Water Talk
Connecting Headwaters to Ocean
Fish Passage Design

June 29, 2017

nhc
northwest hydraulic consultants

Fish passage

Talk Outline

- Passage = ?
- Typical Problems
- Types of Physical Passage Improvements
- Design Criteria
- Examples

Fish passage

Fish passage

- Movement up and downstream under range of hydrologic conditions
- Life cycle requirement for anadromous species like steelhead
- Important for many fish and other species
- Different hydrologic conditions relevant depending on species and life stage

Typical problems

Typical problems

Typical problems

Typical problems

Passage improvement

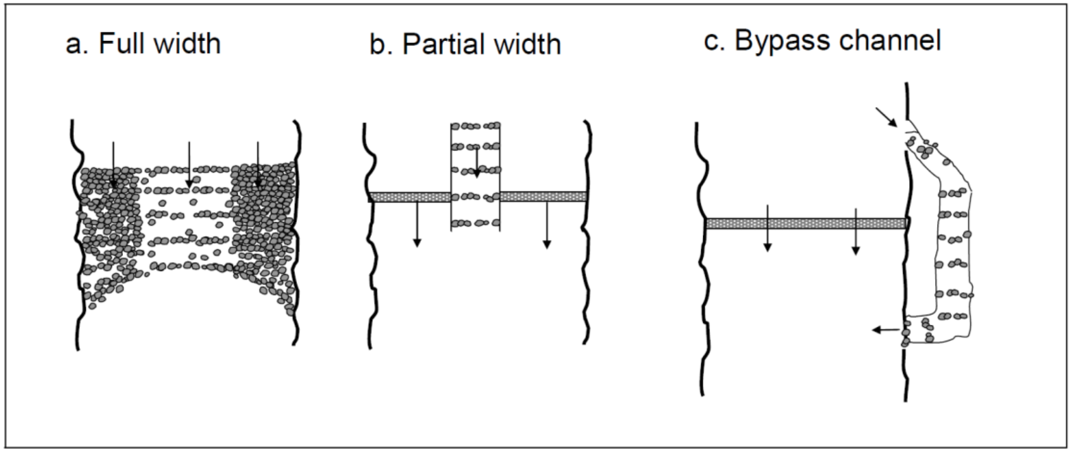
Passage improvement

- Hydrologic restoration/modifications
- Physical modifications (volitional passage)
  - Stream profile restoration/modification
  - Passage structures
- Habitat enhancement
- Hazard reduction
- Fish transport

Types of physical improvements

Barriers

- Removal
- In-stream passage
- Bypass fishways
  - Nature-like
  - Structural



CDFW, 2009

Types of physical improvements

Passage design criteria

- Geomorphic assessment
- Stream simulation
- Hydraulic Design
  - Hydrologic criteria
  - Hydraulic criteria
- References

CDFW, 2009. California Salmonid Stream Restoration Manual, Part XII, Fish Passage Design and Implementation. California Department of Fish and Wildlife. http://www.dfg.ca.gov/fish/Resources/HabitatManual.asp

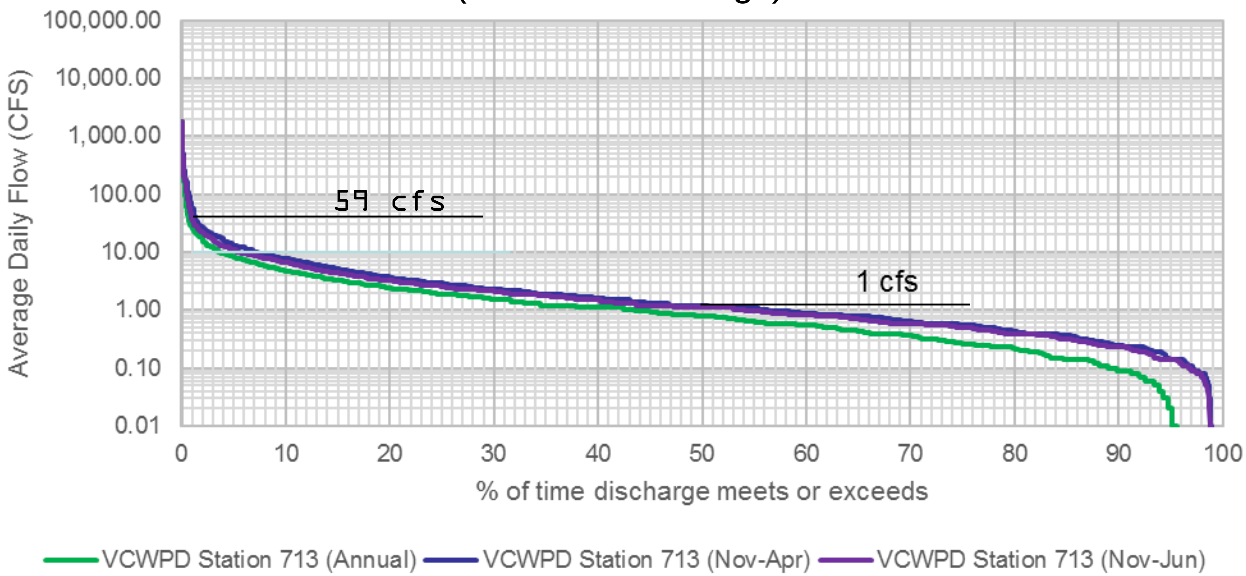
NOAA, 2011. Anadromous Salmonid Passage Facility Design. National Marine Fisheries Service, Northwest Region. http://www.westcoast.fisheries.noaa.gov/publications/hydropower/fish_passage_design_criteria.pdf

NOAA. 2001. Guidelines for salmonid passage at stream crossings. NOAA Fisheries, NMFS SW Region. http://swr.nmfs.noaa.gov/hcd/NMFSSCG.PDF, www.h2odesigns.com/library/FishPassageDesign/Caltrans_FishPassageManual/Appendix-C-NOAA-Guidelines-for-Salmonid-Passage-at-Stm-Xngs-w-cover.pdf.

USFS. 2008. Stream simulation: an ecological approach to road stream crossings. USDA United States Forest Service National Technology and Development Program. http://www.stream.fs.fed.us/fishxing/aop_pdfs.html

Passage design criteria

- Hydrologic criteria
  - Flow duration curve
  - Upstream adult anadromous high and low design flow
    - 5% to 95% (NOAA, 2011)
    - 1% to 50% (CA road crossings)
  - Upstream juvenile anadromous high and low design flow
    - 10% to 95% (CA road crossings)



Pole Creek

Passage design criteria

- Hydrologic criteria
  - Flow frequency curve and alternate minimum flows
  - Upstream adult anadromous high and low design flow
    - 50% of 2-year flow; 3 cfs (CA road crossings)
  - Upstream juvenile anadromous high and low design flow
    - 10% of 2-year flow; 1 cfs (CA road crossings)
  - Use of 50% of 2-year flow in example above increases adult high design flow to 120 cfs
- Limitations of statistical analysis
  - Based on mean daily flow or annual peaks and may not capture pattern of flows important for migration
  - Does not consider connectivity or ecological needs in physical watershed context

Passage design criteria

- Passage delay
  - Application of same criteria results in different passage opportunity and delay depending on geographic region (Lang and Love, 2014)
  - On small to medium S Cal streams analyzed, use of 50% of 2-year instead of 1% exceedance substantially reduced inter-annual variability and high flow delay
- Pole Creek Example
  - Analyzed storm events in below normal, normal, above normal, and substantially above normal water years
  - Selected high passage design flow based on incremental benefit

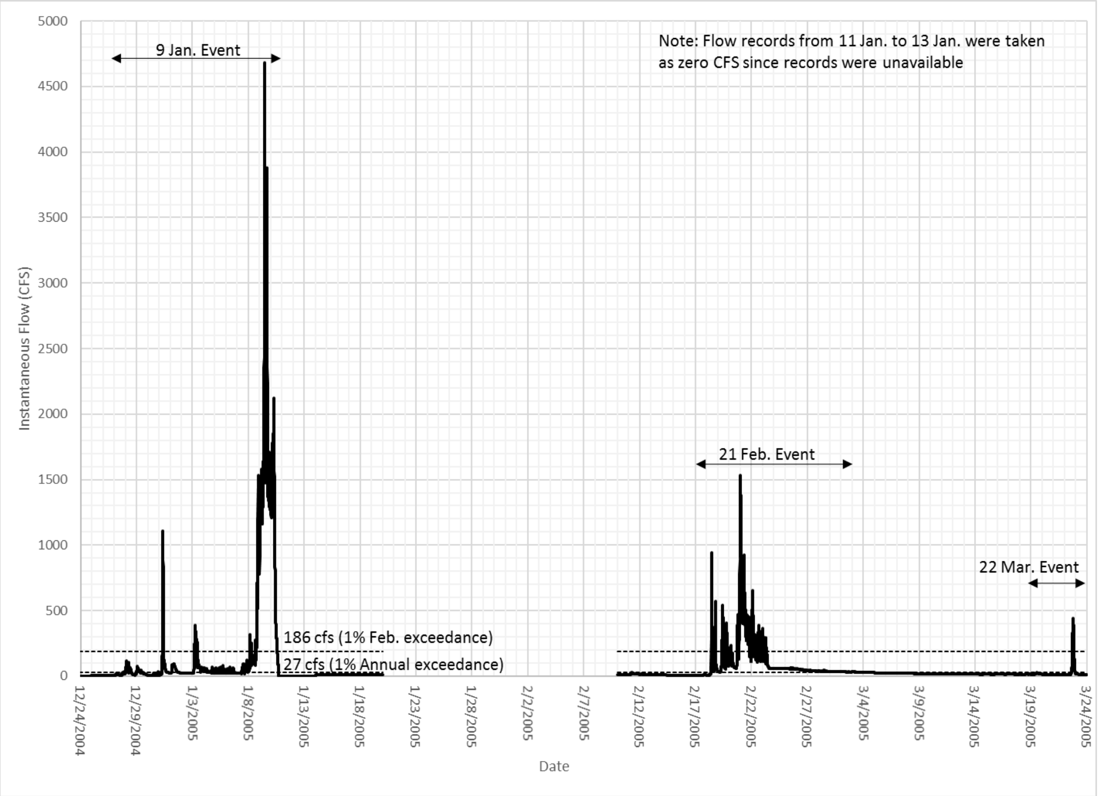


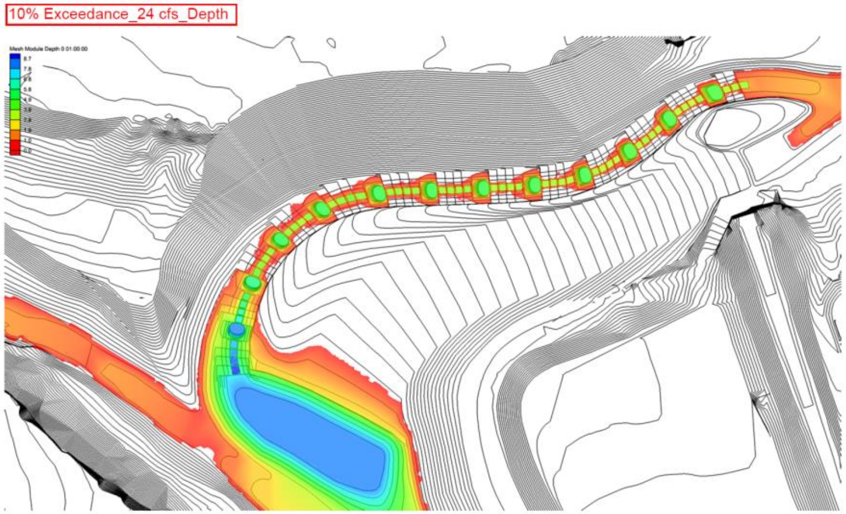
Table 3-3. Calculated delay time for high fish passage design flows

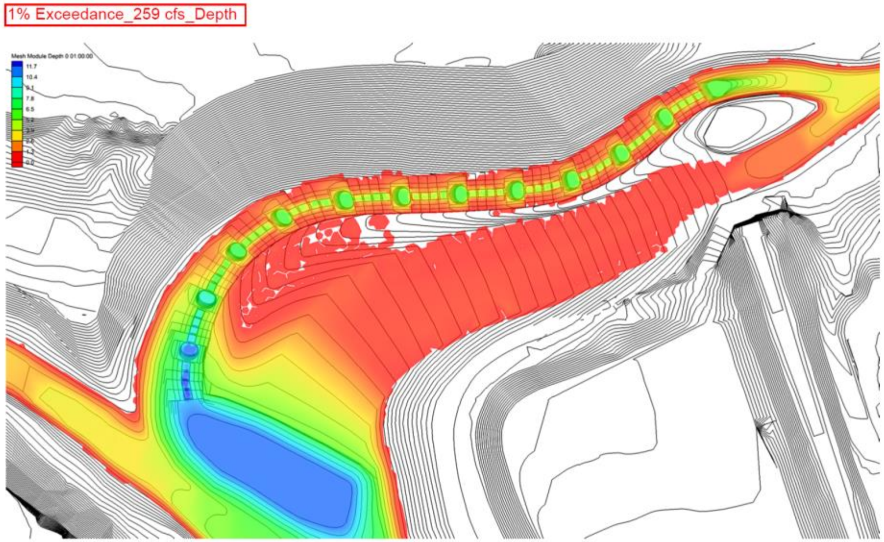
Water Year Analyzed	Flood Events Analyzed	Delay Times (Hour) for Various High Design Flows				
		186 CFS	120 CFS	59 CFS	37 CFS	27 CFS
2008 (Below Normal)	4 Jan.	4.0	4.5	6.2	8.6	9.9
	28 Jan.	1.1	1.3	7.8	19.2	25.8
1992 (Normal)	12 Feb.	11.8	20.0	33.4	45.2	56.8
	22 Mar.	0.0	0.3	3.1	6.3	12.8
2001 (Above Normal)	13 Feb.	4.3	6.8	13.0	32.9	46.0
	6 Mar.	0.0	2.6	10.8	65.8	151.1
2005 (Substantially Above Normal)	9 Jan.	53.9	58.9	111.5	153.4	180.1
	21 Feb.	59.3	74.6	113.1	236.7	303.2
	22 Mar.	2.7	3.8	6.2	7.3	8.3

Passage design criteria

Hydraulic criteria – upstream migration

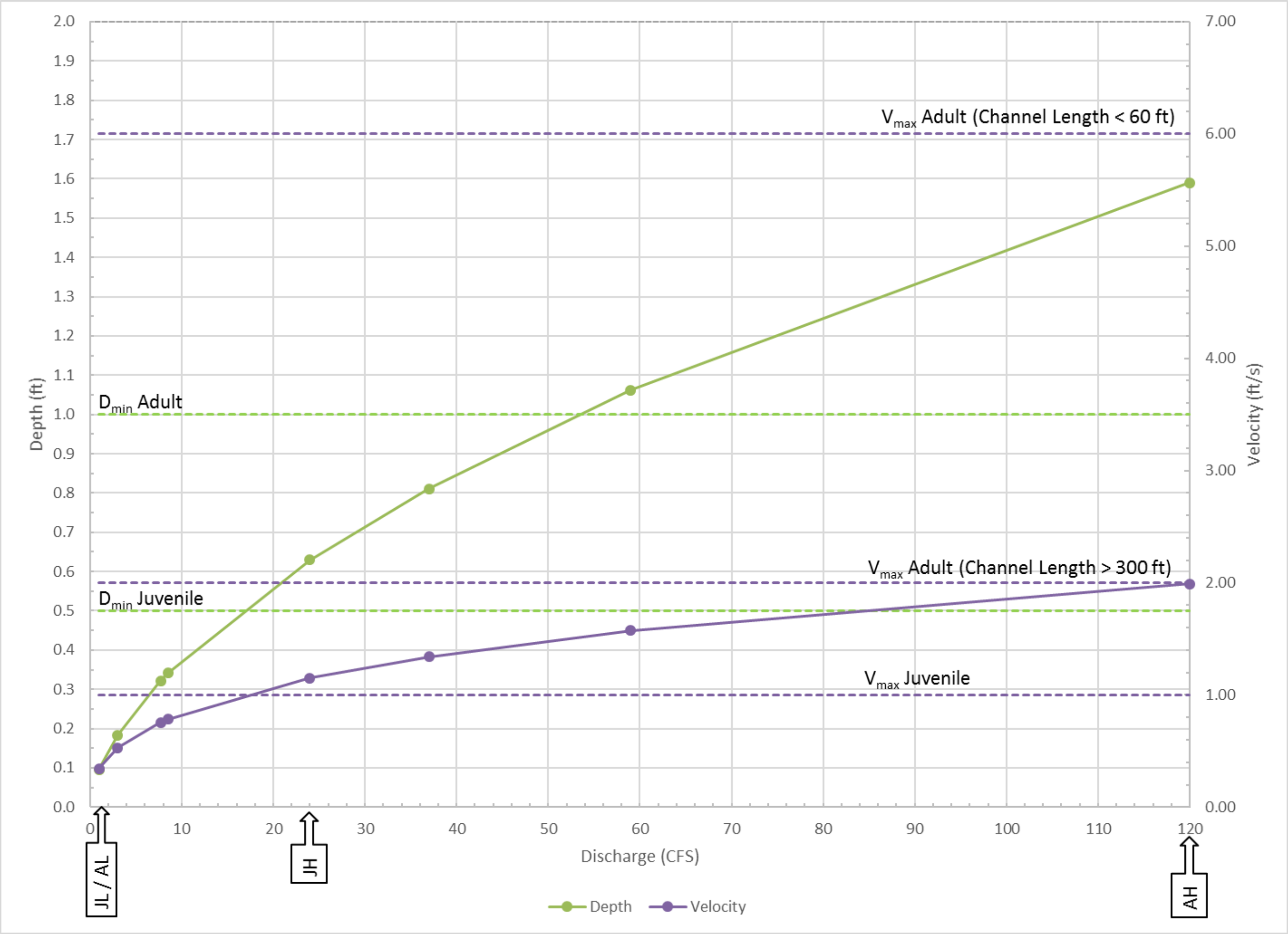
- Match hydraulic conditions in the hydrologic design window to swimming abilities of fish
- Basic criteria are depth, velocity, drop height
- Velocity criteria may vary based on distance
- Hydraulic criteria based on fishway type and life stage
- Additional hydraulic criteria for fishways apply to pool conditions, turbulence, entrance and exit, attraction to the fishway





Passage design criteria

Hydraulic criteria – upstream migration



Examples

- Barrier removal – Arroyo Sequit
  - Two low water crossings in Leo Carillo State Park

Examples

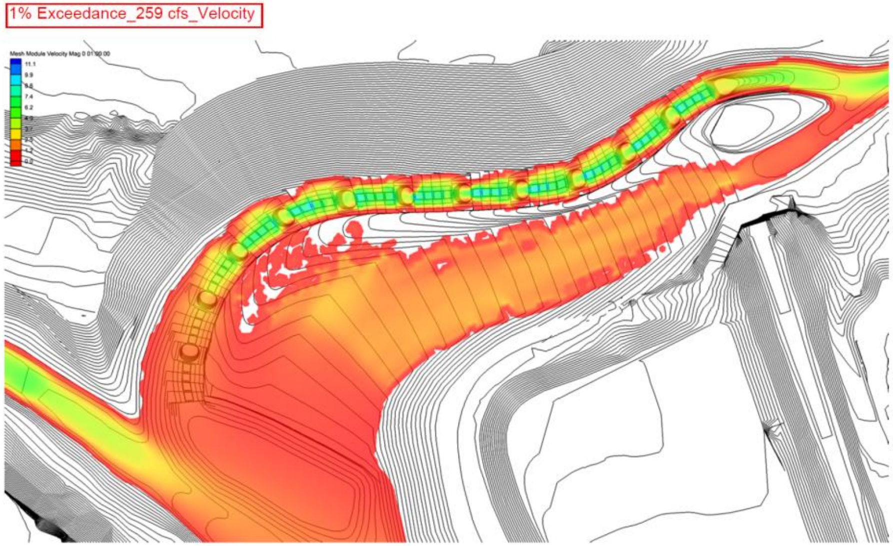
- Barrier removal – Arroyo Sequit
  - Two low water crossings
  - Geomorphic assessment shows stream profile only locally affected
  - Barriers can be removed and stream profile restored
  - Bridge span provides stream wide passage
  - Similar to current project at Sisar Ceek

Examples

- Grade control – Arroyo Trabuco
  - Geomorphic assessment shows stream profile significantly affected by changes in watershed hydrology and sediment supply

Examples

- Grade control – Arroyo Trabuco
  - In-stream and bypass fishways considered; bypass fishway selected for design development
  - Hydrologic and hydraulic analysis to establish and test design criteria

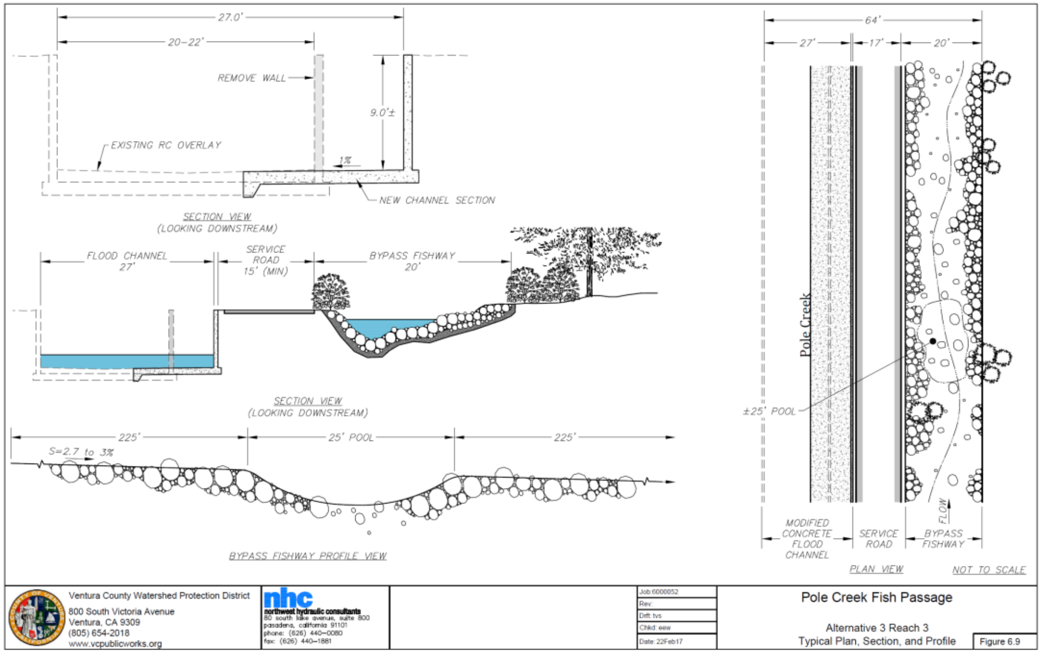


Examples

- Pole Creek Flood Control Channel
  - 2 miles of SCR tributary; 4 reaches with very different characteristics
  - Highly constrained by residential development; supercritical flood control channel; EPA superfund site

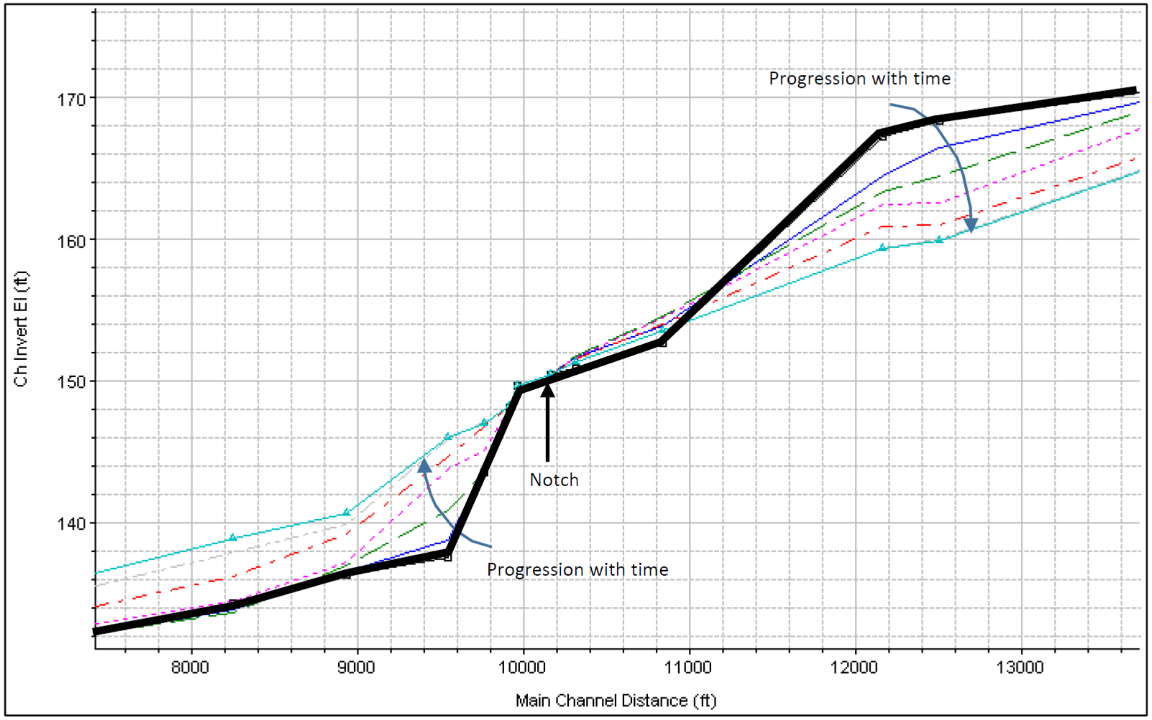
Examples

- Pole Creek Flood Control Channel
  - Hydrologic and hydraulic analysis of existing conditions
  - All four reaches had significant passage problems
  - Collaborative process for developing alternatives
  - Hydraulic analysis of alternatives from in-channel fishway to full channel
  - Bypass nature-like fishway selected as preferred approach for debris basin and concrete channel reaches



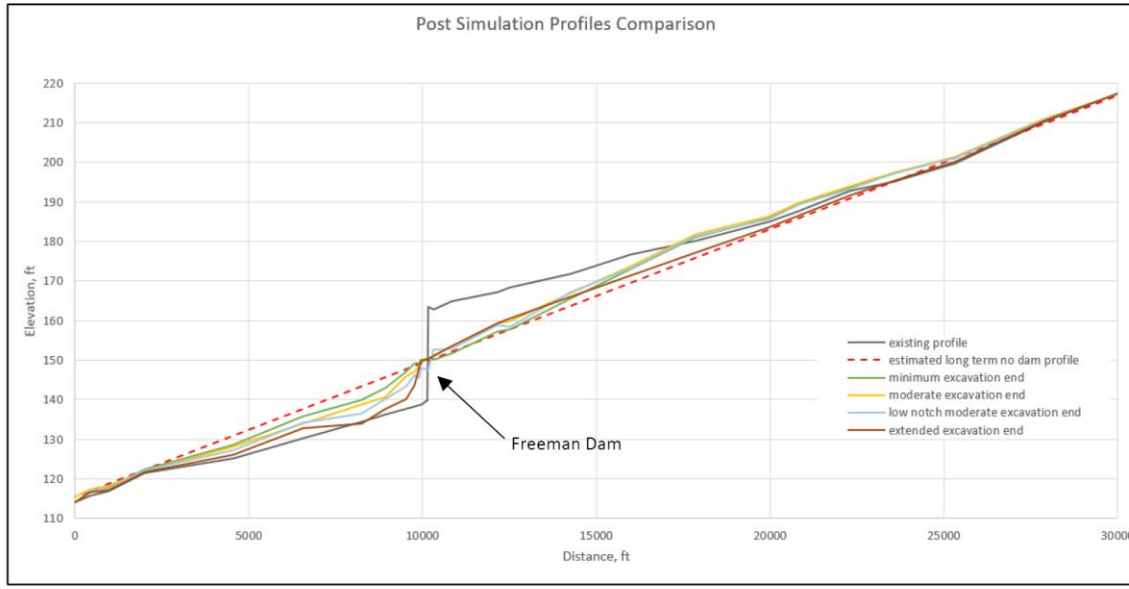
Examples

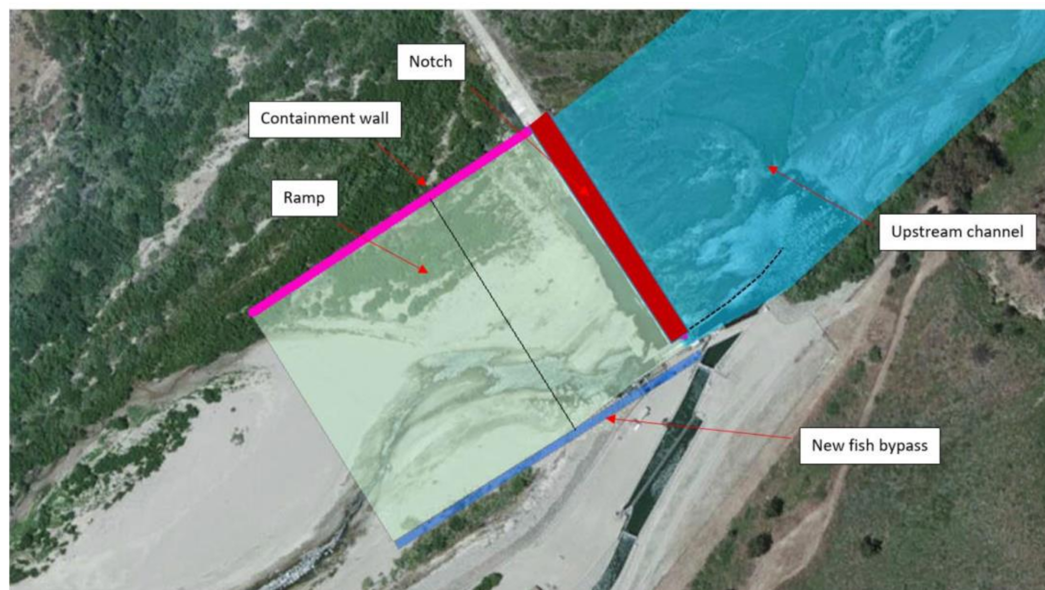
- Vern Freeman Diversion
  - Extended effort for fish passage improvement
  - Hardened ramp design developed for HCP
  - Recent investigation into notch and infiltration gallery alternatives
  - Notch adds a level of complexity related to adjustment of the river profile
  - Long-term and event sediment transport analysis



Examples

- Vern Freeman Diversion
  - Rock ramp for passage while profile aggrades
  - Notch is open above a flow threshold and closed for diversion
  - Bypass fishway for low flows
  - Additional work in progress
    - river behavior and sediment transport
    - hydraulic analysis for rock ramp and bypass fishway
    - hydraulics for operation of diversion





Questions?