Potter Valley Project Ad Hoc Committee

Fish Passage Profiles Evaluation Report

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Developed by the Fish Passage Working Group

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The **scenarios subgroup** developed the conceptual passage scenarios and options.

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Facilitators Gina Bartlett and Stephanie Hori of Consensus Building Institute assisted the subgroups to document the process and compile results into this final report.

Executive Summary

Background and Purpose

The Potter Valley Project on the Eel River is a set of hydroelectric facilities that includes two large dams (Scott and Cape Horn), water-diversion facilities, and a powerhouse. The project involves an inter-basin transfer that stores winter runoff from the upper Eel River and diverts much of that water to the Russian River to generate hydroelectric power and meet contract water demands. Scott Dam, which creates Lake Pillsbury, is a complete barrier to native fish species, preventing access to high value habitat for federally Endangered Species Act (ESA)-listed anadromous salmonids.

To balance diverse Potter Valley Project interests, Congressman Jared Huffman established an Ad Hoc Committee comprised of representative stakeholder groups across four counties, who have agreed to work collaboratively towards a *two-basin solution*. The primary tenet of the two-basin solution is achieving co-equal goals for a future Potter Valley Project, as stated:

1. Improve fish passage and habitat on the Eel River sufficient to support recovery of naturally reproducing, self-sustaining and harvestable native anadromous fish populations including migratory access upstream and downstream at current project dam locations.

2. Minimize or avoid adverse impacts to water supply reliability, fisheries, water quality, and recreation in the Russian River and Eel River basins.

To address the co-equal goal of fish passage, the Ad Hoc Committee formed a Fish Passage Working Group to identify a prioritized list of conceptual-level fish passage scenarios that would facilitate the ability of migratory fish to reach critical habitats beyond the Potter Valley Project (*i.e.*, above Scott Dam) and promote the recovery and long-term viability of currently depressed populations in the Eel River. To achieve this, the Fish Passage Working Group has strived to identify fish passage alternatives that meet the following three objectives:

Focal Fish Species

- Steelhead Trout (*Oncorhynchus mykiss*)
- Chinook Salmon (*Oncorhynchus tshawytscha*)
- Pacific Lamprey (*Entosphenus tridentatus*)
- Sacramento Sucker (*Catostomus occidentalis*)

The analysis focused on specific life history stages that would be most influenced by fish passage modifications.

1. Population viability of Upper Eel River anadromous fishes;
2. Access to abundant high quality habitat; and
3. Functional fish passage.

The Fish Passage Working Group is primarily composed of fish passage engineers, hydrologists, and fish biologists with extensive knowledge of Eel River natural resources and current Potter Valley Project operations.

Evaluation Approach

To identify and evaluate potential fish passage alternatives for the Potter Valley Project, the Fish Passage Working Group initially conducted an academic review of existing large scale fish passage facilities and fish passage technologies that are potentially applicable to the Scott and Cape Horn dams. After considering a wide range of options, the working group narrowed the scope to four primary fish passage scenarios that had the highest probability of success given the specific hydrologic setting, geologic and infrastructure constraints, and target species life-history considerations.

Due to the extensive challenges with achieving habitat access beyond the Potter Valley Project, the working group focused on the complete barrier and larger of the two project dams, Scott Dam (134-foot-high, 805-foot-long). Cape Horn Dam (63-foot-high barrier; 96-foot-high total; 515-foot-long) is located approximately 13 miles downstream of Scott Dam and currently has a pool-and-weir and orifice fishway. For this analysis, the working group assumed that the Cape Horn Dam fishway is functioning at current regulatory standards (California Department of Fish and Wildlife [CDFW] and National Marine Fisheries Service [NMFS]), effectively passing fish upstream and downstream.[1] US Fish and Wildlife Service (USFWS) and CDFW are currently conducting preliminary fish passage investigations to gain a better understanding of how fish are currently using the Cape Horn Dam fishway; however, a formal fish passage compliance evaluation will need to occur in the near future.

Fish Passage Scenarios and Options

The fish passage scenarios evaluated in this analysis include: (1) technical fishway; (2) trap and haul; (3) lowering and/or partial removal of Scott Dam; and (4) complete dam removal of Scott Dam with or without removal of Cape Horn Dam.

Scenarios (1) and (2) included minimal modification to existing water supply infrastructure and recreational facilities at Lake Pillsbury reservoir. Scenarios (3) and (4) included lowering (partial removal) or removing dams, which would require substantial changes in the approach to water diversions and associated operations to achieve the co-equal goals of the two-basin solution. Within each fish passage scenario, the working group developed two-to-three options to explore optimal configurations of each fish passage concept.

Scenarios Overview

- **Scenario 1 | Fishway at Scott Dam**
- **Scenario 2 | Trap and Haul**
- **Scenario 3 | Partial Scott Dam Removal**
- **Scenario 4 | Remove Scott Dam & Modify or Remove Cape Horn Dam**

The Fish Passage Working Group formed two multi-disciplinary technical subgroups representing tribal, federal, state, county, and private entities to refine the details of each scenario's options to subsequently evaluate and score. Each of these scenario options were scored utilizing a standardized scoring matrix that evaluated biological and non-biological parameters. Fish passage scenario options were evaluated

[1] The results of this analysis are contingent on the assumption the fishway meets CDFW and NMFS standards; however, the efficacy of the Cape Horn Dam fishway is unknown. USFWS and CDFW are currently investigating due to observed operational constraints from flooding and sediment deposition, predation, and fish behavior issues.

independently on the passage concept's unique merit and not against each other during the scoring process. Hence, scores reflect the potential of a passage concept to achieve anticipated performance standards independent of a scorer's passage concept preference.

All parameters were scored on a scale of low performance (1) to high performance (10). Scoring was considered through a lens of four native fish species that are of management significance and directly influenced by the project.

Scoring Results and Key Takeaways

Average Biological Feasibility for Fish Passage Scores

The average scores for biological feasibility of upstream and downstream fish passage scenario and options, are presented in Figures 1 and 2. Each marker indicates the average score for a scenario option within each scenario group (*i.e.*, fishway, trap and haul, partial removal, and dam removal) from the multi-disciplinary scoring subgroup.

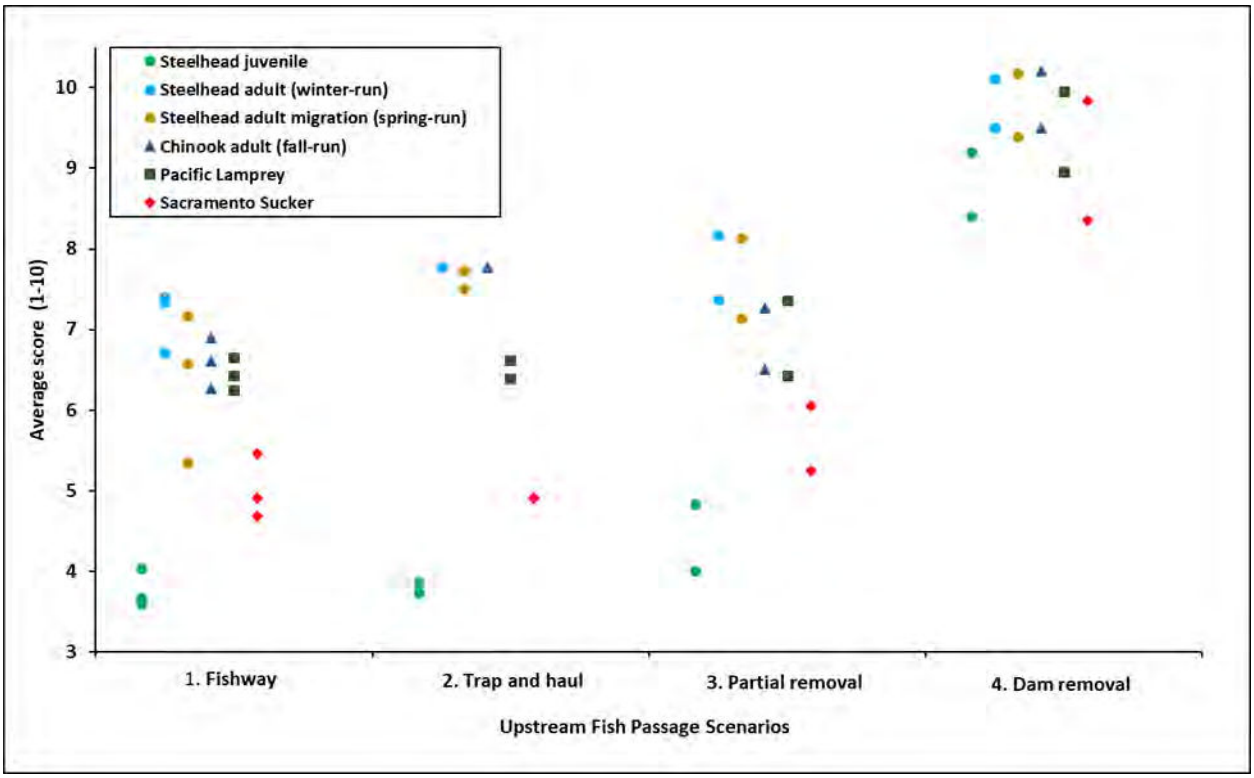

Figure 1. *Biological feasibility for upstream fish passage is the ability for targeted species and associated life stages to successfully find the fishway and migrate to spawning/rearing tributaries above Scott Dam (upper Eel River, Rice Fork, and Salmon Creek, etc.). Allows for the potential benefit to the species by reestablishing occupancy of habitats, thereby promoting ecological and evolutionary processes responsible for local adaptation and diverse life histories.*

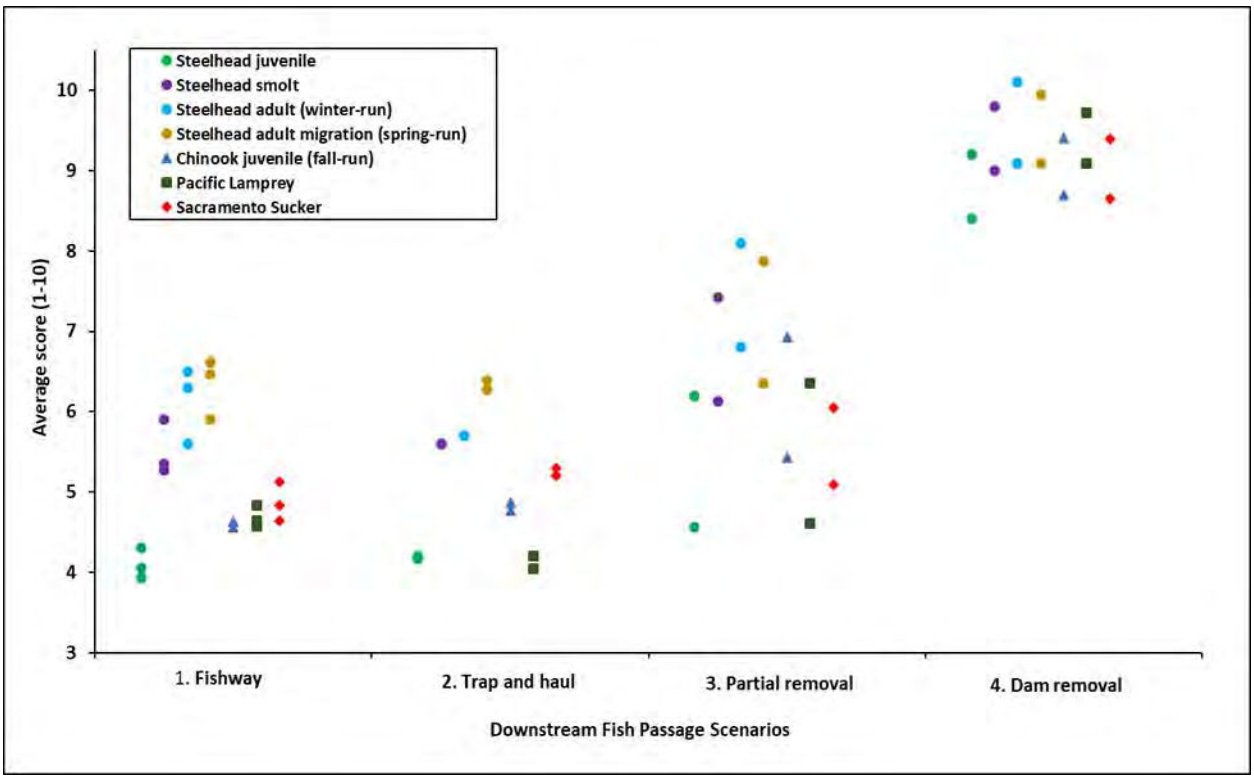

Figure 2. *Biological feasibility for downstream fish passage is ability for targeted species and associated life stages to successfully migrate from spawning/rearing tributaries above Scott Dam (upper Eel River, Rice Fork, and Salmon Creek, etc.) to the lower Eel River and ocean. Allows for the potential benefit to the species by reestablishing occupancy of habitats, thereby promoting ecological and evolutionary processes responsible for local adaptation and diverse life histories.*

Other scoring information collected includes the range of each scored passage option (*i.e.*, level of uncertainty or divergent scores) and the associated biological and non-biological parameters scored (*e.g.*, passage operations, engineering feasibility, and cost considerations, *etc.*). Refer to the main report for this information.

Key Takeaways

Dam removal options were rated to have the highest potential for successful fish passage while achieving maximum biological benefit, as reflected in the scored biological viability parameter (Figure 3). This result was shared by nearly all parameters, species, and life stages. However, dam removals also presented significant uncertainty with water supply and reliability for Lake Mendocino in the Russian River. Therefore, it is uncertain whether Scenario 4 could achieve a two-basin solution and is beyond the scope of this fish-passage analysis. A separate water balance effort is underway to look at alternative water diversion operations to the Russian River under each of these scenarios.

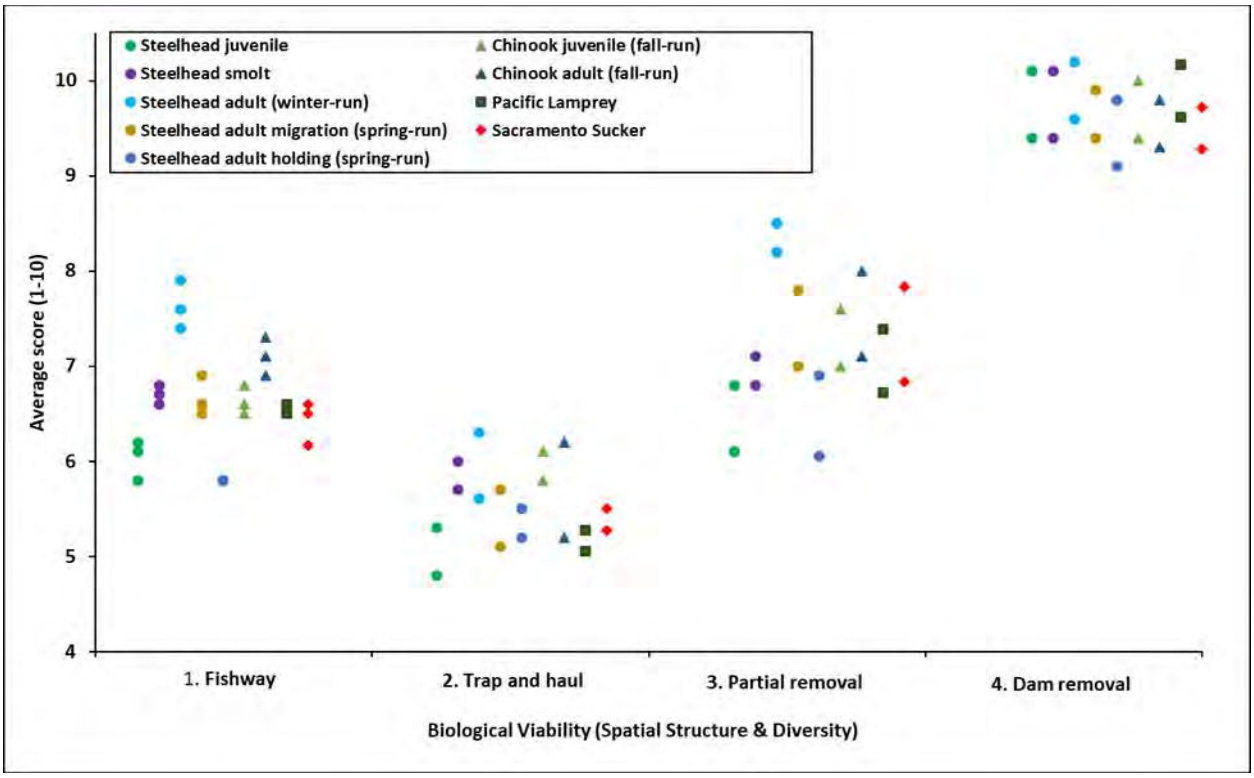

***Figure 3**. Biological viability (spatial structure and diversity) refers to the natural behavior and life history expression of a focal species life stage relevant habitat access and a fish passage option. The passage option allows adult fish to make choices related to spawning location and timing (e.g., site fidelity, mainstem or tributary, no delays). The passage option allows juvenile fish to imprint on natal streams and express diverse rearing and migration strategies. The extent of which the fish passage option includes selective pressures (e.g., degree of human intervention, unnatural environmental constraints, etc.) that could limit life history adaptation and phenotype or genotype expression.*

Excluding dam removals, all other scenarios were found to have substantial uncertainties that would have to be overcome to support recovery of native anadromous fish. Generally, the sediment basin partial dam removal option (50') was scored as having a higher probability of meeting biological goals when compared to all other scenario options. These scores were driven by a range of parameters; however, the biological feasibility for downstream passage and biological viability (spatial structure and diversity) were a primary concern for scenarios other than dam removal (Figures 1 and 3). More specifically, concerns included the ability of fish to successfully navigate through Lake Pillsbury reservoir due to muted flow and/or other environmental cues, the ability to find the targeted downstream migration route, and the high probability of predation on focal juvenile fish species by non-native fish that occupy Lake Pillsbury and Van Arsdale reservoirs.

The Fish Passage Working Group identified several next steps for the Potter Valley Project to seek a two-basin solution. The coupling of potentially high performing fish passage options with water supply operations and further analyses of identified non-biological factors that require in-depth investigations to be properly incorporated into this fish passage evaluation process.

Scenarios and Options Overview

Scenario 1 | Fishway at Scott Dam
Construction of a fishway for volitional upstream and downstream passage at Scott Dam. Three different options of a fishway were explored, including a semi-natural channel (**Option 1.1**), a conventional fishway design proposed by Mead & Hunt 2018 (**Option 1.2a**), and a conventional fishway based on the Mead & Hunt design but modified to facilitate passage at a wider range of reservoir elevations (**Option 1.2b**). The three options were generally similar in nature but varied in location, construction materials, and several specific design features. All options facilitated volitional passage (no trapping or handling) and would require little if any change to current reservoir operations.

Scenario 2 | Trap and Haul
Explored trap-and-haul approaches that would require active management of collecting, loading, and transporting fish upstream and downstream above/below dam infrastructure. Two general options were assessed under this scenario: collecting upstream migrating fish at Cape Horn Dam (**Option 2.1**) or at Scott Dam (**Option 2.2**). In either option, facilities would be developed to collect fish migrating upstream, loaded and transported upstream, and placed at the top of Scott Dam or transferred into a barge for release in the reservoir. A floating downstream migrant trap and extensive guide nets would facilitate downstream passage.

Scenario 3 | Partial Scott Dam Removal
Investigated the concept of lowering Scott Dam to improve the probability of successful fish passage while maintaining some level of reservoir function. Two options were considered under this scenario: lowering Scott Dam to 80 ft to maintain water storage sufficient to meet minimum Potter Valley Irrigation District water demand (**Option 3.1**) or lowering Scott Dam to 50 ft sufficient to contain potentially contaminated sediments (**Option 3.2**). Both options would require a truncated fishway described in Scenario 1.

Scenario 4 | Remove Scott Dam & Modify or Remove Cape Horn Dam
Complete removal of Scott Dam and either modification (**Option 4.1**) or removal of Cape Horn Dam (**Option 4.2**). Under this scenario no fish passage facilities would be needed at Scott Dam, providing unrestricted fish passage. Fish passage would be further unrestricted with Cape Horn Dam Removal (Option 4.2). Substantial modifications to approaches in water management would be required to meet the needs of water users in the Russian River to compensate for lost Lake Pillsbury water storage.

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Reference Appendices via Links
A. Fish Passage Working Group Objectives
B. Scenario Assumptions and Options Table
C. Scenario Filtering Tool
D. Fish Passage Presentation to Ad Hoc (10/2/19)
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F. 2002 Biological Opinion (BiOp) issued by the National Marine Fisheries Service (NMFS)
G. McMillen Jacobs Associates Modifications Feasibility Report
H. Mead & Hunt Study

Document Purpose and Outcomes

The purpose of this document is to capture the work of the Potter Valley Project Ad Hoc Committee's Fish Passage Working Group to evaluate potential future fish passage options for the Potter Valley Hydroelectric Project (FERC Project No. 77-285). The goal is to provide fish passage information and potentially recommendations to Congressman Jared Huffman's Ad Hoc Committee to inform discussions seeking a two-basin solution for the Eel River and Russian River watersheds.

The Ad Hoc Committee charged the Fish Passage Working Group with identifying a prioritized list of conceptual-level passage options that would meet three fish passage objectives for targeted species (e.g., Chinook salmon, steelhead trout, and Pacific lamprey) beyond Cape Horn Dam and Scott Dam, located within the upper mainstem Eel River, California. If these fish passage objectives are achieved, recommended fish passage options will promote the recovery and long-term viability of currently depressed fish populations in the Eel River. Passage options were intended to meet the following objectives for each targeted species:

- Population viability of upper Eel River anadromous fish
- Access to abundant high quality habitat
- Functional fish passage

(Refer to the Fish Passage Working Group Objectives *for more information on the intent and criteria for fish passage options)*

This document consists of three major sections:

1) General **overview** of the fish passage scenarios and options, including key takeaways and a description of the evaluation process;
2) Information on how to **interpret the fish passage scores**; and
3) Detailed **validation report** resulting from the working group's evaluation process.

Section 1 | Fish Passage Overview

Evaluation Approach

Fish Species of Interest

Targeted Species
The Fish Passage Working Group evaluated impacts of passage options on four native species (three anadromous and one other native fish species, which served as a proxy for other native fish species):

Common Name	Scientific Name
Steelhead Trout	*Oncorhynchus mykiss*
Chinook Salmon	*Oncorhynchus tshawytscha*
Pacific Lamprey	*Entosphenus tridentatus*
Sacramento Sucker[2]	*Catostomus occidentalis*

Non-Native Species
The working group also considered impacts on non-native species that have negatively impacted native fish species:

Common Name	Scientific Name
Largemouth Bass	*Micropterus salmoides*
Sacramento Pikeminnow	*Ptychocheilus grandis*

Scenarios

The Fish Passage Working Group identified four "scenarios" for evaluation: a conventional fishway (i.e., fish ladder or channel), trap and haul, lowering Scott Dam, and removing Scott Dam and/or removing/modifying Cape Horn Dam. Each passage scenario has multiple options incorporating various fish passage technologies to enhance the feasibility of the particular passage concept. Each conceptual fish passage option was developed and evaluated by technical teams of experts (see below). All passage scenarios and options assume that Cape Horn Dam/Van Arsdale Fish Station meets current NMFS/CDFW fish passage standards. It is likely that the existing Cape Horn Dam infrastructure will require significant modifications to meet these current fish passage standards.

[2] *Sacramento sucker served as proxy for other native fish species of concern.*

In October 2018, the Fish Passage Working Group formed two technical subgroups to define and qualitatively evaluate the passage options:

1) A **scenarios** subgroup that developed the conceptual passage scenarios and options and
2) A **scoring** subgroup that developed and used a passage scoring matrix to evaluate the passage options.

Subgroups consisted of fish passage engineers, hydrologists, and fishery biologists. The subgroups relied on participants' expertise to refine the passage scenarios with detailed assumptions for each option. The scoring subgroup focused on evaluating the biological and habitat implications of the different passage options (i.e., biological feasibility for upstream and downstream passage, habitat and water quality, hydrologic implications, and biological viability). The group also considered operational feasibility of each option (e.g., engineering, operations, maintenance, and cost); however, members acknowledged that more expertise and information would be needed to better evaluate some of these non-biological categories, but saw value in identifying potential pros and cons for further investigation. Additionally, members acknowledged that focused studies and more information are needed to better evaluate some of the biological and habitat categories, such as downstream passage through the reservoir under most passage concepts outside dam removal.

The scoring subgroup participants scored passage options independently and collectively as a group. The scoring subgroup reviewed and discussed trends in the scores, striving to ensure all scorers had the same level of understanding for each passage option and applied technologies. However, given that the conceptual nature of the scenarios possessed a low level of development for many of the options, members acknowledge that a full common understanding is not achievable until certain options are more fully developed with key assumptions better outlined. Areas of agreement and disagreement among participants during the scoring process were also documented, and divergent opinions can indicate different levels of understanding or key uncertainties during this overall project scenario evaluation process.

This fish passage evaluation process strived to focus on conceptual fish passage alternatives that potentially could support the objectives set by Congressman Huffman's Ad Hoc Committee focusing on a two-basin solution. Additional analyses were conducted by a Water Supply Working Group that provides greater detail regarding water supply implications associated with each passage scenario (Link to full report).

When beginning this process, the Fish Passage Working Group reviewed a breadth of fish passage technologies and agreed to advance and further evaluate these four "scenarios" as those seemed to merit further evaluation.

Fish Passage Scenarios and Options Summary Table

This table provides a summary of the various options for each fish passage scenario that the working group developed and evaluated.

Scenarios	1 Fishway at Existing Scott Dam	2 Trap & Haul	3 Partial Scott Dam Removal	4 Remove Scott Dam and Modify Cape Horn Dam
Options	**1.1 Semi-Natural, Low-Gradient Bypass Channel** **1.2 Conventional Fishway** 1.2a Mead & Hunt Study 1.2b Modified Mead & Hunt	**2.1 Trap & Haul, Van Arsdale to Scott Dam** **2.2 Trap & Haul, at Scott Dam**	**3.1 Lower Scott Dam to 80' ~** Meets current PVID water demand and NMFS 2002 BiOp RPA environmental flows **3.2 Lower Scott Dam to 50' ~** Retain and manage accumulated sediment, no water storage within Lake Pillsbury	**4.1 Remove Scott Dam and Modify Cape Horn Dam** Diversion to East Branch Russian River with modified Cape Horn Dam infrastructure **4.2 Remove both Scott Dam and Cape Horn Dam** With alternative diversion infrastructure

Fish Passage Preliminary Takeaways

[Link to presentation at 10.02.19 Ad Hoc Committee meeting]

- Removal of both Scott and Cape Horn Dams greatly benefits all species and life stages evaluated. However, dam removal without alternative diversion infrastructure or other water supply options challenges a two-basin solution. Loss of Scott Dam would also eliminate the ability to store water for controlled releases into the Eel River.
- Various upstream passage options are available for adult salmonids and lamprey with varying degree of meeting long-term biological viability, but success is likely achievable.
- Fish Passage Working Group members had different perspectives on the value of Scott Dam releases during the dry season and associated water quality conditions downstream (i.e., temperature).
- Significant challenges exist for downstream passage of both salmonids and other species of interest (e.g., lamprey), and will likely be the most limiting factor when considering fish passage options that retain Scott Dam.
- Significant concerns exist with navigation, predation, and water quality within Lake Pillsbury relevant to fish passage, environmental cues, and habitat conditions for focal fish species.
- Engineering a successful fish passage facility on aging infrastructure will potentially be challenging and require special consideration.
- All passage scenarios and subsequent options assume that Cape Horn Dam/ Van Arsdale Fish Station will meet current NMFS/CDFW fish passage standards. Existing Cape Horn Dam infrastructure will need to be properly evaluated during future fish passage investigations, but as stated above it is likely that the existing Cape Horn Dam will require significant modifications to meet these current fish passage standards.

Looking Forward

- The work of both the Fish Passage and Water Supply Working Groups should be integrated to help the Ad Hoc consider feasible options for a two-basin solution.
- While the Fish Passage Working Group identified several upstream passage options, downstream passage options, for both juveniles and adults, are concerning and need further development and investigation.
- More expertise and information are needed to properly evaluate non-biological factors (e.g., operations and maintenance costs and engineering feasibility), especially for integration with aging infrastructure and water supply operations.
- Proper evaluation of alternative flow schedules associated with each fish passage options will need to occur for biological viability and operational fish passage purposes.
- Adequacy of existing Cape Horn Dam fish passage infrastructure is concerning and will need to undergo proper evaluation to ensure compliance with current fish passage standards (CDFW and NMFS). The fish ladder will require major remodeling if not complete replacement.
- Non-passage factors (e.g., recreation and tourism impacts) associated with each passage option need further investigation.

General Suggested Studies

- Further investigate potential flow prescriptions associated with desired water quality and habitat conditions downstream of Scott Dam. Hence, maintaining

cooler water temperatures during the summer juvenile steelhead rearing season and proper flow and environmental cues for other targeted life stages (e.g., migration, etc.) and species.

- Conduct life-cycle modeling to estimate fish production capacity associated with each fish passage option.
- Develop effective predatory fish suppression techniques within and downstream of Lake Pillsbury as part of a fish passage management and operations plan.
- Better understand fish behavior/response to reservoir habitat conditions (particularly for the juvenile out-migrants and steelhead kelts) to identify which passage options and mechanisms may or may not work for safe passage through Lake Pillsbury and downstream of Scott Dam.

Section 2 | Interpreting the Evaluation Scores

Scoring Introduction

The scoring subgroup members developed detailed descriptions of the fish passage categories and variables to consider, as well as what the numerical scores signified. This helped to ensure all evaluators had the same understanding of the fish passage options and used the same approach for scoring. This section describes the fish passage biological and non-biological categories that the evaluators scored, a simplified scoring key for reference, and how to interpret the scores' color coding.

Example Score Results Excerpt:

Low Gradient Bypass Habitat and Biological Feasibility Categories	Juvenile Steelhead		Smolt Steelhead	
	Average	Range	Average	Range
Biological Feasibility for Upstream Passage	**4**	**5**	**NA**	**NA**
Reservoir navigability	3	1	NA	NA
Passage efficiency (fishway, etc.)	5	5	NA	NA
Predation	2	1	NA	NA
Biological Feasibility for Downstream Passage	**3**	**3**	**5**	**4**
Reservoir navigability	4	3	6	5
Passage efficiency (fishway, etc.)	5	2	6	3
Predation	2	1	4	3
Habitat and Water Quality	**6**	**2**	**7**	**3**
Habitat upstream of Scott Dam	7	5	7	5
Water quality within reservoir	5	4	8	3
Habitat downstream of Scott Dam	7	3	7	2
Water quality below reservoir	5	4	7	4
Hydrologic Implications	**5**	**5**	**6**	**6**
Biological Viability (Spatial Structure & Diversity)	**5**	**6**	**6**	**7**

Category Definitions

Below describes the categories and associated variables that the scoring subgroup considered during the scoring process:

Scoring Section I - Habitat and Biological Feasibility Categories	
Biological Feasibility for Upstream Passage	**Ability for targeted species and associated life stages to successfully find the fishway and migrate to spawning/rearing tributaries above Scott Dam (upper Eel River, Rice Fork, and Salmon Creek, etc.). Allows for the potential benefit to the species by reestablishing occupancy of habitats, thereby promoting ecological and evolutionary processes responsible for local adaptation and diverse life histories.**
Reservoir navigability	Ability of fish to find tributaries above Scott Dam (upper Eel River, Rice Fork, Salmon Creek, etc.) from the top of the fishway (reservoir-side) through the reservoir. Potential risk of migration delay into tributaries due to changing reservoir dynamics, elevations, and confluence/delta/sedimentation dynamics, etc. Are tributary delta areas assumed to be impeding passage under the prescribed passage alternative?
Passage efficiency (fishway, etc.)	Specific to each volitional or non-volitional passage alternative required to ascend Scott Dam. Likelihood of achieving desired attraction flows while neutralizing risks of migration delay, fallback potential, confusion or lost migratory cues, etc. Consider all infrastructure, hydraulic, and hydrologic constraints. Successful and efficient fish passage must be safe, timely, and effective. Risk of physical injury, stress to the fish, and passage delay must be minimal, and the system must be able to pass sufficient numbers of individuals (targeted life stages) upstream to support a viable population.
Predation	Potential risk of being consumed by bass, pikeminnow, otters, eagles, or other predators associated with ascending the fishway and through the reservoir.
Biological Feasibility for Downstream Passage	**Ability for targeted species and associated life stages to successfully migrate from spawning/rearing tributaries above Scott Dam (upper Eel River, Rice Fork, and Salmon Creek, etc.) to the lower Eel River and ocean. Allows for the potential benefit to the species by reestablishing occupancy of habitats, thereby promoting ecological and evolutionary processes responsible for local adaptation and diverse life histories.**
Reservoir navigability	Ability of fish to find top of fishway (reservoir-side) as they descend from tributaries above Scott Dam/Lake Pillsbury (upper Eel River, Rice Fork, Salmon Creek, etc.) through the reservoir. Potential risk of migration delay descending from tributaries due to changing reservoir dynamics, elevations, and confluence/delta/sedimentation dynamics. Are tributary delta areas assumed to be impeding passage under the prescribed passage alternative?

Passage efficiency (fishway, etc.)	Specific to each volitional or non-volitional passage alternative required to descend Scott Dam. Likelihood of achieving desired attraction flows while neutralizing risks of migration delay, confusion or lost migratory cues, etc. Consider all infrastructure, hydraulic, and hydrologic constraints. Successful and efficient fish passage must be safe, timely, and effective. Risk of physical injury, stress to the fish, and passage delay must be minimal, and the system must be able to pass sufficient numbers of individuals (targeted life stages) downstream to support a viable population.
Predation	Potential risk of being consumed by bass, pikeminnow, otters, eagles or other predators associated with descending the fishway and through the reservoir.
Habitat and Water Quality	**Quality and quantity of fish habitat and associated water quality conditions**
Habitat upstream of Scott Dam	Potential habitat capacity above Scott Dam (not including water quality, see below). Consider inundated habitat (spawning and rearing) due to reservoir (roughly 6 mi due to Pillsbury and 0.7 mi due to Van Arsdale); migratory habitat (staging/holding).
Water quality within reservoir	Anticipated water quality conditions (temperature, dissolved oxygen, etc.) during the expected presence of the scored life stage. Consider impacts/benefits of reservoir storage conditions and associated flow release schedule on downstream water quality in the Eel River (e.g., cold water pool management, algal dynamics, etc.).
Habitat downstream of Scott Dam	Potential habitat capacity due to passage facility footprint and associated operations. Consider degradation of spawning and rearing habitat due to interruption of sediment and large wood transport.
Water quality below reservoir	Anticipated water quality conditions (temperature, dissolved oxygen, etc.) during the expected presence of the scored life stage. Consider impacts/benefits of reservoir storage conditions and associated flow release schedule on downstream water quality in the Eel River (e.g., cold water pool management, algal dynamics, etc.).
Hydrologic Implications	**Hydrograph implications as it relates to the targeted species and associated life stage. Consider functionality over a range of flows, environmental cues, migration windows (passage opportunity), water quality considerations, etc.**
Biological Viability (Spatial structure & Diversity)	**Natural behavior and life history expression. The passage option allows adult fish to make choices related to spawning location and timing (e.g., site fidelity, mainstem or tributary, no delays). The passage option allows juvenile fish to imprint on natal streams and express diverse rearing and migration strategies. The extent of which the fish passage option includes selective pressures (e.g., degree of human intervention, unnatural environmental constraints, etc.) that could limit life history adaptation and phenotype or genotype expression.**

Scoring Section II - Non-Biological Categories	
Engineering and Geotechnical Feasibility	Likelihood that a passage alternative can be incorporated/modified into existing infrastructure; structural integrity; bank sloughing; dam safety, etc. Long-term stability.
Water Delivery or Storage Potential	Ability of the passage alternative to allow for diversions to the East Branch Russian River and/or storage.
Fish Monitoring and Exclusion Capacity	Ability of the passage alternative to monitor fish; sort and tag fish; exclude exotics, etc.
Passage Operations	Likelihood of successful operations as it relates to the level of complexity for the passage alternative to function properly under a range of reservoir operations and the degree of human intervention needed. Consider flow/wood/sediment conditions, water operations, maintenance, management, and reliability, etc.
Cost: Construction	Relative cost of similar type passage projects. See Mead & Hunt (2018) and Mc Millen Jacobs Associates (2018).
Cost: Operations & Maintenance	Annual operational and maintenance costs, potential failure modes, intensity or operations and maintenance. See Mead & Hunt (2018) and Mc Millen Jacobs Associates (2018).
Timeframe to Achieve Resource Benefits (Fisheries)	Implementation feasibility, short vs. long term, timeframe for construction. Score 1-3 (>25 years); Score 4 - 7 (10-25 years); Score 7-10 (<10 years).
Risks & Uncertainties	Ability to fit into an adaptive management scheme (modify/improve).

Fish Passage Scenario Scoring Key	Score Range 1 5 10	
Biological Feasibility for Upstream Passage		
Reservoir navigability	Difficulty finding tributary	Success finding tributary
Passage efficiency (fishway, etc.)	Migration delay/low success	No delay/high success
Predation	Likely to be consumed	Successfully avoids predators
Biological Feasibility for Downstream Passage		
Reservoir navigability	Difficulty finding way out of lake	Successfully finds route through lake
Passage efficiency (fishway, etc.)	Delay/Low success past dam crest	No delay/high success past dam crest
Predation	Likely to be consumed	Successfully avoids predators
Habitat and Water Quality		
Habitat upstream of Scott Dam	Poor spawning/rearing habitat	Good spawning/rearing habitat
Water quality within reservoir	Warm temp/low dissolved O_2	Cool temp/high dissolved O_2
Habitat downstream of Scott Dam	Poor spawning/rearing/holding habitat	Good spawning/rearing/holding habitat
Water quality below reservoir	Warm temp/low dissolved O_2	Cool temp/high dissolved O_2
Hydrologic Implications	**Unnatural flow timing and duration**	**Natural flow timing and duration**
Biological Viability (Spatial Structure & Diversity)	**Limited natural seasonal movement and life history expression (due to human intervention)**	**Natural seasonal movement and life history expression (no human intervention)**

Scoring Key – General Scoring Guidance

Color Coding

Results from each scoring table present both the **average** and the **range** of evaluators' scores.

Average Scores

- **Darker green scores** indicate that the evaluators had higher confidence in that particular category's feasibility.
- **Darker red scores** indicate evaluators had substantial feasibility concerns.

Range of Scores

- **Darker green scores** indicate evaluators' scores were in greater alignment.
- **Darker red scores** indicate evaluators had divergent viewpoints.

Section 3 | Fish Passage Validation Report

Scenario 1: Fishway Options at Existing Scott Dam

The Fish Passage Working Group considered two types of fishway options: a semi-natural bypass channel (Option 1.1) and variations of a conventional fishway design (Options 1.2a and 1.2b).

All three options shared these characteristics:

- Volitional passage (no trapping or handling).
- No management actions in the reservoir except for guide nets for juveniles (guide nets can be used for post-spawn adult steelhead (kelts) and potentially other species, if needed).
- No presumed modifications to Cape Horn Dam infrastructure; operations assumed to meet current CDFW and NMFS fish passage design criteria.

Option 1.1 Semi-natural, Low-Gradient **Bypass-Fishway Channel**

Brief Description

A bypass channel provides fish passage via a long, low gradient constructed bypass channel on the north side of the Eel River. The bypass channel goes from the Eel River upstream of the Soda Creek confluence to the top of the Scott Dam. In addition, a weir structure would be required in the Eel River at the downstream end of the bypass channel to guide fish into the bypass channel entrance for upstream passage. For downstream passage a modified, top-down operation dam gate that releases flow into a ramp and bypass pipeline would be constructed. Here is the link to a presentation overview of a natural bypass channel option.

Features

The option considered for this effort has the following features:

- Long, low gradient engineered channel using natural materials as much as possible for upstream passage on the north side of the Eel River to the top of the dam.
- Exclusion / guide weir in the river to guide upstream passage into the bypass channel entrance (with attraction flows).
- False weir for the upstream passage exit into the reservoir (water flowing over the false weir at the top of the bypass channel attracts fish to leap over the weir and then slide down into the reservoir via a smooth slideway). Continuous pumping is required to operate the false weir and the fishway when the reservoir level is below the weir.
- Does not require major dam modifications (e.g., tunnel/hole) to support up/downstream passage.
- Guide nets would be used for downstream passage in the reservoir to the dam (Jan-June) with the ability to lower nets during high-debris flow events.
- For downstream passage, a top-down operation, modified dam gate allows water to spill into a smooth ramp and bypass pipeline. During low reservoir water elevations, a pump or Archimedes screw trap will be required to assist with downstream passage.

Primary Benefits and Potential Shortfalls

Generally, this option is biologically feasible for upstream passage of adult salmonids and lamprey. Downstream passage, particularly for juveniles, lamprey, and other non-listed native fish species may be feasible but presents some major challenges due to navigation through the reservoir. Because Lake Pillsbury remains, the same water quality concerns exist for adult and juvenile steelhead that stay in the reservoir during late spring/summer.

Benefits

- Fish volitionally migrate through a semi-natural, low gradient channel.
- Utilizing natural materials adapted to the landscape as much as possible likely reduces the costs for construction and maintenance.
- No penetration of the dam required.
- Capability to pump water into the low gradient bypass channel may provide opportunity to match channel water temperatures with river water temperature providing natural cues during outmigration periods.

Shortfalls

- Need to operate pumps to pump water into the false weir/low-gradient bypass channel at the top of the reservoir when the reservoir elevation is low. If a water temperature control was included in the bypass channel, the pump would have to be multi-level.
- Need to construct a guide weir across the Eel River at the downstream entrance of the low-gradient bypass channel for upstream migration.
- Bypass channel's large footprint increases its vulnerability to geologic instability.

Bypass Channel Summary

Benefits	Limitations / Risks
Fisheries • Provides semi-natural volitional passage. • Feasible for most adult life stages. • Potential to match fishway and Eel River water temperatures during outmigration periods. **Engineering and Operations** • Likely lower construction cost than conventional fish ladder. • Flexible lining is more resilient to earth flows. • Likely cheaper to maintain / repair. • No penetration of the dam required.	**Fisheries** • High predation risk. • Downstream passage through the reservoir (juvenile fish and steelhead kelts). • Other native fish species. • Reservoir hydrology implications. **Engineering and Operations** • Many of the same shortfalls as the conventional fish ladder options. • Challenging to accommodate large fluctuation in reservoir water surface. Would still need a pump to operate. • Still need control structures upstream and downstream. • Larger footprint increases risk of failure due to geologic instability. • Use of guide nets.
Critical Uncertainties / Major Considerations	

- Uncertain geologic stability of the north bank.
- Gentler slopes help facilitate fish passage.
- Unknown whether examples of long, natural channels exist.

Next Steps to Consider Further

Geotechnical studies are needed to better understand the geological risks for building a long, natural channel on the north bank.

Due to the geologic stability concerns and need to build a pump and control structures in any case, the working group decided to focus on the feasibility of other fish passage options. Improving the feasibility of other fish passage structures can feed into improving the feasibility of this option.

Passage Scores - Low Gradient Bypass

Biological and Non-Biological Scoring Results – average and range of scores derived from the Fish Passage Working Group:

Low Gradient Bypass Habitat and Biological Feasibility Categories	Juvenile Steelhead		Smolt Steelhead		Adult Winter-Run Steelhead		Adult Summer (Spring)-Run Steelhead Migration		Adult Summer (Spring)-Run Steelhead Holding		Juvenile Chinook		Adult Fall-run Chinook		Pacific Lamprey		Sacramento Sucker/other native fish species	
	Average	Range	Average	Range	Average	Range	Average	Range	Average	Range	Average	Range	Average	Range	Average	Range	Average	Range
Biological Feasibility for Upstream Passage	**4**	**5**	**NA**	**NA**	**7**	**2**	**6**	**5**	**NA**	**NA**	**NA**	**NA**	**6**	**3**	**6**	**3**	**5**	**3**
Reservoir navigability	3	1	NA	NA	7	3	6	3	NA	NA	NA	NA	7	3	6	5	5	7
Passage efficiency (fishway, etc.)	5	5	NA	NA	7	4	6	6	NA	NA	NA	NA	6	4	7	3	5	6
Predation	2	1	NA	NA	7	3	6	3	NA	NA	NA	NA	6	3	6	2	5	3
Biological Feasibility for Downstream Passage	**3**	**3**	**5**	**4**	**6**	**2**	**6**	**2**	**NA**	**NA**	**4**	**4**	**NA**	**NA**	**4**	**4**	**4**	**4**
Reservoir navigability	4	3	6	5	6	2	6	3	NA	NA	4	4	NA	NA	4	6	3	3
Passage efficiency (fishway, etc.)	5	2	6	3	6	3	6	3	NA	NA	5	5	NA	NA	5	5	5	6
Predation	2	1	4	3	5	3	5	4	NA	NA	3	3	NA	NA	5	4	4	5
Habitat and Water Quality	**6**	**2**	**7**	**3**	**8**	**4**	**7**	**4**	**5**	**3**	**6**	**5**	**7**	**3**	**7**	**5**	**8**	**4**
Habitat upstream of Scott Dam	7	5	7	5	8	1	7	3	7	6	7	5	8	3	9	1	7	4
Water quality within reservoir	5	4	8	3	8	2	7	6	4	4	7	6	8	3	7	6	7	6
Habitat downstream of Scott Dam	7	3	7	2	8	3	7	4	5	6	7	2	8	3	7	6	8	4
Water quality below reservoir	5	4	7	4	8	4	7	5	5	4	6	5	7	4	7	6	8	4
Hydrologic Implications	**5**	**5**	**6**	**6**	**7**	**4**	**6**	**4**	**5**	**5**	**5**	**5**	**6**	**5**	**6**	**4**	**6**	**4**
Biological Viability (Spatial Structure & Diversity)	**5**	**6**	**6**	**7**	**7**	**5**	**6**	**5**	**5**	**4**	**6**	**7**	**6**	**5**	**6**	**5**	**6**	**6**

Low Gradient Bypass Non-Biological Categories	Score	
	Average	Range
Engineering and Geotechnical Feasibility	6	6
Water Delivery or Storage Potential	9	2
Fish Monitoring and Exclusion Capacity	6	8
Passage Operations	5	6
Cost: Construction	6	6
Cost: Operations & Maintenance	5	6
Timeframe to Achieve Resource Benefits (Fisheries)	6	6
Risks & Uncertainties	5	5

Passage Score Insights

Biological Feasibility for Passage

This fishway option would be biologically feasible for upstream passage for adult salmonids and lamprey. There is uncertainty associated with how this concept would perform with upstream migrating summer-run steelhead during the spring recession with respect to water temperature (likely water temperature control would be required for the fishway to match the river water temperature). Questions remain how this passage concept would incorporate upstream passage for juvenile salmonids and other native fish species, particularly with respect to predation in the fishway. Downstream passage is potentially problematic for all life stages and species that require emigration through the reservoir. Parameters influencing the biological feasibility for downstream passage received lower scores with a high level of agreement among the technical team, with predation being the greatest concern.

Habitat and Water Quality

Physical habitat conditions above and below the reservoir were scored favorably with little uncertainty for all species and life stages among scorers. Major uncertainty with moderate concern was expressed by members of the technical team with questions surrounding how adult summer-run steelhead may utilize holding habitat in or below Lake Pillsbury during the dry season and the adequacy of the available water quality conditions.

Hydrologic Implication

Hydrologic conditions influenced by the presence of Scott Dam in combination with this fishway option presented some concerns among the technical group with primary focus on the spring recession and the how the flow regime would support emigrating species and immigrating adult summer-run steelhead.

Biological Viability

Biological viability scored moderately with a high level of uncertainty across all species and life stages among the technical team. The greatest uncertainty being with juvenile Chinook, juvenile steelhead, and steelhead smolts.

Non-Biological Feasibility

The low-gradient bypass-fishway design scored high with low uncertainty in the ability to maintain water storage capacity and delivery. All other non-biological categories received moderate scores with high levels of uncertainty among the technical team.

Option 1.2 **Conventional Fishway** (Mead & Hunt and Modified)

Brief Description

The Fish Passage Working Group evaluated two sub-options for a conventional fishway design: **Option 1.2a – Mead & Hunt Conventional Fishway**, and **Option 1.2b - a slightly Modified Conventional Fishway** design based on Option 1.2a. For both sub-options, the working group adopted an existing pool-and-weir fishway design developed specifically for this facility by the engineering firm Mead and Hunt (Link to report). PG&E contracted with Mead and Hunt to design the Mead & Hunt Conventional Fishway design (Option 1.2a) during the Potter Valley Project relicensing effort and before the Ad Hoc Committee Fish Passage Working Group was established. The Mead and Hunt study provides conceptual design sketches and preliminary decision-level cost estimates for construction of a conventional fishway at Scott Dam. **The scenarios sub-group decided to create Option 1.2b, which modified the fishway design in Option 1.2a, to accommodate a wider range of reservoir elevations.**

Features

Both conventional fishway Options 1.2a and 1.2b have the following features:

- Meets NMFS Anadromous Salmonid Passage Facility Design Criteria.
- Conventional Ice Harbor-type orifice and weir type configuration.
- Provides volitional upstream and downstream passage under most operating conditions.
- Situated on the south side of Scott Dam with ladder entrance at the base of the dam.
- Fish ladder contains a series of step-wise pools. Each pool is separated by a 12-inch change in elevation.
- Tunnel elevation controls the minimum reservoir elevation at which the fishway can be operated.
- Exit gallery contains an additional set of pools that include slide gates on the upstream side of Scott Dam that facilitates fishway operations over a range of reservoir water surface elevations. The exit gallery would require regular management typically every 3 days and more often during storm events.
- Fishway used for upstream and downstream fish passage.
- Floating nets guide downstream migrating fish from Lake Pillsbury to the top of the fishway. Two potential net configurations could be used including: 1) shorter nets extending full depth close to the dam, or 2) longer nets extending from the dam to the Eel River main stem arm.

The Option 1.2a Mead & Hunt Conventional Fishway design has the following features that differ from Option 1.2b:

- Exit gallery reaches 1900' elevation.
- The fish ladder connects to the exit gallery via a 4-foot diameter tunnel through Scott Dam.
- At high reservoir levels and when spillway gates are not installed, fish would have access to migrate downstream over the spillway (~100 ft drop).
- Trap and haul operations could be employed when water surface elevation does not allow a functional ladder. However, the scoring team did not assess the trap and haul component.

Option 1.2b – Modified Conventional Fishway shares many of the features described in Option 1.2a Conventional Fishway except:

- The exit gallery is extended up 10 additional feet to 1910' to allow upstream passage at full pool.
- A 4-foot diameter tunnel through Scott Dam remains necessary.
- Downstream migrating fish would use the extended fish ladder/exit gallery instead of fish ladder plunge pool between 1900-1910'. Otherwise, the ladder would be same as above for downstream passage.
- Provides volitional passage to the range of reservoir elevations observed in the historical record to reduce or eliminate the need for trap and haul component in this option.

Primary Benefits and Potential Shortfalls

Both Options 1.2a and 1.2b provide volitional upstream and downstream passage with little modification of Scott Dam compared to scenarios like complete dam removal or partial removal (lowering). This scenario would result in little change from current operations at Scott Dam and recreational opportunities in Lake Pillsbury. Conventional fishways have been applied in many situations including elevation changes beyond that of Scott Dam and are typically considered successful for providing upstream passage for adult salmonids. Option 1.2b – Modified Conventional Fishway slightly benefits fish due to the extended fish ladder and exit gallery (particularly for adult summer/spring migrating steelhead).

The ability of this scenario to provide effective downstream passage is the primary uncertainty. More specifically, downstream migrating fish may not successfully find the fishway given minimal attraction flow particularly when the spillway is not in use. Downstream migrating fish would be particularly susceptible to predation by non-native predators that occupy Lake Pillsbury including Largemouth Bass and Sacramento Pikeminnow. When the spillway is in use and spillway gates are not installed, fish would have access to migrate down the spillway (up to ~100 foot drop), which may be a source of mortality. A secondary concern is the ability to attract adults to the lower entrance particularly due to changes in water temperature and channel configuration. However, design elements have been added to provide attraction flow, and a weir could be added if needed.

This scenario was originally developed specifically for Chinook salmon and steelhead trout. Operating conditions and timelines associated with the design were developed using count data at Van Arsdale Fish Station for these species. Species with different passage needs and migratory timing such as Pacific lamprey or Sacramento sucker were not considered in the original design. These species could likely be incorporated into this scenario with species specific elements that would not influence passability for salmon or steelhead and may also extend operating windows. The migration timing of summer-run steelhead may require a wider operating window to provide volitional passage particularly dry water-year conditions.

Fishways commonly make fish more susceptible to predation. Fishways focus migration through a specific and constrained route and commonly make fish more accessible to predators. Fishways also tend to congregate predators. This has been observed at the Cape Horn Dam fish ladder, and elsewhere, where native and non-native predators have been found consuming migrating fish. Otters, racoons, bald eagles, osprey, bass, pikeminnow and other predators have been found preying on fish attempting to migrate through the Cape Horn Dam fish ladder.

Construction of the fishway would provide several challenges. Foundation and landslide mitigation is a substantial component of the level of effort needed to construct this scenario. The foundation for the fishway components both upstream and downstream of the dam would require significant ground remediation to support the fishway. An active landslide exists upstream of Scott Dam in the vicinity of the fishway and full landslide mitigation is estimated to exceed $35 million. In addition, construction would require a drawdown of Lake Pillsbury and flood contingencies if construction took multiple years.

Operations of the fishway would require regular and routine attention to function as designed. Specifically, slide gates would need to be changed at a very high frequency (potentially every 3 days). The gates would need to be changed more often during rapid changes in reservoir elevation. Guide nets would also require regular attention with the potential for getting clogged by algae growth or other debris influencing their functionality. The guide nets may need to be managed to facilitate recreational opportunities.

Benefits

- No reduction in water storage capacity in Lake Pillsbury.
- Volitional upstream and downstream passage for migratory fish.
- Maintains existing recreational opportunities in Lake Pillsbury.
- Negligible influence on dam safety.
- Option 1.2b – Modified Fishway enables fish to migrate across Scott Dam during periods of higher reservoir elevations. This would take advantage of fish migrating during spring pulses.

Shortfalls

- The performance of the downstream migration route is highly uncertain due to minimal attraction flow, non-native predators and other factors.
- Not all migratory fish species (e.g., lamprey) or life history stage (e.g., juvenile steelhead) were considered when developing fishway designs and operating windows.
- Increased predation.
- Substantial effort would be required to provide a suitable foundation.
- Slide gates, nets and other features would require regular and routine attention to function as designed.
- Option 1.2b – Modified Fishway would have higher costs than Option 1.2a due to extending the exit gallery and fish ladder to allow for passage at higher reservoir elevations.

Option 1.2 Conventional Fishway (Mead & Hunt and Modified) Summary

Benefits	Limitations / Risks
Options 1.2a and 1.2b • Provides volitional passage. • Retains Lake Pillsbury water storage. • Maintains existing recreational opportunities in Lake Pillsbury. • Negligible influence on dam safety. Option 1.2b only • Passage available even when the reservoir is full.	Options 1.2a and 1.2b • High construction cost and operations and maintenance costs. • High predation risk. • Complexity of construction. Option 1.2a only • Downstream migration more difficult at high reservoir elevations. • High construction costs for tunnel through Scott Dam. • Costs associated with trap & haul operations at low reservoir elevations if employed. Option 1.2b only • Higher costs associated with extending the exit gallery and fish ladder.
Critical Uncertainties / Major Considerations	
Options 1.2a and 1.2b • Downstream migration route may not be successful. • Potential for injury to fish entrained into spillway, • Not all migratory species and life stages were considered in design process and may require design modifications. • Effect of fishway on dam stability. • The need for trap and haul operations vs modification of the design to facilitate functioning at lower reservoir elevations.	

Next Steps to Consider Further

- Address uncertainties related to Scott Dam structural integrity and geotechnical stability around Scott Dam.
- Investigate approaches to improve certainty of downstream migration route.

Passage Scores – Option 1.2a: Mead & Hunt Conventional Fishway

Biological and Non-Biological Scoring Results – average and range of scores derived from the Fish Passage Working Group:

Fish Ladder M&H Habitat and Biological Feasibility Categories	Juvenile Steelhead		Smolt Steelhead		Adult Winter-Run Steelhead		Adult Summer (Spring)-Run Steelhead Migration		Adult Summer (Spring)-Run Steelhead Holding		Juvenile Chinook		Adult Fall-run Chinook		Pacific Lamprey		Sacramento Sucker/other native fish species	
	Average	Range	Average	Range	Average	Range	Average	Range	Average	Range	Average	Range	Average	Range	Average	Range	Average	Range
Biological Feasibility for Upstream Passage	**3**	**2**	**NA**	**NA**	**6**	**1**	**5**	**6**	**NA**	**NA**	**NA**	**NA**	**6**	**3**	**6**	**4**	**4**	**4**
Reservoir navigability	3	1	NA	NA	7	1	6	2	NA	NA	NA	NA	6	2	6	5	5	7
Passage efficiency (fishway, etc.)	4	5	NA	NA	6	2	5	6	NA	NA	NA	NA	5	4	6	4	4	4
Predation	2	4	NA	NA	7	2	7	2	NA	NA	NA	NA	6	3	6	2	5	3
Biological Feasibility for Downstream Passage	**4**	**4**	**5**	**4**	**5**	**4**	**5**	**5**	**NA**	**NA**	**4**	**4**	**NA**	**NA**	**4**	**4**	**4**	**4**
Reservoir navigability	4	4	5	5	6	2	6	3	NA	NA	4	4	NA	NA	4	6	4	3
Passage efficiency (fishway, etc.)	5	4	6	4	5	5	5	6	NA	NA	5	5	NA	NA	5	5	4	4
Predation	3	6	5	6	5	2	6	3	NA	NA	4	6	NA	NA	5	6	4	5
Habitat and Water Quality	**6**	**2**	**7**	**3**	**8**	**4**	**7**	**4**	**5**	**3**	**6**	**5**	**7**	**3**	**7**	**5**	**8**	**4**
Habitat upstream of Scott Dam	7	5	8	5	9	1	8	3	7	6	7	5	8	3	8	2	8	4
Water quality within reservoir	5	4	7	6	9	1	7	6	4	4	7	6	8	4	7	6	7	6
Habitat downstream of Scott Dam	7	3	8	2	8	3	7	4	5	6	7	2	8	3	7	7	8	5
Water quality below reservoir	6	4	7	6	8	4	7	4	5	4	6	5	7	4	8	7	8	5
Hydrologic Implications	**5**	**5**	**6**	**6**	**7**	**4**	**6**	**6**	**5**	**5**	**5**	**5**	**6**	**5**	**6**	**4**	**7**	**4**
Biological Viability (Spatial Structure & Diversity)	**6**	**7**	**6**	**7**	**7**	**5**	**6**	**6**	**5**	**4**	**6**	**7**	**7**	**5**	**6**	**5**	**6**	**6**

Fish Ladder M&H Non-Biological Categories	Score	
	Average	Range
Engineering and Geotechnical Feasibility	5	6
Water Delivery or Storage Potential	9	2
Fish Monitoring and Exclusion Capacity	7	5
Passage Operations	5	6
Cost: Construction	5	5
Cost: Operations & Maintenance	4	4
Timeframe to Achieve Resource Benefits (Fisheries)	6	6
Risks & Uncertainties	5	6

Passage Scores – Option 1.2b: Modified Conventional Fishway

Biological and Non-Biological Scoring Results – average and range of scores derived from the Fish Passage Working Group:

Modified Fish Ladder M&H Habitat and Biological Feasibility Categories	Juvenile Steelhead		Smolt Steelhead		Adult Winter-Run Steelhead		Adult Summer (Spring)-Run Steelhead Migration		Adult Summer (Spring)-Run Steelhead Holding		Juvenile Chinook		Adult Fall-run Chinook		Pacific Lamprey		Sacramento Sucker/other native fish species	
	Average	Range	Average	Range	Average	Range	Average	Range	Average	Range	Average	Range	Average	Range	Average	Range	Average	Range
Biological Feasibility for Upstream Passage	**3**	**2**	**NA**	**NA**	**7**	**2**	**7**	**3**	**NA**	**NA**	**NA**	**NA**	**6**	**4**	**6**	**3**	**4**	**4**
Reservoir navigability	3	1	NA	NA	7	1	7	3	NA	NA	NA	NA	6	3	6	5	5	7
Passage efficiency (fishway, etc.)	5	5	NA	NA	7	4	7	4	NA	NA	NA	NA	6	4	6	3	4	5
Predation	2	4	NA	NA	7	2	7	3	NA	NA	NA	NA	6	3	6	2	5	3
Biological Feasibility for Downstream Passage	**4**	**5**	**5**	**5**	**6**	**2**	**6**	**2**	**NA**	**NA**	**4**	**5**	**NA**	**NA**	**4**	**5**	**5**	**4**
Reservoir navigability	4	4	5	5	6	2	6	3	NA	NA	4	4	NA	NA	4	6	4	3
Passage efficiency (fishway, etc.)	5	4	6	5	5	3	6	4	NA	NA	6	6	NA	NA	5	6	5	5
Predation	3	6	5	6	5	3	6	3	NA	NA	4	6	NA	NA	5	6	4	5
Habitat and Water Quality	**6**	**2**	**7**	**3**	**8**	**4**	**7**	**4**	**5**	**3**	**6**	**5**	**7**	**3**	**7**	**5**	**8**	**4**
Habitat upstream of Scott Dam	7	5	8	5	9	1	8	3	7	6	7	5	8	3	8	2	8	4
Water quality within reservoir	6	6	8	3	9	1	7	6	4	4	7	6	8	4	7	6	7	6
Habitat downstream of Scott Dam	7	3	8	2	8	3	7	4	5	6	7	2	8	3	7	7	8	5
Water quality below reservoir	6	4	7	4	8	4	7	4	5	4	6	5	7	4	8	7	8	5
Hydrologic Implications	**5**	**5**	**6**	**6**	**7**	**4**	**6**	**4**	**5**	**5**	**5**	**5**	**6**	**5**	**6**	**4**	**7**	**4**
Biological Viability (Spatial Structure & Diversity)	**6**	**7**	**6**	**7**	**7**	**5**	**6**	**5**	**5**	**4**	**6**	**7**	**7**	**5**	**6**	**5**	**6**	**6**

Modified Fish Ladder M&H Non-Biological Categories	Score	
	Average	Range
Engineering and Geotechnical Feasibility	5	6
Water Delivery or Storage Potential	9	2
Fish Monitoring and Exclusion Capacity	8	5
Passage Operations	5	5
Cost: Construction	5	5
Cost: Operations & Maintenance	5	4
Timeframe to Achieve Resource Benefits (Fisheries)	6	6
Risks & Uncertainties	5	5

Passage Score Insights

Biological Feasibility

Upstream Passage. Biological feasibility for upstream passage varied by species and life stage. This metric was rated moderately feasible for adult winter-run steelhead and adult fall-run salmon. Conventional fishways have been widely used and generally found to be successful in passing fish upstream. Despite this fact, several factors contributed to the moderate feasibility rating for upstream migration. First, fish attraction to the fishway entrance is uncertain and may require additional design features to improve its efficiency such as a guidance structure downstream of the dam. Secondly, specifically for Option 1.2a – Mead & Hunt Conventional Fishway, fish would be required to ascend >100 vertical feet which may challenge their physiological capabilities and lead to unsuccessful attempts to ascend the fishway. Finally, predation within the fishway, as observed at Cape Horn Dam and other fishways, reduced the upstream passage rating. A similar moderate score was assigned to lamprey assuming incorporation of minor design modifications and extension of the operating windows. This scenario was generally considered less feasible for providing upstream passage for juvenile steelhead and sucker.

Downstream Passage. The biological feasibility for downstream passage is a primary uncertainty for the scenario and relates to reservoir navigability, predation and potential for injury. Fish migrating from the Rice Fork or Eel River would enter Lake Pillsbury and have to navigate the reservoir to find a route downstream. While swimming through the reservoir smaller downstream migrants would be susceptible to predation by non-native species such as bass or pikeminnow. The primary downstream route for downstream migrants would be the fishway which has minimal attraction flow. Alternatively, when the spillway is functioning, fish may be entrained into the spillway and plunge over a substantial height (i.e., >100 ft drop for Option 1.2a) downstream of the dam. The potential for injury to fish that are entrained over the spillway is another source of uncertainty. These factors led to an infeasible rating for downstream migrant juvenile life stages of salmon, steelhead and lamprey. Steelhead smolt or downstream migrating adult steelhead were of less concern and rated as moderate given a reduced risk of predation due to their larger size and stronger swimming ability. The influence of this scenario on downstream movements of sucker was highly uncertain.

Habitat and Water Quality

The influence of the scenario on habitat and water quality varied by species and life stage but were generally rated as moderately beneficial to beneficial as the scenario provides access to high quality riverine habitats above Lake Pillsbury reservoir. Estimates of the amount of habitat upstream of the dam ranges by study, but the most recent estimates range from 40 miles for lamprey, over 90 miles for salmon, and over 150 miles for steelhead (life stage dependent). In this scenario, the riverine habitat under Lake Pillsbury is considered lost. Habitat downstream of Scott Dam is considered enhanced during the summer for juvenile steelhead due to relatively high cool flows, but degraded at other times by dam effects related to reduced streamflow, as well as interruption of large wood and coarse sediment transport regimes. However, these factors were considered minor in relation to the benefits provided by the access to upstream habitats.

Water quality upstream of the reservoir is not influenced by this scenario. However, water quality within and downstream of the reservoir and within the fishway would be influenced by the impoundment and may influence the ability of fish to access the

upstream habitats. For example, water for the fishway would be taken from the warmest water in the reservoir (epilimnion) for periods when salmon, lamprey, and summer-run steelhead are migrating upstream and the reservoir is thermally stratified. This may directly fish attraction to enter the fishway; however, this is highly uncertain and would require additional assessment.

Hydrologic Implication

Depending on the Scott Dam and Lake Pillsbury influence on the hydrology of the Eel River, this metric received moderate or better ratings by species and life stage. The interaction of the flow of the Eel River relative to a natural streamflow regime is complex and has been well studied and has changed through time. In many instances, streamflow releases mimic the general shape of the unimpaired and natural hydrograph within the bounds of operational constraints. There are specific times where the operations deviate from an unimpaired hydrograph. For example, fall freshets are typically muted during times when the reservoir is filling. Fall freshets commonly occur during times of Chinook salmon migration and spawning, and the consequence of muting these flow signals is uncertain but may influence spawn timing and migration patterns. Furthermore, in the spring time during the receding limb of the snowmelt hydrograph, releases from Scott Dam may be higher and cooler than the unimpaired hydrograph and may delay outmigration for salmon and steelhead.

Biological Viability

The ability for the fishway to achieve biological viability was rated moderate or better; however, there was uncertainty if this scenario would yield long-term self-sustaining viable fish populations as evidenced by high variation among raters. The fishway provides a means for fish to expand into historical habitats and return to the ocean. Fish would be challenged with a substantial obstacle to overcome during their entry into the fishway and over Scott Dam, however a proportion would make it into the habitats beyond Scott Dam. A primary uncertainty for this scenario is the ability of downstream migrating fish to successfully navigate through the reservoir and downstream of Scott Dam. Therefore, if fish were able to make it to the upstream habitats but not successfully migrate downstream this option could create a population sink and actually reduce the viability of Eel River fish populations.

Non-Biological Feasibility

Scott Dam would have minimal modification which is also one of the primary benefits of this scenario. Therefore, the stability of Scott Dam would likely be maintained along with current water operations, water storage and recreational opportunities. However, construction of the fishway would provide a set of specific challenges including the need to draw down the reservoir and plunge pool downstream of Scott Dam, reduced downstream water quality during construction, and other challenges in light of the remoteness of the site. One of the primary uncertainties related to construction of the fishway is the level of effort needed for ground remediation which would require additional investigation. Once constructed, the fishway would need regular operation and maintenance to facilitate functioning at various reservoir levels and guide net configurations. The level of maintenance required is uncertain particularly related to guide nets.

Scenario 2: Trap and Haul

The group considered several trap & haul scenarios, as trap & haul approaches can be implemented in a phased approach to serve as both a short-term and long-term solution for a multi-dam complex like this project.

For both options:

- Upstream migrating fish would be released into the watershed above Scott Dam, either directly to a selected tributary mouth in Option 2.1 or into Lake Pillsbury near Scott Dam in Option 2.2, but both release scenarios could be considered for either option.
- Downstream passage methods are the same for both options: near-reservoir-length guide nets to a floating surface collector (FSC) at Scott Dam. Collected fish are transported by truck and released riverside after acclimation.
- Paved road for truck transportation.

Option 2.1 **Trap & Haul at Van Arsdale** Fisheries Station (VAFS) to Lake Pillsbury

Brief Description

This option aims to maximize collection of potential upstream-migrating fish by trapping fish at Cape Horn Dam. Upstream-transported fish are released at the mouth of one of the Lake Pillsbury tributaries to minimize risks with navigating through the reservoir.

Features

Upstream migrating fish are trapped in a modified Van Arsdale Fisheries Station fish ladder, sorted, and then loaded onto a truck for transport to a barge located at Lake Pillsbury. Barge transports fish across reservoir to the mouth(s) of a selected tributary(s).

Primary Benefits and Potential Shortfalls

Trap & Haul at Van Arsdale would work for adult salmonids based on other salmonid trap and haul programs, but it is uncertain if this option works for lamprey. Downstream passage may be feasible but presents a major challenge. Because Lake Pillsbury remains, the same water quality concerns exist for adult and juvenile steelhead that stay in the reservoir during the spring/summer. Lake Pillsbury predation on juvenile salmonids may also be a significant concern.

Benefits

- Some existing facilities at Van Arsdale Fisheries Station can be modified for trapping, sorting, and transferring fish. Can be part of a phased approach to serve as both a short-term and long-term solution.
- Ability to capture more upstream migrating fish at Cape Horn Dam than at Scott Dam.
- Transported fish are sorted and selected. That is, you know exactly what you have.

Shortfalls

- Logistics and operations are the major challenges for trap and haul (continuous human management and operations during fish migration seasons).

- Requires improved road between Cape Horn Dam and Lake Pillsbury for high reliability of fish transport.
- While releasing fish at the mouth of a tributary will help address concerns related to navigation through the reservoir, without doing parentage tributary detection for each fish during trapping and sorting, fish may originate from a different tributary and may reject the release location and navigate to their parentage tributary.
- Some challenges for the FSC and system of guide nets to handle a range of reservoir elevations to attract and capture fish for downstream passage.
- Challenge to determine the optimal collection site for downstream passage whether at the dam, at the mouth(s) of tributary(ies), or instream on a tributary(ies) upstream of Lake Pillsbury.
- Facilities may be similarly costly (or more costly) to full fishway options depending on the design. Design is dependent on the level of "fish handling/ management" required.
- Predation.

Trap & Haul at Van Arsdale Summary

Benefits	Limitations / Risks
• Adaptable, potentially both a short-term and long-term solution and as part of a phased approach. • Van Arsdale Fisheries Station is an existing location for modified fish trapping, sorting and transfer operations.	• Road from Cape Horn Dam requires improvement and is subject to maintenance and environmental conditions. Longer transportation route increases risk. • Fish may originate from a different tributary than where released. • High predation risk. • Moderate to high uncertainty with all species and life stage biological viability.
Critical Uncertainties / Major Considerations	
• Cost estimates are unknown until the design and management requirements are more defined. • Uncertain if trap & haul will work for lamprey migration, may require separate passage facilities anyway.	

Next Steps to Consider Further

- Additional studies on fish ecology and behavior to better understand optimal trap and haul design for collection/release location and timing, especially for downstream migration through the reservoir.

Passage Scores - Trap & Haul at Van Arsdale

Biological and Non-Biological Scoring Results – average and range of scores derived from the Fish Passage Working Group:

Trap and Haul 1 (VAFS to SD) Habitat and Biological Feasibility Categories	Juvenile Steelhead		Smolt Steelhead		Adult Winter-Run Steelhead		Adult Summer (Spring)-Run Steelhead Migration		Adult Summer (Spring)-Run Steelhead Holding		Juvenile Chinook		Adult Fall-run Chinook		Pacific Lamprey		Sacramento Sucker/other native fish species	
	Average	Range	Average	Range	Average	Range	Average	Range	Average	Range	Average	Range	Average	Range	Average	Range	Average	Range
Biological Feasibility for Upstream Passage	**3**	**8**	**NA**	**NA**	**7**	**5**	**7**	**4**	**NA**	**NA**	**NA**	**NA**	**7**	**5**	**6**	**4**	**4**	**8**
Reservoir navigability	3	9	NA	NA	9	3	8	4	NA	NA	NA	NA	8	4	6	6	5	8
Passage efficiency (fishway, etc.)	4	8	NA	NA	7	6	7	4	NA	NA	NA	NA	7	6	6	5	5	8
Predation	3	6	NA	NA	8	3	8	4	NA	NA	NA	NA	8	4	7	4	5	7
Biological Feasibility for Downstream Passage	**4**	**5**	**5**	**5**	**5**	**3**	**6**	**4**	**NA**	**NA**	**4**	**4**	**NA**	**NA**	**4**	**4**	**5**	**6**
Reservoir navigability	4	4	6	4	6	2	6	3	NA	NA	4	4	NA	NA	3	4	4	3
Passage efficiency (fishway, etc.)	5	6	6	4	5	4	6	5	NA	NA	6	5	NA	NA	4	5	5	6
Predation	3	4	5	4	7	4	7	5	NA	NA	5	7	NA	NA	4	7	5	6
Habitat and Water Quality	**6**	**2**	**7**	**2**	**8**	**3**	**7**	**3**	**5**	**3**	**6**	**5**	**7**	**2**	**8**	**2**	**7**	**4**
Habitat upstream of Scott Dam	7	5	7	5	9	1	7	3	7	6	7	5	7	3	8	3	7	4
Water quality within reservoir	5	4	8	3	9	1	7	6	4	6	7	6	8	4	7	6	7	6
Habitat downstream of Scott Dam	7	5	8	4	8	4	7	5	6	7	8	4	8	4	8	4	8	5
Water quality below reservoir	6	5	7	4	8	4	7	5	5	4	6	5	7	4	8	3	8	5
Hydrologic Implications	**5**	**5**	**5**	**5**	**6**	**4**	**6**	**4**	**6**	**5**	**5**	**5**	**5**	**4**	**6**	**4**	**7**	**4**
Biological Viability (Spatial Structure & Diversity)	**4**	**6**	**5**	**6**	**5**	**4**	**5**	**4**	**5**	**5**	**5**	**6**	**5**	**4**	**5**	**4**	**5**	**5**

Trap and Haul 1 (VAFS to SD) Non-Biological Categories	Score	
	Average	Range
Engineering and Geotechnical Feasibility	8	8
Water Delivery or Storage Potential	9	2
Fish Monitoring and Exclusion Capacity	9	5
Passage Operations	4	5
Cost: Construction	7	7
Cost: Operations & Maintenance	3	4
Timeframe to Achieve Resource Benefits (Fisheries)	8	7
Risks & Uncertainties	7	8

Passage Score Insights

There was general agreement among scores, except for those related to uncertainty associated with juvenile steelhead and other native fish upstream passage, general fisheries management paradigms associated with trap and haul passage and the use of newer technology accompanying this option.

Biological Feasibility for Passage:

This passage option could potentially be biologically feasible for upstream passage for adult salmonids with moderately high scores and agreement; however, there is a degree of uncertainty associated with how this concept would perform with upstream migrating lamprey, juvenile steelhead, and other native fish. Questions remain how biologically important it is for upstream passage of juvenile salmonids and other than lamprey native fish species and how this passage concept would incorporate that need. Downstream passage was determined to be potentially problematic for all life stages and species that require emigration through the reservoir with high uncertainty associated with downstream migration performance with a large system of guide nets and a FSC. Except for adult steelhead all other parameters influencing the biological feasibility for downstream passage received relatively low scores.

Habitat and Water Quality:

Physical habitat conditions above and below the reservoir were scored mostly favorably but there is still a major concern for water quality conditions in Lake Pillsbury for steelhead smolts and adult summer-run steelhead. A divergent opinion of scores among the group for habitat conditions in Lake Pillsbury for adult summer-run steelhead holding, juvenile salmon, lamprey, and other native fish is also noted.

Hydrologic Implication:

For this category the group generally agreed on moderate scores relative to this passage option. With Lake Pillsbury remaining there is still a concern that as fall and early winter rain fills the reservoir, releases from the dam do not match the magnitude and duration of unimpaired flows and this can affect upstream migration timing and collection performance for this passage option.

Biological Viability:

Biological viability scored moderately for this passage option with a moderate to high level of divergent scores among the group across all species and life stages. A central tenet for the divergent opinions is around the higher level of human intervention and management that this passage option likely requires as compared to other options providing more volitional passage.

Non-Biological Feasibility

The Trap & Haul at Van Arsdale option scored very high for engineering and geotechnical feasibility but had a very high range of scores among the group, likely representing different levels of experience within the group for the associated technology with this kind of passage option. With Lake Pillsbury remaining with this option water supply received a very high score. Fish passage monitoring and exclusion also received a very high score given that the trap and haul operations allows for very selective possibilities of fish passage although there was acknowledgement within the group that fisheries monitoring did not exclusively require trapping. On the other hand, trap and haul operations provides more capability for exclusion of non-native fish. The other non-biological categories received low to moderate scores with high levels of uncertainty among the technical team due primarily to the higher level of human

intervention and management that this passage option likely requires along with the cost uncertainties, both capital and operations & maintenance (O&M), associated with downstream passage.

Option 2.2 **Trap & Haul at Scott Dam**

Brief Description

Adult fish would be captured at Scott Dam with a new facility rather than at Cape Horn Dam. This reduces risks associated with the longer transportation route from VAFS and allows adult fish to use the mainstem and tributary habitat between the two dams. Additionally, adult fish would be released into Lake Pillsbury rather than at the mouth of a selected tributary.

Features

- Volitional passage at Cape Horn Dam.
- Upstream migrating fish are trapped at base of Scott Dam, sorted, and then loaded onto a truck for transport for release into Lake Pillsbury. The release could include a barge transport to a strategic location in the reservoir or fish could be released directly to the reservoir near the dam or a boat ramp. A WHOOSHH system (a flexible fish transfer conduit or series of conduits) could be considered for transport from the trap below the dam to be released in Lake Pillsbury near the dam.
- Modifications to Cape Horn Dam infrastructure and operations to ensure the facility meets current CDFW/NMFS fish passage criteria

Primary Benefits and Potential Shortfalls

Similar to the first Trap & Haul option, this option should work well for adult salmonids, but presents significant challenges for downstream passage. Lake Pillsbury predation on juvenile salmonids may also be a significant concern. It is also uncertain if trap and haul options work for lamprey.

- Releasing adult fish into Lake Pillsbury rather than at a tributary mouth provides fish with the opportunity to more easily select their natal stream.
- Releasing adult fish into Lake Pillsbury rather than at a tributary mouth increases navigability and predation risks. Fish may be disoriented (and more vulnerable to predation) and have trouble navigating to their natal tributary.
- Some challenges for the FSC and system of guide nets to handle a range of reservoir elevations to attract and capture fish for downstream passage.
- Challenge to determine the optimal collection site for downstream passage whether at the dam, at the tributary mouth(s), or within tributaries upstream of Lake Pillsbury.
- Because Lake Pillsbury remains, the same water quality concerns exist for non-migrating adult steelhead that stay upstream of Scott Dam in late spring/summer.

Trap & Haul at Scott Dam Summary

Benefits	Limitations / Risks
Same as Option 2.1 except: • Adult fish are able to use the mainstem and tributary habitat between the dams. • Shorter transport route reduces the improved road condition requirements between the two dams.	Same as Option 2.1 except: • With release into the reservoir potentially disoriented fish cannot navigate efficiently through it. • High predation risk. • Moderate to high uncertainty with all species and life stage biological viability.
Critical Uncertainties / Major Considerations	
Same as Option 2.1 except: • Uncertain perfomance for a WHOOSHH system to transport fish over Scott Dam. • Unknown how many upstream migrating fish are unable to reach Scott Dam.	

Next Steps to Consider Further

- Additional studies on fish ecology and behavior to better understand optimal trap and haul design for collection/release location and timing, especially for downstream migration through the reservoir.
- Biological studies to explore whether fish experience significant disorientation and vulnerabilities upon release in the reservoir; compare fish that reach Cape Horn Dam but not Scott Dam.

Passage Scores - Trap & Haul at Scott Dam

Biological and Non-Biological Scoring Results – average and range of scores derived from the Fish Passage Working Group:

Trap and Haul 2 (SD) Habitat and Biological Feasibility Categories	Juvenile Steelhead		Smolt Steelhead		Adult Winter-Run Steelhead		Adult Summer (Spring)-Run Steelhead Migration		Adult Summer (Spring)-Run Steelhead Holding		Juvenile Chinook		Adult Fall-run Chinook		Pacific Lamprey		Sacramento Sucker/other native fish species	
	Average	Range	Average	Range	Average	Range	Average	Range	Average	Range	Average	Range	Average	Range	Average	Range	Average	Range
Biological Feasibility for Upstream Passage	**3**	**9**	**NA**	**NA**	**7**	**5**	**7**	**5**	**NA**	**NA**	**NA**	**NA**	**7**	**5**	**6**	**5**	**4**	**8**
Reservoir navigability	3	9	NA	NA	8	2	7	4	NA	NA	NA	NA	8	3	6	6	5	8
Passage efficiency (fishway, etc.)	4	9	NA	NA	8	4	8	3	NA	NA	NA	NA	8	3	6	6	5	8
Predation	3	6	NA	NA	8	3	8	4	NA	NA	NA	NA	8	4	6	4	5	7
Biological Feasibility for Downstream Passage	**4**	**5**	**5**	**5**	**5**	**2**	**6**	**3**	**NA**	**NA**	**4**	**4**	**NA**	**NA**	**4**	**5**	**5**	**6**
Reservoir navigability	4	4	5	4	6	2	6	3	NA	NA	4	4	NA	NA	3	4	3	3
Passage efficiency (fishway, etc.)	5	7	6	4	5	3	6	5	NA	NA	6	6	NA	NA	4	6	5	6
Predation	3	4	5	4	7	4	7	5	NA	NA	5	7	NA	NA	4	7	5	6
Habitat and Water Quality	**6**	**2**	**7**	**2**	**8**	**3**	**7**	**4**	**5**	**3**	**6**	**5**	**7**	**2**	**8**	**2**	**7**	**4**
Habitat upstream of Scott Dam	7	5	7	5	9	1	8	3	7	6	7	5	7	3	8	3	7	4
Water quality within reservoir	5	4	8	3	9	1	7	6	4	4	7	6	8	4	7	6	7	6
Habitat downstream of Scott Dam	7	3	8	2	8	3	7	3	5	6	7	2	8	3	8	4	8	5
Water quality below reservoir	6	4	7	4	8	4	7	5	5	4	6	5	7	4	8	3	8	5
Hydrologic Implications	**5**	**5**	**5**	**5**	**6**	**4**	**6**	**4**	**5**	**5**	**5**	**5**	**5**	**4**	**6**	**4**	**7**	**4**
Biological Viability (Spatial Structure & Diversity)	**5**	**6**	**6**	**6**	**6**	**5**	**5**	**5**	**5**	**5**	**6**	**6**	**6**	**5**	**5**	**4**	**5**	**5**

Trap and Haul 2 (SD) Non-Biological Categories	Score	
	Average	Range
Engineering and Geotechnical Feasibility	7	7
Water Delivery or Storage Potential	9	2
Fish Monitoring and Exclusion Capacity	9	5
Passage Operations	4	5
Cost: Construction	6	6
Cost: Operations & Maintenance	3	3
Timeframe to Achieve Resource Benefits (Fisheries)	7	7
Risks & Uncertainties	7	8

Passage Score Insights

There was general agreement among scores, except for those related to uncertainty associated with juvenile steelhead and other native fish upstream passage, general fisheries management paradigms associated with trap and haul passage and the use of newer technology accompanying this option.

Biological Feasibility for Passage

This passage option could potentially be biologically feasible for upstream passage for adult salmonids with moderately high scores and agreement; however, there is a degree of uncertainty associated with how this concept would perform with upstream migrating lamprey, juvenile steelhead, and other native fish. Questions remain how biologically important it is for upstream passage of juvenile salmonids and other native fish species (other than lamprey), and how this passage concept would incorporate that need. Downstream passage was determined to be potentially problematic for all life stages and species that require emigration support through the reservoir (high uncertainty associated with downstream migration performance with a large system of guide nets and a FSC). Except for adult steelhead, all other parameters influencing the biological feasibility for downstream passage received relatively low scores.

Habitat and Water Quality

Physical habitat conditions above and below the reservoir were scored mostly favorably, but there is still a major concern for water quality conditions in Lake Pillsbury for steelhead smolts and adult summer-run steelhead. Divergent opinions of scores among the group for habitat conditions in Lake Pillsbury for adult summer-run steelhead holding, juvenile Chinook salmon, Pacific lamprey, and other native fish are also noted.

Hydrologic Implication

For this category, the group generally agreed on moderate scores relative to this passage option. With Lake Pillsbury remaining, there is still a concern that as fall and early winter rain fills the reservoir, releases from the dam do not match the magnitude and duration of unimpaired flows; this can affect upstream migration timing and collection performance for this passage option.

Biological Viability

Biological viability scored moderately for this passage option with a moderate to high level of divergent scores among the group across all species and life stages. A central tenant for the divergent opinions is around the higher level of human intervention and management that this passage option likely requires as compared to other options providing more volitional passage.

Non-Biological Feasibility

This Trap & Haul at Scott Dam option scored very high for engineering and geotechnical feasibility, but had a very broad range of scores among the group, likely representing different levels of experience within the group for the associated technology with this kind of passage option. With Lake Pillsbury remaining with this option, water supply received a very high score. Fish passage monitoring and exclusion also received a very high score given that the trap and haul operations allow for very selective possibilities of fish passage; although there was acknowledgement within the group that fisheries monitoring did not exclusively require trapping. On the other hand, trap and haul operations provide more capability for exclusion of non-native fish. The other non-biological categories received low to moderate scores with high levels of uncertainty among the technical subgroup due primarily to the higher level of human

intervention and management that this passage option likely requires along with the cost uncertainties (both capital and O&M) associated with downstream passage.

Scenario 3: Partial Scott Dam Removal

This scenario reduces the height of Scott Dam to make fish passage easier than the Mead & Hunt fish ladder (Option 1.2), while also retaining some reservoir benefits.

For both options:

- Provides volitional fish passage (no handling).
- Assumes Cape Horn Dam meets current CDFW and NMFS fish passage standards. Considers no operational changes to current NMFS Biological Opinion Reasonable and Prudent Alternative (RPA) bypass flows at Cape Horn Dam.

Option 3.1 **Lower Scott Dam to 80'** (Water Supply)

Brief Description

This option was designed to meet minimum annual PVID water demand (15,000 acre-feet (AF) based on past usage), meet current RPA environmental flow requirements (10 cfs [3,500 AF] during the dry season), and enhance the feasibility of successful fish passage.

Features

- Upstream passage is the same as the Mead & Hunt Fish Ladder concept, except at 20' lower elevation.
- Downstream passage is the same as the original Mead & Hunt Fish Ladder concept, except passive floating surface collector fixed in place at dam with smooth "fish friendly ramp" to spillover fish to the river below.

Primary Benefits and Potential Shortfalls

Adult anadromous fish will likely do slightly better than the Mead & Hunt option due to the reduced dam height. The reduced reservoir storage capacity will also reduce cold water storage, increasing water quality concerns (i.e., temperature) for rearing salmonids downstream. There is additional water quality concern for adult and juvenile steelhead that may reside within Lake Pillsbury during late spring and through the dry season.

Benefits

- Meets PVID water demand and RPA environmental flows.
- Resuspension of potentially mercury-laden sediment is a low concern.

Shortfalls

- Because the reservoir is "top heavy," (i.e., most water storage volume is at higher elevations within the reservoir) Scott Dam cannot be lowered below 80' elevation and still supply sufficient water for PVID needs.
- Potentially little or no improvement to upstream and downstream passage compared to current conditions because many of the same challenges remain. Although design would include a floating surface collector and smooth ramp, downstream migrant fish will likely still travel over the dam crest - a potentially fatal route at an 80-foot dam height. Additionally, upstream passage is more daunting for fish. Other mechanisms like the fish ladder would be necessary to provide safe passage.

- Any major reduction in the height of Scott Dam will reduce the cold water pool, leaving less optimal habitat for targeted species and better habitat for invasive species (pike minnow and bass) in Lake Pillsbury. Dam height reduction also may affect water quality conditions downstream (i.e., increase water temperature and decrease dissolved oxygen), potentially degrading fish habitat.

Partial Scott Dam Removal (80') Summary

Benefits	Limitations / Risks
• Water supply for PVID water needs. • Lower sediment resuspension risks.	• Minimal to no improvement for fish passage. Still have fish passage limitations during fall/spring/dry years. • Reduced desirable habitat (i.e., reduced cold water pool) and potential degraded downstream habitat. • Little to no reduction to pike minnow/bass habitat in reservoir. • High predation risk. • High uncertainty with juvenile biological viability.
Critical Uncertainties / Major Considerations	
• Lowering the dam height does not necessarily convert 1:1 with fish ladder height reduction. • Unknown impacts on habitat and water quality (e.g., temperature, dissolved oxygen, algal bloom risks).	

Next Steps to Consider Further

- Explore potential risks and impacts to habitat and water quality (e.g., temperature, dissolved oxygen, and algal blooms), particularly downstream of Scott Dam and within Lake Pillsbury.
- Develop fish passage option that provides better confidence in effectiveness.
- Overall, due to the still substantial height of the dam at 80', the working group expects little change for fish passage compared to current conditions; therefore, this option would still require components similar to the other options (e.g., modified fish ladder or trap & haul design). Refining the feasibility of these other options may feed into further consideration of the partial dam removal at 80' option.

Passage Scores - Partial Scott Dam Removal (80')

Biological and Non-Biological Scoring Results – average and range of scores derived from the Fish Passage Working Group:

Partial Dam Removal (80' - Water Supply) Habitat and Biological Feasibility Categories	Juvenile Steelhead		Smolt Steelhead		Adult Winter-Run Steelhead		Adult Summer (Spring)-Run Steelhead Migration		Adult Summer (Spring)-Run Steelhead Holding		Juvenile Chinook		Adult Fall-run Chinook		Pacific Lamprey		Sacramento Sucker/other native fish species	
	Average	Range	Average	Range	Average	Range	Average	Range	Average	Range	Average	Range	Average	Range	Average	Range	Average	Range
Biological Feasibility for Upstream Passage	**4**	**2**	**NA**	**NA**	**7**	**4**	**7**	**4**	**NA**	**NA**	**NA**	**NA**	**6**	**6**	**6**	**3**	**5**	**6**
Reservoir navigability	3	3	NA	NA	7	2	7	3	NA	NA	NA	NA	6	6	6	5	5	6
Passage efficiency (fishway, etc.)	5	4	NA	NA	7	5	7	5	NA	NA	NA	NA	6	6	6	6	4	5
Predation	3	4	NA	NA	7	3	7	3	NA	NA	NA	NA	6	6	6	5	5	3
Biological Feasibility for Downstream Passage	**4**	**6**	**6**	**4**	**6**	**4**	**6**	**4**	**NA**	**NA**	**5**	**6**	**NA**	**NA**	**4**	**6**	**5**	**6**
Reservoir navigability	4	4	6	4	7	2	7	3	NA	NA	5	4	NA	NA	3	4	4	4
Passage efficiency (fishway, etc.)	5	7	6	4	6	4	6	7	NA	NA	6	7	NA	NA	5	6	4	6
Predation	3	4	5	3	6	4	6	5	NA	NA	5	7	NA	NA	5	7	5	6
Habitat and Water Quality	**6**	**2**	**7**	**3**	**8**	**4**	**7**	**4**	**5**	**3**	**6**	**5**	**7**	**3**	**7**	**5**	**8**	**4**
Habitat upstream of Scott Dam	8	4	8	4	9	1	8	3	7	6	8	4	8	3	8	2	8	4
Water quality within reservoir	4	5	8	2	9	1	7	6	3	4	7	6	8	4	8	4	7	5
Habitat downstream of Scott Dam	7	3	8	2	8	3	7	4	5	6	7	2	8	3	7	7	8	5
Water quality below reservoir	5	5	7	4	8	4	7	6	3	7	5	4	7	4	8	6	8	5
Hydrologic Implications	**6**	**6**	**6**	**6**	**7**	**4**	**6**	**4**	**5**	**5**	**6**	**6**	**6**	**6**	**7**	**4**	**7**	**4**
Biological Viability (Spatial Structure & Diversity)	**6**	**6**	**6**	**6**	**8**	**5**	**7**	**5**	**6**	**4**	**7**	**7**	**7**	**4**	**6**	**5**	**6**	**5**

Partial Dam Removal (80' - Water Supply) Non-Biological Categories	Score	
	Average	Range
Engineering and Geotechnical Feasibility	5	7
Water Delivery or Storage Potential	6	7
Fish Monitoring and Exclusion Capacity	7	5
Passage Operations	6	7
Cost: Construction	5	4
Cost: Operations & Maintenance	5	5
Timeframe to Achieve Resource Benefits (Fisheries)	5	6
Risks & Uncertainties	5	7

Passage Score Insights

Biological Feasibility for Passage

As with other scenarios that preserve Lake Pillsbury, the 80-foot partial dam removal option received low scores for juvenile steelhead upstream and downstream passage. The group evaluated juvenile steelhead and steelhead smolt movements separately. As water temperatures rise in the spring and cool during fall, juvenile non-smolt steelhead may attempt seasonal movements around Scott Dam. For upstream passage, juvenile fish would utilize the Mead & Hunt ladder, then traverse a largely intact reservoir. Passage through the reservoir could be disorienting to fish and make them susceptible to predators. Juvenile non-smolt steelhead migrating downstream might face the same navigation and predation issues associated with the reservoir but also must detect and pass through a floating surface collector. The scoring group was uncertain how effective the surface collector might be during periods of lower flow (early summer through fall). For the same reasons, Pacific lamprey and other native fish received low scores for downstream passage. The group was also uncertain about the effectiveness of the floating surface collector for these fish.

Another factor that reduced scores for juvenile steelhead is related to water quality conditions downstream of Scott Dam. To maintain cool water temperatures below Scott Dam, releases during summer and fall would be restricted to the needle valve (released from the bottom of reservoir), precluding the upstream movement of juvenile steelhead through the ladder. Ratings for steelhead smolts, adult winter steelhead, and adult summer steelhead were higher because fish at those life stages are larger and actively migrate during periods of higher flow and generally cooler water.

Because migrating adult salmon may arrive at the dam site and attempt to pass upstream during the fall (before the onset of higher winter flows and during a time when Lake Pillsbury water temperature may still be warm), adult salmon received intermediate scores with less agreement among raters than adult steelhead.

Habitat and Water Quality

Because the 80-foot dam height preserves a large portion of Lake Pillsbury's surface area, the upper portion of the water column will warm in a similar manner as the current impoundment. Water released near the surface of the reservoir via a surface collector or as flow down the Mead and Hunt style fish ladder is expected to be warm during summer and fall. Reducing the height of Scott Dam also reduces the depth of the water column in the reservoir and volume of the cold bottom layer (hypolimnion) of the lake. As water is drawn from the reservoir (either through the needle valve or via the fish ladder and surface collector), the volume of cold hypolimnetic water decreases such that by late summer/early fall, river water below Scott Dam is expected to be warm. For these reasons, salmonids that may be rearing or holding either below Scott Dam or within Lake Pillsbury may be stressed by high water temperatures.

Consequently, the scoring group assigned low values to juvenile steelhead and holding adult summer-run steelhead for water quality within and below the reservoir. Adult summer-run steelhead migrate upstream in spring then reside in deep pools with cold water and wait to spawn until the onset of winter rains. There was some disagreement among scorers, but the group was concerned that if summer-run steelhead gained access to Lake Pillsbury during the spring via the Mead and Hunt style ladder, they may attempt to hold in the lake and could succumb to higher water temperatures in the reservoir during summer.

Hydrologic Implication

In addition to altering water quality within and below Lake Pillsbury, Scott Dam (even at a reduced height of 80 feet) affects the hydrology of the upper Eel River by altering flows in the fall. As fall and early winter rain fills the reservoir, releases from the dam do not match the magnitude and duration of unimpaired flows. While the group gave moderate scores for the hydrologic implications of the partial dam removal scenario, there was some uncertainty regarding the level of hydrologic impairment. Some scorers also believed the partial dam may have an adverse effect on flows during the spring, as reflected by the uncertainty in scores for juvenile steelhead and steelhead smolts.

Biological Viability

The group gave the 80-foot partial dam removal scenario moderately high biological viability scores (6 to 8 points) for all species and life stages. Variability among scores was widest for juvenile steelhead, steelhead smolts, and juvenile salmon, reflecting the group's uncertainty about the efficacy of downstream passage through the reservoir and surface collector. Upstream volitional passage via the Mead and Hunt fish ladder is likely to improve spatial structure and diversity of populations currently prevented from spawning above the dam. However, if downstream migrant passage efficiency and survival are low, the 80-foot partial dam removal scenario may not yield a long-term, self-sustaining viable population.

Non-Biological Feasibility

The group gave the 80-foot partial dam option moderately high scores for water delivery, fish monitoring and exclusion, and passage operations feasibility. The 80-foot partial dam height is designed specifically to impound enough water for PVID irrigation. However, the reduced volume in the lake affects the reliability of the water supply reservoir and reduces resilience to dry hydrologic conditions. The group gave mid-range scores (5 points) to costs for construction and O&M with less uncertainty than other non-biological factors. Group scores were unequivocal about these costs because the ladder and surface collector were described in the Mead and Hunt and McMillan-Jacobs reports as having moderate costs and somewhat predictable O&M. The group also assumed a mid-range (10-25 year) timeframe to achieve benefits. There was, however, some uncertainty regarding the scenario's ability to deliver timely benefits. With the exception of construction cost, there was some uncertainty for all non-biological categories - a reflection of the need for more information and greater detail in the evaluation of the partial dam removal scenario.

Option 3.2 **Lower Scott Dam to 50'** (Sediment-Management)

Brief Description

This option was designed to retain the potentially mercury-laden sediment accumulated in the reservoir. It would not be able to meet PVID water demands or current RPA environmental flows. The lower Scott Dam height would provide a lower hydraulic drop to support direct passage of juvenile fish over the spillway as well as to provide for a volitional passage fishway.

Features

- Upstream passage is similar to the Mead & Hunt fish ladder concept (Option 1.2), except dam height is 50' (rather than 80'), and minimal reservoir exists.
- No hole in the dam for passage.
- Downstream passage facilitated with spillway and ladder entrance.

Primary Benefits and Potential Shortfalls

Passage feasibility is better for adult salmonids' upstream passage than the 80' ft partial dam concept. Downstream passage feasibility is also better for juvenile salmonids. The reduced reservoir volume eliminates the ability to release water during the dry season causing water quality concerns with any remnant standing water behind the impoundment and downstream releases. These poor water quality conditions may create adverse conditions for adult and juvenile steelhead that stay within the reservoir during late spring/summer and for juvenile steelhead rearing downstream.

Benefits

- Greater potential to design a successful fish passage facility for upstream and downstream migrants.
- Allows greater natural flow regime "Run-of-the-River" concept and fish-friendly fill and spill design for downstream passage.
- Allows for habitat improvements above Scott Dam including channel reconfigurations to access tributaries and enhanced winter floodplain-type habitats.
- Retained sediments behind Scott Dam and associated water quality and habitat benefits (reduced risk of potentially mercury-laden sediment resuspension).
- Lowering the reservoir provides an opportunity to eradicate invasive predatory fish species.
- Operation and maintenance costs are likely lower than the 80' dam.

Shortfalls

- The 50' dam eliminates water storage capacity causing potential water quality issues in Lake Pillsbury and downstream during the dry season.
- Fish passage may be limited in the fall, spring, and dry years prior to reservoir fill and spill.
- Eliminates tailrace flows below Scott Dam.
- Eliminates ability to store water for diversions to Russian River (i.e., potential loss of seasonal water supply and hydro generation).

Partial Scott Dam Removal (50') Summary

Benefits	Limitations / Risks
• More fish-friendly dam height. • • Relatively low O&M costs. • Supports volitional passage • More unimpaired hydrology ~ "Run-of-the-River" flow regime. • Reduced pikeminnow and bass habitat within Lake Pillsbury	• No water storage capacity, resulting in reduced dry season water diversions and hydrogeneration. • Eliminates current summer tailrace conditions for rearing salmonids downstream of Scott Dam. • High predation risk. • May require management of invasive predatory fish. • High uncertainty with juvenile biological viability.
Critical Uncertainties / Major Considerations	
• Unknown impacts on habitat and water quality (e.g., temperature, dissolved oxygen, algal bloom risks). • Effectiveness of a "fish friendly" spillway design for outmigrants and associated timing of fill and spill hydrology. • Effects on sediment management and containment of pollutant laden sediment within Lake Pillsbury.	

Next Steps to Consider Further

- Determine other water supply options to satisfy PVID demand.
- Evaluate sediment management issues associated with this concept.
- Further evaluate downstream passage concepts and hydrologic conditions.
- Evaluate potential water quality concerns.
- Evaluate and develop a predation plan.

Passage Scores - Partial Scott Dam Removal (50')

Biological and Non-Biological Scoring Results – average and range of scores derived from the Fish Passage Working Group:

Partial Dam Removal (50' - Sediment) Habitat and Biological Feasibility Categories	Juvenile Steelhead		Smolt Steelhead		Adult Winter-Run Steelhead		Adult Summer (Spring)-Run Steelhead Migration		Adult Summer (Spring)-Run Steelhead Holding		Juvenile Chinook		Adult Fall-run Chinook		Pacific Lamprey		Sacramento Sucker/other native fish species	
	Average	Range	Average	Range	Average	Range	Average	Range	Average	Range	Average	Range	Average	Range	Average	Range	Average	Range
Biological Feasibility for Upstream Passage	**4**	**4**	**NA**	**NA**	**8**	**5**	**8**	**5**	**NA**	**NA**	**NA**	**NA**	**7**	**6**	**7**	**5**	**6**	**4**
Reservoir navigability	5	6	NA	NA	9	3	8	3	NA	NA	NA	NA	7	7	7	5	7	5
Passage efficiency (fishway, etc.)	5	5	NA	NA	8	5	8	5	NA	NA	NA	NA	7	6	7	7	5	6
Predation	4	4	NA	NA	7	3	7	1	NA	NA	NA	NA	6	6	6	7	5	3
Biological Feasibility for Downstream Passage	**6**	**6**	**7**	**3**	**8**	**2**	**7**	**4**	**NA**	**NA**	**6**	**6**	**NA**	**NA**	**6**	**7**	**6**	**5**
Reservoir navigability	6	6	8	4	8	3	8	3	NA	NA	6	8	NA	NA	5	8	6	4
Passage efficiency (fishway, etc.)	6	7	8	2	8	2	7	7	NA	NA	7	7	NA	NA	6	7	6	5
Predation	4	5	6	3	6	4	7	5	NA	NA	5	7	NA	NA	5	7	5	5
Habitat and Water Quality	**6**	**7**	**7**	**3**	**8**	**4**	**7**	**4**	**5**	**6**	**8**	**4**	**8**	**4**	**8**	**4**	**8**	**4**
Habitat upstream of Scott Dam	8	3	8	3	9	1	8	3	8	7	8	4	8	3	9	1	8	4
Water quality within reservoir	5	8	8	2	9	1	7	6	3	8	7	6	8	4	8	4	8	3
Habitat downstream of Scott Dam	7	3	8	2	8	5	7	4	5	8	8	3	8	4	8	4	8	4
Water quality below reservoir	4	6	7	6	8	4	7	5	3	8	7	6	7	4	8	5	8	5
Hydrologic Implications	**7**	**7**	**7**	**7**	**7**	**5**	**7**	**5**	**6**	**6**	**7**	**7**	**7**	**6**	**7**	**5**	**7**	**4**
Biological Viability (Spatial Structure & Diversity)	**6**	**7**	**7**	**6**	**8**	**5**	**7**	**5**	**6**	**5**	**7**	**7**	**8**	**5**	**7**	**5**	**7**	**4**

Partial Dam Removal (50' - Sediment) Non-Biological Categories	Score	
	Average	Range
Engineering and Geotechnical Feasibility	5	6
Water Delivery or Storage Potential	4	7
Fish Monitoring and Exclusion Capacity	7	5
Passage Operations	7	6
Cost: Construction	4	5
Cost: Operations & Maintenance	6	5
Timeframe to Achieve Resource Benefits (Fisheries)	5	6
Risks & Uncertainties	5	6

Passage Score Insights

Biological Feasibility for Passage

Biological feasibility for upstream passage received high scores for adult winter and summer run steelhead with a relatively low range of divergence of opinion among the technical group. This option should allow for a successful engineering design due to a significantly shortened dam height in conjunction with the natural hydrology anticipated during the migration periods for adult winter and summer run steelhead. It would be likely that the remaining impoundment would be at a fill and spill state prior to the arrival of adult steelhead (starting as early as mid to late December through the spring recession). In contrast, the technical group scored similarly for adult fall-run salmon, but with a wider range of uncertainty due to hydrologic variability during the fall and the timing of impoundment fill and spill prior to the arrival of adult salmon. Lower scores were given for upstream passage of juvenile steelhead and other native fish species. The group felt that Pacific lamprey upstream passage was achievable; however, with much uncertainty due to predation and passage efficiency factors.

Biological feasibility for downstream passage received similar scores as upstream passage across all species and life stages evaluated. Some uncertainty grew among the technical group on the efficiency of downstream migration with the possibility of designing a "fish-friendly" spillway with a secondary emigration route through a fish ladder/fishway. Concerns with predation were expressed for all species and life stages, with the most concern for juvenile steelhead trout, adult Chinook salmon, Pacific lamprey, and other native fish. However, the technical group acknowledged that more discussion will be needed to evaluate the possibility of eradicating invasive fish species during a construction related reservoir drawdown period.

Habitat and Water Quality

Physical habitat conditions scored favorably with the possibility of reconfiguring historic stream channels while incorporating habitat enhancements within the boundaries of the existing Lake Pillsbury footprint. Rehabilitating historical stream channels, designing floodplain type features, and improving and/or ensuring tributary connectivity for upstream and downstream passage were habitat elements all discussed. The technical group had much discussion regarding the habitat value upstream and downstream of this partial dam removal concept with focus on the loss of reservoir releases. Some suggested that existing summer flow releases conditions immediately below Scott Dam are better than natural hydrologic conditions, while others thought that the benefits of successful fish passage to the upper watershed outweigh the value of this habitat area with or without reservoir releases for all targeted species and life stages evaluated. Ultimately, the technical group agreed that habitat upstream of Scott Dam is of high value with little divergence of opinion for all species and life stages considered, except for adult summer-run steelhead. Conflicting opinions remain regarding habitat suitability for adult summer-run steelhead above Scott Dam and Lake Pillsbury.

Hydrologic Implications

Hydrologic implication pertaining to this 50-foot partial dam removal concept averaged fairly high (7s, with a 6 for adult summer-run steelhead) across all species and life stages with the idea that this concept would have less implications (impaired or changes) to the natural hydrograph, offering the opportunity for natural life history expressions to occur associated with the natural hydrology (migration timing, rearing opportunities, and habitat suitability for native fish). However, a few members of the group felt that natural hydrologic conditions have less benefit to juvenile steelhead,

smolt steelhead, juvenile salmon, and adult fall-run salmon than flows currently provided by reservoir releases.

Biological Viability

Biological feasibility scored fairly high for adult winter-run steelhead, adult fall-run salmon, lamprey, and other native fish with moderate to low divergence on scores. The technical group mostly agreed that the 50-foot partial dam removal concept would provide these species and life stages volitional movement through the system while providing adequate opportunity to choose spawning locations with little to no delay on migration. The technical group scored this passage option slightly lower with greater uncertainty for adult summer-run steelhead; mostly due to opposing opinions regarding upstream habitat conditions. Biological viability scored modest for juvenile steelhead, smolt steelhead, and juvenile salmon with a higher divergence of opinion due to passage limitation associated seasonal movements and predation risk. Predation risk on juvenile salmonids continues to be a major concern among the technical group with this concept and other passage options that include an impoundment feature. If a 50-foot partial dam removal was to be further evaluated, more investigation of non-native predatory fish (pikeminnow and bass) suppression/eradication techniques within Lake Pillsbury would need to occur (dewatering the reservoir, etc.).

Non-Biological Feasibility

Non-biological feasibility factors scored moderately with a high degree of divergent perspectives within the technical group. From a non-biological feasibility perspective, benefits of this concept may include the ability for fish monitoring and exclusion capacity (could play a role in managing non-native predatory fish species), ease of passage operability, and operations and maintenance costs. The lowest average scores provided by the technical group included water storage or storage potential and overall construction costs. A 50-foot partial dam removal would not provide water storage for diversion purposes during the dry season but may assist in managing sediment issues behind Scott Dam.

Scenario 4: Scott Dam Removal and Cape Horn Dam Modification / Removal

Removing and/or modifying major physical obstructions to achieve volitional fish passage supporting long-term species viability and recovery were the main drivers for these options.

For both options:

- Removal of Scott Dam, resulting in elimination of Lake Pillsbury.
- Sediment management and restoration of river channel and floodway underneath Lake Pillsbury to accommodate volitional fish passage.
- All fish passage management actions are the same for both options (i.e., fully volitional passage).

Option 4.1 **Remove Scott Dam and Modify Cape Horn Dam**

Brief Description

This option entails complete removal of Scott Dam, but leaves Cape Horn Dam (assume CDFW / NMFS current passage standards are met), diversion tunnel, and the powerhouse in place for continued power generation and water diversions from the Eel River to the Russian River.

Features

- Decommissioning study would be necessary with cost estimates for infrastructure removal (Scott Dam) and modernization (Cape Horn, possibly other elements).
- Full remediation for river channel and stored sediment.
- Full volitional passage and connectivity for anadromous and native fish species.
- Modify Cape Horn Dam to meet current CDFW/NMFS fish passage criteria.
- Retain the diversion tunnel and powerhouse.

Primary Benefits and Potential Shortfalls

All targeted native fish species and life stages would greatly benefit from removal of Scott Dam and modification of Cape Horn Dam. Only full removal of both Scott Dam and Cape Horn Dam would offer greater benefits to Eel River fisheries.

Benefits

- Removal of Scott Dam restores full volitional passage up- and downstream for salmonids and other native species to habitat currently inundated by Lake Pillsbury and above the reservoir's footprint.
- Supports long-term biological viability and recovery of ESA-listed salmonids and other native species.
- Long-term maintenance costs necessary to maintain fish passage limited to Cape Horn Dam.
- Shifting diversion seasons to periods of higher flows will significantly lower hydrologic impairment impacts to the Eel River.
- Reduces pikeminnow and bass habitat and reproductive success. Diminished opportunities for other invasive species to colonize and distribute throughout the Eel River.
- Reduces or eliminates mercury methylation and bio-accumulation.

- Modifications to Cape Horn Dam facilities will allow continued water export to Russian River and the ability to count adult salmonid upstream migrants.
- Satisfies both co-equal goals of two-basin principles by providing volitional fish passage at existing project facilities and maintaining diversion to Russian River.
- Reduces predation risk issues by eliminating optimal predatory fish habitat within Lake Pillsbury

Shortfalls

- Loss of annual water storage capacity in Lake Pillsbury (approximately 65K to 70K acre-feet; minus 10K acre-feet due to dead-pool conditions).
- Impacted non-passage activities associated with loss of Lake Pillsbury (e.g., recreation and tourism).
- Loss of summer diversion and increased costs for water supply reduces viability of current PVID irrigation practices, may reduce viability of some crops. Alternative water storage options may be needed to provide summer water supplies in Potter Valley.
- Reduced ability to manage flows from the project area will result in reduced summer flows and higher summer water temperatures below Scott Dam.
- Requires treatment / management of sediment with potential mercury contamination.

Remove Scott Dam and Modify Cape Horn Dam Summary

Benefits	Limitations / Risks
• Volitional passage for all native species and life stages to upstream habitat. • Supports long-term biological viability and recovery of ESA-listed salmonids. • Substantial benefit for fish passage, habitat, and population benefit at lower long-term cost. • Less impaired regulated annual hydrograph. • Reduced/eliminated mercury methylation and bio-accumulation. • Diversion facility for continued water export to Russian River. • Significantly reduced predation risk and predator recruitment from Lake Pillsbury.	• Loss of Lake Pillsbury and associated impacts (e.g., loss of water storage; affected recreation and tourism). • Loss of ability to manage flows in Eel River downstream. • Reduced summer flows and higher summer water temperatures downstream of Scott Dam. • Impacts to Lake Pillsbury homeowner property. • May require treatment of sediment with potential mercury contamination. • May require water storage alternatives (e.g., increase Coyote Valley Dam storage, multiple PV facilities).
Critical Uncertainties / Major Considerations	
• Federal government trust obligations to tribes. • Potential damage to downstream habitat (release of contaminated sediment, etc.).	

- Future climate change could diminish the amount of habitat available in the upper Eel watershed.
- Should explore alternative diversion mechanisms (see run-of-the-river water supply scenario description).
- Unknown costs of maintaining modified Van Arsdale fish passage structures
- Unknown consequences on water quality.
- Unknown costs for rehabilitating the lakebed (See McMillen Jacobs Study)
- Uncertain about stability of dam infrastructure.

Next Steps to Consider Further

- Develop and evaluate fish passage options for Cape Horn Dam that support the two-basin solution.
- Link to water supply options and considerations.

Passage Scores - Remove Scott Dam and Modify Cape Horn Dam

Biological and Non-Biological Scoring Results – average and range of scores derived from the Fish Passage Working Group:

Remove Scott Dam & Modify CHD Habitat and Biological Feasibility Categories	Juvenile Steelhead		Smolt Steelhead		Adult Winter-Run Steelhead		Adult Summer (Spring)-Run Steelhead Migration		Adult Summer (Spring)-Run Steelhead Holding		Juvenile Chinook		Adult Fall-run Chinook		Pacific Lamprey		Sacramento Sucker/other native fish species	
	Average	Range	Average	Range	Average	Range	Average	Range	Average	Range	Average	Range	Average	Range	Average	Range	Average	Range
Biological Feasibility for Upstream Passage	**8**	**4**	**NA**	**NA**	**9**	**2**	**9**	**2**	**NA**	**NA**	**NA**	**NA**	**9**	**2**	**8**	**3**	**8**	**4**
Reservoir navigability	9	2	NA	NA	10	1	10	1	NA	NA	NA	NA	10	1	10	1	9	2
Passage efficiency (fishway, etc.)	8	5	NA	NA	9	2	9	2	NA	NA	NA	NA	9	2	9	3	8	6
Predation	7	4	NA	NA	9	3	9	3	NA	NA	NA	NA	8	3	8	3	8	4
Biological Feasibility for Downstream Passage	**8**	**4**	**9**	**3**	**9**	**2**	**9**	**2**	**NA**	**NA**	**8**	**4**	**NA**	**NA**	**9**	**2**	**8**	**4**
Reservoir navigability	9	2	10	2	10	1	10	1	NA	NA	9	2	NA	NA	9	3	9	2
Passage efficiency (fishway, etc.)	8	3	9	2	9	2	9	2	NA	NA	9	2	NA	NA	9	2	8	5
Predation	7	4	8	3	8	2	8	2	NA	NA	7	3	NA	NA	8	4	7	4
Habitat and Water Quality	**7**	**8**	**8**	**3**	**9**	**3**	**8**	**4**	**6**	**7**	**9**	**3**	**9**	**3**	**9**	**2**	**9**	**3**
Habitat upstream of Scott Dam	9	3	9	3	9	2	9	4	8	8	9	2	9	4	9	2	9	5
Water quality within reservoir	8	7	9	4	10	1	8	6	6	7	9	4	9	3	9	2	8	3
Habitat downstream of Scott Dam	8	5	9	4	9	7	8	5	6	9	9	4	8	6	9	2	9	3
Water quality below reservoir	5	7	8	6	9	4	7	6	3	8	7	7	8	4	9	2	9	3
Hydrologic Implications	**8**	**4**	**9**	**2**	**9**	**2**	**8**	**3**	**8**	**2**	**9**	**3**	**8**	**4**	**9**	**2**	**8**	**3**
Biological Viability (Spatial Structure & Diversity)	**9**	**2**	**9**	**2**	**9**	**2**	**9**	**2**	**9**	**2**	**9**	**2**	**9**	**3**	**9**	**2**	**9**	**5**

Remove Scott Dam & Modify CHD Non-Biological Categories	Score	
	Average	Range
Engineering and Geotechnical Feasibility	7	5
Water Delivery or Storage Potential	4	6
Fish Monitoring and Exclusion Capacity	7	7
Passage Operations	9	3
Cost: Construction	5	8
Cost: Operations & Maintenance	8	3
Timeframe to Achieve Resource Benefits (Fisheries)	5	8
Risks & Uncertainties	8	5

Passage Score Insights

Biological Feasibility for Passage

Scorers generally agreed that removal of Scott Dam and modification of Cape Horn Dam benefits anadromous fish for passage throughout the entire year, with no unnatural delays in upstream or downstream migration. Dam removal allows all habitat underneath and upstream of Scott Dam to be accessible, including multiple tributaries flowing into Lake Pillsbury. Scott Dam removal eliminates the "ecological trap" resulting from colder water releases below Scott Dam discouraging spring outmigration when conditions downstream of Cape Horn Dam are favorable. In addition, Scott Dam removal reduces the substantial uncertainties associated with engineered passage structures such as guide nets within the reservoir, but still retains impacts associated with passage through the Cape Horn Dam fish ladder and downstream juvenile passage over Cape Horn Dam. Removal of Scott Dam would significantly reduce the effects from pikeminnow predation (and bass), by eliminating the primary source of pikeminnow habitat and production, and alterations to water temperatures from reservoir operations.

Note that project area does not presently support significant numbers (if at all) of adult summer-run steelhead below Scott Dam. The majority of potential adult summer-run holding habitat remains above Scott Dam, which is currently inaccessible due to Scott Dam.

Habitat and Water Quality

Scorers had divergent perspectives on the effect of Scott Dam removal on habitat and water quality, especially juvenile steelhead and adult summer steelhead holding habitat. Scorers generally believe suitable habitat exists *above* Scott Dam (with the exception of adult summer-run steelhead holding habitat). For juvenile steelhead, water quality "within reservoir" (i.e., where Lake Pillsbury now lies) is rated as high, but the wide range of scores suggests significant uncertainty.

Scorers held divergent perspectives on the impacts of water quality below the reservoir on juvenile steelhead rearing habitat and adult summer steelhead holding habitat. Some believed water quality could decrease due to the loss of cold water releases after dam removal. Others believed sufficient habitat would remain. Overall, "water quality below reservoir" scores display a relatively wide range across all species and life histories. This suggests further work clarifying underlying assumptions may reduce the uncertainty of these assessments.

Continued maintenance of Cape Horn Dam retains some negative effects from water impoundment, including increased water temperature, evaporative water losses, and alteration of nutrient and food supply constituents in flow releases downstream of Cape Horn Dam.

Hydrologic Implications

Dam removal (with continued water diversion to the Russian River) restores a more natural annual hydrograph to the Eel River below Cape Horn Dam during all water year types, shifting hydrograph alteration from seasons with more sensitive life stages, i.e., fall (during upstream adult migration when Lake Pillsbury is filling) and spring (during juvenile and smolt outmigration when water diversions and water temperature cues confound outmigration) to winter (when effects of water diversion are relatively minor).

Biological Viability

The strongly aligned scores indicate that scorers rank Scott Dam removal with Cape Horn Dam modification as the second-best alternative (first being removal of both dams) for achieving volitional fish passage. Scott Dam removal accommodates biological viability by enabling volitional movement of adult and juvenile life stages in both upstream and downstream directions. Scott Dam removal improves life history variation, responsiveness to stochastic environmental events (floods, droughts, fires), and reduces risks of extinction by artificially selecting a single or few life history variants (i.e., not putting all your eggs in one life history basket).

Non-Biological Feasibility

This alternative scored relatively low on water delivery/ storage potential, construction, and timeframe to achieve resource benefits for fisheries. Scorers diverged the most (raising the uncertainty associated with the score) on construction and timeframe with fish monitoring and exclusion capacity also receiving a wide range of scores. Further work should seek to clarify the uncertainties in these rankings, increasing the likelihood a proposed solution will achieve hoped-for benefits and reduce undesired shortfalls.

Scorers diverged the most (raising the uncertainty associated with the score) on construction and timeframe with fish monitoring and exclusion capacity also receiving a wide range of scores. Further work should seek to clarify the uncertainties in these rankings, increasing the likelihood a proposed solution will achieve hoped-for benefits and reduce undesired shortfalls.

Option 4.2 **Remove Both** Scott Dam and Cape Horn Dam with Diversion

Brief Description

This option would entail the complete removal of Scott Dam and Cape Horn Dam but retain the diversion tunnel and powerhouse.

Features

- Decommissioning study would be necessary with cost estimates for full infrastructure removal (Scott Dam and Cape Horn Dam) and modernization (diversion facility, tunnel, etc.).
- Full remediation for river channel and stored sediment.
- Full volitional passage and connectivity for anadromous fish throughout the project area.
- Provide Potter Valley Project diversion (i.e., retain the diversion tunnel and the powerhouse).

Primary Benefits and Potential Shortfalls

All targeted native fish species and life stages realize the greatest overall benefits with removal of both Scott Dam and Cape Horn Dam, eliminating all human-made obstructions to fish passage in the project area.

Benefits

- Supports and promotes long-term biological viability and recovery of ESA-listed salmonids and other native fish species.

- Full removal of Scott Dam and Cape Horn Dam provides the maximum fish passage, habitat, and population benefits at the lowest long-term cost (little or no long-term maintenance cost).
- Same benefits as with removal of Scott Dam, but with substantially improved volitional fish passage at Cape Horn Dam.
- Additional cost savings from elimination of maintenance costs associated with Cape Horn Dam.
- Significantly reduces predation risks by eliminating Lake Pillsbury and Van Arsdale Reservoir.

Shortfalls

- Same shortfalls as Option 4.1.
- Without an alternative diversion mechanism, removal of both dams may not satisfy the two-basin solution.
- Eliminates fish counting facility at the Van Arsdale Fish Station.

Remove Both Scott Dam and Cape Horn Dam Summary

Benefits	Limitations / Risks
• Greatest overall benefits for fisheries. • Same as Remove Scott Dam & Modify Cape Horn Dam (Option 4.1), but lower long-term costs because of no Cape Horn Dam maintenance costs. • Significantly reduced predation risk and predator recruitment from Lake Pillsbury.	Same as Remove Scott Dam & Modify Cape Horn Dam (Option 4.1), except: • Higher initial costs to remove both dams. • May require new/additional infrastructure to satisfy the two-basin solution objective, including diversion and storage.
Critical Uncertainties / Major Considerations	
Same as Remove Scott Dam & Modify Cape Horn Dam (Option 4.1), except: • Uncertain whether a run-of-the-river concept may require additional infrastructure at Cape Horn Dam/Van Arsdale to continue 300 cfs water diversion to the Russian River (see water supply section).	

Next Steps to Consider Further

Developing viable water reliability alternatives is needed for this option to support a two-basin solution. This may include both an alternative diversion facility to Cape Horn Dam and additional storage facilities.

Passage Scores - Remove Both Scott Dam and Cape Horn Dam

Biological and Non-Biological Scoring Results – average and range of scores derived from the Fish Passage Working Group:

Remove Both Dams w/ Alternate Diversion Habitat and Biological Feasibility Categories	Juvenile Steelhead		Smolt Steelhead		Adult Winter-Run Steelhead		Adult Summer (Spring)-Run Steelhead Migration		Adult Summer (Spring)-Run Steelhead Holding		Juvenile Chinook		Adult Fall-run Chinook		Pacific Lamprey		Sacramento Sucker/other native fish species	
	Average	Range	Average	Range	Average	Range	Average	Range	Average	Range	Average	Range	Average	Range	Average	Range	Average	Range
Biological Feasibility for Upstream Passage	**9**	**4**	**NA**	**NA**	**10**	**1**	**10**	**1**	**NA**	**NA**	**NA**	**NA**	**10**	**1**	**9**	**2**	**9**	**2**
Reservoir navigability	10	1	NA	NA	10	1	10	1	NA	NA	NA	NA	10	2	10	1	10	1
Passage efficiency (fishway, etc.)	9	3	NA	NA	10	1	10	1	NA	NA	NA	NA	10	1	10	1	10	1
Predation	8	5	NA	NA	9	2	9	2	NA	NA	NA	NA	9	2	9	2	9	4
Biological Feasibility for Downstream Passage	**9**	**4**	**9**	**3**	**10**	**2**	**9**	**2**	**NA**	**NA**	**9**	**4**	**NA**	**NA**	**9**	**3**	**9**	**4**
Reservoir navigability	10	1	10	1	10	1	10	1	NA	NA	10	1	NA	NA	10	1	10	1
Passage efficiency (fishway, etc.)	10	3	10	2	10	2	10	2	NA	NA	10	2	NA	NA	10	2	10	2
Predation	8	5	8	4	9	2	9	3	NA	NA	8	4	NA	NA	8	5	8	5
Habitat and Water Quality	**7**	**9**	**9**	**3**	**9**	**3**	**8**	**4**	**6**	**8**	**9**	**3**	**9**	**3**	**9**	**1**	**9**	**3**
Habitat upstream of Scott Dam	9	3	9	3	9	2	9	4	8	8	9	2	9	4	9	2	9	5
Water quality within reservoir	8	7	9	4	10	1	8	6	6	8	9	4	9	3	9	2	8	3
Habitat downstream of Scott Dam	8	5	9	4	9	7	8	5	6	9	9	4	9	6	9	2	9	3
Water quality below reservoir	5	9	8	6	9	4	7	6	4	10	8	7	8	4	9	2	9	3
Hydrologic Implications	**9**	**4**	**9**	**2**	**9**	**1**	**9**	**4**	**9**	**3**	**9**	**3**	**9**	**4**	**9**	**2**	**9**	**3**
Biological Viability (Spatial Structure & Diversity)	**10**	**1**	**10**	**1**	**10**	**1**	**9**	**2**	**9**	**2**	**10**	**2**	**9**	**2**	**10**	**1**	**9**	**5**

Remove Both Dams w/ Alternate Diversion Non-Biological Categories	Score	
	Average	Range
Engineering and Geotechnical Feasibility	7	7
Water Delivery or Storage Potential	3	5
Fish Monitoring and Exclusion Capacity	3	5
Passage Operations	10	1
Cost: Construction	4	10
Cost: Operations & Maintenance	8	5
Timeframe to Achieve Resource Benefits (Fisheries)	4	8
Risks & Uncertainties	7	8

Passage Score Insights

Biological Feasibility for Passage

Scorers were in strong agreement that the removal of Scott Dam and Cape Horn Dam provides the best alternative for achieving volitional fish passage, for all salmonid species and life stages, for both upstream and downstream migration, and throughout the entire year. Scott Dam and Cape Horn Dam removal performs best in terms of passage efficiency, with no unnatural delays in upstream or downstream migration.

Dam removal allows all habitat underneath and upstream of Scott Dam to be accessible, including multiple tributaries flowing into Lake Pillsbury. Full dam removal eliminates the "ecological trap" resulting from colder water releases below Scott Dam discouraging spring outmigration when conditions downstream of Cape Horn Dam are favorable. In addition, full dam removal avoids the huge uncertainties associated with engineered passage structures such as guide nets within the reservoir, and fish ladders.

Habitat and Water Quality

The overall pattern of scorers' assessments of this alternative follow those for alternative 4.1 fairly closely, with an even greater range of scores on the impact of water quality below the reservoir. Similar to Option 4.1, scorers had divergent perspectives related to habitat upstream of Scott Dam and its impact on non-migrating adult steelhead.

A free-flowing river eliminates unnatural consequences of a water impoundment, including manipulation of water temperatures downstream of Scott Dam, evaporative water losses, and alteration of nutrient and food supply constituents in flow releases downstream of Scott Dam.

Hydrologic Implications

Dam removal (with continued water diversion to the Russian River) restores a more natural annual hydrograph to the Eel River below Cape Horn Dam during all water year types, shifting hydrograph alteration from seasons with more sensitive life stages – i.e., fall (during upstream adult migration, when Lake Pillsbury is filling) and spring (during juvenile and smolt outmigration when water diversions and water temperature cues confound outmigration), to winter (when effects of water diversion are relatively minor).

Biological Viability

Full dam removal best accommodates biological viability of all passage options by enabling volitional movement of juvenile and adult life stages in both upstream and downstream directions, maximizing life history variation, responsiveness to stochastic environmental events (floods, droughts, fires), and reducing risks of extinction by artificially selecting a single or few life history variants (i.e., not 'putting all your eggs in one life history basket').

Non-Biological Feasibility

This alternative scores the highest on engineering, O&M costs, and risks/uncertainties. However, there is a very wide divergence of scores on the cost of construction, and wide divergence on timeframe to achieve benefits, risks/uncertainties, and engineering. This suggests further work is needed to clarify these issues and potentially to develop plans that will reduce that uncertainty.