Uncertainty in Determining the Site-specific Feasibility of Fine-mesh Technologies Considered as Part of an Entrainment BTA Determination

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What is Fine-mesh and When is it needed?

- Fine-mesh (≤ 2.0 mm)
  - Fine-mesh modified traveling water screens
  - Narrow-slot wedgewire
- Used to reduce entrainment of eggs and larvae

US Real-World Examples

- Fine-mesh Traveling Water Screens
  - Big Bend, FL
  - Prairie Island Nuclear Station, MN
  - Somerset Generating Station, MA
  - Brunswick Generating Station, NC
  - Barney Davis, TX
  - Dunkirk, NY
  - East River, NY
- Narrow-Slot Wedgewire
  - Cayuga Power Plant (Cayuga Lake), IN
  - Massanutten Resort, VA
  - Greenidge Generation Facility, NY

Courtesy ISI screens

Define Uncertainty

- Engineering – can a fine-mesh screen be successfully operated and maintained?
- Biological – is there any ecological benefit to installing a fine-mesh screen?

Engineering Uncertainty

- Operation and Maintenance
  - Debris collection
  - Biofouling
  - Sediment
  - Icing
  - Durability
- Hydraulic Impacts
  - Increase clean screen head losses
  - Lower water levels at circulating water pumps

Station Reliability

Biological Uncertainty

- Survival of converts
  - Fine-mesh screens reduce entrainment not entrainment survival
  - Can have a significant impact on benefits of fine-mesh screens
  - Is survival higher through my system then off a fine-mesh screen?
- Exclusion
  - Head capsule depth may overestimate exclusion with traveling water screens
  - Head capsule depth may underestimate exclusion with narrow-slot wedgewire
  - Extrusion through the fine-mesh at high through screen velocities

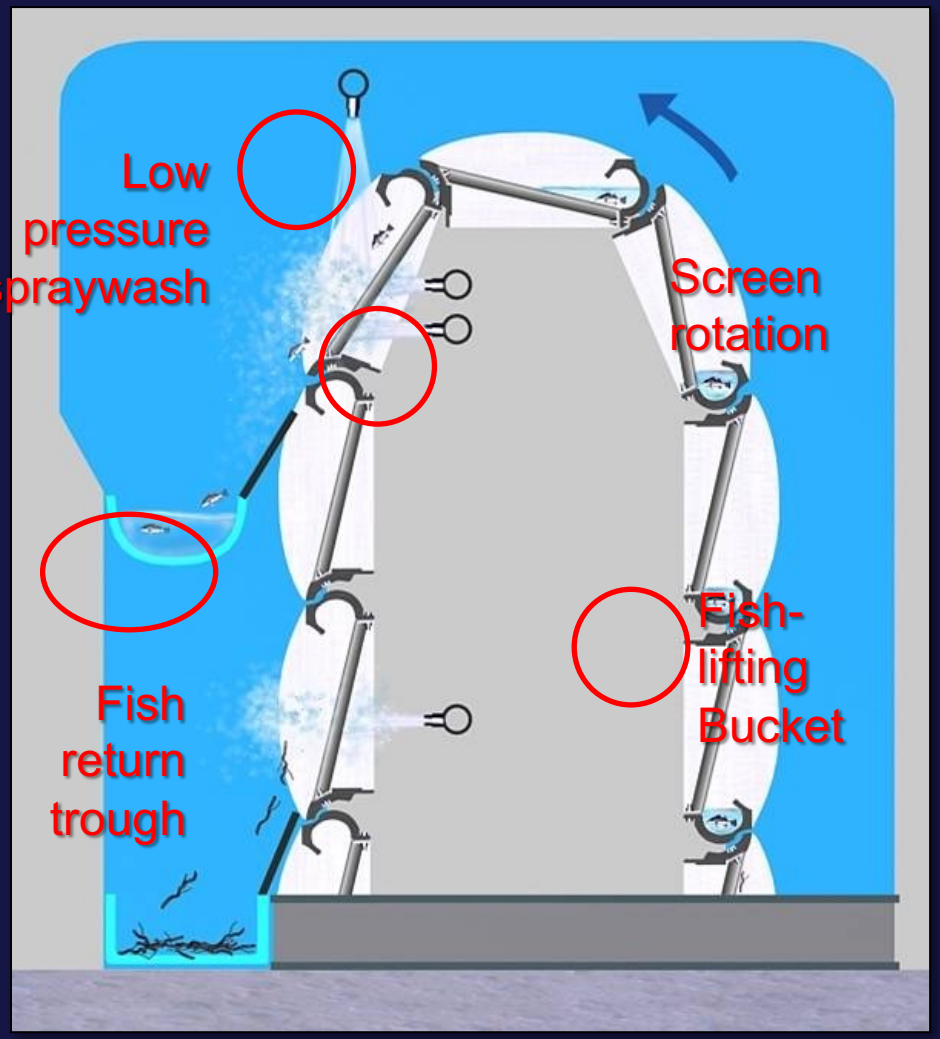
What is My Level of Engineering Uncertainty?

- Does my facility already experience operational issues with coarse-mesh screens (screen failures, reduction or loss of circulating water, pump cavitation, forced outages)
- Does my facility have sediment issues? (dredging, screen burial, sediment deposition in the condensers)
- Does my facility recirculate warm water during the winter (frazil ice)
- Am I a nuclear facility?

If you answered yes to any of these, a definitive determination of feasibility of fine-mesh screen cannot be made.

Fine-mesh Modified Traveling Water Screens

Seasonal overlays
Full time fine-mesh



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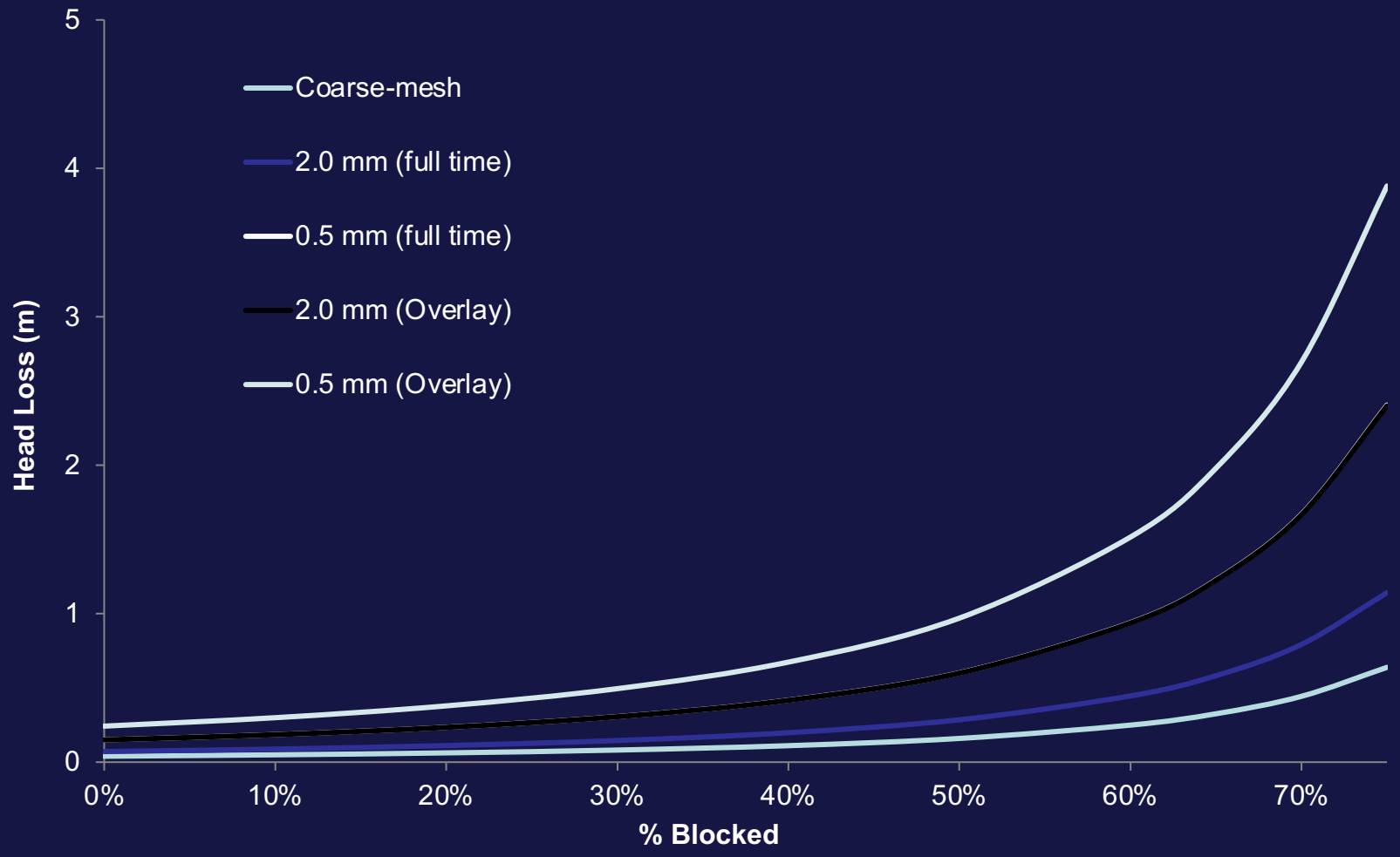
Feasibility Considerations

- Changes to head loss across clean screens
  - Pump operations- decrease in water levels
  - Expanded intake – match existing head loss
- Additional debris retention
  - Increased head loss under debris loading conditions
  - More frequent debris-related operating issues
  - Increased cleaning frequency or screen rotation speed
- Durability
  - Finer wires-reduced strength
  - Need for redundant mesh/screens

Head Loss and Debris Retention



- Higher clean head loss
- Collect smaller debris
- Increased change in head loss

Square Opening Size (mm)	Open Area (mm2)	Reduction in Opening Size (%)
9.5	90.25	0%
2	4	96%
1	1	99%
0.5	0.25	~100%

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Durability

- Wire strength decreases with wire diameter
  - Lower yield strength
  - Lower ultimate tensile strength
  - More easily deformed or damaged
  - Reduced screen reliability

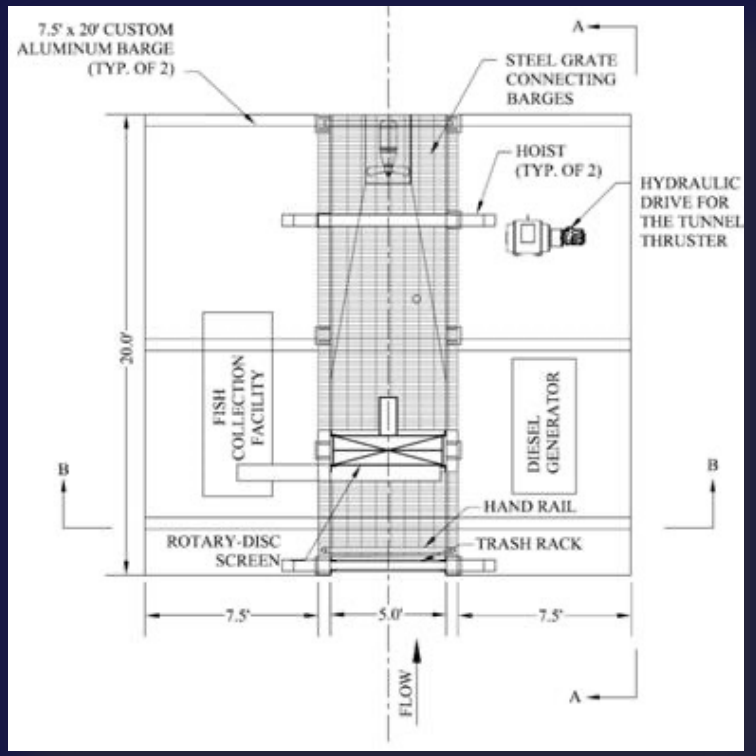
Wire Diameter (Gauge)	Wire Diameter (Inches)	Wire Diameter (mm)
32	0.017	0.325
27	0.012	0.439
19	0.041	1.041
17	0.054	1.372
16	0.063	1.588
14	0.08	2.032
12	0.105	2.68

Studies to Reduce Uncertainty with Fine-mesh Modified Traveling Water Screens?

- Debris Handling and Clogging Pilot Study
- Cooling Water Pump Performance Studies
- Fish Return Studies
- Optimization Study
- Entrainment Survival

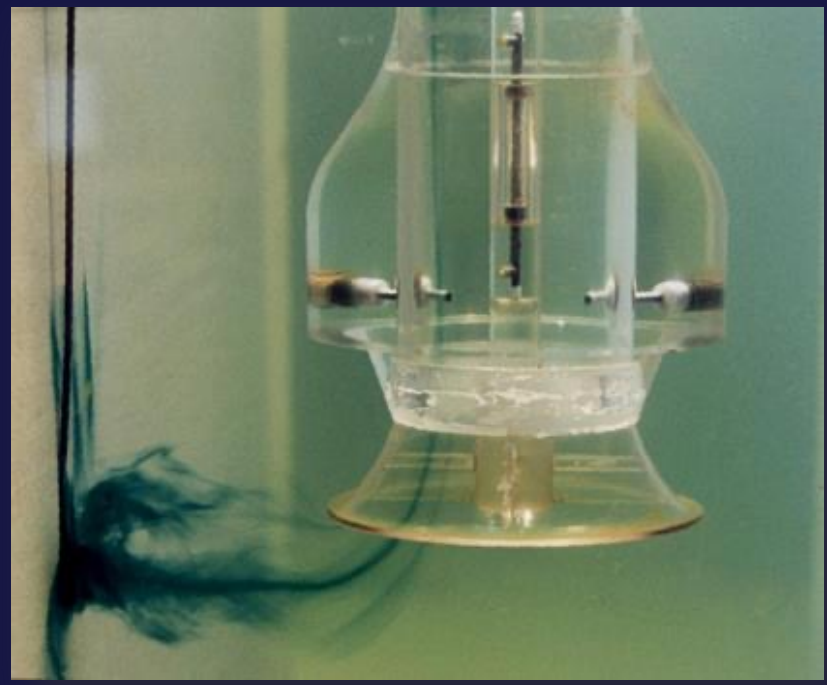
Debris Handling and Clogging Pilot Study

- Unknown
  - Head loss
  - Ability to maintain the screens under site conditions
- Location
  - Site or waterbody specific
  - Opportunity for collaborative studies
- Costs
  - Full scale installation
    - New Screen ($300,000-$850,000)
    - Fine-mesh Overlay Only ($60,000-$250,000)
  - Pilot scale installation
    - Pilot screen with test platform ($400,000 -$800,000)
  - Labor and Reporting (does not include biological component)
    - 1 Year Study ($150,000-$300,000)



Pump Performance Study

- Unknowns
  - Impact of reduced water levels on circulating water pump performance
  - Estimated change in design low water level for the source water body elevation (minimum operating level)
- Location
  - Site-specific,
  - Limited opportunity for collaboration
- Costs
  - Numeric Model ($20,000-$75,000)
  - Physical Model ($300,000-$1,000,000)



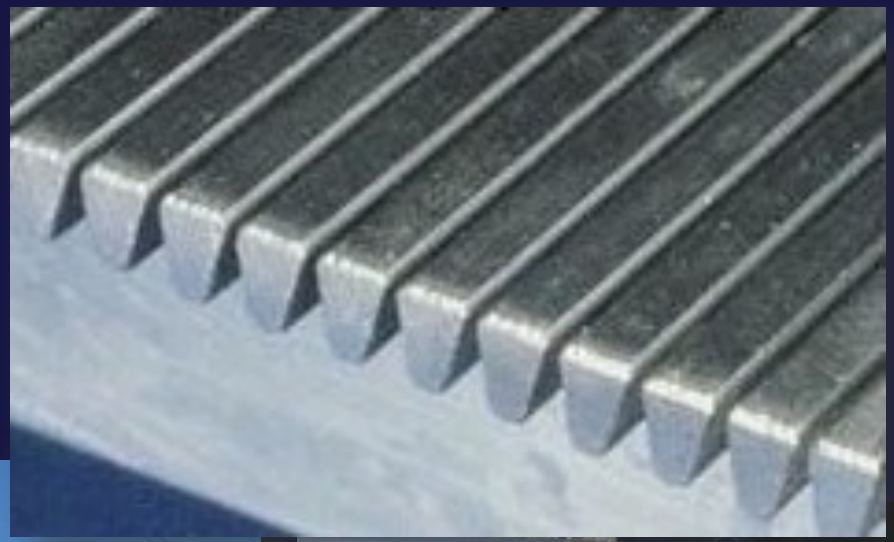
Optimization Study

- Piggyback fine-mesh studies onto IM BTA technology
- Interim/conditional BTA determination
- Unknowns
  - Head loss
  - Ability to maintain the screens under site conditions
  - Environmental Benefits
  - Impact of fine-mesh and higher through screen velocities on IM
- Costs
  - Fine-mesh Overlay Only ($50,000-$200,000)
  - Labor and Reporting (does not include biological component)
    - 1 Year Study ($125,000-$300,000)

Entrainment Survival

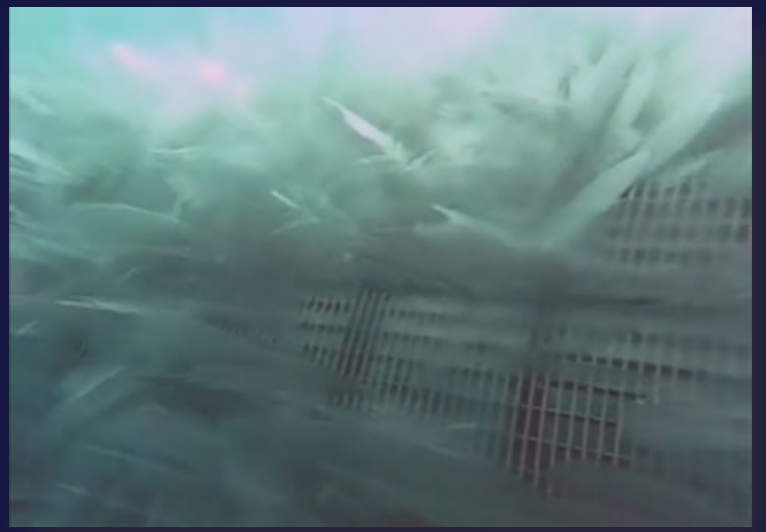
- Comparison of survival off of screens and through-plant survival
  - Screen survival Piggyback with optimization study or desktop study
  - At a minimum must do through-plant (stand-alone study)
- Unknowns
  - Is there ecological justification for fine-mesh screens
  - Temperature and mechanical effects on survival
- Location
  - Site-specific
  - Intake and discharge
- Costs
  - $800,000 to $1,250,000

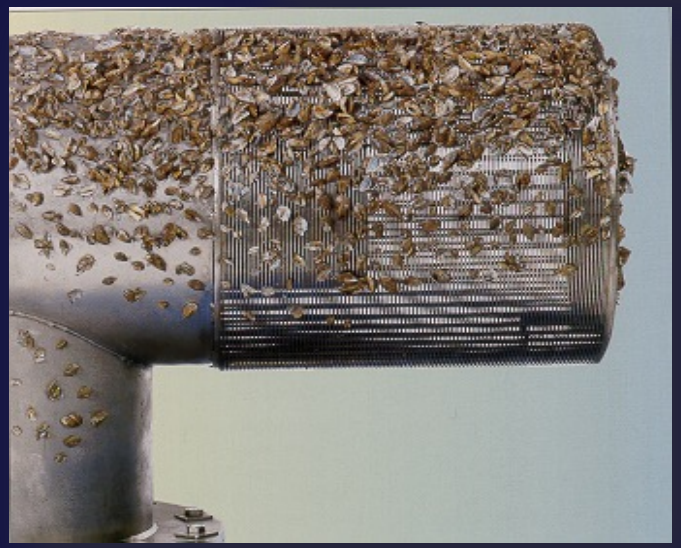
Narrow-slot Cylindrical Wedgewire



Feasibility Considerations

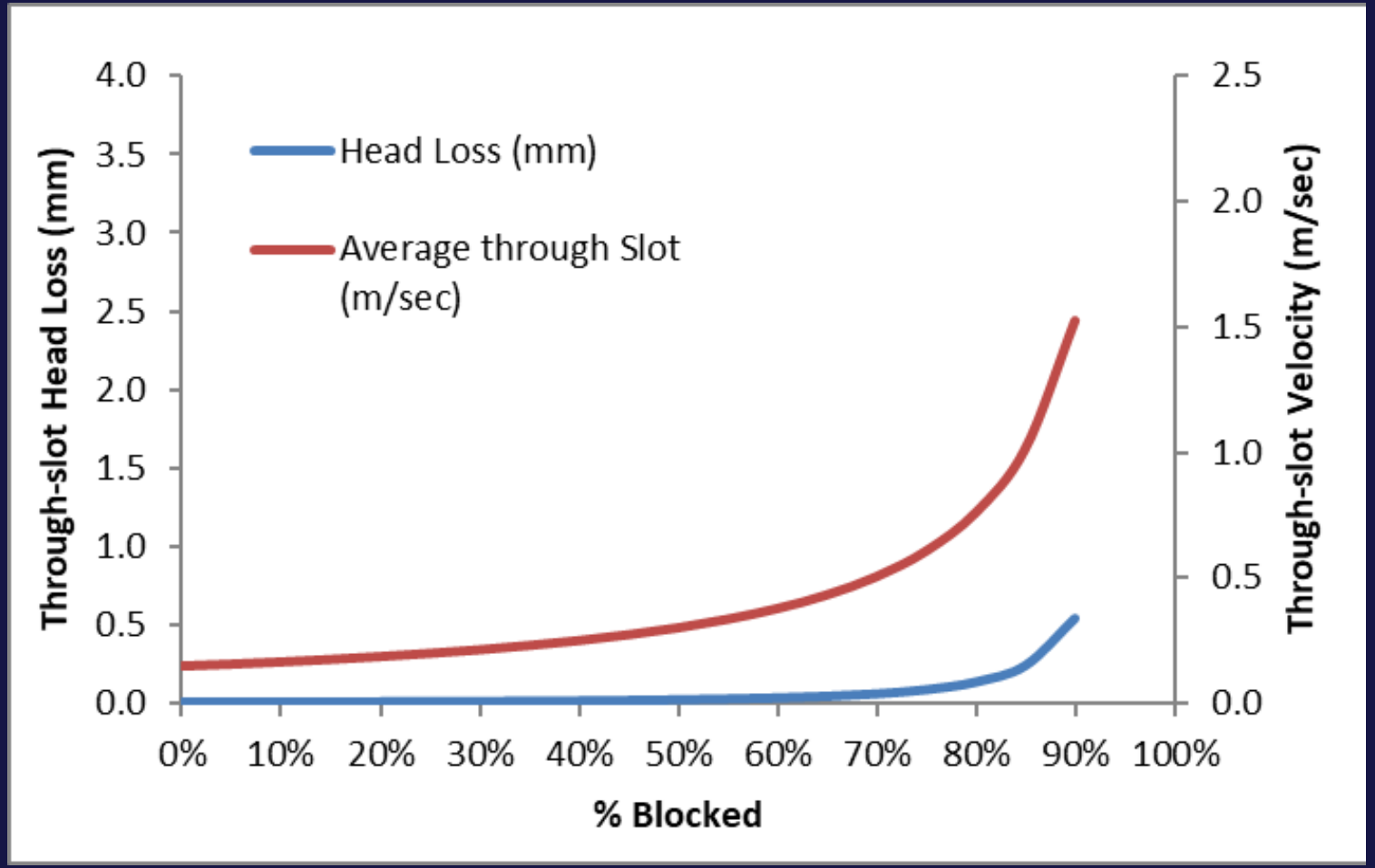
- Changes to head loss across clean screens
  - Pump operations
- Screen Cleaning
  - Debris
  - Sweeping flow
  - Frazil and pack ice
  - Sediment loading
  - Biofouling
- Navigational and recreational impacts





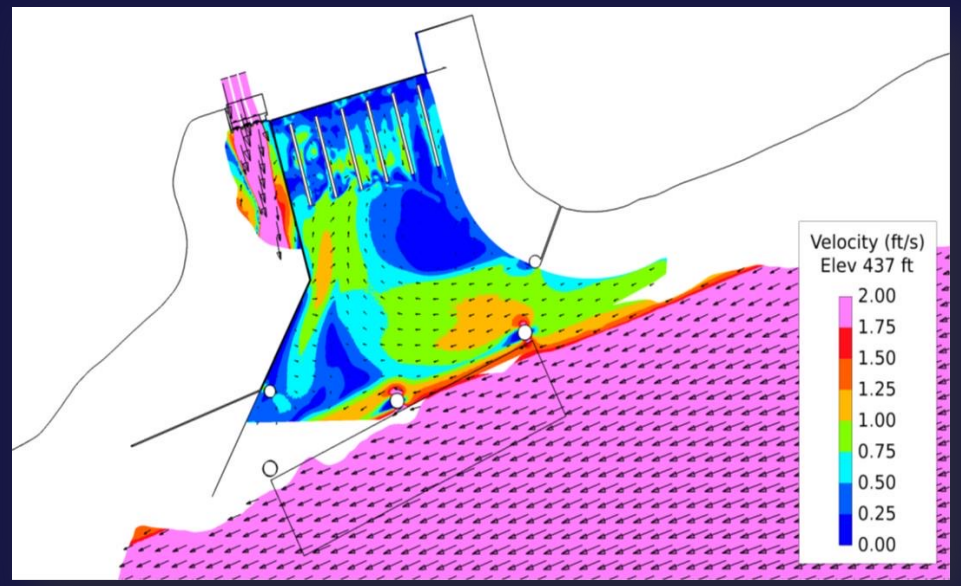
Head Loss

- Change in addition to 0.3 to 0.6 m of loss through screen and piping under clean conditions
- As a result of low through-screen velocity cannot monitor cleanliness until already highly clogged



Hydraulic Model Study

- Unknowns
  - Sweeping currents
  - Sediment transport and depositional conditions (need for a sediment sluicing system)
  - Warm water recirculation (frazil ice)
  - Alternative arrangement
- Location
  - Site-specific
  - Limited opportunity for collaboration
- Costs
  - Numeric Model ($200,000 -$350,000)
  - Physical Model ($600,000 - $975,000)



Debris Handling and Clogging Pilot Study

- Unknown
  - Head loss
  - Ability to maintain the screens under site conditions
- Location
  - Site or waterbody specific
  - Opportunity for collaborative studies
- Costs
  - Full scale installation
    - Cost Prohibitive
    - May result in operational issues
  - Pilot scale installation
    - Barge or bulkhead mounted pilot screen ($100,000 -$750,000)
    - EPRI /Alden has a wedgewire test barge
  - Labor and Reporting (does not include biological component)
    - 1 Year Study ($125,000-$300,000)

Pump Performance Study

- Unknowns
  - Impact of reduced water levels on circulating water pump performance
  - Estimate change in design low water level for the source water body elevation (minimum operating level)
- Location
  - Site-specific,
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- Costs
  - Numeric Model ($20,000-$75,000)
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Summary and Conclusions

- Incorporate Uncertainty into Design Studies
  - Identify uncertainty in technical feasibility study
  - Identify additional data needs to mitigate uncertainty
  - Identify additional studies to mitigate this uncertainty
  - Include costs for these studies as part of overall project costs
  - Discuss availability of interim measures
- Summary
  - Engineering uncertainty- can the screens be maintained?
  - Biological uncertainty- is there any ecological benefit?
  - Hard to definitively say that fine-mesh screens would be feasible at a given site
  - Significant site-specific studies are needed to make a definitive determination

Questions?