



# Designing Fish Passage at Big Bear Falls

**Paul DeVries Ph.D. PE CFP**

**Kleinschmidt-R2**

**Redmond, WA, USA**

*In Collaboration With Syblon-Reid & Barnes, Inc.*

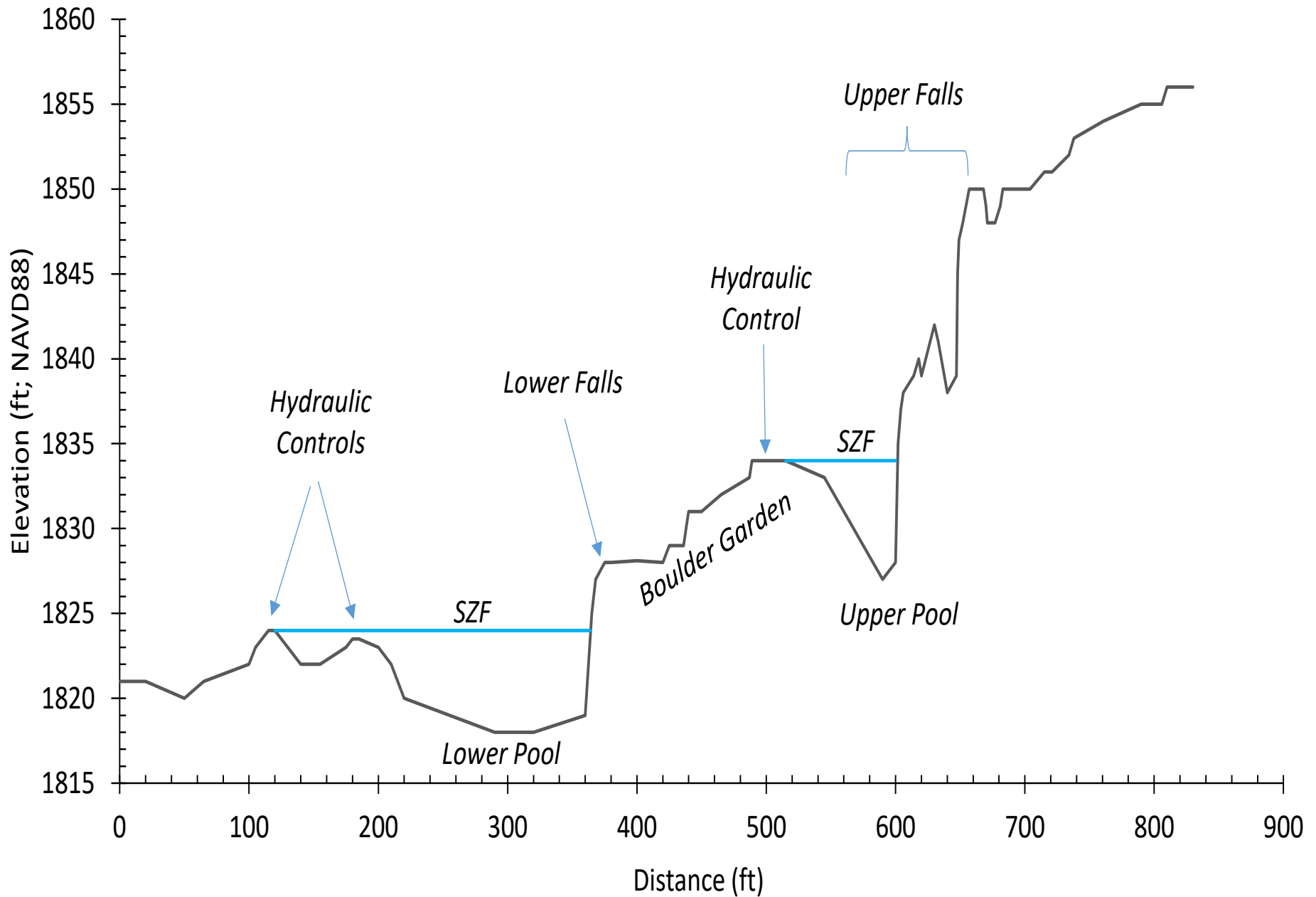




- ~Unused Habitat Upstream
- Depressed Populations
- Restrictive Fish Passage
- No Easy Fix

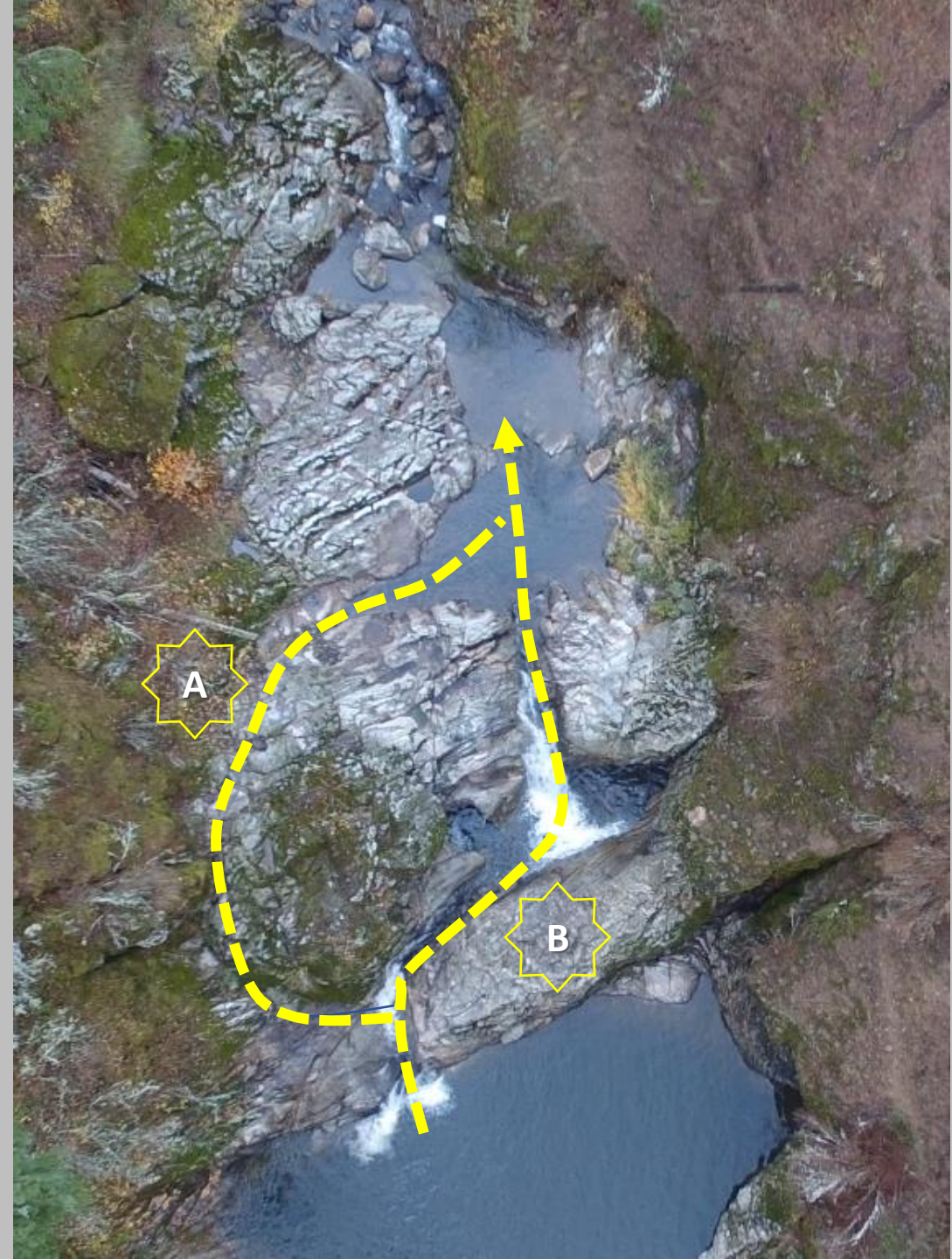






# Solution – Part 1

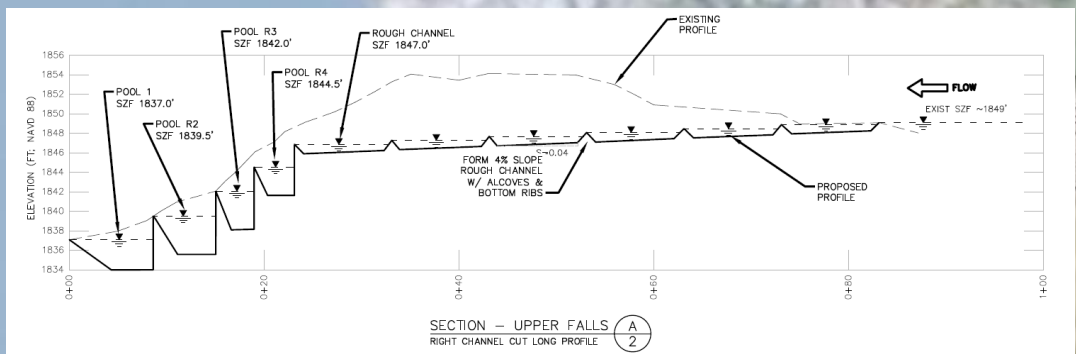
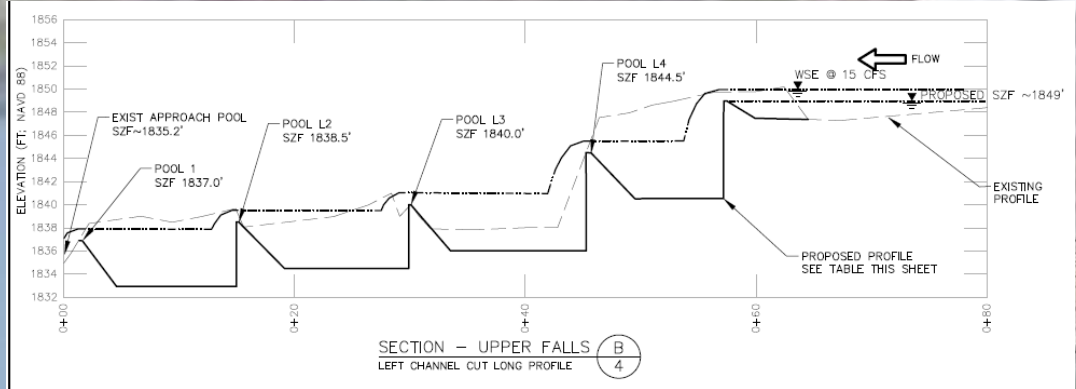
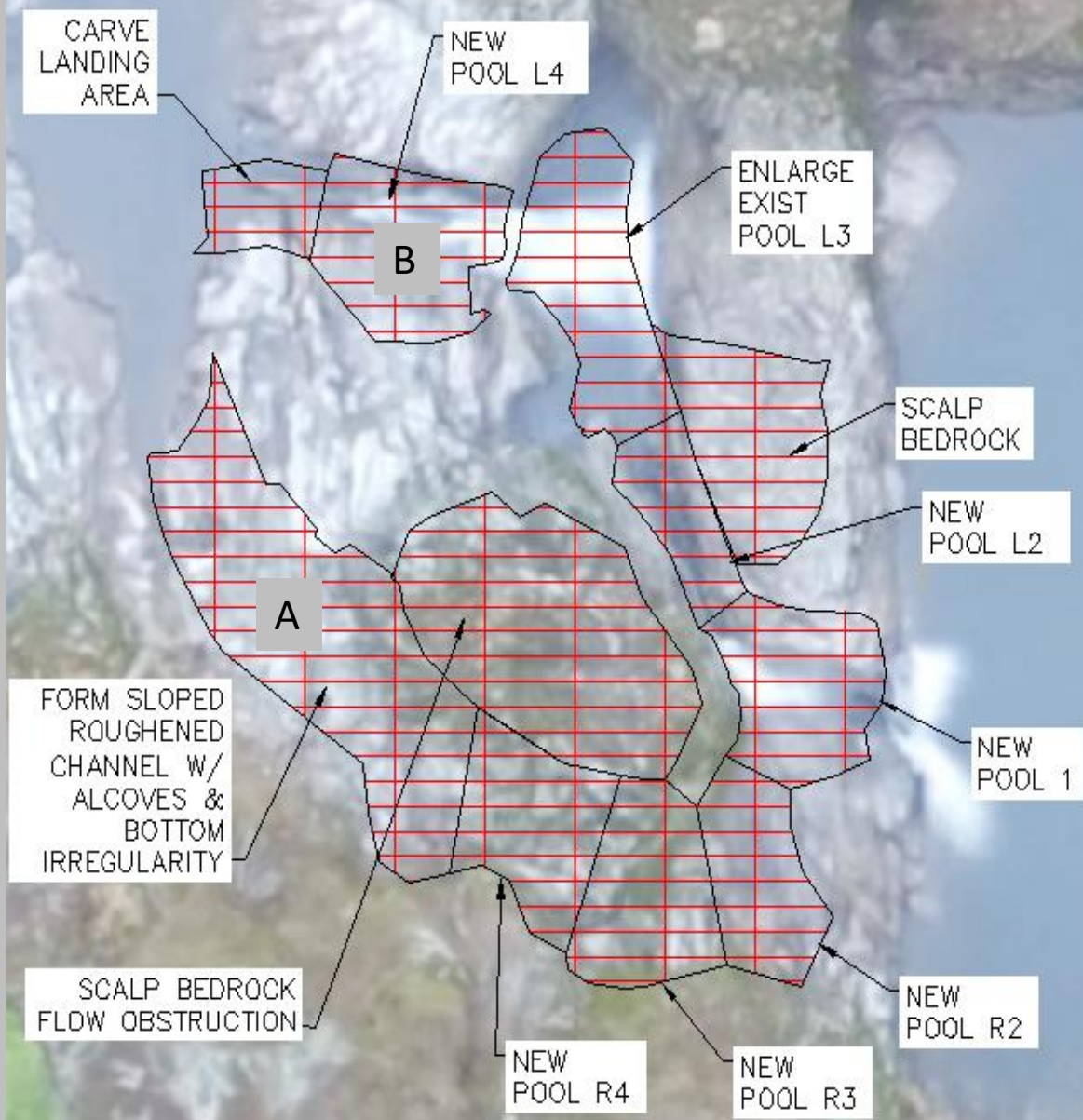
- Multiple Passage Routes in Upper Falls
  - *Overlapping Passage Flow Windows*
  - *Decrease Flow Concentration, Reduce EDF*
  - *Measures to Reduce Debris Blockage*
- Follow Bedrock Topography
  - *Minimize Blasting*
  - *Carve Pools by Controlled Blasting*
  - *Relocate Boulders and Waste Rock Onsite*



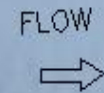
# Solution - Part 2

- Raise Approach Pool WSEs → Decrease Leaping Heights
  - *Use Local Material*
  - *Increase Roughness, Downstream Hydraulic Control*
  - *Emulate Boulder Garden Between Falls*

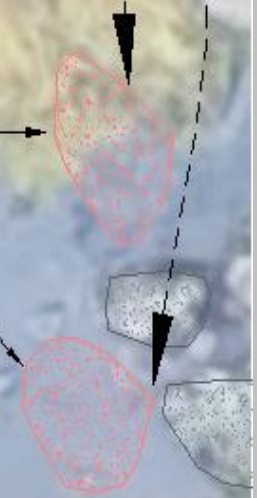




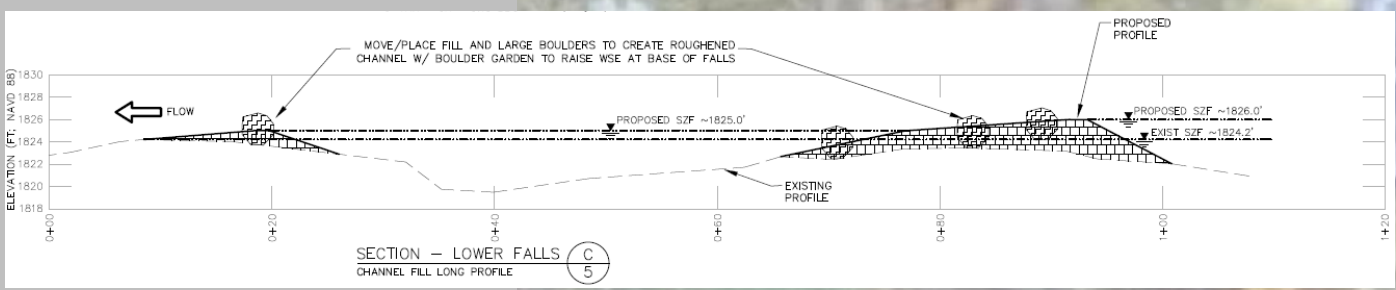
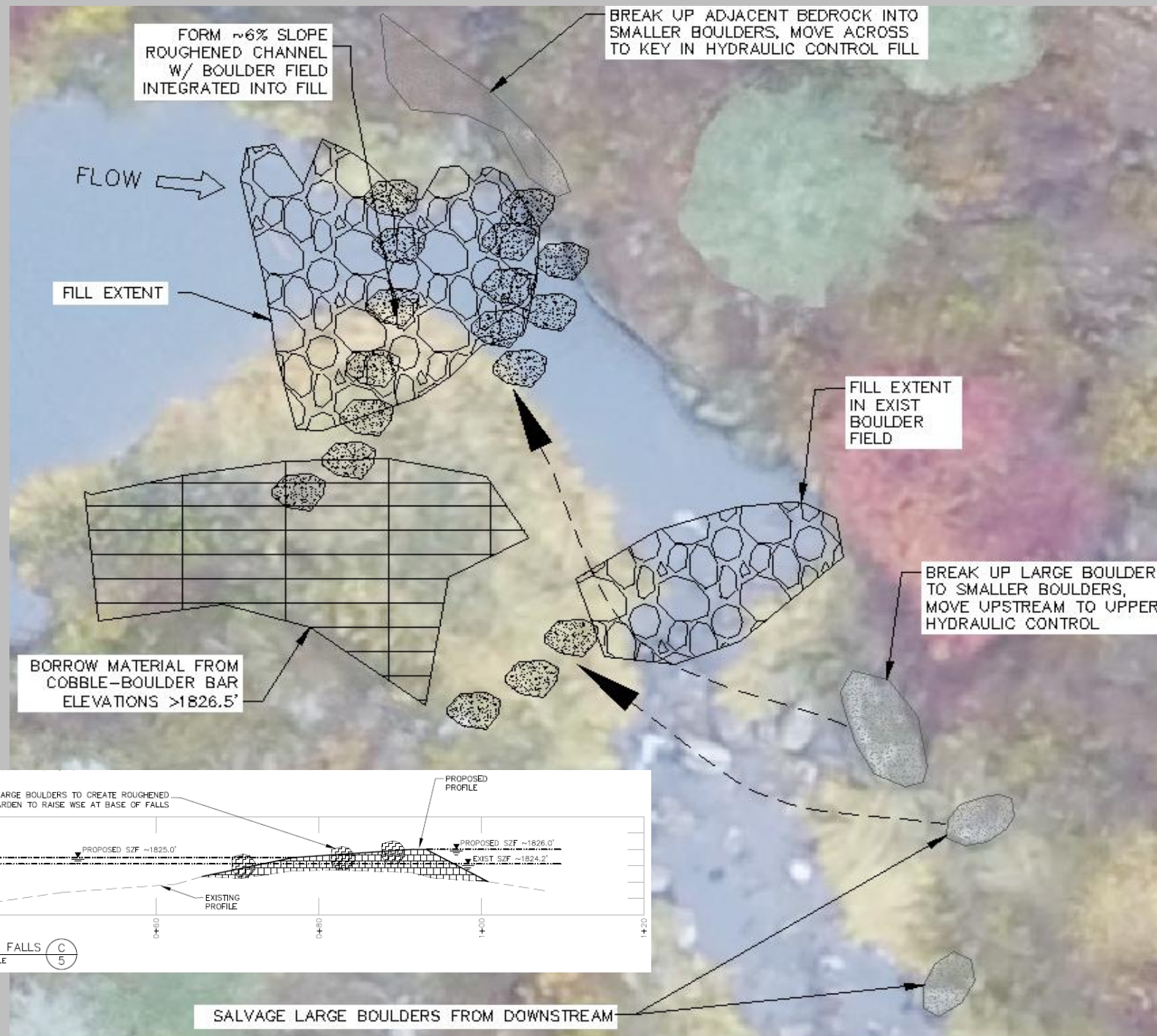
# Upper Falls



MOVE LARGE BOULDERS



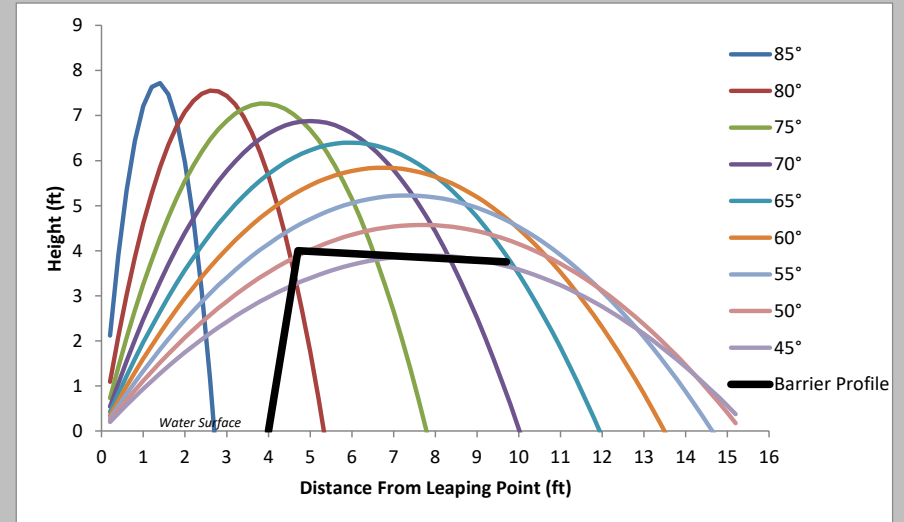
# Lower Falls





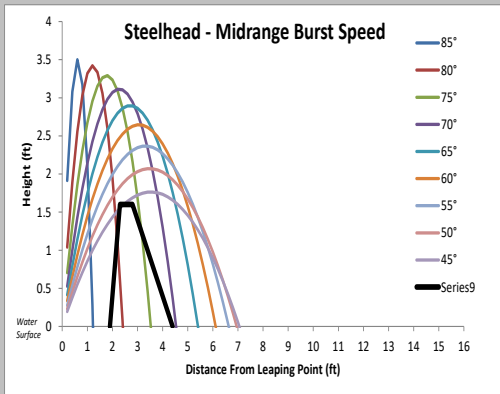
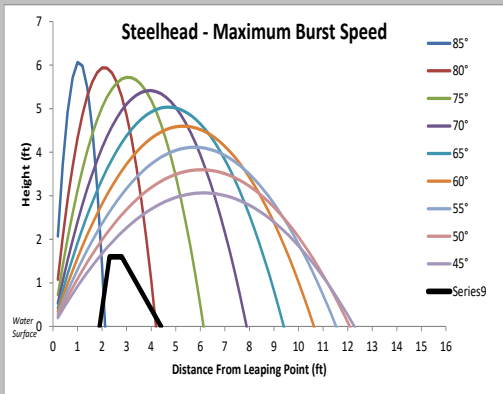
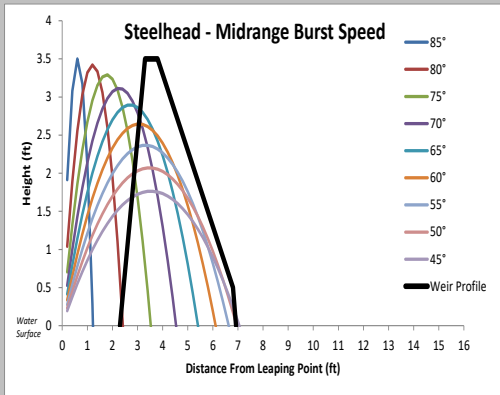
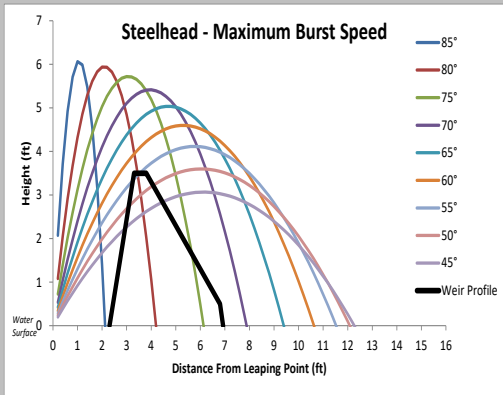
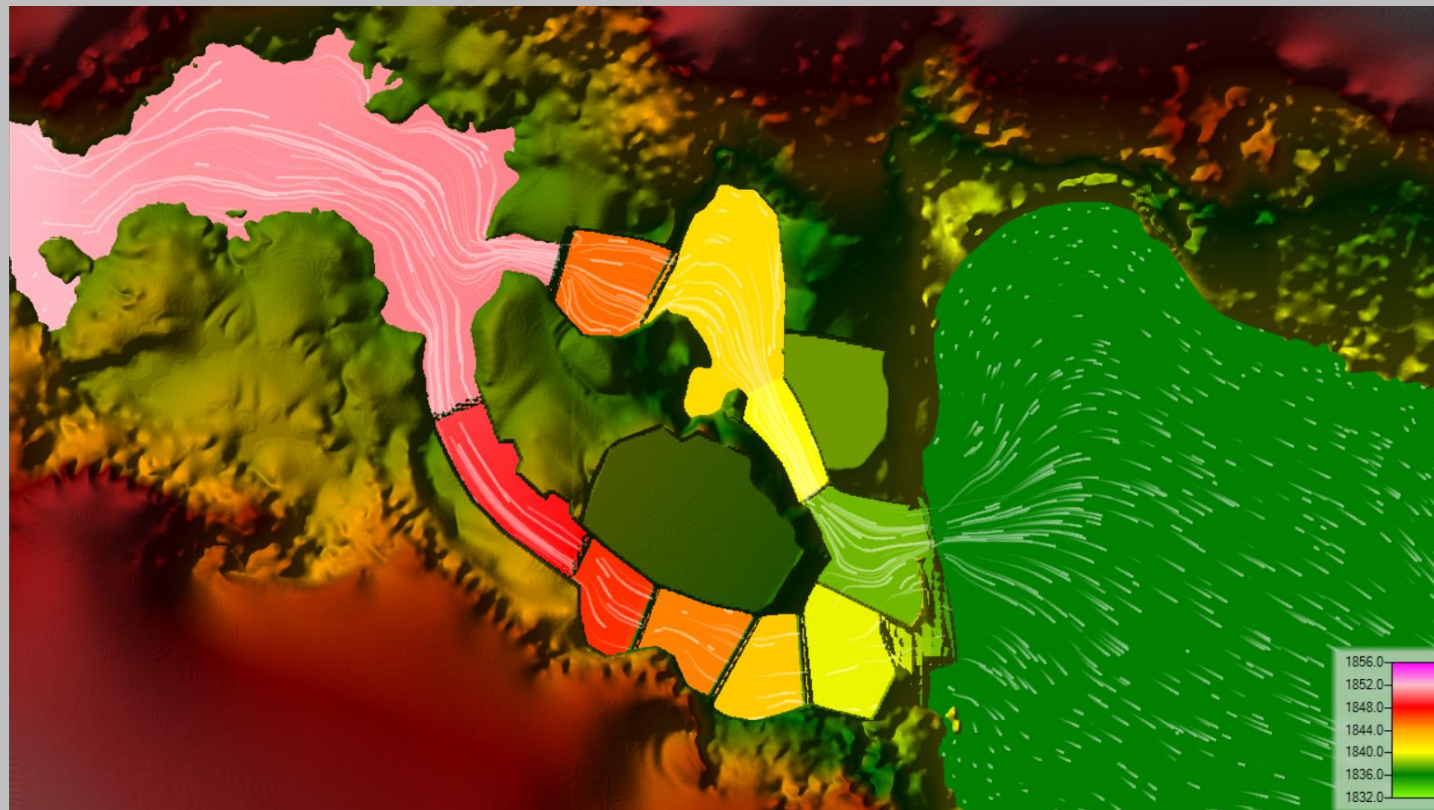
# Key Fish Passage Design Considerations

- **Analysis of Leaping Heights**
  - *Pool Depth/Area vs. Barrier Profile ----->*
  - *# Steps, Notch Backwatering to Reduce Height*
- **Energy Dissipation Factor (EDF)**
- **Passage Flow Windows**
  - *Define Overall Flow Range*
  - *Redundant Design Routes w/ Overlapping Windows*
- **Debris Accommodation**
  - *Woody Debris*
  - *Cobbles*

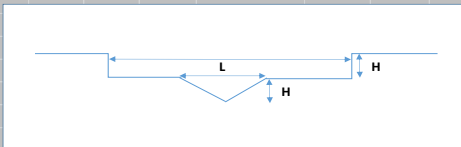


# Hydraulic Modeling

- **2D HEC-RAS Model – Flow Splits To Each Passage Route**
- **For Given Flow Split, Use Analytical Weir Hydraulic Calculations in Design**



Total Flow= 75 cfs										DS Pool WSE= 1836.6 ft								
Pool	Q <sub>model</sub> (cfs)	Outflow Weir Dimensions				Adjust so Total=Q <sub>model</sub> Head (ft)	Calculated Flow (cfs)			Invert Elevations (ft)		WSE (ft)	Head Drop (ft)	Pool Conditions				
		Lower L (ft)	Upper H (ft)	Lower L (ft)	Upper H (ft)		Lower	Upper	Total	Lower	Upper			Bottom Elevation (ft)	Volume (ft <sup>3</sup> )	EDF		
1	29	5	1.0	10	0.1	1.7	19.7	8.8	28.5	1837.0	1838.0	1838.7	2.3	105.0	1833.0	478.8	8.7	
L2	20	4	2.5	11.5	0.1	2.2	19.6	0.0	19.6	1838.5	1841	1840.7	1.9	55.0	1834.5	272.8	8.7	
L3	36	5	2.0	10	0.1	2.6	30.4	7.0	37.3	1840	1842	1842.6	3.9	200.0	1836.0	1056.0	8.3	
L4	36	5	1.0	8.5	1	2	27.6	10.5	38.1	1844.5	1845.5	1846.5	4.5	100.0	1840.5	480.0	21.1	
L4u	36	5	1.0	8	1	2	27.6	9.0	36.6	1849	1850	1851.0						
R2	39	5	1.0	14	0.5	1.8	22.2	19.3	41.6	1839.5	1840.5	1841.3	2.6	85.0	1835.5	394.4	16.0	
R3	39	5	1.0	10	3	1.9	24.8	12.8	37.7	1842	1843	1843.9	2.5	85.0	1838.0	401.2	15.2	
R4	39	5	1.0	10	4	1.9	24.8	12.8	37.7	1844.5	1845.5	1846.4	2.7	85.0	1840.5	401.2	16.4	
R4u	39	5	1.0	7	7	2.1	30.4	6.9	37.3	1847	1848	1849.1						
<b>Overflow</b>	<b>Flow (cfs)</b>																	
Left-L3																		
Left-L2																		
Right-R2																		
Mass Check	46																	



# Permitting

- **Joint Application (IDWR, USACE, IDL)**
- **Preconstruction Notification Watershed**
  - **Confirm USACE NWP Eligibility**
- **IDEQ 401 WQ Certification**
  - **Meet USACE NWP Conditions**
- **ESA - BPA's HIP III Process**
  - **Basis of Design Report Format**
  - **Comment Review Project Tracking Form**

**JOINT APPLICATION FOR PERMITS**

**U.S. ARMY CORPS OF ENGINEERS - IDAHO DEPARTMENT OF WATER RESOURCES - IDAHO DEPARTMENT OF LANDS**

**Authorities:** The Department of Army Corps of Engineers (Corps), Idaho Department of Water Resources (IDWR), and Idaho Department of Lands (IDL) established a joint process for activities impacting jurisdictional waterways that require review and/or approval of both the Corps and State of Idaho. Department of Army permits are required by Section 10 of the Rivers & Harbors Act of 1899 for any structure(s) or work in or affecting navigable waters of the United States and by Section 404 of the Clean Water Act for the discharge of dredged or fill materials into waters of the United States, including adjacent wetlands. State permits are required under the State of Idaho, Stream Protection Act (Title 42, Chapter 38, Idaho Code and Lake Protection Act (Section 58, Chapter 13 et seq., Idaho Code). In addition the information will be used to determine compliance with Section 401 of the Clean Water Act by the appropriate State, Tribal or Federal entity.

**Joint Application:** Information provided on this application will be used in evaluating the proposed activities. Disclosure of requested information is voluntary. Failure to supply the requested information may delay processing and issuance of the appropriate permit or authorization. Applicant will need to send a completed application, along with one (1) set of legible, black and white (8 1/2"x11"), reproducible drawings that illustrate the location and character of the proposed project / activities to both the Corps and the State of Idaho.

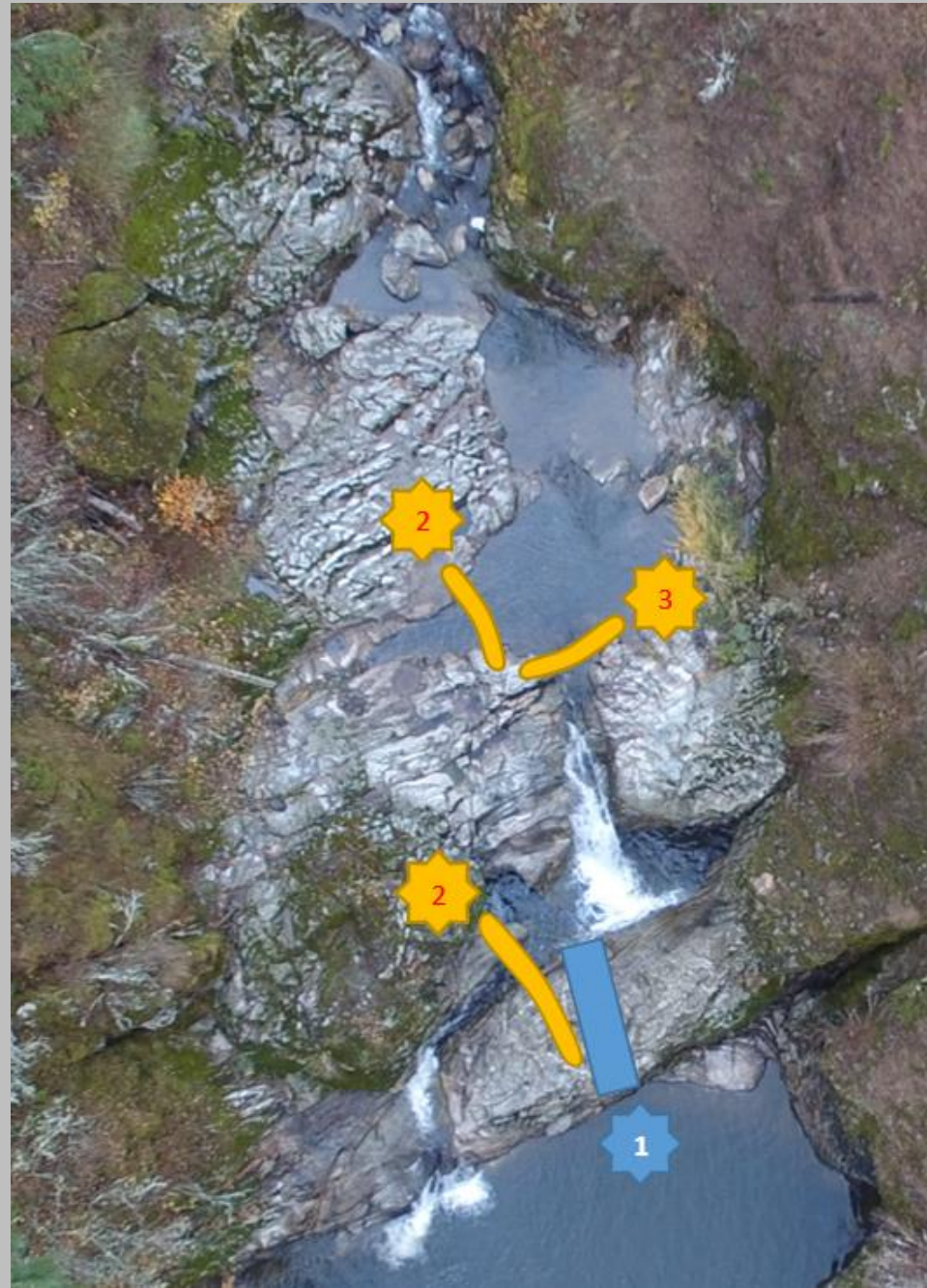
See *Instruction Guide* for assistance with Application. Accurate submission of requested information can prevent delays in reviewing and permitting your application. Drawings including vicinity maps, plan-view and section-view drawings must be submitted on 8-1/2 x 11 papers.

**Do not start work until you have received all required permits from both the Corps and the State of Idaho**

FOR AGENCY USE ONLY					
USACE NWW- _____	Date Received: _____	<input type="checkbox"/> Incomplete Application Returned	Date Returned: _____		
Idaho Department of Water Resources No. _____	Date Received: _____	<input type="checkbox"/> Fee Received DATE: _____	Receipt No.: _____		
Idaho Department of Lands No. _____	Date Received: _____	<input type="checkbox"/> Fee Received DATE: _____	Receipt No.: _____		
INCOMPLETE APPLICANTS MAY NOT BE PROCESSED					
1. CONTACT INFORMATION - APPLICANT Required:			2. CONTACT INFORMATION - AGENT:		
Name: _____			Name: _____		
Company: _____			Company: _____		
Mailing Address: _____			Mailing Address: _____		
City: _____		State: _____	Zip Code: _____		
Phone Number (include area code): _____		E-mail: _____		Phone Number (include area code): _____	
E-mail: _____		E-mail: _____			
3. PROJECT NAME or TITLE: _____			4. PROJECT STREET ADDRESS: _____		
5. PROJECT COUNTY: _____		6. PROJECT CITY: _____		7. PROJECT ZIP CODE: _____	
8. NEAREST WATERWAY/WATERBODY: _____					
9. TAX PARCEL ID#: _____	10. LATITUDE: _____	11a. 1/4: _____	11b. 1/4: _____	11c. SECTION: _____	11d. TOWNSHIP: _____
	LONGITUDE: _____				11e. RANGE: _____
12a. ESTIMATED START DATE: _____		12b. ESTIMATED END DATE: _____		13a. IS PROJECT LOCATED WITHIN ESTABLISHED TRIBAL RESERVATION BOUNDARIES? <input type="checkbox"/> NO <input type="checkbox"/> YES Tribe: _____	
13b. IS PROJECT LOCATED IN LISTED ESA AREA? <input type="checkbox"/> NO <input type="checkbox"/> YES			13c. IS PROJECT LOCATED ON/NEAR HISTORICAL SITE? <input type="checkbox"/> NO <input type="checkbox"/> YES		
14. DIRECTIONS TO PROJECT SITE: Include vicinity map with legible crossroads, street numbers, names, landmarks.  _____					
15. PURPOSE and NEED: <input type="checkbox"/> Commercial <input type="checkbox"/> Industrial <input type="checkbox"/> Public <input type="checkbox"/> Private <input type="checkbox"/> Other Describe the reason or purpose of your project; include a brief description of the overall project. Continue to Block 16 to detail each work activity and overall project.  _____					

# Flow Management

1. Notch Bedrock
2. Fly In Sand Bags and Super Sacks
3. Seal Upstream Face with Plastic Sheeting





# Drilling and Blasting

*Photo From Syblon-Reid*

- Monitor/Adjust Work As Necessary For Best Results
  - *Potential for Underlying Weaker Rock Stratum*
  - *If Necessary, Pin/Epoxy Larger Broken Rock Pieces*

- Spider Excavators with pneumatic drills
- Blasting to form pools
- Onsite monitoring to adapt design as blasting proceeds
  - Possible Weaker Rock Under Exposed Bedrock

# Fish Protection

- Fish Salvage
- Exclusion Netting
- Turbidity Control
- Blasting Overpressures
  - Decrease w/ Distance in Rock
  - Bubble Curtain



Dunlap, K.N. 2009. *Blasting Bridges and Culverts: Water Overpressure and Vibration Effects On Fish and Habitat*. MS thesis, Univ. Alaska Fairbanks.

