10 October 2018

Zebra Mussel Control Study

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Agenda

- Zebra Mussel Overview & Limits of Infestation
- Zebra Mussel Control Strategies
- Overview of Viable Zebra Mussel Control Strategies
- Recommendations & Next Steps (Path Forward)

Zebra Mussel Overview & Limits of Infestation

Zebra Mussel Overview

- **Zebra mussels originated from Russia & were introduced to the Great Lakes in the 1980s**
- **Optimum conditions for zebra mussel growth:**
  - Water temperature above 60°F
  - Velocity less than 7 fps
  - Turbidity < 50 NTU
- **Spawning season in Lewis & Clark Reservoir estimated to be between May and October**

Zebra Mussel Infestation at Intake No. 1

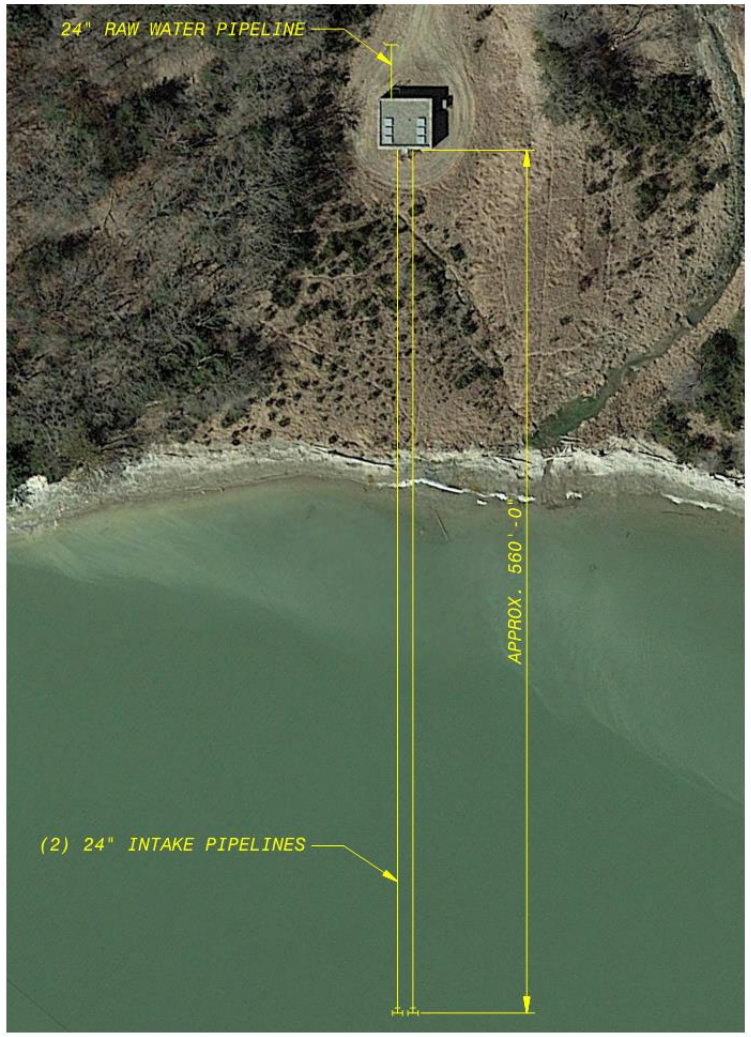
- Zebra mussels observed during pump repair work in April, 2018
- The degree of infestation on the screens, Intake Pipelines and Raw Water Pipeline is unknown

Intake No. 1 – Site Plan & Design Parameters

INTAKE/PUMPING STATION NO. 1
1" = 500'-0"

DESCRIPTION	INTAKE NO. 1
Intake Screen	
Intake Type	T-Screen
Velocity through Intake Screen	< 0.5 fps
Intake Pipeline	
Number of Intake Pipes	2
Diameter	20-inch
Length	Approx. 300 ft.
Velocity in Intake Pipeline	3.7 fps
Intake Pumps	
Firm / Total capacity at normal reservoir level	5.25 / 6.75 MGD
Raw Water Pipeline	
Number of Pipelines	1
Diameter	18-inches
Length	Approx. 9,260 ft.
Velocity	5.9 fps

Intake No. 2 – Site Plan & Design Parameters



INTAKE/PUMPING STATION NO. 2
1" = 1000'-0"

DESCRIPTION	INTAKE NO. 2
Intake Screen	
Intake Type	T-Screen
Velocity through Intake Screen	< 0.5 fps
Intake Pipeline	
Number of Intake Pipes	2
Diameter	24-inch
Length	Approx. 560 ft.
Velocity in Intake Pipeline	4.2 fps
Intake Pumps	
Firm / Total capacity at normal reservoir level	8.6 / 10.2 MGD
Raw Water Pipeline	
Number of Pipelines	1
Diameter	24-inch
Length	Approx. 9,300 ft.
Velocity	5.0 fps

Zebra Mussel Control Strategies

Zebra Mussel Control Strategies

- **Chemical Treatment**
  - Ozone
  - Chlorine Dioxide
  - Hydrogen Peroxide
  - Polymer
  - Chloramines (Chlorine + Ammonia)
  - Sodium Hypochlorite
  - Sodium Permanganate
  - Copper-based biocide
- **Copper Ionization**
- **UV Reactors**

Viable Zebra Mussel Control Strategies

Intake Pipeline, Pump Wetwell & Raw Water Pipeline

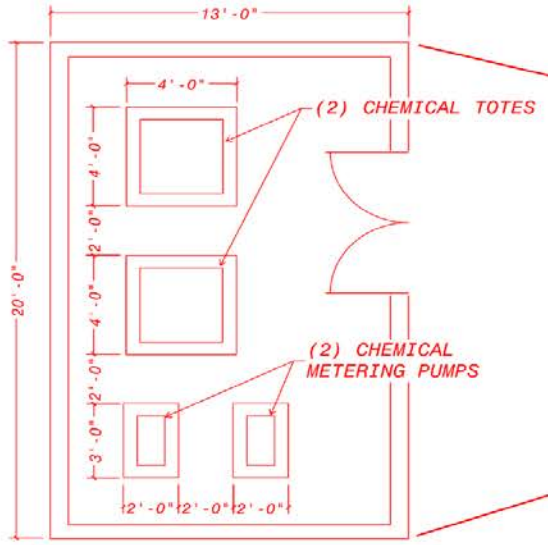
- Alternative 1: Sodium Permanganate
- Alternative 2: Copper-based Biocide
- Alternative 3: Copper Ionization

Intake Screen

- Alternative A: Periodic Inspection & Physical Cleaning
- Alternative B: Replace Intake Screens with mussel-resistant material
- Alternative C: Coat Existing Intake Screens with mussel-resistant material

Overview of Viable Zebra Mussel Control Strategies

Alternative Nos. 1 & 2 – Intake No. 1 Site Plan & Facility Layout (Sodium Permanganate or Copper-based Biocide)



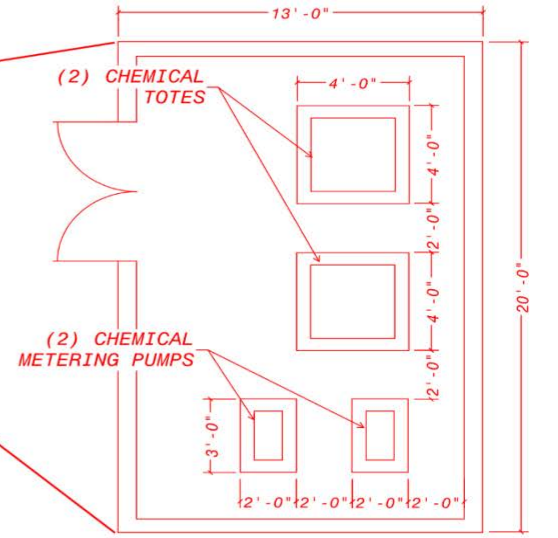
CHEMICAL STORAGE AND FEED SYSTEM
3/8" = 1'-0"

BUILDING FOOTPRINT = 260 SQ.FT.

INTAKE/PUMPING STATION NO. 1

Alternative Nos. 1 & 2 – Intake No. 2 Site Plan & Facility Layout (Sodium Permanganate or Copper-based Biocide)

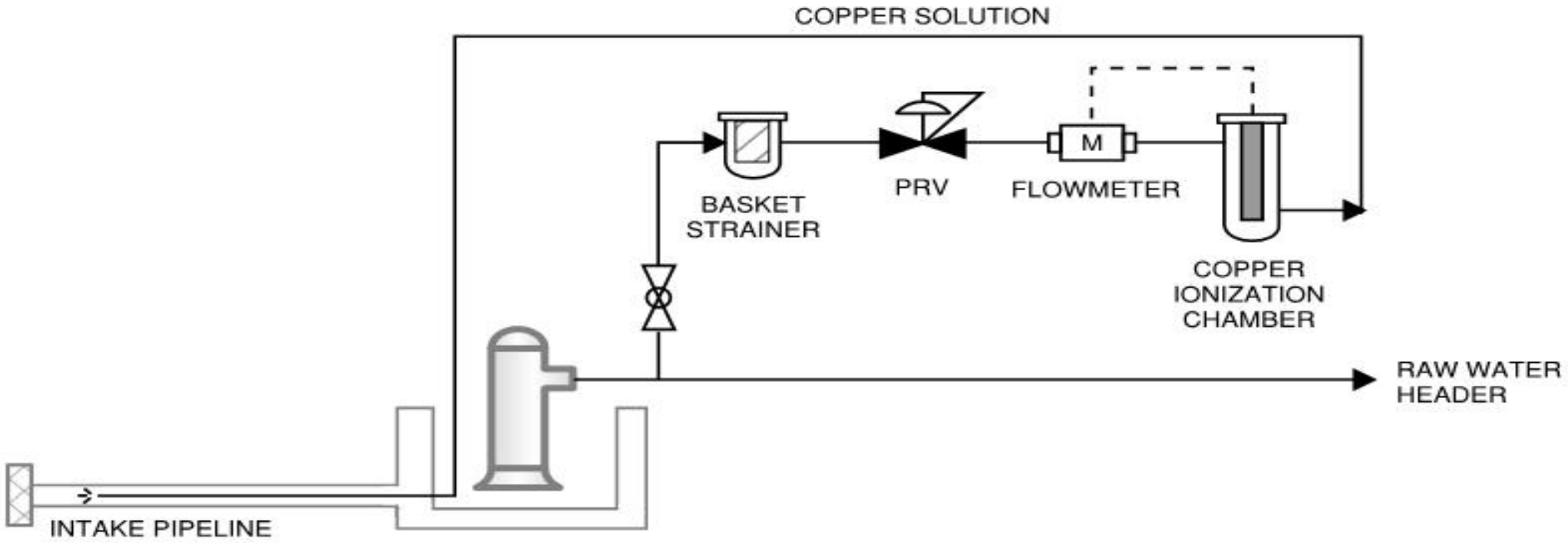
INTAKE/PUMPING STATION NO. 2



CHEMICAL STORAGE AND FEED SYSTEM
3/8" = 1'-0"

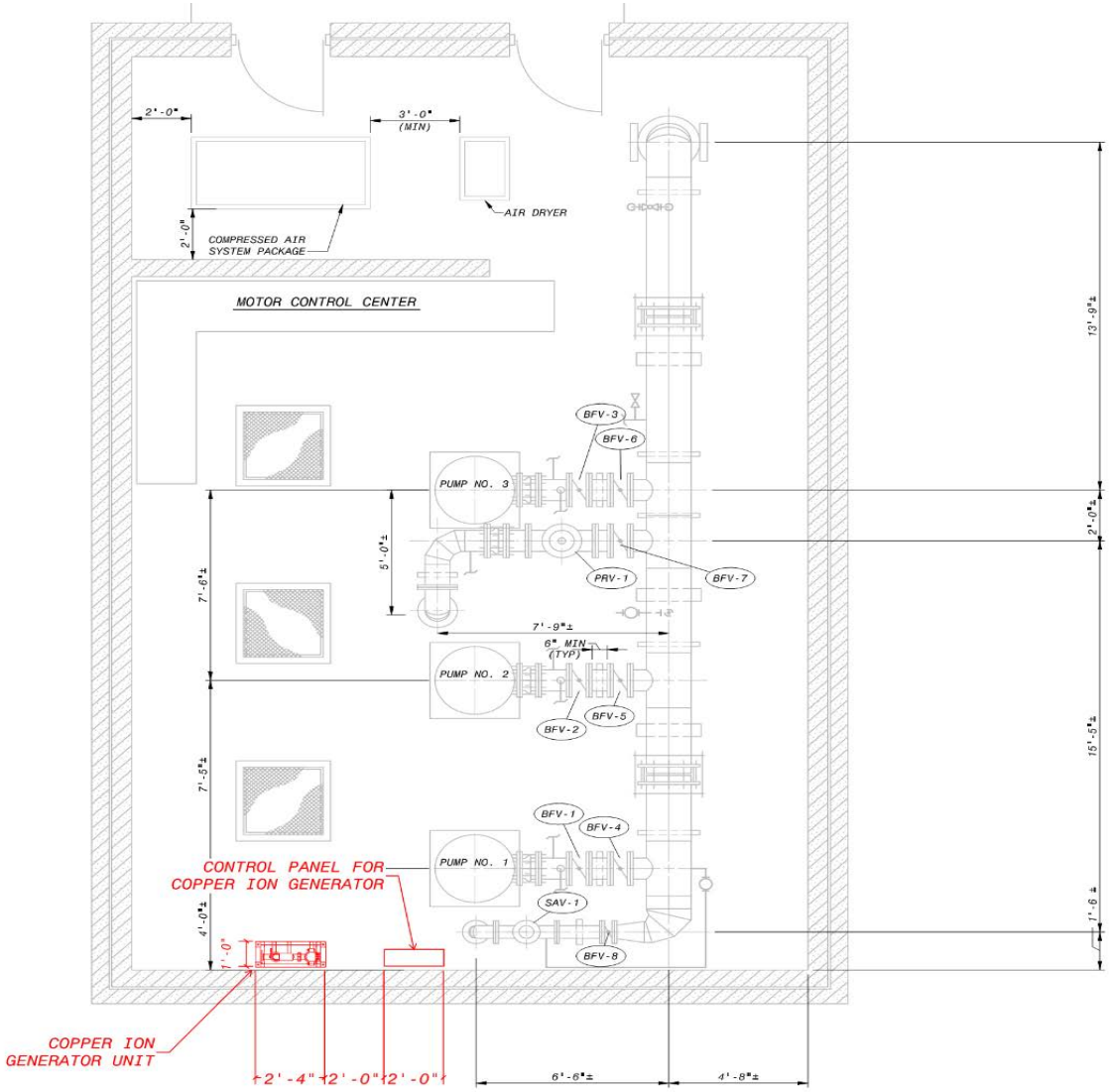
BUILDING FOOTPRINT = 260 SQ.FT.

Alternative No. 3 – Copper Ionization



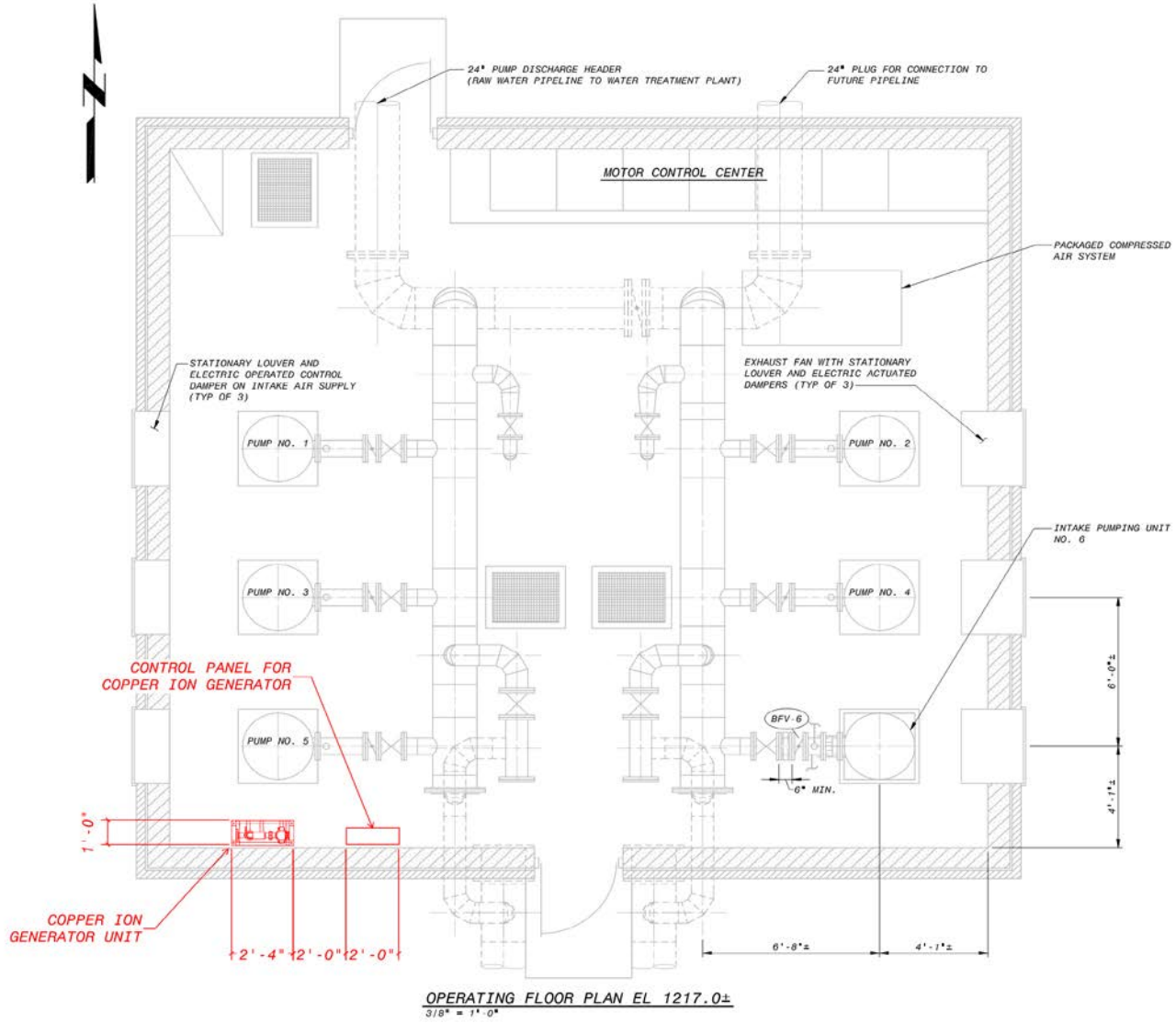
One 10 MGD unit installed at each intake pump station.

Alternative No. 3: Intake No. 1 – Copper Ion Facility Layout



20 MGD copper ion generator installed in Lawrence, KS

Alternative No. 3: Intake No. 2 – Copper Ion Facility Layout



20 MGD copper ion generator installed in Lawrence, KS

Comparison of Viable Alternatives

ALTERNATIVE	ALTERNATIVE 1 – SODIUM PERMANGANATE	ALTERNATIVE 2 – COPPER-BASED BIOCIDE	ALTERNATIVE 3 – COPPER ION GENERATOR
Description	• Chemical storage & feed system housed in a new building	• Chemical storage & feed system housed in a new building	• Copper ion generator located inside existing Intake Pump Station Nos. 1 and 2.
Advantages	• Simple to operate • Does not form DBPs	• Simple to operate • Does not form DBPs	• Compact footprint • Lowest capital and life cycle cost • Does not require chemical deliveries to site • Does not form DBPs
Disadvantages	• Difficulty delivering chemicals to site • Higher capital and life cycle cost • Potential for pink water if overdosed	• Difficulty delivering chemicals to site • Higher capital and life cycle cost	
Capital Cost	$1,265,000	$1,265,000	$465,000
Annual O&M Cost	$28,000	$26,000	$7,000
Total Life Cycle Cost	**$2,310,000**	**$2,255,000**	**$760,000**

Zebra Mussel Control Strategies to Protect Intake Screens

Comparison of Alternatives to Protect Intake Screens

ALTERNATIVE	ALTERNATIVE 1 – APPLICATION OF COATING SYSTEM	ALTERNATIVE 2 – REPLACE EXISTING INTAKE SCREENS	ALTERNATIVE 3 – PERIODIC INSPECTION & CLEANING
Description	• Coat existing intake screens with zebra mussel resistant materials	• Replace existing intake screen with new copper-nickel alloy screen	• Bi-annual inspection and physical cleaning performed by divers
Advantages	• Permanent protection of intake screen from zebra mussel infestation • Requires coating replacement every 10-15 years	• Permanent protection of intake screen from zebra mussel infestation • No annual O&M cost	• Does not require an initial capital investment
Disadvantages	• Requires initial capital investment • Requires removal of existing screens • Cost for recoating screens	• Requires initial capital investment • Requires removal of existing screens	• High annual O&M cost • Potential damage to intake screen during cleaning activities
Capital Cost	$300,000	$480,000	N/A
Annual O&M Cost	$300,000 every 10 years	N/A	$30,000
Total Life Cycle Cost	**$1,300,000**	**$480,0000**	**$820,000**

Recommendations & Next Steps

Recommendations & Next Steps

- **Step 1:** Submit draft report to DENR and solicit feedback.
- **Step 2:** Perform inspection of intake & raw water pipelines using ROV. Perform inspection of intake screens w/ diver.
- **Step 3:** Identify point of chemical application & need for screen replacement based on inspection results.
- **Step 4:** Implement copper ionization system to protect infrastructure identified in Step 3.
- **Step 5:** Replace existing screens with copper-nickel alloy screens when zebra mussel infestation is observed.

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