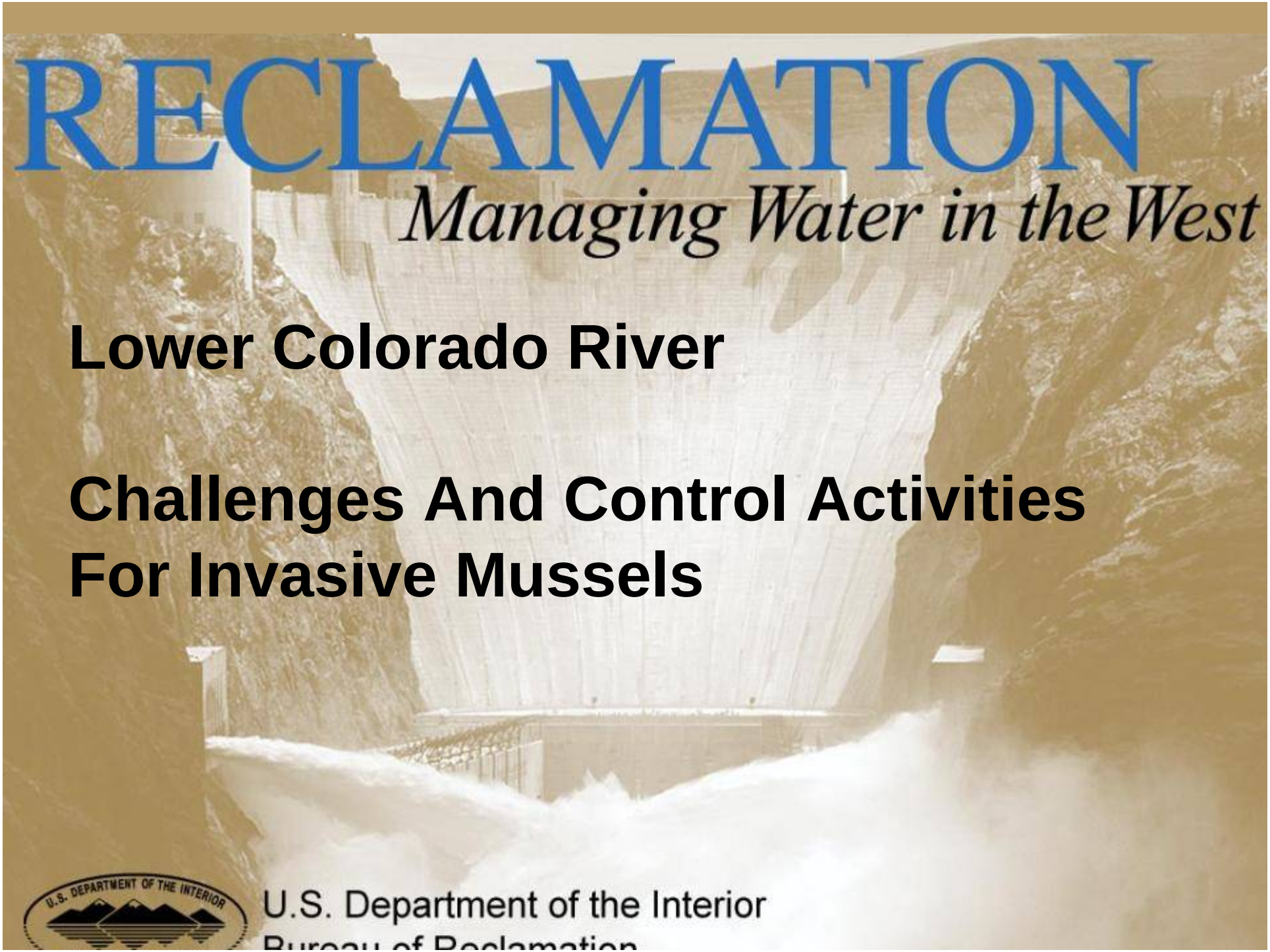

RECLAMATION
Managing Water in the West
Lower Colorado River
Challenges And Control Activities
For Invasive Mussels
U.S. Department of the Interior
Bureau of Reclamation

Agenda

- **Background – January 2007 adult quagga mussel found in Lake Mead (assumed to be from a mussel infested house boat)**
- **Fall of 2007 – Bureau of Reclamation lower Colorado Dams (LCDO) office completed facility review**
- **Findings from review and updated activities of the lower Colorado river dams**
- **Research activities and control barriers that are environmentally friendly**
- **Reclamation costs**

RECLAMATION

Lake Mead, NV & Hoover Dam
House Boat

RECLAMATION

Facility Assessments

RECLAMATION
Managing Water in the West

Facility Vulnerability Assessment Template

Invasive Quagga and Zebra Mussels

http://www.usbr.gov/mussels/

U.S. Department of the Interior
Bureau of Reclamation

May 2009

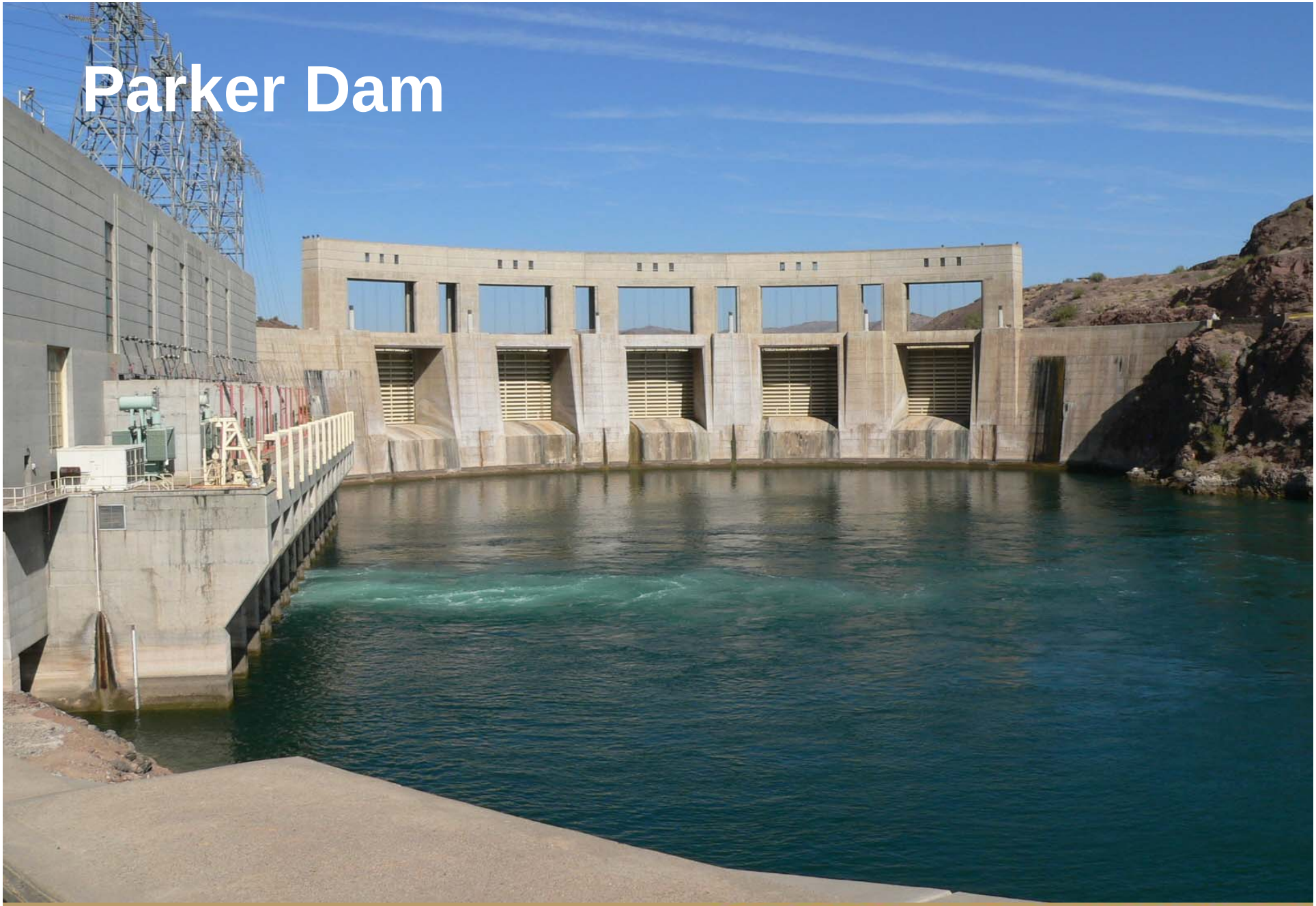
RECLAMATION

What Water Storage and Delivery Facilities are Vulnerable to a *Dreissena* Mussel Infestation?

Comparison of Zebra Mussel Colonization Potential with Environmental Tolerances				
Variable	**Colonization Potential (Infestation Probability)**			
	High	**Moderate**	**Low**	**Very Low**
Salinity, ppm	**0-1,000**	**1,000-4,000**	**4,000-10,000**	**10,000-35,000**
Calcium, ppm	**25-125**	**20-25**	**12-20**	**<7**
pH	**7.4-8.5**	**7.0-7.4** **8.5-9.0**	**6.5-7.0**	**<6.5** **>9.0**
Water temperature °C (°F)	**17-25 (63-77)**	**25-27 (77-81)**	**15-17 (59-63)**	**<12 (<50)**
Turbidity, cm (Secchi disk)	**40-200**	**20-30**	**10-20** **200-250**	**<10** **>250**
Dissolved Oxygen, ppm	**8-10**	**6-8**	**4-6**	**<4**
Water velocity, (ft./sec.)	**1.6-2.3**	**2.3-3.3**	**3.3-6.6**	**>6.6**

RECLAMATION

Parker Dam



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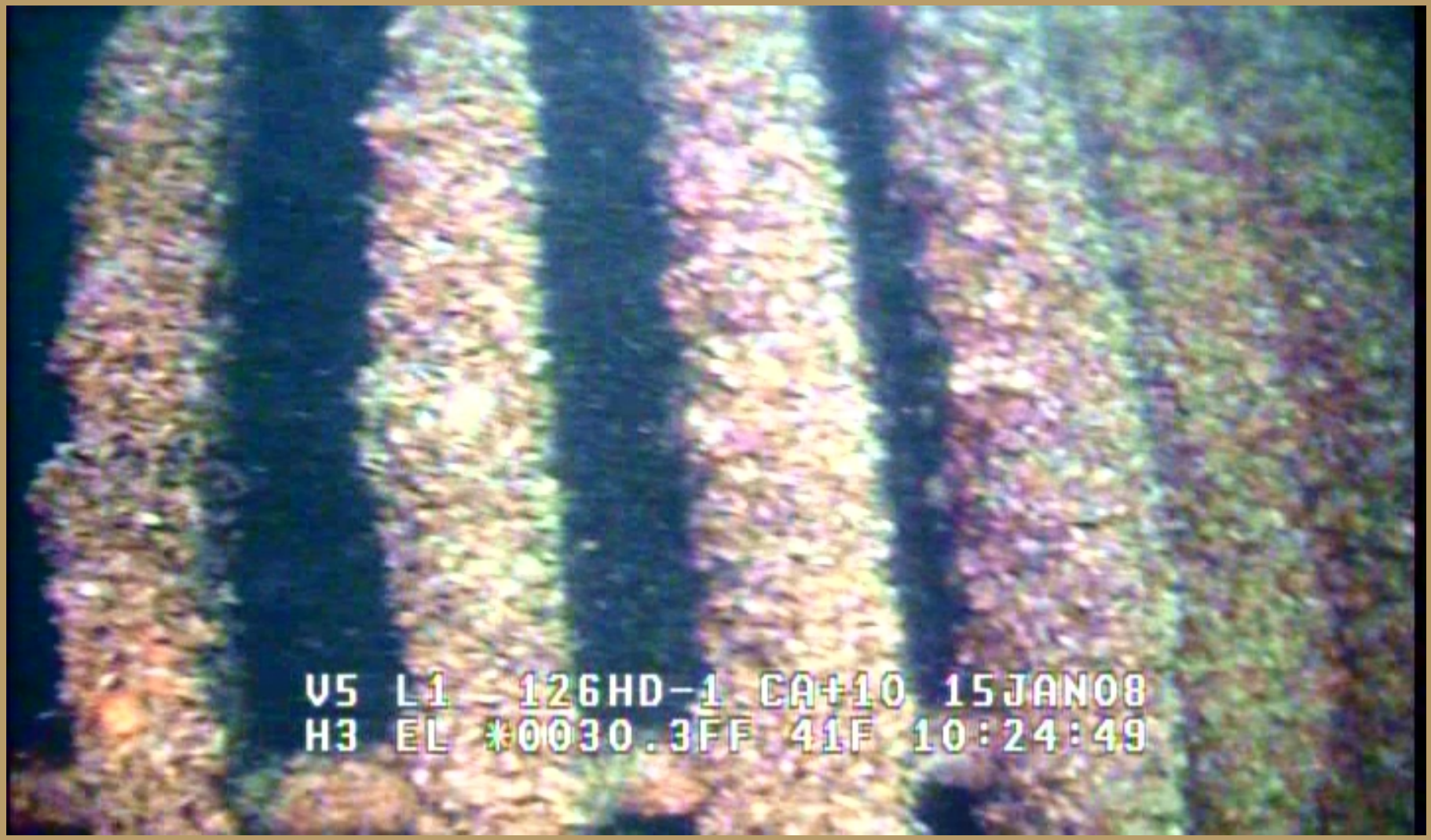
Sampling Plates at Parker Dam
November 11/07 – 6 Weeks of Settlement

RECLAMATION

Parker Dam Monitoring Plate Rope September 2008

RECLAMATION

Underwater Photo – Trash Rack
Parker Dam - January 15, 2008

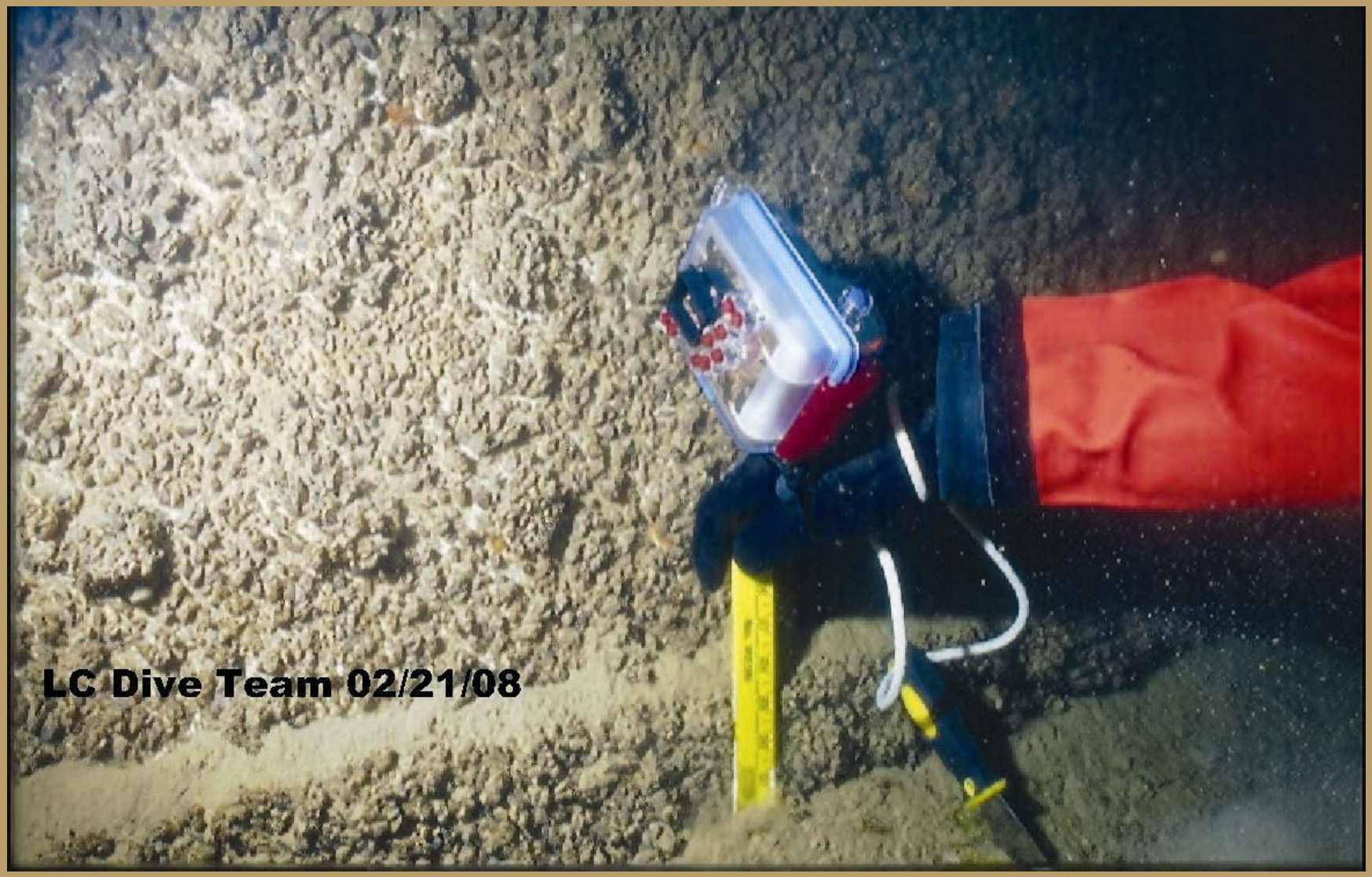


RECLAMATION

Underwater Photo – Domestic Water Intake Parker Dam

RECLAMATION

Spillway Gates – Parker Dam



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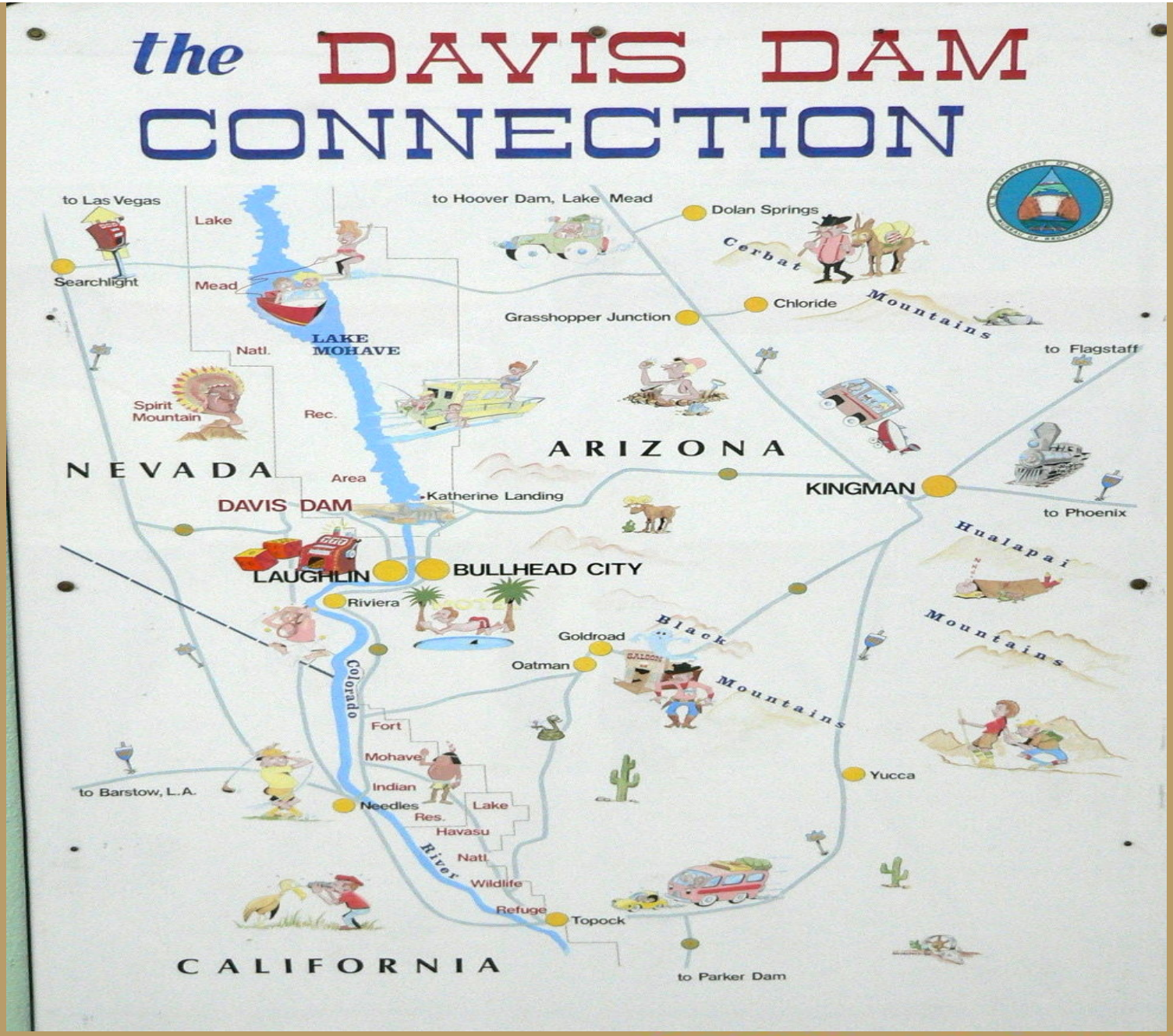


RECLAMATION

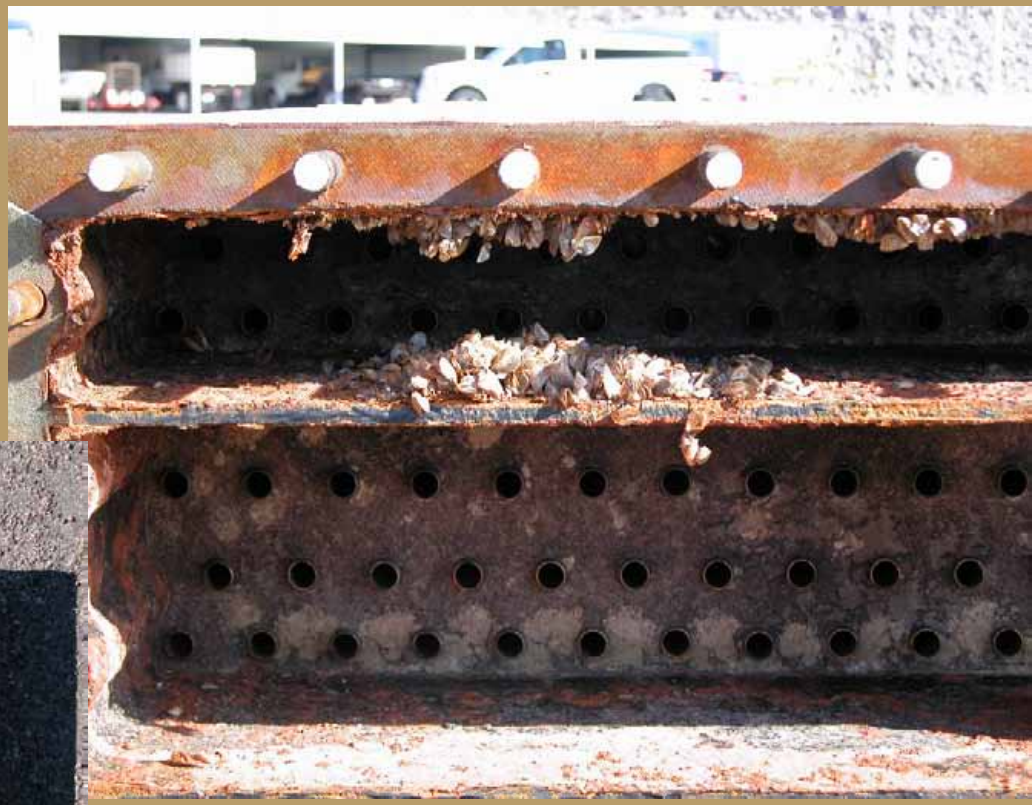
Davis Dam Penstock Gate Oct.07

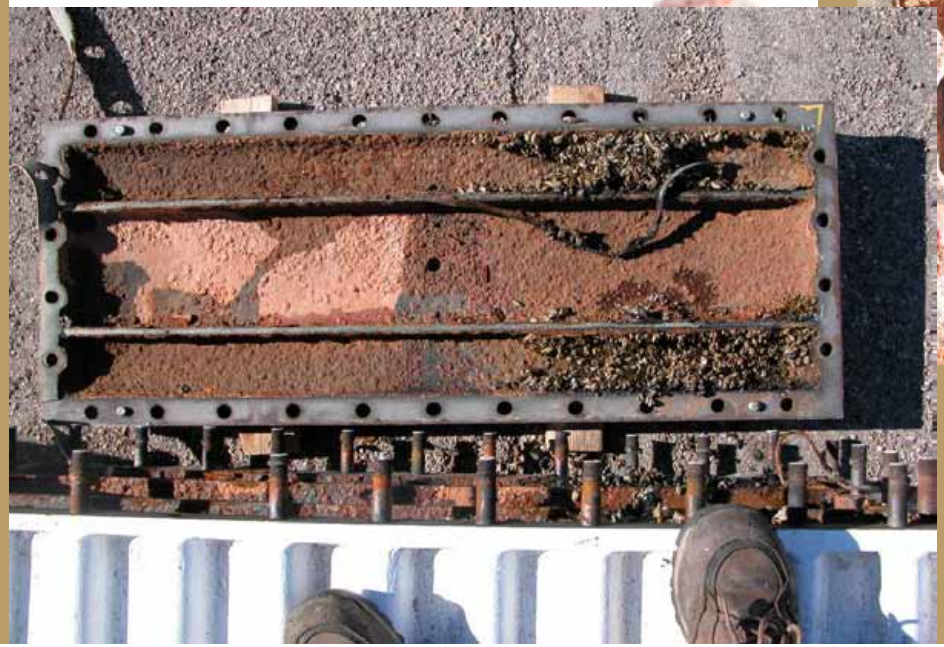
RECLAMATION

Drain Holes Plugged With Mussels

RECLAMATION

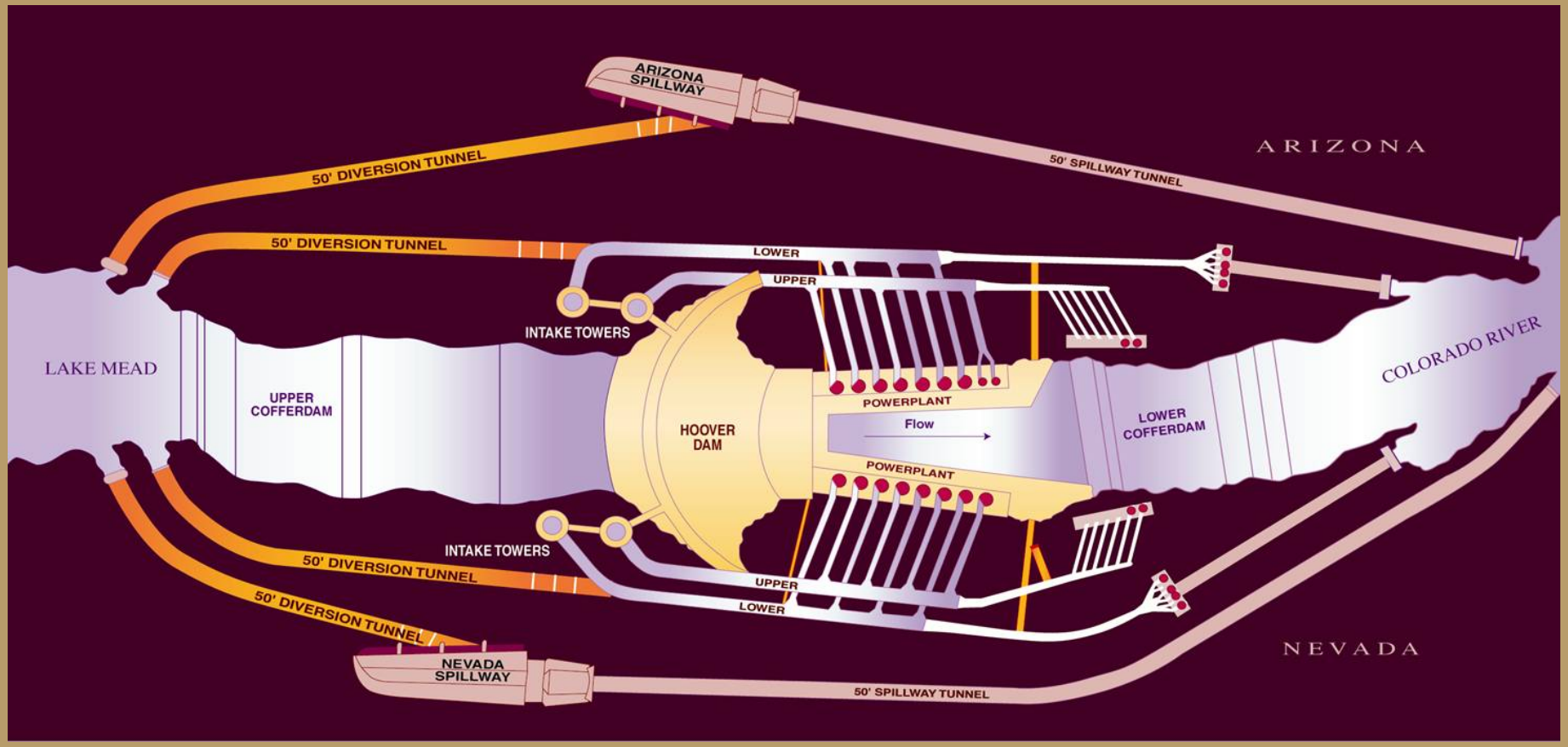
Generator Cooling Water Heat Exchanger Davis Dam Dec 2009





RECLAMATION

Hoover Dam Layout



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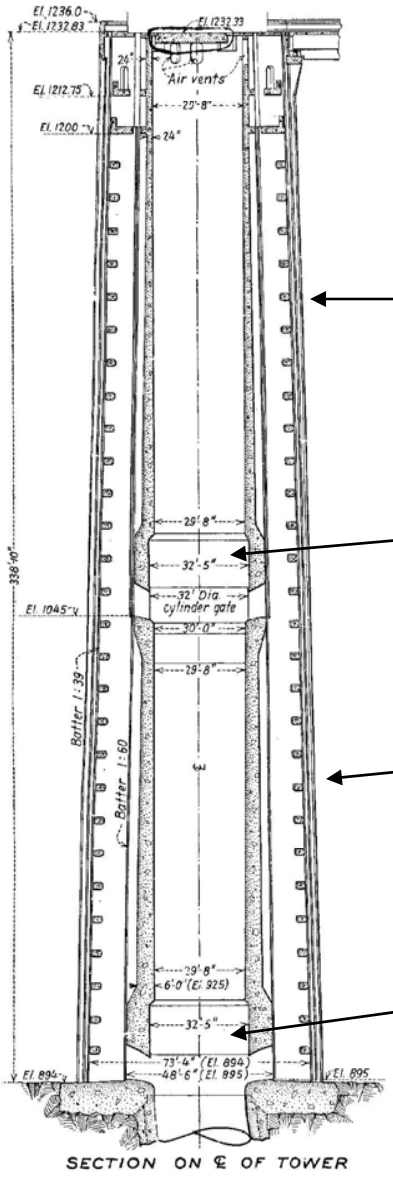

SECTION ON ℄ OF TOWER

Elev 1111
Dec 2007 Lake
Mead Level

Elev 1045
66’

Elev 970
141’

Elev 894
217’

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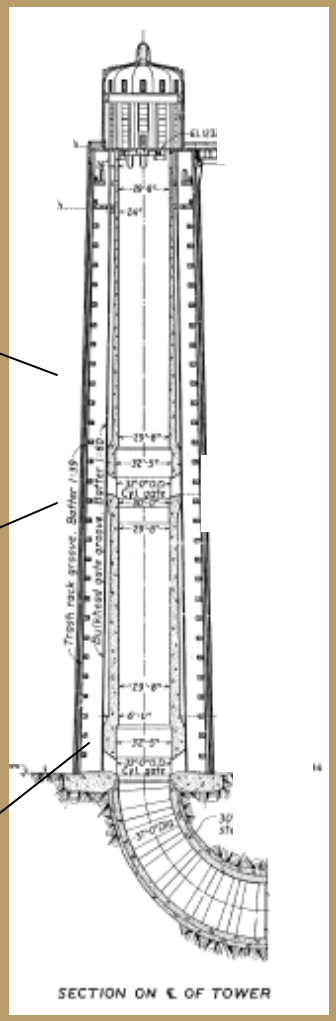
Intake Towers - April 2009

Fore bay - 1094 ft

Intake - 1045 ft

Intake - 895 ft

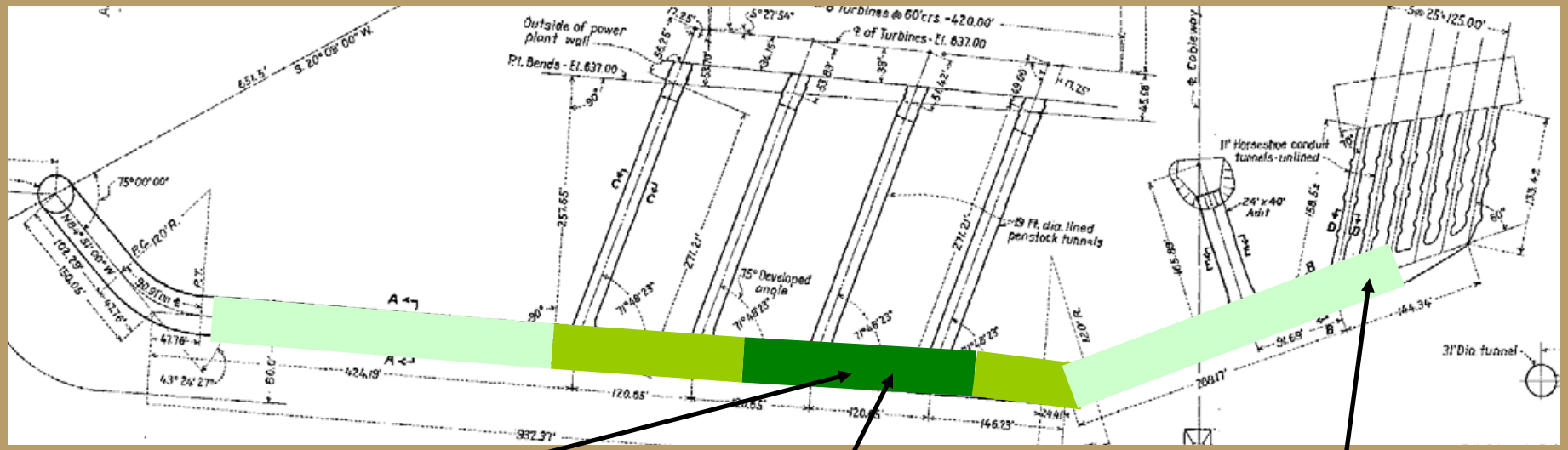


Trash Racks – 6/2009

Upper Cylinder Gate - 11/2007

RECLAMATION

Upper Nevada Penstock
October 2008



RECLAMATION

Observations from inspection of external surfaces – 10/2008

Penstock Lateral Shell Debris (13ft diameter)

Penstock Drain – Heavy Settling

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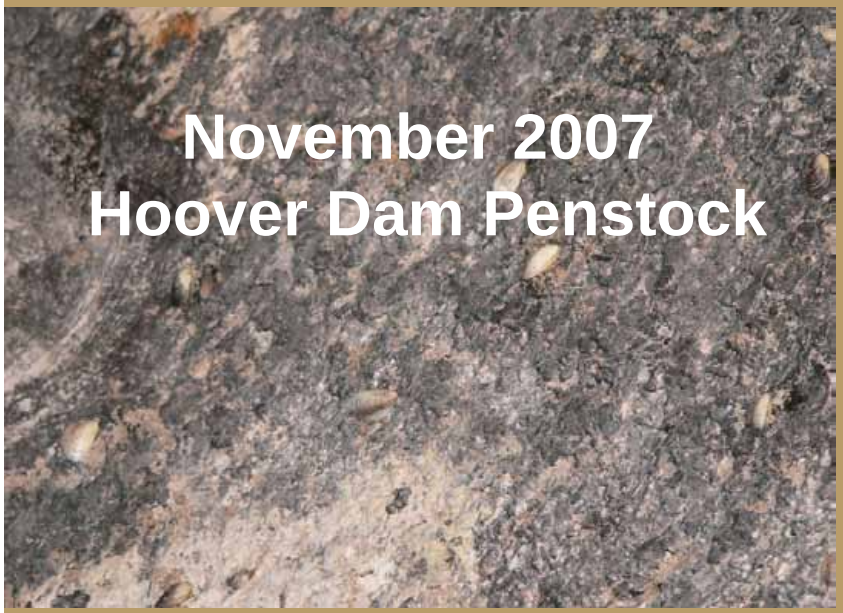
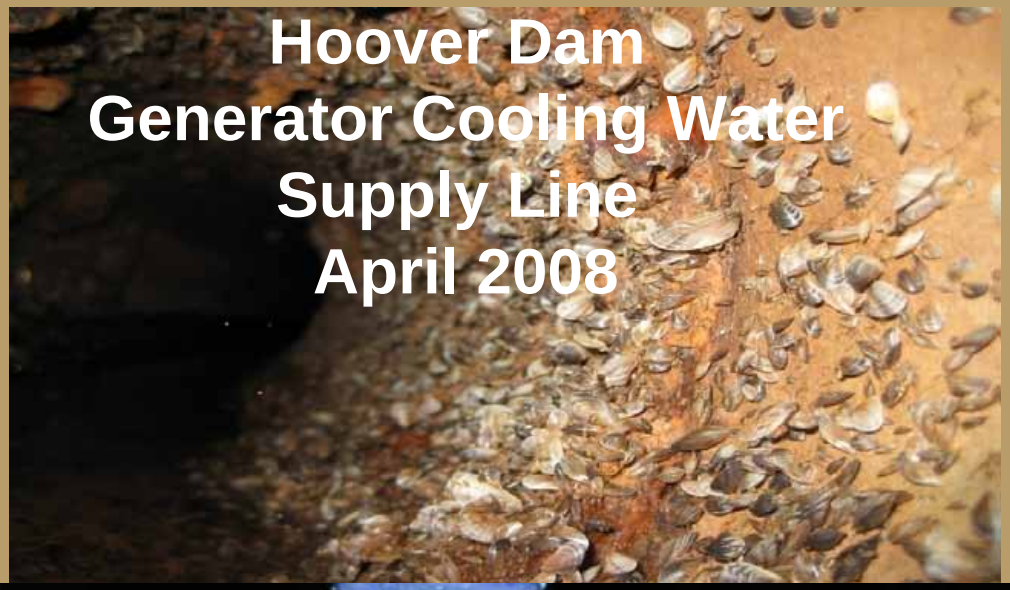
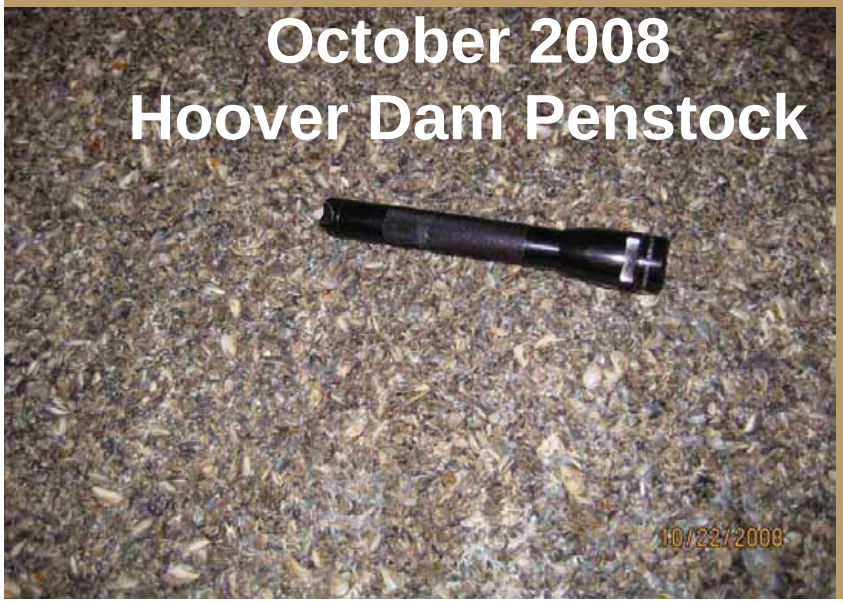
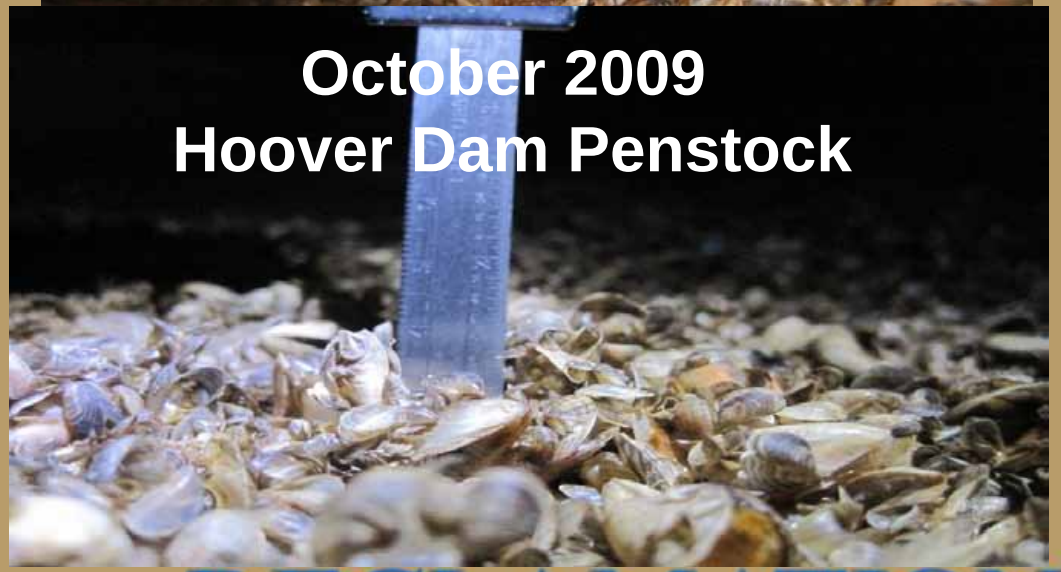
Historical observations









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External Structures Options

Mechanical Cleaning

- **de-water and use power wash**
- **underwater, scrape and vacuum or power wash**

RECLAMATION

Oxidizing Chemical Treatment

- Chlorine
- Bromine
- Chlorine dioxide
- Chloramines
- Ozone
- Potassium permanganate

Chlorine tankers used at Metropolitan Water District of Southern California at Gene Camp for Mussel Control

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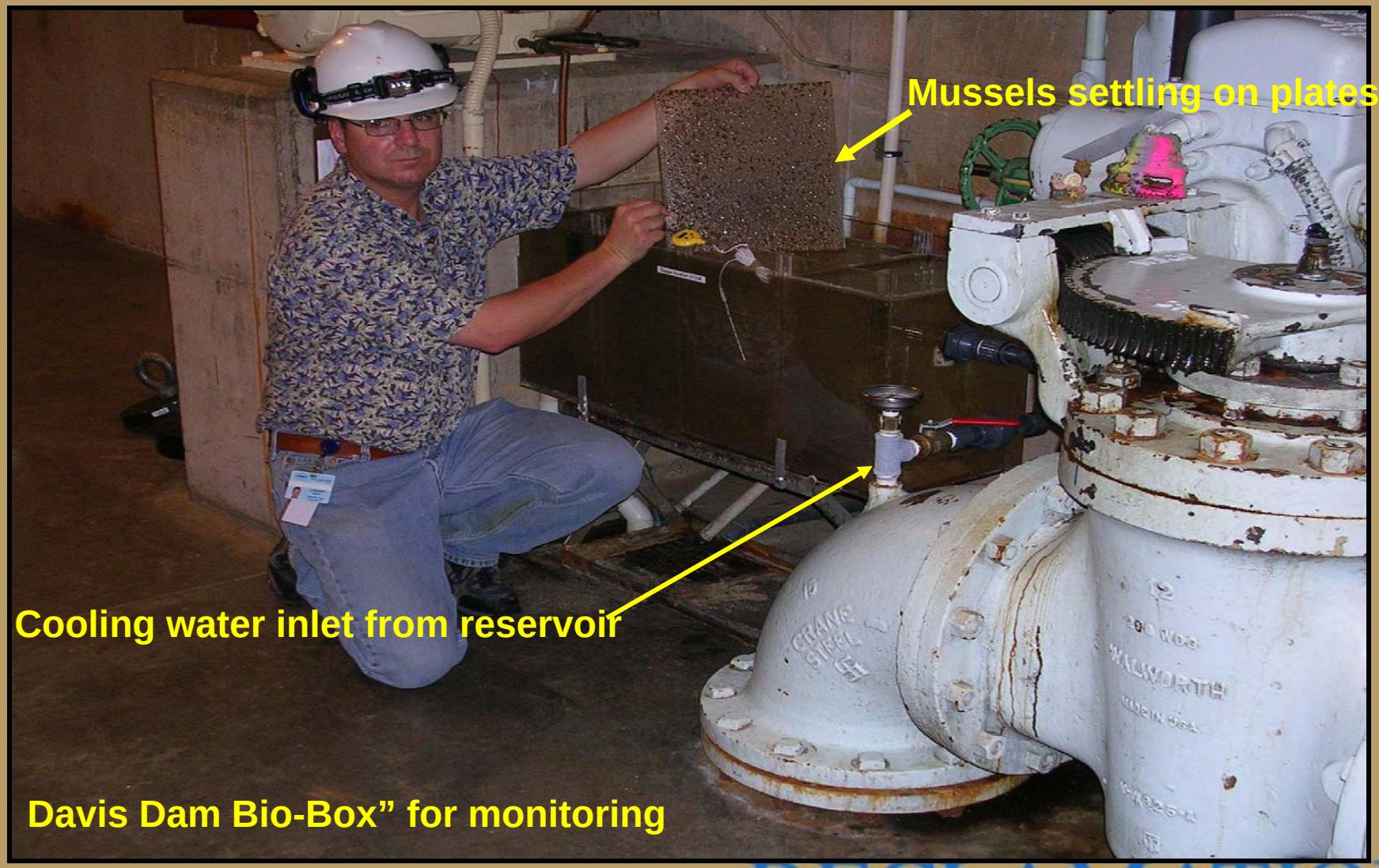
Lower Colorado Region Research Activities

- Monitoring substrate
- Installed bio-boxes
- Evaluating anti-foul coatings and materials to resist mussels (Dr. Allen Skaja, TSC Denver)
- Evaluating ultra-violet light treatment
- Testing 40 & 80 micro filtration systems
- Identifying and evaluating water jetting system for exterior cleaning
- Evaluation of bacterium (Zequanox) treatment
- Evaluating treatment alternatives (Redear Sunfish, sparker, chemical, thermal, biological)

RECLAMATION

Installed Bio-Box Sampler for Plant Monitoring



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Coatings Panels Locations

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Coatings Panels (cont.)

3-month
fouling rate

RECLAMATION


STEEL
ZINC - METALIZED
ICI DEVOE
CATHACOAT 304
FUJI FILM SMART
SURFACES
4 MONTHS
LUMINORE
INTERNATIONAL
INTERSLEEK 970

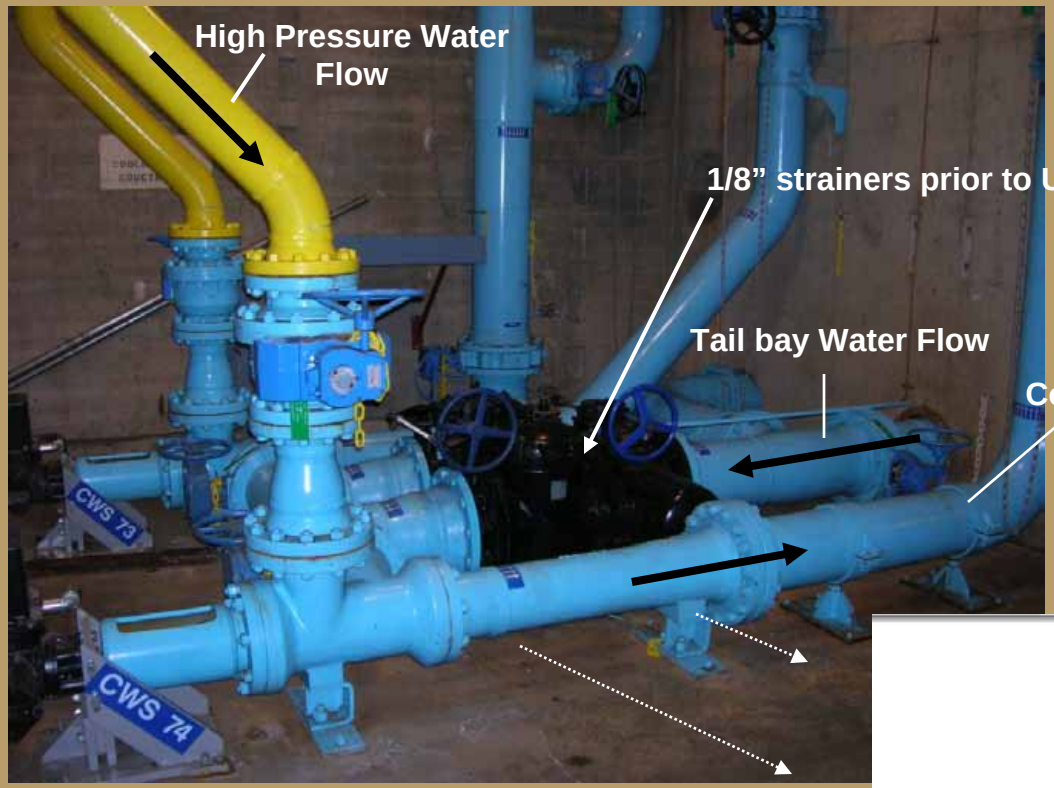
Fish Screen Material (Cu- Ni Wedge Wire)

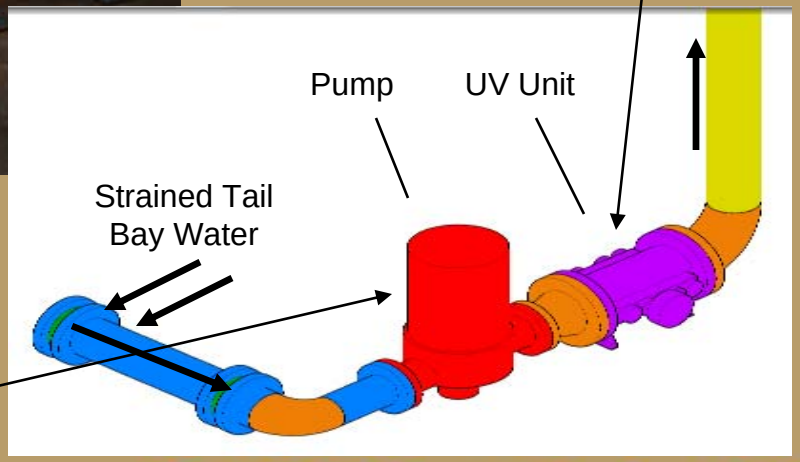
3-month fouling
(Sept. – Dec. 2009)

RECLAMATION

Unit Cooling Water - Current Layout and New Design

UV design lower right corner





New design uses pumps using tail bay water supply instead of fore bay at Hoover Dam

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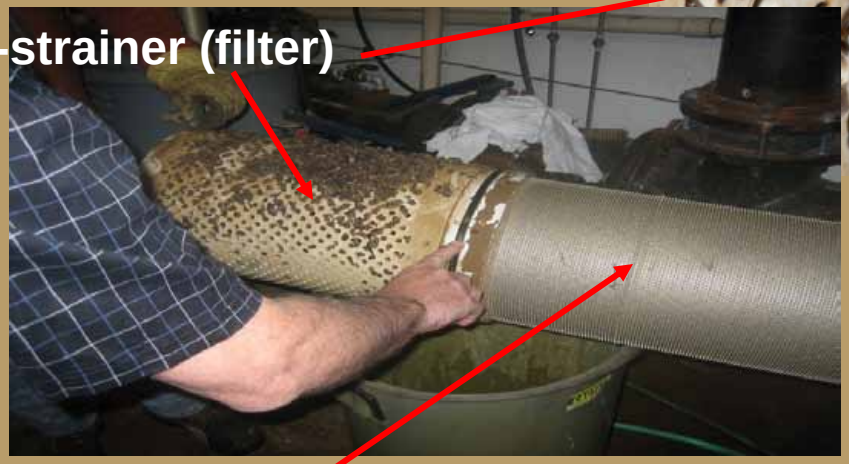
Ballast Safe Filter Housing
Parker Dam - November 2008

RECLAMATION

Self Cleaning Ballast Safe Filter

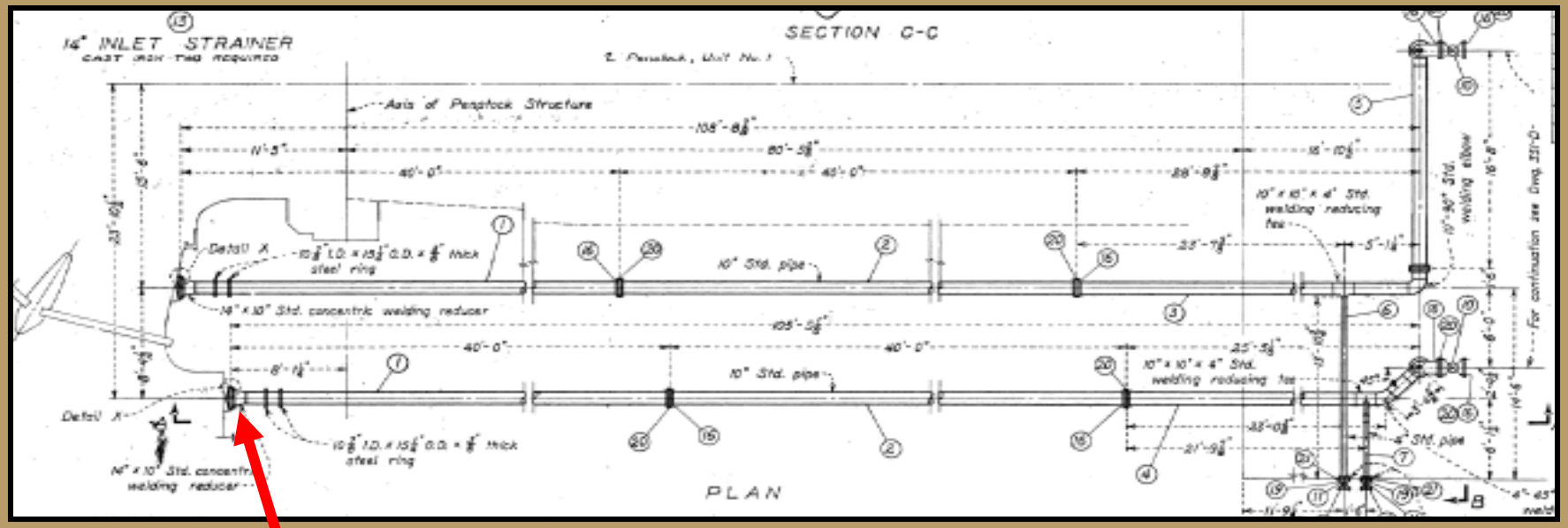
Pre-strainer (filter)



Filter Cartridge – 40 micron

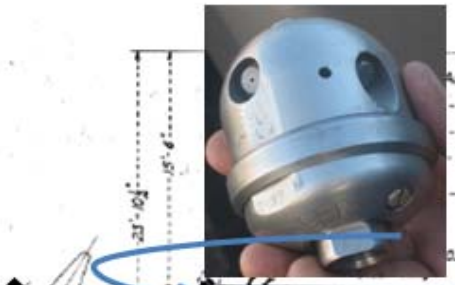
RECLAMATION

Domestic Water Intake – Davis Dam



RECLAMATION

Domestic Water Lines – Davis Dam



RECLAMATION

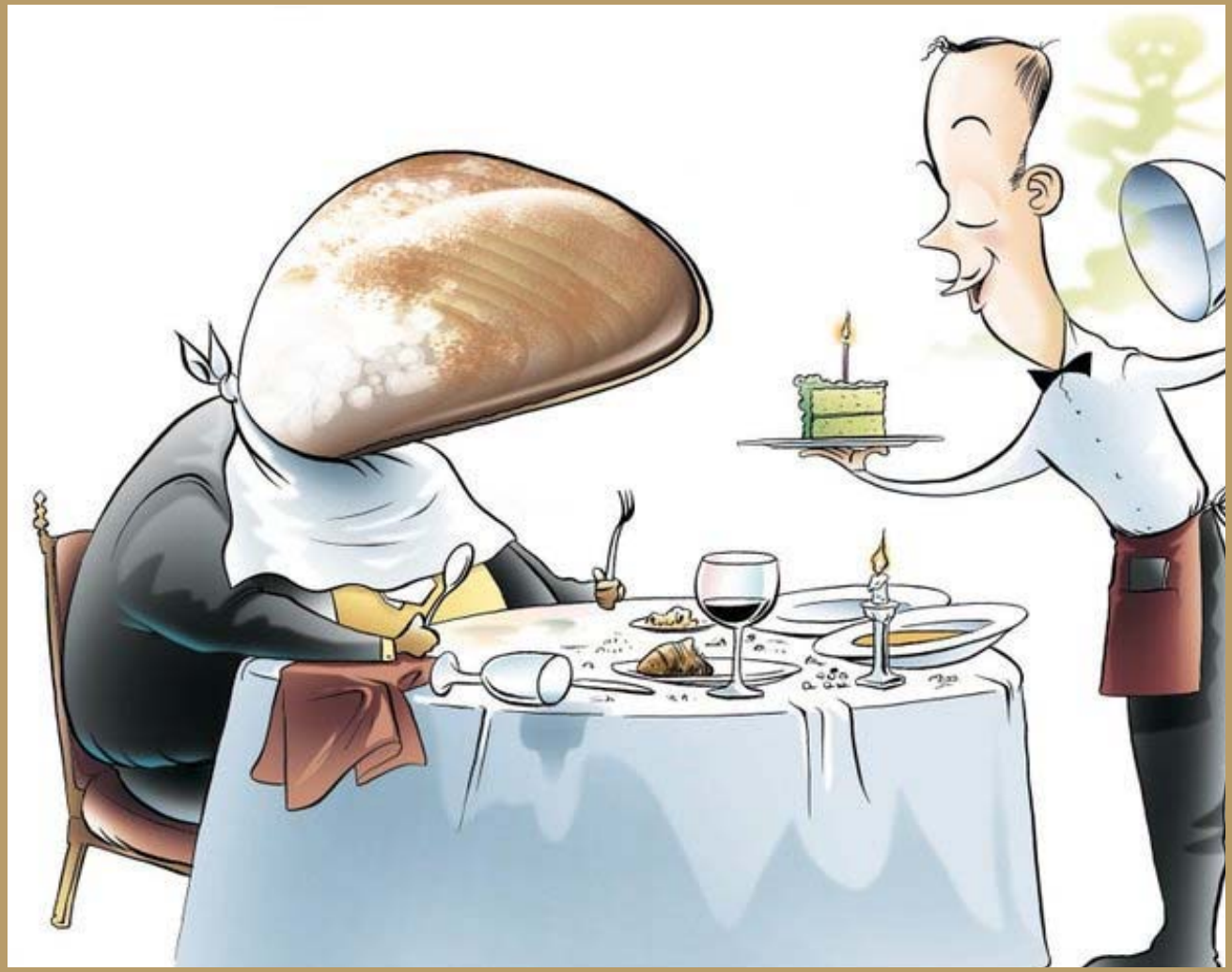
Water Jetting Equipment

Video

- pre inspection
- water jetting
- post inspection

RECLAMATION

Emerging Options - Zequanox
Pseudomonas flourescens (PF)



Mussels' last meal - Scientists want to add PF that are lethal to invasive mollusks to water at Hoover or Davis dams

RECLAMATION

Pseudomonas flourescens Trials
Davis Dam - March 2009

RECLAMATION

Emerging Options

- Bacterial product (Developed at NY State Museum and commercially developed by Marrone Organic Innovations), zebra mussel specific chemical….being tested on Quagga now
- How does it work?

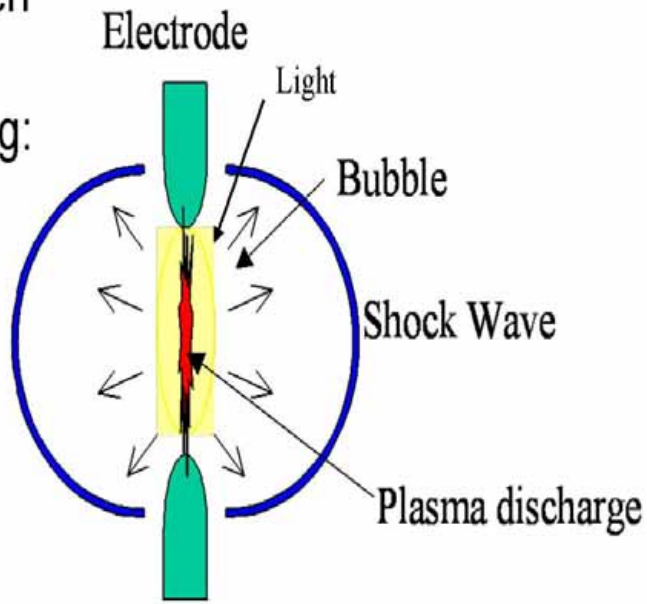
The bacteria produce natural compounds that kill the mussels when ingested. It destroys the mussels' digestive system.

New York State Museum

RECLAMATION

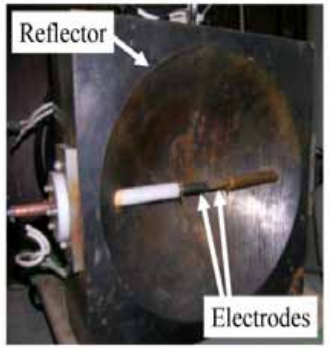
What is a Sparker?

- High voltage spark between electrodes in water
- Vaporizes water, producing:
  - pressure pulse
  - light pulse
  - vapor-filled "bubble"
- The bubble oscillates
- Generate "sparks" at controlled intervals



Reflector Can Direct the Pressure

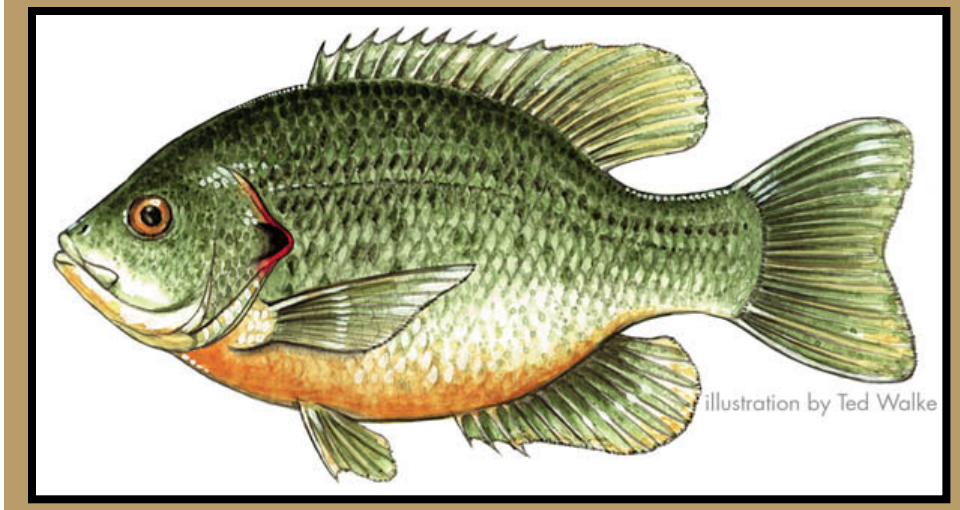
- Parabolic reflector with pressure generated at the focus directs pressure into pipe



How Does Pressure Control Zebra Mussels?

- Repeated pressure pulses create a hostile environment
  - Causes shells to close, preventing feeding
  - Mortality from mechanical damage at short range
  - Prevents larvae (veligers) from remaining in water column
  - Paper to be published in April AWWA Journal

Redear Sunfish, a.k.a. “Shell Cracker”



RECLAMATION

Aquatic Weeds – Lake Havasu, AZ
August 2008

RECLAMATION

Reclamation expenditures
FY 08, 09, 10 and ARRA funding

Reclamation Costs and Budget for Quagga/Zebra Mussels	Total (rounded to near decimal)
Prevention	$ 770 K
Early Detection/Rapid Response	$ 5.3 M (ARRA Funding $ 4.5 M)
Control and Management	$ 1.7 M
Research	$ 3.5 M
Education and Outreach	$ 1.2 M
Total	**$ 12.59 M**

RECLAMATION

RECLAMATION

Managing Water in the West

Questions

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U.S. Department of the Interior
Bureau of Reclamation