Budiselich Flashboard Dam Fish Passage Improvement Project

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CA Department of Water Resources

Fish Passage Improvement Program

Salmonid Restoration Federation

Fish Passage and Protection Workshop

April 4, 2012

Fish Passage Improvement Program

- Formed in 1999
- Staffed with Environmental Scientists and Engineers
- Funded mainly through the Ecosystem Restoration Program (CalFed/DFG)
- Provides in-kind services on passage projects, mainly in the Central Valley to support ERP objectives

Presentation Outline

- Colleagues, Partners, and Roles
- Background
- Fish Passage Issues at Budiselich
- Design
- Construction
- Monitoring

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CA Department of Water Resources

Fish Passage Improvement Program

- Trevor Greene
- Colin Hanley
- Roger Padilla
- James Newcomb
- Leslie Pierce

Division of Engineering

- Joe Royer
- Will Hicks
- Chris Erickson
- Arnie Sanchez
- Jeannie Kuttel

Partners

Stockton East Water District

- John Green
- Jacob Bejarano
- Kevin Kauffman
- Andres Lozano
- Tom Bergin
- The construction crew

CA Dept. of Fish and Game

- George Heise

USFWS

- Donnie Ratcliff
- Ramon Martin
- David Hu (now with USFS)

Fishery Foundation

- Kari Burr
- Trevor Kennedy

Roles

DWR Fish Passage Improvement Program

- Topographic Surveying
- Design
- Hydraulic Modeling
- Hydraulic Monitoring

Stockton East Water District

- Funding
- Coordination
- Permitting
- Construction

USFWS

- Funding
- Calaveras Fish Group Coordination

DFG

- Funding
- Technical Engineering Assistance

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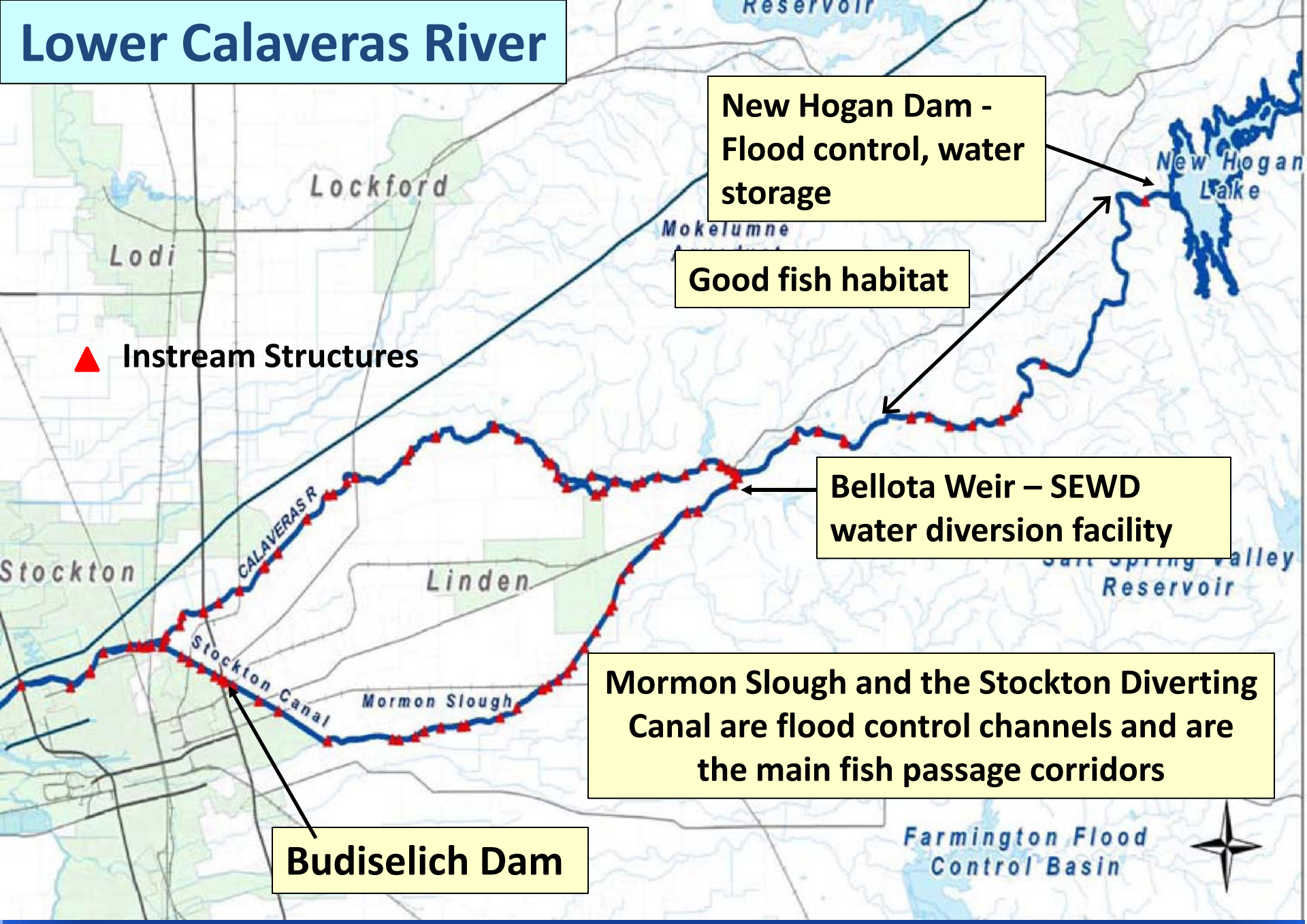
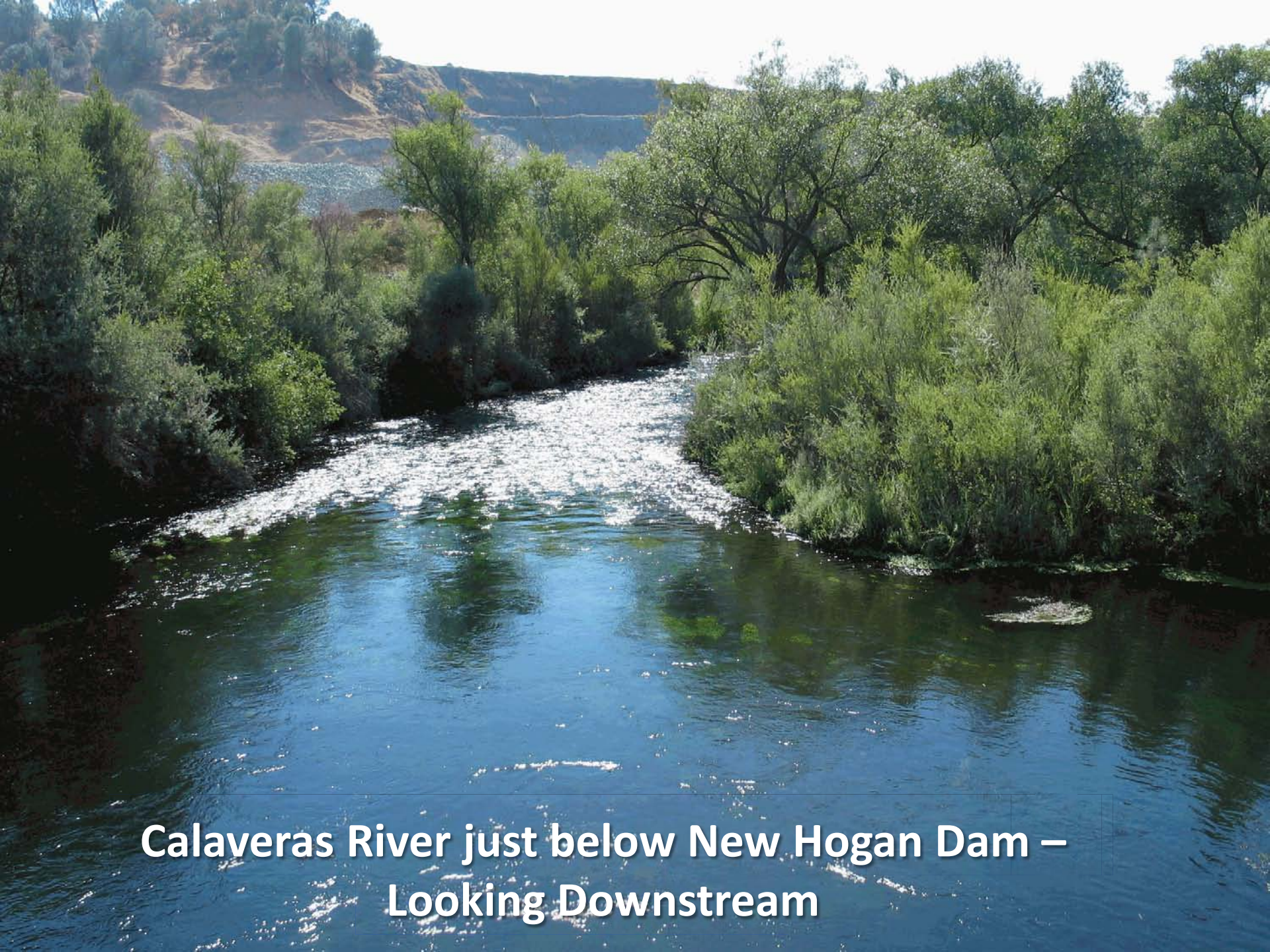
Target Species

- Central Valley Steelhead *(Oncorhynchus mykiss)*
- Fall-run Chinook salmon *(Oncorhynchus tshawytscha)*

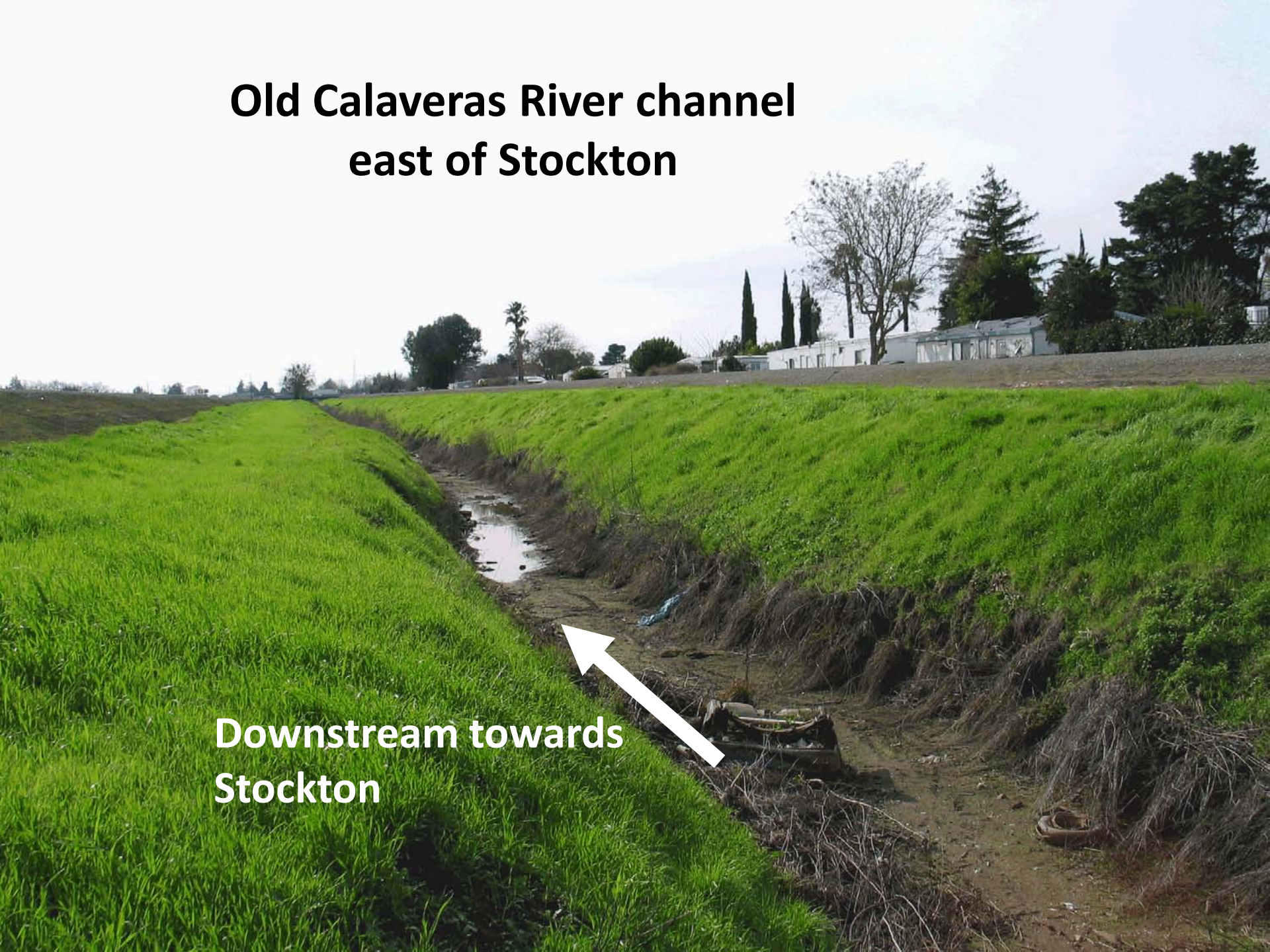
Lower Calaveras River





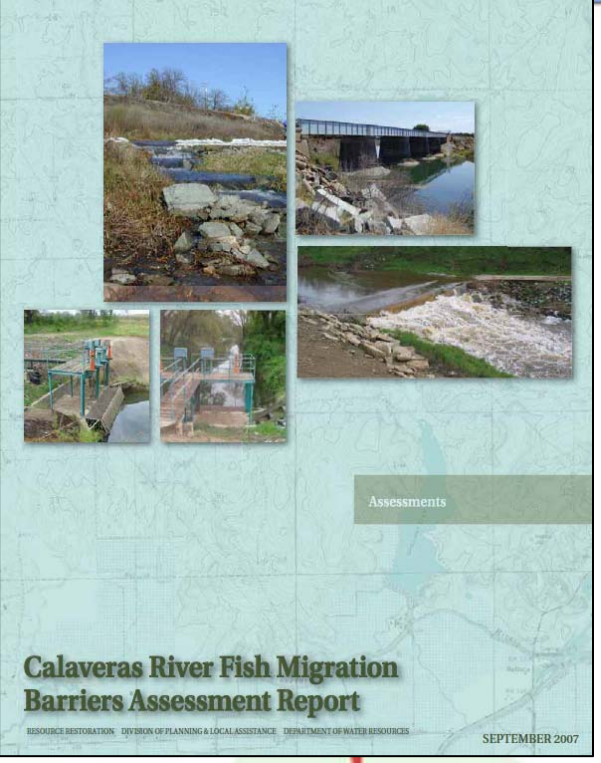
Calaveras River just below New Hogan Dam – Looking Downstream

Old Calaveras River channel east of Stockton



Mormon Slough


Stockton Diverting
Canal



Worst Fish Passage Barriers (not in order of ranking)

1. Calaveras Headworks
2. Clements Flashboard Dam
3. Cherryland Flashboard Dam
4. Gotelli Low Flow Road Crossing
5. Central California Railroad Crossing
6. Budiselich Flashboard Dam
7. Caprini Low Flow Road Crossing
8. Hosie Low Flow Road Crossing

Lockford

Calaveras River

Murphy Flashboard Dam

Bellota Weir

Linden

Flow

Stockton Diverting Canal

Mormon Slough

Mormon Slough Railroad Crossing

Stockton

N

Budiselich Flashboard Dam – Calaveras Fish Group's No. 1 Priority

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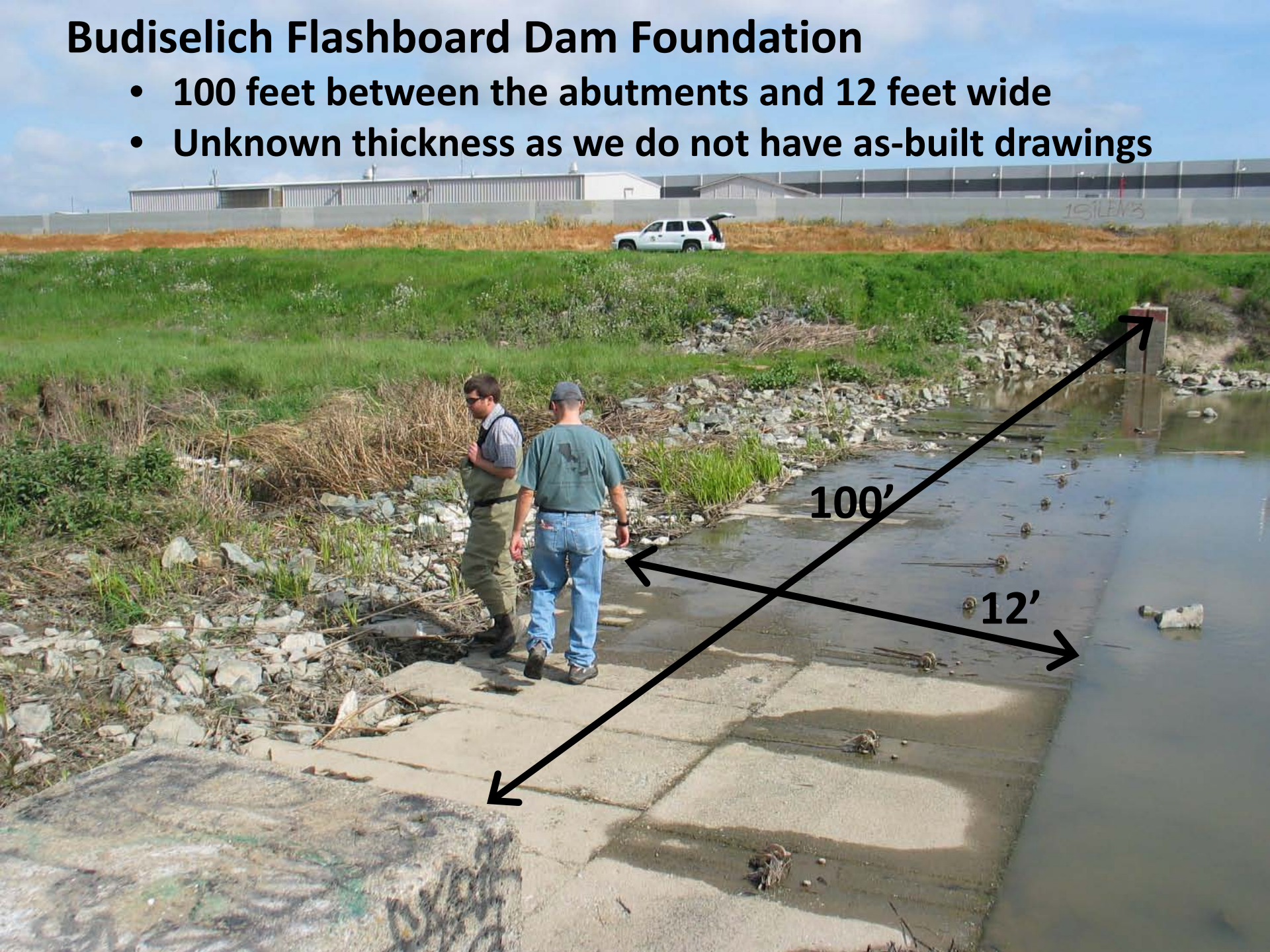
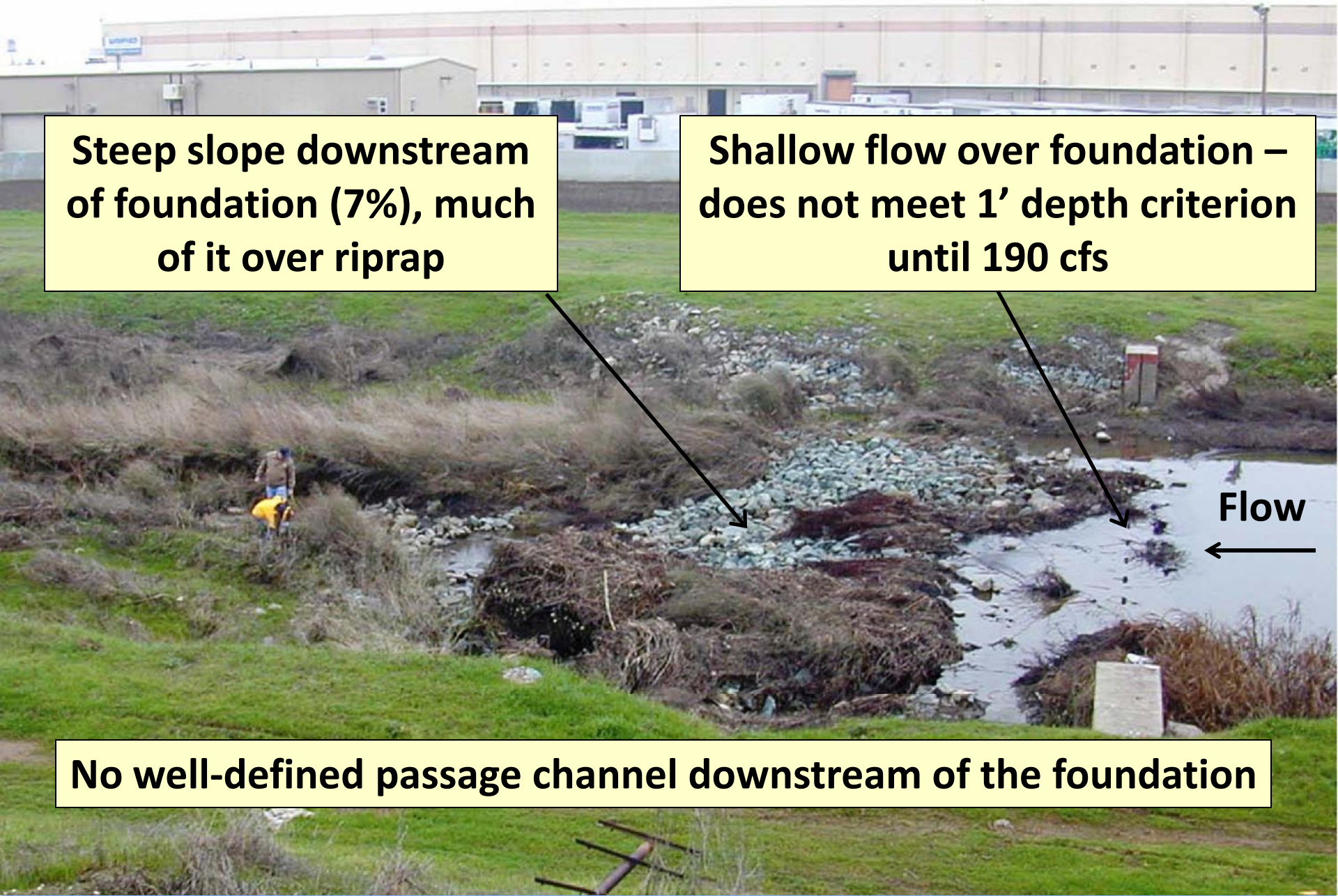
Budiselich Flashboard Dam Foundation

- 100 feet between the abutments and 12 feet wide
- Unknown thickness as we do not have as-built drawings



Fish Passage Issues




October 24, 2001
Steep slope and riprap

February 28, 2006 – Flow Magnitude Unknown


February 4, 2004 - 185 cfs


February 19, 2004 - 267 cfs

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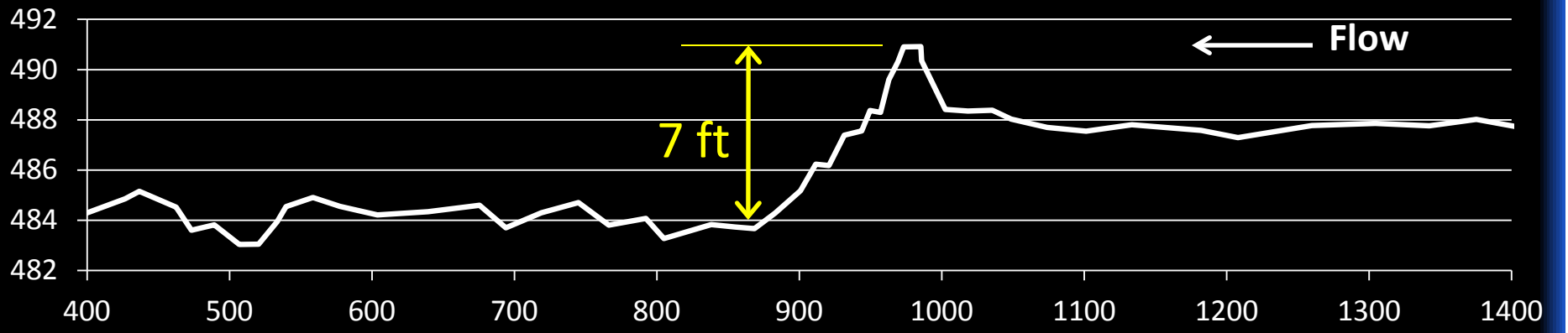
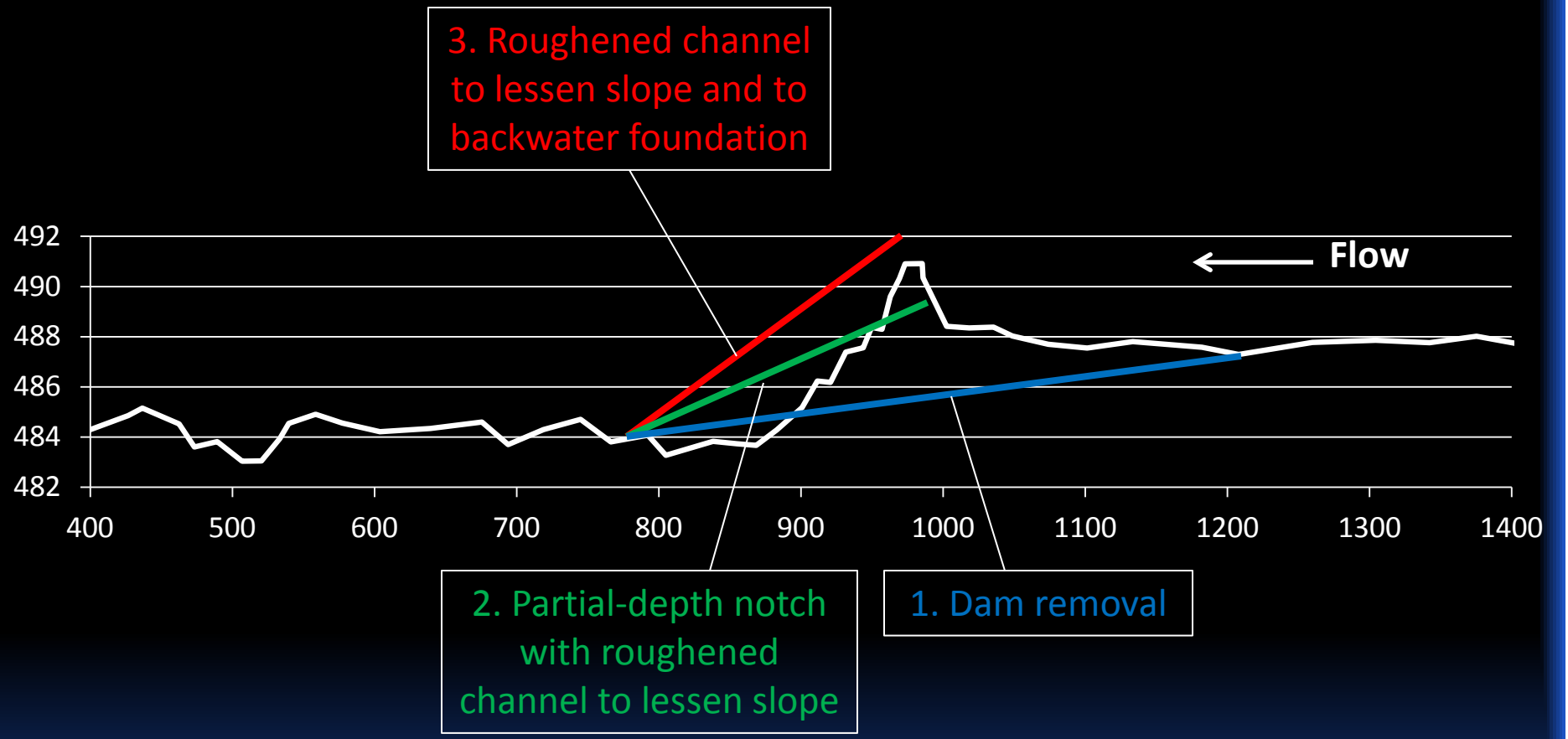
January 2009

Topographic Survey

Longitudinal Profile



Design Alternatives



Preferred Alternative

Alternative 3 - No alteration to dam and construction of a roughened channel downstream

Because:

- **SEWD still uses the dam**
- **Design team thought construction would be simpler**
- **The dam is of unknown**
  - **Thickness**
  - **Stability**
  - **Integrity**

Roughened Channel Design Goal

- Greatly improve fish passage by creating a nature-like passage channel that:
  - Reduces the slope downstream
  - Provides adequate depths
  - Removes riprap
  - Provides multiple passage paths
  - Is stable at all flows

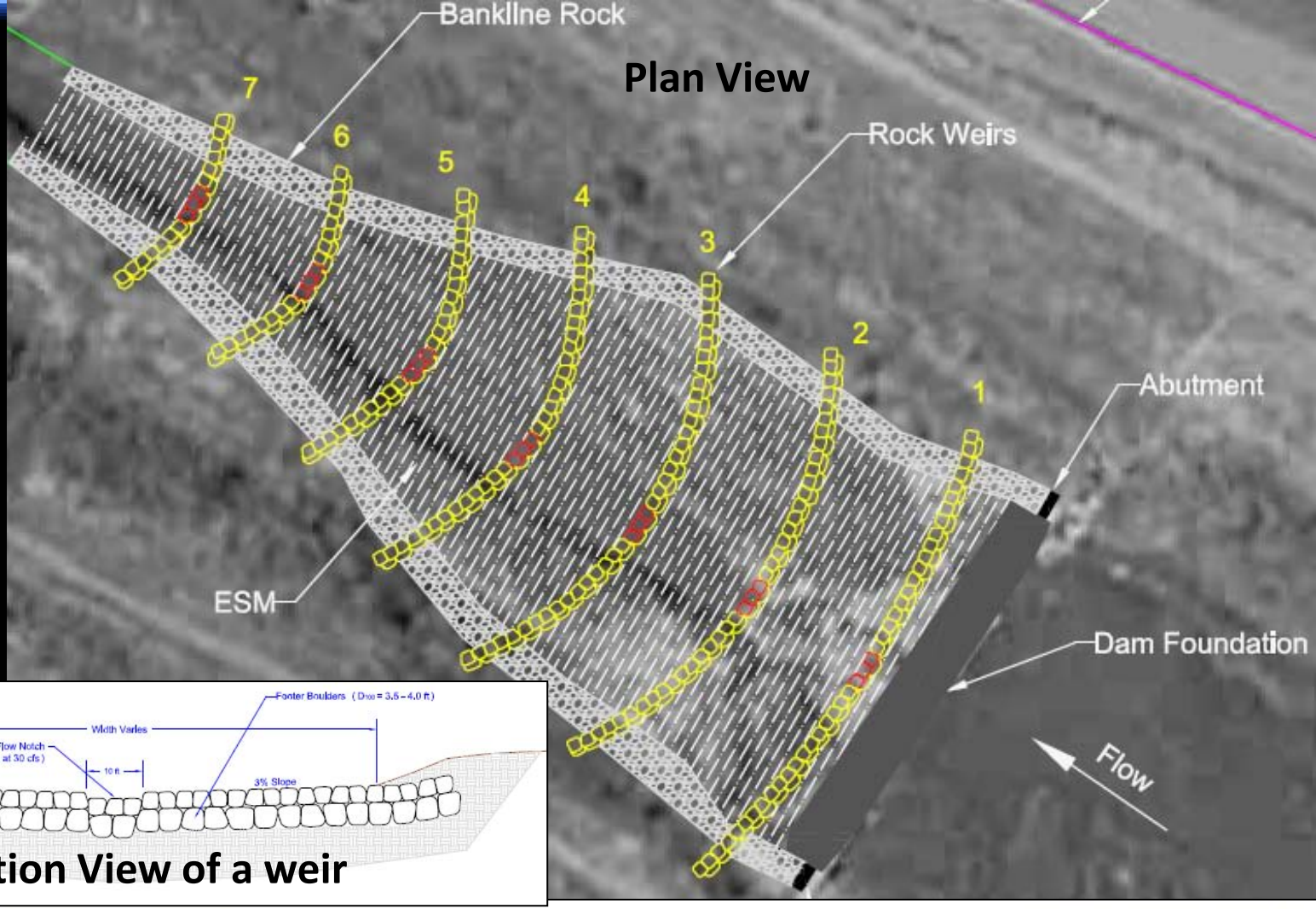
Design Guidance and Criteria

- Used DFG's Fish Passage Design and Implementation Manual
- Used hydraulic design method, which uses fish swimming abilities for guidance
- Designed for adult anadromous salmonids
- Met DFG and NMFS criteria and guidelines

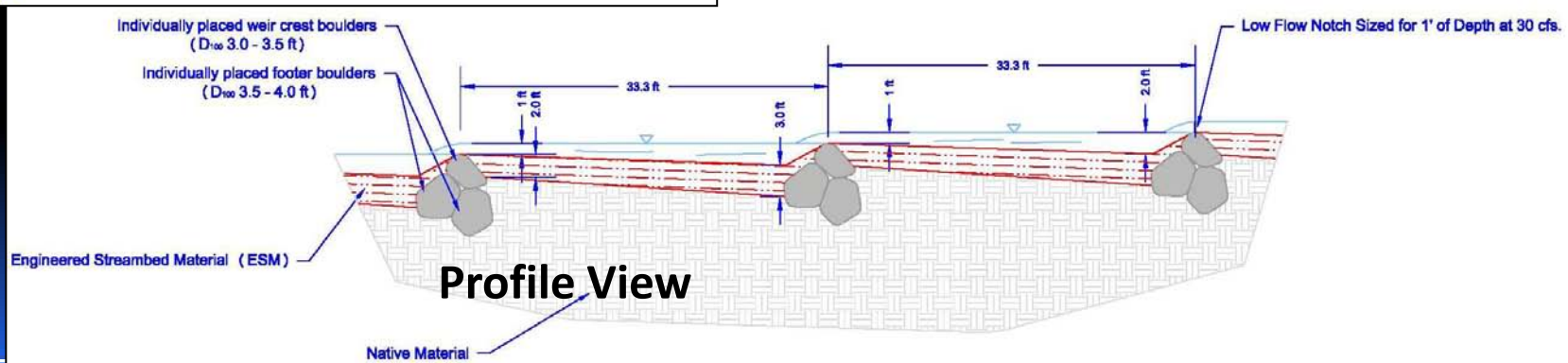
Initial Roughened Channel Design

- Step-pool, boulder weir design
- Longitudinal slope of 3%
- One foot of drop between weirs
- Weirs 33 feet apart
- Low-flow notch sized for the minimum fish passage flow of 30 cfs
- Weirs arched upstream to increase stability and direct flow to center of channel
- Weirs sloped at 3% towards center of channel
- Most upstream weir is flat and one foot above the dam foundation

Initial Design



Section View of a weir



Profile View

Initial Material Sizing

- Calculated the size of the weir boulders, engineered streambed material (ESM), and bankline rock mix for 30 cfs, 200 cfs, and 15,000 cfs using equations in the DFG Manual

- Results:
  - Boulders 3 to 4 foot diameter
  - Bankline Rock Mix – Particle sizes ranged from 1.3 feet down to silt
  - ESM – Particle sizes ranged from 1 foot down to silt

Flood Control Guidelines

- We designed the initial roughened channel to meet the Central Valley Flood Protection Board's guideline of a 0.1-foot maximum water surface rise for the 100-year event due to the project
- However, San Joaquin County , who were initially fine with the project as a pilot project, later stated that they wanted a maximum water surface rise of no more than 0.0 feet due to the project

So…

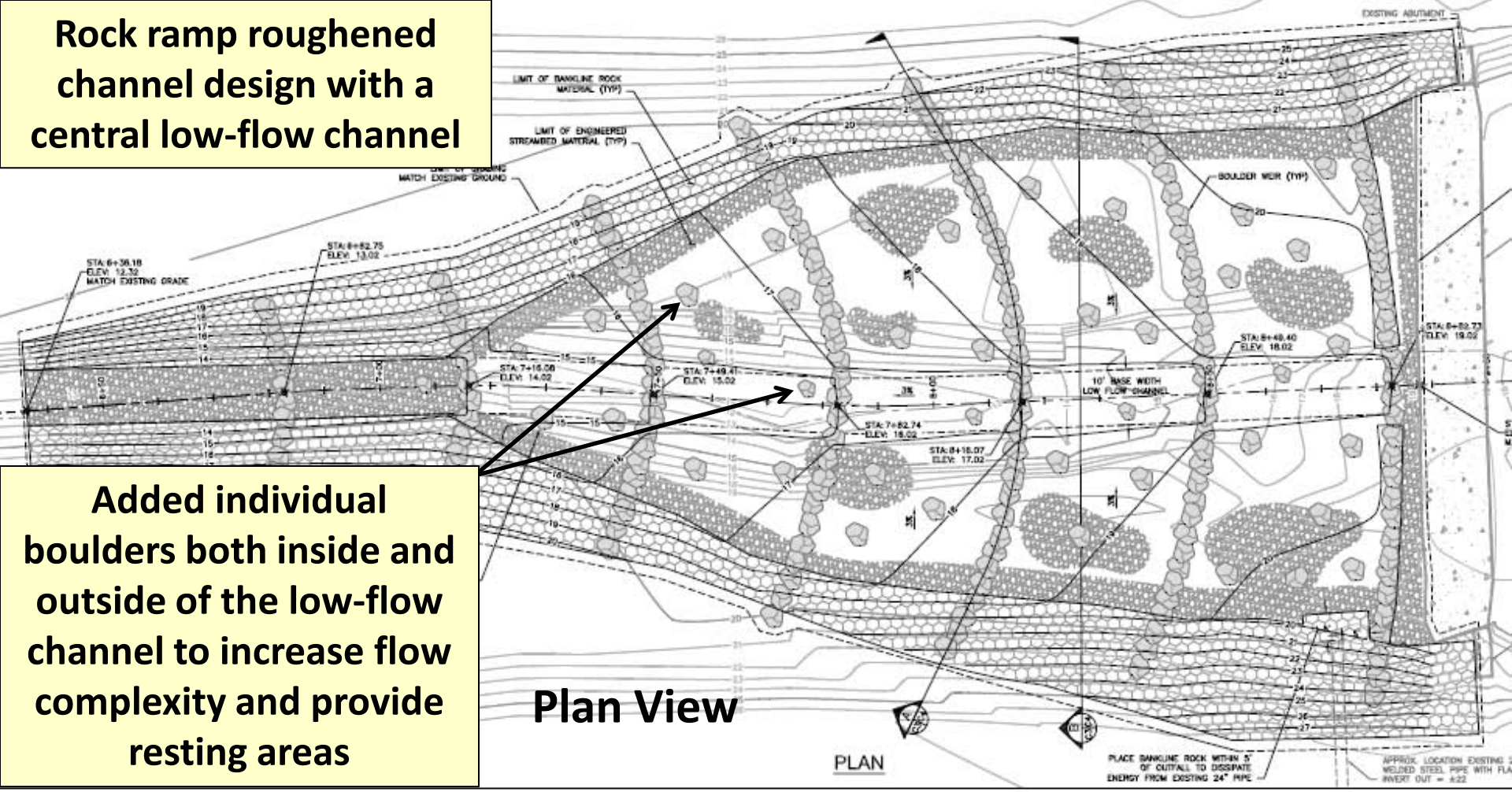
The design had to change and the project became a rock ramp roughened channel

Rock Ramp

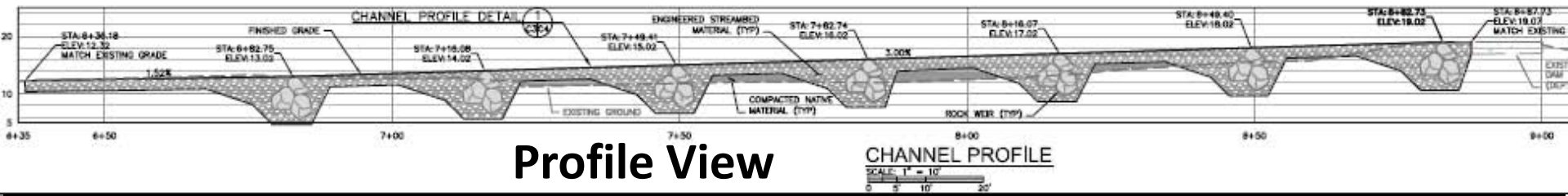
- Took the previous design and filled in the pools to lower the hydraulic roughness during high flow events
- Left the boulder weirs from the initial design as grade control
- Kept the bankline rock and ESM mixes the same

Rock ramp roughened channel design with a central low-flow channel

Added individual boulders both inside and outside of the low-flow channel to increase flow complexity and provide resting areas

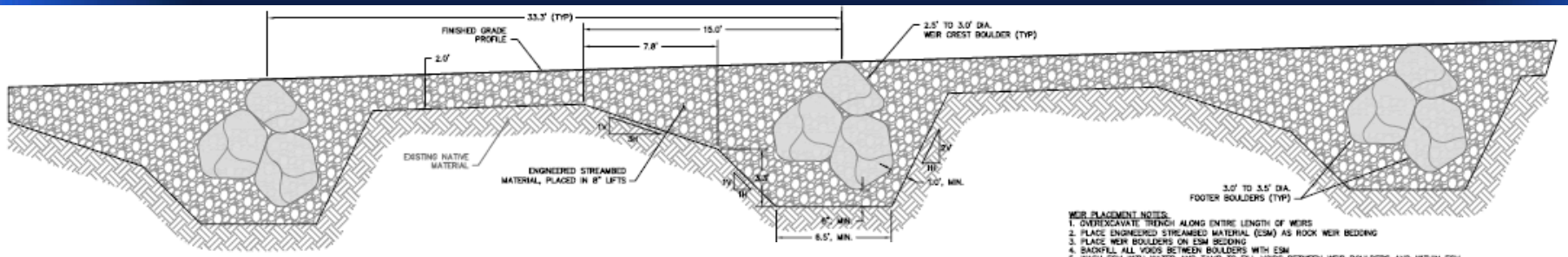


Plan View



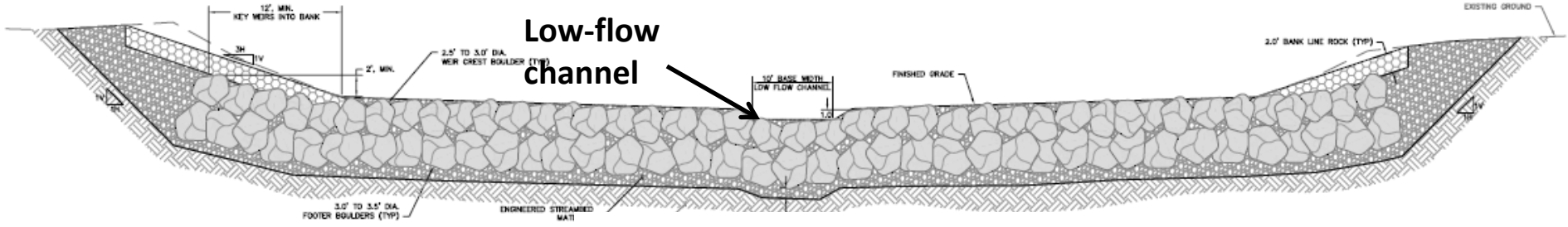
Profile View

Project footprint roughly 250 feet by 130 feet

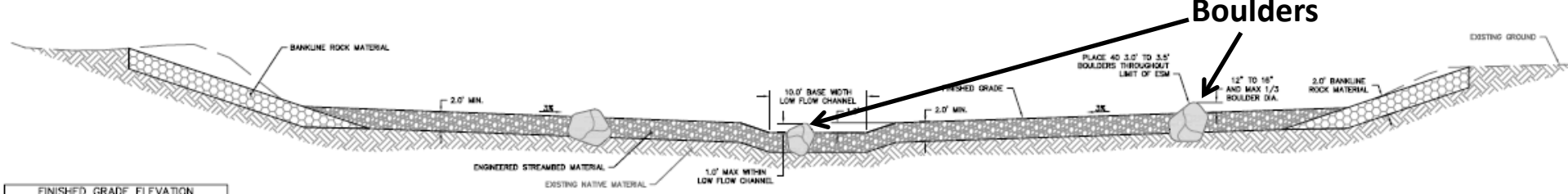


WEIR PLACEMENT NOTES:
1. OVEREXCAVATE TRENCH ALONG ENTIRE LENGTH OF WEIRS
2. PLACE ENGINEERED STREAMBED MATERIAL (ESM) AS ROCK WEIR BEDDING
3. PLACE WEIR BOULDERS ON ESM BEDDING
4. BACKFILL ALL VOIDS BETWEEN BOULDERS WITH ESM
5. WASH ESM WITH WATER AND TAMP TO FILL VOIDS BETWEEN WEIR BOULDERS AND WITHIN ESM
5. PLACE ESM TO FINISHED GRADE
6. WASH ESM WITH WATER TO FILL VOIDS WITHIN ESM AND ENSURE ABOVE GRADE FLOW, MINIMIZING FLOW THROUGH THE ESM.
7. PLACE HAND-SELECTED 10" TO 12" BOULDERS WHERE REQUIRED TO FILL GAPS BETWEEN BOULDERS.

Profile Detail



Boulder Weir Section



FINISHED GRADE ELEVATION CONSTRUCTION TOLERANCES	
BANKLINE ROCK MATERIAL	−0.5' TO +0.5'
ENGINEERED STREAMBED MATERIAL	−0.25' TO +0.25'
TOP OF WEIR CREST BOULDERS	0.0' TO +0.5'

NOTES:
1. LOCAL SURFACE IRREGULARITIES OF THE ABOVE MATERIALS MUST FALL WITHIN THE ABOVE TOLERANCES.
2. THE MEAN DIFFERENCE BETWEEN AS-BUILT AND DESIGN ELEVATIONS OF ANY 5 POINTS TAKEN 20' MINIMUM BETWEEN POINTS ALONG THE FINISHED GRADE OF THE UPSTREAM-MOST WEIR (STA: 8+87.73) MUST HAVE A MAXIMUM VALUE OF 0.10'.

ENGINEERED STREAMBED MATERIAL	
1 PART	10" TO 12" BOULDERS
2 PARTS	5" TO 10" COBBLES
5 PARTS	2.5" TO 5" COBBLES
5 PARTS	0.3" TO 2.5" GRAVEL
3 PARTS	0.08"-0.3" FINE GRAVEL
2 PARTS	< 0.08" FINES

NOTE: MIX MATERIAL ON SITE.

BANK	
5 PARTS	
5 PARTS	
7 PARTS	0.3"-2.5" GRAVEL
2 PARTS	0.08"-0.3" FINE GRAVEL
1 PART	FINES

Roughened Channel Section

PLACEMENT NOTES:
MIX ESM ON SITE TO ENSURE THE INDICATED MATERIAL GRADATION IN THE ESM TABLE.
PLACE ESM IN 8" MAX LIFTS, TAMPING TO COMPACT EACH LIFT.
WASH EACH LIFT WITH WATER TO ENSURE THAT ALL AIR VOIDS ARE FILLED, AND THE ESM IS NOT ALLOW SUBSURFACE WATER TO FLOW THROUGH VOIDS.
IF WATER FLOWS THROUGH VOIDS, PLACE ADDITIONAL FINE-GRAINED MATERIAL ABOVE THE 1 LIFT AND WASH WITH WATER. CONTINUE THIS PROCESS UNTIL THE ESM DOES NOT ON WATER TO FLOW BELOW ITS SURFACE.
UPPER 16" OF ESM MUST BE ROUNDED RIVER-RUN MATERIAL THROUGHOUT LIMIT OF WORK.
5. THE UPPER 36" OF ESM WITHIN 10 FEET DOWNSTREAM OF EACH WEIR MUST BE ROUNDED RIVER-RUN MATERIAL.
7. THE LOWER PORTIONS OF ESM NOT MENTIONED ABOVE MAY BE ANGULAR ROCK MEETING THE GRADATION IN THE ESM MATERIAL TABLE.

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Groundbreaking - September 6, 2011


September 8, 2011 Pre-Construction


Construction Began on September 12
Materials being stockpiled
Water pumping and conveyance
Cardinal Ave
Google Earth – September 15


September 16, 2011
Excavation of native material down to subgrade elevation

September 16, 2011

Excavation of native material down to subgrade elevation

September 16, 2011

Some of the Engineered Streambed Material Components


September 20, 2011
Mixing the Engineered
Streambed Material


September 20, 2011
The Mixed Engineered Streambed Material


September 16, 2011
Weir Boulders


September 20, 2011
Trench for the 1st Weir


September 20, 2011
Bank key for the 1st weir

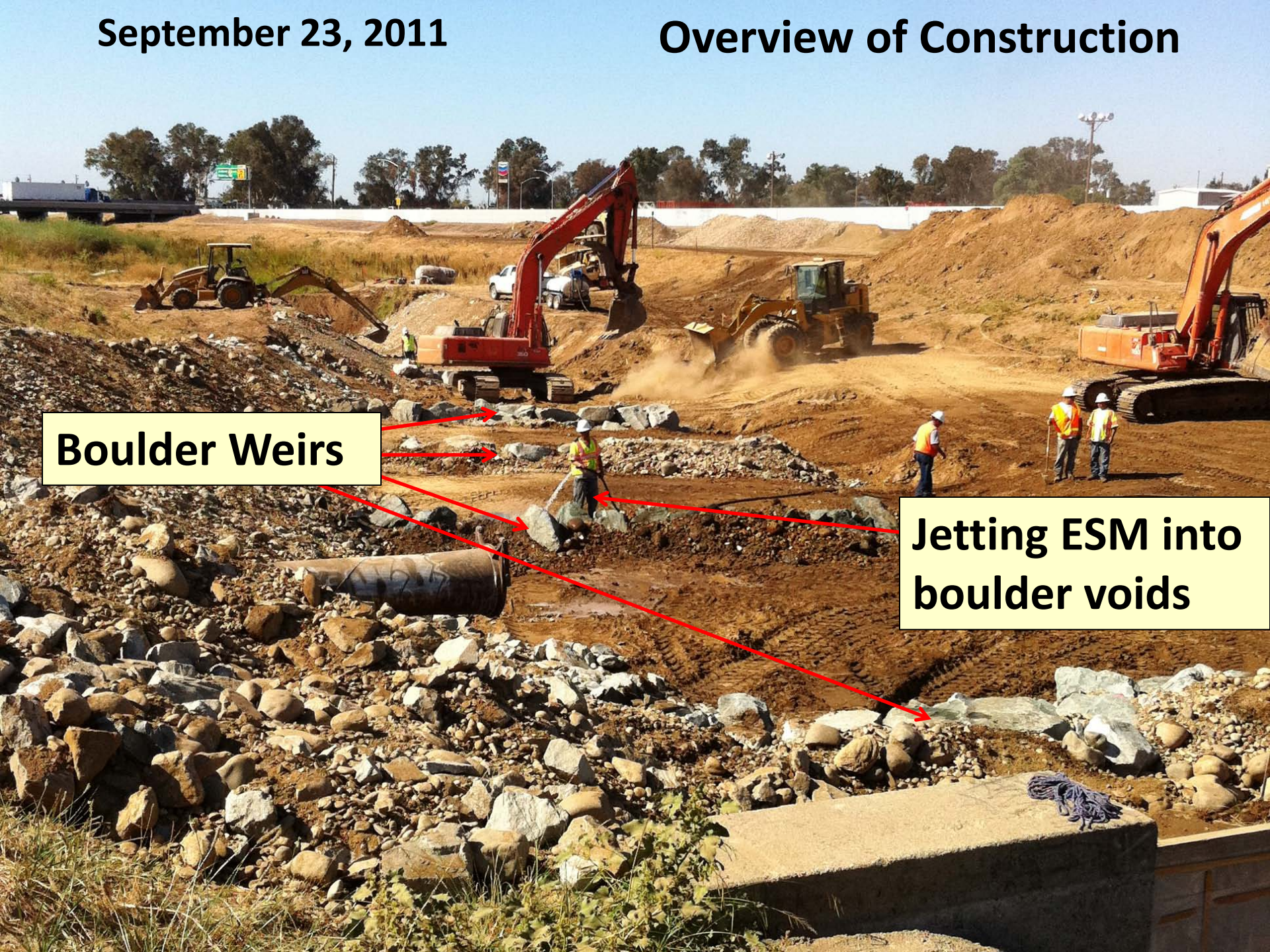

September 22, 2011
Keyed into the bank
The 1st weir


September 23, 2011
The partial 2nd weir
The finished
1st weir

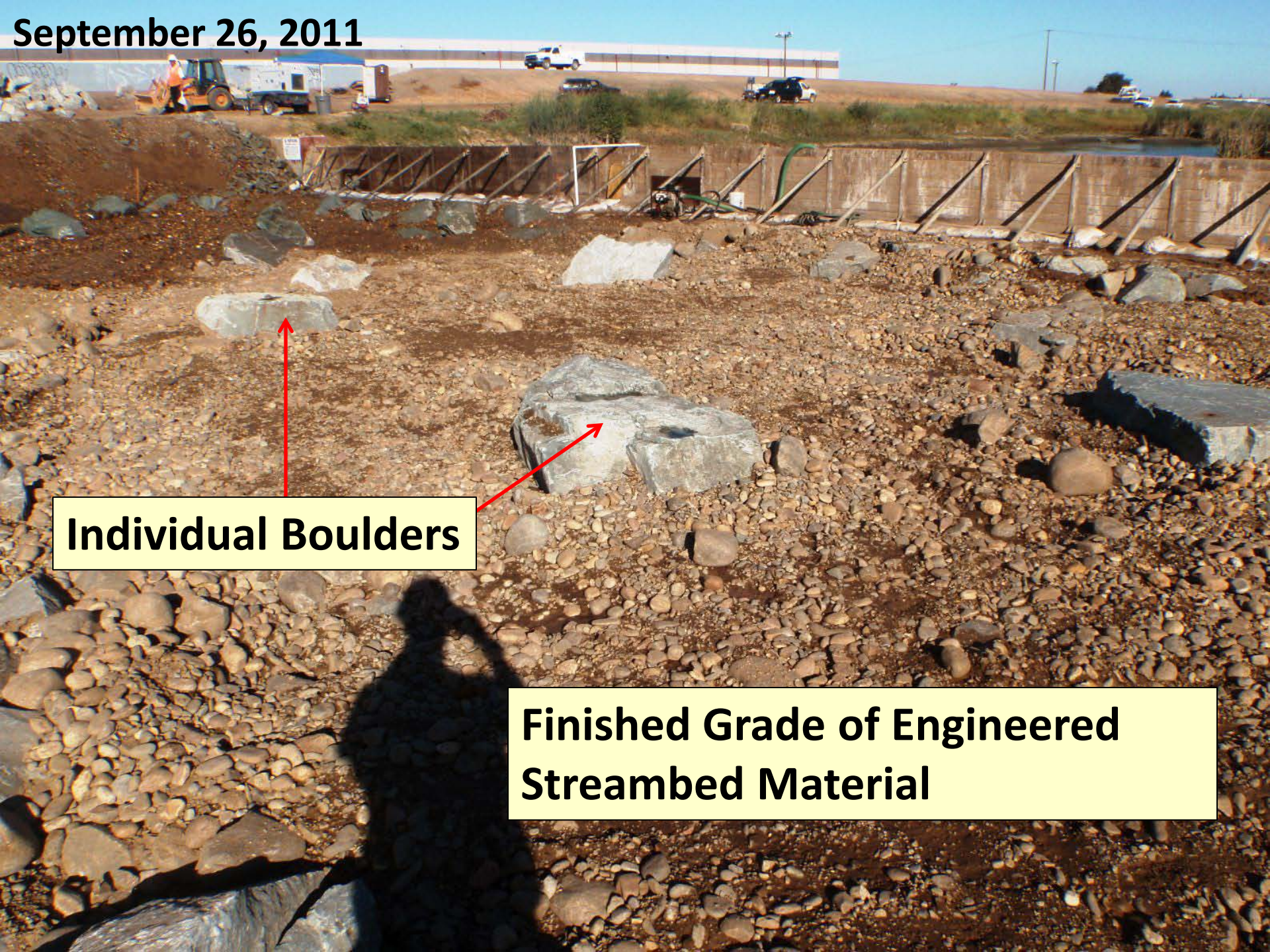
FPIP also provided construction staking and elevation surveys

September 23, 2011

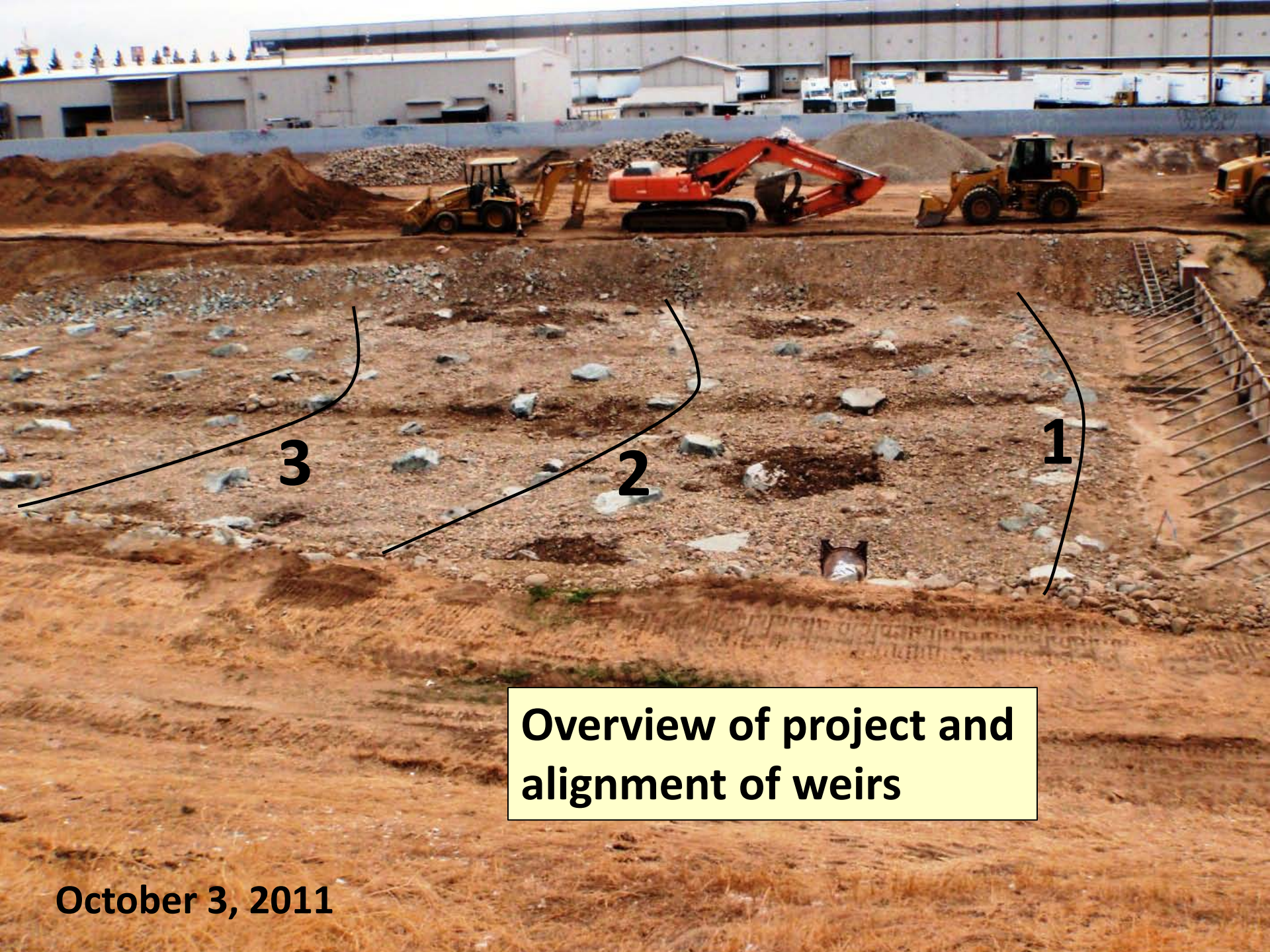
Overview of Construction




September 26, 2011
Washing of Engineered
Streambed Material to fill voids

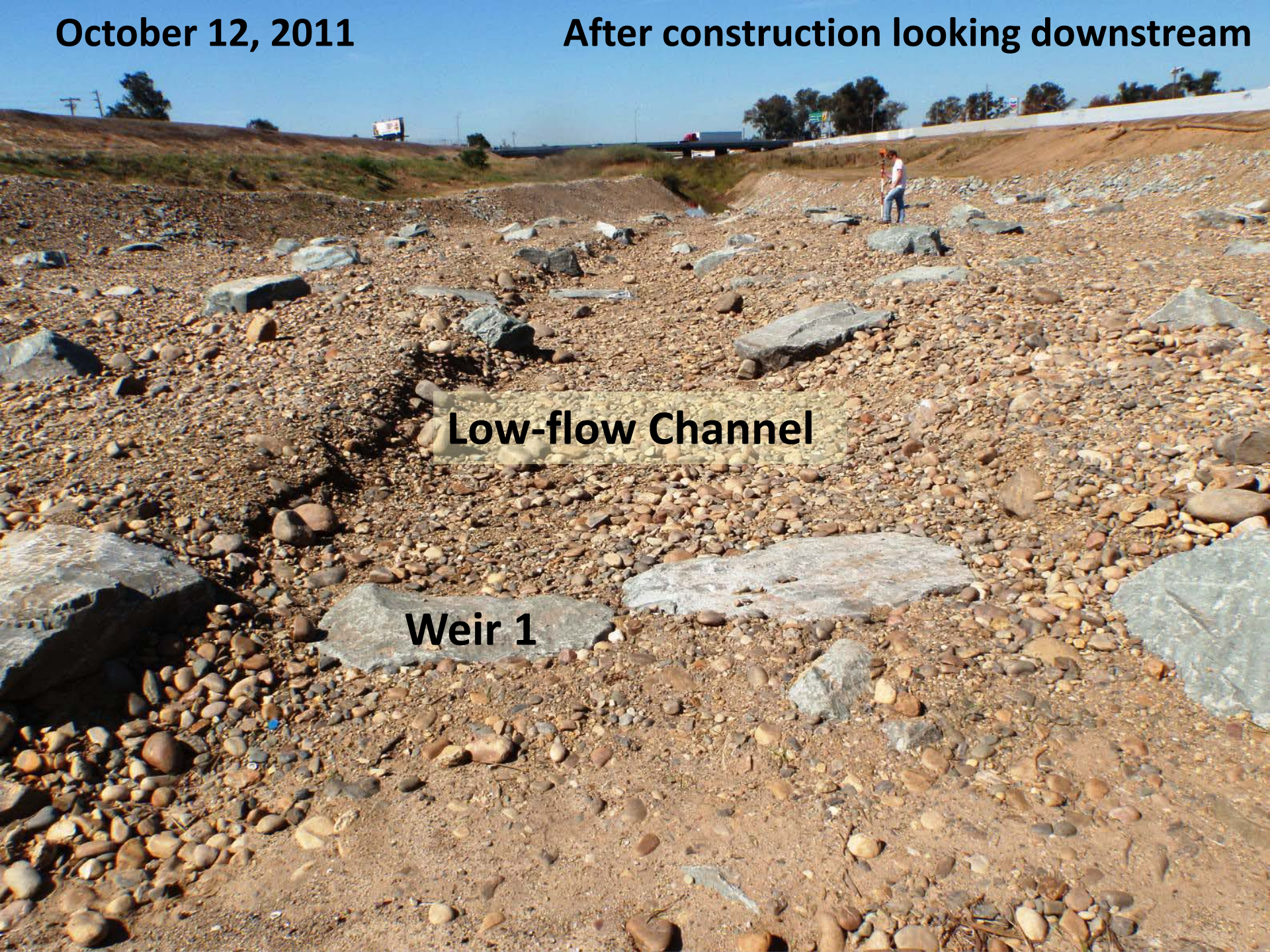

September 26, 2011
Individual Boulders
Finished Grade of Engineered Streambed Material


September 27, 2011
The downstream end of the roughened channel showing the last weir and the bankline rock



Overview of project and alignment of weirs

October 3, 2011


October 12, 2011
After construction looking downstream
Low-flow Channel
Weir 1


October 12, 2011
After construction looking upstream

Project Cost

- USFWS = ~ $155,000
- SEWD = ~ $155,000
- DWR FPIP = ~ $150,000
- DFG = $39,000

- TOTAL = ~ $500,000

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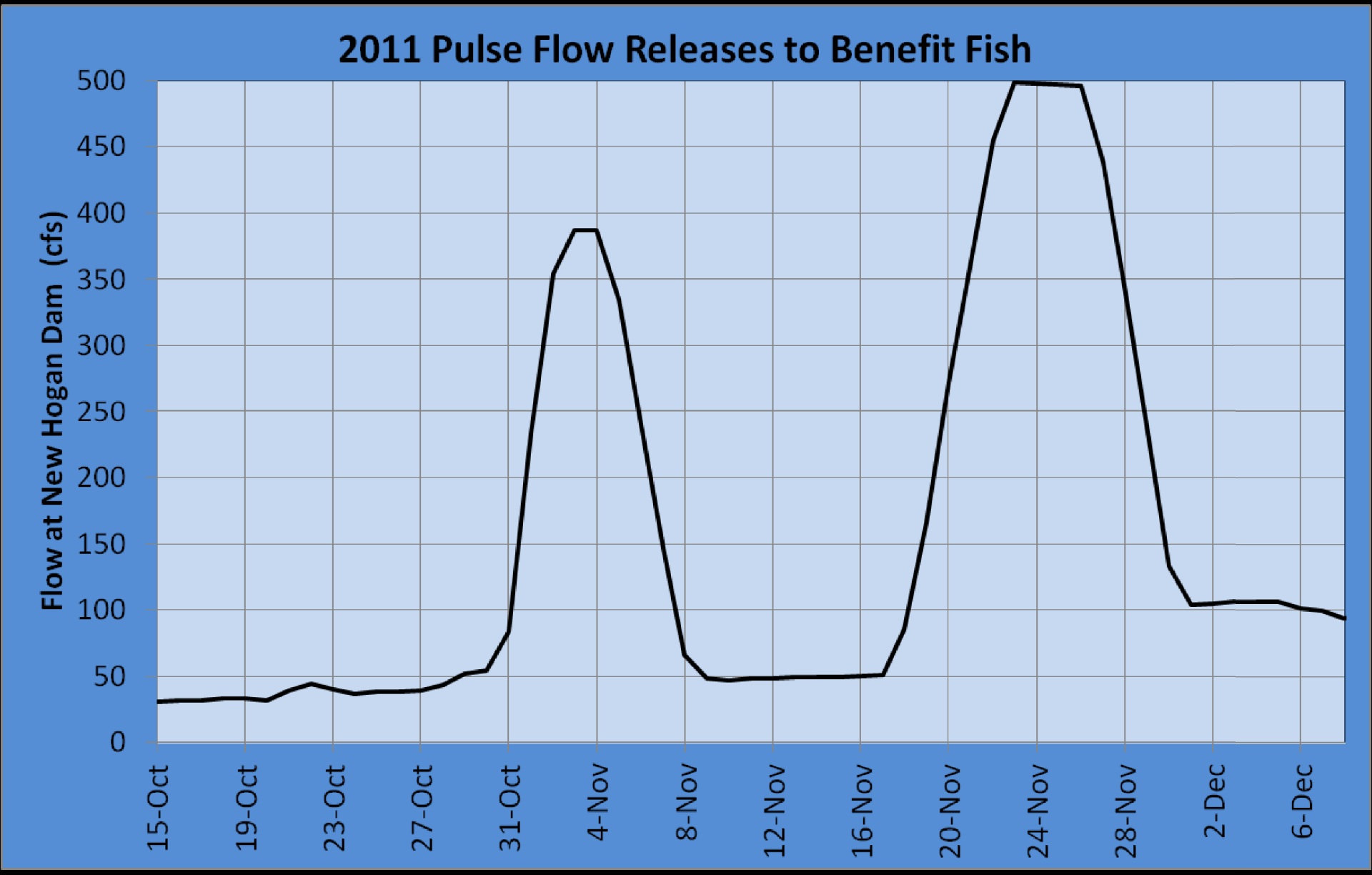
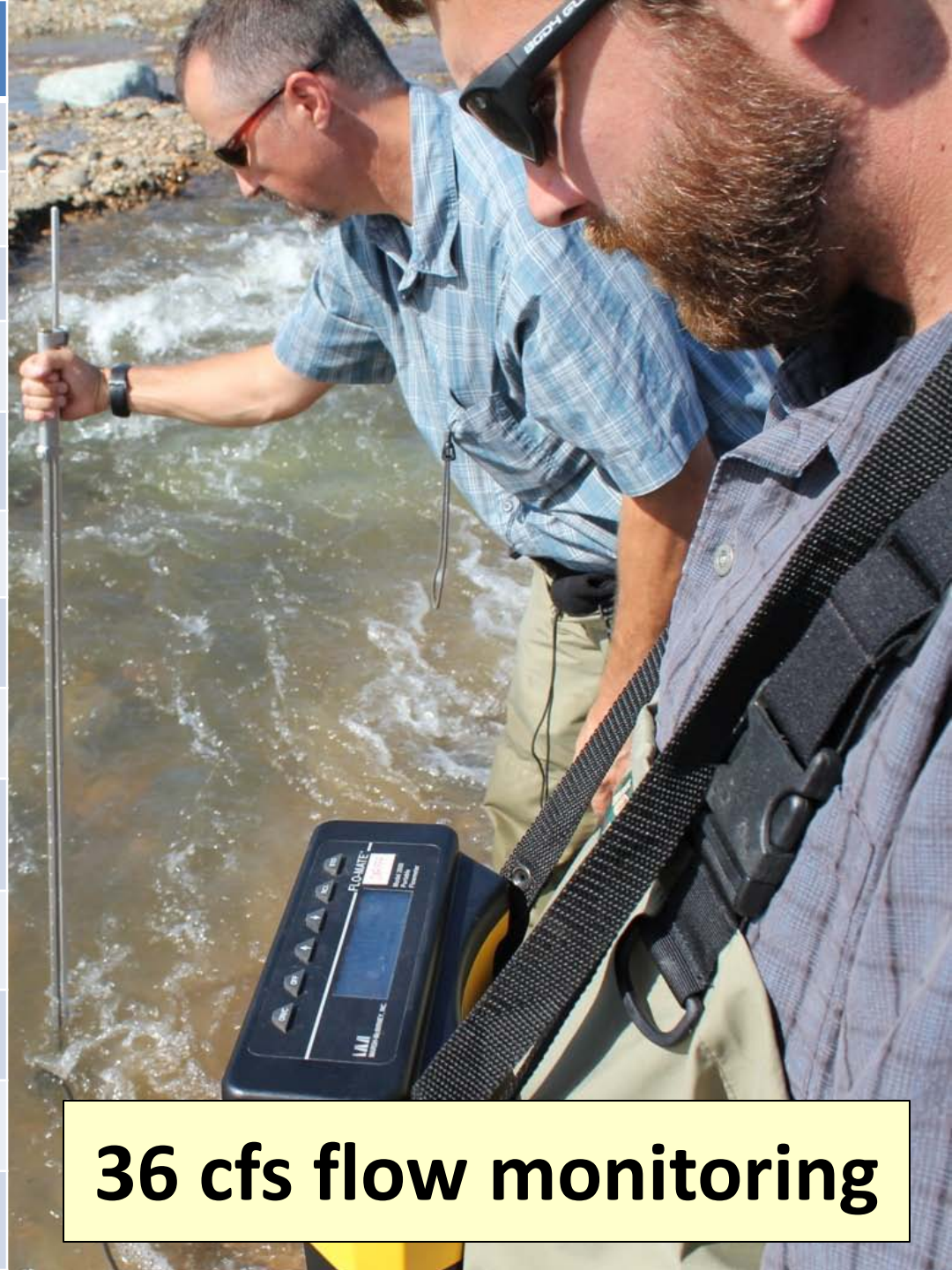

2011 Pulse Flow Releases to Benefit Fish
Flow at New Hogan Dam (cfs)
500
450
400
350
300
250
200
150
100
50
0
15-Oct
19-Oct
23-Oct
27-Oct
31-Oct
4-Nov
8-Nov
12-Nov
16-Nov
20-Nov
24-Nov
28-Nov
2-Dec
6-Dec


October 18, 2011 – 36 cfs

October 18, 2011 – 36 cfs


October 18, 2011 – 36 cfs
Individual boulders in low-flow channel create flow complexity

Station (ft)	Depth (ft)	Velocity (ft/s)	Notes
	1.15	0.83	dam foundation
0	0.9	3.06	weir 1
6	1.3	5.33	downstream of weir 1
17	1.4	6.12	at constricting boulders
33	0.9	7.70	at weir 2
33	0.8	3.36	2’ from left edge
49	1.3	3.84	at constricting boulders
65	1.1	5.37	at weir 3
87	1.5	6.54	at boulder between weirs 3 and 4
98	1.0	5.68	at weir 4
121	1.0	5.14	between weirs 4 and 5
135	1.0	5.02	at weir 5
155	2.6	0.58	in backwater area



36 cfs flow monitoring

November 2, 2011 – 150 cfs

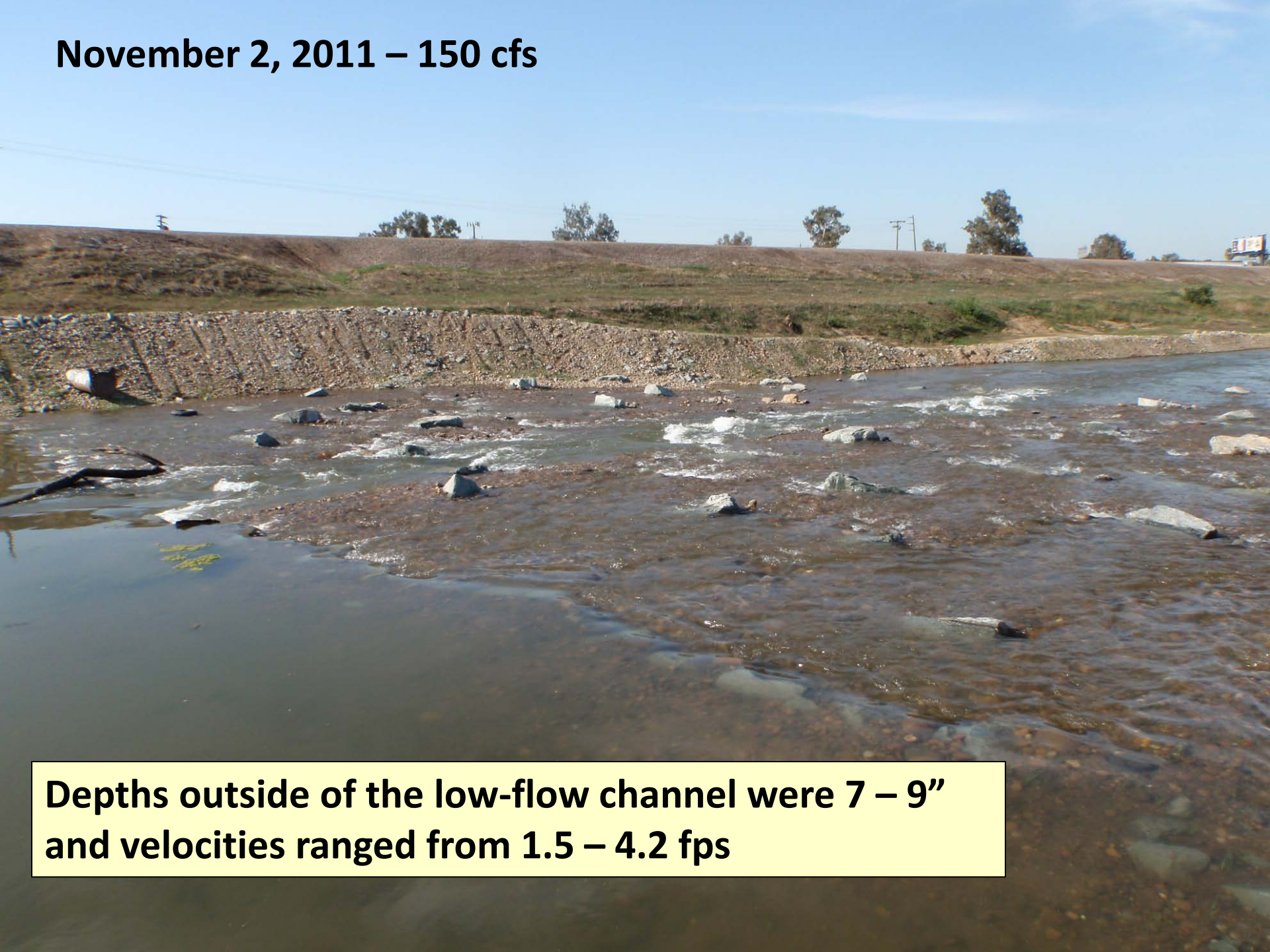

November 2, 2011 – 150 cfs

November 2, 2011 – 150 cfs

150 cfs flow monitoring

Station (ft)	Depth (ft)	Velocity (ft/s)	Notes
0	1.6	2.3	Dam foundation
5	1.0	4.6	at weir 1 (fish observed passing)
10	1.3	4.8	5' downstream of weir 1
20	1.2	5.0	at constricting boulders
38	1.6	6.0	at weir 2
50	2.4	4.8	3' upstream of boulders between weirs 2 and 3
53	2.1	7.4	at boulders between weirs 2 and 3
66	2.1	6.3	6' upstream of weir 3
72	2.1	6.1	at weir 3
87	2.9	3.3	midway between weirs 3 and 4


We did see a fish pass at this location
November 2, 2011 –
Approximately 150 cfs
Resting areas behind boulders


November 2, 2011 – 150 cfs
Depths outside of the low-flow channel were 7 – 9”
and velocities ranged from 1.5 – 4.2 fps

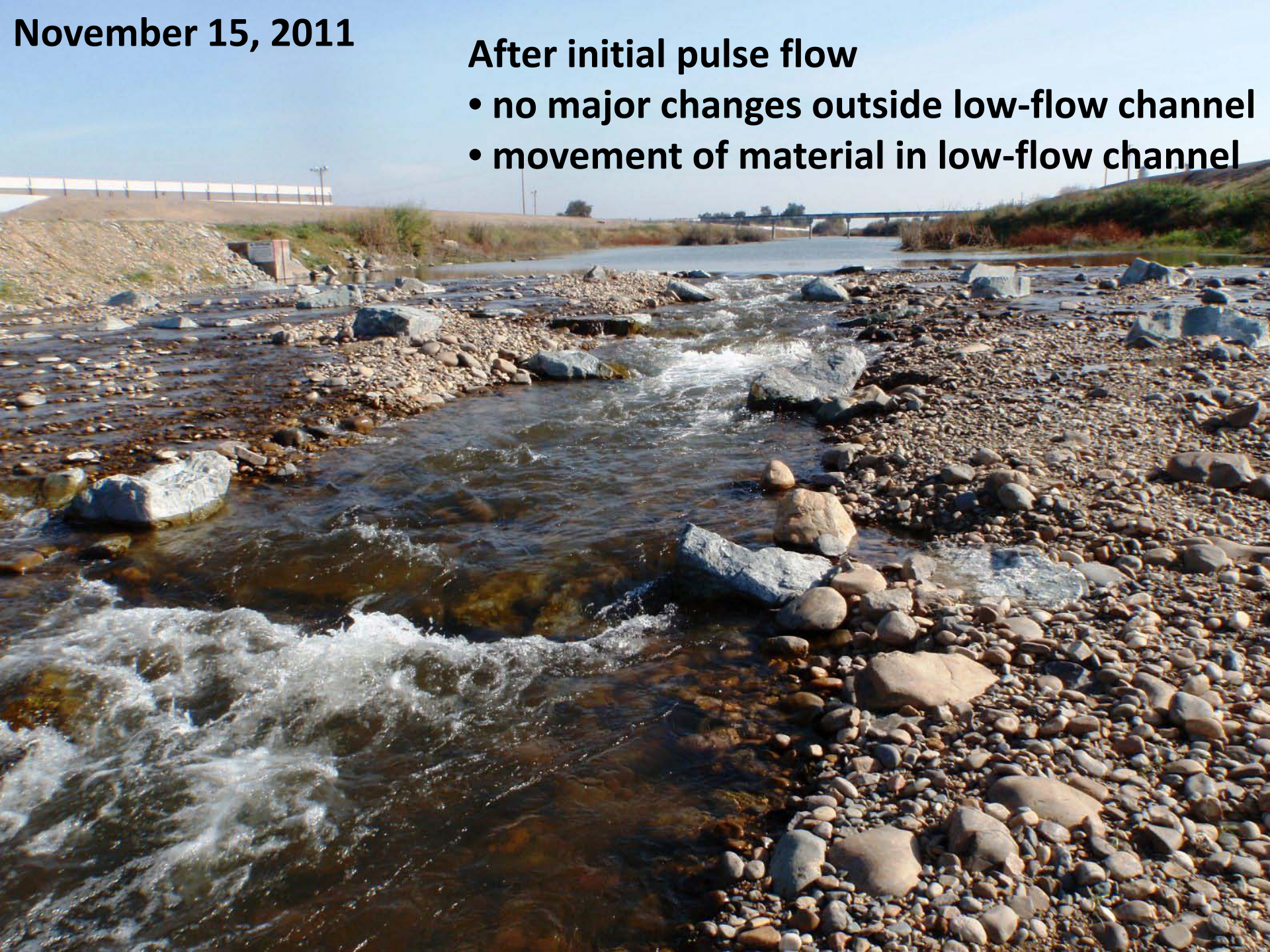

November 3, 2011 - 300 cfs


November 3, 2011 - 300 cfs
Shows the resting areas behind the boulders


October 18, 2011 – 36 cfs
Next 3 slides show the same camera angle at 3 different flows

November 2, 2011 – 150 cfs


November 3, 2011 - 300 cfs


November 15, 2011
After initial pulse flow
• no major changes outside low-flow channel
• movement of material in low-flow channel


November 15, 2011


November 15, 2011


February 7, 2012
Transported ESM in lower low-flow channel, generally 4 - 5” and lower in size


February 7, 2012
Upper end of low-flow channel much coarser and boulders have been scoured

Why did this material move?

- During design
  - our initial ESM calculations gave 9” as the largest particle size – we sized up to 12” since we used rounded material
  - shear stress calculations gave 6” as the largest particle that should move in the low-flow channel (we did account for an instantaneous maximums and a factor of safety) – Fischenich 2001
  - we thought that the larger material would help to hold the smaller material in place
- However,
  - while we expected some movement of ESM, the magnitude was greater than we anticipated
  - we believe that the individual boulders produced flow patterns that created significant scour areas
  - local residents created small dams to poach fish which caused localized increases in channel slope and subsequent scour


February 7, 2012

Fish Passage Conclusions

- Although no studies were completed to assess the passage efficiency of the project,
- the measured depths and velocities are well within the range of salmonid swimming abilities, and
- there are resting areas so fish do not have to pass the whole project at once
- In addition, it was estimated that over 400 fall-run Chinook passed upstream of the project
- Therefore, we believe that we met the fish passage goal of the project

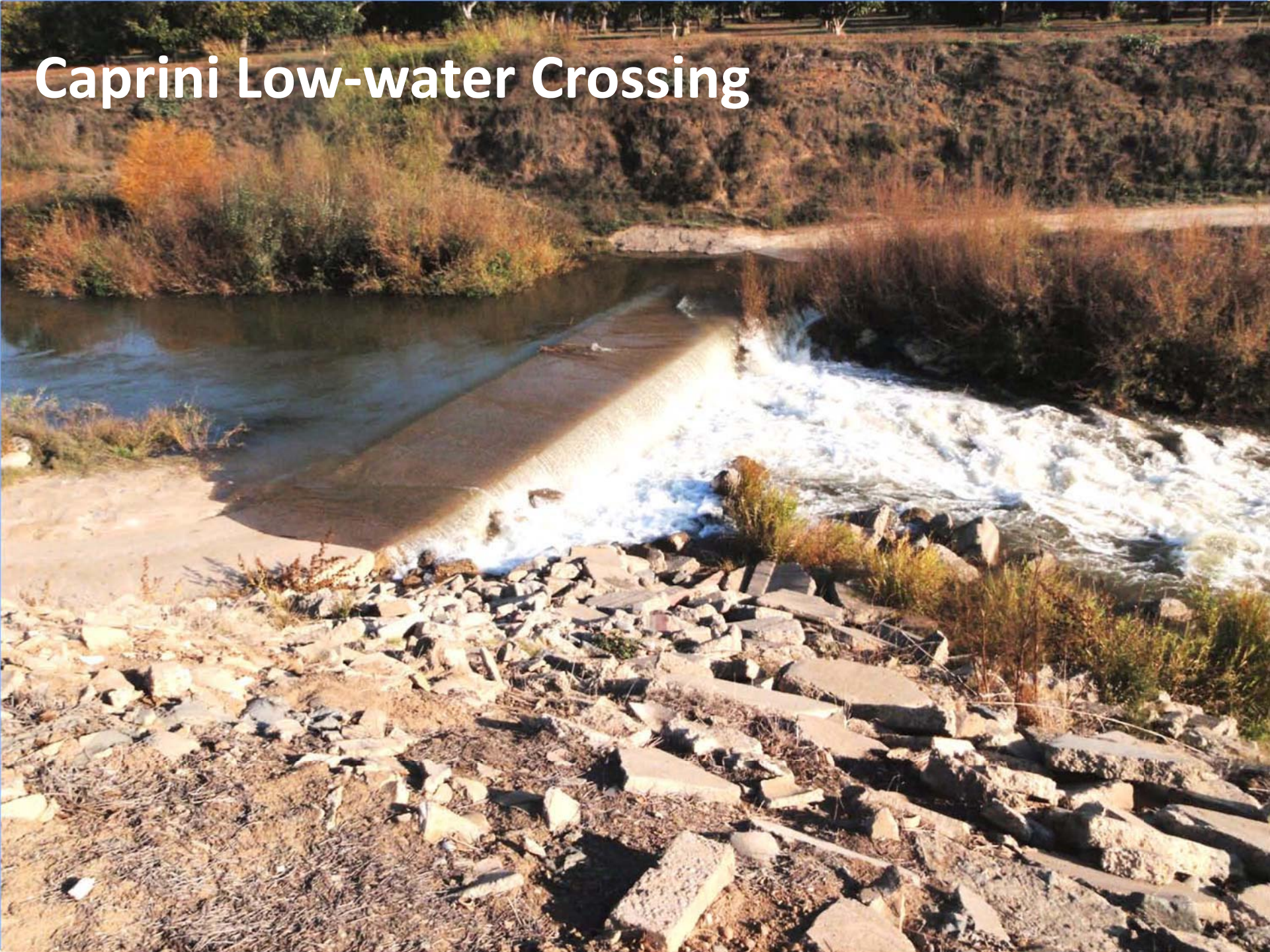
Lessons Learned

- Look for ways to reduce the project footprint to reduce project costs and environmental impacts
- Rock Ramp Low-flow Channel
  - In adding flow complexity, smaller material can move if significant amounts of larger material are not present
  - Need to coarsen the low-flow channel by increasing the percentage of larger material
  - Need to increase size of individual boulders in the low-flow channel
  - Perhaps make the low-flow channel a step-pool design

We are currently in design on two other projects in the system

Central California Traction Railroad Crossing

Caprini Low-water Crossing



Thank you

http://www.water.ca.gov/fishpassage