NORTH COAST RESOURCE PARTNERSHIP

North Coast Resource Partnership
2018/19 IRWM Project Application

The North Coast Resource Partnership (NCRP) 2018/19 Project Application Instructions and additional information can be found at the NCRP 2018/19 Project Solicitation webpage (https://northcoastresourcepartnership.org/proposition-1-irwm-round-1-implementation-funding-solicitation/). Please fill out grey text boxes and select all the check boxes that apply to the project. Application responses should be clear, brief and succinct.

Project Applications will be accepted until 5:00 pm, ~~March 8, 2019~~ **March 15, 2019.** It is important to save the application file with a distinct file name that references the project name. When the application is complete, please email to kgledhill@westcoastwatershed.com

If you have questions, need additional information or proposal development assistance please contact:

- Katherine Gledhill at kgledhill@westcoastwatershed.com or 707.795.1235
- Tribal Projects: Sherri Norris, NCRP Tribal Coordinator at sherri@cieaweb.org or 510.848.2043

Project Name: Scott River Valley Managed Aquifer Recharge

A. ORGANIZATION INFORMATION

1. **Organization Name: California Trout, Inc.**

2. **Contact Name/Title**
   Name: Drew Braugh
   Title: Mt. Shasta/Klamath Regional Director
   Email: dbraugh@caltrout.org
   Phone Number (include area code): 530-926-3768

3. **Organization Address (City, County, State, Zip Code):**
   360 Pine Street, 4th Floor, San Francisco, CA 94104

4. **Organization Type**
   ☐ Public agency

☒ 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:

5. **Authorized Representative** (if different from the contact name)
   Name: Gabriella Roff
   Title: Director of Institutional Giving
   Email: groff@caltrout.org
   Phone Number (include area code): 4153928887x110

6. **Has the organization implemented similar projects in the past?** ☒ yes ☐ no
   Briefly describe these previous projects.
   The Mill Creek Shackelford Bridge project, Scott Watershed (2017-19)
   Scott Instream restoration project phase - 1 (2016 -18)
   Scott Basin GSA (2019)
   CV rice farm winter inundation (2014 - 2019)
   Scott Valley Aquifer Recharge (2016)

7. **List all projects the organization is submitting to the North Coast Resource Partnership for the 2018/19 Project Solicitation in order of priority.**
   Only this project - Scott Valley Managed Aquifer Recharge .

8. **Organization Information Notes:**

B. ELIGIBILITY

1. **North Coast Resource Partnership and North Coast IRWM 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 NCIRWMP 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, and 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 and reduce flood risk in support of public safety

2. **Does the project have a minimum 15-year useful life?**
   ☒ yes ☐ no
   If no, explain how it is consistent with Government Code 16727.

3. **Other Eligibility Requirements and Documentation**

   CALIFORNIA GROUNDWATER MANAGEMENT SUSTAINABILITY COMPLIANCE
   a) Does the project that directly affect groundwater levels or quality?
      ☒ 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

   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 there is no monitoring entity, please indicate whether the project is wholly located in an economically disadvantaged community.
      ☐ yes ☐ no

URBAN WATER MANAGEMENT PLAN

a) Is the organization required to file an Urban Water Management Plan (UWMP)?
☐ yes ☐ no

b) If Yes, list the date the UWMP was approved by DWR:

c) Is the UWMP in compliance with AB 1420 requirements?
☐ yes ☐ no

d) Does the urban water supplier meet the water meter requirements of CWC 525?
☐ yes ☐ no

c) 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, list date the AWMP was approved by DWR:

c) Does the agricultural water supplier(s) meet the requirements in CWC Part 2.55 Division 6?
☐ yes ☐ no

SURFACE WATER DIVERSION REPORTS

a) Is the organization required to file surface water diversion reports per the requirements in CWC Part 5.1 Division 2?
☐ yes ☐ no

d) If Yes, will the organization be able to provide SWRCB verification 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

e) 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 North Coast IRWM Plan, should the project be selected as a Priority Project?
☐ yes ☐ no

C. GENERAL PROJECT INFORMATION

1. Project Name: Scott Valley Managed Aquifer Recharge

2. Eligible Project Type under 2018/19 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:

3. Project Abstract

The Scott Valley Managed Aquifer Recharge Project will augment groundwater conditions to enhance flow and improve water quality at critical habitat on the mainstem Scott River. Utilizing the Scott Valley Irrigation Dirstrict (SVID) canal system, approximately 20 to 30 cfs will be diverted and applied to identified agricultural fields, during the non-irrigation season, from Dec 1st through Feb 15th using existing flood irrigation turnouts and mobile pumping methods. Project benefits will measured

4. Project Description

The purpose of the project is to recharge the aquifers in the Scott Valley basin to improve instream flow and water quality for downstream users and threatened SONCC coho. Increased summer flows in the mainstem Scott will alleviate temperature impairments and improve seasonal salmonid escapement and juvenile rearing.

Implementing the community plan's Managed Aquifer Recharge objective – the project uses the SVID canal system to apply off-season floodwater for groundwater recharge and instream enhancement purposes.

Project data gathered will inform regional water management – describing a model practice and correlating winter flood irrigation, groundwater recharge and instream flow for listed salmonids. Specifically, we propose to flood farms in winter, quantify the groundwater recharge and benefits to streamflow, temperature, water quality, and biotic response.

Surface Water Diversion – Approximately 2,400 AF to 4,500 AF of water will be applied annually, with a range of 9,600 AF to 18,000 AF being applied over the 5-year term of the project. SVID infrastructure and mobile pumping units will be utilized to disperse water throughout the project area.

Permitting & Environmental Compliance –SVID will submit an annual application to appropriate water to the SWRCB through the existing emergency drought declaration and then the temporary application process.

Diversion Parameters – The SVID point of diversion at Scott River Reach 14 is a primary spawning and rearing location for Chinook salmon, coho salmon, and steelhead trout. The SRCD has completed a decade of on-site fisheries, flow, and water quality monitoring.

Expected Benefits:

- Quantified improvements in stream flow and water quality resulting from aquifer recharge, particularly during the summer/fall baseflow period
- Improved regional water management for all stakeholders
- Improved habitat and connectivity for salmonids
- Improved aquatic habitat for other animals and riparian plants
- A sustainable practice modelled and vetted
- Comprehensive understanding of groundwater-surface water interaction to inform GSP

5. Specific Project Goals/Objectives

Goal 1: Protect groundwater resources from over-draft
Goal 1 Objective: Increase groundwater recharge and aquifer management through a proof of concept project
Goal 1 Objective: Install integrated monitoring systems to quantify applied water and measure static groundwater elevations
Goal 1 Objective:
Goal 1 Objective:

Goal 2: Conserve, enhance, and restore watersheds and aquatic ecosystems, including functions, habitats, and
Goal 2 Objective: Increase instream flows and improve water quality in the Scott River
Goal 2 Objective: Monitor and assess the physical and biological effects of flow enhancement and water quality improvements throughout the targeted project reach
Goal 2 Objective:
Goal 2 Objective:

Goal 3: Build intraregional cooperation and adaptive management
Goal 3 Objective: Facilitate tribal engagement in the water management solution to insure downstream beneficial uses
Goal 3 Objective: Build upon an established multi-stakeholder partnership to offer regional water management solutions to inform SGMA efforts.
Goal 3 Objective:

Additional Goals & Objectives (List)

6. Describe how the project addresses the North Coast Resource Partnership and North Coast IRWM Plan Goals and Objectives selected.

This project directly addresses the NCRP and NC IRWM Plan (NCIRMP) Goals and objectives by (1) protecting groundwater resources from over-draft (2) Restoring watersheds and aquatic ecosystems including stream flow and water quality, and (3) Building intraregional cooperation in NCIRWMP implementation and improving tribal communications in the SGMA process in Siskiyou County. A key goals is to provide an ongoing framework for inclusive, efficient intraregional cooperation and effective, accountable NCIRWMP implementation. As a member of the Scott Valley TAC, CalTrout is committed to bringing together landowners, tribes, agencies, universities and other nonprofit organizations to pursue groundwater studies and implementation projects to better understand the interaction of groundwater and surface waters. he project aims to enhance salmonid populations by conserving, enhancing, and restoring required habitats and watershed processes.

7. **Describe the need for the project**.
   Throughout the dry summer months in the Scott Valley, low flows negatively impact water quality for the surrounding DAC community and endangered salmonids and curtail water delivery downstream to tribal communities. Under current projections, climate change is anticipated to further lengthen the summer/fall baseflow period, suggesting that dryer and warmer conditions in the Scott Valley - and the consequent effects on listed salmonids - may be the new normal. The project will pilot a solution to augment groundwater conditions within the Valley to enhance streamflow and improve water quality in critical locations of the mainstem Scott River. The project builds on an existing collaboration between local landowners, the irrigation district, the RCD, UC Davis, and CalTrout and engages the tribes to build a solution that addresses all stakeholder needs. The work will be leveraged to inform the groundwater sustainability plan currently under development for the region.

8. **List the impaired water bodies (303d listing) that the project benefits:**
   Scott River

9. **Will this project mitigate an existing or potential Cease and Desist Order or other regulatory compliance enforcement action?** ☐ yes ☒ no
   If so, please describe?

10. **Describe the population served by this project.**
    The Scott River watershed spans the DAC rural communities of Fort Jones, Greenview, Etna, Mugginsville, Cheeseville, and Callahan, as well as multiple disenfranchised communities and homesteads. The 8000+ residents are mostly Caucasian with a large Native America community and small Hispanic immigrant base. The project also benefits downstream water users in the mid-Klamath basin with enhanced flow, water reliability and quality, and reduced regulatory pressure associated with salmon recovery

11. **Does the project provide direct water-related benefits to a project area comprised of Disadvantaged Communities or Economically Distressed Communities?**
    - ☒ Entirely
    - ☐ Partially
    - ☐ No

    List the Disadvantaged Community(s) (DAC)

    The town of Callahan is in the project area and is a DAC. The disenfranchised communities of Mugginsville, Greenview, Cheeseville are also in the project area

12. **Does the project provide direct water-related benefits to a project area comprised of Severely Disadvantaged Communities (SDAC)?**
   - ☐ Entirely
   - ☒ Partially
   - ☐ No

   List the Severely Disadvantaged Community(s)
   Fort Jones, Etna

13. **Does the project provide direct water-related benefits to a Tribe or Tribes**?
   - ☐ Entirely
   - ☒ Partially
   - ☐ No

   List the Tribal Community(s)
   Quartz Valley Indian Reservation
   If yes, please provide evidence of support from each Tribe listed as receiving these benefits.

14. **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.**
   DWR DAC Mapping Tool qualifies the project area (GEOID 06093000800) as a DAC with an MHI of $45,193, < 80% of the state's MHI of $63,783 (U.S Census Bureau 2012-2016). The project area DAC and Tribal water needs include a dependable water source for municipal water supply, agricultural operations, outdoor recreation, and tribal cultural resource and subsistence protection. The project also contributes to Tribal Tradition and Culture described by the SWB as uses of water to support the cultural, spiritual, ceremonial, or traditional rights or lifeways of Tribes, including navigation, ceremonies, or fishing, gathering, or consumption of natural aquatic resources; and Tribal Subsistence Fishing described as uses of water involving the non-commercial catching or gathering of natural aquatic resources, for consumption by individuals, households, or communities of California Native American Tribes for sustenance.

15. **Does the project address and/or adapt to the effects of climate change? Does the project address the climate change vulnerabilities in the North Coast region?** ☒ yes ☐ no
   If yes, please explain.
   Climate change is cited as the greatest threat to North Coast salmonids. NMFS (2014) expects average summer temperatures in the region to increase 2.7 °C and explains: "Climate change will likely decrease summer base flow, reduce summer rearing habitat for fish, and increase irrigation demand in the Scott River basin." Climate change demands new groundwater management strategies to maintain reliable water supply for irrigation and adequate instream flows for fish, wildlife, and recreation.

16. **Describe how the project contributes to regional water self-reliance.**
   In 2008, stakeholders began development of the SV Community Study Plan - summarizing Scott Valley hydro-agro-eco-geography understandings and needs to identify best management practices. This project realizes on-the-ground over a decade of local work and science to improve regional water management and self-reliance, piloting the Managed Aquifer Recharge scenario. The project will inform the GSP currently under development and engages Tribes, Resource Agencies and landowners in collaborative based solutions.

17. **Describe how the project benefits salmonids, other endangered/threatened species and sensitive habitats.**
NMFS (2014) identifies agricultural practices and altered hydrologic function as "very high" threats to endangered salmonids in the Scott River. This project will establish the methodologies, water delivery infrastructure, and landowner partnerships to flood dormant fields in the winter, recharge groundwater and restore summer flows - improving aquatic habitat within the critical habitat boundary for SONCC coho and other salmonid species.

18. **Describe local and/or political support for this project.**
This project is a public-private collaboration between California Trout, UC Davis Dept. of Land, Air, and Water Resources, Scott Valley Irrigation District, Siskiyou County Flood Control and Water Conservation District (GSA), Siskiyou Resource Conservation District, and the Scott Valley Groundwater Advisory Committee including tribal representation from the Quartz Valley Indian Reservation – all working together to find real, cost effective water management solutions for fish and agriculture.

19. **List all collaborating partners and agencies and nature of collaboration.**
UC Davis, with assistance from the Siskiyou Resource Conservation District, will monitor the benefits of applied recharge and biological responses. The Scott Valley Irrigation District and local agricultural producers are also critical partners as the project will utilize the SVID canal system to apply water to agricultural fields during the non-irrigation season. CalTrout and UCD will coordinate with the North Coast Regional Water Quality Control Board and CDFW to collectively advance results at the local, regional, and statewide levels.

    CalTrout has obtained letters of support from County of Siskiyou Flood Control and Water Conservation District, the Quartz Valley Indian Reservation, the North Coast Regional Water Quality Control Boar

20. **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 so, please describe?
The project builds on the Scott Valley Community Study Plan – to outline regional water management research needs and objectives, specifically the Managed Aquifer Recharge objective. The project leverages the findings of the Scott Valley Integrated Hydrologic Model, years of UCD analysis of precipitation, streamflow, evapotranspiration, irrigation, and soils data, and a 2016 recharge project lead by UCS, the SRCD and SVID.

21. **Describe the kind of notification, outreach and collaboration that has been done with the County(ies) and/or Tribes within the proposed project impact area, including the source and receiving watersheds, if applicable.**
Public meetings coordinated by GSA and the SV Groundwater Advisory Committee are attended by all stakeholders. Siskiyou County strongly supports the project. The Quartz Valley Indian Reservation will play an active role in shaping the final design. A Tribal Coordinator on project staff will engage downriver tribes - the Karuk and Yurok – to compare and integrate stakeholder data, build science and design consensus, and develop shared conservation objectives and vision moving forward.

22. **Describe how the project provides a benefit that meets at least one of the Statewide Priorities as defined in the 2018 IRWM Grant Program Guidelines and Tribal priorities as defined by the NCRP?**

CalTrout will leverage relationships with water managers, county officials, and ag interests to develop way-of-life conservation practices and will facilitate the involvement of the Tribes to restore flows and cultural resources for communities downstream - as well as provide safe water for the surrounding DAC. CalTrout represents the lone conservation voice on the Scott GSA - developing the Groundwater Sustainability Plan and, supported by this project, will play an active role in shaping the GSP to ensure appropriate sustainability targets and real solutions to improve groundwater management are presented. A strong plan will better integrate water management, increase regional self-reliance, and manage for summer months when stretches of the Scott run dry. Securing summer flows in Scott tributaries through sustainable groundwater practices will protect and restore a critical ecosystem for the recovery of salmon and steelhead, an opportunity magnified by the 2020 Klamath Dam removal

23. **Project Information Notes:**

D. PROJECT LOCATION

1. **Describe the location of the project**
   Geographical Information
   The project will take place across 500 acres to 600 acres of agricultural fields in the Shell Gulch and Hamlin Gulch areas of the Scott Valley Irrigation District service area. The project is located in Siskiyou County, CA

2. **Site Address (if relevant):**

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
   ☒ No If No, please provide a clear and concise narrative with a schedule, to obtain necessary access.
   ☐ NA If NA, please describe why physical access to a property is not needed.
   Three landowners have currently volunteered to participate in the project and have given verbal consent for access, this will be formalized in writing once the project is funded to move ahead.

4. **Project Location Notes:**

E. PROJECT TASKS, BUDGET AND SCHEDULE

1. **Projected Project Start Date:** 3/15/20
   Anticipated Project End Date: 3/15/25

2. **Will CEQA be completed within 6 months of Final Award?**
   ☒ Yes State Clearinghouse Number: no number is available at this time

☐ NA, Project is exempt from CEQA
☐ NA, Not a Project under CEQA
☐ NA, Project benefits entirely to DAC, EDA or Tribe, or is a Tribal local sponsor. [Projects providing a water-related benefit entirely to DACs, EDAs, or Tribes, or projects implemented by Tribes are exempt from this requirement].
☐ No

3. **Please complete the CEQA Information Table below**
Indicate which CEQA steps are currently complete and for those that are not complete, provide the estimated date for completion.

CEQA STEP	COMPLETE? (y/n)	ESTIMATED DATE TO COMPLETE
Initial Study	y	1/30/19
Notice & invitation to consult sent to Tribes per AB52	N	11/1/19
Notice of Preparation	N	4/1/20
Draft EIR/MND/ND	N	5/15/20
Public Review	N	6/1/20
Final EIR/MND/ND	N	7/1/20
Adoption of Final EIR/MND/ND	N	7/15/20
Notice of Determination	N	8/1/20
N/A - not a CEQA Project		

If additional explanation or justification of the timeline is needed or why the project does not require CEQA, please describe.

4. **Will all permits necessary to begin construction be acquired within 6 months of Final Award?**
☒ Yes
☐ NA, Project benefits entirely to DAC, EDA, Tribe, or is a Tribal local sponsor
☐ No

5. **PERMIT ACQUISITION PLAN**

Type of Permit	Permitting Agency	Date Acquired or Anticipated
CA Environmental Quality Act	CDFW	7/1/20
Lake & Streambed Alteration Ag	CDFW	9/1/20
Temp App to Approriate Water	CASWRCB	9/1/20

For permits not acquired: describe actions taken to date and issues that may delay acquisition of permit.
Assessments complete, discussions with regulatory agencies complete, permit applications in development

6. **Describe the financial need for the project**.
   To implement a MAR project of the proposed scale, high levels of coordination, development, outreach, and monitoring are required. Optimal science and due diligence is required to establish a solid foundation for constructive refinforement and future growth. Absent funding from NCIRMP, the project team and local agricultural community (partnership base) does not have the combined financial resources to carry out the proposed project.

7. **Is the project budget scalable?** ☒ yes ☐ no
   Describe how a scaled budget would impact the overall project.
   This project is scalable by 25%. A scaled down budget would reduce project footprint by 200 acres from the current 600 acre proposed and limit the overall benefits. This decrease would reduce certain monitoring and management expenses, as well as a portion of the engineering and construction costs. However, a 25% scaled down budget would still provide meaningful benefits to the aquifer and mainstem and would allow for the development of SGMA compliant management practices.

8. **Describe the basis for the costs used to derive the project budget according to each budget category.**
   All costs related to project management and groundwater monitoring derive from the 2016 MAR pilot project completed by UCD, SRCD, and SVID. Fisheries, water quality, and water quantity monitoring costs represent standard regional rates for scientific and technical personnel, and project labor is based on local hourly wages/ prevailing wage. Project construction, engineering services, permitting, and filing fees are all sourced from experienced parties and the respective government agencies

9. **Provide a narrative on cost considerations including alternative project costs.**
   Alternative cost considerations were evaluated to ensure that meaningful project benefits are also cost effective. However, the team's intent is to develop a project that provides the largest benefit to the aquifer and river system, while at the same time allows for maximum involvement with stakeholder groups—landowners, tribes, agencies, etc. Engaging with as many groundwater users as possible to obtain potential SGMA compliance is a key consideration moving forward.

10. **List the sources of non-state matching funds, amounts and indicate their status**.

    California Trout – $30,000, funds have been secured and would be dispersed throughout the five-year term of the project for outreach, education, and development of MAR implementation

11. **List the sources and amount of state matching funds.**

    North Coast Regional Water Quality Control Board - $200,000, funding notification is pending for research, development and modeling related to MAR implementation

12. **Cost Share Waiver Requested (DAC or EDA)?** ☒ yes ☐ no
    Cost Share Waiver Justification: 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 provide benefits that address a water-related need of a DAC/EDA.
    The project benefits a DAC community with SDAC areas

13. Major Tasks, Schedule and Budget for NCRP 2018 IRWM Project Solicitation

Please complete MS Excel table available at https://northcoastresourcepartnership.org/proposition-1-irwm-round-1-implementation-funding-solicitation/; see instructions for submitting the required excel document with the application materials.

14. Project Tasks, Budget and Schedule Notes:

Project set up – roles and deliverables:

Finance and bookkeeping

Pay staff and sub-contractors, purchase equipment, review, approve, and submit invoice packages, track all expenses and match funding, and oversee all financial transactions associated with grant award.

Deliverables: Invoices, proof of payments, audited financial statements

Grant administration

Develop and execute all grant agreements, sub-contracts, MOUs, and land owner access agreements. Submit invoice packages with support documentation. Provide audited financial statements and other deliverables as required

Deliverables: grant agreement, sub-contracts, landowner access agreements, invoice packages, status reports and final reports

Regional director

Oversee all aspects of grant implementation including final designs, permitting, contracting, construction, monitoring, community outreach, and reporting.

Deliverables: Successful grant implementation, construction deliverables, final reporting and close out

Labor compliance

Per California Labor Code sections 1720-1860, ensure that all workers employed under a public works contract are paid prevailing rate of per diem wages as well as federal labor standards set forth in the Davis Bacon Act (40 USC 276) and the Contract Work Hours Safety Standards Act (CWHSSA) (40 USC 327-333).

Deliverables: Labor compliance code followed for all grant elements and reports/interviews completed and filed appropriately

Final design and engineering

Qualified professional engineer will complete 100 % design drawings of water conveyance infrastructure needed for the diversion and application of winter water on dormant fields

Deliverables: 100% construction designs

Permitting and agreements

Qualified contractor (Siskiyou RCD) will complete all surveys, monitoring, and assessment needed to complete CEQA, 1600 agreements, and all additional permitting needed to implement the project

Deliverables: CEQA, 1600 agreement, other necessary permits and agreements needed for the diversion of water related to the project.

Construction project management

Manage and coordinate all construction and implementation aspects of project. Facilitate communications, outreach, and scheduling with all project partners including Scott Valley Groundwater Committee.

Deliverables: successful construction implementation, water diversion, aquifer recharge, scientific monitoring and data collection, and partnership coordination

CalTrout project coordination

Assist Construction Project Manager with coordinating all project elements. Facilitate intraregional cooperation with NCIRWM and tribal representation with the Quartz Valley Indian Reservation.

Deliverables: Intraregional cooperation, tribal engagement, SGMA integration and county collaboration

Larry Walker and Associates

Larry Walker and Associates will analyze data and update SGMA database, utilize the Scott Valley Integrated Hydrologic Model, a surface water-groundwater model of the Scott Valley, to simulate the diversion and recharge occurring during the experiment as a simulation scenario. Perform crop tolerance studies to document impact of winter recharge on alfalfa and other key crops.

Deliverables: Database established with all the newly collected data, to be integrated into the SGMA database which will be developed by the County, maps completed representing monitored groundwater levels and hydrographs of surface water conditions, model simulations completed using the newly collected information.

UC Davis

UCD will monitor the effects of winter flooding and groundwater recharge to understand how the project affects the quantity and quality of salmonid rearing habitat. Specifically, UCD will monitor the effects of winter flood irrigation and groundwater recharge on streamflow, temperature, water quality, and biotic response (macroinvertebrate sampling and the presence/absence of juvenile salmon).

Deliverables: Fish utilization, water quality and quantity reporting and outreach.

Siskiyou Resource Conservation District

SRCD, in coordination with the UCD, will monitor the effects of managed aquifer recharge and biological instream responses. In addition, the SRCD will monitor flow and fish presence above and below the SVID point of diversion to understand potential impacts to salmonid spawning and rearing areas and to ensure no take of salmon occurs due to project implementation.

Deliverables: flow monitored, groundwater monitoring data collected and disseminated, reports completed

Menne Ranch Hay, Inc.

Install, operate, and maintain pump stations, monitoring equipment including solar powered data-loggers, pressure transducers, soil sensors, and flow meters.

Deliverables: pump stations, water conveyance and soil moisture monitoring systems installed and maintained

Scott Valley Irrigation District services
Maintain SVID ditch and water conveyance to project area. Secure temporary permit to appropriate surface water for groundwater recharge and later instream fish and wildlife habitat enhancement

Deliverables: Unimpeded canal flow during implementation period, landowner support

Materials and equipment
4-inch PVC and fittings, 2 head gates, 5 measuring weirs, monitoring equipment and devices, 6 pump stations

Deliverables: equipment purchased and operational

Field grading and reseeding
Professional qualified farm contractor will regrade fields and re-seed project area after annual flooding if required. Project coordinator will review and determine if grading and reseeding is required.

Deliverables: fields maintained and restored for participating landowners

Tribal partnership coordinator
Facilitate meaningful tribal engagement in the Scott Valley groundwater recharge project to ensure beneficial uses of water for tribal tradition and culture (CUL) as defined by the state water board. Collaborate on data interpretation and scientific assessment of aquifer management strategies. Integrate Traditional Ecological Knowledge (TEK) in collaboration with regional Tribes to incorporate practices into North Coast Project and Plans.

Deliverables: tribal partnerships established, MOU established, scientific collaborations established, tribal participations, county SGMA efforts

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F. PROJECT BENEFITS & JUSTIFICATION

1. **Does the proposed project provide physical benefits to multiple IRWM regions or funding area(s)?**
   ☒ yes ☐ no
   If Yes, provide a description of the impacts to the various regions.
   This project establishes a model and quantifies the benefit of aquifer recharge to instream flow. Contemporary litigation to determine the connection between groundwater pumping and protection of the public trust centers on the Scott River, making this project especially relevant as SGMA is developed over multiple IRWM regions

2. **Provide a narrative for project justification. Include any other information that supports the justification for this project, including how the project can achieve the claimed level of benefits. List any studies, plans, designs or engineering reports completed for the project.** *Please see the instructions for more information about submitting these documents with the final application.*

The project will draw on over a decade of research and development -the Scott Valley Integrated Hydrologic Model, and the 2016 SRCD/SVID managed aquifer recharge experiment. This pilot will scientifically describe the benefits of winter flooding and provide compliance options for Scott Valley SGMA.

The technical basis includes monitoring for groundwater, streamflow, temperature, nutrients, macroinvertebrates and fish:

Groundwater Monitoring: Flow, Water Quality, and Stream/Aquifer Interactions –Privately owned and new monitoring wells will be instrumented with pressure transducers connected via telemetry that monitor continuous groundwater level and temperature. Wells equipped with sensors for electrical conductivity (EC) will track information about the origin of the groundwater. The telemetry set up will allow data to be transferred daily to a webserver with stakeholder access. The goal is to create a data network to facilitate future groundwater monitoring for this specific project and for SGMA compliance.
Streamflow – A streamflow monitoring network will be established to inform winter diversion rates and measure subsequent stream response from proposed aquifer recharge activities. Discharge gaging stations will determine available flow above and below Young's Dam in relation to the USGS station at river-mile 21 so that diversion rates can be tailored to the hydrograph and CDFW requirements. Time series streamflow records will be developed to standard USGS monitoring protocols (Rantz 1982).
Water temperature – Water temperature data will be collected using automated data loggers on a sub-hourly timestep for the duration of the project. Numerous temperature monitoring stations will be established above, within, and below the project boundaries to capture potential changes in water temperature associated with the project. Temperature conditions will be monitored, following EPA guidelines, prior to winter flooding to establish baseline conditions.
Water quality (nutrients) – Water quality grab samples will be analyzed for a suite of nutrients, pH, turbidity, and EC to inform linkages between physical, chemical, and ecological function in the Scott River, and to qualitatively assess potential productivity for coho salmon. Sampling methods will follow the Surface Water Ambient Monitoring Program.
Macroinvertebrates – samples will be collected pre and post winter flood irrigation application each year of the project to understand biological response. Sampling will follow the Surface Water Ambient Monitoring Program Bioassessment Procedures for wadable streams.
Fish presence/absence – Juvenile presence/absence non-will be monitored pre and post winter flood application; snorkel surveys throughout the spring and summer per Apperson et al. (2015); spawning ground surveys will identify the redd distribution in the reach below the SVID point of diversion and ensure that diversion activity does not impact migrating or spawning fish.

3. **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.

4. **Does the project provide safe, clean, affordable, and accessible water adequate for human consumption, cooking, and sanitary purposes consistent with AB 685?** ☐ yes ☒ no
If Yes, please describe.

Yes, this project will support more reliable water supply for municipal use as well as irrigation and wildlife

5. **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.
The project develops innovative methodologies for improving groundwater management and aquifer recharge to address North Coast climate change vulnerabilities. These methodologies will be critically important for protecting fish and wildlife and for improving water reliability for irrigators and downstream Tribes. Project innovations will support the developing regional GSP with a collaborative, scientifically and logistically vetted practice.

6. **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.** [*See the NCRP Project Application Instructions, Potential Project Benefits Worksheet and background information to help complete the table. The NCRP Project Application, Attachment B includes additional guidance, source materials and examples from North Coast projects*.]

PROJECT BENEFITS TABLE

Potential Benefits Description	Physical Amt of Benefit	Physical Units	Est. Economic Value per year	Economic Units
Water Supply				
Increase mainstem flow for environmental purposes	TBD	Cubic Feet per Secon	Project specific	$25 - $85 per AF
Increase seasonal flow particularly during the summer and fall baseflow periods	TBD	Cubic Feet per Secon	Project specific	$65 - $85 per AF
Increase groundwater recharge	TBD	Acre feet	Project specific	not monetize d
Water Quality				
Increase mainstem flow for water quality	miles improved	River miles	Project specific	not monetize d
Improve water temperature	coldwater input	temp decrese	Project specific	Not monetize
Increased dissolved oxygen	incresed oxygen	mg/L	Project specific	Not monetize
Other Ecosystem Service Benefits				
Improved fish passage	TBD	Miles of habitat	Project specific	Not monetize
Fishery improvement	TBD	miles of habitat	Project specific	Not monetize

Potential Benefits Description	Physical Amt of Benefit	Physical Units	Est. Economic Value per year	Economic Units
Aquatic habitat restoration	increase	wetted habitat	Project specific	n/a
Stream food web enhancement	increase	# invertebrates	Project specific	n/a
Other Benefits				
Enhanced tribal uses – subsistence fishing	Tribal populations	salmonids	Project specific	n/a
Enhanced tribal uses – cultural	Tribal populations	salmonids	Project specific	n/a
Update education and technology	Scott River Valley	15 landowners	Project specific	n/a
Jobs created	Scott River Valley	5 part time jobs	Project specific	n/a
Future SGMA compliance	Scott River Basin	15 landowners	Project specific	n/a

7. **Project Justification & Technical Basis Notes:**
   Scott Valley Managed Aquifer Recharge: Executive Summary

The Scott Valley Managed Aquifer Recharge project represents an opportunity to make significant aquifer management progress in the Scott River Basin through the treatment of off-season surface water application within key areas of the watershed. California Trout (CalTrout) will act as project lead and complete this work in partnership with the U.C. Davis Department of Land, Air, and Water Resources (UCD), the North Coast Regional Water Quality Control Board (NCRWQCB), the Siskiyou Resource Conservation District (SRCD), the Scott Valley Irrigation District (SVID), and local agricultural producers. Project outcomes and experiences gained will be shared with the Scott Valley community, Siskiyou County (the Scott Basin GSA) and other interested parties, with the goal of integrating this work into future State Groundwater Management Act compliance. In addition, the project will establish long-term partnerships, as well as develop methodologies and best management practices that can be used for future collaboration.

This project will employ the diversion of surface water through the SVID conveyance system during the non-irrigation season and disperse said water throughout key locations under the SVID service area. To meet legal and environmental requirements for the act of diverting water, CalTrout will coordinate with the SVID Board of Directors (water-right holder), Cal Fish and Wildlife, and the State Water Board to fully understand impacts to the canal system, potential effects to fisheries, and requirements needed for the act of diverting water during the non-irrigation season. CalTrout and UCD will also rely on feedback from participating landowners to understand any effects on crop yields and field conditions, and updated management techniques will be incorporated if crop or field damage is encountered.

By utilizing the SVID canal system, the project partners will apply water during the non-irrigation season from December 1stthrough February 15th. Approximately 20 cfs to 30 cfs will be consistently diverted and applied to agricultural fields in the Shell Gulch and Hamlin Gulch areas through the use of existing flood irrigation turnouts and mobile pumping methods. The project will be conducted annually over four years and incorporate 500 acres to 600 acres of agricultural lands consisting of alfalfa and pasture ground. Approximately 2,400 acre-feet to 4,500 acre-feet of water will be applied seasonally, with a range of 9,600 acre-feet to 18,000 acre-feet being applied throughout the term of the project.

CalTrout will be responsible for project oversight and management, while UCD, with assistance from the SRCD, will monitor the benefits of applied recharge to the aquifer and river system. In addition, CalTrout and UCD will coordinate with the NCRWQCB regarding limiting factors to project implementation, and the three parties will collectively advance results at the local, regional, and statewide levels. The team also aims to understand the most cost-effective methods for the application and monitoring of applied off-season water and what crop types are best suited for this treatment.

Watershed Information – The Scott River is a major tributary to the Klamath River and supports anadromous fish runs for three salmonid (Oncorhynchus) species: Chinook salmon (O. tshawytscha), coho salmon (O. kisutch) and steelhead trout (O. mykiss). The Scott River Watershed is a snowmelt driven system that relies on groundwater for suplemental flow and cold-water inputs. The basin covers an area of 819 square miles where land ownership is 55% private and 45% public. Land use in the Scott Valley upland areas is predominantly commercial timber harvest and recreational wilderness, where as land use on the valley floor is predominantly farming and ranching. The area's economy is based in logging and farming, with the former being largely supressed. Farming practices are relativley stable but have a high dependency on groundwater and surface water use, which often contributes to water quaility issues for salmonids during the late summer months.

Scott River coho salmon are part of the Southern Oregon Northern California Coast Coho ESU, which are listed as threatened under the Federal Endangered Species Act and the California Endangered Species Act. The Scott system supports a core, functionally independent population that has been identified as the most productive natural stock in the upper Klamath River basinand state of California.However, due to degradation of historic habitat, and the currently low population numbers for coho salmon in the Klamath, strategic action is needed to ensure that restoration and enhancement efforts are effectively placed for the benefit of the species.

Detailed Project Background – In 2008, the University of California, Davis (UCD) developed the Scott Valley Community Study Plan (Study Plan) with Thomas Harter, PhD serving as principle investigator. The Siskiyou County Board of Supervisors and local stakeholder groups requested development of the Study Plan, which derived from the Scott River TMDL Action Plan that identified management strategies for addressing temperature impairments. The Study Plan summarized Scott Valley hydro-agro-eco-geography understandings and outlined research needs and management objectives, all of which where amalgamated into the Scott Valley Integrated Hydrologic Model. Over the course of multiple years, UCD researchers analyzed precipitation, streamflow, evapotranspiration, irrigation, and soils data, and investigated relevant irrigation use, land use, and watershed information (amongst other components) to refine the model. In 2011, UCD partnered with the Scott Valley Groundwater Advisory Committee, a group consisting of local agricultural producers and municipal stakeholders, to identify best management practices and groundwater recharge scenarios. One of the primary scenarios developed was a Managed Aquifer Recharge (MAR) concept that would utilize the Scott Valley Irrigation District (SVID) canal system and constituency base to apply off-season floodwater for groundwater recharge and instream enhancement purposes. Modeling results indicated that 42 cfs diverted and applied to 1,400 acres over a three-month period could provide a 7.5 cfs increase in mainstem flow during the summer months. This potential increase would attenuate temperature fluctuations through problematic reaches, as well as assist with seasonal salmonid escapement and juvenile rearing.

In 2016, SVID filed an Application to Appropriate Water to the California State Water Resources Control Board (SWRCB) for the purpose of benefiting instream flows for fisheries needs and to gain a scientific understanding of MAR projects. The application derived from Governor Jerry Brown's emergency drought declaration (Executive Order B-39-17) that prioritized temporary water-right permits for local groundwater storage and recharge purposes. From February 4ththrough March 31st, approximately 680 acre-feet (AF) were applied to various locations within the SVID service area, which was completed in partnership with UCD, the Siskiyou Resource Conservation District (SRCD), and agricultural producers. Results showed a significant holding capacity for aquifer recharge with no negative impacts to crop yield. Above average rainfall during the implementation period limited the amount of AF that could be applied throughout the project area, and it was determined that 680 AF of water was too small to provide measurable benefits. However, this recharge effort was considered a successful implementation of a MAR project, and the partners felt it would enhance instream conditions within the basin if applied on a larger scale.

Diversion Parameters/CDFW Outreach – The SVID point of diversion is located within Scott River Reach 14, which is a primary spawning and rearing location for Chinook salmon, coho salmon, and steelhead trout. The SRCD has completed extensive fisheries, flow, and water quality monitoring within the reach for the past fifteen years and has a detailed understanding of these components. In addition to permit filing and CEQA development, the project partners have coordinated with CDFW Region 2 personnel to establish diversion parameters that ensure salmonid spawning and rearing conditions are not impacted during the implementation period.

Fisheries projection parameters include the following:

- USFS Water Right – The United States Forest Service (USFS) holds a 200 cfs water right, as measured at the Scott River USGS gage, to benefit substance level fisheries conditions that include spawning, incubation, rearing, migration, and summer survival. As such, the project partners agree to only divert flow during periods when the USFS water right is met. The graph below (USGS 11519500) shows the historical median flow conditions in the Scott River during the project implementation period (December 1 through February 15 of each year), and the graph indicates that the proposed 20 cfs 30 cfs diversion range will be available unless critical low flow conditions are present. Prior to seasonal implementation, CalTrout will coordinate with CDFW and the SWRCB to confirm that the USFS water right is met.
- Diversion Range – CDFW and the project partners have agreed that a maximum diversion range of no more than 10% to 20% of the total available flow at the SVID point of diversion will be diverted at any given time. UCD and the SRCD will establish flow monitoring stations above and below the point of diversion to monitor instream conditions during seasonal project implementation. Technical personnel will calculate flow and coordinate the available diversion range with the management team, who in turn will notify CDFW personnel.
- Direction Observation Assessments – UCD and the SRCD will complete flow and fisheries assessments below the SVID point of diversion to monitor for potential impacts to salmonid spawning and rearing areas and to ensure no take of salmon occurs due to project implementation. Specifically, staff will conduct carcass, redd, and adult salmon surveys downstream of the point of diversion immediately and prior to project implementation. Discharge will also be measured directly above and below the point of diversion to ensure compliance with the agreed upon diversion range. Monitoring protocols have been discussed and amended accordingly based on conversations with the CDFW. We plan to continue our consultations with CDFW throughout the life of the project.

F. Project Benefits and Justification

The following is a detailed description of the Project Benefits Table.

Water Supply

- Increased Mainstem Flow For Environmental Purposes: The physical amount of benefit will be measured in acre-feet and will provide an estimated 2,400 AF increase in mainstem flow. The estimated value of this contribution is $25/AF to $85/AF depending on flow improvement timing in relation to irrigation water demand. This price per AF is sourced from the Scott River Water Trust.

- Increased Seasonal Flow: The physical amount of benefit will be measured in acre-feet and will provide an estimated 1,800 AF increase in mainstem flow during the summer low flow period. The estimated value of this contribution is $65/AF to $85/AF depending on fish presence and irrigation water demand. This price per AF is sourced from the Scott River Water Trust.
- Increased Groundwater Recharge: Approximately 2,400 AF to 4,500 AF of surface water will be applied to enhance aquifer conditions and provide instream improvements. The estimated economic value per year is project specific, and there are no monetized economic units.

Water Quality

- Increased Mainstem Flow For Water Quality: The physical amount of benefit will be measured in the number of instream miles improved and will overlap with other fishery improvements. The estimated economic value per year is project specific, and there are there are no monetized economic units.
- Decreased Water Temperature: The project will provide a change in maximum daily temperature within problematic areas of the mainstem Scott River, and this benefit will overlap with other fishery improvements. The estimated economic value per year is project specific, and there are there are no monetized economic units.
- Increased Dissolved Oxygen: The physical amount of benefit will be measured in increased levels of dissolved oxygen concentration (mg/L) throughout the project reach, and this benefit will overlap with other fishery improvements. The estimated economic value per year is project specific, and there are no monetized economic units.

Other Ecosystem Service Benefits

- Improved Fish Passage: The physical amount of benefit will be determined from the miles of improved and enhanced accessibility of rearing and migratory habitat. The estimated economic value per year is project and species specific, and there are no monetized economic units.
- Fishery Improvement: Project benefits will be measured in the amount of improved rearing and migratory habitat, as well as relative density of salmonids and other native fishes in the project reach. The estimated economic value per year is project and species specific, and there are no monetized economic units.
- Aquatic Habitat Restoration: The physical amount of benefit will be measured in the miles of improved wetted habitat during below normal water years. The estimated economic value per year is project and species specific, and there are no monetized economic units.
- Stream Food Web Enhancement: Project benefits will be measured through the increase of invertebrates and taxonomic richness within the project reach. The estimated economic value per year is project specific, and there are no monetized economic units.

Other Benefits

- Enhancement of Beneficial Uses – Tribal Subsistence Fishing: This benefit will enhance Scott River salmonid populations through an increase in run percentage, frequency, and duration, as well as overlap with other fisheries improvements. The estimated economic value per year is project specific, and there are no monetized economic units.
- Enhancement of Beneficial Uses – Tribal Cultural Uses: This benefit will increase tribal utilization of water and adjacent resources for cultural uses. The estimated economic value per year is project specific, and there are no monetized economic units.
- Updated Education and Technology: Project benefits will include updated aquifer recharge enhancement techniques and monitoring methods. The estimated economic value per year is project specific, and there are no monetized economic units.
- Jobs Created: The physical amount of benefit will be measured in part-time jobs created (5). The estimated economic value per year is project specific, and there are no monetized economic units.

- Future SGMA Compliance: The physical amount of benefit will be measured in the number of landowners who can use this enhancement tool to achieve SGMA compliance. The estimated economic value per year is project specific, and there are no monetized economic units.

Major Tasks, Schedule and Budget for North Coast Resource Partnership 2018/19 IRWM Project Solicitation

Project Name: Scott River Valley Managed Aquifer Recharge
Organization Name: California Trout

Task #	Major Tasks	Task Description	Major Deliverables	Current Stage of Completion (%)	IRWM Task Budget	Non-State Match	Total Task Budget	Start Date	Completion Date
A	**Category (a): Direct Project Administration**								
1	Finance & bookkeeping	Pay staff and sub-contractors, purchase equipment, review, approve, and submit invoice packages, track all expenses and match funding, and oversee all financial transactions associated with grant award.	Invoices, proof of payments, audited financial statements	0%	$6,566.00	$0.00	$6,566.00	3/15/20	3/15/25
2	Grant administration	Develop and execute all grant agreements, sub-contracts, MOUs, and land owner access agreements. Submit invoice packages with support documentation. Provide audited financial statements and other deliverables as required.	Grant agreement, sub-contracts, landowner access agreements, invoice packages, status reports and final reports	0%	$22,878.00	$0.00	$22,878.00	3/15/20	3/15/25
3	Regional director	Oversee all aspects of grant implementation including final designs, permitting, contracting, construction, monitoring, community outreach, and reporting.	Successful grant implementation, construction deliverables, final reporting and close out	0%	$67,257.00	$0.00	$67,257.00	3/15/20	3/15/25
4	Labor compliance	Per California Labor Code sections 1720-1860, ensure that all workers employed under a public works contract are paid prevailing rate of per diem wages as well as federal labor standards set forth in the Davis Bacon Act (40 USC 276) and the Contract Work Hours Safety Standards Act (CWHSSA) (40 USC 327-333).	Labor compliance code followed for all grant elements and reports/interviews completed and filed appropriately	0%	$5,625.00	$0.00	$5,625.00	3/15/20	3/15/25
B	**Category (b): Land Purchase/Easement**								
C	**Category (c): Planning/Design/Engineering/Environmental Documentation**								
1	Final design & engineering	Qualified professional engineer will complete 100 % design drawings of water conveyance infrastructure needed for the diversion and application of winter water on dormant fields.	100% construction designs	60%	$78,750.00		$78,750.00	3/15/20	3/15/25
2	Permitting & agreements	Qualified contractor (Siskiyou RCD) will complete all surveys, monitoring, and assessment needed to complete CEQA, 1600 agreements, and all additional permitting needed to implement the project.	CEQA, 1600 agreement, other necessary permits and agreements needed for the diversion of water related to the project.	0%	$98,000.00	$0.00	$98,000.00	3/15/20	3/15/25
D	**Category (d): Construction/Implementation**								
1	Construction project management	Manage and coordinate all construction and implementation aspects of project. Facilitate communications, outreach, and scheduling with all project partners including Scott Valley Groundwater Committee.	Successful construction implementation, water diversion, aquifer recharge, scientific monitoring and data collection, and partnership coordination	0%	$163,125.00	$0.00	$163,125.00	3/15/20	3/15/25
2	CalTrout project coordination	Assist Construction Project Manager with coordinating all project elements. Facilitate intraregional cooperation with NCIRWM and tribal representation with the Quartz Valley Indian Reservation.	Intraregional cooperation, tribal engagement, SGMA integration and county collaboration	0%	$44,064.00	$0.00	$44,064.00	3/15/20	3/15/25
3	Surface water-groundwater modeling and SGMA database management, Larry Walker and Associates	Larry Walker and Associates will analyze data and update SGMA database, utilize the Scott Valley Integrated Hydrologic Model, a surface water-groundwater model of the Scott Valley, to simulate the diversion and recharge occurring during the experiment as a simulation scenario. Perform crop tolerance studies to document impact of winter recharge on alfalfa and other key crops.	Database established with all the newly collected data, to be integrated into the SGMA database which will be developed by the County, maps completed representing monitored groundwater levels and hydrographs of surface water conditions, model simulations completed using the newly collected information.	0%	$148,125.00	$0.00	$148,125.00	3/15/20	3/15/25
4	Physical and biological response surveys, UC Davis	UCD will monitor the effects of winter flooding and groundwater recharge to understand how the project affects the quantity and quality of salmonid rearing habitat. Specifically, UCD will monitor the effects of winter flood irrigation and groundwater recharge on streamflow, temperature, water quality, and biotic response (macroinvertebrate sampling and the presence/absence of juvenile salmon).	Fish utilization, water quality and quantity reporting and outreach.	0%	$159,375.00	$0.00	$159,375.00	3/15/20	3/15/25

Project Name: Scott River Valley Managed Aquifer Recharge
Organization Name: California Trout

Task #	Major Tasks	Task Description	Major Deliverables	Current Stage of Completion (%)	IRWM Task Budget	Non-State Match	Total Task Budget	Start Date	Completion Date
5	Flow monitoring and fish presence surveys, Siskiyou Resource Conservation District	SRCD, in coordination with the UCD, will monitor the affects of managed aquifer recharge and biological instream responses. In addition, the SRCD will monitor flow and fish presence above and below the SVID point of diversion to understand potential impacts to salmonid spawning and rearing areas and to ensure no take of salmon occurs due to project implementation.	Flow monitored, groundwater monitoring data collected and disseminated, reports completed	0%	$196,875.00	$0.00	$196,875.00	3/15/20	3/15/25
6	Install and maintain monitoring equipment, Menne Ranch Hay, Inc.	Install, operate, and maintain pump stations, monitoring equipment including solar powered data-loggers, pressure transducers, soil sensors, and flow meters.	Pump stations, water conveyance and soil moisture monitoring systems installed and maintained	0%	$105,600.00	$0.00	$105,600.00	3/15/20	3/15/25
7	Maintain and operate SVID water conveyance ditch, Scott Valley Irrigation District services	Maintain SVID ditch and water conveyance to project area. Secure temporary permit to appropriate surface water for groundwater recharge and later instream fish and wildlife habitat enhancement	Unimpeded canal flow during implementation period, landowner support	0%	$50,625.00	$0.00	$50,625.00	3/15/20	3/15/25
8	Field grading and reseeding	Professional qualified farm contractor will regrade fields and re-seed project area after annual flooding.	Fields maintained and restored for participating landowners	0%	$69,375.00	$0.00	$69,375.00	3/15/20	3/15/25
9	Tribal partnership coordinator	Facilitate meaningful tribal engagement in the Scott Valley groundwater recharge project to ensure beneficial uses of water for tribal tradition and culture (CUL) as defined by the state water board. Collaborate on data interpretation and scientific assessment of aquifer management strategies. Integrate Traditional Ecological Knowledge (TEK) in collaboration with regional Tribes to incorporate practices into North Coast Project and Plans.	Tribal partnerships established, MOU established, scientific collaborations established, tribal participations, county SGMA efforts	0%	$34,125.00	$34,125.00	$68,250.00	3/15/20	3/15/25
10	Materials & Equipment	4-inch PVC and fittings, 2 head gates, 5 measuring weirs, monitoring equipment and devices, 6 pump stations	Materials & equipment purchased		$130,218.00	$0.00	$130,218.00		
	Total North Coast Resource Partnership 2018/19 IRWM Grant Request				**$1,380,583.00**	**$34,125.00**	**$1,414,708.00**		
	Is Requested Budget scalable by 25%? If yes, indicate scaled totals; if no delete budget amount provided.				**$1,035,437.25**	**$25,593.75**	**$1,061,031.00**		
	Is Requested Budget scalable by 50%? If yes, indicate scaled totals; if no delete budget amount provided.				**$690,291.50**	**$17,062.50**	**$707,354.00**		

2019 IRWM NCRP Application – Scott Valley Managed Aquifer Recharge Project

Supplemental Attachments

1. Media
    a. "Scott Valley pioneers instream flow and groundwater management for reconciled water use," California WaterBlog – pgs. 2-5
    b. "Projects evaluate recharge on cropland," AgAlert – pgs. 6-8
    c. "Grower sees potential for groundwater recharge," Farm Progress – pgs. 9-24
2. "Managed winter flooding of alfalfa recharges groundwater with minimal crop damage" UCD Research paper published in *California Agriculture*, January 16, 2018 – pgs. 25-33
3. Maps
    a. Watershed map – pg. 34
    b. Project map – pg. 35
    c. Shell block map – pg. 36
    d. Hamlin block map – pg. 37
4. Letters of Support
    a. Quartz Valley Indian Reservation – pg. 38
    b. County of Siskiyou Flood Control and Water Conservation District – pg. 39
    c. Scott River Water Trust – pg. 40
    d. North Coast Regional Quality Control Board – pgs. 41-42
    e. Scott Valley Irrigation District – pg. 43
5. 2016 Managed Aquifer Recharge report from UCD – pgs. 44-75

Scott Valley pioneers instream flow and groundwater management for reconciled water use

Posted on August 21, 2016 by UC Davis Center for Watershed Sciences

by Gus Tolley

Scott River at Horn Lane, November 2013. Photo credit: Sari Sommarstrom.

The Scott River is one of California's four major undammed streams and important spawning habitat for coho (a species listed as "threatened") and Chinook salmon. This peaceful and pastoral agricultural valley is at the center of several water-related conflicts and lawsuits. However, it is also pioneering a range of instream flow and groundwater management activities that could set the example for balanced water use in California.

At first glance, water management in the Scott Valley appears to be a story of farms vs fish, one that is common in California: A dry year results in dry stream reaches near groundwater-irrigated fields in August that persist beyond the irrigation season into September, even October. With the Chinook fall spawning migration arriving in mid-October and coho following soon after, a dry streambed raises valid concerns about how irrigation pumping and the removal of riparian vegetation may have led to warmer and drier streamflow patterns in Scott Valley.

The story behind the valley's seasonally dry streams is complex. Irrigated pasture, alfalfa, and cattle production have been part of the socioeconomic fabric since it was settled by white people during the mid 1800s. Current dry conditions are partly due to legacy impacts from historical land management policies, flood control, and gold mining, along with natural climatic and geologic variations.

On average, the annual discharge of the Scott River is more than five times the total evapotranspiration demand from the 34,000 irrigated acres in the valley; seemingly enough water for fish and farming. But – like elsewhere in California – surface water supplies usually dry up around July when the last of the snowmelt in the upper watershed disappears. Streamflow from mid-summer until the beginning of the rainy season largely depends on baseflow from the valley aquifer. Fed by recharge from tributaries, rainfall, and excess irrigation, the aquifer acts as a large, sponge-like reservoir that provides a steady contribution to streamflow in the summer and early fall.

In the 1970s, average late-summer streamflow in the Scott River decreased markedly by about 50%, resulting in increased stream temperatures and – during dry years – more pronounced dry stream reaches along the lower valley floor. How did the Scott River get to the condition it is in today?

Figure 1: Late summer streamflow in the Scott River has decreased significantly since the 1970s.

A driving factor for the change in average summer flows may be a switch from reliance on surface-water prior to the 1970s to a greater use of groundwater for irrigation. Following the 1977 drought, many farmers moved from using surface water for flood irrigation to pumping groundwater. Groundwater is more reliable and the preferred source for more efficient irrigation methods such as wheel lines and center-pivots that are encouraged by agencies like the National Resource Conservation Service (NRCS). Access to groundwater allows for irrigation after surface water supplies are no longer available, but pumping groundwater reduces discharge from the aquifer to the stream.

Changing sources of irrigation water has had several major impacts in the valley, including:

1. decreased groundwater recharge in the spring and summer due to increased irrigation efficiency,
2. increased groundwater pumping, and
3. net increase in consumptive crop water use (evapotranspiration) due to the ability to irrigate alfalfa into August or September for a third or fourth cutting instead of two cuttings through July.

Notably, with water supplies greatly exceeding water demand, there is no evidence of long-term groundwater overdraft in the Scott Valley. However, pumping near the Scott River seasonally lowers groundwater levels sufficiently to impact streamflow during the late summer, especially during the critical time between the end of the irrigation season and the beginning of the rainy season when Chinook and coho start their fall spawning runs.

Valley residents have been proactive in finding solutions to the problem of decreased late-summer streamflow. The Scott River Water Trust, the first active water trust in California, leases water from farmers with the goal of improving streamflow for salmon and steelhead at critical points during their lifecycle. The Scott Valley Groundwater Advisory Committee was established, which assists with data collection and monitoring, provides information about local farming practices, and suggests potential methods for increasing late-summer streamflow in the Scott River. Additionally, a Community Water Level Measuring Program has been monitoring about 34 wells monthly since 2006. UC Davis professor Thomas Harter and his research group have used this information to develop an integrated groundwater-surface water model of the Scott Valley that can test different management options for increasing late-summer streamflow.

One proposed solution for groundwater recharge is flooding dormant agricultural fields during the winter when streamflow is high and water is available. In January 2016, the Scott Valley received the first temporary groundwater storage permit issued in California to test this option. The goals of the groundwater recharge project, headed by UC Davis professor Helen Dahlke, are to quantify how much water can be recharged on agricultural fields, determine potential negative effects on the crop, and identify best management practices in the hopes this method can be applied to other areas in California as well.

Another management option is the conjunctive use of surface-water and groundwater involving a dual-irrigation system where more surface-water is used while it is available during the spring months to reduce groundwater pumping. Although this would require an investment in infrastructure and coordination among stakeholders, preliminary modeling results show promising streamflow increases when this management scenario is implemented.

Work will continue to improve fish habitat quality and quantity in the Scott Valley while also maintaining agriculture. There is no magic bullet, and the path forward will rely on a portfolio of management solutions, supported by active stakeholder engagement, monitoring, assessment, and modeling. Some actions may be achieved relatively easily, while others will require coordination and cooperation among stakeholders with some significant investments to successfully implement.

Gus Tolley is a doctoral candidate in the Hydrologic Sciences Graduate Group at UC Davis and 2015 UC President's Global Food Initiative fellow. His work focuses on numerical modeling of interactions between groundwater and surface water in agricultural areas.

Further Reading

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Website for Professor Dahlke's Research Group

Website for Professor Harter's Research Group

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5 Responses to *Scott Valley pioneers instream flow and groundwater management for reconciled water use*

gymnosperm *says:*
August 22, 2016 at 7:55 am

It is not clear if the monthly averages in the last two graphs are anomaly or absolute flow. It seems absolute flow should be integrated. Higher winter and spring flows that are otherwise lost to the system diverted to groundwater recharge are a net gain for the system.

Groundwater is not only a sponge. It also flows.

★ Like
Reply

Gus Tolley *says:*
August 22, 2016 at 2:54 pm

The last two graphs are simulated monthly streamflow gains at the USGS gage near the outlet of the Scott Valley. Our model currently runs from October 1, 1990 through September 30th, 2011, so the graphs show the simulated average monthly streamflow gain over this 21 year period (the error bars indicate one standard deviation). I apologize for not making that more clear in the article.

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Pingback: *MAVEN'S NOTEBOOK - Water news*

Pingback: *California Water and Drought News for August 23, 2016*

groundwater consultants *says:*
November 15, 2016 at 1:46 am

Groundwater modeling is the best solution for several types of civil engineering and water resource planning problems. A ground water modeling are based on groundwater flow equation.

★ Like
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AgAlert
THE WEEKLY NEWSPAPER FOR CALIFORNIA AGRICULTURE

Projects evaluate recharge on cropland

Issue Date: October 24, 2018
By Christine Souza

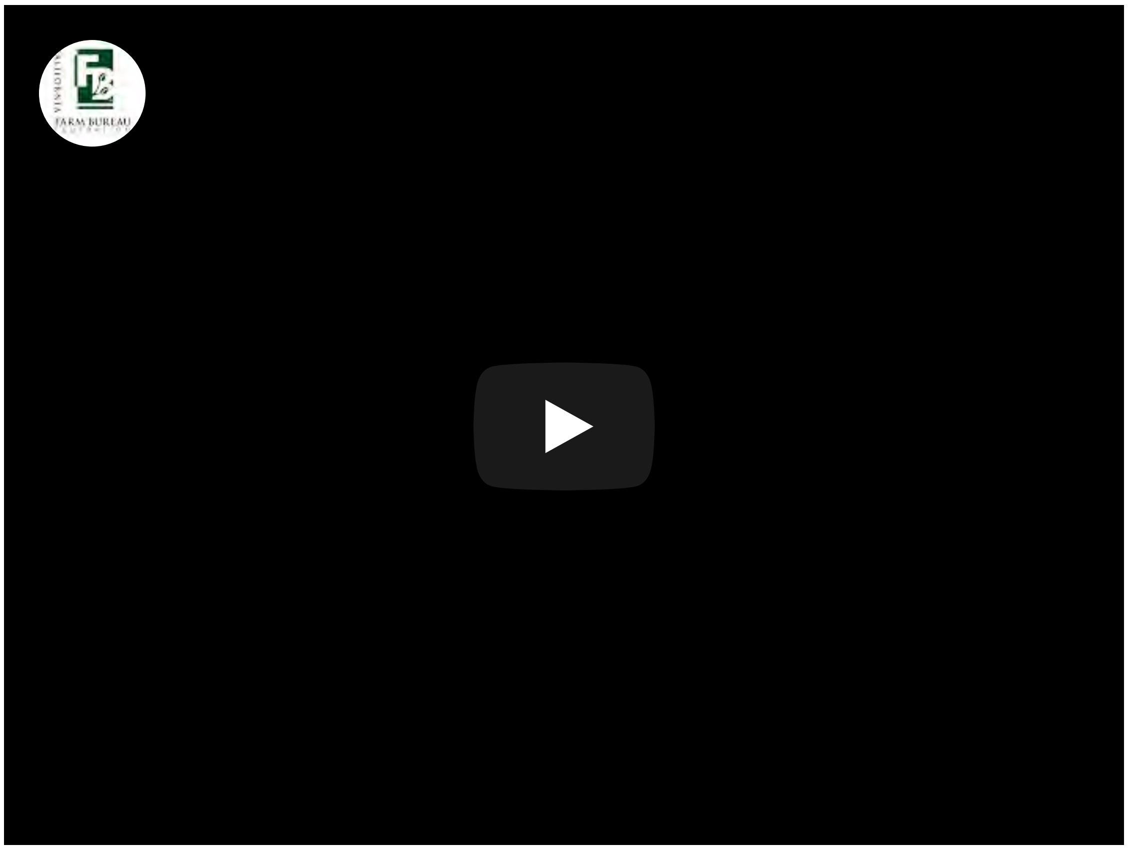
At Costa Vineyards in Acampo, the farm's owner has teamed with his water district and a nonprofit organization to examine the impact of flooding this 14-acre vineyard to recharge groundwater. In similar projects around the state, farmers and groundwater experts want to learn how such recharge efforts affect both aquifers and crops.
Photo/Christine Souza

Can water be spread onto active farmland to replenish underground aquifers without harming crops? That's the question under study in a variety of California locations on land holding vineyards, nut orchards, alfalfa and other crops.

These efforts, some of which have been ongoing for years, have become more important since the 2014 passage of the Sustainable Groundwater Management Act, which requires local agencies and groundwater users to develop plans to manage aquifers within their jurisdictions.

"Farmers and ranchers recognize that replenishing groundwater with on-farm recharge projects is one of the tools that we need to use to implement SGMA successfully," California Farm Bureau Federation Senior Counsel Jack Rice said.

One pilot project, at a zinfandel winegrape vineyard near Acampo, involves flooding 14 acres of the vineyard with up to 500 acre-feet of Mokelumne River water each year to recharge the underlying groundwater basin.



Landowner Al Costa is working with the North San Joaquin Water Conservation District and the nonprofit organization Sustainable Conservation on the project.

Costa's granddaughter, Tera Clark, said her family considers the vineyard a prime spot for groundwater recharge.

"My grandpa over the years was amazed at how fast the water would permeate the ground," Clark said. "He tried to contact some people to do a project because he said the water was needed and there was a good spot for the water to go straight down."

The current demonstration project on the Costa property, now in its second year, tests and promotes recharge in a district that receives little surface water and in which many farmers have converted crops to drip irrigation.

Dave Simpson, a director of the North San Joaquin Water Conservation District, said the district didn't deliver any surface water during the recent five years of drought, which led to increased groundwater use and to increased motivation for recharge.

Flooding the vineyard began in early October and is set to continue through early November.

Joe Choperena of Sustainable Conservation said the demonstration project aims to increase participation by other districts.

"Because this area and many other areas of California have critically overdrafted basins, this seems like a good way to maintain ag production but also utilize the landscape to recharge the aquifer," Choperena said. "This is one of six on-farm recharge monitoring sites, and the other monitoring sites are on almonds, other grapes—winegrapes and raisin grapes—walnuts and pistachios."

An early adopter of groundwater recharge, Don Cameron of Terranova Ranch in Fresno County, said he broke ground last week on a large-scale groundwater recharge project he has been pursuing for almost a decade through the state Department of Water Resources. Once completed, the project—a partnership among Terranova Ranch, Sustainable Conservation and the University of California, Davis—will add 30,000 acre-feet a month into the underground water system near the Kings River when floodwater is available.

In Northern California, professors from UC Davis are working on a small-scale study with the Scott Valley Irrigation District to recharge groundwater during winter months, in order to support added streamflow and fisheries, such as chinook salmon, during the summer.

"We're not looking at recharging in this valley for us to consume as agriculture, because we get pretty much a full recharge of water," said farmer and rancher Jim Morris of Yreka, president of the Scott Valley Irrigation District. "We're looking at slowing the water down and allowing it to get back for fisheries purposes later."

With no real surface storage in the region, Morris said, trying to keep the river running through the valley can be tricky, so groundwater recharge could be an option.

UC Davis professor Thomas Harter said the Scott Valley project examines storing winter runoff underground in order to support late-summer streamflow.

Morris said the project is also looking at how added water in the wintertime will affect alfalfa.

"Alfalfa doesn't like to have its feet wet when it's growing," he said, "but can we do this in January, February and March, before the alfalfa breaks dormancy, without causing any adverse effects?"

Harter said studies around the state will gauge the impact of groundwater recharge on crops.

"Is there an agronomic disadvantage to putting floodwaters in an orchard or a vineyard or a fallow field? Those are questions that we need to address," he said.

Sustainable Conservation will hold a workshop about the Costa Vineyards project on Nov. 5, from 9 a.m. until noon, at the Woodbridge Winery Old Barrel Warehouse, 5950 East Woodbridge Road in Acampo. RSVP to groundwater@suscon.org or 209-408-0612.

"We are definitely trying to work on reaching sustainable groundwater levels in a way that does not impact the agricultural economy and communities and agricultural business," Choperena said.

(Christine Souza is an assistant editor of Ag Alert. She may be contacted at csouza@cfbf.com.)

Etna, Calif., rancher Jim Morris checks for armyworm in one of his alfalfa fields, where he has done groundwater recharge field trials in cooperation with the University of California.

Grower sees potential for groundwater recharge

Jim Morris’ ranch was the site of landmark University of California research into using alfalfa fields to replenish aquifers.

Tim Hearden | Sep 04, 2018

Jim Morris had lots of reasons for embracing a University of California research project to use his alfalfa field for groundwater recharge.

His operation, the Bryan-Morris Ranch in Etna, Calif., has emphasized environmental stewardship since his wife’s family started it in the 1850s. The ranch was the site of soil conservation and other studies as long ago as the 1940s.

Morris also believes that being seen as using sustainable practices will help growers become less of a target for critics, he says.

So Morris gladly allowed his ranch to be one of two sites that UC-Davis and UC Cooperative Extension scientists used to flood established alfalfa stands with storm water during the winters of 2015 and 2016.

The study's initial results were published earlier this year in the UC's journal California Agriculture, asserting that alfalfa can tolerate very heavy winter flooding for groundwater recharge.

"I think there's a tremendous future" when it comes to recharge projects in alfalfa fields, Morris says.

"For people who are looking for ways to benefit the aquifer under SGMA (the Sustainable Groundwater Management Act), it could be one of the more important tools they have."

But Morris still has plenty of questions he'd like to see answered in the next round of research, including how long it takes the water he floods his field with to get back into the Scott River. Answering this question might reassure critics who think he just wants to bank the water for his own use, he says.

MORE QUESTIONS

Other questions may arise as the work continues, he says.

"I think there will be a lot of things we want to know, but we just don't know what they are yet," he says.

Morris has more than 300 acres in alfalfa and grass hay production and raises

Morris has more than 300 acres in alfalfa and grass hay production and raises Suffolk/Hampshire-cross sheep and Angus cattle. Jim and wife Katie married in 1988 and are partners with Katie's father, Mike Bryan, in running the ranch.

Their ranch in the scenic Scott Valley about 30 miles south of the Oregon-California state line and another farm near Davis were selected for the research because the soils in those areas have relatively high water percolation rates, university officials say.

“We found that most of the applied water percolated to the groundwater table,” wrote lead author Helen Dahlke, an integrated hydrologic science professor at UC-Davis.

The alfalfa endured saturdated conditions in the root zone for a short time, but the yield loss was minimal, noted Dahlke and her coauthors – USDA Natural Resources Conservation Service soil scientist Andrew Brown, UCCE specialists Dan Putnam and Toby O'Geen and the late UCCE advisor Steve Orloff.

The scientists noted that the alfalfa trial's results show tremendous potential for the state's groundwater basins. They estimated that if all the suitable alfalfa acreage were flooded with six feet of winter water, and assuming 90 percent percolates past the root zone, it would be possible to bank 1.6 million acre-feet of groundwater each year. The calculation was based on an index created by O'Geen that identifies areas where soils are suitable for on-farm groundwater recharge.

By comparison, Lake Oroville, the second-largest reservoir in the state, has a storage capacity of 3.5 million acre-feet, Dahlke wrote. An acre-foot is about 326,000 gallons, or enough water to serve an average California household for a year, according to the Water Education Foundation.

'GREAT PROMISE'

The alfalfa research was the latest in a series of projects by UC researchers studying the effects of using farmland to capture and bank winter storm water. Other scientists are looking at recharge efforts in almond orchards and vineyards. Such projects have great promise but also often require collaboration among numerous jurisdictions and agencies, the UC explains in a news release.

The alfalfa trials were paused after the death of the Siskiyou County-based Orloff last fall, Morris says. Orloff was instrumental in leading many water conservation-related projects along the Scott River, a key Klamath River tributary and a spawning ground for endangered salmon. Low levels in the Scott have prompted legal challenges and led to state restrictions on irrigation.

An overall lack of water and other complications prevented researchers from doing field trials last winter, but scientists do plan on doing more research this winter, Dahlke told Western Farm Press in an email.

Researchers plan to use two commercial alfalfa fields as well as a field at the Kearney Agricultural Research and Education Center to test the effect of modest and high amounts of winter water application on growing-season alfalfa yield in different soils and under different climate conditions, Dahlke says.

“In addition, we will quantify how winter water application affects growing season water balance and irrigation demand,” she says.

Much of the research in the next round will focus on the Central Valley’s southern end, where alfalfa is grown but doesn’t go dormant because of the warmer climate. Applications on Morris’ farm have been done when the alfalfa is dormant.

WINTER ABUNDANCE

In the Scott Valley, the only time sufficient water is available for recharge is during big winter rains and snow melt in the early spring, Morris says. He tried applying different amounts of water in different segments of the field to learn how much water his alfalfa could take without losing yields, and found that fields with suitable, well-draining soils could work for recharge.

But if the plants are actually growing, too much water saturating the roots for too long will kill

But if the plants are actually growing, too much water saturating the roots for too long will kill the plant, he says. And most growers don't want to fallow fields because it isn't economically feasible, he says.

Among other things for growers to consider is that the times he was flooding his fields for recharge are typically when growers want to put on herbicides. He wouldn't want to use most herbicides when putting water in the aquifer, and eventually the river, so it creates a weed problem, he says.

Morris has responded by over-seeding with orchard grass, which edges out weeds and creates an alfalfa-orchard grass mix, he says.

Another issue is that obtaining state permits for taking offseason storm water from the irrigation ditch for recharge can be a lengthy process, and growers may not see it through considering there's no economic benefit from doing a recharge project.

"I think that will be streamlined over time," he says.

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News of Agribusiness: Lummus Corporation names Ben Hinnen Chief Executive Officer

Ben Hinnen is joining Lummus Corporation as CEO, effective March 1, 2018.

Mar 12, 2019

Lummus Corporation, the parent company of System Solution of Kentucky (SSK) and Lummus, announced today that Ben Hinnen is joining the company as CEO, effective March 1, 2018. Hinnen brings tremendous leadership experience to this position, having most recently served as CEO and President of Fives Intralogistics Corp., where he helped transform the company by achieving significant growth and creating sustainable operations.

Lummus Corporation's chairman, Phil DiIorio, stated on behalf of the Lummus board, "Ben brings a wealth of experience leading diverse businesses, has an outstanding leadership reputation, an entrepreneurial mindset, and the passion to build great businesses, all of which are critical in the evolution and transformation of Lummus and its subsidiaries. Working with Ben, we will continue to drive significant and sustainable growth. Further, we are actively focusing on value-added acquisitions globally."

Experienced Manager

Hinnen's career spans more than two decades across multiple industries, with a focus on management, strategy, sales and marketing leadership, innovation and commercialization, customer service, and M&A. Hinnen has led companies in varying phases of maturity through critical transformation periods. Prior to his work as the CEO and president of Fives Intralogistics Corp., Hinnen served as vice president and business unit manager at Swisslog for over 8 years, growing his business at 2 times the market growth in both revenue and profits.

Hinnen says he looks forward to this new opportunity to serve as the Lummus CEO. "I am extremely excited to join Lummus during an important and exciting time. We will leverage the Lummus manufacturing and engineering strengths, with the significant demand in the intralogistics market that our company SSK is experiencing, and capture an even greater market share. With my passion to build great businesses, this is the perfect opportunity to use my industry experience to build something truly great. I look forward to working with a strong team leading Lummus and its subsidiaries through the next phase of growth."

Described by colleagues as a "remarkable and charismatic leader" with a penchant for innovation and collaboration, Hinnen holds a Master of Business Administration from the University of Denver, and a Master of Engineering and a Bachelor of Science in Mechanical Engineering, both from the University of Colorado. Originally from Denver, Colorado, Hinnen resides in Louisville, Kentucky, with his wife and three children.

In 2016, Lummus Corporation acquired System Solutions of Kentucky (SSK), a leading integrator of conveyor and sortation equipment for the postal, parcel, baggage, industrial, and cargo industries.

Lummus is recognized as the world leader in the supply of machinery and replacement parts for the cotton ginning industry. Lummus also manufactures and markets a limited line of equipment for the synthetic fiber industry. A separate division, Carver/Gump, provides processing equipment for the oilseed industry and separations products for the food industry.

TAGS: COTTON

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Afternoon Market Recap for March 12, 2019

Low grain prices attract bargain buyers.

Ben Potter | Mar 12, 2019

Wheat futures leap forward, with corn and soybean taking moderate gains

A major round of technical buying and short-covering pushed some wheat contracts 5% higher Tuesday, with corn and soybeans enjoying more moderate gains of around 1% on some spillover strength and bargain buying today.

Expect variable weather for the rest of this week, depending on where you live – with cooler-than-normal temperatures more prevalent farther West and above-average temperatures likely farther East. And the latest [72-hour cumulative precipitation map from NOAA]() shows wet weather likely for much of the central U.S. over the next three days, with some areas picking up another 2" or more accumulation during this time.

On Wall St., Boeing shares dropped more than 6% after a high-profile plane crash this weekend of one of its 737 MAX jets – the second such incident in less than six months. That applied downward pressure to the Dow, which dipped 54 points in afternoon trading to 35,597. Energy prices were mixed again today, with crude oil firming slightly to approach $57 per barrel, while gasoline and diesel were each down around 0.5% today. The U.S. Dollar softened slightly.

President Donald Trump's 2020 budget proposal would make significant cuts to the several federal agencies, including the EPA (-31%) and USDA (-15%). In contrast, the proposed budget would hand out spending increases for the Department of Defense, Homeland Security and Veterans Affairs. Click here to read a more detailed account of the numbers.

Corn prices climbed more than 1% higher Tuesday on technical buying and spillover strength from surging wheat prices. March futures gained 4 cents to $3.5650, with May futures up 3.5 cents to $3.6550.

Corn basis bids were largely steady to slightly firm Tuesday, ticking 1 to 2 cents higher across several river terminals and ethanol plants today.

IEG Vantage (formerly Informa Economics) is now projecting 2019 U.S. corn plantings at 91.771 million acres, up from its prior estimate of 91.591 million acres.

Brazil's Conab made small adjustments to the country's 2018/19 corn crop production estimates from February, increasing the total to 3.654 billion bushels. If realized, that puts this year's production nearly 15% above 2017/18 totals. Conab also projects 2018/19 corn exports to rise 25% year-over-year, reaching an estimated 1.220 billion bushels.

Russian consultancy SovEcon estimates the country's corn exports will reach 7.9 million bushels in March, which would be the lowest monthly total since last October, if realized.

Turkey purchased 11.8 million bushels of feed corn in a series of international tenders that closed earlier today, although details regarding origin(s) were not immediately available. The grain is for shipment in April or May.

South Korea purchased 2.7 million bushels of corn from optional origins in an international tender that closed earlier today. The grain is for arrival in October.

Taiwan issued an international tender to purchase 2.6 million bushels of corn from optional origins, closing March 13. The grain would be for shipment in May or June.

What will planting corn this year deliver in terms of risk versus reward? Farm Futures senior grain market analyst breaks down the numbers and offers exclusive insights in his latest Corn Outlook column.

Soybean prices were in the green Tuesday after attracting bargain buyers after slumping for most of this month. March futures picked up 7 cents to $8.8475, while May futures gained 6.75 cents to $8.9675.

Soybean basis bids were mostly steady Tuesday but spiked 6 to 14 cents higher across several river terminal and processor locations today as relatively slow farmer sales continue this week.

IEG Vantage (formerly Informa Economics) is now projecting 2019 U.S. soybean plantings at 85.494 million acres, down 0.6% from its mid-February forecast of 86.044 million acres.

Brazil's Conab estimates the country's 2018/19 soybean production will reach 4.169 billion bushels, trending 1.6% below its February projection and 4.9% below the country's total 2017/18 production. Conab also estimates Brazilian exports will fall 16.3% year-over-year, at 2.572 billion bushels.

A separate production estimate from Brazilian consultancy AgRural projects the country's 2018/19 soybean crop even lower, at 4.148 billion bushels, although that number ticked 0.4% higher than the consultancy's prior estimate.

A lot of seasonal trends are in play this spring for soybeans, including prospective U.S. acres, Brazilian production and China's prospective purchases. What does it all mean for price trends and marketing opportunities? Read Farm Futures senior grain market analyst Bryce Knorr's latest Soybean Outlook column to learn more.

Preliminary volume estimates were for 92,879 contracts, falling about 28% below Monday's final count of 129,523.

Wheat prices caught a much-needed break Tuesday, with some contracts climbing 5% after tumbling prices over the past several weeks finally prompted a technical rebound. May Chicago SRW futures gained 23.75 cents to $4.5225, May Kansas City HRW futures rose 21 cents to $4.4125, and May MGEX spring wheat futures added 14.5 cents to $5.5850.

Russia's wheat exports are expected to slow significantly in March, dropping 42% below the prior eight-month average to reach 77.2 million bushels, according to the country's SovEcon consultancy. Russian barley exports could reach 9.2 million bushels in March, trending above February's total but also significantly behind the prior eight-month average.

Tunisia issued an international tender to purchase 3.4 million bushels of soft wheat, 1.5 million bushels of durum wheat and 3.4 million bushels of feed barley, closing March 13. The grain is for shipment starting in mid-April.

Japan issued a regular tender to purchase 4.3 million bushels of food-quality wheat from the United States, Canada and Australia that closes Thursday. Of the total, about 30% is expected to be sourced from the U.S.

Jordan again made no purchases in its international tender to purchase 4.4 million bushels of milling wheat that closed earlier today. The country has struggled to close similar deals in recent months amid generally low trader participation.

Preliminary volume estimates were for 144,091 CBOT contracts, up a bit from Monday's final count of 130,712.

Preliminary volume estimates were for 391,176 contracts, climbing moderately above Monday's final count of 307,653.

Closing Prices for Key Commodities

		High	Low	Last	Change
Corn	$/bush	cents/bu			
	19-Mar	357.75	352.75	356.5	4
	19-May	367.5	361	365.75	3.5

19-May	367.5	361	365.75	3.5
Soybeans				
19-Mar	885	880.25	884.75	7
19-May	899.75	887.75	897	6.75
Soymeal $/ton				
19-May	304.5	300.3	303	1.4
Soyoil cents/lb				
19-May	30.08	29.58	29.99	0.33
Wheat $/bushel				
19-Mar	443	424	446.25	24
19-May	457	427.5	453	23.75
KC Wheat				
19-Mar	410		435.75	
19-May	445	418.25	442.75	21
MPLS Wheat				
19-Mar			552.25	1.5
19-May	561.75	546.75	560.75	14.5
Live Cattle cents/lb				
19-Apr	129.4	126.325	126.35	-2.65
Feeder Cattle cents/lb				
19-Apr	146.075	143.75	144.25	-1.725
Lean Hogs cents/lb				
19-May	71.85	70.225	71.6	0.575
Crude Oil $/barrel	*Energy prices may not represent final settlements			
19-Apr	57.55	56.74	56.95	0.16
Diesel				
19-Mar	2.0166	1.974	1.9854	-0.0088
Unleaded Gasoline $/gallon				
19-Mar	1.8397	1.8116	1.8166	-0.0094
Natural Gas				
19-May	2.81	2.765	2.798	0.013
Ethanol Futures				
19-Mar	1.315	1.293	1.31	0.017
U.S. Dollar Index				

	97.245	96.875	96.885	-0.289
Gold $/ounce				
19-Apr	1300.5	1292	1294.7	5.9
Copper				
19-Mar	2.951	2.911	2.9285	0.0285
Fertilizer Swaps			(as of 03/08)	
DAP Tampa-index			388.5	UNCH
DAP-New Orleans			366.5	-2
Urea-New Orleans			257.9	4
Urea-Middle East			245.0	-10
Urea-Black Sea			226.5	-3
UAN (32%) New Orleans			187.4	-2.76

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Managed winter flooding of alfalfa recharges groundwater with minimal crop damage

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NALT Keywords
alfalfa, flooding tolerance, groundwater, groundwater recharge, Medicago sativa

Abstract

It is well known that California experiences dramatic swings in precipitation that are difficult to predict and challenging to agriculture. In times of drought, groundwater serve as a crucial savings account that is heavily relied upon. However, few tools exist to proactively refill this crucial reserve in wet years. We explored the idea of intentional winte flooding of agricultural land to promote on-farm recharge of the underlying groundwater. Field experiments were conducted on two established alfalfa stands to determine the feasibility of groundwater recharge and test realistic water application amounts and timings and potential crop damage. We studied soils with relatively high percolation rates and found that most of the applied water percolated to the groundwater table, resulting in short-lived saturated conditions in the root zone and minimal yield loss. Whil caution is appropriate to prevent crop injury, winter recharge in alfalfa fields with highly permeable soils appears to be a viable practice.

Full text

Groundwater is a vital resource in California, providing approximately 38% of the state's water supply in normal years and at least 46% in dry years (DWR 2014). During the recent drought (water years 2011–2012 through 2015–2016), the majority of groundwater wells (90%) experienced a drop in groundwater levels of at least 10–50 ft (3–15 m) while some wells (8%) showed declines in groundwater level of more than 50 ft (>15 m) (DWR 2017). Groundwater overdraft persisted for most of the 20th century but th rate has dramatically increased since 2000 to about 7.2 million acre-feet (ac-ft), or 8.9 cubic kilometers (cu km) per year between 2006 and 2010 (Faunt 2009; Scanlon et al. 2012). State legislation now requires the implementation of groundwater sustainability plans to ensure that all groundwater basins are managed sustainably by 2040 (SWRC 2014).

Managed groundwater recharge on agricultural lands in winter, when surplus surface water often is available, is one promising strategy for replenishing overdrafted aquifers (Bachand et al. 2014). This practice may also be beneficial to agriculture by recharging soil water profiles before an irrigation season. However, challenges and concerns remai regarding the effects of wintertime flooding of fields, particularly in perennial cropping systems such as alfalfa or tree and vine crops. Risks include excessive anaerobic conditions that may damage roots, increased risk of root diseases, excess aboveground humidity affecting insects or diseases, excessively high water tables, nutrient and herbicide leaching, and inability to perform field operations due to wet conditions.

Alfalfa is a promising candidate for groundwater recharge. It is a short-lived perennial that is widely grown in the western United States, with approximately 800,000 ac, or 3,237 square kilometers (sq km) planted in California (USDA NASS 2017). Because alfalfa is a nitrogen-fixing plant, it seldom receives nitrogen fertilizer. Therefore, environmental concerns associated with water application beyond crop needs (i.e., leaching of nitrate to groundwater) are considerably lower than for other crops (Putnam and Lin 2016; Walley et al. 1996).

Approximately 80% to 85% of the alfalfa acreage in California is irrigated with flood irrigation systems (Schwankl and Pritchard 2003) capable of conveying large amounts of surface water to fields for groundwater recharge. Thus, given the large acreage of alfalfa in the Central Valley with suitable irrigation infrastructure, there are likely to be many fields that also have the soil and underlying aquifer conditions suitable for recharge.

Additionally, on a per-acre basis, average revenue from alfalfa is substantially lower than that for other perennial crops, such as grapes, almonds and walnuts, that are also candidates for managed winter groundwater recharge. For alfalfa, establishment costs are $500 to $600 per ac (Orloff et al. 2012), with average annual yields across the state of 7 tons per ac, or 17.3 tons per hectare (ha), and recent market prices from $140 to $375 per ton (Geisseler and Horwath 2016; USDA AMS 2017). As such, economic incentives designed to offset the risks associated with winter groundwater recharge would be comparatively affordable for alfalfa.

An experimental alfalfa plot at the UC Davis Plant Sciences Field Facility is flooded to evaluate crop impacts and groundwater recharge potential. The majority of alfalfa acreage in California is watered with flood irrigation systems capable of conveying large amounts of surface water to fields, many of which likely also have soil and underlying aquifer conditions suitable for recharge

Winter flooding of alfalfa presents risks of crop injury, yield reduction or stand loss under saturated conditions. Alfalfa can be damaged by lack of oxygen in the root zone from prolonged saturation; however, the extent of crop damage is temperature dependent (Barta 1988; Barta and Sulc 2002; Drew and Lynch 1980). Alfalfa is less susceptible to injury when temperatures are cooler, even after prolonged saturation (Barta and Schmitthenner 1986; Cameron 1973; Finn et al. 1961; Heinrichs 1972).

To evaluate the suitability of alfalfa fields for groundwater recharge, we conducted on-farm experiments to measure the amount of groundwater recharge possible and assess crop response to excess winter water applications. Two on-farm experiments were conducted, one at the Plant Science Research Farm at UC Davis (Yolo County) in 2015, and one at Etna, in Scott Valley (Siskiyou County) in 2015 and 2016. In both experiments, the effects of different water amounts, timings and durations of water application were evaluated (fig. 1).

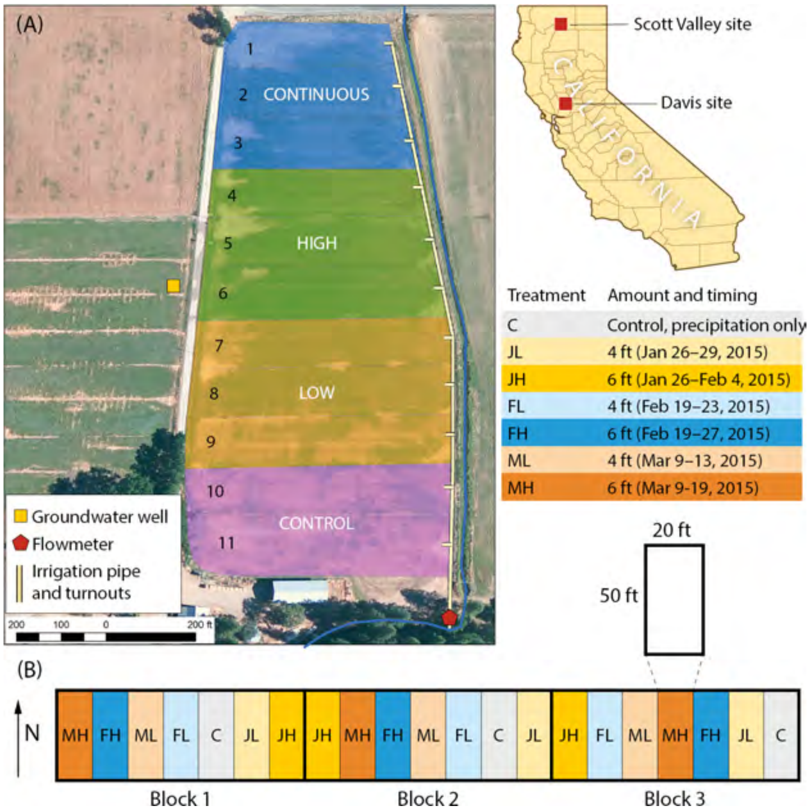

Fig. 1. Field layout of the experimental sites at (A) Scott Valley, in Siskiyou County (see also Table 1), and (B) Plant Sciences Field Facility, Davis. For the Davis site, a randomized complete block design consisting of seven treatments with three replicates was implemented. The table above summarizes the treatments for the Davis site. C is the control, H and L stand for high and low water amounts of 4 ft and 6 ft, respectively, and J, F and M indicate the month in which the winter recharge was performed (i.e., January, February, March).

Davis and Scott Valley sites

The Davis site is on a Yolo silty clay loam with an available water capacity of 11 inches (in), or 28.1 centimeters (cm), for a 100 cm pedon, underlain by a sandy substratum within 3 ft of the soil surface. The field was an established alfalfa stan (entering its fifth growing season in 2015) with a fall dormancy rating of 8 (variet WL 550.RR). The depth to groundwater at the site was approximately 15 ft (4.5 m in January 2015. Total rainfall and mean temperature for the experimental perio (January to April) in 2015 were 7.7 in (19.6 cm) and 53.9°F (12.1°C).

The Scott Valley site is in the Klamath Mountains at an elevation of 2,784 ft (848 m). The experiment was conducted on a 15 ac (6 ha) field. The alfalfa variety planted was not known definitively, but was either BlazerXL (fall dormancy rating 3) or Xtra-3 (fall dormancy rating 4). The soil type is a Stoner gravelly sandy loam with an available water capacity of 4.9 in (12.5 cm). The alfalfa stand was entering its ninth growing season in 2015 and depth to groundwater was approximately 2 ft (7.3 m) at the beginning of the experiment (January 2015). Mean temperature during the experiment (February–May in 2015 and 2016) was 47°F (8.3°C); total precipitation over the course of the experiment in both years was 3.3 in (8.5 cm) and 6.8 in (17.3 cm).

Experimental layout

The UC Davis experiment was a replicated study with two winter water application amounts (low = 4 ft (120 cm); high = 6 ft (180 cm)) and three water application timings (January, February, March) and the control (i.e., winter precipitation only). The treatments were replicated three times using a randomized complete block design (fig. 1B) resulting in 21 individual 20 by 50 sq f (93 sq m) plots.

One irrigation check (435 ft by 50 ft) of a 3 ac field was divided into 21 plots for the experiment (fig. 1B). Plots were separated from one another by berms approximately 1 ft high and 2.5 ft wide, which were established in November 2014. Repeated irrigation events of approximately 1 ft of water per day were use to apply the total treatment quantity. Irrigation treatments began on Jan. 26, 2015, and continued until March 19, 2015 (fig. 1).

At the Scott Valley site, winter recharge experiments were conducted for 2 years (2015 and 2016). The treatments evaluated were (1) a continuous recharge treatment: application of water every day, continuously except for the times when water was being applied to other treatments; (2) a high recharge treatment: three to five water applications per week; (3) a low recharge treatment: one to three water applications per week; and (4) the control, receiving winter precipitation only.

Total amounts applied in each treatment are shown in table 1 for both years. These treatments were each applied to three contiguous irrigation checks (fig. 1A). All treatment received the standard irrigation amount of 3 in before the first cutting and 5 in between the first and the second cutting. Winter recharge treatments lasted from Feb. 17 to April 9 in 2015 and from Feb. 4 to March 21 in 2016.

TABLE 1. Total applied winter water (ft) for groundwater recharge at the Scott Valley site, 2014–2015 and 2015–2016

Treatment	Check	Check size	Applied winter water for recharge							
			2014–2015 (Feb 17–Apr 9, 2015)				2015–2016 (Feb 4–Mar 21, 2016)			
			Total	Feb	Mar	Apr	Total	Feb	Mar	Apr
		ac	*ft*				*ft*			
Continuous	1	0.84	30.74	2.50	22.34	5.90	13.52	6.99	6.52	0.00
	2	1.10	24.87	3.69	16.68	4.51	10.32	5.34	4.98	0.00
	3	1.19	23.38	3.93	15.28	4.17	9.54	4.94	4.61	0.00
High	4	1.18	7.08	2.55	3.70	0.83	4.45	2.83	1.61	0.00
	5	1.35	6.55	2.39	3.48	0.68	3.89	2.48	1.41	0.00
	6	1.44	8.06	3.17	4.06	0.82	3.86	2.54	1.32	0.00
Low	7	1.41	5.10	0.95	1.94	2.21	12.96	1.06	0.68	11.22
	8	1.51	3.54	0.81	2.01	0.72	1.63	0.99	0.64	0.00
	9	1.54	3.26	0.80	1.70	0.76	1.60	0.97	0.62	0.00
Standard	10	1.46	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	11	1.86	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

* This check received an additional 11.3 ft of water in two irrigation events on April 6–8 and April 21–22, 2016.

TABLE 1. Total applied winter water (ft) for groundwater recharge at the Scott Valley site, 2014–2015 and 2015–2016

Water balance modeling

A water balance model based on the Thornthwaite-Mather procedure (Steenhuis and Van der Molen 1986) was set up for each site to estimate the fraction of applied water going to deep percolation (i.e., groundwater recharge) versus to evapotranspiration and to storage in pore space. The model was applied only to the root zone (upper 2 ft), where most evapotranspiration demand takes place.

Attenuation of applied water in the deeper soil profile (transmission zone, 2 to 5 ft) was modeled with a one-dimensional vertical flow model capable of simulating saturated and unsaturated flow (fig. 2). More detailed information on field measurements, statistical analyses and soil water balance measurements are provided in the technical appendix.

Winter rainfall

The winter of 2014–2015 had below average precipitation in both Davis and the Scott Valley. Total November to April precipitation for Davis was 12.3 in (31 cm) - the 1981 to 2010 average was 17.55 in (44.5 cm) — with most rain, 8.2 in (20.8 cm), falling in December (fig. 3A). Total November to April precipitation in the Scott Valley was 16.9 in (43 cm), of which 5.9 in (15 cm) fell in December and January (fig. 4A). At both sites, December rainfall abruptly increased available soil water in the root

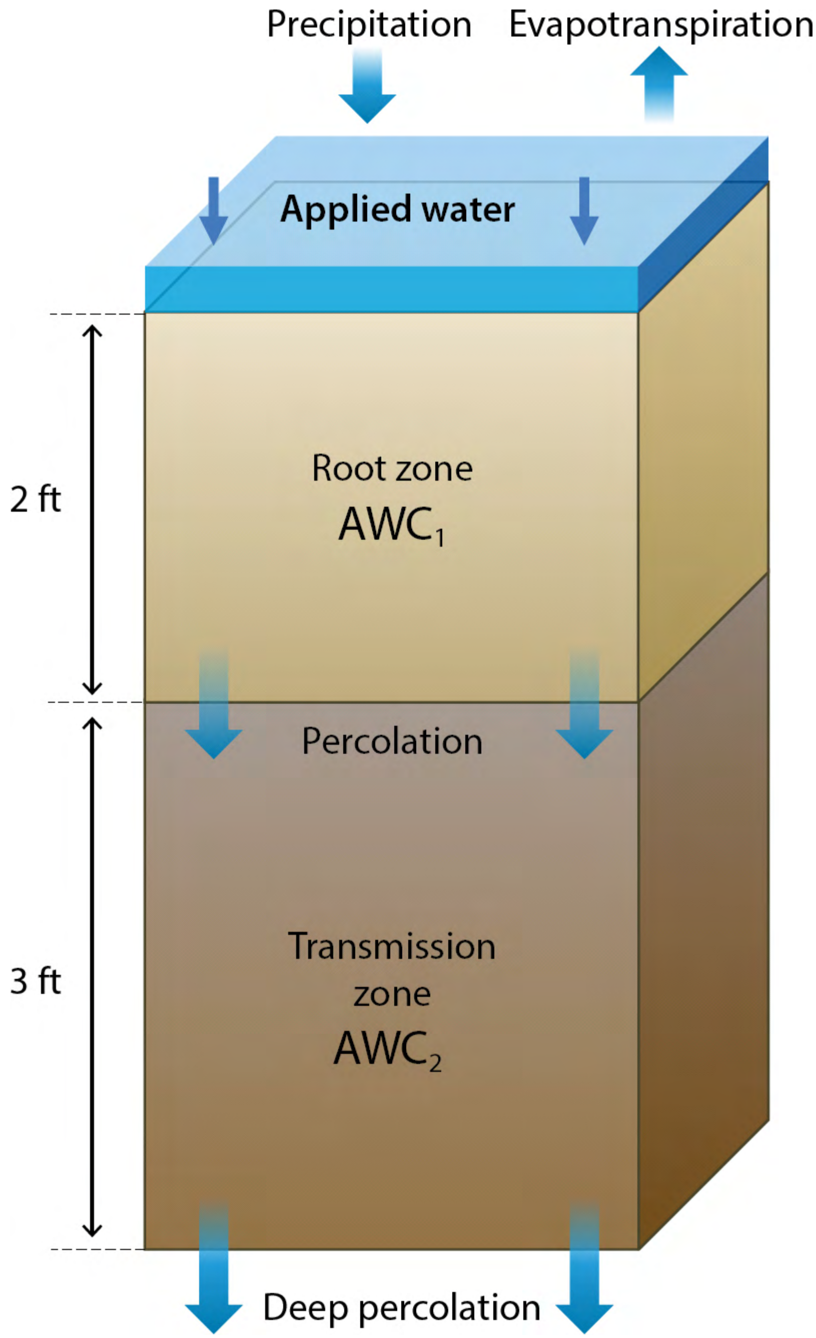

Fig. 2. Conceptual diagram of two-layered soil water balance model. The root zone is modeled with the Thornthwaite-Mather procedure and includes the loss of soil water by evapotranspiration. Saturated and unsaturated flow in the transmission zone is modeled with a one-dimensional vertical flow model receiving only the deep percolation from the root zone as water input. AWC is the soil-specific available water capacity. Variables are explained in the technical appendix.

zone to field capacity, followed by a short dry-out period in January. Volumetric water contents were above 75% of available water capacity at both sites before water applications occurred between January and April.

Davis site percolation amounts

At the Davis site, a small portion of the applied water for each treatment (low: 4 f high: 6 ft) was used to fill empty pore space in the soil profile, and as the water application progressed, water-filled pore space increased from field capacity (water retained in soil by gravity) to saturation (freely drainable water) (O'Geen 2012). Saturated conditions prevailed for up to 12 hours in the loamy root zone (upper 2 ft) and up to 4 hours in the transmission zone.

Total deep percolation amounts (i.e., including recharge from rainfall) for the 5 ft pedon were similar across treatments and ranged from 48.2 to 53.5 in (122 to 13 cm) for the low treatments and from 76.8 to 82.2 in (195 to 209 cm) for the high treatments (table 2). About 95% to 98% of the applied winter water left the root zone (upper 2 ft) as deep percolation, and 92% to 96% left the transition zone as deep percolation, indicating small losses to soil storage and evapotranspiration. Depending on the timing of the winter water application with respect to antecedent rainfall, about 0.9 to 3 in (2.3 to 7.6 cm) of the applied winter water was used to bring the water content in the root zone to field capacity. This contribution to soil storage increased to about 2.7 to 4.7 in (7 to 12 cm) when the transmission zone (2 to 5 ft) was included in the water balance.

Although water application timing had little effect on total deep percolation amounts, it played a vital role for the root zone water balance at the onset of the growing season. In the control plot at Davis, available water in the 2 ft root zone reached field capacity only in December and early February, after which it steadil declined (fig. 3B). It would have reached the wilting point in early June without irrigation. A similar dry-out dynamic was observed for January low and high treatment plots, in which winter water was applied between Jan. 26 and Feb. 4, 2015 (fig. 3B), indicating that applying winter water for recharge 4 to 6 weeks before the onset of the growing season provides little advantage for the growing season water balance because most of the plant-available water is supplied naturally by precipitation in a normal or wet year.

In both the control and January treatment plots, available water stored in the roo zone reached 50% of field capacity on March 23, 2015 (alfalfa irrigation management guidelines, e.g. Orloff and Hanson (2000), recommend maintaining a water content of 80% to 90% of field capacity in the root zone; allowable depletion is 50% of field capacity in the root zone — below that point plants coulc be damaged) (fig. 3B). In contrast, water applied in February and March resulted i a clear increase of plant-available water during the first month of the growing season (end of March). In February treatments, the root zone stayed saturated between Feb. 19 and Feb. 27, 2015, and then began to lose water, reaching 50% c field capacity on April 1 and 2, 2015. In March treatments, the root zone was saturated from March 9 to March 19, 2015, and dried to 50% of field capacity on April 18, 2015. In contrast to the control, the plots receiving additional water for winter recharge had more plant-available water stored in the soil profile at the beginning of the growing season; it amounted to about 1.3 in and 1.7 in (3.3 to 4.3 cm) in the February low and high treatments and 2.6 in to 3 in (6.6 to 7.6 cm) in th March low and high treatments.

Scott Valley site percolation amounts

At the Scott Valley site, in 2015 and 2016 a total volume of 135 ac-ft (166,520 cu m) and 107 ac-ft (131,982 cu m) of water, respectively, was applied for recharge on the 15 ac field. Table 2 summarizes the amounts of applied winter water for each check and treatment for both years.

During the first year, the low, high and continuous treatment plots received a total of 47 in (120 cm), 87 in (221 cm) and 311 in (789 cm) of winter water, of which 44 in (112 cm), 83.6 in (212 cm), and 306.8 in (779 cm) percolated to the water table, respectively (table 2). These winter application amounts translate to about 4, 7.3 and 25.9 ac-ft per ac of water, which is equal to 1.25, 2.4 and 8.6 times the annual growing season water demand of alfalfa in Scott Valley (assuming a water demand of 36 in). Low, high and continuous treatment plots received winter water for a total of 2.7, 6.3 and 31.6 days, respectively. The late-winter water application (mid-February to April) kept soils near field capacity, allowing about 93% to 99% of the applied winter water to go to deep percolation. Roughly 3.2 to 3.7 in (8.1 to 9.5 cm) of the applied water filled empty pore space to bring the water content in the root zone to field capacity.

During the second year (2016), water was applied for 11, 20 and 46 days, respectively, on low, high and continuous treatment plots between Feb. 4 and March 21. The low treatment plot received a total of 20 in (51 cm) of winter water, which is slightly over 50% of the annual growing season water demand of alfalfa in the Scott Valley. The high treatment received 48 in (123 cm) of winter water, which equals about 1.25 times the annual growing season water demand of alfalfa in the Scott Valley. The continuous treatment received 131 in (332 cm) of winter water, or about 3.5 times the growing season demand in 2016 (table 1). In addition, check 7 received 135 in (11.3 ft) of water on April 6–8 and April 21–22, 2016.

These numbers highlight that during one wet winter the growing season's water demand for about 3 years could be recharged. Nearly 100% of the applied water went to deep percolation in 2015–2016, likely because of the wet winter-spring season (table 2). Only 0.15 in (0.4 cm) of the applied water was used to bring the water content of the root zone to field capacity. For irrigation check 7, which received most of the winter water in April, the contribution of applied winter water to soil storage was 3 in (7.5 cm).

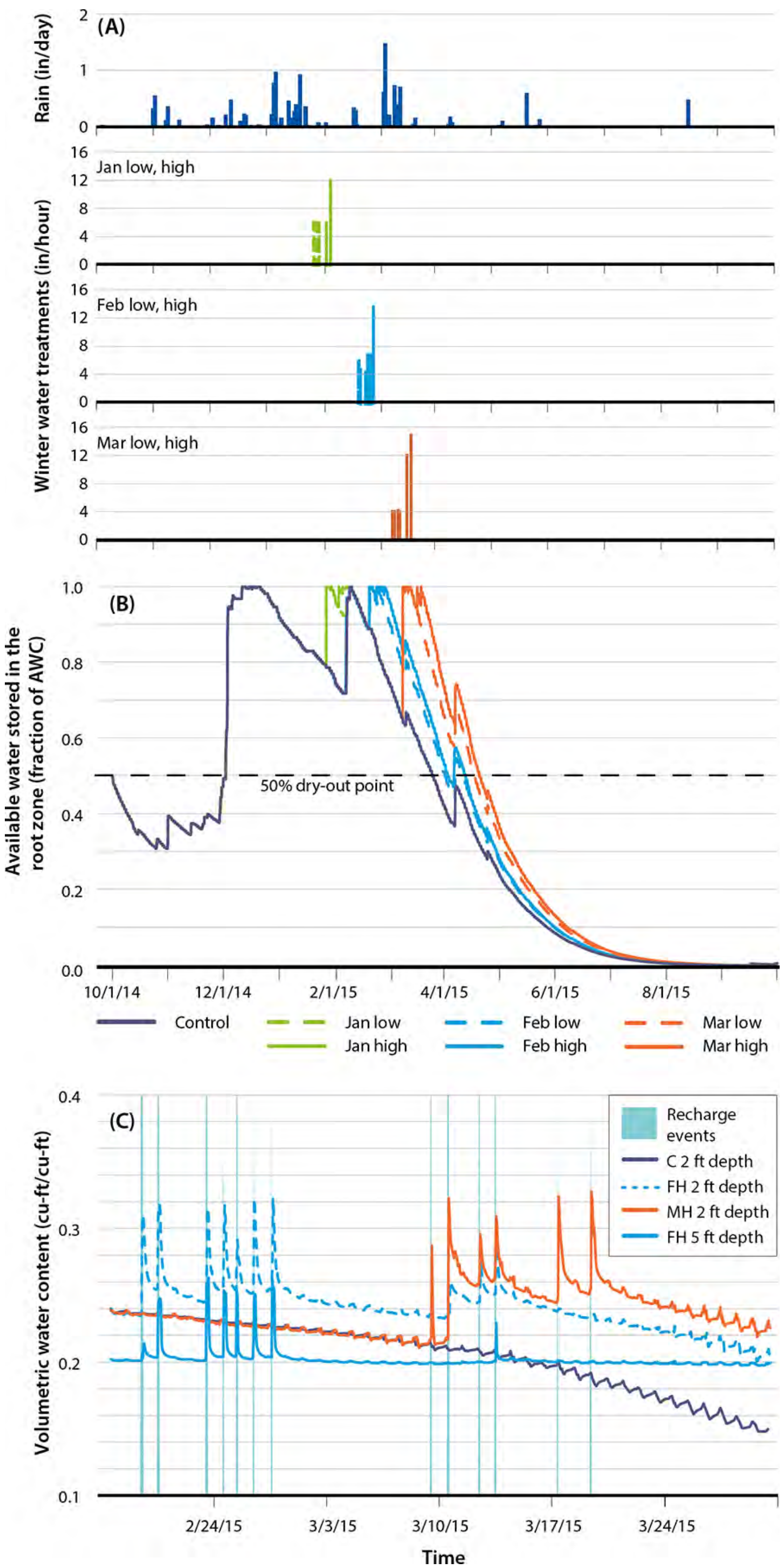

Fig 3. Water balance summary for the Davis site. (A) Daily precipitation and timing of winter water treatments. (B) Change in available soil water in the root zone (0–2 ft) as fraction of the soil-specific available water capacity (AWC). (C) Measured change in soil water content at 2 ft and 5 ft depth. Deep percolation occurred when volumetric soil water content was at a maximum.

Because of the dry winter in 2014–2015, the available water in the root zone of the grower's control plots increased to field capacity only during the winter months (December to February). Dry-out started early in 2015, around mid-February, and progressed rapidly, reaching 50% of field capacity on April 23, 2015 (fig. 4C). Dry-out in the winter water application plots was delayed by about 1 month; all treatment plots remained nearly saturated until mid-April and reached 50% of field capacity either on May 10, 2015 (low and high treatment), or on May 14, 2015 (continuous).

Because of the late-winter water application, low, high and continuous plots had about 2.5 in (6.5 cm) of additional plant-available water stored in the root zone at the beginning of the 2015 growing season (April) compared to the control (fig. 4C). This amount is almost equal to one growing season irrigation event (3 in). In contrast, because of the wet winter and spring in 2015–2016 (total November to April precipitation was 130% of normal: 22.5 in) and the earlier timing of winter water applications, winter recharge did not provide an advantage for the root zone water balance at the onset of the 2016 growing season (fig. 4D). Irrigation check 7 was an exception; it had an additional 2.5 in (6.5 cm) of plant-available water stored at the end of April (fig. 4D). In 2016, dry-out to 50% field capacity of the control occurred about 1 month later than in the drought year of 2014–2015, indicating the generally wetter conditions in 2016.

For the first two winter recharge events conducted in February and March 2015, the groundwater table rose notably within 11 to 18 hours after water application started, indicating that the applied water moved through the 25 ft (7.6 m) vadose zone in less than 24 hours. The applied winter water in conjunction with natural precipitation caused a rise in the groundwater table of approximately 6 ft (1.8 m) in 2015 and 4.5 ft in 2016 (fig. 5). Although surface water was applied nearly continuously at the Scott Valley site, the applied water never created prolonged ponded conditions after water application ceased. Often, the application was supply limited and water moved only two-thirds to three-quarters down each check. Based on the duration and amount of winter water applied at the Scott Valley site, we estimated an infiltration rate of 0.9 ft (27 cm) per day.

Minimal effects on alfalfa

At the Davis site, statistical analysis of the effect of winter water application quantity and timing on alfalfa yield using a mixed-model analysis of covariance (ANCOVA) did not show a significant relationship between alfalfa yield and winter recharge. Overall, alfalfa yield at the Davis site in the first cutting averaged 1 ton per ac (2.47 tons per ha).

Yields were variable (0.7 to 1.2 tons per ac; 1.7 to 3 tons per ha) across the three blocks and the within-plot replicates (fig. 6A). Despite the variability between plots, alfalfa yields were not significantly different across the timing of water applications ($F = 0.98$, $p = 0.4$) and total applied water amounts ($F = 0.07$, $p = 0.94$) or their interaction (timing amount: $F = 0.74$, $p = 0.5$). Plant counts made prior to the treatments were not significant predictors of yield but explained approximately 15% of the variation in alfalfa yield across treatments. Plant counts were positively correlated with yield ($r = 0.45$), suggesting that low plant density limited yield in some of the observation plots such as the January low plots, but plant counts were not related to the irrigation treatments.

At the Scott Valley site, alfalfa yield did not show a significant correlation to total applied winter water for three out of the four cuttings measured over the 2 years (fig. 6B, C). Similarly, mean weed and orchardgrass biomass in 2016 did not show significant correlation to total applied winter water (fig. 6C). During the second cutting in spring 2015, alfalfa yield showed a significant negative correlation with increasing amounts of applied winter water ($p = 0.02$) (fig. 6B). Despite this significant correlation, yield in the continuous treatment plot, which received about 26 ac-ft per ac of water, was only 0.76 tons per ac lower than the control.

To our surprise, in 2016, the continuously irrigated checks, which received the largest amount of winter water, showed a slightly higher yield than the control plots during the first and second cutting. A similar pattern was observed during the first cutting in 2015, with yields slightly lower at the center of the field (low and high treatments) than toward either of the edges (control and continuous treatments). Alfalfa yields for first and second cuttings at the Scott Valley site were comparable between 2014–2015 and 2015–2016 and reached, on average, around 1.7 tons per ac (4.2 tons per ha) per cutting.

The alfalfa yield results show that application of 2 to 26 ft of water for winter recharge did not conclusively result in a significant decline in yield. Neither experiment showed significant declines in alfalfa yield during the first cutting, which would be expected if environmental factors influenced crop health. The yield data together with the deep percolation results suggest that the effect of winter flooding on dormant alfalfa is potentially small for highly permeable soils. However, alfalfa yields were also highly variable among treatments, which complicated the statistical analysis of the water application effect. For the Davis site, results indicated that water application timing and amount were not significant predictors of yield, while initial plant count and variability in soil properties across the field did explain some of the variability in yield observed across the treatments.

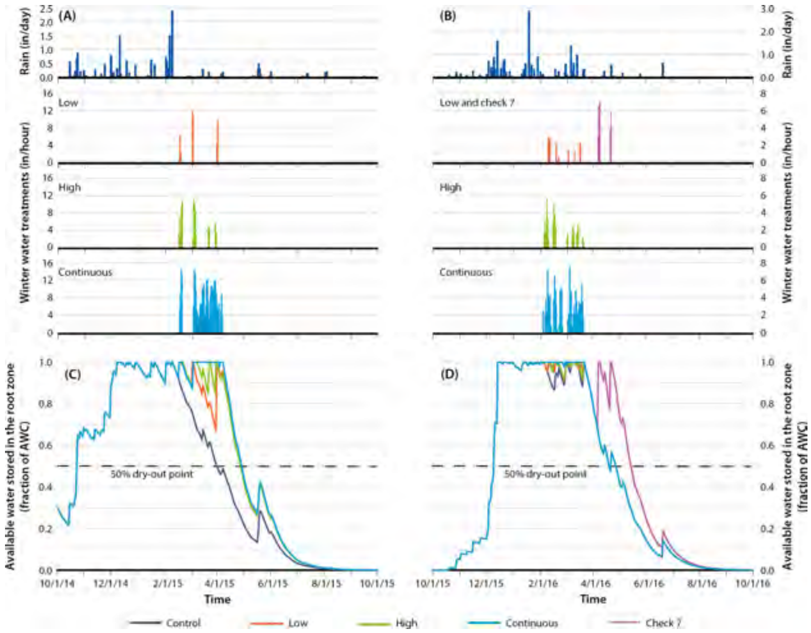

Fig. 4. Daily precipitation and timing of winter water treatments for the Scott Valley site for 2015 (A) and 2016 (B). Change in available soil water in the root zone (0–2 ft) as fraction of the available water capacity (AWC) (C, D).

TABLE 2. Summary of water inputs (precipitation and applied winter water) and estimated deep percolation and soil storage contribution amounts for the two experimental sites

	Precipitation	Applied winter water	Total annual deep percolation*	Deep percolation from winter water application	Deep percolation as percentage of applied water	Contribution to soil storage†	
	(in‡)	*(in)*	*(in)*	*(in)*	*(%)*	*(in)*	*(%)*
DAVIS Root zone (0–2 ft)							
Control	14.1	0.0	4.9	—	—	—	—
Jan low	14.1	48.8	53.5	47.1	96%	1.7	3.5%
Jan high	14.1	72.8	77.5	70.6	97%	2.2	3.0%
Feb low	14.1	45.6	49.0	44.6	98%	0.9	2.0%
Feb high	14.1	80.4	83.3	79.0	98%	1.4	1.7%
Mar low	14.1	49.4	51.5	47.1	95%	2.2	4.5%
Mar high	14.1	76.5	77.8	73.5	96%	3.0	3.9%
DAVIS Root zone and deeper soil profile (0–5 ft)							
Control	14.1	0.0	4.9	—	—	—	—
Jan low	14.1	48.8	53.5	45.3	93%	3.5	7.2%
Jan high	14.1	72.8	77.5	70.1	96%	2.8	3.8%
Feb low	14.1	45.6	48.2	42.9	94%	2.7	5.9%
Feb high	14.1	80.4	82.2	76.4	95%	4.0	4.9%
Mar low	14.1	49.4	50.5	45.4	92%	3.9	8.0%
Mar high	14.1	76.5	76.8	71.8	94%	4.7	6.1%
SCOTT VALLEY 2015							
Standard	19.6	0.0	7.8	—	—	—	—
Low	19.6	47.2	51.8	44.0	93%	3.2	6.8%
High	19.6	87.0	91.4	83.6	96%	3.4	3.9%
Continuous	19.6	310.6	314.5	306.8	99%	3.7	1.2%
SCOTT VALLEY 2016							
Standard	23.7	0.0	11.2	—	—	—	—
Low	23.7	19.8	30.9	19.7	99%	0.2	0.8%
High	23.7	48.5	59.6	48.7	100%	0.2	0.3%
Continuous	23.7	130.6	141.7	130.5	100%	0.1	0.1%
Check 7	23.7	155.6	163.8	152.6	98%	3.0	1.9%

* Includes deep percolation from precipitation.
† Amount of applied winter water used to bring soil water content to field capacity.
‡ 1 in = 2.54 cm.

TABLE 2. Summary of water inputs (precipitation and applied winter water) and estimated deep percolation and soil storage contribution amounts for the two experimental sites

Both experimental sites were older alfalfa stands (5-year stand in Davis, 9-year stand in the Scott Valley) with relatively low plant count prior to the recharge experiments, which likely influenced the yield measurements. To more accuratel determine the effect of large winter water applications for groundwater recharg on alfalfa health and yield, experiments need to be replicated on younger, high-yielding fields at more sites with varying soil types and drainage characteristics. Further study on susceptibility to root disease, stand survival and long-term productive capability is also needed.

Winter flooding from high rainfall is a known risk for alfalfa production, particularly during early stand establishment (Putnam et al. 2017). Thus, older stands may be preferred for groundwater recharge strategies. Older stands are lower risk since they are usually past peak production.

While there are risks to plant stand and crop productivity with high winter water applications to alfalfa, the risk of economic loss is likely lower than compared to other perennial crops with higher cost structures. Moreover, the risk of crop loss may be low in highly permeable soils, especially when temperatures are low. These risks also may be offset to some degree by benefits from greater early-season moisture in the root zone being available for crop production. The risks also should be weighed against the value of groundwater recharge, which may improve local groundwater resources, making water available during dry summe months or for transfer to other crops.

Application timing, soil oxygen status

We tested the continuous application of winter water over several days and weeks as well as application of winter water in the form of isolated irrigation events. Based on our field observations neither method had a large influence on the amount of the total applied water that went to deep percolation. We attribut this mainly to the highly permeable character of the soil at both sites and the low evapotranspiration rates encountered during the experimental periods.

Soil moisture data collected at both sites further indicated rapid drainage of the soil profile following the end of the recharge events. Since lack of oxygen caused by prolonged flooding is directly related to development of root or plant diseases (Barta and Schmitthenner 1986; Cameron 1973; Heinrichs 1972), free drainage o the applied winter water through the root zone is important and presents one of the main risk factors when applying large amounts of water for winter recharge (Finn et al. 1961).

Oxidation-reduction potential measurements at 4- and 8-in depths at the Scott Valley site revealed close correlation between oxygen status and water content (fig. 7). Reduced oxygen conditions occurred only during the water application events, and returned quickly to aerated conditions after water applications ceased. In addition, both experiments were conducted during the winter period when alfalfa is dormant or growing very slowly. Both findings suggest that pulsed application of water for groundwater recharge is preferred from a crop health perspective and that the intensity and frequency of the winter water application should be tailored to site-specific soil drainage characteristics.

Corroboration of SAGBI

Our field measurements corroborate that the Soil Agricultural Groundwater Banking Index (SAGBI) (O'Geen et al. 2015) may be a reliable predictor of soil suitability for on-farm groundwater recharge. SAGBI (casoilresource.lawr.ucdavis.edu/sagbi/) considers five major factors critical to sustaining crop health and rapid deep percolation of applied water: soil profile percolation rate, root zone residence time, chemical limitations, topography, and soil surface condition. The index ranks soils on a six-class scale ranging from very poor to excellent (O'Geen et al. 2015).

Both of our sites rank in the SAGBI good category. At both sites, recharge is not restricted significantly by chemical limitations (e.g., no accumulation of salts that could result in degradation of water quality), topography or water-restrictive features in the root zone or deeper soil profile, such as hardpan or claypan. For both sites, the root zone residence time and deep percolation ability were the most limiting characteristics du to relatively high clay content. However, as showcased by our field data, both sites nonetheless supported significant amounts of deep percolation.

Potential benefits, need for research

Results from our two on-farm experiments indicate that an astoundingly large fraction of the applied winter water percolated past the root zone toward the groundwater table. Over 90% of the applied water went to deep percolation, ranging between 4 ft (122 cm) and 6.7 ft (204 cm) at the Davis site and 2.6 ft (79 cm) and 26 ft (792 cm) at the Scott Valley site. Less than 10% of the applied water was either evaporated or used to fill up soil pore space to bring the soil to field capacity.

Applying our field observations to the statewide SAGBI map allows a simple approximation of the potential benefit of using alfalfa fields for groundwater recharge for California's groundwater resources. Using a geospatial analysis of crop land data (USDA NASS 2017) and the unmodified SAGBI index, we determined that approximately 300,000 ac (1,214 sq km) of alfalfa in California are planted on soils with a SAGBI rating of moderately good or better. Applying 6 ft of winter water and assuming 90% of it percolates past the root zone, 1.6 million ac-ft (1.9 cu km) of groundwater recharge would be possible if all alfalfa land ranked as suitable for on-farm recharge were used. This is equivalent to 12.8% of the statewide average annual agricultural groundwater

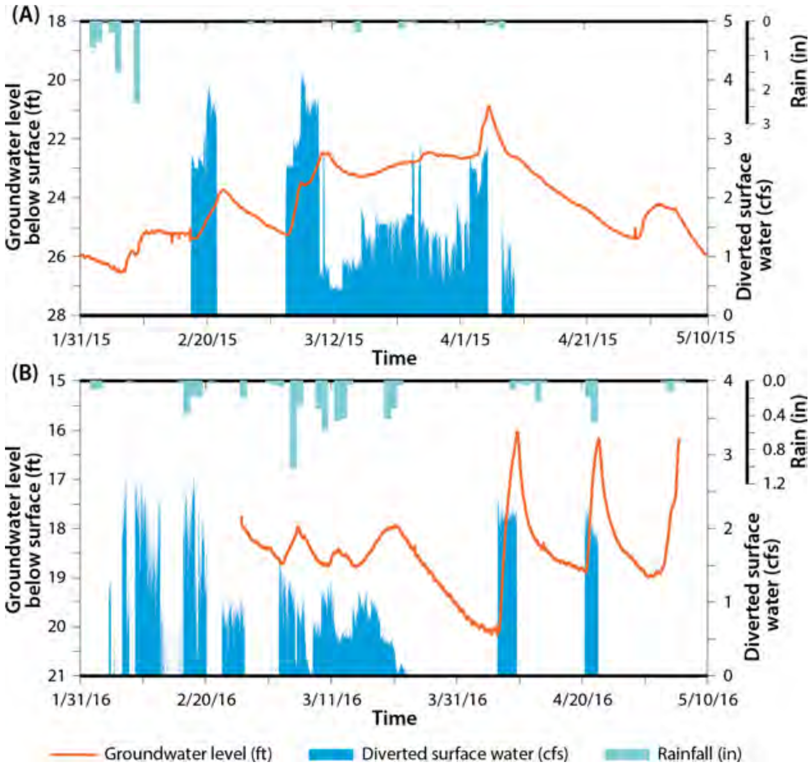

Fig. 5. Amount of winter water applied for recharge (cfs), change in depth to the groundwater table (ft) and rainfall (in per day) measured between January and May in 2015 (A) and 2016 (B) for the Scott Valley site.

use between 2005 and 2010 (DWR 2015). For reference, the Oroville reservoir, second largest in the state, has a storage capacity of 3.5 million ac-ft.

Our study has mainly looked at the physical feasibility of using alfalfa fields for the replenishment of groundwater with winter excess surface water. However, adoption of this practice is locally dependent on many site-specific factors, which influence the overall cost and benefits of this practice to the farmer. On-site factors such as soil suitability; climate (e.g., winter temperature, precipitation); age, health and fall dormancy rating of the alfalfa variety; capacity of the local water conveyance system; and ease at which water can be conveyed onto a field (e.g., involving potential additional labor or electricity cost) influence the rate and total amount of excess water that can be used for recharge and the potential costs, such as from crop damage.

Most landowners will likely have to purchase the surface water they are diverting for recharge (unless it is free-of-charge delivered floodwater), which can cost between $15 per ac-ft (Emil Cavagnolo, General Manager Orland-Artois Water District, personal communication) and $1,456 per ac-ft (CPUC 2016). In addition, most landowners will likely have to expand their existing or obtain a new appropriative surface water right for the diversion of additional surface water outside the growing season. If the state of California decides to adopt the fee structure for the temporary permit for groundwater recharge from Governor Brown's Executive Order B-36-15, the cost for the permit would include a minimum fee of $100 for the application plus $1 per 100 ac-ft in excess of 10,000 ac-ft (based on water actually diverted), but the cost could be as high as $498,665 if a standard permit is pursued (table 3).

To capitalize on the recharge rates that some of the most suitable soils promote, landowners may want to consider expanding the capacity of their water conveyance system. For example, to recharge 200 ac-ft in 10 days on an 80 ac field (assuming an infiltration capacity of 3 in per day), the conveyance system would need to have a minimum capacity of 10 cu ft per second (cfs). For soils that can infiltrate water at higher rates (e.g., 1 ft per day), such as the Stoner gravelly loam in the Scott Valley site, a diversion capacity of 40 cfs would be needed for an 80 ac field. The least cost-extensive method would be to divert water using the existing conveyance capacity and apply the water using the same method as during the growing season (i.e., irrigation of individual checks); alternatively, if the conveyance capacity does not support the infiltration capacity of the soil, the area to which the water is applied could be reduced to match the water delivery rate of the conveyance system.

Recharged water would provide several benefits to landowners and associated water districts, including increased water supply and water security, achievement of sustainable groundwater management goals, flood protection, improved water quality, reduction in imported water use, mitigation of land subsidence and seawater intrusion, and long-term benefits for nearby groundwater-dependent ecosystems (e.g., rivers, wetlands). The recharged water would also provide indirect benefits to the conjunctive use of surface and groundwater resources and might stimulate statewide trading of water, which, considering an average market price of $650 per ac-ft of water in 2015 (Howitt et al. 2015), might provide a supplemental source of income for alfalfa growers. These tradeoffs and economic incentives could inform and motivate agricultural groundwater banking programs statewide. Hence, the risks and value of groundwater recharge strategies for agricultural fields including alfalfa should be considered as California attempts to balance its groundwater demand with the sustainability of water resources available on a seasonal basis.

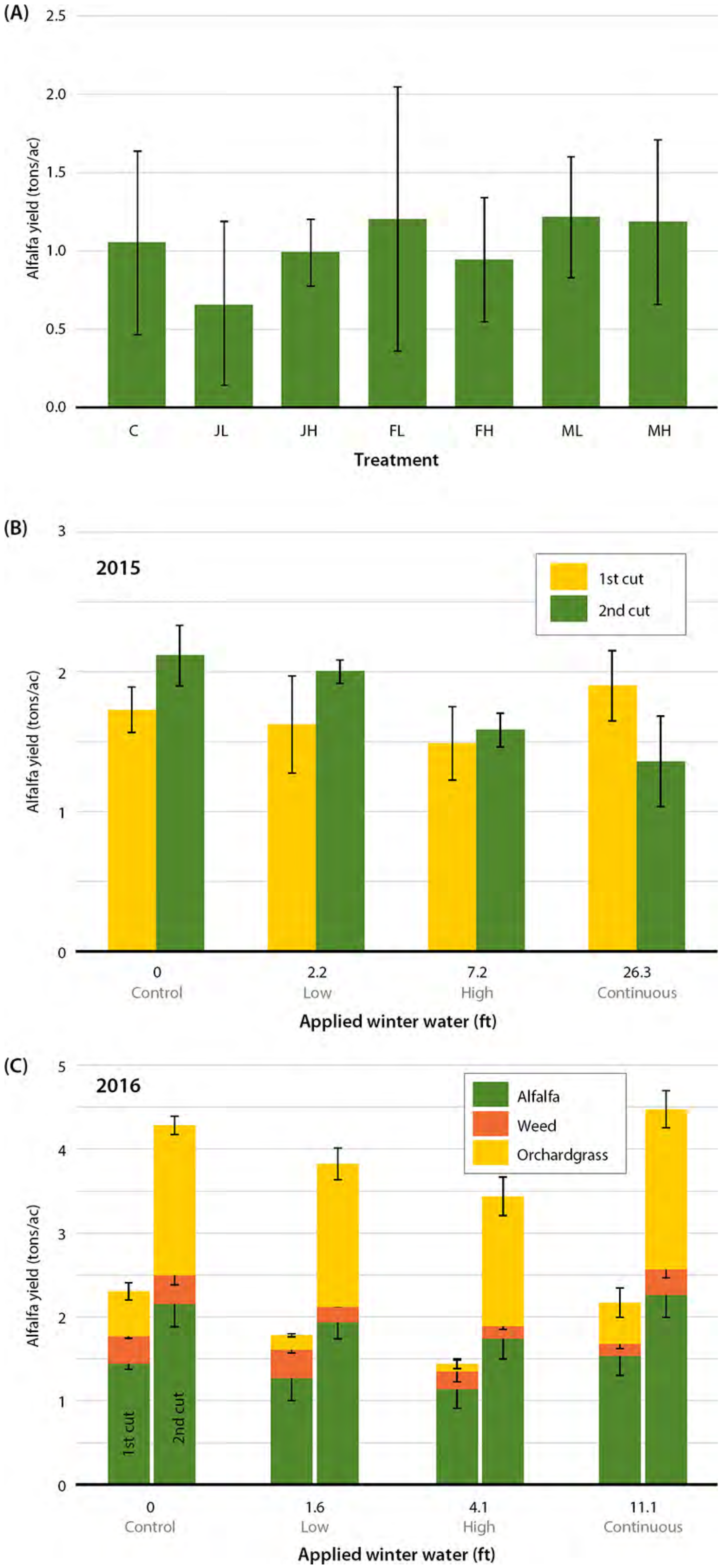

Fig. 6. Mean alfalfa yield (tons per ac) for the Davis (A) and Scott Valley (B, C) sites. For the Davis site, yield was estimated from the replicated treatment plots (*n* = 3) on April 23, 2015. C is the grower standard, L and H stand for low and high water amounts of 4 ft and 6 ft, respectively, and J, F and M indicate the month in which the winter recharge was performed (i.e., January, February, March). For the Scott Valley site, yield is shown for the first (end of May) and second (mid-July) cuttings in the control, low, high and continuous treatment plots in 2015 (B) and 2016 (C). Error bars indicate one standard deviation.

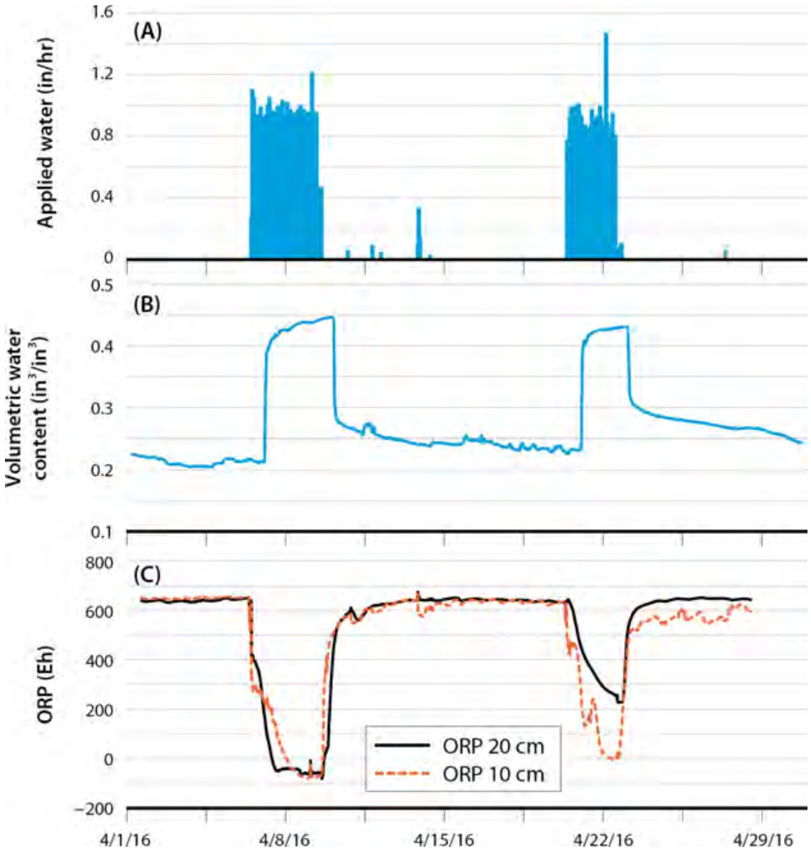

Fig. 7. Precipitation and applied water (A), volumetric water content at 8 in depth (B) and oxidation-reduction potential measured at 10 am (red dots) and 20 cm depth (black line) (C) at the Scott Valley site.

TABLE 3. Application filing fees for water permits with the State Water Resources Control Board (SWRCB), 2017

Application	Minimum fee	Fee structure	Maximum
Standard permit	$1,000	$1,000 + $15 per ac-ft in excess of 10 ac-ft	$498,665
Standard temporary permit	$2,000	Half the fee for an equivalent standard permit or $2,000, whichever is greater	$249,333
Temporary permit for recharge	$100	$100 + $1 per 100 ac-ft in excess of 10,000 ac-ft (based on water actually diverted)	N/A

Source: www.waterboards.ca.gov/waterrights/water_issues/programs/applications/groundwater_recharge/docs/staffpresentation.pdf.

TABLE 3. Application filing fees for water permits with the State Water Resources Control Board (SWRCB), 2017

Supporting material

Technical Appendix

Technical appendix for Dahlke et al. doi:10.3733/ca.2018a0001

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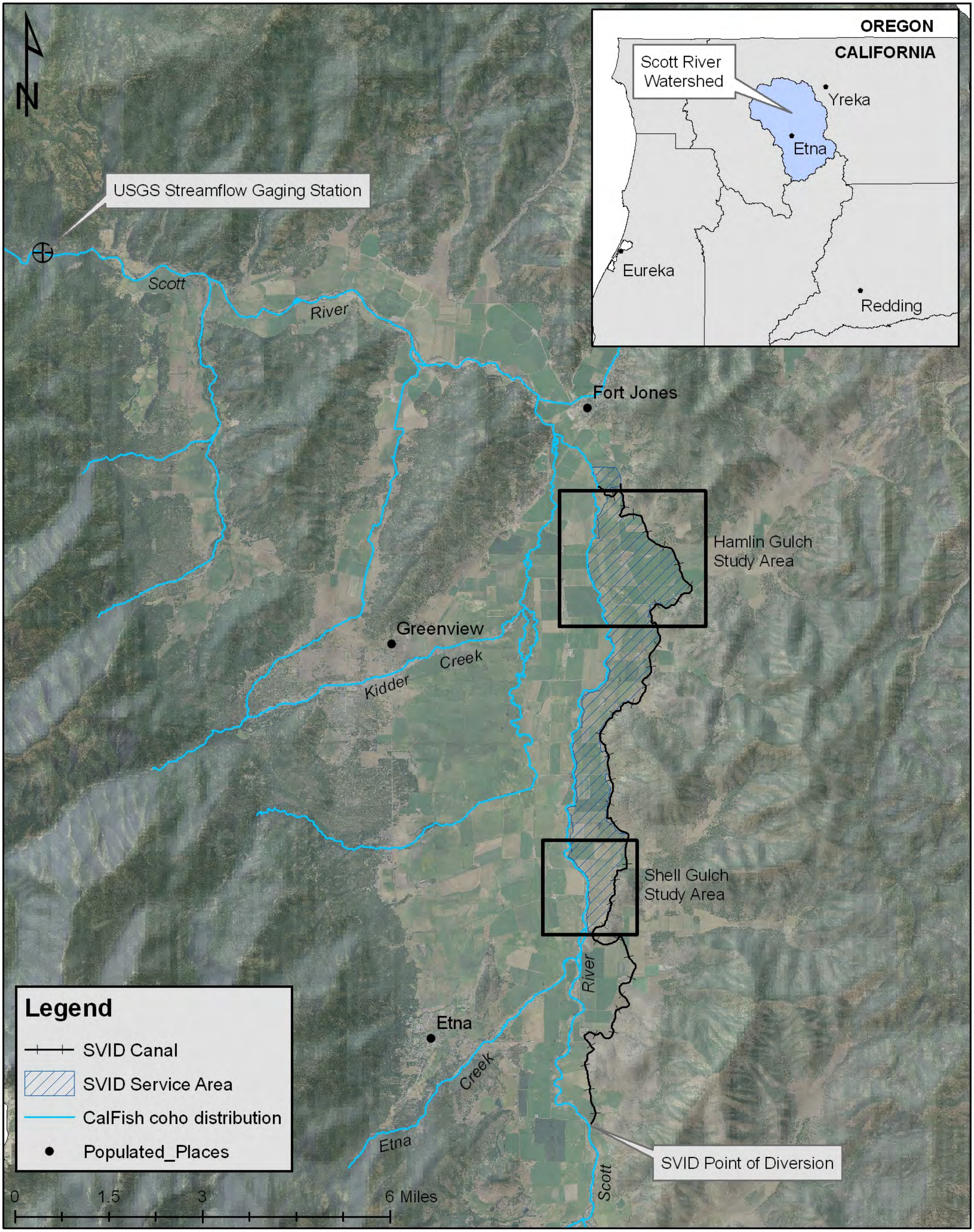
Scott Valley Managed Aquifer Recharge



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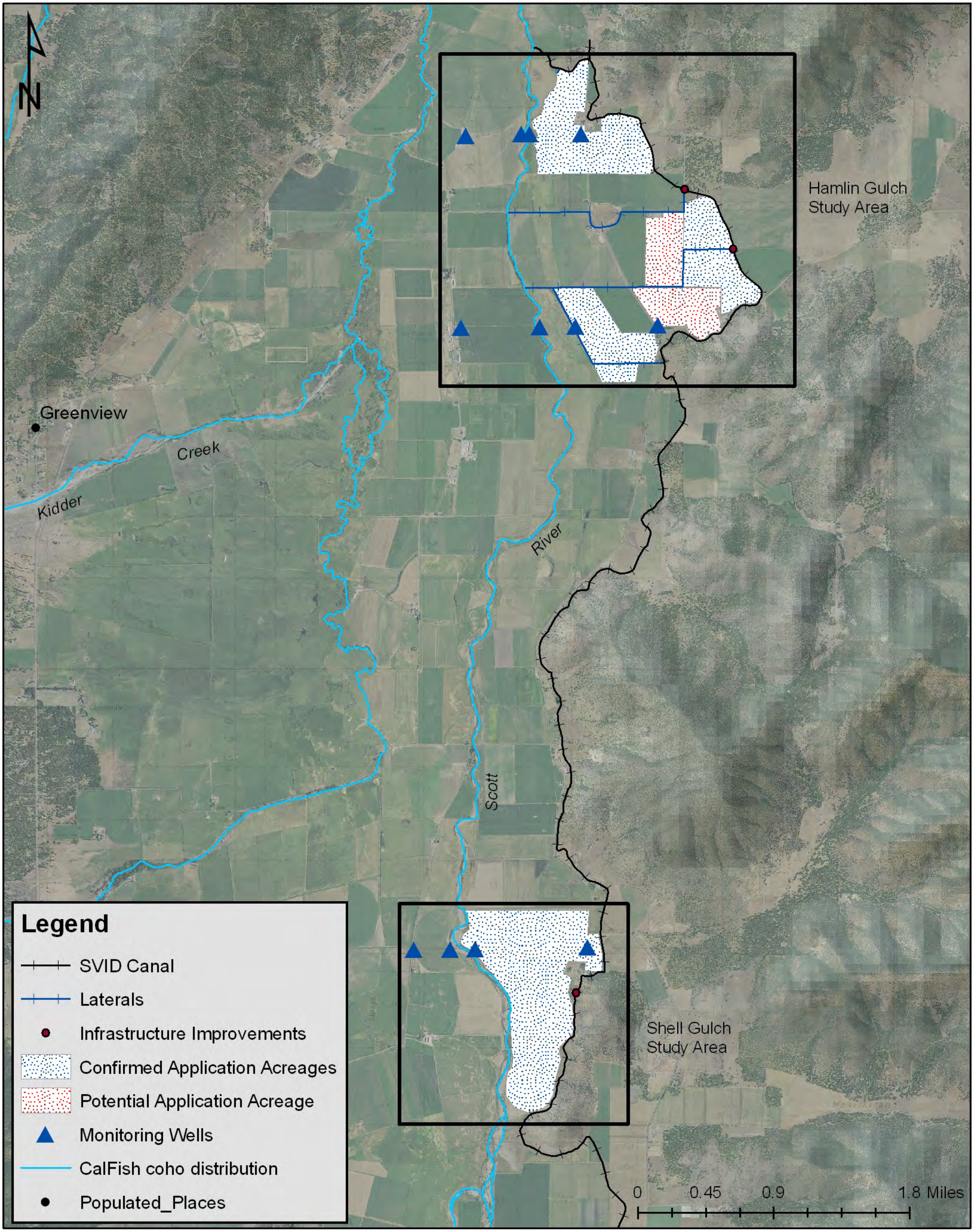

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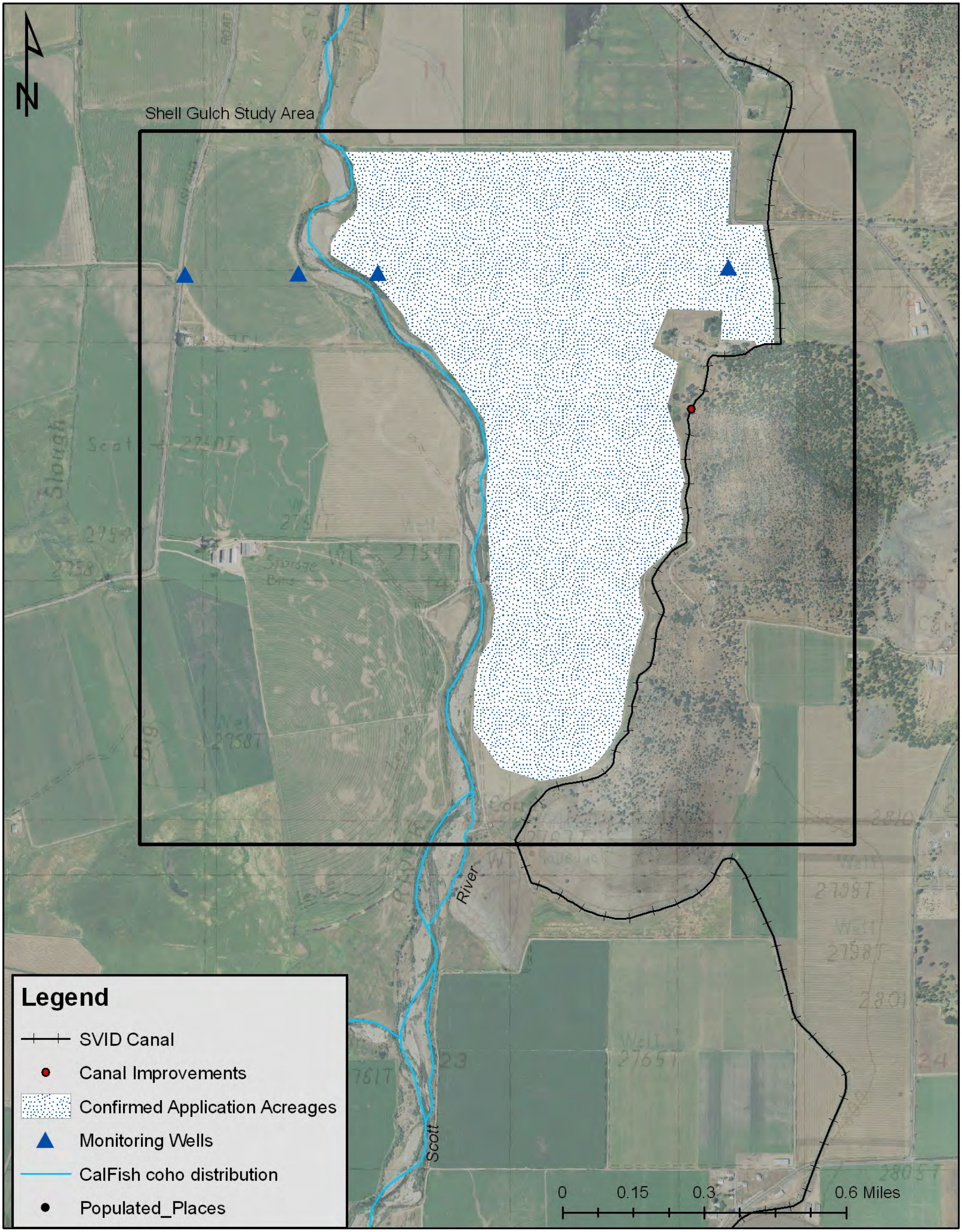

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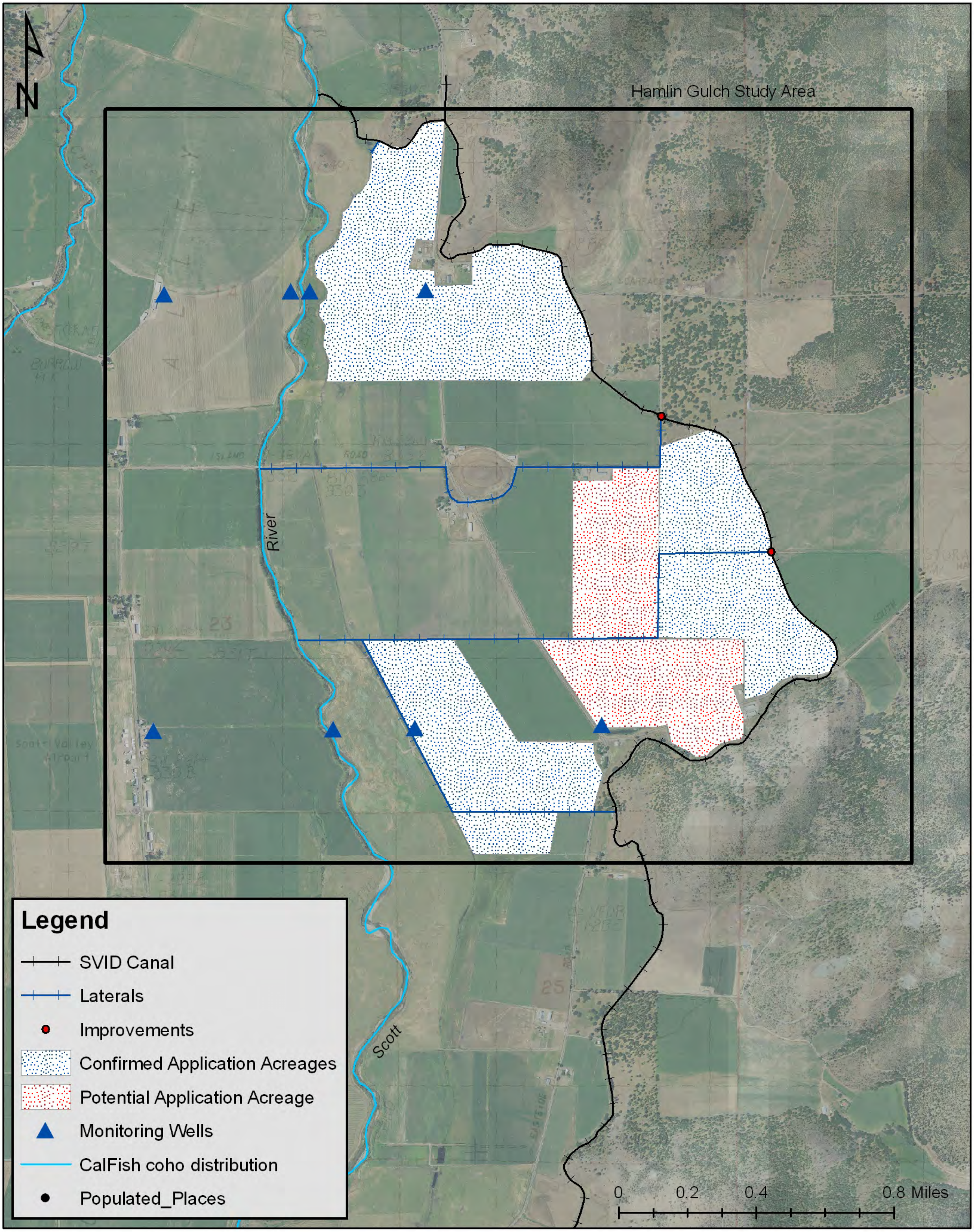

Quartz Valley Indian Reservation

February 26, 2019

To: North Coast Regional Partnership
P.O. Box 262
Healdsburg, CA 95448

From: Crystal Robinson, Environmental Director QVIR
Crystal.robinson@qvir-nsn.gov

Re: Scott Valley Manage Aquifer Recharge

To Whom It My Concern,

The Quartz Valley Indian Reservation supports California Trout's proposal to enhance groundwater conditions through managed aquifer recharge for the benefit of tribal resources and our agriculture economy. The Scott River Basin supports populations of Chinook salmon and steelhead trout, and a growing population of coho salmon. In order for salmonid populations to thrive, integrated land management and progressive restoration methods must be applied through a coordinated process based in partnership development.

As such, the Quartz Valley Indian Reservation believes that managed aquifer recharge can play a critical role in enhancing groundwater elevations to improve water quality throughout strategic areas of the Scott River Basin. This project could also be incorporated into future SGMA compliance and provide long-term benefits to salmonid populations.

Thank you for considering this proposal and for your interest in conserving tribal resources and the economic foundation of the Scott River Basin. If you have any questions, please feel free to contact me at the above information.

Sincerely,

Crystal Robinson

Crystal Robinson, Environmental Director
Quartz Valley Indian Reservation

Administration: 530-468-5907 Fax: 530-468-5908

13601 Quartz Valley Road, Fort Jones, CA 96032

COUNTY OF SISKIYOU

Flood Control and Water Conservation District

P.O. Box 750 :: 1312 Fairlane Rd
Yreka, California 96097
www.co.siskiyou.ca.us

(530) 842-8005
FAX (530) 842-8013
Toll Free: 1-888-854-2000, ext. 8005

March 05, 2019

North Coast Resource Partnership
P.O. Box 262
Healdsburg, CA, 95448

Subject: California Trout IRWM grant proposal in Scott Valley

To Whom It May Concern:

The Siskiyou County Flood Control and Water Conservation District (District), acting as the Groundwater Sustainability Agency for the Scott Valley Groundwater Basin, supports the California Trout (CalTrout) grant application submitted under the Integrated Regional Water Management (IRWM) North Coast Resource Partnership 2018/2019 grant program.

CalTrout, in collaboration with the Siskiyou Resource Conservation District (Siskiyou RCD) and the U.C. Davis Department of Land, Air, and Water Resources (UCD), approached Siskiyou County Natural Resources staff and the Scott Valley Groundwater Advisory Committee (Advisory Committee) to discuss their intent to apply for grant funding in order to implement a managed aquifer recharge project within the Scott Valley Irrigation District. This project will provide valuable information pertaining to understanding the beneficial effects of managed groundwater recharge; such as cost-effectiveness, monitoring the water applied on the ground and its impacts on the aquifer, analyzing effects on crop types, and evaluating potential fishery impacts. This analysis will provide valuable information to the District, Advisory Committee, and Larry Walker Associates/UC Davis, who is the District's technical consultants for the Sustainable Groundwater Management Act (SGMA).

The District supports local projects that can provide benefits to both agriculture and anadromous fish, and supports CalTrout's application for IRWM grant funding. The District looks forward to collaborating with CalTrout staff on this project for the benefit of sustainable groundwater management in the Scott Valley and meeting the requirements of SGMA. If you have any questions, please free to contact Matt Parker, Natural Resources Specialist at mparker@co.siskiyou.ca.us or 530-842-8019. This letter was approved by the Flood Control and Water Conservation District on March 5, 2019, by the following vote:

AYES:	Supervisors Haupt, Kobseff, Valenzuela, Nixon and Criss
NOES:	NONE
ABSENT:	NONE
ABSTAIN:	NONE

Sincerely,

Brandon A. Criss

Brandon Criss, Chair
Flood Control and Water Conservation District

Scott River Water Trust
P.O. Box 591 – Etna, CA 96027
530-643-2395 scottwatertrust@gmail.com

February 22, 2019

North Coast Regional Partnership
P.O. Box 262
Healdsburg, CA 95448

Re: Scott Valley Manage Aquifer Recharge

To Whom It My Concern,

The Scott River Water Trust supports California Trout's proposal to enhance groundwater conditions through managed aquifer recharge for the benefit of our local agriculture economy and fishery resource. The Scott River Basin supports stable populations of Chinook salmon and steelhead trout, and a growing population of coho salmon. In order for salmonid populations to thrive, integrated land management and progressive restoration methods must be applied through a coordinated process based in partnership development.

To this point, the Water Trust feels that managed aquifer recharge can play a critical role in enhancing groundwater elevations and improve water quality throughout strategic areas of the Scott River Basin. This project could also be incorporated into future SGMA development and would be a valuable management tool for landowners to achieve regional compliance.

Thank you for considering this proposal. If you have any questions, please feel free to contact directly at the email address posted above.

Sincerely,

Dave Krell

Dave Krell, Board Chair
Scott River Water Trust

March 14, 2019

North Coast Resource Partnership
P.O. Box 262
Healdsburg, CA 95448

Dear Selection Committee,

The North Coast Regional Water Quality Control Board (Regional Water Board) supports California Trout's (CalTrout) Scott Valley Managed Aquifer Recharge Project proposal to enhance instream flows through managed aquifer recharge for the benefit of water quality, fisheries, and a secure water supply. The Scott River is listed on the 303(d) list of impaired water bodies as a result of water quality impairments associated with excess sediment and elevated temperature conditions. As a result, the Regional Water Board developed Total Maximum Daily Loads (TMDL) for those pollutants and in 2006 adopted the Action Plan for the Scott River Sediment and Temperature TMDLs, which identifies the need to pursue groundwater studies to better understand the interaction of groundwater and surface waters. Since that time, the Regional Water Board has funded and supported the development of the Scott Valley Community Groundwater Study Plan and University of California at Davis' (UC Davis) Scott Valley Integrated Hydrologic Model. CalTrout's proposed project is an outcome of those efforts, and the Regional Water Board considers this project critical for TMDL implementation.

The Regional Water Board expects to continue supporting UC Davis' efforts to investigate groundwater-surface water interaction and conjunctive use in Scott Valley with a new contract this summer. The contract will fund the development of additional model scenarios. CalTrout's project will compliment this next phase of UC Davis' inquiry and provide data to further refine the model and assess the feasibility of conjunctive use strategies.

The Scott River Basin supports populations of Chinook salmon and steelhead trout, and a growing population of coho salmon. Actions to address habitat and water shortages through a coordinated stakeholder-driven flow enhancement effort such as this project are critical to ensure the survival of salmonid populations. The Regional Water Board believes that strategically-sited managed aquifer recharge areas can play a central role in enhancing groundwater dynamics to improve water quality the Scott River Basin. This project could also be incorporated into future Sustainable Groundwater Management Act compliance to provide long-term benefits to salmonid populations.

Thank you for considering this proposal and for your interest in conserving water quality and fisheries of the Scott River Basin. If you have any questions, please feel free to contact Bryan McFadin of my staff at 707-576-2751 or bryan.mcfadin@waterboards.ca.gov.

Sincerely,

Matthias St. John
Executive Officer

Scott Valley Irrigation District
B.O. Box 216 Fort Jones, CA 96032

March 8, 2019

North Coast Regional Partnership
P.O. Box 262
Healdsburg , CA 95448

Re: Scott Valley Irrigation District MAR Participation

To Whom It May Concern,

The Scott Valley Irrigation District (SVID) Board of Directors writes to notify you of our intent to participate in the Scott Valley Managed Aquifer Recharge that has been developed by California Trout and UC Davis.

Members of our board have worked in collaboration with UC Davis to pioneer recharge concepts that can be advanced throughout California, and past efforts within our district have shown great potential for significant groundwater recharge and instream benefit. Furthermore, we feel this project could be a future component of SGMA compliance within the basin.

Thank you for considering this proposal.

Sincerely,

Rich Harris
SVID Board Member

TEMPORARY PERMIT FOR DIVERSION AND USE OF WATER

APPLICATION T032564
TEMPORARY PERMIT 21364

Permittee:

Scott Valley Irrigation District
PO Box 216
Fort Jones, CA 96032

Summary Report

Prepared by:
Helen E. Dahlke, Assistant Professor
Dept. of Land, Air and Water Resources, UC Davis

Jim Morris, Director, Scott Valley Irrigation District

And contributions from
Preston Harris, Erich Yokel, Gary Black, Gus Tolley, Steve Orloff and Thomas Harter

Executive Summary

On January 13, 2016 the Scott Valley Irrigation District (SVID) received a temporary permit to appropriate surface water for groundwater recharge and later instream fish and wildlife habitat enhancement between River Mile (RM) 46.7 and RM 21 in the period January 1 to March 31, 2016. The original application proposed to divert up to 5,400 acre-feet (AF) for groundwater recharge on agricultural fields (about 1,400 acres) adjacent to the SVID ditch. Diversion of surface water for groundwater recharge started on February 4th and ceased on March 31, 2016. Based on streamflow estimates at the point of diversion (POD) at RM 46.7, a total of 680 AF were diverted for groundwater recharge while an almost equal amount (675 AF) was diverted for stockwater use. Surface water was recharged on 5 fields. A total of 8 groundwater wells were instrumented with pressure transducers on the east side of the Scott River to monitor changes in the groundwater surface elevation in response to the artificial recharge activities and natural recharge of precipitation. Based on these measurements a clear response and rise of the groundwater table by 4.5 ft could be detected in the near vicinity of the recharge site in response to the artificial recharge indicating that on-farm recharge resulted in a clear and measurable increase in groundwater storage and possibly additional groundwater contribution to streamflow. Overall the amount of surface water recharged was too small to create a *measurable* increase in streamflow at the Fort Jones stream gauge. However, since October 1, 2015 the Scott Valley also received a total of 23.75 inches of precipitation which had a much larger effect on groundwater storage than the small field-scale recharge events as indicated by the monitoring data. Surface water-groundwater modeling of the past winter indicates that 42 cfs would have to be diverted for 3 months to see a significant enhancement (7.5 cfs) of summer streamflow, which creates a clear target for future replication of these activities. Overall, the study can be considered a successful implementation of artificial recharge on agricultural land for groundwater storage and streamflow enhancement with significant amounts of water recharged and considerable landowner support for adoption of these practices.

In addition to the hydrometric measurements and modeling performed a field trial was set up on a 15-acre, 10-year alfalfa stand to estimate the effect of different winter irrigation amounts on alfalfa forage crops. Winter off-season irrigation treatments ranged from 1.6 (low), 4.1 (high) to 11.1 ft of water (continuous) per acre in addition to winter precipitation. Overall, the alfalfa yield in the three treatment areas showed no discernible difference in yield in response to the winter irrigation. Interestingly, checks receiving the largest amount of winter water showed a higher yield than the control plots during the 1st and 2nd cutting indicating that winter recharge might lead to increased crop water availability in the deep soil profile offsetting potential irrigation deficits during the growing season. These results suggest that alfalfa is a promising crop for ag-recharge if grown on suitable, well-draining soils.

Table of Contents

1 Diversion and streamflow measurements 6

2 Groundwater recharge and storage 10

3 Streamflow enhancement modeling 23

4 Flooding tolerance of alfalfa 27

4.1 Experimental Setup 27

4.2 Results 28

4.3 Major findings – Crop study 32

5 References 32

Figures

Figure 1: Daily average discharge (cfs) at USGS stream gauge near Fort Jones (USGS 11519500) (a) and at the SVID point of diversion (POD) (b). The orange dotted line in (a) indicates the minimum flow requirement of 426 cfs specified in the Scott River Decree. 6
Figure 2: Calculated and measured discharge (cfs) at SVID point of diversion – 2/1 – 4/3/2016. 7
Figure 3: Daily accumulated volume (acre feet) - SVID point of diversion. 8
Figure 4: Discharge (cfs) at USGS Station (11519500) Scott River near Fort Jones – Data retrieved at http://waterdata.usgs.gov/ca/nwis/uv/?site_no=11519500&PARAmeter_cd=00065,00060 on 5/18/2016. 8
Figure 5: Locations of groundwater and surface water elevation monitoring. POD is the point of diversion, CIMIS 225 is the location of the California Irrigation Management Information System station where meteorological parameters were measured, BL, HA and HR locations are points where water surface elevation was monitored. 12
Figure 6: Location of field receiving surface water for groundwater recharge. Note the experimental site instrumented by UC Davis is not shown on this map (see Figure 33). 12
Figure 7: Calculated and measured water surface elevation – HA2. 13
Figure 8: Water temperature – HA2. 13
Figure 9: Calculated and measured water surface elevation – BL1 15
Figure 10: Water temperature – HA2. 15
Figure 11: Calculated and measured water surface elevation –BL3 16
Figure 12: Water temperature – HA2. 16
Figure 13: Calculated and measured water surface elevation – BL4. 17
Figure 14: Water temperature – HA2. 17
Figure 15: Calculated and measured water surface elevation – BL5 18
Figure 16: Water temperature – HA2. 18
Figure 17: Calculated and measured water surface elevation – EH Pond. 19
Figure 18: Water temperature – HA2. 20
Figure 19: Calculated and measured water surface elevation – HA3. 20
Figure 20: Water temperature – HA2. 21
Figure 21: Calculated and measured water surface elevation – HR1. 21
Figure 22: Water temperature – HA2. 22
Figure 23: Calculated and measured water surface elevation – HR2. 22
Figure 24: Water temperature – HA2. 23
Figure 25: Recharge locations and recharge rates from on-farm flooding assumed in the SVIHM model. 24
Figure 26: Modelled vs. observed groundwater elevation at location BL1 for Jan. 1 – May 1, 2016 (left) and the 2016 calendar year. 25

Figure 27: Modelled vs. observed groundwater elevation at location BL3 for Jan. 1 – May 1, 2016 (left) and the 2016 calendar year. 25
Figure 28: Modelled vs. observed groundwater elevation at location EH_pond for Jan. 1 – May 1, 2016 (left) and the 2016 calendar year. 26
Figure 29: Modelled vs. observed groundwater elevation at locations HA1 and HA2 for Jan. 1 – May 1, 2016 (left) and the 2016 calendar year. 26
Figure 30: Modelled vs. observed groundwater elevation at location HA3 for Jan. 1 – May 1, 2016 (left) and the 2016 calendar year. 26
Figure 31: Modelled vs. observed groundwater elevation at location JM1 for Jan. 1 – May 1, 2016 (left) and the 2016 calendar year. 27
Figure 32: Comparison of simulated streamflow at USGS Fort Jones stream gauge between the base scenario (black line) and the recharge scenario (blue line) (left) and flow difference for the 2016 calendar year (right). 27
Figure 33: 15-acre field with 10-year alfalfa stand. Three different water application rates were tested: continued, high, low and no water (control) application. Numbers indicate individual checks. 28
Figure 34: Amount of water diverted for winter recharge (cfs), change in groundwater level below surface (ft) and rainfall (in) measured in winter 2014/15 and 2015/16. 29
Figure 35: Alfalfa yield for 1st (orange, end of May), 2nd cutting (blue, mid-July), and 3rd cutting (green, end of August) vs. average applied winter water (ft) for 2015 and 2016. 30
Figure 36: Winter flood irrigation on the second field on Bryant-Morris ranch. Flow from the valve was estimated at 0.3 cfs. 32

Tables

Table 1: Periodic discharge (cfs) measurements performed at the SVID POD for 2016 Groundwater Recharge. 7
Table 2: Daily average discharge (cfs) and daily volume (acre feet) at SVID point of diversion. Daily discharge and daily volume diverted for recharge (column 4 and 5). 9
Table 3: List of recharge sites and time periods during which surface water was applied for groundwater recharge. 10
Table 4: Coordinates of HA2 and SVID Canal water surface elevation. 12
Table 5: Coordinates of BL1 – BL5 and SVID Canal & Scott River water surface elevation. 14
Table 6: Coordinates of HA3 and EH Pond. 19
Table 7: Total applied winter water (ft) for groundwater recharge for winters of 2014/15 and 2015/16. 29
Table 8: Harvest data for second alfalfa field on Bryant-Morris ranch. Forage was harvested on June 1, 2016. 31

1 Diversion and streamflow measurements

The temporary permit for groundwater recharge was issues by the State Water Resources Control Board (SWRCB) to the Scott Valley Irrigation District (SVID) on January 13, 2016. Shortly after the permit was issued SVID volunteer staff started instrumenting groundwater wells and the SVID point of diversion with hydrologic sensors to measure flow rate at the point of diversion and changes in the depth to the groundwater table near fields that woul d receive water for groundwater recharge. Diversion of surface water for groundwater recharge began on February 4, 2016 and ended on March 31, 2016. Recharge was extended until April 22, 2016 on the research field described below.

Based on precipitation data from the Western Regional Climate Center (Fort Jones Ranger Station, COOP ID 043182, Elev. 2730 ft a.s.l.) the Scott Valley received a total of 23.75 inches of precipitation in water year (WY) 2015/16. Of that, 5.07 inches fell between February 1 and March 31, 2016. The total annual average precipitation in WY 2015/16 was slightly above the long-term average of 19.5 inches (1935-2012). In response to the large precipitation events, the flow in the Scott River stayed consistently high (above the 1,000 cfs mark) between January and April in 2016. At no time during this 2-months groundwater recharge period did the streamflow at USGS stream gauge in Fort Jones drop below the USFS minimum flow requirement specified in the Scott River Decree (Fig. 1a).

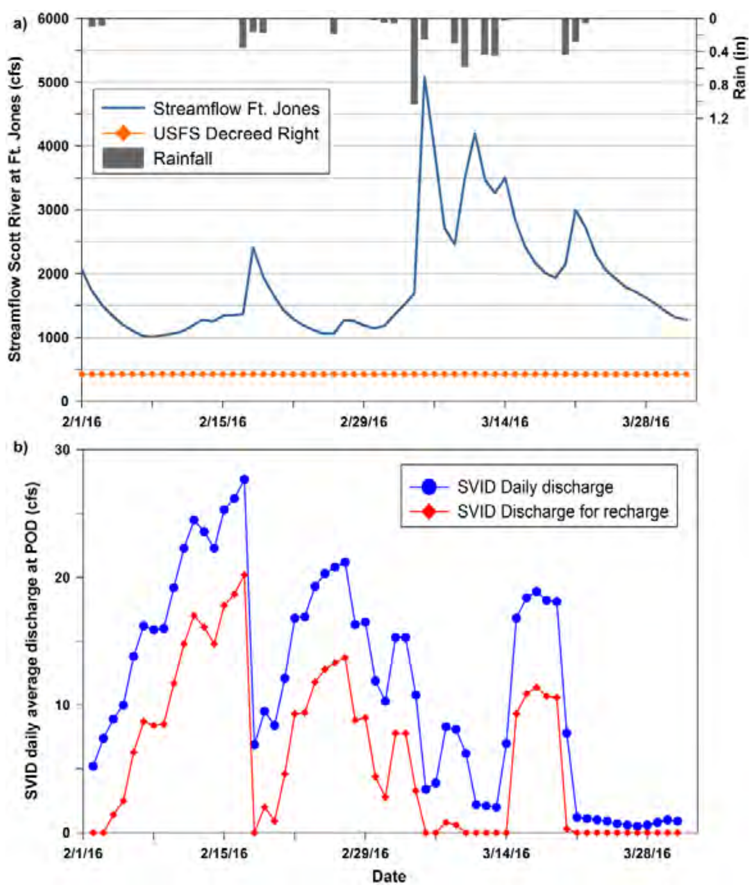

Figure 1: Daily average discharge (cfs) at USGS stream gauge near Fort Jones (USGS 11519500) (a) and at the SVID point of diversion (POD) (b). The orange dotted line in (a) indicates the minimum flow requirement of 426 cfs specified in the Scott River Decree.

The discharge measured at the SVID POD during the diversion period for groundwater recharge is shown in Figure 2. Stage measurements (ft) were converted to volume measurements through a stage-discharge relationship. To establish the stage-discharge relationship eight discharge (cfs) measurements were taken with a flow meter at different flow rates as indicated by the blue dots in Figure 2. Table 1 summarized the dates, time and observed discharge measured with the flow meter at SVID POD.

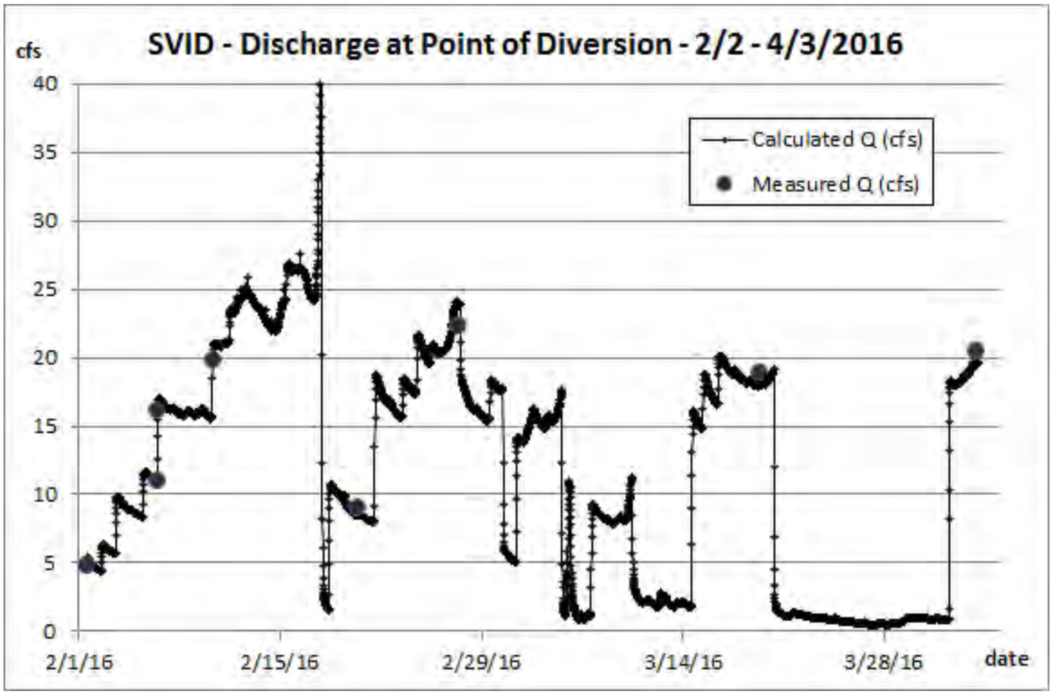

Figure 2: Calculated and measured discharge (cfs) at SVID point of diversion – 2/1 – 4/3/2016.

Table 1: Periodic discharge (cfs) measurements performed at the SVID POD for 2016 Groundwater Recharge.

Date	Time (PST)	Discharge (cfs)
2/1/2016	14:00	4.8
2/6/2016	11:30	11.0
2/6/2016	13:30	16.1
2/10/2016	10:00	19.9
2/20/2016	10:00	9.1
2/27/2016	10:00	22.3
3/19/2016	9:15	18.8
4/3/2016	10:45	20.4

Between February 1 and April 1, 2016 a total of 1355 AF of surface water were diverted at SVID POD from the Scott River. This total includes the amount of water diverted under the existing SVID stockwater right as well as the water diverted for groundwater recharge under this permit

(Figure 3). Surface water demand for livestock approximates about 7.5 cfs. Thus, this amount was subtracted from the observed SVID POD discharge on days when discharge was greater than 7.5 cfs (Table 2). On days when SVID POD discharge was less than 7.5 cfs it was assumed that the SVID discharge was entirely used for livestock. Based on this assumption a total of 680 AF was diverted for groundwater recharge. This number is likely underestimated as water demand for livestock is varying on a day-to-day basis based on temperature and needs.

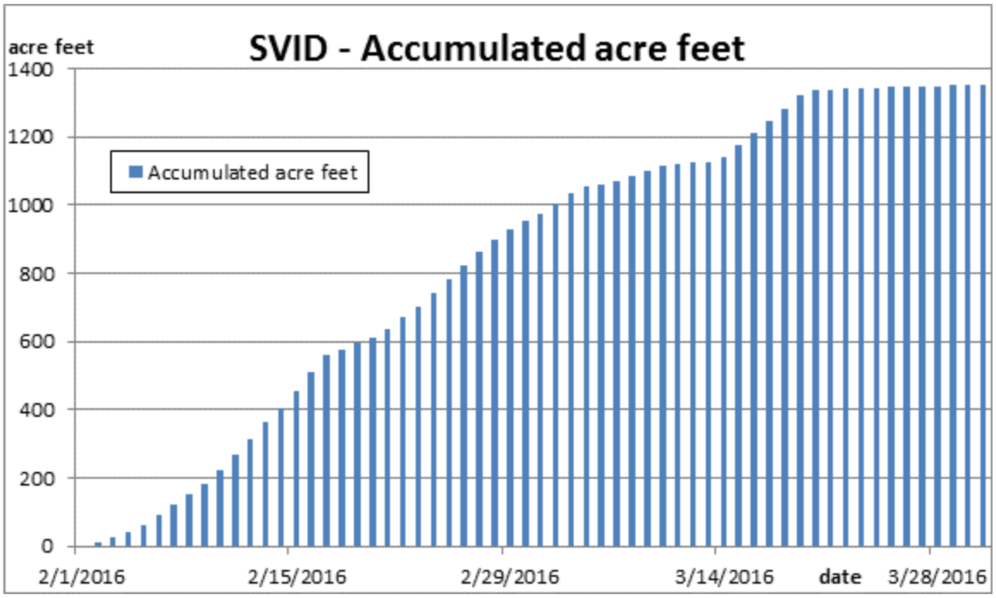

Figure 3: Daily accumulated volume (acre feet) - SVID point of diversion.

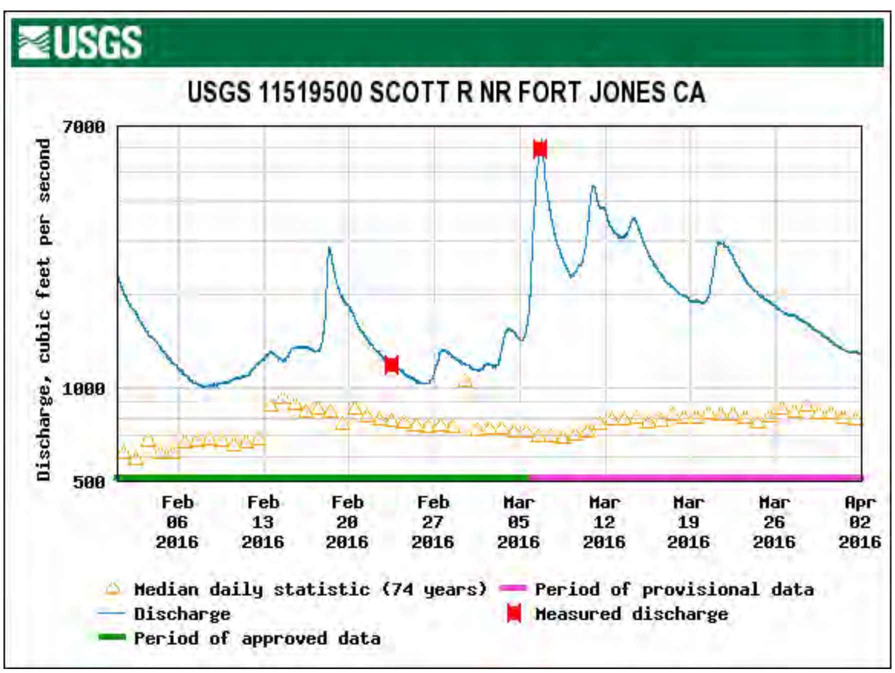

Figure 4: Discharge (cfs) at USGS Station (11519500) Scott River near Fort Jones – Data retrieved at http://waterdata.usgs.gov/ca/nwis/uv/?site_no=11519500&PARAmeter_cd=00065,00060 on 5/18/2016.

Table 2: Daily average discharge (cfs) and daily volume (acre feet) at SVID point of diversion. Daily discharge and daily volume diverted for recharge (column 4 and 5).

	Discharge measured at POD (cfs)	Daily volume diverted at POD (AF)	RECHARGE (cfs) (If Q > 7.5 cfs, flow was used for recharge)	Recharge volume (AF)
2/2/2016	5.2	10.3	0	0.0
2/3/2016	7.4	14.7	0	0.0
2/4/2016	8.9	17.6	1.4	2.8
2/5/2016	10	19.8	2.5	5.0
2/6/2016	13.8	27.3	6.3	12.5
2/7/2016	16.2	32.1	8.7	17.2
2/8/2016	15.9	31.5	8.4	16.6
2/9/2016	16	31.7	8.5	16.8
2/10/2016	19.2	38.0	11.7	23.2
2/11/2016	22.3	44.2	14.8	29.3
2/12/2016	24.5	48.6	17	33.7
2/13/2016	23.6	46.8	16.1	31.9
2/14/2016	22.3	44.2	14.8	29.3
2/15/2016	25.3	50.1	17.8	35.3
2/16/2016	26.2	51.9	18.7	37.1
2/17/2016	27.7	54.9	20.2	40.0
2/18/2016	6.9	13.7	0	0.0
2/19/2016	9.5	18.8	2	4.0
2/20/2016	8.4	16.6	0.9	1.8
2/21/2016	12.1	24.0	4.6	9.1
2/22/2016	16.8	33.3	9.3	18.4
2/23/2016	16.9	33.5	9.4	18.6
2/24/2016	19.3	38.2	11.8	23.4
2/25/2016	20.3	40.2	12.8	25.4
2/26/2016	20.8	41.2	13.3	26.4
2/27/2016	21.2	42.0	13.7	27.1
2/28/2016	16.3	32.3	8.8	17.4
2/29/2016	16.5	32.7	9	17.8
3/1/2016	11.9	23.6	4.4	8.7
3/2/2016	10.3	20.4	2.8	5.5
3/3/2016	15.3	30.3	7.8	15.5
3/4/2016	15.3	30.3	7.8	15.5
3/5/2016	10.8	21.4	3.3	6.5
3/6/2016	3.4	6.7	0	0.0
3/7/2016	3.9	7.7	0	0.0
3/8/2016	8.3	16.4	0.8	1.6
3/9/2016	8.1	16.1	0.6	1.2
3/10/2016	6.2	12.3	0	0.0
3/11/2016	2.2	4.4	0	0.0
3/12/2016	2.1	4.2	0	0.0
3/13/2016	2	4.0	0	0.0
3/14/2016	7	13.9	0	0.0
3/15/2016	16.8	33.3	9.3	18.4
3/16/2016	18.4	36.5	10.9	21.6
3/17/2016	18.9	37.5	11.4	22.6
3/18/2016	18.2	36.1	10.7	21.2
3/19/2016	18.1	35.9	10.6	21.0
3/20/2016	7.8	15.5	0.3	0.6
3/21/2016	1.2	2.4	0	0.0
3/22/2016	1.1	2.2	0	0.0
3/23/2016	1	2.0	0	0.0
3/24/2016	0.9	1.8	0	0.0
3/25/2016	0.7	1.4	0	0.0
3/26/2016	0.6	1.2	0	0.0
3/27/2016	0.5	1.0	0	0.0
3/28/2016	0.6	1.2	0	0.0
3/29/2016	0.8	1.6	0	0.0
3/30/2016	1	2.0	0	0.0
3/31/2016	0.9	1.8	0	0.0
Total Acre Feet		**1355.1**		**680.1**

2 Groundwater recharge and storage

Groundwater and surface water elevations were documented using water level loggers during the period of February – April 2016 in selected locations within the Scott Valley Irrigation District (SVID). Nine sites were monitored of which 8 were groundwater wells (Fig. 5).
Seven of the monitored sites' elevations were documented using a RTK GNSS survey system with a post correction from NGS – OPUS to NAVD 88 computed using GEIOD 12B. Two of the sites elevations were calculated using the previous documented elevation (HR1 & HR2).
Water level loggers (Onset U20 and U20L) were placed in the monitored sites. Manual measurements of depth to water from the surveyed reference point were performed. Calculations of the water surface elevation were performed using the continuous data, manual data and surveyed reference point elevation. Water temperature was documented.

Water was diverted onto 5 fields: JM1, JM2, BL3, HR2, and HA3 (Fig. 5). In addition, a small fraction (0.5 cfs) was turned out from SVID ditch into one of the laterals in Hamlin Gulch. The following table is summarizing the time periods for which water was applied onto each site.

Table 3: List of recharge sites and time periods during which surface water was applied for groundwater recharge.

Site	Time period
JM1	2/4/ – 4/1/2016
JM2	2/4/ – 4/1/2016
BL3	2/23 – 2/28 and 3/9 – 3/16/2016
HR2	3/2 – 4/1/2016
HA3	3/12 – 3/22/2016

Most water surface elevations showed an increase in elevation in response to the large precipitation events in mid-February and early March. In some cases, water surface elevations increased by several feet over the winter and spring season. The large influx of surface water into the Scott Valley groundwater aquifer system was also supported by the groundwater temperature data, which in all cases showed a decrease in temperature in response to the influx of colder surface water.

With exception to the Bryant-Morris ranch, where the groundwater surface elevation response could be monitored directly on site, it was not possible to quantify the rise in groundwater surface elevation related to groundwater recharge vs. natural recharge from precipitation. This is in part due to the fact that most monitoring wells were either located at larger distance or upgradient from the research sites, or the monitoring well was located in an area that received a large influx of surface water from tributaries (gulches) along the east side of the valley. Considering that the winter of 2015/16 had above average precipitation, we conclude that the amount of surface water applied for groundwater recharge was too small to be discernible from natural recharge. For future work, we hope to increase the amount, spreading area and duration of surface water applications for groundwater recharge to maximize the benefits for instream flows.

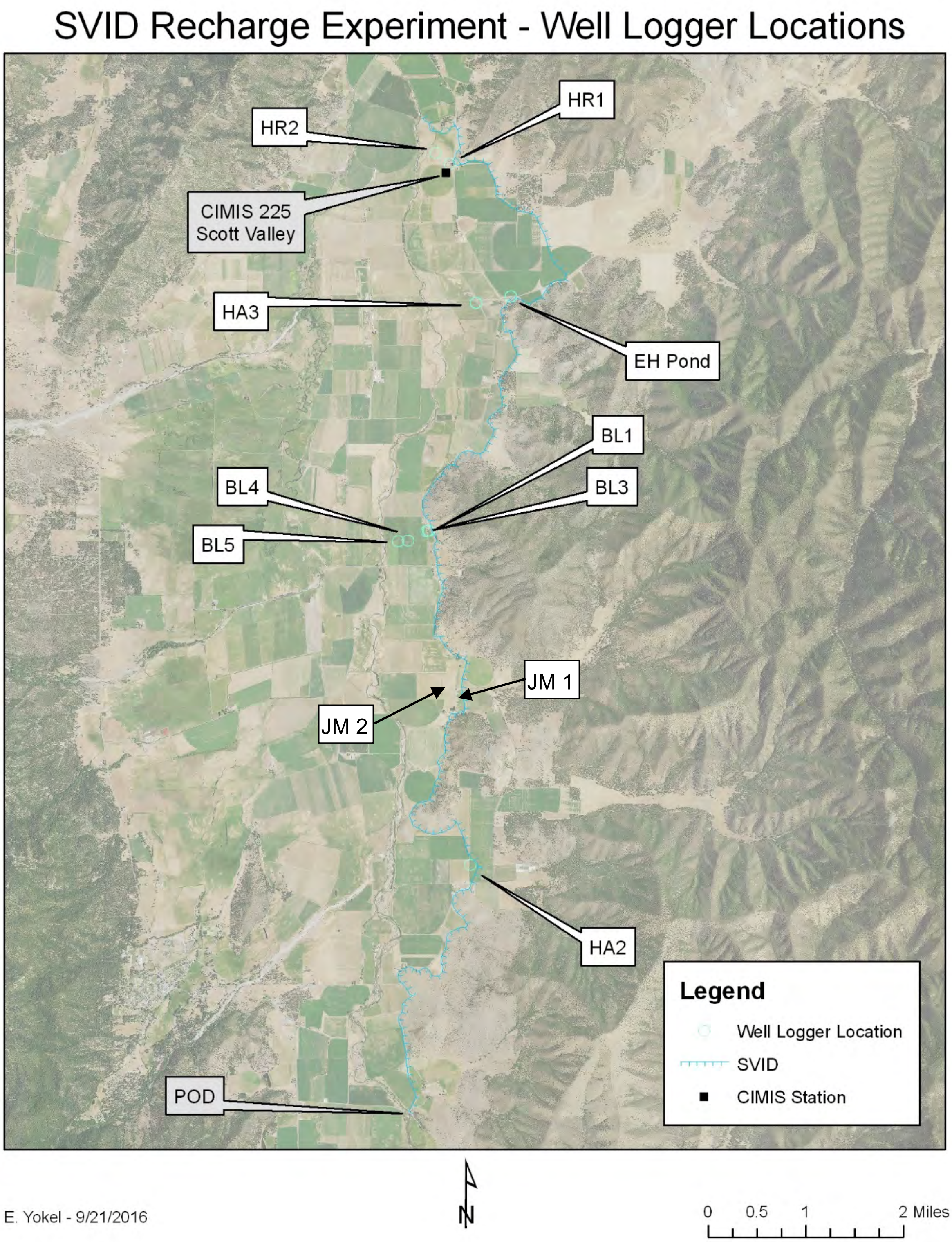

Figure 5: Locations of groundwater and surface water elevation monitoring. POD is the point of diversion, CIMIS 225 is the location of the California Irrigation Management Information System station where meteorological parameters were measured, BL, HA and HR locations are points where water surface elevation was monitored.

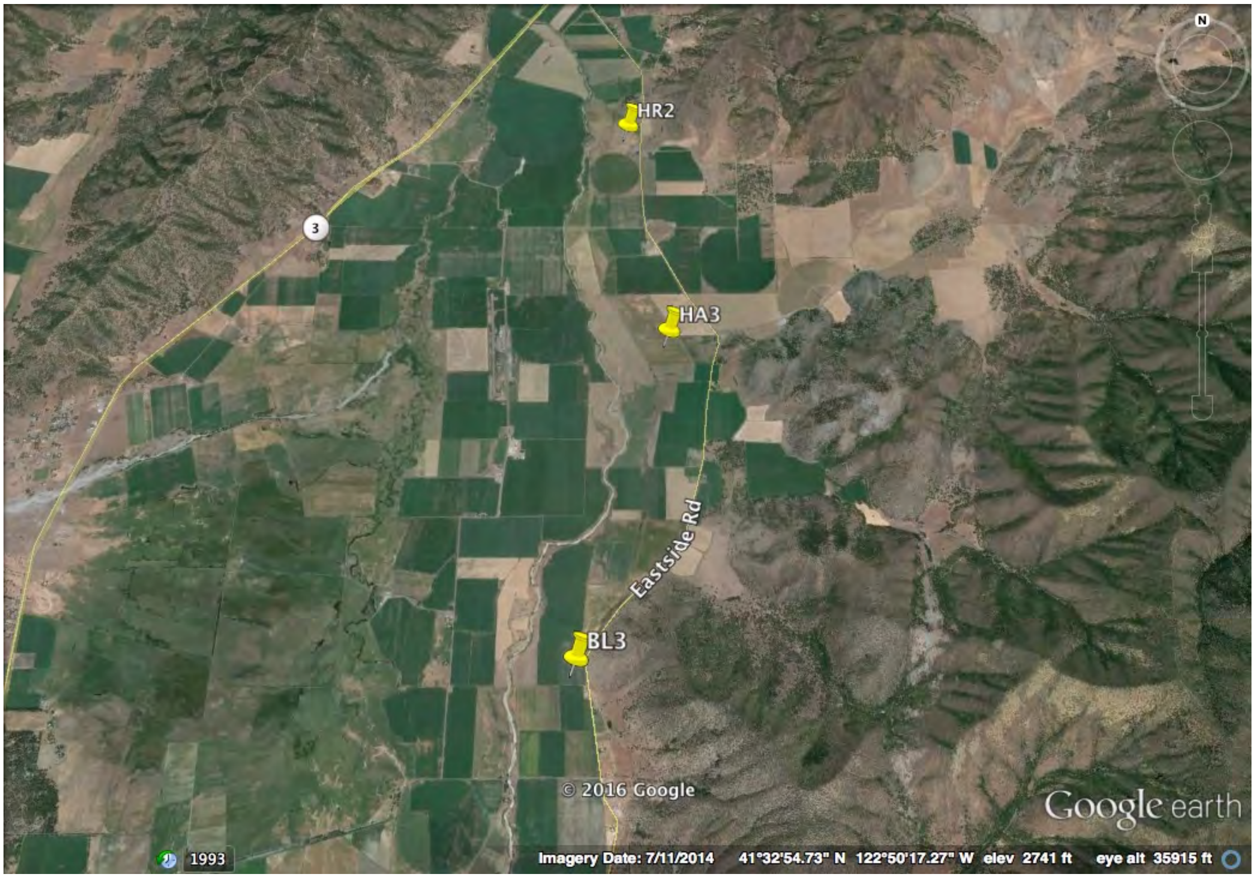

Figure 6: Location of field receiving surface water for groundwater recharge. Note the experimental site instrumented by UC Davis is not shown on this map (see Figure 33).

Table 4: Coordinates of HA2 and SVID Canal water surface elevation.

Site	Feature	Northing (m)	Easting (m)	Elevation (ft)
SVID	**WSE**	**4591484.0**	**514044.5**	**2787.96**

Site	Feature	Northing (m)	Easting (m)	Elevation (ft)
HA2	**GP**	**4591515.6**	**513884.7**	**2784.07**
	RP	**4591515.6**	**513884.5**	**2785.81**

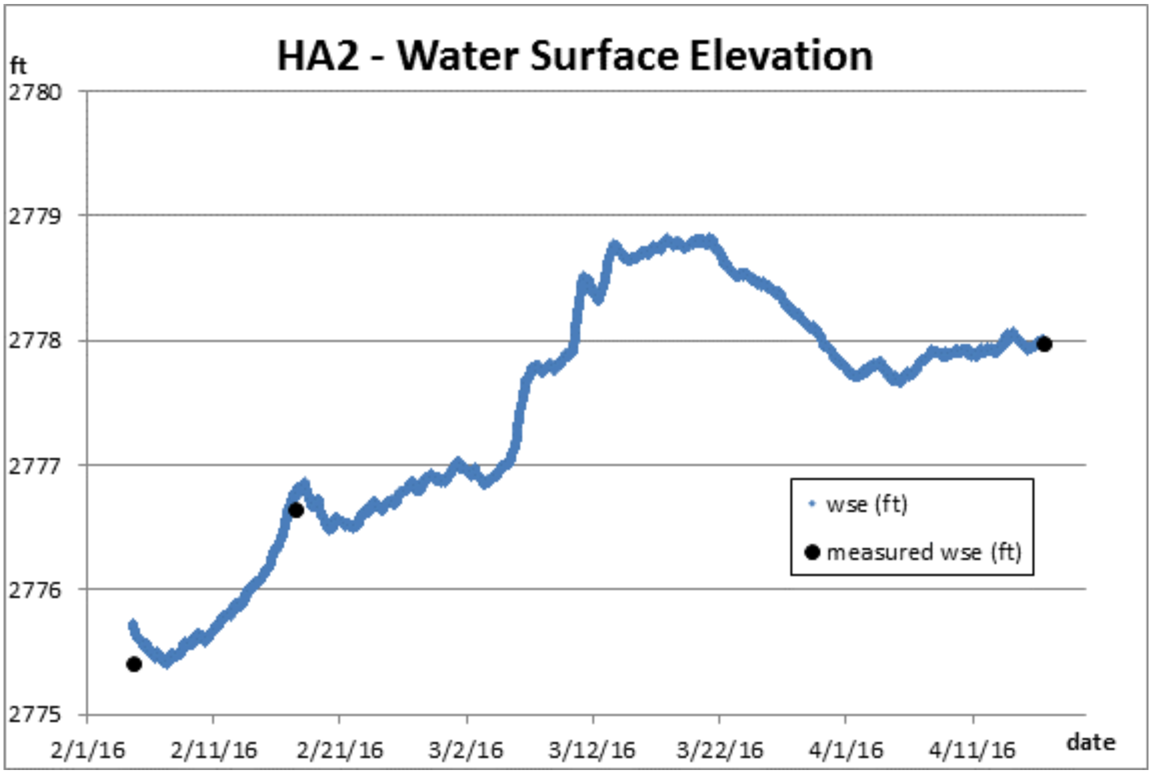

Figure 7: Calculated and measured water surface elevation – HA2.

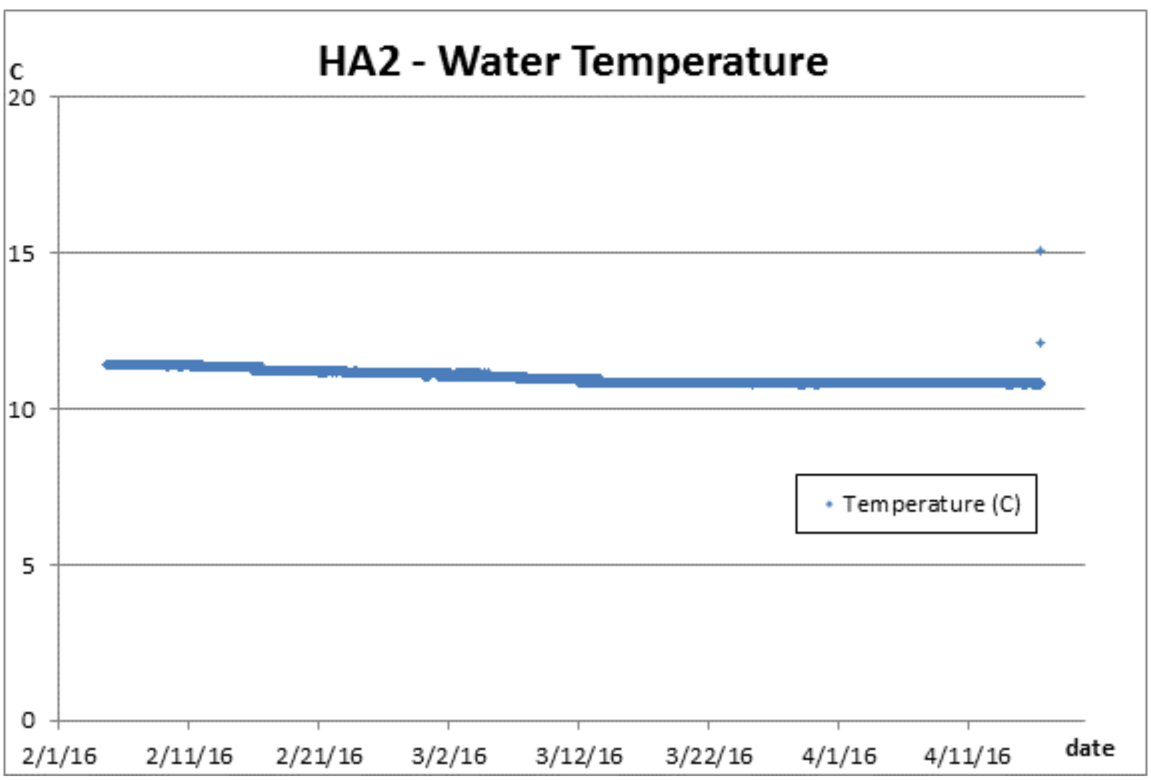

Figure 8: Water temperature – HA2.

Table 5: Coordinates of BL1 – BL5 and SVID Canal & Scott River water surface elevation.

Site	Feature	Northing (m)	Easting (m)	Elevation (ft)
SVID	WSE	4597022.6	513282.6	2775.70

Site	Feature	Northing (m)	Easting (m)	Elevation (ft)
BL1	GP	4597012.8	513206.0	2757.14
	RP	4597014.4	513206.5	2759.72

Site	Feature	Northing (m)	Easting (m)	Elevation (ft)
BL2	GP	4597008.7	513192.8	2755.38
	RP	4597007.9	513192.8	2757.13

Site	Feature	Northing (m)	Easting (m)	Elevation (ft)
BL3	GP	4597002.5	513165.5	2749.68
	RP	4596999.1	513163.6	2746.23

Site	Feature	Northing (m)	Easting (m)	Elevation (ft)
BL4	GP	4596843.9	512854.6	2743.64
	RP	4596843.9	512854.7	2744.12

Site	Feature	Northing (m)	Easting (m)	Elevation (ft)
BL5	GP	4596841.3	512695.5	2745.28
	RP	4596841.4	512695.7	2745.59

Site	Feature	Northing (m)	Easting (m)	Elevation (ft)
Scott R	WSE	4596839.6	512475.2	2735.28

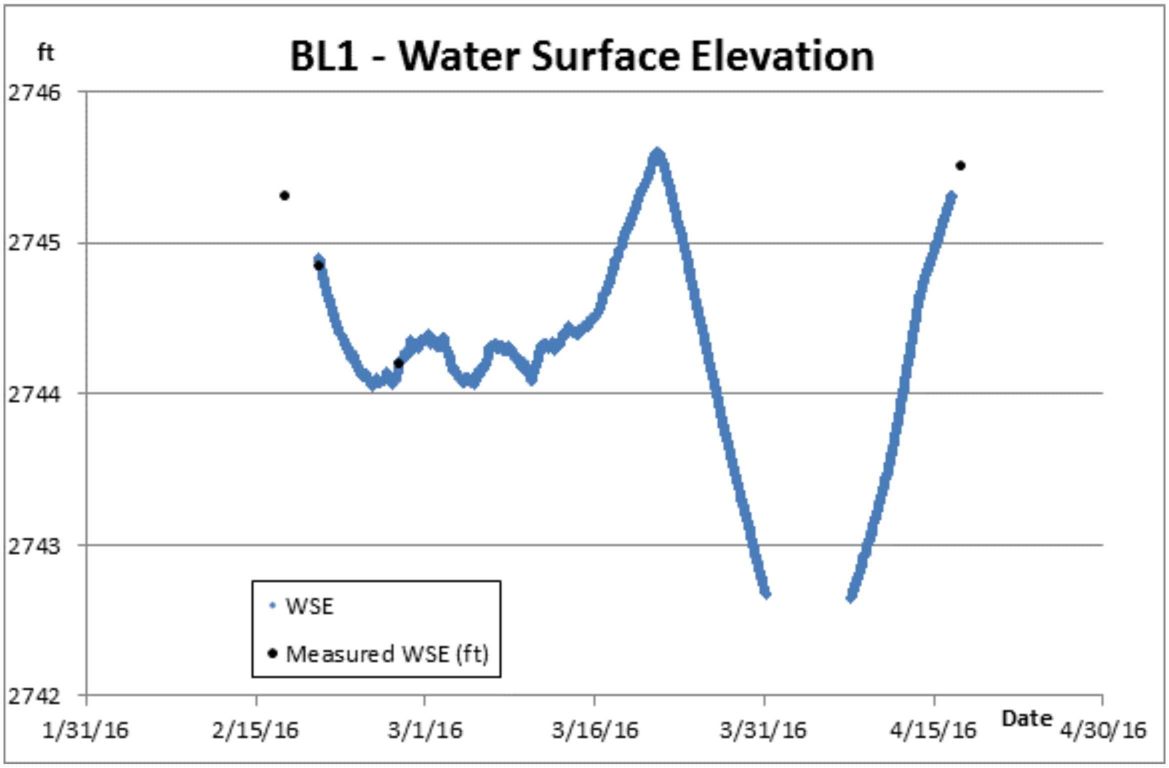

Figure 9: Calculated and measured water surface elevation – BL1.

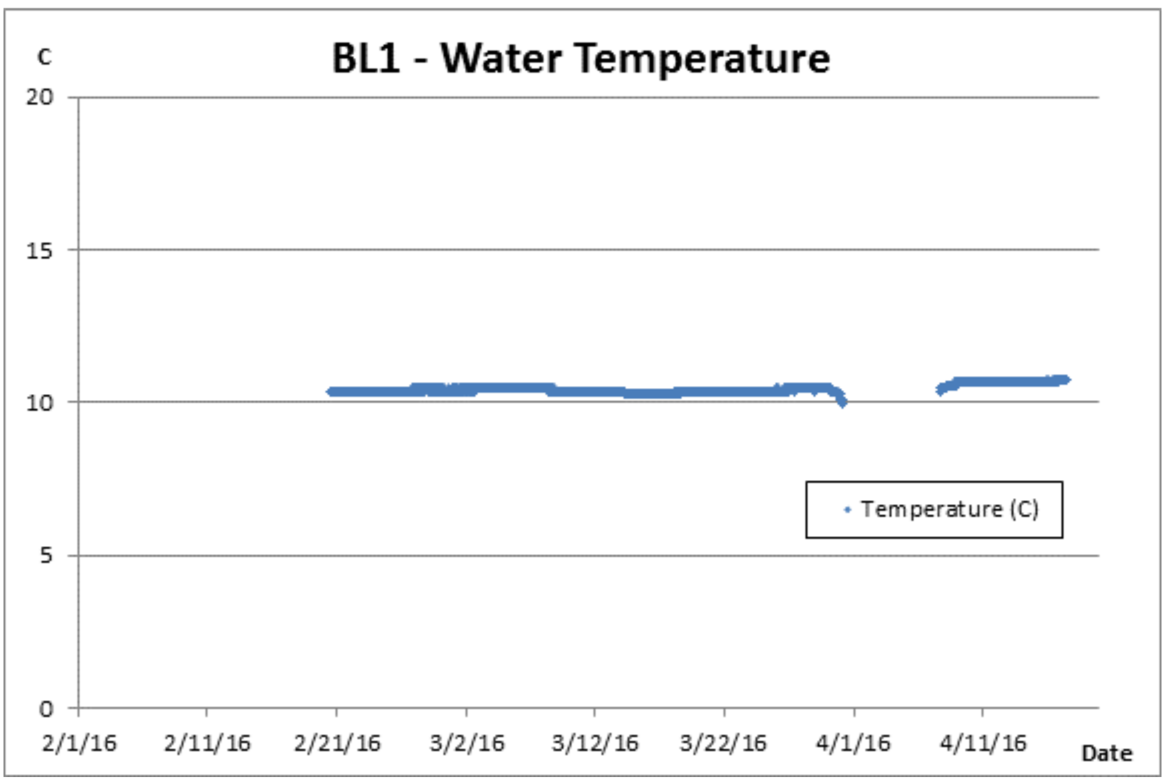

Figure 10: Water temperature – HA2.

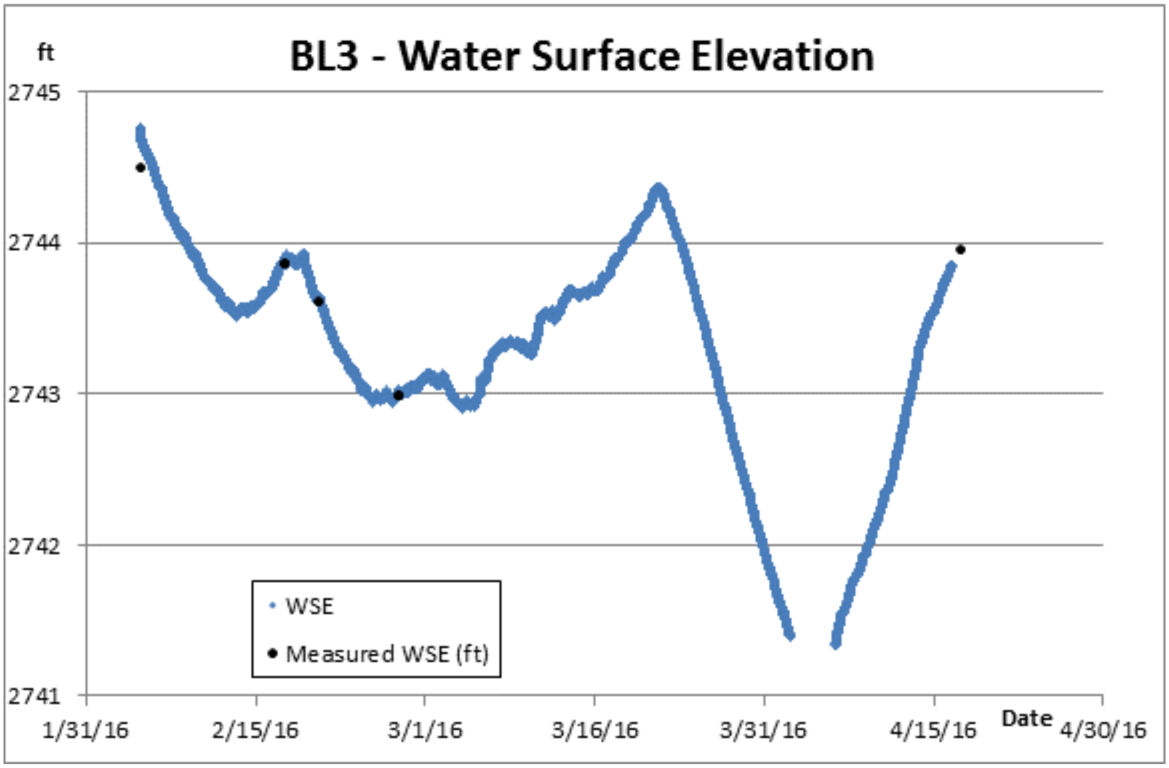

Figure 11: Calculated and measured water surface elevation –BL3.

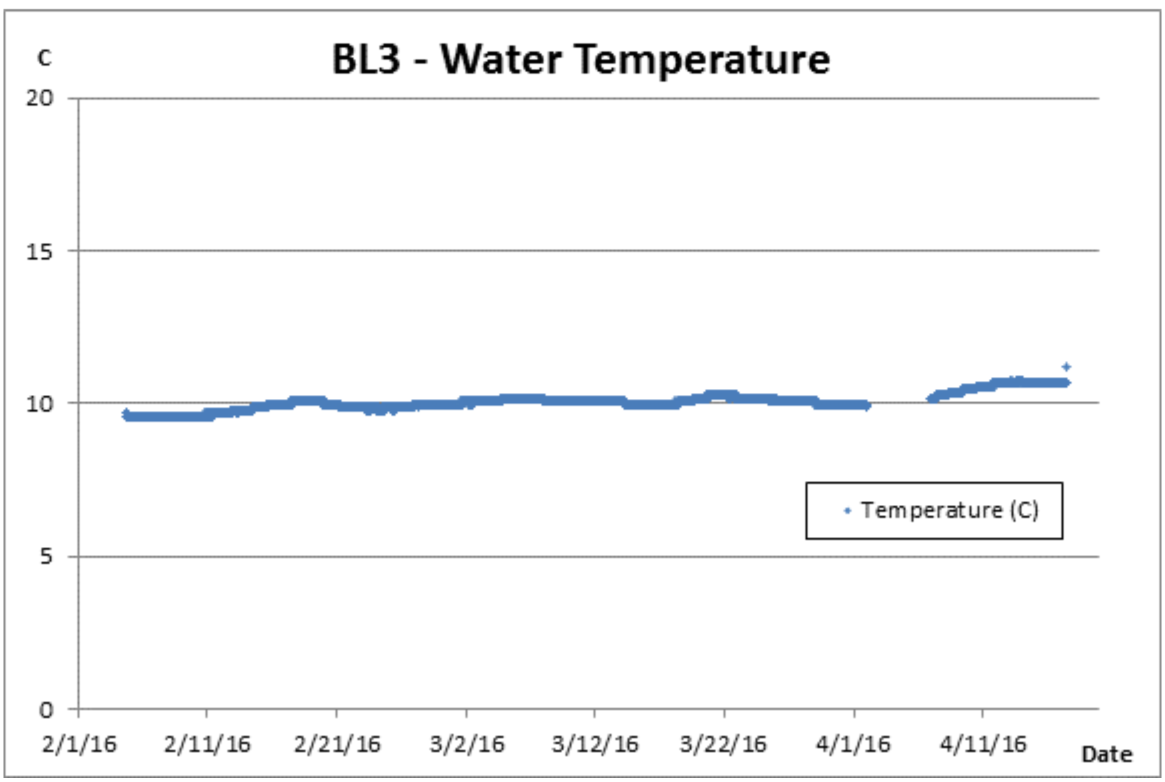

Figure 12: Water temperature – HA2.

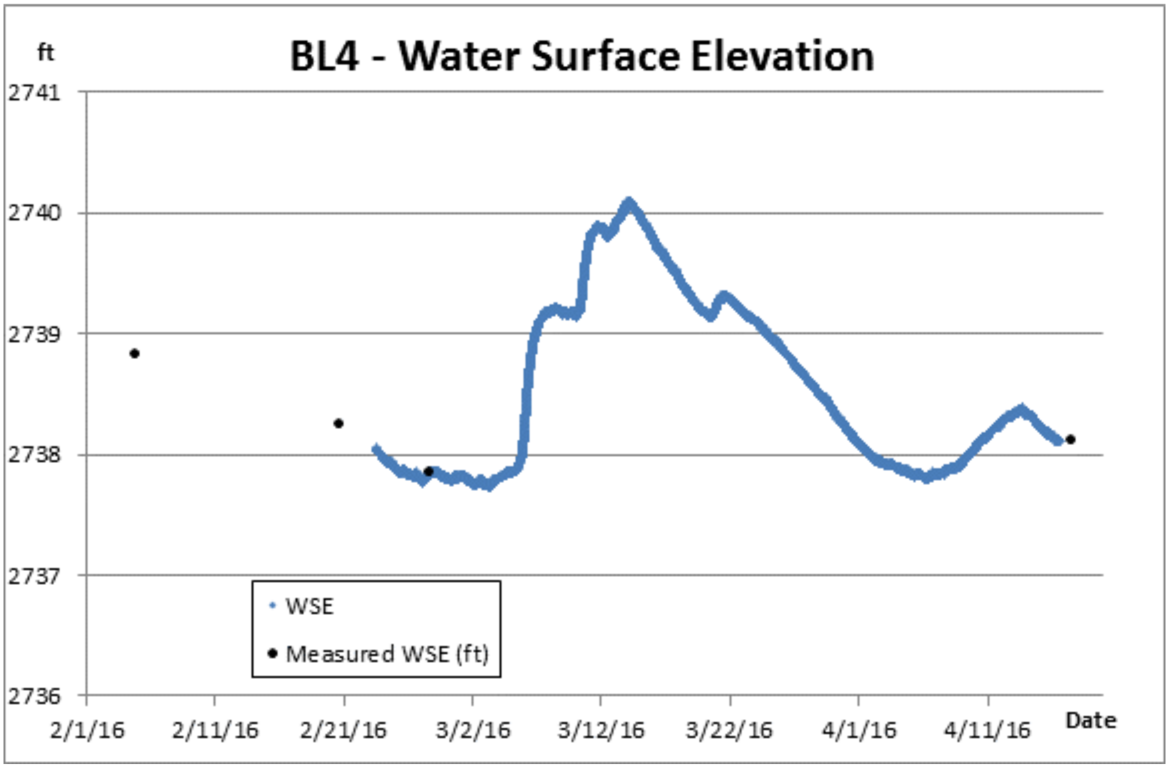

Figure 13: Calculated and measured water surface elevation – BL4.

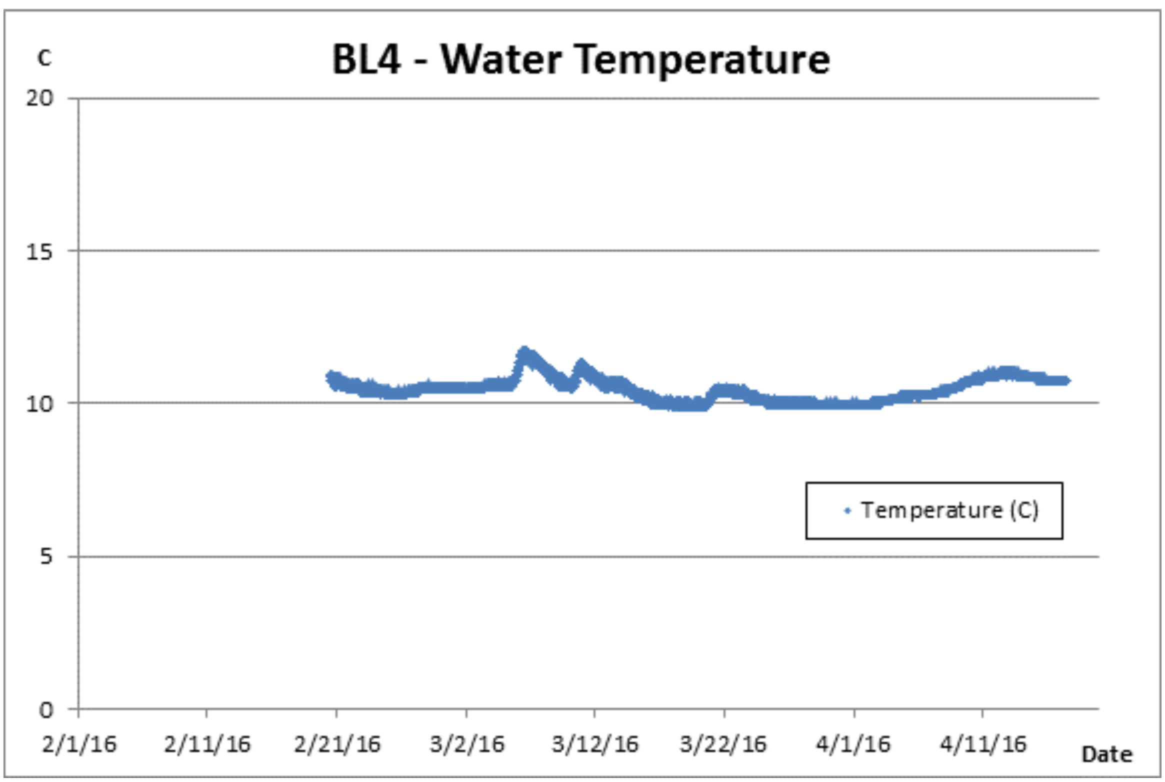

Figure 14: Water temperature – HA2.

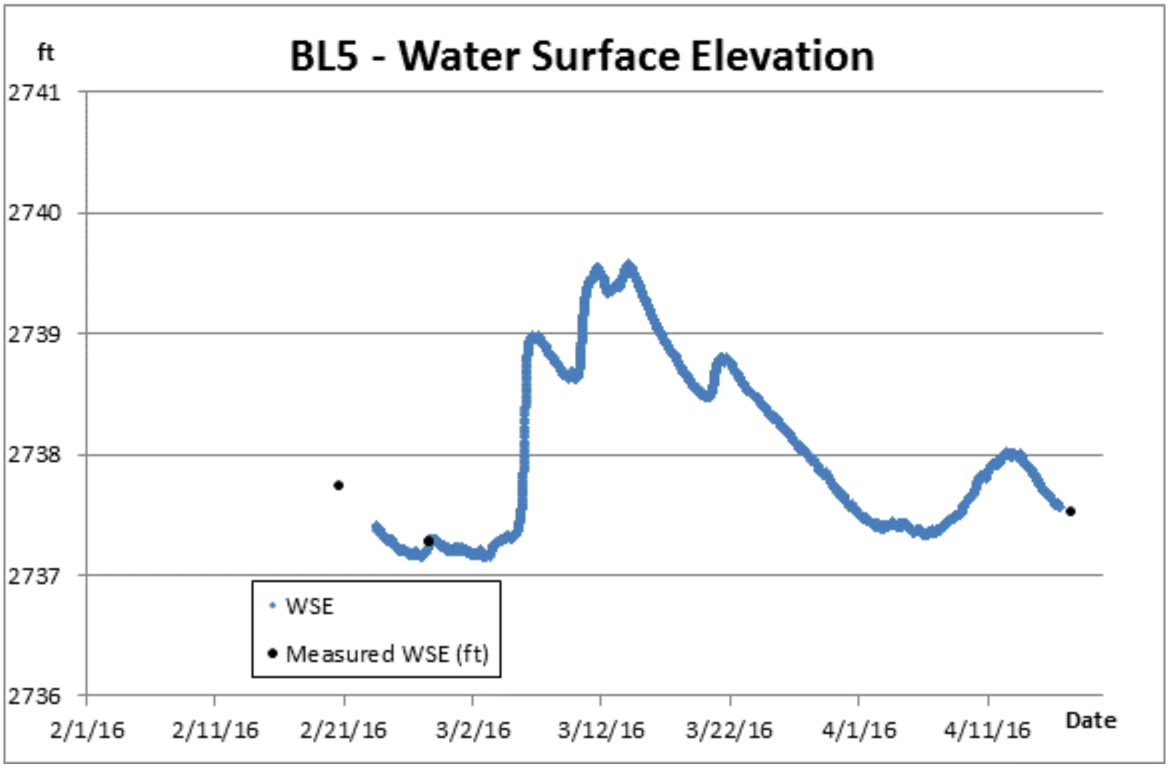

Figure 15: Calculated and measured water surface elevation – BL5.

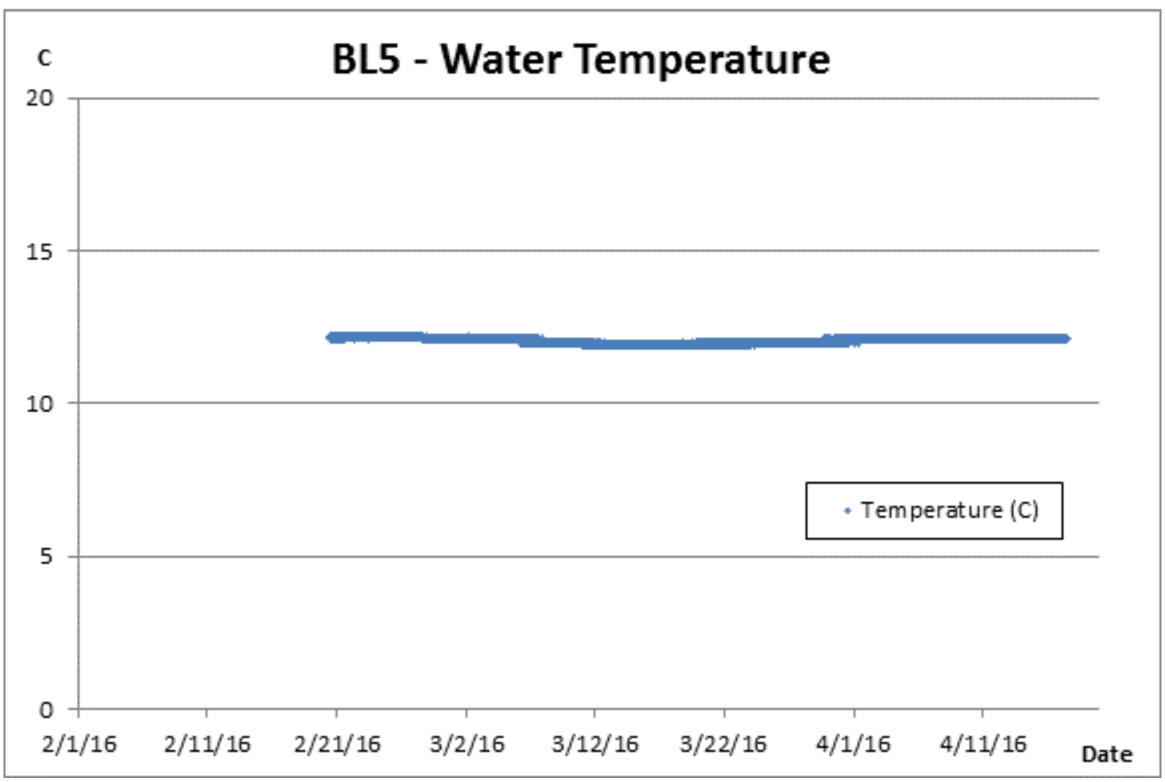

Figure 16: Water temperature – HA2.

Table 6: Coordinates of HA3 and EH Pond.

Site	Feature	Northing (m)	Easting (m)	Elevation (ft)
HA3	**GP**	**4600760.3**	**513983.4**	**2732.88**
	RP	**4600756.0**	**513983.3**	**2735.76**

Site	Feature	Northing (m)	Easting (m)	Elevation (ft)
EH Pond	**GP**	**4600875.9**	**514553.4**	**2746.96**
	RP	**4600867.1**	**514555.2**	**2746.47**

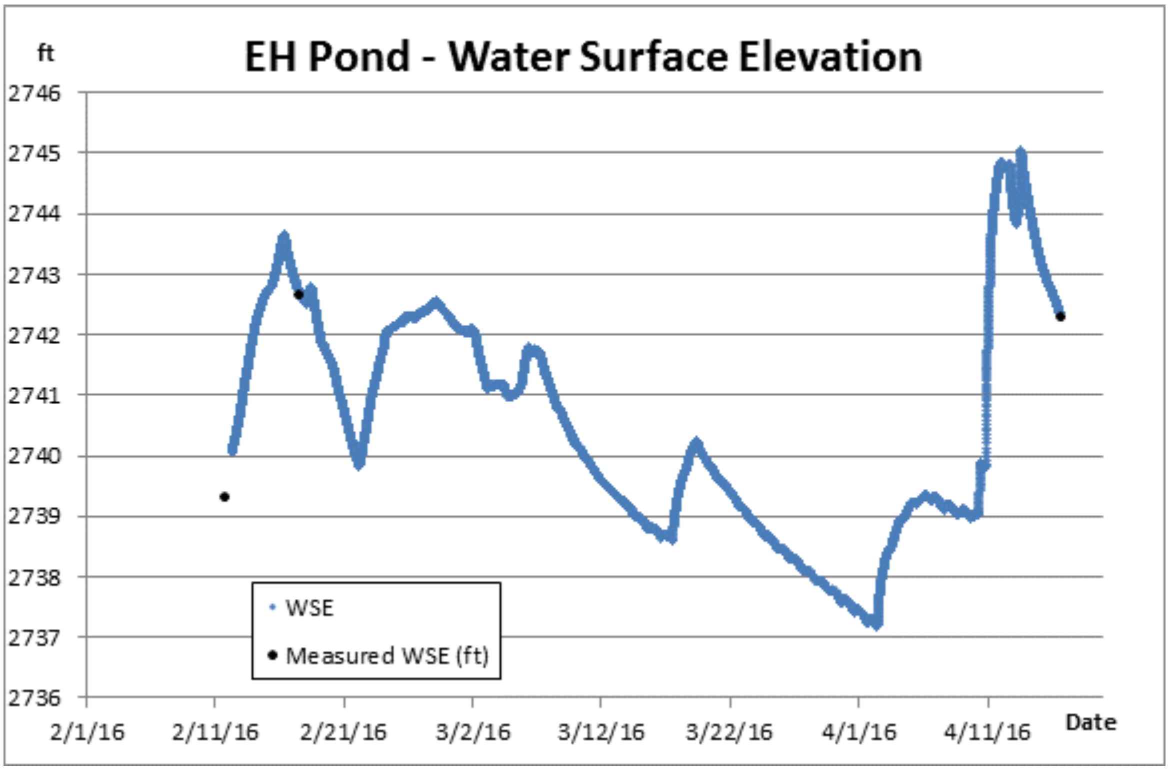

Figure 17: Calculated and measured water surface elevation – EH Pond.

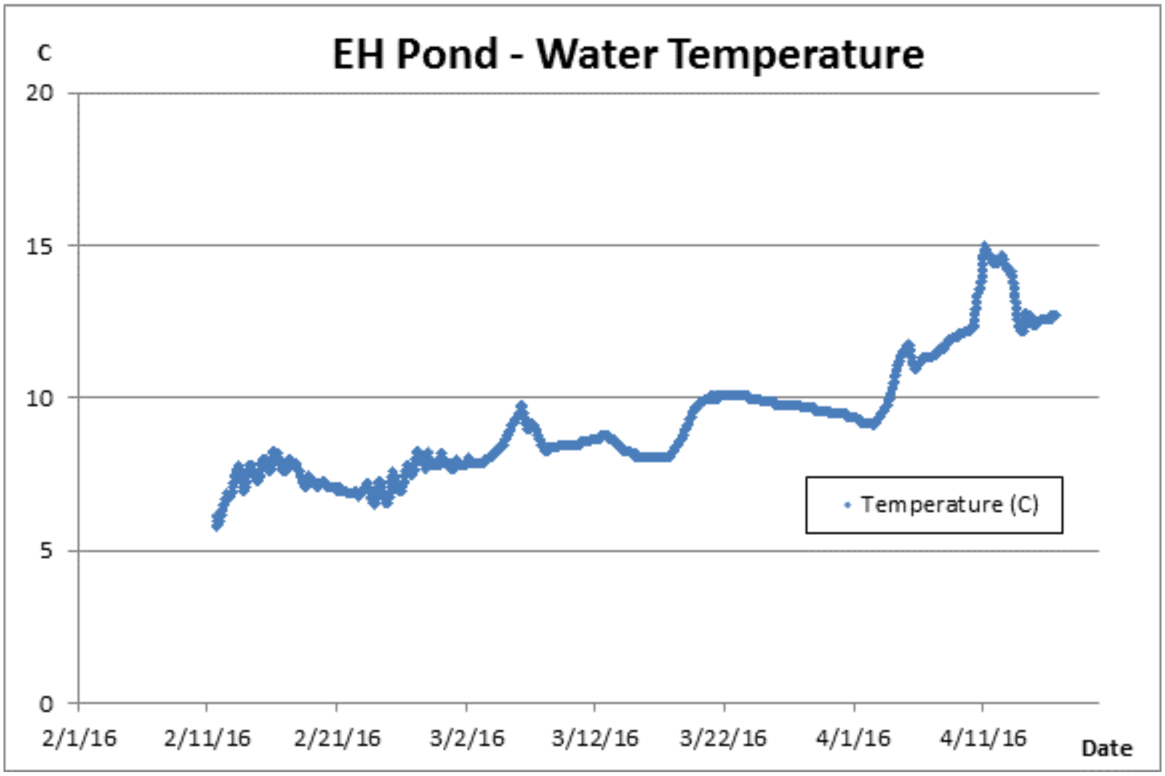

Figure 18: Water temperature – HA2.

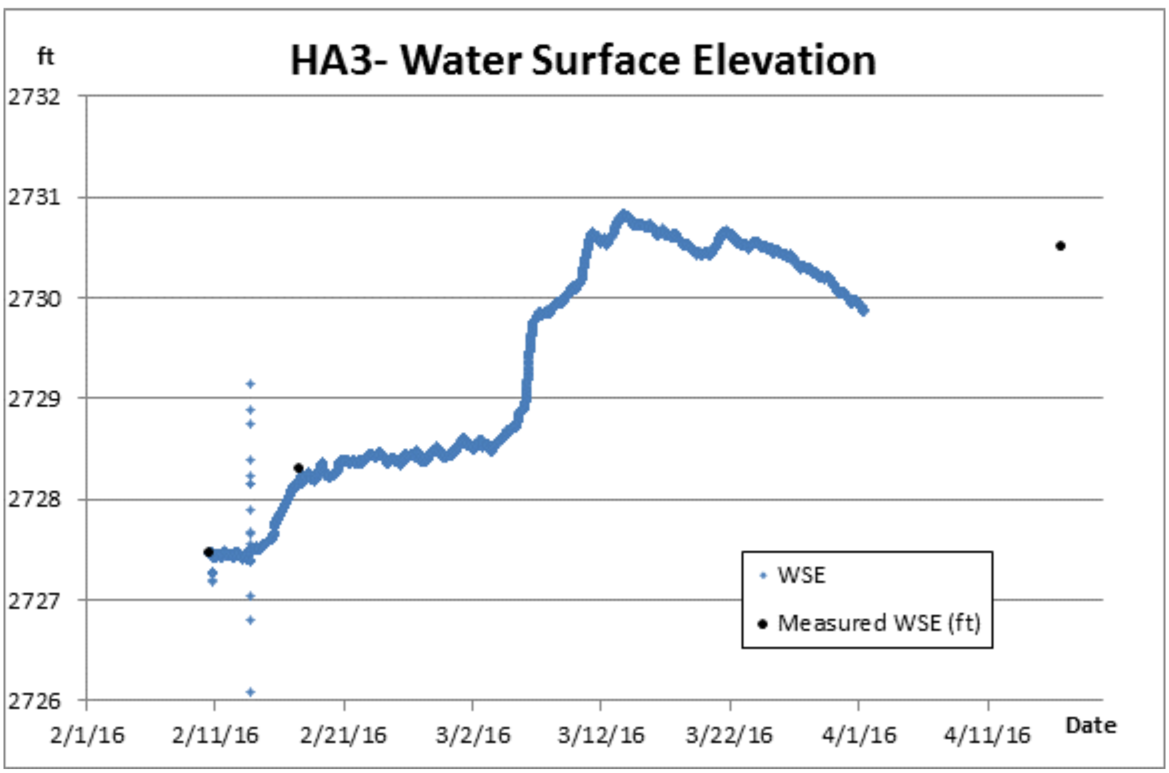

Figure 19: Calculated and measured water surface elevation – HA3.

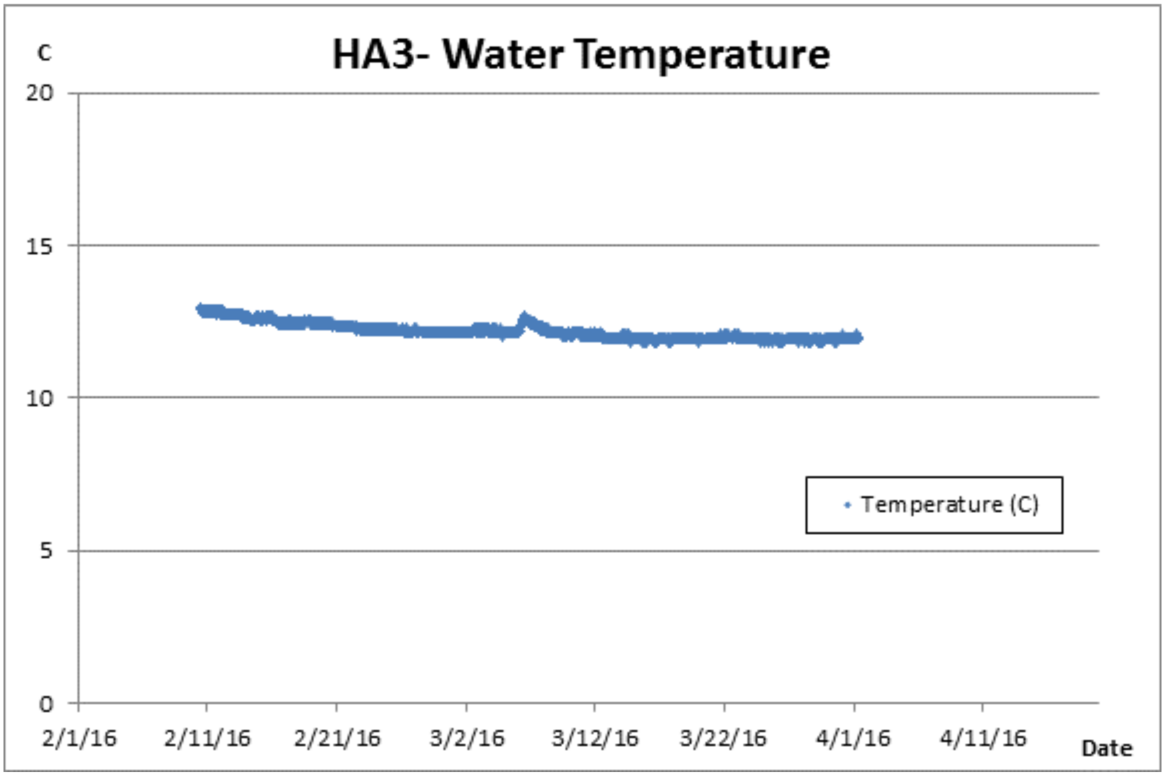

Figure 20: Water temperature – HA2.

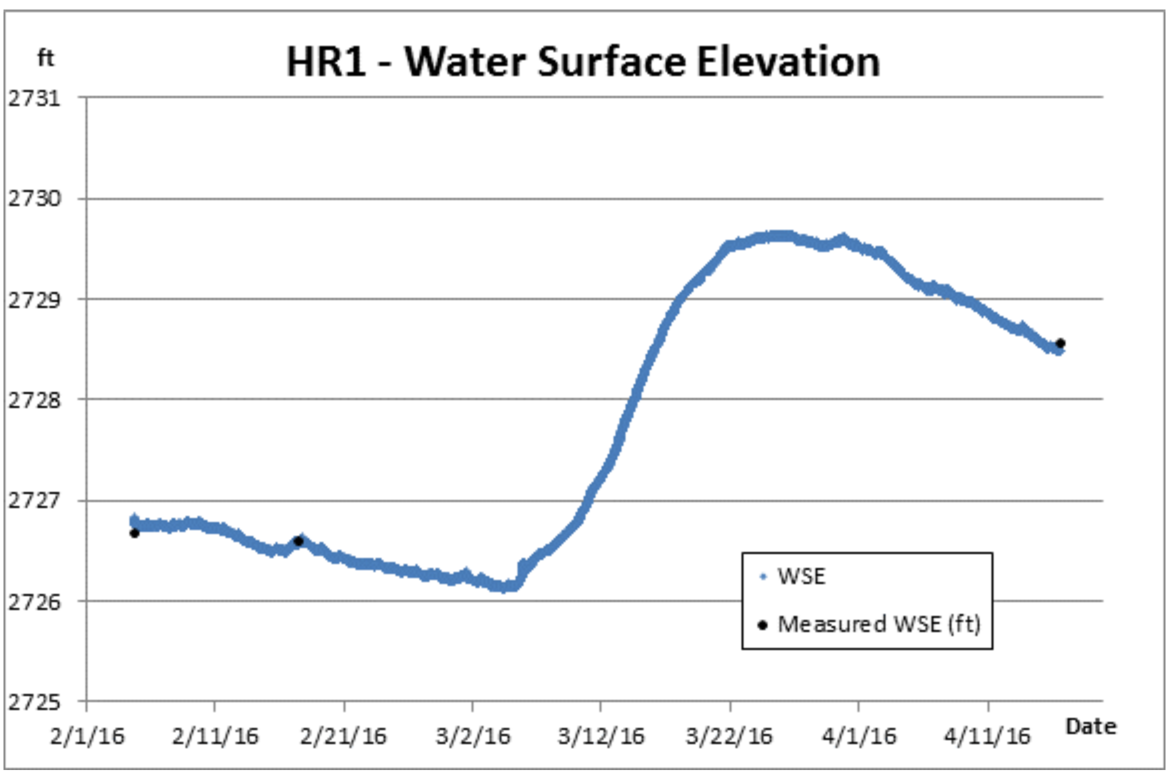

Figure 21: Calculated and measured water surface elevation – HR1.

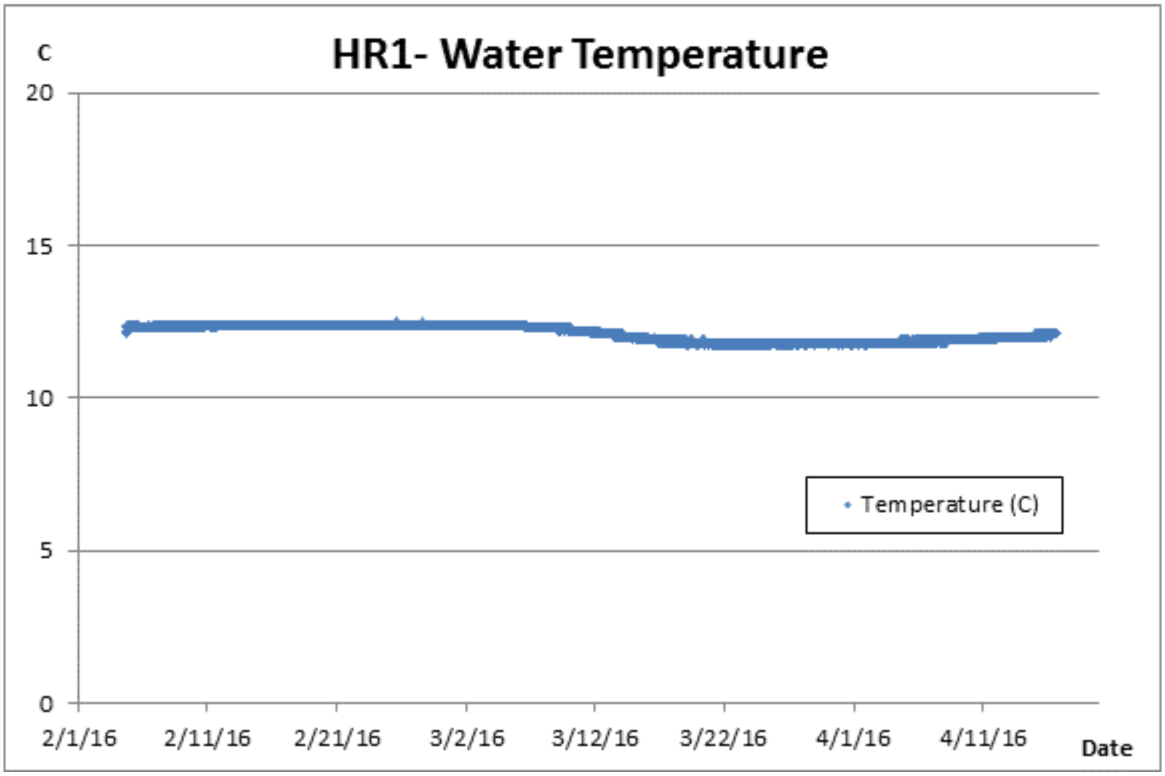

Figure 22: Water temperature – HA2.

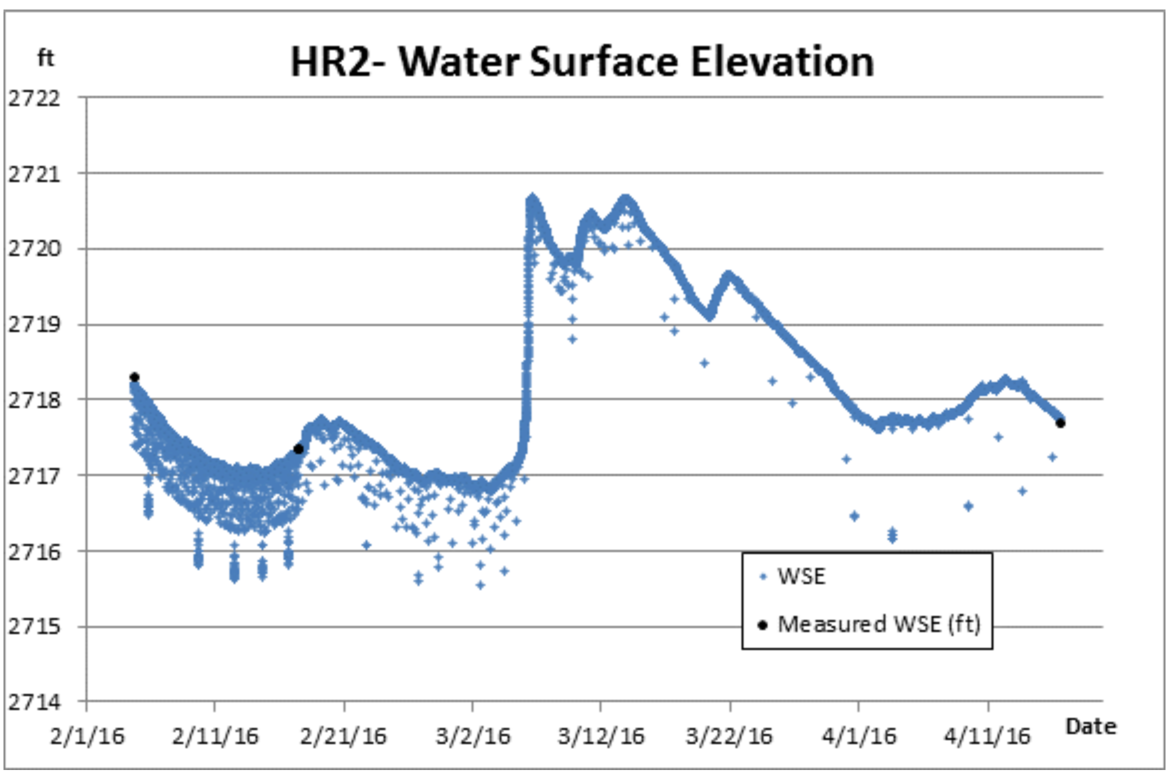

Figure 23: Calculated and measured water surface elevation – HR2.

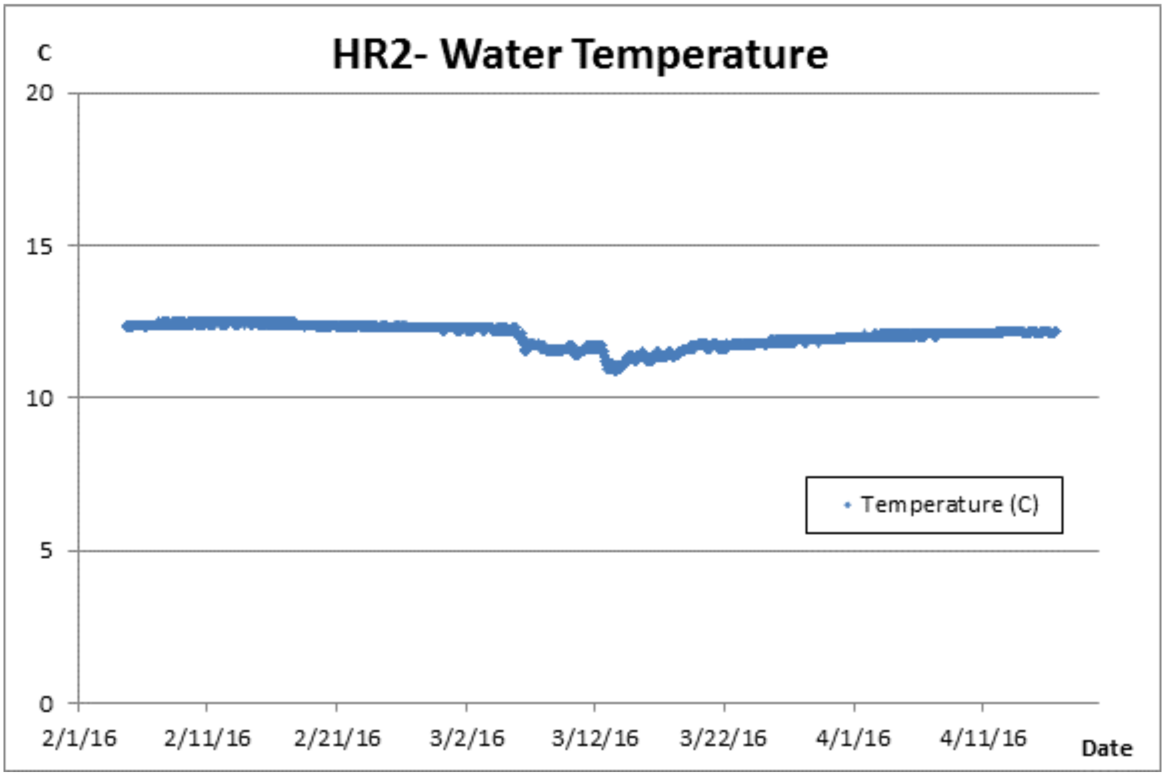

Figure 24: Water temperature – HA2.

3 Streamflow enhancement modeling

The Scott Valley Integrated Hydrologic Model (SVIHM), consisting of a soil-water budget model coupled uni-directionally with a MODFLOW-based groundwater-surface-water model was used to estimate the effect of the on-farm recharge conducted between February and April 2016 on streamflow in the Scott River. For the modeling two different scenarios were compared: 1) recharge scenario in which the total measured amount of surface water (1355 AF) was diverted from the Scott River at the point of diversion and recharged over 55 days, and 2) base scenario in which the model was run without recharge and surface diversions assuming just recharge from precipitation.

The amount of diverted surface water translates to a flow rate of approximately 12 cfs. This amount of water was removed from the Scott River at the SVID POD in the model for the months of February and March. The model year 1998 was used as a proxy for 2016 as the two years had approximately similar streamflow conditions during the early part of the year. Figure 25 is showing the recharge locations and approximate recharge amounts considered in the model. Approximately 70% of the estimated 688 AF of recharge was applied to the green fields and 30% was applied to the pink fields. This corresponded to additional recharge rates of 0.0194 m/day and 0.0098 m/day, respectively, being added to the recharge-from-precipitation rates in the model at these fields. Hydrographs of these locations are shown in figures 26 to 31 show modeled increases in groundwater levels. Figure 32 shows comparisons of streamflow for the base and recharge scenario.

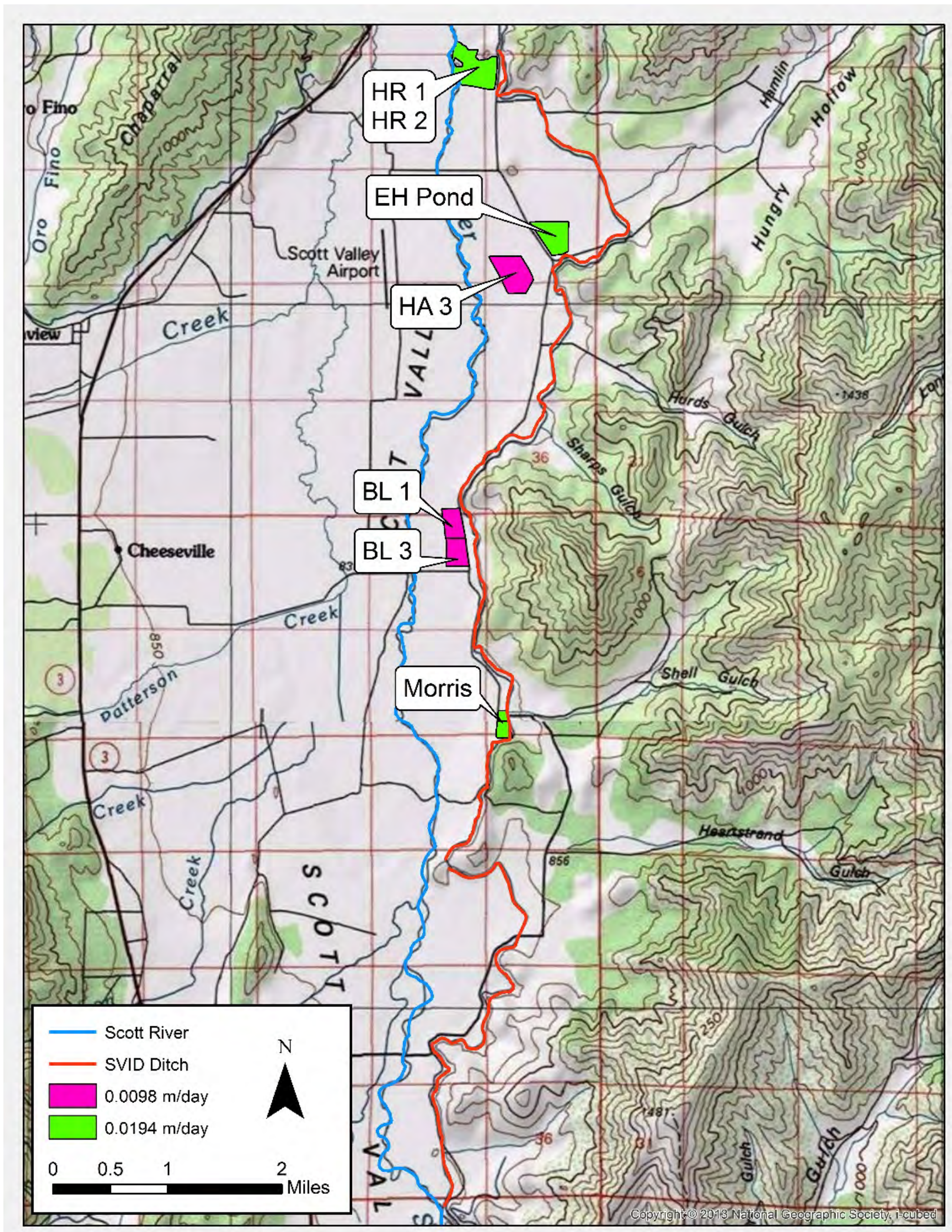

Figure 25: Recharge locations and recharge rates from on-farm flooding assumed in the SVIHM model.

The modeling results indicate that the 688 AF of recharge resulted in a negligible increase in streamflow. There was an approximately 7.5 cfs decrease at the gage during the time of the diversion (February and March), which corresponds to less than 1% of the flow rate observed at the Fort Jones gauge at that time of the year. The results from this simulation agree with previous managed aquifer recharge modeling, which indicated that the greatest streamflow gains are realized in the months immediately following the recharge (e.g. April, May, June). Howeever, there is very little difference in the simulated streamflow for both scenarios after July. The increase in simulated streamflow shown in December may be due to groundwater levels being slightly higher with the artificial recharge scenario, resulting in greater gradients to the stream when winter storms arrive.

Previously modeled managed aquifer recharge scenarios assuming a diversion of 42 cfs for three months (total of ~7500 acre-ft) showed streamflow gains on the order of about 2.5 cfs in the late summer season. This would correspond to approximately 8-25% increase in late-summer streamflow depending on the year. However, these simulations assumed that all diverted water was recharged to the aquifer. In contrast for the modeling of this years' groundwater recharge activities only about 50% recharge efficiency was assumed for this simulation. The results suggest an order of magnitude increase in recharge would be necessary to impact late-summer streamflow. The previous managed aquifer recharge simulations also indicated that maximum gains in streamflow were not recognized until after several consecutive years of treatment.

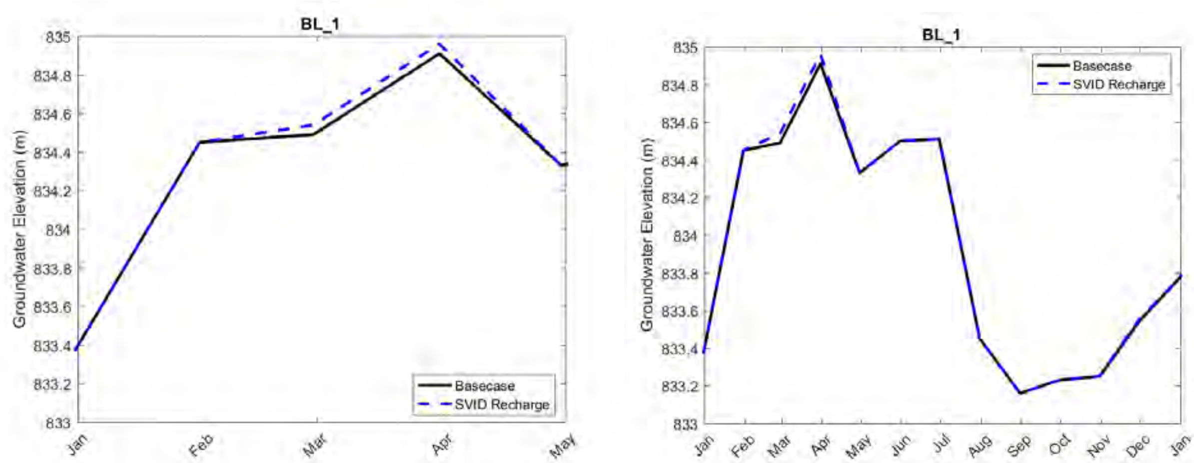

Figure 26: Modelled vs. observed groundwater elevation at location BL1 for Jan. 1 – May 1, 2016 (left) and the 2016 calendar year.

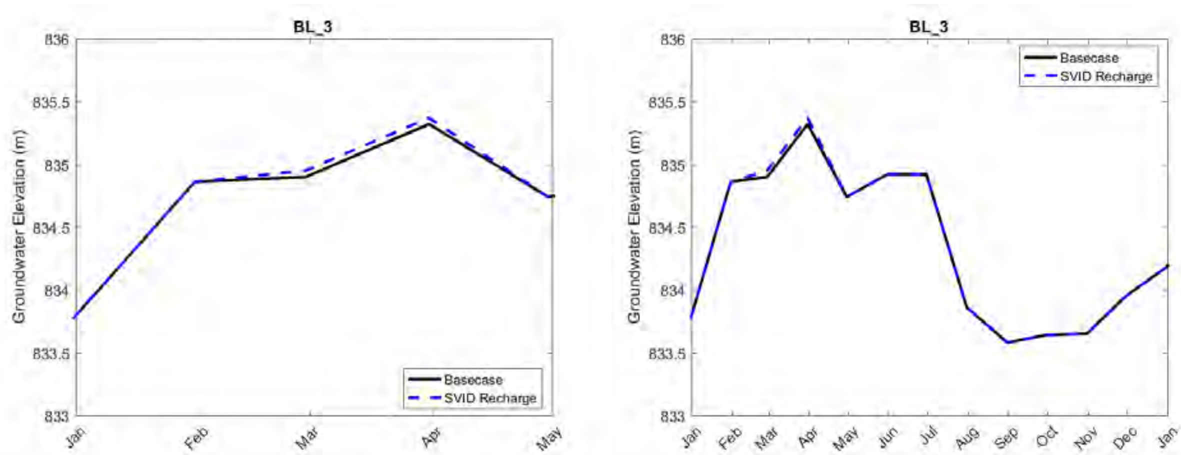

Figure 27: Modelled vs. observed groundwater elevation at location BL3 for Jan. 1 – May 1, 2016 (left) and the 2016 calendar year.

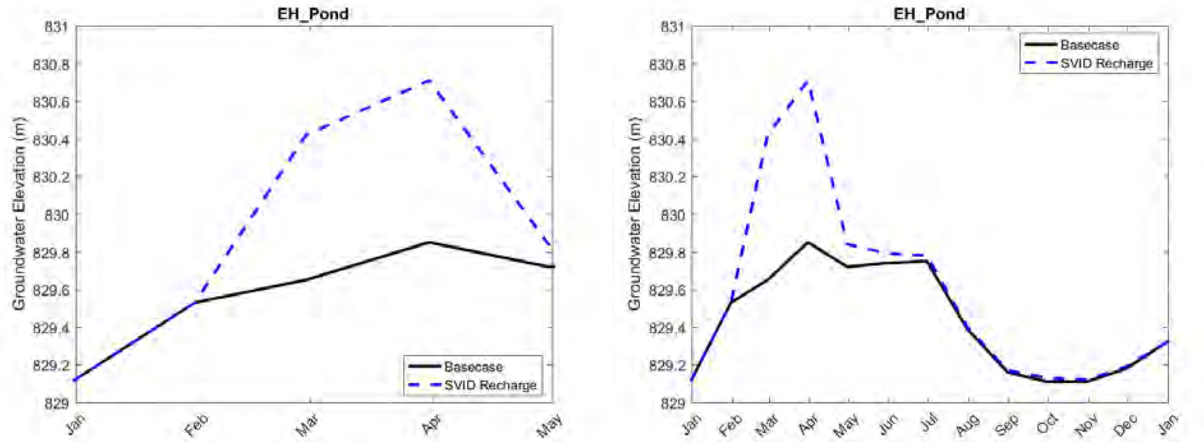

Figure 28: Modelled vs. observed groundwater elevation at location EH_pond for Jan. 1 – May 1, 2016 (left) and the 2016 calendar year.

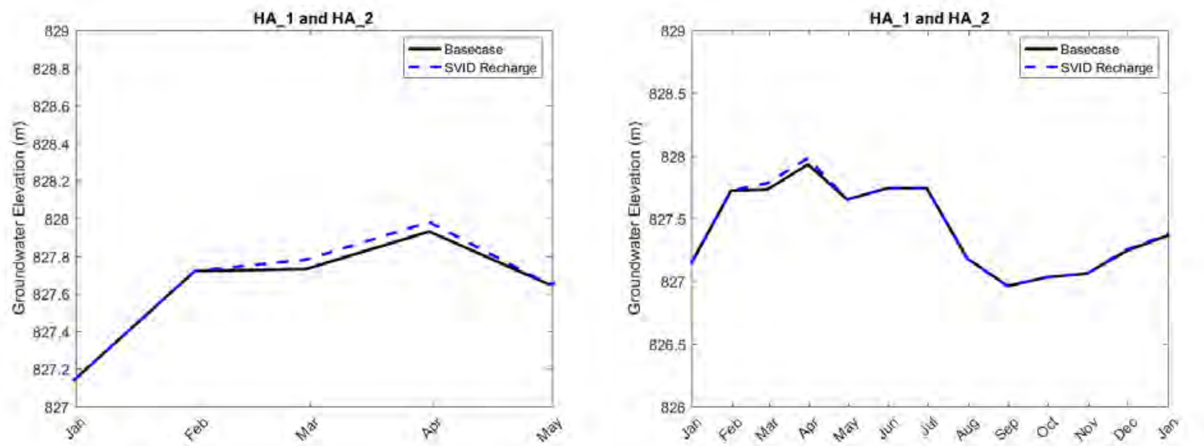

Figure 29: Modelled vs. observed groundwater elevation at locations HA1 and HA2 for Jan. 1 – May 1, 2016 (left) and the 2016 calendar year.

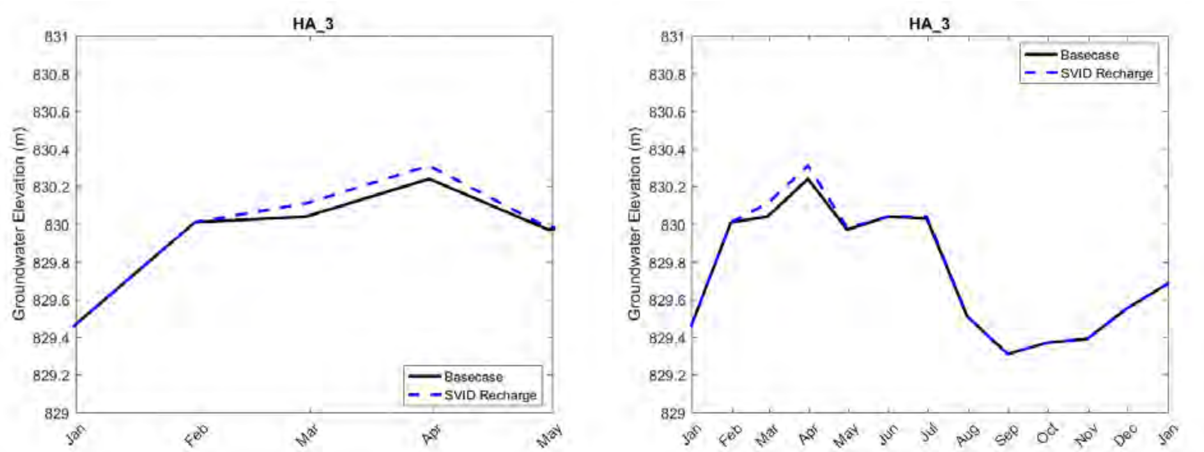

Figure 30: Modelled vs. observed groundwater elevation at location HA3 for Jan. 1 – May 1, 2016 (left) and the 2016 calendar year.

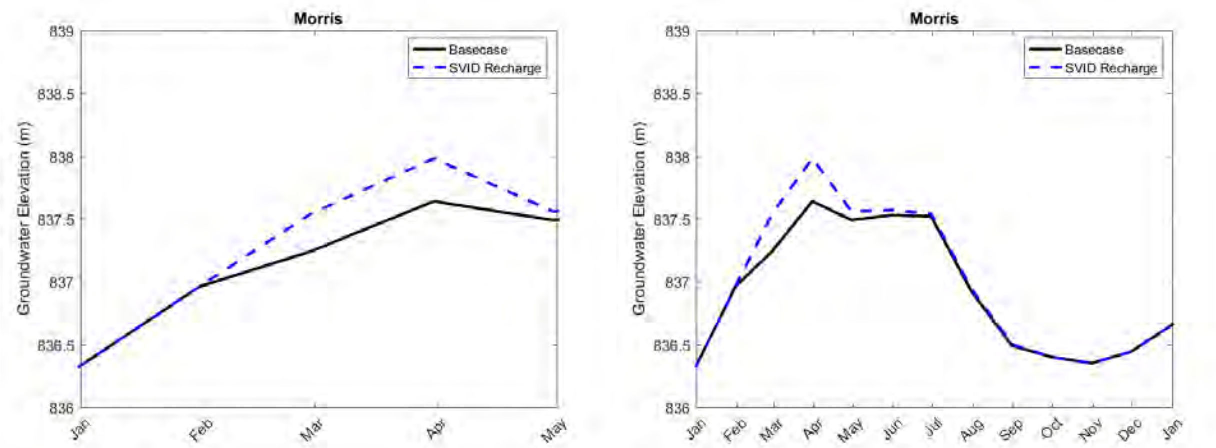

Figure 31: Modelled vs. observed groundwater elevation at location JM1 for Jan. 1 – May 1, 2016 (left) and the 2016 calendar year.

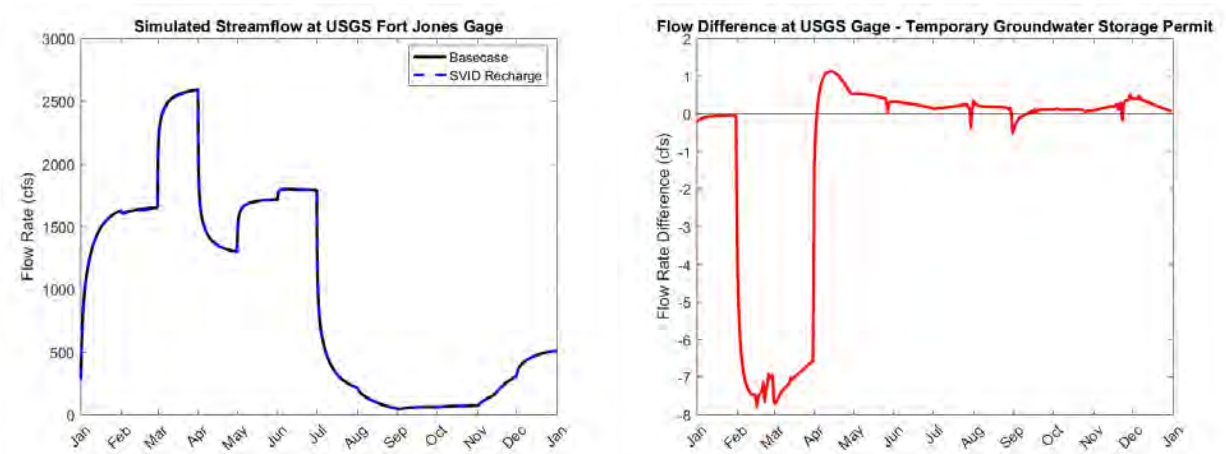

Figure 32: Comparison of simulated streamflow at USGS Fort Jones stream gauge between the base scenario (black line) and the recharge scenario (blue line) (left) and flow difference for the 2016 calendar year (right).

4 Flooding tolerance of alfalfa

4.1 Experimental Setup

To assess the tolerance of alfalfa to winter irrigation and to determine how much water can be recharged on a field planted with alfalfa, an on-farm experiment was conducted on a 15-acre alfalfa field in the Scott Valley (10-year stand in 2016) in the winters of 2014/15 and 2015/16. The field is divided into 11 checks, which were grouped into contiguous areas to test the following four water application rates (see Fig. 33):

(1) ***continuous*** application: every-day application of water except when water was being applied to other treatments (3.13 acres total area, checks 1-3),
(2) ***high*** water application: 3-5 water applications per week (3.97 acres, checks 4-6),
(3) ***low*** water application: 1-3 water applications per week (4.46 acres, checks 7-9),
(4) ***control:*** no winter water application (3.3 acres, checks 10 and 11, received precipitation only).

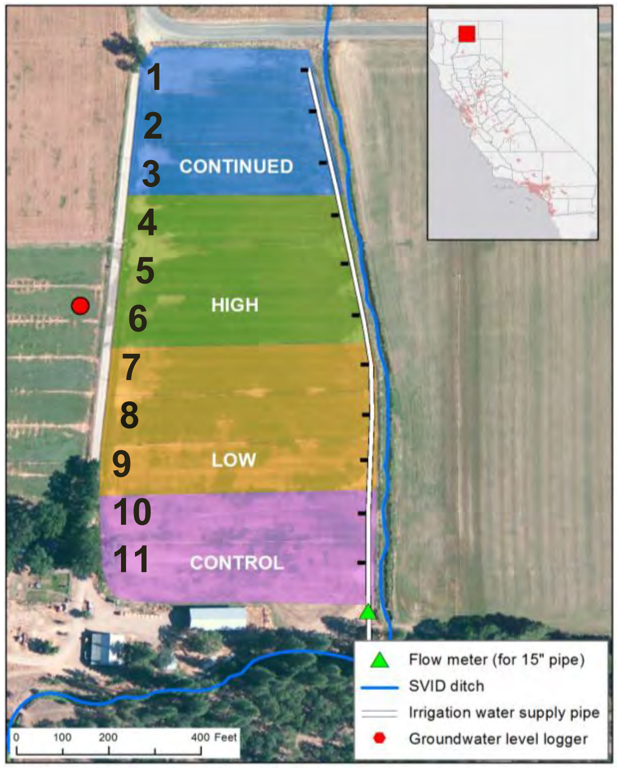

Figure 33: 15-acre field with 10-year alfalfa stand. Three different water application rates were tested: continued, high, low and no water (control) application. Numbers indicate individual checks.

The total amount of applied winter water was measured with a doppler flow meter (Greyline Instruments Inc., green triangle, Fig. 33) and changes in groundwater level was recorded with a pressure transducer deployed in a nearby groundwater well (red dot, Fig. 33). Plant physiological parameters (e.g. total biomass, stem and plant count) were determined in each treatment area before and after the recharge events. In 2015 yield was measured during the first and second cutting on May 27, 2015 and July 15, 2015, respectively. In fall of 2015, the alfalfa field was overseeded with orchardgrass. Plant biomass was harvested on May 24, 2016 (1st cutting) and July 20, 2016 (2nd cutting). In 2015 biomass was collected by hand in several randomly chosen quadrats of 5.5 sq. ft. (0.5 m^2) in size. The cut biomass was dried at 140°F (60°C) and yield (tons/acre) was reported on a dry matter basis. In 2016 yield was estimated based on the total wet biomass harvested using a flail-type forage harvester from an approximately 25 x 3 sq. ft. section from each of the 11 checks. A small subsample was taken from the cut biomass and dried at 50 degrees C for at least 48 hours to determine the dry matter of the forage. Subsamples were also collected by hand clipping areas adjacent to the mowed area to determine the relative proportion of alfalfa, orchardgrass and weed biomass present.

4.2 Results

On the 15-acre field 135 AF and 107 AF of water were applied during the winter/spring season of 2015 and 2016, respectively. Table 7 summarizes the amounts of applied winter water for each check and treatment for both years. The recharged surface water in conjunction with natural precipitation falling caused a rise in the groundwater table in a nearby well (red marker, Fig. 33) of approximately 6 feet in 2015 and 4.5 ft in 2016 (Fig. 34). The continuous treatment plot received winter water for 31 and 46 days in 2015 and 2016, respectively. Estimated infiltration rates averaged 0.9 ft of water per day.

Table 7: Total applied winter water (ft) for groundwater recharge for winters of 2014/15 and 2015/16.

			Applied winter water (ft) for recharge							
			2014-2015 (02/17-04/09/2015)				**2015-2016** (02/04-03/21/2016)			
Treat-ment	Check	Check size (acres)	Total	February	March	April	Total	February	March	April
Contin.	1	0.84	32.66	2.72	24.03	5.90	13.52	7.09	6.86	0.09
	2	1.1	26.49	4.00	17.97	4.51	10.32	5.43	5.32	0.09
	3	1.19	24.87	4.22	16.48	4.17	9.54	5.03	4.94	0.09
High	4	1.18	7.20	2.67	3.70	0.83	4.45	2.93	1.95	0.09
	5	1.35	6.65	2.50	3.48	0.68	3.89	2.57	1.75	0.09
	6	1.44	8.16	3.27	4.06	0.82	3.86	2.64	1.66	0.09
Low	7*	1.41	5.20	1.05	1.94	2.21	12.96	1.16	1.02	11.31
	8	1.51	4.18	0.90	2.56	0.72	1.63	1.09	0.97	0.09
	9	1.54	3.35	0.89	1.70	0.76	1.60	1.07	0.96	0.09
Con trol	10	1.46	0.00	0.00	0.00	0.00	0.53	0.10	0.34	0.09
	11	1.86	0.00	0.00	0.00	0.00	0.53	0.10	0.34	0.09

* This check received an additional 11.3 ft of water in two irrigation events in April 2016.

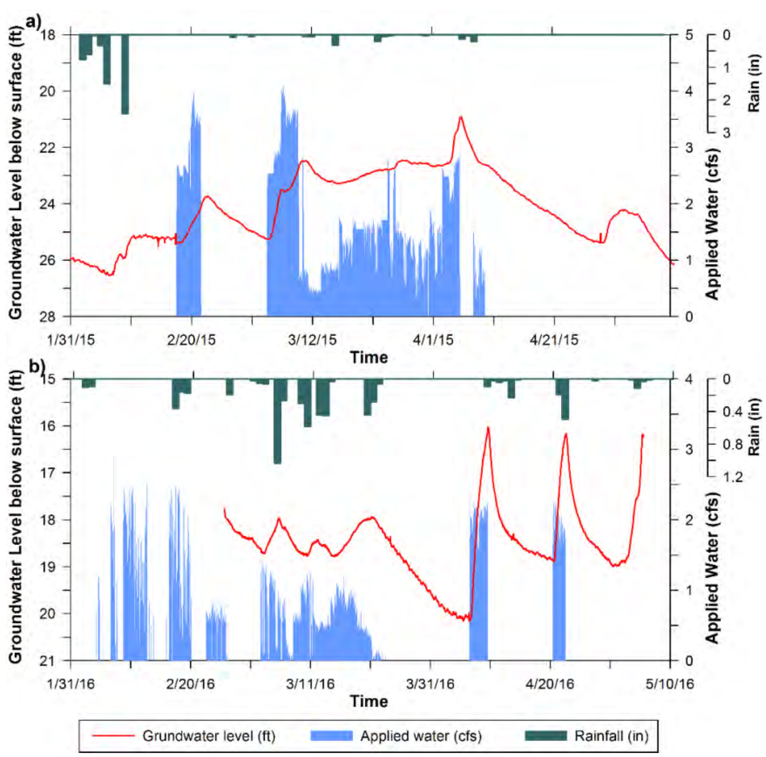

Figure 34: Amount of water diverted for winter recharge (cfs), change in groundwater level below surface (ft) and rainfall (in) measured in winter 2014/15 and 2015/16.

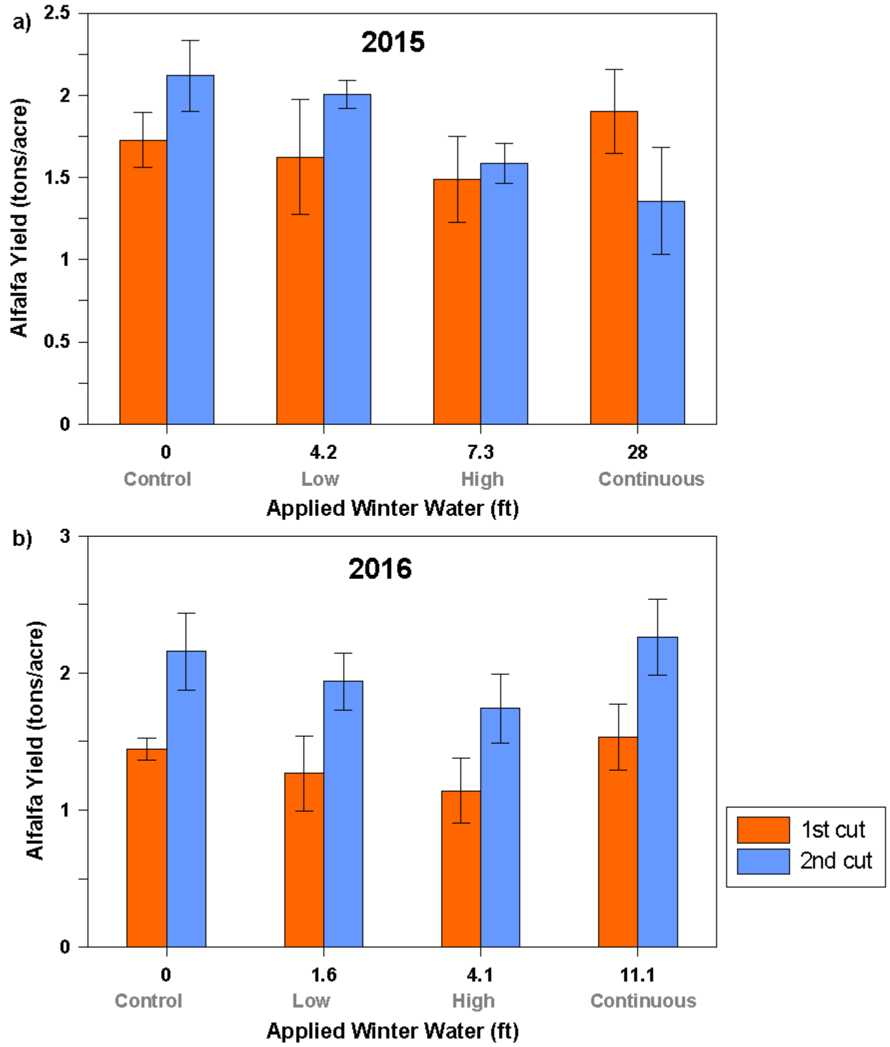

Figure 35: Alfalfa yield for 1st (orange, end of May), 2nd cutting (blue, mid-July), and 3rd cutting (green, end of August) vs. average applied winter water (ft) for 2015 and 2016.

The winter water application of up to 32 ft of water per treatment showed no discernible effect on alfalfa yield except for the 2nd cutting in 2015, which showed a significant decline in alfalfa yield with increasing amount of applied winter water (Fig. 35a). However, despite the significant decline, the yield in the continuous treatment plot was only 0.5 tons/acre lower than the control, indicating that the economic loss for high water application amounts is modest.

In 2016 checks receiving the largest amount of winter water showed a higher yield than the control plots during the 1st and 2nd cutting indicating that winter recharge might lead to increased crop water availability in the deep soil profile offsetting potential irrigation deficits during the growing season.

Part of a second field was flooded on the Bryant-Morris ranch with SVID water between February 4 and March 31, 2016. To estimate the effect of the applied water onto alfalfa yield, biomass was harvested with flail-type forage harvester (see method described in section 4.1). Alfalfa yield data summarized in Table 8 shows the yield data for two areas of the field, one that received additional water during the winter (flooded), the other just rainfall (untreated). In agreement with the experimental plot, there was no discernible difference in the yield between the winter irrigated and non-irrigated areas. However, when both plots were harvested the alfalfa in the non-winter-flooded area seemed drier, less dense and probably more drought stressed (indicated by the dry matter data in Table 8). In contrast, the alfalfa in the winter-flooded area seemed more lush, potentially supporting the hypothesis that winter recharge is supporting plant water demand during the growing season from deep soil water storage. This could especially prove beneficial to the regrowth of the alfalfa after cutting and drying days, when the alfalfa crop cannot be irrigated.

Table 8: Harvest data for second alfalfa field on Bryant-Morris ranch. Forage was harvested on June 1, 2016.

Treated (Flooded)		Harvest wt (lbs)	Plot length (ft)	Wet weight (g)	Dry weight (g)	Dry Matter	Yield (tons/acre)
	1	18.0	21.1	504.7	137.1	0.27	1.7
	2	21.8	22.3	505.1	136.3	0.27	1.9
	3	18.2	19.3	449.5	114.2	0.25	1.7
	4	18.4	19.1	480.0	126.7	0.26	1.8
Average		**19.1**		**484.8**	**128.6**	**0.26**	**1.8**

Untreated		Harvest wt (lbs)	Plot length (ft)	Wet wt (g)	Dry wt (g)	Dry Matter	Yield (tons/acre)
	1	19.5	20.7	435.4	125.1	0.29	2.0
	2	20.8	21.6	402.7	120.0	0.30	2.1
	3	20.9	28.4	438.1	126.4	0.29	1.5
	4	17.7	22.5	484.1	142.7	0.29	1.7
Average		**19.7**		**440.1**	**128.6**	**0.29**	**1.8**

Figure 36: Winter flood irrigation on the second field on Bryant-Morris ranch. Flow from the valve was estimated at 0.3 cfs.

4.3 Major findings – Crop study

- Alfalfa is a promising crop for ag-recharge if grown on suitable, well-draining soils
- Application of 4-28 ft of water in February/March showed no discernible effect on alfalfa yield
- Winter water application for groundwater recharge might increase soil water availability for alfalfa and offset irrigation deficits during the growing season
- In CA about 300,000 acres of alfalfa are grown on soils suitable for recharge – applying 6 ft of water would result in 1.6 MAF of recharge (if 90% passed root zone)

5 References

Foglia, L., Mcnally, A., Hall, C., Ledesma, L., Hines, R., and Harter, T., 2013, Scott Valley Integrated Hydrologic Model : Data Collection, Analysis, and Water Budget. Final Report North Coast Regional Water Board, SWRCB Contract 09-084-110 and 11-189-110, 101 pp.