From: Staples, Rose
Sent: Monday, April 28, 2014 11:31 AM
BCC To: Don Pedro Relicensing Participants Email Group
Subject: Don Pedro FLA Filed Today

The Districts have e-filed with FERC the Final License Application for the Don Pedro Hydroelectric Project under P-2299-075. As you can see by this message, a copy of the filing (all 75 individual files) will be available shortly on FERC's E-Library (www.ferc.gov). I will also be uploading them to the Relicensing Website at www.donpedro-relicensing.com -- but as each file is uploaded and titled separately, it will take a while for all of them to be processed--most probably not until later tonight. Thank you.

Rose Staples, CAP-OM
Executive Assistant
HDR Inc
Rose.Staples@HDRinc.com

-----Original Message-----
From: eFiling@ferc.gov [mailto:eFiling@ferc.gov]
Sent: Monday, April 28, 2014 10:59 AM
To: Staples, Rose; efilingacceptance@ferc.gov
Subject: FERC Acceptance for Filing in P-2299-082

Acceptance for Filing

The FERC Office of the Secretary has accepted the following electronic submission for filing (Acceptance for filing does not constitute approval of any application or self-certifying notice):

-Accession No.: 201404285069, 201404285070, 201404285071
-Docket(s) No.: P-2299-082
-Filed By: Turlock Irrigation District and Modesto Irrigation District -Signed By: Steve Boyd, Greg Dias -Filing Type: License/Relicense Application -Filing Desc: Application For Relicense of Turlock Irrigation District and Modesto Irrigation District's Don Pedro Hydroelectric Project under P-2299.
-Submission Date/Time: 4/27/2014 1:42:26 PM -Filed Date: 4/28/2014 8:30:00 AM

Your submission is now part of the record for the above Docket(s) and available in FERC's eLibrary system at:

http://elibrary.ferc.gov/idmws/file_list.asp?accession_num=20140428-5069

If you would like to receive e-mail notification when additional documents are added to the above docket(s), you can eSubscribe by docket at:

https://ferconline.ferc.gov/eSubscription.aspx

There may be a 10 minute delay before the document appears in eLibrary.

Thank you again for using the FERC Electronic Filing System. If you need to contact us for any reason:

E-Mail: efiling@ferc.gov mailto:efiling@ferc.gov (do not send filings to this address) Voice Mail: 202-502-8258.

From: Staples, Rose
Sent: Friday, May 2, 2014 8:14 PM
BCC To: Don Pedro Relicensing Participants Email Group List
Subject: Don Pedro Final License Application Files

As mentioned in my notification earlier in the week, the Don Pedro Hydroelectric Project's Final License Application, e-filed Monday, April 28, 2014, is available both on FERC's E-Library at www.FERC.gov and on the relicensing website at www.donpedro-relicensing.com. Once on the relicensing website's home page, click on DOCUMENTS, and then scroll down to the list of file folders. The second folder contains the Final License Application files. Click on the folder and you will see a subfolder labeled "Final (75)"—click on the subfolder and all 75 files will load.

I thought you might find the file number index below helpful in determining which numbered file contains the part of the license application that you are seeking.

You will note the files are consecutively numbered from 01 to 75—and follow the order suggested by the Table of Contents; i.e., Exhibit A through Exhibit H, plus the attachments to the application. The index below has the full names of the individual files, rather than the abbreviated versions necessary to meet FERC's 60 character file name limit.

P-2299-075_01_DP_FLA_CvrLtr-TOC-IntlStmt-ExecSum_140428
through
P-2299-075_75_DP_FLA_AttC_StdyRptDiurnalTempVar_140428

File# ***File Content***

01 Transmittal Letter – TOC - Initial Statement– Executive Summary
02 Exhibit A: Project Description
03 Exhibit B: Project Operations and Resource Utilization
04 Appendix B-1 Current License Articles
Appendix B-2 Development of Unimpaired Hydrology
Appendix B-3 1997 to 2012 Historical and Base Case Annual and Monthly Flow Duration Curves
05 Appendix B-4 Model Description and User's Guide
06 Appendix B-5 Base Case Conditions 1971 to 2012
07 Exhibit C: Construction History and Proposed Construction Schedule
08 Exhibit D: Statement of Costs and Financing
09 Exhibit E: Environmental Report (Part 1: Sections 1.0 through 3.9, plus 7.0 Lit Cited)
1.0 Introduction
2.0 Proposed Action and Alternatives
3.0 Environmental Analysis
3.1 General Description of the Tuolumne River Basin and Don Pedro Project
3.2 Scope of Cumulative Effects Analysis
3.3 Geology and Soils
3.4 Water Resources
3.5 Fish and Aquatic Resources
3.6 Botanical Resources
3.7 Wildlife Resources
3.8 Threatened and Endangered Species
3.9 Recreation, Land Use, and Shoreline Management
7.0 Literature Cited
10 Exhibit E: Environmental Report (Part 2: Sections 3.9 through 8.0)

61 W&AR-10 *Oncorhynchus mykiss* Population Study
62 W&AR-12 *Oncorhynchus mykiss* Habitat Survey
63 W&AR-13 Fish Assemblage and Population Between Don Pedro Dam and La Grange Dam Study
64 W&AR-15 Socioeconomics Study
65 W&AR-16 Lower Tuolumne River Temperature Model
66 W&AR-17 Don Pedro Fish Population Survey
67 W&AR-18 Sturgeon Study
68 W&AR-19 Lower Tuolumne River Riparian Information and Synthesis Study
69 W&AR-20 *Oncorhynchus mykiss* Scale Collection and Age Determination Study
70-72 Lower Tuolumne River Instream Flow Study
73 Lower Tuolumne River Instream Flow Study—Pacific Lamprey and Sacramento Splittail 1-D PHABSIM Habitat Assessment
74 Pulse Flow Study
75 In-River Diurnal Temperature Variation Study

Any difficulties accessing these files; please do let me know. Thank you.

ROSE STAPLES
CAP-OM

HDR Engineering, Inc.
Executive Assistant, Hydropower Services

970 Baxter Boulevard, Suite 301 | Portland, ME 04103
207.239.3857 | f: 207.775.1742
rose.staples@hdrinc.com | hdrinc.com

From: Manji, Annie
Sent: Thursday, June 5, 2014 11:36 AM
To: Devine, John; Staples, Rose; Boyd, Steve, Dias, Greg
Cc: Murphey, Gretchen; Heyne, Tim; Barnes, Peter; Tsao, Steve
Subject: RE: W&AR-14 Temperature Criteria Assessment

Thank you John that is very helpful. Do you know if the attached documents are the most up to date descriptions of the ongoing work (for our reference)? We had lost track of progress on this one but the FLA schedule and recent FISHBIO work served as a reminder that work was indeed ongoing with more planned.

Thank you

Annie Manji
Statewide FERC Coordinator
Department of Fish and Wildlife
Water Branch
601 Locust Street
Redding, CA 96001
(530) 225-2315

From: Devine, John
Sent: Thursday, June 5, 2014 11:05 AM
To: Manji, Annie; Staples, Rose; Boyd, Steve; Dias, Greg
Cc: Murphey, Gretchen; Heyne, Tim; Barnes, Peter
Subject: RE: W&AR-14 Temperature Criteria Assessment

Annie,

Thank you for your continuing interest in the W&AR-14 study. The Districts have almost completed the extensive preparations needed to conduct the swim tunnel portion of the study consistent with our discussions with relicensing participants. The swim tunnels have been constructed and delivered. A mobile-mini has been brought on-site to house the lab facilities needed by the FishBio/UC Davis Team for conducting the swim tunnel work. We plan to invite interested relicensing participants to see the facilities once the initial systems start-up phase of work is complete.

To your specific question, there are no salmonid collection activities ongoing at the present time; however, snorkel surveys have been conducted recently by FishBio to identify target locations for *O. mykiss* collections that are planned to occur later this summer. Consistent with the NMFS Section 10 and CDFW SCP for this work, we will notify CDFW and NMFS before the start of any salmonid collection activities. We are currently estimating that FishBio will begin collection of in-river *O. mykiss* by seining, consistent with the study plan and permits, during the week of July 9. The summer flows from Don Pedro to the lower Tuolumne River have continued to be in excess of the required minimums by almost 100 percent, so flow conditions in this reach are not being affected by the current drought. We'll forward you a copy of the study plan as requested. Please let me know if you have any other questions.

JOHN DEVINE
P.E.

HDR Engineering, Inc.
Senior Vice President, Hydropower Services

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john.devine@hdrinc.com | hdrinc.com

From: Manji, Annie]
Sent: Tuesday, June 03, 2014 11:30 AM
To: Staples, Rose; Devine, John; Boyd, Steve; Dias, Greg
Cc: Murphey, Gretchen; Heyne, Tim; Barnes, Peter
Subject: W&AR-14 Temperature Criteria Assessment

Rose and Co.

Sorry for the incomplete message earlier – I hit send by mistake – I was going to add that one reason I am particularly interested in getting the most recent study plan is trying to ascertain is collection of live salmonids part of this study and going on currently?

Again, thank you for any help you can provide

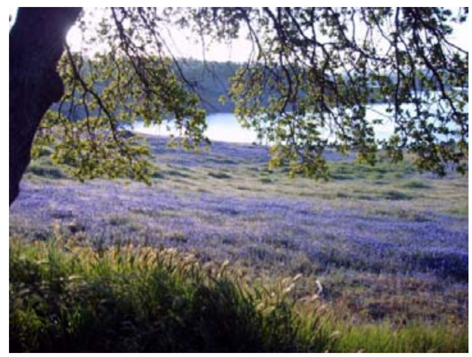
Annie Manji
Statewide FERC Coordinator
Department of Fish and Wildlife
Water Branch
601 Locust Street
Redding, CA 96001
(530) 225-2315

TEMPERATURE CRITERIA ASSESSMENT

(Chinook Salmon and *Oncorhynchus mykiss*)

PROGRESS REPORT
DON PEDRO PROJECT
FERC NO. 2299





WATER & POWER
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MID
Modesto Irrigation District

Prepared for:
Turlock Irrigation District – Turlock, California
Modesto Irrigation District – Modesto, California

Prepared by:
HDR Engineering, Inc.

January 2013

Temperature Criteria Study
Progress Report

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List of Attachments

List of Acronyms

ac ....acres

ACEC ....Area of Critical Environmental Concern

AF ....acre-feet

ACOE.........................U.S. Army Corps of Engineers

ADA ....Americans with Disabilities Act

ALJ.............................Administrative Law Judge

APE ....Area of Potential Effect

ARMR........................Archaeological Resource Management Report

BA ....Biological Assessment

BDCP ....Bay-Delta Conservation Plan

BLM ...........................U.S. Department of the Interior, Bureau of Land Management

BLM-S ....Bureau of Land Management – Sensitive Species

BMI ....Benthic macroinvertebrates

BMP ....Best Management Practices

BO ....Biological Opinion

CalEPPC ....California Exotic Pest Plant Council

CalSPA.......................California Sports Fisherman Association

CAS ....California Academy of Sciences

CCC............................Criterion Continuous Concentrations

CCIC ....Central California Information Center

CCSF..........................City and County of San Francisco

CCVHJV ....California Central Valley Habitat Joint Venture

CD ....Compact Disc

CDBW........................California Department of Boating and Waterways

CDEC ....California Data Exchange Center

CDFA ....California Department of Food and Agriculture

CDFG ....California Department of Fish and Game (as of January 2013, Department of Fish and Wildlife)

CDMG........................California Division of Mines and Geology

CDOF ....California Department of Finance

CDPH ....California Department of Public Health

CDPR.........................California Department of Parks and Recreation
CDSOD......................California Division of Safety of Dams
CDWR........................California Department of Water Resources
CE ....California Endangered Species
CEII...........................Critical Energy Infrastructure Information
CEQA.........................California Environmental Quality Act
CESA ....California Endangered Species Act
CFR............................Code of Federal Regulations
cfs...............................cubic feet per second
CGS............................California Geological Survey
CMAP ....California Monitoring and Assessment Program
CMC...........................Criterion Maximum Concentrations
CNDDB......................California Natural Diversity Database
CNPS..........................California Native Plant Society
CORP ....California Outdoor Recreation Plan
CPUE ....Catch Per Unit Effort
CRAM........................California Rapid Assessment Method
CRLF..........................California Red-Legged Frog
CRRF ....California Rivers Restoration Fund
CSAS..........................Central Sierra Audubon Society
CSBP..........................California Stream Bioassessment Procedure
CT ....California Threatened Species
CTR............................California Toxics Rule
CTS ....California Tiger Salamander
CVRWQCB ....Central Valley Regional Water Quality Control Board
CWA ....Clean Water Act
CWHR........................California Wildlife Habitat Relationship
Districts......................Turlock Irrigation District and Modesto Irrigation District
DLA ....Draft License Application
DPRA.........................Don Pedro Recreation Agency
DPS ....Distinct Population Segment
EA ....Environmental Assessment
EC ....Electrical Conductivity

EFH ....Essential Fish Habitat
EIR ....Environmental Impact Report
EIS..............................Environmental Impact Statement
EPA ............................U.S. Environmental Protection Agency
ESA ....Federal Endangered Species Act
ESRCD.......................East Stanislaus Resource Conservation District
ESU ....Evolutionary Significant Unit
EWUA........................Effective Weighted Useable Area
FERC..........................Federal Energy Regulatory Commission
FFS ....Foothills Fault System
FL ....Fork length
FMU ....Fire Management Unit
FOT ....Friends of the Tuolumne
FPC ....Federal Power Commission
ft/mi............................feet per mile
FWCA ....Fish and Wildlife Coordination Act
FYLF ....Foothill Yellow-Legged Frog
g..................................grams
GIS ....Geographic Information System
GLO ....General Land Office
GPS ....Global Positioning System
HCP............................Habitat Conservation Plan
HHWP........................Hetch Hetchy Water and Power
HORB ....Head of Old River Barrier
HPMP.........................Historic Properties Management Plan
ILP..............................Integrated Licensing Process
ISR ....Initial Study Report
ITA ....Indian Trust Assets
kV...............................kilovolt
m ....meters
M&I............................Municipal and Industrial
MCL ....Maximum Contaminant Level
mg/kg ....milligrams/kilogram

mg/L..........................milligrams per liter
mgd ....million gallons per day
mi ....miles
mi^2 ....square miles
MID...........................Modesto Irrigation District
MOU ....Memorandum of Understanding
MSCS.........................Multi-Species Conservation Strategy
msl.............................mean sea level
MVA ....Megavolt Ampere
MW ....megawatt
MWh ....megawatt hour
mya............................million years ago
NAE ....National Academy of Engineering
NAHC ....Native American Heritage Commission
NAS...........................National Academy of Sciences
NAVD 88..................North American Vertical Datum of 1988
NAWQA ....National Water Quality Assessment
NCCP ....Natural Community Conservation Plan
NEPA ....National Environmental Policy Act
ng/g ....nanograms per gram
NGOs ....Non-Governmental Organizations
NHI ....Natural Heritage Institute
NHPA.........................National Historic Preservation Act
NISC ....National Invasive Species Council
NMFS.........................National Marine Fisheries Service
NOAA ....National Oceanic and Atmospheric Administration
NOI ....Notice of Intent
NPS ............................U.S. Department of the Interior, National Park Service
NRCS ....National Resource Conservation Service
NRHP.........................National Register of Historic Places
NRI............................Nationwide Rivers Inventory
NTU ....Nephelometric Turbidity Unit
NWI............................National Wetland Inventory

NWIS ....National Water Information System
NWR ....National Wildlife Refuge
NGVD 29 ....National Geodetic Vertical Datum of 1929
O&M ....operation and maintenance
OEHHA.......................Office of Environmental Health Hazard Assessment
ORV ....Outstanding Remarkable Value
PAD.............................Pre-Application Document
PDO.............................Pacific Decadal Oscillation
PEIR............................Program Environmental Impact Report
PGA.............................Peak Ground Acceleration
PHG.............................Public Health Goal
PM&E ....Protection, Mitigation and Enhancement
PMF.............................Probable Maximum Flood
POAOR ....Public Opinions and Attitudes in Outdoor Recreation
ppb...............................parts per billion
ppm ....parts per million
PSP..............................Proposed Study Plan
QA...............................Quality Assurance
QC ....Quality Control
RA ....Recreation Area
RBP ....Rapid Bioassessment Protocol
Reclamation ...............U.S. Department of the Interior, Bureau of Reclamation
RM ....River Mile
RMP ....Resource Management Plan
RP................................Relicensing Participant
RSP ....Revised Study Plan
RST ....Rotary Screw Trap
RWF ....Resource-Specific Work Groups
RWG ....Resource Work Group
RWQCB......................Regional Water Quality Control Board
SC................................State candidate for listing under CESA
SCD.............................State candidate for delisting under CESA
SCE ....State candidate for listing as endangered under CESA

SCT ....State candidate for listing as threatened under CESA
SD1 ....Scoping Document 1
SD2 ....Scoping Document 2
SE...............................State Endangered Species under the CESA
SFP.............................State Fully Protected Species under CESA
SFPUC ....San Francisco Public Utilities Commission
SHPO ....State Historic Preservation Office
SJRA ....San Joaquin River Agreement
SJRGA ....San Joaquin River Group Authority
SJTA ....San Joaquin River Tributaries Authority
SPD ....Study Plan Determination
SRA............................State Recreation Area
SRMA ....Special Recreation Management Area or Sierra Resource Management Area (as per use)
SRMP.........................Sierra Resource Management Plan
SRP ....Special Run Pools
SSC ....State species of special concern
ST...............................California Threatened Species under the CESA
STORET ....Storage and Retrieval
SWAMP.....................Surface Water Ambient Monitoring Program
SWE...........................Snow-Water Equivalent
SWRCB......................State Water Resources Control Board
TAC............................Technical Advisory Committee
TAF ....thousand acre-feet
TCP ....Traditional Cultural Properties
TDS............................Total Dissolved Solids
TID.............................Turlock Irrigation District
TMDL ....Total Maximum Daily Load
TOC............................Total Organic Carbon
TRT............................Tuolumne River Trust
TRTAC ....Tuolumne River Technical Advisory Committee
UC..............................University of California
USDA.........................U.S. Department of Agriculture

USDOC......................U.S. Department of Commerce
USDOI ......................U.S. Department of the Interior
USFS..........................U.S. Department of Agriculture, Forest Service
USFWS ......................U.S. Department of the Interior, Fish and Wildlife Service
USGS .........................U.S. Department of the Interior, Geological Survey
USR...........................Updated Study Report
UTM..........................Universal Transverse Mercator
VAMP........................Vernalis Adaptive Management Plan
VELB ....Valley Elderberry Longhorn Beetle
VRM ....Visual Resource Management
WPT...........................Western Pond Turtle
WSA...........................Wilderness Study Area
WSIP..........................Water System Improvement Program
WWTP ....Wastewater Treatment Plant
WY............................water year
µS/cm ....microSeimens per centimeter

1.0 INTRODUCTION

1.1 General Description of the Don Pedro Project

Turlock Irrigation District (TID) and Modesto Irrigation District (MID) (collectively, the Districts) are the co-licensees of the 168-megawatt (MW) Don Pedro Project (Project) located on the Tuolumne River in western Tuolumne County in the Central Valley region of California. The Don Pedro Dam is located at river mile (RM) 54.8 and the Don Pedro Reservoir formed by the dam extends 24-miles upstream at the normal maximum water surface elevation of 830 ft above mean sea level (msl; NGVD 29). At elevation 830 ft, the reservoir stores over 2,000,000 acre-feet (AF) of water and has a surface area slightly less than 13,000 acres (ac). The watershed above Don Pedro Dam is approximately 1,533 square miles (mi^2).

Both TID and MID are local public agencies authorized under the laws of the State of California to provide water supply for irrigation and municipal and industrial (M&I) uses and to provide retail electric service. The Project serves many purposes including providing water storage for the beneficial use of irrigation of over 200,000 ac of prime Central Valley farmland and for the use of M&I customers in the City of Modesto (population 210,000). Consistent with the requirements of the Raker Act passed by Congress in 1913 and agreements between the Districts and City and County of San Francisco (CCSF), the Project reservoir also includes a “water bank” of up to 570,000 AF of storage. CCSF may use the water bank to more efficiently manage the water supply from its Hetch Hetchy water system while meeting the senior water rights of the Districts. CCSF’s “water bank” within Don Pedro Reservoir provides significant benefits for its 2.6 million customers in the San Francisco Bay Area.

The Project also provides storage for flood management purposes in the Tuolumne and San Joaquin rivers in coordination with the U.S. Army Corps of Engineers (ACOE). Other important uses supported by the Project are recreation, protection of the anadromous fisheries in the lower Tuolumne River, and hydropower generation.

The Project Boundary extends from approximately one mile downstream of the dam to approximately RM 79 upstream of the dam. Upstream of the dam, the Project Boundary runs generally along the 855 ft contour interval which corresponds to the top of the Don Pedro Dam. The Project Boundary encompasses approximately 18,370 ac with 78 percent of the lands owned jointly by the Districts and the remaining 22 percent (approximately 4,000 ac) is owned by the United States and managed as a part of the U.S. Bureau of Land Management (BLM) Sierra Resource Management Area.

The primary Project facilities include the 580-foot-high Don Pedro Dam and Reservoir completed in 1971; a four-unit powerhouse situated at the base of the dam; related facilities including the Project spillway, outlet works, and switchyard; four dikes (Gasburg Creek Dike and Dikes A, B, and C); and three developed recreational facilities (Fleming Meadows, Blue Oaks, and Moccasin Point Recreation Areas). The location of the Project and its primary facilities is shown in Figure 1.1-1. .

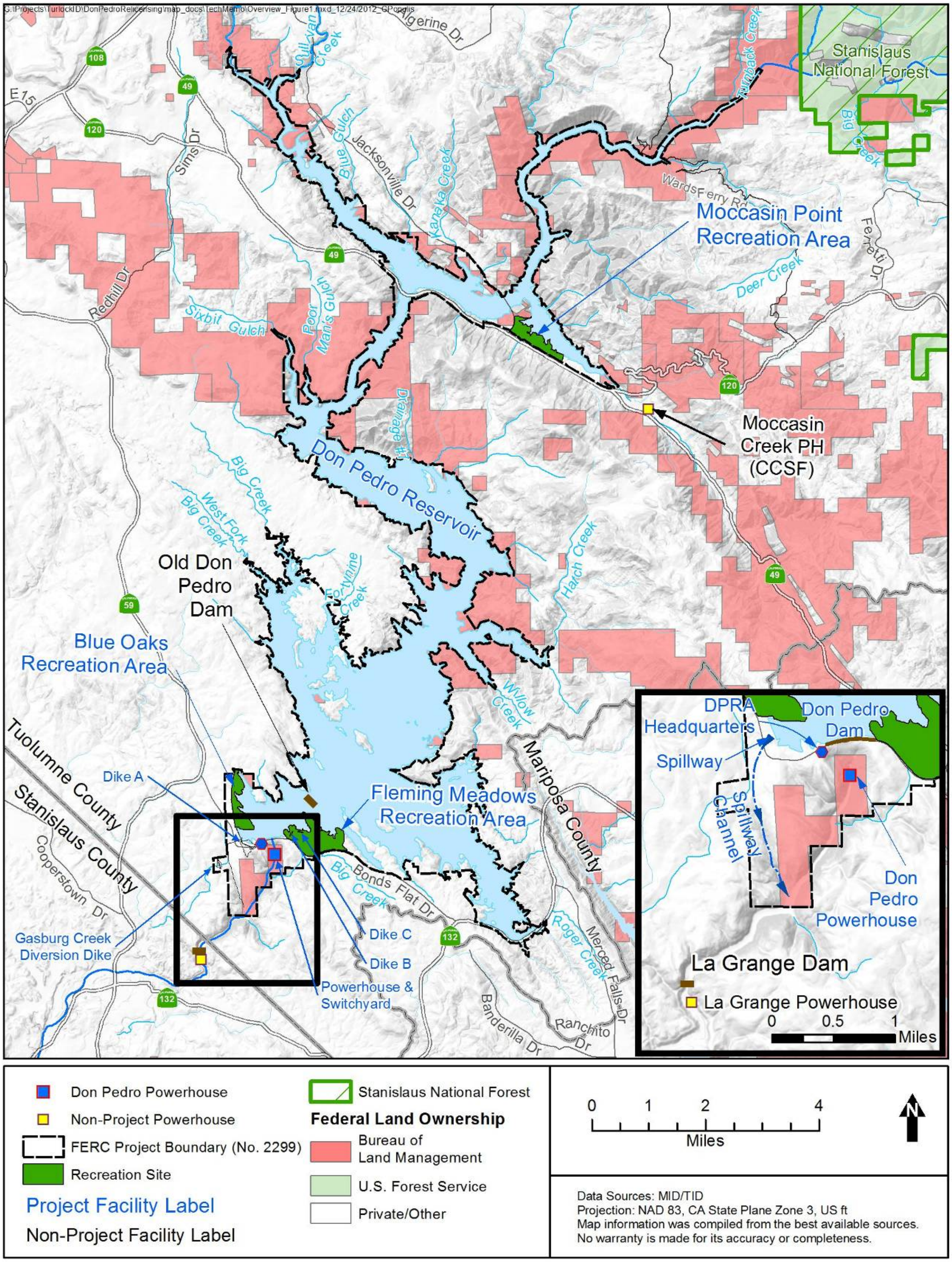

Figure 1.1-1. Don Pedro Project location.

1.2 Relicensing Process

The current FERC license for the Project expires on April 30, 2016, and the Districts will apply for a new license no later than April 30, 2014. The Districts began the relicensing process by filing a Notice of Intent and Pre-Application Document (PAD) with FERC on February 10, 2011, following the regulations governing the Integrated Licensing Process (ILP). The Districts' PAD included descriptions of the Project facilities, operations, license requirements, and Project lands as well as a summary of the extensive existing information available on Project area resources. The PAD also included ten draft study plans describing a subset of the Districts' proposed relicensing studies. The Districts then convened a series of Resource Work Group meetings, engaging agencies and other relicensing participants in a collaborative study plan development process culminating in the Districts' Proposed Study Plan (PSP) and Revised Study Plan (RSP) filings to FERC on July 25, 2011 and November 22, 2011, respectively.

On December 22, 2011, FERC issued its Study Plan Determination (SPD) for the Project, approving, or approving with modifications, 34 studies proposed in the RSP that addressed Cultural and Historical Resources, Recreational Resources, Terrestrial Resources, and Water and Aquatic Resources. In addition, as required by the SPD, the Districts filed three new study plans (W&AR-18, W&AR-19, and W&AR-20) on February 28, 2012 and one modified study plan (W&AR-12) on April 6, 2012. Prior to filing these plans with FERC, the Districts consulted with relicensing participants on drafts of the plans. FERC approved or approved with modifications these four studies on July 25, 2012.

Following the SPD, a total of seven studies (and associated study elements) that were either not adopted in the SPD, or were adopted with modifications, formed the basis of Study Dispute proceedings. In accordance with the ILP, FERC convened a Dispute Resolution Panel on April 17, 2012 and the Panel issued its findings on May 4, 2012. On May 24, 2012, the Director of FERC issued his Formal Study Dispute Determination, with additional clarifications related to the Formal Study Dispute Determination issued on August 17, 2012.

This progress report describes the objectives, methods, and results of the Temperature Criteria Study (W&AR-14) as implemented by the Districts in accordance with FERC's SPD and subsequent study modifications and clarifications. Documents relating to the Project relicensing are publicly available on the Districts' relicensing website at www.donpedro-relicensing.com.

1.3 Study Plan

FERC's Scoping Document 2 identified potential effects of the Project on aquatic resources including anadromous fish. The continued operation and maintenance (O&M) of the Don Pedro Project (Project) may contribute to cumulative effects on habitat availability and production of in-river life stages of Chinook salmon and *O. mykiss* in the lower Tuolumne River. FERC's December 22, 2011 SPD did not recommend that the Districts conduct the W&AR-14 *Temperature Criteria Assessment (Chinook salmon and Oncorhynchus mykiss)*. FERC determined that documents provided by the California Department of Fish and Game (CDFG) and the National Marine Fisheries Service (NMFS) support the use of Environmental Protection Agency (EPA; 2003) temperature criteria for all life stages of salmonids in the lower Tuolumne

River. As such, FERC determined that the existing information concerning the effects of water temperature on specific life-stages of salmonids is sufficient (study criterion 4), and that while the Districts' temperature criteria assessment may have the potential to inform W&AR-05 *Salmonid Populations Information Integration and Synthesis Study*, FERC will continue to rely upon the temperature criteria in EPA (2003) for its evaluation of Project effects, unless empirical evidence from the lower Tuolumne River is provided that suggests different criteria are appropriate for salmonids in the lower Tuolumne River. As such, FERC does not see the need for the Districts to conduct this study.

The Districts are carrying out the temperature criteria study consistent with the study plan, including development of empirical evidence from the lower Tuolumne River that could suggest different criteria are appropriate for evaluating potential effects of temperature on salmonids in the lower Tuolumne River.

2.0 STUDY GOALS AND OBJECTIVES

The Districts propose a study that would develop information on the influence of temperature on the in-river life-stages of Chinook salmon and *O. mykiss* found in the lower Tuolumne River. The specific study objectives include the following:

- Identify life stage-specific fisheries population effects related to water temperatures found in the lower Tuolumne River (e.g., effects on growth, disease susceptibility, predation risk, etc.);
- Identify life stage-specific water temperature evaluation parameters (i.e., effects associated with expected range of water temperatures);
- Assess and select an acceptable, informative approach to analyzing temperature regimes and their influences on Chinook salmon and *O. mykiss* in the lower Tuolumne River; and
- Evaluate the historical exceedance of identified water temperature criteria.

3.0 STUDY AREA

The study area includes the observed habitat use by Chinook salmon and *O. mykiss* in the Tuolumne River, extending from the La Grange dam (RM 52) downstream to the confluence with the San Joaquin River (RM 0). However, because this study plan addresses different Chinook salmon and ***O.*** *mykiss* life stages, these boundaries can vary by life stage.

4.0 METHODOLOGY

The study is using literature and information, including previously conducted studies and ongoing Tuolumne River monitoring, to examine biologically relevant water temperature parameters for in-river life-stages of Chinook salmon and *O. mykiss*. Tasks in this study plan that address life stage-specific criteria for anadromous *O. mykiss* also would serve to address life stage-specific criteria for resident *O. mykiss* during freshwater life stages.

As confirmed by FERC in its December 2011 SPD, the development, evaluation and application of empirical evidence that would reduce uncertainties regarding temperature-related effects on Tuolumne River salmonids is a prime directive of this study. Acquisition and evaluation of information collected as part of previous and ongoing evaluations of salmonids in the LTR and in other Central Valley streams is a fundamental approach to this study. Additionally, FERC's emphasis on empirical evidence has further encouraged the Districts to identify and consider new evaluations that could contribute to more focused understanding of potential influences of temperature on LTR salmonids. As such, the Districts have updated and expanded the approach originally defined in W&AR 14 to include identification and consideration of evaluations that could build on existing information and potential original investigations of LTR salmonids to provide empirical evidence that could assist FERC in evaluating Project-related temperature influences on LTR Chinook salmon and *O. mykiss*. A major part of this effort has involved the Relicensing Participants in the review and comment on the identification and development of studies proposed to provide applicable, meaningful, empirical information to the temperature criteria evaluation.

The study is being conducted using the following steps defined in W&AR 14. Steps undertaken by the Districts upon initiation of this study that targeted acquisition and evaluation of additional empirical information are listed here and defined further in Attachment A – *Additional Study Plans for Acquisition and Evaluation of Information Supporting Development of Emperical Evidence Addressing Temperature Criteria for Salmonids in the Lower Tuolumne River.*

<u>Step 1 – Review Relevant Literature.</u> In order to successfully evaluate the influences of water temperature regimes on salmonid life history, relevant in-river life stages and life-history timing will be identified using existing river-wide monitoring and through coordination with fishery agency personnel. Evaluation will also include a literature review, including those already identified by RPs. The review and subsequent tasks to be conducted during this study will involve RP participation to be facilitated by convening coordination meetings once the study begins.

To identify appropriate water temperature evaluation parameters for the selected life stages and identified life history timing, the study will focus on effects of a range of temperatures that are beyond those identified as thresholds or benchmarks of optimum conditions (e.g., EPA 2003). The study is supported by a review of existing water temperature criteria guidance documents that will (1) provide logical and biologically sound rationale for each life stage definition and/or combination of life stages; (2) interpret the literature on the life stage-specific fisheries population effects (e.g., egg mortality, growth effects, disease incidence, predation risk, acute lethal temperatures, etc.); and (3) consider the effects of exposure time at either constant or fluctuating temperatures.

The types of literature anticipated to be examined include scientific journals, Master's theses and Ph.D. dissertations, peer reviewed literature, and agency publications. To the extent available, data from recent unpublished or ongoing studies will be evaluated, including reported observations on water temperature-related effects, dose-response studies, and empirical relationships between water temperature and measures of fish biological performance (e.g., egg-retention percentage, fertilization percentage, embryo viability, pre-spawning mortality, onset of smolting, juvenile growth, increased incidence of disease, etc.).

The literature review will emphasize relevant laboratory and field experiments identifying water temperature-related effects on Chinook salmon and *O. mykiss* in a hierarchical manner. Literature that provides information from the Tuolumne River will be given the greatest emphasis, followed by information from the San Joaquin River system, and then followed by other Central Valley streams and rivers, as well as regulatory documents such as biological opinions from NMFS. Studies on fish from outside the Central Valley will be included, as appropriate, to augment the review.

Preliminary cursory literature review indicates that the application of temperature parameters to determine potential effects on targeted life stages varies and much of the literature on salmonid water temperature requirements refers to "stressful," "tolerable," "preferred or "optimal" water temperatures or water temperature ranges (e.g., McCullough 1999). Because of the variation in description of potential effects of elevated water temperatures on anadromous salmonids, care will be taken to identify an appropriate range of water temperature criteria that describe the range of effects that could occur. Water temperature criteria will be identified to represent a gradation of potential effects, from reported optimal water temperatures increasing to lethal water temperatures for each life stage from data gathered in both the laboratory and in the field so as to not bias the results by relying on a temperature recommendation developed using a single technique. In addition, care will be taken to verify the appropriateness of individual temperature criteria, and in particular, recommendations supported by references to other literature. For example, Hinze (1959) actually examines the effects of water temperature on incubating Chinook salmon eggs, yet Hinze (1959) is cited in Boles et al. (1988); Marine (1992); and NMFS (1997) in statements regarding the effects of water temperature on holding Chinook salmon adults. Boles et al. (1988) and Marine (1992) were then further cited by McCullough et al. (2001) in support of statements regarding how water temperature affects the viability of gametes developing in adults.

The results of information developed under Step 1 will identify:

- The relevant life history timing of Chinook salmon and *O. mykiss* in the Tuolumne River.
- The types of life stage-specific effects on Tuolumne River Chinook salmon and *O. mykiss* that could occur over a range of water temperatures.
- Life stage-specific effects of temperatures in the lower Tuolumne River on Chinook salmon and *O. mykiss*.

- The most robust approach to developing parameters applicable to characterizing effects of temperature conditions in the lower Tuolumne River on its Chinook salmon and *O. mykiss* populations.

The list of the references reviewed in this study is being maintained and some of the references have been provided to Relicensing Participants during preparation for W&AR 14 meetings. The list will be updated during the conduct of Step 1.

Step 2 – Develop Water Temperature Evaluation Parameters.

Based upon the literature and information review conducted in Step 1, biologically defensible water temperature evaluation parameters will be developed. The criteria development will synthesize existing water temperature reviews and guidance documents (e.g., Marine 1992, Myrick and Cech 2001, EPA 2003) as well as approaches for criteria development (e.g., Baker et al 1995, Jager et al. 1997, Sullivan et al 2000, Pagliughi 2008, RMT 2010).

The study will use the term "index" as a metric characterizing temperature data (measured or modeled) over specific time periods of interest (i.e., a life stage); examples include daily or seasonal average temperatures, daily or annual maximum temperatures, 7-day average of daily maximum temperatures (7DADM), and the annual maximum weekly average temperature (MWAT) among others. Temperature "thresholds" are identified in Step 1 above, and are defined as the value of a selected index that temperature must remain below to avoid specified (i.e., adverse) impacts. Temperature "Criteria" are defined as a combination of an index and associated threshold(s).

Acute Criteria. Acute temperature criteria refer to "lethal" conditions (often reported as the upper incipient lethal temperature, or UILT) and will be based primarily on laboratory studies with adjustments for acclimatization and other factors (e.g., Myrick and Cech, 2001) using the appropriate indices reflecting short term exposure (e.g., daily maximum water temperature). It may also be possible to set acute temperature standards at lower temperatures using a longer term exposure approach (e.g., MWAT) approach if supported by available literature or survey data reliably documenting life-stage presence/absence at conditions corresponding to the selected index.

Chronic and Sub-lethal Criteria. There are a variety of chronic and sub-lethal effects that can adversely affect anadromous salmonid populations (EPA 2003). These chronic and sub-lethal effects include reduced juvenile growth, increased incidence of disease, reduced viability of gametes in adults prior to spawning, increased susceptibility to predation and competition, and suppressed or reversed smoltification. Sub-lethal criteria will be based upon the effects assessment developed in Step 1 above, including reduced growth, increased susceptibility to disease, predator avoidance, or other identified effects on individual fish. Literature-based criteria for juvenile life stages developed from literature sources may be adjusted by application of bioenergetics approaches proposed by Sullivan et al (2000). Adaptation of this approach will require (1) review of existing estimates of food consumption and ration size (TID/MID 1997, Report 96-9), (2) identification of biologically relevant growth criteria (e.g., percent reduction from optimal, size at date, etc.), and (3) bioenergetic growth modeling as functions of temperature and fish size (i.e., length or weight). Depending upon the suitability of existing data, criteria specific to the Tuolumne River will be developed and compared with those reviewed in Step 1.

The results of information developed under Step 2 will identify:

- In-river temperatures that would be protective of Chinook salmon and *O. mykiss* at each identified in-river life-stage.
- Indices, or metrics, that should be used to assess individual and population-level effects of a specific water temperature regime on Chinook salmon and *O. mykiss* in the Tuolumne River.
- Appropriate water temperature evaluation criteria for the Tuolumne River.

<u>Step 3 – Relate Baseline Water Temperature Conditions to Population</u>. Following the literature review and identification of water temperature and population-level fisheries parameters in Steps 1 and 2 above, the criteria will be applied to water temperatures recorded at various locations in the lower Tuolumne River. Exceedance probability distributions will be developed for the various criteria (e.g., optimum, stressful) from ranked and sorted water temperature data and the proportion of time that each of the water temperature evaluation parameter is exceeded will be calculated. Based on these exceedance probabilities, the potential effects on anadromous salmonids will be summarized and discussed.

The results of information developed under Step 3 will identify:

- How often each of the life stage-specific water temperature evaluation parameters are met under baseline conditions.
- How often various water temperature evaluation parameters were met, and the likely sub-lethal and population-level effects on Tuolumne River Salmonids.

5.0 RESULTS

In response to FERC's SPD stating that FERC would consider empirical evidence from the lower Tuolumne River in addressing modification of temperature criteria for evaluation of Project effects on salmonids, the Districts initiated an investigation of potential sources of empirical evidence that could be integrated into Study W&AR 14. Conduct of the four steps comprising W&AR 14, defined above, is ongoing and will continue concurrent with the additional empirical studies identified in this progress report.

Eight studies identified as potentially yielding empirical evidence on temperature effects in the Tuolumne River were discussed with Relicensing Participants during the April 11, 2012 meeting on W&AR-14 - Temperature Criteria Assessment Study. During the workshop, questions were raised concerning data availability and utility to conduct the five studies considered "desktop" studies, since they would involve evaluation of existing field data. The studies and their status was discussed with relicensing participants at the November 16, 2012 progress meeting, and are briefly described in the following sections. Three additional studies also discussed during the meetings would require additional data collection. These studies are no longer being considered for implementation.

The study team has further evaluated the availability and utility of data to conduct the five "desktop" studies and have determined that there are sufficient data to conduct all or part of three studies (2, 3 and 7 below), but are insufficient to conduct all or part of three studies (3, 6 and 8 below). Additionally, the Districts will proceed with proposed Study 1, but have determined that Studies 4 and 5 will not be pursued further. Further detail on each study is summarized below.

Study 1 - Local Adaptation of Temperature Tolerance of O. mykiss Juveniles in the Lower Tuolumne River

Objective: Determine the temperature tolerance of juvenile and subadult *O. mykiss* captured from the lower Tuolumne River (LTR) to assess any local adaptation to warmer temperatures occurring in the southern extent of *O. mykiss* range.

Status: The Districts propose to conduct this study during 2013 and have initiated discussions with the National Marine Fisheries Service (NMFS) in order to obtain a Section 10 permit required to conduct this study. A study plan is included in Attachment A.

Study 2 – Spatial distribution juvenile O. mykiss in response to temperature

Objective: Identify temperature thresholds that define rearing temperature tolerances for juvenile *O. mykiss* rearing.

Status: Data availability and utility have been determined to be sufficient to support conduct of this study. A study plan is included in Attachment A.

Study 3 – Influence of temperature on growth of O. mykiss and Chinook salmon

Objective: Identify temperature thresholds that support "acceptable/expected" growth of juvenile *O. mykiss* and juvenile Chinook salmon in the lower Tuolumne River.

Status: Evaluation of the availability and utility of data to support this study has shown that data are not available to conduct an evaluation of the observed influence of temperature on growth of *O mykiss*. Therefore, the Districts will not pursue this aspect of the study. However, data are available and suitable for conducting an evaluation of observed temperature influences on growth of Fall-run Chinook salmon. Therefore, the Districts will pursue this aspect of the study.

Study 4 – Effect of temperature observed as changes in condition/health of Chinook salmon

Objective: This study would evaluate the influence of the temperature regime of the Tuolumne River on Chinook salmon survival potential, measured as specific temperature-related affects to health and condition of smolt or smolt-sized Chinook salmon. The study would evaluate quality of Chinook salmon smolt rearing in the Tuolumne River using methods previously applied by CDFG (Rich and Loudermilk 1991) and USFWS (Nichols and Foote 2002) to assess Chinook salmon condition in the San Joaquin River system

Status: The Districts will not pursue implementation of this study

Study 5 – Influence of temperature on location, movement, survival potential of O. mykiss.

Objective: Acoustic tagging *O. mykiss* during early summer in various locals with various temperature expectations and monitor movement and survival to emigration.

Status: The Districts will not pursue implementation of this study

Study 6 – Influence of temperatures during the early Chinook salmon spawning period on egg survival.

Objective: Identify the relationship between temperature and egg-fry survival in the lower Tuolumne River. Study would evaluate the influence of observed temperature conditions during spawning on Chinook salmon spawning (egg to emergence survival).

Status: The Districts will not pursue implementation of this study. Data required to conduct this study are not available. Data on emergence of Chinook salmon fry from redds within the Tuolumne River are available, but those data are not associated with temperature conditions, were not complete, or were too few to allow evaluation of influences of temperature on redd survival.

Study 7 – Influence of temperature on timing of initial spawning of Chinook salmon

Objective: Identify adult Chinook salmon response to temperatures that exceed optimum, per EPA (2003) in the lower Tuolumne River in the early portion of the spawning period. Evaluation of inter annual timing of spawning will be compared with temperatures during early spawning period using redd surveys or carcass survey results to identify temporal distribution of early spawning, and pre-spawning mortality, potentially measured as egg retention during carcass surveys.

Status: Data availability and utility have been determined to be sufficient to support conduct of this study. A study plan is included in Attachment A.

Study 8 – Chinook salmon production related to precedent temperature conditions

Objective: Identify effects of early temperature regime influence on Chinook salmon production measured as the relationship between spawner population and juvenile emigration from the natal stream reach.

Status: The Districts will not to pursue implementation of this study

6.0 DISCUSSION AND FINDINGS

Results of the temperature criteria evaluation will be available in 2013.

7.0 STUDY VARIANCES AND MODIFICATIONS

There are no study variances for W&AR-14. The study has been modified to include the updates to the study and additional, empirical evaluations, described in Attachment A.

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STUDY REPORT WAR-14
TEMPERATURE CRITERIA ASSESSMENT

ATTACHMENT A

ADDITIONAL STUDY PLANS FOR ACQUISITION AND EVALUATION OF INFORMATION SUPPORTING DEVELOPMENT OF EMPIRICAL EVIDENCE ADDRESSING TEMPERATURE CRITERIA FOR SALMONIDS IN THE LOWER TUOLUMNE RIVER.

Study 1 - Local Adaptation of Temperature Tolerance of O. mykiss Juveniles in the Lower Tuolumne River

1.0 PROJECT NEXUS

The continued operation and maintenance (O&M) of the existing Don Pedro Project (Project) has the potential to cumulatively affect the anadromous fish populations between La Grange Diversion Dam and the confluence of the Tuolumne River and San Joaquin River.

2.0 STUDY GOALS

Determine the temperature tolerance of juvenile and subadult *O. mykiss* inhabiting the lower Tuolumne River (LTR) to assess any local adaptation to temperature.

3.0 EXISTING INFORMATION AND NEED FOR ADDITIONAL INFORMATION

Speculation on the adaptability of anadromous salmonids to the various temperature regimes encountered throughout their range suggests that *O. mykiss* in the southern extent of their range may be innately more tolerant of warmer temperature regimes than reported in the literature. The local adaptability of LTR *O. mykiss* would allow better performance at warmer temperatures than would be predicted based on studies of *O. mykiss* populations in the northern extent of the range. A determination that LTR *O. mykiss* are locally adapted to warmer temperatures would support the reassessment and establishment of different optimum temperature thresholds (i.e., relative to EPA 2003) that may be appropriate for *O. mykiss* in the Central Valley stream system.

This study will evaluate if *O. mykiss* that inhabit the LTR are adapted to higher temperature tolerances that may better define site-specific temperature performance metrics. A case study of temperature tolerance among fishes is likely to prove extremely fruitful in addressing the more general and important question of animal resilience and adaptability to environmental change (Farrell 2009). Fishes generally have evolved around species-specific niches, living in almost every conceivable aquatic habitat and representing almost half of the earth's vertebrate species (Farrell 2009). Thus, it is expected that *O. mykiss* populations in different parts of the species range would show differences in physiological performance and in other biological traits that reflect adaptations to regional or more localized environmental conditions.

4.0 STUDY METHODS

4.1 Study Location

The study area is the reach of the lower Tuolumne River between the San Joaquin River (RM 0.0) and the La Grange Diversion Dam (RM 52.2).

4.2 Study Approach

The Districts would follow methods described by Parsons (2011) and others to evaluate the capabilities of local *O. mykiss* to accommodate warmer temperatures. Specifically, Parsons (2011) studied the respiratory physiological basis for temperature tolerance in sockeye salmon and examined the overall hypothesis that each sockeye salmon population has adapted to meet specific upriver migration conditions. Swimming respiratory performance was compared over a range of temperatures across wild, migrating adult sockeye salmon populations.

Fish evaluated as per Parsons (2011) were tested in Brett-type swim tunnels. The first day (24-hour duration) of the Parsons (2011) study required placement of an individual fish into the swim tunnel to acclimate it to its new environment. The Districts propose using swim tunnels to measure the optimal temperature (T_{opt}) and critical temperature (T_{crit}) for fish ranging from about 100 to 200 mm fork length (FL). The T_{opt} window, as defined by Parsons (2011)**,** is *"the range in temperatures between the upper and lower T_p when maximum aerobic scope is maintained*". Aerobic scope--which is measured at a given temperature--is the observed difference or range between the maximum respiratory performance (i.e., maximum oxygen consumption) and resting respiratory performance (i.e., resting oxygen consumption) at that temperature. The T_p points are the pejus temperatures (pejus means getting worse); therefore, the T_p points are the temperatures where aerobic scope is getting worse (i.e., becomes smaller in width) (Figure 1). If a respiratory limitation exists for exercising salmonids during warming, increases in aerobic scope should cease once T_{opt} is reached (Farrell 2009). Ultimately, as warming approaches T_{opt} the potential to increase maximum respiratory performance (oxygen consumption by exercising fish) fails to keep up with the required increase in respiratory rate in a resting fish (Farrell 2009). As a result, because aerobic scope does not increase above T_{opt} (Figure. 1), swimming effort either declines or stops (Farrell 2009).

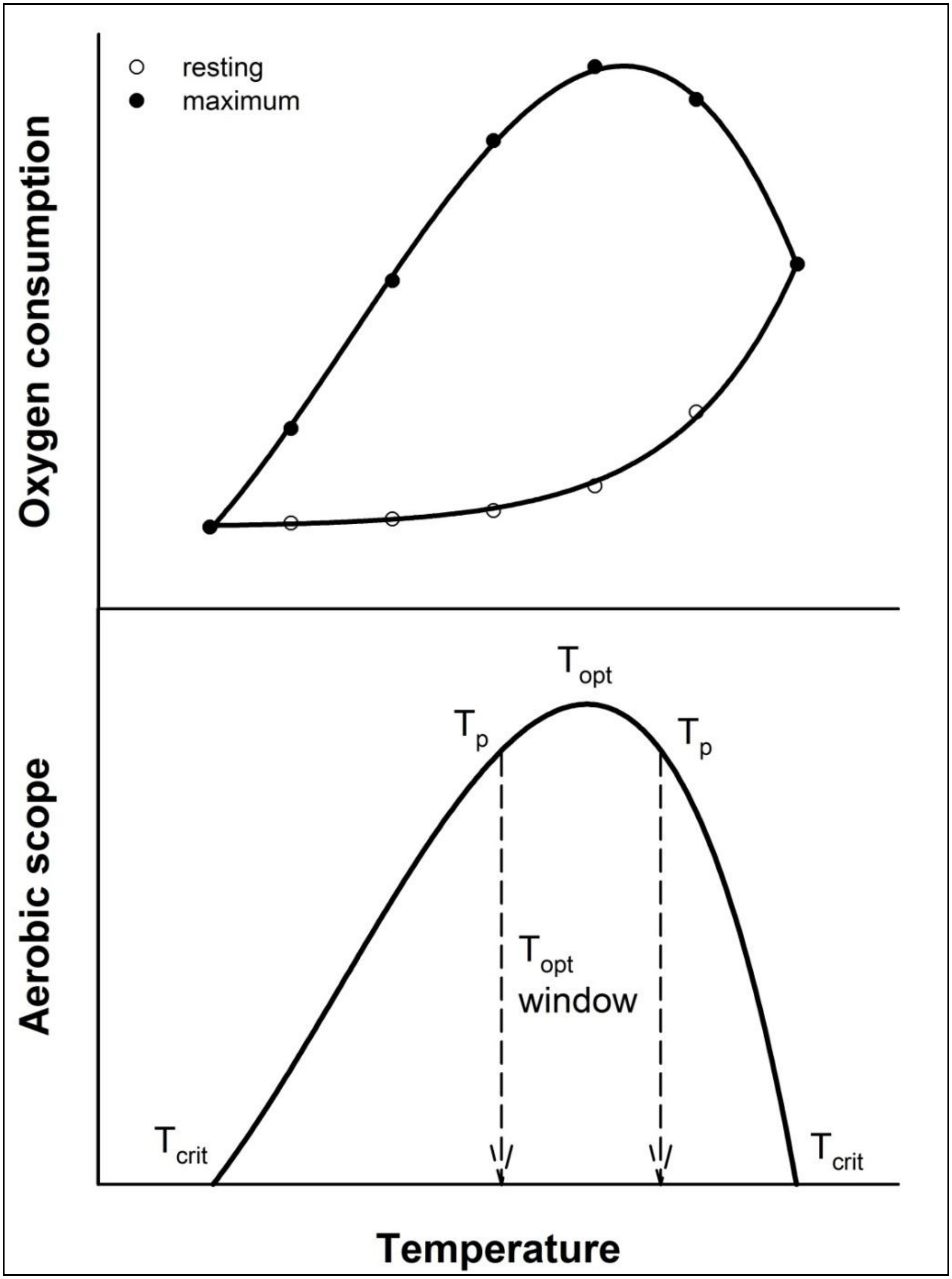

Figure 1. Schematic of resting and maximum oxygen consumption and aerobic scope. See text for details. T_{opt} = optimum temperature, T_p = pejus temperatures, T_{crit} = critical temperatures. The T_{opt} window corresponds to the range of temperatures between the upper and lower T_p (Source – Parsons 2011).

The primary goal of the swim tunnel experiment would be to determine the temperatures that bound the T_{opt} window for LTR *O. mykiss*, and how rapidly aerobic scope declines between the upper T_p and T_{crit}. These temperatures and the shape of the aerobic scope curve could then be compared with those of other *O. mykiss* populations to determine if there is evidence for local temperature adaption for LTR fish compared to more northern populations. These results could also be applied to assess relative responses to temperatures including potential variation in observed T_{opt} compared to EPA (2003) criteria, and relative performance between T_{opt} and T_{crit}. This assessment should help define more accurate criteria for evaluation of temperature tolerance for juvenile *O. mykiss* rearing in the LTR.

The study is designed to measure a routine, or resting, (minimum) and a swimming (maximum) metabolic rate for each individual fish and then test each fish at a targeted temperature that occurs between the ambient temperature at the time of capture and upper T_{crit}. The selection of test temperatures will depend on the lifestage. Iincrements of 1^oC are preferred. Replication at each temperature will depend on individual variability, but at least six fish will be tested at each temperature.

Each fish will be tested at a specific temperature ranging from the ambient, or current temperature of the LTR to a potentially T_{crit} (e.g., 23 ^oC). For example, if ambient temperature is 18 ^oC, six temperatures would be tested to determine resting and swimming metabolic rate. At least six replicates (potentially six fish tested) will be conducted for each temperature. If there are six temperatures to be tested, the study would require a minimum of 36 tests (for more detail see discussion below).

The precise protocol can be varied somewhat depending on the number of fish available and the time frame targeted for the work (e.g., 1 month, etc.) The variation in potential protocols is discussed below. Under ideal conditions, a fish would be placed in the tunnel in the evening, left overnight, a routine measurement would be made early in the morning and then the fish would be tested shortly afterwards for the maximum measurement. This fish would be tested only at one temperature. To obtain a reliable resting metabolic rate will require the fish to be undisturbed for at least 4 h after handling (capture). The measurement takes about 30 min. The swim test can be conducted immediate afterwards and takes about 2 h.

There are a number of variations of the basic swim-tunnel type of study that would generally accommodate a field-test of the aerobic metabolic performance of the *O. mykiss*. . As such, there are several ways of conducting the study in terms of experimental-design protocol. For example, individual fish might be tested for aerobic metabolic rate at a single temperature but for two different (low and high) flows, as done in the Parsons study. Alternatively, it may be feasible to test each subject fish repetitively—i.e., at two different flows for each of several test temperatures—assuming that the tested fish are allowed sufficient recovery period between testing episodes. Repetitive testing procedures have been used in Farrell‘s previous studies (pers. comm. A. Farrell, December 2012), some of which indicate that individual fish may show decreased metabolic performance (i.e., reduced aerobic scope) if repeatedly tested without sufficient recuperation time.

Details of the protocol that is eventually selected depends on a variety of conditions that will be identified during the implementation of this scope of work (SOW). Ultimately, it would be the prerogative of the experimental team to decide on the specific approach to be utilized and on various details of the testing protocol. The team's decision would require coordination with NMFS to assure that the selected protocol would meet NMFS's permitting requirements and accommodate the study goal and objectives. As such, two primary options for the testing protocol have been identified and are described in more detail in scenarios presented below.

Juvenile *O. mykiss* would be collected from the LTR during spring-summer[1] 2013, using seining or similar methods that would need to be approved by CDFG and NMFS in a Section 10 permit and California Scientific Collecting Permit SCP). Parsons (2011) indicates that at least six fish will be tested for each temperature to be evaluated; as such, 30 individuals would be needed for the study if starting temperature is about 18 ^{o}C and 42 fish if starting temperature is about 16 ^{o}C. After collection in the field, individual fish would be placed into the Brett-type swim tube for a period of 24 hours to acclimate to the test equipment (Parsons 2011). The experiment would be conducted during the second day once the fish have acclimated to the tube. Following completion of the experiment, fish would be held until they recover. Once recovered, fish would be released downstream of the initial capture location. One fish per swim tube per use-day would be needed. Results of previous, similar tests conducted by the investigators indicate that the risk of mortality resulting from the test is extremely low.

The study will comprise four tasks:

Task 1 – Planning and Logistics

- Apply for a Section 10 Research Permit from NMFS to collect and evaluate *O. mykiss* from the LTR. The minimum number of *O. mykiss* to be collected will depend upon the selected protocol (see below).
- Secure laboratory equipment and personnel to conduct field evaluations.
- Identify source (method) and personnel to collect fish.
- Finalize schedule based on permit process and personnel and equipment availability. Setup stream-side facilities for tests.

Various questions will need to be resolved per this task, including the method to be used to collect the test fish. Based on previous year's rotary screw trap (RST) trapping results on the LTR, the likelihood is that sufficient numbers of *O. mykiss* will not be available from RST captures in a timely manner. Seining surveys of the lower Tuolumne River conducted by FISHBIO for the Districts have shown seining can most likely be used to successfully capture juvenile *O. mykiss* during the spring to support this study. The abundance of seine-caught *O. mykiss* has been low, less than would be required for the study. However, the abundance of fish required, (e.g., 30 fish over a 30 day period), would likely be accommodated with an increase in seining effort and an expansion in sampling locations. FISHBIO used angling to collect *O. mykiss* for age and growth analysis, per W&AR 20. Based on results of W&AR 20, angling

[1] The timing of fish collection will be subject to fish availability and selected protocol that will define the duration of the testing.

would likely provide larger (> 150 mm FL) *O. mykiss*. Other methods of acquiring test fish need to be considered, potentially in conjunction with RST trapped fish, to be used in an opportunistic manner. Ultimately, a Section 10 permit would dictate the allowable capture method. Additionally, the potential effect of the capture method on the ability to acclimate the fish and to conduct the study would need to be evaluated prior to requesting the NMFS permit.

The required test equipment would be available for lease from the University of British Columbia (UBC). Alternative sources of equipment may be available locally and will be explored.

The permit application process has been started (October 2012) and will include informal discussions with NMFS staff to identify specific study details necessary to determine the potential utility of the study and associated take, as determined by NMFS. The application process includes confirmation of study protocol, options for collecting fish, the details of holding, acclimating, testing, and post-testing and how the tests are to be conducted at "streamside". Logistical requirements would be identified and accommodated based on the permit.

Task 2 – Fish collection

The conduct of the testing is proposed to occur during spring-summer of 2013. The targeted species will be *O. mykiss*, ranging in size from approximately 100 mm to 200 mm FL. Based on current studies being conducted by the Districts to collect *O. mykiss* for an age structure evaluation, collection of *O. mykiss* via angling has successfully yielded fish in this range (primarily between 150 and 200 mm FL). The results of the age structure survey should be included in an assessment of the timing of the study (e.g., if the targeted size can be obtained by angling earlier or later), or if the targeted size should be increased.

Task 3 – Field Test

The following discussion provides a more detailed description of the protocols that have been identified by the study team as the potential study design alternatives for conducting the field experiments. The protocols differ primarily in the use of test fish and in the number of replicate tests that will be required to meet the study goals and objectives to be considered.

Protocol Option 1-- based on the methods of Parsons (2011)

- Individual fish tested only once—i.e., on only one day—allowed to recover, then released.
- Each fish will be individually measured for aerobic scope at a single temperature, but at both the basal-resting (low) flow and active-swimming (high) flow.
- Different sets of individual fish will be tested at each of the specified test temperatures—e.g., some fish at 15°C and others at 17°C, 19°C, and 21°C.
- Ideally, each fish will only be tested once and there will be a different set of individuals (e.g., minimum six fish) tested at each of the test temperatures. The proposed minimum sample (or set) size (# of fish) per test-temperature is a determination based on the experience of

researchers who have conducted such studies (e.g. Dr. Farrell & Dr. Parsons). Dr. Farrell's initial estimate is the source of the proposed number of (about) 6 fish being required for each temperature being tested. Ultimately, the number of fish used per test and the number of fish required for the entire experiment will depend upon fish availability, permit requirements, and to some degree the results of the test as it is being conducted (e.g., mortality of test fish, ambient temperature and thus the number of temperatures to be tested between ambient and Tcrit.

- Protocol Option 1 may be viewed as a "vertical" design—i.e., because each individual is tested at a single specified temperature, but at first low and then high flows.

Example Scenario using Protocol Option 1.

Pre-Test Day. Transfer an individual fish from holding tank to the swim tunnel during late-afternoon of the day before the test.

Test Day morning.

[A] If the fish is to be tested initially at the lowest test temperature (i.e., the river and holding-tank temperature):

(1) Start by measuring the metabolic rate at the basal flow;
(2) Increase flow to the specified test-flow level while keeping temperature constant, then measure metabolic rate at that flow;
(3) Test is now over for this individual; remove it from swim tunnel and release soon after.

Or,

[B] If the fish is to be tested at a temperature higher than the lowest (river or holding-tank) temperature:

(1) Increase the swim tunnel temperature above the initial, lowest temperature at a rate of 1-2°C per hour until the test temperature is reached; during this time, the flow is kept at the basal flow rate;
(2) After the test temperature is reached, measure metabolic rate (at basal flow);
(3) While keeping the swim tunnel at the specified test temperature, increase the flow up to the specified active-swimming test flow;
(4) Measure metabolic rate at that active-swimming (high) test flow;
(5) Test is now over for the individual; reduce flow to basal flow, bring the water temperature back to the ambient LTR temperature, remove fish from swim tunnel and release soon after.

Protocol Option 2—a variation of the methods of Parsons (2011)

Individual fish will be tested multiple times—i.e., metabolic rates will be measured at a different temperature on each of two or three days, depending on how many test temperatures will be used.

Hence, an individual will be held for testing for a period of 3-4 days to allow enough time for acclimation, testing and recuperation between tests.

Generally, the procedures for Protocol Option 2 will be the same as in Protocol Option 1 except that an individual will be repetitively tested at different temperatures, with intervening periods of 1-2 days to allow for recuperation of that individual between tests. Applying this option would allow the study to occur if too few fish are collected to allow six individuals to be tested for each of the study temperatures.

Task 4 – Data analysis and QA/QC

Data analysis and QA/QC would be conducted by UBC personnel following procedures reported by Parsons (2011) and references there in.

Task 5 – Report

A report will be prepared and submitted to agencies and FERC.

5.0 SCHEDULE

The Districts anticipate the schedule to complete the study proposal as follows, assuming appropriate permits are obtained from NMFS and CDFG by spring 2013:

Prepare implementation plan and other information necessary to prepare and submit Section 10 Permit to NMFS (Task 1) ....Initiated October 2012 and is ongoing
Prepare for field survey.. February-March 2013
Collect test fish and conduct field evaluations (Task 2)...................................... March-June 2013
Conduct QA/QC and data analysis (Task 3)...July 2013
Prepare and deliver final report (Task 4) .... July - September 2013

6.0 REFERENCES

Farrell, A.P., Commentary – Environmental, antecedents and climate change: lessons from the study of temperature physiology and river migration of salmonids. The Journal of Experimental Biology 212, 3771-3780 Published by The Company of Biologists 2009 doi:10.1242/jeb.023671. Available online at: http://jeb.biologists.org/content/212/23/3771.full.pdf

Parsons, E.J.E. 2011. Cardiorespiratory physiology and temperature tolerance among populations of sockeye salmon (*Oncorhynchus nerka*). A thesis submitted in partial fulfillment of the requirements for the degree of Doctor of Philosophy in the Faculty of graduate studies (Zoology) The University of British Columbia (Vancouver) August 2011.

U.S. Environmental Protection Agency (EPA). 2003. EPA Region 10 Guidance for Pacific Northwest State and Tribal Temperature Water Quality Standards. Available online at: http://www.epa.gov/region10/pdf/water/final_temperature_guidance_2003.pdf[1]

Study 2. Spatial distribution juvenile O. mykiss in response to temperature

Objective: Identify temperature thresholds that define rearing temperature tolerances for juvenile *O. mykiss*.

Status: Data availability and utility have been determined to be sufficient to support conduct of this study.

1.0 PROJECT NEXUS

The continued operation and maintenance (O&M) of the existing Don Pedro Project (Project) has the potential to cumulatively affect the anadromous fish populations between La Grange Diversion Dam and the confluence of the Tuolumne River and San Joaquin River.

2.0 STUDY GOALS

Determine the influence of temperature on spatial and temporal distribution of *O. mykiss* juvenile rearing in the LTR

Objectives:

Identify and evaluate empirical information on the distribution of juvenile *O. mykiss* rearing in the lower Tuolumne River relative to concurrent and antecedent temperatures with a focus on temperature influence on over-summer or year-long rearing habitat availability, to include assessment of:

- Intra annual distribution relative to temperature
- Inter annual distributions relative to temperature
- Range of temperatures providing useable habitat conditions expressed as occupancy
- Temperature thresholds that empirically define rearing temperature tolerances for juvenile *O. mykiss*.

3.0 EXISTING INFORMATION AND NEED FOR ADDITIONAL INFORMATION

A putative factor limiting the *O. mykiss* population in the lower Tuolumne River, downstream of La Grange Dam, is the paucity of suitable rearing habitat during the warmer, typically summer months (over summering habitat). Summaries of *O., mykiss* distributions observed during snorkel surveys of the Tuolumne River indicate that distribution and density of *O. mykiss* is related to antecedent temperature conditions (TID/MID 2012). Further evaluation of these data is required to define a more specific relationship between temperature and *O. mykiss* rearing to reduce uncertainties regarding potential water temperature-related limitations on the distribution and abundance of *O. mykiss* rearing habitat.

4.0 STUDY METHODS

4.1 Study Area

The study area is the reach of the lower Tuolumne River between the San Joaquin River and La Grange Diversion Dam.

4.2 Study Approach

This study is intended to provide empirical evidence of the influence of temperature on juvenile *O. mykiss* rearing. The expectation is that *O. mykiss* will occupy areas as long as water temperatures are tolerable. This study will compare occupancy with precedent temperature conditions to potentially bracket a threshold for rearing temperature tolerance. Inter-annual variations in longitudinal distribution of *O. mykiss* will be related to differences among temperature gradations. For example, when *O. mykiss* are present within a particular reach of the river subjected to one temperature regime but not there during a different (assume warmer) temperature regime, occupancy versus precedent temperature conditions would be considered an indicator of temperature tolerances. As such, temperature tolerances would be reflected in the response (occupied or vacated) to temperature longitudinally within and among years using existing information on spatial distribution of juvenile rearing and concurrent temperatures.

Existing data have been identified that include survey results showing longitudinal distributions of *O.* mykiss and data have undergone an assessment to determine if they meet the needs of this study. Some of the results include fish density and some of the surveys occurred seasonally (during both the cool and warm seasons). An example of data that support this study is summarized by TID/MID (2012) and is provided below (Table 1 and Figure 1).

The Districts will evaluate the spatial distribution of rearing *O. mykiss* relative to temperature precedent conditions to identify temperatures where occupancy continued and occupancy ended. The temperature regime where occupancy continued would be considered tolerable and the regime where occupancy ended would be intolerable.

Response to temperature in the form of occupancy will be identified within years as seasonal temperatures increase and occupancy either continues or ends, and inter annually where sites known to be occupied during the later, warmer period at least once during the 10 year period would be evaluated to determine if and under what precedent temperature conditions occupancy either continued or ended. Where occupancy continued, the temperature regime would be considered tolerable, where occupancy was not observed, precedent temperature conditions would be considered intolerable. Temperature conditions would be characterized by several, acceptable metrics (used by other investigators to describe temperature conditions relative to fish tolerance), including 7DADM, daily max, mean daily, etc.

For example, if mean daily temperatures increased from May to September, from 15 to 20 ^{o}C and fish continue to occupy the site, the mean daily temperature of 20 ^{o}C would be considered tolerable (for the lifestage/age of fish size etc). If site A is occupied in year 1 when September temperatures are 19 ^{o}C but not in year 2 when September temperatures were 25 ^{o}C, 25 ^{o}C would be considered intolerable, 19 ^{o}C tolerable. The expectation is that the variation in temperature conditions within the 10 year period would be sufficient to broaden understanding of temperature tolerances within the lower Tuolumne River.

Similar evaluations have been conducted for Chinook salmon and *O. mykiss* on the Mokelumne River (Pagliughi 2008) and for coho salmon rearing in northern California (Hine and Ambrose 2000)

The study will be conducted by implementing the following steps:

Step 1. Acquire and evaluate utility of data on *O. mykiss* distribution and abundance and associated temperature conditions. All data sources will be checked to assure that the data have been collected per prescribed methods, represent the conditions reported, and have been accurately recorded.

Step 2. Graphical depictions of the data will be developed to identify potential relationships among distribution and temperatures. Data comparing intra and inter annual distributions will be assessed. The results of this analysis will be used to identify the type and focus of additional evaluations.

Step 3. Based on results of Step 2, relationships among temperature and *O. mykiss* rearing distribution and densities will be evaluated using methods similar to those described by Pagliughi (2008) and Hines and Ambrose (2000). . Consideration will be given to use of non-parametric assessments, to be determined by a qualified biostatistician.

Step 4. A report will be prepared describing the methods, results and potential application to evaluation of influences of temperature on *O. mykiss* distribution and abundance in the lower Tuolumne River.

Table 1. Example of distribution data available to conduct this study (Source: Stillwater 2012)

Location	River Mile	2001		2002		2003		2004			2005	2006	2007		2008	2009	2010		2011	
		June	September	June	September	June	September	June	August	September	September	September	June	September	June	June	August	November	September	November
Riffle A3/A4	51.6								5											
Riffle A7	50.7	7	3	5	1	66	16	12	6	11	10	115	106	75	76	80	35	33	249	6
Riffle 1A	50.4								4											
Riffle 2	49.9	3	3	1	4	8	2	23	2	7	7	15	34	16	9	12	58	67	203	27
Riffle 3B	49.1	8	1	11	1	5	21	22	5	7	6	66	45	12	78	27	73	67	261	8
Riffle 4B	48.4								8											
Riffle 5B	48.0	4	2	3	X	6	10	11	15	6	36	54	92	10	21	11	26	16	149	41
Riffle 7	46.9	4	X	5	2	14	9	13	5	2	2	106	22	7	13	6	25	6	88	9
Riffle 9	46.4								3											
Riffle 13A–B	45.6	3	X	2	4	1	6	5	13	X	46	103	15	57	24	4	33	14	129	8
Riffle 21	42.9	2	3	1	X	X	6	5	9	7	15	32	10	10	11	X	8	2	33	8
Riffle 23B–C	42.3	X	X	X	X	1	1	X	1	X	14	27	5	7	X	2	9	10	52	32
Riffle 30B	38.5			X	X															
Riffle 31	38.1	X	X			X	X	X	X	X	1	21	12	4	X	X	1	X	10	2
Riffle 35A	37.0			X	X	X	X	X	X	X	2		X	X	X	X	X	X	3	X
Riffle 36A	36.7											4								
Riffle 37	36.2	X	X																	
Riffle 41A	35.3	X	X	X	X	X	X	X	X	X	X	X	2	X	X	X	X	3	2	6
Riffle 57–58	31.5	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X	1
Total *O. mykiss*		**31**	**12**	**28**	**12**	**101**	**71**	**91**	**76**	**40**	**139**	**543**	**343**	**198**	**232**	**142**	**268**	**218**	**1179**	**148**

X = Locations that were sampled with no *O. mykiss* observed.

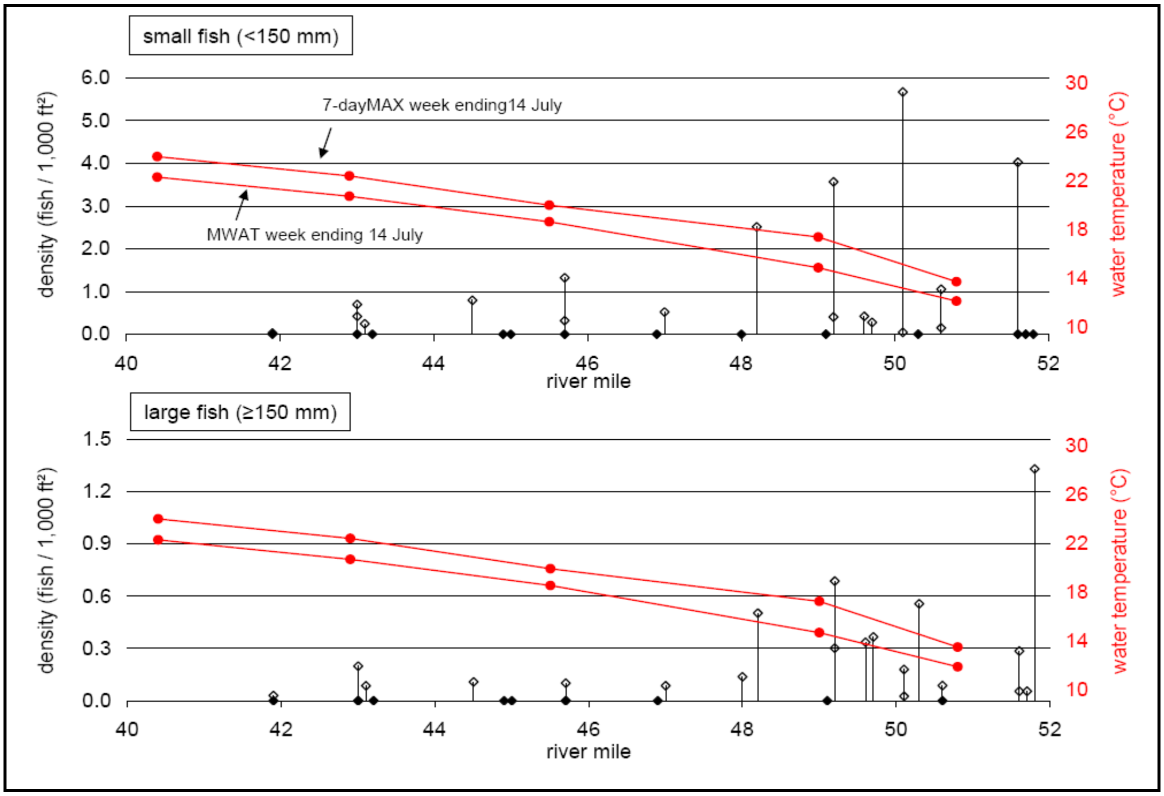

Figure 1. Longitudinal distribution of observed *O. mykiss* and water temperature in the lower Tuolumne River, July 2009. Solid diamonds are observed zeros; open diamonds are observed non-zero values). Source: Stillwater 2009

5.0 SCHEDULE

The Districts anticipate the schedule to complete the study proposal as follows:

Step 1 ....Ongoing, to be completed February 2013
Step 2 ....February – March 2013
Step 3 ....March – April 2013
Report Preparation ....April – June 2013
Report Issuance ....June 2013

6.0 CONSISTENCY OF METHODOLOGY WITH GENERALLY ACCEPTED SCIENTIFIC PRACTICES

This study will apply methods that are consistent with other, similar investigations,

7.0 REFERENCES

Hines, D. and J.Ambrose. 2000. Evaluation of stream temperatures based on observations of juvenile coho salmon in northern California streams. Accessed at:

http://vwvvv.krisweb.com/krisrussian/krisdb/html/krisweb/biblio/gen_afs_hinesetal_xxxx.pdf

Pagliughi, S.W. 2008. Lower Mokelumne River, Reach Specific Thermal Tolerance Criteria by Life Stage for Fall-Run Chinook Salmon and Winter-Run Steelhead. East Bay Municipal Utility District, Lodi, CA.

Stillwater Sciences. 2009. March and July 2009 population size estimates of *Oncorhynchus mykiss* in the Lower Tuolumne River. Prepared for the Turlock Irrigation District and the Modesto Irrigation District by Stillwater Sciences, Berkeley, CA. November. Accessed at: http://www.tuolumnerivertac.com/Documents/2009%20BCE%20Report2009Nov.pdf

Turlock Irrigation District and Modesto Irrigation District (TID/MID). 2012. *Oncorhynchus mykiss* Habitat Survey Study Plan (W&AR-12). Attachment to Don Pedro Hydroelectric Project Revised Study Plan. April 2012.

Study 3. Influence of temperature on growth of juvenile Chinook salmon

Status: Evaluation of the availability and utility of data to support this study has shown that data are available to conduct an evaluation of the observed influence of temperature on growth of juvenile Fall-run Chinook salmon in the lower Tuolumne River.

1.0 PROJECT NEXUS

The continued operation and maintenance (O&M) of the existing Don Pedro Project (Project) has the potential to cumulatively affect the anadromous fish populations between La Grange Diversion Dam and the confluence of the Tuolumne River and San Joaquin River.

2.0 STUDY GOALS

Objective: Identify temperature thresholds that support "acceptable/expected" growth of juvenile Chinook salmon in the lower Tuolumne River.

3.0 EXISTING INFORMATION AND NEED FOR ADDITIONAL INFORMATION

Concern has been expressed that Chinook salmon growth in the lower Tuolumne River is too slow, potentially delaying Chinook salmon from reaching a larger, smolt-sized fish in time to successfully emigrate. For example, growth would be considered as expected if the majority of Fall-run Chinook salmon achieve 70-90 mm FL by end of April and essentially all Fall-run Chinook salmon have the opportunity to achieve smolt size by the end of May. By tracking RST size composition from the earliest migrating juvenile Chinook salmon, a trend in growth can be identified and the timing and cumulative composition of emigrating smolt-sized fish can be determined and contrasted with the precedent temperature regime to evaluate occurrence of adverse effects on Chinook salmon growth.

Data have been collected on size of Chinook salmon during their migrations during the previous eight years using rotary screw traps. Fish length data are typically collected daily from throughout the entire emigration period (typically January through May). Additionally, temperature data are available to describe the conditions present during the growth period.

4.0 STUDY METHODS

4.1 Study Area

The study area is the reach of the lower Tuolumne River between the San Joaquin River and La Grange Diversion Dam.

4.2 Study Approach

This study is intended to provide empirical evidence of the influence of temperature on growth of juvenile Chinook salmon in the lower Tuolumne River.

Approach: Compare observed size at time/age, interpreted as growth, of Chinook salmon in the lower Tuolumne River with expected growth based on literature and growth rates observed/reported in other, similar waters. Relate temperature regime associated with observed growth in the lower Tuolumne River to identify those temperature conditions that either support or do not support expected growth.

This study would evaluate growth of Fall-run Chinook salmon in lower Tuolumne River as a function of precedent temperature conditions. Growth would be evaluated by comparing observed growth in the lower Tuolumne River with expected growth to be defined based on the literature or observations from other similar watersheds. The size at time, to be estimated based on timing of spawning and emergence, (as data are available), would be contrasted with reported, acceptable or expected size at time

Similar evaluations have been conducted for Chinook salmon on the Stanislaus, Mokelumne, American, and Yuba Rivers.

The study will be conducted by implementing the following steps:

Step 1. Acquire and evaluate utility of data on juvenile Chinook salmon size at time and associated temperature conditions. All data sources will be checked to assure that the data have been collected per prescribed methods, represent the conditions reported, and have been accurately recorded.

Step 2. Graphical depictions of the data will be developed to identify potential relationships among size at time (growth) and temperatures. Data comparing intra and inter annual distributions will be assessed. The results of this analysis will be used to identify the type and focus of additional evaluations.

Step 3. Based on results of Step 2, relationships among temperature and Chinook salmon growth will be evaluated using methods similar to those described by Campos and Massa (2010) and Pyper and Justice (2006) Anderson and Neumann (1996), Richards (1959), Ricker (1975)and others, as appropriate. The appropriate application of these methods will be determined by a qualified biostatistician.

Step 4. A report will be prepared describing the methods, results and potential application to evaluation of influences of temperature on Chinook salmon growth in the lower Tuolumne River.

5.0 SCHEDULE

The Districts anticipate the schedule to complete the study proposal as follows:

Step 1 ....Ongoing, to be completed February 2013
Step 2 ....February – March 2013
Step 3 ....March – April 2013
Report Preparation ....April – June 2013
Report Issuance..June 2013

6.0 CONSISTENCY OF METHODOLOGY WITH GENERALLY ACCEPTED SCIENTIFIC PRACTICES

This study will apply methods that are consistent with other, similar investigations,

7.0 REFERENCES

Anderson, R.O. and R.M. Neumann. 1996. Length, Weight, and Associated Structural Indices. Pages 447-482 in B.R. Murphy and D. W. Willis, ed. Fisheries techniques, 2nd edition. American Fisheries Society, Bethesda, Maryland.

Campos, C. and D. Massa (2010). Lower Yuba River Accord monitoring and evaluation plan annual rotary screw trapping report, October 1, 2008—August 31, 2009. Prepared for: The Lower Yuba River Accord Planning Team by Pacific States Marine Fisheries Commission, May2010.

Pyper, B. and C. Justice. 2006. Analysis of rotary screw trap sampling of migrating juvenile Chinook salmon in the Stanislaus River, 1996-2005. Cramer Fish Sciences, Gresham, OR 97030 August 2006

Richards, F.J. 1959. A flexible growth function for empirical use. Journal of Exp. Botany, 10:290-300.

Ricker, W. E. 1975. Computation and interpretation of biological statistics of fish populations. Bulletin 191 of the Fisheries Research Board of Canada. Ottawa.

Study 7. Influence of temperature on timing of initial spawning of Chinook salmon

Objective: Identify adult Chinook salmon response to typically warmer temperatures occurring in the lower Tuolumne River in the early portion of the spawning period. Evaluation of inner annual timing of spawning will be compared with temperatures during early spawning period using redd surveys or carcass survey results to identify temporal distribution of early spawning, and pre-spawning mortality, potentially measured as egg retention during carcass surveys.

1.0 PROJECT NEXUS

The continued operation and maintenance (O&M) of the existing Don Pedro Project (Project) has the potential to cumulatively affect the anadromous fish populations between La Grange Diversion Dam and the confluence of the Tuolumne River and San Joaquin River.

2.0 STUDY GOALS

Objective: Identify the potential influence of water temperature on the timing of initial Chinook salmon spawning in the lower Tuolumne River.

3.0 EXISTING INFORMATION AND NEED FOR ADDITIONAL INFORMATION

Chinook salmon are known to migrate to the Tuolumne River and other San Joaquin River tributaries early in fall, before water temperatures are suitable for spawning. The response of early arriving Chinook salmon to warmer temperatures, such as delayed spawning and/or prespawning mortality of eggs is undocumented. CDFG and the Districts have monitored timing of arrival of adult Chinook salmon at the Tuolumne River, timing and distribution of spawning, and prespawning mortality, indicated by egg retention in spawned Chinook salmon.

4.0 STUDY METHODS

4.1 Study Area

The study area is the reach of the Tuolumne River between the San Joaquin River and La Grange Diversion Dam.

4.2 Study Approach

This study is intended to provide empirical evidence of the influence of temperature on early, temporal distribution of Chinook salmon spawning in the lower Tuolumne River.

Approach: Compare timing of initial spawning with precedent temperature conditions using CDFG redd survey results.

Redd count data by survey date and redd location are available from 1987-2004, with no survey data in 2003 or since 2004. The Districts' approach is to evaluate water temperature at the time of first spawning and during the first 3-4 weeks after the observation of the first spawning and compare those data with precedent temperatures. Timing of Chinook salmon adult arrival at the Tuolumne River will be compared with timing of spawning and temperature for those years when both adult immigration was monitored using a counting weir, and redd or carcass surveys were also conducted.

Similar evaluations have been conducted for Chinook salmon on the American River (SWRI 2004).

The study will be conducted by implementing the following steps:

Step 1. Acquire and evaluate utility of data on Chinook salmon spawning, including redd surveys and carcass surveys and associated temperature conditions. All data sources will be checked to assure that the data have been collected per prescribed methods, represent the conditions reported, and have been accurately recorded.

Step 2. Graphical depictions of the data will be developed to identify potential relationships among timing of spawning, egg retention, and temperatures. Data comparing intra and inter annual distributions will be assessed. The results of this analysis will be used to identify the type and focus of additional evaluations.

Step 3. Based on results of Step 2, relationships among temperature and Chinook salmon spawning will be evaluated using methods to be determined by a qualified biostatistician.

Step 4. A report will be prepared describing the methods, results and potential application to evaluation of influences of temperature on the timing of Chinook salmon spawning and potentially related prespawning mortality in the lower Tuolumne River.

5.0 SCHEDULE

The Districts anticipate the schedule to complete the study proposal as follows:

Step 1 ....Ongoing, to be completed February 2013
Step 2 ....February – March 2013
Step 3 ....March – April 2013
Report Preparation ....April – June 2013
Report Issuance...June 2013

6.0 CONSISTENCY OF METHODOLOGY WITH GENERALLY ACCEPTED SCIENTIFIC PRACTICES

This study will apply methods that are consistent with other, similar investigations,

7.0 REFERENCES

SWRI. 2004. Aquatic Resources of the Lower American River: Draft Baseline Report. Sacramento, CA: Surface Water Resources, Inc.

From: Staples, Rose
Sent: Monday, June 30, 2014 3:43 PM
To: Alves, Jim; Amerine, Bill; Asay, Lynette; Barnes, James; Barnes, Peter; Barrera, Linda; Beeco, Adam; Blake, Martin; Bond, Jack; Borovansky, Jenna; Boucher, Allison; Bowes, Stephen; Bowman, Art; Brenneman, Beth; Buckley, John; Buckley, Mark; Burke, Steve; Burt, Charles; Byrd, Tim; Cadagan, Jerry; Carlin, Michael; Charles, Cindy; Cooke, Michael; Cowan, Jeffrey; Cox, Stanley Rob; Cranston, Peggy; Cremeen, Rebecca; Damin Nicole; Day, Kevin; Day, P; Denean; Derwin, Maryann Moise; Devine, John; Dowd, Maggie; Drake, Emerson; Drekmeier, Peter; Edmondson, Steve; Eicher, James; Fargo, James; Fernandes, Jesse; Ferranti, Annee; Ferrari, Chandra; Findley, Timothy; Fleming, Mike; Fuller, Reba; Ganteinbein, Julie; Giglio, Deborah; Gorman, Elaine; Grader, Zeke; Groves, Catherine J; Gutierrez, Monica; Hackamack, Robert; Hastreiter, James; Hatch, Jenny; Hayden, Ann; Hellam, Anita; Heyne, Tim; Holley, Thomas; Holm, Lisa; Horn, Jeff; Horn, Timi; Hudelson, Bill; Hughes, Noah; Hughes, Robert; Hume, Noah; Hurley, Michael; Jackson, Zac; Jauregui, Julia; Jennings, William; Johannis, Mary; Johnson, Brian; Jones, Christy; Jsansley; Justin; Keating, Janice; Kempton, Kathryn; Kinney, Teresa; Koepele, Patrick; Kordella, Lesley; Le, Bao; Levin, Ellen; Linkard, David; Loy, Carin; Lwenya, Roselynn; Lyons, Bill; Madden, Dan; Manji, Annie; Marko, Paul; Martin, Michael; Mathiesen, Lloyd; McDaniel, Dan; McDevitt, Ray; McDonnell, Marty; Mein Janis; Mills John; Morningstar Pope, Rhonda; Moses, Matt; Motola, Mary; Murphey, Gretchen; Murray, Shana; O'Brien, Jennifer; Orvis, Tom; Ott, Bob; Ott, Chris; Pavich, Steve; Pool, Richard; Powell, Melissa; Puccini, Stephen; Raeder, Jessie; Ramirez, Tim; Rea, Maria; Reed, Rhonda; Reynolds, Garner; Richardson, Daniel; Richardson, Kevin; Riggs T; Romano, David O; Roos-Collins, Richard; Rosekrans, Spreck; Roseman, Jesse; Rothert, Steve; Sandkulla, Nicole; Saunders, Jenan; Schutte, Allison; Sears, William; Shakal, Sarah; Shipley, Robert; Shumway, Vern; Shutes, Chris; Sill, Todd; Simsiman, Theresa; Slay, Ron; Smith, Jim; Staples, Rose; Stapley, Garth; Steindorf, Dave; Steiner, Dan; Stender, John; Stone, Vicki; Stork, Ron; Stratton, Susan; Taylor, Mary Jane; Terpstra, Thomas; TeVelde, George; Thompson, Larry; Tmberliner; Ulibarri, Nicola; Verkuil, Colette; Vierra, Chris; Villalobos, Amber; Wantuck, Richard; Ward, Walt; Welch, Steve; Wenger, Jack; Wesselman, Eric; Wetzel, Jeff; Wheeler, Dan; Wheeler, Dave; Wheeler, Douglas; Wilcox, Scott; Williamson, Harry; Willy, Allison; Wilson, Bryan; Winchell, Frank; Wooster, John; Workman, Michelle; Yoshiyama, Ron; Zipser, Wayne
Subject: Don Pedro W-AR-14 Swim Tunnel Demonstration July 10

The study team for the Don Pedro Relicensing *W&AR-14 Tuolumne River O. mykiss Temperature Adaptation Assessment* will begin field work in mid-July. The Districts and the lead researchers from UC-Davis have set up a mobile lab on site near La Grange powerhouse to conduct the swim tunnel metabolic tests. The study will investigate temperature tolerances of *O. mykiss* from the Tuolumne River using the swim tunnels to measure the optimal and critical temperatures for aerobic scope for fish ranging from about 100 to 200 mm fork length.

The study team will be testing and calibrating the equipment with hatchery fish, and will provide a demonstration of the equipment on Thursday, July 10 for relicensing participants. (An alternate date of Wednesday, July 9 may be used, based on RSVPs.) The testing of wild fish will begin the week of July 14. While the wild fish tests are running, it will not be possible to view the fish in the tunnels, so the best opportunity for viewing the laboratory testing procedures is during these equipment tests.

A draft study plan was submitted with the Initial Study Report in January 2013, and a revised plan reflecting all permit requirements has been posted on the Districts' website at: www.donpedro-relicensing,com. (See Documents Tab\Studies\Final (1). It is also attached to the CALENDAR for July 10th.

La Grange is a secure site so if you would like to attend, please provide your availability for Thursday, July 10 (or alternately, Wednesday, July 9). Please RSVP to Rose Staples (rose.staples@hdrinc.com) by Monday, July 7. It is anticipated that the site visit will go from 10 am to Noon. Further logistics will be provided following receipt of RSVPs.

Finally, relicensing participants interested in learning more about swim tunnels may wish to visit the website for Loligo Systems, the manufacturer of the study equipment. Please find below links to the Loligo Systems website, including videos of a swim tunnel in use.

http://www.loligosystems.com

http://vimeopro.com/user20324571/loligo-systems-videos/video/72805729

http://vimeopro.com/user20324571/loligo-systems-videos/video/73922896

Rose Staples, CAP-OM
Executive Assistant

HDR
970 Baxter Boulevard Suite 301
Portland ME 04103
D 207-239-3857
rose.staples@hdrinc.com

hdrinc.com/follow-us

BCC To: Gretchen Murphy, Deborah Giglio, Allison Boucher, Ellen Levin, Art Godwin
From: Staples, Rose
Sent: Monday, July 7, 2014 6:57 PM
Subject: Don Pedro W&AR-14 Study Swim Tunnel Site Visit – July 10 at 10 a.m.

Thank you for responding to the W&AR-14 Study Swim Tunnel Site Visit invite.

The date will be Thursday, July 10th and those attending should meet at the locked gate to La Grange at 10:00 a.m. A TID staff member will be there to unlock the gate and direct you to the work area. At the work area we will introduce you to Christine Verhille, a researcher from U.C. Davis, and other team members involved with the swim tunnel work.

Thank you for your continuing interest and involvement with the Don Pedro relicensing.

If you have any questions, please do not hesitate to contact John Devine at 207-775-4495.

Rose Staples, CAP-OM
Executive Assistant

HDR
970 Baxter Boulevard Suite 301
Portland ME 04103
D 207-239-3857
rose.staples@hdrinc.com

hdrinc.com/follow-us

From: Staples, Rose
Sent: Friday, July 18, 2014 12:31 PM
BCC To: Relicensing Participants Email Group List as of 7-18-2014
Subject: Districts E-Filings with FERC on Don Pedro W-AR-12 and W-AR-21

The Districts have e-filed with FERC today the following documents:

(1) Update on W&AR-12 *O.mykiss* Habitat Assessment – Second Year of LWD Collection

(2) Final Meeting Notes and Responses to Relicensing Participants' Comments on W&AR-21 Floodplain Hydraulic Assessment Consultation Workshop No. 1, held on February 23, 2014

Copies of these fillings are on both FERC's E-Library at www.ferc.gov and on the Don Pedro Relicensing website at www.donpedro-relicensing.com under the ANNOUNCEMENT tab. *On FERC's E-Library, please access the second filing today, which has Attachment A (final notes) and Attachment B (RP comment).*

Also referenced in the filing for W&AR-21 is the draft TUFLOW 1-D-2D DOMAIN BOUNDARY LINE. The draft document has been uploaded to the Don Pedro relicensing website under ANNOUNCEMENTS—and is available for review and comment by relicensing participants. Comments are due by August 29, 2014; please forward them to rose.staples@hdrinc.com.

Thank you.

Rose Staples, CAP-OM
Executive Assistant

HDR
970 Baxter Boulevard Suite 301
Portland ME 04103
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hdrinc.com/follow-us

TUFLOW 1D-2D Domain Boundary Line

0 250 500 1,000
Feet

N

Floodplain Hydraulic Modeling

Don Pedro Project (FERC No.2299)

Map information was compiled from the best available sources.
No warranty is made for its accuracy or completeness.
Data Sources: Hydrography - USGS NHD, TID/MID;
Data is NAD83, State Plane CA Zone 3 U.S. Ft.

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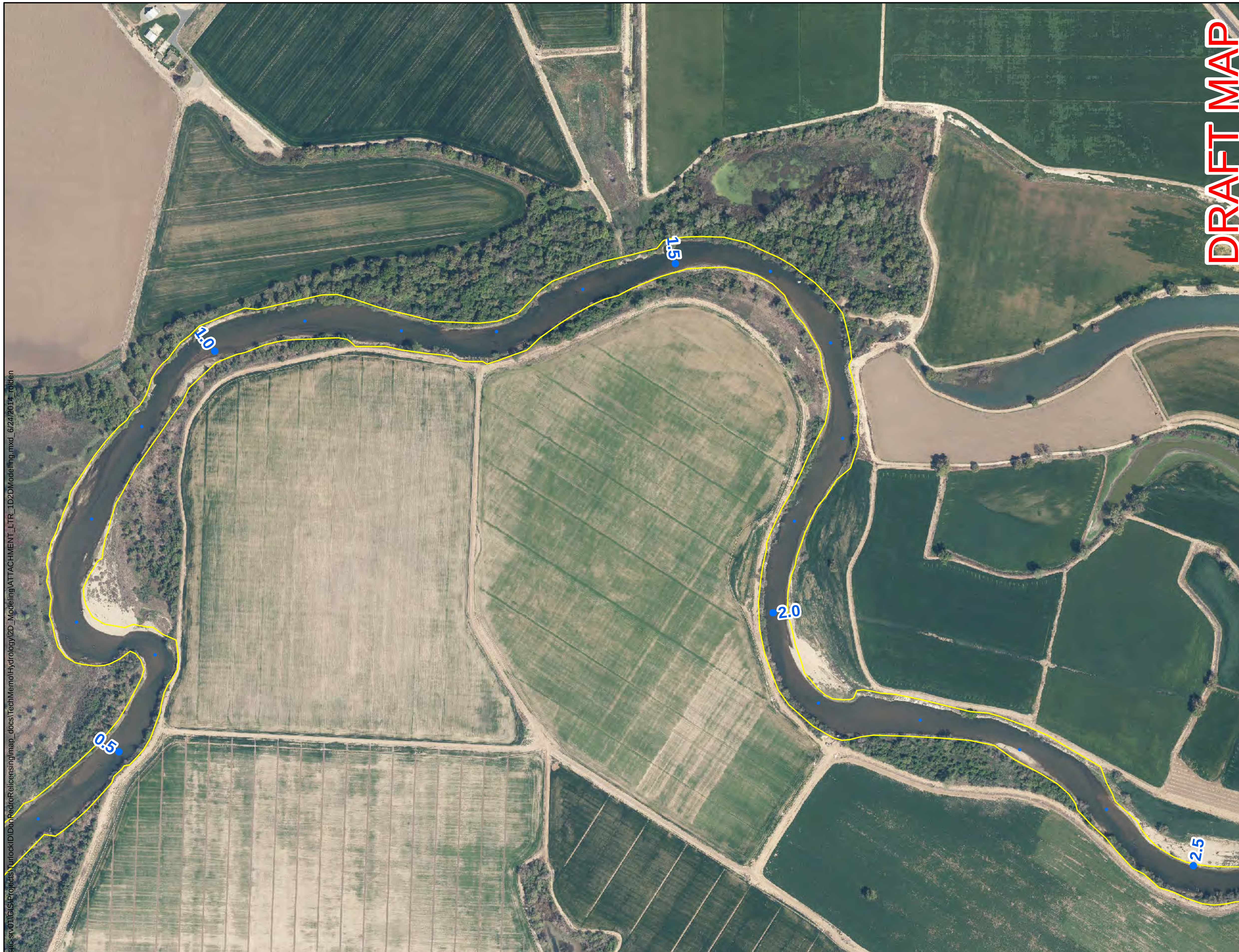

TUFLOW 1D-2D Domain Boundary Line

0 250 500 1,000
Feet

N

Floodplain Hydraulic Modeling

Don Pedro Project (FERC No.2299)

Map information was compiled from the best available sources.
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Data is NAD83, State Plane CA Zone 3 U.S. Ft.

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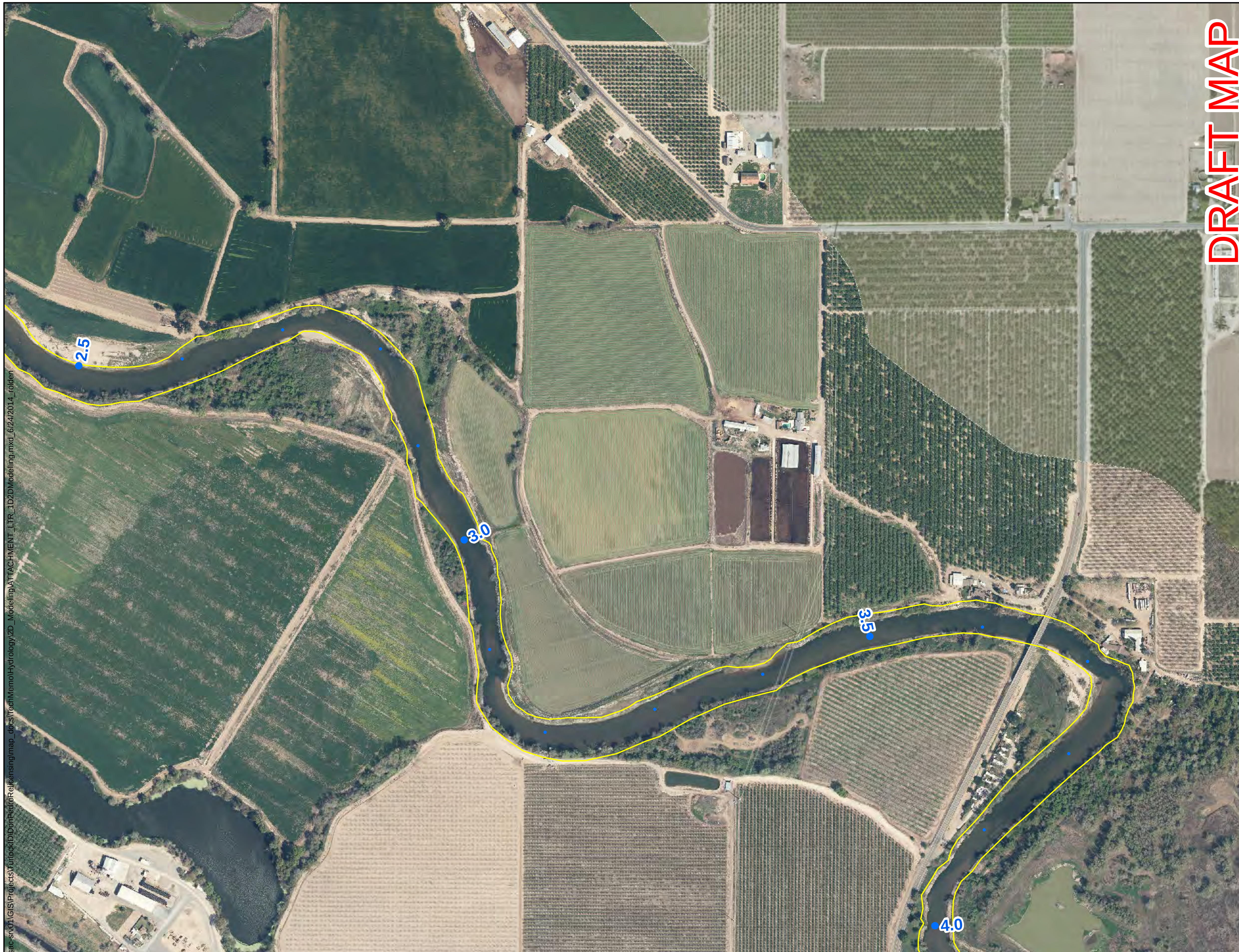

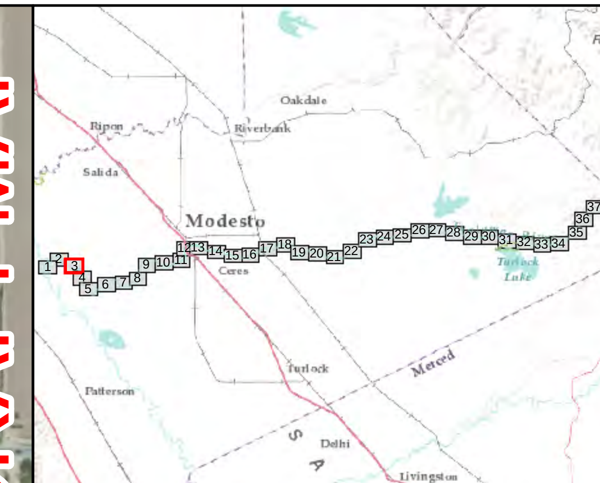

TUFLOW 1D-2D Domain Boundary Line

0 250 500 1,000
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Floodplain Hydraulic Modeling

Don Pedro Project (FERC No.2299)

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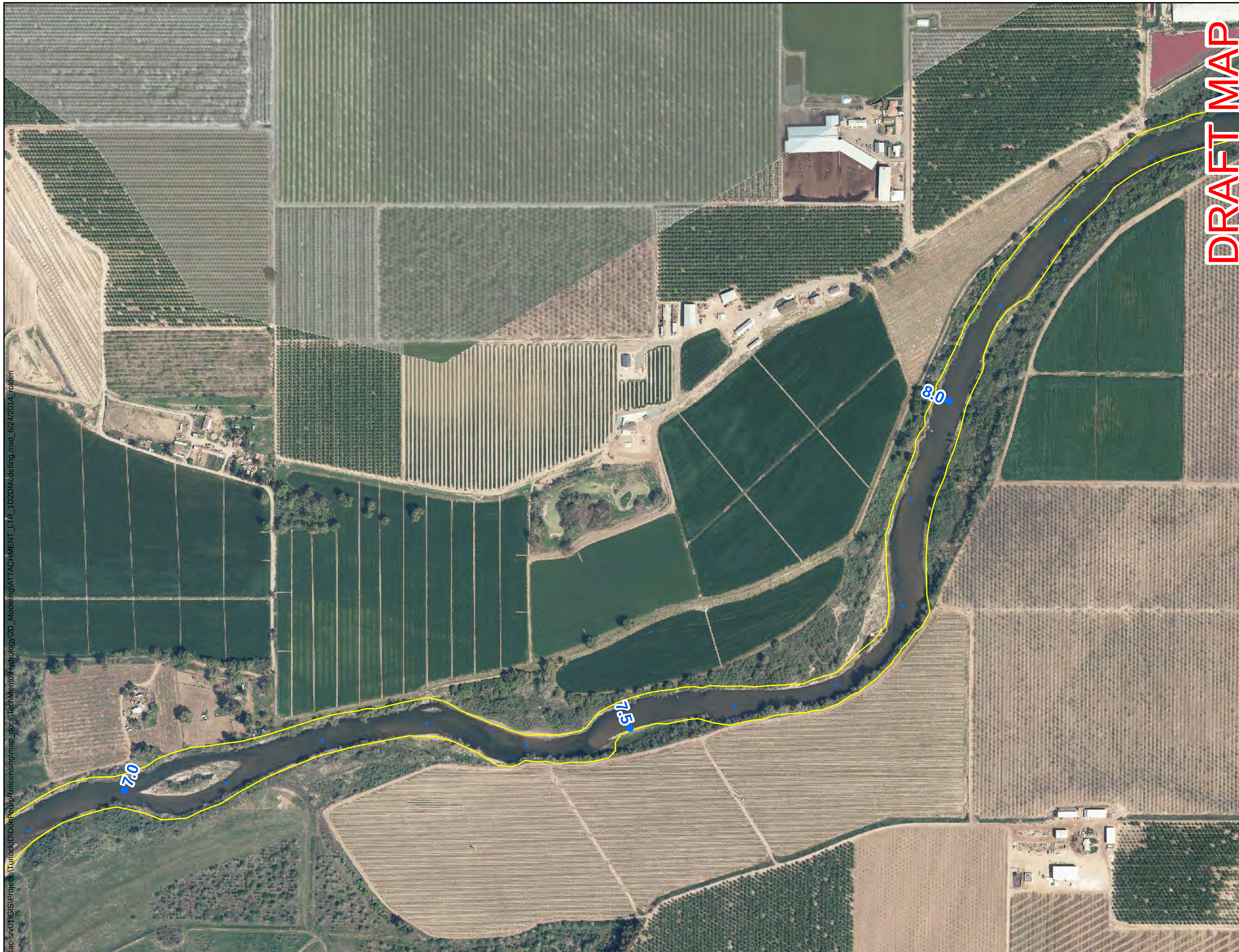

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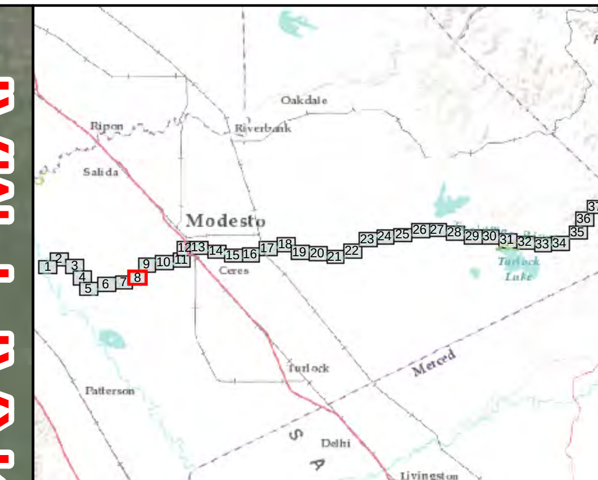

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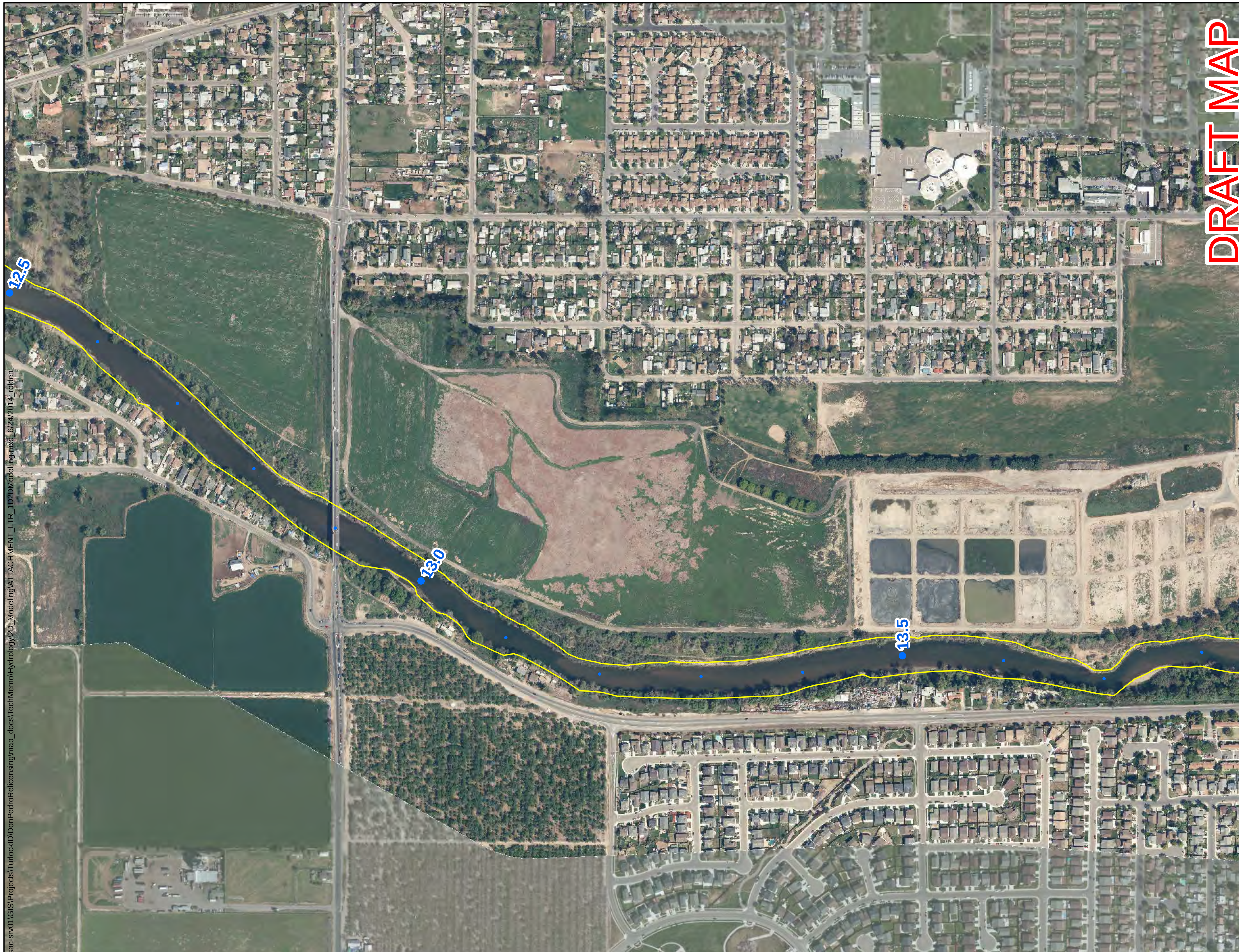

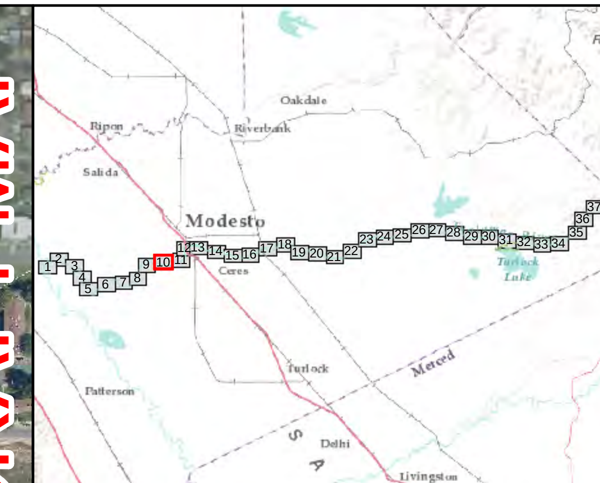

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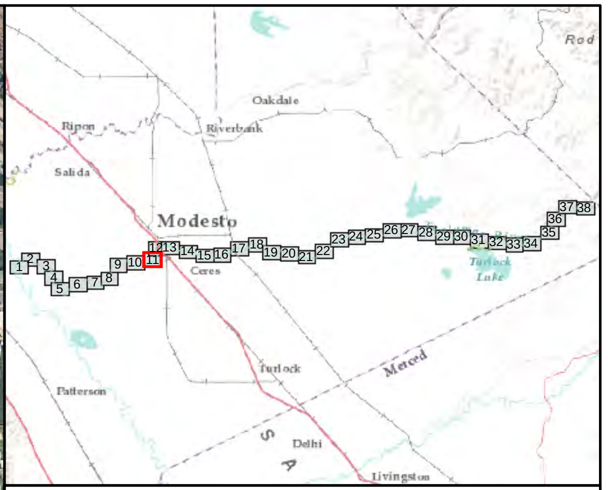

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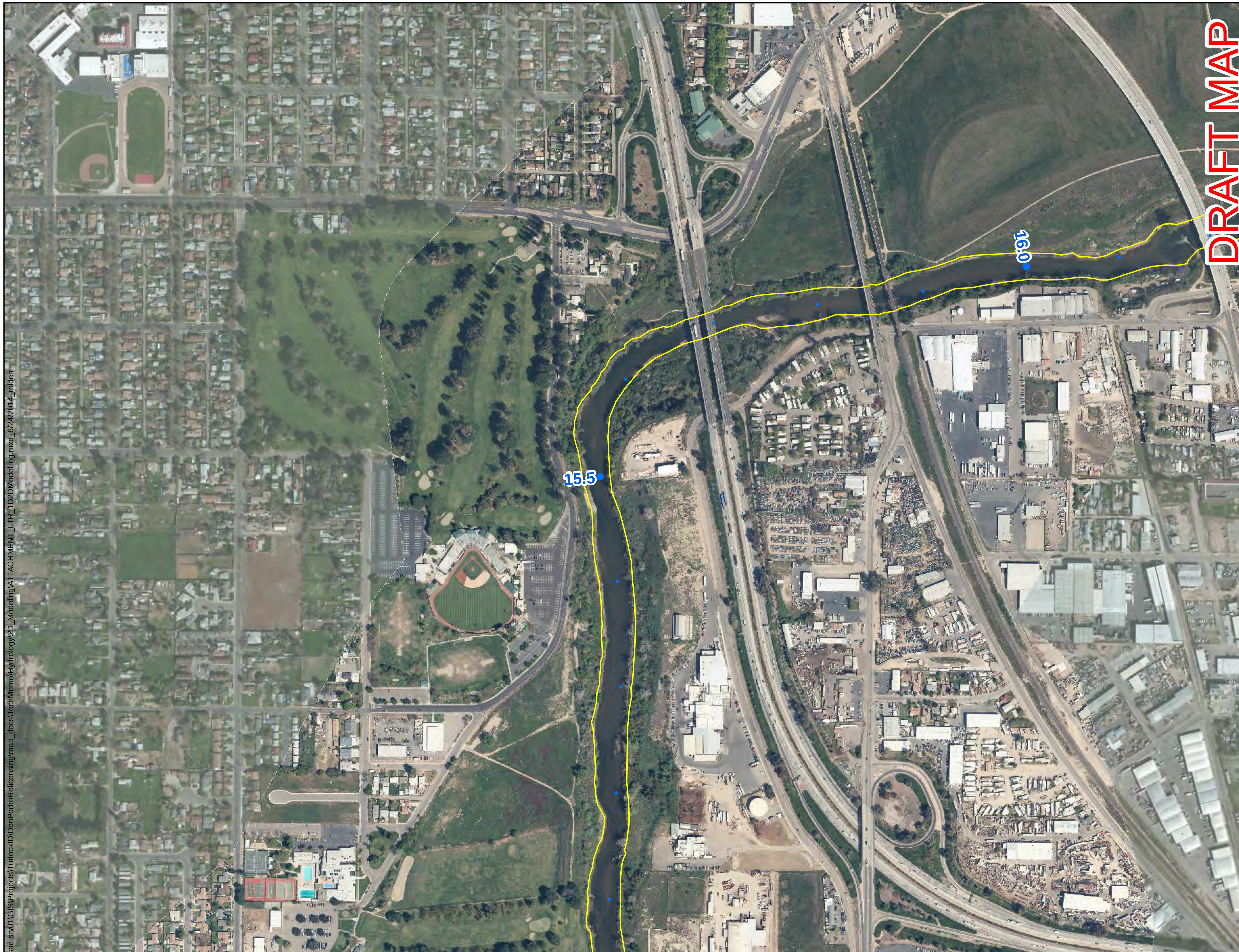

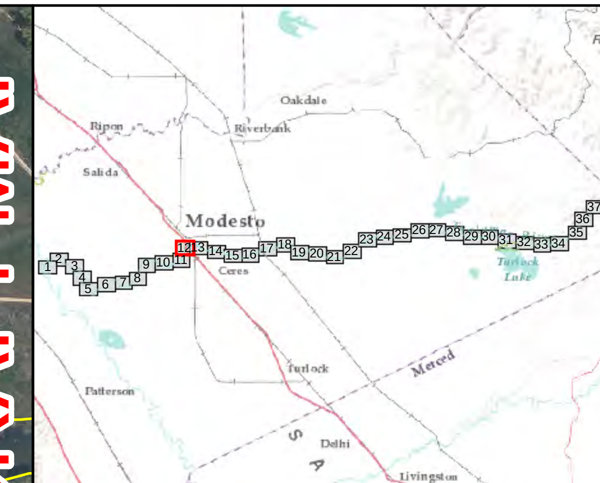

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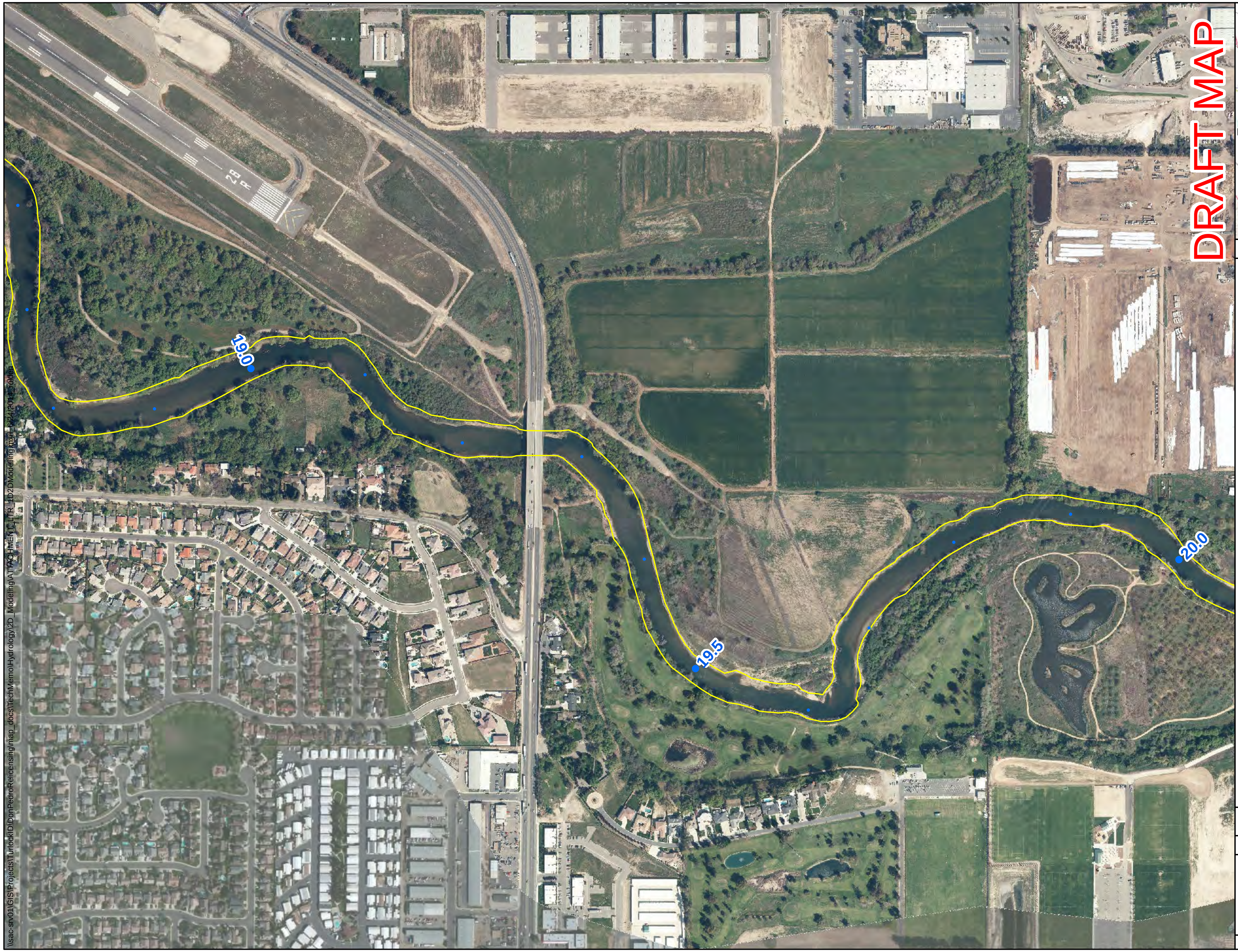

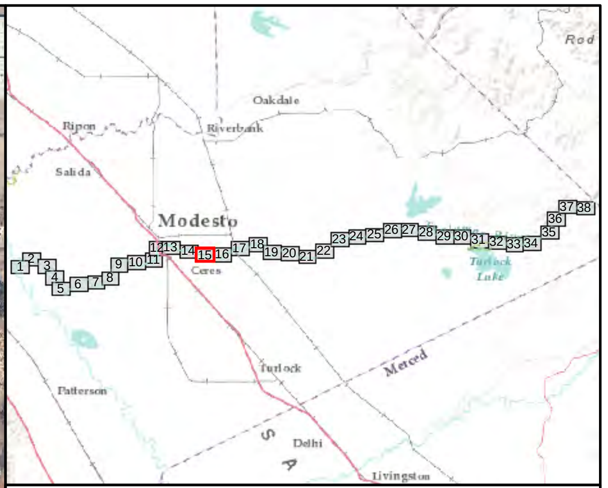

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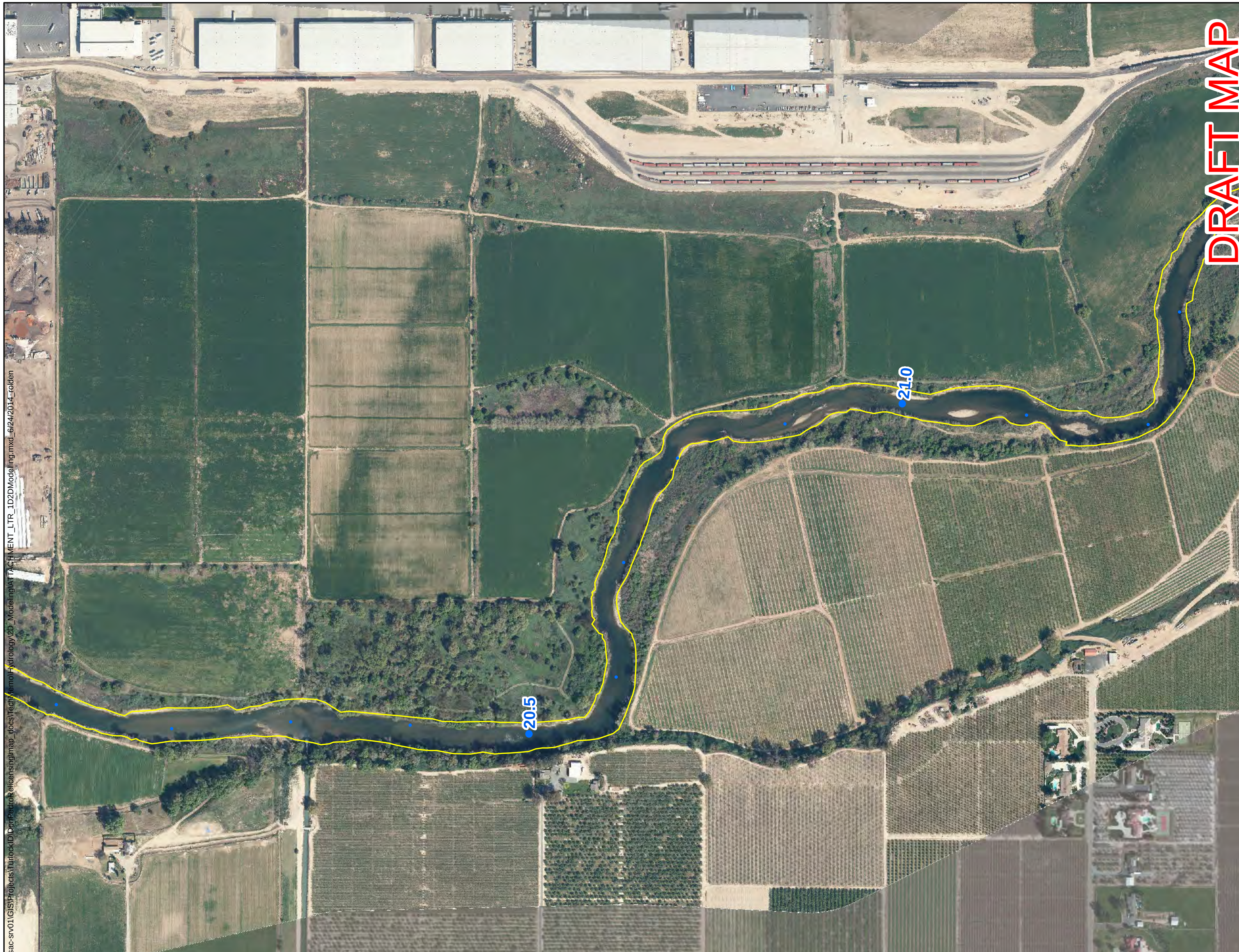

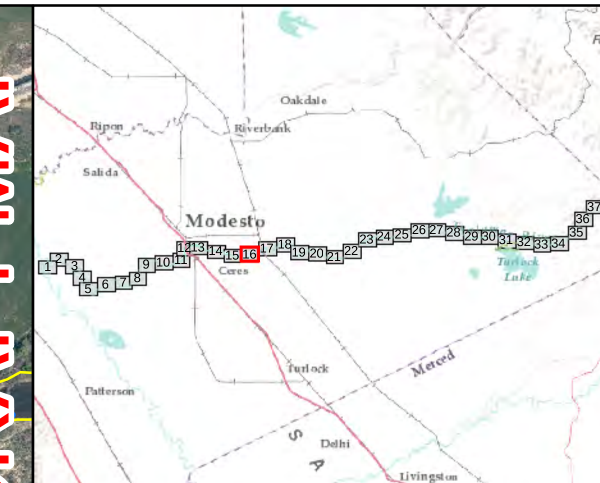

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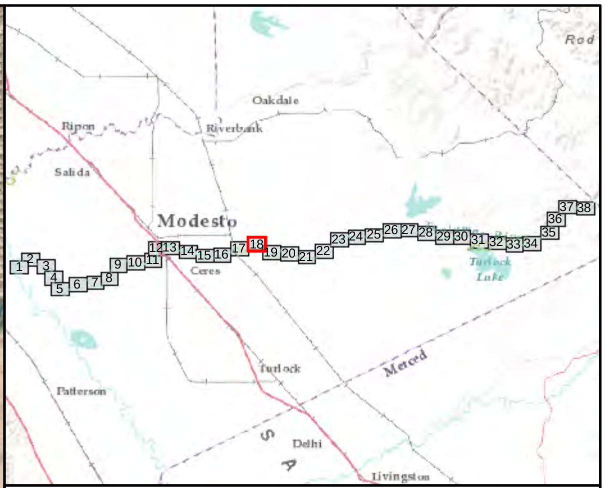

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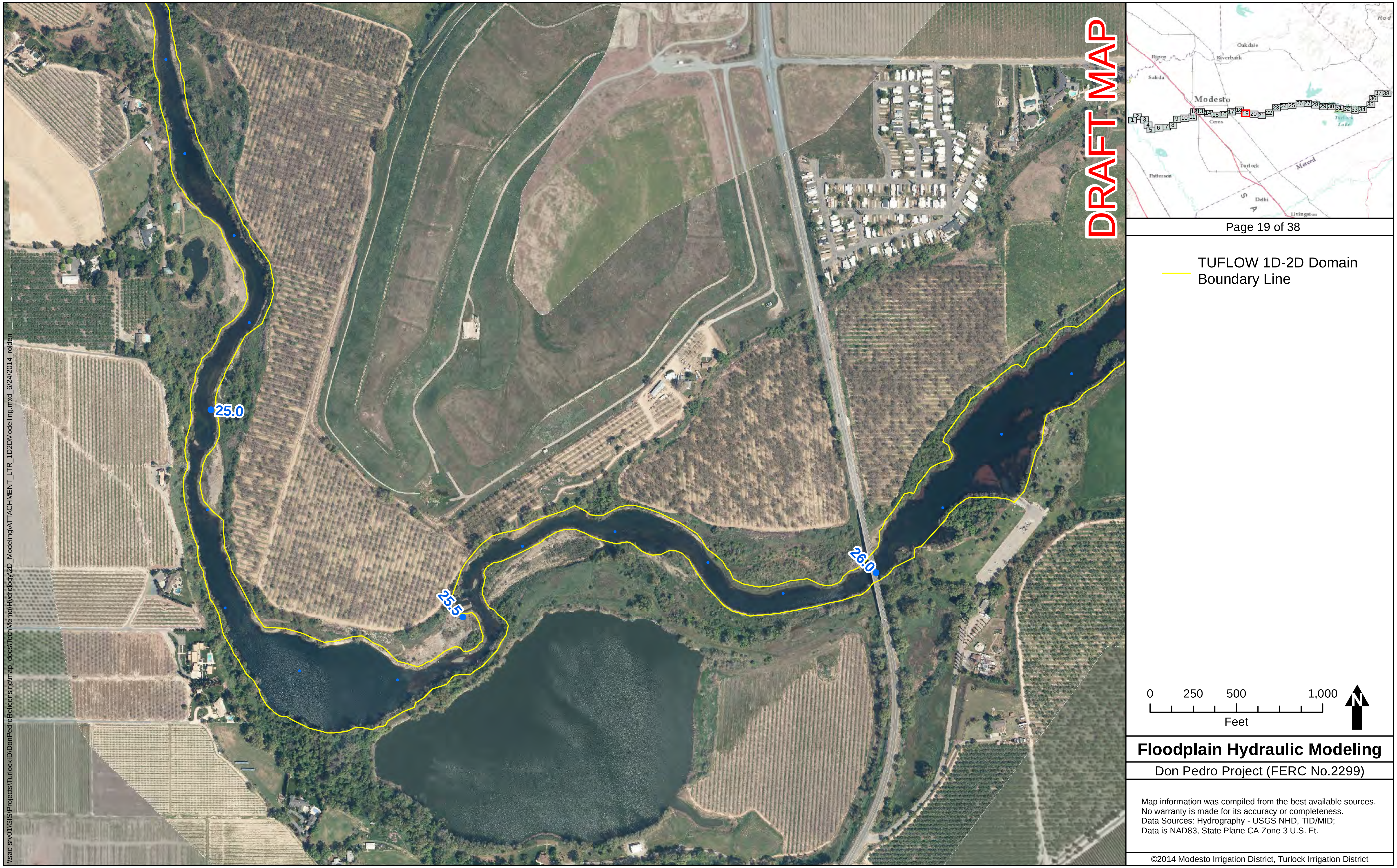

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Page 22 of 38

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0 250 500 1,000
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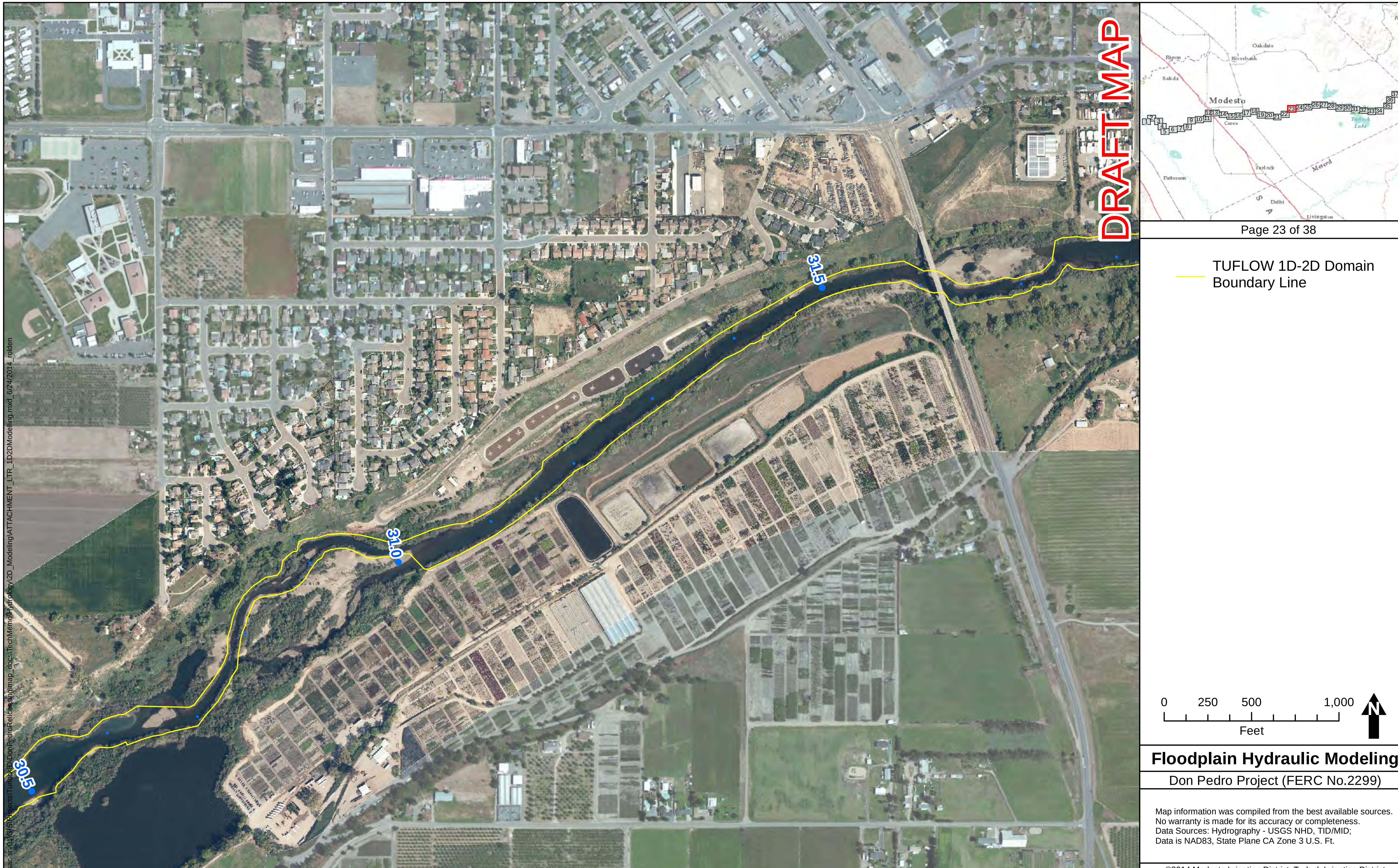

TUFLOW 1D-2D Domain Boundary Line

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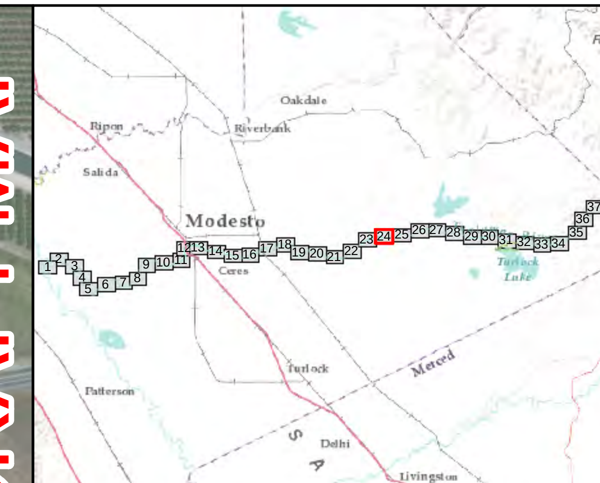

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BCC to: Relicensing Participants Email Group List as of 11-17-2014
From: Staples, Rose
Sent: Monday, November 17, 2014 5:03 PM
Subject: Date Preference Sought for Don Pedro W-and AR-21 Workshop No 2

On February 13, 2014, Turlock Irrigation District and Modesto Irrigation District (collectively, "the Districts") held Workshop No. 1 for the *Lower Tuolumne River Floodplain Hydraulic Assessment (W&AR-21)*. The purpose of this Workshop was to present the model TUFLOW and the associated 2-D hydraulic and habitat modeling approach. Also at this workshop, the basis for delineating the demarcation between in-river and overbank habitat for the entire 52-mile reach was described and discussed.

The Districts propose to hold a second half-day Workshop to discuss with relicensing participants calibration of the model and the habitat analysis for the upper 12 miles of the model. The Districts propose to hold *Workshop No. 2* on either ***Thursday, December 18*** or ***Friday, December 19***, at Modesto Irrigation District's office. Please provide your preference for date and time from the following schedule options:

A. Thursday, December 18 – Morning Workshop
B. Thursday, December 18 – Afternoon Workshop

C. Friday, December 19 – Morning Workshop
D. Friday, December 19 – Afternoon Workshop

Please provide your schedule preference to me at rose.staples@hdrinc.com by **Friday, November 21.** Thank you.

Rose Staples, CAP-OM
Executive Assistant

HDR
970 Baxter Boulevard Suite 301
Portland ME 04103
D 207-239-3857
rose.staples@hdrinc.com

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From: Staples, Rose
Sent: Monday, November 24, 2014 5:08 PM
BCC To: Relicensing Participants Email Group List
Subject: Don Pedro W-AR-21 Workshop No 2

Thank you to all who responded to my request for feedback on your schedule preference for December 18 or 19--(morning or afternoon)--for a half-day Workshop No. 2 for the Don Pedro W&AR-21 Study: *Lower Tuolumne River Floodplain Hydraulic Assessment*. Thursday was the preferred day, with more folks able to attend an afternoon session.

Therefore, the Districts are scheduling the W&AR-21 Workshop No.2 for Thursday, December 18 from 1:00 to 4:30 at the MID Offices in Modesto. The purpose of the workshop will be to discuss with relicensing participants calibration of the model and the habitat analysis for the upper 12 miles of the model.

Rose Staples, CAP-OM
Executive Assistant

HDR
970 Baxter Boulevard Suite 301
Portland ME 04103
D 207-239-3857
rose.staples@hdrinc.com

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BCC To: Relicensing Participants on Email Group List as of 12-5-2014

From: Staples, Rose
Sent: Friday, December 5, 2014 7:48 PM
Subject: Don Pedro W-AR-21 Workshop No 2 Dec 18 AGENDA

Attached is the agenda for the Don Pedro Hydroelectric Project *Lower Tuolumne River Floodplain Hydraulic Assessment (W&AR-21)* Workshop No. 2, which will be held on December 18 from 1:00 p.m. to 4:30 p.m. at the MID Offices in Modesto.

Rose Staples, CAP-OM

Executive Assistant

HDR

970 Baxter Boulevard Suite 301
Portland ME 04103
D 207-239-3857
rose.staples@hdrinc.com

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Don Pedro Hydroelectric Project
Floodplain Hydraulic Assessment (W&AR-21)
Workshop No. 2 Agenda

Thursday, December 18
1:00 pm – 4:30 pm
MID Offices, 1231 11th Street, Modesto, CA

Phone number: 866-994-6437
Conference code: 542-469-7994
Link to online meeting: Join Lync Meeting (Lync Meeting Help)

- Review agenda and purpose of the meeting
- Study plan goals and objectives
- Overview of study methodology
  - Study flows
- Summary of Workshop No. 1
- River hydraulic model background
  - 2D TUFLOW model
  - 1D HEC-RAS model
- Model reaches
  - Model A: RM 52.2 to RM 40
  - Model B: RM 40 to RM 21.5
  - Model C: RM 21.5 to the confluence
- Data sources
- River hydraulic model calibration process (RM 52.2 – RM 21.5)
- Habitat analysis status
  - Analysis approach
  - Model A – preliminary results
    - Bobcat Flat example
    - Reach estimated usable area
    - Area-duration frequency analysis
- Next steps and schedule

BCC: Relicensing Participants Email Group List as of 12-16-2014
From: Staples, Rose
Sent: Tuesday, December 16, 2014 1:53 PM
Cc: Staples, Rose (Rose.Staples@hdrinc.com) <Rose.Staples@hdrinc.com>
Subject: Don Pedro Relicensing Workshop No. 2 for W-AR-21 Floodplain Hydraulic Assessment Study

Please find attached a resend of the workshop AGENDA, which also includes the call-in number / link to on-line meeting if you are unable to attend the meeting in person.

Rose Staples, CAP-OM
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Don Pedro Hydroelectric Project
Floodplain Hydraulic Assessment (W&AR-21)
Workshop No. 2 Agenda

Thursday, December 18
1:00 pm – 4:30 pm
MID Offices, 1231 11th Street, Modesto, CA

Phone number: 866-994-6437
Conference code: 542-469-7994
Link to online meeting: Join Lync Meeting (Lync Meeting Help)

- Review agenda and purpose of the meeting
- Study plan goals and objectives
- Overview of study methodology
    - Study flows
- Summary of Workshop No. 1
- River hydraulic model background
    - 2D TUFLOW model
    - 1D HEC-RAS model
- Model reaches
    - Model A: RM 52.2 to RM 40
    - Model B: RM 40 to RM 21.5
    - Model C: RM 21.5 to the confluence
- Data sources
- River hydraulic model calibration process (RM 52.2 – RM 21.5)
- Habitat analysis status
    - Analysis approach
    - Model A – preliminary results
        - Bobcat Flat example
        - Reach estimated usable area
        - Area-duration frequency analysis
- Next steps and schedule

From: Ramalingam, Pani
Sent: Tuesday, December 23, 2014 11:07 AM
To: 'Gard, Mark'
Subject: RE: Tuolumne floodplain modeling

Hi Mark, thanks for the kind words. It is always nice to hear positive feedback. I apologize for the late reply.

I'm glad you asked this question as it is very relevant.

I have been asked this question before in other studies of why use 1d-2d model and why NOT use a fully 2d model. Every investigation, like every river, is unique and model software selection has to be decided with the specific study scope, goals and uses in mind.

I would again choose TUFLOW for Tuolumne floodplain assessment if I had to do over the modeling given the scope and requirements set out in the study plan approved by FERC.

Primary reasons are:

1. It will be difficult to use a 2d only model when there is no continuous bathymetry data available for river below RM 38.

2. TUFLOW has a 1d component to appropriately capture low flow channel hydraulics by using available transect data (collecting transects data is much cheaper than continuous bathymetry).

3. Using a 2d model for river would require much smaller cell size (less than 10 ft for Tuolumne River) for modeling hydraulic characteristics. This would necessitate multiple models for 52 miles of stream – this could be tedious and setting up boundary conditions for contiguous models will be difficult.

4. Also for this study, results are required for only overbank areas. An earlier PHABSIM study covers the habitat analysis for the riverine portion.

5. The need to model 52 miles of stream & overbanks efficiently – Using a 1d-2d model results in more efficient cell size and computational efficiency resulting in faster run times which also helps control cost

I have also attached couple of slides (was presented in first workshop on Feb 13, 2014) that highlights the suitability of TUFLOW for this project.

I'm happy to explain more or give you a call to discuss.

Thank you

Pani Ramalingam, PhD, PE
D 916.817.4851

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From: Gard, Mark [mailto:mark_gard@fws.gov]
Sent: Friday, December 19, 2014 11:21 AM
To: Ramalingam, Pani
Subject: Fwd: Tuolumne floodplain modeling

Hi Pari:

I enjoyed your presentation yesterday, particularly as I'm doing pretty much the same thing on the Stanislaus and Merced Rivers. If you had to do the modeling over again, would you have used TUFLOW? I'm not familiar with that model, as I've been using a strictly 2D model, SRH2D, for the floodplain modeling I'm doing on the Stanslaus and Merced Rivers.

Mark Gard Ph.D., PE 40701
Fish and Wildlife Biologist
U.S. Fish and Wildlife Service
Anadromous Fish Restoration Program
2800 Cottage Way, Suite W-2605
Sacramento, CA 95825
Phone: Mon,Wed, Fri (916) 414-6589; Tues, Thur (916) 799-0534
Fax: (916) 414-6712

---------- Forwarded message ----------
From: **Noah Hume** <noah@stillwatersci.com>
Date: Fri, Dec 19, 2014 at 10:48 AM
Subject: RE: Tuolumne floodplain modeling
To: "Gard, Mark" <mark_gard@fws.gov>, "Pani.Ramalingam@hdrinc.com" <Pani.Ramalingam@hdrinc.com>

Mark let me introduce Pani Ramalingam; Pani please meet Mark :)

I'll let you both continue regarding potential TUFLOW applications to the Stanislaus and Merced.

Mark – I haven't gotten the green light on your data request but we should have the area discharge file to you in the next week or so. Not for certain, but I think we might need to wait a bit longer on sharing the velocity and depth predictions, at least until the Draft report is complete (which it isn't).

Have a good holiday!

Noah Hume PE, PhD
Aquatic Ecologist/Senior Scientist

Stillwater Sciences | 2855 Telegraph Avenue, Suite 400, Berkeley, CA 94705
510.990.6214 direct | 510.848.8098 company | 510.541.2131 cell
www.stillwatersci.com

From: Gard, Mark [mailto:mark_gard@fws.gov]
Sent: Friday, December 19, 2014 9:16 AM
To: Noah Hume
Subject: Re: Tuolumne floodplain modeling

Thanks!

What's Pani's e-mail address? I would be interested in chatting with him about his experience with TUFLOW - I've been using SRH2D for the floodplain modeling I've been doing on the Stanislaus and plan to do on the Merced (see our latest CVPIA annual report on our website if you are interested in more information about that):

http://www.fws.gov/sacramento/fisheries/Instream-Flow/fisheries_instream-flow_reports.htm

Mark Gard Ph.D., PE 40701

Fish and Wildlife Biologist

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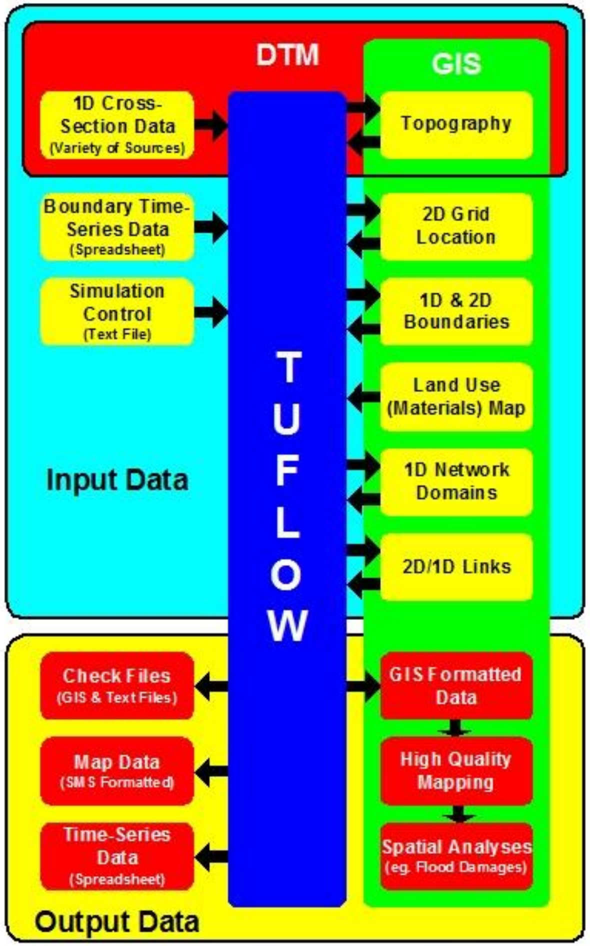
TUFLOW Model

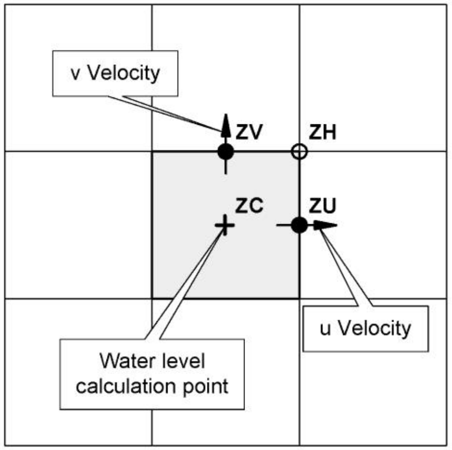
- Unsteady 2D model
- Implicit finite difference scheme – FAST!
- 2D overbank areas with 1-D low flow channel
- River-wide modeling



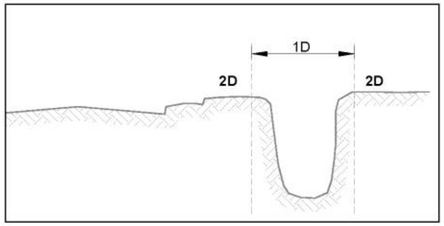
TUFLOW Data Input and Output Structure

Advantages of LTR Study

- Powerful GIS-centric architecture
- Layered data approach
- Flexible grid size
- 1-D low flow channel



Location of Zpts and Computation Points



Modelling a Channel in 1D and the Floodplain in 2D