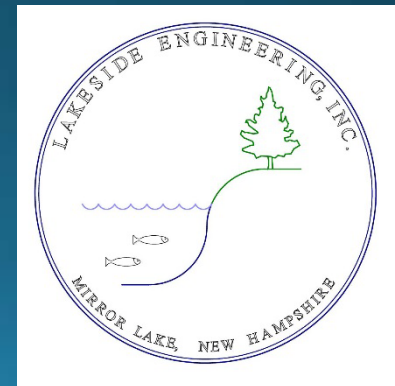


American Eel Symposium:  
Future Directions for Science, Law and Policy  
October 23-25, 2015

# Designing Upstream Eel Passage at Hydroelectric Plants

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# Basic Design Considerations

Locate the entrance in areas where eels congregate and have access, while considering river and eelway flows, the ability to maintain the structure, and its capability to survive in the river in this location.

- **Locate where eels congregate**

- Portable traps- ramp, submerged basket trap

- Night personnel observation

- Consider predation
- Attraction and transport flows (relatively small for eels)
- How eels move or you move them above the obstruction (dam)
- Location of discharge should be where they will not be swept back downstream
- Monitoring – live car, video

Ramp channel (plywood, plastic, aluminum) ~4-6" high by 8-18" wide, with removable cover; length, width dependent on site characteristics; turns and resting pools acceptable

Trap tank & cover; polyethylene or custom-built, size depends on required capacity

Pump or siphon at inlet - inlet must be screened to prevent clogging of pump/hose

Ramp climbing substrate: type & size dependent on eel size range

Tank drain hose enters ramp at highest point for gravity feed

Attraction water hose enters ramp just above high tailwater level; flow must not block ascending eels

Modular semi-rigid/positionable hose (e.g., 3/4" LOC-LINE hose kit (P/N 60513))

Valve to control ramp flow

Padlocks if required

Flexible supply hose; size dependent on attraction flow volume

Flexible attraction water hose

Flexible gravity drain hose

Tank drain; through bottom of tank

12" minimum, to prevent eels from climbing out

6" - 12" water depth; dependent on required capacity

Height variable; dependent on site

Outlet strainer, commercial or construct similar; maximum 1.5 mm mesh or slit width; clean regularly

Smooth transition of ramp to bottom; lower end of substrate always submerged at all water levels

≤ 45 degrees

### Detail of "overshot" ramp nozzle

Substrate installed as high on ramp as possible

Flow jet adjusted to deliver 1-2 mm water depth over substrate & adequate turnover flow to holding tank

Aluminum overshot ramp w/ min. 2" radius at invert, flush with ramp substrate for smooth transition

< 45 degrees from vertical



## "Generic" Temporary Eel Ramp Pass Trap

Design by Alex Haro, Research Ecologist ([aharo@usgs.gov](mailto:aharo@usgs.gov))

S.O. Conte Anadromous Fish Research Center, U.S. Geological Survey, Biological Resources Turners Falls, MA USA

*Note: Any use of trade, products, or firm names is for description only, and does not imply endorsement by USGS*

January 2012

# Portable Ramp Trap



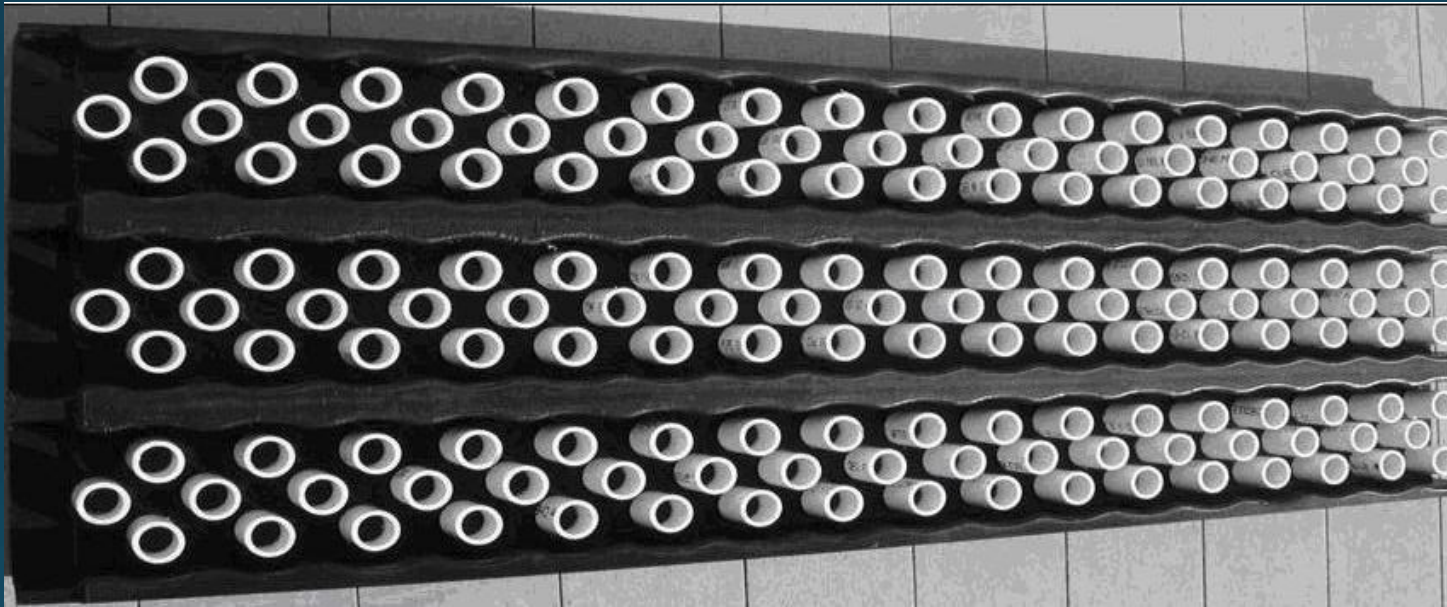
Entrance generally located in areas of low flow and at highest elevation

Useful for locating eels prior to building permanent eel passage

# Substrate/Slope

- Surface tension will allow smaller eels to climb vertical surfaces
- Generally accepted max slope is 40 degrees (83%) but eel ramps have worked at greater slopes
- Steeper slope and large eels require substrate with greater projections
- If there is a great size variation of eels at the same site different substrate sizes may be required
- Some typical types of substrate
  - Pegs- Milieu, Akwadrain, Pipes, Studliner
  - Mesh -Enkamat
  - Brush
  - Gravels, sand, sticks and stones

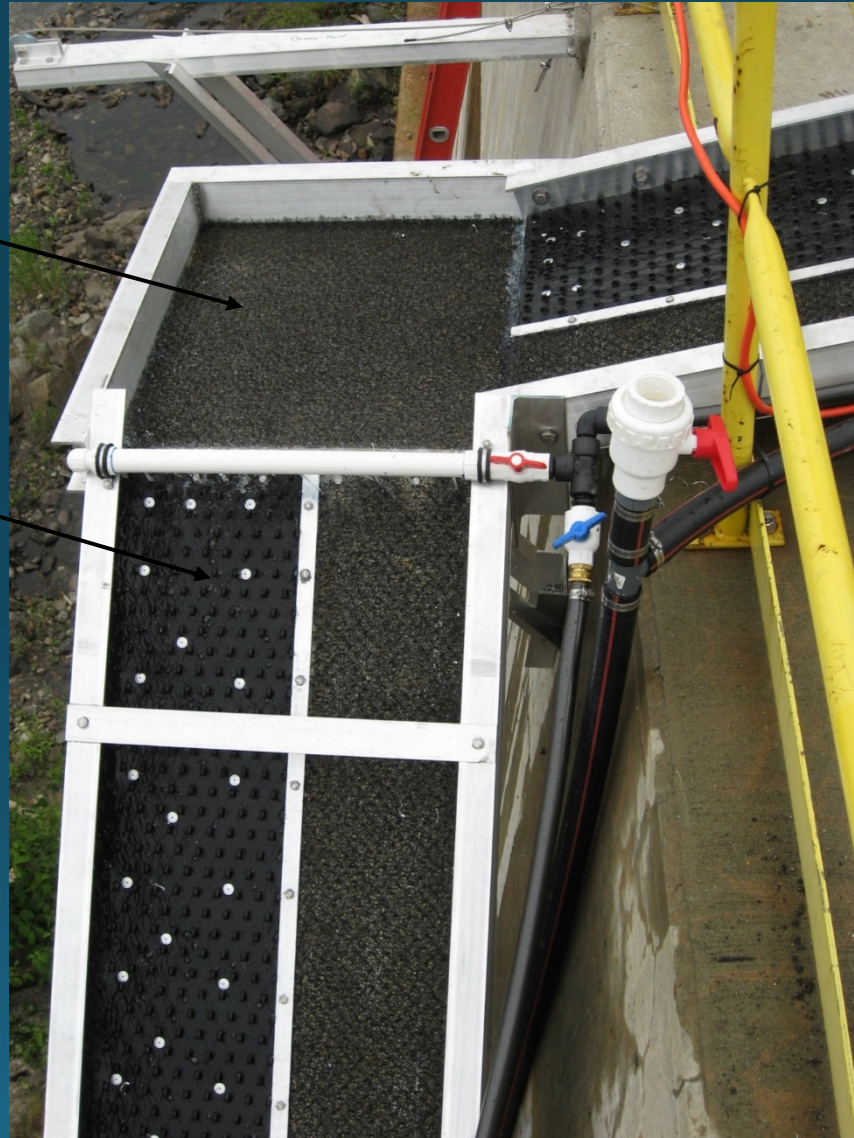
# Milieu Peg



# Multiple Substrates

Enkamat

Studliner



# Brush





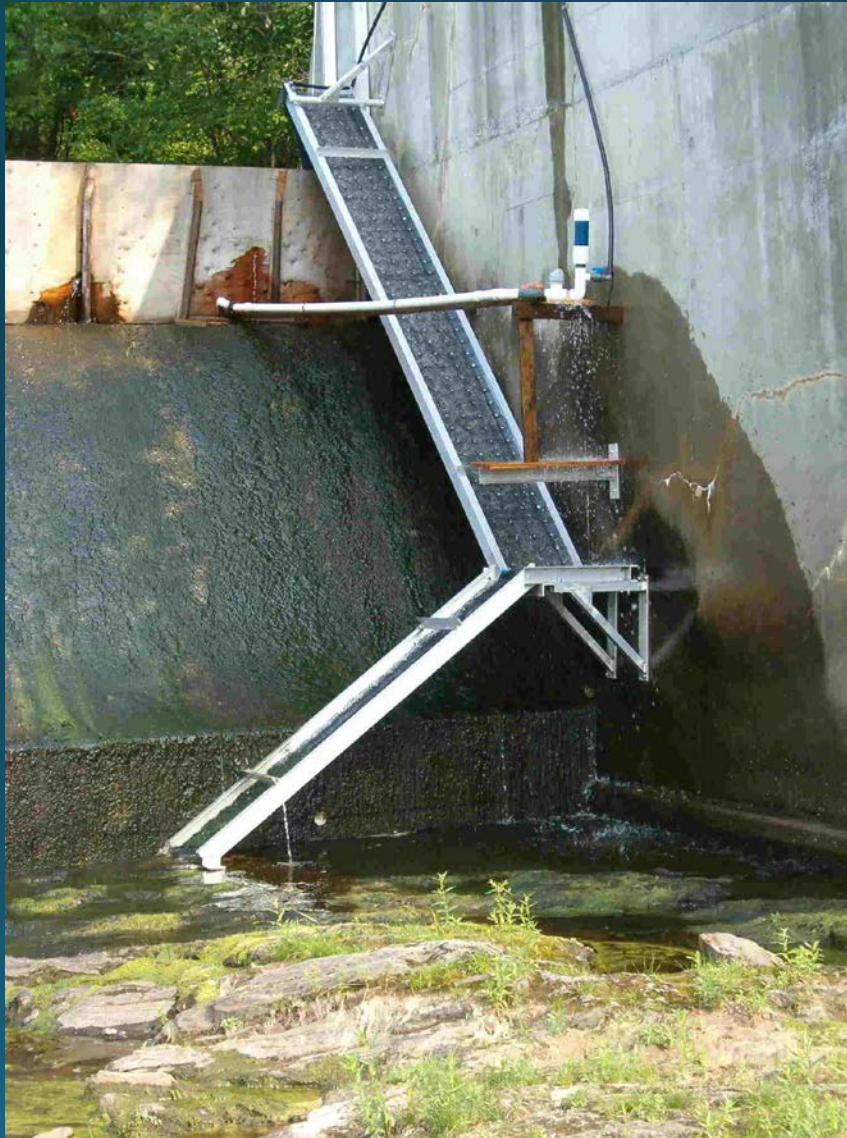
# Predation

- Have seen predation from birds, mink, muskrat, pelicans, fish
- Cover eelway to limit predation
- Covers have benefit of giving a longer period of movement (not just night)
- Exclusion mesh

# Water

- More water is required in the immediate area to attract eels to an entrance area (50 gpm)
- Takes little water to wet transport substrate (1-2 gpm)
- Eels have been seen going through damp grass around a dam

# Eel Ramp with Ram Pump



# Transport Water From Below Eelway Crest



# Types of Upstream Eel Ramps

- Gravity Flow
- Gravity Flow with Trap
- Pumped Flow with Trap and/or Sluice to Headpond
- Lifts

# Gravity Flow Ramp to Exit in Headpond

- Requires control of headpond or means to compensate for headwater variation
- Types
  - V shaped for headwater changes. If there is a 45 degree lateral slope the effective head range is approximately 2'.
  - Brush on wall
  - Substrate on dam

# Brush Eelway

Examples of installation of the prototype bristle board eel pass.

Example 1: Frog Mill on the River Hamble (Southern region). NGR SU 5222 1491



4.12 Downstream view of pass installation at Frog Mill, River Hamble (NGR: 5222 1491). Note the area of slack water on left for elver and eel to enter pass.



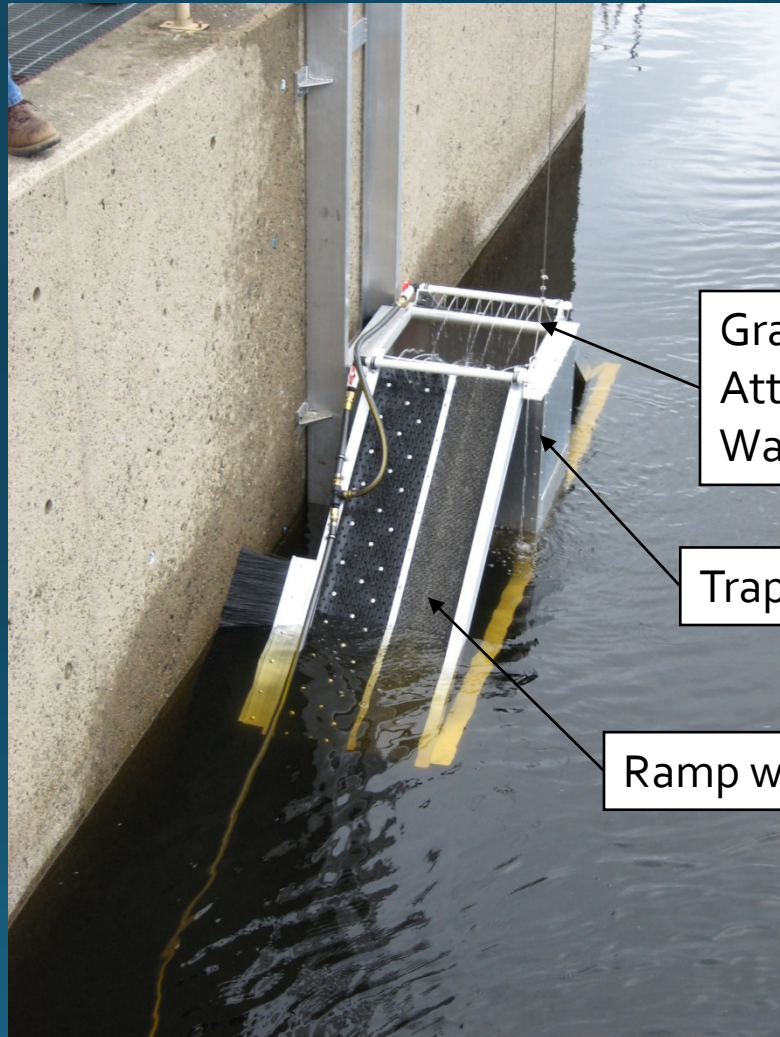
Figure 4.13: Installed pass, showing brackets and fixings

# Gravity Flow Trap Eelway

- Gravity flow provides attraction and transport
- Can't provide unattended passage above dam
- Requires a holding trap. Periodically, eels must be removed from the trap and released above the dam or in a preferred location.



# Combined Eelway / Trap

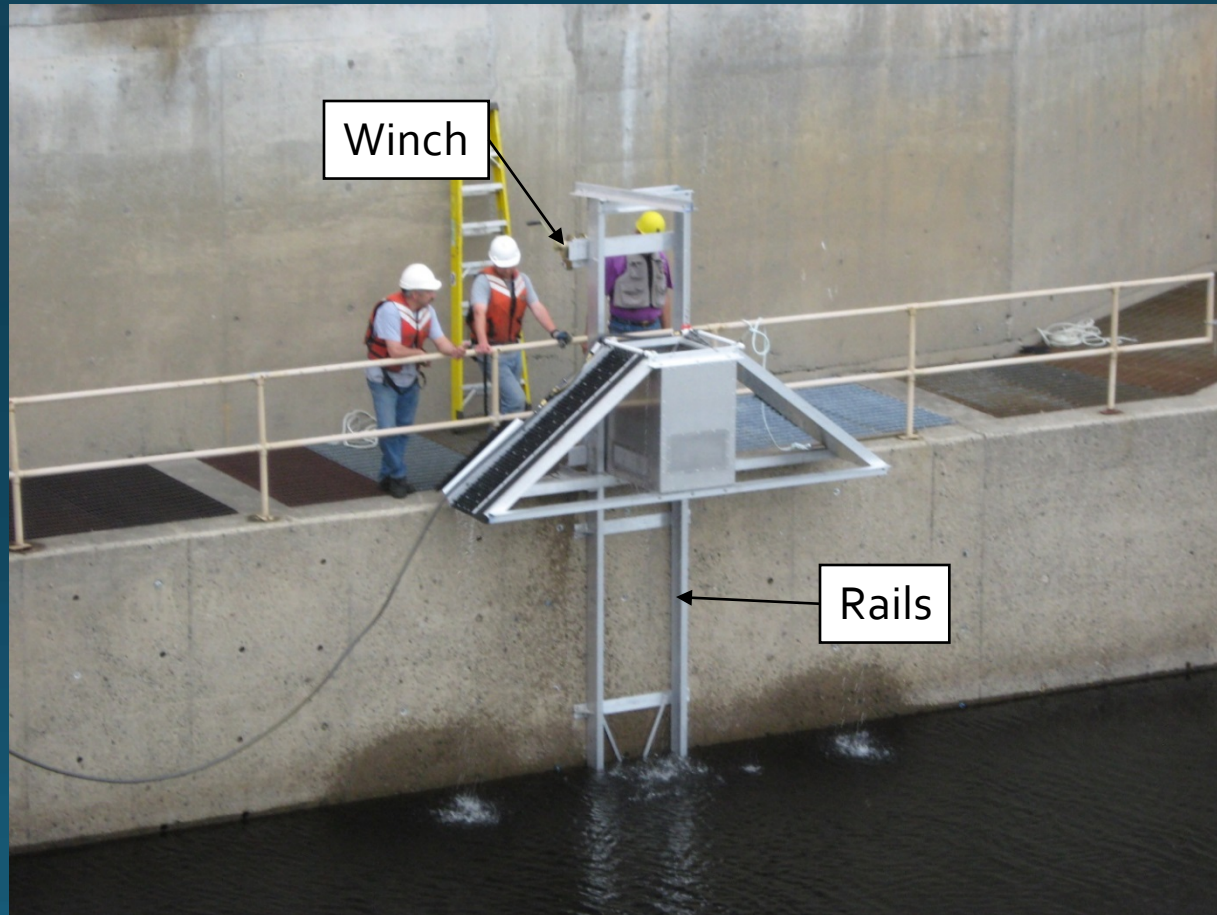


Gravity (or Pumped)  
Attraction / Transport  
Water

Trap

Ramp with Two Substrates

# Trap & Eel Ramp Raised



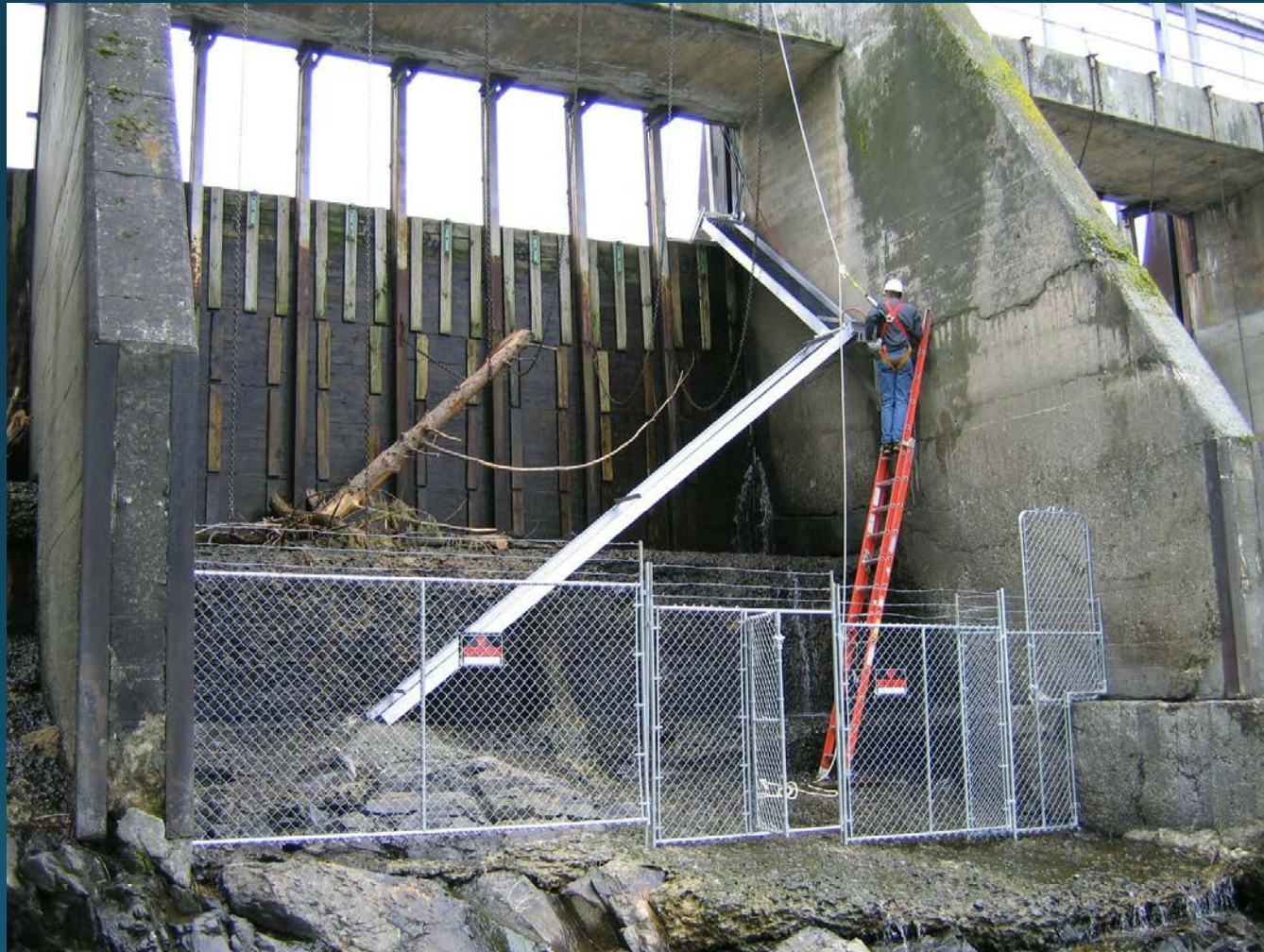
# Pumped Water –Trap/Sluice

- Allows eels egress over the dam
- May go into a trap, then sluice into headpond
- Use of trap facilitates enumeration

# Sample Eel Ramps



# Sample Eel Ramp



# Helical Eel Ramp



Useful where site geometry prohibits a straight ramp.

# Eel Lifts

- Become cost effective at over 20' of head or when there are special conditions
- Requires power

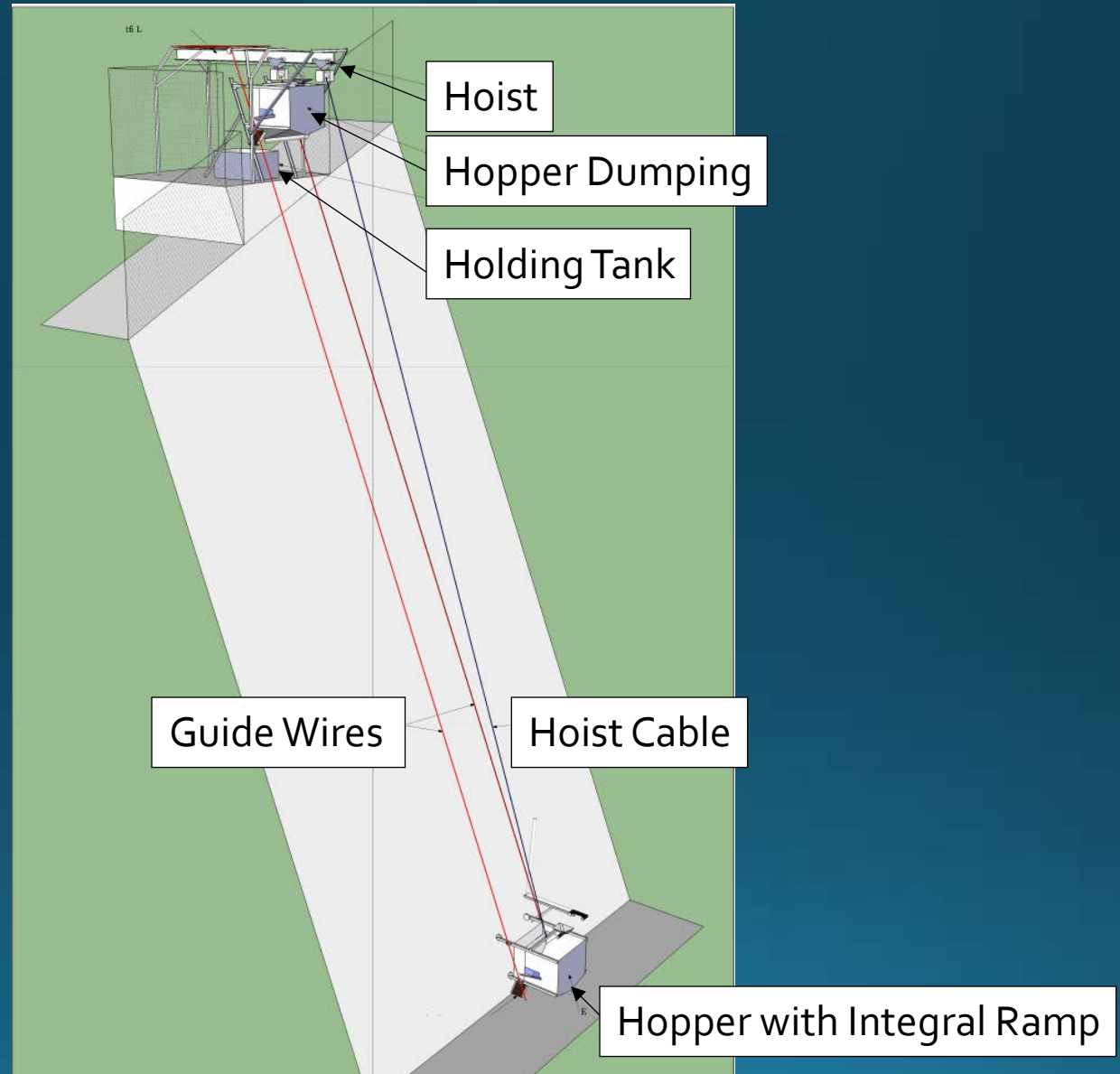
# Site Downstream of Spill Gate



Note Person



# Schematic of Eel Lift



# 65' Lift – No Guide Rails

Hopper Discharge

Pumped Water Supply

Sluice To Headpond

Fishing Location

Access Ramps



# Raising Hopper

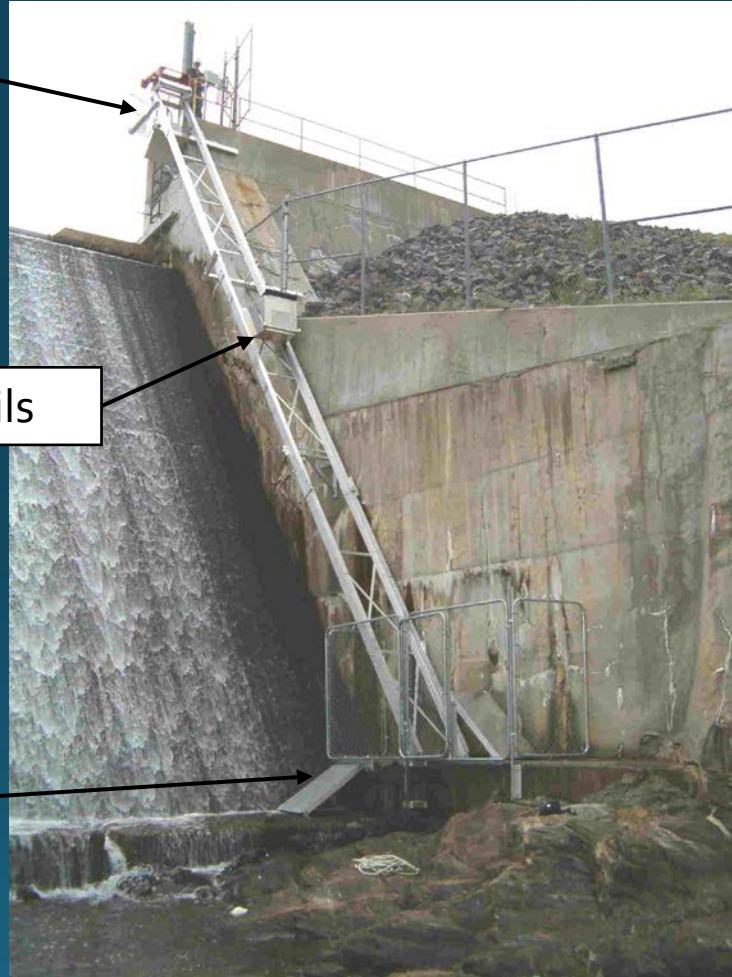


# Rail Type Skip Hoist 45' Lift

Discharge Point

Hopper Traveling Up Rails

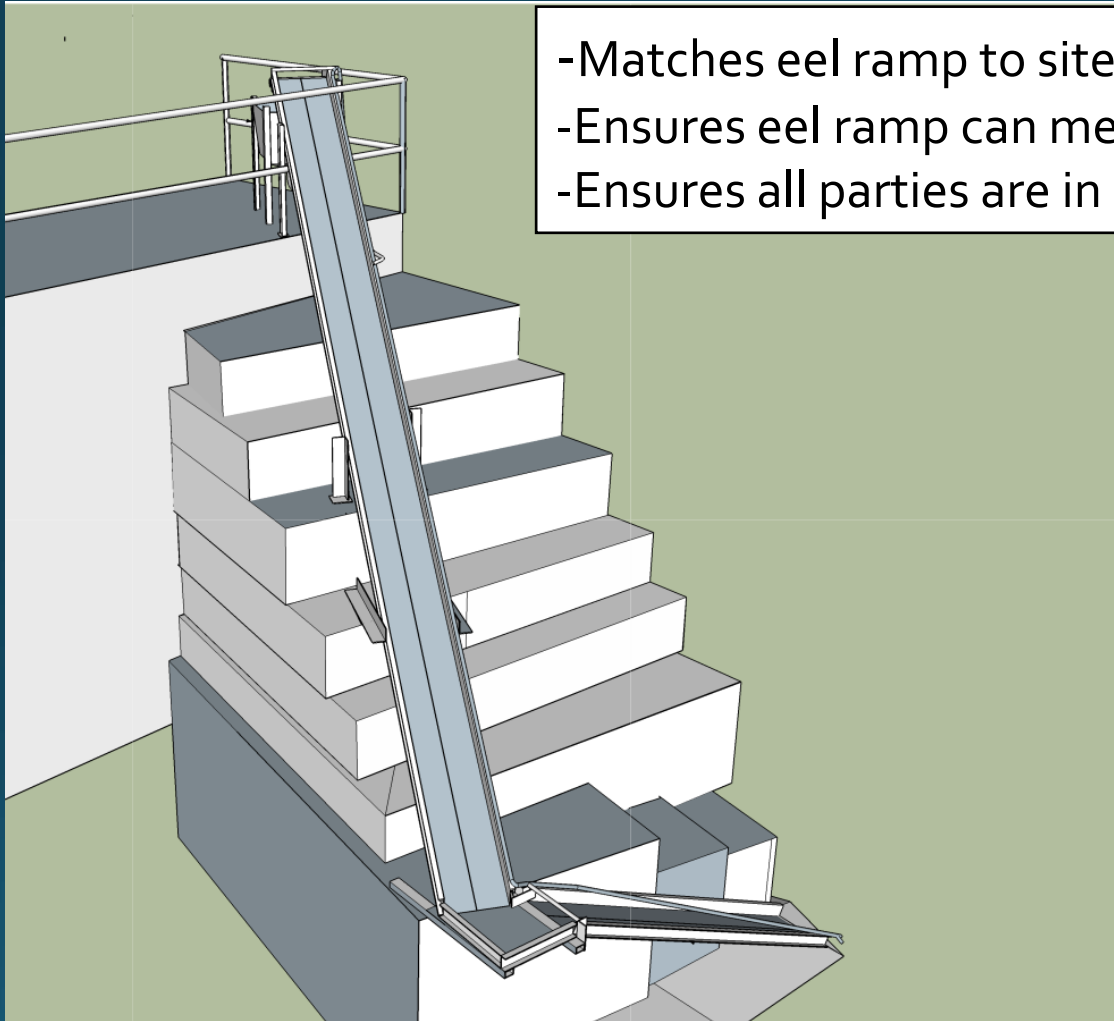
Access Ramps



# Summary Design of Typical Eelway



# 3D CAD Model Development



- Matches eel ramp to site geometry
- Ensures eel ramp can meets specifications
- Ensures all parties are in agreement with design

# Eel Ramp Overview



# Maintain Submerged Ramp Entrance





# Turnpool



# Spraybar at Turnpool



# Eel Collection Tank



Attraction  
Water Hose

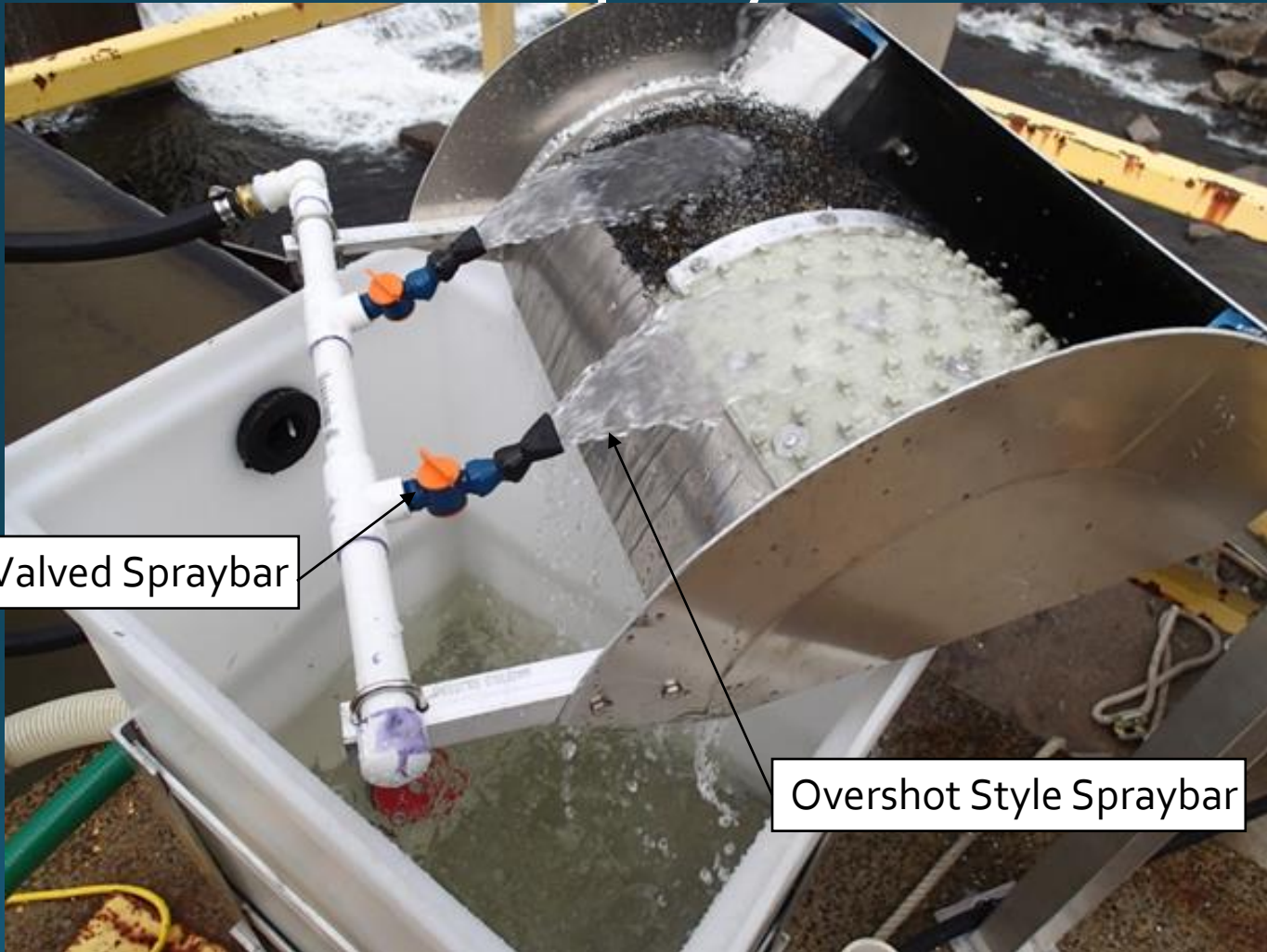
Valve For  
Flushing

Discharge To  
Headpond

Hose From Pump

Eel Collection Tank

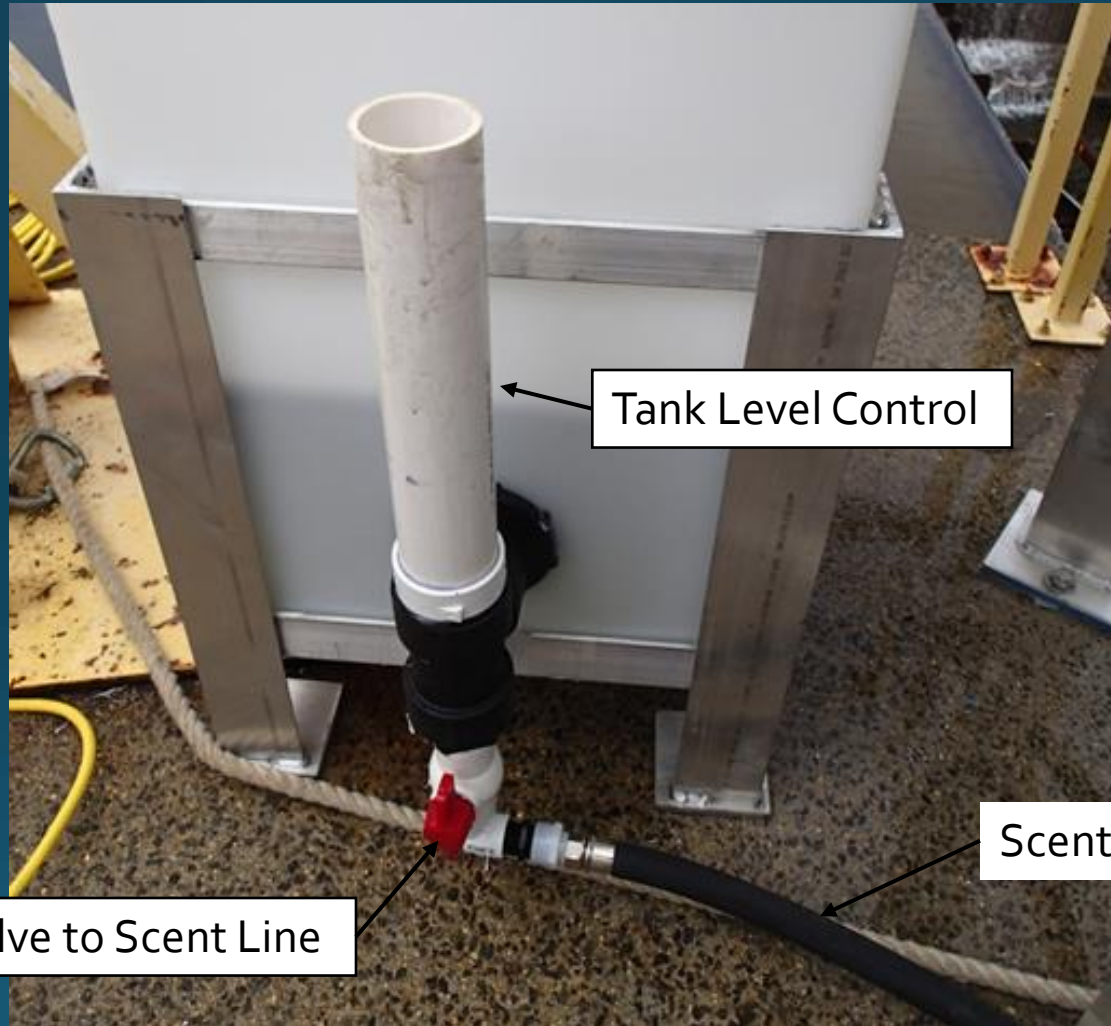
# Exit Area with Spraybar



Valved Spraybar

Overshot Style Spraybar

# Tank Overflow To Scent Line



Tank Level Control

Valve to Scent Line

Scent Line To Ramp

# Drain To Headpond In Collection Tank



# Resources:

The following papers offer detailed upstream eel passage designs. These papers are available on the internet.



Science Report SC020075/SR2



## Elver and eel passes

A guide to the design and implementation of passage solutions at weirs, tidal gates and sluices

The Eel Manual— GEHO0211BTMV-E-E