

# RECLAMATION

*Managing Water in the West*

## **Lower Colorado Dam's Quagga Mussel Assessment and Potential Control/Preventive Program**



U.S. Department of the Interior  
Bureau of Reclamation

# Agenda

- **BACKGROUND**
- **BUREAU OF RECLAMATION LOWER COLORADO DAMS (LCD) CONTRACTED WITH QUAGGA MUSSEL CONSULTANT – RENATA CLAUDI (RNT CONSULTING)**
- **LESSONS-LEARNED FROM ONTARIO POWER PLANTS**
- **COMPREHENSIVE FACILITY REVIEW OF THE DAMS**
- **FINDINGS & POTENTIAL CONTROL/PREVENTIVE MEASURES**

# Site Visit Experience Ontario Hydro Power Facilities (reactive approach)



Sir Adam Beck #2



Sir Adam Beck #1



DeCew #2



Pump Generating Station

RECLAMATION



# Nanticoke Coal Fired Facility Ontario (proactive approach)



RECLAMATION

# Over time if left untreated

- Transformer cooling water piping plugged at Ontario Hydro Power



**Water Cooled  
Transformer Piping**

# Ontario Hydro Plant Unit Coolers



Dead Mussels Found in Unit Coolers

# Quagga Mussel Infestation at Dams; What have we learned and what do we recommend

RNT Consulting Inc.

RECLAMATION





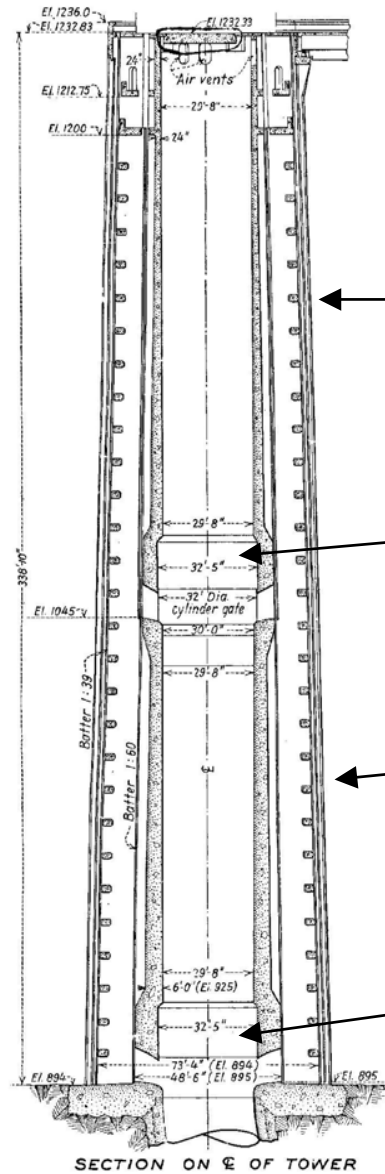


# Observations from inspection of external surfaces

- Mussels are present in the lower penstock (Living 220' below Lake evaluation)







Elev 1111  
Dec 2007 Lake  
Mead Level

Elev 1045  
66'

Elev 970  
141'

Elev 894  
217'



Elevation 1045, (66' below water)



RECLAMATION



# Sampling Plates at Parker Dam

November 11/07 – 6 Weeks of Settlement



RECLAMATION



# Stainless Steel Pipe 11/07



RECLAMATION



# Davis Dam Penstock Gate Oct.07



RECLAMATION



# Proactive vs. Reactive Control Measures

- Proactive

Does not allow growth of mussels in the system or on the surface protected

- Reactive

Does allow mussels to grow in the system or on the surface. Established populations have to be eliminated periodically

# Findings & Potential Control Measures

- All three dams use the same settlement substrate on the sampling plates
- Same dimensions
- At the same depth (10ft, 20....down to maximum depth)
- Examine the plates at the same time interval and in the same manner
- Multiple strings of sampling plates lakeside and in the tailbay





**RECLAMATION**



# Install Side stream sampler for plant monitoring

## **Bio-box**



RECLAMATION

# Bio-Box Spiked with Live Mussels

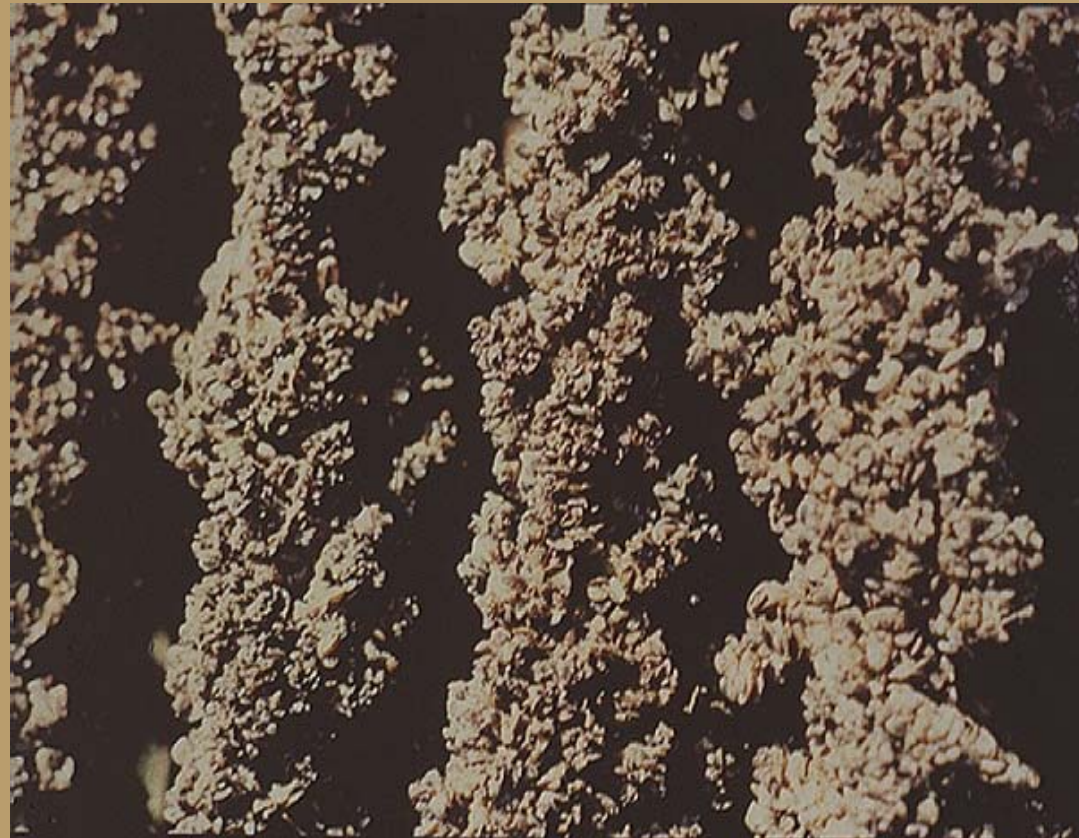


RECLAMATION



# Options for External Structures\*

\*Structures That Are in Direct Contact With the External Environment; No Isolation Is Possible



RECLAMATION

# Reactive Options for External Structures

## Mechanical Cleaning



- de-water and use powerwash
- underwater, scrape and vacuum or powerwash



# Proactive Options for External Structures

- Antifouling Coatings - for both steel and concrete
- Toxic, copper based coatings
- Non-toxic, silicone based is (Foul Release Coating)
- Life-span 5-7 years before topcoat needs to be refreshed

# Substrate Preference

(Decreasing from Top to Bottom)

- Copper
- Galvanized Iron
- Aluminum
- Acrylic
- PVC
- Teflon
- Vinyl
- Pressure Treated Wood
- Black Steel
- Polypropylene
- Asbestos
- Stainless Steel



**Kerr Lock and Dam (COE),  
Tulsa OK**

**Source - Kilgour and Mackie, 1993**

**RECLAMATION**



# Initial Suggestions for Control

- Rapid Response Option (if settlement and shell transport increases dramatically and suddenly):

- Install portable chlorine skids to protect critical areas



- Use thermal treatment where possible
  - 32°C for 48 hours (90° F)
  - 40°C for 1 hour (104° F)

Use weak acids to dissolve shells and corrosion products

Mechanical cleaning as system performance deteriorates

# Oxidizing Chemical Treatment

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





# Emerging Options

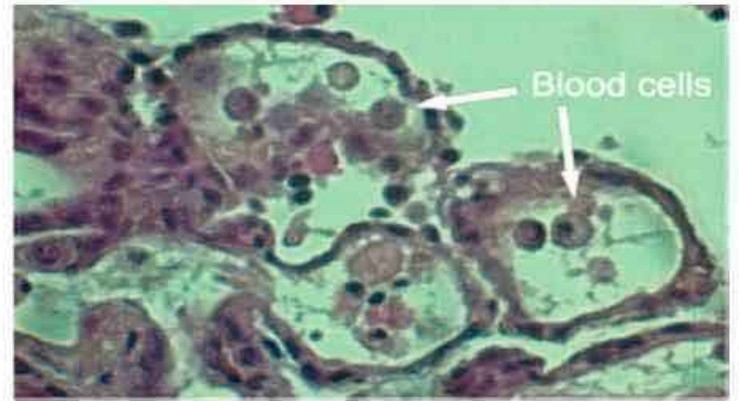
- Bacterial product (Marrone Organic Innovations), zebra mussel specific chemical....being tested on Quagga now

## How does it work?

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



In healthy mussels, epithelial cells (arrows) appear as a thick layer lining the tubules of the digestive gland.



Following bacterial treatment, epithelial cells are destroyed. Blood cells are abundant as the digestive gland hemorrhages.

# Proactive Options for Internal Piping Systems

- Sand/media filtration - has to remove all particles greater than 40 micron
- Mechanical filtration - has to remove all particles greater than 40 micron



# Example of Self Cleaning Filter

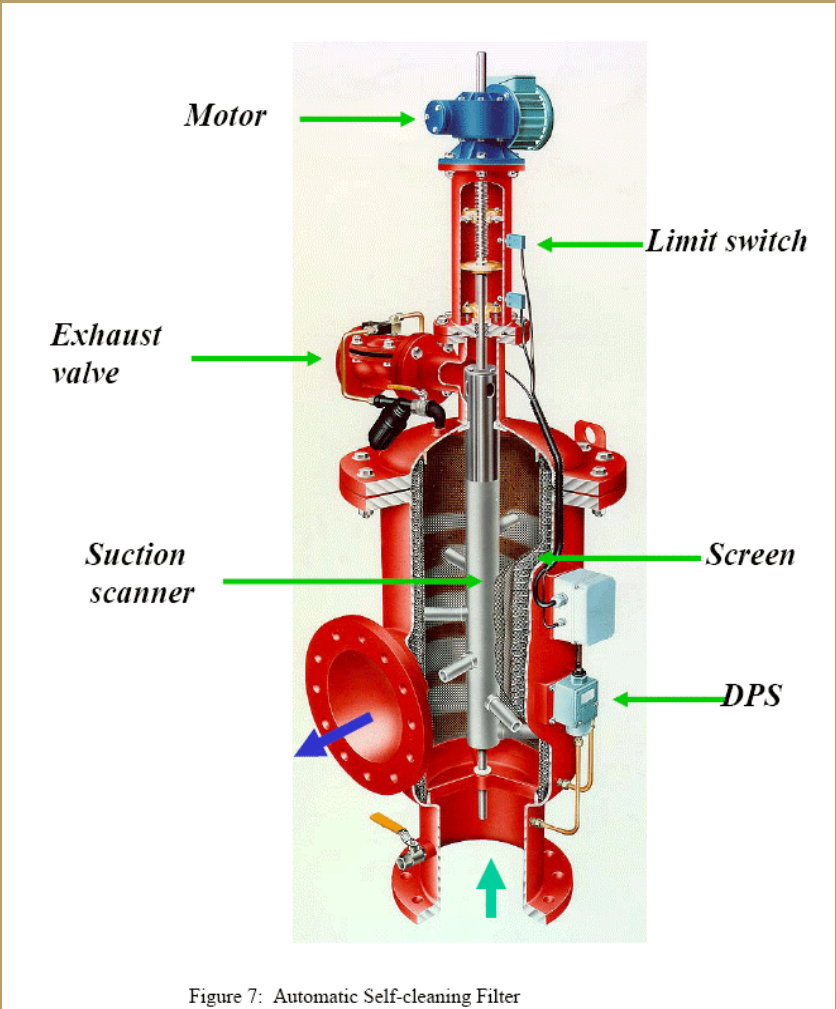
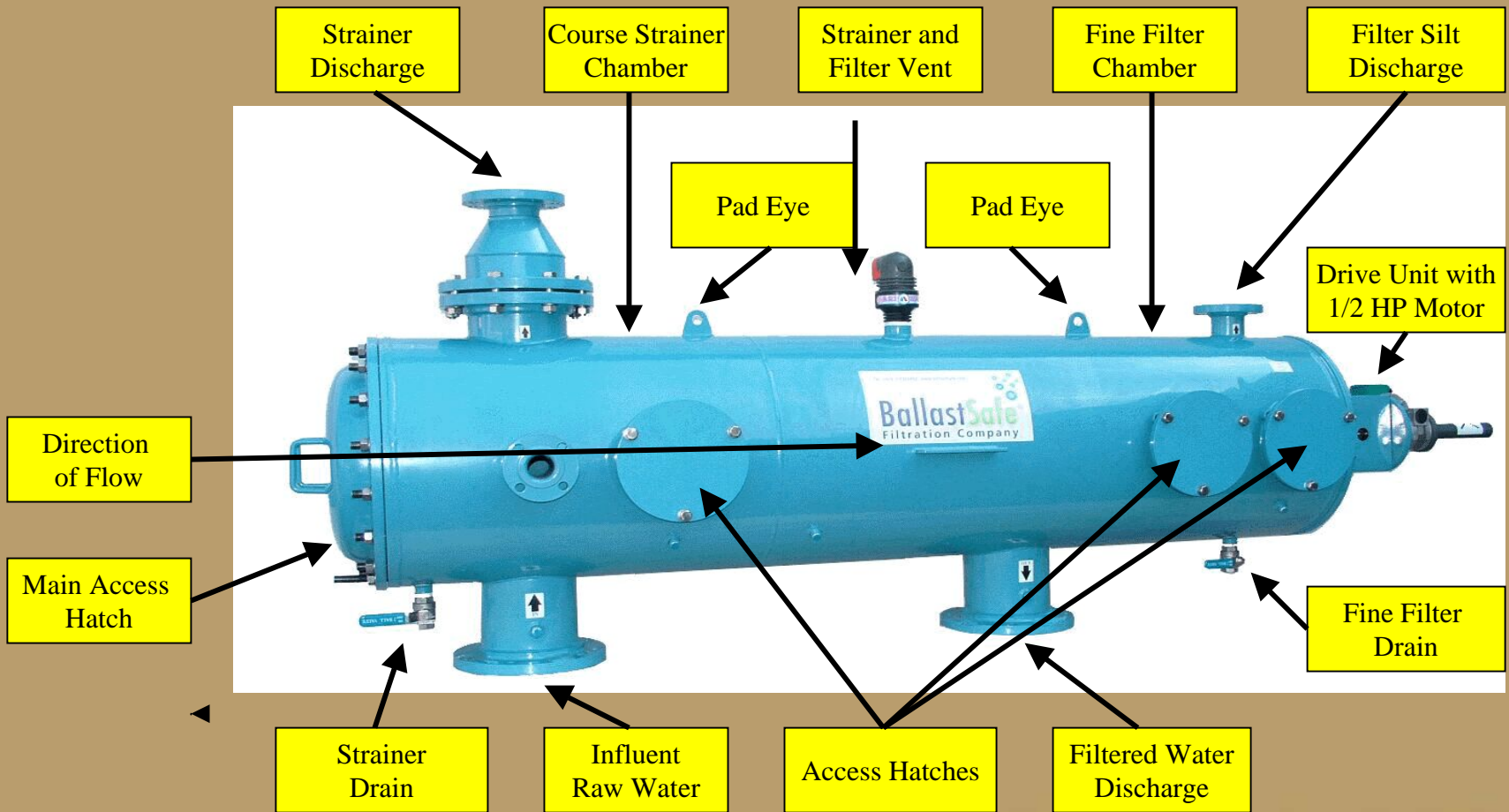


Figure 7: Automatic Self-cleaning Filter

# 25 to 50 MICRON SELF CLEANING FILTER



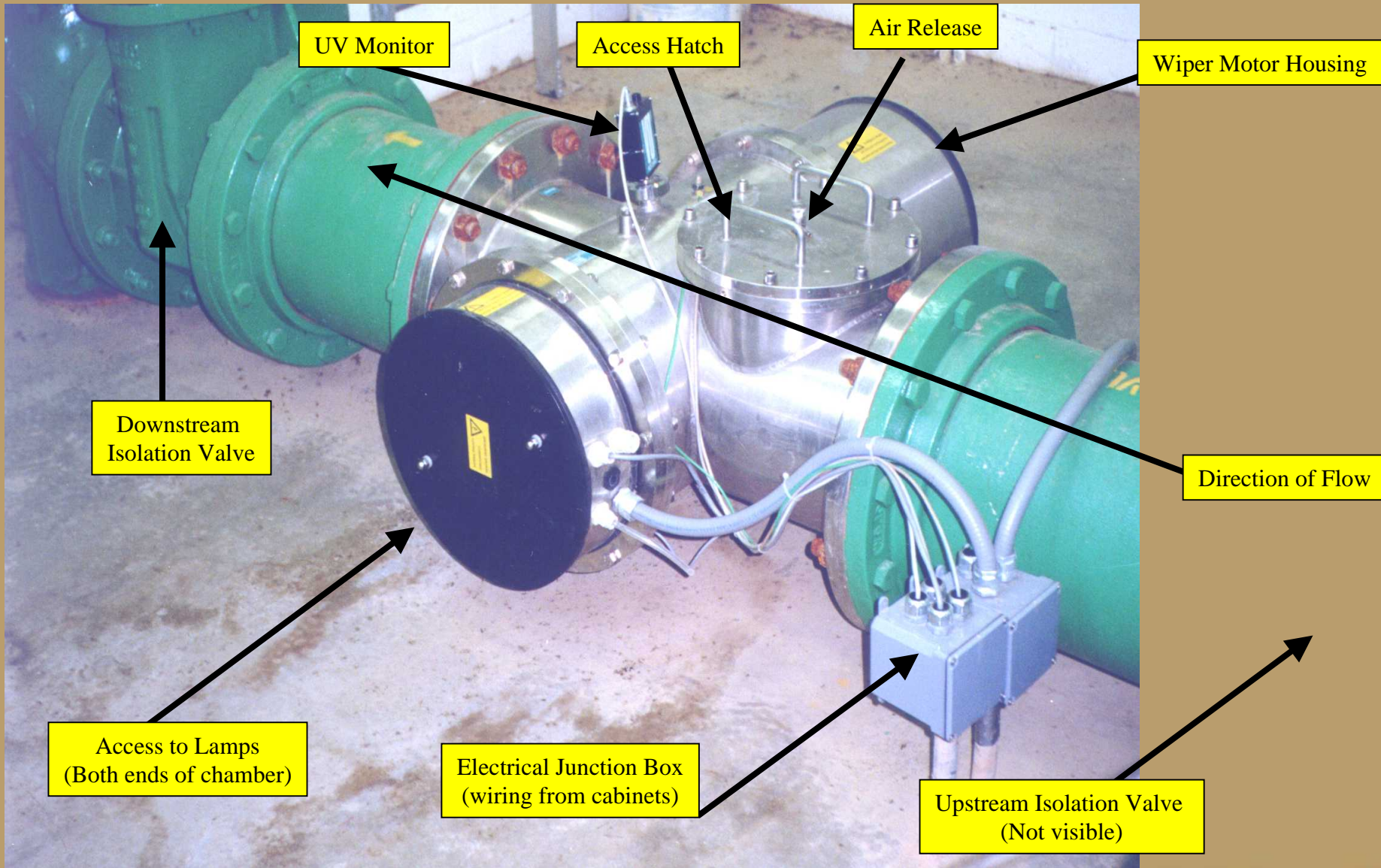
RECLAMATION



# Additional Proactive Options for Internal Piping Systems

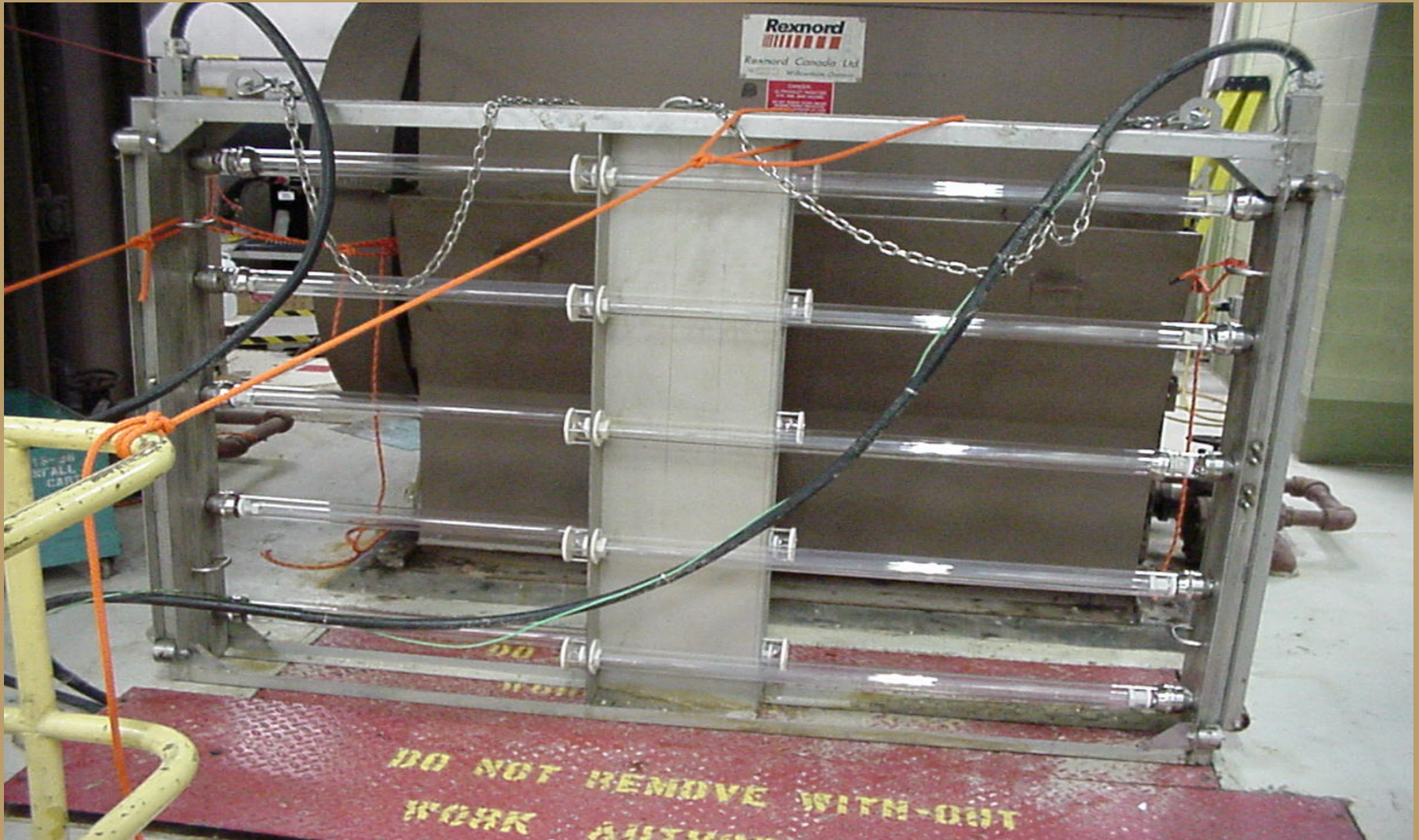
- **UV systems**
- **Closed Loop Cooling**
- **Oxidizing chemicals**
- **Non-Oxidizing chemicals**

# In Line Pipeline UV Installation





# UV Light Bank for Open Channel



RECLAMATION

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

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



# Cost for Mussel Control

- Ontario Hydro Experience

Average cost per MW = \$1020/MW (Capital Costs)

Average Annual Operating Cost = \$50/MW

# Consultant and LCD Quagga Mussel Point of Contact

- Contracted with RNT Consulting Inc.  
Ms. Renata Claudi, Chief Scientist  
823 County Road 35 - Picton, Ontario, Canada K0K 2T0  
Phone/Fax (613) 476-7994 - E-mail: [rnt@idirect.com](mailto:rnt@idirect.com)
- Bureau of Reclamation – Hoover Dam Engineering  
Mr. Leonard Willett, Water Treatment Manager  
Boulder City, NV 89006 – Phone (702) 494-2216  
E-mail: [lwillett@lc.usbr.gov](mailto:lwillett@lc.usbr.gov)



# RECLAMATION

*Managing Water in the West*

## QUESTIONS



U.S. Department of the Interior  
Bureau of Reclamation