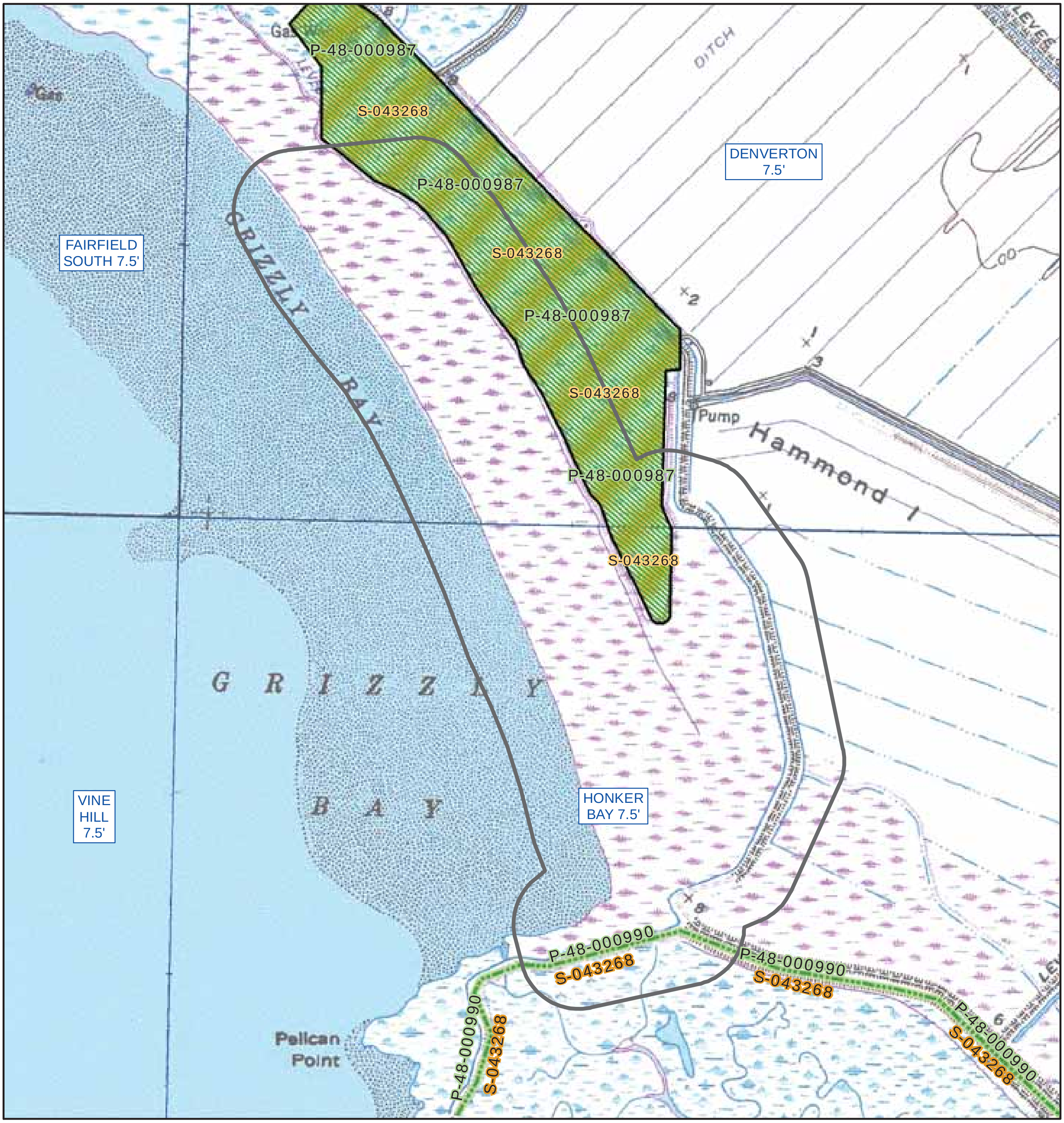
Should you require any additional information for the above referenced project, reference the record search number listed above when making inquiries. Requests made after initial invoicing will result in the preparation of a separate invoice.

Thank you for using the California Historical Resources Information System (CHRIS).

Sincerely,

Lisa C. Hagel
Researcher

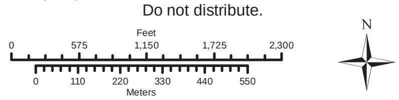
Tule Red Tidal Marsh Restoration Project



Northwest Information Center

File #14-1588, 9 June 2015, L. Hagel

May depict confidential cultural resource locations.
Do not distribute.



Report List

Report No.	Other IDs	Year	Author(s)	Title	Affiliation	Resources
S-000848		1977	David A. Fredrickson	A Summary of Knowledge of the Central and Northern California Coastal Zone and Offshore Areas, Vol. III, Socioeconomic Conditions, Chapter 7: Historical & Archaeological Resources	The Anthropology Laboratory, Sonoma State College; Winzler & Kelly Consulting Engineers	
S-001784		1979	David Chavez	Preliminary Cultural Resources Identification: San Francisco Bay Study for Corps of Engineers Projects		01-000033, 01-000034, 01-000079, 01-000081, 01-000082, 01-000083, 01-000084, 01-000086, 01-000087, 01-000088, 01-000089, 01-000090, 01-000097, 01-000100, 01-000101, 01-000104, 01-000105, 01-000109, 01-000110, 01-000112, 01-000113, 01-000115, 07-000046, 38-001318, 41-000006, 41-000044, 41-000080, 41-000095, 41-000109, 41-000124, 41-000125, 43-000021, 48-000025, 48-000030, 48-000042, 48-000079, 48-000081, 48-000082, 48-000083, 48-000084, 48-000090, 48-000181
S-009462		1977	Teresa Ann Miller	Identification and Recording of Prehistoric Petroglyphs in Marin and Related Bay Area Counties	San Francisco State University	07-000323, 21-000087, 21-000376, 21-000378, 21-000379, 21-000380, 21-000381, 21-000382, 21-000383, 21-000384, 21-000386, 21-000387, 21-000388, 21-000389, 21-000390, 21-000391, 21-000392, 21-000393, 21-000394, 21-000395, 21-000396, 21-000397, 21-000398, 21-000399, 21-000400, 21-000401, 21-000402, 21-000546, 23-000789, 23-000790, 49-000629, 49-000785, 49-000787
S-015529		1993	Robert L. Gearhart II, Clell L. Bond, Steven D. Hoyt, James H. Cleland, James Anderson, Pandora Snethcamp, Gary Wesson, Jack Neville, Kim Marcus, Andrew York, and Jerry Wilson	California, Oregon, and Washington: Archaeological Resource Study	Espey, Huston & Associates, Inc.; Dames & Moore	01-000033, 01-000034, 01-000084, 01-000086, 01-000104, 07-000133, 07-000173, 07-000175, 07-000177, 17-000072, 17-000392, 21-000048, 21-001915, 23-001704, 27-000100, 27-000236, 27-000335, 27-000356, 27-000386, 27-000485, 38-000028, 38-000072, 38-000085, 38-000098, 41-000080, 41-000265, 44-000179
S-017835		1975	Judy Myers Suchey	Biological Distance of Prehistoric Central California Populations Derived from Non-Metric Traits of the Cranium	University of California, Riverside	01-000086, 01-000104, 01-000105, 06-000025, 07-000080, 07-000081, 07-000083, 07-000087, 21-000017, 21-000193, 21-000242, 21-000252, 48-000010, 57-000145

Report List

Report No.	Other IDs	Year	Author(s)	Title	Affiliation	Resources
S-032596	Caltrans - EA No. 447600; Other - Contract #04A2098	2006	Randall Milliken, Jerome King, and Patricia Mikkelsen	The Central California Ethnographic Community Distribution Model, Version 2.0, with Special Attention to the San Francisco Bay Area, Cultural Resources Inventory of Caltrans District 4 Rural Conventional Highways	Consulting in the Past; Far Western Anthropological Research Group, Inc.	
S-033600		2007	Jack Meyer and Jeff Rosenthal	Geoarchaeological Overview of the Nine Bay Area Counties in Caltrans District 4	Far Western Anthropological Research Group, Inc.	01-000001, 01-000002, 01-000014, 01-000063, 01-000064, 01-000067, 01-000080, 01-000124, 01-000139, 01-000140, 01-001795, 01-002110, 01-002160, 01-002162, 01-002245, 07-000019, 07-000024, 07-000037, 07-000047, 07-000075, 07-000079, 07-000088, 07-000089, 07-000108, 07-000182, 07-000185, 07-000186, 07-000217, 07-000239, 07-000401, 07-000721, 21-000010, 21-000048, 21-002615, 28-000009, 28-000028, 28-000301, 28-000967, 38-000006, 38-000028, 38-000101, 38-000102, 38-000119, 41-000080, 41-000284, 43-000016, 43-000189, 43-000296, 43-000308, 43-000310, 43-000423, 43-000424, 43-000448, 43-000451, 43-000485, 43-000561, 43-000604, 43-000608, 43-000614, 43-000623, 43-001015, 43-001058, 43-001080, 43-001163, 43-001194, 43-001576, 48-000007, 48-000157
S-043268		2013	Jack Meyer, Julia Costello, Patricia Mikkelsen, Melissa Johnson, and Naomi Scher	Volume 1 - Archaeological Resources: Suisun Marsh Habitat Management, Preservation, and Restoration Plan Cultural Resources Contextual Report	Far Western Anthropological Research Group, Inc.; Foothill Resources, Inc.; JRP Historical Consulting, LLC	48-000021, 48-000042, 48-000127, 48-000129, 48-000131, 48-000142, 48-000185, 48-000189, 48-000190, 48-000191, 48-000192, 48-000193, 48-000194, 48-000196, 48-000197, 48-000198, 48-000199, 48-000200, 48-000443, 48-000513, 48-000514, 48-000794, 48-000978, 48-000979, 48-000980, 48-000981, 48-000982, 48-000983, 48-000985, 48-000986, 48-000987, 48-000989, 48-000990, 48-000991
S-043268		2013	Cheryl Brookshear and Rand Herbert	Suisun Marsh Cultural Resources Contextual Report - Volume 2: Built Environment	JRP Historical Consulting	

Resource List

Primary No.	Trinomial	Other IDs	Type	Age	Attribute codes	Recorded by	Reports
P-48-000987		Resource Name - Suisun Marsh Duck Clubs; Other - SM Hunting Preserve; Other - DBI/ Forest Pond; Other - Golden Gate; Other - Teal; Other - Ibis; Other - Arnold Ranch; Other - Tule Belle; Other - The Island Club; Other - Grizzly Duck Club; Other - Montezuma Gun Club; Other - Gum Tree Farms; Other - DUXRUS; Other - Four Winds Duck Club; Other - Rizz/Fizz Club; Other - Little West Wind Duck; Other - Garben Ranch; Other - The Honkers Club; Other - Grizzly King; Other - Bent Barrel Duck; Other - Club; Other - Wild Turkey; Other - Grizzly Ranch; Other - Balboa Farms; Other - Grizzly Fair View Farms; Other - Bul-Rush Farms; Other - Gang Bang Duck Club; Other - Windmill Club; Other - Marsh Club; Other - Merganser Farms; Other - The Sleeping Pintail; Other - Schafer Farms; Other - Frost Slough; Other - Sheriff Pond; Other - Boles Pond; Other - Goodyear; Other - Morrow Island Land Co.; Other - Mallard Haven; Other - Fleetside; Other - Montezuma Ranch; Other - Honker Bay Farms	Building	Historic	HP39 (Other)	2012 (Cheryl Brookshear, JRP Historical Consulting)	S-043268

Resource List

Primary No.	Trinomial	Other IDs	Type	Age	Attribute codes	Recorded by	Reports
P-48-000990		Resource Name - Initial Facilities; Other - Roaring River Distribution System; Other - Morrow Island Distribution System; Other - Goodyear Outfall	Structure	Historic	HP11 (Engineering structure)	2013 (Cheryl Brookshear, JRP Historical Consulting, LLC)	S-043268

Appendix 3

Native American Consultation

Sacred Lands File & Native American Contacts List Request

Native American Heritage Commission
1550 Harbor Blvd, Suite 100
West Sacramento, CA 95691
916-373-3710
916-373-5471 – Fax
nahc@nahc.ca.gov

Information Below is Required for a Sacred Lands File Search

Project: **Tule Red Marsh Restoration**

County: **Solano**

USGS Quadrangle Name: **Denverton and Honker Bay 7.5'**

Township: **3N** **Range:** **1W** **Section(s):** **none (swampland)**

Company/Firm/Agency: **Peak & Associates, Inc.**

Street Address: **3941 Park Drive, Suite 20-329**

City: **Eldorado Hills, CA** **Zip:** **95762**

Phone: **(916)939-2405**

Fax: **(916)283-5239**

E-mail: **peakinc@surewest.net**

Project Description:

This property will be converted back to the tidal marsh that it once was. It includes about 375 acres of land, mostly marsh. Map attached.

STATE OF CALIFORNIA Edmund G. Brown, Jr., Governor

NATIVE AMERICAN HERITAGE COMMISSION
1550 Harbor Blvd.
West Sacramento, CA 95691
(916) 373-3710
Fax (916) 373-5471

June 11, 2015

PEAK & ASSOCIATES INC
3941 Park Drive, Ste 20-329
El Dorado Hills, CA 95762

FAX: 916-283-5239

2 Pages
Tule Red Marsh Restoration project, Solano County

Per Your Request;

A record search of the sacred land file has failed to indicate the presence of Native American cultural resources in the immediate project area. The absence of specific site information in the sacred lands file does not indicate the absence of cultural resources in any project area. Other sources of cultural resources should also be contacted for information regarding known and recorded sites.

Enclosed is a list of Native Americans individuals/organizations who may have knowledge of cultural resources in the project area. The Commission makes no recommendation or preference of a single individual, or group over another. This list should provide a starting place in locating areas of potential adverse impact within the proposed project area. I suggest you contact all of those indicated, if they cannot supply information, they might recommend others with specific knowledge. By contacting all those listed, your organization will be better able to respond to claims of failure to consult with the appropriate tribe or group. If a response has not been received within two weeks of notification, the Commission requests that you follow-up with a telephone call to ensure that the project information has been received.

If you receive notification of change of addresses and phone numbers from any of these individuals or groups, please notify me. With your assistance we are able to assure that our lists contain current information. If you have any questions or need additional information, please contact me at (916) 373-3713.

Sincerely,

Katy Sanchez for

Debbie Pilas-Treadway
Environmental Specialist III

Native American Contacts
Solano County
June 9, 2015

Kesner Flores
P.O. Box 1047 Wintun / Patwin
Wheatland , CA 95692
(925) 586-8919

Cortina Band of Indians
Charlie Wright, Chairperson
P.O. Box 1630 Wintun / Patwin
Williams , CA 95987
(530) 473-3274 Office

(530) 473-3301 Fax

Yocha Dehe Wintun Nation
Leland Kinter, Chairperson
P.O. Box 18 Wintun (Patwin)
Brooks , CA 95606
lkinter@yochadehe-nsn.gov
(530) 796-3400

(530) 796-2143 Fax

Yocha Dehe Wintun Nation
Native Cultural Renewal Committee
P.O. Box 18 Wintun (Patwin)
Brooks , CA 95606
(530) 979-6346
(530) 796-3400 - office
(530) 796-2143 Fax

This list is current only as of the date of this document.

Distribution of this list does not relieve any person of statutory responsibility as defined in Section 7050.5 of the Health and Safety Code, Section 5097.94 of the Public Resource Section 5097.98 of the Public Resources Code

This list is only applicable for contacting local Native Americans with regard to cultural resources for the proposed Tule Red Marsh Restoration project, Solano County.

PEAK & ASSOCIATES, INC.
CONSULTING ARCHEOLOGY

June 1, 2015

Dear :

Peak & Associates, Inc. has contracted with Westervelt Ecological Services to perform a cultural resources assessment of the proposed Tule Red Tidal Marsh Restoration Project, a wetlands creation project to be developed on roughly 350 acres on the east side of Grizzly Bay in the Suisun Marsh area, Solano County. The project area is depicted on the enclosed map, using portions of the Denverton (north) and Honker Bay USGS maps. The project area lies in un-sectioned land in township 3N, range 1W in an isolated area that has been used for agriculture and a duck club in recent years.

We are contacting individuals identified by the Native American Heritage Commission as persons who might have information to contribute regarding potential Native American concerns in the project area. Any information or concerns that you may have regarding village sites, traditional properties or modern Native American uses in any portion of the project vicinity will be welcomed. If you know other individuals who are familiar with the vicinity, we would welcome this information as well.

We recognize that much of the information about protected and sacred sites may be confidential within your community and cannot be shared with those outside of your community. We will work with you to minimize impact on your cultural resources. Please contact me to discuss how we can accomplish protection of your cultural resources within your limits of confidentiality and the needs of the project.

Thank you for your assistance.

Sincerely,

Robert A. Gerry
Consulting Archeologist

RG//
Encl.

MAILING LIST

Cortina Band of Indians
Mr. Charlie Wright, Chairperson
PO Box 1630
Williams, CA 95987

Yocha Dehe Wintun Nation
Mr. Marshall McKay, Chairperson
P.O. Box 18
Brooks, CA 95606

Mr. Kesner Flores
PO Box 1047
Wheatland, CA 95692

Yocha Dehe Wintun Nation
Mr. Leland Kinter, Native Cultural Renewal Committee
P.O. Box 18
Brooks, CA 95606

Yocha Dehe Wintun Nation
Ms. Cynthia Clarke, Native Cultural Renewal Committee
P.O. Box 18
Brooks, CA 95606

YOCHA DEHE
CULTURAL RESOURCES

June 26th, 2015

Robert A. Gerry
Peak & Associates, Inc.
3941 Park Drive, Suite 20-329
El Dorado Hills, CA 95762

RE: Tule Red Tidal Marsh Restoration Project

Dear Mr. Gerry:

Thank you for your comment request letter dated June 1, 2015 regarding the proposed Tule Red Tidal Marsh Restoration Project Solano County, CA. We appreciate your effort to contact us.

The Cultural Resources Department has reviewed the project and concluded that it is within the aboriginal territories of the Yocha Dehe Wintun Nation. Therefore, we have cultural interest and authority in the proposed project area.

We would like more information on your project can you please send us the following information: approximate date of the project and approximate depths the project would be excavating? Also, has your company completed a record search with the CHRIS or conducted a pedestrian survey?

Should you have any questions, please feel free to contact the following individual:

Mr. James Sarmento
Cultural Resources Manager
Yocha Dehe Wintun Nation
Office: (530) 723-0452, Email: jsarmento@yochadehe-nsn.gov

Please refer to identification number YD – 06152015-01 in any correspondences concerning this project.

Thank you for providing us with this notice and the opportunity to comment.

Sincerely,

James Kinter
Tribal Secretary
Tribal Historic Preservation Officer

Appendix 4

Site Record

State of California - The Resources Agency
DEPARTMENT OF PARKS AND RECREATION
PRIMARY RECORD

Primary #
HRI#
Trinomial
NRHP Status Code

Other Listings:
Review Code: Reviewer: Date:

 Resource Name or #: (assigned by recorder) Tule Red Duck Club

P1. Other Identifier:

P2. Location: ☐ **Not for Publication** ☒ **Unrestricted** (P2b and P2c or P2d. Attach a Location Map as necessary)

a. County: Solano
b. USGS 7.5' Quad: Honker Bay Date: 1953 (PR80) T. 3N ;R. 1W ; ¼ of ¼ of Sec. None ; MD B.M.
c. Address: City: Zip
d. UTM: (Give more than one for large and/or linear resources) NAD27 Zone: 10; 05 89 412 mE/; 42 18 7412 mN
e. Other Locational Data: (e.g. parcel #, directions to resource, elevation, etc., as appropriate)
At the northern edge of Grizzly Island Road about 400 feet north of Roaring River Canal.

P3a. Description: (Describe resource and its major elements. Include design, materials, condition, alterations, size, setting, and boundaries)
The headquarters of the Tule Red Duck Club is a two story frame building built on a steel base consisting of the hull of an old barge. It has wood siding and a composite shingle roof with asymmetrical shape. It was designed with functionality as the main consideration and executed in what materials were most readily available. It is associated with a "tower" consisting of a frame shed with flat topped rough for an observation deck. There is also a pump house shed on the slough adjacent to the structure and a trailer providing housing for the caretaker parked very close to the rear (south) or the main building.

P3b. Resource Attributes: (List attributes and codes) HP-39 Other

P4. Resources Present: ☒ Building ☐ Structure ☐ Object ☐ Site ☐ District ☐ Element of a District ☐ Other (Isolates etc.)

P5a. Photo or Drawing (Photo required for buildings, structures, and objects)

P5b. Description of Photo: (View, date, accession #) Tule Red duck Club, 6/27/15. Main house at left, caretaker's trailer center, pump house right.

P6. Date Construction/Age and Sources: Historic ☒ Prehistoric ☐ Both ☐
1991 except for the barge.

P7. Owner and Address:
Westervelt Ecological Services
600 North Market Blvd., Suite 3
Sacramento, CA 95834

P8. Recorded By: (Name, affiliation, and address)
Robert Gerry
Peak & Associates, Inc.
3941 Park Drive, Suite 20, #329
El Dorado Hills, CA 95762

P9. Date Recorded:
June 27, 2015

P10. Survey Type: (Describe)
Complete, linear transects, project related

P11. Report Citation: (Cite Survey report and other resources, or enter "none") Determination of Eligibility and Effect for the Proposed Tule Red Tidal Marsh Restoration Project, Solano County, California. Peak & Associates, Inc. 2015

ATTACHMENTS: ☐ NONE ☒ Location Map ☒ Sketch Map ☒ Continuation Sheet ☒ Building, Structure, and Object Record ☐ Archaeological Record ☐ District Record ☐ Linear Feature Record ☐ Milling Station Record ☐ Rock Art Record ☐ Artifact Record ☐ Photograph Record ☐ Other:

 ***NRHP Status Code:** 6Z Resource Name or #: (assigned by recorder) Tule Red Duck Club

B1. Historic Name: Tule Red Duck Club
B2. Common Name:
B3. Original Use: Barge B4. Present Use: Clubhouse
B5. Architectural Style: Vernacular
B6. Construction History: (Construction date, alterations, and date of alterations.)
There are no buildings shown at this location on the Honker Bay USGS map edition of 1953 as photorevised in 1980. So the barge could not have been used as the base for construction before 1980. The frame structures were built in 1991 (information from caretaker).

B7. Moved? ☒ No ☐ Yes ☐ Unknown Date: Original Location:
B8. Related Features:
Numerous duck blinds are scattered throughout the area west and north of the clubhouse (toward the bay).

B9a. Architect: None b. Builder: Unknown
B10. Significance: Theme **Area**
Period of Significance **Property Type** **Applicable Criteria**
(Discuss importance in terms of historical or architectural context as defined by theme, period, and geographic scope. Also address integrity.)

The property basically does not have an applicable historic theme. A study of the duck clubs of the Suisun Marsh area (Meyer et al. 2013) identified 153 duck clubs it the study area, none of which were eligible for the National Register. The buildings are not associated with historically important persons or events and are too recent to be of archaeological interest. The ides of building a superstructure on a barge for use as a duck club may be interesting, but the barge is the only part of the structure that is older than fifty years in age. There are no criteria of significance that are satisfied by this property.

B11. Additional Resource Attributes: (List attributes and codes)

B12. References:
Meyer, Jack, Julia Costello, Patricia Mikkelson, Melissa Johnson and Naomi Scher
2013 Volume I - Archaeological Resources: Suisun Marsh Habitat Management and Restoration Plan Cultural Resources Contextual Report. Ms on file: Northwest Information Center, Rohnert Park.

B13. Remarks:

B14. Evaluator: R. Gerry, Peak & Associates, Inc.

Date of Evaluation: 8/1/2015

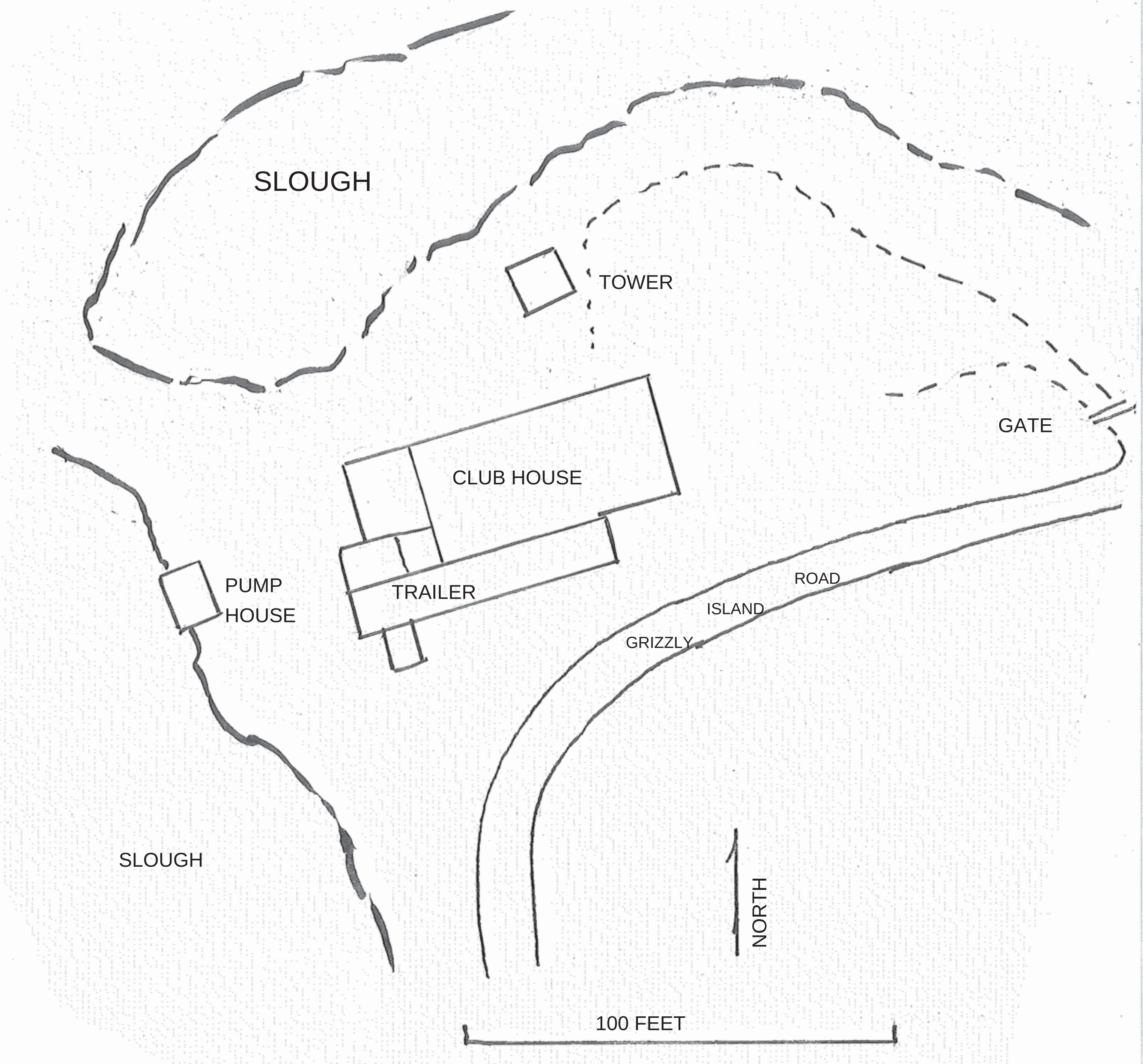
This space reserved for official comments.

State of California Natural Resources Agency
DEPARTMENT OF PARKS AND RECREATION
SKETCH MAP

Primary #
HRI#
Trinomial

Page 3 of 5 *Resource Name or # (Assigned by recorder) Tule Red Duck Club

*Drawn by: Gerry *Date of map: 2015



Primary#
HRI #
Trinomial

CONTINUATION SHEET

Property Name: ___Tule Red duck Club___Tule Red Duck Club____

Duck Club looking north from Grizzly Island Road.

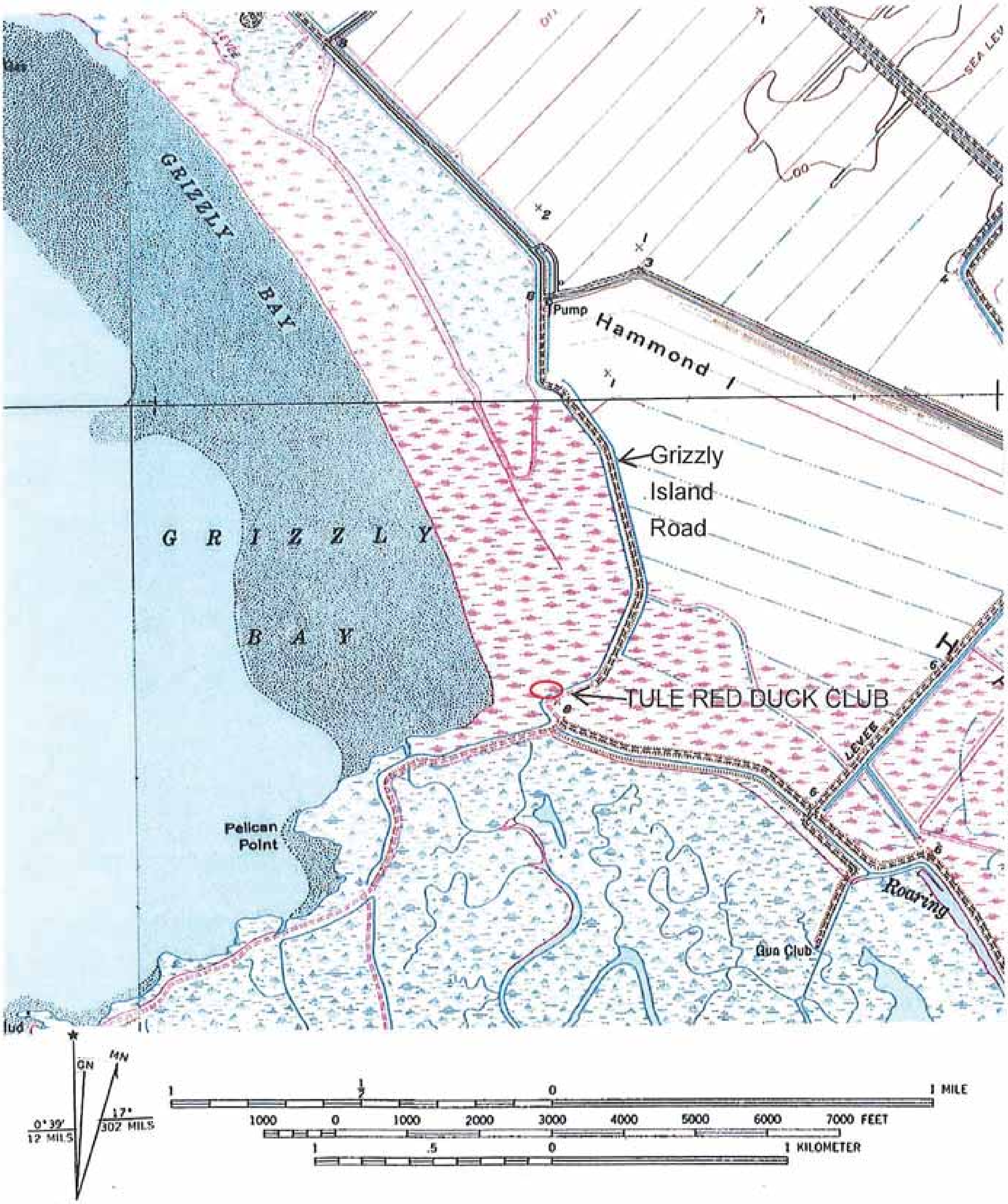
Looking south across slough. Observation tower on right.

State of California Natural Resources Agency
DEPARTMENT OF PARKS AND RECREATION
LOCATION MAP

Primary #
HRI#
Trinomial

 *Resource Name or # (Assigned by recorder) Tule Red Duck Club

*Map Name: Denverton/Honker Bay *Scale: 1:24,000(7.5') *Date of map: 1953(PR80)



DPR 523J (Rev. 1/1995)(Word 9/2013) * Required information