RECLAMATION

Managing Water in the West

Saving Farmers, Fish and Frogs

Brent Mefford, PE

U.S. Department of the Interior
Bureau of Reclamation

A Little History

The first Reclamation model study used to obtain hydraulic data specifically to address fishery issues was a model of Grand Coulee Dam in 1936.

Extensive velocity data was measured and provided to the Department of Fisheries to determine if migratory fish could pass the dam during construction.

A Little History

The first hydraulic model that included a fishway was a study of Roza Diversion Dam in 1939.

1:48 scale

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1943 - Fishway Hydraulics Study

A hydraulic model of the Keswick Dam fishway was constructed in 1943 to determine the operating characteristics of the fish ladder and auxillary water supply. Keswick is located downstream of Shasta Dam on the Sacramento River, Ca. The fishway and auxiliary water supply diffuser were modeled.

1:20 scale

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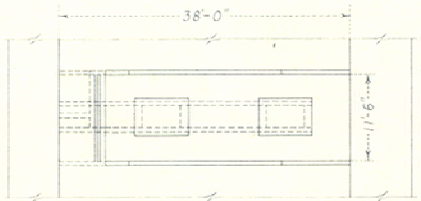
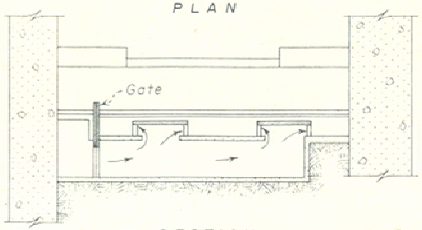


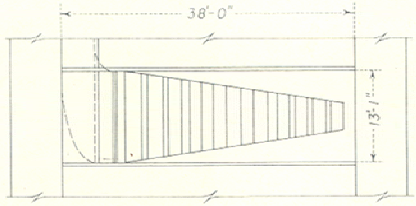
PLAN



SECTION

DESIGN 1

(Original Design)



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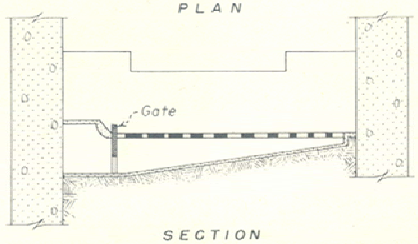

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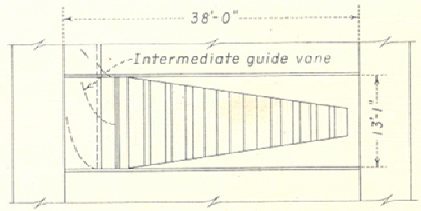
DESIGN 2



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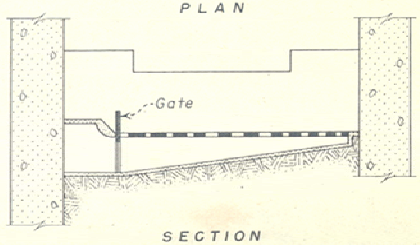
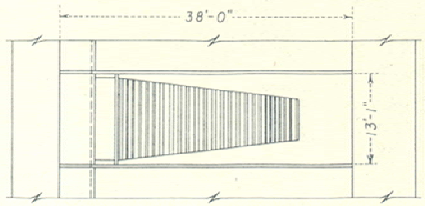


SECTION

DESIGN 3



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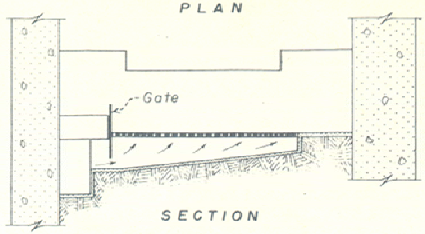
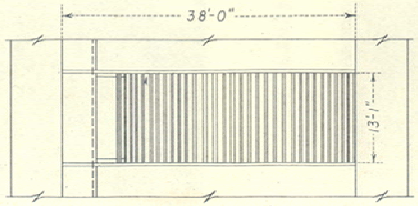


SECTION

DESIGN 4



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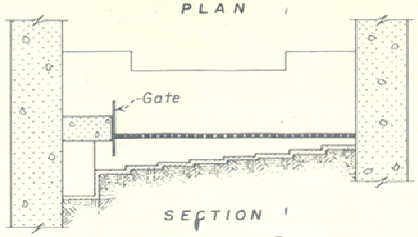


SECTION

DESIGN 5

(Recommended Design)

NOTES

Dimensions are prototype.
Views are schematic only.

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
CENTRAL VALLEY PROJECT - CALIFORNIA
KENNETT DIVISION

KESWICK DAM

HYDRAULIC MODEL STUDIES - 1 TO 10 SCALE
AUXILIARY FISHWAY SUPPLY OUTLET - TESTED DESIGNS

DRAWN	K.J.	SUBMITTED	
TRACED	E.J.H. - F.L.D.	RECOMMENDED	
CHECKED		APPROVED	

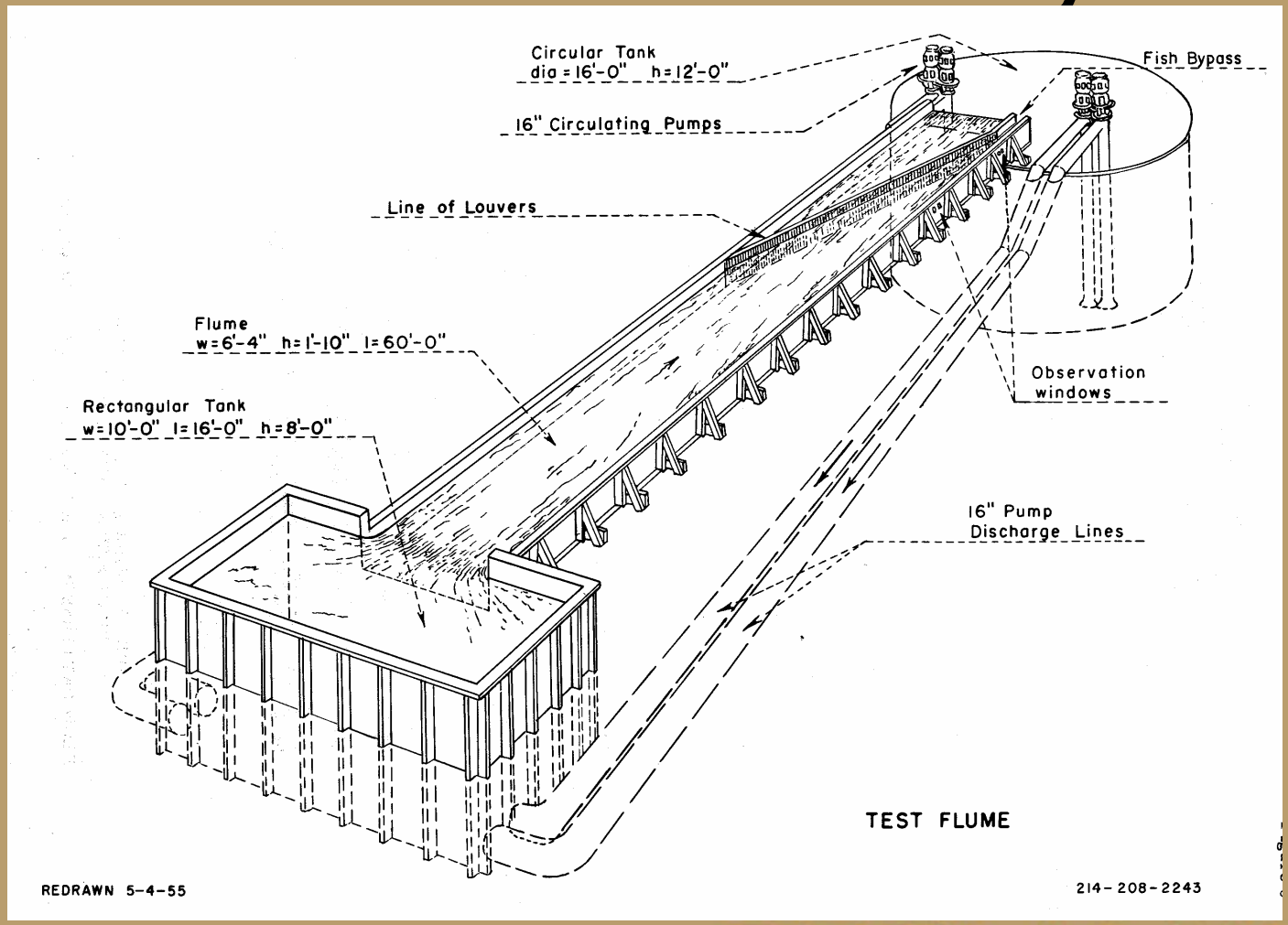
DENVER, COLORADO. - MARCH 3, 1943.

1955 – The Biologist Emerge

The first engineer/biologist research team was initiated in 1955 to develop a method to screen, hold, transport and restock wild fish entrained by the Delta Mendota Canal, California Central Valley Project. The research effort significantly advanced the development of louvers for fish guidance.

The project was conducted by Tom Rhone, Hydraulic Engineer in the Bureau's Lab and Daniel Bates, Fishery Research Biologist, Bureau of Commercial Fisheries, Portland, Oregon.

1955 Fish Protection Research on Louver Design and Guidance Efficiency, Tracy Fish Collection Facility



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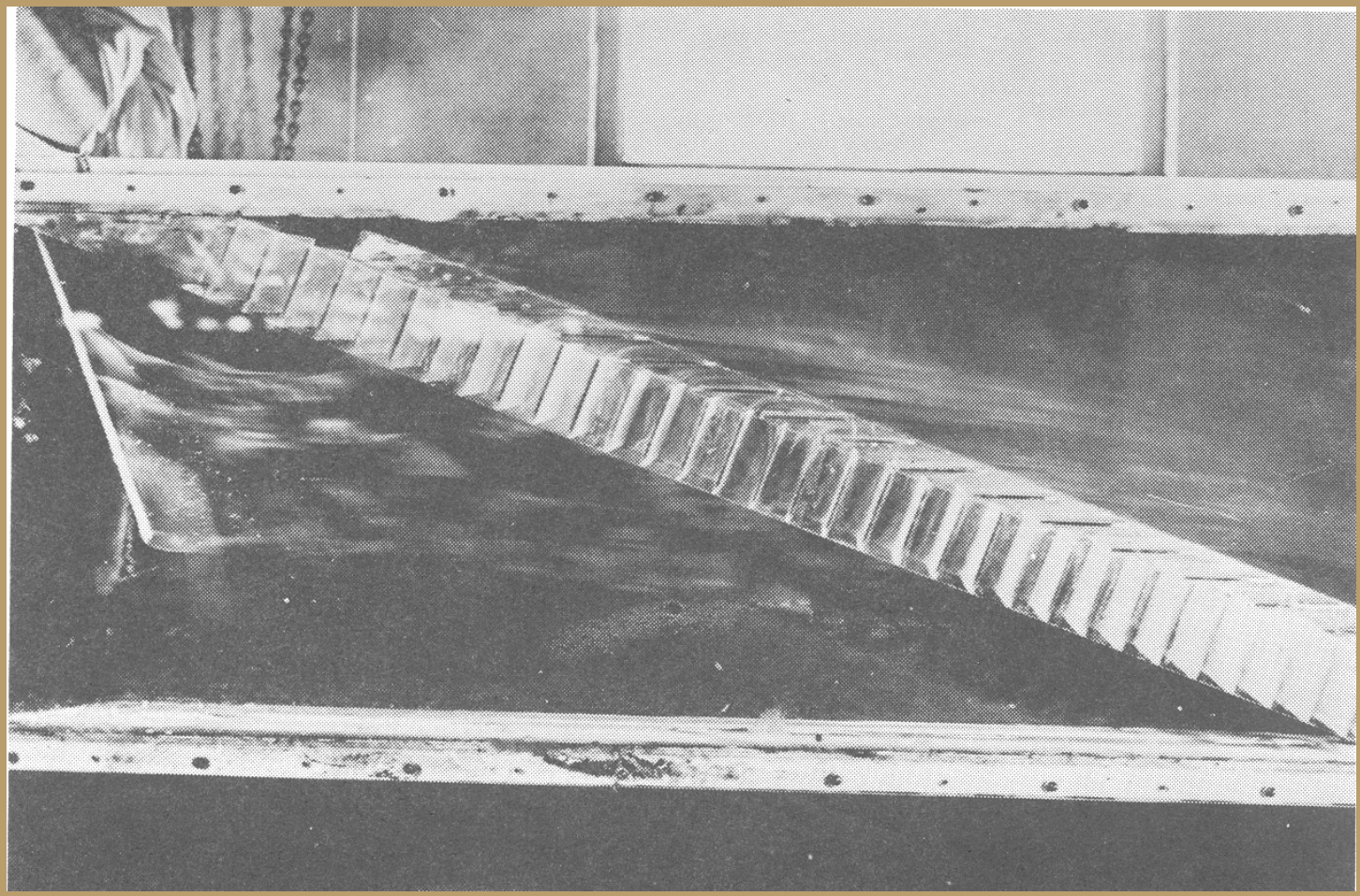
Origin of Louvers – "Louvers had been used to deflect moss in irrigation canals. This suggested the possibility of their use deflecting fish."



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Methods of Fish Protection Studied for Tracy Fish Salvage Facility in the 1950's

- Sonar and Sound Waves
- Electric Fields
- Revolving Drum Screens
- Multiple Eddy Trap
- Compressed Air
- Curtain Walls
- Traveling Screens
- Louvers

History Test

In What State was the First Bureau Fish Ladder Constructed?

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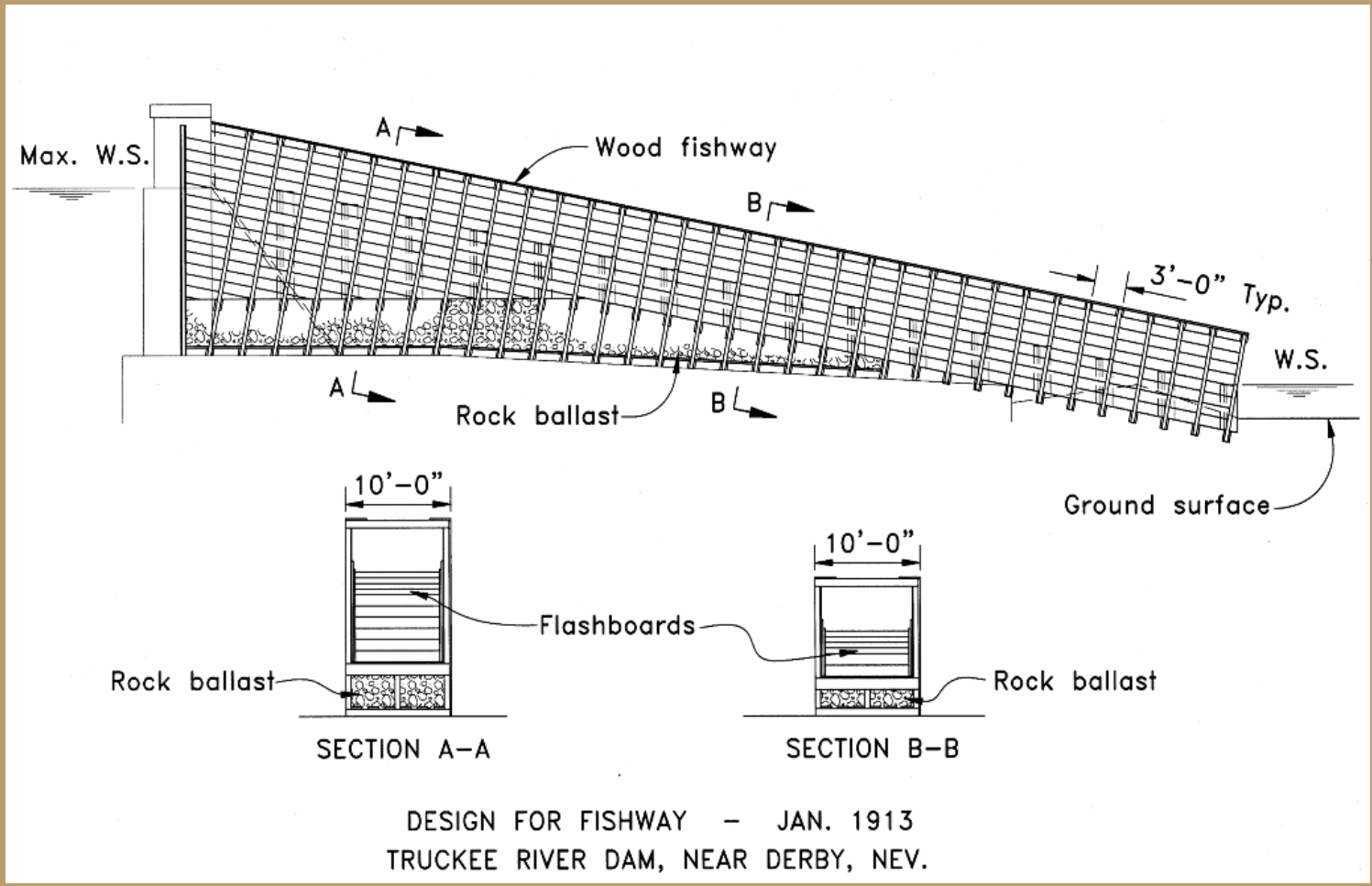
Nevada, 1913
Derby Diversion Dam Fishway



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1861 – Nevada Territory Assembly Calls for Fish Passage on all Dams

1905 – Construction of Derby Diversion Dam 30 miles upstream of Pyramid Lake

1906 – Water Diverted from the Truckee River to the Newlands Project

1913 – Fishway Constructed

1928 – Fishway is Destroyed in a Flood

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- 1942 – Falling Lake Levels Prompted Bureau of Indian Affairs to Construct a Gradient Stabilization Dam and Fishway above Pyramid Lake
- 1945 - Pyramid Lake Lahontan Cutthroat is extinct and Cui-ui suckers
- 1950 – Dam and Fishway Destroyed by Flood
- 1967 – Pyramid Lake Elevation reaches 87 ft below 1906 levels
- 1970 – Reclamation Reinitiates Project to Construct a Gradient Stabilization Dam and Fishway above Pyramid Lake
- 1972/3 – New Species of Lahontan Cutthroat Trout Introduced
- 1975 – Marble Bluff Dam and Pyramid Lake Fishway are Completed

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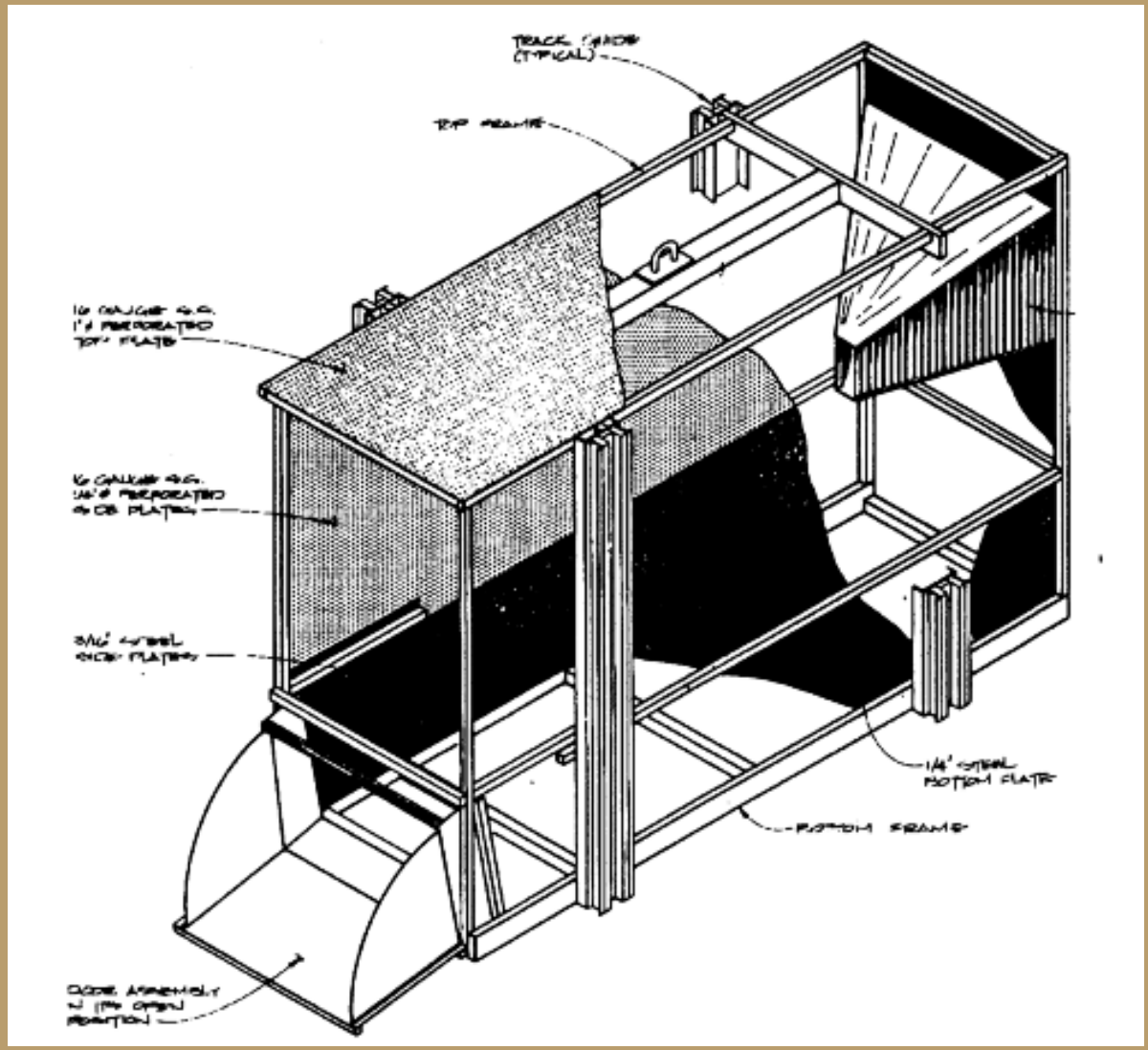
RECLAMATION



Fish Trap
and Lift

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Pyramid Lake Fishway

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Poor Communication Between Federal Agencies Let Cui-ui Slip Toward Extinction

- Mid 1970's to Mid 1990's -

  Pyramid Lake Fishway Ladders and the River Fish Trap and Lift System Failed to Meet the Passage Needs of Cui-ui Suckers. Fish Passage Remained Low for Cui-ui and LCT.

Reclamation and Fish and Wildlife Service Decide to Work Together

- 1995 – Reclamation Worked with Federal, Tribal, State and Private Organizations to Solve the Fish Passage Problems at Marble Bluff Dam.

- 1996-1998 – Laboratory Studies were Conducted to Aid in the Design of New Fish Passage Facilities

- 1998 – Reclamation's First Fish Lock, First Fish Friendly River Gradient Control Structure and First Fishway Designed Specifically for Suckers were Constructed.

Reclamation's First Fish Lock

Provides a 43 ft lift

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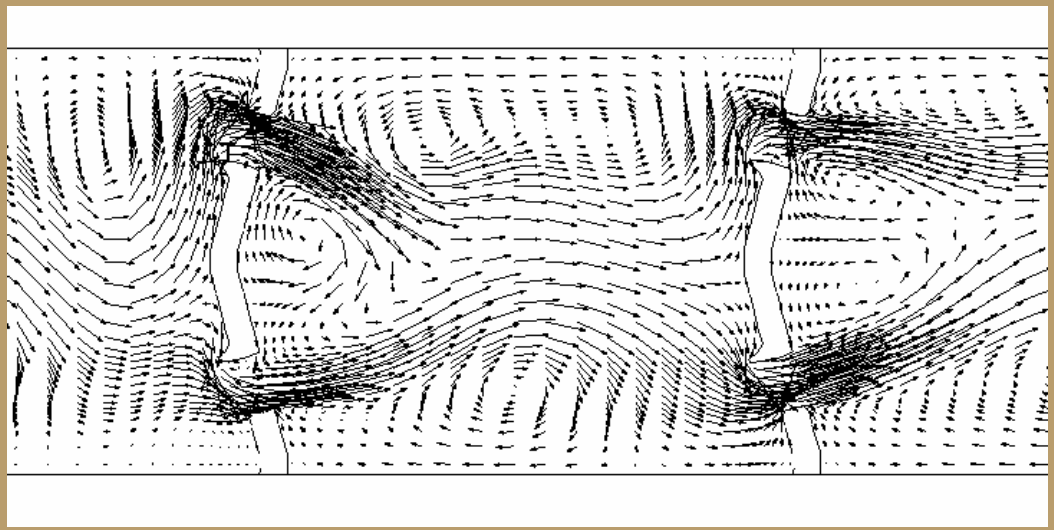
Marble Bluff Dual Vertical Slot Fishway Designed with Suckers in Mind



Numerical model of the Flow Field

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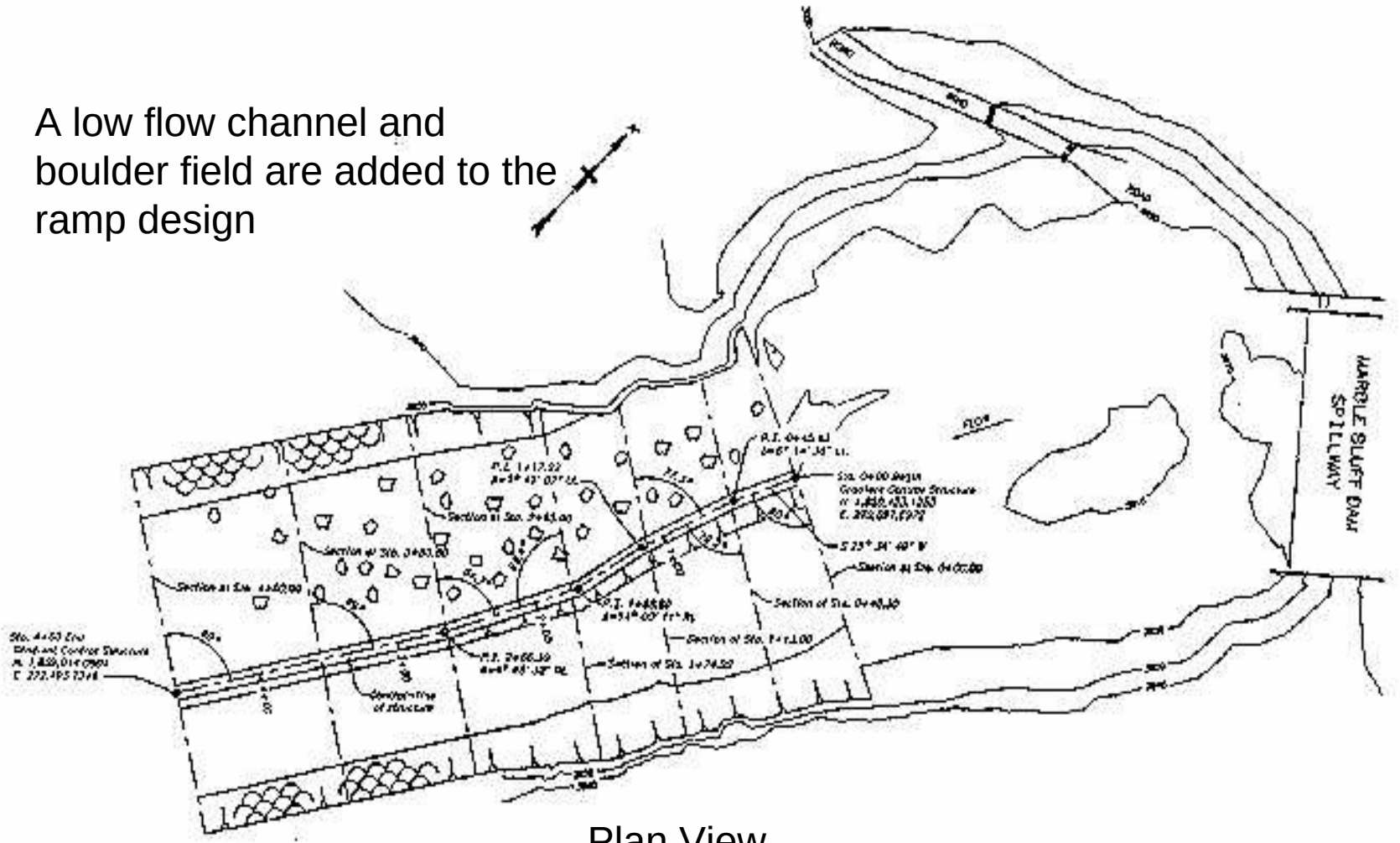
Rock Ramp with Boulder Field

A low flow channel and boulder field are added to the ramp design



Plan View

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Nearly Completed Structure

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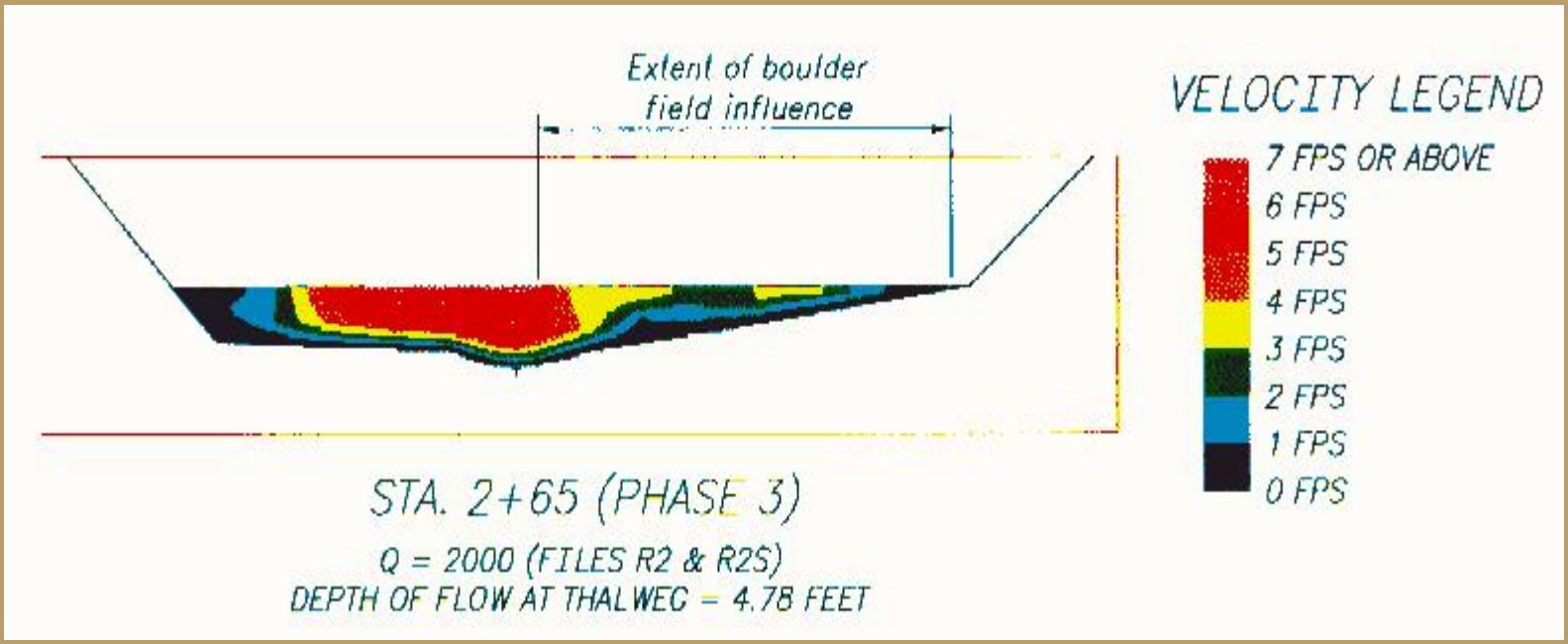
A Hydraulic model was used to design the rock ramp profile



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Marble Bluff Dam Rock Ramp and Fish Lock

Cui-ui spawning run is the biggest in years

By Faith Bremner
RENO GAZETTE-JOURNAL

Pyramid Lake's annual cui-ui spawning run is winding down and so far 400,000 of the endangered fish have moved from the lake to the lower Truckee River to spawn.

This is the largest cui-ui spawning run since the U.S. Bureau of Reclamation built a dam and fish-handling facility along the river at Marble Bluff 22 years ago. Last year, 307,000 fish moved through the facility. Since then, BOR made some improvements that allow more fish to move more quickly.

"It's working as designed," U.S. Fish and Wildlife Service Fisheries Biologist Lisa Heki said. "Conditions greatly improved for fish."

A small number of cui-ui started moving up the river April 6 in search of fresh water in which to lay their eggs. Their numbers peaked two weekends ago, when 65,000 responded to the warm spring weather and moved through the facility in one 24-hour period. Since the return of the cold weather, their numbers have dropped off. Heki said she expects another pod of cui-ui to move through when the weather warms up.

When they get up the Truckee, the cui-ui spend one to three weeks milling around and searching for a good place to spawn. It takes three or four weeks for the eggs to hatch. The larvae then float down the river to the lake.

In previous years, the adult cui-ui had the choice of using either a fish ladder or an elevator to get to their spawning grounds. The fish ladder is a three-mile-long artificial water channel that connects with the Truckee River above Marble Bluff dam. It's a cumbersome journey that tended to weed out the older, more fertile female fish. The elevator was located at the base of Marble Bluff dam. However, the elevator was usable only when there was enough water in the river for the fish to swim to it.

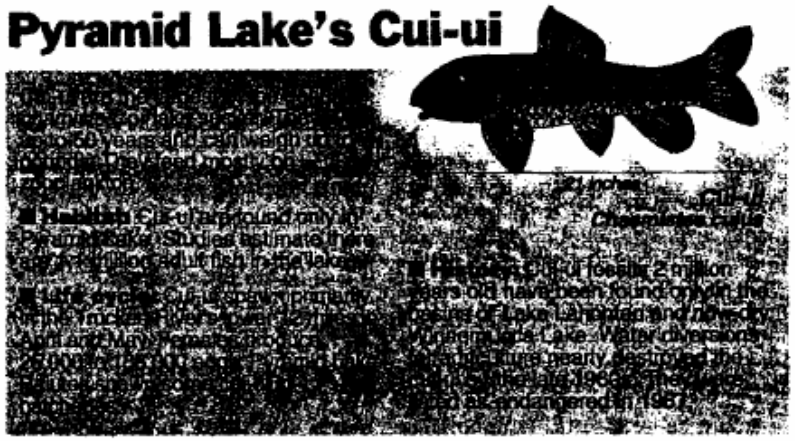
There is so much water in the Truckee this year that wildlife officials didn't even open the ladder. Earlier this year, BOR replaced the elevator with a new fish lock that can move 3,500 fish at a time. The old cage-like elevator could safely lift only 600 to 800 fish at a time.

"With the lock, the fish never leave the water," Heki said. "The cage lifted the fish out of the water, which is a hazard if you have a mechanical problem."

The fish lock was installed in the old 40-foot-high elevator shaft. The shaft is filled with water and when the fish move into the bottom of the shaft, a perforated, false bottom moves up and crowds the fish into the top of the shaft and into a watery passageway that leads to the river above the dam.

BOR built the dam in 1976 to stop the river from eroding its banks and consuming Nixon. The river became unstable after the Newlands Reclamation Project diverted water from the Truckee River for agriculture. Pyramid Lake dropped 90 feet and the river began downcutting and depositing huge amounts of sediment where it meets the lake, creating a delta.

Pyramid Lake's Cui-ui



Source: U.S. Fish and Wildlife Service — Reno Gazette-Journal

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Starting about the mid-1990's we started incorporating fish into our hydraulic models to understand more about how fish react to flow conditions in fishways and screening facilities. This has lead to the development of many new innovative fish passage and protection designs and better facilities.

Boulder Weir Fishways
Development of a Standard Design

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Shovelnose sturgeon
Yellowstone River, Mt

Rio Grande
Silvery Minnow, NM

http://www.fguardians.org

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Flow Velocity between Boulders = 4.0 ft/s

Putting Research to Work

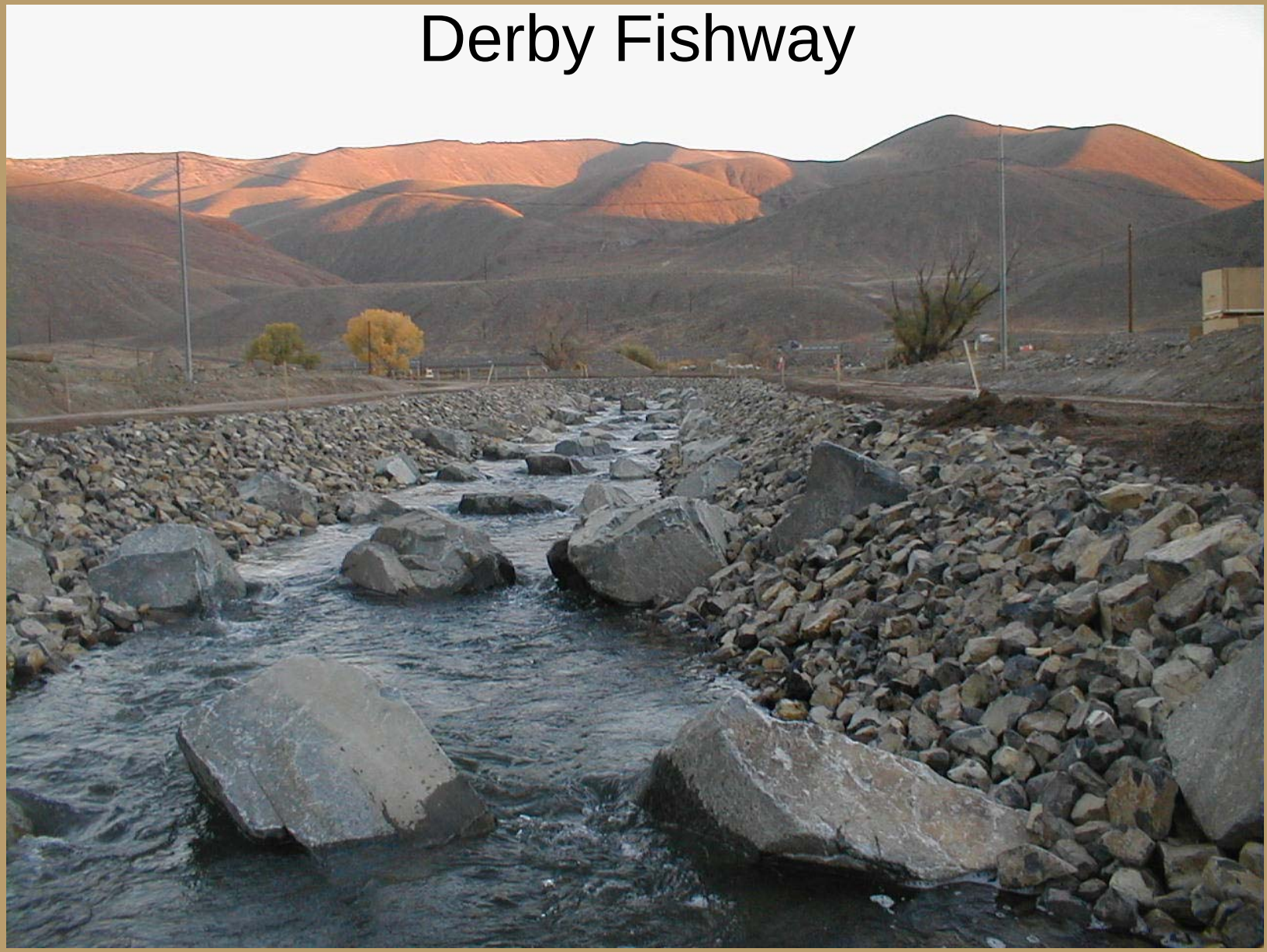
Boulder Weir Rock Fishways Constructed:

- Derby Diversion Dam Rock Fishway, Nv
- PNM Rock Fishway, NM
- Huntley Diversion Dam Rock Fishway, Mt (AquaEngineering)

Boulder Weir Fishways being Designed:

- City of Albuquerque Water Diversion, NM (URS Engineering)
- Kendrick Diversion Dam, Wy (Habitech and WWC Engineering)
- Tongue and Yellowstone Rivers Diversion Dam, Mt
- Price Stubb Dam, Co

Derby Fishway



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PNM Fishway

RECLAMATION

RECLAMATION

PNM Boulder
Weir Fishway
Farmington, NM

Razorback Sucker
Colorado River

Colorado Pike Minnow
Colorado River

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Huntley Fishway

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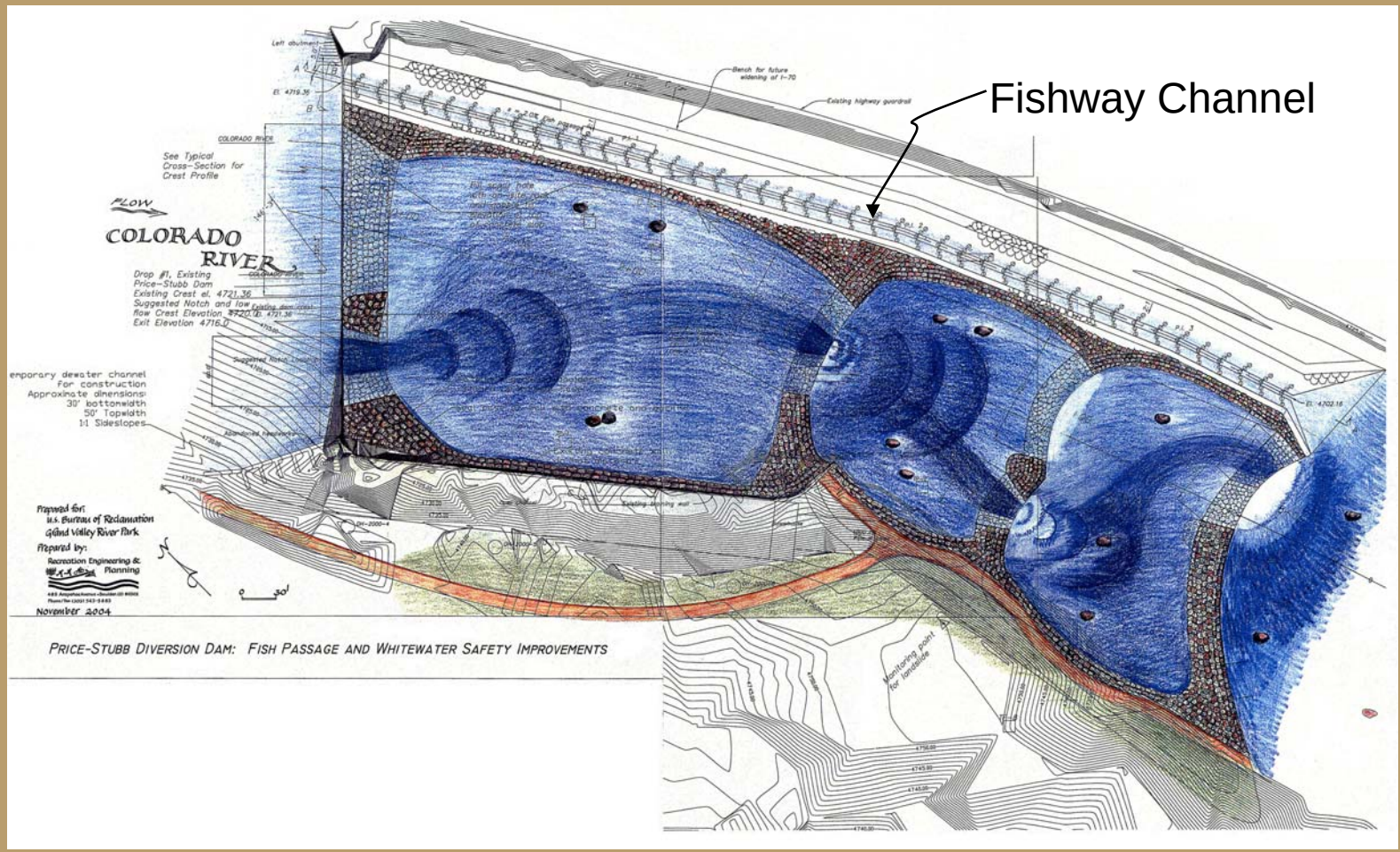
Proposed Whitewater Run and Fishway for Price-Stubb Diversion Dam



Recreational Engineering Inc.

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Can’t Find Boulders – Next best thing is Concrete pipe weirs filled with rock

Flow

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Second Generation Technical Fishways

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Second Generation Baffle Design
Lab studies showed improved fish guidance

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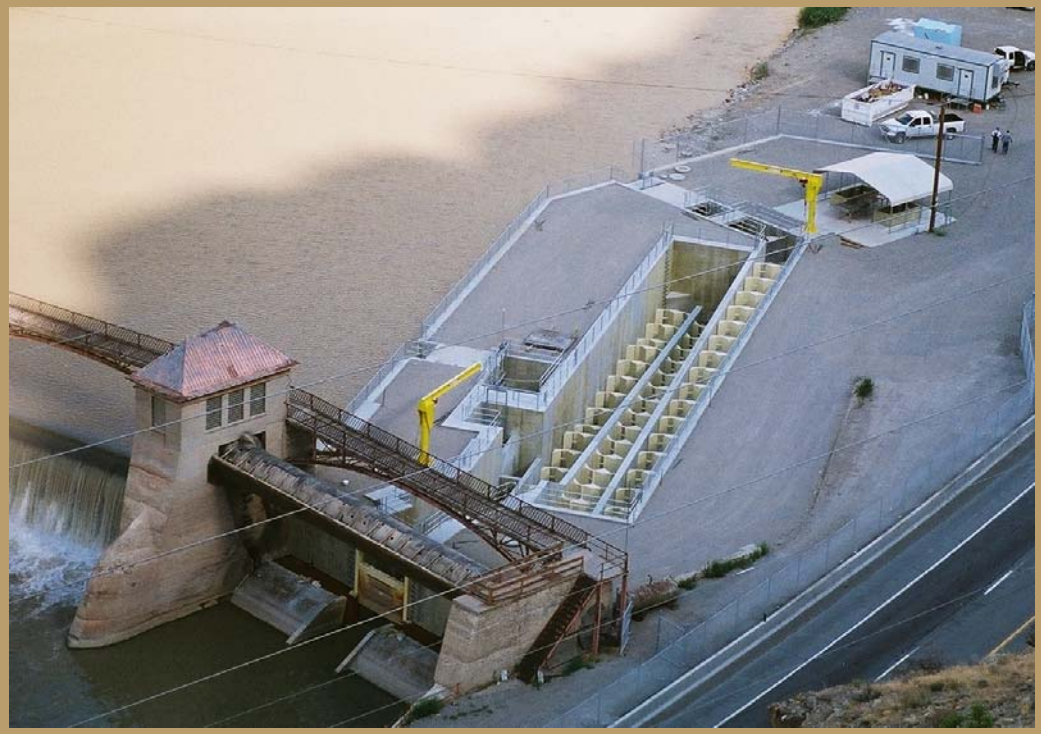
Grand Valley Diversion Dam
Colorado River



Hydraulic Height = 16.75 ft

Fishway Slope = 4.5 Percent

Max Slot Head Differential = 0.36 ft

Max Passage Velocity = 4.7 ft/s

Max Pool EDF = 3.3

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Dual Vertical Slot Design

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Link River Dam
Klamath Falls, Oregon

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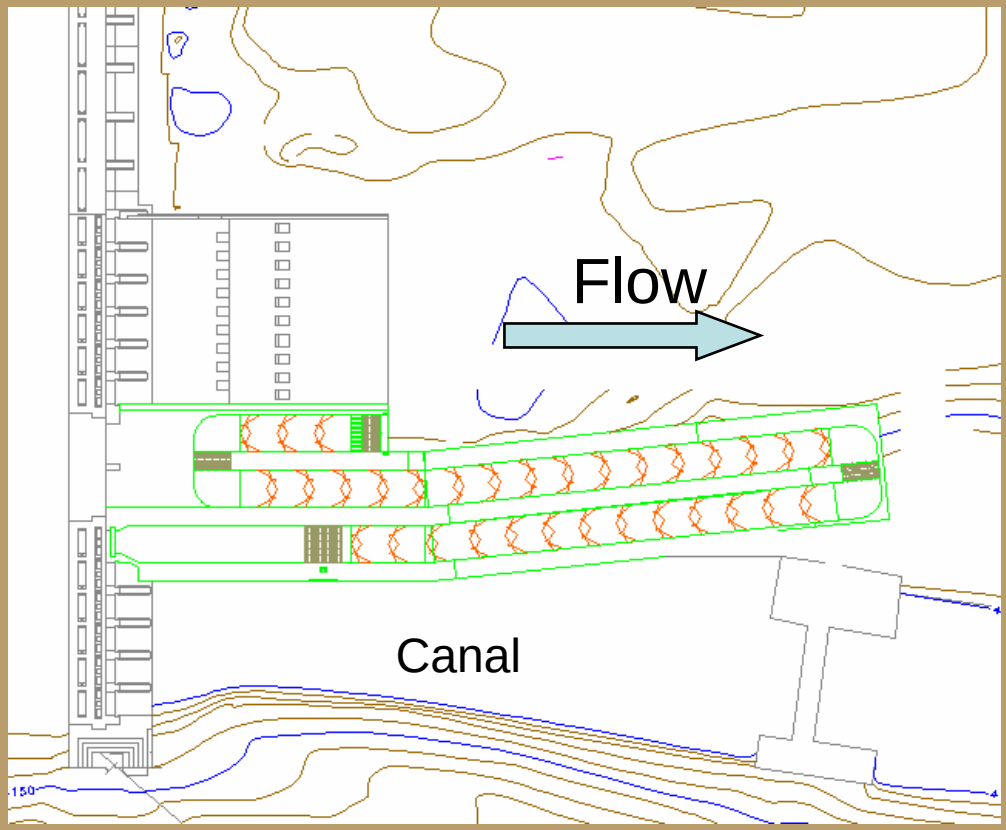
Link River Fishway



Design Parameters

Hydraulic Height = 12 ft

Fishway Slope = 4.5 Percent

Max Slot Head Differential = 0.36 ft

Max Passage Velocity = 4.7 ft/s

Max Pool EDF = 3.3

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Link River Fishway

Looking Downstream

Fishway Entrance

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Fisheries Engineering and Environmental Hydraulics

Combining Engineering and Biology

Species of Concern on Recent Projects	Species Used in Recent Lab Studies
Salmon	****
Steelhead	****
Trout	****
Cui-ui suckers	
Lost River suckers	
Shortnose suckers	
June suckers	
Razorback suckers	****
Shovelnose sturgeon	****
Pallid sturgeon	
Green sturgeon	
White sturgeon	
Bull trout	****
Silvery minnow	****
Delta smelt	
Blackfish	****
Burbot	
Pacific Lamprey	
Splittail	****
Stripped bass	****
Catfish	
Pikeminnow	
Mitten Crabs	****
Snapping Turtles	

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Its all how we look at it, Farmers, Fish and Frogs can all use the same water.

Roger Muggli, T&Y Irrigation District, Mt

SPECIAL REPORT

Little Dams, BIG BARRIERS

Diversion dams on the Yellowstone River system cause the loss of countless fish each year, including one species' near-extinction. One irrigator has found a way to keep fields watered while helping fish survive. Will others follow? **BY TOM DICKSON**

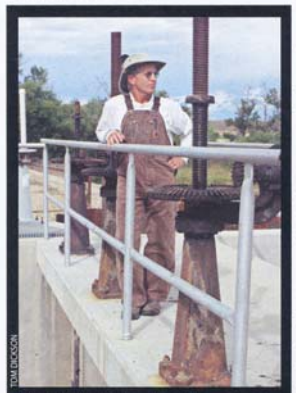
Roger Muggli had seen enough. In June of 1988, as he had every spring for years, the manager of the Tongue and Yellowstone (T-Y) Irrigation District in southwestern Montana watched as hundreds of downstream-swimming fish were sucked into the irrigation canals where the 12-Mile Diversion Dam diverts the Tongue River. The 100-plus miles of canals in the T-Y irrigation system send water to crops such as alfalfa, corn, and barley, as well as to vegetable gardens and orchard trees, on 9,400 acres owned by roughly 300 families. But the channels also capture sauger, catfish, perch, sunfish, smallmouth bass, and a dozen other fish species.

"It just killed me to see those fish get trapped in the canals," Muggli says.

Each spring, several dozen species spawn in the upper Tongue and other tributaries of the Yellowstone River. After the eggs hatch, the young fish float downstream with the current. Before the region was settled, they eventually would end up in the Yellowstone.

But that was before construction of diversion dams—3- to 8-foot-tall concrete or rock structures on the Yellowstone and major tributaries. The dams divert water from the main current into canals to irrigate crops in thirsty fields nearby. Unfortunately, fish move into the canals along with river water. They are then inadvertently pumped out onto crop fields as part of flood irrigation. Or they stay in the canals, easy prey for herons and raccoons when the canals are drained in late summer.

"Either way, the vast majority of those fish don't make their way back to the Yellowstone," says Brad Schmitz, Montana Fish, Wildlife & Parks regional fisheries manager in Miles City.



TOM DICKSON

FISH FRIENDLY Roger Muggli, shown here on the Tongue River's 12-Mile Diversion Dam, says he felt a personal obligation to find some way for fish to move past the irrigation structure.

Schmitz and other biologists estimate that hundreds of thousands of fish are lost each year on the Yellowstone system to what they call "entrainment."

The 12-Mile Diversion Dam, 12 miles up the Tongue River from Miles City, was built in 1885. Muggli's father managed the water there for nearly 30 years, and his grandfather before that. As a boy, Muggli had seen fish entrained in the canals. In 1988, when he became manager, he decided to do something about it.

"I vowed then that if I lived long enough, I'd get the Tongue River fixed," says Muggli, who also runs a feed processing plant near Miles City with his family.

Over the next 11 years, Muggli "fought like hell to get support for this project," he says. To document fish entrainment, he convinced FWP to set survey nets. Biologists found that at least 37,000 fish go down the irrigation canal each year. Then Muggli galvanized financial support from public agencies and national conservation groups to replace the aging inlet into the canal. The renovation included adding a downstream bypass to screen fish from the canal and allow them to move around the dam (page 15). Completed in 1999, the project cost $900,000; just $60,000 was required from the irrigation district.

"That was a big selling point for our guys," says Muggli.

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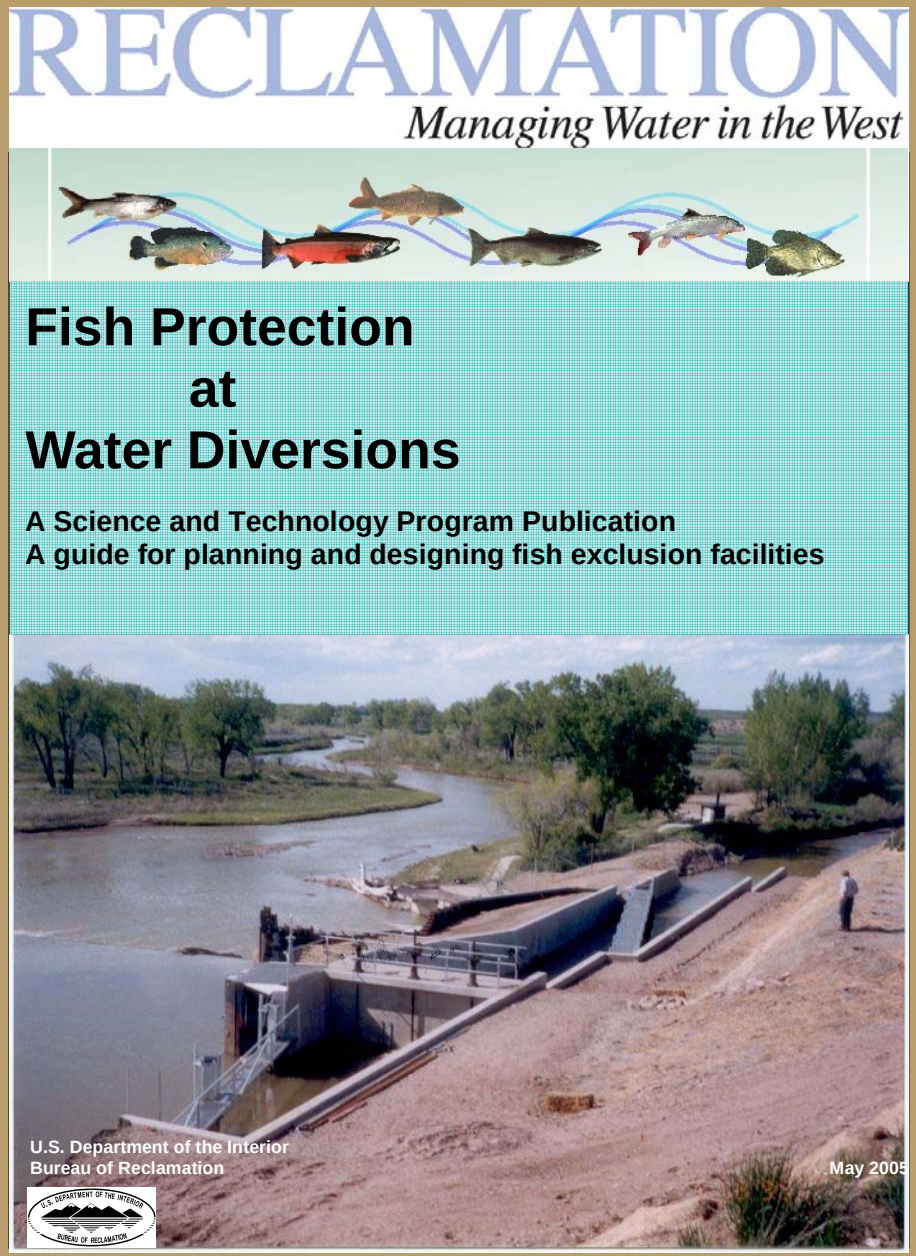
Fish Screening Manual

Due out this Fall



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Thanks For Many Reclamation Offices That Support The Laboratory

A Special Thanks From the Engineering Fishheads to:

Office of Science and Technology
Tracy Fish Collection Facility,
Tracy Field Office
Montana Area Office
Western Colorado Area Office
Albuquerque Area Office
Kalmath Area Office
Willows Construction Office

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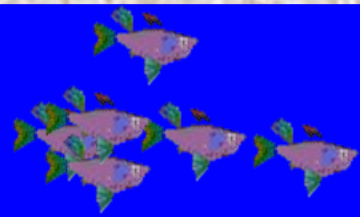
Managing Water in the West

Thank You



Brent Mefford, PE

U.S. Department of the Interior
Bureau of Reclamation