Nature Like Fishways: Modern Perspectives and Techniques Session 5 & Project Spotlights

A Workshop at the 41st Annual Salmonid Restoration Conference Santa Rosa, California, March 26-29, 2024

Workshop Coordinators:

- Tyler Kreider, PE, *Kleinschmidt*
- Mike Garello, PE, HDR, Inc.
- Mike Love, PE, *Michael Love & Associates*



This instructor-led workshop, organized by the American Fisheries Society–Bioengineering Section, with funding from the Resources Legacy Fund, to presents a two-day-nature-like fishway workshop. This in-person workshop took place over two days and was instructed by several leading practitioners in the field of Nature Like Fishways (NLF) implementation, including representatives from both private and public agencies. The list of speakers includes Michael Garello (HDR), Michael Love (MLA), Jesus Morales (U.S. Fish and Wildlife Service), Tyler Kreider (Kleinschmidt), Bjorn Lake (NOAA Fisheries), Barry Chilibeck (Northwest Hydraulic Consultants), Brian Cluer (NOAA Fisheries), and Marcin Whitman (retired California Department of Fish & Wildlife). The goal of the workshop was to share knowledge of nature-like fishway design and long-term stability observations among practitioners, regulators, and operators to improve the collective awareness of contemporary NLF science and design methodologies to ultimately provide more effective and sustainable passage for fish. This workshop included the following topics:

- History and state of nature-like fishways
- Application of NLFs to natural and built environments
- Site reconnaissance, project assessment, project development
- Identifying data and modeling needs and necessary in-field data collection
- Example design methods, practices, constraints, and uncertainties—also highlight current/ forthcoming design guidance documents
- Construction methods and oversight
- Monitoring
- Lessons learned from previously constructed NLFs
- Risk evaluation in NLF Design
- Getting the right rocks and placing them for long-term stability

Presentations



•	Contracting Methods & Construction Documentation	Slide 6
•	Contracting Methods, Consideration, & Challenges	lide 42
•	Project Spotlights	lide 56

Nature-like Fishways: Modern Perspectives and Techniques



Session 5 Contracting and Implementation



AGENDA

- 01 Contracting methods & construction documentation
- **02** Construction methods, considerations, & challenges
- **03** Project Spotlights
- 04 Break
- 05 Project spotlights
- **06** Closing Statements

Nature-like Fishways: Modern Perspectives and Techniques





Contracting methods and construction documentation

- Overview of NLF Project Delivery Methods
- Use of contract documents as a communication tool for NLF construction
- Contract execution



Overview of NLF Project Delivery Methods



Nature-like Fishways: Modern Perspectives and Techniques



Design Bid Build

design team and a general contractor working directly for the owner under separate contracts



Construction Manager at Risk

The construction manager acts as a representative for the owner during the design and construction phases, and the CM takes on project risk (usually with a contract that has a guaranteed maximum price).



Design Build

In design-build construction, an owner enters into a single contract to cover both the architectural design services and the physical construction of the build, streamlining the collaboration, communication, and coordination process.



Progressive Design Build

Offramp at 60% level of project definition. If the owner and contractor cannot agree on the design or budget for construction services, the owner can decide to use the "off ramp" built into the PDB agreement.



Design Build and Operate

In design-build operate construction, an owner enters a single contract to cover both the engineering design services, the physical construction of the project, and operation of the constructed project. Operation is paid for a specific duration and then renewed via additional operation contracts by owner and operator.



Design Build Finance and Operate, Public Private Partnership (PPP)

A private company and government entity collaborate on a project, typically funded by the government entity and managed by the private company.



Construction Delivery Methods Overview

 Two Most Common Delivery Methods for NLF Projects



Design Bid Build

Example Project Timeline...



Design Bid Build Advantages

- Widely used method for public agency projects
- Agencies typically have developed standard contracts and procedures based on experiences from many projects
- Owners are comfortable with the DBB approach
- Owner maintains a high level of control during the design phase
- Typically, a large pool of contractors
- Owner and contractor familiar with the process
- Ability to attract competition

Disadvantages

- Requires the longest time for design and construction
- No design competition
- Little collaboration between designers, builders and operators
- Lack of emphasis on life cycle costs
- Firm construction costs are not known until bidding process is complete
- Prone to change orders
- Low bid contractor selection increases risk of performance problems
- Owner retains the risk for design errors and project performance Page 14

Design Bid Build

Example Project – Quiota Creek Watershed Fish Passage Restoration Program Cachuma Operation and Maintenance Board, *Quiota Creek, Santa Ynez, CA*



Quiota Creek Crossing 2 Santa Ynez, CA



Quiota Creek Crossing 6 Santa Ynez, CA



Design Build

Example Project Timeline...



Design Build

Example Project – Manastash Creek Restoration Program Kittitas County Conservation District and Bonneville Power Administration Manastash Creek, WA



Pre-Project Manastash Diversion Dam

Manastash Diversion Dam

STATISTICS IN IT

Pre-Project Keach-Jensen Diversion Dam

Post-Project Keach-Jensen Diversion Dam

Post-Project **Barnes Road Diversion**

Barnes Road Diversion













Reference Design – Permanent Double Vertical Slot Fishway Big Bar, Fraser River, Lillooet, BC Temporary Emergency Passage Big Bar, Fraser River, Lillooet, BC

Design Build Advantages

- Builder and designer are selected on qualifications and overall best value
- Can use prequalification to narrow field of proposers to best qualified.
- Builder's and designer's interests are aligned. Limits contract changes.
- Transfer of design, construction and performance risk to the design-builder
- Single contract for design and construction shields the owner from disputes between designer and builder
- Shortens project schedule and potentially reduces overall project cost and cost risk.

Disadvantages

- Owners have less familiarity
- Best value proposal evaluation can be complex to prepare and select. Longer, more involved procurement phase
- Owner gives up more control of details. Limited opportunity for the owner and DB contractor to collaborate once price is set
- Design drawings are less detailed than in DBB
- Regulatory agencies may not have a procedure in place to review partially complete designs
- Limited focus on life cycle costs. Owner retains the operating risk.

Construction Delivery Methods Overview

Which delivery methods is right for your project...

- Speed of Delivery Amount of schedule reduction, inflation
- Risk Allocation Manage risks, dispute avoidance, transfer of risks
- Owner Control of Design Which design vision is most critical
- Cost Certainty Early cost certainty, manage change
- Procurement Considerations market and political viability, selection system simplicity
- Relative Costs Is there a potential for substantial savings
- Performance Certainty Allow for innovation

Nature-like Fishways: Modern Perspectives and Techniques





Overview

- A contractual framework between the Owner and the Builder or Design-Builder composed of multiple parts
- Provides scope of work, payment terms, work timelines, constraints, requirements, guidelines, stipulations, and change management protocol the Owner and the Builder or Design-Builder agree to adhere to.
- Is a communication tool between owner, designer, and builder throughout a construction project
- Not all construction contracts and documentation are assembled the same way
 - Terms and conditions, standards, and overall content vary by Owner and unique project composition
 - Level of detail and complexity can be scaled dependent upon the contract type and situation.

Summary of Basic Construction Contract Elements





Scenario 1 - DBB with Low Bidder Selection Requirement

- Requires a higher level of detail with higher level of effort spent on developing linkages between plans, notes, specifications, and contract authority
- Minimum responsive requirements for contractor qualifications and experience must be clearly written into bidding requirements
- Additional clarity required on material standards, acceptance of materials, and requirements during execution of work – emphasis on notes and specifications within overall contract
- Assume that construction may be executed with or without original engineer of record
- Risk Mitigation strategies include:
 - Execute a prequalification process if possible so that only experienced contractors provide bid proposals
 - Negotiate and plan for a higher level of effort during design to accommodate level of detail
 - Communicate clear recommendations to owner to involve design engineer and or qualified and experienced inspectors during construction
 - Prepare for more cost and schedule overruns elevate contingency funds standard of care is ~10%

Scenario 2 - DBB with Best Value Selection Process

- Contractor qualifications and experience can be evaluated with their price proposal during selection
- Selected contractor may not be the least costly, but may result in the best, most cost-effective project overall
- Material standards, acceptance of materials, and requirements during execution of work are likely better recognized and understood by the selected contractor
- There is a higher probability that a highly qualified contractor will execute more effective means and methods – less schedule and cost risk
- Risk Mitigation strategies include:
 - Execute a prequalification process if possible so that only experienced contractors provide bid proposals
 - Communicate clear recommendations to owner to involve design engineer and or qualified and experienced inspectors during construction
 - As budget allows, provide a similar level of detail and level of effort spent on developing linkages between plans, notes, specifications, and contract authority.
 - Invite the contractor to provide value proposals during the bidding process

Scenario 3 - DBB with Engineer of Record as CM

- Involving a highly experienced contractor coupled with the experienced engineer of record provides the greatest likelihood of success.
- Material standards, acceptance of materials, and requirements during execution of work are likely better recognized, understood, and implemented by the selected contractor. The design intent can be clearly communicated by the design engineer.
- In this case, the level of effort can focus on the scope of work, timeline constraints, and material requirements needed by the contractor to accomplish the work. Execution of work can be communicated by the engineer.
- Decisions are more effectively navigated using the processes provided by the contract authority
- Risk Mitigation strategies include:
 - Execute a prequalification process if possible so that only experienced contractors provide bid proposals
 - Provide adequate time and budget for the engineer of record to participate throughout construction execution
 - Invite the contractor to provide value proposals during the bidding process



Scenario 1 - DB with Engineer of Record as Owner Representative

- Contractor qualifications and experience can be evaluated with their price proposal during selection
- Selected contractor may not be the least costly, but may result in the best, most cost-effective project overall
- There is a higher probability that a highly qualified contractor will execute more effective means and methods less schedule and cost risk
- Material standards, acceptance of materials, and requirements during execution of work are the responsibility of the design builder after a design has been accepted. They assume the risk.
- Risk Mitigation strategies include:
 - Execute a prequalification process if possible so that only experienced design-builder teams provide bid proposals
 - Provide a clear set of expectations, scope of work, timeline constraints, environmental standards, and any guidelines to be followed by the design-builder. Execution of work is the responsibility of the design-build team.
 - Provide clear expectations regarding the extent and duration of communications and any review and acceptance practices to be followed.

Contract Authority – Resolution of Conflicts or Discrepancies



- Example drawings and specifications
- Lower level of detail
- High engineer engagement during construction



SPECIFICATIONS

- IS DEFINED HEREIN AS THE ENTITY RESPONSIBLE FOR ON SITE ALL ITEMS SPECIFIED AND SHOWN IN THE CONTRACT DOCUMENT UNLESS OTHER ARRANGEMENTS ARE MADE THE CONTRACTOR SHALL LIMIT THEIR ACTIVITIES TO THE STAGING AND ACCESS AREAS INDICATED ON THE DRAWINGS
- CONTRACTOR IS RESPONSIBLE FOR IMPLEMENTING WHATEVER MEASURES ARE ESSARY FOR THE PROTECTION OF ALL EXISTING FACILITIES. INCLUDING ISE ASSOCIATED WITH TEMPORARY ACCESS OR STAGING ON ADJOINING PREVIEW. DURING THE COMPSE OF THE CONSTRUCTION. ANY REPAIRS. CEMENTS OR RESTORATION MEASURES MADE NECESSARY BY THE ACTOR'S ACTIVITIES WILL BE MADE AT THE CONTRACTOR'S EXPENSE
- AFETY OF ALL ON SITE WORKERS SHALL BE THE RESPONSIBILITY OF THE ACTOR. USE EXTREME CALITION AT ALL TIMES WHILE WORKING WORDER. IN ROUND THE WATER, CONFORM TO ALL LAWS AND CODES GOVERNING WYTE WODE

- EXISTING CONTOUR INFORMATION ARE BASED ON SURVEYS CONDUCTED IN 2004-2005 BY HUIBREGTSE, LOUMAN ASSOCIATES, INC. 801 NORTH 39th AVE, VAKIMAL WASHINGTON 88902 PHONE509-985-3800
- THE CONTRACTOR IS RESPONSIBLE FOR FURNISHING. INSTALLING AND MAINTAININ ALL NECESSARY MEASURES TO CONTROL EROSION IN ACCORDANCE WITH APPLICABLE STATE AND FEDERAL DEGULATIONS.
- CLEARING AND GRUBBING SHALL NOT EXCEED LIMITS OF CONSTRUCTION SHOWN ON THE GRANINGS, THE CONTACTOR IS RESPONSIBLE FOR DISPOSAL OF CLEARING DEBRIS. DEBRIS SHALL BE DISPOSED TO A STATE APPROVED OFF-SITE FACILITY OR AT THE DIRECTION OF THE DUNKE.
- HE CONTRACTOR IS RESPONSIBLE FOR THE REMOVAL AND OLSPORAL OR UNPERION THEORE EXECUTION SILE WITHOUT DISTURBING ADJOINT BARES FROM DIVERSION STRUCTURE CARL, TION SHALL BE DISPOSED IS SULVACED AND THE THANGPARTY STRUCTURE ON A LOCATION ACCEP-IES AN ACCE DANS TO THIS CREATED BY REMOVING EXISTING STRUCT RE DIMER, MOLES AND FILS CREATED BY REMOVING EXISTING STRUCT RECOMPARY MOLES AND FILS CREATED BY REMOVING EXISTING STRUCT CORRECT HEAT AND A DAY AND A
- E CONTRACTOR IS RESPONSIBLE FOR MAINTAINING A SAFE WORKING AREA. L DISCHARGE TRAD BERATERING EFFORTS SHALL BE HOUTED TO THE INFIGATION NAL AND SHALL MEET ALL STATE AND FEDERAL REGULATIONS, SHORING, WHERE CESSARY, SHALL BE PERFORMED IN ACCORDANCE WITH THE FOLLOWING:
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- THE PROPOSED PLAN FOR SHORINGS AND PROTECTI ADDRESS, AS A MINIMUM, THE FOLLOWING ITEMS:
- a) TYPE OF SHORING OR OTHER PROTECTIVE WORKS TO BE USE
- b) SEQUENCE OF CONSTRUCTION FOR SHORING OR OTHER PROTECTIVE WORKS

ORDINARY HIGH

STREAMBED COBBLES PER SEC 9-03,11(2

EXISTING

- c) PROVISION FOR LIMITING SILTATION OR DTHER EFFECTS ON THE RIVERS AND STREAMS.
- d) PROVISIONS FOR REMOVAL OF TEMPORARY SHORINGS OR PROTECTIVE WORKS AND REPLACEMENT OR GRADING OF THE FOUNDATION AREAS FOLLOWING REMOV.



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- COPIES OF THE TEST RESULTS SHALL BE SUBMITTED TO THE DWNER. ANY LAYER OR PORTION OF A LAYER WHICH HAS NOT ATTAINED THE REQUIRED DUNSITY SHALL BE SCARFIED. MOISTURE ADDED IF REQUIRED AND RECOMPACTED UNTIL THE REQUIRED DENSITY IS OBTAINED AT NO ADDITIONAL EVENSE TO THE OWNER.
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ORDINARY HIGH

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ELEV "A"-

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TYPICAL ROCK WEIR PROFILE

TYPICAL SECTION THROUGH BYPASS CHANNEL AREA

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SCALE IN FEET 5 0

2% SLOPE FROM EXISTING TOE OF SLOPE




Project Manual over 1,000 pages ...

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DIVISION 03 - CON

11120-JOB CO

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Construction Documentation

- DBB delivery with low-bid municipal environment
- Example drawings and specifications
- Higher level of detail

Construction Documentation

Specifications are Not Created Equal

- Federal Standards and formats
- State Standards (e.g., WSDOT, Caltrans, etc.)
- Municipal Standards (County or City)
- Construction Specifications Institute (CSI) Format
- Owner specific formats
- Special provisions



Construction Documentation

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Example Specifications - WSDOT



Standard Specifications

FOR ROAD, BRIDGE, AND MUNICIPAL CONSTRUCTION M 41-10

2024



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- 01 57 24 Care and Diversion of Water During Construction
- 31 23 00 Earthwork
 - excavation, backfilling, grading, compaction, disposal of waste and • surplus materials, aggregate, stone, rock, placement of materials, construction of rock features, shoring, bracing, and other Earthwork related work.



Nature-like Fishways: Modern Perspectives and Techniques

02

Construction methods, considerations, and challenges

 An overview of NLF construction considerations, methods, and challenges



Construction methods, considerations, and challenges

- Rock material properties and gradation
- Material handling
- Material sourcing
- Equipment, equipment limitations, constructability
- Use of hydraulic jetting as a tool for settlement and plugging interstitial space
- Care of water

Rock Gradation and Quality

- Shape Angular, Subangular, Rounded
- Specific Gravity Density
- Hardness Breaking and fracturing
- Durability Response to abrasion
- Size and Gradation Size class and distribution of sizes







Rock Gradation

Testing Methods Differentiated

Designation: D 5519 - 94 (Reapproved 2001)

Standard Test Method for Particle Size Analysis of Natural and Man-Made Riprap Materials¹

This standard is issued under the fixed designation D 5519; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1.3 Three alternate procedures are provided. The procedure used shall be as indicated in the specification for the material being tested. If no procedure is specified, the choice should be selected and confirmed by the testing agency. The procedures and referenced sections are:

1.3.1 Test Method A: Size-Mass Grading—Grading of the material based on both the size and mass. See 9.2.

1.3.2 Test Method B: Size-Range Grading—Determination of the grading of the material based on the sizes of the individual particles. See 9.3.

1.3.3 Test Method C: Mass-Range Grading—Determination of the grading of the material based on the mass of the individual particles. See 9.4.



Onsite Material Receiving, Sorting, and Handling





Project Construction Cota Street Bridge NLF Project Construction Quiota Creek Crossing 9

SUN COAST REATALS

Project Construction Eagle Creek (courtesy Michael Love)

Large Rock Handling





Environmental permitting efforts should consider construction means and methods to the extent possible. Changes in construction tactics not covered by approved permits can result in costly schedule delays.

7408







Care of Water, Construction Isolation, Temporary Stream Diversions, and Dewatering



A broad variety of materials can be used to develop coffer dams for temporary stream diversions



Temporary stream diversions are configured to meet the need and complexity of the project to accommodate the anticipated range of flows during construction.



Project Construction Eagle Creek (courtesy Michael Love) **Project Construction Cota Street Bridge NLF**

TSD Discharge Quiota Creek, Crossing 4

ANY ANY ANY







Construction Monitoring

- Traditional survey methods
 - Set project benchmark and reference points
 - Grade rods, transits, and levels
- Modern survey techniques
 - RTK Survey equipment with cell phone capable real-time differential correction
 - Drone LiDar
 - 3D LiDar scanning
 - 3D terrain capable excavators





Construction methods, considerations, and challenges

Open Discussion...

Successes and failures during construction?







Fraser River Big Bar Landslide Fish Passage Mitigation

Barry Chilibeck, PEng Northwest Hydraulic Consultants

Wednesday March 27 2024 SRF 2024





Clearing Rock Slide at Hell's Gale, Frazer River Rock moved 76, 850 cu jas. Drilled 9, 534 Feel

























Pre-slide Fall 2017

Post-slide Summer 2019





When did this occur?



October 26th 2018



November 2nd 2018
Why did this occur?



Notes:

1. Daily maxiumum and minimum temperature measured at Lillooet weather station (elevation: 239.50 m.asl)

2. Daily precipitation at Big Bar rockslide site, based on interpolation between precipitation data measured between local Natural Resources Canada weather stations.

Big Bar Slide Timing

760,000 m³ stored water behind the slide 4 m/s kinematic velocity at 600 m³/s Slide occurred at 1900 h PST on Nov 1st 2018

* 616 ac-ft 9.7 fps

21,200 cfs



WSC 08MF040 Fraser River above Texas Creek

Initial Emergency Response

Federal Government: salmon and oceans

- DFO Fisheries and Oceans Canada
- CCG Canadian Coast Guard

Provincial Government:

FLNRORD – Water, Land, Flooding, Wildfire

Indigenous Groups:

 Upper Fraser Fisheries Conservation Alliance, High Bar First Nation and others

Initial Site Assessment



Fish Monitoring and Transport



Seining and Heli-Transport

51,000 Sockeye 8,500 Chinook 500 Pink 3 Coho



Helicopter Transport Above the Slide

- 50 to 65% tagged fish resumed upstream migration after release
- 40% Chinook and 30% Sockeye fell back over the slide
- Multiple transits above the slide were recorded

Reasons for fall back behaviour:

- Capture and handling stress
- Water temperature
- Fish condition



Site Access and Rock Scaling



Site Access and Rock Scaling







Rock Manipulation for Fish Passage



Not much room to start with....



"Old Fashioned" Work





Rock Breaking and Expanding Grout







Create roughened micro channels along bank line:

- 0.5 to 1.0 m wide
- 0.3 to 0.5 m deep
- 0.3 to 0.5 m drop
- Step pool form

Rock Manipulation for Fish Passage





Rock Manipulation for Fish Passage





Rock "Manipulation" for Fish Passage



Monitoring and Assessment

Daily video and still imaging

Real-time upstream and downstream water level measurements

RTK UAV imaging

Terrestrial LIDAR

Re-established WSC 08MD013 Fraser River at Big Bar

Hydroclimate Station



Particle Image Velocimetry





Big Bar Hydrometrics



Jul 17th 2019 2,800 m³/s 99 kcfs



Nov 22th 2019 2,290 m³/s 81 kcfs



Jan 16th 2020 536 m³/s 19 kcfs



Bathymetry

Bathymetry data below high water to assess slide rock fill Challenges of safe access, aeration and limits of technology







Hydraulic Modelling

Compiled a preliminary DEM Value of a Geomatics Engineer TELEMAC 2D hydraulic modelling to look at effects of rock removal

- large-scale side rock removal
- Key large boulders
- Slide crest



Hydraulic Modeling



Slide Hydraulics



But what were the Fish telling us?



Observed Fish Movement

Active Cycling Resting Milling Zombie Mode Fall-back Dispersal



The fish were not happy fish...




Salmon Migration Past the Slide



Volitional Fish Movement at Big Bar Slide





Significant Losses of Fish to Spawning Grounds

Spring Chinook

- Many rivers with 0 to 10 spawners, few with 50 or more
 Early Stuart Sockeye
 - 26,000 entered the Fraser Canyon
 - Less than 100 fish on the spawning grounds

Summer Chinook

- Better than spring runs
- Some rivers with 2,000 fish

Impacts beyond the Fraser River

- It is not likely possible to remove all the rock in the river.
- Volitional fish movement is now a function of Fraser River hydrology and freshet timing.
- There is a meaningful chance of extinction for:
 - Early Stuart Sockeye
 - Mid Fraser and Upper Fraser Spring Chinook.
- Massive negative implications to Fraser Salmon.

Bookend Mitigation Options

Action:

Don't remove additional slide rock

Remove industry-accessible rock and reduce the size of the slide impact

Remove all the rock to completely mitigate impact of slide on river hydraulics

Reaction:

Prepare site and build a technical fishway

Maximize natural fish passage and minimize fishway structure need

Completely restore natural volitional passage

2020 Winter Work Program

Mobilizing to remove rock during seasonal low flows

A. Remove Slide crest

B. Remove East toe

C. Modify West Bank



Work completed: 2020 East Toe Removal





Fish Passage Planning

- 1. Volitional (non-directive)
 - In-River Roughened Slope
 - Technical Vertical Slot Fishway
- 2. Non-volitional / Assisted
 - Whoosh Trail
 - Fish Passage during construction



MOD 4 – 3,500 cms



MOD 4 - 3,500 cms



Planned Vertical Slot Fishway



Work completed: 2021 Bench



2020 flow conditions at 2,500 m³/s



2021 NLFW build



2022 at 2,500 m³/s zoomed in



Small vertical hydraulic separations

NLF roughness creates slower hindered flow zone along edge

distributed hydraulic drop over length of NLF

2022 at 2500 m³/s zoomed in



Work completed: River rock removal with 'fingers'



Current Conditions





NLF Project Spotlight:

North Fork Battle Creek, Eagle Canyon Natural Barrier Modification Manton, CA



By: Michael Love

3/27/2024

Eagle Canyon Upper Barrier Modifications









Battle Creek Hydropower Schematic with Lower and Upper Barriers



Design Overview

Site Characterizations

- Survey (total station, sonar, laser scan)
- Geotechnical investigation
- Boulder mapping
- Flow lines mapping
- Sieve mapping
- Pressure transducers
- Timelapse cameras
- Flow measurements



Geologic Mapping of Canyon Wall By Cotton, Shires and Associates

Scan point cloud



Upper Barrier Site Profile

Primary Drop

✤ 12.5 ft



Upper Barrier Site Flow Paths thru<u>Sieves</u>



Primary Drop * 12.5 ft * No pool

<u>Upper Barrier Site</u> Boulders and Bedrock to be Removed





2D Hydraulic Simulation coupled with Fish Energetics

and Routing



Implementation 2021






Lesson: Label what you know

SRC





1,800 tons of rock removed (3,600,000 lbs)















Implementation: Final Outcome













TLC2000 2021/12/25 15:00:01

Eagle Canyon Team











Landowners: David Gamon & April Gamon John Gamon & Donnette Thayer





Hydrologic Solutions

TEHAMA ENVIRONMENTAL SOLUTIONS, INC. Environmental Consulting • Habitat Restoration







COTTON, SHIRES AND ASSOCIATES, INC. CONSULTING ENGINEERS AND GEOLOGISTS

NLF Project Spotlight:

Pawcatuck River NLF at the Bradford Dam Westerly, Rhode Island Jesus Morales USFWS



3/262024



KEY CONSIDERATIONS AND PROJECT GOALS

Need to maintain unnatural pool elevation upstream of the dam for recreation

01



03 Need to provide routes of passage for native migratory fish over a range of fish passage design flows







Bradford Dam NLF in Westerly, Rhode Island

- Purpose and Objectives
 - Removal of Dam and Old Denil Fish Ladder
 - NLF Construction for Native Migratory Fish Species
 - Low-flow Channel Construction and Slope Stabilization
- Key Features
 - Pool & Weir NLF
 - Dimensions:
 - Length = 210 FT
 - Overall Slope = 2.8%
 - Width = 160 FT
 - Multiple distinct routes of passage at varying elevations
 and hydraulic conditions
 - Adequate submergence depth at each weir notch and energy dissipation at the pools for the full range of fish passage design flows



FUSS & O'NEILL ENGINEERS • SCIENTISTS • PLANNERS







Need to provide routes of passage for native migratory fish over a range of fish passage design flows

THREE ROUTES OF PASSAGE AT VARYING INVERT ELEVATIONS





03

WATER MANAGEMENT PLAN



ROCKS WEIRS CONSTRUCTION

GRADE CONTROL WEIR										
STONE TYPE	STONE LENGTH (A)*	STONE WIDTH (B)	STONE HEIGHT (C)							
FOUNDATION STONE	3.0'-5.0'	2.5 '— 3.0'	2.5'-3.0'							
NOTCH STONE	3.0'-5.0'	2.5'-3.0'	3.0'-3.5'							
WEIR STONE	3.0'-5.0'	2.5'-3.0'	3.0'-3.5'							



ROCKS ABUTTING AGAINST EACH OTHER SHOULD HELP CREATE STRUCTURAL INTEGRITY BY TRANSFERING THE RIVER POWER TOWARDS THE STABLE BANKS



DOWNSTREAM SIDE OF WEIR WITH LARGE, WELL EMBEDED FOUNDATION STONES



EEN FOUNDATION STONES AND WEIR







BRADFORD NATURE-LIKE FISHWAY FINAL COST: \$1.8 MILLION

2018 & 2019 American Shad and Alewife Biological Performance Evaluation



Passage Performance of Alewife and American Shad in the Pawcatuck River, Rhode Island



Prepared by:

Alex Haro, Ph.D.

U.S. Geological Survey, Leetown Science Center S.O. Conte Anadromous Fish Research Laboratory Turners Falls, Massachusetts



Memorandum prepared for the U. S. Fish and Wildlife Service, Coastal and Partners Program, 50 Bend Road, Charlestown, Rhode Island

20 July 2020

2018 & 2019 American Shad and Alewife Biological Performance Evaluation

 Table 6: Number of radio tagged Alewife and American Shad passing and failing to pass a site, and resultant proportion and 95% confidence interval, for 2018 and 2019.

			Alewife						American Shad	
			2018 Releases			2019 Releases			2018 Releases	2019 Releases
		Pass/Fail	Route	Potter	Horseshoe	Route	Potter	Horseshoe	Potter	Potter
	Site	Proportion	78	Hill Dam	Falls Dam	78	Hill Dam	Falls Dam	Hill Dam	Hill Dam
		N Pass	5			6				
	White	N Fail	0			0				
	Rock	Proportion Passed (95% CI)	1.00			1.00				
		N Pass	0			0				
		N Fail	1			6				
	Potter Hill	Proportion Passed (95% CI)	0.00			0.00				
		N Pass		18			49		2	12
		N Fail		9			0		20	16
	Bradford	Proportion		0.667			1.00		0.091	0.429
		Passed (95% CI)		(0.529- 0.864)					(0.038- .309)	(0.301- 0.600)

Few American Shad ascended beyond the Bradford site; only one fish ascended as far as below the Lower Shannock site. Consistent congregations of American Shad below the Bradford site in deeper, slower moving reaches suggest that although they can pass Bradford, most American Shad do not do so. It may be possible that American Shad cease migrating below Bradford to spawn in the reach between Bradford and Potter Hill Dam. Analysis of stationary radio receiver data below Bradford indicated that many American Shad in these holding areas ascend to below the Bradford NLF passage structure at night, primarily in the early morning hours, which may be indicative of spawning activity in this location. Passage Performance of Alewife and American Shad in the Pawcatuck River, Rhode Island



Prepared by:

Alex Haro, Ph.D. U.S. Geological Survey, Leetown Science Center S.O. Conte Anadromous Fish Research Laboratory Turners Falls, Massachusetts







NLF Project Spotlight:

Santa Paula Fishway Santa Paula Creek, Santa Paula, CA Mike Garello, PE and Marcin Whitman, PE



3/262024

Santa Paula Fishway at the USACE Flood Control Inlet

Project Objectives and Key Features

- Purpose and Objectives
 - Provide fish passage for ESA Southern California Steelhead
 - Provide hardened, stable, and durable profile control at inlet to USACE Flood Control Channel Sedimentation Basin
 - Project was necessitated by previous channel straightening and headcutting

• Key Features

- Hardened technical fishway pool and chute
- 58 feet wide, 250 feet long, gradient of 7.5%
- Inset into 250-foot-wide grouted rip rap inlet apron
- Unit discharge of 160 cfs/ft (0.01 APE, peak discharge of 40,000 cfs) and 20 cfs/ft (0.05 PCE mean daily flow, 1,200 cfs)
9,270 feet

atenDente Creek

Fishway

Overview of Project Area





Pre-Project Conditions
2001

A DEEP HEADCUT FORMS AT THE FCC INLET AFTER CONSTRUCTION

Key Considerations, Challenges, and Risks

01 Inlet to Essential Flood Control Infrastructure

02 Steep Gradient 7 to 109 w/ Underlying Hardpan



Flashy Hydrologic and Fluvial Watershed

04

- Essential flood control facility
- Maintenance and sediment removals are already costly – fish passage costs not a part of the original plan

- Steep inlet gradient
- High levels of hydraulic force – velocity, shear, stream power
- Discontinuous channel substrate
- Transition from low gradient non-uniform channel to stabilized channel with uniform geometry

- Original funding cap at
 \$1M
- Short implementation
 timeline
- Lack of early engagement with CDFW and NMFS
- Lack of clarity regarding fish passage expectations

- Project did not take into consideration watershed level geomorphic context, geology, or existing river processes
- Flashy hydrologic response typical of Southern California watersheds

• Is this a suitable environment for an NLF?

Initial Solution

- Lack of adequate communication and consultation with CDFW, NOAA resulting in unclear fish passage expectations
- USACE originally designed a small technical fishway (10 cfs)
- After engagement with CDFW, NOAA, and constrained with \$1M construction cost cap, USACE designed and constructed a highly engineered technical fishway...

STONE INVERT, TYP

FOR TOP OF STON

FLEVATIONS.

- 17 Steel Reinforced Weirs
- o Weir Length 57.75 ft
- Weir Thickness 18-in
- Design Hydraulic Drop 1-ft
- o 1-D/S Bed Stabilizer

o Total Vertical Height 16-ft



USACE CONSTRUCTS A HEAVILY REINFORCED TECHNICAL FISHWAY

GRADIENT TRANSITIONS UPSTREAM AND DOWNSTREAM OF THE FCC INLET

S=3.00%

S=7.50%

S=1.78%

Made star Wate

BEDLOAD ACCUMULATION AT THE FISHWAY EXIT CREATES HYDRAULIC FLANKING

ann an-

JUST AFTER CLEANING, SMALL HYDROLOGIC EVENTS MOBILIZE MATERIAL WHICH ACCUMULATES IN POOLS

Early 2003

BEDLOAD ACCUMULATION AT THE FISHWAY EXIT CREATES HYDRAULIC FLANKING

A ATANK KANNER

(III)

Late 2003

BEDLOAD DEPOSITS REMOVED FROM LADDER POOLS

2004

Post-Project Conditions 2004

7.367.4.4

ADDITIONAL CHANNEL INCISION AT THE FISHWAY ENTRANCE. ADDRESSED WITH A CONCRETE BED STABILIZER. MAINTENANCE OF THE FISH LADDER PERSISTS.

THE EFFECTIVE 100-YEAR EVENT INFLICTS SIGNIFICANT DAMAGE TO THE FISH LADDER

THE EFFECTIVE 100-YEAR EVENT INFLICTS SIGNIFICANT DAMAGE TO THE FISH LADDER



2005

AFTER CLEAN-UP AND REPAIRS, THE FISH LADDER IS STILL FUNCTIONAL, BUT SEDIMENT MANAGEMENT ISSUES CONTINUE TO DEGRADE LADDER PERFORMANCE

2009 Feasibility Study

ALTERNATIVE FORMULATION AND EVALUATION. ROUND TWO...

A B 03 04

Like Modifications to the Existing Structure

Repair with like design features. Longer to address toe degradation.

Construct a Bypass Fishway along the FCC Inlet

Design and construct a fishway around the inlet apron.

Demo and Replace with a Multi-Slope Nature-Like Fishway

Two to Three 5% Gradient Slopes with transition structures

Demo and Replace with a Multi-Slope Nature-Like Fishway Single 3 to 4% Gradient

Selection Factors Based on:

- Perceived Effectiveness
- Operation and Maintenance Effort
- Flexibility of Design
- Nature Like Characteristics
- Durability
- Capital Cost



2009 Feasibility Study

- In 2010 Alternative A was developed to a 100% level of design
- Funding and schedule restraints further limited the ability to implement the Alternative with the resources available
- Environmental and co-sponsor concerns favored a more comprehensive approach
- No action has taken place to date...

Lessons Learned



- Geomorphic and hydrologic context plays a critical role in structure selection and design
- Engage stakeholders and agency representatives early
- Provide sufficient time and effort for engagement and communication
- Funding and schedule constraints introduce significant project risk – plan accordingly



NLF Project Spotlight:

Trabuco Creek at I-5 and Metrolink San Juan Capistrano, CA









Drop Structure at Metrolink Crossing CONTRACTOR OF

I-5 Complex

Trabuco Creek Historical Incision and Knickpoints

- Up to <u>20 feet</u> of vertical channel incision
- Drop thru I-5 Complex = <u>29 feet</u>
- Drop across Metrolink Crossing = <u>24 feet</u>
- Project Objective Passage for Adult and Juvenile Steelhead



Camino Capistrano/I-5 Complex (4 bridges/19 lanes)

Metrolink Bridge & Utility Crossing



I-5 Complex Selected Project

Key Fish Passage Components (Upstream to Downstream)

- 1. Transport Channel with Corner Baffles
 - 12 ft Wide x 3.5 ft Deep
 - 0.87% Slope Length = 670 ft
- 2. NLF in Concrete Bypass Channel
 - Flow Control: Orifice at Fishway Exit
 - Type: Chutes and Pools Roughened Channel
 - Length = 637 feet Width = 20 ft
 - Head Drop (Entrance-Exit) = 21 feet
 - Overall Slope = 3.3%
 - Boulder Chute Slope = 4.5%
 - Drop between Pools = 1.9 feet
 - Qhp Flow in NLF = 89 cfs (21%)
- 3. Fish Guidance Barrier at NLF Entrance
 - 10.5 ft tall with sloping apron



Fishway Entrance and Guidance Barrier

Fish guidance barrier Fishway



1:25 NHC Physical Model Photo 2. Flow patterns at the fish guidance barrier and fishway entrance at 425 cfs.

Chutes and Pools Roughened Channel



1:8 NHC Physical Model at 425 cfs





Baffled Transport Channel

Fishway Exit Pool Downstream of Orifice





Transition Pool and Orifice at Fishway Exit



1:8 NHC Physical Model Sedimentation Patterns

Baffled Transport Channel

Strongs Creek, Fortuna CA Looking Downstream

> Example of a Baffled Transport Channel



1:25 NHC Physical Model





CFD (3D) Modeling – Velocities in horizontal planes at various depths (206 cfs)





https://vimeo.com/797822371



I-5 fish passage 3D animation

Metrolink Crossing Downstream of I-5 Complex



Metrolink NLF Project

Key Fish Passage Components (Upstream to Downstream)

- 1. Drop Structure with Out-Migrant Channel~
 - Head Drop = 14 ft
 - Concentrates Flow for Downstream Passage
- 2. NLF Bypass Channel—
 - Fishway Exit Channel: 90° to Flow
 - Chutes and Pools Roughened Channel with Asymmetrical Cross Section
 - Head Drop (Entrance-Exit) = 26 feet
 - Length = 686 feet Width = 30 ft
 - Overall Slope = 3.8%
 - Boulder Chute Slope = 5.75%
 - Drop between Pools = 2.5 feet
 - Qhp Flow in NLF = 212 cfs (50%)
- 3. Fish Guidance Barrier at NLF Entrance
 - Low Flow Ramp & Stacked Boulder Weir





Perspective view of 3D rendering showing the proposed project and existing contours, looking upstream





nel/Poo

Chan

Metrolink fish passage 3D animation

Interstate 5 Bridge Array and Metrolink Railroad Bridge Fish Passage Barriers – Trabuco Creek, Orange County CA



Hydraulic Fishway Solutions Status: 90% Design

Project Team Engineering: NHC, Mike Love & Assoc., Gannett Fleming Permitting: Stillwater Sciences Project Lead: California Trout

Project partners/stakeholders include: California Department of Fish and Wildlife, National Marine Fisheries Service/NOAA, U.S. Fish & Wildlife Service, Orange County Public Works, Orange County Flood Control District, City of San Juan Capistrano, Acjachemen, California Department of Transportation, Southern California Regional Rail Authority, Moulton Niguel Water District, Highpointe Inc, and private landowners Funders: CA Dept of Fish and Wildlife, National Fish and Wildlife Foundation, Wildlife Conservation Board

Project Partners





Excellence Delivered As Promised

Stillwater Sciences

NLF Project Spotlight:

Shikellamy NLF Shamokin Dam, PA





By: Tyler Kreider



Shikellamy NLF

- Purpose and Objectives
 - Allow American Shad & River Herring passage at the dam
 - Provide passage when the dam was inflated
 - Maintain vehicle access to dam and emergency boat launch
- Key Features
 - NLF Type: Roughened Channel Bypass
 - Length: 700 feet Width: 120 feet Head: 8 feet
 - Overall slope: 1.3-1.5% Riffle Slope: 2.2-2.4%
 - Design NLF Flow: 950 cfs,
 - Operating range: 95%-5% exc. flow during fish passage season (~2,700-46,000 cfs river flow)







Key Challenge: Right-sizing design criteria


Challenges & Solutions

- Wetlands \rightarrow kept NLF up near dam
- Attraction ("detraction") flow → keep NLF entrance as close to dam as feasible
- Access road \rightarrow ACB road in floodplain



Photos courtesy of KC Construction





Lessons Learned: - Tie-ins are critical - Failure at the weakest member = soil - Reminder that flood flow vectors don't match "typical" flow vectors



Key Challenge: Watering up & Maintenance



Shikellamy NLF – Questions?



NLF Project Spotlight:

James Creek Mendocino County, CA Mike Garello, PE



3/26/2024

James Creek

Project Objectives and Key Features

- Purpose and Objectives
 - Mitigate channel incision associated with encroachment of state highway road embankment spoils
 - Provide Passage to Chinook Salmon, Coho Salmon, and steelhead trout
 - Restore access to more than 3 miles of upstream habitat
- Key Features
 - Channel spanning, step pool roughened channel
 - 250 feet long, varies 25 to 50 feet wide, gradient of 6.5 %
 - 0.1 APE (100-year peak discharge) = 2,160 cfs
 - 0.5 APE (2-year peak discharge) = 630 cfs

Pre-Project Conditions
2011

Pre-Project Conditions
2011

Key Considerations, Challenges, and Risks





Proposed Design Plan and Profile

age 6

Delayed Construction

- Additional funding made available through CDFW Fisheries Restoration Grant Program (FRGP)
- Pacific Watershed Associates were hired to construct the project in 2016
- Proposed construction over two seasons as a potential cost saving strategy

Benefits

- Reduce construction costs,
- Allow adaptive management during construction,
- Limit the amount of imported alluvium required to construct the project
- Reduce imported gravel costs by up to 50%.
- Reduce transportation-related impacts.
- Reduce risk of introducing non-native species.
- Allow design to "settle in" and adapt design in Phase II if shortcomings are observed.
- Sequester up to 1,000 CY of excess channel-stored sediment.

Risks

- No bedload mobilizing event during winter reduces cost benefits.
- Slight increase in construction equipment/labor costs.
- Potentially restrict access by steelhead for one winter.
- Two episodes of disturbance vs. one.



Two-Phase Construction Strategy: Phase 1 Construction







Two-Phase Construction Strategy: After Phase 1

Post-Project Conditions 2018









- Construction methodology is critical and there are more ways than one to successfully construct a project
- Use of qualified contractors experienced in similar in-water work provides value and is an asset throughout construction
- Address potential dewatering challenges in the design process



 Interstitial gaps between placed rock can be addressed by hydraulicly placed sediment and streambed fill