NORTH COAST RESOURCE PARTNERSHIP

A. General Project Information

1. Organization / Project Sponsor Name:
   Salmonid Restoration Federation

2. Project Name:
   Sproul and Redwood Creek, South Fork Eel Storage and Forbearance Program

3. Has the organization implemented similar projects in the past? ☐ yes ☒ no

4. **If the project sponsor has worked with NCRP in the past, describe the project and outcome.**
   SRF has been awarded a storage and forbearance grant through NCRP for a similar project on Redwood Creek where we are working with five households to develop dry season storage. This past grant award is in the final stages of being contracted.

5. **Please describe the qualifications, experience, and capacity of the project team that will be overseeing project implementation.**

SRF has been actively engaged in flow enhancement planning in the SF Eel River for 10 years including providing technical education and assistance, conducting targeted outreach, low flow monitoring, and preparing implementation plans and feasibility studies with Stillwater Sciences. Stillwater is also the lead on multiple projects in this region including Sanctuary Forest flow enhancement projects, and Eel River Watershed Improvement Group restoration activities in Redwood and Sproul Creeks.

6. Is this project part of a larger project or program? If so, what effectiveness monitoring is being conducted and what are the results?

This project is part of SRF's larger South Fork Eel River Flow Enhancement Planning efforts to improve flows in Redwood and Sproul Creeks. SRF began low-flow monitoring in Redwood Creek in 2013 and in Sproul Creek in 2018. Monitoring results show that both creeks become disconnected by mid-summer when water temperature and DO become unsuitable for salmon. Other pre-project data in Redwood Creek show an abundance of juvenile Coho salmon and that these fish become stranded by September.

7. Project Abstract [500 characters max.]

SRF will design, permit and construct three storage and forbearance projects along Lower Mainstem Sproul Creek with ~150,000 gallons of total storage for domestic use and wildfire suppression and to maintain flows for salmonids. Additionally, this project provides cost share to the existing Redwood Creek project covering half of construction cost for 250,000 gallons of storage. Finally, SRF will administer/monitor the storage and forbearance projects during the first several years of operations.

8. **Project Description** [3,000 characters max.]

SRF's Sproul and Redwood Creek, South Fork Eel River Storage and Forbearance Program will address drought impacts in the Sproul and Redwood Creek tributaries and provide multiple benefits to salmonids, wildlife, fire resilience, and rural communities. Both Sproul and Redwood Creeks suffer from the legacy impacts of industrial logging and unregulated cannabis diversions yet still retain high-habitat value for threatened salmon and other aquatic species. These tributaries become disconnected during the dry season and are lacking sufficient municipal infrastructure for the number of residents.

According to the California Water Action Plan, the South Fork Eel River is considered one of five priority watersheds for flow enhancement projects in California. Sproul Creek is a critical tributary to the South Fork Eel River because of its high potential for salmonid recovery. Lack of instream flows is a primary limiting factor for salmonids and contributes to lack of water reliability for rural landowners. Recent drought conditions have impacted flows, fire protection resources, water availability and water quality.

The project would design, permit and implement three sites with 150,000 gallons of total water storage in a concentrated reach of Lower Sproul Creek and supplement storage and forbearance efforts in the mainstem of Redwood Creek. Please note that we are requesting a $275,000 line item (Task D.3) to cover half of construction for the recently contracted Redwood Creek storage and forbearance project since the price of materials has drastically increasinced since we submitted that proposal in 2021. Please note that the multi-benefit drought solicitation (2021) and this DWR Prop 1 solicitation are from different funding sources and can provide a match.

SRF will manage program implementation including: landowner coordination, permit compliance support, ongoing community outreach and overall project management. Stillwater will develop designs, coordinate permiting, and oversee construction.

Expected benefits include regional self-sufficiency, enhanced habitat for juvenile salmonids and steelhead, and improved fire resilience. Other benefits include creating a scalable model for a localized and replicable storage and forbearance program that can be expanded in Redwood and Sproul Creeks and can be implemented in other watersheds lacking in municipal infrastructure.

SRF's Sproul Creek Low Flow Monitoring page can be found at: https://www.calsalmon.org/programs/sproul-creek-low-flow-monitoring.

SRF's Redwood Creek Low Flow Monitoring page can be found at: https://www.calsalmon.org/programs/redwood-creek-low-flow-monitoring

Stillwater is preparing Flow Enhancement Implementation Plans for the Redwood and Sproul Creek watersheds that will be available in January 2023. Within these plans, the storage and forbearance projects proposed herein are high priority actions.

9. Specific Project Goals/Objectives

Goal 1: Improve Instream flows for salmon habitat and water security [100 characters max.]
Goal 1 Objective: Prioritize winter diversion to storage projects that facilitate forbearance during the dry season [200 characters max.]
Goal 1 Objective: Build capacity for water self-reliance
Goal 1 Objective: Conserve instream flows for salmonids
Goal 1 Objective: Serve as a pilot project and build support for larger-scale restoration projects

Goal 2: Advance Multi-Benefit Regional Planning to Address Climate Change and Fire Risk
Goal 2 Objective: Improve fire resilience and planning
Goal 2 Objective: Reduce fire hazard risks
Goal 2 Objective: Increase water reliability during longer dry seasons
Goal 2 Objective:

Goal 3: Ensure Water Supply Reliability and Quality
Goal 3 Objective: Increase water storage for use during the dry season
Goal 3 Objective: Improve water quality by conserving instream summer flows
Goal 3 Objective: Create a storage and forbearance paradigm and program
Goal 3 Objective:

Additional Goals & Objectives (List)
This project is part of a larger programmatic effort to improve streamflow in the South Fork Eel River watershed. Other qualitative goals and objectives include creating a paradigm for landowners and small municipalities to store wet season runoff for use during the dry season. SRF hopes to create storage and forbearance resources that can be utilized in other decentralized watersheds that lack sufficient municipal water infrastructure to meet human needs and sustain conservation resources.

10. Describe how the project addresses the NCRP Goals and Objectives selected. [1,000 characters max.]

This project aligns with several NRCP Goals and Objectives including: Goal 1) Multi-Benefit Regional Planning, Goal 2) Healthy Ecosystems, Habitats and Species, and Goal 4) Clean Water for Human Communities. The project will accomplish this by working in critical reaches of Sproul and Redwood Creeks that have high aquatic habitat value and are also densely populated by humans. This project would provide storage and forbearance projects to enable participating landowners to forbear from diverting water during the dry summer months when juvenile salmonids are most vulnerable to low flow conditions and high water temperatures. Additionally, this project would provide water storage to fight wildfires. The regional planning efforts associated with this project are scalable and could be applied to other areas within the watersheds.

11. **Describe the physical, biological and/or community need for the project**. [1,000 characters max.]

Sproul and Redwood Creeks are significant tributaries to the SF Eel River which suffers from the legacy impacts of logging and cannabis cultivation but still retains high-habitat value for salmonids.

According to the Sproul and Redwood Creek SHaRP reports (CDFW and NOAA), fisheries populations remain depressed due to a history of anthropogenic disturbance. Suitable summer water availability and quality is a primary limiting factor. The storage and forbearance projects proposed herein are specifically target stream reaches where SRF's flow and temperature monitoring indicate highest flow and water quality impairments.

The community need for the project is high since landowners are responsible for their own water systems with no financial support or available municipal water provider. Most landowners don't currently have sufficient storage and rely on dry season diversion from already depleted streamflows.

12. **Describe the financial need for the project**. [1,000 characters max.]

In general, throughout the project area, landowners are responsible for their own water systems, so providing technical and/or financial assistance can provide many landowners with the support they need to become more conservation-conscious and self-reliant. In addition, water storage projects help communities prepare for dry periods and provide more reliable and safe drinking water all while protecting important stream ecosystems through the forbearance agreement mechanism.

Many landowners are good stewards of their land but do not necessarily have the resources to forbear from diverting water for these increasingly longer dry seasons. Additionally, there is a financial need to have rural landowners have plumbing hookups for easy fire department hose connections during fire emergencies. Sproul Creek and much of Redwood Creek are in a DAC and there is no municipal water.

13. **Describe potential adverse impacts from project implementation and how they will be mitigated.**

There are no foreseen adverse impacts to the proposed storage and forbearance projects except for grading which will be permitted through the Humboldt County Building Department. Project benefits including water storage and erosion control and native grass seeding will offset any grading impacts. Projects will also be selected on flat terrain and all sites will be vetted by Stillwater's licensed professional geologists and engineers.

14. **Will this project mitigate an existing or potential Cease and Desist Order or other regulatory compliance enforcement action?** ☐ yes ☒ no
    If yes, please describe. [500 characters max.]

15. **Does the project address a contaminant listed in AB 1249 (nitrate, arsenic, perchlorate, or hexavalent chromium)?**
    ☐ yes ☒ no
    If yes, provide a description of how the project helps address the contamination. [500 characters max.]

16. **Describe how the project contributes to regional water self-reliance and addresses climate change.** [1,000 characters max.]

This project would enable water self-reliance for multiple landowners whose water reliability is affected by longer dry seasons and intermittent dry season flows. These tributarie are largely in private ownership with domestic, agricultural and forestry related water uses and no municipal water infrastructure.

Part of the work proposed for this planning and implementation project will be to develop permit conditions and project operation approaches that take extreme climate conditions into consideration. For example, proposed forbearance periods will not be based solely on observed historic conditions, but rather will be extended to provide a margin of safety under climate change conditions.

By building projects that will reduce the amount of water diverted for human use during the dry season, this project will provide climate change resilience above baseline conditions.

17. **Does the project increase public safety with regards to flood protection, wildfire hazard risk reduction, increasing firefighting capacity, or in other ways contribute to regional emergency resiliency?**
    ☒ yes ☐ no
    Please explain. [500 characters max.]

This project would increase public safety in regards to wildfire hazard risk reduction and increase firefighting capacity by having hookups associated with the proposed tank storage.

18. **Does the project employ new or innovative technologies or practices, including Decision Support Tools that support the integration of multiple jurisdictions, including, but not limited to, water supply, flood control, land use, and sanitation?** ☐ yes ☒ no
    If yes, please describe. [500 characters max.]

19. **Describe the population served by this project, including any economically disadvantaged communities or Tribes that will directly benefit.**

The population served by this project are rural landowners who have no access to a water utility. They are long-term stewards of their property but do not have the funds required to invest in the level of water storage required to forbear for a 5-month dry season. Sproul Creek is adjacent to Garberville, CA which is a DAC. Redwood Creek is adjacent to Lower Redway which is also a DAC. SRF has done outreach to Wailaki tribal members.

20. **Describe local and/or political support for this project.** [500 characters max.]

SRF has received local and political support for our flow enhancement planning efforts in the South Fork Eel including support letters for related projects from the NCRWQCB, Senator Mike McGuire's office, Congressman Huffman's office, and Hum Co Board of Supervisors. Other forms of local support have included previous coordination with the Briceland and Sproul Creek Volunteer Fire Departments and Eel River Watershed Improvement Group who has several restoration projects in both watersheds.

21. **List all collaborating partners and agencies and nature of collaboration.** [750 characters max.]

Collaborating partners include the Wagner Ranch (one of the largest private landowners in Sproul Creek), and other landowners in the Lower reaches of mainstem Sproul Creek. SRF has also partnered with Cal Trout, Green Diamond, the Marshall Ranch and CDFW/NOAA re: Sproul and Redwood Creek SHaRP efforts. SRF's TAC has provided technical expertise in our Sproul and Redwood Creek planning efforts. Our TAC includes representatives from the Wildlife Conservation Board, CDFW, NCRWQCB, and NOAA, as well as prominent stakeholders in Sproul Creek. SRF is also partnering with David Sanchez, GM of the Marshall Ranch, who represents the Wailaki tribe and is helping coordinate tribal consultations.

22. **Is this project part or a phase of a larger project?** ☒ yes ☐ no
    Are there similar efforts being made by other groups? ☒ yes ☐ no
    If yes to either, please describe. [500 characters max.]

This project is part of SRF's larger flow enhancement planning effort in the SF Eel River watershed that includes planning and prioritization efforts in Sproul and Redwood Creek. Stillwater (on behalf of SRF) is in the process of completing Feasibility Studies and Implementation plans for Sproul and Redwood Creeks that looks at a variety of flow enhancement approaches. SRF has worked closely with Sanctuary Forest for several years to build capacity for administering this type of program.

B. Project Location

1. **Describe the latitude and longitude of the project site.**
   Latitude: 40.068 Longitude: 123.831

2. **Site Address (if relevant):**
   3925 Sproul Creek Rd, Garberville, CA 95542 and other nearby properties; and mainstem Redwood Creek properties downstream of the Marshall Ranch in Briceland, CA

3. **Does the applicant have legal access rights, easements, or other access capabilities to the property to implement the project?**
   ☒ yes — If yes, please describe below
   ☒ no — If no, please provide a concise narrative below with a schedule, to obtain necessary access
   ☐ NA — If NA, please describe below why physical access to a property is not needed

   Explanation. [500 characters max.]

Landowner permission and access will be required. If funded, SRF will secure landowner permission and access agreements for all project sites.

4. **Project Location Notes:**

The proposed project includes the mainstem of Redwood Creek near Briceland and Lower Sproul Creek which is approximately one mile west of Garberville. Both tributaries are approximately 26-square miles and flow into the South Fork Eel.

C. Benefits To Disadvantaged Communities and/or Tribes

1. **Does the project provide direct water-related benefits to a project area comprised of Disadvantaged Communities or Economically Distressed Communities?** If partially, please estimate percentage of project that benefits disadvantaged communities and list the communities.
   ☒ Entirely
   ☐ Partially; estimate the percentage of benefits provided directly to DAC:
   ☐ No

List the Disadvantaged Community(s)

Sproul Creek is adjacent to Garberville, CA which is a DAC. Redwood Creek is adjacent to Lower Redway which is also a DAC.

2. **Does the project provide direct water-related benefits to a project area comprised of Severely Disadvantaged Communities (SDAC)**? If partially, please estimate percentage of project that benefits disadvantaged communities and list the SDACs.
   ☐ Entirely
   ☐ Partially; estimate percentage of benefits provided directly to SDAC:
   ☒ No
   List the Severely Disadvantaged Community(s)

3. **Does the project provide direct water-related benefits to a Tribe or Tribes**? If partially, please estimate percentage of project that benefits Tribe(s) and list the Tribes.
   ☐ Entirely
   ☐ Partially; estimate percentage of benefits provided directly to Tribe(s):
   ☒ No
   List the Tribal Community(s)

   If yes, please provide a letter of support from each Tribe listed as receiving these benefits.

4. **If the project provides benefits to a DAC, EDA or Tribe, explain the water-related need of the DAC, EDA or Tribe and how the project will address the described need.** [750 characters max.]

This project would benefit residents that rely on water systems on their properties. Sproul Creek has no water municipality and Redwood Creek's is only for a small portion serviced by BCSD. Historically, there was reliable water availability but in the last decade, flows have become extremely low with longer dry seasons. Climate change trends indicate that longer dry seasons and higher fire risk are the new norm. Some residences already need to have water trucked in which is costly economically and environmentally. This project would provide a means for residences to store water during the winter months which would provide more water security for the residences while protecting instream flow and resources for fire hazard reduction.

5. **Describe the kind of notification, outreach and collaboration that has been completed with the county(ies) and/or Tribes within the proposed project impact area, including the source and receiving watersheds, if applicable.** [500 characters max.]
   SRF has a webpage about Sproul Creek flows and updates it along with social media throughout the dry season. SRF has hosted several community meetings to discuss the monitoring and planning conducted in Sproul Creek and flow enhancement opportunities.

The meetings were promoted with press releases, email blasts, social media announcements, radio interviews, and posters throughout the greater community. SRF has also done preliminary tribal consultations in Sproul Creek.

D. Project Benefits & Justification

1. **For each of the Potential Benefits that the project claims, complete the following table to describe an estimate of the benefits expected to result from the proposed project. Provide quantitative benefit amounts for at least the primary and secondary benefits. Provide a qualitative narrative description of expected benefits that cannot be quantified.** *See the NCRP Project Application Instructions for more information and a listing of potential benefits.*

PROJECT BENEFITS TABLE

Benefit Description	Units	Quantitative Amount	Qualitative Description
Water Supply			
Increased streamflow	cfs	0.21	8 * 10 gpm pump rate
Avoided cost, water supply purchases	water truck trips	$37,500	$680 * 55 trips
Improved Water Supply Reliability & Management	Households	8	# of participants
Water Quality			
Water Temperature	Degrees	Unknown	Temp may decrease
Dissolved oxygen	Mg/L	Unknown	DO will increase
Climate Change			
Enhanced firefighting capabilities	Households	8	New fire hydrants
Other Ecosystem Service Benefits			
Instream Habitat	miles	6	Downstream reaches

Benefit Description	Units	Quantitative Amount	Qualitative Description
Jobs Created or Maintained			
Construction worker	Hrs	660	Project budget hrs
Non Profit staff	Hrs	1038	Project budget hrs
Consultants	Hrs	1178	Project budget hrs
Other Benefits			
Education & Training	households	8	Technical assistance

2. **Does the proposed project provide physical benefits <u>outside</u> of the North Coast Region?**
   ☐ yes ☒ no
   If yes, describe the impacts to areas outside the North Coast Region. [500 characters max.]

3. **List the impaired water bodies (303d listing) that the project benefits**:
   The South Fork Eel River is listed in the 2002 CWA Section 303 (d) as having pollution/stressors of sedimentation/siltation and temperature with potential sources including Hydromodification and flow regulation/modification. This project will improve the flow in the South Fork Eel River.

4. **Describe how the project benefits salmonids, endangered/threatened species and sensitive habitats.**
   Specifically, this project will improve rearing habitat for juvenile coho salmon and steelhead by improving summer flows. The result of the site-specific flow enhancement projects within the sub-basins would be increased water quantity during the existing dry season low-flow conditions and improved water quality (i.e., decreased temperature and increased dissolved oxygen), which would increase survival of many species.

   Lack of flow and water quality during the dry season is the primary factor that limits juvenile salmon survival. Through planning and implementation, this project aims to protect and improve the rearing habitat that is essential for the viability of salmon populations in the project area. Increasing streamflow in key reaches would greatly improve the potential for coho salmon survival in these tributaries.

5. **Have alternative methods been considered to achieve the same types and amounts of physical benefits as the proposed project?**
   ☒ yes ☐ no
   Please explain. [500 characters max.]

SRF and Stillwater Sciences have spent years researching the flow enhancement potential in Sproul and Redwood Creek. In Sproul Creek there is not a lot of flat terrain for large-scale flow enhancement projects. In Redwood Creek, SRF will implement a 10-million gallon direct flow augmentation project in 2023 that will release cool water into the mainstem. However even with large scale flow augmentation, storage and forbearance is critical to ensure that released water will not be diverted.

6. **Is the proposed project the lowest cost alternative to achieve the physical benefits?**
   ☒ yes ☐ no
   Please explain. [500 characters max.]

Although other approaches for flow enhancement are being explored, storage and forbearance remains the only proven method with a long track record. This project will use grant funds for high-priority projects where landowners have limited financial means, but landowners will bear the ongoing costs of operations and maintenance through legal forbearance agreements and permits.

7. **How will the project be monitored to determine whether it is producing the desired benefits?**

SRF will conduct several years of project monitoring as part of this grant. Additionally, SRF and participating landowners will comply with the long-term operations and maintenance requirements of Prop 1 grant awards.

8. **Provide a narrative for project technical justification. Include any other information that supports the justification for this project, including how the project can achieve the claimed level of benefits listed below.** [3,000 characters max.]

- SRF anticipates that increased water storage in Sproul and Redwood Creeks would provide multiple tangible benefits to habitat conditions, aquatic species, and towards fire hazard reduction. The proposed project would enhance instream flows in Sproul and Redwood Creeks, both critical tributaries to the South Fork Eel River. The California Water Action Plan (CWAP) recognizes the SF Eel as one of five priority watersheds in the state for flow enhancement. To benefit local water systems, the CWAP tasks CDFW with developing 10 off-channel storage projects in coastal watersheds. Improving water storage capacity within the project area will result in improved regional self-reliance, increased water security for people, and improved habitat conditions for fish and wildlife in a time of drought.

  NOAA Fisheries identifies the South Fork Eel River as a core population vital to the preservation of the Southern Oregon Northern California Coast (SONCC) ESU. The SONCC

Coho Recovery Plan indicates the need for “improving flow timing or volume” in each of the first ten action items in the plan (NMFS 2014). The proposed project is consistent with several recommendations in the Final Southern Oregon/Northern California Coast Coho Salmon Recovery Plan, NOAA Fisheries, Arcata, CA, 2014 including hydrology tasks to improve flow timing or volume:

SONCC-SFER 3.1.6.3 Hydrology - Identify diversions in tributaries that have sub-surface or low flow barrier conditions during the summer.

The SHaRP process ranked both Sproul and Redwood Creeks as high priority tributaries for habitat value but despite decades of instream restoration work these creeks suffer from lethal low-flow conditions where flows are often sub-surface in the summer.

The NCRWQCB, Action Plan to Implement Water Quality Objectives for Temperature in the Mattole, Navarro, and Eel River Watersheds, August 2013: includes the following water quality objectives for temperature: 6.5.9: Water Use, “to support efforts to develop off stream water storage for diverters that currently divert surface water during the dry season.” This effort is intended to lead to increased cold-water flows instream during the time of highest water temperatures.

CDFW, South Fork Eel Assessment Report, Coastal Watershed Planning and Assessment Program, 2014: This comprehensive report summarizes the initial results of SRF’s Redwood Creek study in the “Recent Low Flow Studies and Water Diversion and Voluntary Conservation” sections (p.112-114) as a model project for incentivizing water storage and minimizing summer diversions.

9. **List and include any studies, plans, designs or engineering reports completed for the project as a “Technical & Reference Supporting Materials” into one document that includes a Table of Contents and is limited to** approximately **50 pages.** *Please see the instructions for more information about submitting these documents with the final application.*

10. **Project Justification & Technical Basis Notes: Please provide any additional information *not included above* that you think is important.**

SRF is engaged in a multi-phased approach to flow enhancement in the South Fork Eel River which includes identifying priority direct flow augmentation projects, passive groundwater recharge opportunities, forest management, retrofitting and improving existing ponds, and implementing strategic storage and forbearance projects in populated reaches of Redwood and Sproul Creeks. SRF currently has funding for a large implementation project on the Marshall Ranch in the mainstem of Redwood Creek and we have 65% Designs developed for a large pond project in La Doo Creek a tributary to Sproul Creek.

The proposed storage and forbearance project is critical to ensure that the instream benefits of larger scale projects remains instream for multi-beneficial uses and to build community support for larger-scale projects that could benefit salmon, other aquatic species, and water quality for these rural communities.

E. Project Tasks, Budget, And Schedule

1. **Projected Project Start Date:** 7/1/23
   Anticipated Project End Date: December 31, 2027

2. **Describe the basis for the costs used to derive the project budget in each budget category.** [500 characters max.]

The project costs are based on detailed budgeting by SRF and Stillwater that analyzed and summarized the amount of staff time needed to implement the project. Construction costs are based on preliminary project designs, initial materials procurement, and discussion with heavy equipment contractors.

3. **Provide a narrative on cost considerations including alternative project costs.** [500 characters max.]

Project costs vary site by site (See Table 3-1 in DRAFT Implementation Plan). Although, storage and forbearance projects are up to four times as expensive as direct flow augmentation on a price per gallon basis, there are locations within Sproul and Redwood Creek where storage and forbearance is critical to prevent flow diversion from a stream reach that supports critical aquatic habitat.

4. **List the sources of non-state matching funds, amounts and indicate their status**. Proposition 1 requires a minimum cost share of 50% of the total project costs, though a waiver may apply (see Question 6 below).

SRF is requesting a waiver since the proposed project area is 100% within a Disadvantaged Community.

5. **List the sources and amount of State matching funds.**

A recently awarded NCRP grant from the Multi-Benefit Drought solicitation (not Prop 1) can serve as match for the Redwood Creek implementation portion of this grant. This grant is also administered through NCRP. $320,000 of the recently awarded grant is being applied as matching funds per the attached budget table.

6. **Cost Share Waiver Requested (DAC or EDA)?** ☒ yes ☐ no
   Describe what percentage of the proposed project area encompasses a DAC/EDA, how the community meets the definition of a DAC/EDA, and the water-related need of the DAC/EDA

that the project addresses. In order to receive a cost share waiver, the applicant must demonstrate that the project will ***directly*** provide benefits that address a water-related need of a DAC/EDA.

The Project is entirely within an economically distressed area (EDA) as shown on the NCRP Interactive Map. In this rural enclave, the majority of residents have to manage, collect, and steward the water that flows through their land. Serving as your own water provider is challenging and expensive. Most residents do not have sufficient water storage or the ability to forbear from diverting water without financial or technical assistance. Project benefits to this disadvantaged community would include stored water available for fire hazard reduction, improved water quality, and enhanced instream flows for salmonids.

7. **Is the project budget scalable?** ☒ yes ☐ no

8. **Describe how a scaled budget would impact the overall project,** its expected benefits and state the minimum budget amount that would be viable (see Instructions E.7 for scaled budget examples). [500 characters max.]
   A scaled budget would result in less overall water storage volume.

9. **Major Tasks, Schedule and Budget for Project Solicitation**
   Please complete MS Excel table available at https://northcoastresourcepartnership.org/ncrp-proposition-1-irwm-round-2-solicitation/see instructions for the information to be included in this document and for how to submit the required excel document with the application materials.

10. **Project Tasks, Budget and Schedule Notes:**

Task A.1: Project Management

In cooperation with the County of Humboldt sign a sub-grantee agreement for work to be completed on this project. Develop invoices with support documentation. Provide audited financial statements and other

Timeline: Entire Project

Deliverables: Invoices, financial statements and other deliverables as required

Task A.2: Reporting

Develop monthly reports describing work completed, challenges, and strategies for reaching remaining project objectives. Develop Final Report

Timeline: Entire Project

Deliverables: Quarterly and Final Reports

Task C.1: Design Storage and Forbearance Projects for Sproul Creek Diverters

Stillwater Sciences will develop designs for three properties and 150,000 gal of cost-effective storage and forbearance projects to optimize water supply reliability and help maintain flows in mainstem Sproul Creek. The first step of this process will be working with the landowners to finalize development of a site-specific Water Management Plan including type and size of tank storage, exact location of tank and trench locations (requiring archaeology and botany site clearance first), system components needed to connect storage to existing system, leak safety and controls, and participant cost share tasks and responsibilities.

An engineering geologic soils plan will be prepared for each site including a excavated test pit and soil sample the guides foundation design recommendations.

Next, the tank or tanks are designed along with other plumbing needed to facilitate use of the stored water. Design components include site preparation; tank assembly; trenching and piping from tank to house; pressure pump and small pressure tank installation if needed; plumbing and electrical hook-ups; meter installation; CDFW/NOAA compliant fish screen installation; and filtration system installation. The filtration system prevents deterioration of stored water.

Timeline: January to June 2024

Deliverable: designs for five tank installations and associated plumbing

Task C.2: Permit Storage and Forbearance Projects for Downstream Diverters
Under this Task, SRF and Stillwater will secure all permitting/compliance/CEQA including:

1. Forbearance agreement,
2. Small Domestic Use Registration with SWRCB
3. LSAA Agreement with CDFW, and
4. Humboldt County Grading Permit

The forbearance agreement is recorded on the landowners’ property title and results in legally binding and enforceable restrictions for 15 years in which direct diversion riparian rights are limited to seasons with adequate flows. The landowners' existing or new Small Domestic Use Registration allows for storage of longer than 30 days. Additionally, CDFW terms and conditions to protect bypass flows and instream habitat are incorporated in the modified water right. Finally, the landowner enters into a LSAA agreement with CDFW that incorporates all of the protections and restrictions of the forbearance agreement and the water right. A Humboldt County grading permit is needed for project that involve more than 50 cubic yards of cut or fill which is anticipated for these projects.

These are small projects that will achieve CEQA exemption through the Humboldt County ministerial permit process.

Timeline: June 2024 to June 2025

Deliverable: Fully executed permits for all tank projects

Task D.1: Construct Administration

SRF and Stillwater Sciences will administer construction of the project described below in Tasks D.2 and D.3. Stillwater will conduct engineering oversight during construction, and prepare as-built report.

Timeline: June 2024 to June 2026

Deliverable: Completed construction administration tasks documented in monthly progress reports; As-built plans and photos of constructed projects..

Task D.2: Sproul Creek Storage and Forbearance Project Construction

SRF will hire a subcontractor to construct the tanks. This task includes purchase and delivery of water tanks, earthwork to prepare the tank site in accordance with the design plans and project permits, upgrade of the diversion pump and screen (as applicable), new buried plumbing infrastructure, and erosion control including mulch and native grass seed.

Operating instructions are prepared upon completion of each system. System review with the landowners including a site walk through to explain all parts of the water system including operational controls, leak safety controls, and winterizing tasks.

Timeline: June 2025 to June 2026

Deliverable: Construction Completed

Task D.3: Redwood Creek Storage and Forbearance Project Construction

Same as Task 4 except work will occur in Redwood Creek.

Timeline: June 2024 to June 2025

Deliverable: Construction Completed

Task D.4: Project Performance Monitoring

As part of the Redwood Creek Storage and Forbearance Program, SRF and Stillwater will develop thresholds that trigger both the restricted pumping season and the no-pump season. SRF will continue to monitor streamflow in Redwood Creek and inform storage and forbearance participants by email and phone regarding the diversion schedule and restrictions.

Compliance monitoring by SRF will include a minimum of one site visit and one phone contact per year. Spring monitoring will occur by phone and ensure that water system maintenance has occurred, all conservation systems are in place for the low flow months, and that tanks are properly topped off prior to the dry season. Fall monitoring will include a site visit to determine if objectives are being met by reviewing water meter records. Spot monitoring during the dry season will also be an option.

Anticipated emergencies include leaks or other equipment failures. All systems will be outfitted with leak safety devices; however, emergencies could still occur. Leaks will be handled by providing replacement water or managing a safe refilling plan. Adaptive management will help refine the seasonal water management program for maximum compliance and workability.

Timeline: June 2024 to end of project

Deliverable: Annual monitoring reports

11. **Project Information Notes.** Please provide any information that that has not been specifically requested that you feel is important for the NCRP to know about your project.

Please see the attached Excerpts from the DRAFT Redwood Creek Implementation Plan that will be finalized by January 2023 as a Wildlife Conservation Board deliverable.

Major Tasks, Schedule and Budget for North Coast Resource Partnership IRWM Project Solicitation

Project Name: Sproul and Redwood Creek, Storage and Forbearance Program
Organization Name: Salmonid Restoration Federation

Task #	Major Tasks	Task Description	Major Deliverables	IRWM Task Budget	Non-State Match	Other Match	Total Task Budget	25% Scaled IRWM Budget	50% Scaled IRWM Budget	Current Stage of Completion (%)	Start Date	Completion Date
A	**Category (a): Direct Project Administration**											
1	Project Management	In cooperation with the County of Humboldt sign a sub-grantee agreement for work to be completed on this project. Develop invoices with support documentation. Provide audited financial statements and other deliverables as required.	Invoices, audited financial statements and other deliverables as required	$25,000.00	$0.00	$10,000.00	$35,000.00	$0.00	$0.00	0%	6/1/23	End of Project
2	Reporting	Develop monthly reports describing work completed, challenges, and strategies for reaching remaining project objectives. Develop Final Report.	Quarterly and Final Reports	$25,000.00	$0.00	$10,000.00	$35,000.00	$0.00	$0.00	0%	6/1/23	End of Project
B	**Category (b): Land Purchase/Easement**											
1				$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00		
C	**Category (c): Planning/Design/Engineering/Environmental Documentation**											
1	Water Storage Design for Sproul Creek Landowners	Prepare design plans and engineering/geologic soils report for four Sproul Creek properties	Final engineer-stamped design plans and geologist-stamped soils report	$73,030.00	$0.00	$0.00	$73,030.00	$54,772.50	$36,515.00	0%	6/1/23	6/1/24
2	Water Storage Permitting for Sproul Creek Landowners	Secure all necessary permits and environmental compliance including CEQA exemptions, forbearance agreements, Small Domestic Use Registrations, LSAAs and Humboldt County Grading Permits	CEQA NOE, Fully executed agreements and permits	$67,000.00	$0.00	$0.00	$67,000.00	$50,250.00	$33,500.00	0%	6/1/24	6/1/25
D	**Category (d): Construction/Implementation**											
1	Construction Oversight, Administration and As-builts reports	Develop advertisement for bids and contract documents; Complete tasks necessary to administer construction contract	Bid documents; Construction Management Logs; Completed construction administration tasks documented in monthly progress reports; As-built reports, operating instructions, and photo documentation of constructed projects; DWR Certificate of Project Completion	$46,950.00	$0.00	$0.00	$46,950.00	$35,212.50	$23,475.00	0%	6/1/24	End of Project
2	Sproul Creek Water Storage Construction	SRF will hire a sub-contractor to construct 150,000 gal of tank storage at three properties. This task includes purchase and delivery of water tanks, earthwork to prepare the tank site in accordance with the design plans and project permits, upgrade of the diversion pump and screen, new buried plumbing, infrastructure, and erosion control including mulch and native grass seed.	Construction Completed (as built report prepared under Task D.1)	$330,000.00	$0.00	$0.00	$330,000.00	$247,500.00	$165,000.00	0%	6/1/25	10/1/25
3	Redwood Creek Water Storage Construction	SRF will hire a sub-contractor to construct 250,000 gal of tank storage at five properties. This task includes purchase and delivery of water tanks, earthwork to prepare the tank site in accordance with the design plans and project permits, upgrade of the diversion pump and screen, new buried plumbing, infrastructure, and erosion control including mulch and native grass seed.	Construction Completed (as built report prepared under Task D.1)	$275,000.00	$0.00	$300,000.00	$575,000.00	$206,250.00	$137,500.00	0%	6/1/24	10/1/24
4	Project Performance Monitoring	SRF and Stillwater Diversion coordination and compliance monitoring	Annual monitoring reports inlcuding summary of diversion cut-off thresholds and individual project monitoring information	$25,470.00	$0.00	$0.00	$25,470.00	$19,102.50	$12,735.00	0%	10/1/24	End of project
	Total North Coast Resource Partnership IRWM Grant Request			**$867,450.00**	**$0.00**	**$320,000.00**	**$1,187,450.00**	**$613,087.50**	**$408,725.00**			
	Percentage of Total Project Cost			**73.05%**	**0.00%**	**26.95%**	**100.00%**	**51.63%**	**34.42%**			

BUDGET DETAIL

Row (a) Direct Project Administration Costs					
Project Management Type	**Personnel by Discipline**	**Number of Hours**	**Hourly Wage**	**% of Cost ***	**Total Admin Cost**
Administration	Executive Director	250	$90		$22,500
Labor	Contract Manager / Bookkeeper	100	$75		$7,500
Labor	Project Associate / Streamflow Monitor	300	$60		$18,000
Printing and Signage	N/A				$1,000
SRF Mileage	N/A				$1,000
Total					$50,000
*** What is the percentage based on (including total amounts)?**		**n/a**			n/a
*** How was the percentage of cost determined?**		**n/a**			n/a

Row (b) Land Purchase/Easement

Row (c) Planning/Design/Engineering & Environmental Documentation					
Personnel (Discipline)	**Major Task Name**	**Number of Hours**	**Hourly Wage**	**Total Cost**	
Senior Engineer (Stillwater Sciences)	Tasks C.1 and C.2, Sproul Cr water storage design and permitting	120	$226	$27,120	
Infrastructure Engineer (Stillwater Sciences)	Tasks C.1 and C.2, Sproul Cr water storage design and permitting	100	$152	$15,200	
Project Engineer (Stillwater Sciences)	Tasks C.1 and C.2, Sproul Cr water storage design and permitting	310	$123	$38,130	
Permitting Specialist (Stillwater Sciences)	Tasks C.2, Sproul Cr water storage permitting	180	$136	$24,480	
Botanist (Stillwater Sciences)	Tasks C.1 and C.2, Sproul Cr water storage design and permitting	80	$150	$12,000	
Mileage (Stillwater Sciences)	Tasks C.1 and C.2, Sproul Cr water storage design and permitting			$2,000	
Permit Fees (LSAA, County Grading, SDUR)	Tasks C.2, Sproul Cr water storage permitting			$6,000	
Executive Director (SRF)	Tasks C.2, Sproul Cr water storage permitting	40	$90	$3,600	
Contract Manager (SRF)	Tasks C.2, Sproul Cr water storage permitting	40	$75	$3,000	
Project Associate/Streamflow Monitor (SRF)	Tasks C.2, Sproul Cr water storage permitting	40	$60	$2,400	
Archeologist (William Rich and Associates)	Tasks C.1 and C.2, Sproul Cr water storage design and permitting	68	$75	$5,100	
Mini Excavator Rental to dig test holes	Tasks C.1 water storage design			$1,000	
Total				**$140,030**	

Row (d) Construction/Implementation				
Personnel (Discipline)	**Work Task and Sub-Task (from**	**Number of**	**Hourly**	**Total Cost**
Senior Engineer (Stillwater Sciences)	Tasks D.1 and D.4, Construction oversight and project performance	100	$226	$22,600
Infrastructure Engineer (Stillwater Sciences)	Tasks D.1 and D.4, Construction oversight and project performance	40	$152	$6,080
Project Engineer (Stillwater Sciences)	Tasks D.1 and D.4, Construction oversight and project performance	180	$123	$22,140
Mileage (Stillwater Sciences)	Tasks D.1 and D.4, Construction oversight and project performance			$1,500
Executive Director (SRF)	Tasks D.1 and D.4, Construction oversight and project performance	60	$90	$5,400
Contract Manager (SRF)	Tasks D.1 and D.4, Construction oversight and project performance	48	$75	$3,600
Project Associate/Streamflow Monitor (SRF)	Tasks D.1 and D.4, Construction oversight and project performance	160	$60	$9,600
SRF Mileage	Tasks D.1 and D.4, Construction oversight and project performance			$1,500
Plumbing contractor - labor	Tasks D.2 and D.3, Construction storage in Sproul and Redwood Creeks	220	$120	$26,400
Heavy equipment contractor - operator	Tasks D.2 and D.3, Construction storage in Sproul and Redwood Creeks	330	$120	$39,600
Heavy equipment contractor - laborer	Tasks D.2 and D.3, Construction storage in Sproul and Redwood Creeks	110	100	$11,000
Materials and Equipment	**Work Task and Sub-Task (from**	**Number of**	**Unit Cost**	
5,000 gallon tank purchase and delivery	Tasks D.2 and D.3, Construction storage in Sproul and Redwood Creeks	55	$7,000	$385,000
Pump and Screen (per property)	Tasks D.2 and D.3, Construction storage in Sproul and Redwood Creeks	5.5	$5,000	$27,500
Pipes, valves, fittings, filters (per property)	Tasks D.2 and D.3, Construction storage in Sproul and Redwood Creeks	5.5	$10,000	$55,000
Excavator rental (per hr)	Tasks D.2 and D.3, Construction storage in Sproul and Redwood Creeks	220	$120	$26,400
Trencher Rental (per hr)	Tasks D.2 and D.3, Construction storage in Sproul and Redwood Creeks	110	$40	$4,400
Compactor Rental (per hr)	Tasks D.2 and D.3, Construction storage in Sproul and Redwood Creeks	110	$40	$4,400
Sand for tank pad (10 yds delivered)	Tasks D.2 and D.3, Construction storage in Sproul and Redwood Creeks	11	$1,200	$13,200
Erosion control (seed, straw per site)	Tasks D.2 and D.3, Construction storage in Sproul and Redwood Creeks	5.5	$2,200	$12,100
Total				**$677,420**

ORGANIZATION INFORMATION

1. **Project Name:**
   Redwood and Sproul Creek, South Fork Eel River Storage and Forbearance Program

2. **Applicant Organization Name:**
   Salmonid Restoration Federation

3. **Contact Name/Title**
   Name: Dana Stolzman
   Title: Executive Director
   Email: srf@calsalmon.org
   Phone Number (include area code): 707 923-7501

4. **Organization Address (City, County, State, Zip Code):**
   425 Snug Alley, Unit D, Eureka, CA 95501

5. **Organization Type**
   ☐ Public agency
   ☒ 501(c)(3) Non-profit organization
   ☐ Public utility
   ☐ Federally recognized Indian Tribe
   ☐ California State Indian Tribe listed on the Native American Heritage Commission's California Tribal Consultation List
   ☐ Mutual water company
   ☐ Other:

6. **Authorized Representative** (if different from the contact's name)
   Name:
   Title:
   Email:
   Phone Number (include area code):

7. **List all projects the organization is submitting to the NCRP for this Solicitation in order of priority.**
   Redwood Creek and Sproul Creek, South Fork Eel River Storage and Forbearance Program

8. **Organization Information Notes:**

The mission of Salmonid Restoration Federation (SRF) is to promote restoration and stewardship of California's native salmon, steelhead, and trout populations and their habitat. To accomplish our mission, we have been working since 1986 to advance the art and science of habitat restoration for California's precious salmonid species. In Humboldt County—a region critical to the recovery of California's endangered Coho salmon and where our office is based—we have been actively engaged in local efforts to address low summer water flows on the South Fork of the Eel River.

ELIGIBILITY

1. North Coast Resource Partnership Goals and Objectives

GOAL 1: INTRAREGIONAL COOPERATION & ADAPTIVE MANAGEMENT

☐ Objective 1 - Respect local autonomy and local knowledge in Plan and project development and implementation

☒ Objective 2 - Provide an ongoing framework for inclusive, efficient intraregional cooperation and effective, accountable NCRP project implementation

☐ Objective 3 - Integrate Traditional Ecological Knowledge in collaboration with Tribes to incorporate these practices into North Coast Projects and Plans

GOAL 2: ECONOMIC VITALITY

☐ Objective 4 - Ensure that economically disadvantaged communities are supported and that project implementation enhances the economic vitality of disadvantaged communities by improving built and natural infrastructure systems and promoting adequate housing

☒ Objective 5 - Conserve and improve the economic benefits of North Coast Region working landscapes and natural areas

GOAL 3: ECOSYSTEM CONSERVATION AND ENHANCEMENT

☒ Objective 6 – Conserve, enhance, and restore watersheds and aquatic ecosystems, including functions, habitats, and elements that support biological diversity

☒ Objective 7 - Enhance salmonid populations by conserving, enhancing, and restoring required habitats and watershed processes

GOAL 4: BENEFICIAL USES OF WATER

☒ Objective 8 - Ensure water supply reliability and quality for municipal, domestic, agricultural, Tribal, and recreational uses while minimizing impacts to sensitive resources

☒ Objective 9 - Improve drinking water quality and water related infrastructure to protect public health, with a focus on economically disadvantaged communities

☒ Objective 10 - Protect groundwater resources from over-drafting and contamination

GOAL 5: CLIMATE ADAPTATION & ENERGY INDEPENDENCE

☒ Objective 11 - Address climate change effects, impacts, vulnerabilities, including droughts, fires, floods, and sea level rise. Develop adaptation strategies for local and regional sectors to improve air and water quality and promote public health

☐ Objective 12 - Promote local energy independence, water/ energy use efficiency, GHG emission reduction, and jobs creation

GOAL 6: PUBLIC SAFETY

☒ Objective 13 - Improve flood protection, forest and community resiliency to reduce the public safety impacts associated with floods and wildfires

2. Does the project have a minimum 15-year useful life?

a) ☒ yes ☐ no

b) If yes, will the organization be able to provide compliance documentation outlined in the instructions should the project be selected as a Priority Project?

☒ yes ☐ no

3. Other Eligibility Requirements and Documentation

CALIFORNIA GROUNDWATER MANAGEMENT SUSTAINABILITY COMPLIANCE

a) Does the project directly affect groundwater levels or quality?

☐ yes ☒ no

b) If yes, will the organization be able to provide compliance documentation outlined in the instructions including a Groundwater Sustainability Agency letter of support, to include in the NCRP Regional Project Application should the project be selected as a Priority Project?

☐ yes ☐ no

CASGEM COMPLIANCE

a) Does the project overlie a medium or high groundwater basin as prioritized by DWR?

☐ yes ☒ no

b) If yes, list the groundwater basin and CASGEM priority:

c) If yes, please specify the name of the organization that is the designated monitoring entity:

d) If yes, please specify whether the local Groundwater Sustainability Agency has endorsed the project:

URBAN WATER MANAGEMENT PLAN

a) Is the organization required to file an Urban Water Management Plan (UWMP)?

☐ yes ☒ no

b) If yes, has DWR verified the current 2020 UWMP?

☐ yes ☐ no

c) If the 2020 UWMP has not been verified by DWR, explain and provide anticipated date for verification:

d) Has DWR verified a water loss audit report in accordance with SB 555 as submitted by the urban water supplier?

☐ yes ☐ no

e) Does the urban water supplier meet the water meter requirements of CWC 525?

☐ yes ☐ no

f) Does the urban water supplier meet the State Water Resources Control Board's Water Conservation and Production Reporting requirement?

☐ yes ☐ no

g) If yes, will the organization be able to provide compliance documentation outlined in the instructions, to include in the NCRP Regional Project Application should the project be selected as a Priority Project?

☐ yes ☐ no

AGRICULTURAL WATER MANAGEMENT PLAN

a) Is the organization – or any organization that will receive funding from the project – required to file an Agricultural Water Management Plan (AWMP)?

☐ yes ☒ no

b) If yes, will the organization be able to provide compliance documentation outlined in the instructions, to include in the NCRP Regional Project Application should the project be selected as a Priority Project?

☐ yes ☐ no

SURFACE WATER DIVERSION REPORTS

a) Is the organization required to file State Water Resources Control Board (SWRCB) annual surface water diversion reports per the requirements in CWC Part 5.1?

☐ yes ☒ no

b) If yes, will the organization be able to provide compliance documentation outlined in the instructions, to include in the NCRP Regional Project Application should the project be selected as a Priority Project?

☐ yes ☐ no

STORM WATER MANAGEMENT PLAN

a) Is the project a stormwater and/or dry weather runoff capture project?

☐ yes ☒ no

b) If yes, does the project benefit a Disadvantaged Community with a population of 20,000 or less?

☐ yes ☐ no

c) If this is a stormwater/dry weather runoff project but does not benefit a small DAC population, please provide documentation that the project has been included in a Stormwater Resource Plan that has been incorporated into the NCRP IRWM Plan:

d) If no, will the organization be able to provide documentation that the project is included in a Stormwater Resource Plan that has been incorporated into the NCRP IRWM Plan, should the project be selected as a Priority Project?

4. Eligible Project Type under 2022 IRWM Grant Solicitation

- ☐ Water reuse and recycling for non-potable reuse and direct and indirect potable reuse
- ☒ Water-use efficiency and water conservation
- ☒ Local and regional surface and underground water storage, including groundwater aquifer cleanup or recharge projects
- ☐ Regional water conveyance facilities that improve integration of separate water systems
- ☒ Watershed protection, restoration, and management projects, including projects that reduce the risk of wildfire or improve water supply reliability
- ☐ Stormwater resource management projects to reduce, manage, treat, or capture rainwater or stormwater
- ☐ Stormwater resource management projects that provide multiple benefits such as water quality, water supply, flood control, or open space
- ☐ Decision support tools that evaluate the benefits and costs of multi-benefit stormwater projects
- ☐ Stormwater resource management projects to implement a stormwater resource plan
- ☐ Conjunctive use of surface and groundwater storage facilities
- ☐ Decision support tools to model regional water management strategies to account for climate change and other changes in regional demand and supply projections
- ☐ Improvement of water quality, including drinking water treatment and distribution, groundwater and aquifer remediation, matching water quality to water use, wastewater treatment, water pollution prevention, and management of urban and agricultural runoff
- ☐ Regional projects or programs as defined by the IRWM Planning Act (Water Code §10537)
- ☐ Other:

5. Describe how the project provides a benefit that meets at least one of the Statewide Priorities as defined in DWR's Final 2022 Guidelines (see page 7) and Tribal priorities as defined by the NCRP?

3. Drought Preparedness-promote water conservation
4. Climate Resilience-Use water more effieciently. When landowners built their houses along Sproul Creek, there was enough water year round to divert. With prolonged drought, there have been dry seasons that the Sproul Creek has stopped flowing. By Storing Water, landowners are able to store water during the wet season to use in the dry season and allow the water to stay in the stream for ecological purposes.

NORTH COAST RESOURCE PARTNERSHIP

CERTIFICATION OF AUTHORITY

By signing below, the Authorized Representative executing the certificate on behalf of the Project Sponsor affirmatively represents that s/he has the requisite legal authority to do so on behalf of the Project Sponsor. The Authorized Representative executing this proposal on behalf of the project sponsor understands that the NCRP is relying on this representation in receiving and considering this proposal. The person signing below hereby acknowledges that s/he has read the entire NCRP 2022 Project Review and Selection Process Guidelines and the NCRP 2022 Proposition 1 IRWM Round 2 Project Application & Instructions documents and has complied with all requirements listed therein.

Official Authorized to Sign for Proposal

Signature

Dana Stolzman

Date
November 4, 2022

Excerpts from Redwood Creek Draft Implementation Plan

Table of Contents

3 IMPLEMENTATION APPROACHES TO ENHANCE DRY SEASON FLOW

Based on dry season streamflow conditions, flow enhancement targets, and watershed characteristics described above, there are multiple approaches to enhance dry season flows. Many of the techniques are new and innovative with pilot projects underway in the Mattole River watershed that will inform future flow enhancement work. The combination of multiple "stacked" flow enhancement actions, large and small, within the watershed are anticipated to result in meaningful flow increases.

3.1 Storage and Forbearance

Storage and forbearance projects enable landowners to forbear from diverting water during the dry season by providing them with a water storage system that has sufficient capacity to supply their needs during the dry season. Each landowner is educated on how to operate the water storage system, including water use reductions through conservation and leak proofing, along with guidelines for habitat protection while filling and topping off their tanks. Each landowner signs a legally enforceable forbearance agreement with restrictions that protect aquatic habitat, including the following: 1) minimum streamflows below which no pumping is allowed; 2) maximum pumping rates and bypass flows; 3) assigned pumping days to minimize cumulative impacts; and 4) pump intake screens that comply with CDFW and NMFS criteria.

Sanctuary Forest and the community in the Mattole River headwaters, have pioneered a storage and forbearance program with funding from CDFW and other agencies. By 2014, 32 households and institutions were participating in seasonal forbearance along the Mattole mainstem resulting in measurable improvements in streamflow. More recently, Sanctuary Forest has expanded the storage and forbearance program to Mattole River tributaries that are also experiencing low flows during the dry season.

Sanctuary Forest has developed a relatively streamlined permitting/compliance approach for their storage and forbearance program consisting of three agreements/permits:

1) Forbearance agreement,
2) Small Domestic Use Registration with SWRCB, and
3) LSAA Agreement with CDFW.

The forbearance agreement is recorded on the landowners' property title and results in legally binding and enforceable restrictions for 15 years in which direct diversion riparian rights are limited to seasons with adequate flows. The landowners' existing or new Small Domestic Use Registration allows for storage of longer than 30 days. Additionally, CDFW terms and conditions to protect bypass flows and instream habitat are incorporated in the modified water right. Finally, the landowner enters into a LSAA agreement with CDFW that incorporates all of the protections and restrictions of the forbearance agreement and the water right.

Planning and design work includes community outreach to achieve landowner participation, development of a Water Management Plan for each property including type, size, and location of water storage features; trench layout (requiring archaeology and botany site clearance first); system components needed to connect storage to existing system; leak safety and controls; and participant cost share tasks and responsibilities. After the project is designed, permitting is completed through the pathway listed above.

Next, the plumbing and water storage system is constructed including site preparation; tank/pond installation; trenching and piping from storage to house; pressure pump and small pressure tank installation if needed; plumbing and electrical hook-ups; meter installation; CDFW/NOAA compliant fish screen installation; and filtration system installation. The filtration system prevents deterioration of stored water.

As built drawings along with operating instructions are prepared upon completion of each system. System review with the landowners including a site walk through to explain all parts of the water system including operational controls, leak safety controls, and winterizing tasks.

SRF and Stillwater currently have funding to begin a storage and forbearance program in Redwood Creek modeled off Sanctuary Forest's program. The program will be initiated in early 2023 with planning, design, and construction for five properties near the town of Briceland (described in more detail in Sections 4 and 5 below).

3.1.1 Operations and maintenance considerations

The storage systems are designed and constructed with high quality materials with the goal of being as maintenance free as possible for the first 25 years of operations. However, the landowner will be responsible for standard operations and maintenance (O&M) which includes filling the tanks during the wet season and performing standard yearly maintenance.

As part of the Redwood Creek Storage and Forbearance Program, SRF and Stillwater will develop thresholds that trigger both the restricted pumping season and the no-pump season. SRF will continue to monitor streamflow in Redwood Creek and inform storage and forbearance participants by email and phone regarding the diversion schedule and restrictions.

Compliance monitoring by SRF will include a minimum of one site visit and one phone contact per year. Spring monitoring will occur by phone and ensure that water system maintenance has occurred, all conservation systems are in place for the low flow months, and that tanks are properly topped off prior to the dry season. Fall monitoring will include a site visit to determine if objectives are being met by reviewing water meter records. Spot monitoring during the dry season will also be an option.

Anticipated emergencies include leaks or other equipment failures. All systems will be outfitted with leak safety devices; however, emergencies could still occur. Leaks will be handled by providing replacement water or managing a safe refilling plan. Adaptive management will help refine the seasonal water management program for maximum compliance and workability.

3.2 Direct Flow Augmentation

Direct flow augmentation is achieved by capturing runoff in ponds during the wet season and releasing the water during the height of the dry season via pipes and valves to maintain a wetted channel. Recent flow enhancement initiatives in lower Russian River tributaries have displayed that direct augment is highly successful at enhancing dry-season streamflow. Flow releases from agricultural ponds in Green Valley Creek and Porter Creek have resulted in significant instream benefits (Grantham et.al. 2018, RRCWRP 2019). As described in Ruiz et al. (2018) of California Sea Grant, the project began in 2015 and is ongoing. Data shows that flow augmentations in all years from 2015-2018 were able to appreciably increase wetted channel habitat, increase dissolved oxygen in the stream, and decrease water temperature downstream from the flow augmentation release points. For example, releases into Dutch Bill Creek averaging 36 gpm beginning in late August of 2015 and were able to cumulatively re-wet more than 2,300 feet of stream channel with effects measurable up to 1.8 miles downstream.

While modest compared to winter flows, these augmentations have the potential to increase pool connectivity and water quality. A foundational hypothesis that increased pool connectivity will bolster over-summer salmonid survival, is strongly supported by the work of Obedzinski et al. (2018). Their study found that days of disconnected surface flow showed a strong negative correlation with juvenile coho salmon survival rate in four tributaries to the Russian River.

In Redwood Creek, direct flow augmentation projects are being considered in two settings:

1) Repurposing of existing on-stream ponds, and
2) Newly constructed off-stream ponds.

Ponds used for direct flow augmentation typically need to have significant water storage capacity to offset the impacts of evaporation loss and high-water temperatures and nutrient loading that can occur in small ponds. Typically, a minimum pond volume of one million gallons is considered appropriate for direct flow augmentation although ponds can be smaller depending on setting and the size of watercourse that flow augmentation is targeting.

There are several on-stream ponds within the Redwood Creek watershed where repurposing for direct flow augmentation is underway or proposed. These are discussed further in Sections 4 and 5 below. Direct flow augmentation projects require a water right if surface water is diverted or detained from a watercourse. A Small Domestic Use Registration may be used if the total diversion is less than 10 acre-feet and there is a human residence or dwelling within the vicinity of the project. Otherwise, a full Appropriative Water Right is needed.

Suitable locations for new off-stream ponds in Redwood Creek are limited based on topographic, geologic, and infrastructure constraints – much of the Redwood Creek watershed is comprised of steep terrain and the flatter locations are inhabited or bisected by roadways. Stillwater has assessed many pond locations throughout the watershed. Currently, the highest priority target areas for off-stream ponds are located on terraces near existing watercourses. These sites have several advantages compared to upslope sites:

1) Low-lying terraces are the largest low-gradient areas within the watershed thus requiring the least amount of earthwork to construct ponds,
2) Terrace ponds can be filled with rainfall and gravity fed diversions from nearby watercourses, and
3) Flow releases are delivered directly to a watercourse where benefits are immediately realized.

Upslope or ridgetop pond sites have also been considered and several suitable locations have been identified as described in Sections 4 and 5. However at this time, due to the three considerations described above, ponds on near-stream terraces are considered a higher priority for Redwood Creek.

Pond construction requires extensive excavation and placement of an earthen berm. The berm will then be raised in one-foot lifts and compacted with a vibratory sheepsfoot roller. The ponds are sealed either with a High-Density Polyethylene (HDPE) liner, naturally occurring clay soils, or imported bentonite clay. In general, the naturally occurring soils in Redwood Creek are porous and do hold water on their own, although there are some locations within the watershed that do have a high clay content. The use of bentonite clay to construct an impervious restrictive barrier or keyway within and underneath the pond berm is an approach that is being piloted in the Mattole River headwaters. This method has been used in other settings for levee and dam repairs. The keyway approach works well at locations where the native soil already has some clay and the proposed pond site is located in naturally concave topography allowing for the keyway to tie into bedrock on both extents of the pond berm. This technique is described further in

Section 3.3.3 below. HDPE liners are the best approach to seal ponds at locations with highly porous underlying soils and/or on terraces where the pond berms do not tie into the hillslope.

All ponds will have spillways engineered to withstand 100-year storm events, armored with small rock, and located on native ground (rather than within the berm). All disturbed soil is mulched and seeded with native grass.

At this time, new onstream ponds are not proposed within Redwood Creek. Onstream ponds have several issues that make them a lower priority including: 1) sediment supply capture/disruption, 2) higher risk of failure during storm events, 3) permanent habitat conversion, and 4) permitting difficulty. However, depending on the results of the flow enhancement actions proposed herein and ongoing climatic trends toward longer dry seasons, new onstream ponds may need to be considered in the future to provide sufficient flows for aquatic habitat.

3.2.1 Operations and maintenance considerations

Direct flow augmentation projects require significant long-term O&M. Flow conditions within the watershed need to be closely monitored to inform diversion during the wet season and flow augmentation during the dry season. Similar to storage and forbearance, direct flow augmentation projects require yearly maintenance to ensure that all systems are functioning as designed. Each direct flow augmentation project will have a O&M plan developed specifically for that project with a list of operations, monitoring, maintenance and adaptive management tasks and activities. The O&M plan typically describes operations for a minimum of 20 years post-construction.

Unlike the storage and forbearance projects that provide domestic water for individual landowners who thereby take ownership in the O&M, direct flow augmentation projects are designed with the primary objective of improving aquatic habitat conditions and therefore typically require management by a non-profit organization and some type of long-term funding mechanism. For the Marshall Ranch Flow Enhancement Project, SRF and the Marshall Ranch have secured a funding commitment from a private foundation to cover long-term O&M costs.

Although O&M requirements are significant, direct flow augmentation is likely the best approach for guaranteeing measurable flow enhancement benefits in August and September during drought conditions. The other approaches described in this report have not proven to result in measurable flow enhancement benefits during the driest conditions.

3.3 Runoff Detention and Passive Release

Runoff detention and passive release is achieved by slowing the rate of wet-season runoff which results in increased groundwater recharge. This additional groundwater storage is then released to watercourses during the spring recession and dry season.

A variety of approaches in different settings throughout the watershed can be used to achieve this objective:

1) Log and rock weirs
2) Beaver dam analogues
3) Subsurface clay restrictive barriers
4) Floodplain reconnection and stage zero channel grading

5) Large wood structures
6) Detention basins

These six approaches are described in more detail below and are often used in tandem to complement each other. The relatively small scale of these approaches requires stacking of project features to achieve measurable flow enhancement benefits. Also, because these features rely on passive groundwater release, their flow releases typically mimic the natural hydrograph with extensive flow augmentation during the spring when groundwater is high and decreasing significantly throughout the summer as groundwater levels lower.

3.3.1 Log and rock weirs

Instream log and rock weirs can be constructed as described in CDFW's Stream Habitat Restoration Manual (Flosi et. al 2010) to raise the channel bed resulting in additional groundwater recharge in the upstream channel, banks and floodplain. These structures can also increase surface flow because they are typically keyed into the bedrock or impervious clay under the streambed, thereby pushing the subsurface flow to the surface at each weir. In addition to the flow benefits, weirs also help store and sort spawning gravels, increase pool depth and area, and generally increase instream habitat complexity.

Weir construction begins with a trench in the channel and banks to prevent undercutting and flanking around the weir. Logs or boulders are placed in the trench and streambed material excavated from onsite consisting of gravel and clay is used to backfill against the weirs. Fish passage is provided for by creating structure with maximum one foot jump heights. Subsurface clay restrictive barriers can also be constructed in association with the weirs as discussed below.

Proof of concept for increasing water availability and floodplain habitat with weirs has been demonstrated in Baker Creek, tributary to the Mattole River, where an instream project completed between 2012 and 2017 installed approximately 20 instream log weirs along approximately 1,800 linear feet of Class I channel and has raised water levels by approximately 1.5 feet along a portion of the project reach. The instream structures have significantly increased water availability within the project vicinity during the period of mid-June through mid-August. Pool depth and area has greatly increased and the pools persist much later into the dry season as compared with pre-project conditions.

Similar results in terms of increased water availability were seen in McKee Creek, tributary to the Mattole River, following construction of 16 weirs in 2018 and 2019. High long-duration storm discharges during the 2018/2019 wet season transported approximately 540 CY of gravels and fines into the project reach transforming the habitat. The project also appears to have increased water availability within the reach. The summer of 2019 was the first summer in 20 years with surface flow all summer.

3.3.2 Beaver dam analogue (BDA) structures

Beaver dam analog structures can be used in small watercourses to achieve similar objectives as t weirs: increase gravel storage, increase groundwater storage in the streambed and banks, increase pool depth and area, and generally increasing habitat complexity. BDA structures are not effective for bringing subsurface flow to the surface because they are by nature more porous than weirs and do not include trenching.

BDAs consist of posts installed by hand or with an excavator attachment to form one or two rows across the channel. Willow stems or other locally sourced brush or tree branches are woven into the post line to create a semipermeable structure. Cobble, gravel, straw and clay is placed at the upstream base of the structure to reinforce, reduce permeability and retain surface water. Stability measures to reduce scour on the downstream side and tipping of the structures will include placement of cobble and a small diameter log pinned with additional posts. Gravel/clay to be used as backfill against the weirs is excavated on site from strategically selected high points in the existing floodplain, where excavation will facilitate increased floodplain inundation.

Some concern has been expressed about the application of BDAs because the historic presence of beavers in the Mattole headwaters or Redwood Creek has not been documented. However, the abundance of large and small wood in the creek channels provided a similar function as beaver dams, and the large-scale removal of that wood in the 1980s has significantly contributed to channel incision, disconnected floodplains, and a lower water table. In addition, the heavily logged forests in the region will not be contributing large wood for many decades and therefore BDAs aim to utilize small wood to build instream structures that are designed to restore the functions that were lost. Similar projects utilizing channel spanning post- assisted check dams have been implemented in other western states with well documented outcomes showing benefits to anadromous fish (Bouwes et. al. 2016). BDAs are envisioned to serve as small log jam analogs with a comparison shown on Figures 3-1 and 3-2 below.

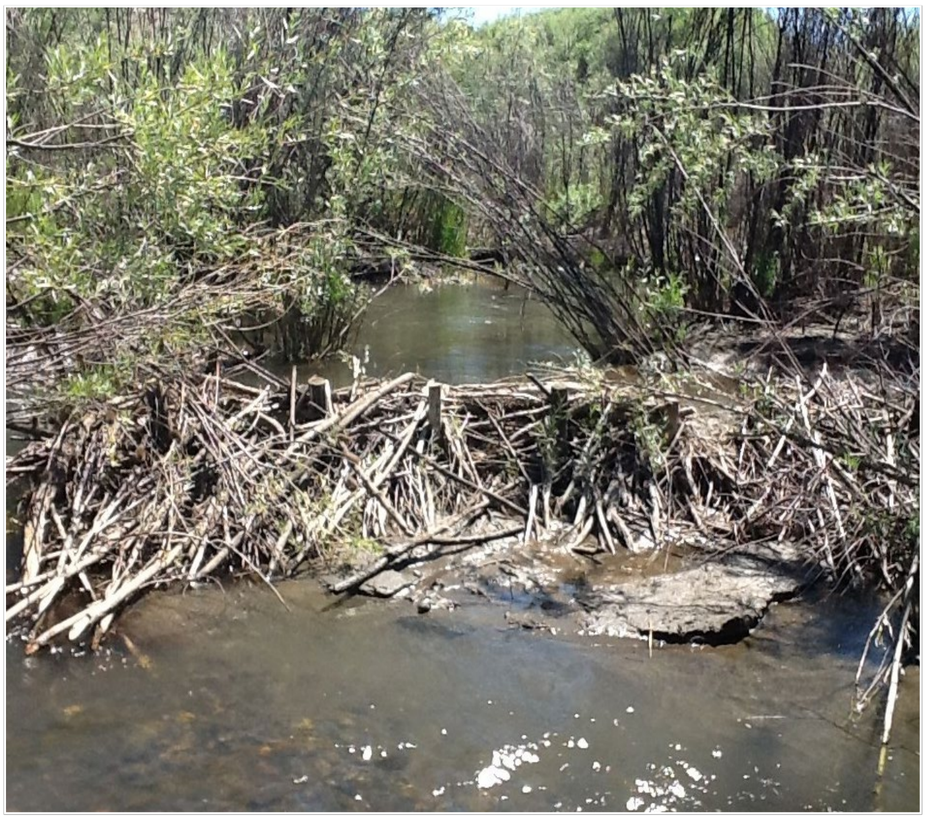

Figure 3-1: Photo of a beaver dam analog with post line and willow weave (photo from Dr. Michael Pollock)

Figure 3-1 and Figure 3-2 illustrate the similarities between these structures with Figure 3-1 showing a beaver dam analog from Oregon and Figure 3-2 showing a small debris jam in North Fork Lost River (Mattole River tributary). Both structures raise the streambed and water elevation upstream of the structure, connecting the floodplain for improved winter habitat and increasing groundwater storage in the streambed material and adjacent banks and floodplains. In addition, both structures create a scour pool downstream of the structure thereby improving summer pool habitat and sorting gravel.

Figure 3-2. Photo of small wood jam in a Mattole River tributary (photo from Sanctuary Forest).

Sanctuary Forest implemented their first BDA installation project in the South Fork Lost River, tributary to the Mattole River, in 2019. Although monitoring of that project is just underway, some important lessons have already been learned. In terms of construction, large scale BDAs are time-consuming and expensive to construct by hand. If equipment access is possible, BDAs are likely less expensive (and less back breaking) with heavy equipment utilized for installation of the posts and hauling/placement of gravel, with hand labor limited to weaving the willow. Initial results from the 2019/2020 wet season suggest that the BDAs may be highly effective at retention of wet season runoff for sites where weir heights are greater than 3 feet and streambeds are thick enough for post installation. As previously discussed, because BDAs are built on top of the streambed, subsurface clay restrictive barriers are needed to keep the streambed full and bring water to the surface. Since log weirs are effective for slowing both subsurface and surface flow, they are likely the best fit for projects where logs are readily available. However, Sanctuary Forest has not had good results with log weirs greater than 3 feet in height and at that size they are more difficult to modify and maintain than BDA's. With BDA's it is relatively easy to adjust weir height, add another weir for jump heights, etc., and hand labor is feasible for the maintenance phase.

One key site selection consideration for design of instream features is the degree of channel incision. When channels are incised more than 6 feet below their floodplain, and particularly where streams have incised down into the bedrock, groundwater storage in the streambank is limited. Therefore, large weirs and BDAs are typically only proposed along stream reaches where the channel is less than 6 feet below its floodplain (optimally three to four feet).

Within the reaches that are suitable for weirs and BDA's additional design measures are applied to provide stability and achieve objectives:

1) The structures are strategically located such that high flows will overflow onto adjacent floodplains reducing the hydraulic forces on the structures and minimizing undercutting and/or flanking. Gravel to be used as backfill against the weirs will be excavated on site from strategically selected high points in the existing floodplain, where excavation will facilitate increased floodplain access. These strategies also achieve the project objectives of reconnecting floodplains and spreading high flows out over the floodplains.
2) Weirs and/or BDAs are also installed as a series of structures. Each structure is designed to support the function and stability of the other structures and achieve desired objectives. Additionally, series of structures are used to form step pools or side channels for fish passage.

3.3.3 Subsurface clay restrictive barriers

Subsurface clay restrictive barriers are intended to greatly slow the flow of shallow groundwater. These features consist of trenches dug perpendicular to groundwater flow down to an impervious layer (bedrock or clay) and then backfilled with compacted clay intended to create a barrier to subsurface groundwater flow. Clay can either be derived from on-site or off-site sources or native soil mixed with bentonite.

Instream subsurface barriers are typically installed in tandem with weirs or BDAs. The intent of the subsurface barriers is to greatly reduce the rate of subsurface flow within the channel and streambanks. While grade control structures typically are tied into the bed and banks to reduce undercutting and flanking during high flow events, the intent of the restrictive barrier is to go a step farther and reduce underflow and flanking by groundwater. Therefore, native clay or bentonite will be used to fully seal the upstream side of the log weirs with the bedrock and/or clay in the bed and banks. Subsurface clay restrictive barriers can also be used in association with off-stream ponds to increase groundwater storage potential and reduce the rate of seepage loss.

3.3.4 Floodplain reconnection and Stage Zero channel grading

Many stream reaches in Redwood Creek have evidence of significant past disturbance from legacy timber harvest activities with incised channels and disconnected floodplains. In some reaches, remnant logging roads in the creek channel are still evident and actively eroding. These types of sites can be treated with grading to elevate the channel. In some cases, a modified Stage Zero channel restoration approach is used and, in some cases, more targeted channel filling can help connect the floodplains. This channel grading is different than the Stage Zero approach utilized in the Pacific Northwest where entire wide valleys have been reshaped. Instead, this work proposes reshaping of narrower valleys extending from the base of one hillslope to the opposite side, generally 20 feet to 100 feet in width, filling the existing incised channel and adding a combination of grade control and roughness that will directing flows along a more sinuous path. Due to the Mediterranean climate and no snowmelt, extreme dry season water scarcity exists in this region and aggrading the streams without the inclusion of subsurface clay restrictive layers would result in increased subsurface flow during the dry season.

Combining Stage Zero and targeted floodplain grading with weirs also eliminates the problems of sediment starving the downstream reaches if weirs and/or BDAs are installed such that they create a sediment sink.

3.3.5 Large wood structures

Large wood structures as described in CDFW's Stream Habitat Restoration Manual (Flosi et. al 2010) can provide some flow enhancement benefit if they are sufficiently large-scale to result in geomorphic and hydraulic change. Structures can be anchored or unanchored depending on the size of wood and stream setting. These structures are typically intended to provide sufficient roughness such that channel aggradation occurs or at a minimum incision rate is reduced. These structures can also back up high flows to push water onto the floodplain and increase groundwater recharge. However, the timing of flow benefits resulting from these types of structures is not aligned with the dry season. Increased groundwater storage resulting from these types of structures is typically released in the spring.

The large wood structures have multiple habitat enhancement objectives including enhancing summer and winter habitat as well as sorting/retaining gravel. Also, they can often be used in parallel with other features described herein to result in a wholistic restoration project that benefits aquatic habitat for a range of flow conditions. However, as a stand-alone flow enhancement action, they are unlikely to result in measurable benefit.

3.3.6 Detention basins

Detention basins or ponds capture runoff during the wet season and passively release the water through seepage back into the groundwater and downslope watercourses. A relatively large-scale example of this approach is the Baker Creek String of Pearls project constructed by Sanctuary Forest in the Mattole headwaters. This project is comprised of three ponds with a total surface water storage volume of approximate three million gallons. The ponds fill during the wet season from rainfall and shallow groundwater and drain during the spring and early summer. Based on a hydrologic analysis, the ponds have effectively increased streamflow during the late spring and early summer, but have not resulted in a measurable flow benefit during the peak of the dry season.

Another consideration is the placement of these features within the watershed context. Small scale features higher on the hillslope that capture and infiltrate road runoff could potentially be more effective at providing flow enhancement benefit during the driest months due to longer groundwater flow paths, than detention features constructed on low lying terraces which deliver their benefit in the late spring/early summer. However, there is much uncertainty associated with the hillslope hydrologic processes making it difficult to design and monitor upslope projects of this type. In addition to the task of finding topographically and geologically suitable locations (relatively flat and stable) for these types of upslope retention features, there is also uncertainty regarding the recharged groundwater flow timing and pathways: the flow could take years to reach the stream, daylight in a different watershed, or also daylight mid-slope and increase the risk for landslides.

Large scale upslope infiltration projects have not been implemented in our region to date. However, there could be strong synergy with several of the other approaches describe herein including BDA type check-dam structures in small upslope gullies and forest management activities described below in Section 3.4. A combination of these approaches could result in measurable flow benefits.

3.3.7 Operations and maintenance considerations

Flow detention features typically have minimal operations and maintenance needed.

3.4 Evapotranspiration Reduction through Forest Management

One approach to increasing stream flow to support fish is reducing evapotranspiration (ET) through forest thinning. The theory is that if evapotranspiration is reduced, other components of the water balance (including storage and runoff) would increase. Paired watershed studies, however, show that the effect of forest thinning or logging on the baseflow varies (Harr 1980, Hicks et al. 1991) and tends to be short-lived with the length of the effect dependent on local conditions (Hicks et al. 1991, Lane and MacKay 2001, Dan Moore and Wondzell 2005). Goeking and Tarboton (2020) reviewed 78 studies of the hydrologic response to drought, fire, insects and harvest to changes in forest stand density from 2000-2019. These studies showed that the ET could increase, decrease, or remain unchanged, although ET was more likely to decrease (and streamflow increase) in studies where forests were only partially impacted than studies where the entire stand was replaced by high-intensity fire or harvest. Most of the studies in Goeking and Tarboton (2020) were in snow-dominated watersheds. A further study suggests that the effect of thinning are more persistent in wetter and colder areas (i.e., Washington State and Montana) than drier ones (Goeking and Tarboton 2022). The effects of logging on flow are short-lived because thinned areas become revegetated as available water and sunlight promotes plant growth. Forest thinning (and associated roads) may also change rainfall-runoff relationships, causing an increasing portion of the rainfall to runoff directly to channels rather than enter the groundwater system, thereby further reducing summer baseflow. Decreases in evapotranspiration following forest thinning are likely to be short-lived and may only contribute to changing flows during wetter times of the year, rather than summer baseflows where aquatic organisms can be most affected by water withdrawal.

A recent group of papers exploring the effects of a change in fire management in a watershed in Yosemite National Park shows the effects of returning to natural fire regime (e.g., Boisrame et al. 2017, 2019). Starting in 1972, fire suppression ceased in the watershed. The forest has subsequently had lower intensity fires about every 10 years. The constant fires have helped to limit understory causing an increase in soil moisture and transforming parts of the watershed from forest to dry and wet meadow. Hydrological modeling shows that through time, baseflow has increased downstream. The baseflow gains are modest, however.

3.4.1 Operations and maintenance considerations

Significant work is necessary to maintain flow enhancement benefits achieved through forest thinning. After a thinning project is complete, smaller trees and shrubs begin to grow back immediately and maintenance of this regrowth is necessary. Forest management using controlled burning techniques is likely the most cost-effective approach, although there are many issues associated with risk and liability. Some controlled burning pilot projects are underway within the watershed as described in Section 4. Expanding controlled burning activities will be greatly supported by more overall water storage within the watershed both through storage and forbearance and direct flow augmentation projects.

3.5 Impacts Assessment

Based on observations within the project area and elsewhere throughout the region, flow enhancement activities can result in potential negative impacts: increased erosion, reduction in flows during the diversion season, poor water quality, and introduction of invasive species. In all cases, these potential impacts can be avoided and/or mitigated through appropriate planning, design, and maintenance.

3.5.1 Erosion potential

Flow enhancement projects should be constructed with strong consideration for local geologic and geomorphic constraints to reduce instabilities and erosion potential. Similarly, the site designs should incorporate strong erosion control features to reduce erosion.

Projects not constructed at suitable locations or engineered properly have the potential to cause significant negative impacts, including increased surface erosion and/or mass wasting. In the worse-case scenario, failed ponds and/or fill slopes can cause significant gullying or landslides. It is recommended that experienced licensed professionals should design all significant flow enhancement projects, and experienced licensed contractors should perform all construction work. Long-term monitoring, maintenance, and adaptive management is also critical to ensure that all project components are functioning as designed.

3.5.2 Reduction in wet season streamflows

If water is diverted to off-stream storage and detained in basins and ponds during the wet season, it has the potential to reduce stream flows during this period. Typically, the most critical periods to minimize diversions (in addition to the dry season) are: 1) the late fall and early winter when streamflows first rise and fish begin to move into and within the system, and 2) the spring and early summer when flows recede and fish require suitable flow and temperature to avoid stressful low-flow conditions.

Storage and forbearance and off-stream direct flow augmentation projects can avoid risks to in-channel aquatic resources during the wet season by diverting during periods with high flow. Sufficient water is available in Redwood Creek to divert for at least one to two months during a typical winter. The diversion management considerations described in Sections 3.1 and 3.2 above will greatly reduce the potential for wet-season runoff impacts caused by storage and forbearance and direct flow augmentation projects.

It is critically important to reduce the degree to which storage is “topped-off” late in the spring, especially higher in the watershed at spring diversions, because depending on groundwater flow timing, this diverted water could be the base flow in downstream channels.

Flow enhancement projects that utilize runoff detention and passive release approaches have the potential to impact wet season flows during the first precipitation events of the year as the groundwater recharge associated features fills with runoff. For small scale projects, this impact is likely immeasurable, however, for larger projects implemented over a broader scale, the potential impacts to the early wet-season hydrograph should be considered and monitored to inform adaptive management and future project planning and design.

Overall, a broad variety of projects spread throughout the watershed that divert or detain water during different periods and within multiple sub-sheds within the watershed is a good approach for flow enhancement, and by focusing larger scale projects where dry season flows are greatest impaired.

3.5.3 Draining of Groundwater

A concern with this type of feature is the interception of shallow groundwater from pond excavation and loss of the intercepted water to evaporation. However, groundwater is very flashy in Redwood Creek with peak water tables of approximately four feet below ground surface and dropping by two feet per week after heavy rains stop. Therefore, if some of this peak groundwater flow can be captured and held for several months, it can augment flows in the spring and early summer. Evaporation during these months is relatively low so the benefits of the detention typically outweigh the evaporation loss in an overall water balance. In the months when evaporation is higher (June through October) the pre-project groundwater table is generally lower than the maximum excavation depth. Since none of the deeper groundwater will be intercepted during this period, none of it will be lost to evaporation, and the only pond water that will be lost to evaporation is the pond water that was retained during the wet season and would have otherwise discharged from the system. Typically, these features should not be constructed downslope from year-round springs with the intent of capturing that water, because you could see a net water loss if you're capturing dry season runoff that would otherwise provide streamflow benefit and losing that water to evaporation.

3.5.4 Water quality

Water quality is a significant concern for direct flow enhancement projects. The primary water quality issues are high temperature and/or low dissolved oxygen (DO). High water temperature can be mitigated by releasing water from the bottom of the pond and ensuring sufficient water depth in the pond during the peak of the dry season to maintain stratifications. This approach is discussed in the Marshall Ranch Basis of Design Report Appendices (Stillwater Sciences 2022). High DO can be mitigated by releasing flow through a nozzle providing significant just before it gets delivered to a watercourse.

Further, these concerns can be mitigated by running flow through subsurface soil and gravel. Experimental projects of this type were conducted by the California State Water Quality Control Board (SWRCB) in Sonoma County in the summer of 2015. Agricultural pond water was used for direct flow enhancement in critical fish-bearing streams that were going dry. Initially, the quality of the stored water was not suitable for flow enhancement. However, when it was allowed to flow through substrate and mix with ground water, the resulting input to streamflow was suitable for aquatic habitat and the methodology proved effective for increasing stream flow.[1]

The Marshall Ranch project also proposes a pilot cooling/filtration gallery that will further test this approach of running flows through a constructed sand and gravel gallery. Another approach is to use aggraded reaches in existing downstream watercourses to naturally cool the water through hyporheic flow.

All direct flow augmentation projects need to consider water quality, although depending on the aquatic conditions at the point of release, the water quality targets may be very different.

3.5.5 Invasive species and inhabitation by native species

The potential to introduce and propagate invasive species (e.g., bullfrogs, canary reed grass, bass and other Centrarchids) should be avoided to the greatest extent feasible when planning and designing flow enhancement projects. An invasive species monitoring and management plan should be developed for any project involving a pond. At a minimum, periodically monitoring and if needed, draining of the pond for bullfrog management is required (Cite CDWF Bullfrog management plan).

There are many ways to drastically minimize the amount of mosquito activity on your pond. One of the easiest ways is to keep the water from remaining stagnant by adding a pond aeration system capable of disrupting the surface of the water. Native tadpoles can reduce larvae populations also, and when they become frogs they will consume large amounts of adult mosquitoes. Altering the environment and structure of the pond is another method to minimize mosquitoes. Vegetation and aquatic weeds growing in the water and along the edge can create pockets of calm and shady water even if you have an aeration system agitating most of the surface. Overhanging bushes and trees also support ideal shady locations, so clipping these back is a good idea.

[1] Schultz, Daniel, CA State Water Resources Control Board presentation at 2016 Salmonid Restoration Federation Annual Conference.

Another consideration is the native species that may be present (newts, frogs) when a pond is drained to clean for water quality of mange for bullfrog. Therefore, it is important to have a relocation plan either to a nearby pond or other appropriate location.

3.6 Climate Change

In north coastal California, climate change is likely to bring more severe droughts and longer/hotter dry seasons. Generally, these projects are designed to make Redwood Creek more resilient to these conditions by storing wet season precipitation and runoff and metering it out during the dry months to provide increased stream flow.

It is critical to design project with a consideration for future expected drought conditions, so that they will still function with less precipitation and a longer dry season. When wide variations in climate are factored into project design, projects with more adjustable systems (and thereby more O&M) may be more resilient to climate change rather than projects that are completely passive.

3.7 Cost-Benefit Analysis

The costs of different flow enhancement projects are summarized on Table 3-1. These cost estimates are based on a range of projects at various phases – completed, under construction, and planned. Project costs vary site by site so the specific project costs or unit costs listed on Table 3-1 should be considered approximate. However, the results highlight findings that are key to watershed flow enhancement planning:

1) Storage and forbearance projects are up to four times as expensive as direct flow augmentation on a price per gallon basis
2) Detention and passive release projects have the potential to be the most cost effective, but the timing of the flow enhancement does not coincide with the aquatic habitat need.
3) There is too much uncertainty about the flow-related benefits of forest thinning to make any estimate at this time.

Although the cost benefit analysis is a useful tool to guide watershed planning, it is one of many considerations. Even though it is the most expensive approach, there are locations within Redwood Creek where storage and forbearance is critical to prevent flow diversion from a stream reach that supports critical aquatic habitat.

Table 3-1. Costs for Planning, Design and Construction of Flow Enhancement Projects.

	Site assessment engineer-ing, and permitting	Earthwork, forest thinning	Water storage supplies liners/ tanks	Plumb-ing	Total Cost	Flow Enhance-ment Benefit (gal)	Cost per gallon	Typical Period of Benefit
Storage and Forbearance (100,000 gallon system)								
Tank system only	$40,000	$20,000	$120,000	$30,000	$210,000	100,000	$2.10	July-Nov
Tanks & Small Pond	$40,000	$40,000	$70,000	$40,000	$190,000	100,000	$1.90	July-Nov
Direct Flow Augmentation								
Marshall Ranch (9,500,000 gal HDPE lined ponds)	$800,000	$1,500,000	$500,000	$500,000	$3,300,000	7,000,000	$0.47	July-Nov
NFLR (1,500,000 gal unlined ponds with bentonite keyway)	$150,000	$400,000	$150,000	$20,000	$720,000	1,000,000	$0.72	July-Nov
Runoff Detention and Passive Release								
Baker Creek Instream (weirs)	$75,000	$400,000	$0	$0	$475,000	1,000,000	$0.48	May-July
McKee Creek Instream (weirs)	$100,000	$250,000	$0	$0	$350,000	500,000	$0.70	May-July
NFLR Instream (weirs, LW placement, channel grading, BDAs)	$125,000	$750,000	$0	$0	$875,000	1,650,000	$0.53	May-July
South Fork Lost River (BDAs)	$75,000	$100,000	$0	$0	$175,000	200,000	$0.88	May-July
Baker Creek String of Pearls (unlined detention ponds)	$75,000	$750,000	$0	$0	$825,000	4,000,000	$0.21	May-July
Evapotranspiration Reduction through Forest Thinning								
40 acres of forest thinning	$200,000	$200,000	$0	$0	$400,000	Unknown	Un--known	Unknown