M & T / Llano Seco Fish Screen Facility
Short-Term/Long-Term Protection Project

SUMMARY REPORT

Investigative Studies and Supportive Information

Prepared for:

M&T/LLANO SECO PUMPING PLANT INFORMATION / EARLY SCOPING PUBLIC MEETING
July 27, 2005
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INTRODUCTION

This report has been prepared to provide a complete compendium of information for public review in concert with the M&T/Rancho Llano Seco Ranches Pumping Plant Information / Early Scoping Meeting being held on July 27, 2005. The purpose of the report is to compile pertinent information, such as, background, meetings discussions, studies, and documents related to the conditions posed by the deposition of alluvial sediment at the M&T Chico Ranch/Rancho Llano Seco fish screened diversion on the Sacramento River as well as the operation of the City of Chico wastewater outfall located approximately 300 feet downstream of the pumping plant. These documents are a result of a technical review and planning process framed by the CALFED Ecosystem Restoration Program for the purpose of protecting the existing facilities and finding a long-term solution addressing fish-friendly surface water diversion and public health safety.

Due to the size and length of these reports and investigations, some of the documents have not been reproduced for the public meeting. However, copies of these documents may be accessed and downloaded from the following website:

http://www.ducks.org/conservation/Projects/Western/MandT/mt.asp.

The viewer will find a complete volume of all documents, reports and studies included in the Public Meeting presentation and all other supportive documentation. If you experience any difficulty accessing this information, please contact Olen Zirkle, Project Manager, Ducks Unlimited, (916) 852-2000.

BACKGROUND

Various and cumulative impacts are associated with the falling trends of all four species of Chinook salmon, steelhead trout, Sacramento splittail and other Sacramento River aquatic species within the Sacramento River Basin. Unscreened diversions, dams, poorly screened pump intakes, and large diversions have contributed to the decreasing numbers of aquatic species in the Sacramento River Basin. As part of a major effort to reduce the risk of mortality within the Sacramento River Basin, the M&T Chico Ranch/ Rancho Llano Seco diversion pumps, once located on Big Chico Creek, were relocated to the Sacramento River in 1997. The relocated diversion was designed with a state-of-art fish screen system supplying a total capacity of 150 cubic feet per second (cfs). As part of the relocation, the M&T Chico Ranch and Rancho Llano Seco agreed not to divert 40 cfs of their long-held water right out of Butte Creek (October 1 through June 30) to support Butte Creek fisheries as long as replacement water would be guaranteed by the new diversion located on the Sacramento River. The M&T/Rancho Llano Seco pumping plant provides a reliable water supply to approximately 15,000 acres of farmland and refuge land, including over 4,000 acres of wetland owned and managed by the

U.S. Fish and Wildlife Service (USFWS) and the California Department of Fish and Game (CDFG) that provides key wetland habitat for waterfowl and other wetland species.

The M&T/Llano Seco pumping plant location is just downstream of the confluence of Big Chico Creek and the Sacramento River, on the east bank of the Sacramento River just south of the Bidwell State Park at river mile (rm) 193, approximately six miles SSW of the City of Chico. Approximately 300 feet downstream from the M&T/Llano Seco pumping plant is the City of Chico wastewater treatment plant outfall (WWTP).

Sediment deposition has posed a threat to the normal operation of the fish screened diversion. An encroaching gravel bar adjacent to the Bidwell State Park migrates at an unpredictable rate to the vicinity of the fish screened diversion and WWTP outfall. As a result of this sediment deposition, the intake screens are no longer receiving sufficient sweeping flows (parallel to screen), inconsistent with National Marine Fisheries Service (NMFS) and the California Department of Fish and Game (CDFG) fish screen criteria. Consequently, due to the river morphologic changes there is a potential the anadromous fish in the Sacramento River and Big Chico Creek could be adversely impacted.

The uncertain rate of river meandering and sediment deposition will continue to pose problems to the operations and safety of the M&T/Llano Seco intake and fish screen system as well as the City of Chico wastewater outfall. The rate at which the sediment is accumulating near the fish screened intake is mostly dependant on the flow conditions on the Sacramento River (the gravel bar growth and rate of migration is accelerated during wet years). This condition poses a dilemma between protecting ecosystem functions by accommodating the natural processes of the river and also protecting the present pumping facility in order to provide a fish screened diversion without presenting a threat to the anadromous species and providing water for crops, habitat and waterfowl.

In response to this dilemma, the Bay-Delta Authority requested that a team of multidisciplinary experts be consulted in order to collaborate on the best scientific knowledge available that will assess the problem and provide a proposal that will develop a long-term solution. A Steering Committee has been formed to address the following fundamental questions and develop a solution to the problems:

FUNDAMENTAL QUESTIONS TO BE ADDRESSED

1. What is the rate and uncertainty associated with river meander and sediment deposition at the project site?
2. What is the realm of possible alternative means to meet the water requirements of the beneficiaries?
3. What are the current fish screen criteria and can these criteria be changed to accommodate innovative solutions?
4. What are the uncertainties associated with the simultaneous interaction between river meander, pumping plant capacity and fish screen protection?

M&T/LLANO SECO PROJECT STEERING COMMITTEE

A Steering Committee was formed to guide and provide recommendations the project through short and long-term solutions of the project. The steering committee is a collaborative group comprised of

stakeholders, CALFED representatives, engineers, and a team of multi-disciplinary experts in the fields of fluvial geomorphology, sediment transport, hydraulic modeling, fish screening and pumping plant technology.

CALFED has selected qualified experts to serve on the Steering Committee in a capacity to perform an internal peer review of all investigation and studies recommended by the Steering Committee members.

The overall purpose of the committee is to provide a balanced and unbiased view of the issues, to characterize the status of knowledge of the project, and to identify and prioritize key scientific issues associated with the project. The Steering Committee will guide development of the long-term solution ensuring that any further actions will consider the necessary objectives and parameters to maintain and effective, fish friendly diversion for M&T/Llano Seco pumping plant. The Steering Committee is charged with investigating innovative diversion techniques, fish protection, and natural riverine processes to provide a long-term solution to the stakeholders and California Bay-Delta Authority (CBDA).

PRIMARY PROJECT GOAL

- To protect the existing M&T/Llano Seco fish-screen facility and its beneficiaries while investigating and identifying a technically and economically feasible long-term solution to adapt the fish-friendly pumping facility to the lateral migration of the Sacramento River.

PROJECT OBJECTIVES

The main objectives of the long-term study are:

- To obtain an authoritative and unbiased description of the state of scientific knowledge related to the Sacramento River meander, fish screen and pumping plant technology by convening a multidisciplinary team of experts in the fields of fluvial geomorphology, hydraulic modeling, fish screen and pumping plant technology.

- To provide an opportunity for stakeholders and scientists to test and refine an understanding and potential for unintended effects between managing the natural riverine system, fisheries requirements and pumping requirements.

- To conduct an exhaustive literature search, fill identified data gaps and conduct modeling to provide important data essential in answering specific questions that support a strong research approach in accomplishing the primary project goal.

- To determine performance measures/indicators that will guide the long-term solution in meeting the primary project goal.

- To fully document the investigative process of determining, identifying and justifying the long-term solution that will meet the primary goal of the project.

M&T/LLANO SECO PROJECT STEERING COMMITTEE

The Steering Committee is a collaborative group comprised of stakeholders, CALFED representatives, engineers and a team of multi-disciplinary experts in the fields of fluvial geomorphology, hydraulic modeling, sediment transport analysis and fish screen and pumping plant technology. The scientists selected for this Steering Committee are recognized to have the highest level of expertise and scientific stature, advisory experience, record of technical publications, relevant knowledge, collaboration and interdisciplinary skills.

Members of the Steering Committee:

Technical Scientific Expertise
Yantao Cui, PhD, PE, Research Scientist Hydrology/Geomorphology
Michael Harvey, PhD, PE, Principal Geomorphologist, Muesstter Engineering, Inc.
Eric Larsen, PhD, Research Scientist-Geology
Robert Muesstter, PhD, PE, Principal Engineer, Muesstter Engineering, Inc.

Local Technical Expertise
Michael Aceituno, Supervisor, Sacramento Area Office, National Marine Fisheries Service
Koll Buer, Chief, Geologic Investigations Section, California Dept. of Water Resources
Stacy Cepello, Environmental Scientist, California Dept. of Water Resources
Jim Gaumer, PE, Engineer, M&T Chico Ranch
Dan McManus, PE, Assoc. Engineering Geologist
Rick Wantuck, Hydraulic Engineer, National Marine Fisheries Service
Paul Ward, Assoc. Fishery Biologist, Region 2, California Dept. of Fish & Game
Dennis Dorratcague, PE, Principal Engineer, MWH Americas
Neil Schild, PE, Principal Engineer, MWH Americas
Robert Strand, Engineer, MWH Americas

CALFED Representatives
Dan Castleberry, Program Mgr. Ecosystem Restoration Program, California Bay-Delta Authority
Rebecca Fris, Restoration Coordinator, California Bay-Delta Authority
Vickie Newlin, California Bay-Delta Authority Sacramento Valley Regional Coordinator

Stakeholders
Burt Bundy, Manager, Sacramento River Conservation Area
Woody Elliott, District Resource Ecologist, California Dept. of Parks & Recreation
Kevin Foerster, Project Leaders, Sacramento Valley national Wildlife Refuge
Les Heringer, Manager, M&T Chico Ranch
David Sieperda, Manager, Rancho Llano Seco
Marc Sulik, City of Chico Water Pollution Control Plant
Richard Thieriot, Owner, Rancho Llano Seco

Project Management
Olen Zirkle, Manager, Conservation Programs, Ducks Unlimited, Inc.
Chris Leininger, Project Development, Ducks Unlimited, Inc.

To date, the Steering Committee has met together in three workshop settings to develop a proposal for determining and prioritizing alternative actions to meet long-term protection goals of the water supply while having minimal impacts on river meander functions and anadromous fish. This Summary Report is a compendium of all project studies, reports and information compiled to support the development of this expert consensus on a technically and economically feasible long-term solution to met the following project goals and objectives. In addition, the report includes a list of historical documents that document programmatic support for the project and pertain to the decision-making that led to the relocation of the pumping facility.

HISTORICAL DOCUMENTS

(documents in full can be found at this link: http://www.ducks.org/conservation/Projects/Western/MandT/mt.asp).

January 1989

Upper Sacramento River Fisheries and Riparian Habitat Management Plan. The Resources Agency, State of California. [http://www.sacramentoriver.ca.gov]

November 1993

Restoring Central Valley Streams: A Plan for Action. California Dept. of Fish & Game. http://www.dfg.ca.gov/nafwb/pubs/1993/RCVS.pdf [site will take over 10 minutes to download]

April 14, 1995

Technical Memorandum from CH2M HILL to M&T Chico Ranch re: M&T Chico Ranch Pump State Relocation Feasibility Study. CH2M HILL.

June 1995

Butte Creek Water Supply and Fish Passage Study. U.S. Department of the Interior, Bureau of Reclamation.

December 6, 1995

Draft Anadromous Fish Restoration Plan: A Plan to Increase Natural Production of Anadromous Fish in the Central Valley of California. U.S. Fish & Wildlife Service. [http://www.delta.dfg.ca.gov/afrp/documents.asp]

April 1996

Finding of No Significant Impact/Mitigated Negative Declaration and Draft Environmental Assessment/Initial Study for the M&T / Parrott Pumping Plant and Fish Screen Project. California Department of Fish and Game, City of Chico, Jones and Stokes.

May 21, 1996

Agreement for Relocation of M&T/Parrott Pumping Plan Providing for Bypass of Flows in Butte Creek. M&T Chico Ranch, Parrott Investment Company, U.S. Fish and Wildlife Service, and California Department of Fish and Game.

August 12, 2003

Technical Memorandum from Stillwater Sciences to M&T Chico Ranch, Sacramento River Conservation Area Forum and California Department of Water Resources, re: Final Draft of M&T Ranch and Llano Seco Wildlife Refuge Pump Intake. Stillwater Sciences.

September 2001

Initial Study and Proposed Mitigated Negative Declaration – M&T Ranch/Llano Seco Ranch/City of Chico Sacramento River Water Intake Stream Channel Maintenance. California Department of Fish and Game, City of Chico, and HDR Engineering, Inc.

WORKSHOPS

Workshop #1: Orientation and Information Workshop, November 12-14, 2003

(documents in full can be found at this link: http://www.ducks.org/conservation/Projects/Western/MandT/mt.asp).

A. Steering Committee Membership

B. Hypothesis and Conceptual Model

C. Workshop #1 Agenda

D. Workshop #1 Minutes

E. Technical Memorandum #1 – MWH Americas
   a. Existing Studies Report
   b. Literature Search (Eric Larsen – UC Davis)

F. Workshop #1 Summary

Steering Committee members conducted a site visit on the Sacramento River to collectively view the pumping/fish screen facility and to evaluate the current position and threat of the encroaching gravel bar. The members met at the Llano Seco Rancho for three days to begin the development of a long-term solution such that it is likely to result in innovative solutions to protect threatened and endangered anadromos fish populations and pumping requirements for adjacent agriculture, managed wetlands (federal, state and private), and the City of Chico wastewater facility outfall without a significant effect upon river meander.

A thorough review was made of the existing studies, past and current conditions of the pumping plant and fish screen facility, e.g., geologic investigations, pumping plant/fish screen construction/capacity/existing conditions, groundwater conditions and construction/existing conditions of the City of Chico Wastewater Treatment Plant outfall. As a result of these discussions the Steering Committee developed the following list of possible alternatives to meet the project goals:

- Installation of Additional "Tee" Fish Screen
- Groundwater Extraction from Production Wells
- Groundwater Extraction from Ranney Wells
- Installation of Rock Groins

It was agreed by the Steering Committee that there was not a sound basis to choose a preferred alternative and recommend further investigations to more fully evaluate the feasibility of the above-listed alternatives. It was also agreed that a better understanding of the river dynamics and sediment transport and deposition was key to meeting the objectives of the project. As a result of these recommendations, the following actions were approved:

- Determine the physical feasibility of extracting 150 cfs of groundwater from the study area.
- Develop preliminary cost estimates for the installation of an additional "tee" fish screen, ground water extraction with production wells and ground water extraction with Ranney Wells.
- Evaluate the economic and legal aspects of the above-listed alternatives.
- Evaluate the water supply and water demands.
- Consider impacts to the City of Chico Wastewater Treatment Plant outfall.
- Conduct a river meander and sediment transport analysis for the project site.

Workshop # 2 would be scheduled at a later date to review and discuss the compiled information to advance the selection of a preferred alternative.

G. Supportive Information
   a. CALFED Science Program Framework [http://science.calwater.ca.gov]

Workshop #2: Technical Review and Recommendation Workshop, March 17 – 19, 2004
(documents in full can be found at this link: http://www.ducks.org/conservation/Projects/Western/MandT/mt.asp).

A. Workshop #2 Agenda

B. Workshop #2 Minutes

C. Steering Committee Charge

D. Technical Memorandum #2 – MWH Americas
   a. Groundwater Model for Test Well
   b. Potential Water Supply Alternative – Scenarios 1 through 4
   c. Preliminary Cost Estimates, legal and economic discussion for Potential Water Supply Alternative – Scenarios 1 through 3
   d. M&T/Llano Seco Water Supply and Demand – City of Chico Wastewater Treatment Plant Impacts
   e. Optional Fish Screen Criteria

E. Investigative Studies
   a. Channel and Sediment Transport Dynamics near River Mile 193, Sacramento River

F. Workshop #2 Summary
   The Steering Committee conducted a site visit on the Sacramento River to evaluate changes to the gravel bar and existing bank erosion. The three-day workshop was again

held at Rancho Llano Seco headquarters. The members reviewed and discussed the preliminary technical review of the river meander and sediment deposition, the additional "tee" fish screen, ground water studies and standards and potential for flexibility for fish screen criteria.

After reviewing the technical reports, the Steering Committee listed all of the possible alternatives and then evaluated each alternative against meeting fish screen criteria, pumping capacity, river meander, advantages, disadvantages, risks, uncertainties and fatal flaws. The following is an outline of this evaluation:

Collector Basin (Infiltration Gallery)

Meets Fish Screen Criteria	YES
Compatible with Meander	YES
Meets Pumping Capacity	Info Gap (Test Well)

Other - Low cost; Compatible w/present facility;Minimal Impact

Uncertainties	Fatal Flaws
• Gravel permeability	• Large area required
• Draw downs	• Public safety
• Underground basin	• Liability – levee breach
• Site selection	• Reclamation Bd. Permits
• River movement	• River meander impacts
• Economics	• Maintenance – siltation (no back-flush ability)
• Groundwater impacts	

Extended Intake – Down the River

Meets fish screen criteria	Yes
Compatible with meander	Yes
Provides pumping capacity	Maybe
Compatible with outfall	

Uncertainties	Flaws
•River meander – will it have to be moved.	•Project life
•City of Chico selection of alternatives.	
•Head loss / affects on pump state.	

Extended Intake – Across the River

Meets fish screen criteria	Yes
Compatible with meander	Yes
Provides pumping capacity	Maybe
Maintains facility	

Uncertainties

- Flood flows at the new location
- Air burst
- Scour depth
- River meander

Flaws

- River shift
- Accessibility

In-Conduit Fish Screen

Meets fish screen criteria	YES
Compatible with meander	YES
Provides pumping capacity	YES
Maintains existing facility	
Pumping costs remain the same	
Known technology	

Uncertainties

- Pipe extensions – cost/permitting/long-term maintenance
- Capacity variables
- Pumping costs
- Acceptable state technology

Flaws

- Bypass pipe / predation
- Intake – chase meander

Dredging / Stillwater Screen

Meets fish screen criteria	YES
Compatible with meander	YES
Provides pumping capacity	YES
Maintains existing pumping plant	
Low initial cost (new screens)	

Uncertainties

- How much dredging to maintain capacity
- Dredging costs
- Where do the spoils get deposited
- Screen costs (flat plate?)

Flaws

- Annual dredging
- Permit process
- Dredging when endangered species are present
- Other ownership issues – state parks
- As river moves west, channel would need to increase in width and length

Groins

Meets fish screen criteria	YES
Compatible with meander	NO
Provides pumping capacity	YES
Protects outfall	
Maintains current operations	
Improves current situation	
Reasonable confidence in utility	

Uncertainties

- Off-site impacts
- Mitigation costs
- Mitigation possibilities (trading)
- Authorities / maintenance
- Cost
- Short-term dredging costs

Flaws

- Public safety
- Environmental impact to river meander
- Institution constraints

Multiple Production Wells

Meets fish screen criteria YES
Compatible with meander YES
Provides pumping capacity YES
Out of the river
Minimal environmental impact
Spread drought risks

Uncertainties
- Power
- Distribution system
- Groundwater
- Farmland impacts
- Water rights / legal issues

Flaws
- Required area
- Higher maintenance costs

Ranney Collectors

Meets fish screen criteria YES
Compatible with meander YES
Provides pumping capacity YES
Minimal environmental impacts
No loss of farmland
Possible use of existing large pumps
Out of the river

Uncertainties
- Permeability of gravels
- Cost for pumping and long-term maintenance
- Impacts – river meander
- Capacity / cost
- Life cycle costs
- Water rights

Flaws
- Additional pumping expense
- Highest cost idea

Combination of one Ranney Collector / Dredging

- Supplemental supply
- Two systems to ensure capacity

Other alternatives briefly discussed:

- Alternative Water Source – Western Canal
- Collection Pond – Ranney Collector
- Additional Butte Creek water
- Dredging Fish-Friendly Pumps
- Redistribution – Scattered Production Wells / Ranney Collectors

The Steering Committee agreed that two categories of unknowns surfaced from the investigations: (1) alternatives outside the levee; and, (2) alternatives inside the levee. The members held lengthy discussions about the information gaps associated with each of these alternative approaches and identified a the following list of unknowns and uncertainties for each:

Uncertainties - Inside the Levee

•Level of dredging •Screen cost •Dredging cost •Spoils disposal •Flood flows •Aquifer depth •Meander •Model dikes (2D) •City of Chico alt. •Pipe head loss •Off-site impacts	•Mitigation Cost •Maintenance •Construction cost/permits •Dredging cost •Protect outfall •CEQA/NEPA •Water Rights/Legal issues	•Pipe Extension – cost/permits •Long-term Maintenance •Pumping cost •No acceptable technology •Distribution •Groundwater •Farmland Impact

Uncertainties - Outside the Levee

•Permeability of gravels •Impact on draw down •Estimated size of basin •Site selection	•River Movement •Economics •Legal issues •City of Chico •Alternatives	•Additional Pumping Costs •Canal seepage losses

After extensive review and discussions, the Steering Committee felt that they could not reach a final conclusion and make a recommendation to California Bay-Delta Authority without additional modeling and data collection to answer several remaining unknowns on river meandering and to understand the hydraulic capacity of underground water bearing strata.

What is known at this point is that the river will move away from the pumping plant site and the gravel bar will continue to build. It is also known that the underground water bearing strata may be able to produce sufficient flows to meet the project needs.

The proposed modeling will answer specific questions as to actions that could be taken to maintain the pumping plant within the river boundaries. The test well study will determine if the pumping plant needs could be met by moving outside of the river and installing a large capacity ground water collection system (Ranney Collector). The following recommended reports will assist in answering the unknowns:

2-D MODEL TO EVALUATE POTENTIAL RIVER CONSTRAINTS

- This modeling effort is designed to achieve the following specific purposes: (1) to better understand how sediment is transported through the site; (2) to understand the effects of the upstream revetment on flow patterns through the site; (3) to evaluate the necessary length and location of the spur dikes discussed at the Committee meeting.

FUTURE MIGRATION MODEL OF RIVER REACH WITHOUT BANK CONSTRAINTS

- This modeling effort will perform a meander migration analyses to simulate upstream and downstream effects of groins. The model will include calibration and modeling with and without groins using a spatially variable erosion field. It will also include a simulation with different upstream conditions (remove revetment at River Road).

- The model will perform meander migration simulations to model downstream mitigation possibilities that include simulation with a prototype of cutoff simulations and a calculation of area reworked.
- The model will perform meander migration simulations to model possible scenarios of channel avulsion (cutoff) at Pine Creek and the downstream consequences of this possible cutoff on channel migration dynamics at the M&T site.

GROUND WATER TEST WELL / MONITORING WELLS

- This study will involve drilling a test well and several monitoring wells outside the levee to develop the needed aquifer capacity information for underground water-bearing strata at the site. It is expected that the test well could be completed this summer and monitoring data developed by year-end.
- Description: Drill a test well, 150 feet deep x 36 inches in diameter, in the area immediately adjacent to the M&T/Llano Seco Pumping Plant and outside the Sacramento River east levee; equip the well with test pumping equipment; drill six monitoring wells, 150 feet deep x 6 inches in diameter, located according to a plan developed for the project by DWR and MWH engineers; operate the test well and monitoring wells; prepare a report summarizing the methodology and findings; present the information in Workshop #3 to discuss the results with the Steering Committee.

The issue of gravel bar encroachment was discussed as an on-going monitoring responsibility. Previous monitoring substantiates that the gravel bar is continuing to encroach on the site and may have to be removed before the long-term solution can be developed and implemented. This encroachment has been further verified by the modeling completed by the Steering Committee members that shows that the pumping plant site could be completed inundated in only one year if a major storm event occurs or in five years under normal winter flow conditions. The gravel bar was last removed in November 2001which was three winter seasons ago. By extending this Long-term study an additional year, the vulnerability of the site to encroachment by the gravel bar is likewise extended. No decisions were made at the workshop regarding the gravel bar. Dive reports on the gravel bar encroachment will be available at the end of April when the river water levels subside and the dive team can access the site. Once the information is made available to the Steering Committee members, an informed decision can be made to implement a gravel bar reduction project.

Workshop # 3 would be scheduled at a later date for an in-depth review and discussion of the proposed investigation to refine the selection of a preferred alternative.

G. Information
   a. National Marine Fisheries Service – Southwest Region
      Fish Screening Criteria for Anadromous Salmonids – January 1997
   b. State of California – Resources Agency – Department of Fish and Game
      Fish Screening Criteria – June 19, 2000

Workshop #3 – Project alternatives and Feasibility Workshop, February 16 – 18, 2005
(documents in full can be found at this link: http://www.ducks.org/conservation/Projects/Western/MandT/mt.asp).

A. Workshop #3 Agenda

B. Workshop #3 Minutes

C. Technical Memorandum #3
   a. Aquifer Text Draft Report – January 21, 2005
   b. Ranney Well Collector Power Cost

D. Investigative Studies
   a. Two-dimensional Modeling to Evaluate Potential River Training Works at M&T Pumping Plant, Sacramento River, RM 192.5
   b. Future Meander Bend Migration and Floodplain Development Patterns Near River Miles 200 to 191 of the Sacramento River
   c. Memorandum from Yantao Cui, February 3, 2005, RE: Spur Dikes on the Sacramento River near M&T Pumping Plant
   d. Memorandum from Yantao Cui, March 4, 2005, RE: Dredging near M&T Intake on the Sacramento River
   e. Chico Water Pollution Control Plant (WPCP) 12 mgd Expansion Project – Presentation of Outfall Investigation to M&T Steering Committee - Carollo Engineers Power Point Presentation

E. Information
   a. Ranney Well Construction / Operations / Maintenance Presentation
   b. Geomorphic Investigation of Sacramento River Migration and Bar Sedimentation at the Proposed City of Chico Pollution Control Plant Outfall Diffuser
   c. Sacramento River Conservation Area Form Principle and Guidelines [http://www.sacramentoriver.ca.gov]
   d. Towards Greener Riprap: Environmental Considerations from Microscale to Macroscale
   e. Fate of Lower Mississippi River Habitat Associated with River Training Dikes
   f. Effectiveness of Spur Dike Notching
   g. Environmental Guidelines for Dike Fields

F. Workshop #3 Summary
   At the February 16-18, 2005 Steering Committee Meeting four alternatives were identified. The no action alternative was considered to be unacceptable. Three alternatives were identified that would meet the requirements of providing a reliable source of water for the M&T Ranch, Llano Seco Ranch, U.S. Fish and Wildlife Service and California Dept. of Fish and Game Refuges and meet the project goal. The three alternatives included: (1) Ranney Collector wells, (2) spur dikes on the right bank of the Sacramento River opposite the existing pumping plant, and (3) dredging of the river to provide both short- and long-term water access to the existing pumps while meeting required fish screen criteria.

After thorough discussion and review, the Steering Committee recommended that comprehensive concurrent investigations be conducted on these alternatives to assess the feasibility of individual and combinations of alternatives to meet the goals and objectives for a 30-year project life based on the projected life of the stainless steel fish screens. Because of uncertainty about the operation costs, yields, long-term maintenance and efficiencies, project life expectancy and water rights issues associated with the Ranney System, it was decided that simultaneous further evaluations of the other two alternatives should be conducted to ensure the on-going operation and protection of the fish screen facility in the event that the Ranney Collector alternative fails to meet feasibility criteria.

In addition, due to the accelerated erosion issues in the river, the Committee recommended an interim action to maintain the viability of the three alternatives. Because the ability to use dikes to rectify the hydraulic conditions at the fish screens and pumps is limited by further erosion of the right bank of the river opposite the pumps, it was further recommended that emplacement of a temporary self-launching windrow rock revetment be evaluated along the right bank of the river to prevent further erosion thereby preserving the existing bank line during the alternative selection and NEPA/CEQA period.

As a result of these recommendations by the Steering Committee, the following actions are being implemented to bring the project to a final preferred alternative:

- Conduct four feasibility studies to investigate and prioritize identified risks and uncertainties associated with Ranney Collectors, spur dikes, and dredging and fish screen modification'
- Perform a river meander migration analysis and refinement to simulate upstream and downstream effects of proposed alternatives at 5-year intervals up to 50 years
- Present all the investigations to the Steering Committee in Workshop #4;
- Immediately begin environmental documents for gravel bar extraction.
- Preserve the spur dike option - conduct a windrow rock revetment (RM 192.5R) feasibility study.

The following is a brief justification for the above-listed actions:

- RANNEY COLLECTOR FEASIBILITY STUDY

The results of aquifer testing at M&T Chico Ranch indicate that the shallow groundwater system is a sustainable source of water supply to meet the pumping capacity essential to meet project goals through the use of Collectors. An Aquifer Test Report provided data to show that a strong connection with the Sacramento River which will most likely replenish the shallow aquifer system almost as quickly as groundwater is withdrawn, providing that the river maintain its current location. The Steering Committee also concurred that there is significant uncertainty about the operation costs, actual yields, potential to reduce diversion needs, long-term maintenance and efficiencies, project life and water rights issues associated with this preferred alternative. Calculations to determine yearly operational costs were estimated at $1million. These costs are quadruple current costs (about $32/AF compared to existing cost of about $8/AF) and are significantly beyond the capacity of the farming and wetland operators to support; and, determined unacceptable by the M&T Chico Ranch ,Llano Seco Ranch, USFWS Wildlife Refuge and Calif. Dept. of Fish and Game.

As a result of Steering Committee review of the data, it was recommended that further investigations are necessary to determine pumping lift and energy costs and site-specific well locations and spacing appropriate to increase project life and reduce energy requirements; assessment of transmissivity of the aquifer; identification and evaluation of critical conditions to compute water costs; evaluation of water efficiencies and alternative water supplies; review of long-term maintenance costs and well-life depreciation; refinment of data to understand well yield from groundwater versus river water; refinement of well construction costs, conveyance systems and water rights legal analysis; and, existing operational Ranney Collector data on a range of river types and evaluation of the effects of river migration on water yield.

Answers to these questions are critical to the implementation of a Ranney Collector system alternative as a long-term viable solution to provide a reliable off-stream, fish-friendly water supply protected from the river meander. Successful implementation of this alternative approach would meet the preliminary project goals and objectives. The preliminary investigations identified high capital costs and high operations and maintenance costs. Additional studies must be conducted to accurately assess the financial long-term feasibility of this alternative.

In addition, the investigations to date continue to show that the river will move away from the pumping plant site and the gravel bar is continuing to build and is increasing the threat to the existing facility. The off-stream alternative has been selected that may provide the long-term solution. Aquifer testing at the M&T Chico Ranch indicates that the shallow groundwater system is a sustainable source of water supply. Long-term drawdown and overdraft of the aquifer is not anticipated as long as the aquifer is connected to the Sacramento River that will continue to replenish the shallow aquifer system. However, identified of high initial capital costs to construct the Ranney Collectors may not be acceptable to the funding agency given that the CALFED Ecosystem Restoration Program has invested approximately $7 million to date.

- SPUR DIKE FEASIBILITY STUDY

Because there has been no history of dike use on the Sacramento River, a modeling effort was conducted to evaluate the basic feasibility of using dikes to prevent bank erosion and to return the river configuration to a condition (1996 conditions) where the hydrodynamic conditions were adequate to meet the pumping and fish screen criteria at the M&T pumps. In order to reduce the cost of the basic feasibility study, existing available river topography was utilized and a basic dike design was developed to test the technical feasibility of this alternative. Two-dimensional (2-D) hydrodynamic modeling of the Sacramento River from about RM 191 to RM 195 by Mussetter Engineering, Inc. (MEI), as well as sediment-transport modeling with the hydraulic output from the 2-D model (MEI, 2005), demonstrated that the proposed spur dike configuration that included eight rock dikes should create hydraulic conditions within the reach that would prevent downstream migration of the upstream gravel bar (dredged in 2002) during high flows (4,000 to 14,000 cfs) and prevent build up of sands at the screened intakes during lower flows when the pumps are generally operated However, the modeling was conducted with 1996 in-river topography (Ayres Associates) that was modified to approximate the bar dredging and the

bankline shown on 2003 aerial photography. As a result, modeled conditions may not represent existing conditions at the site, especially since there has been localized retreat of the right bank of up to 50 feet since the 2003 aerial photography was flown.

The Steering Committee, therefore, concluded that in-channel surveys are required to provide existing conditions topography, and the new topography should be used for subsequent hydrodynamic modeling to further evaluate the utility of the proposed spur dike alternative, modifications to the upstream revetment at River Road, and the addition of an additional dike at the downstream end of the proposed alignment.

Because the efficacy of the dikes is extremely time-sensitive, it was further recommended that placement of a temporary self-launching windrow rock revetment be evaluated along the right bank of the river to slow erosion during the analysis and NEPA/CEQA period. Maintenance of the existing bank line during the review period would maintain the viability of the spur dike alternative. In the event that the spur dike alternative is selected, the windrow rock would be incorporated into the dikes, and if the alternative is not selected, the rock would be removed from the toe of the bank. A basic design for a windrow revetment will be developed. The design will identify the volume and gradation of rock that will be required and associated costs for emplacement on the top of the right bank. The limits of the windrow revetment will be shown on the most recent aerial photography of the site. Thorough evaluation and design of this action would maintain the viability of the spur dike alternative to support an off-stream solution**.** The windrow revetment design that supports a spur dike option would additional provide significant protection to the City of Chico outfall.

Other than the recent installation of spur dikes at the Butte City Bridge by CALTRANS, spur dikes have not been previously used as a form of bank protection on the Sacramento River (Harvey et al., 2004). Review of the literature (Shields et al., 1995) suggests that spur dikes can have significant beneficial environmental effects, and they are a more ecologically acceptable form of bank stabilization when it is necessary to prevent river meandering to protect riverside infrastructure as envisaged in the Senate Bill 1086 process. Since the erosion control effectiveness and environmental impacts of spur dikes have not been investigated on the Sacramento River, the Steering Committee recommended that an Adaptive Management-based experiment be developed for the proposed spur dikes that would enable their physical and ecological/biological effects to be assessed. As part of the development of the experiment, hypotheses will be developed and quantitative performance measures for both erosion control and ecological/biological effects will be developed to test the hypotheses. It is anticipated that the experiment will involve comparison of physical and ecological/biological characteristics in the spur dike reach and a geomorphically similar reach that will be allowed to continue to erode. Such a site is located on the right bank of the river at approximately RM 173. Information derived from the experiment would then be used to inform decisions regarding future bank protection and its ecological/biological impacts at other required locations on the Sacramento River system. Furthermore, the results of the experiment will provide a means of quantifying the ecological/biological effects of dikes, which in turn will provide a sound basis for establishing any mitigation requirements.

- DREDGING & FISH SCREEN MODIFICATION FEASIBILITY STUDY

As a result of evaluations of risks and uncertainties associated with Ranney Collectors and Spur Dikes, the Steering Committee is recommending that further investigations be conducted to evaluate the alternative to perform annual dredging activities. This alternative was selected to provide assurances that a channel will be maintained to meet present pumping capacity and fish screen requirements when necessary. In order to refine an opinion about this alternative, it was recommended that the river meander model be run to estimate the gravel bar location through time. In addition, it is the resolution of the Steering Committee members that discussions begin with key agency representatives to discuss relaxation of fish screen critieria due to the stringent sweeping flow velocity requirements at the face of the screens. Relaxing fish screen criteria based on more informed science would provide the basis for salvaging a portion of the initial CALFED investment by finding a solution that maintains the existing pumping facility and installs a redesigned fish screen. This approach can be supported by data and experience now available through years of operations and maintenance of Sacramento River fish screens currently in use.

- RIVER MEANDER MIGRATION ANALYSIS

As the investigations of alternatives begin to be refined, it will be necessary to continue on-going modeling of potential unintended effects on the riverine process. The Steering Committee is recommending that a river meander migration analysis be performed by Eric Larsen, technical advisor, Steering Committee, to simulate upstream and downstream effects. The meander migration analysis will be modeled with variable erosion field providing a 50-year prediction with bank line output mapped at 5-year increments under the following conditions: (1) to assume the placement of Ranney collectors and evolution from the current river planform; (2) to simulate downstream effects of extended bank restraints at state park site and downstream groins; and, (3) to simulate downstream effects of removing bank restraints at River Road.

In addition, after investigating the current winter deposition of the gravel bar, the Steering Committee recommended that Ducks Unlimited obtain CBDA approval to initiate gravel bar reduction and immediately begin the permit process. This action will ensure short-term protection of the pumping plant and fish screen facility while a permanent solution is developed.

- GRAVEL BAR REDUCTION

As reported in past contract amendments, a partial or entire excavation of the encroaching gravel bar may be necessary to eliminate a potential threat to the operations and function of the M&T/Llano Seco Fish Screen facility and City of Chico outfall. On-going monitoring has been conducted each year to trigger the need to execute this task. As a result of the 2004 asssessment, the Steering Committee is recommending that, due to the seditment deposition that has accumumlated to date, Ducks Unlimited request CBDA's approval to proceed immediately with the permitting process to implement the gravel bar reduction action. This encroachment has been verified by the modeling completed by the Steering Committee members and evaluated at Workshop No. 3. This request will allow the

owners/stakeholders additional time to assure water supply with the existing pumping and fish screen facility while a permanent solution is developed.

After three very productive meetings and review of comprehensive investigations of off-stream and in-stream alternatives at the pumping plant site, the Steering Committee concurred that they could not reach a final conclusion and make a recommendation without thorough evaluations of the risks and uncertainties, the complex technical and legal issues, as well as economic impacts associated with identified alternatives. Critical questions regarding long-term feasibility and operations must be answered to ensure that a viable solution is implemented. In the interim is was decided that an interim action should be taken to preserve the opportunity of the three alternatives. It was agreed that the evidence justified an attempt to temparily hold the west bank of the river unil the Steering Committee could made a sound decision to select a final preferred alternative.

- SHORT-TERM ALTERNATIVE PROTECTION – WINDROW ROCK

The Steering Committee agreed that because the ability to use dikes to rectify the hydraulic conidtions at the fish screen and pumps is limited by further erosion of the right bank of the river opposite the pumps, that emplacement of a temporary self-launching windrow rock revetment be evaluated along the right bank of the river to prevent further erosion thereby preserving all of the alternatives during the alternative selection and NEPA/CEQA period. A feasibility study and preliminary design will be developed for Steering Committee review.

In conclusion, the proposed studies will answer complex questions critical to understanding long-term water supply reliability, economic viability and potential impacts to the resources. The Steering Committee is not willing to recommend one alternative, or a combination of alternatives, until these questions have been addressed. The tasks outlined in this request are based on the unanimous recommendations of the Steering Committee members and are designed to reduce, to the extent possible, the risk and uncertainty associated with selecting an alternative that may not meet the following primary goals of protecting the water supply and, at the same time meeting dynamic river and environmental protection and enhancement goals. It is the opinion of the Steering Committee that the future investigations will provide the necessary information to identify a viable alternative that will provide a long-term solution for the project. In addition, the interim protection actions will ensure an extension of time to allow the Steering Committee to make an informed decision with the best available technical information.

Workshop #4 would be scheduled at a later date to review and discuss the compiled information to advance the selection of a final preferred alternative.

NEXT STEPS

In accordance with the recommendations and actions approved by the Steering Committee the following tasks are being implemented to provide the necessary steps for selecting a preferred alternative for the M&T/Llano Seco Fish Screen Protection Project:

GRAVEL BAR REDUCTION

Depending on existing and future sediment depositions by the riverine process, a partial or entire excavation of the encroaching gravel bar and/or windrowed rock placement on the opposite bank of the river may be necessary to eliminate a potential threat to the operations and function of the M&T/Llano Seco Fish Screen Facility and the City of Chico outfall while the long-term solution is being developed. Environmental compliance documents will be completed, biological assessment and opinions will be conducted, and the permitting for both the gravel bar reduction and the windrowed rock projects will be completed.

A gravel bar assessment will be performed to determine if any reduction of the gravel bar is needed. Likewise, a windrowed rock assessment will be performed to determine the feasibility of placing the windrowed rock. CBDA will review and provide written guidance/approval prior to project(s) implementation.

A general monitoring plan will be prepared to provide detailed supplemental information to the existing data and to augment ongoing monitoring. The on-going physical monitoring plan will establish a firm understanding of existing conditions, enable informative assessment of current gravel bar encroachment, and act as a trigger to initiate any future gravel bar reduction activities.

MAINTENANCE OF ALTERNATIVES– WINDROW ROCK

A feasbility study has been initiated including a preliminary project design in the following document: Windrow Rock Design [MEI plans / drawings]

The proposed interim protection measure will be previewed at the Public Workshop scheduled for July 27, 2005. Once public comments have been received, the Steering Committee will conduct a final review of the windrow rock temporary protection measure.

WORKSHOP #4

Workshop #4 will be scheduled in the future to present the Ranney Collector Feasbility Study, the River Meander Analysis / Refinement, the Spur Dike Feasibility Study and the Dredging & Fish Screen Feasbility Study. This workshop goal will be to select a final alternative, develop a conceptual design and frame a project proposal for the California Bay-Delta Authority.

Since time is of the essence regarding continued river bank erosion, the Steering Committee will be asked to electronically collaborate and provide their expertise in evaluating the windrow rock protection measure for final recommendation and approval.

Future reports and project information will continue to be posted to the following project website: http://www.ducks.org/conservation/Projects/Western/MandT/mt.asp.

Please contact Olen Zirkle, Project Manager, for any questions, issues and/or concerns: (916) 852-2000 – ozirkle@ducks.org.