

6. Adaptation Strategies to Increase Resilience

The development of adaptation strategies to increase the resilience across the Russian River watershed involved several steps. The main steps involved in soliciting and organizing adaptation concepts included:

1. Identifying areas of highest vulnerability
2. Frame breadth of potential adaptation concepts
3. Solicit input on potential adaptation concepts
4. Synthesize input and develop adaptation strategies and actions

The sections that follow summarize these steps in the adaptation strategy development process.

6.1 Identifying Priority Areas based on Vulnerability

As presented in Chapter 5, climate change vulnerabilities were identified throughout the watershed and across all water sectors. These vulnerabilities were characterized for the seven water resource sectors and organized into geographical areas of upper river, middle river, lower river, and adjacent or “plus” areas. Approximately 20 key climate vulnerabilities were identified. A summary of the key vulnerabilities are provided in Figure 6-1.

Most of these vulnerabilities have strong interdependencies across multiple water resource sectors. For example, many surface water supply vulnerabilities are also linked to vulnerabilities related to groundwater supply and recreation. And many flood management vulnerabilities are linked to ecosystem and water quality vulnerabilities. Due to these strong interdependencies of vulnerability, strategies may also provide multiple benefits for increasing the resilience in the watershed. For these reasons, we have developed a key to indicate which water resource vulnerabilities may be addressed by various strategies. This water resource vulnerability key is shown in Figure 6-2.

Figure 6-1. Summary of Key Climate Vulnerabilities in the Russian River Watershed

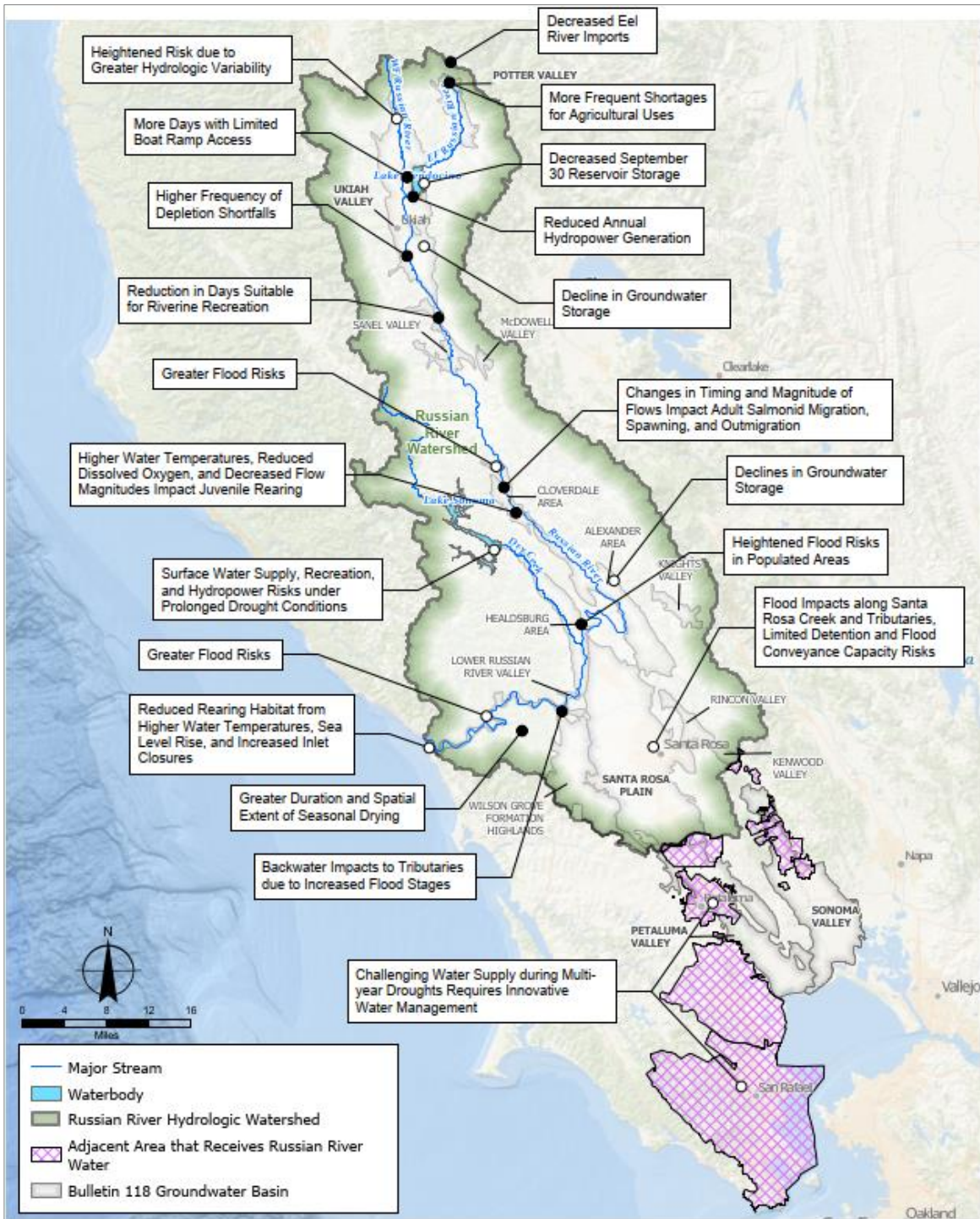
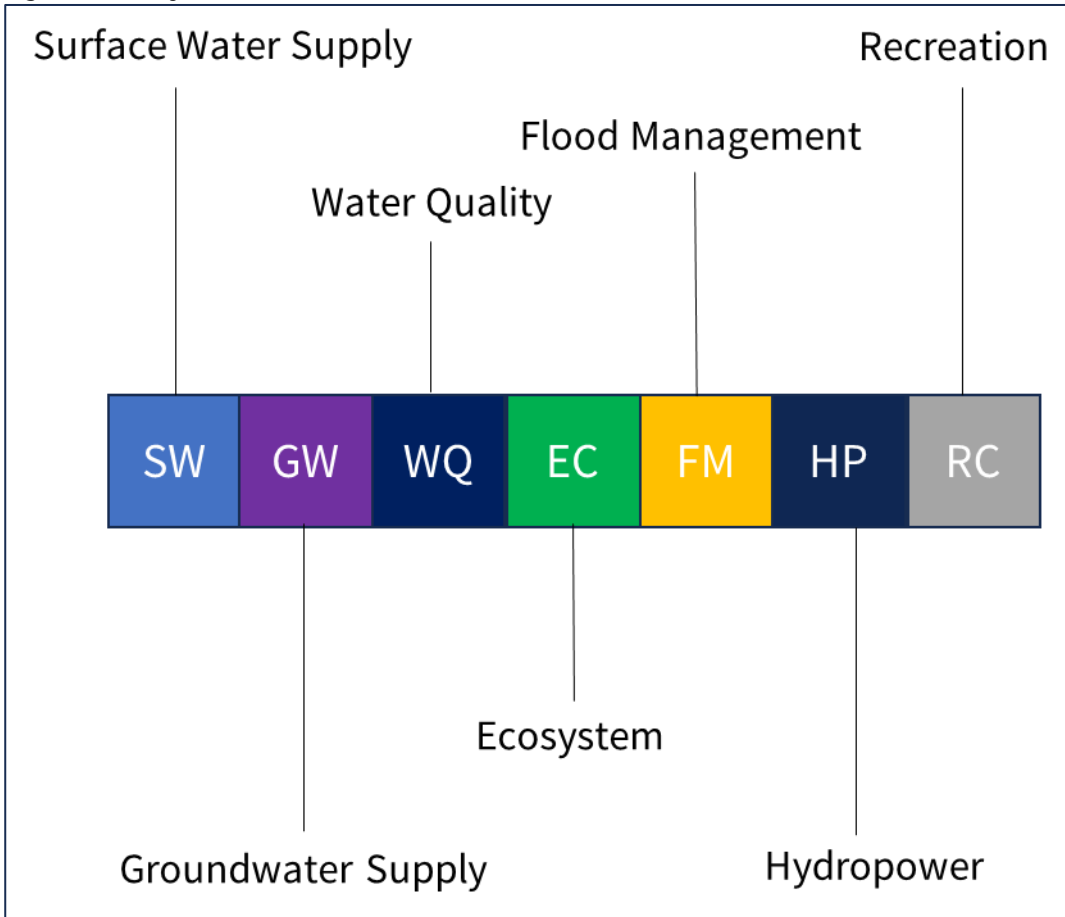


Figure 6-2. Key to Indicate Water Sector Vulnerabilities

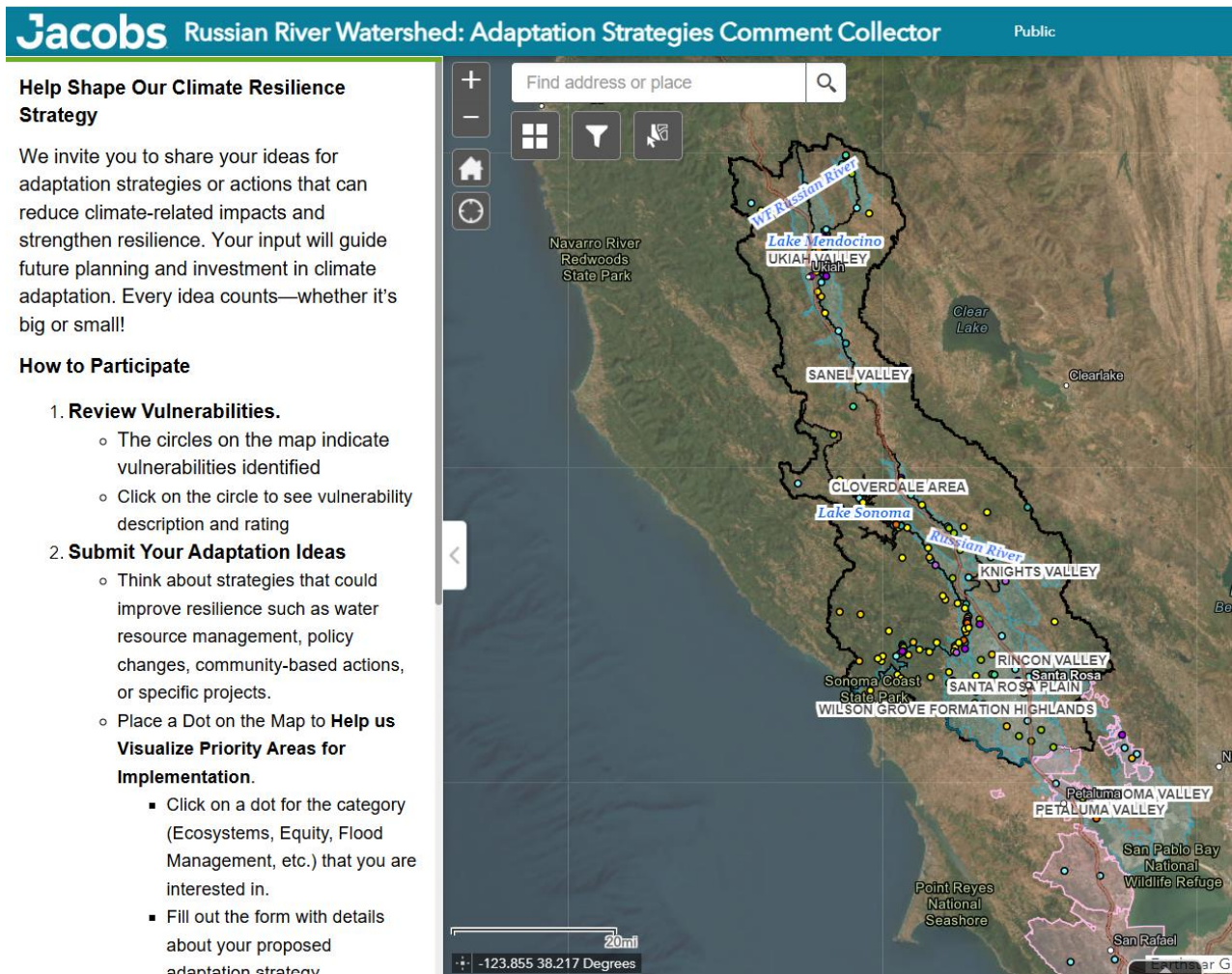


6.2 Development of Initial Ideas on Adaptation Concepts

After careful review of the key climate vulnerabilities, initial ideas on adaptation strategies were compiled from the Watershed Network. The Network participants have a wealth of knowledge about various watershed and were engaged to provide initial ideas on potential strategies.

Two Network meetings were dedicated, in part, to describe the adaptation strategy process and receive input on adaptation strategy ideas. An interactive, online GIS portal was developed to allow participants to visualize vulnerabilities and indicate various strategy ideas on a map of the watershed (Figure 6-3). Over 200 ideas were compiled from participants in this manner.

Figure 6-3. Interactive, Online GIS Portal for Collecting Adaptation Strategy Concepts



In addition, the Project Team reviewed several related reports and studies to incorporate previously developed strategies. These reports include:

- Sonoma Water Climate Adaptation Plan (2022, 2026)
- Potter Valley Water Supply Reliability Study (2025)
- Local Hazards Mitigation Plan (2023; 2026 update)
- Sonoma Water Regional Water Supply Resilience Study (2026)
- Sonoma Water CIP Resilience Projects (2025)

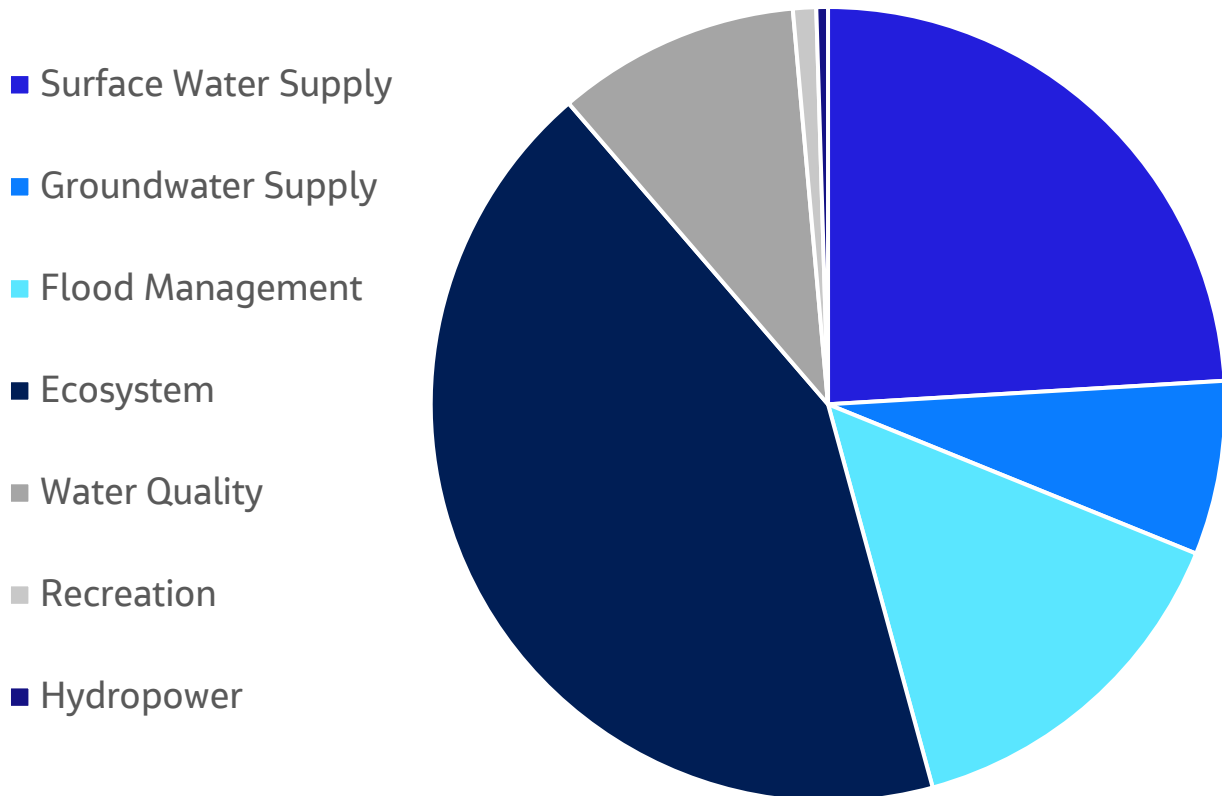
Approximately 10 additional meetings were also held with the Project Team and individual groups (agencies, trusts, tribes, etc) to gain additional insight into the potential adaptation strategies and alignment with programs that may amplify the ability to adapt.

In the end, over 250 adaptation strategies were compiled from either direct Watershed Network input, review of existing report recommendations, and individual group input. Figure 6-4 shows a summary of the distribution of adaptation concepts compiled from the Watershed Network process. Strategy ideas were compiled for all water resource sectors and in all regions of the watershed. A complete listing of the adaptation concepts that were compiled is included in Appendix D. The largest number of adaptation ideas or

concepts were compiled for ecosystem, water supply (both surface and groundwater supply), flood management, and water quality – reflecting the most critical vulnerabilities and also the knowledge-base and participant engagement distribution.

Figure 6-4. Summary of Distribution of Adaptation Concepts Compiled from the Watershed Network

Distribution of Adaptation Concepts Compiled



6.3 Recent Accomplishments toward Resilience

Many of the water and resource managers in the Russian River watershed have been active at driving adaptation actions over the past decade. Several examples illustrate the activity of this community and foresight to work toward resilience implementation:

- Forecast-Informed Reservoir Operations at Lake Mendocino and Lake Sonoma – use of advanced weather and hydrological forecasts, adaptive reservoir water control manuals, conserving water supply for potential dry years (see Appendix D).
- Regional Sonoma-Marín Saving Water Partnership – regional program to advance water conservation and water use efficiency resulting in award-winning savings.
- Dry Creek Rancheria Fire Resilience Projects – demonstration projects to increase wildfire resilience through incorporation of traditional ecological knowledge and cultural burn approaches.

- Ag+Open Space Vital Lands Initiative – initiative to protect vital lands for agricultural, water, communities, and wildlands through conservation easements.
- Sonoma Land Trust Conservation Program – program to focus conservation easements and acquisition on critical Coho streams.
- **NOTE TO NETWORK PARTICIPANTS – IF YOU HAVE A PROGRAM THAT HAS ADVANCED RESILIENCE ACTION THAT YOU WOULD LIKE TO HIGHLIGHT, PLEASE INDICATE IN YOUR COMMENTS.**

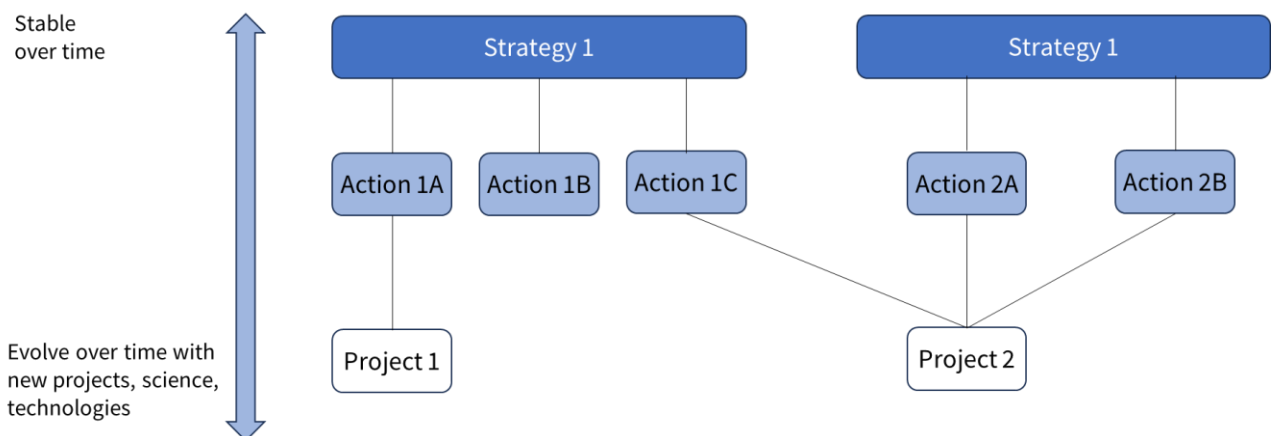
The Russian River Watershed Network has shown an ability to move toward action, although in a less coordinate manner. The strategies and actions that are described in the next sections build from this good foundation and expand the types of adaptations considered.

6.4 Developing Adaptation Strategies and Actions

Adaptation strategy input received from the Watershed Network and those compiled through other sources and meetings varied in the level of detail and specificity. Some concepts reflected a broad strategy or objectives that could be applied to the entire watershed, while others were related to specific projects at specific locations on the river or tributaries. To organize the strategies into a more consistent presentation, the Project Team developed an approach to incorporate this input into a structured strategy template.

The structured strategy template organizes adaptation strategies into three elements of increasing level of specificity: Strategies, Actions, and Projects. Strategies are high-level themes designed to achieve particular goals. These are thought of as “north star” themes that should be relatively stable over time. Actions are more specific methods in which parts of the strategy can be accomplished. And Projects are the most specific and may address all or parts of actions or may align with several Actions to varying degrees. The organization of adaptation Strategies, Actions, and Projects is shown graphically in Figure 6-5.

Figure 6-5. Organization of Adaptation Strategies, Actions, and Projects



A total of 13 climate adaptation strategies were developed as part of this process as shown in Table 6-1. These strategies were developed to target one or more climate vulnerabilities and include elements related to water management infrastructure, operations, land and water stewardship and management, policy and governance, and science and technology. Each climate adaptation strategy has been developed to address one or more vulnerabilities. In many cases, the benefits derived from a strategy are anticipated to span several water resource sectors. Table 6-1 indicates the strategy and primary and secondary sectors that are expected to benefit.

Table 6-1. Climate Adaptation Strategies included in the Russian River Watershed Resilience Plan

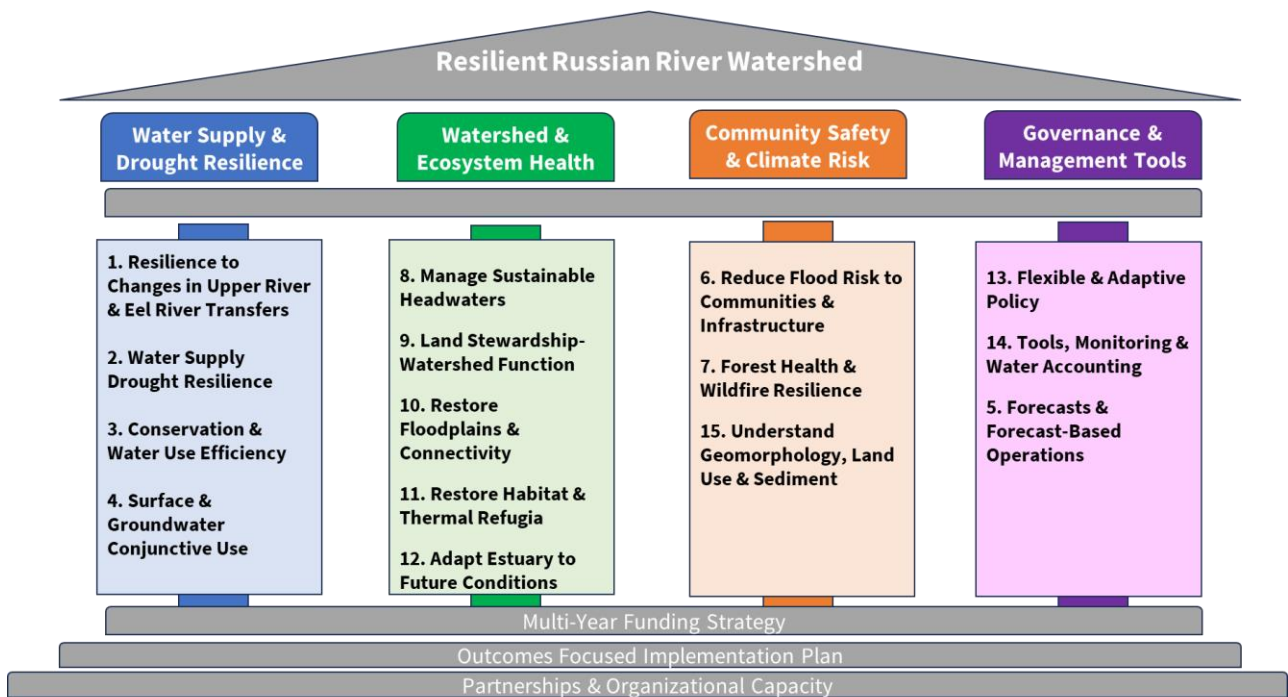
Climate Adaptation Strategy	Water Resource Sectors
1. Increase Resilience to Changes in Upper River and Eel River Transfers	
2. Increase Water Supply Resilience to Drought	
3. Increase Water Conservation and Water Use Efficiency	
4. Expand Conjunctive Use of Surface Water and Groundwater	
5. Improve Forecasts and Forecast-Based Operations	
6. Reduce Flood Risk to Communities and Infrastructure	
7. Manage Sustainable Headwaters and Support Wildfire Resilience	
8. Promote Land Stewardship Measures to Restore Watershed Function	
9. Restore Floodplains and Connectivity	
10. Restore Hydrological Function, Habitat, and Thermal Refugia in Tributaries	
11. Adapt Russian River Estuary to Future Conditions	
12. Support Flexible and Adaptive Policy for Resilient Watershed Management	
13. Enhance Tools, Monitoring, and Water Accounting Methods	

The overarching goal of the WRP is to help create a more resilient Russian River Watershed to current and future climates. The WRP organizes the 13 climate adaptation strategies around 4 main pillars as shown in Figure 6-6:

1. Water Supply & Drought Resilience
2. Watershed & Ecosystem Health
3. Community Safety & Climate Risk
4. Governance & Management Tools

Each of these pillars incorporates several related strategies that help to achieve similar outcomes. These pillars are supported by foundational implementation elements including multiyear funding, outcomes focused implementation plan, and partnerships and organization capacity. These implementation elements are discussed in detail in Chapter 7.

Figure 6-6. An Integrated Russian River Resilient Strategy



Each of the strategies is presented in more detail in the following sections. These descriptions include strategy, related actions, and a project spotlight to demonstrate an example of a project level implementation. In subsequent work with the Watershed Network, projects will be better identified for each of the actions and a more comprehensive project database and tracking mechanism will be developed.

6.4.1 Strategy #1 - Increase Resilience to Changes in Upper River and Eel River Imports

Strategy #1 - Increase Resilience to Changes in Upper River and Eel River Imports	
Actions	Vulnerabilities Addressed
Action 1 - Increase Surface and/or Groundwater Storage in Upper River	
Action 2 – Improve Water Demand Management	
Action 3 – Implement Managed Aquifer Recharge and Storage	
Action 4 – Maximize Flexibility through Forecast-Based Operations at Lake Mendocino	
Action 5 – Manage Immediate Risk due to Planned PVP Decommissioning	

Project Spotlight: Implement Water Use Efficiency, Groundwater, and Storage Actions in Potter Valley

Several efforts are currently underway to address water reliability challenges in the Upper River and Potter Valley due to combined effects of climate change and Potter Valley Project decommissioning. The Potter Valley Water Supply Reliability Study (2025) includes recommendations to develop an integrated water supply strategy for the Potter Valley that includes:

- Accelerate Efforts to Reduce Water Demand in Potter Valley. Reduce Potter Valley water demands by 20 to 30% through irrigation delivery system improvements and on-farm irrigation demand management.
- Develop New In-Valley Pond Storage. Develop at least 2,500 acre-feet (AF) of new in-valley pond storage.
- Develop New Groundwater Supply in Potter Valley. Develop a new groundwater supply of at least 3,500 AFY by constructing agricultural production wells to provide supplemental supply during June through September.
- Incentivize Storage and Well Development throughout Potter Valley. Due to the large number of new small ponds and new wells that will be required, it is likely that a decentralized approach toward reliability will be most effective. To provide an incentive to develop ponds and production wells as soon as possible, a Potter Valley water fund could be established to offer reduced costs (or rebates) to individuals who develop such projects.



6.4.2 Strategy #2 – Increase Water Supply Resilience to Drought

Strategy #2 - Increase Water Supply Resilience to Drought	
Actions	Vulnerabilities Addressed
Action 1 – Increase Drought and Emergency Water Storage	
Action 2 – Improve and Integrate Regional Storage Operations	
Action 3 – Increase Reliability of Conveyance and Interconnections	
Action 4 – Expand Use of Recycled Water Supply	
Action 5 – Update and Expand Water Conservation	

Project Spotlight: Lower System Regional Water Bank

Sonoma Water and regional partners are currently studying the feasibility of Regional Water Bank that would improve the drought and seismic water supply resilience in the lower system. The Regional Water Bank would integrate excess winter water diversion with the available groundwater storage in Santa Rosa Plain, Sonoma Valley, and Petaluma Valley groundwater basins and available surface storage in Lake Sonoma, Lake Stafford, and Marin Reservoirs. Through either direct movement of diverted water to storage pools or through indirect transfers through in-lieu exchanges, water could be stored during periods of river high flows and used as drought or emergency supply during dry conditions or abrupt disruptions on the aqueduct system.



The main components of the proposed Regional Water Bank include:

- Enhance Diversion of Available Winter Water at Wohler and Mirabel facilities.
- Expand Groundwater ASR and/or In-Lieu Injection and Extraction Capacities in Santa Rosa Plain, Sonoma Valley, and Petaluma Valley groundwater basins.
- Develop Bank Storage and Water Bank Accounting Mechanisms. Integrate surface storage, groundwater storage, and transmission system conveyance to develop bank.
- Augment Water Supply for Use During Droughts and Transmission and Emergencies

6.4.3 Strategy #3 – Increase Water Conservation and Water Use Efficiency

Strategy #3 - Increase Water Conservation and Water Use Efficiency	
Actions	Vulnerabilities Addressed
Action 1 – Expand Water Conservation and Water Use Efficiency in Municipal and Industrial Sectors	
Action 2 – Expand Water Conservation and Water Use Efficiency in Agricultural Sector	
Action 3 – Expand Use of Recycled Water Supply	
Action 4 – Adapt Rate Structures for Variability and Volatility of Sales	
Action 5 – Improve Measurement, Water Budget, and Accounting Systems	

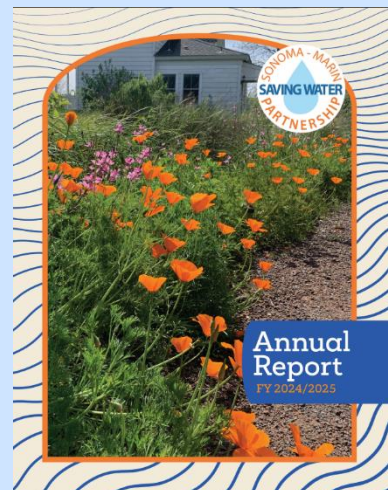
Project Spotlight: Sonoma-Marín Saving Water Partnership

The Sonoma-Marín Saving Water Partnership (Partnership) represents 13 water utilities in Sonoma and Marin counties that have joined together to provide regional solutions for water use efficiency. The utilities include the Cities of Santa Rosa, Rohnert Park, Petaluma, Sonoma, Cotati, Cloverdale, and Healdsburg, North Marin and Valley of the Moon Water Districts, Marin Water, Town of Windsor, California American Water – Larkfield District and Sonoma Water (Partners). Each of the Partners offer water conservation programs that can assist customers in reducing their water use.

The Partnership was formed to identify and recommend implementation of water use efficiency projects and maximize the cost-effectiveness of water use efficiency programs in our region. The Partnership supports programs related to various water conservation programs such as water conservation rebates and incentives, Water Smart plant guides and labels, irrigation scheduling technology and tools, water education and water saving tips, and rainwater harvesting.

Through these actions the reduction in regional per capita water use exceeded the targets set by the 20x2020 program. The Partnership continues its work to meet new water reduction goals such as the State Board's new water conservation framework, called Making Water Conservation a California Way of Life, and to secure a reliable water future for all our communities.

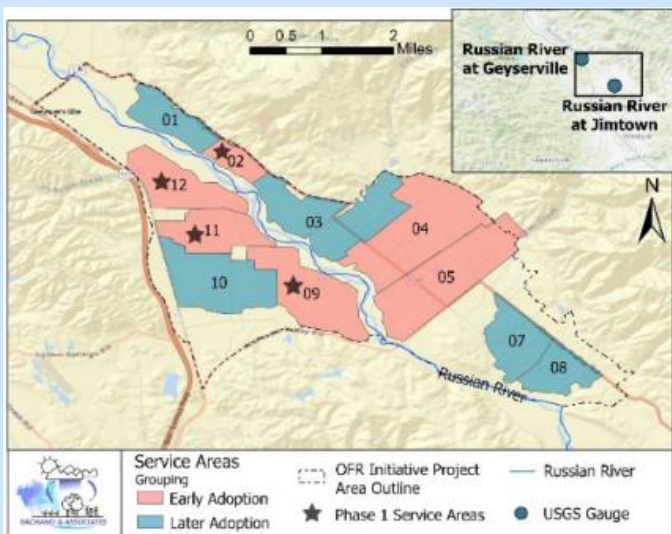
Continued and expanded investments in the Partnership and related water conservation programs throughout the Russian River watershed can contribute to future water supply resilience for the region.



6.4.4 Strategy #4 – Expand Conjunctive Use of Surface Water and Groundwater

Strategy #4 – Expand Conjunctive Use of Surface Water and Groundwater	
Actions	Vulnerabilities Addressed
Action 1 – Integrate Managed Aquifer Recharge Projects	
Action 2 – Install New or Rehabilitate Existing Wells for Operable Production Wells	
Action 3 – Improve Understanding of Surface Water-Groundwater Dependence in Alluvial Basins	
Action 4 – Support GSAs to Maximize Watershed Infiltration and Groundwater Recharge	

Project Spotlight: Alexander Valley On-Farm Recharge Initiative



The Dry Creek Rancheria of Pomo Indians, in partnership with local landowners – Jackson Family Wines, Constellation, Foley Family Wines, Rodney Strong, Vino Farms, Silverado, Robert Young are piloting an on-farm recharge project to create sustainable water resources with benefits to local fisheries, agriculture, and communities. The Alexander Valley On-Farm Recharge (OFR) Initiative’s Pilot Phase envisions recharging across 3,000 acres of active and fallow vineyards with an annual 6,000 - 7,000 acre-foot (AF) capacity, exceeding vineyard irrigation demands by an estimated 50%.

The Initiative will “sip” diversion water during high flows in fall and winter months using

shallow wells along the Russian River and distribute diversions to vineyard partners to apply to their fields as recharge. The Initiative will help stabilize regional water resources and support the local community through current and future challenges (e.g., changing climate, threatened and endangered salmonid species, Potter Valley decommissioning, and contracting wine sales).

2025 WY and 2026 WY pilot studies are being conducted to refine OFR designs and operations. The 2025 WY pilot studies found that OFR did not degrade groundwater quality in the shallow aquifer below.

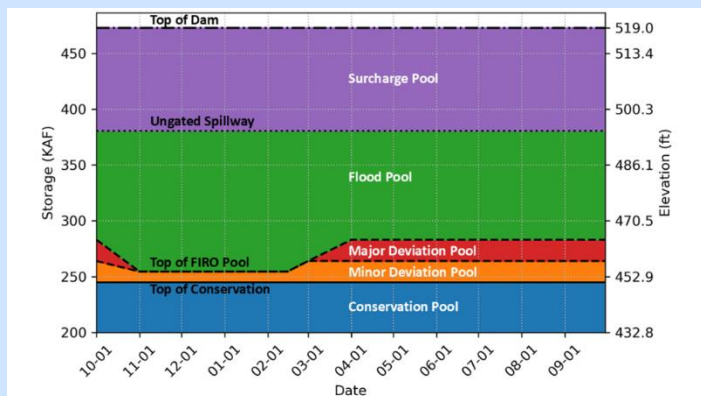
Phase 1 construction will be completed Spring 2026 and will serve 1,000 vineyard acres and have an annual recharge capacity of 2,300 AF.

6.4.5 Strategy #5 – Improve Forecasts and Forecast-Informed Operations

Strategy #5 – Improve Forecasts and Forecast-Informed Operations	
Actions	Vulnerabilities Addressed
Action 1 – Operationalize FIRO at Lake Sonoma and Lake Mendocino	
Action 2 – Operationalize Use of Advanced Quantitative Precipitation Information for Forecast-Based Operations	
Action 3 – Expand Transition to Applications for Subseasonal to Seasonal (STS) and Decadal Climate Predictions	
Action 4 – Expand Weather and Stream Gaging Networks	
Action 5 – Improve Understanding and Forecasts of Water Temperature	

Project Spotlight: Lake Sonoma Forecast-Informed Reservoir Operation (FIRO)

FIRO is a reservoir-operations strategy that better informs decisions to retain or release water by integrating additional flexibility in operation policies and rules with enhanced monitoring and improved weather and water forecasts (American Meteorological Society, 2020). FIRO operations have been applied at Lake Mendocino for nearly 10 years, providing credible proof of the water supply, flood, and ecological benefits of improved operations.



Based on the successes of FIRO at Lake Mendocino, Sonoma Water and the FIRO Steering Committee began to investigate FIRO at Lake Sonoma. Beginning in the Fall of 2022, Sonoma Water has requested a minor deviation for Lake Sonoma that includes 9,500 acre-feet of encroachment in the flood control pool from November 1 to February 14, a spring refill that begins on February 15 and increases linearly to a level of 19,000 acre-feet on March 1, and remains at 19,000 acre-feet of encroachment for the dry season until October 1. Each year that this minor deviation has been requested, the USACE has skillfully operated Lake Sonoma to achieve the maximum possible water supply benefit of 19,000 acre-feet. Sonoma Water is currently working with the USACE to implement a major deviation at Lake Sonoma and, if approved, will include the same level of flood control pool encroachment as the minor deviation (9,500 acre-feet from November 1 to February 14), but on February 15 the spring refill will increase linearly to a level of 38,100 acre-feet on March 1, and will remain at this level through the dry season until October 1. It is anticipated that this major deviation will be implemented in Fall of 2026 to support operations for water year 2027.

The upcoming major deviation for Lake Sonoma will establish guidelines and rules for detaining water within the FIRO pool based on forecasted information. Sonoma Water intends to request this major deviation to be in place for up to 5 years, or until it is replaced with a modified Water Control Manual that implements FIRO for Lake Sonoma, which is currently scheduled to be completed by 2028.

6.4.6 Strategy #6 – Reduce Flood Risk to Communities and Infrastructure

Strategy #6 – Reduce Flood Risk to Communities and Infrastructure	
Actions	Vulnerabilities Addressed
Action 1 – Expand and Restore Russian River Floodplains	
Action 2 – Support Regional Coordinated Flood Planning and Policies	
Action 3 – Implement Stormwater and Watershed-Based Infiltration Programs	
Action 4 – Adapt or Relocate Critical Infrastructure in Floodplains	
Action 5 – Acquire or Develop Conservation Easements over Existing Floodplains	
Action 6 – Update Flood Management Design Guidance	







Project Spotlight: Laguna-Mark West Creek Watershed Planning Scoping Study

The Laguna - Mark West Watershed Planning Scoping Study encompasses an effort to identify the potential for projects within the watershed that provide flood protection and promote groundwater recharge and other watershed benefits, such as ecosystem, water quality, water supply, agricultural, open space, and other community benefits.



The core project objectives are to reduce flood hazard and promote groundwater recharge within the watershed. Flood alleviation projects that provide flow and volume attenuation through storage and infiltration can also promote recharge. In contrast, in - stream hydraulic capacity projects such as floodwalls and pipeline bypasses may provide flood reduction benefits but are not generally effective in reducing overall flood flows or volumes or in promoting groundwater recharge. Examples of project types or elements that may be combined include swale or floodplain expansion, detention or retention, forest restoration, bypass channel, sediment removal or reduction, channel or bank modification, and existing reservoir expansion.

6.4.7 Strategy #7 – Manage Sustainable Headwaters and Support Wildfire Resilience

Strategy #7 – Manage Sustainable Headwaters and Support Wildfire Resilience	
Actions	Vulnerabilities Addressed
Action 1 – Support Headwaters Conservation and Restoration	
Action 2 – Implement Watershed Fuels Management	
Action 3 – Develop Coordinated Post-Fire Remediation Plan	
Action 4 – Integrate Traditional Ecological Knowledge	
Action 5 – Remove Invasive Vegetation	
Action 6 – Increase Forest Rehabilitation and Carbon Sequestration	

Project Spotlight: Dry Creek Rancheria Fire Resilience Project

The Dry Creek Rancheria Band of Pomo Indians is actively enhancing its fire resilience through comprehensive vegetation management, dedicated emergency services, and climate adaptation planning, particularly in response to risks highlighted by the 2019 Kincade Fire. The Tribe has focused on expanding its fire-fuel reduction efforts across its 75-acre Rancheria and has taken steps to secure its infrastructure through renewable energy and improved fire services.



Key Fire Resilience Projects and Initiatives

- **Dry Creek Rancheria Fire Resilience Project:** This project, supported by the State Coastal Conservancy, focuses on reducing fire fuels on approximately 57 acres of Tribal land, including areas damaged by the Kincade Fire and along Rancheria Creek. It includes vegetation management, forest thinning, and the development of long-term management strategies.
- **Tribal Climate Adaptation Plan:** The Tribe is integrating fire resilience with climate change adaptation by focusing on restoring Rancheria Creek, managing vegetation, and reducing the risk of catastrophic wildfire, which helps improve forest health and water quality.
- **Traditional Ecological Knowledge (TEK):** The Tribe is documenting and implementing TEK to guide forest management, focusing on historical landscape practices to improve climate resiliency.

Broader application of lessons learned from these projects and incorporation of TEK can increase the wildfire resilience of the watershed.

6.4.8 Strategy #8 – Promote Land Stewardship to Restore Watershed Function

Strategy #8 – Promote Land Stewardship to Restore Watershed Function	
Actions	Vulnerabilities Addressed
Action 1 – Protect Undeveloped Floodplains	
Action 2 – Integrate Tribal Traditional Ecological Knowledge	
Action 3 – Support Preservation of Riparian Buffers	
Action 4 – Acquire and Protect Properties in Key Fish Habitats	
Action 5 – Establish Resources and Education for Landowners for Grants and Permitting Support	

Project Spotlight: Sonoma Ag+Open Space Vital Lands Initiative







The mission of Ag + Open Space is to permanently protect the diverse agricultural, natural resource, and scenic open space lands of Sonoma County for future generations. In support of the Sonoma County community's vision, the Vital Lands Initiative is a long-range comprehensive plan to prioritize the land conservation activities of Sonoma County Ag + Open Space through 2031. The Vital Lands Initiative outlines five specific land conservation goals:



- Agricultural Lands: Protect lands that support diverse, sustainable, and productive agriculture.
- Community Identity: Protect open lands that surround and differentiate the County's urban areas and contribute to the unique scenic character of the County.
- Healthy Communities: Protect open space and publicly accessible lands in and near cities and communities and connect people with protected lands.
- Water: Protect natural lands and aquatic habitats that support sustainable aquatic ecosystems and water resources.
- Wildlands: Protect natural lands and terrestrial habitats that support plants, wildlife, and biodiversity.

The primary tool used to meet the Initiative goals and objectives is the conservation easement. Conservation easements are legal agreements between a willing landowner and the agency that permanently limit uses of the land to protect its conservation values ensure that the terms of the conservation easement are being honored, – specific agricultural, natural, scenic, or recreational attributes of the property that provide a public benefit. Since its formation, Ag + Open Space has protected and continues to perpetually steward over 118,000 acres of high priority open space lands, preserving productive agricultural land and local food, healthy watersheds, functional ecosystems and biodiversity, scenic landscapes and greenbelts, and providing a wide variety of recreational opportunities for Sonoma County residents and visitors.

6.4.9 Strategy #9 – Restore Floodplains and Connectivity

Strategy #9 – Restore Floodplains and Connectivity	
Actions	Vulnerabilities Addressed
Action 1 – Implement Floodplain Restoration at Former Gravel Pits on Russian River	
Action 2 – Protect Instream Flows and Restoration Projects in Critical Coho Watersheds	
Action 3 – Implement Restoration Concepts from Laguna Restoration Plan	
Action 4 – Improve Modeling of Riparian, Floodplain, and Flood Dynamics	
Action 5 – Acquire and Protect Undeveloped Lands at Tributary Mouths	
Action 6 - Improve Understanding of Historical Geomorphology, Land Use, and Sediment	

Project Spotlight: Laguna de Santa Rosa Restoration Plan

The Laguna de Santa Rosa is an expansive freshwater wetland complex that hosts a rich diversity of plant and wildlife species, and is also home to a thriving agricultural community. Since the mid-19th century, modifications to the Laguna and its surrounding landscape have degraded habitat conditions for both wildlife and people. Together with partners at the Laguna de Santa Rosa Foundation, and funded by Sonoma Water and the California Department of Fish and Wildlife, the goal of the Laguna de Santa Rosa Master Restoration Plan project is to develop a plan that supports ecosystem services in the Laguna—through the restoration and enhancement of landscape processes that form and sustain habitats and improve water quality—while considering flood management issues and the productivity of agricultural lands.



A Restoration Vision, Plan, and Framework have been developed for the Laguna de Santa Rosa. A series of reports describe a long-term vision for the landscape and a potential future Laguna. The Restoration Plan that was built from the Vision identifies restoration opportunities and conceptual designs to support the establishment of implementable restoration projects. The Restoration Plan includes the following elements:

- A restoration framework that offers a planning structure for landscape scale restoration that can be further developed and refined over time.

- Restoration project concepts in the Laguna's 100-year floodplain developed from selected restoration opportunity areas shown in the Vision.
- Criteria for prioritizing and sequencing restoration project concepts.

The utilization of the Restoration Plan and the ultimate success of restoration efforts in the Laguna will require local landowner support and adequate funding to implement the restoration and manage and sustain the benefits through long-term stewardship. It will also require coordination among all the agencies responsible for managing the land and water within the Laguna and its surrounding watershed.

6.4.10 Strategy #10 – Restore Hydrological Function, Habitat, and Thermal Refugia in Tributaries

Strategy #10 – Restore Hydrological Function, Habitat, and Thermal Refugia in Tributaries	
Actions	Vulnerabilities Addressed
Action 1 – Protect Instream Flows in Critical Coho Watersheds	
Action 2 – Support Riparian Restoration on Critical Tributaries	
Action 3 – Identify Locations of Russian River Thermal Refugia	
Action 4 – Support Enhanced Watershed Processes in Shallow Groundwater-Supplied Streams	


Project Spotlight: Studies on Importance of Flow-Related Variables on Thermal Refugia

Recent studies (Obedzinsk et al 2018) have established the importance of the relationships between survival of juvenile salmonids and flow-related variables in intermittent streams. With predictions for a higher frequency of drought conditions due to climate change and the associated increasing human demand for water during the dry season, understanding fish–flow



relationships is becoming increasingly important for the protection of sensitive aquatic species. The study examined the effects of low streamflow on juvenile salmonids rearing in small intermittent streams, including Mill Creek, Green Valley Creek, and Dutch Bill Creek in the Russian River watershed from 2011 to 2013. Survival was positively associated with streamflow magnitude, wetted volume, and dissolved oxygen and negatively associated with days of disconnected surface flow (days of disconnection) and temperature. Days of disconnection best explained survival, though the relationship varied by geomorphic reach type. Survival was lower in alluvial reaches than in bedrock and clay reaches and showed a faster rate of decline with increasing days of disconnection and drought condition. In all reaches, the onset of pool disconnection represented a turning point at which water quality, water quantity, and survival declined. For this reason, the authors suggest that days of disconnection (or the flow magnitude at which pools become disconnected) is a useful metric for identifying flow-impaired reaches, informing streamflow protection strategies, and prioritizing streamflow enhancement efforts designed to benefit sensitive salmonid populations in intermittent streams

6.4.11 Strategy #11 – Adapt Russian River Estuary to Future Conditions

Strategy #11 – Adapt Russian River Estuary to Future Conditions	
Actions	Vulnerabilities Addressed
Action 1 – Develop Improved Understanding of Future Estuary Conditions	
Action 2 – Develop Adaptation Pathways for Estuary Management and Structure Protection	
Action 3 – Promote Adaptive Regulatory Approaches for Evolving Estuary	
Action 4 – Identify and Protect Critical Estuary Habitat and Refugia	

Project Spotlight: Russian River Estuary Management Project








The Russian River Estuary may close at any time of the year as a result of a sandbar forming at the mouth of the Russian River. The sandbar usually closes from the spring through the fall when river flows are relatively low and long period waves transport sand landward, rebuilding the beach that was removed by winter waves and river outflows.

Closures result in the formation of a lagoon in the Russian River behind the sandbar and water level increases in the estuary. Natural breaching events occur when estuary water surface levels exceed the sandbar height and overtop the sandbar, scouring an outlet channel, or when ocean wave conditions erode the barrier beach. Public agencies have been involved in breaching the sandbar since at least the 1960s. Sonoma Water became responsible for breaching activities in 1994.

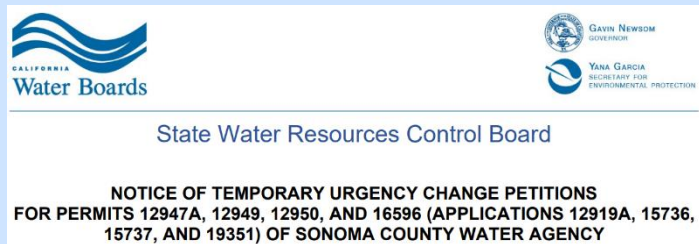
Sonoma Water staff mechanically breach the sandbar to minimize the potential flood risk of low-lying shoreline properties along the estuary. As sea levels continue to rise, temperatures increase, and flow regimes change, the estuary will also change. Proactive study of the conditions likely in the future can inform the future management plans.

6.4.12 Strategy #12 – Support Flexible and Adaptive Policy for Resilient Watershed Management

Strategy #12 – Support Flexible and Adaptive Policy for Resilient Watershed Management	
Actions	Vulnerabilities Addressed
Action 1 – Support Flexible and Adaptive Regulations	
Action 2 – Acquire Conservation Easements to Support Watershed Resilience	
Action 3 – Support Action Plan to Address Water Quality Impairments	
Action 4 – Modify Russian River Hydrologic Index	
Action 5 – Improve Integration of Flood and Land Management	

Project Spotlight: State Water Resources Control Board Temporary Urgency Change Petitions

The State Water Resources Control Board regulates conditions associated with water rights on the Russian River. Sonoma Water controls and coordinates water supply releases from Lake Mendocino and Lake Sonoma to implement the minimum instream flow requirements in water rights Decision 1610, which the State Water Resources Control Board adopted in 1986. Decision 1610 specifies minimum flow requirements for the Upper Russian River, Dry Creek, and the Lower Russian River. These minimum flow requirements vary based on water supply conditions. The Decision 1610 requirements for the Upper Russian River and Lower Russian River are contained in term 20 of the Water Agency's water-right Permit 12947A. The Decision 1610 requirements for the Lower Russian River are contained in term 17 of the Water Agency's water-right Permit 12949 and term 17 of the Water Agency's water-right Permit 12950. The Decision 1610 requirements for Dry Creek and the Lower Russian River are contained in term 13 of the Water Agency's water-right Permit 16596.



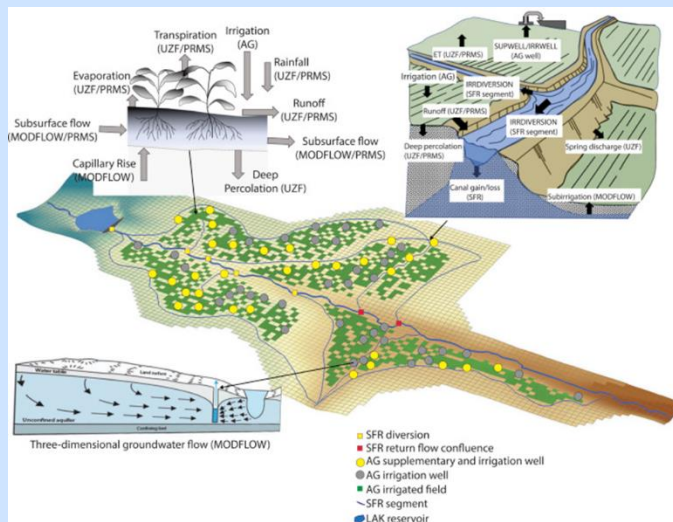
During periods of extreme dry hydrology or incongruent measurement of hydrology and operations, Sonoma Water has petitioned the Board to temporarily modify the conditions to more effectively manage the resources of the river. The State Board has shown flexibility in approving these conditions and temporarily modifying water rights conditions due to actual watershed conditions and modified hydrologic indices. Much more regulatory adaptability and flexibility will be required for future climate, but examples demonstrate a potential willingness to proactively adapt critical regulations.

6.4.13 Strategy #13 – Enhance Tools, Monitoring, and Water Accounting Methods

Strategy #13 – Enhance Tools, Monitoring, and Water Accounting Methods	
Actions	Vulnerabilities Addressed
Action 1 – Improve Modeling of Riparian, Floodplain, and Flood Dynamics	
Action 2 – Improve Monitoring Techniques to Inform Near Real-Time Modeling and Responses	
Action 3 – Develop Fully Integrated Hydrologic, Hydraulic, and Water Quality Modeling Suite	
Action 4 – Continue to Advance Climate and Weather Modeling and Forecasting	
Action 5 – Expand Watershed Models to Incorporate Tributary Processes	

Project Spotlight: Russian River Groundwater Surface Water Flow (GSFLOW) Model

The Russian River Integrated Hydrologic Model (RRIHM) is a computer-based simulation tool developed by the U.S. Geological Survey (USGS) in collaboration with Sonoma Water and the California State Water Resources Control Board. The RRIHM simulates stream-aquifer interactions using the coupled Groundwater and Surface-water Flow hydrologic model (GSFLOW). The model is coupled with MODSIM to represent coupled reservoir operations and priority-based water allocations. Agricultural water demands are simulated dynamically and are passed to MODSIM for determining reservoir operations and irrigation withdrawals. It is designed to better understand how groundwater and surface water interact across the Russian River watershed, and helps scientists and water managers evaluate water availability, movement, and quality in three dimensions.



The model simulates movement and exchanges of water through the watershed, including rainfall-runoff processes, flow through the surface-water system (in rivers and streams), in the groundwater system (in aquifers), and in response to human systems (agricultural and urban surface-water and groundwater diversions). Dynamic simulation of these processes and feedbacks allows for characterization of impacts of future climate change and drought, as well as changes in land use and water management decision-making.

6.5 Linking Actions to Projects

As indicated previously, adaptation strategy input received from the Watershed Network and those compiled through other sources and meetings varied in the level of detail and specificity. Most input was not what could be described as “projects” in that it lacked definition, specific location, and detailed description. However, the next step in this adaptation strategy development process is to compile and develop a more comprehensive, living database of projects aligned with each strategy and action. The database would also indicate the project proponent who would be expected to champion the effort. Chapter 7 provides further information on moving from strategies and actions to implementable projects.