Zebra Mussel Mitigation Strategies

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Surface Water Treatment Workshop

Outline

- Zebra Mussel Basics
- Mitigation Basics
- Copper Biocide Systems
- Ion Generation Systems
- In River Systems

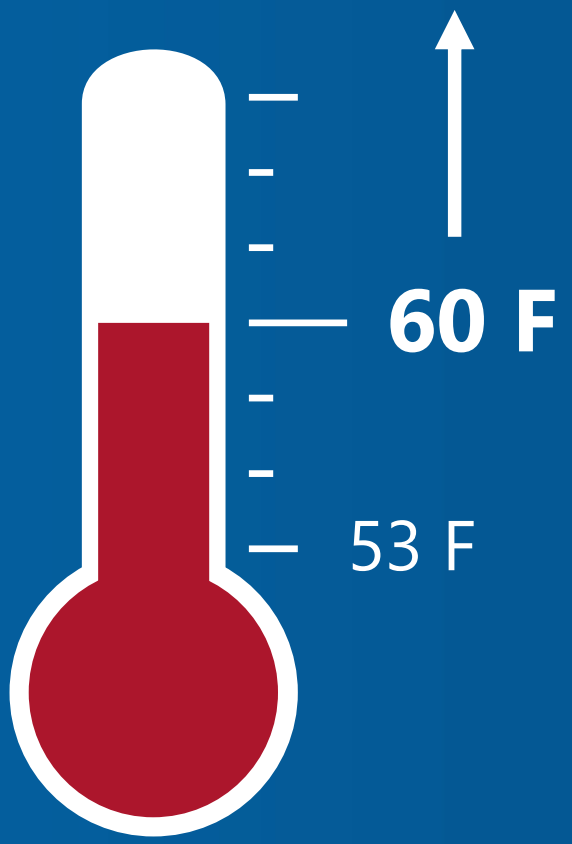
Zebra Mussel Basics

- Lifespan of 3-5 years
- Veligers are free-moving larvae within the water column
- Attached by byssal threads
  - Have the ability to detach and relocate
- Growth occurs faster in warmer water
- 18-30 days from fertilization to settling phase

Zebra Mussel Basics

Generally seasonal

- Spawning assumed to occur continuously once it's started
- Optimum spawning occurs above 60 °F but can occur as low as 53 °F



Mitigation Basics

- Physical and Chemical Mitigation Options Available
- Physical:
  - Velocities greater than 6.5 FPS prevent veligers from settling[1]
  - Pigging: only feasible in pipelines
  - Hand removal

1: USACE Zebra Mussel Resource Document. Trinity River Basin, Texas. Published June 2013.

Mitigation Basics

- Chemical Mitigation: Involves oxidants
- Goal is to keep veligers from attaching with their byssal threads
  - Copper Biocides
    - Neat fed
    - Onsite generation
  - UV – Usually ineffective due to low transmittance of raw surface waters

Mitigation Basics

- Chlorine – High raw water TOC creates DBP concerns
- Chlorine Dioxide – Mixed results if it performs better or worse than chlorine
- Hydrogen Peroxide – Requires 9 times higher dose than chlorine it not economically competitive
- Ozone – High capital and O&M costs
- Potassium Permanganate – Does not form DBP

Potassium Permanganate

Adults

- Concentrations below 4 PPM are ineffective for adults
- 8 PPM caused 50% mortality after 96 hours (4 days)

Veligers

- 4 PPM caused 50% mortality after 180 hours (7.5 days)
- 8 PPM caused 50% mortality after 120 hours (5 days)

Coyle et. al. Potassium permanganate's effect on zebra mussel adults and veligers. 2014

Copper Biocide Systems

What is it?

Proprietary blends containing copper sulfate

- Also toxic to algae and aquatic insects

Copper Biocide Systems

Pros

- Operator familiarity
- Lower capital cost
- Higher dosage (60 PPB Cu) leads to better/quicker mortality rates
- Not generally detected by zebra mussels[1]

1: USACE Zebra Mussel Resource Document. Trinity River Basin, Texas. Published June 2013.

Copper Biocide Systems

Cons

- Very corrosive – pH of 0.2-0.3
- Secondary containment required
- Storage over 500 pounds requires 3-hr fire rated walls
- “Toxic” – Requires space to be sprinkled and contain shower/eyewash

Copper Biocide Systems

Ion Generation Systems

What is it?

Utilizing electricity and a copper anode to create copper ions

- Originally developed 40 years ago to protect ship cooling systems

Ion Generation Systems

Pros

- Compact
- Lower O&M – no chemical deliveries
  - Annual anode replacement
- No storage, only ‘conveyance’
  - No secondary containment
  - No fire rating concerns

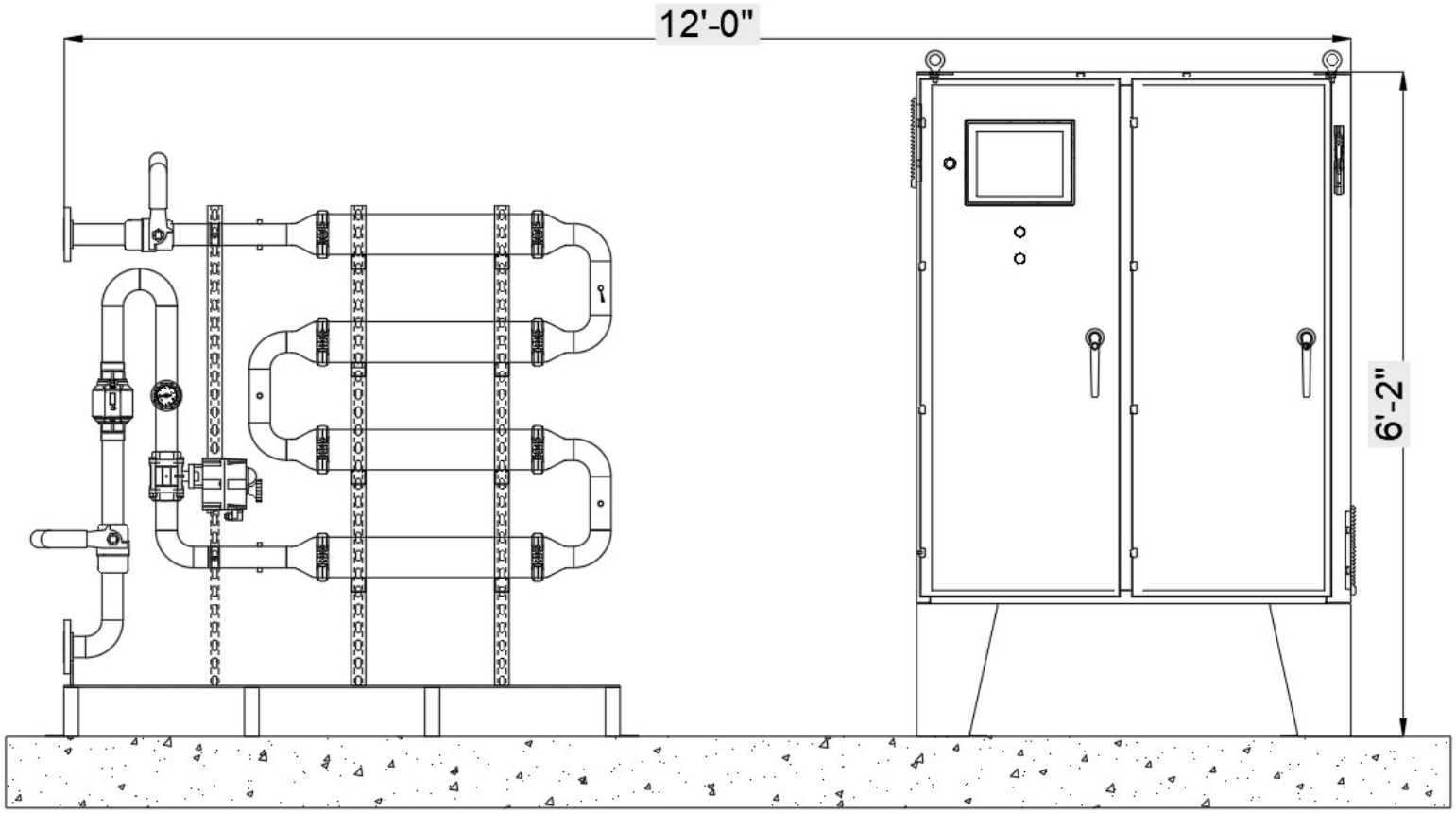
Ion Generation Systems

Cons

- High capitol cost, power cost, and water use
- Effectiveness varies with alkalinity[1]
- Lower dosage (15 PPB) leads to lower mortality rates
- Existing adults can detect it and close, reducing effect[1]

1: USACE Zebra Mussel Resource Document. Trinity River Basin, Texas. Published June 2013.

Layout Considerations



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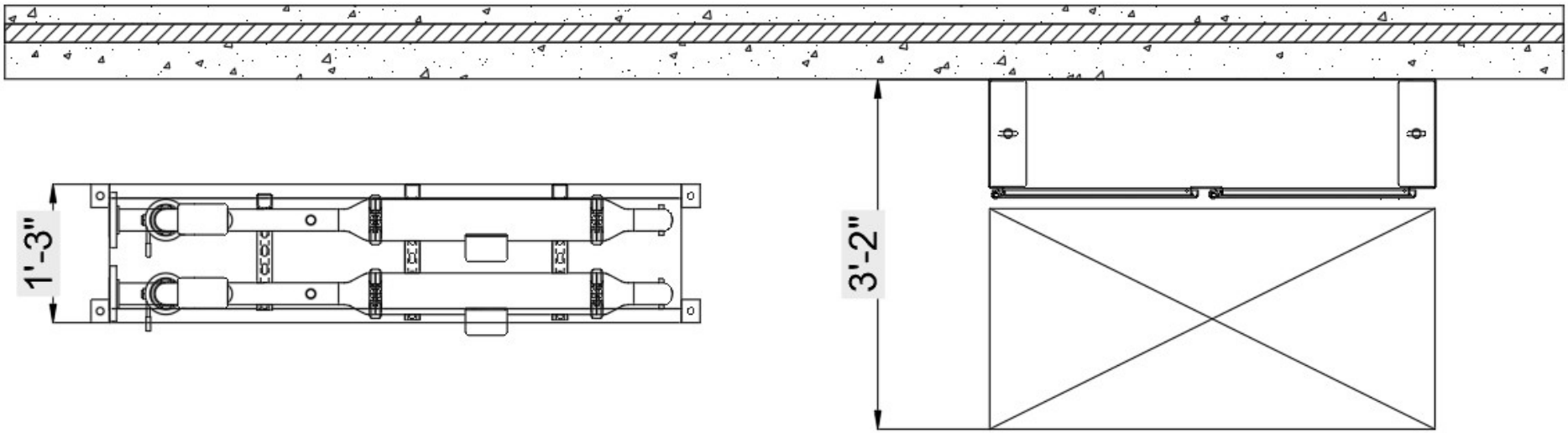

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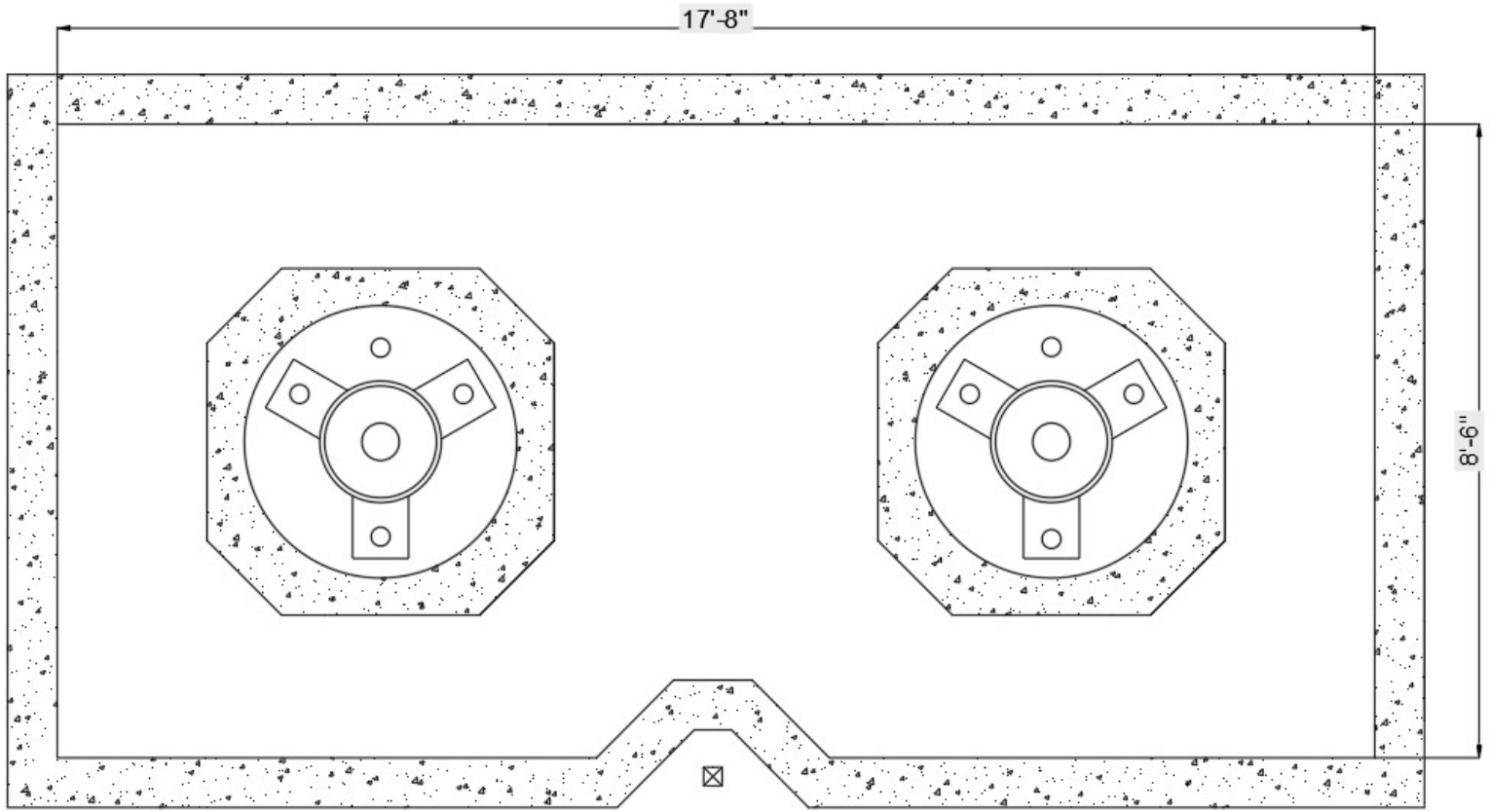

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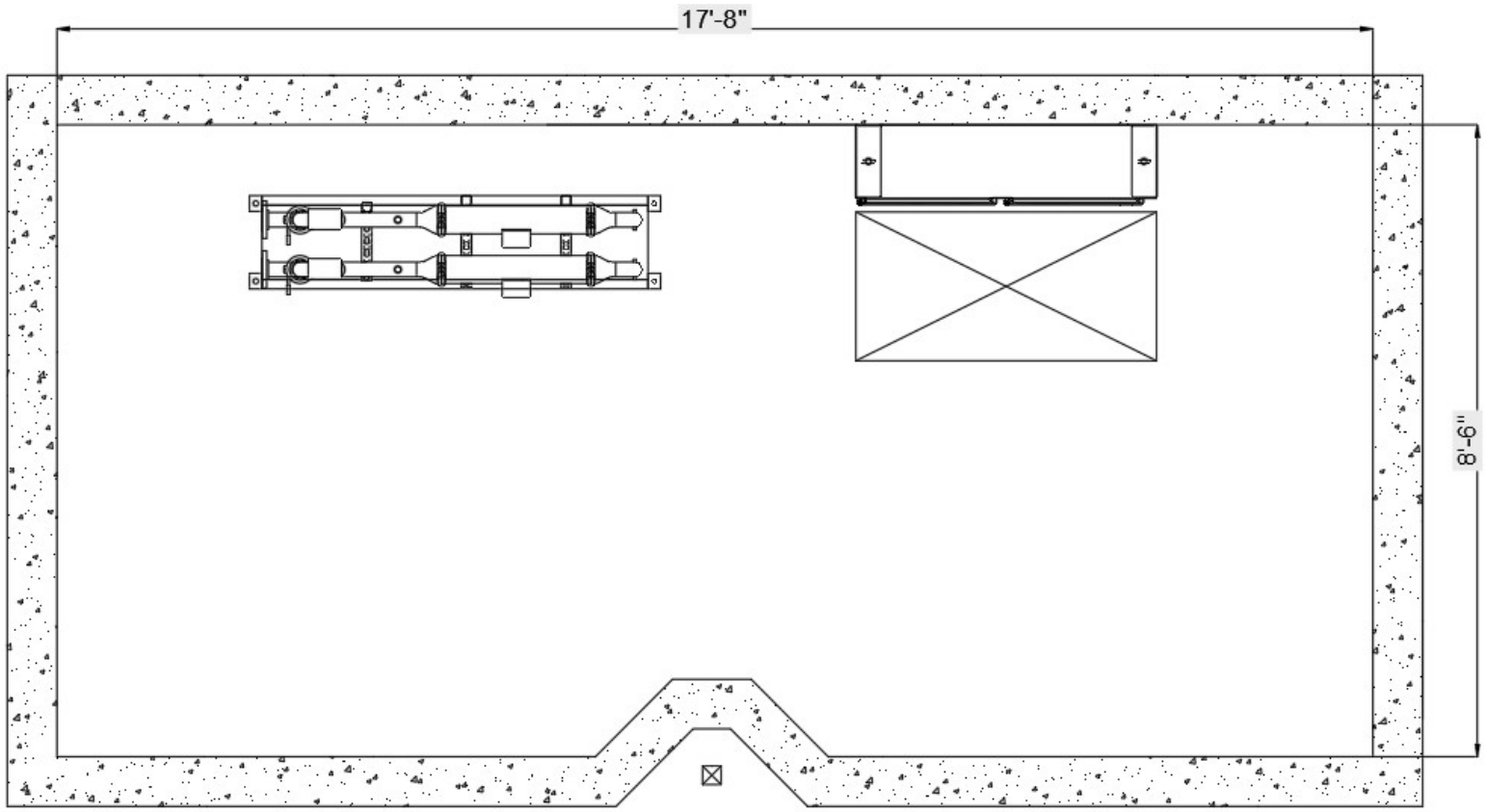

In River Mitigation

- Biocides cannot be utilized on intake screens
- Mechanical/Physical Removal
- Copper alloyed intake mitigate growth on the screen itself
- Coatings

Coatings

- Available as a retrofit option
- Silicone based
- Prone to wear
- Effective life of 6-years[1]

1: USACE Zebra Mussel Chemical Control Guide. Version 2.0. Published July 2015.

Cost Comparisons

	Copper Biocide	Ion-Generation	Alloy Screen	Alloy Screen
Capacity	40 MGD	40 MGD	20 MGD	25 MGD
Cost	$290,000	$525,000	$262,000	$280,000
Date	November 2023	July 2023	April 2023	April 2023
Source	Contractor Bid	Engineer's Estimate	Supplier Quote	Supplier Quote

Thank you!

Questions?

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