M & T / Llano Seco Fish Screen Facility
Long-Term Protection Project
Examination of Further Analysis of Workshop #6
Technical Team Recommended Alternatives
October 26, 2011
10:00 a.m to 4:00 p.m.
Holiday Inn
685 Manzanita Court, Chico, CA 95926

DRAFT MEETING SUMMARY NOTES

Attendees:

Chris Barr, Deputy Project Leader, U.S. Fish & Wildlife Service, Sacramento National Wildlife Refuge Complex
Paul Bratovich, Vice President/Principle Scientist, HDR Engineering
Pat Britton, Environmental Compliance Specialist, Ducks Unlimited, Inc.
Mike Crump, Director, County of Butte, Public Works Department
Yantao Cui, Research Scientist, Research Scientist, Hydrology/Geomorphology
Jane Dolan, Executive Director, Sacramento Conservation Area Forum
Dennis Dorratcague, Principal Engineer, MWH Americas
Mary Dunne, Staff Environmental Scientist, Calif. Dept. of Fish and Game
Brendon Flynn, Chair of the Board, Sacramento Valley Landowners Association
Dan Frisk, Project Leader, Sacramento National Wildlife Refuge Complex
Jim Gaumer, Engineer, M&T Chico Ranch
Greg Golet, Ecologist, The Nature Conservancy
Quene Hansen, Projects Manager, City of Chico
Michael Harvey, Principal Geomorphologist, Tetra Tech, Inc.
Les Heringer, Manager, M&T Chico Ranch
Buford Holt, Environmental Specialist, U.S. Bureau of Reclamation, Northern Area Office
Chris Leininger, Project Development Consultant, Ducks Unlimited, Inc.
Ryan Luster, Project Director Sacramento River, The Nature Conservancy
Tracy McReynolds, Assoc. Fishery Biologist, Region 2, Calif. Dept. of Fish & Game
Tamara Miller, Principal Engineer, MPM/Engineering, for the City of Chico
Kelley Moroney, Refuge Manager, Sacramento Valley National Wildlife Refuge Complex
Robert Mussetter, Principal Engineer, Tetra Tech, Inc.
Amanda Ransom, Associate, Environmental Planner, HDR Engineering
Patricia Roberson, NEPA-Refuges, U.S. Fish & Wildlife Service
Neil Schild, Principal Engineer, MWH Americas
Dianne Simodynes, Project Manager/Senior Environmental Scientist, HDR Engineering
Richard Thieriot, Shareholder, Rancho Llano Seco
Chris Thomas, Senior Planner, City of Chico, Public Works Department
Gretchen Umlauf, Fishery Biologist, National Marine Fisheries Service
Jim Well, Director of Conservation Programs South Pacific Flyway
Dan Welsh, Assistant Field Supervisor, Ecosystem Restoration Program, U.S. Fish & Wildlife Service
Dave Zezulak, Environ. Program Mgr. I, Water Branch-Bay Delta Conservation Plan, Calif. Dept. of Fish & Game

Welcome and Introductions / Purpose of Meeting

Jim Well, Director, Ducks Unlimited, opened the meeting with round-table introductions and presented the following information regarding the Purpose of the Meeting and the follow-up studies recommended in Workshop #5:

Purpose of Meeting

Examination of Further Analysis of Workshop #6
Technical Team Recommended Alternatives

On October 26, 2011, the M&T/Llano Seco Fish Screen Facility Long-Term Protection Project will hold an informational meeting to discuss the results and findings of the following Technical Studies that were recommended by the project Technical Team and approved by the Steering Committee in Workshop #5 held on September 30, 2008:

Phase III Two-Dimensional Modeling of M&T/Llano Seco Pumping Plant Reach, Sacramento River, RM 192.5

Tetra Tech updated the existing Two-Dimensional Model (2-D) Model) of the M&T/Llano Seco reach with new bathymetry and merged the model with the Army Corps of Engineers Hamilton City "J Levee" Model to evaluate hydrodynamic and sediment transport conditions within the wider reach of the Sacramento River project area; and, to provide boundary conditions for the reformulated physical model.

The two-dimensional hydraulic investigations of the M&T/llano Seco Pumping Plant reach of the Sacramento River were to meet the following specific objectives:

(1) Investigate the hydraulic impacts, if any, of the upstream Hamilton City Setback Levee project on the existing M&T Pumps and at the relocated City of Chico wastewater outfall;

(2) Evaluate the hydrodynamic conditions over a range of flows at two potential alternative pumping sites located 2,200 and 3,500 feet downstream, respectively from the existing pumping site;

(3) Investigate the hydraulic impacts, if any, of the Hamilton City Setback Levee project on the potential long-term solution alternatives at the M&T Pumps and the City of Chico outfall, and conversely, investigate the long-term solution alternatives impacts, if any, on the Hamilton City Setback Levee project; and

(4) Investigate the hydrodynamic impacts of locating a gravel stockpile on the west overbank opposite the M&T Pumps and to investigate the mobility of the sediments in the stockpile.

Physical Model – Colorado State University Hydraulics Lab

Colorado State University Hydrology Lab re-formulated an existing physical model to evaluate hydraulic conditions and long-term sedimentation patterns near the current M&T/Llano Seco pump intake location and two alternative relocation sites (approx. 2,200 feet and 3,500 feet downstream of the current pump intake) across a variety of discharges and river configurations. Workshop #5 recommendations to investigate the two above-described relocation alternatives for the pump/intake were outside the footprint of the existing physical model, and thus the model required reformulation to encompass the new alternatives. The physical model was reformulated with the current topography and bathymetry of the river determined by new hydrographic surveys.

The following three (3) channel configurations were also modeled: (1) existing channel conditions; (2) current conditions with the inclusion of a gravel dredge material stockpile on the west bank; and, (3) realignment of a section of the east bank. The physical model included a rigid west bank as the previously migrating west bank has been stabilized by revetment.

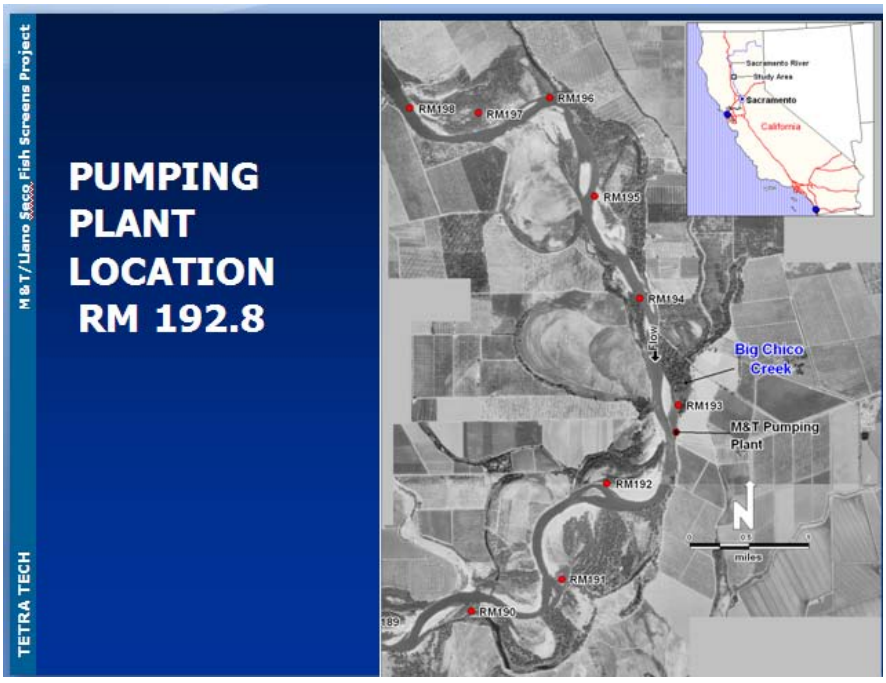
West Bank Stabilization Project

Report on performance and condition of the temporary bank protection placed at River Mile 193R on the U.S. Fish & Wildlife Service Capay Unit to prevent further river migration and preserve options for the long-term solution to protect the M&T/Llano Seco pump intake and fish screens.

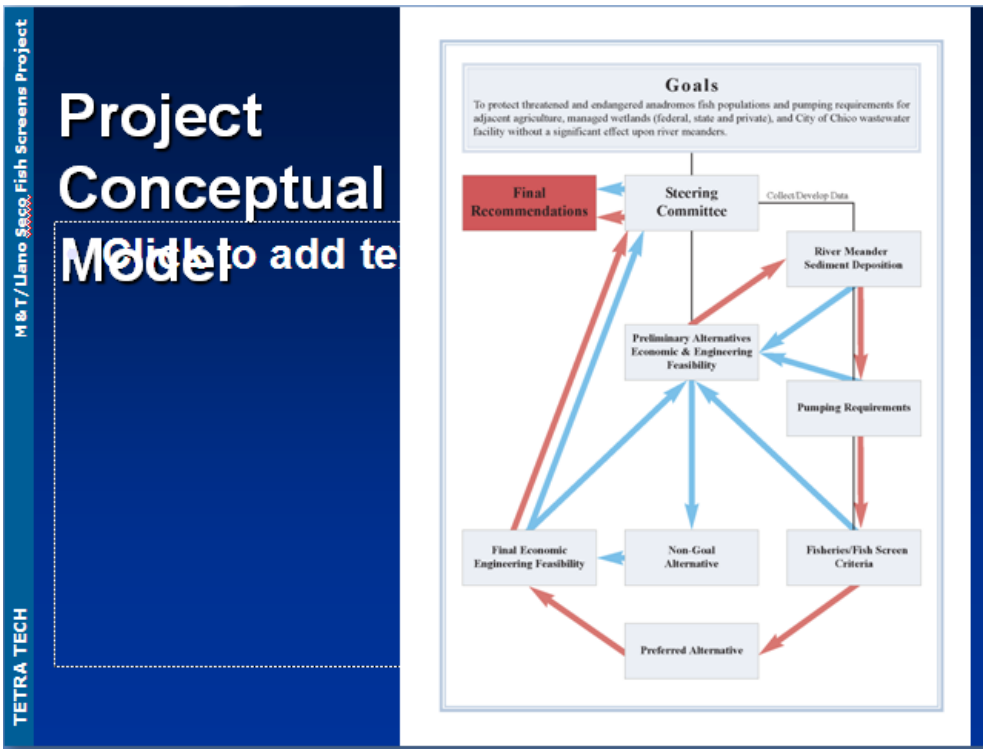
Jim then introduced Mike Harvey, PhD, Principal, Tetra Tech to present an overview of the project.

Project Review

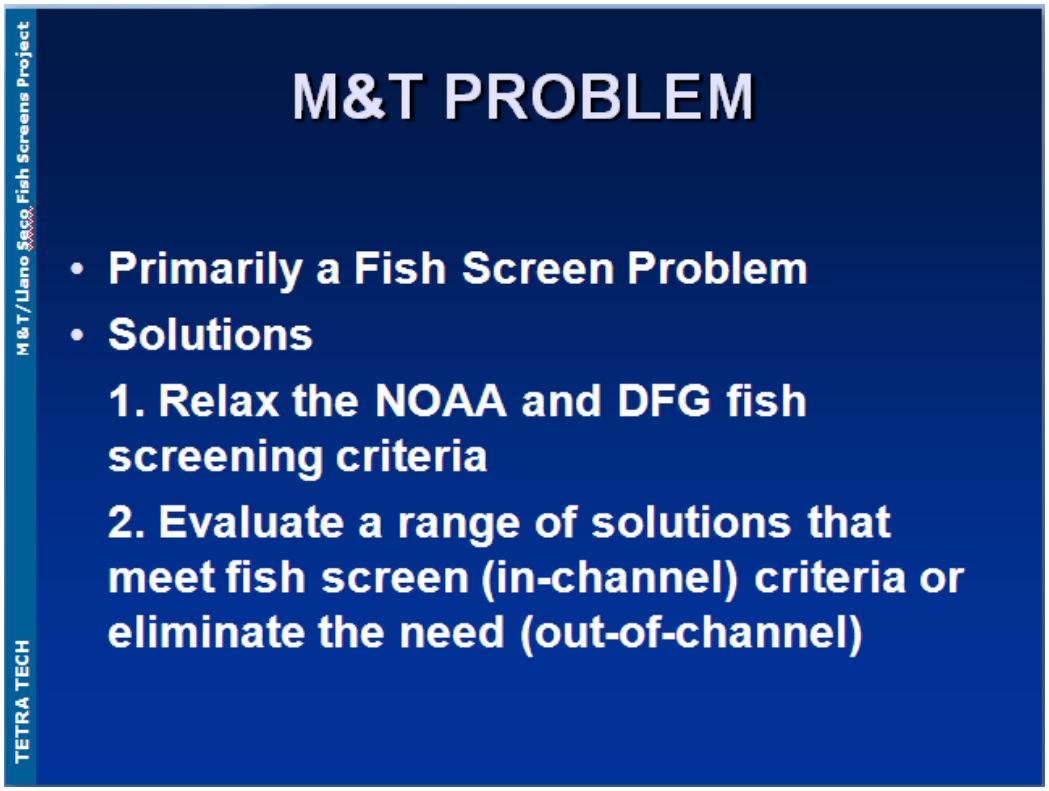
Mike Harvey, Principal, Tetra Tech, Inc. gave a brief history and review of the project activities since Workshop #5. Workshop #5 proposed a range of long-term solution alternatives including two relocation sites (2,200 feet and 3,500 feet) downstream from the existing pump intake. In addition, there was the expectation of another sediment removal project to protect the pump intake until a long-term solution was implemented.



Mike reviewed the project location along the river at River Mile 193.

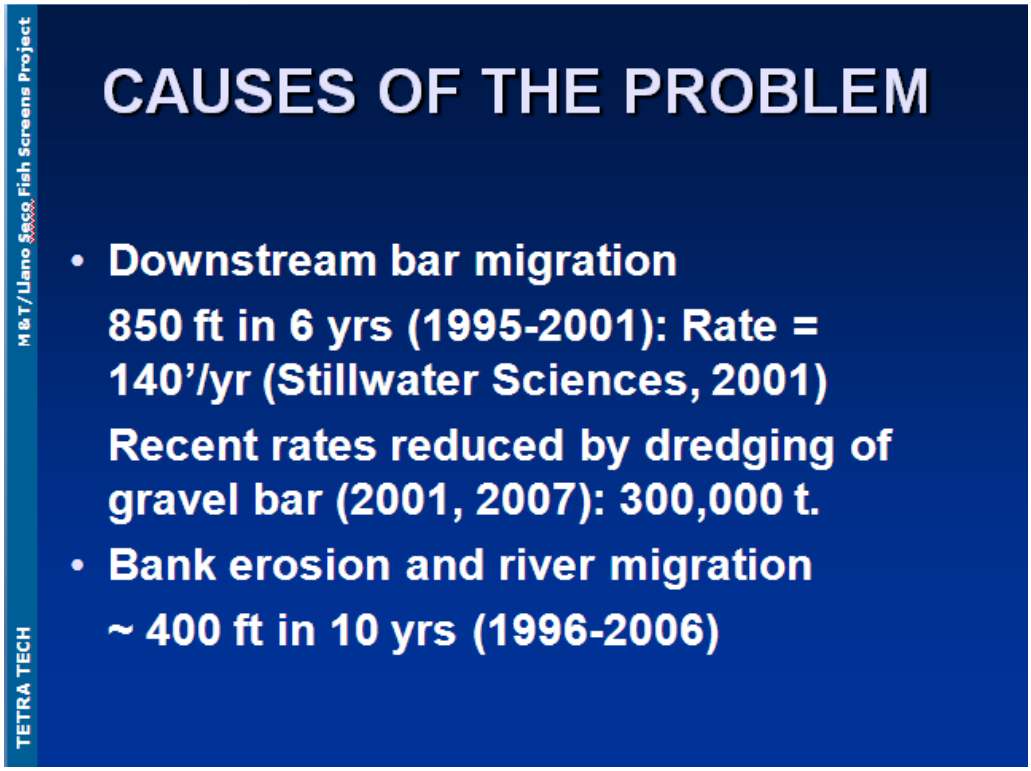


Mike reviewed three objectives of the project (1) river meander; (2) pumping requirements; and, (3) fish screens. The goal was to work through the all the requirements to come up with a solution. The reality is that the studies have looked at a number of alternatives and none of the alternatives have taken the preferred pathway. What resulted from all the investigations was a non-goal alternative that does not meet all the objectives.

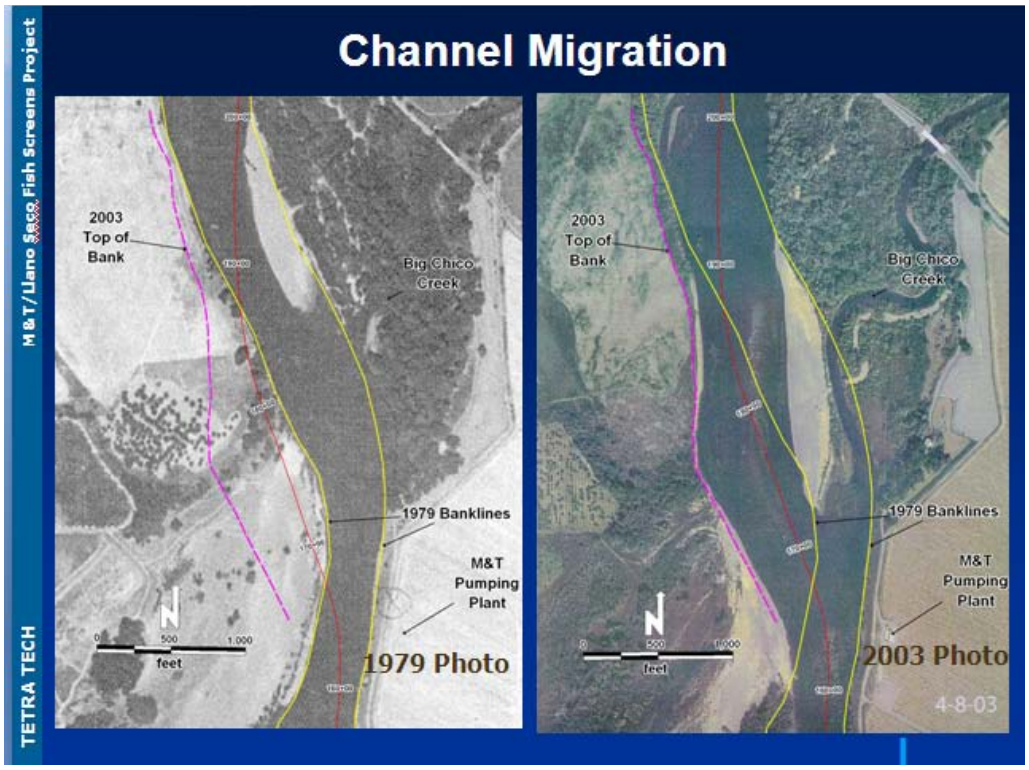


Mike explained the M&T problem. There has been a lot of discussion regarding relaxing the fish screen criteria, however, that approach has never moved forward.

The project has evaluated a range of solutions to meet the fish screen needs both in-channel and out-of-channel. To date, a range of 18 potential solutions have been analyzed.

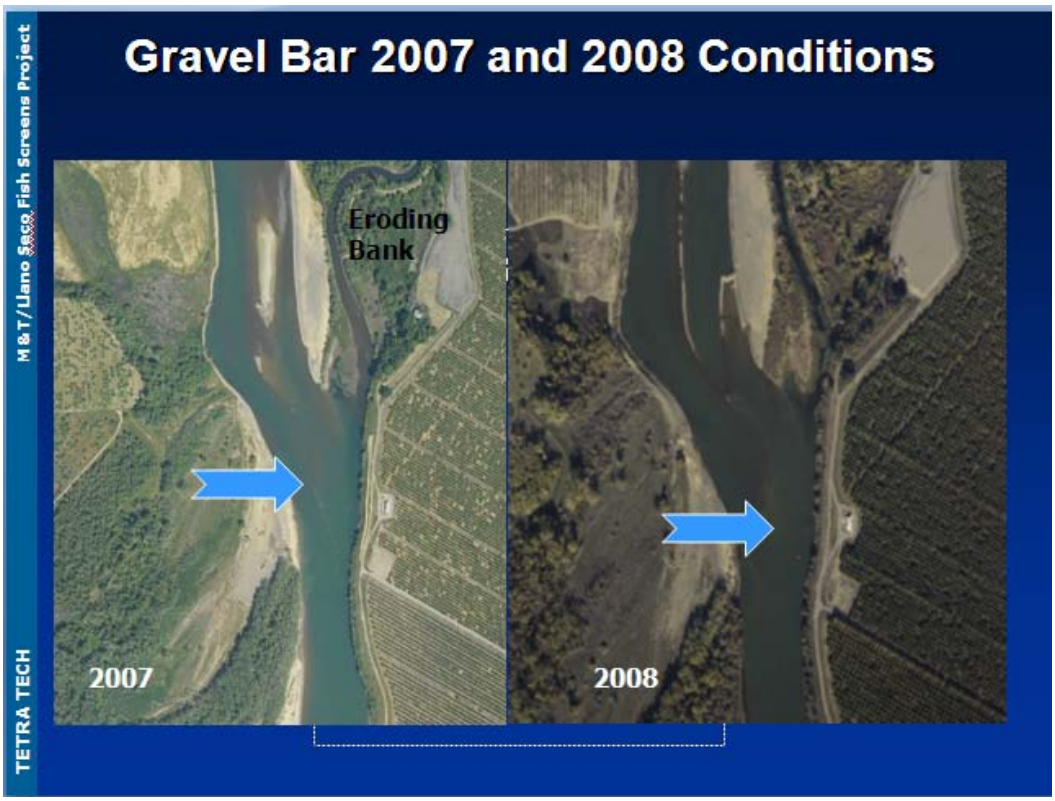


Mike reviewed the project constraints. Basically, a large gravel bar attached to the east bank of the river upstream of the Chico Creek confluence is migrating downstream. The rate of migration has been slowed due to the dry-land dredge operations conducted in 2001 and 2007 that removed approximately 300,000 tons of material which is stockpiled on the east bank of the river on the M&T Chico Ranch property. An additional problem is associated with removing the stockpile—nobody wants the spoils due to the economics.

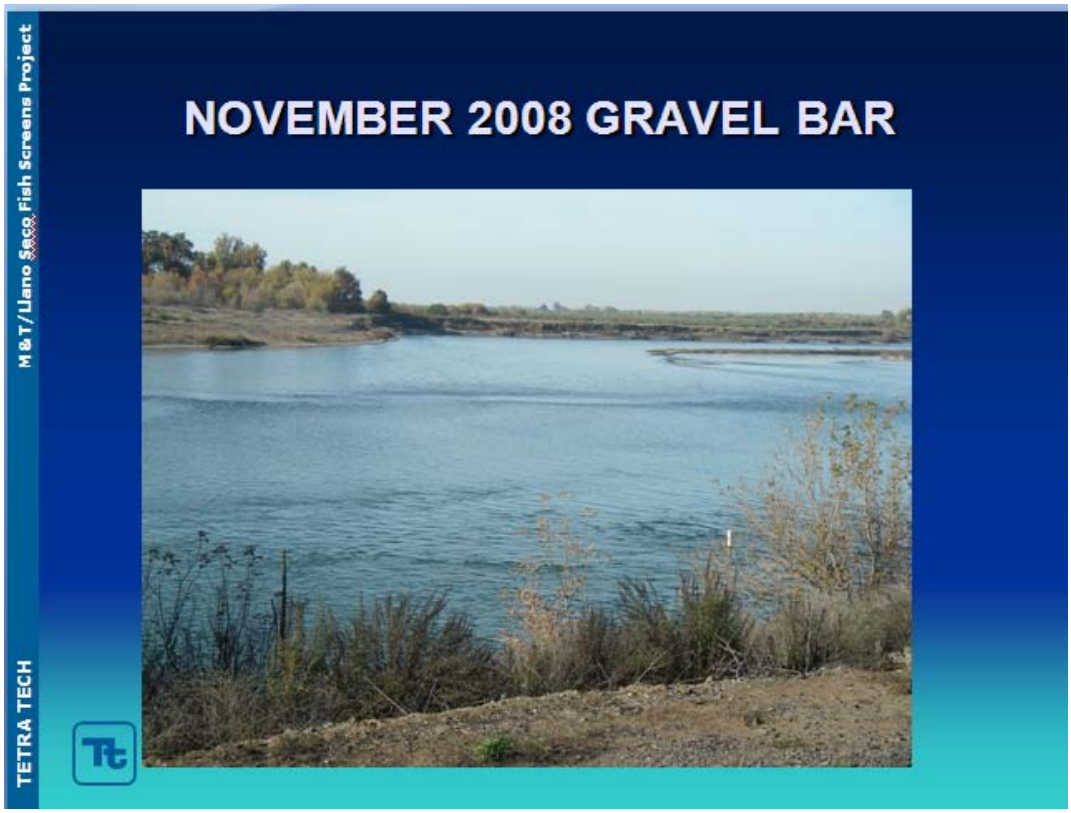


Another element of the problem, and closely tied together with the gravel bar, is the west bank of the river has migrated roughly one-channel width to the west above the intake, approximately 400 feet in 10 years. That is the main problem with the change in the channel geometry. The velocities within the vicinity of the fish screen and the intake have changed with the movement of the west bank --- that is the root of the problem.

To show the change in the river, note the 1979 photo with the 1979 banklines. The 2003 photos depicts where the active channel is now. The westward migration which widens the area out, reduces the sediment transport capacity. Basically, a feed-back loop that causes more deposition which causes more lateral migration of the river.



This shows the outline of the gravel bar under water just above the intake and fish screens. In 2008, the photo shows the berm that remains from the 2008 dry-land dredge. However, the nose of the bar is actually downstream opposite the intake. This condition is the major concern—that the gravel bar moves down and buries the fish screens and intake.



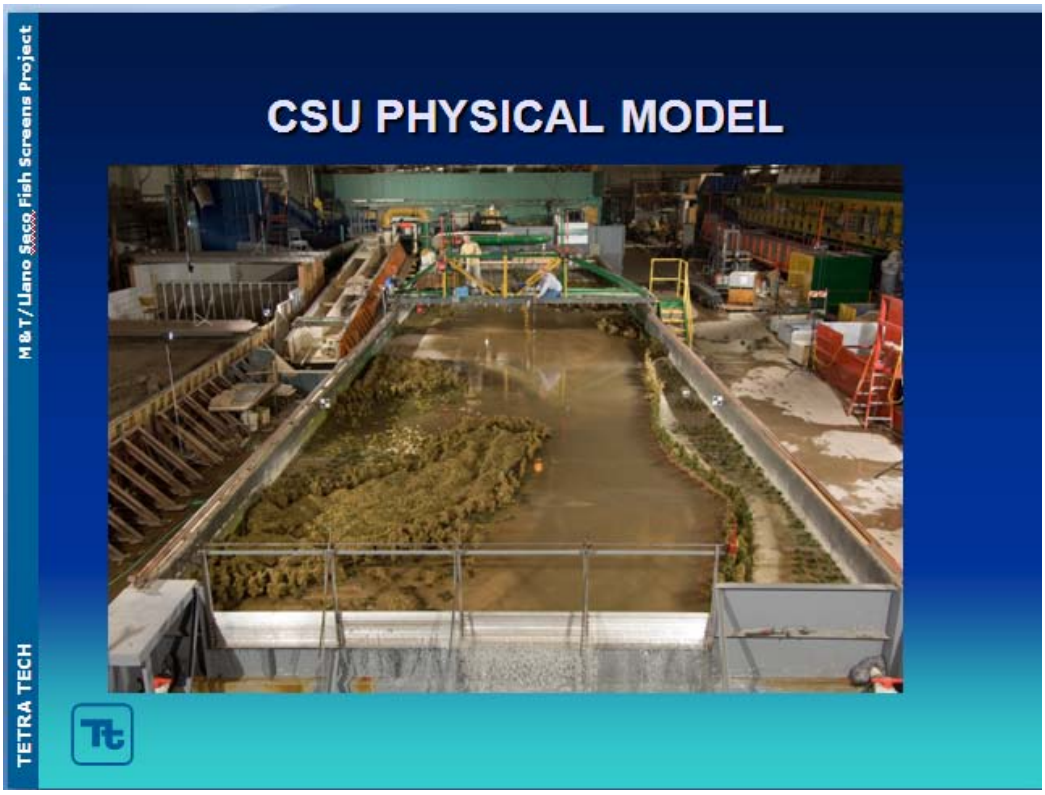
This slide shows the berm around the last dry-land dredge operation and the buoy over the fish screens. This shows that you could actually walk out into the river opposite the fish screens onto the gravel under the water. There is deposition upstream driving erosion at the west bank. But, as this has widened out, it has allowed the bar to move farther down. The nose of the bar is now down opposite the fish screens.

The basic hydraulics of the river, from about River Road downstream, there is a big flow expansion zone coming into the mouth of Big Chico Creek and when you compare the sediment transport rates at about River Road, there is a massive drop off and there is deposition there and that deposition is moving downstream over time.

River Road is a hard point created by the rip rap which holds the river and creates a narrow channel at that location. When you come downstream, the width of the channel expands and the transport rate drops. So it starts with relatively high transport rates and, once the river hits the widened channel, it begins deposition of the sediment. It forms the bar initially and then it feeds on itself.

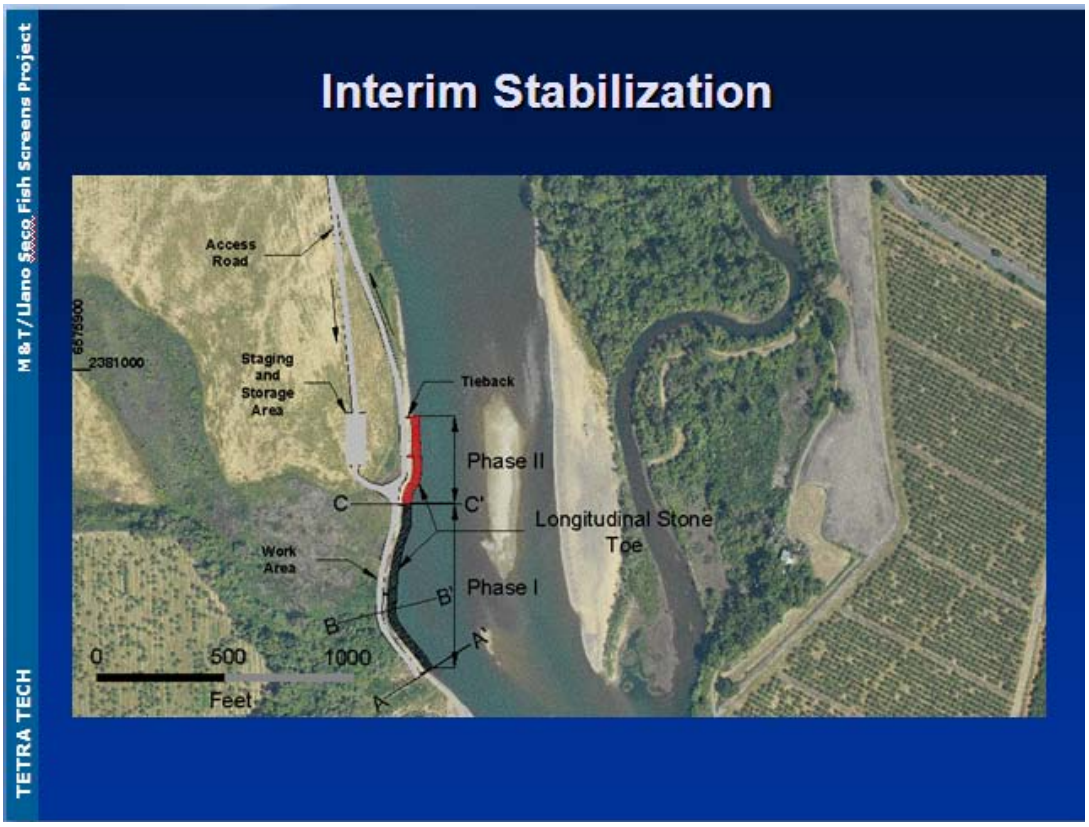
This slide depicts the downstream movement of the gravel bar over time.

A number of actions have taken place on the project. The river has been surveyed, numerical modeling has been conducted (one and two dimensional), and a scaled physical model has been developed of the project area.



This slide shows the initial set-up of the physical model at Colorado State University. The dikes were modeled and subsequently the model was extended to look at the two relocations alternatives.

As part of this project, we also have a short-term measure implemented as a toe protection along west bank on the National Refuge property to prevent the continuation of the feed-back loop while a long-term solution is being determined. 1,500 feet of toe protection was constructed in 2007. Nothing was done to the upper bank. (Please see next two slides).



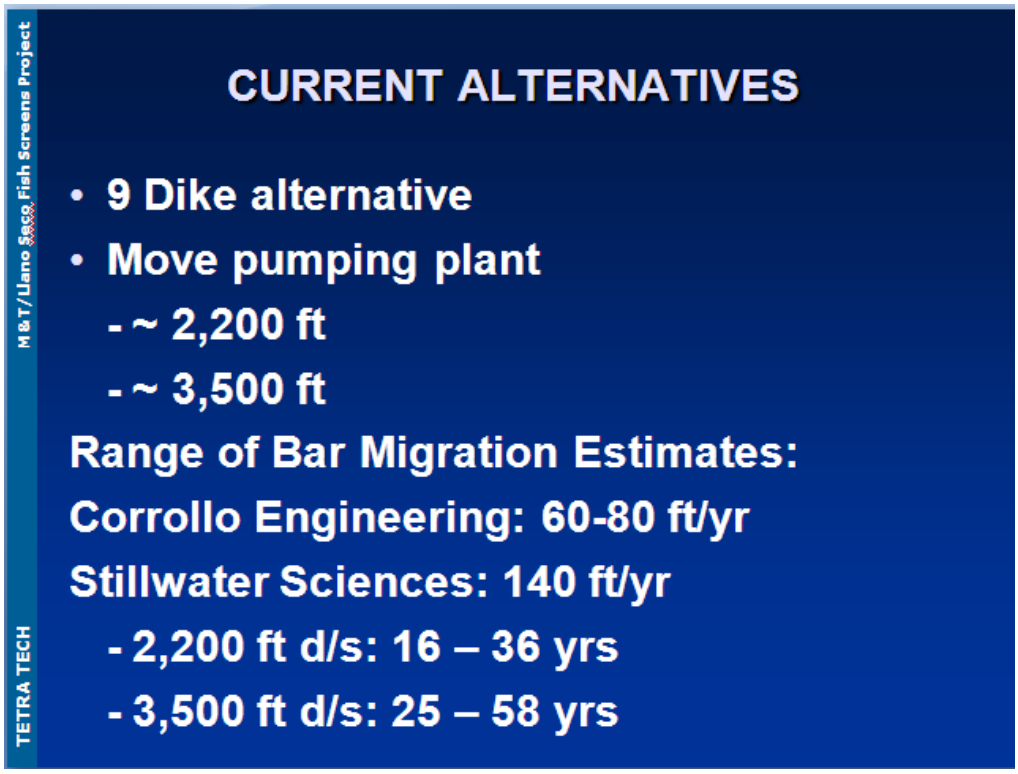
Schematic of west bank protection project.

Construction activity of the west bank toe protection project.

In 2007, a dry-land dredge was conducted that removed approximately 100,000 tons of material from the river (another short-term measure to ensure that the pumping plant and fish screens continue to operate).

The dry-land dredge method included the use of an excavator and dump trucks on the shoreline removing the material. However, now the deposition of material has moved farther down the river and that dredging method is no longer an alternative.

The next short-term protection project will have to be a wet dredging which will add a new dimension the project both in complexity and cost.

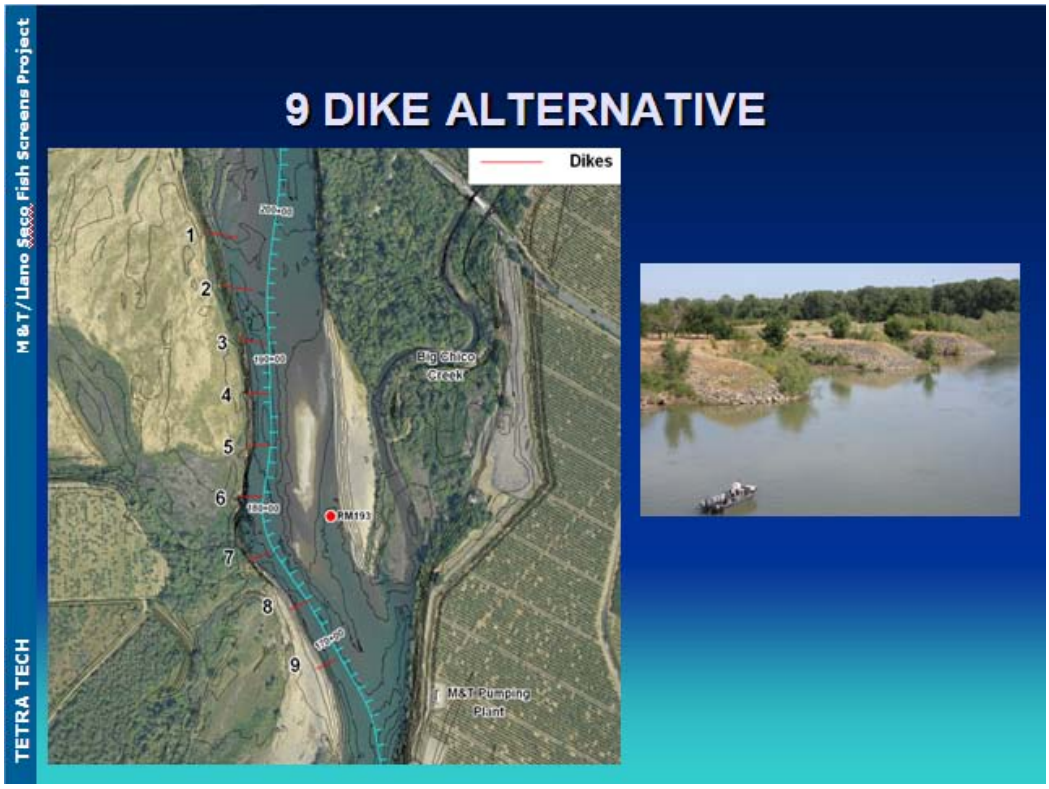


The above slide illustrates the Current Project Alternatives.

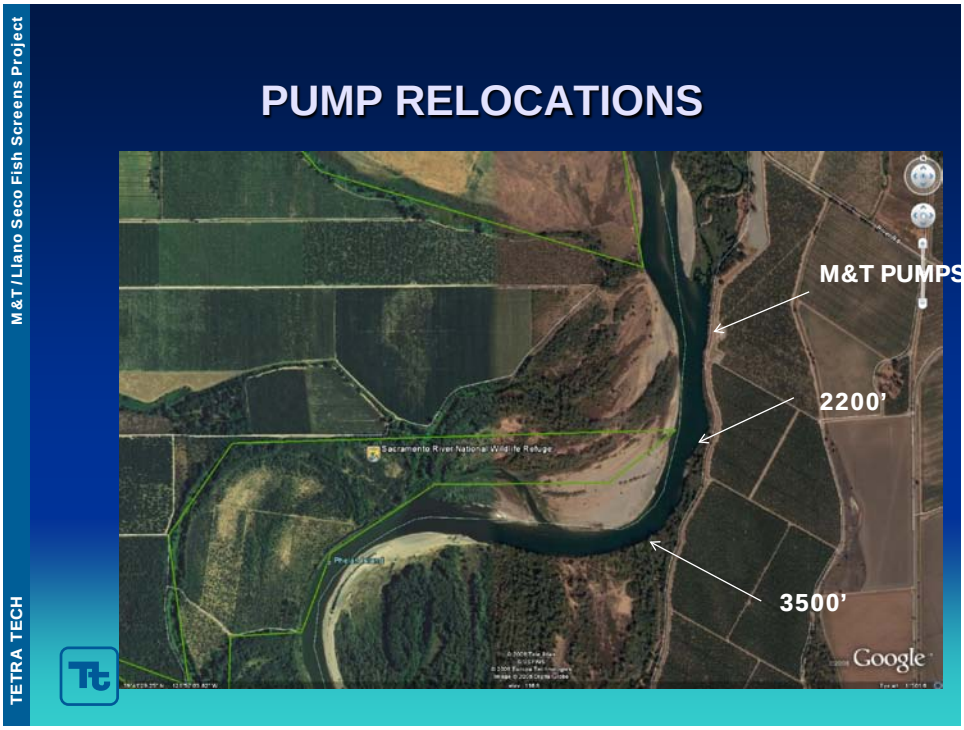
There is risk associated with doing nothing. There is risk associated with the two relocation sites. Over time the gravel bar will continue to move downstream and eventually threaten the relocation sites. The relocations are not an absolute fix.

Based on the estimates of the downstream migration, if you move the pumping plant downstream 2200 feet and leave all other things in the existing condition, based on the historic performance of the system then we have somewhere between 16 and 36 years of life before the gravel bar catches up with the first relocation or 25 to 58 years for the second relocation (3,500 feet).

Just shifting it is not a necessarily a finite solution if nothing else changes. An upstream alternative was also analyzed previously and was deemed not viable.



This slide shows the nine-dike alternative at the red marks.



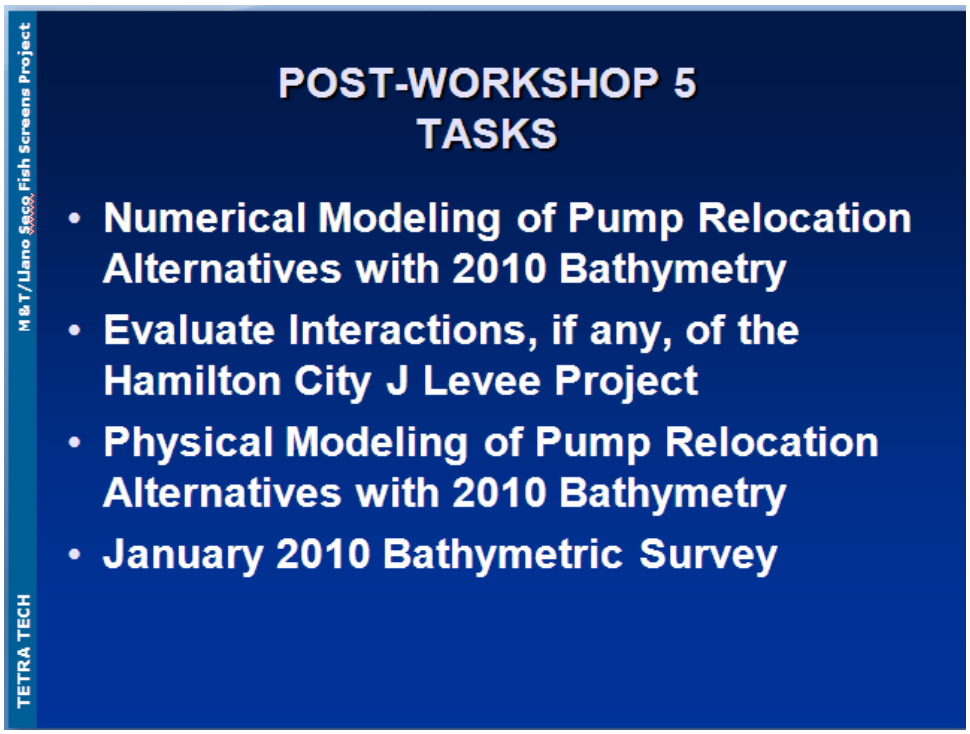
This slide shows the property boundaries of The Nature Conservancy (TNC) and U.S. Fish and Wildlife Service. Also, the side shows the two relocation sites. TNC has determined that the dikes are antithetical to the purpose of the easement on the property.

An example of recently constructed dikes above the Butte City Bridge shows revegetation and soft banks between the dikes

One of the reasons the dikes are proposed is to reestablish the original hydraulic conditions that existed in 2006. The purpose is not to shift the river back over to the original bankline, but to get the hydraulics back to the original state when the fish screens and pump inlets were constructed..

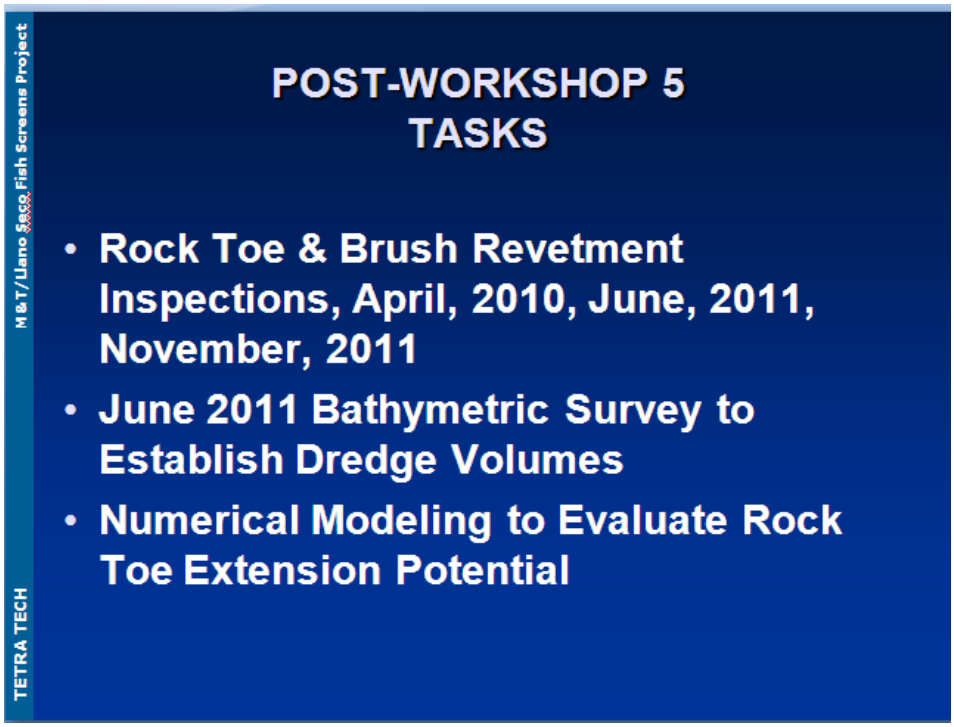
If constructed, there will be deposition in between the dikes that will create terrestrial habitat and anticipated fish habitat based on work done up in Oregon looking at salmonids habitat.

In addition, not shown on the slide is the City of Chico relocation site of the new outfall that is valued at $8 million. The City of Chico has an interest in this project as well. If the bar keeps migrating downstream, the outfall will have to be relocated again.



This slide lists the data collection and analyses that has been conducted since Workshop#5. There are some questions that have come up concerning the Corps of Engineers J-Levee Project. The J-Levee Project proposes pulling back an existing levee upstream of the M&T project and extending a levee down river to provide a higher flood protection for Hamilton City. The questions are-- will the proposed dike project have an impact on the J-Levee Project -- will the J-Levee Project have an impact on the proposed dike project. Those questions were evaluated by the 2-D model.

In addition, Colorado State University took the 2010 bathymetry and essentially retooled the initial 1:75 scale physical model to encompass the downstream pump relocation sites.



Monitoring of the west bank protection project has been conducted over time.

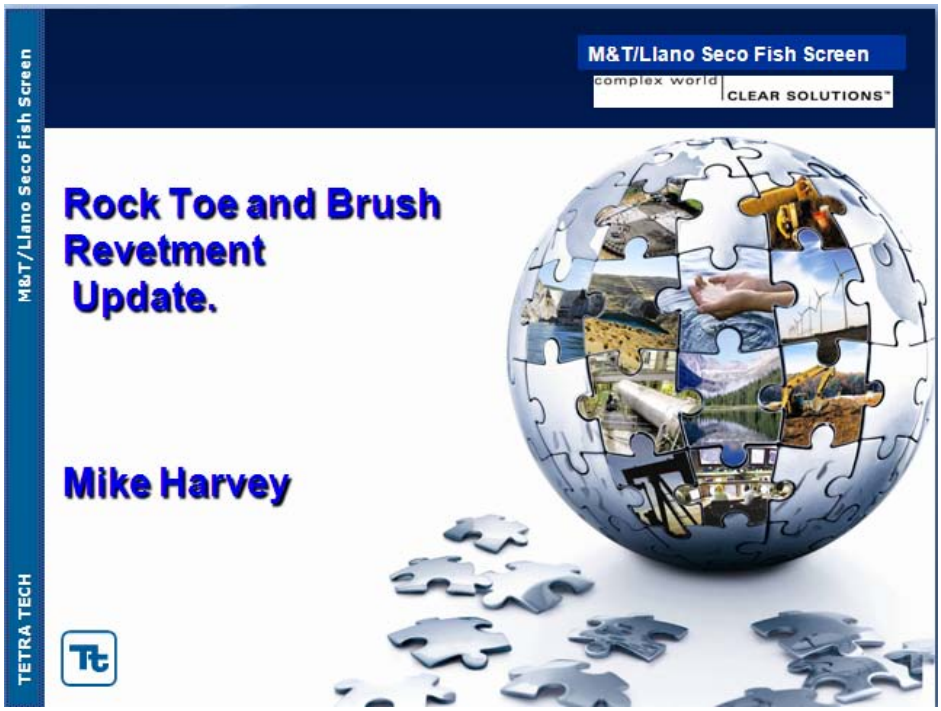
In anticipation of another dredge project, another bathymetric survey was conducted in 2010 primarily to determine the amount of material that would be necessary to be wet-dredged out of the area.

We saw something interesting with that data when we started to look at the long-term data. We have surveys in 2005, 2006, 2010 and 2011. We thought we saw a pattern and we were able to conduct some numerical modeling to see if our thoughts could be proved up. In June 2011, a Bathymetric Survey was conducted in anticipation of another dredge event to established volume of dredge material.

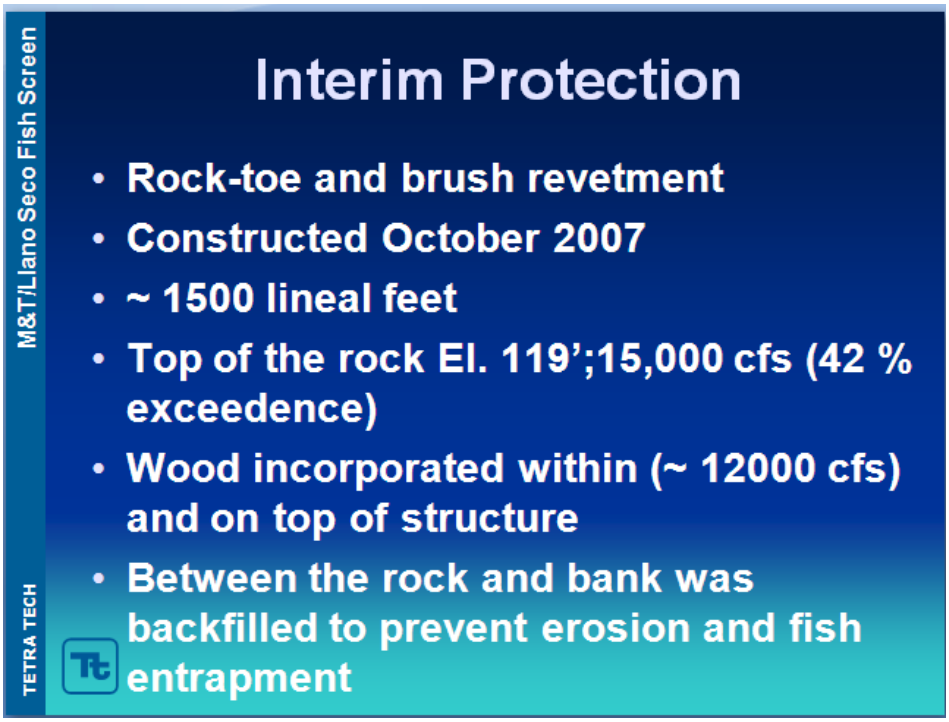
Discussions were held regarding the retreat of the west bank and the relationship between river flows and the movement of sediment through the system.

High river flows seem to move the sediment while low flows contribute to the accumulation of sediment in the vicinity of the M&T pumps.

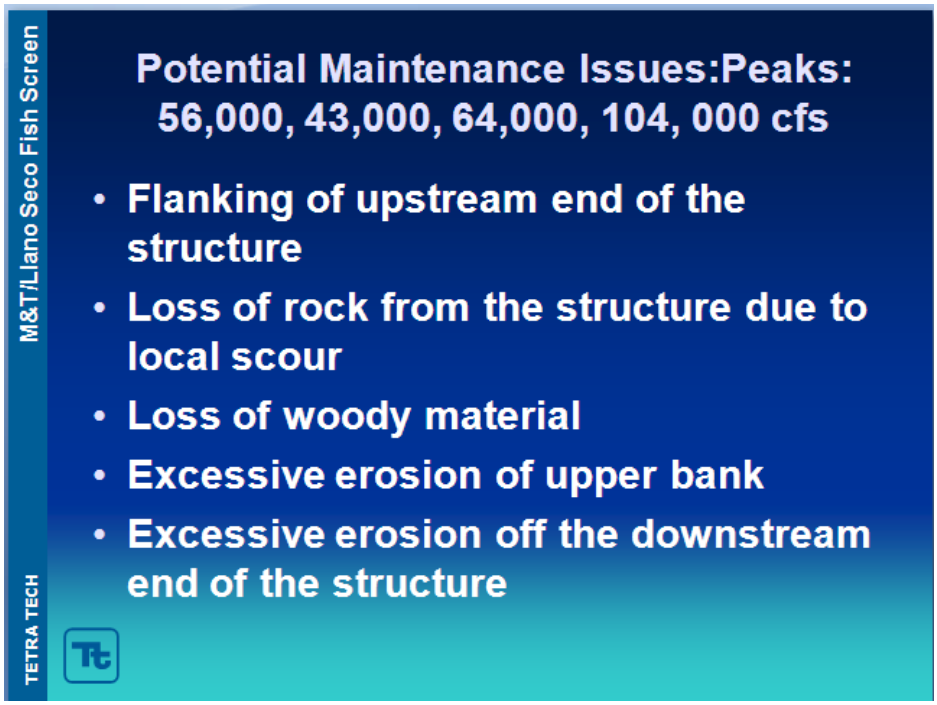
West Bank Stabilization Project (Rock-Toe/Brush Revetment)Update
Mike Harvey, Principal, Tetra Tech
Structural Monitoring Reports Summary



One of the project tasks is to monitor and evaluate the west bank stabilization project.



Mike reviewed the construction of the rock-toe and brush revetment. This project is only a toe-protection. A prism of rock was placed--4 to 6 tons were placed per lineal foot and some backfilling behind the rock for stability purposes and to eliminate fish entrapment.



Mike described the peak flows that the structure has been exposed to this year. He reviewed the potential impacts that could occur on the revetment.

Nothing was done to the upper bank. The idea is, that if you hold the toe, the upper bank will erode back to an angle that will become vegetated and stable. Also, the question is what happens to the downstream end when you go from hard to soft. These are the major concerns.

This slide shows what the upstream end looked like before construction in 2006. It shows the erosion occurring. The bank is no longer there. One of the major meander loops came back to the river at this location. Where the heavy vegetation appears is one of the old channels.

Some of the fine grained sediment in the upper bank have bank swallow nests which required mitigation that M&T Chico Ranch provided downstream.

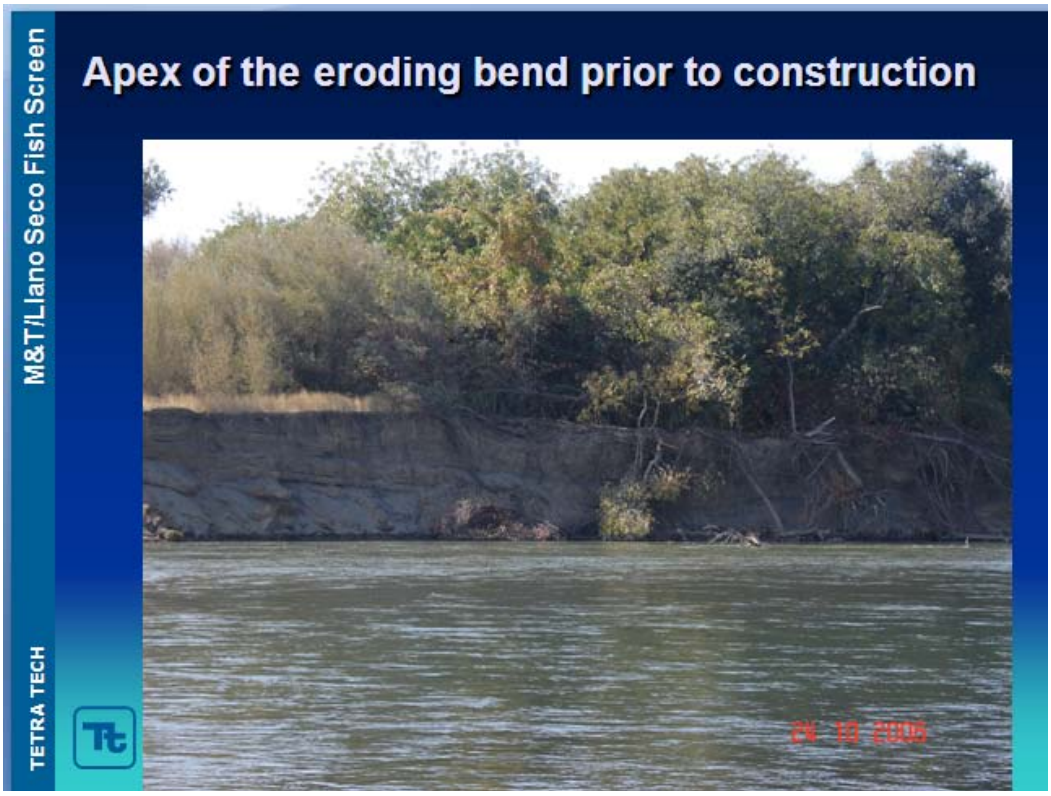


Photo of pre-construction vegetation for comparison with present conditions under variable flows and then photo documented for each year thereafter to illustrate condition of revetment to present. Brush sites seem to recruit other plants and micro eddies creating good fish refugia. Getting some bank retreat, however, no scour at the base of the rock. More vegetation at the bend – abundant willow volunteers, doesn't appear to be much bank retreat.

M&T/Llano Seco Fish Screen

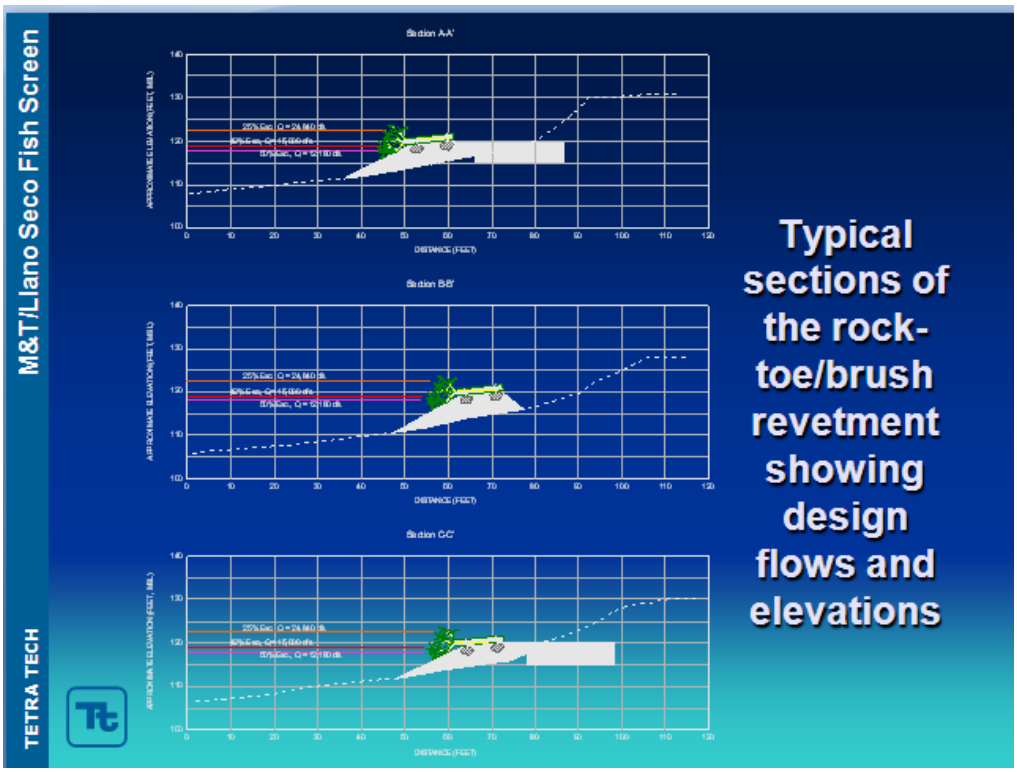
Middle part of the downstream part of the site prior to construction

TETRA TECH

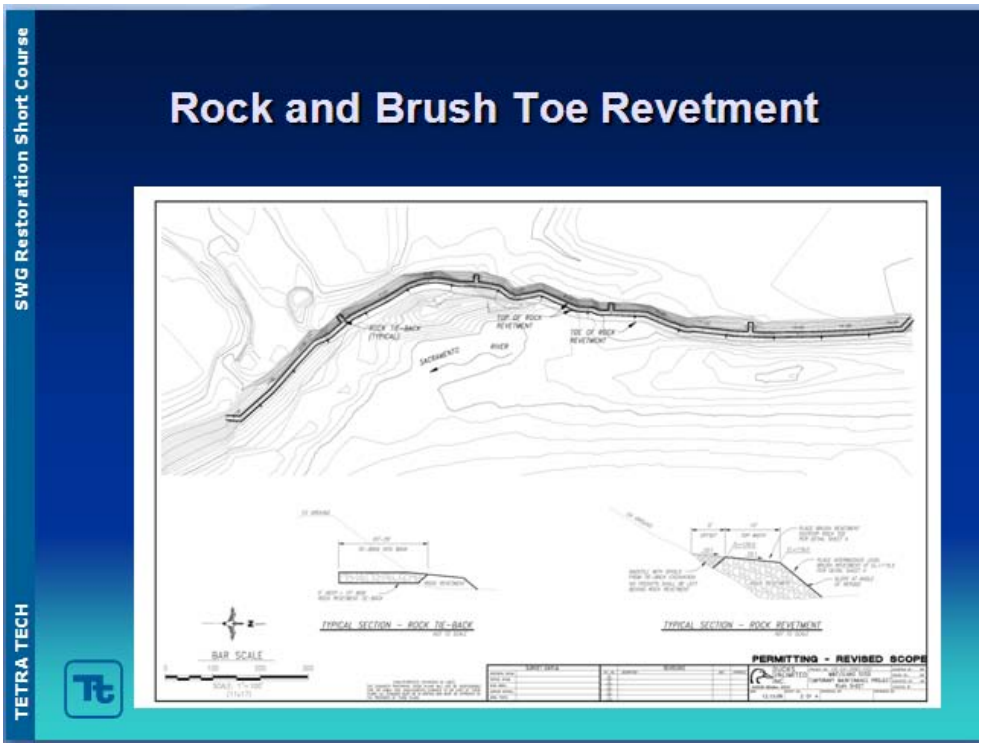
M&T/Llano Seco Fish Screen

Downstream end of the site prior to construction

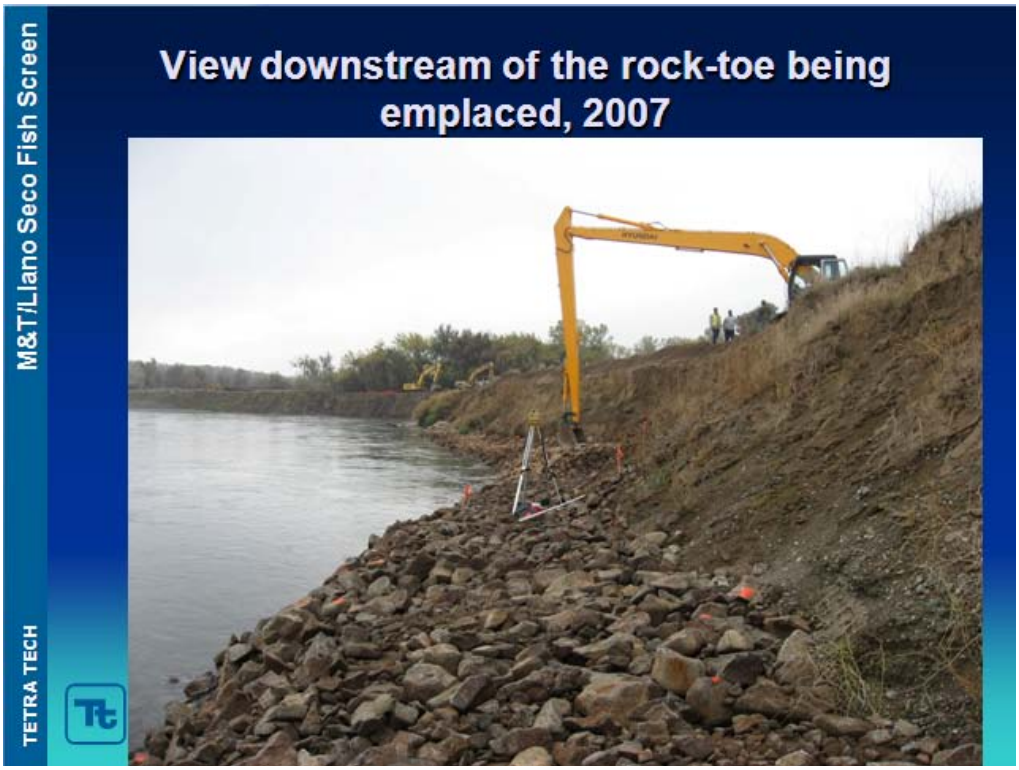
TETRA TECH



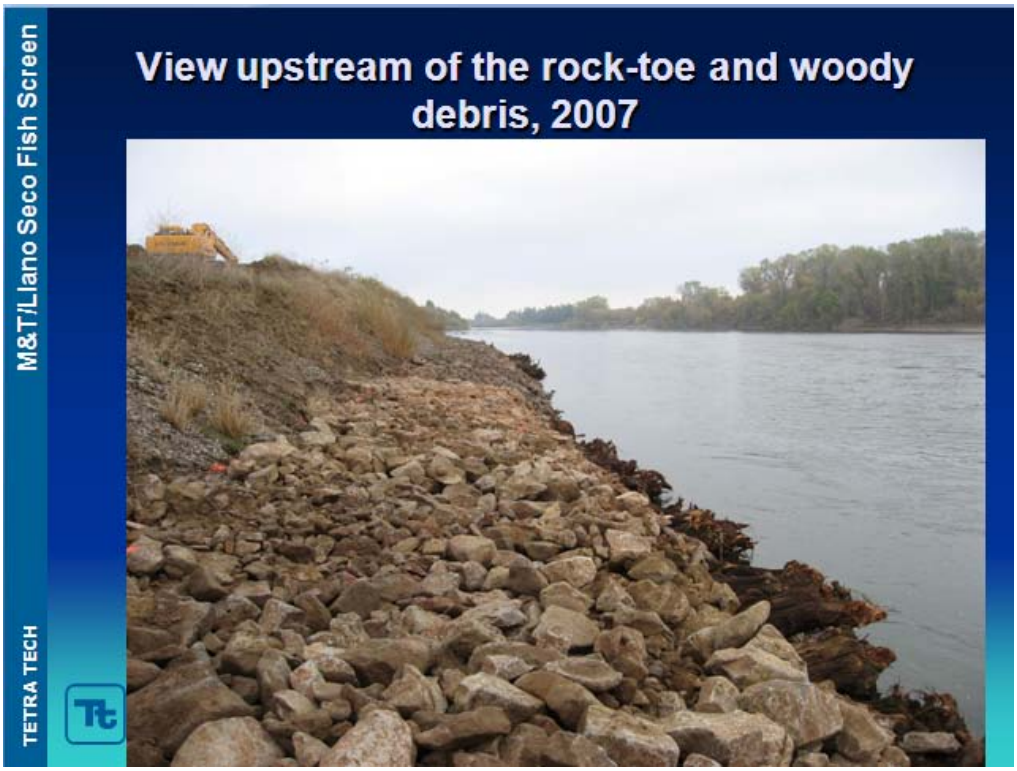
This slide shows the design flow elevations, vegetation on the top cabled into the bank. Depicts flow levels over a reasonable range to provide habitat.



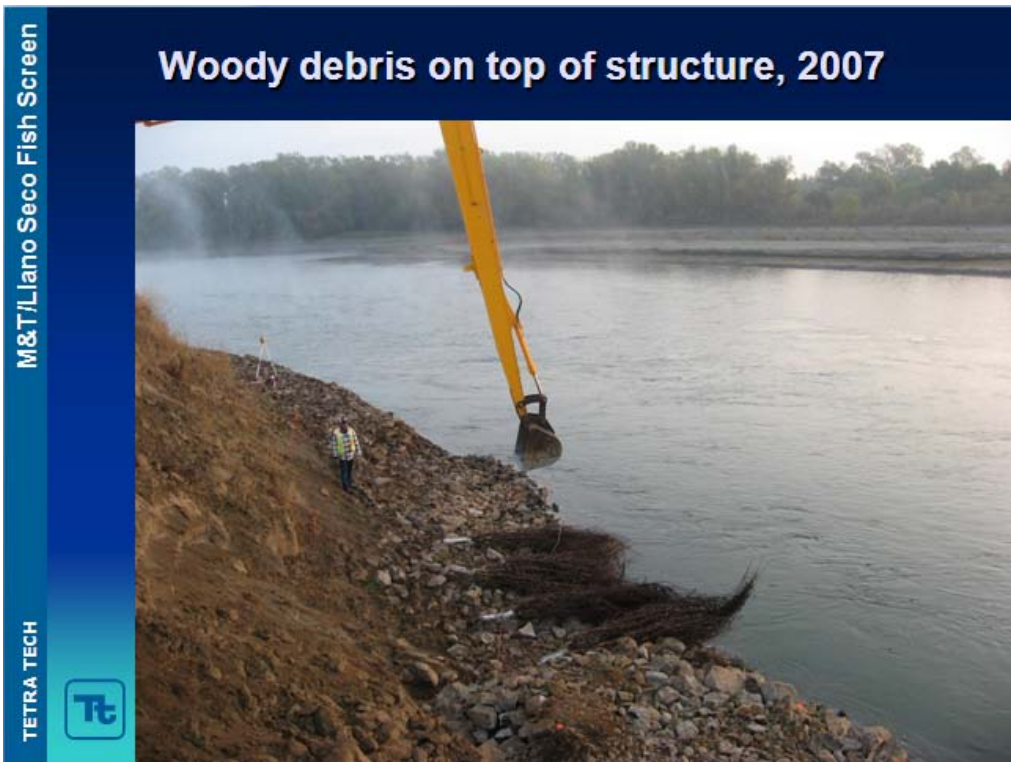
This slide shows the layout of the revetment upstream to downstream. The illustration shows the tiebacks.



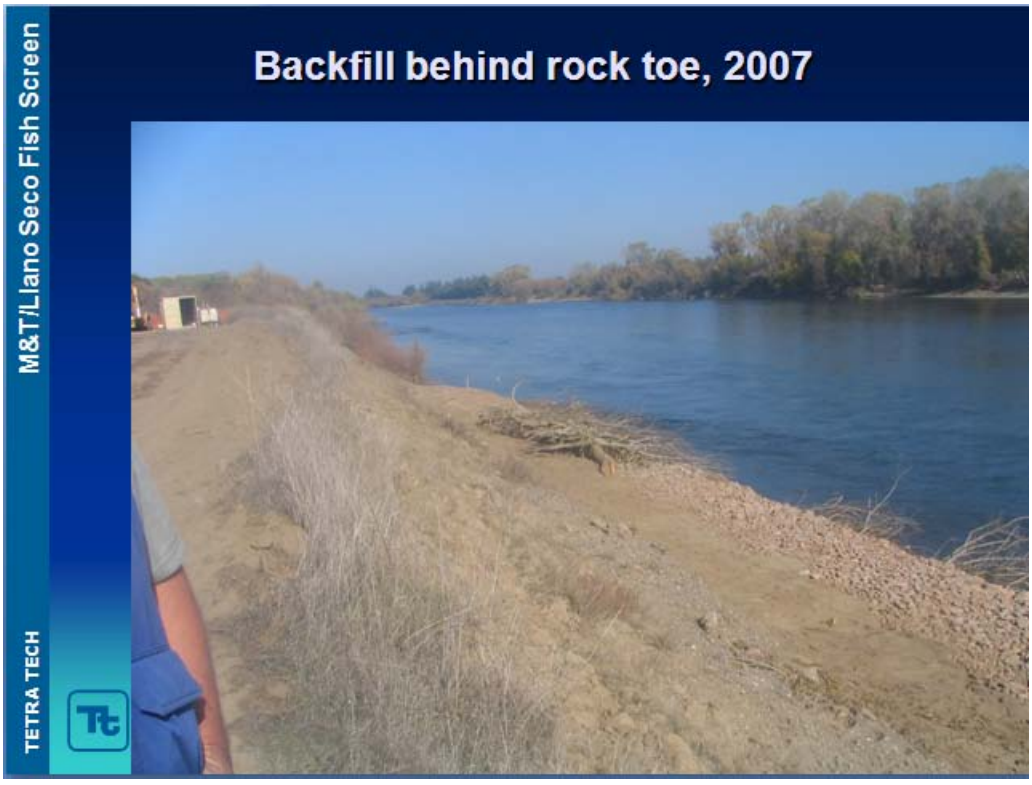
All construction was conducted from the top of bank.



This slide shows the vegetation buried into the rock.

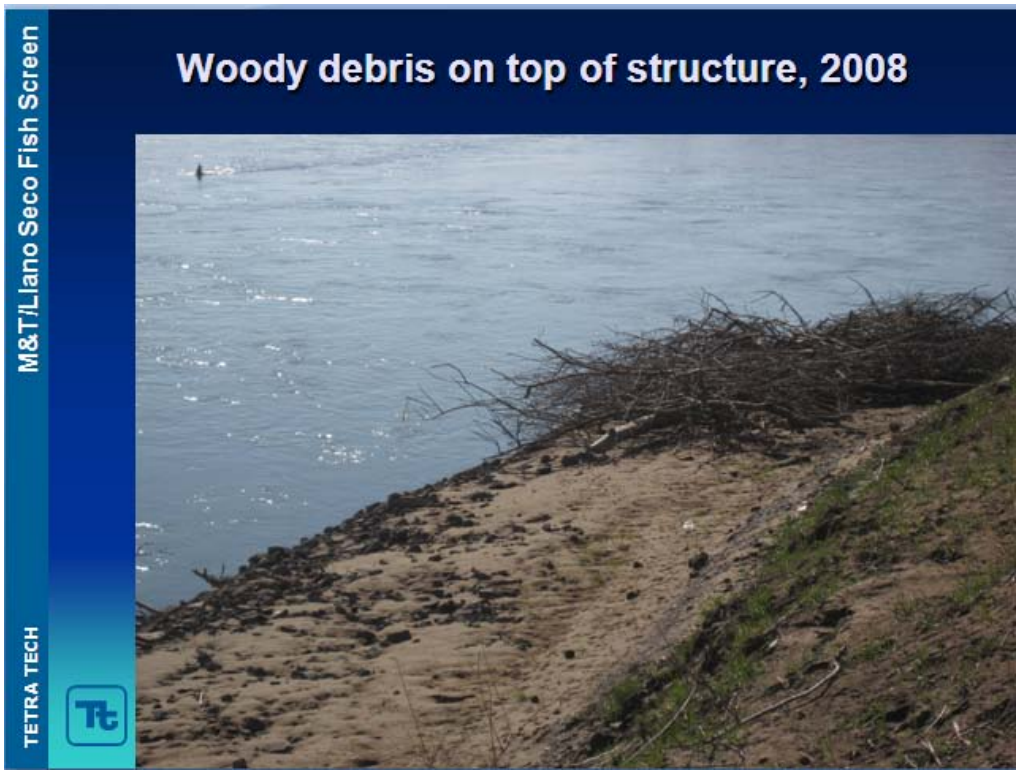


Slide shows the brush being placed on the top of the rock.

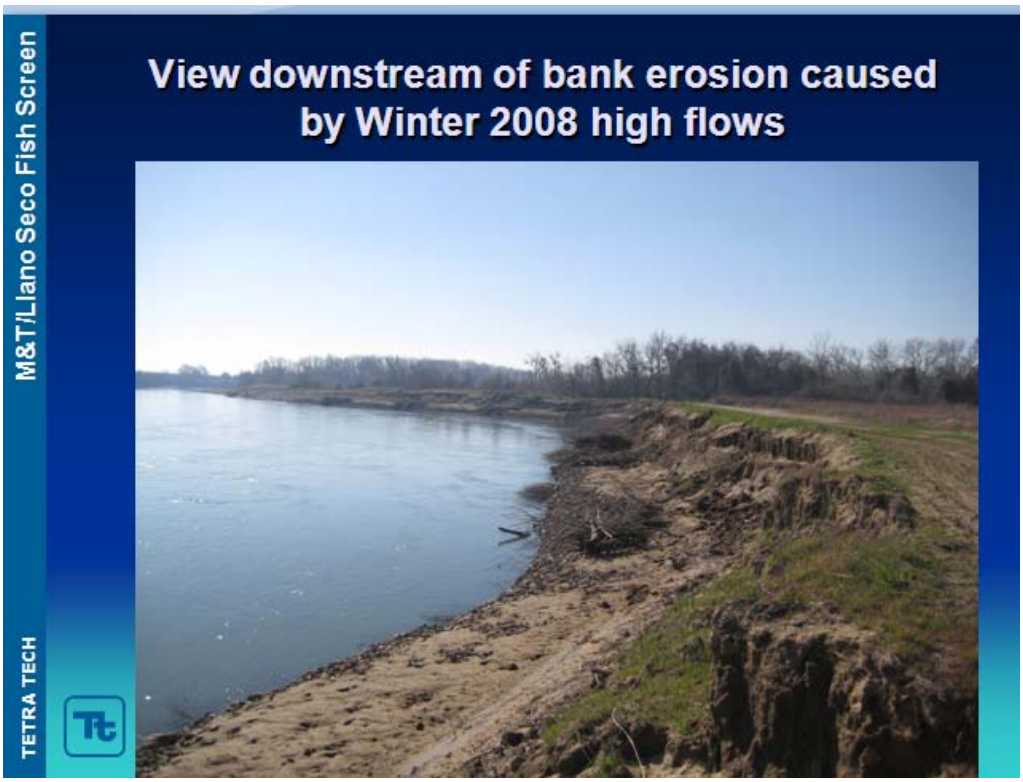


This slide shows the backfill behind the rock.

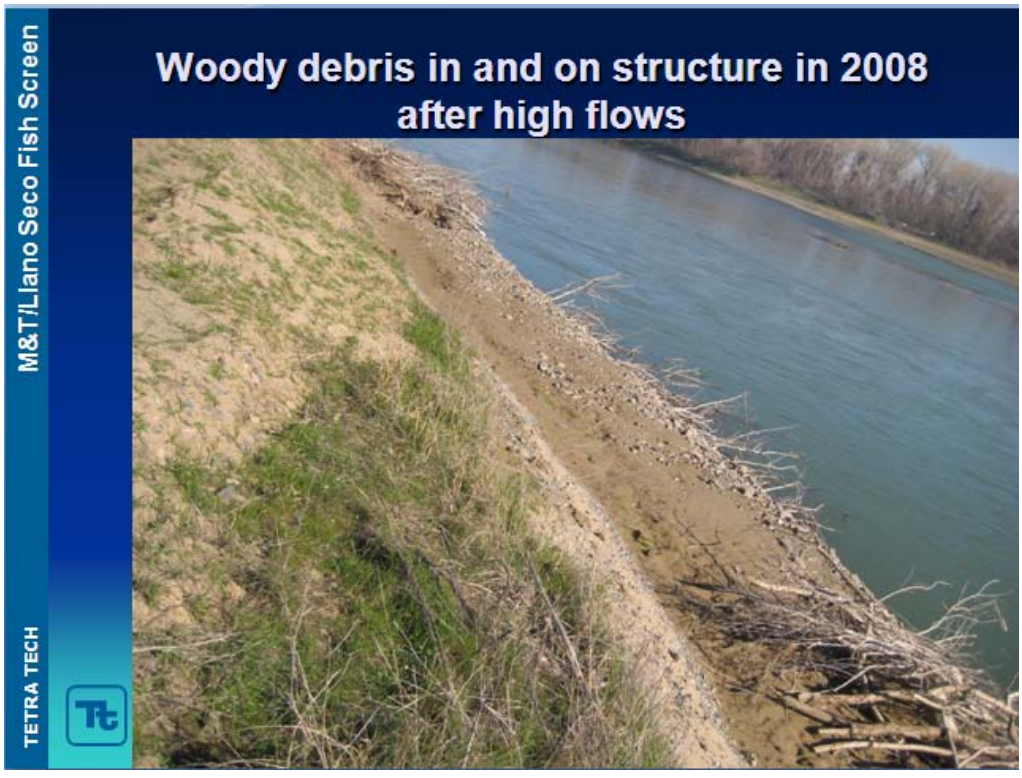
The upstream end; notice willows as a reference point in time and the brush piles are still in place after the winter. Also, there is deposition on top of the rock.



By 2008, there were flows up to 60,000 cfs and the brush remained in place. It is important to note that there is deposition at the site in terms of vegetation coming in on the site.

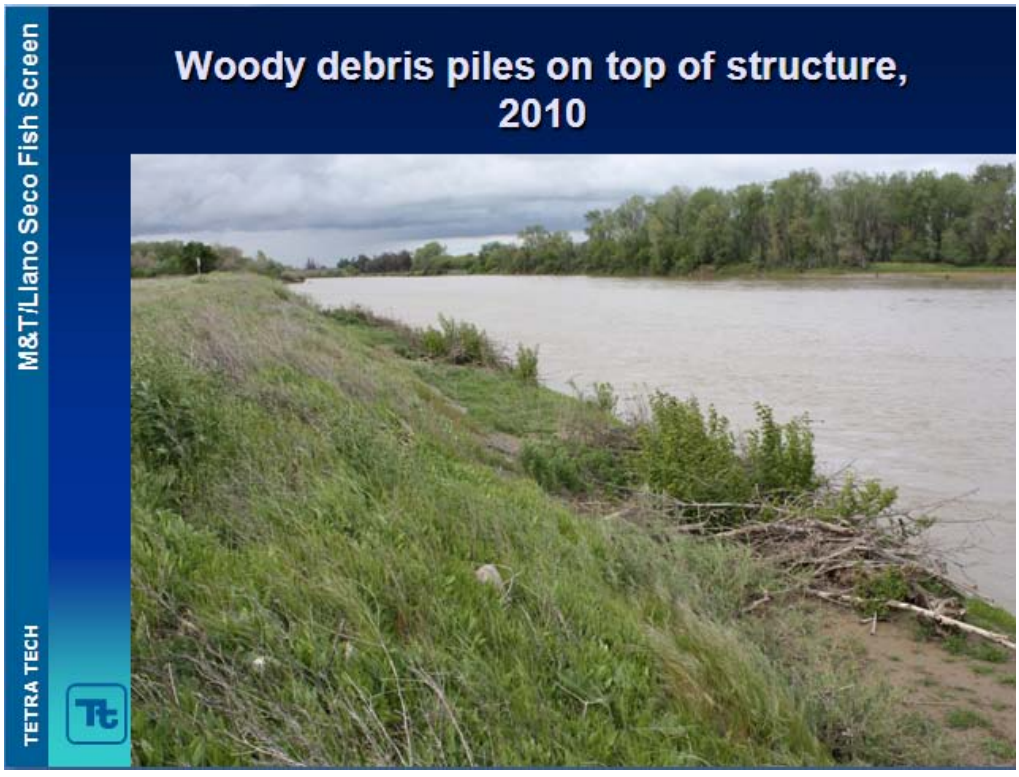


Looking downstream, the upper bank is still eroding and the structure is still intact.

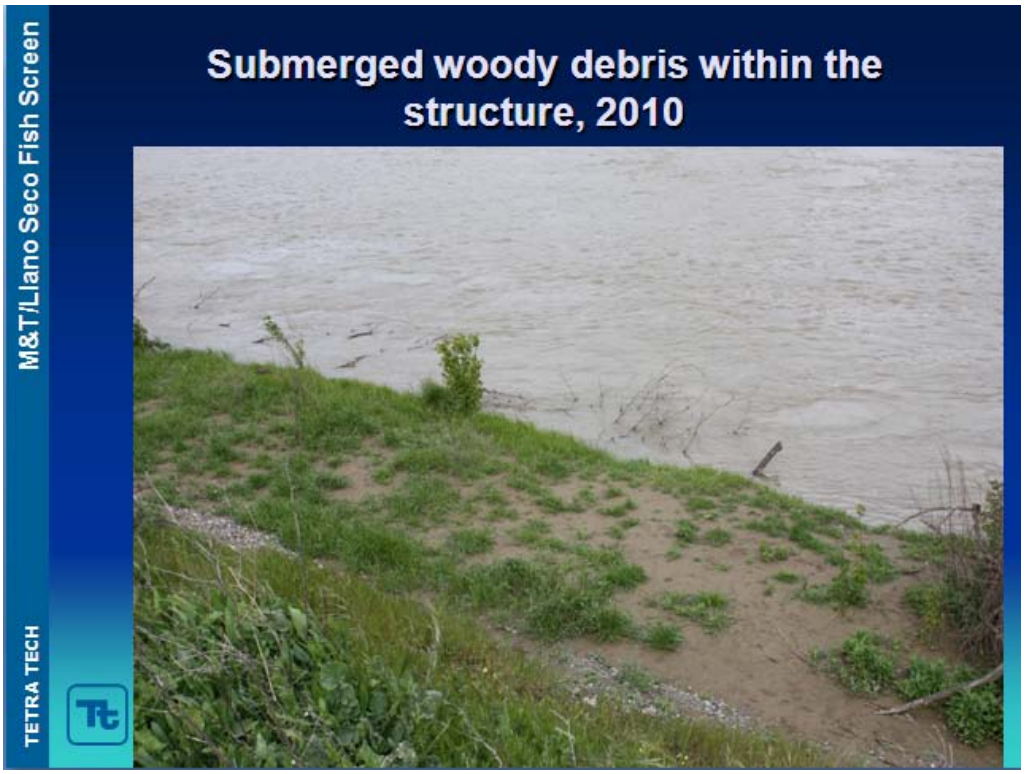


The vegetation that was buried in the structure is still intact.

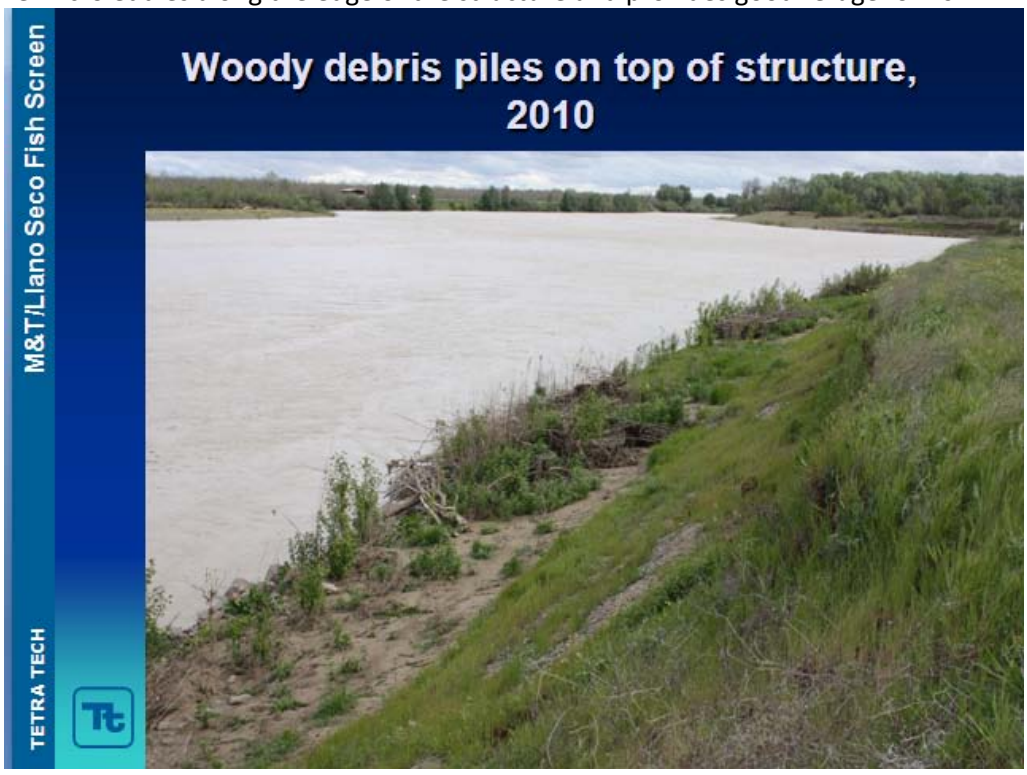
This slide shows there is no flanking at the upstream end of the revetment.



This slide shows the brush piles. What is interesting is that the brush piles seem to recruit other plants. There is a significant amount of box elder growing at the site.



This slide shows the micro eddies along the edge of the structure and provides good refuge for fish.

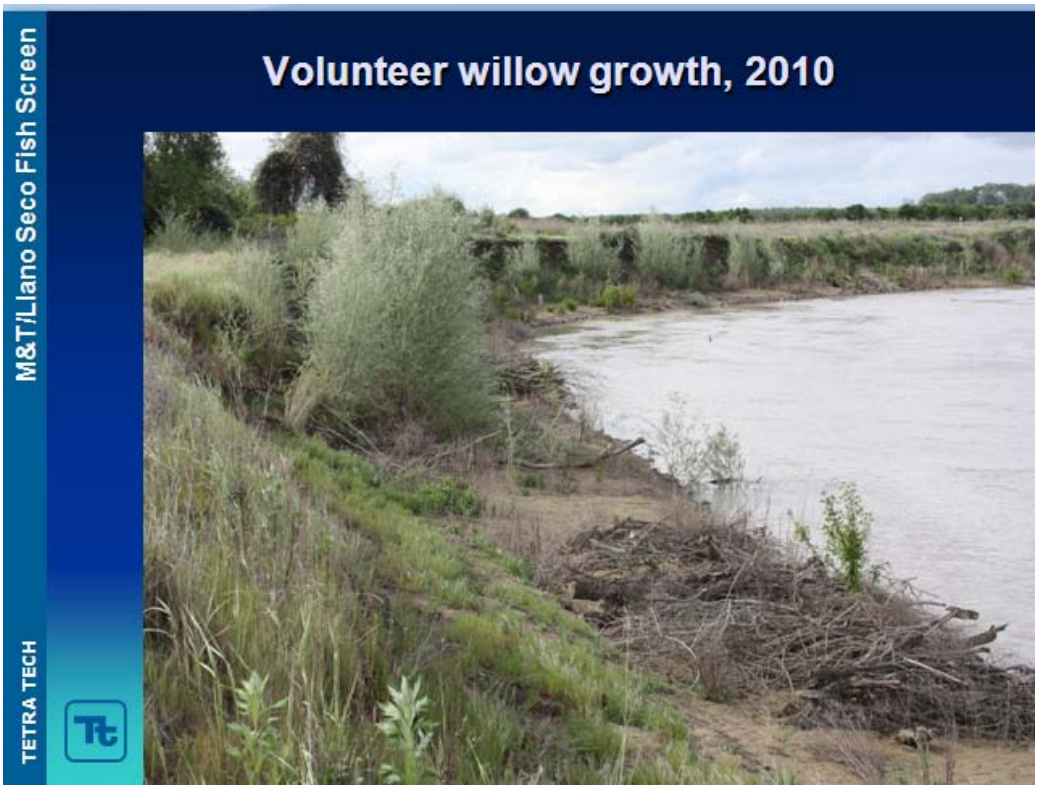


This side shows the revetment and brush piles are intact with vegetation coming in.

Another slide that shows the recruitment of vegetation.

This slide shows that there is still retreat on the upper bank.

This slide shows the upper bank retreating, however, there is no scour along the base of the bank.

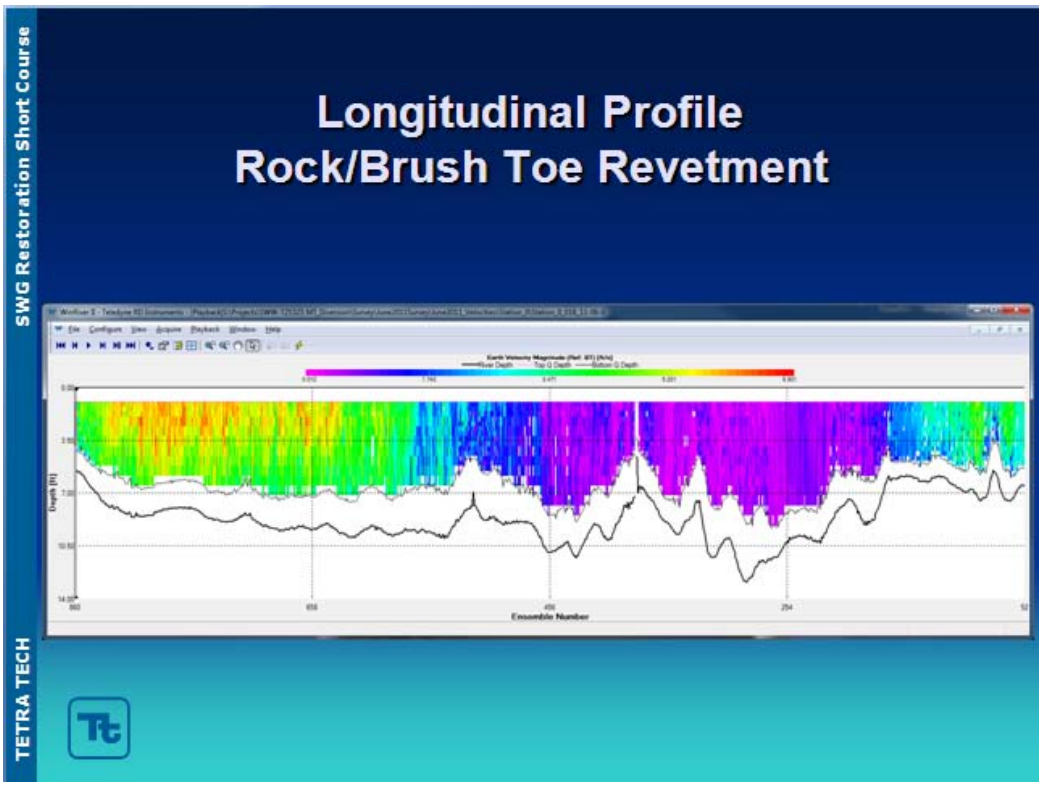


This slide shows the belly of the bend. What is interesting is the site is picking up more volunteer vegetation due to the low velocity. A healthy growth of willows is establishing in the bend.

This slide shows the downstream end of the revetment with reasonable revegetation being recruited at the site.

This slide shows the end of the structure with no retreat of the bank. The willows downstream are a reasonable marker.

In June, the project area was surveyed using an ACDP Unit to get a detailed 3-D flow measurements and to collect velocity profiles at different depths, averaging around 10 to 15 different depths. So when a pass is taken in the river with the ACDP, there is a basically a three-dimensional flow field all the way across and down the river. As the equipment crosses the river, the unit automatically calculates the discharge and produces high-resolution hydraulic data and traces the river bottom.

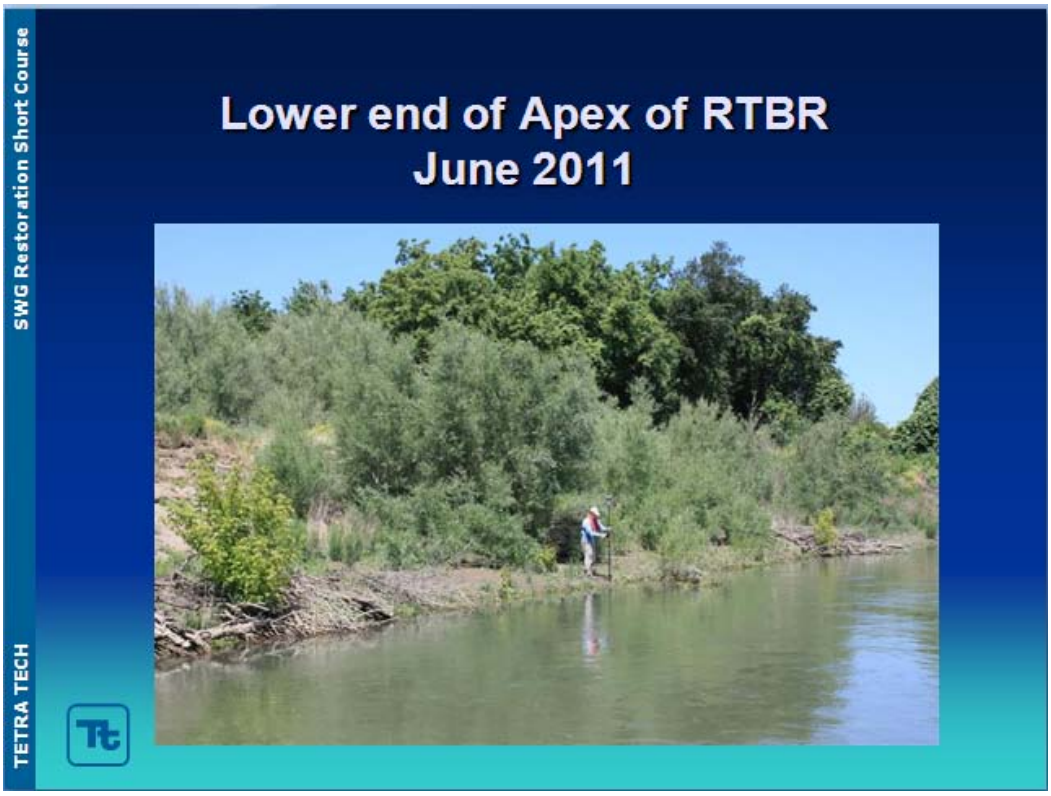


This is a trace of upstream to downstream along the rock-toe on the west side of the river. As you would expect, there are velocities of around 5 feet/second (green-yellow transition). The graph is parallel to the bank. The question was if there was any scour along the toe. The survey was run right along the toe of the structure. Upstream begins on the left. The solid black line is the bed trace and it shows no significant scour. There are very low velocities at the belly of the structure. No real scouring appears to have occurred since construction. Velocities pick up at the lower end. There is no major damage to the structure.

This slide shows the revetment the same day that the ACDP survey was conducted.

This slide shows the willows. If there was any significant retreat, there would be no willows. It seems very stable at the bottom end.

This slide shows the vegetation at the lower end of the revetment. Not losing any vegetation.



Another slide showing the revegetation.

This slide shows the belly of the revetment and the revegetation. Due to the deposition, it is difficult to see the rock. It was a high flow year at 104,000 cfs in the winter.

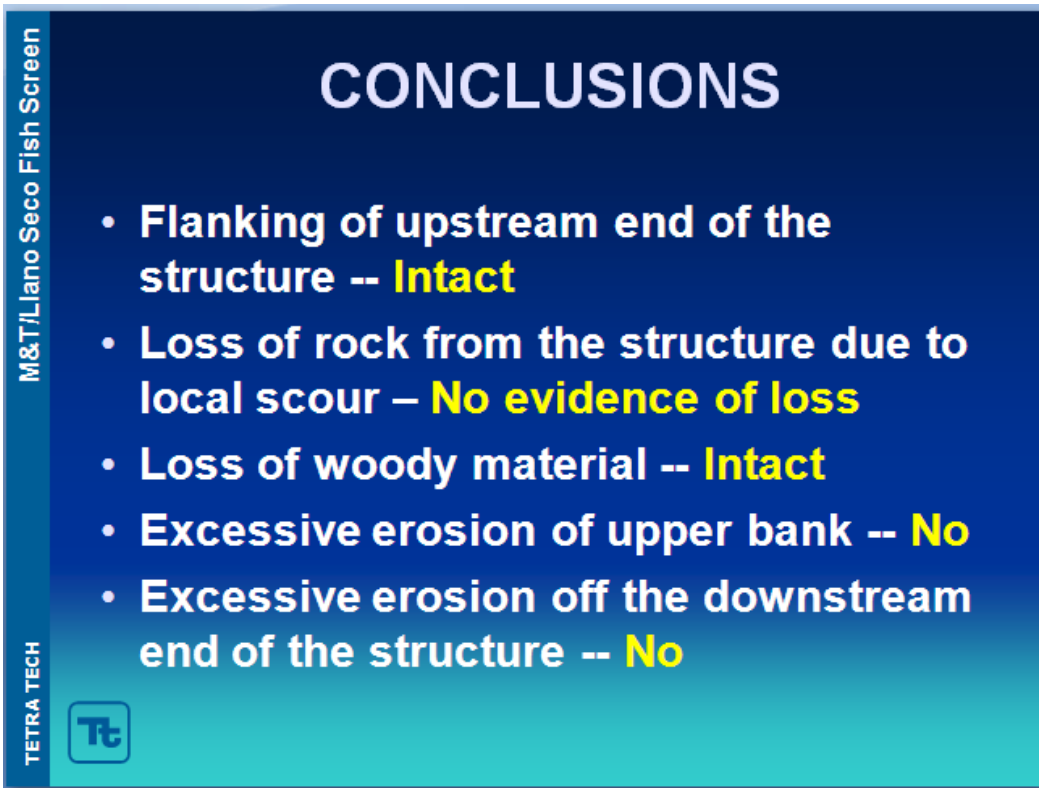
This slide shows that the revetment is really stable and the bank behind is also stable. This is working well. The brush piles are still intact. There is still some retreat of the upper bank taking place, however, there is vegetation growing towards the toe. As the bank recedes the vegetation is colonizing the area.

Another slide that shows the recruitment of vegetation along the brush piles.

This slide is about 2/3 the way up the revetment and shows very dense vegetation.

Another slide showing the dense revegetation.

This slide shows the transition into the unprotected area of the bank. The flow is approximately 17,000 cfs. The structure was designed to overtop at between 15,000 cfs and 17,000 cfs. It appears that the structure is operating as it was designed. The vegetation is doing remarkably well.

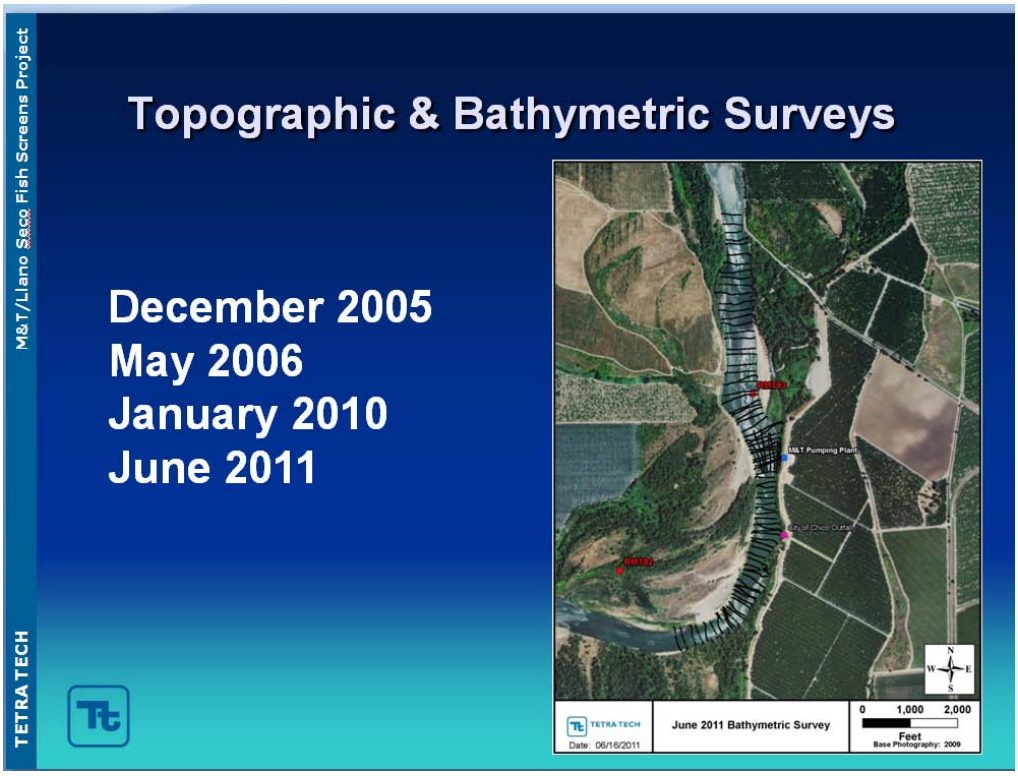


Conclusions – no evidence that the revetment is failing. No evidence of loss of rock on the outboard side. More monitoring will be conducted at low flows to get a visual inspection of the toe. No scallops at the top. The wood material is still there and seems to recruit vegetation. There is no excessive erosion on the upper bank. It is laying back as it was expected in the design with no flanking or accelerated erosion. There seems to be no retreat at the upstream or downstream transitions. Bottom line, the structure is doing what it was intended to do after being subjected to some pretty reasonable river flows.

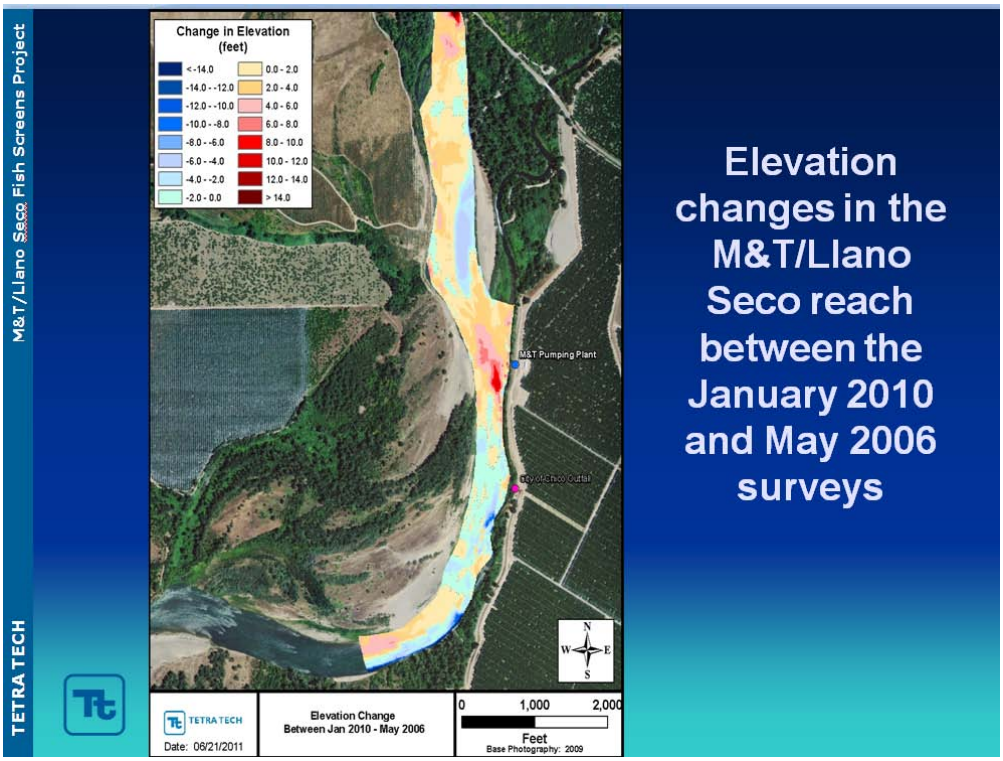
In this reach, bankfull is usually around 90,000 cfs so the structure overtopped this year at about 104,000 cfs peak flow. It is a good example of what can be done with toe rock.

At this time, there is no need for maintenance. In the long-term, however, all structures ultimately need maintenance. If the river goes over bankfull and spreads, the shear does not go up proportionally. It is a question of the duration of really high flows.

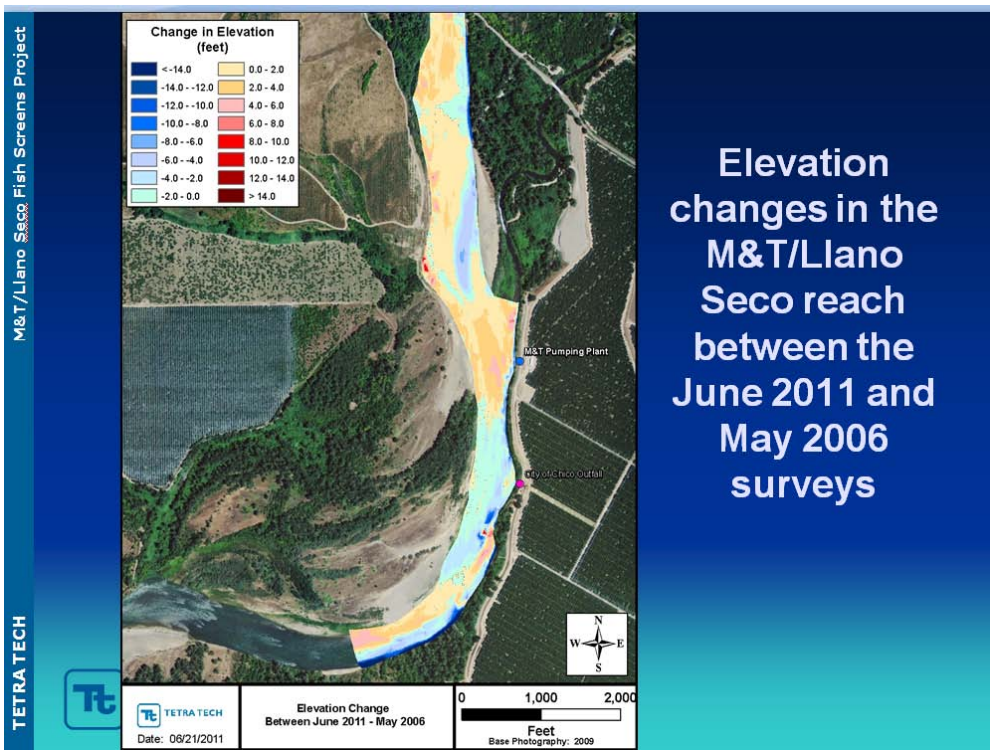
Topographic/Bathymetric Surveys - Mike Harvey, Principal, Tetra Tech
Dredge Volumes and Dive Reports
Topographical Survey Results based on multiple surveys (2005-2011)



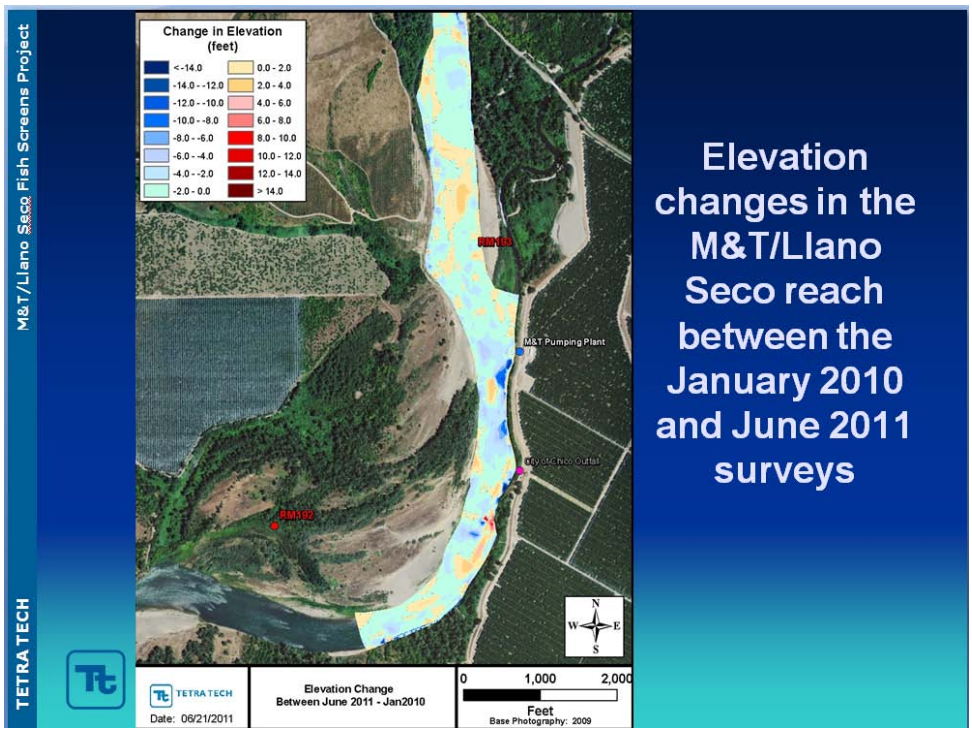
The information from this study may indicate potential cyclical behavior in the reach that may provide the project with another alternative. More hard data must support this idea. This slide shows a typical survey map that shows how the river has been surveyed four times with various types of equipment. For the overbank survey, the U.S. Army Corp of Engineers (ACOE) surveys were used, basically, the Comp Study topography. It was checked periodically to see that it did not change. This shows in-channel bathymetry. In December 2005, an initial survey was conducted. Immediately after the survey there was a high flow in the river. The group agreed that the river should be resurveyed before the modeling was conducted.



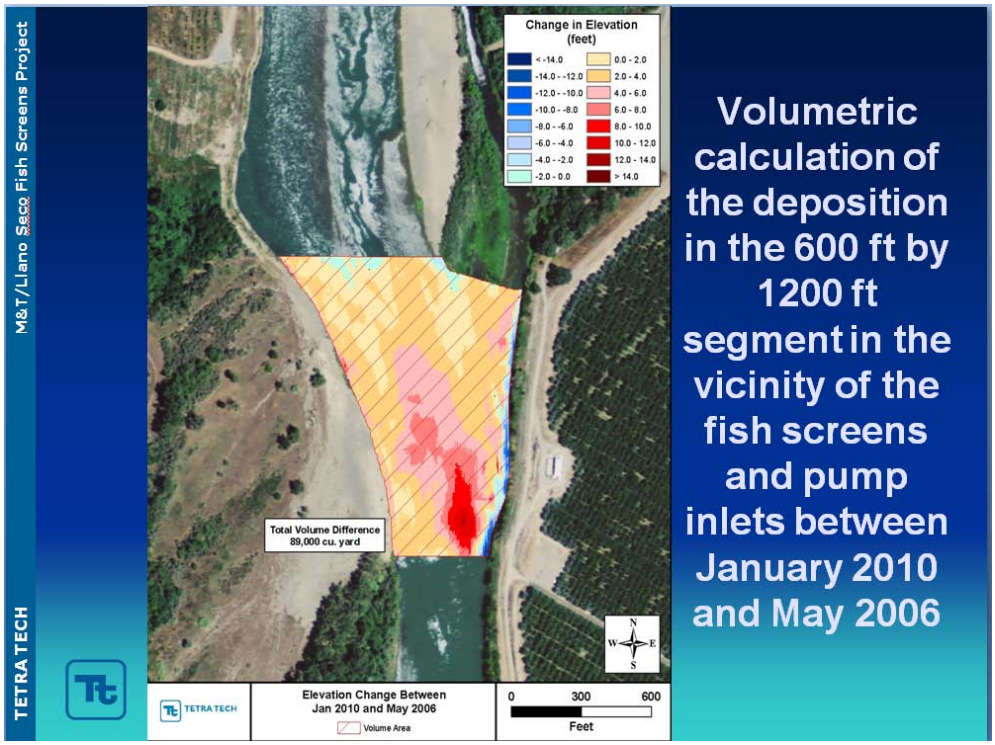
Comparative May 2006 and January 2010 surveys showed the bar migrating downstream onto the intake and fish screens.



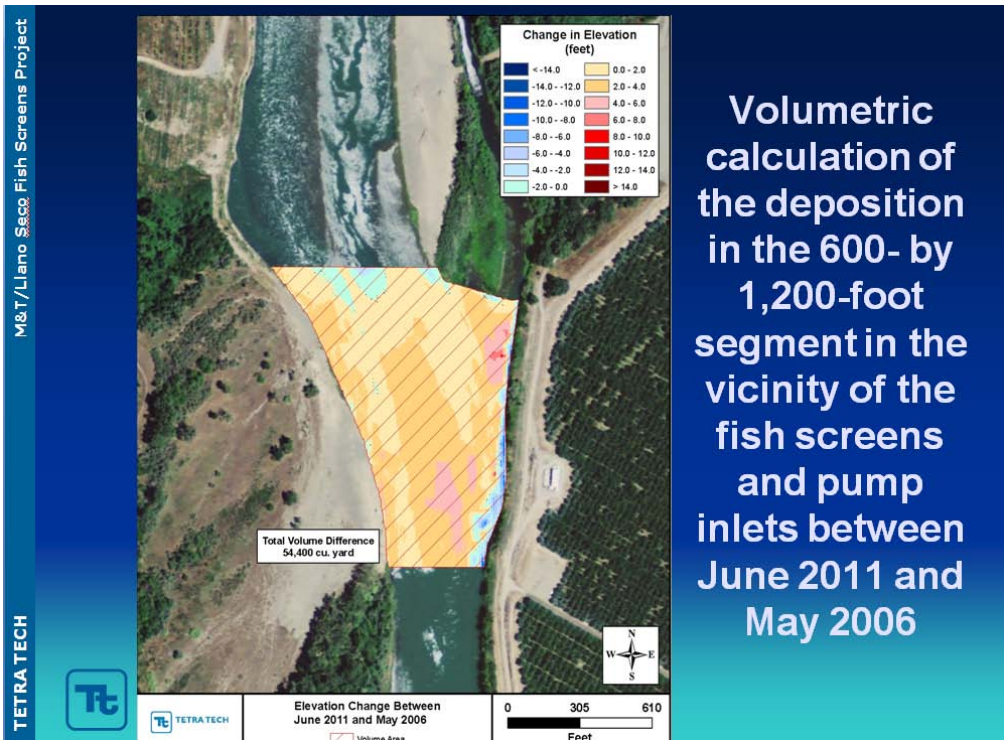
This slide shows the June 2011 survey which was conducted as part of the dredge requirement. It shows that the bar is still around the pump intake but there has been loss of material between the 2010 and 2011 surveys



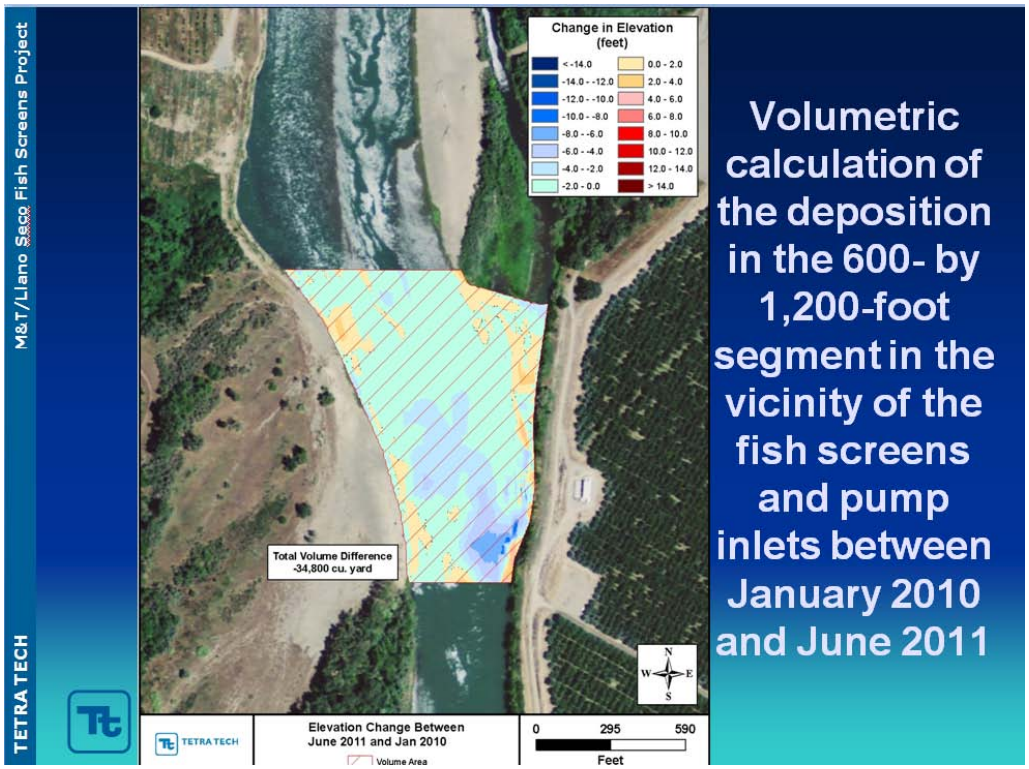
This slide shows the elevation changes between 2010 and 2011.



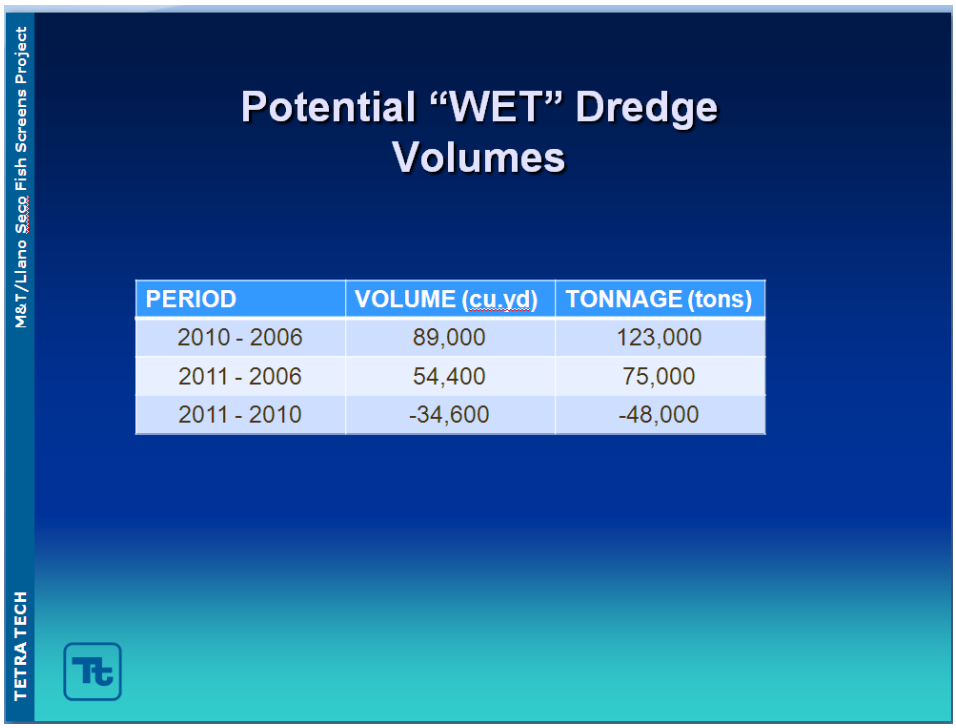
This slide shows a major buildup of sediment out in front of the pumping plant intake, which is the bar moving downstream. The blue colors are negative, red colors are positive. The buildup seems to be between 12 feet and 15 feet (red colors).



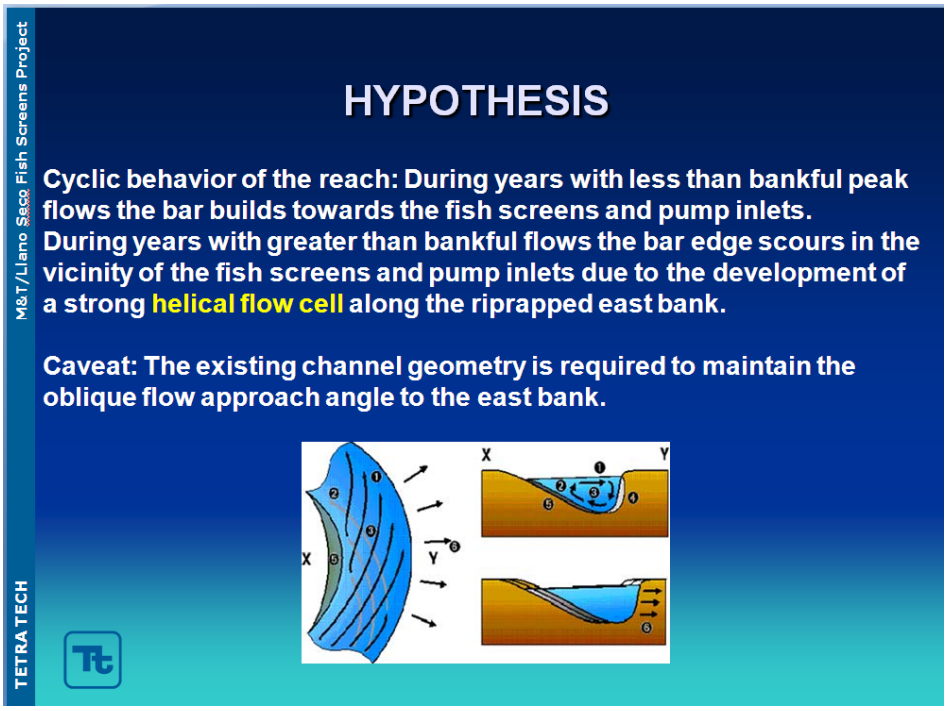
In the same comparison, the 2011 survey and the 2006 survey under exactly the same scale, we see the red color has moved and it is back down to 2 feet to 4 feet of aggradation in that area. What this implies is that the high flow in 2011 cleaned a lot of the material out.



When you compare 2011 with 2010, what you see is some deposition (yellow) but around the pump intake, there is a loss of sediment. The high flows moved a significant amount of sediment through the system.



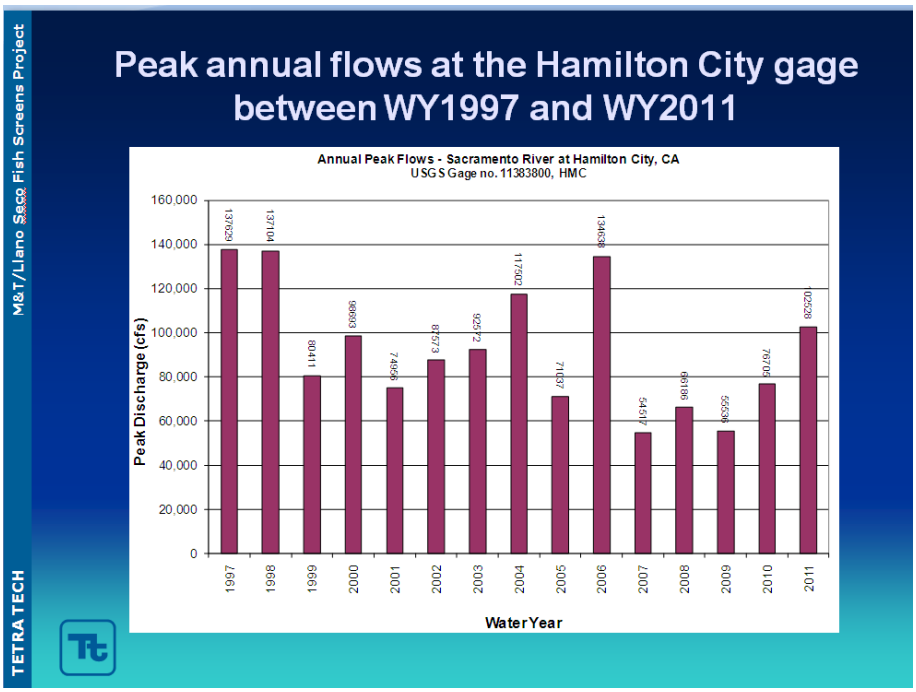
Between 2006 and 2010 there was a positive gain of 89,000 cubic yards, compared to 2011. The 2011 flows removed about 34,600 cubic yard of material.



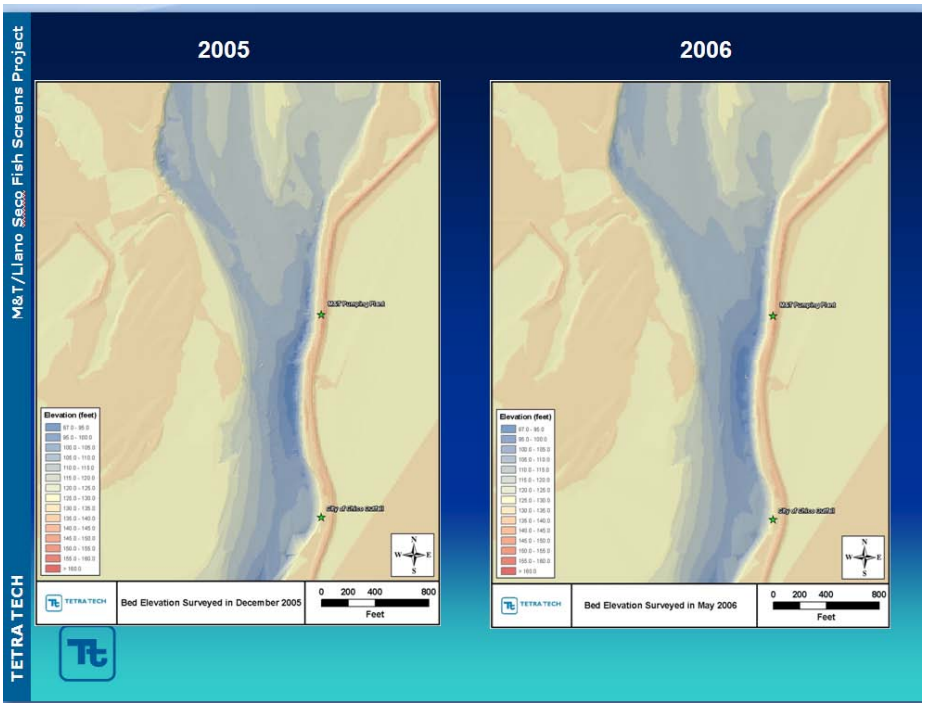
What the information suggests is that with the current configuration that includes the west bank toe rock which is preventing lateral migration of the river the high flows of this year (2011) of 104,000 cfs moved a significant amount of material out of the bar. After reviewing the information, we put the observations into a hypothesis that a helical flow cell is responsible for the changes. What is a helical flow cell? The illustration shows a typical meander bend on the river. The river is going downstream looking at a cross section as flow comes to the outer bank flow comes inwards to the bank at the top and then it flows out at the bottom and up. And so you have a helix or spiral through there.

In a meandering river, that dynamic helps move the sediment out, the bank retreats, the bar builds. What we have is a situation where the right bank is rip rapped and has been for a long time. What we think is happening is currently the higher flows come in obliquely to the bank and then to go downstream the flows translate into a helix.

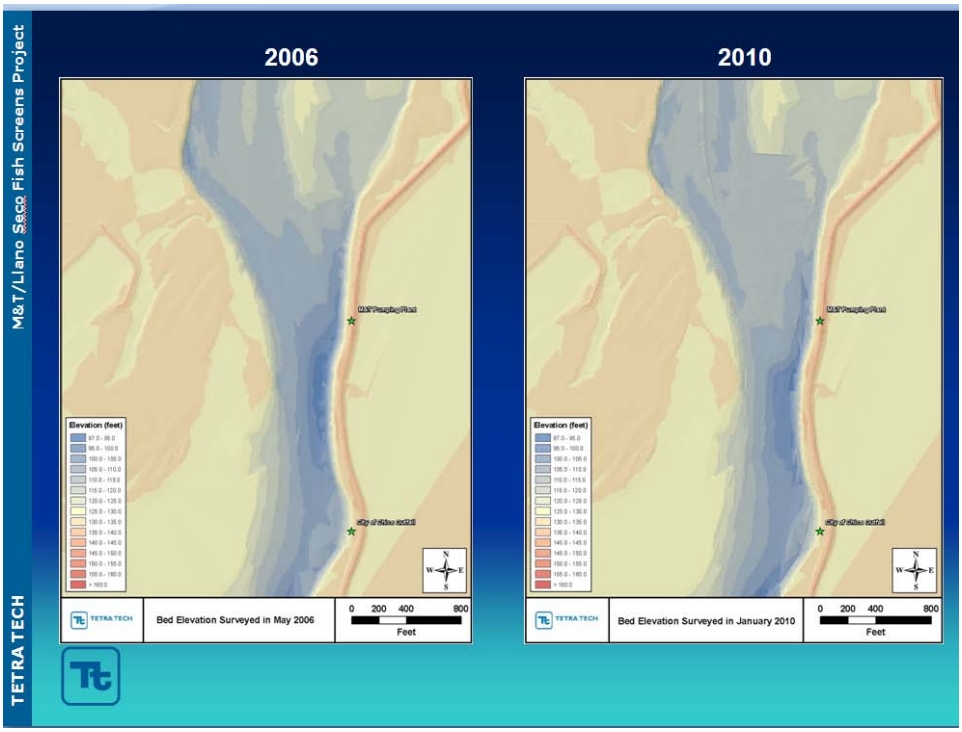
You see this action quite a few places in a river, especially in sand-bed rivers where you have a hard bank and a big sand bar comes in and the flow is approaching it, the sand bar itself never gets to the bank. It doesn't mean that sediment doesn't get to the bank, it means that along the bank and a distance out from the bank , the energy is so high, the form itself cannot work its way into the bank, it just gets eroded out by the helix. If that is the case, we may have a situation at the fish screens and intake where, with the current geometry, it gets close to burying the pump intake in lower flow years, but when we get a high flow, this helix gets stronger and stronger and it cleans out a volume of material keeping the pumps from being buried. This is just a hypothesis. The caveat is that for this to be applicable, the channel geometry has to say the same. There must be that same oblique flow coming into the rip rapped bank to generate the helix.



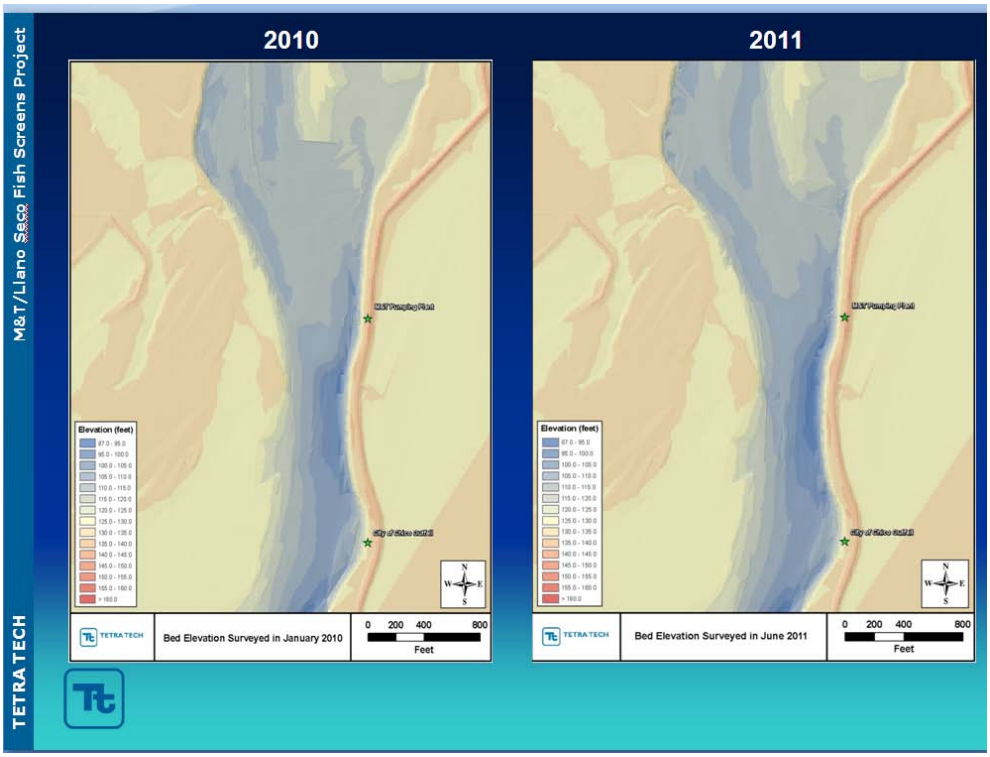
This slide shows the peak flows. In late 2005 we conducted surveys and in early 2006 we had a large flow and then conducted another survey after the flows. Then there was a period of relatively low flows. We resurveyed the channel in 2010 then we had a moderate flow in 2011 and then resurveyed the river. So we have essential two cycles. We have a period of low flows, a big flow, a low flow and a big flow. Just as a reminder, the first dredging was conducted in 2001 and the second dredging was done in October 2007.



This slide shows color gradient plots at various times. The blue is deep and the yellower is shallow. In 2005, there is a blue trough where the fish screens and pumps are located. If you go to 2006, what you see is during the higher flows, the trough actually got a little bigger and you see some of the yellow retreated there was more blue around the pump inlets and fish screens.



This slide compares 2006 with 2010 where there is a reasonable blue trough. In 2010, the bar built down but there is still a small trough.

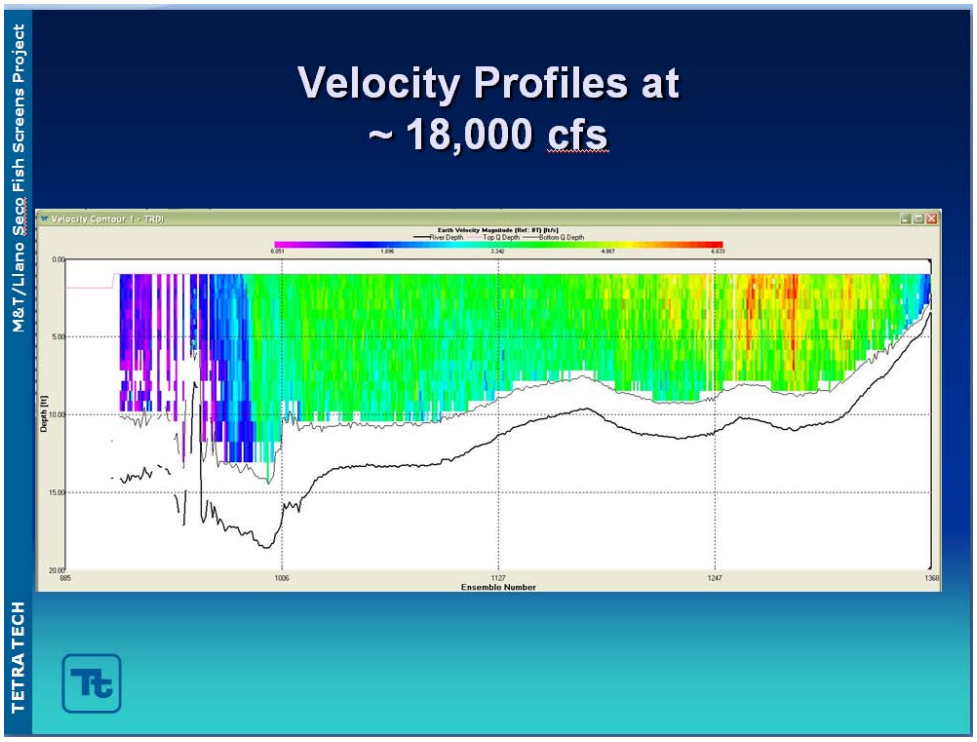


This slide compares 2010 and 2011. Notice again that one area is being carved off and another area is widening out (dark blue). An interpretation of the data would suggest, that if it is true, it looks like we might have a reasonable solution. It is a self-cleaning system provided the current river geometry stays the same. Obviously, that has an implication. It means the west bank must be held in place.

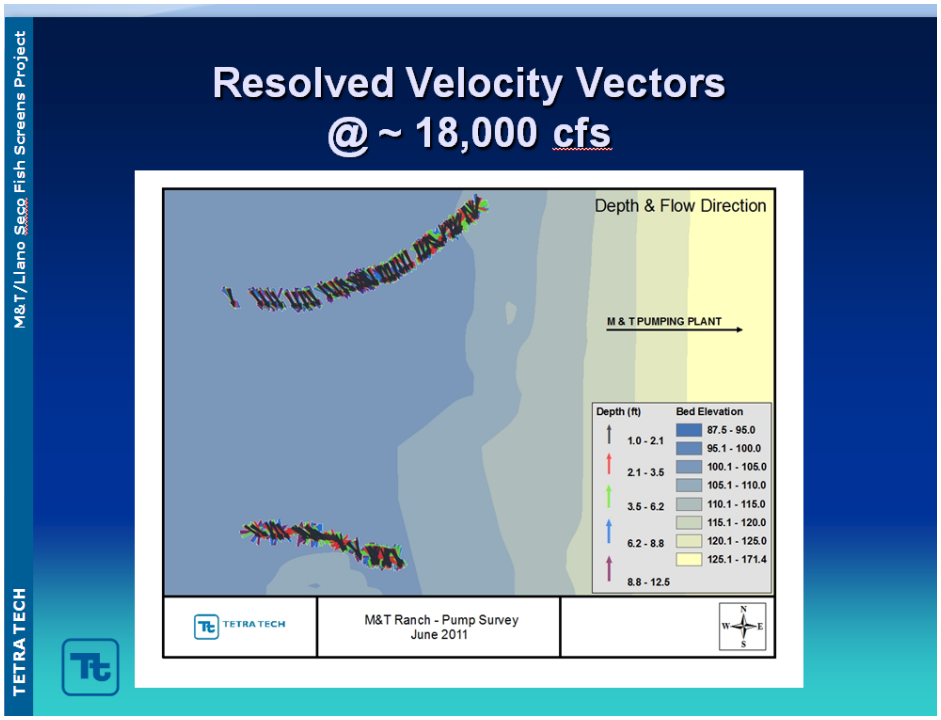
The 2007 dredge was conducted and the west bank revetment was constructed at the same time. At that stage, this dynamic had not been seen. Could we have gotten away with not dredging? Can't answer that question. We must think in terms of a general area and a localized area around the pumps—that is where there is a lot of activities. The question is can we maintain a sediment-free area around the pumps.

Did the west bank project and the dredge set the stage for an acceptable stage for bar formation and scouring? That is basically what the data is suggesting.

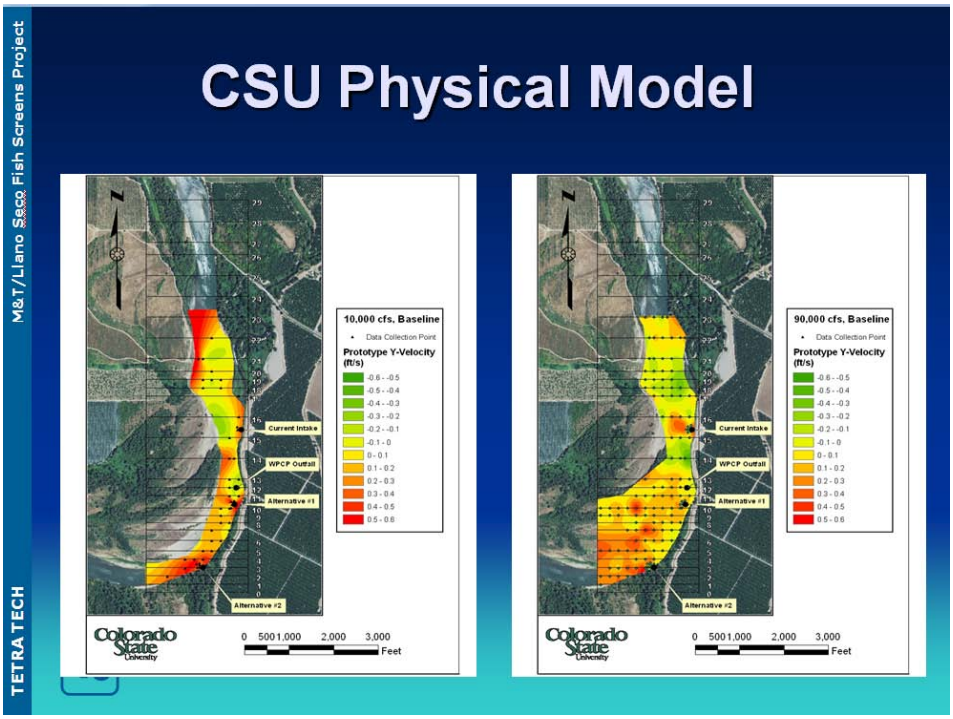
Looking back at the bed elevation slides---Mike described the area around the City of Chico's new outfall. There is a shallow area located at that site. In 2010 and 2011, the shallow area still exists. It is a local depositional area in close to the bank. When you get off the bank, you see higher velocities. The area in the belly will always be depositional with the current geometry of the river.



This slide describes the Velocity Profile from the left bank to the right bank. In the black area is the fish screens and there is a lot of turbulence around that area. Around the fish screen is a trough along the outside. If you review the historical annual dive reports, what you tend to see is not much evidence of sedimentation around the screens. It may be that the turbulence around the screens may be enough to keep moving the materials. There appears to be an eddy around 17,000 cfs. This discharge should not be represented as a cleaning discharge. It is just the flows that we evaluated while the data was compiled. This suggests that this should be evaluated at a much broader range of flows.



This slide depicts the data as you go depth wise, the vectors turn and go out. Out in the river the vectors stay the same. What it looks like is that even at 17,000 cfs, there is a weak helical cell in the location of the intake and fish screens. CSU reviewed the data to evaluate any similar activity in the physical model.



This slide was produced by CSU to show the velocity in the Y direction of the river when data was being collected during modeling. At that time, CSU was collecting both X and Y velocity vectors during the data collection process. At 10,000 cfs, there is almost nothing happening. The highest velocities are over on the west side. However, at 90,000 cfs, what you see is positive velocities heading west at about 0.6 of the water column depth. This post-process data does suggest

that at 90,000 cfs there is actually a cross stream velocity. This would tend to suggest that a helical cell does exist. It is a tantalizing suggestion, however, there are no field data to back up the hypothesis.

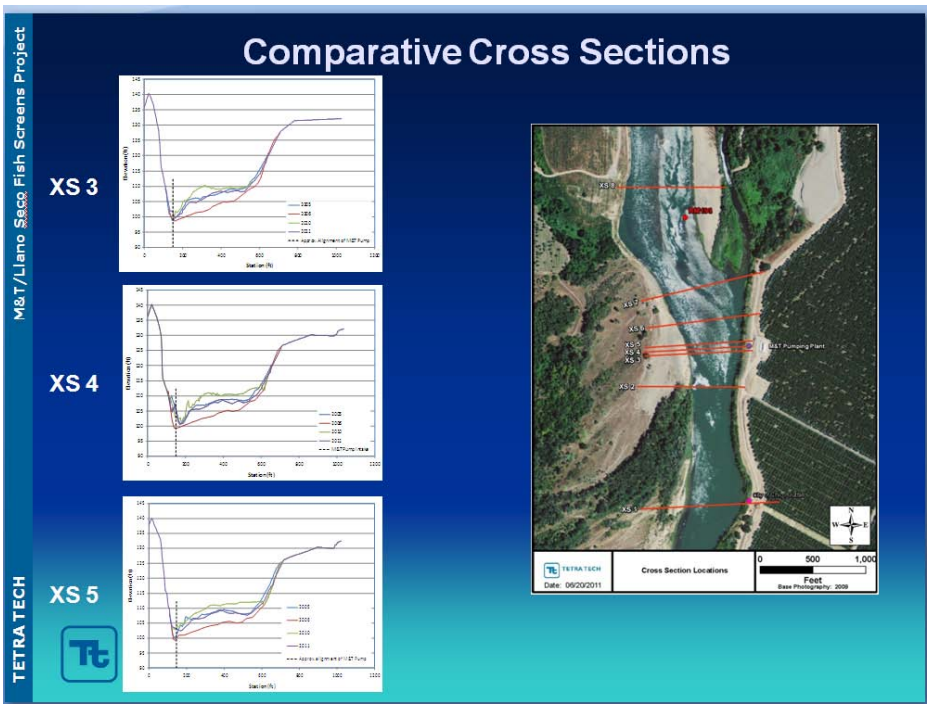
Helical flows have to reach a certain velocity before it is possible to move gravel. In order to understand what range of velocities the helical flows must maintain to move material is a three-dimensional question. However, the current available 2-D models are not able to describe that process. A 3-dimensional model is needed to correctly describe that question. Field data would be the most appropriate to answer the questions. Clearly, something is producing the changes from 2010 to 2011.

One of the next steps should be to collect data at different flow levels, especially conduct ACDP surveys at higher flows to verify our hypothesis and to determine the strength of the cell.

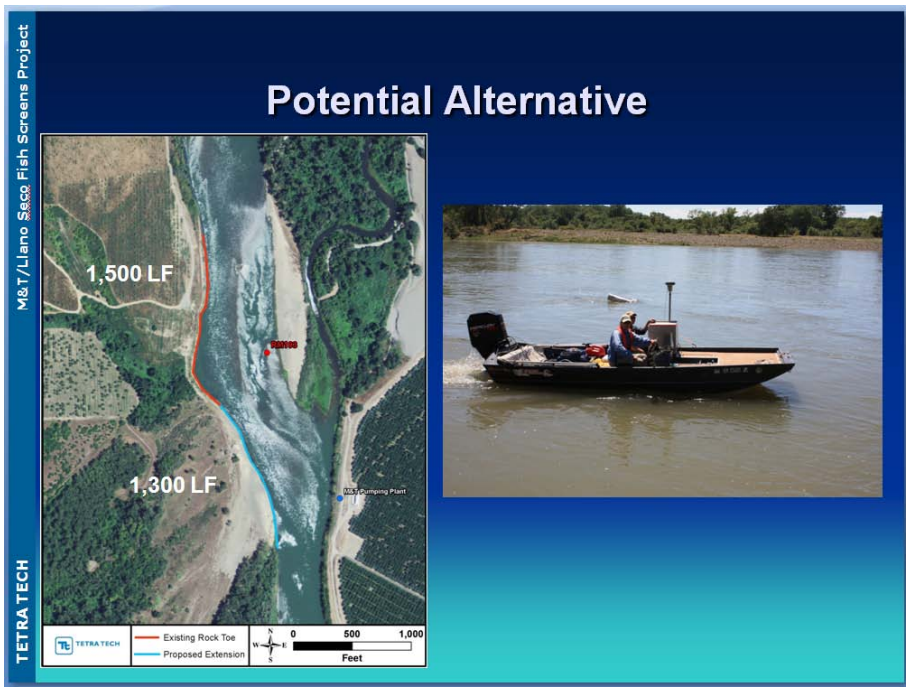
Over the time of the project, historical data were evaluated. Eric Larsen applied his meander model to this river reach to ascertain planform 50 years into the future with and without various controls that are in the reach. The problem is that there is a far field versus a near field issue that we are discussing at the moment and thus Larsen's model does not apply.

If the existing channel geometry is maintained, the bar appears to be stalled. During moderate flow years, the bar builds up and scours during high flow years. It is a near field as opposed to a far field issue. In the long term, if nothing is done, the river will widen out to the west and the bar will move down and everything will be high and dry.

The question is, how do we maintain both the pumps and the outfall?



This slide describes the Comparative Cross Sections in three sections downstream and upstream of the intake from 2005 to 2011. Black, vertical hatch mark is the location of the fish screens. Basically what you see is that the bed builds and scours back over time. This is the same as we saw with the planform geometry.



This slide shows the large gravel bar across from the fish screens. It is a high-flow pathway—flows come up out of the river at about 90,000 cfs and move off toward the south west. Pretty low velocities at that location. The flowst may transport sands and silts out of there, but it is not taking gravel. If you look at the site, it will need about 1,300 feet of toe rock revetment to stop the river expansion. The information suggests a possible fix. If we believe that there is self-cleaning environment it is a requirement to maintain the bankline and the geometry. In order to meet this need, it would require another 1,300 feet downstream extension of the toe rock protection. However, the same limitations would apply to the extension of the toe protection as the proposed spur dikes.

In order to verify our assumptions about the helical flow, data should be collected over a range of flows this winter.

To extend the toe protection will provide a factor of safety. If there is a self-cleaning mechanism in the river with the current configuration, then it really depends on keeping the current geometry. The extension of the toe protection is a factor of safety and would eliminate a significant risk if the 1,300 foot bankline retreated.

There has been some erosion downstream of the toe protection, however, there have only been low flows. Part of the bank has laid back and it's difficult to tell the extent of the erosion. Traverses have been run along the crest of the bank protection and seems to be more or less in the same place. The toe can shift.

It is not an either or proposition to have the west bank held in place, the risk is far too high not to maintain the bank.

If the approach geometry is the same, the strength of the cell is still there. During low flows, not sure if a dredge would be required. A decision was made not to dredge this year based on the data collection. It does appear, that even during the buildup in 2010, a dredge was not necessary. There has been a historical trend of a buildup of sedimentation and the project anticipated a dredge.

Yantao: The alternative hypothesis could be that during a high flow year, sediment is deposited at the upstream end and erosion occurs downstream and essentially would have some kind of feedback. Wonder if we want to do an exercise to calculate a bigger area?

Mike Harvey: You may be right, we're looking at a fairly long reach and there is no reason that an expansion zone will not induce deposition in time. It is still there. It's just we have not let it get any worse. The real question is if the current geometry is sufficient to stop the sedimentation from moving through. Or, it builds up during the lower flows and peak flow years scours out.

We don't know the answer to how much sedimentation will accumulate over a range of low-flow years. The 104,000 cfs river flow of last year seems to have stalled the bar out, and actually scoured out somewhat. But what happens in those intermediate flow years, will the bar continue to progress downstream at intermediate flows levels when there is enough energy to mobilize the gravel upstream but it is not really cranking like it was last year. That's the big question. It may be at really high flows, there is a tendency to scour the area out and the bar doesn't build downstream, but maybe in the middle range of 70,000 cfs or something it does come downstream far enough even with the current geometry. There is simply not an answer.

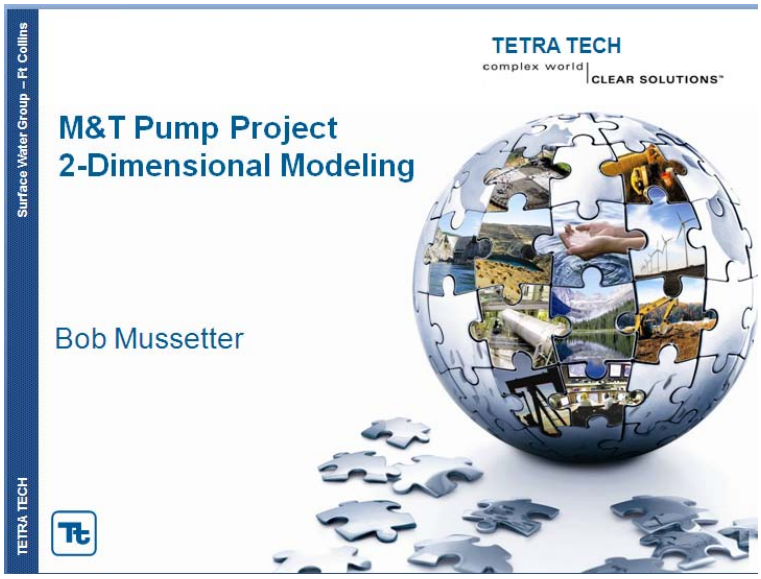
Over the next year it would be important to collect data. If it cannot be demonstrated from the data collection that there is a helical cell we will probably have to abandon the idea.

There is uncertainty regarding the stages of flows that the helical cell builds and if there will be a wide range of flows during the winter to capture the right information. The 2-D model may be used to look at the vectors at least in a 2-dimensional field.

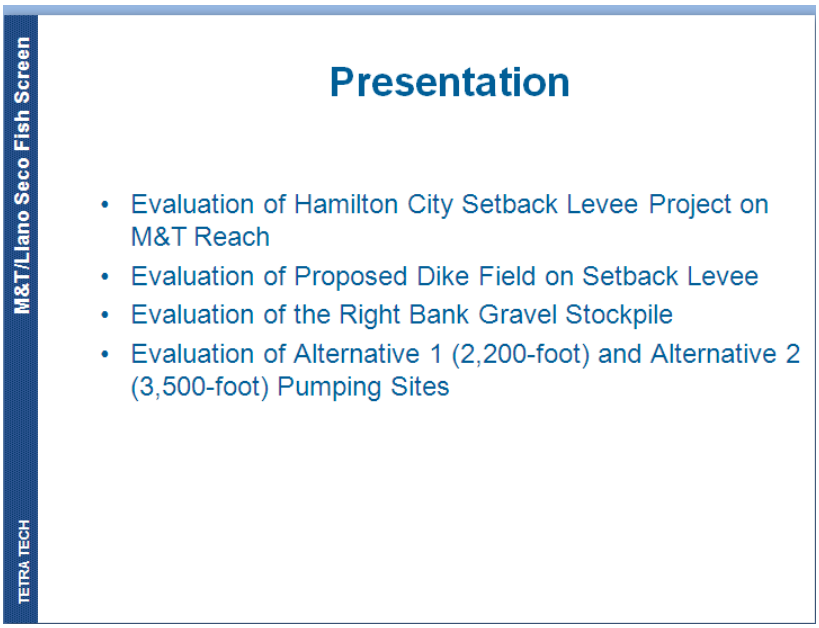
There is a feeling that the helical cell will not change at higher flows that go over bank. The problem is the 2-D model is two dimensional and this is a three dimensional question.

TECHNICAL ANALYSIS

Two-dimensional Model Report / J-Levee Impact Report
Bob Mussetter, Principal, Tetra Tech



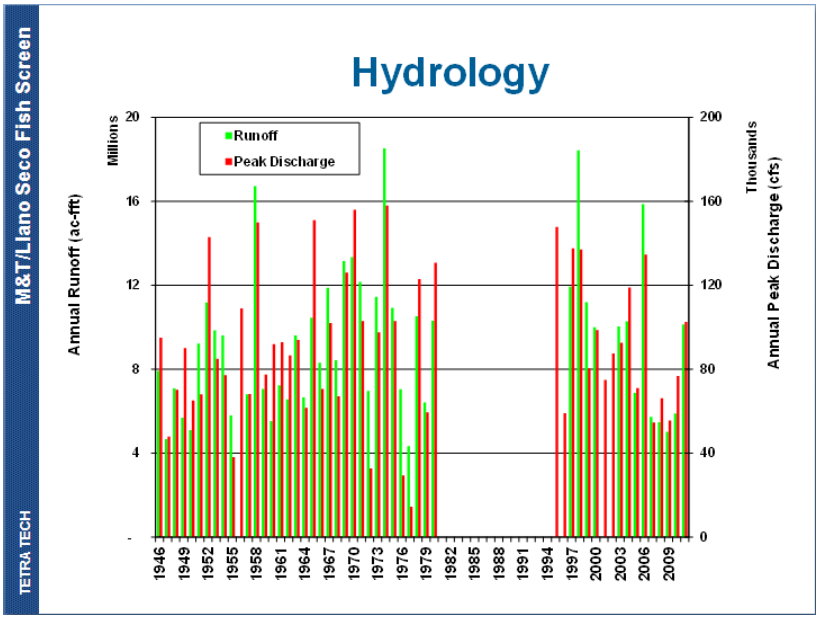
Bob Mussetter, Principal, Tetra Tech, presented the information regarding the Two-dimensional Model Report and the J-Levee Report.



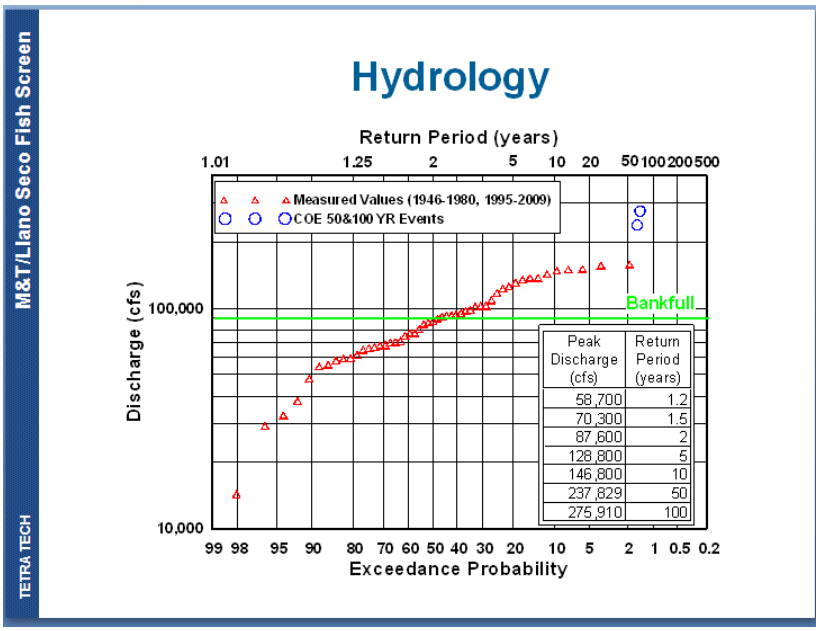
The following specific issues have been evaluated regarding the project with the 2-Dimensional model: (1) the question whether the M&T/Llano Seco Project could have an impact on the Hamilton City J-Levee Project; or, (2) whether the Hamilton City Levee changes will impact the M&T/Llano Seco Project. The U. S. Army Corps of Engineers (ACOE) model has been incorporated into the 2-D model and some runs have been made to evaluate that question. As part of that evaluation, we incorporated the 9-dike alternative into that model. We ran the model for existing conditions with and without the J-Levee Project and incorporated the 9-dike alternative to see if there were any changes.

We also thought about the question whether, if the dredging operation is continued and the spoiled material were to be put on the gravel bar located on the Shaw property with the TNC easement, if it were placed in a way that it would re-entrain and continue to resupply gravel to the river rather than just remove it from the river. So we put some simulated gravel piles in the model and looked at the possibilities of entraining that material.

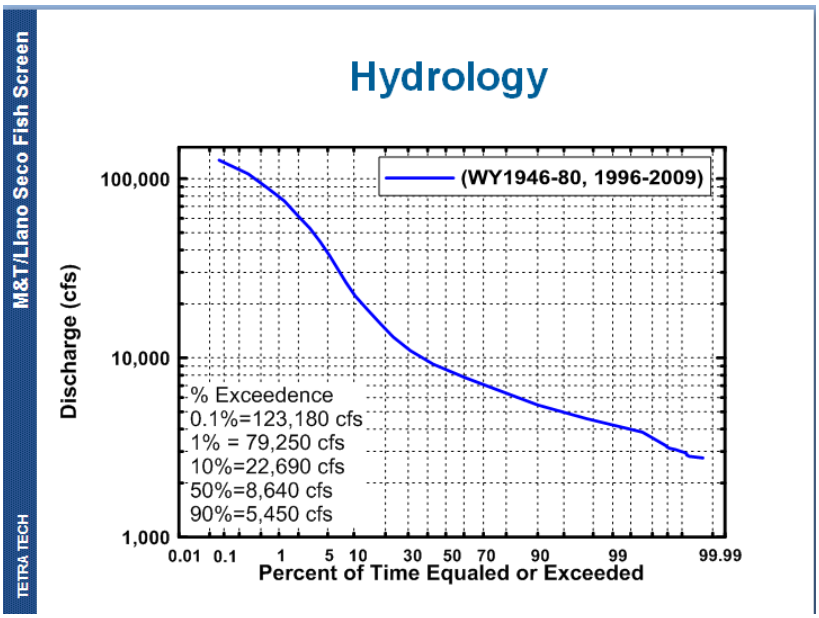
We also did some more detailed evaluation of the hydraulic conditions at the two alternate pump relocation sites to use the information for preliminary design and costs.



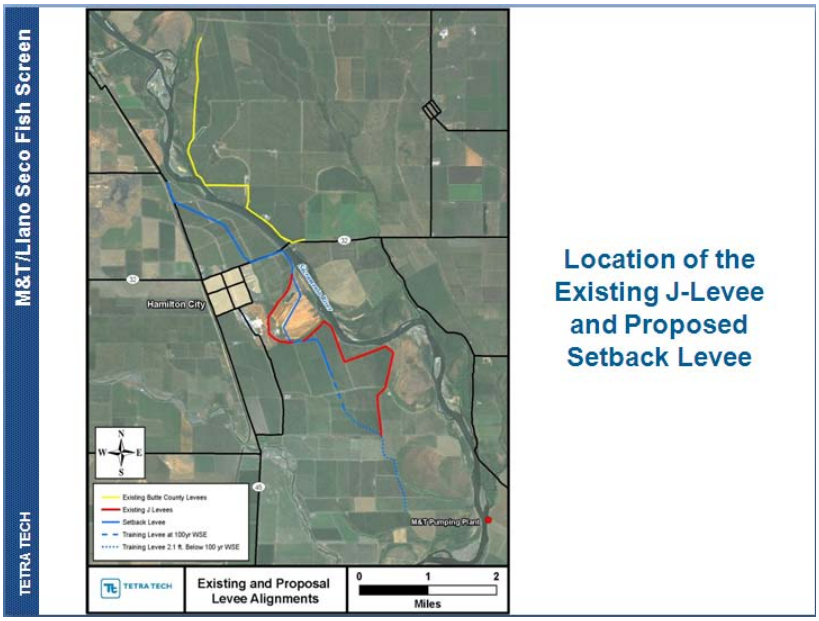
In terms of the hydrology, we have gone from 2006 when we had a big water year and some fairly high-peak flows to a fairly dry period. Last year we had a peak flow that was over 100,000 cfs.



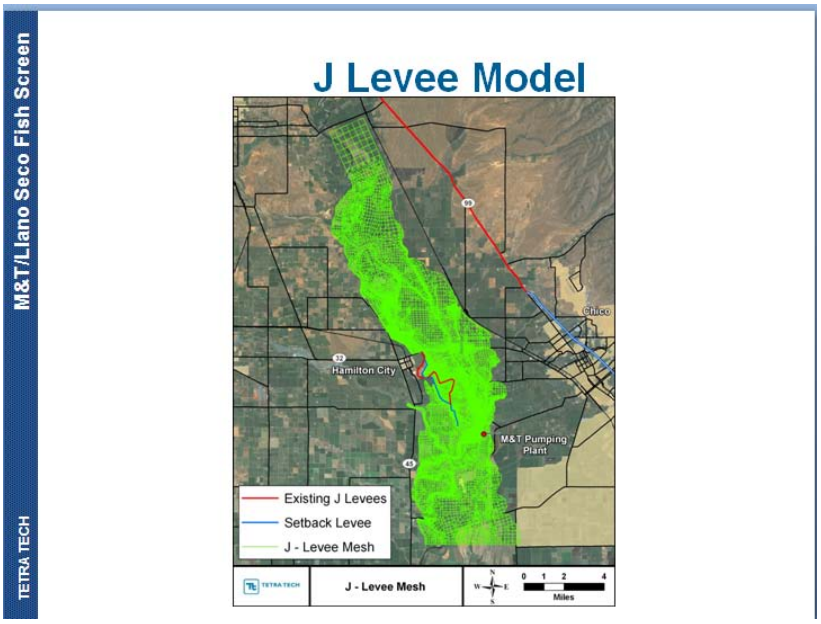
The flood frequency analysis shows that the 2-year flow is still in the 90,000 cfs range which is consistent with bankfull discharge rate in this reach. And the 50 & 100 year flows are in the range of 280,000 to 290,000 cfs.



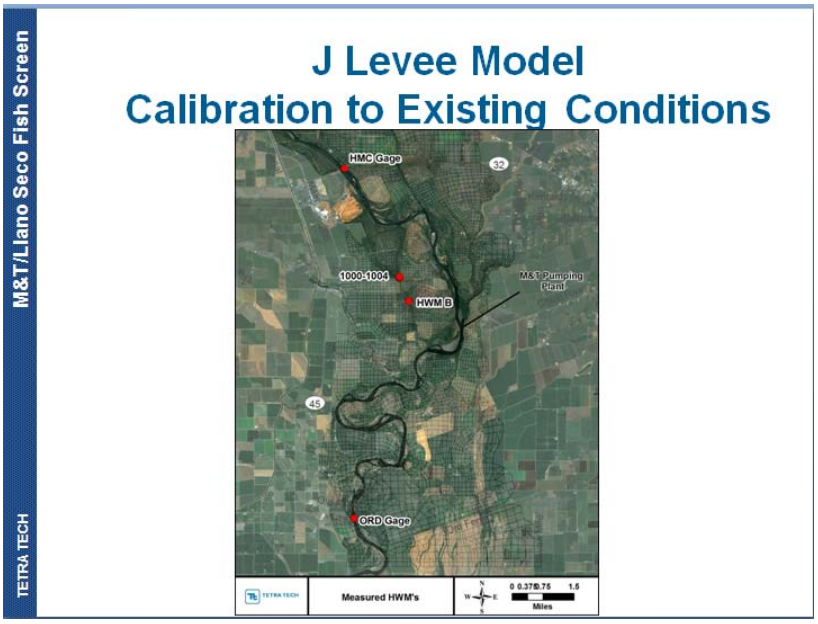
The 50- and 100-year flows are the flows there were evaluated to see whether there were impacts from the J-Levee Project on our site and vice versa. At lower flows there will not be an effect on the hydraulic conditions.



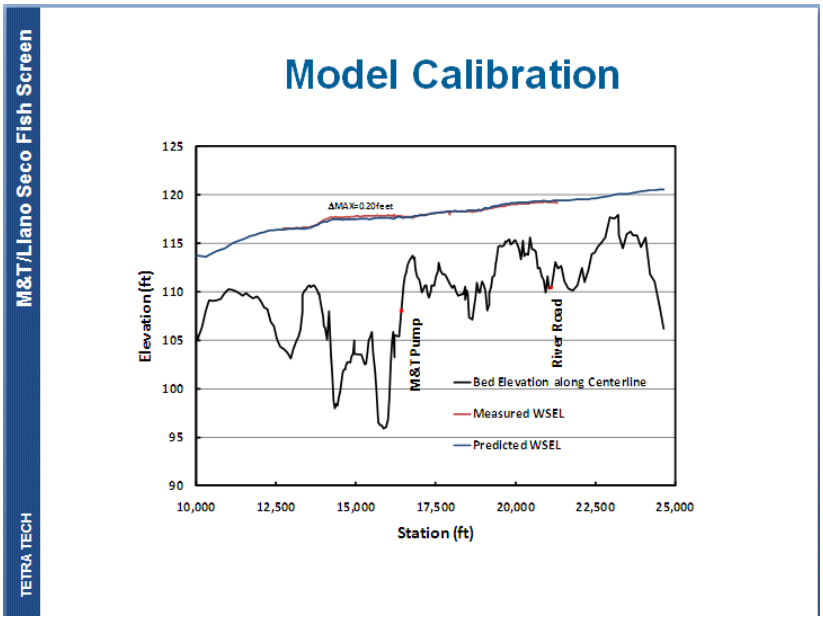
This slide shows the red line as the existing levee-proposed setback levee. The proposed project is to set the existing levee back which is shown by the blue line. The coarse dashed line will be a levee constructed to withstand a 100-year flow. It would be tapered down as it goes downstream so that it becomes about 2-feet below the 100-year flow as it approaches the area of the pumping plant.



The ACOE has done a study of the J-Levee Project and used a 2-D model to conduct the evaluation. This model was obtained from the ACOE, however, we were not able to make that model run. We were not able to get from the ACOE the output files or any of their spin-down files. In lieu of that data, we converted the ACOE model over into the SRH 2-D format, which is a U.S. Bureau of Reclamation model, which we have been using over the last four to five years. It is a more robust model and easier to use. This slide is the image of the resulting model grid.



An essential part of the study was to make sure that the model was calibrated to known water surfaces to make sure that our version of the model was actually representing reality. And secondly, we wanted to compare back to the ACOE model to determine if there were any differences between the models.



This slide shows the simple calibration file at the 100-year peak. The red line is the measured water surface elevation. The blue line is the predicted value for the model. Maximum difference is about 2/10ths of a foot.

M&T/Llano Seco Fish Screen

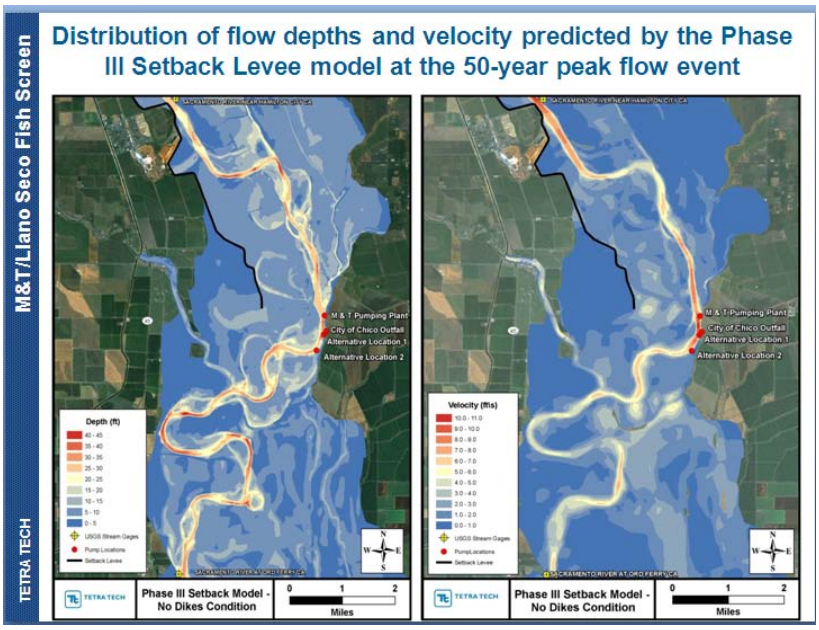
TETRA TECH

J Levee Model Calibration to Existing Conditions

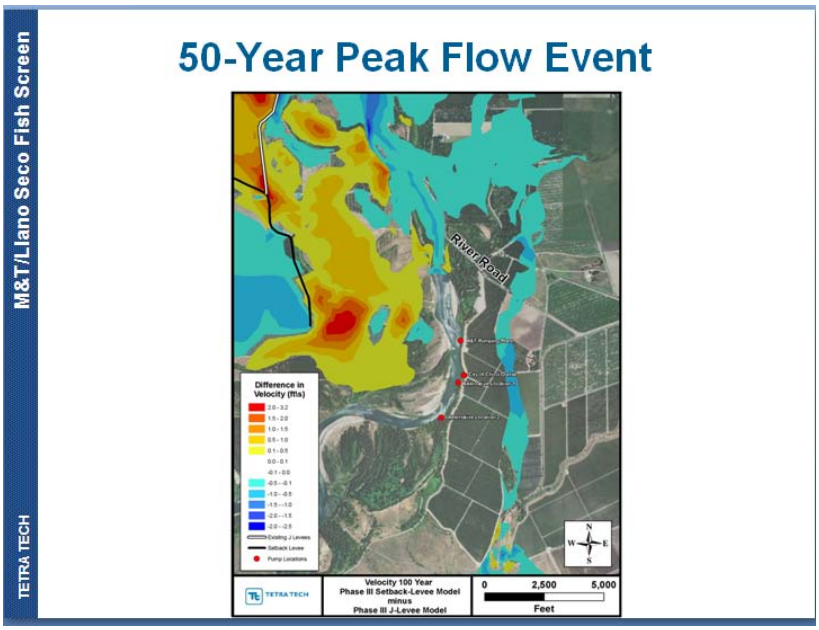
Location	Measured	J Levee Model (RMA-2V) Model	J Levee Model (RMA-2V) Difference		Updated Model (SRH-2D) Model	Updated Model (SRH-2D) Difference
January 1, 2006 flow event (134,638 cfs)						
HMC Gage	146.84	146.27	-0.57		145.78	-1.09
ORD Gage	115.24	116.54	1.30		115.84	0.60
1000	134.40	134.60	0.20		134.25	-0.2
1001	134.20	134.60	0.40		134.25	0.1
1002	134.20	134.70	0.50		134.25	0.1
1003	134.20	134.70	0.50		134.46	0.3
1004	134.20	134.80	0.60		134.46	0.3
December 29, 2005 flow event (109,322 cfs)						
HMC Gage	144.05	145.10	1.05		144.75	0.7
ORD Gage	113.19	115.60	2.41		115.84	1.9
HWM B	131.95	132.50	0.55		132.12	0.3

Modified from J-Levee Report (2008)

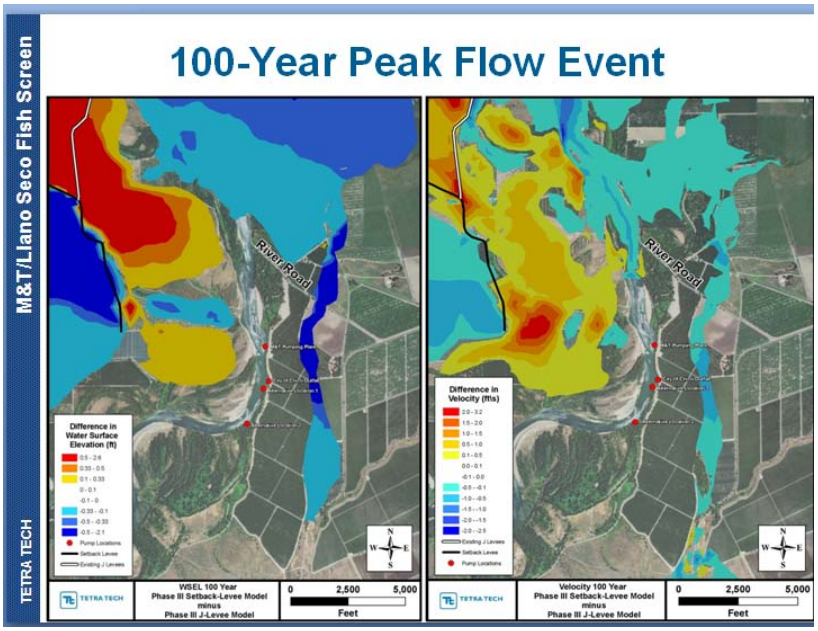
The interesting point is that, when you compare back to the ACOE model, the average difference in ACOE model is at the high water mark that the ACOE uses to calibrate to in the range of ½ foot or more. Bottom line is that we feel we have a model that is very representative of what is out there.



The model gives us depths and velocity vectors over the whole area. This slide is just a color gradient plot. The red colors are deeper so that top is 40 to 45 ft. The blue colors are shallow and the dark blue is less than five feet. The left side is the depth pattern through that area with the proposed J-Levee in place. The right is the velocity. Again, low velocities are blue and high velocities are red. The highest is 11 feet/second.



This slide is the result of the 50-year flood and identifies the differences in velocity between the existing J levee and the modified levee

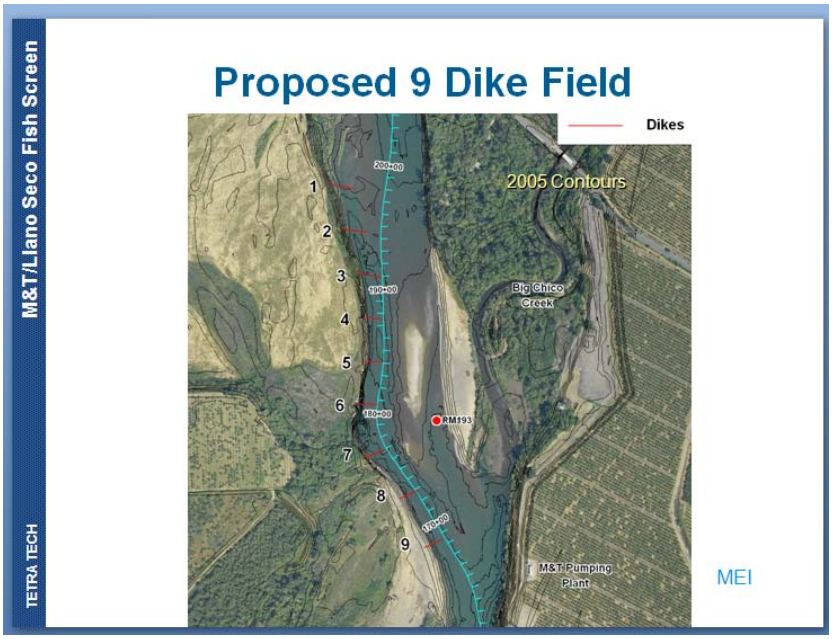


This slide is the results of the 100-year flood. It is difficult to evaluate the figures alone. We evaluated by comparing the two and taking the difference—with the J-Levee model and the existing conditions model to see how the velocities and depths will change over the whole model grid and to see whether or not those changes propagate down into the M&T project site. The fairly significant difference is in the vicinity of the levees in the west overbank area.

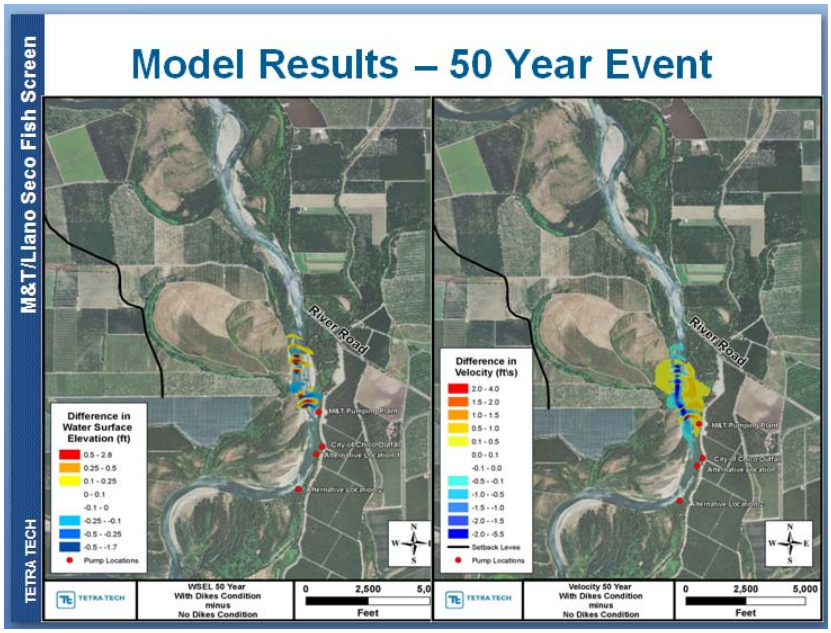
When you look down into the channel in the area we are concerned about, there is no difference in hydraulics. Bottom line is the J-Levee Project has no impact on the M&T project site. Some changes do occur out in the fringes of the flood plain. Out in the middle through the river is essentially the same.

The left side of the slide is the difference in water surface elevation between the existing conditions and the proposed J-Levee. The dikes are not in these versions of the models. The right illustration is the differences in velocities.

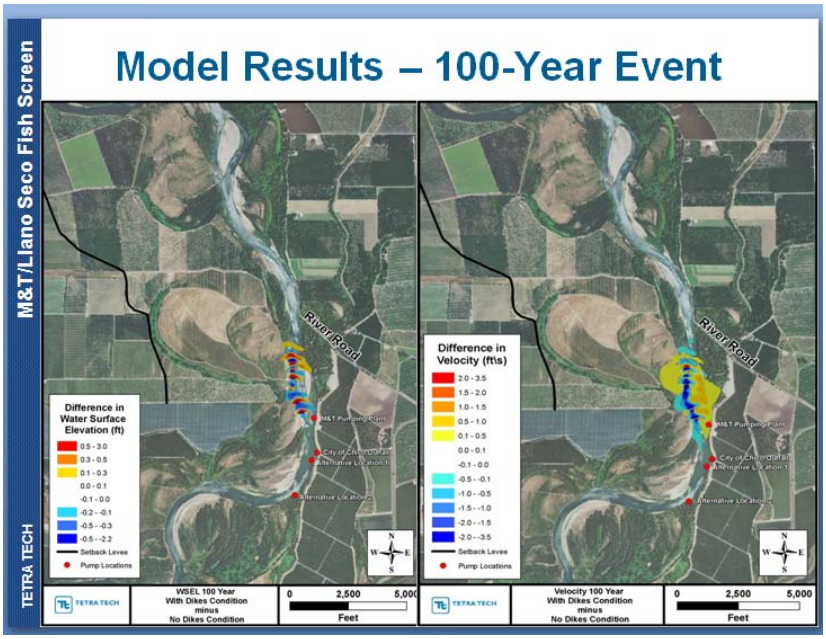
The dark blue is ½ foot to 2 feet lower under J-Levee conditions. The red is ½ foot to 2 ½ feet higher. On the other side, the velocities are 2 to 2 ½ feet per second, slower under failing conditions, 2 to 3 feet higher.
Modeling was also used to determine if there were any changes in the area; and, if the 9-dike version of the project would propagate any changes up into the J-Levee project.



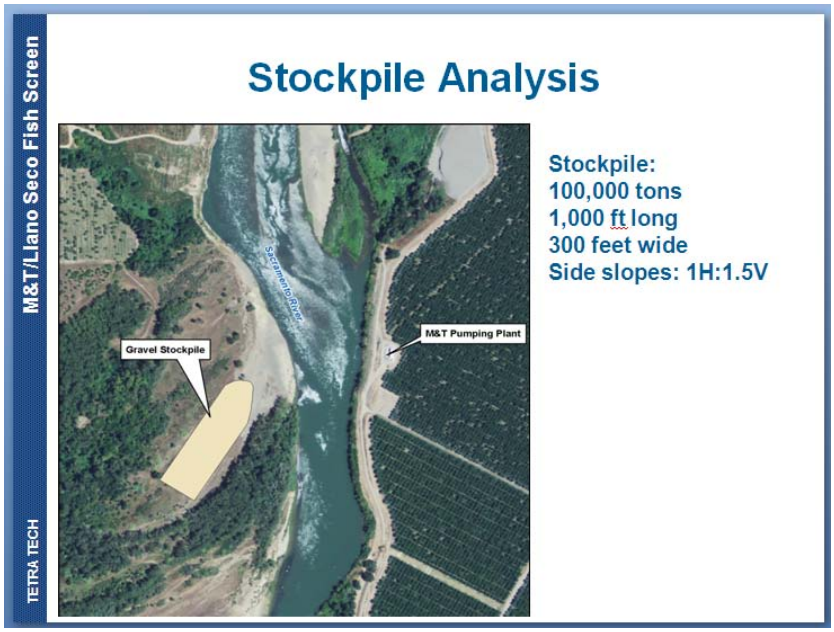
This slide illustrates the 9-dike configuration with the red lines.



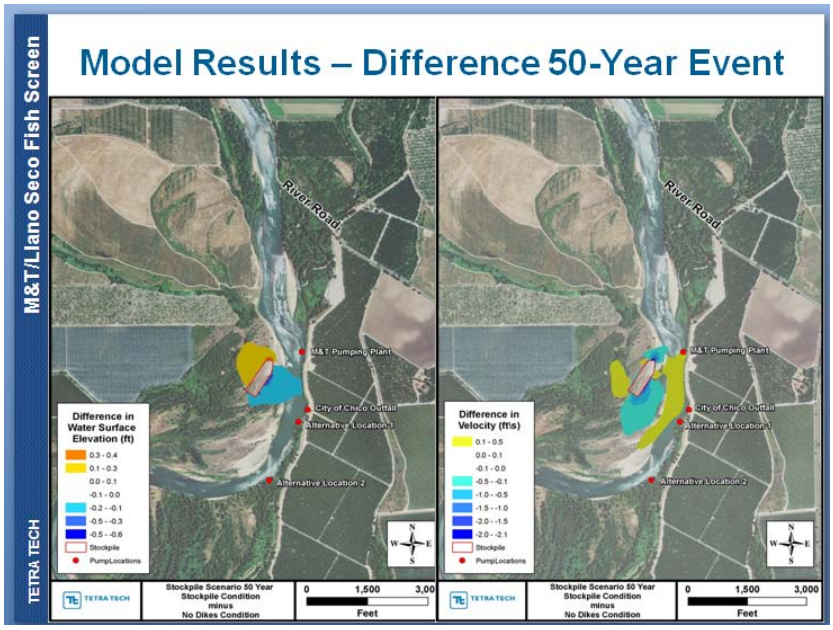
This slide shows the differences with dikes and without dikes down in the channel. You see at the 50-year event all the differences are clustered in and around where the dikes are in place. Dark blue is reducing the water surface elevation by ½ to 2 feet. And the red is ½ foot to 3 feet higher. Red is raising the water surface and blue is lowering the water surface. All local affects. Nothing out in the area of the J-Levee project and the velocities are the same pattern as locally around the project site. You do see the increased velocities associated with the 9-dike system around the pumping plant.



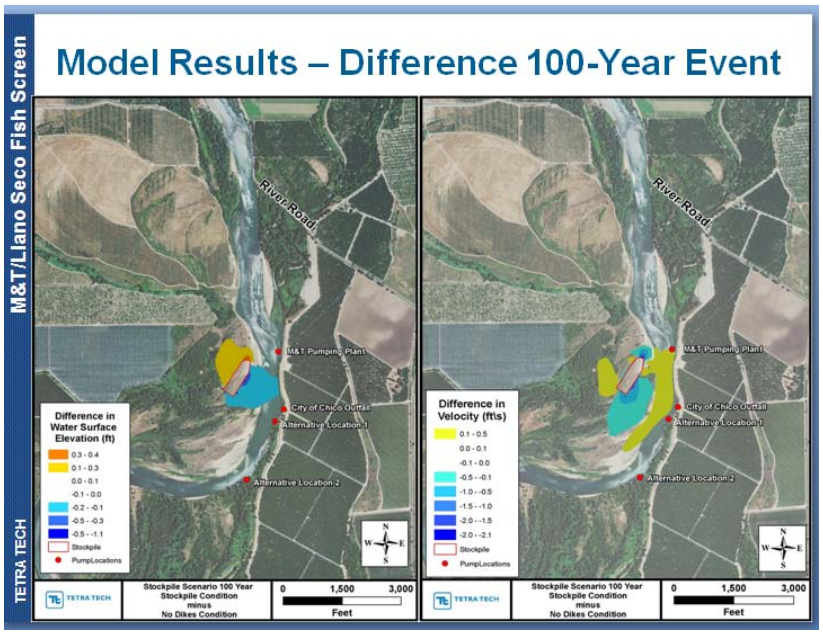
This slide is the 100-year results. This seems to indicate that same results. The results show that the J-Levee is no problem for the M&T project.



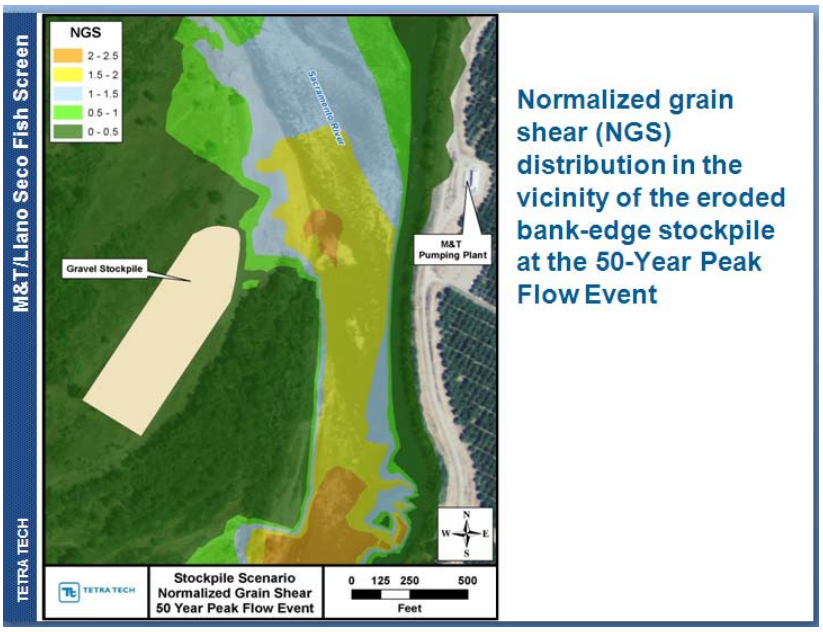
The next question is placing the stockpile on the gravel bar downstream in the river opposite the pumping plant.



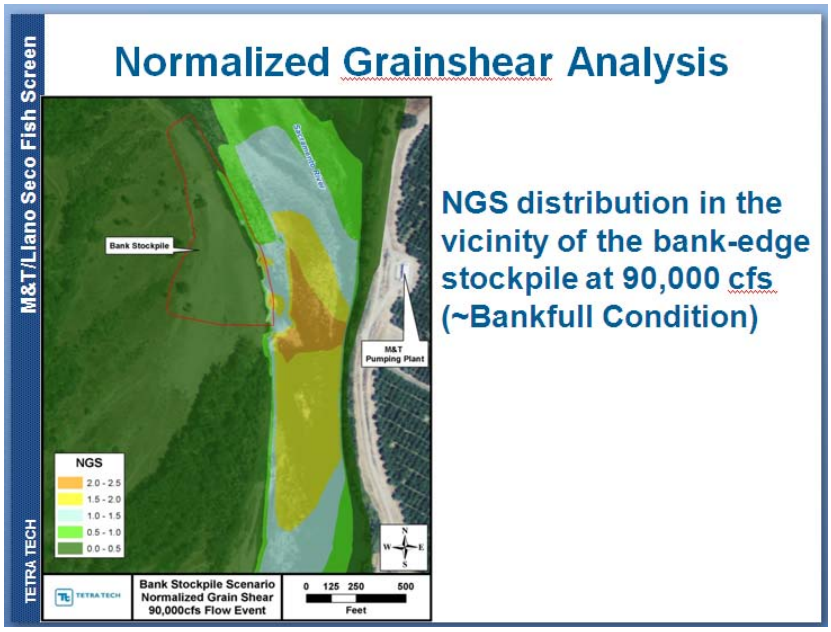
A couple of different versions were investigated. Initially, we looked at putting a 1,000 foot long by 100 yard wide pile of gravel, approximately 100,000 tons of material, more or less consistent with the two sedimentation removal efforts with side slopes of 1 : 1.5. The model was run with that sort of encroachment in the system. Looking at the differences and current hydraulics between having no stockpile located there and not having the stockpile (left side is the water surface), it tends to raise the water surface by a few tenths on the upstream side of the stockpile and there is a bit of a drawn-down effect on the downstream side because of contractions. That causes velocities in the channel to go up by a few tenths. In the shadow of the stockpile, there is an eddy at much lower velocities.



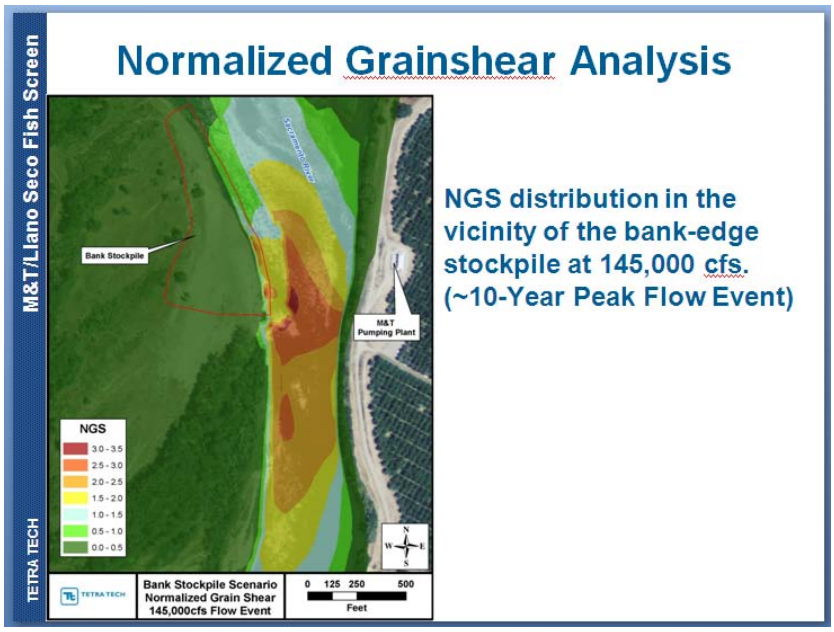
The impacts on the river channel at the 50-year event and the 100-year event are very similar.



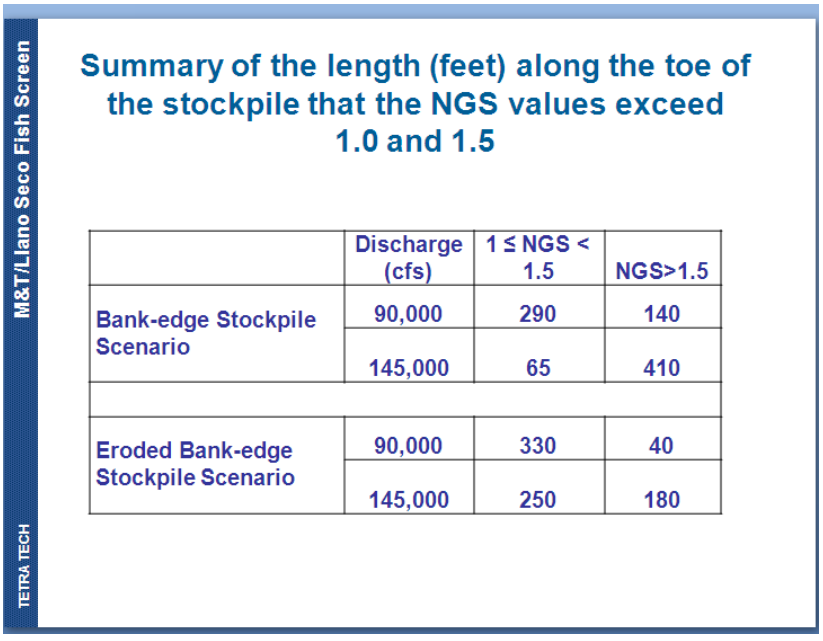
This slide looks at the shear stress--the ability of the water to move the gravel. We are plotting the normalized grain shear. It means that if the value is 1, there is enough energy there to just barely start to move the rocks. If there is more than 1, there is more of a tendency to move the gravels. If it is below 1, then it is basically stable.



At the 50-year peak, it is up to the 1.5 to 2.0 range and the gravel can be moved through that area. But out around the nose of the stockpile at the initial site, there is a little bit of mobilization out on the edge of the bar. However, it is not high enough. With this configuration, even in a 50-year flood, there is not enough energy to take very much of the gravel away (approximately 45 millimeters in size). The stockpile would never be topped. The idea is to let the river chew into the side of the stockpile.



Since the configuration would not work as hoped, a more radical approach would be to push it out into the channel so that the edge of the stockpile is about 1 foot to 1 ½ feet below the bankfull flow, so that normal flows will attack the edges of the stockpile allowing it to undercut and allowing the material to entrain back into the river. The red outline indicates the stockpile location with approximately 110,000 yards. What you see is the upstream portion is inundated but it is not generating enough energy to entrain the stockpile. When you get down towards the lower end, there are spots where you get enough energy to erode the edge of the stockpile at bankfull discharge.

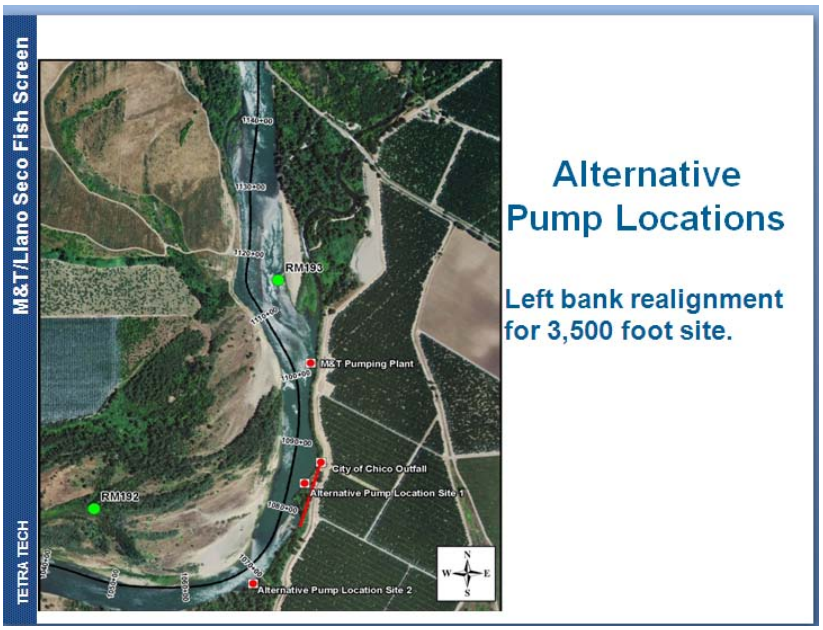


	Discharge (cfs)	1 ≤ NGS < 1.5	NGS>1.5
Bank-edge Stockpile Scenario	90,000	290	140
	145,000	65	410
Eroded Bank-edge Stockpile Scenario	90,000	330	40
	145,000	250	180

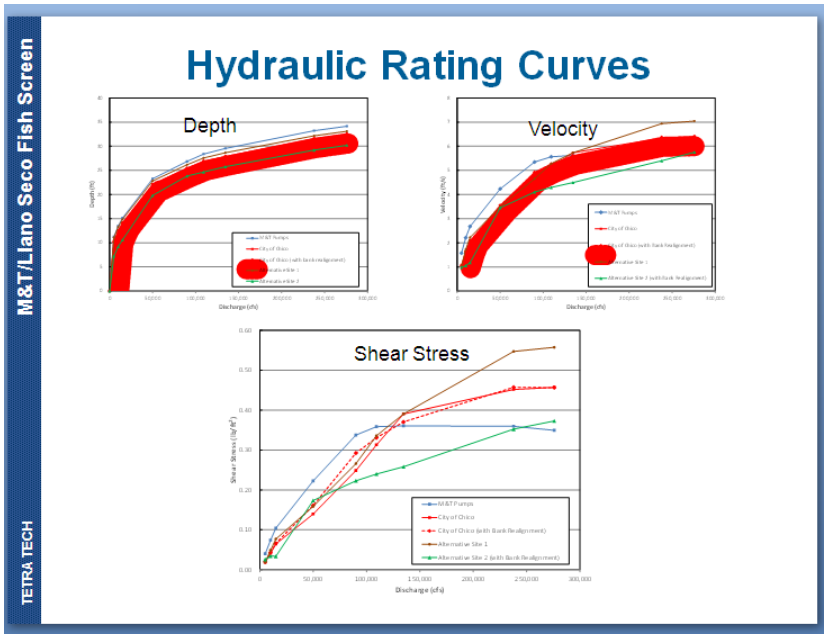
This is a breakdown of the grain sheer in two parts between 1 and 1.5 there is a bit of transport rock rolling out once in a while but it is not significantly eroding. When it reaches above 1.5, you can assume that it becomes continuous transport. Along the edge of the pile, there is roughly 300 feet that is the transition zone and only about 140 feet that is up in the area where you would like to see substantial erosion. If we push it out farther, it raises to a little over 300 feet. The problem is that the edge of the does not have to erode very far back onto the bar before that all goes away and it's right back where it started. Unless there is some intervention to push the gravel into the river during high flows, this not

going to get the gravel where it needs to be in terms of entraining the gravels back into the system. There not enough energy out on the edge of the bar to get it entrained.

This modeling is based on the current configuration of the river. The existing main gravel bar is continuing to build in the downstream direction. As it does that, it continues to put pressure on both banks, except the left bank is hard so it pushes it to the right and that allows the bar to keep moving downstream. If we can hold it where it is now, you can stall the bar out and not have worry about the gravel bar continuing to progress down the river. If nothing is done in this area, the pressure will just keep increasing and eventually will erode out into the bar.



We have done the modeling to develop the hydraulic conditions down at the two alternate pumping sites. One of the alternatives is within a rocked bank and would not have to be redone for that alternative except for on the edge. The 3,500 foot relocation site is down in the bend, and in order to make that alternative work, we would have to realign the bank and extend the rock farther downstream. In the versions of the model where we are looking at the alternative site 1 (2,200 ft relocation), we used existing river configuration, and in the versions that we used to evaluate the second alternative, we assumed that the bank would be realigned to be more consistent with the main alignment with the outside of the bend.



This slide shows the model results in depth, velocity and shear stress in rating curves at the M&T/Llano Seco pump location and the City of Chico's outfall both with and without the bankline realignment for the Alternative Sites 1 and 2. This information has been provided to MWH to determine feasibility of pumping and costs. There are some aspects of behaviors of these curves that are interesting from a transport point of view where they start to flatten off with discharge. The discharges are on the bottom and have to do with the channel geometry and bankfull depth.

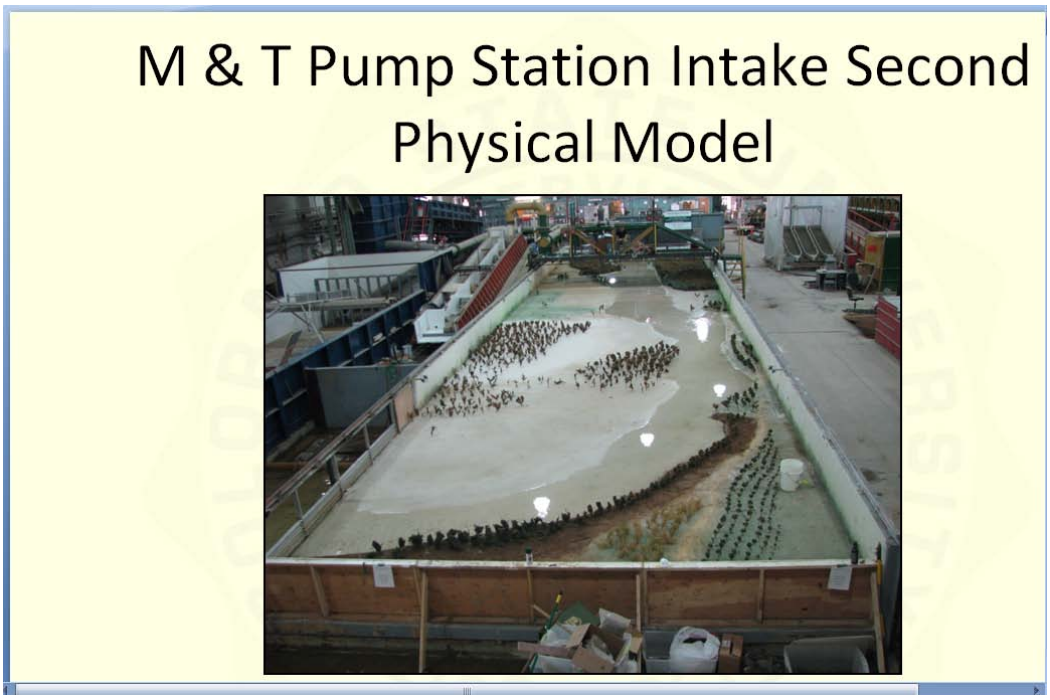
Conclusions: J-Levee does not have any impact on the project or the project does not have an impact on the J-Levee even with the 9-dike configuration. The gravel pile on the Shaw Property will not entrain into the river unless the material can be pushed into the river.

Physical Model

Mike Harvey, Principal, Tetra Tech

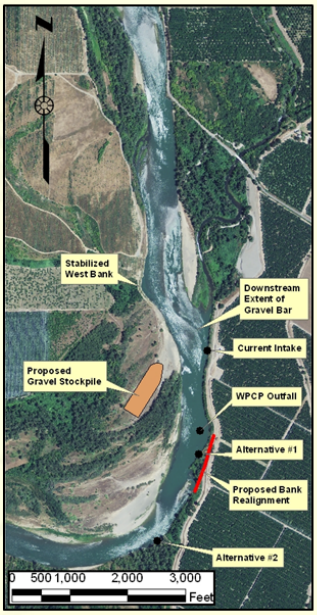
2,200 ft relocation - 3,500 ft relocation

Spoils placement on West Bank



Introduction

- Since prior 2007 testing, bar migration and sedimentation at the current pump intake has continued
- TetraTech, Inc., working in coordination with Ducks Unlimited, Inc., funded a second physical model study in 2010
- Evaluate hydraulic, morphologic, and sedimentation patterns near the following sites:
  1. Current pump intake location
  2. Proposed Alternative 1 site, ~2,200 ft downstream of the current pump-intake location
  3. Proposed Alternative 2 site, ~3,500 ft downstream of the current pump-intake location
- Three channel configurations:
  1. Current field conditions (Baseline)
  2. Gravel-stockpile on the west floodplain
  3. Realigned section of the east bank with revetment for Proposed Alternative 2 site



Locus map illustrating the study reach

02:48:41

Colorado State designed a physical model to evaluate the two relocation sites (2,200' and 3,500') and also evaluated the spoil pile on the west side of the bank. The red section in the photo is where the bank would have to be realigned for a relocation site.

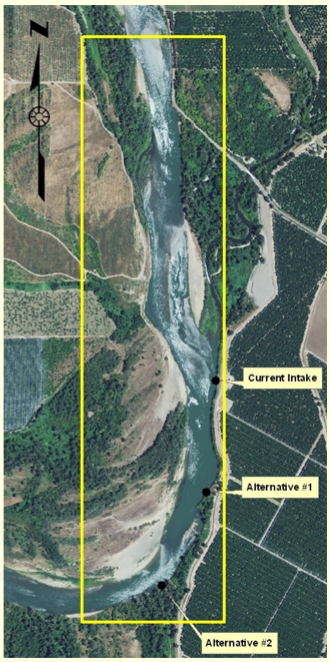
Physical Model

- 10,300-ft reach of the Sacramento River
- 1:100 Undistorted Froude-scale
- Sediment Scaling
  - Ratio of Shields parameter to critical Shields parameter
  - Ratio of flow velocity to critical flow velocity
  - Rouse number
- Scaled sediment sizing for mobile material within the channel
  - Model bed material d_{50} = 0.15 mm
  - Prototype bed material d_{50} = 40 mm
- 3 scaled discharges evaluated:
  - 145,000-cfs (10-yr recurrence interval flow)
  - 90,000-cfs (bankfull discharge)
  - 10,000-cfs (50% exceedance flow)

Variable	Symbol	Dimension	Similitude Relationship
Length	L	L	$L_p = 100 \cdot L_m$
Time	T	T	$T_p = 10 \cdot T_m$
Velocity	V	L/T	$V_p = 10 \cdot V_m$
Shear Stress	τ	M/LT^2	$\tau_p = 100 \cdot \tau_m$
Discharge	Q	L^3/T	$Q_p = 100{,}000 \cdot Q_m$
Unit Discharge	q	L^3/T	$L_p = 1{,}000 \cdot L_m$

Note: Subscripts m and p denote model and prototype, respectively

Froude-scale conversions



Model extents identified on aerial photograph of the Sacramento River

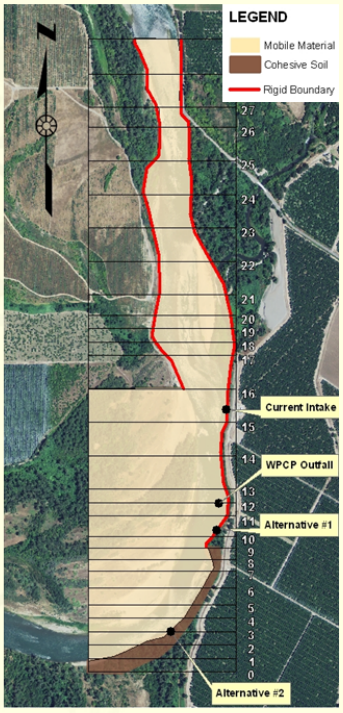
All the scale factors are the same that were used on the initial modeling. Same range of flows 145,000, 90,000 to 10,000 are the same range of as were used on the first physical model and the numerical model.

Physical Model

Model construction started in the summer of 2010:

- 30 E-W soil-cement cross sections
- 1 N-S cross-section defining the downstream boundary
- Very fine sand material to model bed and floodplain sediment
- Cohesive soil to model cohesive stream banks along downstream east bank
- Mesh baffle to provide uniform flow entrance conditions
- Downstream gate to control backwater
- Sediment feed upstream of the test reach
- Installation of artificial trees and canopy

Summary of Variables			
Variable		Prototype	Model
Hydraulic			
	Elevation, Length	110 ft	1.10 ft
	Flow Depth	25.0 ft	0.25 ft
	Discharge	145,000 cfs	1.45 cfs
	Flow Velocity	6.0 ft/s	0.6 ft/s
	Shear Stress	2.0 psf	0.02 psf
Sediment			
	Sediment d_{50}	40 mm	0.15 mm
	Time	22.9 hr	1 hr



Identified Sediment Locations

The first model constructed in 2007 was limited and had to be extended (rebuilt) for the 2010 investigations. It required knocking the model down and rebuilding the model to accommodate the two relocation sites.

Test Matrix

- Baseline
  - 10,000 cfs (8.5 hrs)
  - 90,000 cfs (143 hrs)
  - 145,000 cfs (7.5 hrs)
- Gravel Stockpile
  - 145,000 cfs (7.5 hrs)
- Realigned Bank
  - 10,000 cfs (4 hrs)
  - 90,000 cfs (148 hrs)
  - 145,000 cfs Test 1 (8 hrs)
  - 145,000 cfs Test 2 (8 hrs)
    - bed reset to original realigned-bank elevations between Test 1 and Test 2
  - 145,000 cfs Test 3 (8 hrs)
    - Bed elevations not reset between Test 2 and Test 3 resulting in 16 total hours of 145,000-cfs testing

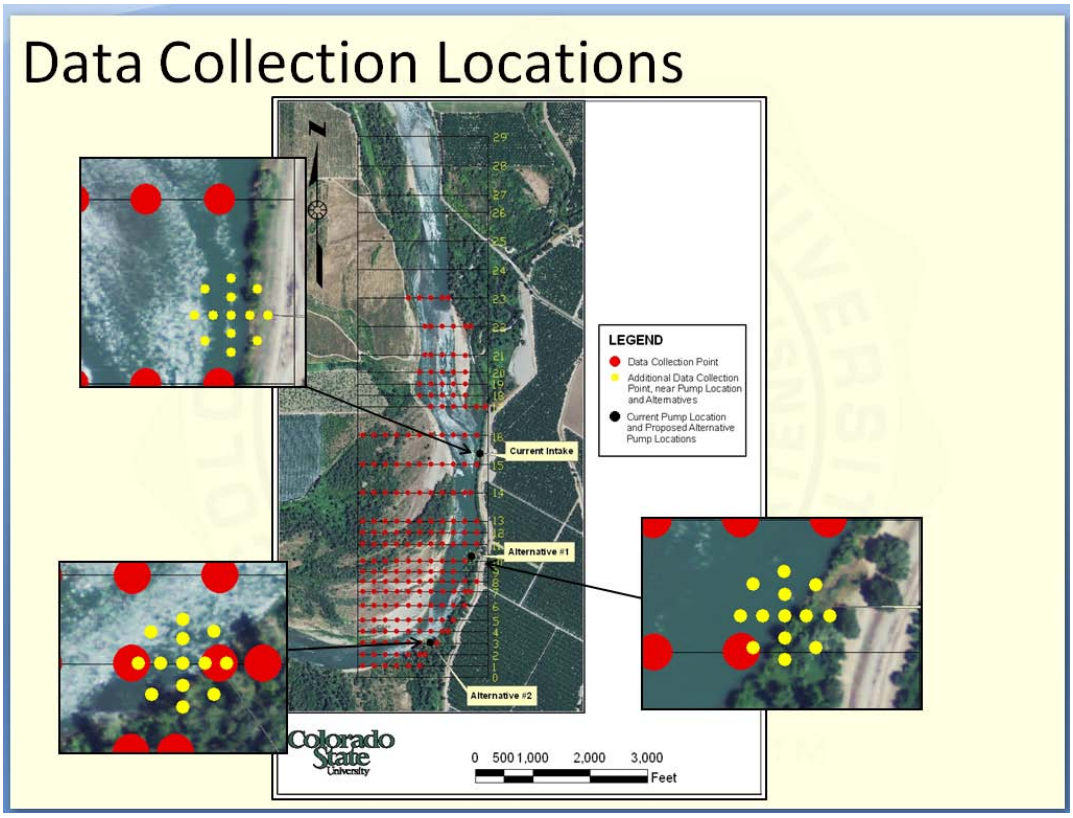
The slide shows what the model looked like after the reconstruction. 2010 topography and bathymetric survey was used in the model to represent the 2010 condition. The mobile sediment was put in and the model was run for a period of time to adjust the model to existing conditions.

Typical Testing Program

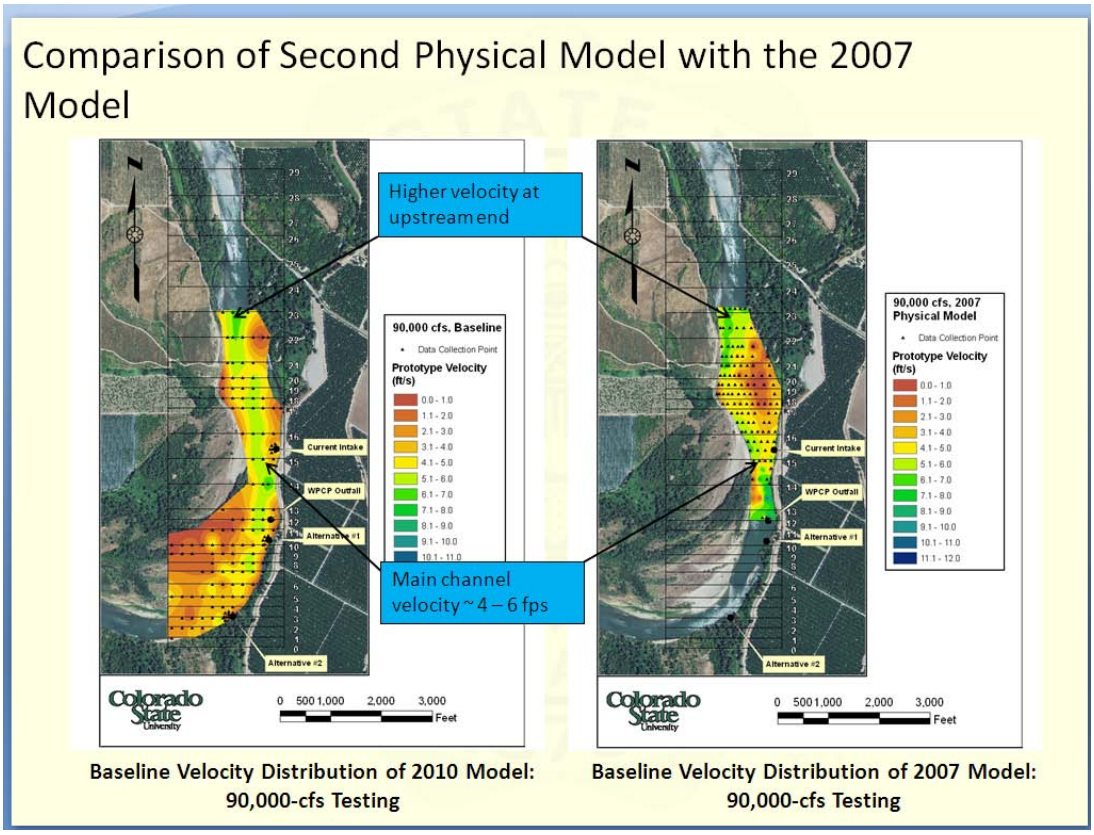
- Testing program:
  - Measure bed elevation before testing
  - Establish model discharge and backwater
  - "Begin" testing
    - Measure flow velocities
    - 10,000-cfs testing for ~8-hours
    - 90,000-cfs testing for ~140-hours
    - 145,000-cfs testing for ~8-hours
  - Slowly decrease the discharge and drain the model
  - Measure bed elevation after testing

10,000-cfs Baseline Testing

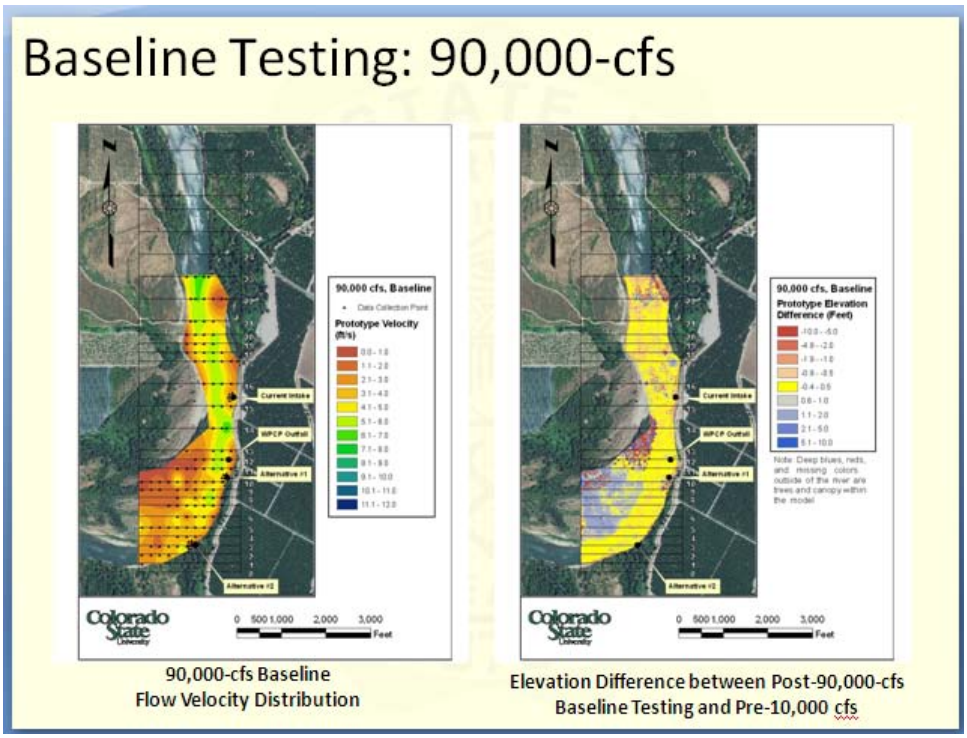
The model was run at 10,000 cfs (warm-up run) for about 8 hours. At 90,000 cfs for about 140 hours and 145,000 cfs for about 8 hours. Additional duration modeling at higher flows to really look at the impacts of the realignment that is required for Alternative 2 to see if there was an adverse impact on the City of Chico's outfall.



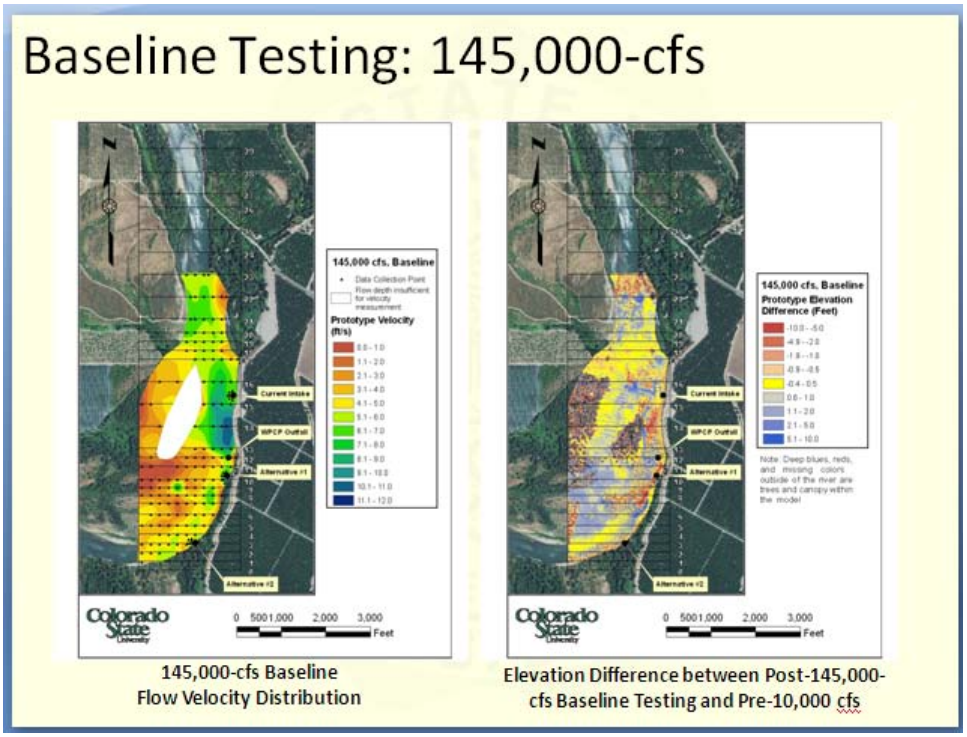
We ran the model and brought the flows down and used LiDAR to map the topography. During the flows at a number of locations, 2-dimensional velocity data and depth data was collected at the sites.



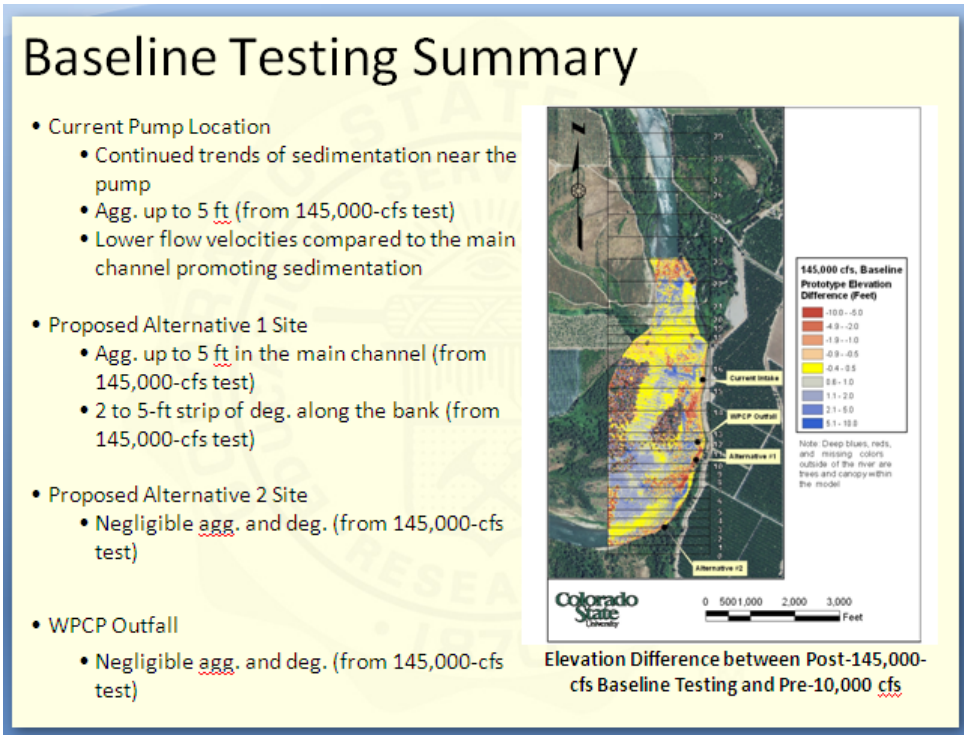
One thing that was determined was whether the model itself affects the results. We used a comparison between the initial 2007 model with the 2010 extended model so we would have reasonable confidence that the changes were not a result of the changes in the model. The upstream end of the model shows higher velocities, however, the core of the model shows the velocities are the same. It is believed that the results of the second model are not skewed by the physical changes to the model.



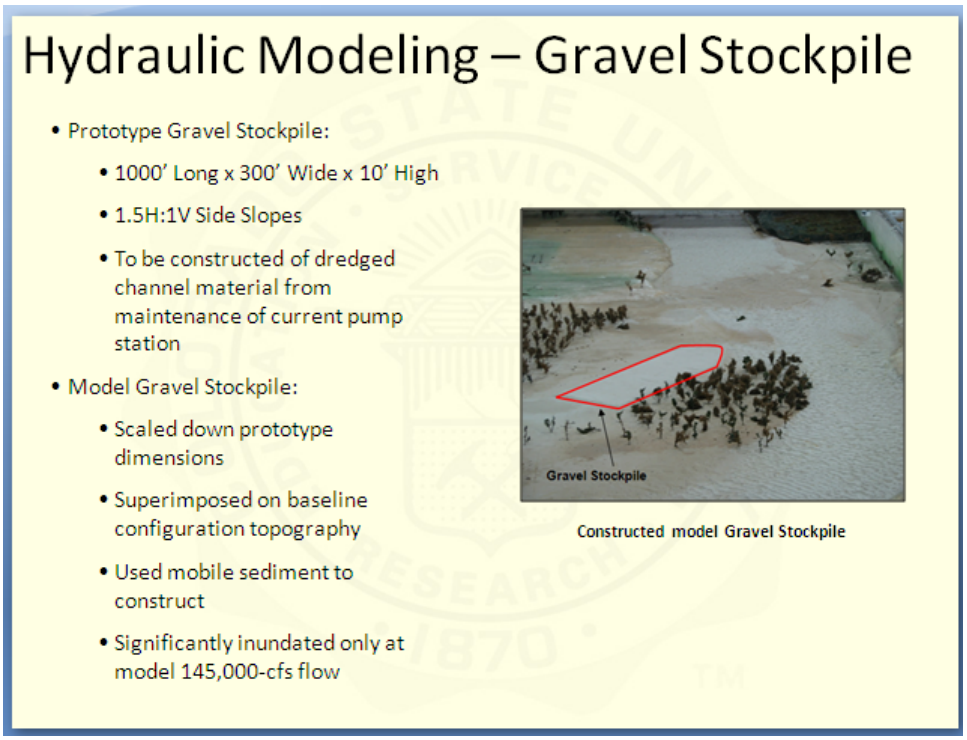
This slide shows the comparison of runs at 90,000 cfs (velocity patterns) and after the 90,000 cfs run, comparing to the 80,000 cfs warm-up. What is seen under these conditions is the red is aggradation and the blue is degradation. The model is showing some aggradation at 90,000 cfs.



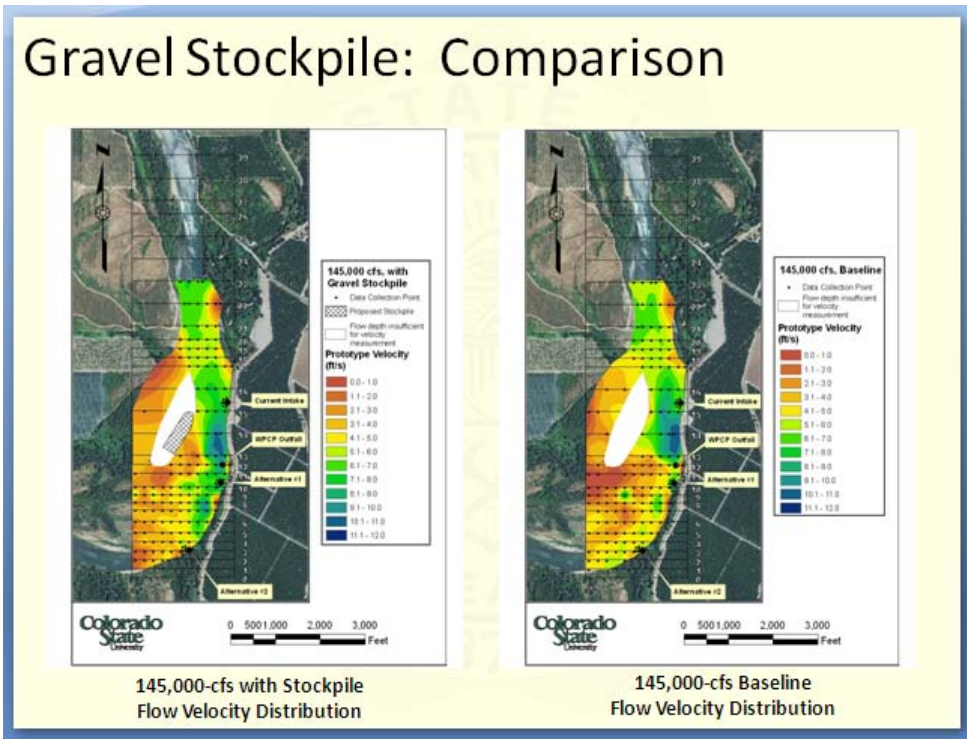
At 145,000 cfs, doing a similar comparison, we see more aggradation in the downstream area of the gravel bar which is what you would expect. Interestingly, what you also see is deposition down towards the outfall. And, we see some deposition downstream of Alternative 1 site. That correlates well with a large riffle that has developed at that site over time. It is a reasonable test that the physical model is reproducing a prototype.



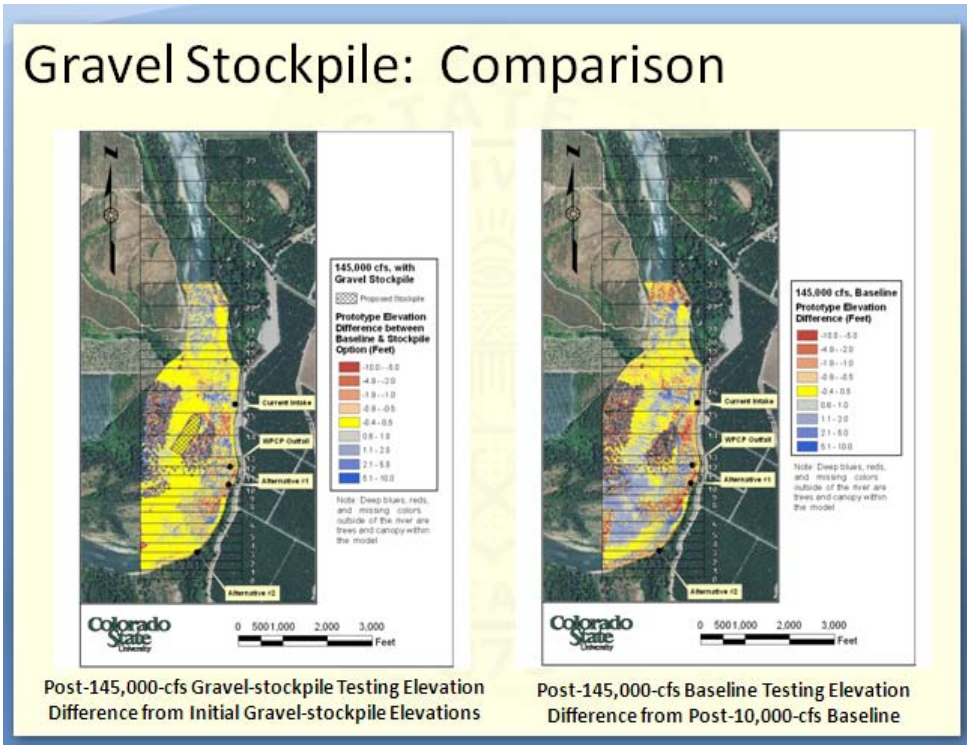
At the current intake site, there is sedimentation near the pump intake up to about five feet under low velocity. Under baseline conditions, at Alternative Site 1 there is the possibility of some aggradation in this area. Also, along the rock you see degradation and you get scour against the rock. At the Alternative Site 2, you see very little changes over time. The reason for no change is that it is fairly wide and the velocities and flow patterns do not change very much. At 145,000 cfs around the outfall, we do not see any aggradation or degradation. What we see is continued aggradation in the general vicinity at the existing pump intake. Some potential aggradation at the Alternative 1 Site and nothing going on at the Alternative 2 Site.



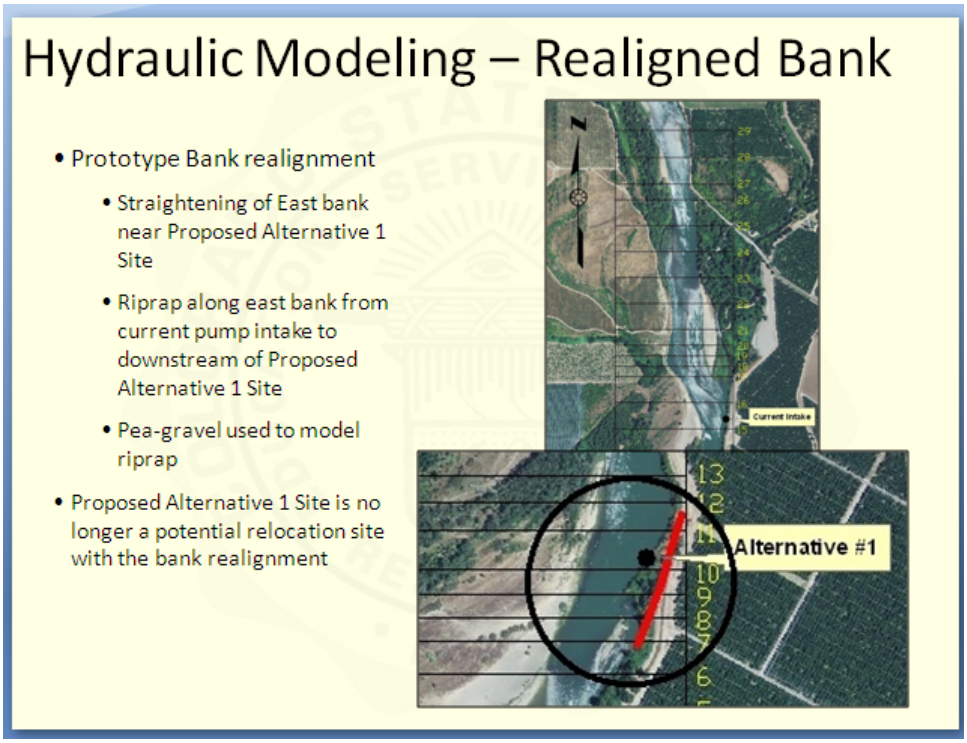
CSU included the proposed location of the gravel stockpile site on the west bank of the river in the modeling. It was run at the 145,000 cfs flow. Exactly the same dimensions for the stockpile were used for the physical model and the numerical model.



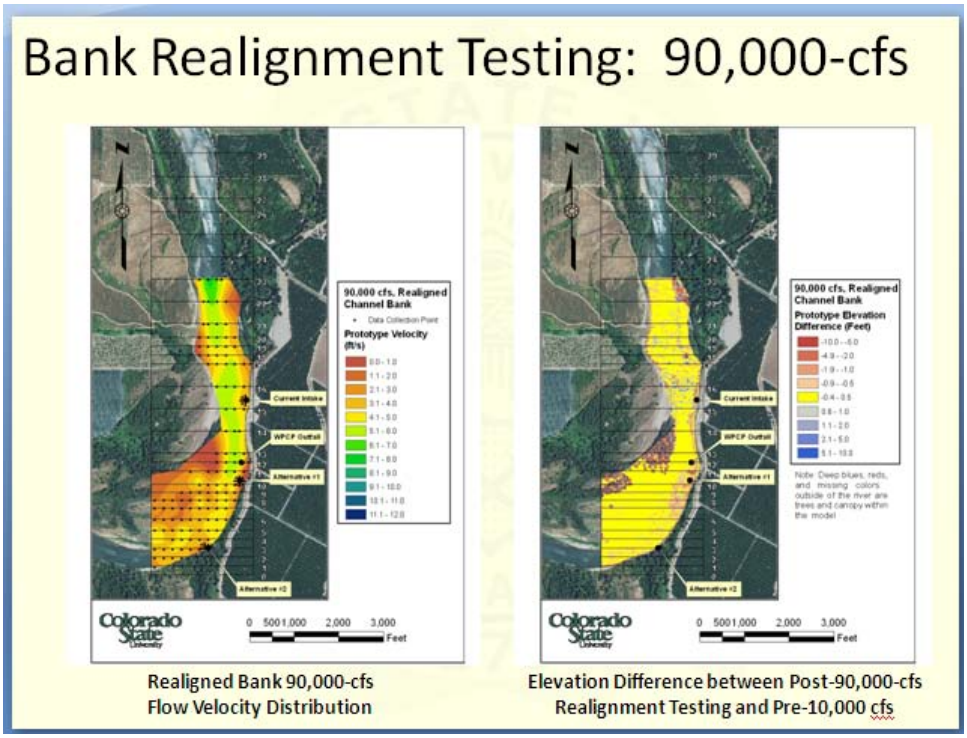
In this slide, the hatched area represents the stockpile. The white area around the stockpile depicts very shallow flows that made it impossible to collect data. This shows a comparison with and without the stockpile which shows very little change to the stockpile.



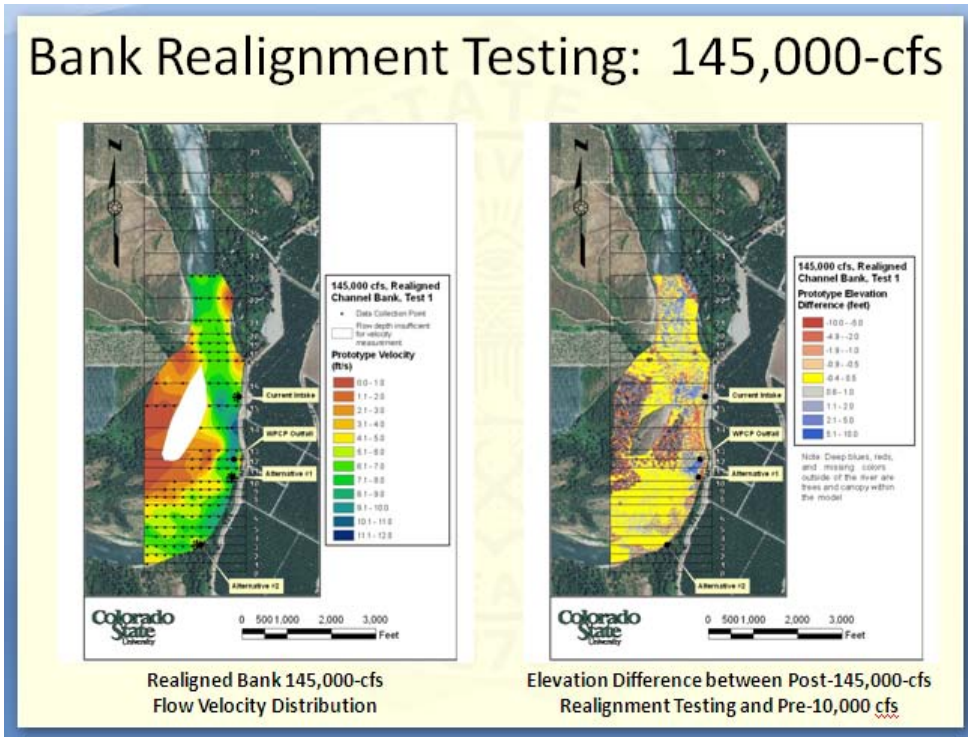
This slide shows the elevation differences with and without the stockpile. The bottom line is that the stockpile in the west over bank has no impact.



Under the initial model, there was an erodible bank downstream at the end of the rip rap and it could in fact retreat. The rip rap used to extend farther out which is the reason for the curvature. Since then it has eroded off the end and eroded back which essentially leaves the existing hook that sits out from the bank. Over time the bank has retreated. If a structure is placed at the Alternative 2 Site, it makes no sense to put it on an eroding bank—the bank must be hardened. It cannot just be hardened locally, it must be made continuous in the downstream direction.

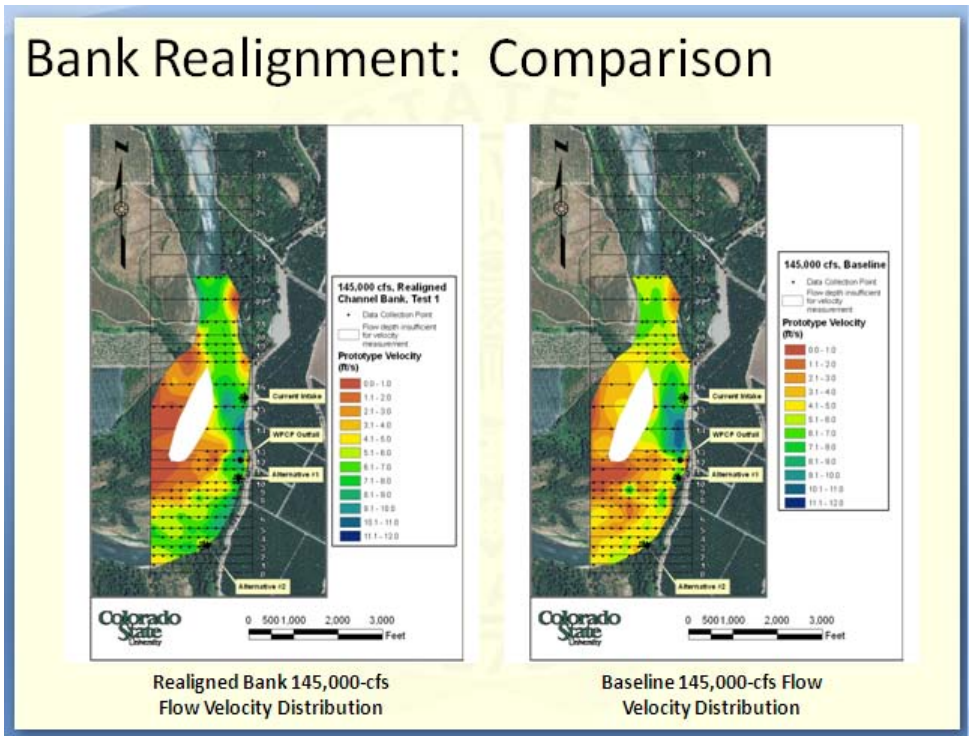


In the model, gravel was cemented in to simulate the roughness. This slide shows the realigned bank and flow distribution and shows any scour or aggradation that takes place is a function of the realignment. What you see is a little aggradation that has very little impact throughout the system. So the realignment does not have much of an impact.

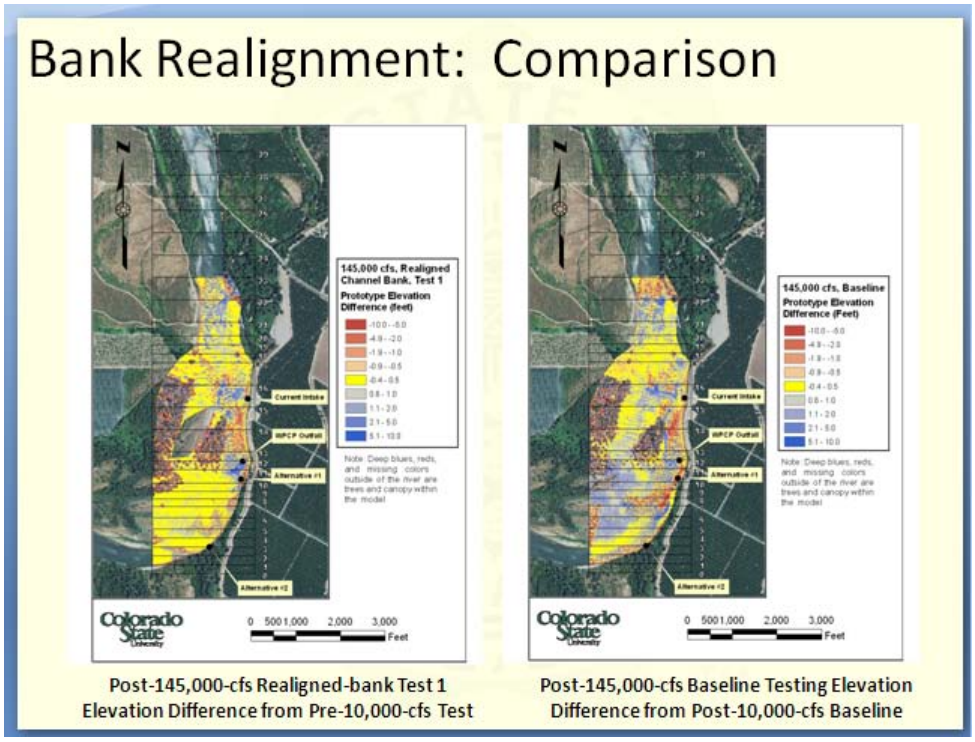


At 145,000 cfs, the conditions look different. It looks as though there is a little aggradation between the current pump intake and the new City of Chico outfall location and scour where the bank is straightened out. Not much occurs at Alternative 2 site location. If you look at the velocity distributions, realigned versus the baseline, what you see is that

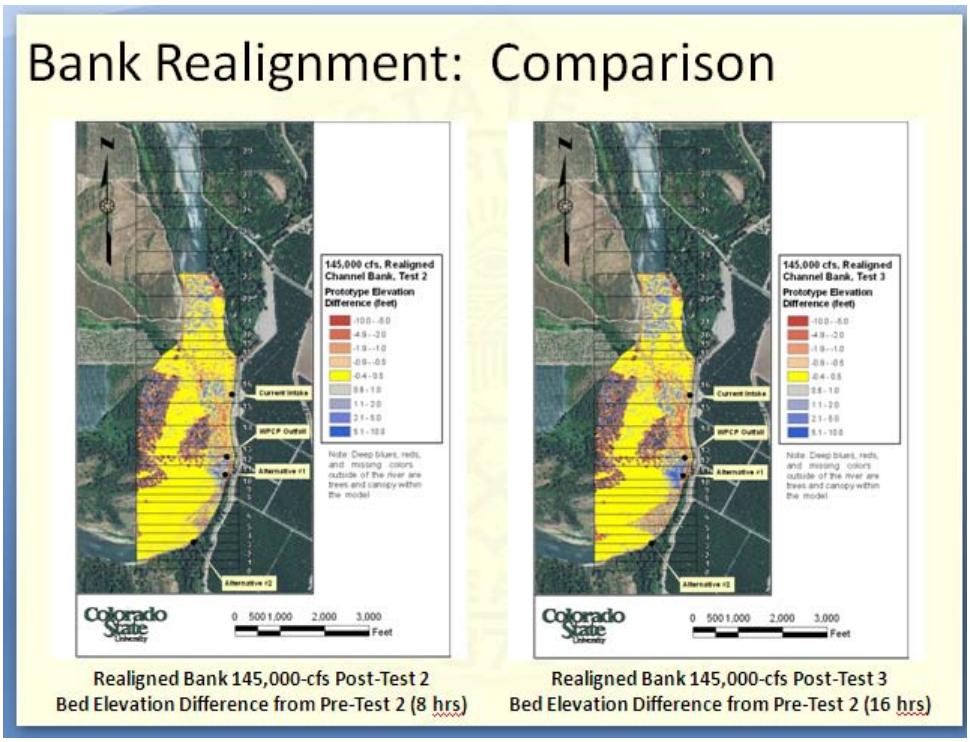
there are slightly higher velocities upstream of the Alternative 1 Site and the outfall because the backwater affect is reduced by straightening out the channel downstream so there are somewhat higher velocities.



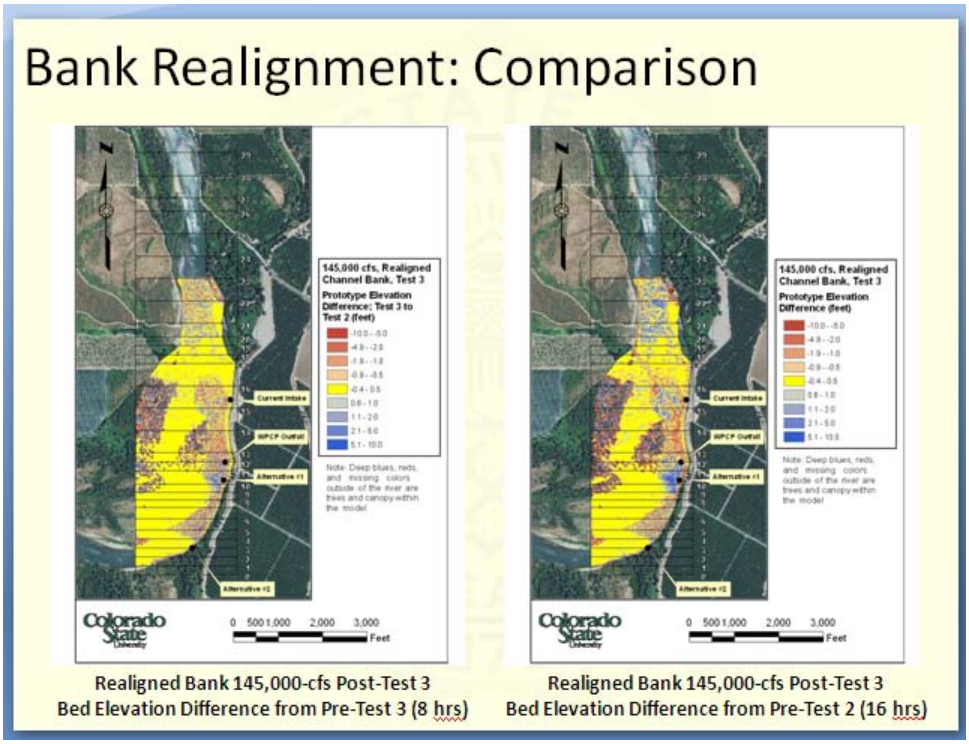
This slide shows some deposition at the Alternative 1 Site. Alternative 1 Site does not need the bank straightened. There is a bit more deposition on the riffle. We ran the test for a longer period of time (8 hours and 16 hours) to let the model settle down over time. What you see was a little more deposition and a little less south of the site and not much change.



At 16 hours there were very similar patterns and a little more scour.



With the realignment, at the current intake location, we are still getting the same amount of aggradation as occurred at the baseline. At relocation site 1, there looks like there is a couple feet of deposition at 10,000 cfs and 90,000 cfs and possibly more, up to about 5 feet, at 145,000 cfs. At pump relocation site 2, not much is going on, it is a stable site vertically.



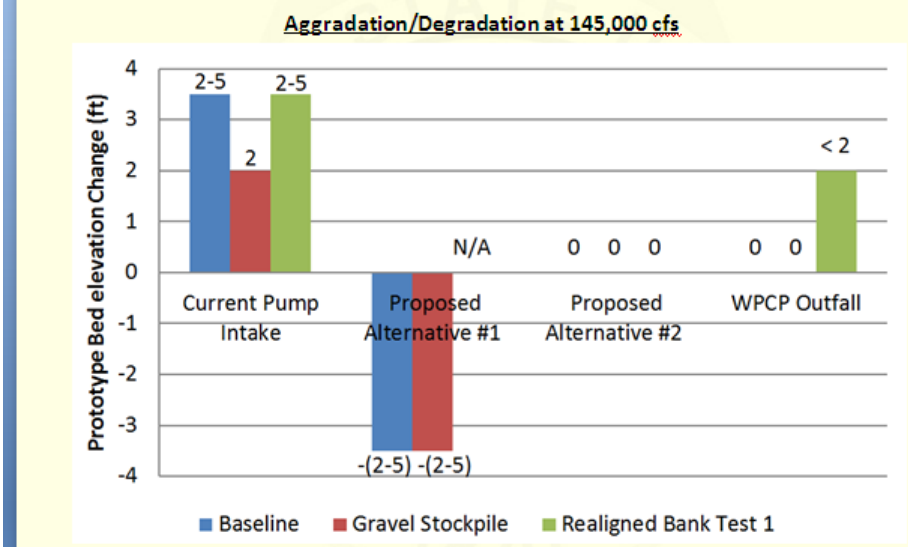
At the outfall you get some aggradation upstream of the outfall, you get some degradation downstream of the outfall. The interpretation is over time, the realignment could cause some aggradation up to a couple of feet in the outfall area.

Bank Realignment Testing Summary

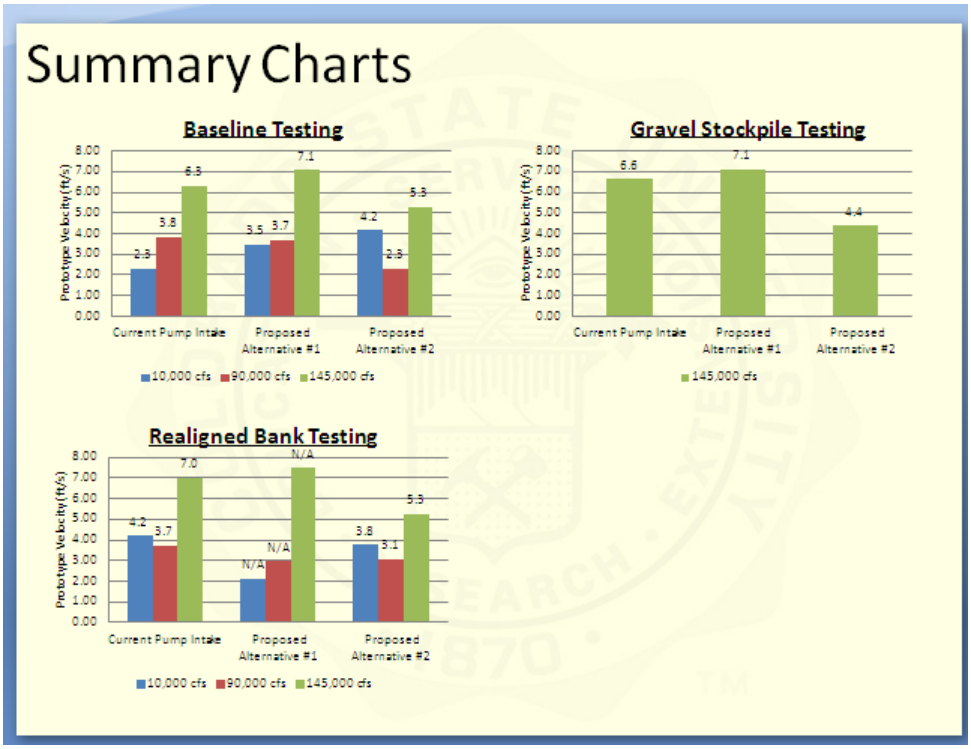
- Hydraulic and sedimentation trends varied from Baseline and Gravel-stockpile trends
- Higher main-channel flow velocities compared to Baseline Testing
- Current pump location
  - Agg. up to 5 ft just northwest of current pump-intake (from 145,000-cfs test)
  - Negligible velocity difference compared to Baseline conditions
- Proposed Pump Alternative Location #1
  - Deg. up to 2 ft at 10,000 cfs and 90,000 cfs
  - Agg. up to 5 ft immediately upstream (from 145,000-cfs test)
  - Increased flow velocities compared to baseline conditions at 145,000 cfs
- Proposed Pump Alternative Location #2
  - Negligible agg. and deg. (from 145,000-cfs test)
  - Increase in velocity of main channel compared to Baseline
- WCPC Outfall
  - Agg. immediately upstream
  - Deg. immediately downstream
  - Measured upstream agg. suggests that a maximum of 2 ft of aggradation could be expected at the WPCP outfall

In summary, the information suggests that there is very little difference between any of the alternatives except the stockpile squeezes the flows a little and there is a little less aggradation.

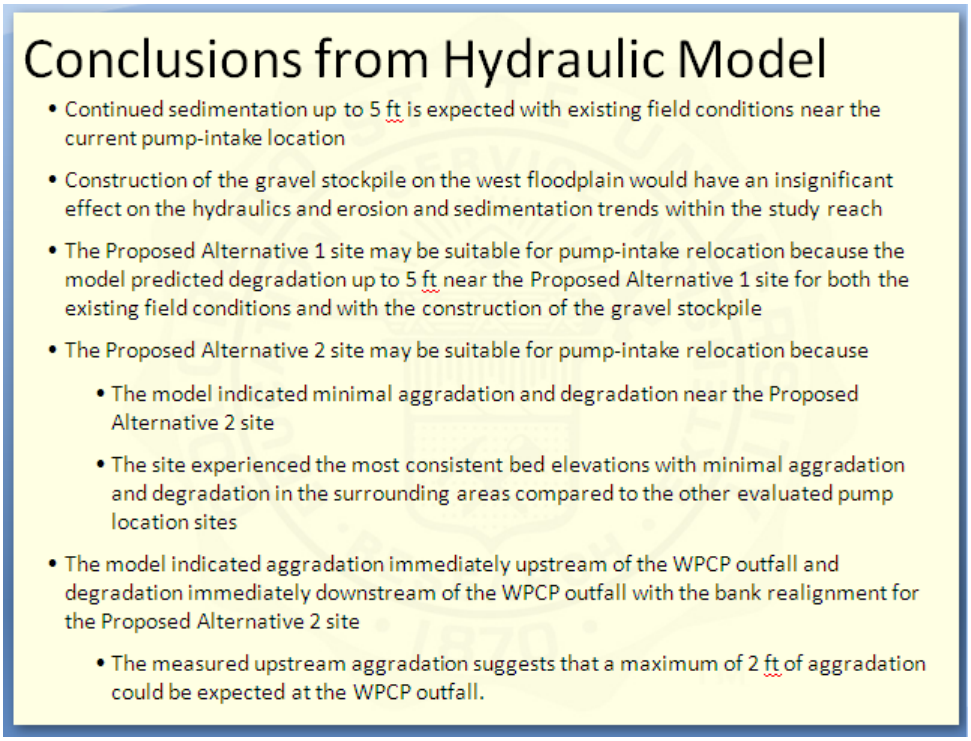
Summary Chart



The Alternative 1 Site was showing degradation for the baseline and the gravel stockpile run. This does not apply to this alternative. Nothing taking place at the Alternative 2 Site. With the realigned bank test, there could be some aggradation at the wastewater outfall.



In terms of the velocities, at baseline for the same conditions, there is somewhat higher velocities at the current pump intake because of the reduced backwater at the higher flows. Similarly, at the Alternative 1 Site and at Alternative 2 Site, not much changes. The realigned bank reduces backwater, increases the velocities The stockpile doesn't affect the alternatives. It's far enough out there, is just squeezes the flow and only at the very high flows.



We conclude from all this that up in the existing pump area, we can expect continued aggradation. None of us would dispute that observation. The gravel stockpile has very little impact. The Alternative 1 site which about 2,220 feet down seems to be net degradational under existing conditions and maybe a better site. The proposed alternative downstream, although it is stable aggradationally, is actually quite shallow at all flows. Putting in fish screens and all the rest of the requirmeents in there, because of the shallow flows would be pretty difficult. And obviously, the downstream one requires the addition of another 1,500 feet of full- bank rip rap plus additional pump and pipelines. Moving the existing bankline may have a slight impact on the City of Chico's outfall – local aggradation of a couple feet.

From the results of the Physical Model, we can say that results have matched what was expected. Continued aggradation on the bar and at the existing pump intake. The model appears to show good flow pattern at about 90,000 cfs in the vicinity of the intake. Before the model is torn down, it would be good to see whether you could run the model to replicate 2011 conditions.
03:12:22
Alternative 1 tends to be more degradational than aggradational. If at some point, you allow the west bank to relax, the bar is going to move downstream. It depends on the rate that is put on the downstream migration of the bar. Yantao
Question: Is the theory that the site 2 has enough flow depth for the screen?

Mike Harvey: We looked at that and it looks like it would have to be in-bank, a flat-plate screen. You would not be able to put in cylindrical screens.

Yantao Cui: It is odd because it is on the outside of the bend.

Mike Harvey: Yes, but it is retreating. It is an actively retreating bend with active sedimentation at that site. It is not the classical asymmetric bend.

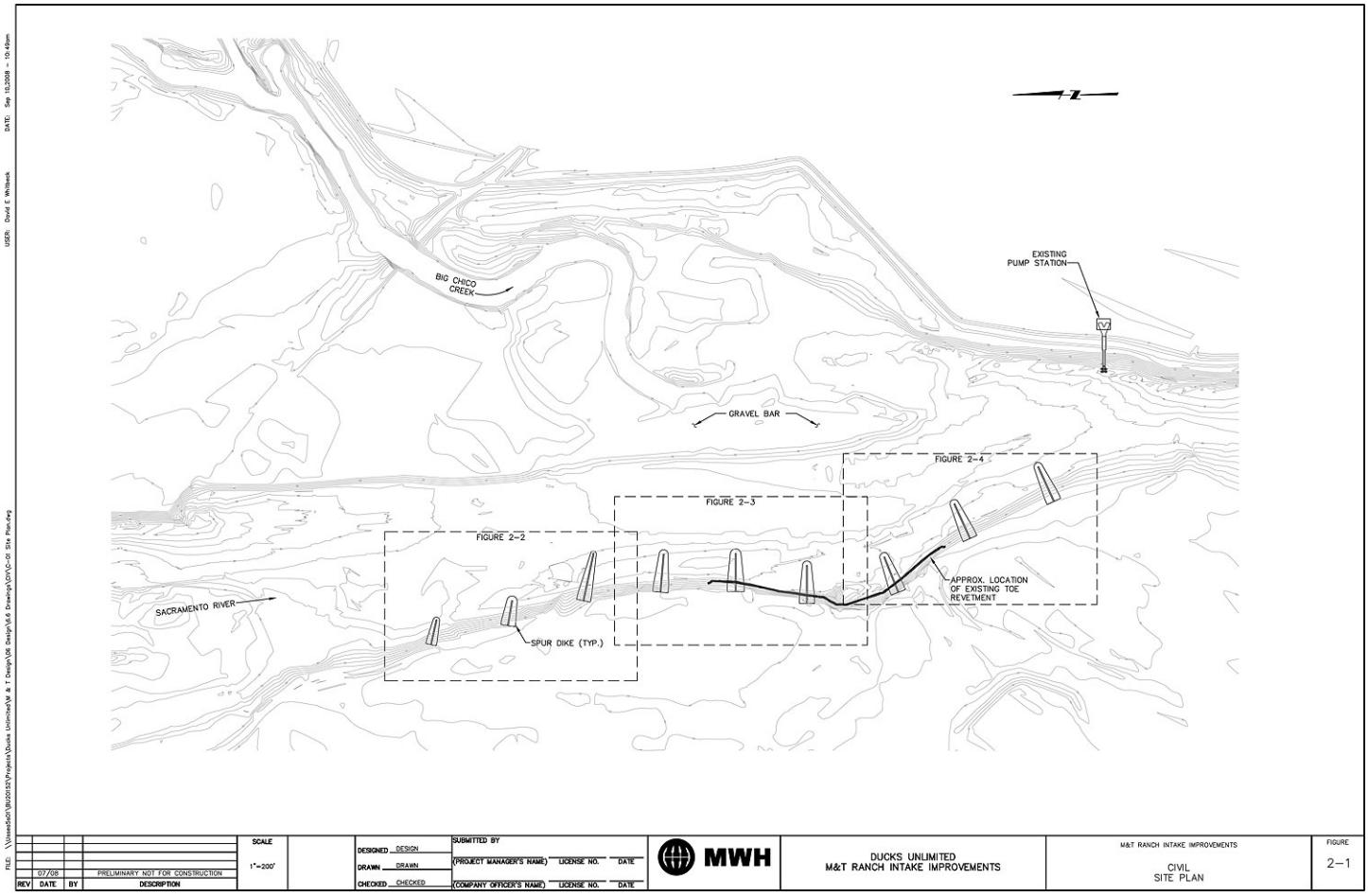
Yantoa Cui: If bank is hardened?

Mike Harvey: It should scour against it.
Yantao Cui: At least we know, that if we put in a screen, the bed is likely to scour.
Discussions about the Princeton Codora project.

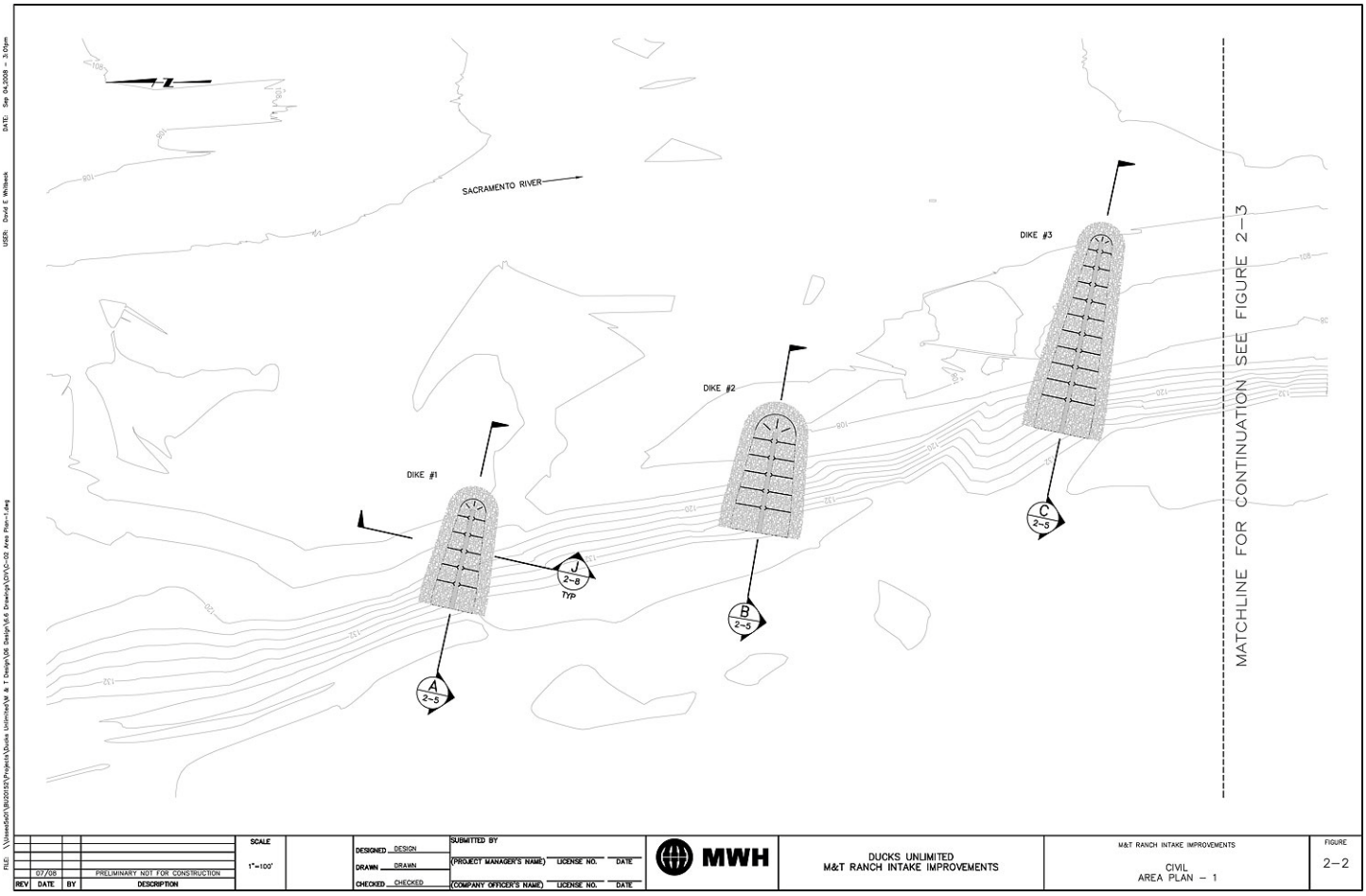
Estimated Costs for Recommended Alternatives

Dennis Dorratcague, Principal, MWH Americas

This presentation is focused on the construction and costs for the Spur dikes/Groin Alternative (9 dikes in the river) and the two intakes relocations.



Described 9-dike configuration showing bathymetry from 2006.



FILE: \\sssedc01\BU2013\Projects\Ducks Unlimited\M & T Design\06 Design\6-6 Drawings\Civil\C-02 Area Plan-1.dwg
USER: David E Willbeck
DATE: Sep 04,2009 - 3:01pm

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SCALE: 1"=100'

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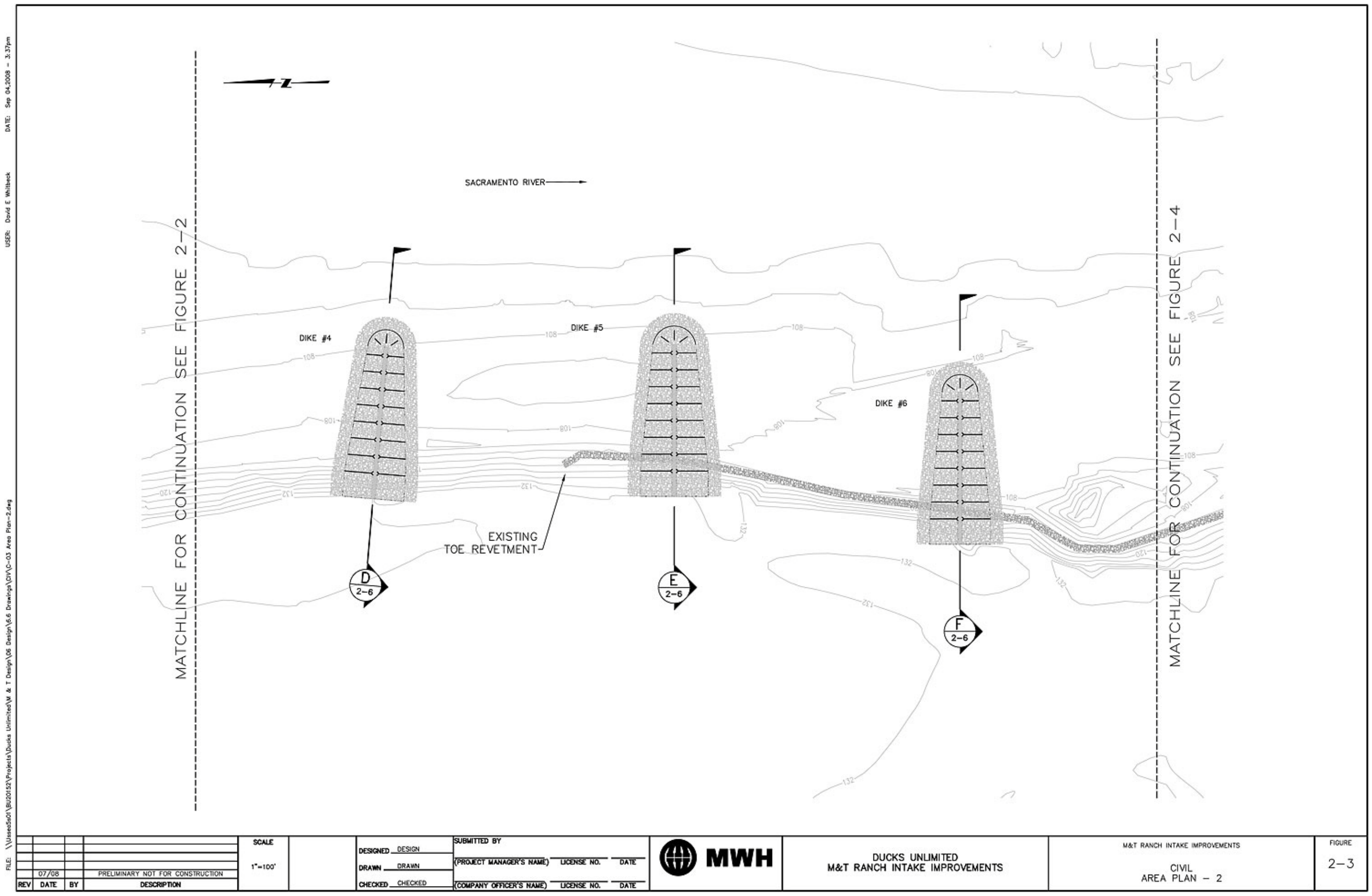
(COMPANY OFFICER'S NAME) LICENSE NO. DATE

MWH

DUCKS UNLIMITED
M&T RANCH INTAKE IMPROVEMENTS

M&T RANCH INTAKE IMPROVEMENTS
CIVIL
AREA PLAN - 1

FIGURE
2-2



MATCHLINE FOR CONTINUATION SEE FIGURE 2–2
SACRAMENTO RIVER
DIKE #4
DIKE #5
DIKE #6
EXISTING TOE REVETMENT
D 2–6
E 2–6
F 2–6
MATCHLINE FOR CONTINUATION SEE FIGURE 2–4
07/08 PRELIMINARY NOT FOR CONSTRUCTION
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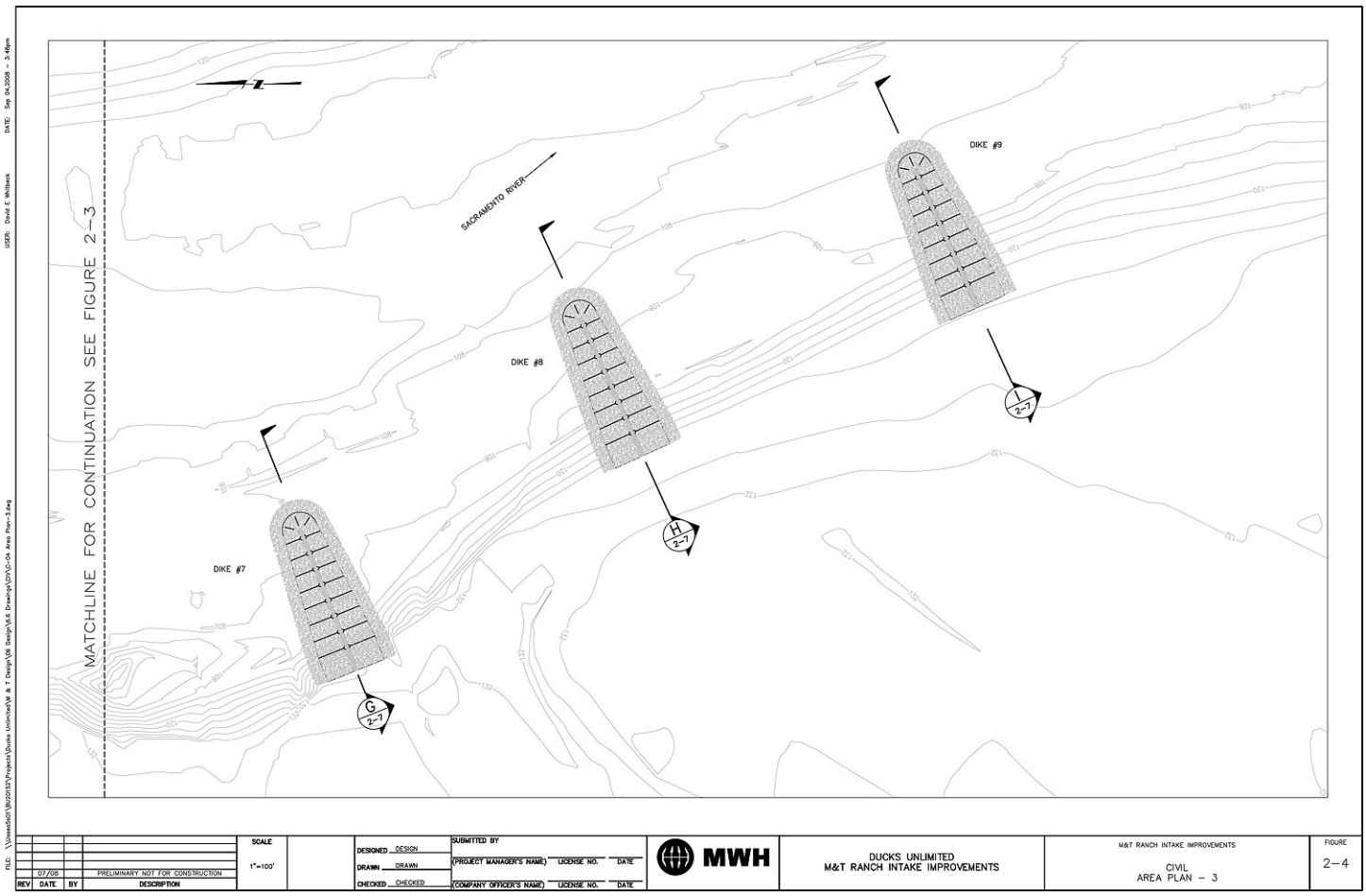
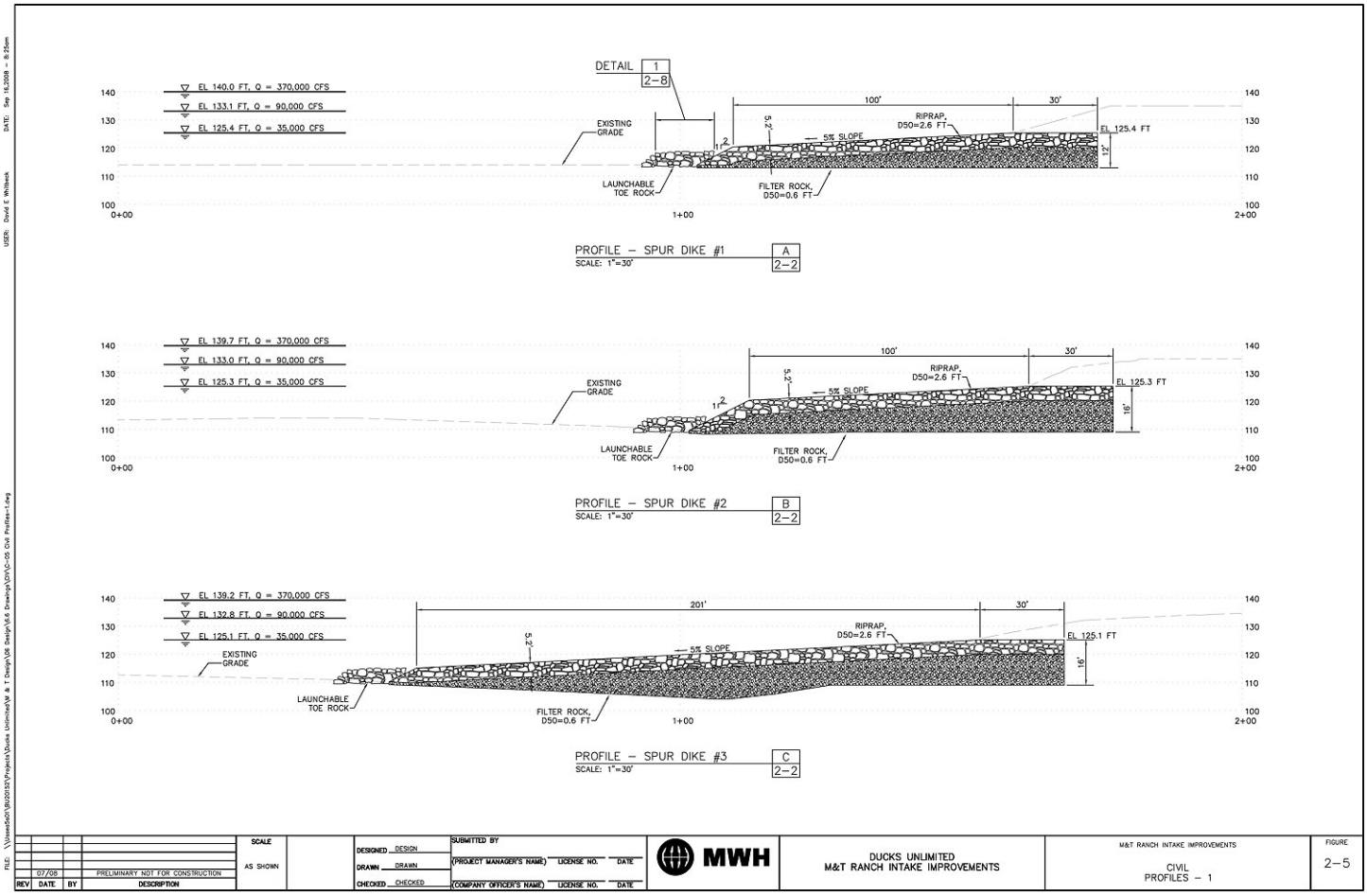
AREA PLAN – 2
FIGURE 2–3



This is the groin alternative. They vary in size from upstream to downstream

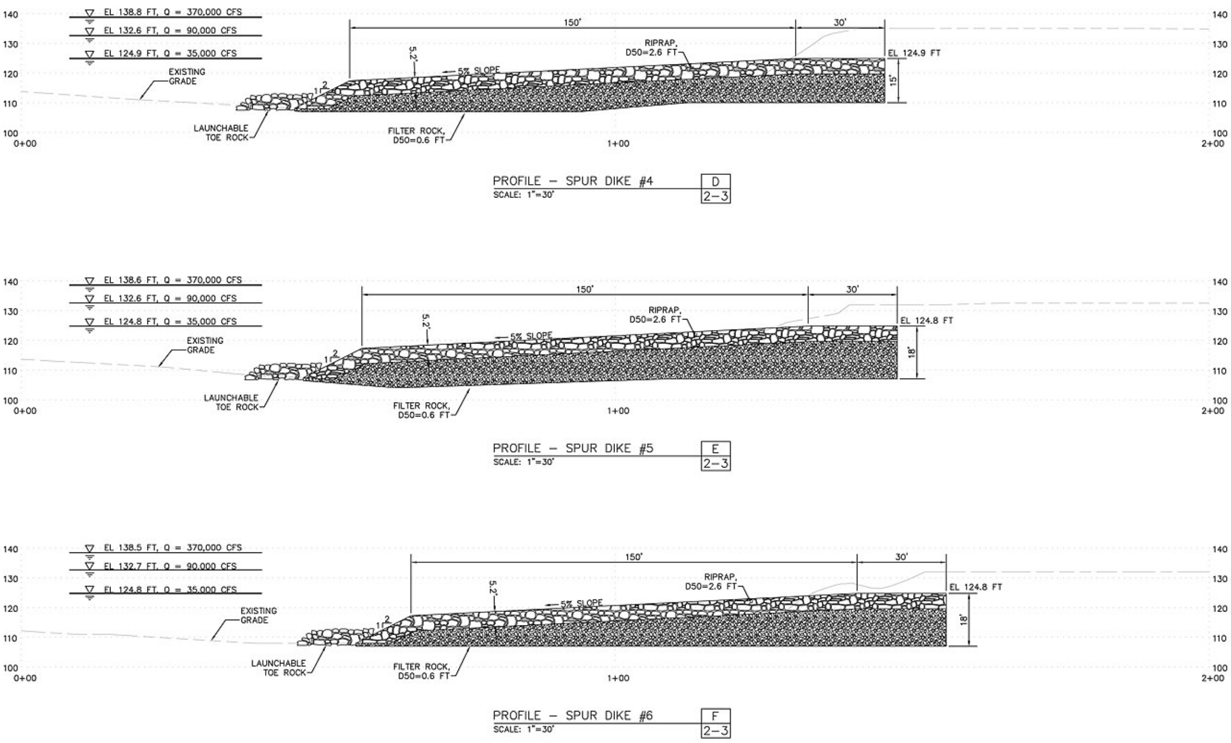


Here is a drawing of what a typical groin looks like coming out from the bank

Here's the bankline and the bottom of the river. We key it into the bank about 30 feet

This particular one is about 100 feet long. There are two dikes at 100 feet long and 7 dikes at 150 feet long from the bankline to the end of the dike.

There is some extra toe protection.



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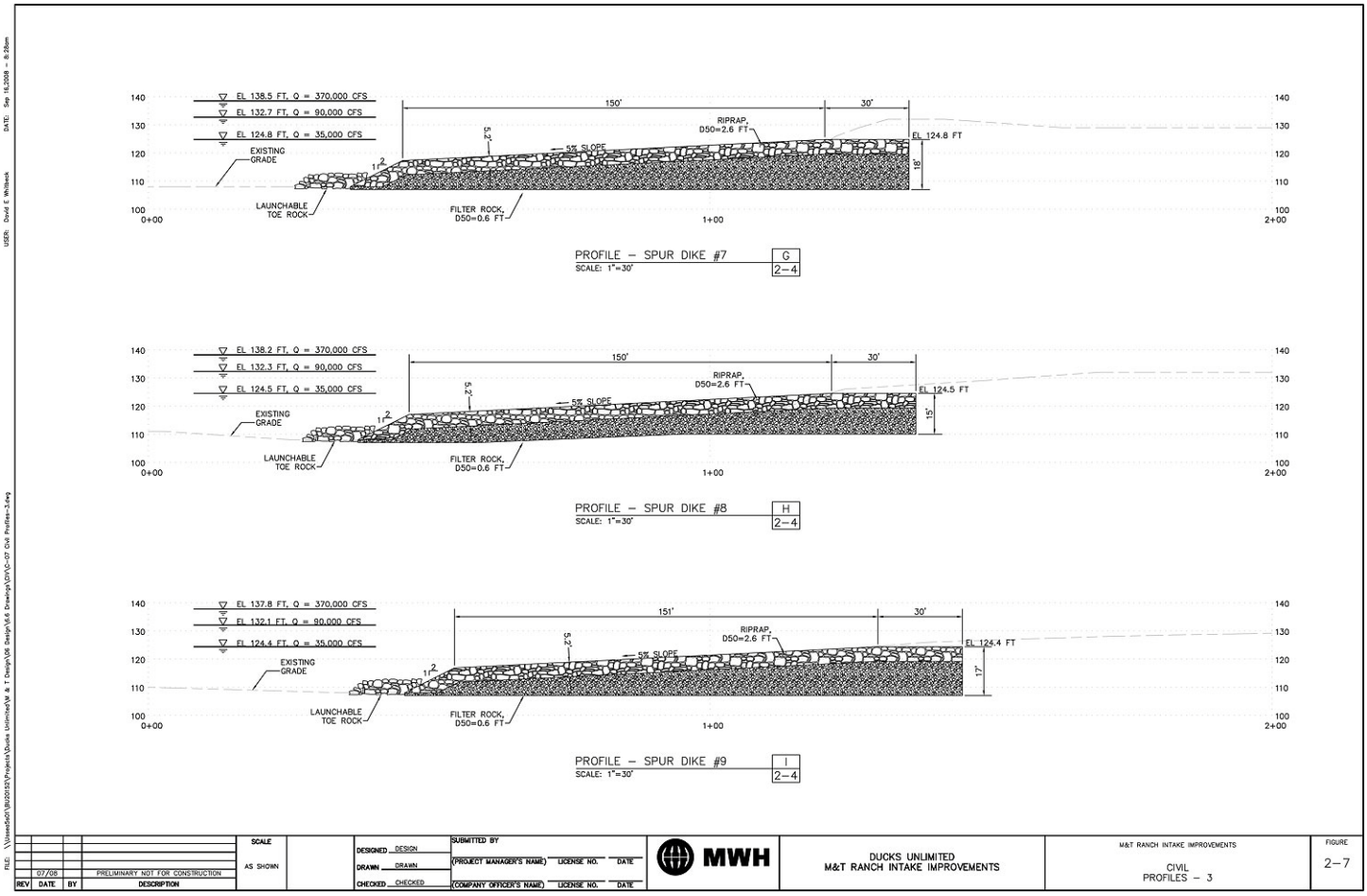
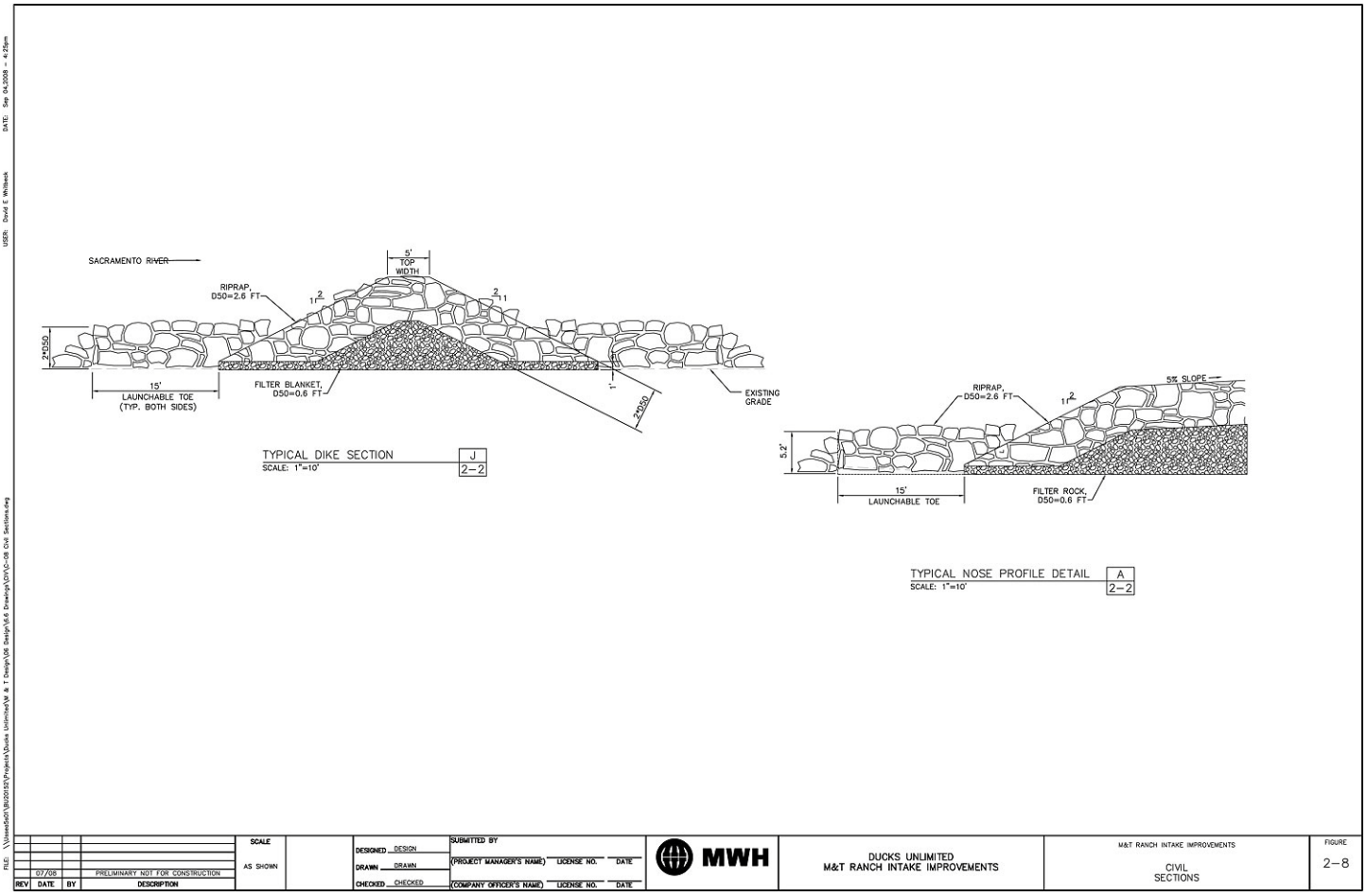


The idea is the dikes would be built from shore. The bank would be dug out and the rock would be piled—the fill rock first. When it is above water, the machinery can walk down on the rock. No rock between the groins along the bank.



Here is a cross section through the dike.

We have the fill and a filter blanket under the fill and the rock out on top of it. There is rock that is sacrificial because it will scour around the end. It will scour under the rock and the rock will fall in and arrange itself. The top width above the water is 5 feet. The dike slopes upward as it goes into the bank.

The idea is to build the 9 dikes with no structure in between the dikes. The water will eddy behind the dike but it's not like a bridge abutment that is vertical. The dike is sloping into the river so it becomes a 3-D eddy—some going over and around. It will eddy around the end and fill in behind it to some degree and scour on the downstream side. And that it what the extra rock I showed is about. In the areas that fill in, they can be typically planted.

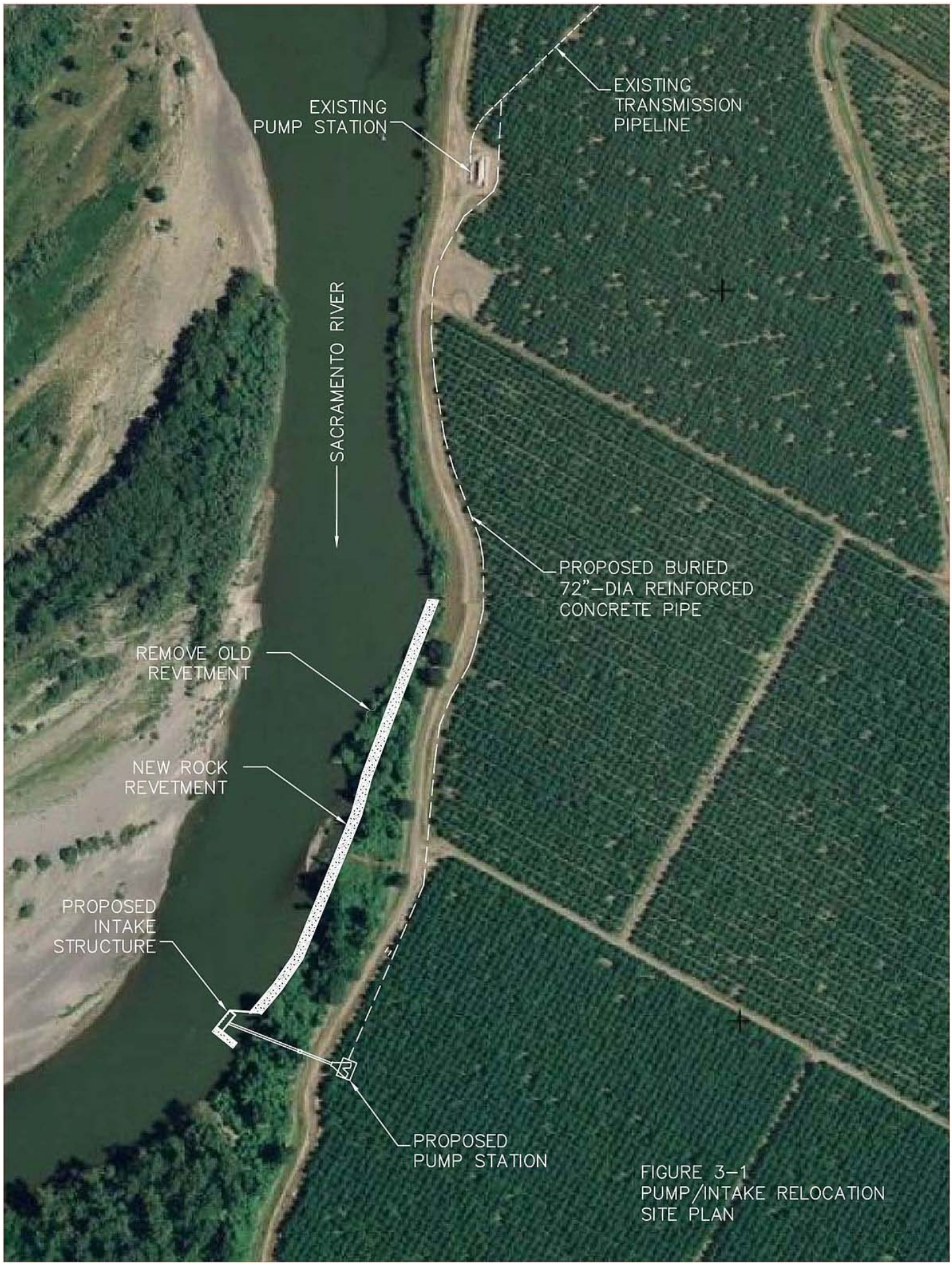
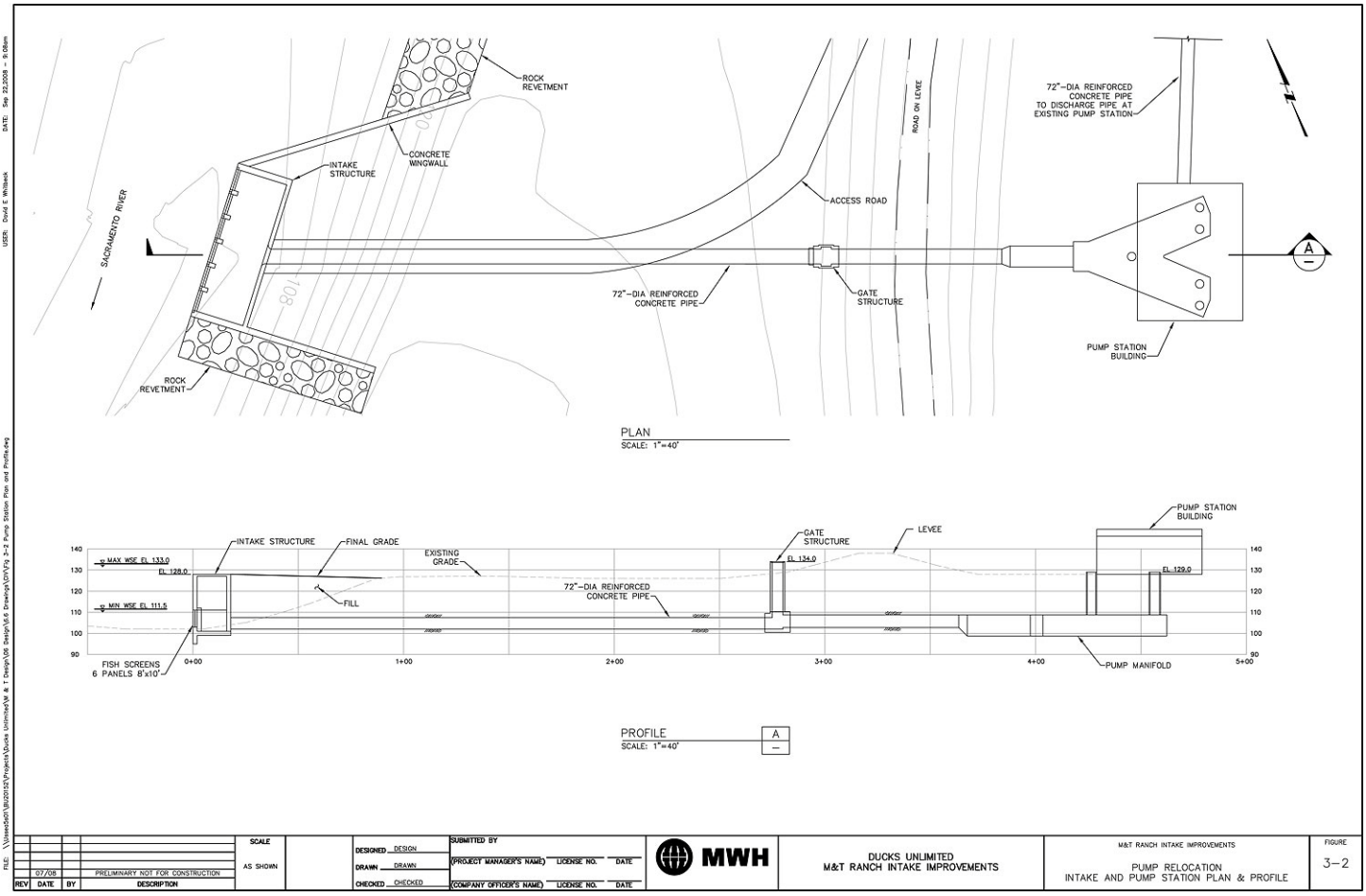
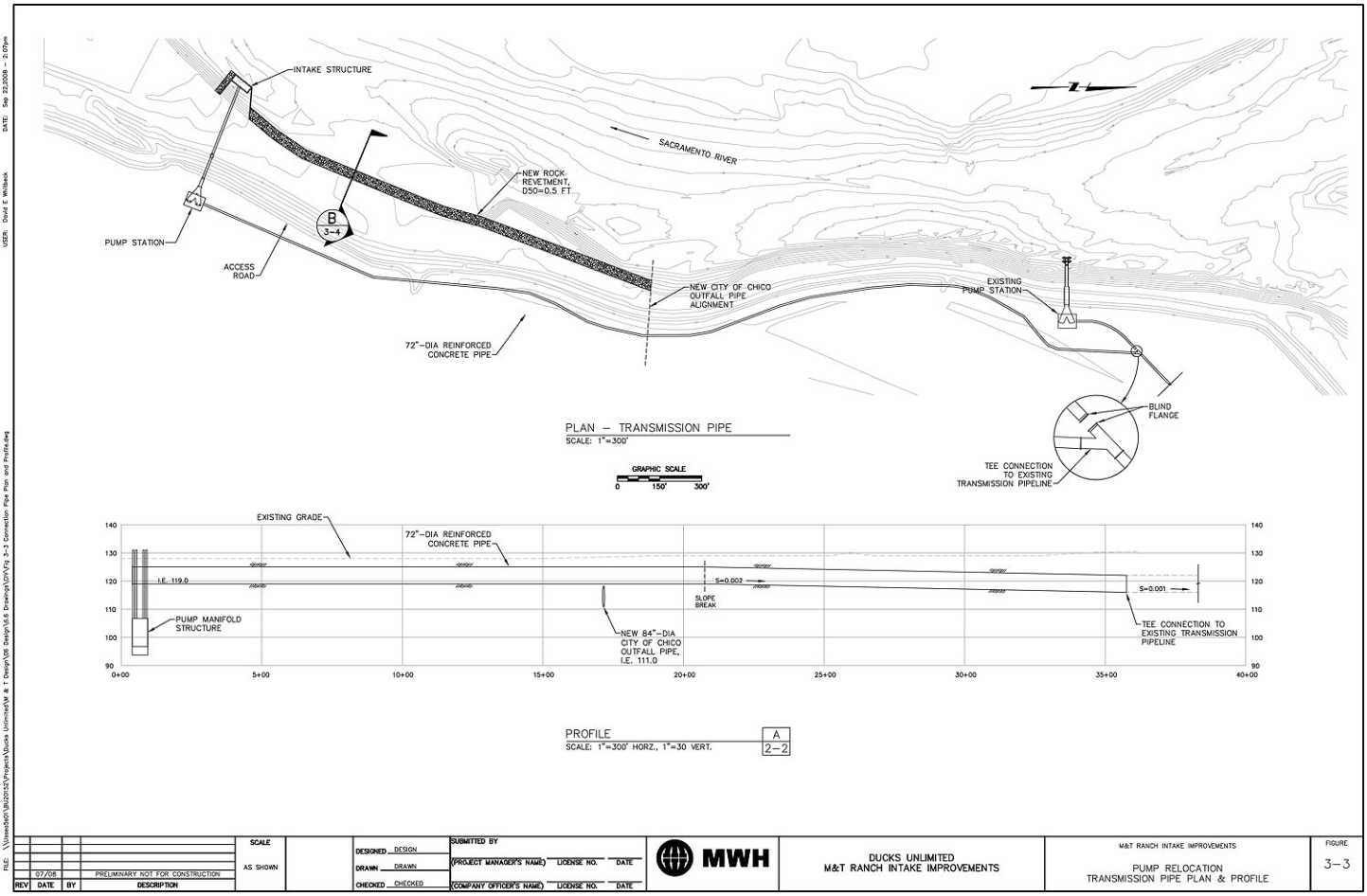


FIGURE 3–1
PUMP/INTAKE RELOCATION
SITE PLAN

These alternatives came up later. The river is pulling this way. North is to the left and this is the alternative 2 intake.

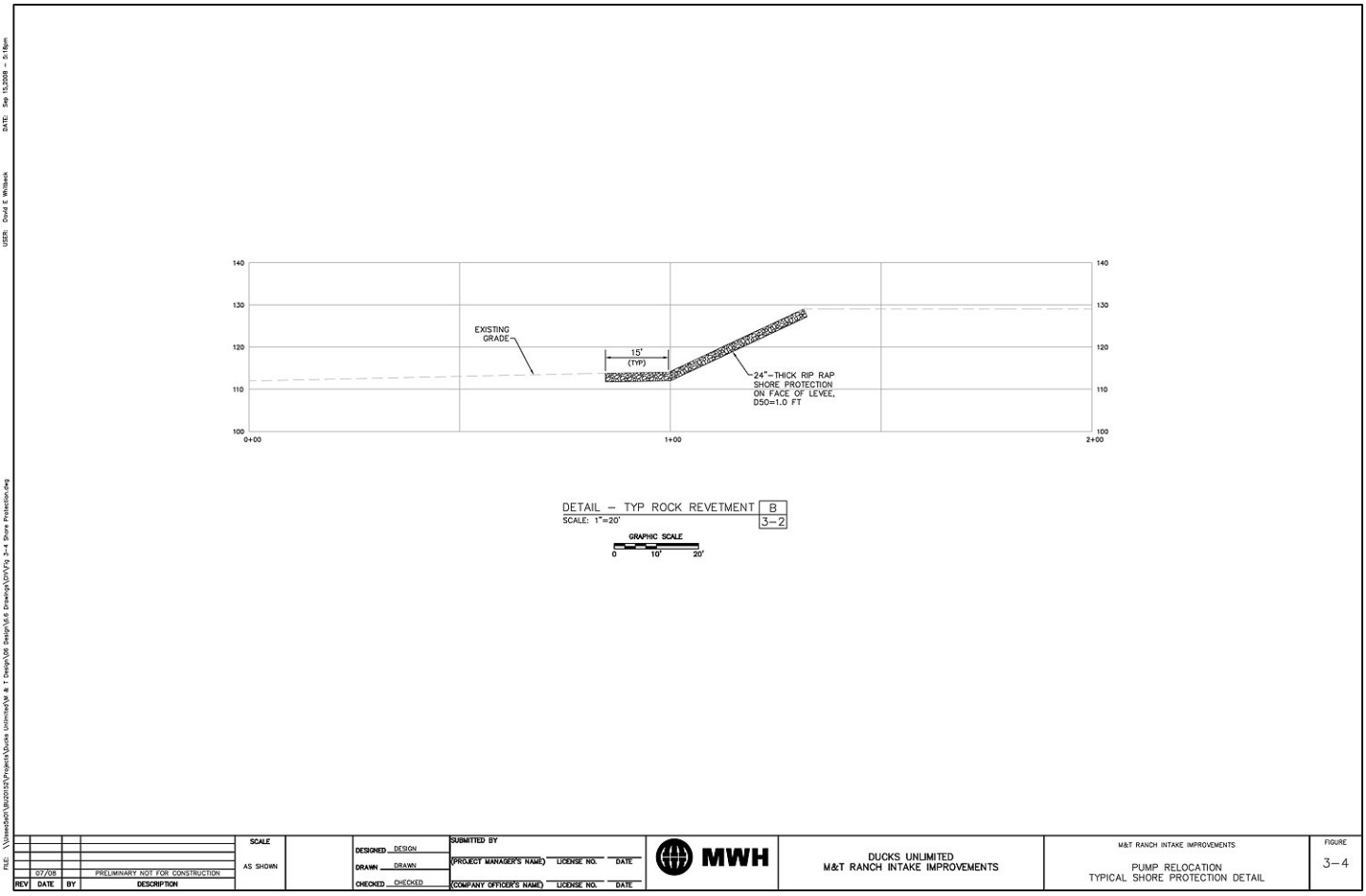


This is an intake in the river and a 72" pipe under the levee. A pump station on the back side –pumped up to the existing pump station but it goes around it and joins into the existing pipeline here and the pipeline from the existing pump station would be cut at that point.



The 3,500 foot alternative is 72" pipe. On both alternatives (2,200 ft and 3,500 ft) we looked at using the same pumps here and essentially sucking the water in the intake at the pipe --- it doesn't work. The pumps won't handle it. You would have to redo this pump station in order to make that happen. It's about the same money to put in a new pump station on the other side of the levee.

We have to straighten this bank we need to protect this bank because of what's going on up here. This is in the 3,500 alternative.



This is the intake in the Sacramento River is running through the top and the bottom. We show a flat plat screens we did not try to optimize the design this is using the 2006 bathymetry which is pretty close to what was measured in 2010 we can go back and redo this if that's the plan but we wanted to see what would come out of this meeting before we did that.

This is a typical section of new rock revetment in the Sacramento River.

There is protection around the intake water is going through the pipe under the levee into the pump station on the back side. We used a similar design as the existing pump station just for comparison purposes

This is a flat plate screen –we did not look at an incline screen which is a possibility. It is not deep enough at this location to place cylindrical screens similar to what is in place now. Much the same in both locations, the bathymetry is pretty shallow and flat and not conducive to locating an intake on the bank right there.

The screens are located here and are 8 feet high and set at the low water level we took the bottom of the channel approximately at that point and essentially call that good

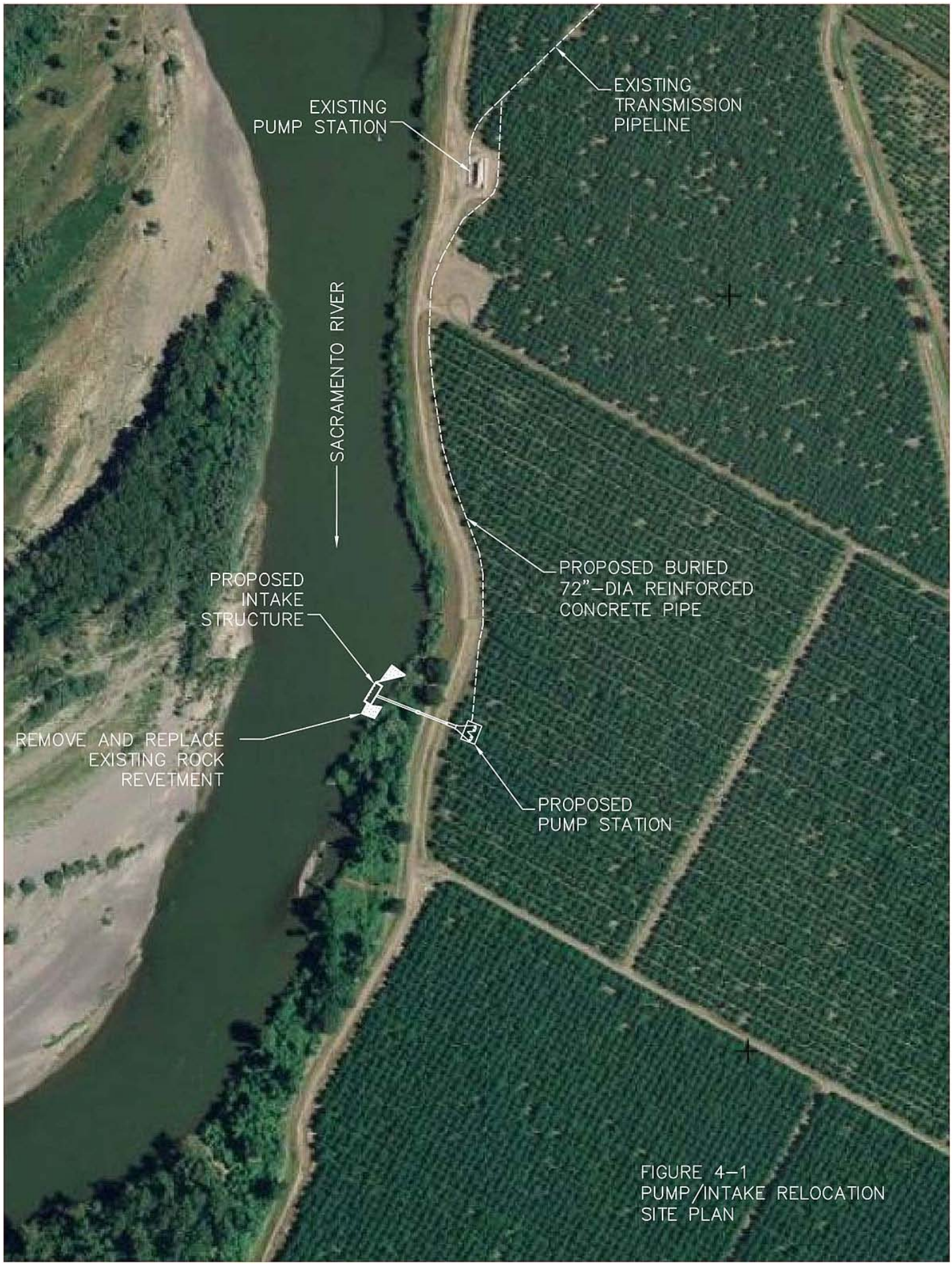
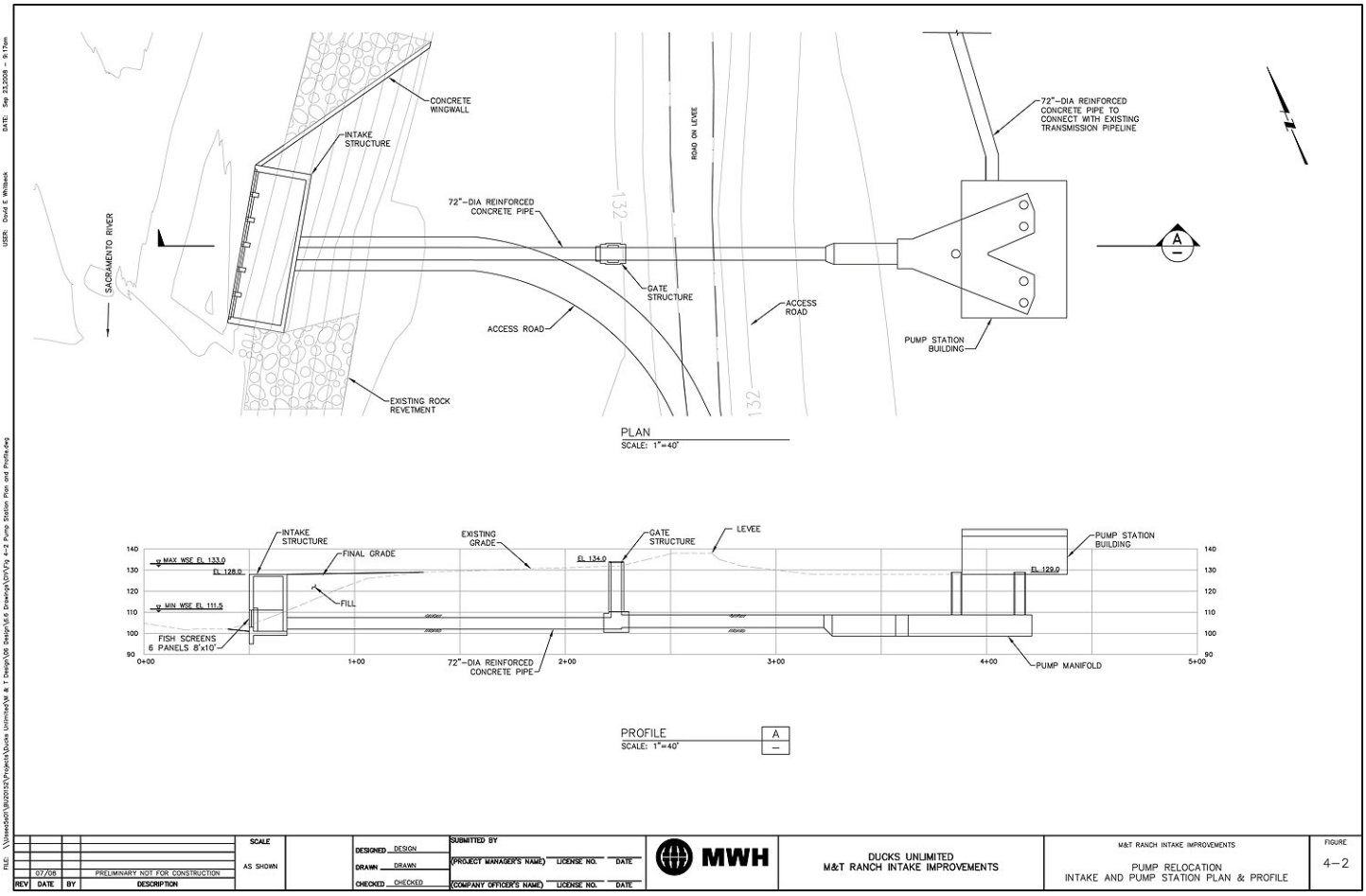


FIGURE 4–1
PUMP/INTAKE RELOCATION
SITE PLAN



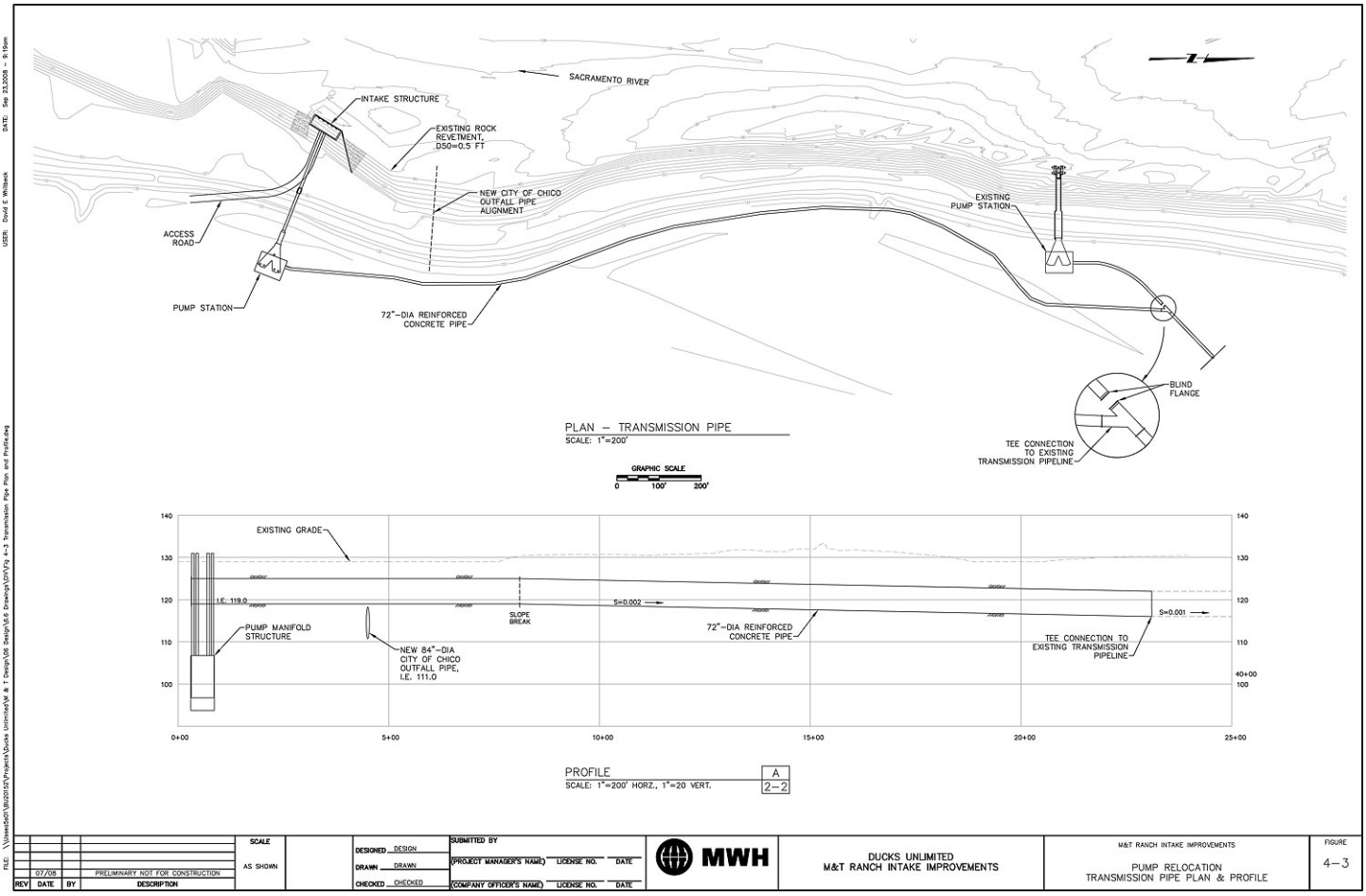
This is the 72-inch pipe under the levee.

The pump station is essentially the same design and what is currently in place.

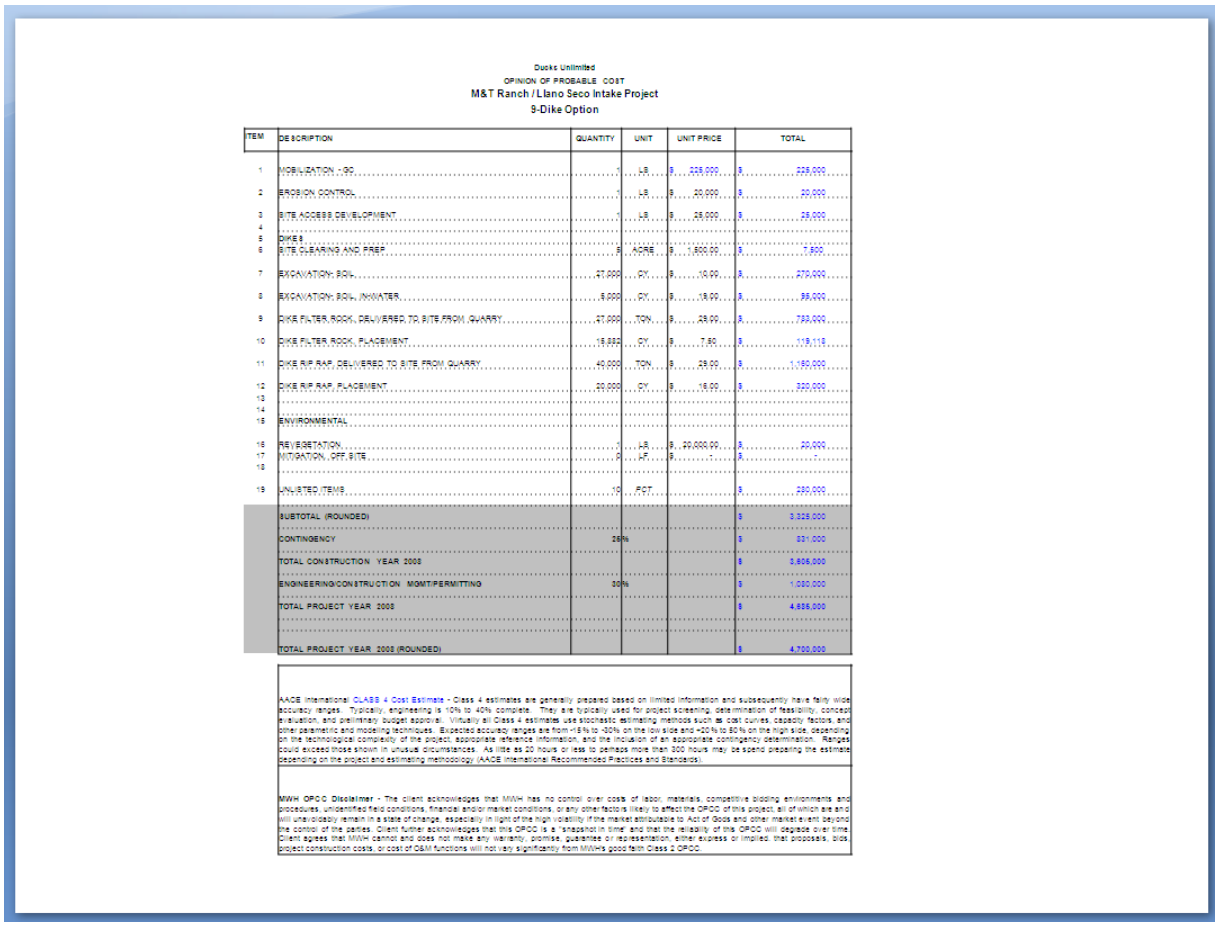
Dennis pointed out the proposed intake and the bank protection.

Mike explained that the current bank protection begins from the confluence of Big Chico Creek all the way downstream to the new relocation sites and ends off the point.

The bank, the river is down through here and it takes off in this direction so we did not locate if over here because that extends the pipe through the riparian area trying to minimize the impacts.



This is the 2,200 foot alternative. This is the Chico outfall. This is the same design – intake to the pump station and a pipe joining the existing pipe. Essentially the same layout and situation. The theory is that if the gravel bar moved into here and opened up this then this thing could be reopened.



Ducks Unlimited
OPINION OF PROBABLE COST
M&T Ranch / Llano Seco Intake Project
9-Dike Option

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	MOBILIZATION - 9D	1	LS	$ 225,000	$ 225,000
2	EROSION CONTROL	1	LS	$ 20,000	$ 20,000
3	SITE ACCESS DEVELOPMENT	1	LS	$ 25,000	$ 25,000
4					
5	DIKE 8				
6	SITE CLEARING AND PREP	5	ACRE	$ 1,500.00	$ 7,500
7	EXCAVATION, BOL	27,000	CY	$ 10.00	$ 270,000
8	EXCAVATION, BOL, IN-WATER	9,000	CY	$ 18.00	$ 99,000
9	DIKE FILTER ROCK, DELIVERED, TO SITE FROM QUARRY	27,000	TON	$ 29.00	$ 783,000
10	DIKE FILTER ROCK, PLACEMENT	15,882	CY	$ 7.50	$ 119,115
11	DIKE RIP RAP, DELIVERED, TO SITE FROM QUARRY	40,000	TON	$ 29.00	$ 1,160,000
12	DIKE RIP RAP, PLACEMENT	20,000	CY	$ 16.00	$ 320,000
13					
14					
15	ENVIRONMENTAL				
16	REVEGETATION	1	LS	$ 20,000.00	$ 20,000
17	MITIGATION, OFF SITE	0	AC	$ -	$ -
18					
19	UNLISTED ITEMS	10	PCT		$ 250,000
	SUBTOTAL (ROUNDED)				$ 3,325,000
	CONTINGENCY	25%			$ 831,000
	TOTAL CONSTRUCTION YEAR 2008				$ 3,806,000
	ENGINEERING/CONSTRUCTION MGMT/PERMITTING	30%			$ 1,080,000
	TOTAL PROJECT YEAR 2008				$ 4,886,000
	TOTAL PROJECT YEAR 2008 (ROUNDED)				$ 4,700,000

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There are costs in the 2008 report. In that report, we tried to include mitigation costs. Discussions after that we all concluded that the mitigation costs were really tough to get a handle on as to what it would take so in these figure I have left these out

These are the construction costs for what I just showed you on the drawings.

The groins were estimated at $4.7 million.

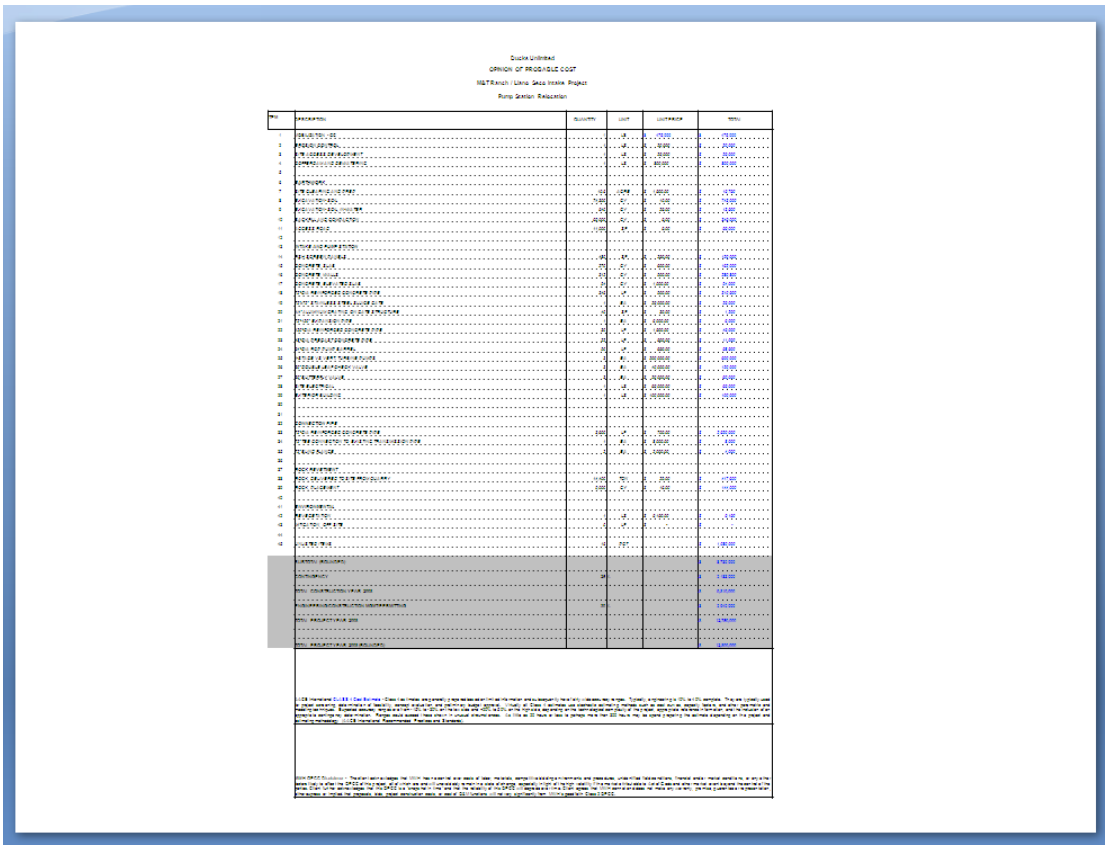
$9.4 million for the 2,200 foot downstream intake – that is in 2008 dollars.

Then I escalated those to present dollars which is essentially 7% in the last almost three years

So present dollars is $5 million and $10.1 for the 2,200 foot $ 13.6 million for the 3,500 foot

These figures do not include mitigation costs. The revetment for the 3500 foot, there were some plantings that went with that approximately $20,000 to $40,000 that are included in the costs. The biggest mitigation costs, if we would have included in the 2008 report, went with the groins.

If the project is estimated not to be built for another four years, another 7% to 10% should be considered.



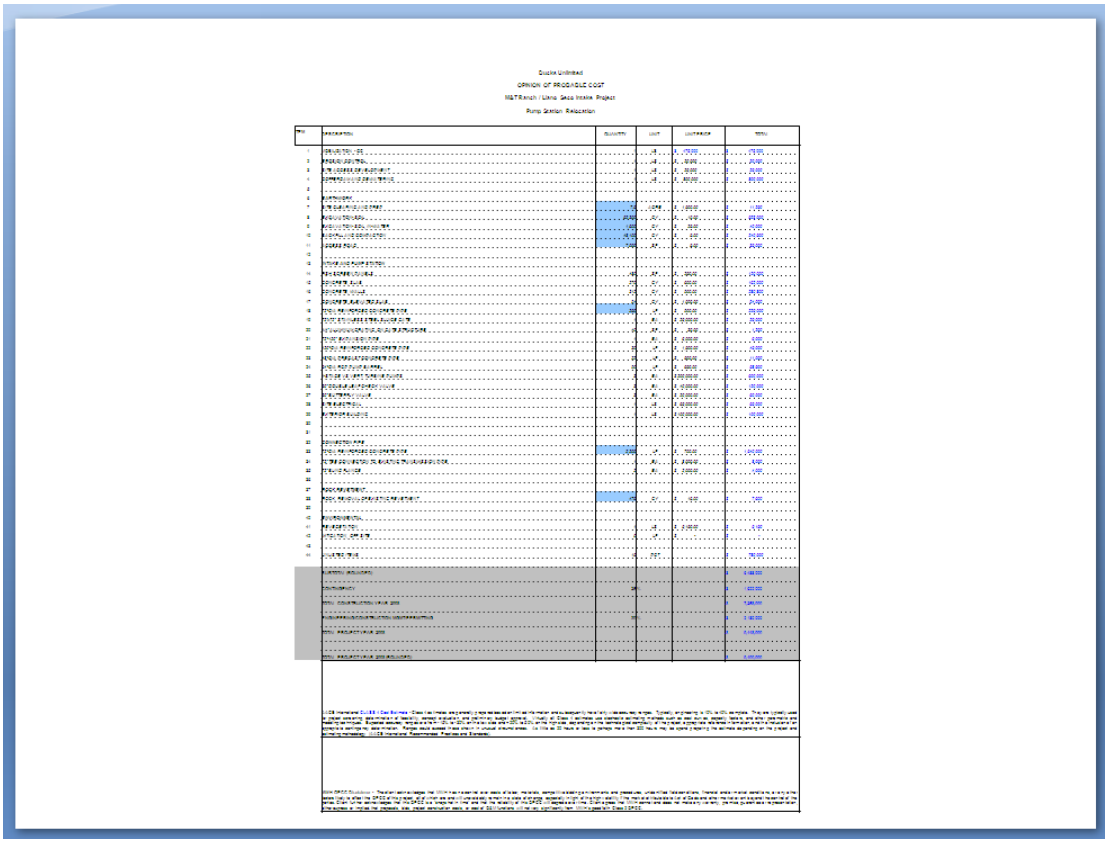
Ducks Unlimited

OPINION OF PROBABLE COST

M&T Ranch / Llano Seco Intake Project

Pump Station Relocation

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	[illegible]		LS	$ 70,000	$ 70,000
2	[illegible]		LS	$ 15,000	$ 15,000
3	[illegible]		LS	$ 30,000	$ 30,000
4	[illegible]		LS	$ 80,000	$ 80,000
5					
6	[illegible]				
7	[illegible]	10	LSFM	$ 7,000	$ 7,000
8	[illegible]	2,500	CY	$ 40	$ 99,000
9	[illegible]	200	CY	$ 150	$ 30,000
10	[illegible]	2,000	CY	$ 50	$ 10,000
11	[illegible]	1,000	SF	$ 40	$ 40,000
12					
13	[illegible]				
14	[illegible]	40	LF	$ 2,500	$ 70,000
15	[illegible]	20	CY	$ 2,500	$ 50,000
16	[illegible]	10	CY	$ 2,500	$ 25,000
17	[illegible]	2	CY	$ 7,500	$ 15,000
18	[illegible]	20	LF	$ 2,500	$ 50,000
19	[illegible]		AU	$ 20,000	$ 20,000
20	[illegible]		LS	$ 5,000	$ 5,000
21	[illegible]		AU	$ 5,000	$ 5,000
22	[illegible]		LS	$ 20,000	$ 20,000
23					
24					
25	[illegible]				
26	[illegible]	100	LF	$ 500	$ 50,000
27	[illegible]		AU	$ 5,000	$ 5,000
28	[illegible]		AU	$ 5,000	$ 5,000
29					
30	[illegible]				
31	[illegible]		LS	$ 5,000	$ 5,000
32	[illegible]				
33	[illegible]				
34	[illegible]	1,000	CY	$ 150	$ 150,000
35	[illegible]		AU	$ 5,000	$ 5,000
36	[illegible]		AU	$ 5,000	$ 5,000
37					
38	[illegible]				
39	[illegible]	1,000	TON	$ 250	$ 250,000
40	[illegible]	2,000	CY	$ 150	$ 300,000
41					
42	[illegible]				
43	[illegible]		LS	$ 5,000	$ 5,000
44	[illegible]				
45					
46	[illegible]	10	TON		$ 50,000
	SUBTOTAL (INCLUDING)				$ 1,750,000
	CONTINGENCY	20%			$ 350,000
	TOTAL CONSTRUCTION COST (2019)				$ 2,100,000
	PLANNING/DESIGN/ENVIRONMENTAL/ADMINISTRATION	10%			$ 210,000
	TOTAL PROJECT COST (2019)				$ 2,310,000
	TOTAL PROJECT COST (2021 ADJUSTED)				$ 2,500,000



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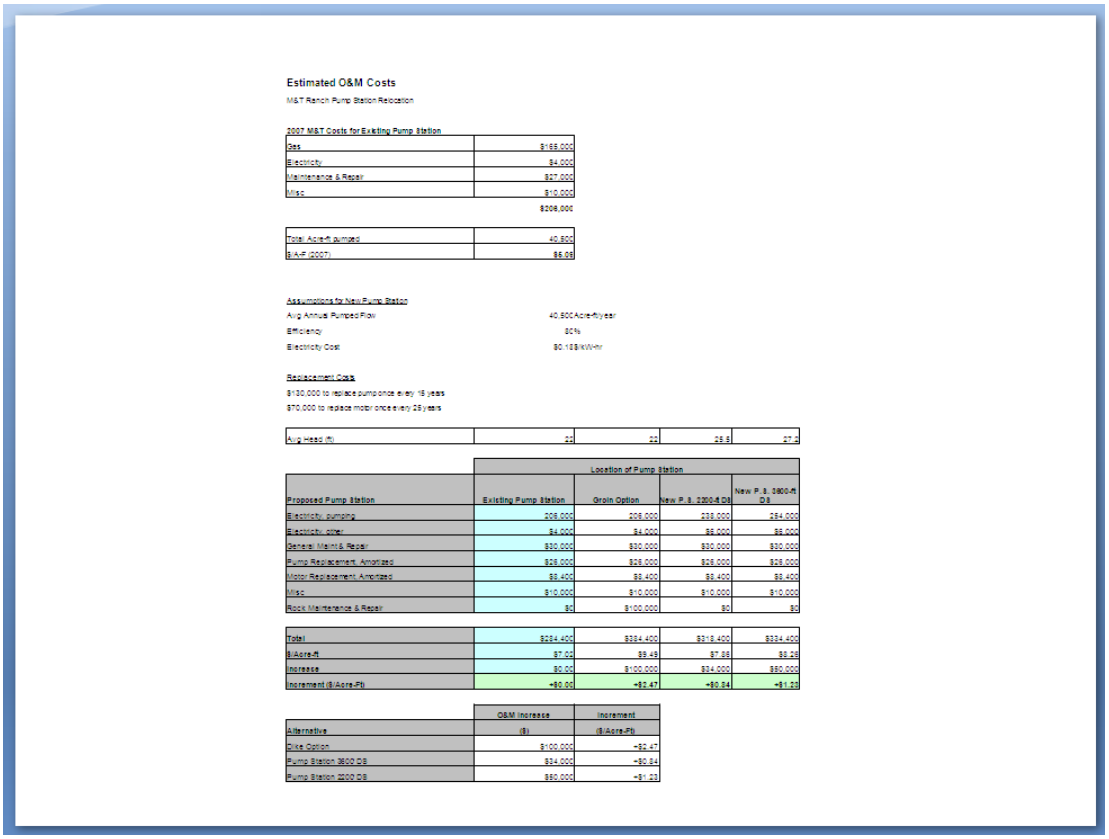
OPINION OF PROBABLE COST

M&T Ranch / Llano Seco Intake Project

Pump Station Relocation



Estimated O&M Costs

M&T Ranch Pump Station Relocation

2007 M&T Costs for Existing Pump Station

Gas	$155,000
Electricity	$4,000
Maintenance & Repair	$27,000
Misc	$10,000
	$206,000

Total Acre-ft pumped	40,500
$/A-F (2007)	$5.09

Assumptions for New Pump Station

Avg Annual Pumped Flow	40,500 Acre-ft/year
Efficiency	80%
Electricity Cost	$0.10 $/kW-Hr

Replacement Cost

$130,000 to replace pump once every 15 years

$70,000 to replace motor once every 25 years

Avg Head (ft)	23	23	26.5	27.3

	Location of Pump Station			
Proposed Pump Station	Existing Pump Station	Groin Option	New P. S. 2200-ft DS	New P. S. 3800-ft DS
Electricity, pumping	208,000	208,000	238,000	254,000
Electricity, other	$4,000	$4,000	$6,000	$6,000
General Maint.& Repair	$30,000	$30,000	$30,000	$30,000
Pump Replacement, Amortized	$26,000	$26,000	$26,000	$26,000
Motor Replacement, Amortized	$6,400	$6,400	$6,400	$6,400
Misc	$10,000	$10,000	$10,000	$10,000
Rock Maintenance & Repair	$0	$100,000	$0	$0
Total	$284,400	$384,400	$318,400	$334,400
$/Acre-ft	$7.02	$9.49	$7.86	$8.26
Increase	$0.00	$100,000	$34,000	$50,000
Increment ($/Acre-Ft)	+$0.00	+$2.47	+$0.84	+$1.23

Alternative	O&M Increase ($)	Increment ($/Acre-Ft)
Dike Option	$100,000	+$2.47
Pump Station 3800 DS	$34,000	+$0.84
Pump Station 2200 DS	$50,000	+$1.23

On the O&M for the groins---what we assumed, it is an average annual that we are trying to come up with. We said about $100,000 per year for repairs. I think that this $7,000 is the escalation since we did the report three years ago.

That is an assumption the whole maintenance thing on groins is just to repair it if rock rolls out and it needs to be repaired. We assumed $100,000 three years ago.

These costs here is just the differential in electricity between the existing and future. So when we are talking these two intakes, that is just the differential between operating costs now versus operating costs in the future.

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OPINION OF PROBABLE COST

M&T Ranch / Llano Seco Intake Project

5-Dike Option

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	MOBILIZATION / BC	1	LS	$ 225,000	$ 225,000
2	EROSION CONTROL	1	LS	$ 20,000	$ 20,000
3	SITE ACCESS DEVELOPMENT	1	LS	$ 25,000	$ 25,000
4					
5	DIKE 5				
6	SITE CLEARING AND PREP	5	ACRE	$ 1,500.00	$ 7,500
7	EXCAVATION: SOIL	27,000	CY	$ 10.00	$ 270,000
8	EXCAVATION: SOIL IN-WATER	5,000	CY	$ 19.00	$ 95,000
9	DIKE FILTER ROCK, DELIVERED TO SITE FROM QUARRY	27,000	TON	$ 29.00	$ 783,000
10	DIKE FILTER ROCK, PLACEMENT	15,000	CY	$ 7.80	$ 119,118
11	DIKE RIP RAP, DELIVERED TO SITE FROM QUARRY	40,000	TON	$ 29.00	$ 1,160,000
12	DIKE RIP RAP, PLACEMENT	20,000	CY	$ 15.00	$ 300,000
13					
14					
15	ENVIRONMENTAL				
16	REVEGETATION	1	LS	$ 20,000.00	$ 20,000
17	MITIGATION, OFF SITE	0	LF	$ -	$ -
18					
19	UNLISTED ITEMS	10	PCT		$ 250,000
	SUBTOTAL (ROUNDED)				$ 3,325,000
	CONTINGENCY	25%			$ 831,000
	TOTAL CONSTRUCTION YEAR 2008				$ 5,806,000
	ENGINEERING/CONSTRUCTION MGMT/PERMITTING	20%			$ 1,000,000
	TOTAL PROJECT YEAR 2008				$ 4,806,000
	TOTAL PROJECT YEAR Oct 2011 (ROUNDED)				$ 5,000,000

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OPINION OF PROBABLE COST

M&T Ranch / Llano Seco Intake Project

Pump Station Relocation

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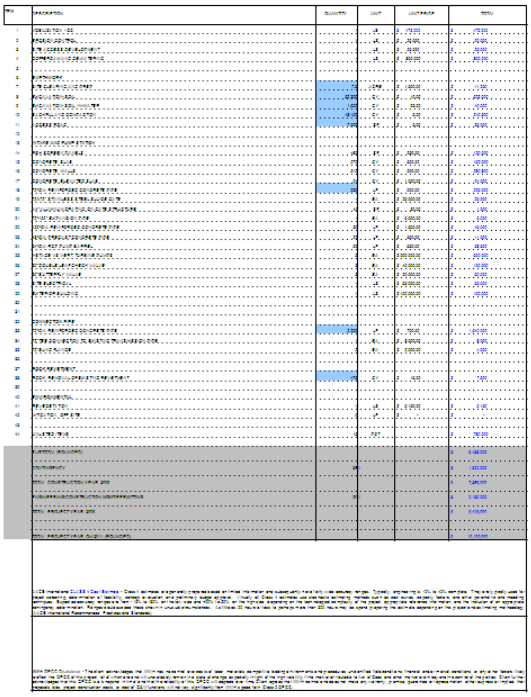
OPINION OF PROBABLE COST

M&T Ranch / Llano Seco Intake Project

Pump Station Relocation



Estimated O&M Costs

M&T Ranch Pump Station Relocation

2007 M&T Costs for Existing Pump Station

Gas	$165,000
Electricity	$4,000
Maintenance & Repair	$27,000
Misc.	$10,000
	$206,000

Total Acre-ft pumped	40,800
$/AcF (2007)	$5.08

Assumptions for New Pump Station

Avg Annual Pumped Flow	40,800 Acre-ft/year
Efficiency	80 %
Electricity Cost	$0.10 $/kW-Hr

Replacement Costs

$130,000 to replace pump once every 15 years

$70,000 to replace motor once every 25 years

Avg Head (ft)	22	22	26.5	27.2

	Location of Pump Station			
Proposed Pump Station	Existing Pump Station	Groin Option	New P.S. 2300-ft DS	New P.S. 3800-ft DS
Electricity, pumping	220,000	220,000	255,000	272,000
Electricity, other	$4,280	$4,280	$6,420	$6,420
General Maint.& Repair	$32,100	$32,100	$32,100	$32,100
Pump Replacement, Amortized	$27,820	$27,820	$27,820	$27,820
Motor Replacement, Amortized	$8,988	$8,988	$8,988	$8,988
Misc.	$10,700	$10,700	$10,700	$10,700
Rock Maintenance & Repair	$0	$107,000	$0	$0
Total	$303,888	$410,888	$341,028	$388,028
$/Acre-ft	$7.50	$10.16	$8.42	$8.84
Increase	$0.00	$107,000	$37,140	$84,140
Increment ($/Acre-Ft)	+$0.00	+$2.64	+$0.92	+$1.34

	O&M Increase	Increment
Alternative	($)	($/Acre-Ft)
Dike Option	$107,000	+$2.64
Pump Station 3800 DS	$37,140	+$0.92
Pump Station 2300 DS	$84,140	+$1.34

These are operating costs that we applied to the new pump stations also. The only difference is the additional pumping costs to pump the water farther away downstream.

That's why essentially these numbers are here. The numbers are comparing with existing alternative. It would costs $37,000 per year for electricity to pump the extra 2,200 feet. Over and above current costs.

Just like the groins are over and above current costs, because there are no groins out there.

The reason that we did the initial cost was because our charter was not to increase the operations and maintenance costs. The extra 2,200 feet cost the water users that much more per year.

There is a comparison to the Patterson Project.

The construction costs on the Patterson Project was a little over $9 million. That was $9 million for a just completed pump for 195 cfs on the San Joaquin River. A flat plate screen, on the bank with electric pumps. However, it did not pump 2,200 feet. It lifts about 18 feet. Total costs of design, feasibility, and construction management totaled about $15 million.

The presentation was just construction costs. Permitting and engineering is estimated at about 25% more.

The essence of the groins is that if you put enough rock in there it is self adjusting the beauty of it is that you beef up the up-front costs just wondering for the O&M costs what do you envision on the dikes?

There will probably be an overflow on the top and maybe some rock is lost on the top with the downstream corners losing most likely but probably zero for 10 years. Then you get a big flood and then you – don't know what the cost might be. Granted we made an estimate of $100,000, it may, however, be one half that. We would be putting a lot of protection around the toe to settle in to protect the toe

What we did for the self-adjusting rock is just lay it on the bottom. We did not dig a hole at the toe like a lot of Corps projects, mucking around in the river

Discussions regarding alternative power sources, e.g., natural gas vs PG&E

SUMMARY & DISCUSSIONS

Jim Well: That concludes the presentations. We need to insert those alternatives into the NEPA/CEQA process to see which option passes the environmental test. We still have to garnish funding. The environmental review process is going to take approximately two years beginning sometime this winter. In the short term, we need to be aware of gravel bar movement in the vicinity of the fish screens; and, in the long-term, get through the environmental process.

Tracy McReynolds: Do you know the cost of survey for this coming winter? Is funding secure and in contract for the survey? Is there partial funding or no funding?

Jim: No unless we can divert some funding from some other task.

Tracy McReynolds: Ultimately is that the dike option still off the table and not viable due to the TNC position? There is also NEPA with the rock toe.

Jim Well: There are additional discussions to be had.

Tracy McReynolds: Is there any hope from TNC or is the door completely shut? Maybe through discussions, there is a glimmer? Is this even a viable option or is it dead in the ground? Why we are discussing the option in the evaluations now if it is not a viable option?

Greg Golet: That's a good question. I think we've been pretty clear on our position the last couple years. We have provided letters and documentation supporting why we say that groins or even extending the toe rock or the stockpile would not be allowed on the easement. So we have already provided that information.

Tracy McReynolds: I'm assuming you stance is not changing. For me, that isn't even a viable option.

Gretchen Umlauf: I think that the dike option could be in line for restoration if you turned it into a fish-friendly option. That has not been discussed and should be looked at. Part of what we are doing is trying to mix and match two very different goals and objectives. I think that one of the things that we should do is get on the same page is in terms of trying to work with the community regarding the easement. In earlier discussions with Mike regarding what has been valid with goldmine fields, that by the time you perfect something that is already natural anyway, why don't we try to include improvements. Let's look at using that side channel as other options to bring that sediment out of it through flowing out the side channel. I know we can't study this anymore. I think that there are so many great fish-friendly, recreational, and public enjoyments that can be brought together with the geomorphology experts.

4:20:46

Jim Well: The intent was to make the spur dikes as fish-friendly as possible by constructing benches in the dikes. The design just depicts slopes in the drawings. However, we are aware of that and this approach would be incorporated before the dikes were built.

Gretchen Umlauf: I knew that you had that in mind and I think that TNC would be a little more friendly toward it.

Jim Well: TNC reviewed the easement. The determination was that there is specific language in the easement that does not allow the placement of rock on the river banks.

Gretchen Umlauf: This question is for Mike-- part of the messages I got from your presentation on the topographic and bathymetric is that if the river geometry is maintained, the river will be self-cleaning. That is very encouraging. What is unclear to me is how essential is the 1,300 foot rip rap extension downstream to achieving the project goal?

Mike: If you look at what Bob showed you, it appears as though the sheer stress along that right bank is pretty low. It is my innate caution to make sure that it's going to work. It may work at the moment. Let's assume it works. Then, if you end up with erosion in that area, then I guarantee you that it won't work because you don't have that constriction in there. If that widens out, then all bets are off.

By fortune or otherwise, the geometry of the river has changed and that is why we have that belly upstream. It's that belly upstream that's kicking the flows. The question we don't know or the answer to the question is how strong is the helical flow. We do know that if that bank erodes back it will get weaker. It will straighten things downstream. So, if we are looking at something that is a long-term fix. This is not a technical answer.

Gretchen Umlauf: Just asking for a professional judgment. There is more certainty if the rip rap is there.

4:24:35

Bob Mussetter: The extent of the existing toe rock ends well upstream from the critical area. So basically, we have an unprotected bank all the way along there that can potentially erode out The idea is right -- to continually build the bar, the bar continues to put pressure on that bank. That is what makes me uneasy to leave the toe rock the way it is.

Tracy McReynolds: Did Eric Larsen model the original 1,500 feet of toe rock and the extension to look at velocity change with the rock on the Shaw property? We looked at spur dikes on the Shaw property but did we look at the rock toe on the Shaw property? The big unknown is deposition rates, hydraulics. How is it going to change? How many dry years? Is the helical effect going to keep up with the deposition rate? I think we still need to prepare for periodic dredging with that option. If we get in a drought scenario, we may have to come in and do a short-term dredge. Have we modeled that section to see if the velocities pick up?

Bob Mussetter: I think the idea with the toe revetment would not so much to change the existing bankline, but to hold it where it is. We have effectively modeled the scenario that you are talking about. What we haven't talked about is what happens if the bank doesn't stay there and erodes back. Eric Larsen's model is not capable of modeling at the necessary resolution to answer the question.

Dave Zezulak: Help me to understand that by adding the 1,300 feet of protection on the west bank and putting in the 9 spur dikes and over time they are going to silt in behind them. Effectively, what you are doing is moving the west bank out into the river some 60 to 80 feet and that, presumably, will narrow the channel. It may or may not deepen the channel. It may or may not cause a scour.

Mike Harvey: There is a set of issues. As of yet, we have not thought about a combination extending the toe rock. Separately, the idea of the dikes is to shift the flow field to the east back more on the alignment when the pumps were originally constructed. If that can be achieved, then the flow, velocities, etc. are enough to sweep that area. You will get some deposition whenever you put a dike field in. You always get deposition between the dikes and it will be closest to the bank in the root area. Basically, once the dikes are overtopped, you get a big eddy in that area which induces the sedimentation. Farther out from there, you don't have that eddy. So it limits how far the deposition will occur. Vegetation will come in there.

Dave Zezulak: I'm really interested in whether or not there is going to be a clear channel to the intakes?

Mike Harvey: Yes, with the dikes.

Bob Mussetter: We have done the physical model and the numerical model and showed that it will with the dikes. Until this helical flow idea came up with this year's data, we didn't really think that it would stay clear with even the existing alignment. Now, we see that we haven't had gravel over the intake yet. Now, we are starting to wonder maybe we don't have to put dikes in there-- maybe it will work if we just put toe rock in and hold it where it is.

Yantao Cui: By constricting the flow you are increasing the velocities and basically scouring the bed.

Jim Well: Another thing to take home is that the rock toe that was constructed under temporary conditions in 2007. However, all our modeling shows that it needs to remain there permanently in order for any of these alternatives to work. It was intended to protect all the options with a 5-year limit. In hindsight, we it should have not been limited.

Mike Harvey: The reality is, if you don't hold the west bank, forget the pumping plant, forget the outfall. If you don't hold that west bank, all bets are off for the pumping plant and the City of Chico. That's at all locations.

Les Heringer: We can talk about moving down river but, if we don't harden that west bank, then it is only just a matter of years before that gravel bar migrates down to not only our location but the City of Chico's location.

Mike Harvey: As you get deposition on the bar, it forces erosion on the west side; and, in doing that it feeds on itself it's a feedback loop and so in a period of about 10 years the bank went back a width of the channel approximately 400 feet and it will keep doing that and the river will keep moving westward. As the river moves westward, it leaves behind the existing pumping plant and eventually the City of Chico outfall.

Tracy McReynolds: The current toe revetment is on FWS property. It was not intended to stay in perpetuity. It is there and it is OK because it is not on the Shaw property. To date, FWS has allowed the current 1,500 feet. It is only supposed to be there for 5 years. I think you can work with FWS to leave it there.

Jim Well: [To TNC] Your estimate on where your easement ends is further out into the river than the current bank is that correct? The language says to the high watermark. What defines the high watermark?

Audience: When the bank moves back The Nature Conservancy loses property in their easement. The boundary accretes

Bob Mussetter: By definition, the boundary is going to be somewhere around where we put the stockpile, somewhere around that bar.

Jim Well: The State Lands Commission considers any minerals up to that high watermark under their ownership.

Tracy McReynolds: Have all the long-term dredging options been thrown off the table and are now not viable?

Jim Well: The channels did not last. After a high flow they filled in.

Tracy McReynolds: Did we look at costs? We are talking about moving forward with an environmental document with options and really two of them are not viable because of the current easement issue.

Jim Well: We cannot determine that question here.

Greg Golet: I need to clarify that there have not been any discussions or negotiations. We have provided our input and that's it.

Mike Harvey: The base cost for dredging is around $1,000,000.

Jim Well: That is not all the costs, that is just the construction cost.

Tracy McReynolds: It may look a little different with the rock toe in. We can assume that it stays. We may have X amount of years that it stops the migration of the bar every so often. It will scour itself then maybe a long-term dredge will be possible.

Paul Bratovich: I don't think that there has been a clear distinction made between the short-term project and the long-term project. I'm not sure whether there has been an agreement that dredging has been removed from consideration regarding any combination of components addressing the long-term solution.

Dave Zezulak: For the last three or four years, the Department of Fish and Game, Fish and Wildlife Service and NOAA Fisheries have been making recommendations that, if dredging is the long-term or future dredging should become part of the ranch's operations; and, if they are going to continue to be funded by bond measures, they are not going to continue to do periodic dredging in perpetuity. That's why there has been this much money put forth to analyze the alternatives and to determine a solution. A solution may include dredging, but it is going to have to be in a program that

is self-sustaining and pays for itself. I'm not saying it's not an option. I'm just saying that continued funding is a problem. There isn't even a place to stockpile the material, It seems to be a difficult road to go down.

Les Heringer: I cannot run a farming operation, not sure about the refuge managers, if they can run a refuge not, knowing whether they will have water from one year to the next. It takes a year plus to get permits to dredge and the farm cannot have interrupted water supply. That is what you would be asking me to do, if dredging was a long-term solution. I just cannot farm that way. It would not work. The ranch has never diverted from Big Chico Creek. The pumping plant was on Big Chico Creek but the water supply was from the Sacramento River. The ranch has the right to take the water back from Butte Creek, if the water from the Sacramento River is unavailable. Even if the ranch goes back to Butte Creek, it is not enough water because it is shared 50/50 with the refuges.

Paul Bratovich: One of the initial steps of the environmental documentation process is going to be to identify a range of viable and reasonable alternatives. The identification of a reasonable range of alternatives will determine what suite of alternatives is carried forward for detailed analyses in the environmental document. Today, Mike revealed and described the helical scouring concept, which probably needs some additional exploration to determine whether or not it is a feasible alternative, or a component of an alternative. This exploration should examine whether this concept accomplishes the project's objectives, as they are stated and defined.

I think it is paramount to remember that a no project/no action alternative will be included in the environmental document. It is extremely important that the no project/no action alternative be appropriately defined. As Les stated, if the Sacramento River diversion becomes unusable, the no action/no project alternative may include consideration of diversions from Butte Creek. So, it behooves us all to solve these problems, define and characterize alternative components, and develop a range of feasible alternatives to carry forward for detailed analyses in the environmental document. That doesn't mean that we have to identify a preferred alternative now. In fact, we probably shouldn't. Instead, we should establish a suite of alternatives, subject them to screening criteria, determine whether there is a "fatal flaw" with any of them, evaluate which of the alternatives should be carried forward for detailed evaluation, and then evaluate the environmental benefits and impacts of each alternative. That is what the environmental process is all about.

Again today we heard some exciting and interesting new information, although I think at present it is not clearly defined as an alternative. There is additional work that needs to be done to bring to fruition many of these alternatives. Also there are technical details and issues that need to be clarified in the characterization of many of these alternatives, and components of these alternatives. For example, relocating the diversion and designing a new fish screen raises several technical issues. Specifically defining the issues so that they can be evaluated is part of this on-going process.

Several specific issues have been discussed today. The question about an upstream location with a hard point to avoid Big Chico Creek was discussed, and there was agreement that an upstream location was not viable.

It was emphasized by all the technical advisors that there are no safe locations on the river without hard points.

It also was emphasized that the City of Chico was an important stakeholder in the process.

Tamara Miller: The outfall and intake are within 1,500 feet of each other. For us to go and spend millions of dollars for both parties to find another solution--we have the potential to find a solution mutually beneficial for both. We already had to solve our problem once and-- then again? And how many times to we say, again? Our perspective is when a highway structure in an emergency gets rock groins and yet we had assets on the river that had value beyond a highway structure and we struggled to have a cohesive forward momentum.

Paul Bratovich: It is incumbent on the environmental documentation process to evaluate and identify any potential redirected impacts or unintended consequences, as well.

Jim Well: Next steps are to have HDR get started on the environmental documents as soon as we get the signatures from the California Department of Fish and Game. I have talked with our grant manager about the helical flow study. We are trying to compile the necessary information to move forward with the study.

Kelly Moroney: We need to sit down with HDR to help them understand what our expectations are with the NEPA/CEQA document.

Discussions about used fish screens.

Ryan Luster: Just wanted to hear about what the project proponents were proposing. Again, we have provided the information that says that the easement conditions do not provide for any alterations so that the only easement option is condemnation. So it that what is being proposed? That is my question.

Jim Well: That is a possibility.

Discussions regarding the reluctance of the agencies to carry the condemnation forward.

Tamara Millller: The recommendation on the table is to put all alternatives forward and screen them through the NEPA/CEQA. If the TNC easement and all alternatives related to the easement appear to be environmentally superior to others, and there is only a legal issue, it would be important to know that at the end of the process. To take it out of the beginning of the environmental process, if we don't even know if that is the most preferred environmentally even though there is this huge legal issue.

Paul Bratovich: The process is that the environmental document will establish screening criteria which will include a plethora of specific considerations that are specific resource-related, and can include socio-economic considerations, legal and jurisdictional issues, and conformance with policies and plans – an entire suite of considerations go into the screening criteria. The lead agencies ultimately are responsible to determine what alternatives are carried forward for detailed evaluation in the environmental document. Alternatives will be carried forward for detailed evaluation in the environmental document if they pass the screening criteria. There will be a section in the environmental document that describes alternatives considered but not carried forward for detailed evaluation.

Quene Hansen: The City of Chico definitely wants to see the spur dike included in the environmental process.

Tracy McReynolds: The agency will be in contact with the consultant to be the environmental process.

Question: What is the timeframe for completion of the finals reports to CALFED?

Chris Leininger: The project end date is June 30. All reports will be final at the end of June.

Meeting End