DECEMBER 2021

CHAPTER 2: PLAN AREA AND BASIN SETTING

SISKIYOU COUNTY FLOOD CONTROL & WATER CONSERVATION DISTRICT

Scott Valley Groundwater Sustainability Plan

FINAL DRAFT REPORT

SISKIYOU COUNTY FLOOD CONTROL AND WATER CONSERVATION DISTRICT
GROUNDWATER SUSTAINABILITY AGENCY
SCOTT RIVER VALLEY GROUNDWATER SUSTAINABILITY PLAN

BOARD

Brandon Criss, County of Siskiyou
Ed Valenzuela, County of Siskiyou
Michael Kobseff, County of Siskiyou
Nancy Ogren, County of Siskiyou
Ray A. Haupt, County of Siskiyou

STAFF

Matt Parker, Natural Resources Specialist, County of Siskiyou

TECHNICAL TEAM

Laura Foglia, LWA
Thomas Harter, UC Davis

Andrew Calderwood, UC Davis
Brad Gooch, UC Davis
Cab Esposito, LWA
Katrina Arredondo, LWA
Kelsey McNeill, LWA
Claire Kouba, UC Davis
Bill Rice, UC Davis

ADVISORY COMMITTEE

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Michael Stapleton, Residential
Paul Sweezey, Member-at-large
Tom Jopson, Private Pumper
Tom Menne, Scott Valley Irrigation District
Bill Beckwith, City/Municipal

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2.1 Description of the Plan Area

2.1.1 Summary of Jurisdictional Areas and Other Features

The Scott Valley Groundwater Basin[1] ("Basin") is located in the Scott River watershed ("Watershed"), part of the larger Klamath River watershed which spans sections of Northern California and Southern Oregon. Under the 2019 basin prioritization conducted by the California Department of Water Resources (DWR), the Scott Valley Groundwater Basin (DWR Basin 1-005) was designated as medium priority (DWR 2019b). With a length of 25 miles (mi) (40 kilometers [km]) and a width that varies from 0.5 to 6 mi (1-10 km), the Basin covers a surface area of 100 sq mi (259 sq km). The Basin boundary, shown in Figure 1, generally corresponds to the contact between the valley alluvium and older consolidated rock (DWR 2004). The surrounding Scott River watershed covers 814 square miles (2,108 square km).

Scott Valley is encircled by mountain ranges with elevations that can exceed 8,000 ft (2,438 m) above mean sea level (amsl). The Scott Bar, Marble, Salmon, and Scott Mountains bound the Watershed to the north, west, southwest, and south, respectively, while hills and ridges east of the Scott Valley divide the Scott and Shasta watersheds. The East and South Forks of the Scott River converge near the community of Callahan, 58 mi from its confluence with the Klamath River. The Scott River is the main water feature in the Basin, and is one of the major undammed streams in California. Within the Basin boundary, the Scott River flows south to north until it turns westward near Fort Jones. The Scott River flows northwest out of the Basin, traveling around the Scott Bar Mountains through a steep canyon to join the Klamath River at River Mile 143 (Harter and Hines 2008). Along the course of the main stem of the Scott River, the valley floor slopes from 3,120 ft (951 m) amsl at the confluence of the East and South Forks to 2,620 ft (799 m) amsl in the northern part of the Basin.

2.1.1.1 Jurisdictional Areas

As the sole Groundwater Sustainability Agency (GSA) for the Basin, the County of Siskiyou Flood Control and Water Conservation District (Agency) is responsible for the Basin areas covered by this Groundwater Sustainability Plan (GSP). There are two areas within the Basin that are not required to form GSAs or develop GSPs under SGMA: the interconnected zone covered by a groundwater adjudication (Figure 1) and the Quartz Valley Indian Reservation (Figure 2). While outside the jurisdiction of the GSA, these portions of the Basin are considered by the GSP as they are within or adjacent to the GSA area. In 1980, the Scott River and some of the surrounding interconnected groundwater were adjudicated by decree No. 30662 (Superior Court of Siskiyou County 1980). The groundwater adjudicated area, covering approximately 12,975 acres (53 sq km) of the Basin (DWR 2019c), is subject to annual reporting requirements, as specified in Water Code §10720.8. Additionally, because water users on federal tribal lands are not subject to SGMA, the Quartz Valley Indian Reservation (QVIR) is exempt from the Act; however, a tribal representative is a member of the GSA Advisory Committee.

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[1] Scott River Valley Groundwater Basin is the name used by DWR in Bulletin 118. Throughout the GSP, the Basin is referred to as "Scott Valley Basin", or the "Basin".

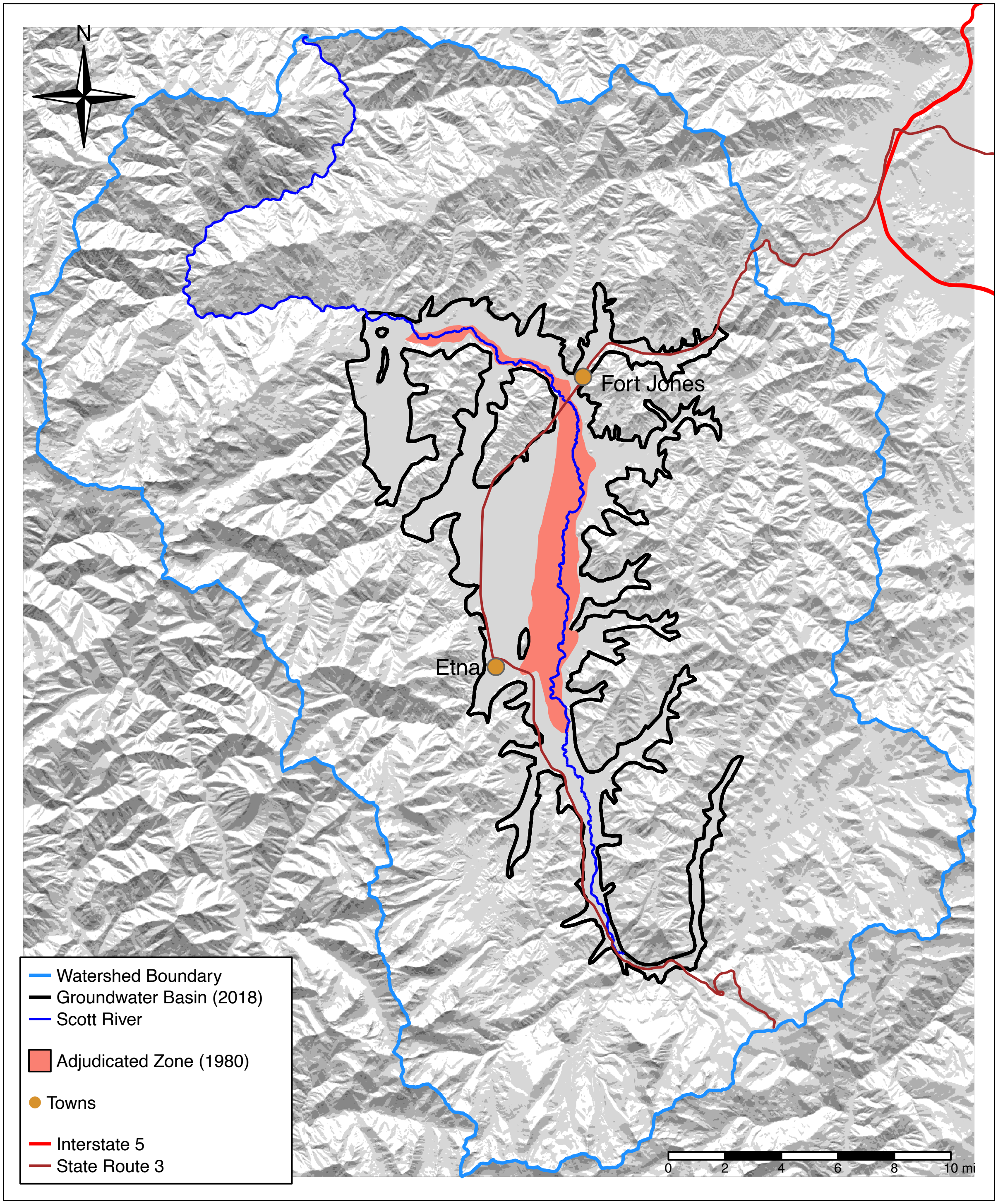


Figure 1: Scott River Valley Bulletin 118 basin boundary (DWR 2018) and area subject to the 1980 Scott River Adjudication Decree (Superior Court of Siskiyou County 1980).

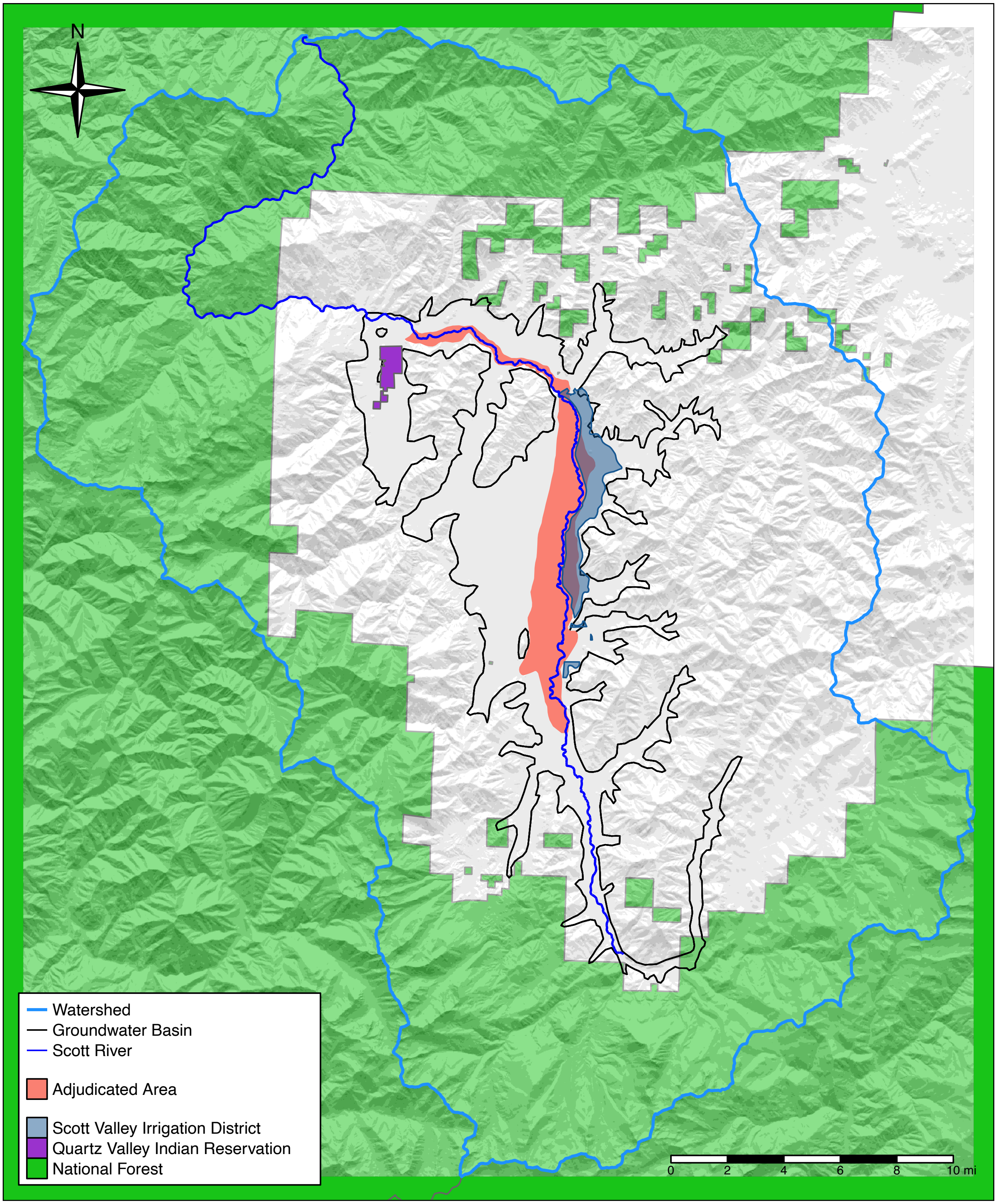


Figure 2: Jurisdictional areas within Scott Valley.

The Basin boundary encompasses the incorporated communities of Etna and Fort Jones; the unincorporated communities of Callahan, Greenview, and Quartz Valley/Mugginsville; and the QVIR on tribal trust lands. The population of Scott Valley was estimated at 8,000 (SRWC 2005), including the populations of the two incorporated towns. In the 2010 Census the number of residents of Fort Jones and Etna was estimated at 839 and 737, respectively (U.S. Census Bureau 2012). Three communities in Scott Valley are categorized as disadvantaged: Fort Jones, Etna, and Greenview. Communities with an annual median household income (MHI) of less than 80% of the average annual MHI in California are classified as disadvantaged communities (DACs), while communities with annual MHIs of less than 60% of California's average annual MHI are considered severely disadvantaged communities (SDACs). Based on the 2013–2017 American Community Survey Five Year Estimates, the statewide annual MHI is $67,169, and Fort Jones and Etna both qualify as SDACs with annual MHIs of $29,662 and $35,333, respectively (U.S. Census Bureau 2018). Greenview is listed in government databases as a DAC, but no MHI data are available for this community (DWR 2019a). A map of the DACs and SDACs in the Basin is shown in Figure 3. These communities and their sources of water are discussed further in Section 2.1.4.

2.1.1.2 Selected Land Uses

About two thirds of the land within the Scott River watershed is under private ownership with the remaining area managed by QVIR, the United States (U.S.) Department of the Interior Bureau of Land Management (BLM) and U.S. Forest Service (USFS) (Harter and Hines 2008). Much of the watershed surrounding Scott Valley is National Forest land. The Scott Valley Irrigation District (SVID) serves water to users east of the Scott River (Figure 2). The municipalities of Fort Jones and Etna cover approximately 1.3% of the Basin area (Figure 4). According to land use surveys conducted by DWR (DWR 2017), half of the Basin area is covered by agriculture, with most of that split approximately evenly between pasture and an alfalfa/grain rotation (Figure 5). Acreages associated with various 2016 land uses surveyed by DWR are included in Table 1.

Land Use Category	Acres	Percent of Basin Area
Native Vegetation	25,138	39.4
Pasture	17,088	26.8
Alfalfa	13,457	21.1
Residential	3,741	5.9
Grain	2,062	3.2
Urban	1,082	1.7
Water	665	1.0
Idle	439	0.7
Other Crops	159	0.2

Table 1: Acreage and percent of total Basin area covered by generalized land uses as reported in DWR's 2016 land use survey.

2.1.1.3 Well Drilling Records

California Water Code Section 13751, effective January 1997, requires anyone that constructs, alters, or destroys a water well, cathodic protection well, groundwater monitoring well, or geothermal heat exchange well to file a report of completion with the Department of Water Resources within 60 days of completion of the work. Locations of existing wells were accessed via the publicly available DWR Online System for Well Completion Reports (OSWCR; DWR 2019b). Although these data are aggregated by Public Land Survey System (PLSS) section, it is possible to visualize the approximate distribution (i.e., well density) of domestic,

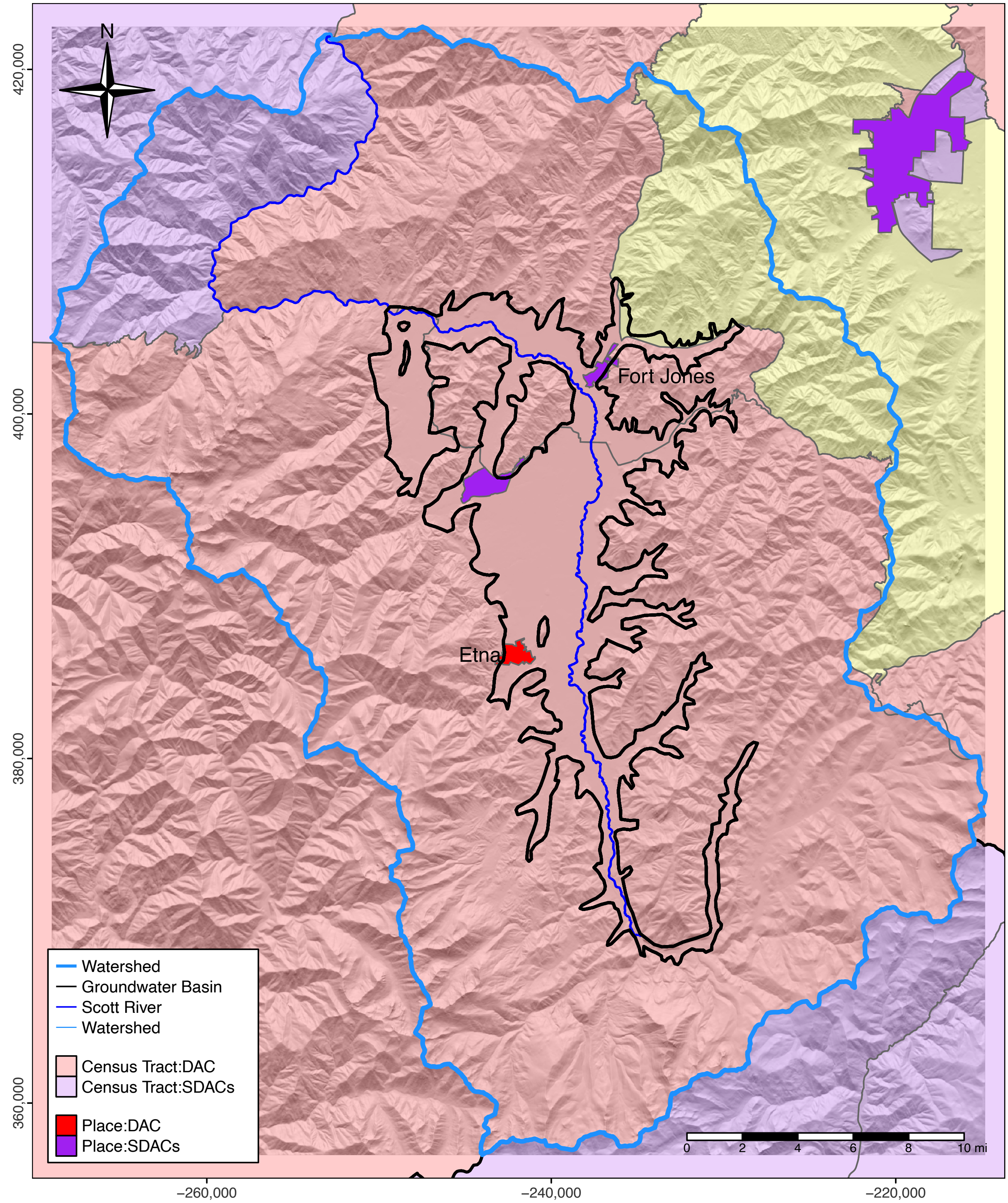


Figure 3: Based on the 2016 U.S. Census areas in the Scott Valley Watershed classified as Disadavntaged Communities (DACs) and Severeley Disadvantaged Communities (SDACs) using data from the Department of Water Resources DAC Mapping Tool (https://gis.water.ca.gov/app/dacs/).

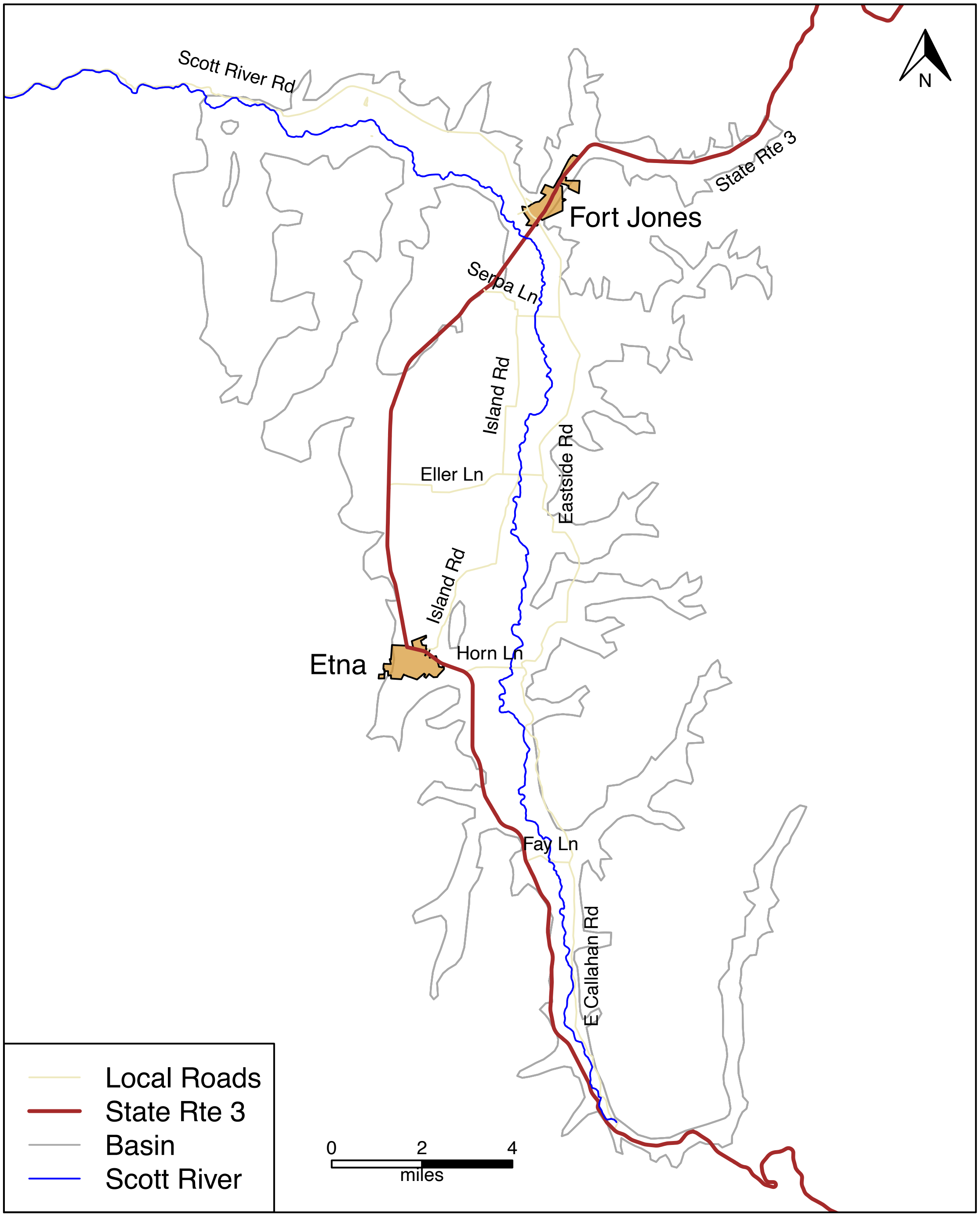


Figure 4: City limits of Basin municipalities and selected roads, including State Route 3 and several roads crossing the Scott River.

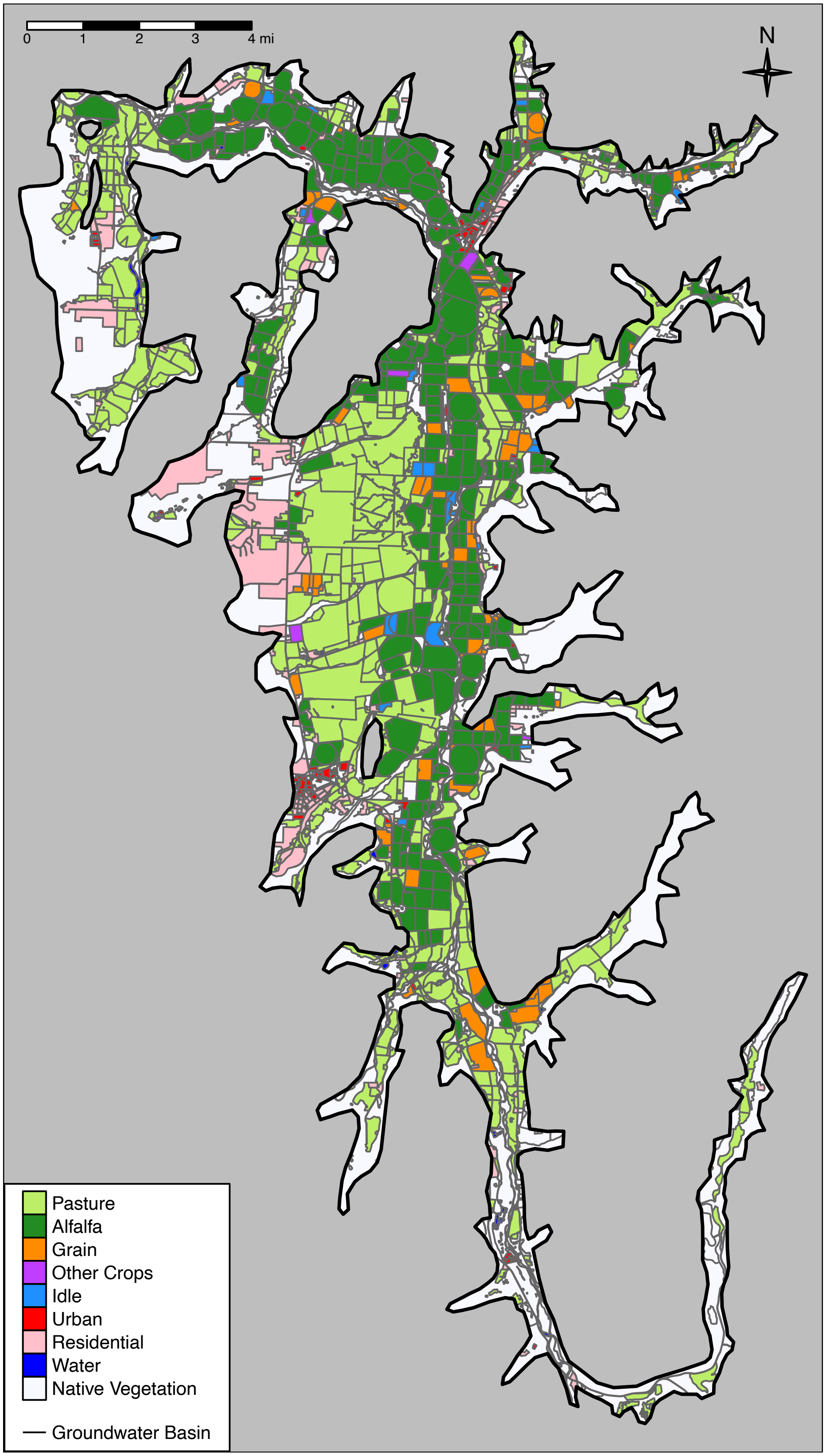


Figure 5: Land uses within the Scott River Valley Groundwater Basin boundary. Adapted from the 2016 DWR Land Use Survey (DWR 2016).

agricultural production, and public drinking water wells in the Basin (Figure 6). Because OSWCR represents an index of Well Completion Report records dating back many decades, this dataset includes abandoned or destroyed wells. Though there can be quality control issues such as inaccurate, missing or duplicate records, OSWCR is nevertheless a valuable resource for general planning efforts. Under California Water Code Section 13751, and under Title 5, Chapter 8 of the Siskiyou County Code of Ordinances, well completion reports are required to be submitted for well construction, destruction, or modification. Records of these reports are maintained by DWR and the County of Siskiyou Environmental Health Division. The County Environmental Health Division's records include new wells, but do not include records of well abandonment or replacement.

2.1.2 Chronology of Groundwater Management in Scott Valley

Groundwater resources are an integral part of Scott Valley's history. A chronology of significant groundwater events in Scott Valley, including the passage of key legislation and the development and publication of important studies, is provided below. Many components of this timeline are discussed in greater detail throughout this chapter. This chronology was provided by Sari Sommarstrom (2019), with additional details from select sources.

- **1953–1955**: Seymour Mack, of the U.S. Geological Survey (USGS), conducts a groundwater investigation (Mack 1958).
- **1958**: A USGS water-supply paper, "Geology and Ground-Water Features of Scott Valley Siskiyou County, California", is published (Mack 1958).
- **1964**: The California Department of Water Resources investigates groundwater development for use in irrigation and concludes that development of groundwater supply is the more cost-effective option to provide water for irrigation than surface storage development (DWR 1960).
- **1970**: Initiation of the adjudication of surface and interconnected groundwater in the Basin. The Scott Valley Irrigation District (SVID) petitions the State Water Resources Control Board (SWRCB), prompted by concerns over the effects of groundwater pumping on surface water supply (Langridge et al. 2016).
- **1971**: The California Water Code is modified by the legislature to include groundwater that is interconnected with the Scott River as part of the stream system.
- **1972**: SWRCB grants SVID's petition for adjudication and initiates an assessment of the stream system.
- **1972–1974**: SWRCB investigates the stream system and adds numerous water stage recorders; the subsequent "Report on Supply and Use of Water" is published in 1974.
- **1974**: SWRCB approves a petition made by USFS to extend the area of adjudication to the confluence with the Klamath River.
- **1975**: SWRCB publishes "Report on Hydrologic Conditions, Scott River Valley".
- **1976**: A SWRCB engineer publishes "Measurement of Use of Water and Static Water Levels in Wells in Scott Valley-1976"
- **1980**: The Siskiyou County Superior Court adjudicates surface waters and interconnected groundwater of the Scott River stream system under the Scott River Decree No. 30662. The Scott Valley Area Plan and Environmental Impact Report are adopted by the County Board of Supervisors as part of the General Plan for the County (see Section 2.1.4 for more information).
- **1990**: The County of Siskiyou adopts Standards for Wells in Title 5, Chapter 8 of the County Code of Ordinances.
- **1991**: DWR publishes "Scott River Flow Augmentation Study".
- **1995**: The "Fall Flows Action Plan" is adopted by the Scott River Coordinated Resource Management Council to address low flows in the Scott River stream system.
- **1998**: The County of Siskiyou adopts a groundwater Management Ordinance, restricting groundwater exports, contained in Title 3, Chapter 13 of the County Code of Ordinances.

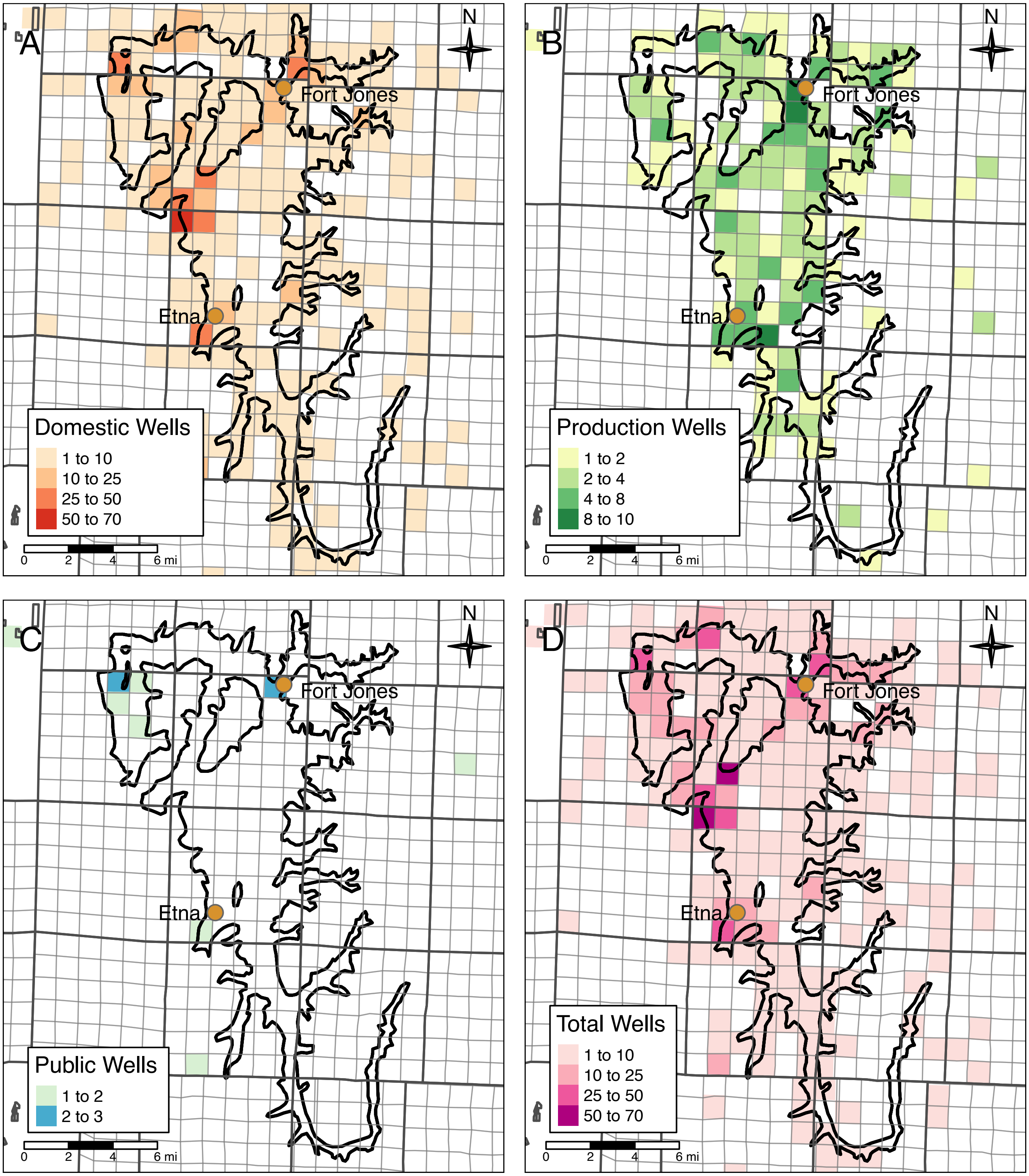


Figure 6: Choropleth maps indicating number of domestic (panel A), agricultural production (panel B), and public (panel C). Well Completion Reports recorded in each Public Land Survey System (PLSS) Section. Adapted from data in the DWR Online System for Well Completion Reports (OSWCR). Panel D shows the sum of panels A-C. PLSS sections delineated on maps are nominally one square mile.

- **2000–2005**: The Scott River Watershed Council replaces the Coordinated Resource Management Planning (CRMP) Committee and holds Water Committee meetings.
- **2004**: The Town of Fort Jones, for which groundwater is the sole source of water supply, completes its Water Study.
- **2004–2006**: Mike Deas (Watercourse Engineering) models Scott River and publishes reports on water balance, runoff forecast, and water supply indices.
- **2005–2006**: The North Coast Regional Water Board (NCRWQCB or Regional Water Board) adopts the Action Plan for the Scott River Watershed Sediment and Temperature Total Maximum Daily Load (TMDL) in December 2005 and it is integrated into the Water Quality Control Plan for the North Coast Region in 2006. A Scott Valley groundwater study is recommended in this document.
- **2005–2006**: Five partners, the Siskiyou Resource Conservation District (RCD), U.S. Department of Agriculture Natural Resource Conservation Service (NRCS), Scott River Watershed Council (SRWC), University of California Cooperative Extension (UCCE), and the County of Siskiyou adopt a memorandum of understanding (MOU) for the Scott Valley Community Groundwater Measuring Program. Monthly data collection from 24 to 42 wells commences in April 2006.
- **2007**: QVIR begins a groundwater monitoring program on the Reservation and begins to monitor surface water throughout the Scott River basin
- **2007**: Dr. Thomas Harter from the University of California, Davis (UCD or UC Davis) begins work with the Water Committee and County investigating groundwater issues in Scott Valley.
- **2008**: The “Scott Valley Community Groundwater Study Plan” (Harter and Hines 2008) is adopted by the County Board of Supervisors and submitted to the Regional Water Board. UCD and SRWC coordinate to implement the plan.
- **2010**: Provision for the formation of Groundwater Advisory Committees (GWACs) for groundwater basins in the County of Siskiyou is adopted in Title 3, Chapter 19 of the County Code of Ordinance.
- **2010–2011**: The Scott Valley GWAC is created in 2010 and begins meeting monthly with the public and holding meetings with the 11 appointed representatives of major groundwater users in the valley. Work begins with UCCE on local water use data and with UCD on groundwater modeling.
- **2010–2019**: Litigation proceeds regarding Siskiyou County’s duty to consider the Public Trust when taking action that affects groundwater that is interconnected with the Scott River (a public trust resource). In 2018, the Third Appellate District published an opinion on the *Environmental Law Foundation v. State Water Resources Control Board (“ELF”)* which noted that the County has a public trust duty to consider if groundwater extractions impact public trust uses and that SGMA does not supersede, fulfill, or replace the County’s public trust duties.
- **2012**: The “Voluntary Groundwater Management & Enhancement Plan for Scott Valley” (GWAC Plan) is produced and adopted by the Scott Valley GWAC.
- **2012**: S.S. Papadopolous & Assoc., a consultant for the Karuk Tribe, prepares the report “Groundwater Conditions in Scott Valley, California”.
- **2013**: The County Board of Supervisors adopts the GWAC Plan following a public comment period. The report “Scott Valley Integrated Hydrologic Model: Data Collection, Analysis, and Water Budget” (Foglia et al. 2013) is submitted to the SWRCB and the NCRWQCB.
- **2014**: The California Legislature and Governor approve the Sustainable Groundwater Management Act (SGMA). Under this Act, the development of Groundwater Sustainability Plans (GSPs) is required. Under its designation as a medium priority basin, the Scott Valley GSP is due by January 31, 2022.
- **2015**: The Siskiyou County’s Flood Control and Water Conservation District (FCWCD) becomes the Groundwater Sustainability Agency (GSA) for the Scott River Valley Groundwater Basin.
- **2016**: The SWRCB issues the first temporary groundwater storage permit to Scott Valley to capture and store winter and spring flows for a local recharge study with the SVID led by Dr. Helen Dahlke from UCD.
- **2018**: The FCWCD established a new Scott Valley Groundwater Basin Advisory Committee of nine members that are representative of beneficial users and users of groundwater in the Basin (Resolution No. FLD 18-05).

- **2018**: UC Davis publishes report on the initial version of the Scott Valley Integrated Hydrologic Model, as a peer-reviewed publication in California Agriculture, 2018 (Foglia et al. 2018).
- **2019**: UC Davis publishes a calibrated update of the Scott Valley Integrated Hydrologic Model as a peer-reviewed publication in Water Resources Research, with data available online (Tolley, Foglia, and Harter 2019).

2.1.3 Water Resources Monitoring and Management Programs

There is substantial historical and ongoing work in the Basin and Watershed related to monitoring and management of surface water and groundwater resources. A summary of these monitoring and management programs is included in Table of Plans and Programs, shown in Tables 2 - 4. The following section describes each monitoring and/or management program and outlines the current understanding of (a) how those programs will be incorporated into GSP implementation and (b) how they may limit operational flexibility in GSP implementation.
The programs described include the following:

- United States Department of Agriculture (USDA) Forest Service (USFS)
- United States Geological Survey (USGS)
- Endangered Species Conservation Laws
- California Department of Fish and Wildlife (CDFW)
- State Water Resources Control Board (SWRCB)
- California Department of Water Resources (DWR)
- California Statewide Groundwater Elevation Monitoring Program (CASGEM)
- Water Quality Control Plan for the North Coast Region
- Siskiyou County Environmental Health Division
- Scott River Adjudication
- Public Trust Doctrine
- Scott Valley and Shasta Valley Watermaster District
- Quartz Valley Indian Reservation
- University of California, Davis
- University of California Cooperative Extension
- Siskiyou Resource Conservation District (RCD)
- Scott Valley Groundwater Advisory Committee
- Scott Valley Community Well Measuring Program
- Scott Valley Irrigation District (SVID)
- Scott River Watershed Council (SRWC)
- Scott River Water Trust (SRWT)

Activity Type	Name of Organization(s)	Plan/Program name or activity summary	Year(s)	Regulatory?	What is regulated?
Management	Superior Court of Siskiyou County and State Water Resources Control Board	Scott River Adjudication	1980	Yes	Surface water diversions and groundwater pumping (within the Interconnected Zone)
Management	Scott Valley and Shasta Valley Watermaster District	Watermaster services in Oro Fino, Sniktaw, Wildcatt, Shackleford, and Mill Creeks	2007-2013	Yes	Surface water diversions
Management	Scott Valley and Shasta Valley Watermaster District	Watermaster services in French Creek	2007-present	Yes	Surface water diversions
Management	County of Siskiyou Environmental Health Division (CSEHD)	Well permitting, well completion reports, and enforcement of the County's well ordinances	1991-present	Yes	Well permitting
Management	Scott Valley Irrigation District	Diverts and distributes Scott River water to 25 landowners	1920s-present	Yes	Surface water diversion at SVID ditch
Management	Scott River Watershed Council	Stream habitat restoration and construction and study of beaver dam analogs	2000-present	–	–
Management	Scott River Water Trust	Seasonal surface water leases to improve flow in priority fish habitat	2007-2017	–	–

Table 2: Groundwater-related Management in Scott Valley.

Activity Type	Name of Organization(s)	Plan/Program name or activity summary	Year(s)	Regulatory?	What is regulated?
Monitoring	Groundwater Advisory Committee	Scott Valley Community Well Measuring Program	2006-2020	–	
Monitoring	California Department of Water Resources	Monitoring programs, including CASGEM (groundwater elevation), CIMIS (atmospheric water demand) and periodic land use surveys	1950s-present	Yes	Agency is required to conduct CASGEM groundwater elevation monitoring to be eligible for state funding
Monitoring	University of California Cooperative Extension	Farm Advisor program (including soil moisture and groundwater elevation monitoring, study of irrigation practices and conservation)	1998-present	–	–
Monitoring	Quartz Valley Indian Reservation Environmental Department	Annual surface and groundwater quality monitoring	2012-2019	–	–
Monitoring	Siskiyou Resource Conservation District	Surface water gauging, stream temperature monitoring, aquatic species monitoring (among others)	1997-present	–	–
Monitoring	Scott River Watershed Council	Surface and groundwater elevation and stream temperature in vicinity of beaver dam analog projects	2015-present	–	–
Monitoring	Klamath Basin Monitoring Program	Consortium of groups monitoring water quality in the Klamath Basin	2006-present	–	–

Table 3: Groundwater-related Monitoring in Scott Valley.

Activity Type	Name of Organization(s)	Plan/Program name or activity summary	Year(s)	Regulatory?	What is regulated?
Plan	North Coast Regional Water Quality Control Board	Water Quality Control Plan for the North Coast Region (Basin Plan) and Total Maximum Daily Loads (TMDLs)	2006	Yes	Objectives set for groundwater quality and surface water quality affected by groundwater (e.g., stream temperature)
Plan	University of California, Davis	Groundwater Study Plan	2008	–	–
Plan	Groundwater Advisory Committee	Groundwater Management and Enhancement Plan	2008-2012	–	
Plan	Siskiyou Resource Conservation District and Scott River Watershed Council	Scott River Watershed Riparian Restoration Strategy and Schedule	2014	–	–
Plan	Scott River Watershed Council	Strategic Action Plan	2005	–	–
Tool	University of California, Davis	Scott Valley Integrated Hydrologic Model (SVIHM)	2008-present	–	–

Table 4: Groundwater-related Plans and modeling tool (SVIHM) in Scott Valley.

United States Forest Service

The U.S. Department of Agriculture (USDA) Forest Service (USFS) is a federal agency that works to manage and protect natural forests and grasslands. The USDA Forest Service manages the Klamath National Forest lands located within and around the Watershed, as shown in Figure 2, and operates the Salmon/ Scott River Ranger District. The Salmon/ Scott River Ranger District is involved in monitoring efforts in the Basin (e.g., as the measuring agency for snow stations). In addition to involvement in multiple restoration, planning, and monitoring efforts, USFS was granted a priority instream water right in the Scott River Stream System Decree No. 30622 (Superior Court of Siskiyou County 1980). Data from USFS monitoring efforts and studies are used GSP to characterize Basin conditions and will be used to inform future management decisions. Water rights allocated to USFS in the 1980 Decree Table 5, which are not required to be subject to this GSP, may affect operational flexibility in GSP implementation in the Basin. The GSA will seek to coordinate GSP management actions or projects with USFS.

Month or Dates	Instream uses for Fish and Wildlife (cfs)	Instream use for incremental fish flows, and for recreational, scenic, and aesthetic purposes (cfs)
January	200	226
February	200	226
March	200	226
April	150	276
May	150	276
June 1-15	150	134
June 16-30	100	184
July 1-15	60	132
July 16-31	40	152
August	30	47
September	30	32
October	40	96
November	200	158
December	200	226

Table 5: Water rights assigned to USFS in the 1980 Scott River Adjudication Decree.

United States Geological Survey (USGS)

USGS is a science bureau within the Department of Interior that collects and analyzes data related to natural resources. In addition to the key publication, “Geology and Ground-Water Features of Scott Valley Siskiyou County, California” (Mack 1958), USGS also operates the stream gauge at Scott River near Fort Jones (USGS 11519500). The 1958 paper (Mack 1958) was used in this GSP to define much of the geological component of the Basin setting. The USGS streamflow data was used throughout this GSP, particularly in characterization of Basin conditions and in definition of the sustainable management criteria for the depletion of interconnected surface water sustainability indicator, located in Chapter 3. Monitoring at the stream gauge (USGS 11519500) is ongoing and will be used with other data to inform future management decisions. No limitations to operational flexibility in GSP implementation are expected in the Basin due to USGS operations.

Endangered Species Conservation Laws

Federal Endangered Species Act (ESA)

The Endangered Species Act of 1973 (ESA) outlines a structure for protecting and recovering imperiled species and their habitats. Under the ESA, species are classified as “endangered”, referring to species in danger of extinction throughout a significant portion of its range, or “threatened”, referring to species likely to become endangered in the foreseeable future. The ESA is administered by two federal agencies, the Interior Department’s U.S. Fish and Wildlife Service (FWS), primarily responsible for terrestrial and freshwater species, and the Commerce Department’s National Marine Fisheries Service (NMFS) which primarily handles marine wildlife and anadromous fish. In Scott Valley, coho salmon are listed as threatened under the ESA, as part of the Southern Oregon and Northern California coasts (SONCC) evolutionary significant unit (ESU).

California Endangered Species Act (ESA)

The California Endangered Species Act (CESA) was first enacted in 1970 with the purpose of conserving plant and animal species at risk of extinction. Similar to the ESA, CESA includes the designations “endangered” and “threatened”, used to classify species. Definitions for these designations are similar to those under the ESA and apply to native species or subspecies of bird, mammal, fish, amphibian, reptile, or plant. An additional category “candidate species” exists under CESA that includes species or subspecies that have been formally noticed as under review for listing by the California Department of Fish and Wildlife. Coho salmon are also listed as threatened under CESA. Additional detail on other species in Scott Valley listed under CESA can be found in Section 2.2.1.7 as part of the discussion on groundwater dependent ecosystems (GDEs).

Both the ESA and CESA are used in the GSP to guide the identification of key species for consideration as part of groundwater dependent ecosystems. Listed species will continue to be considered throughout GSP implementation, as part of any project and management actions, and to help inform future management decisions. These endangered species conservation laws may limit operational flexibility in GSP implementation. The GSA will incorporate this legislation into its decision-making and may seek to coordinate with the relevant state and federal lead agencies, as necessary.

California Department of Fish and Wildlife (CDFW)

CDFW, previously known as the California Department of Fish and Game (CDFG), is responsible for the care and protection of the California’s fish, wildlife and plants, enforcing the California Endangered Species Act (CESA), and enforcing the Fish and Game Code, § 1600 et seq. CDFW is responsible for implementing and enforcing regulations set by the Fish and Game Commission and shares data with the Commission to support decision-making. Under Fish and Game Code Section 1602, CDFW must be notified prior to any action that may affect rivers, streams or lakes through: diversion or obstruction of natural flow, modification of the bed, channel or bank, use of material from the water body or deposition of materials into the water body; a Lake and Streambed Alteration Agreement (LSA) is required if these changes significantly affect fish and wildlife resources. CDFW also issues permits for surface water diversions and works with the SWRCB to review and comment on new water rights, conditions for water rights permits, and changes to existing water rights, and identifies data needs for establishing conditions protective of fish and wildlife resources. Additionally, CDFW maintains a database of species listed under CESA, reviews petitions for species listings under CESA, and manages regulatory permitting programs for listed species. Scott River has been identified by CDFW as a high priority watershed for coho salmon recovery and is covered in the statewide Recovery Strategy for California Coho Salmon, developed by CDFW (California Fish and Game Comission 2004). Interim instream flow criteria Table 6 have been developed for the Fort Jones Gauge (USGS 11519500). The criteria were developed for Scott River to be acceptable for the anadromous fish in the Watershed, particularly for coho salmon, which are listed under the Federal Endangered Species Act as “threatened” (CDFW 2017). However, they have not been reviewed and adopted by the State Water Resources Control Board and do not constitute a regulatory instream flow requirement at the time when this Plan was adopted. In the Watershed, CDFW has been involved in monitoring efforts for anadromous fish including coho salmon fish counts, Chinook salmon adult counts, spawner surveys and juvenile monitoring as well as fish rescues of both coho salmon and steelhead (ESA Associates 2009; Knechtle and Giudice 2021).

Data from CDFW monitoring efforts is used for the GSP to characterize Basin conditions, particularly in relation to anadromous fish, and will be used to inform future management decisions. Guidance was also provided from CDFW for specific information to be included in the Scott Valley Basin GSP. This includes a list of anadromous fish and species supported by groundwater and surface water in the Basin which are considered under the discussion of GDEs in Section 2.2.1.7 of this Plan. CDFW also provided valuable resources and tools for use in the identification of groundwater dependent ecosystems and evaluation of potential threats. Projects and management actions during the implementation phase of the GSP may require authorization from CDFW under CESA or pursuant to relevant sections of the Fish and Game Code (i.e., for managed aquifer recharge projects). CDFW operations may limit operational flexibility and the GSA will seek to coordinate with CDFW throughout GSP implementation.

Time Period	Recommended Flow
Jan 1 – 15	362 cfs or NF
Jan 16 – 31	362 cfs or NF
Feb 1 – 14	362 cfs or NF
Feb 15 – 28	362 cfs or NF
Mar 1 – 15	354 cfs or NF
Mar 16 – 31	354 cfs or NF
Apr 1 – 15	134 cfs or NF
Apr 16 – 30	134 cfs or NF
May 1 – 15	165 cfs or NF
May 16 – 31	165 cfs or NF
Jun 1 – 15	165 cfs or NF
Jun 16 – 30	165 cfs or NF
Jul 1 – 15	165 cfs or NF
Jul 16 – 31	134 cfs or NF
Aug 1 – 15	77 cfs or NF
Aug 16 – 31	77 cfs or NF
Sep 1 – 15	62 cfs or NF
Sep 16 – 30	62 cfs or NF
Oct 1 – 15	134 cfs or NF
Oct 16 – 31	139 cfs or NF
Nov 1 – 15	266 cfs or NF
Nov 16 – 30	266 cfs or NF
Dec 1 – 15	337 cfs or NF
Dec 16 – 31	337 cfs or NF

Table 6: Interim instream flows for Scott River, as measured at the Fort Jones Gauge USGS 11519500 (CDFW 2017).

State Water Resources Control Board (SWRCB)

In addition to managing a water rights permitting licensing program, the State Water Resources Control Board (SWRCB), Division of Water Rights, is also responsible for conducting statutory and court reference adjudications. Statutory adjudications, such as those issued for Scott River (1980) and Shackleford Creek (1948), comprehensively determine water rights in a stream system and can stem from petition of the SWRCB, as was the case for the Scott River Adjudication (Langridge et al. 2016). The SWRCB receives statements of water use and diversion from surface water users in accordance with SB 88 (California State

Senate 2015). In Scott Valley, the SWRCB Division of Water Rights contributed several key assessments of surface water and groundwater in the Basin as listed in Section 2.1.2 Chronology of Groundwater Management in Scott Valley, as well as preparing the Scott River Adjudication Decree No. 30662 and the supporting maps of interconnected groundwater.

The SWRCB may also issue curtailment orders under drought emergency conditions, e.g., in 2014-2017. On August 30, 2021, the SWRCB issued a drought emergency order for the Scott and Shasta River watersheds that authorized the Division of Water Rights to issue curtailment orders including curtailment orders for groundwater pumpers. On September 10, 2021, curtailment notices were sent to all surface water diverters, to all pumpers within the adjudicated zone (see below), and to all overlying groundwater pumpers outside the adjudicated zone in Scott Valley. Certain domestic, public, and stockwater use rights were exempt.

California Department of Water Resources (DWR)

DWR has long been actively involved in the monitoring and management of groundwater resources in the Basin. Multiple key publications have been authored by DWR since the mid-1900's, as listed in Section 2.1.2 Chronology of Groundwater Management in Scott Valley. DWR facilitates data collection in the Basin through periodic land and water use surveys, operation of a California Irrigation Management Information System (CIMIS) station (online since 2015), and data collection from stream gauges in tributaries to the Scott River. Long-term monitoring of groundwater levels has been conducted by DWR semi-annually in 4-5 wells, with the earliest records from the 1950's (Harter and Hines 2008). Data from DWR monitoring efforts is used GSP to characterize Basin conditions and will be used to inform future management decisions.

California Statewide Groundwater Elevation Monitoring Program

The California Statewide Groundwater Elevation Monitoring (CASGEM) Program collects and centralizes groundwater elevation data across the state and makes them available to the public. The CASGEM Program was established in response to the passage of California State Senate Bill X7-6 in 2009. Currently, all CASGEM data are made available to the public through the interactive mapping tool on the CASGEM Public Portal website (DWR 2019c). Additionally, the full dataset can be retrieved from the California Natural Resources Agency (CNRA) Open Data website (CNRA 2019).

In Scott Valley, as of August 2019, there were 4 CASGEM wells and 8 wells designated as "Voluntary" status mapped within the Basin boundary (DWR 2019c). "Voluntary" status indicates that the well owner has contributed water level measurements to the CASGEM Database, but the well is not enrolled in the CASGEM monitoring program.

Well monitoring under the CASGEM Program is ongoing on a monthly basis, performed by UCCE and Siskiyou County Natural Resources. CASGEM water level data are used in the GSP to characterize historical Basin conditions and water resources (see Section 2.2.2) and will be used with other well data to inform future management decisions. No limitations to operational flexibility in GSP implementation are expected in the Basin due to the CASGEM Program.

Water Quality Control Plan for the North Coast Region

Groundwater quality within Scott Valley is regulated under the North Coast Regional Water Quality Control Board (NCRWQCB) Water Quality Control Plan for the North Coast Region (Basin Plan) (NCRWQCB 2018c). Water quality objectives in the Basin Plan are based on the designated beneficial uses of the water body (NCRWQCB 2018c). Table 2-1 in the Basin Plan designates all groundwaters with the following existing beneficial uses of: Municipal and Domestic Supply (MUN), Agricultural Supply (AGR), Industrial Service

Supply (IND), and Native American Culture (CUL). The Basin Plan also designates groundwater with the potential beneficial uses of Industrial Process Supply (PRO) and Aquaculture (AQUA) (NCRWQCB 2018b). The MUN beneficial use, a designation assigned to waters used as sources of human drinking water, has the most stringent water quality objectives. The Basin Plan refers to the California Code of Regulations for Domestic Water Quality and Monitoring Regulations (Title 22) for nearly all numeric limits; water quality objectives are found in Chapter 3 of the Basin Plan (NCRWQCB 2018c).

Water quality monitoring data collected and/or assembled by the NCRWQCB has been used in this GSP to describe current groundwater conditions (see Section 2.2.2.3). Water quality thresholds set by the NCRWQCB for nitrate and specific conductivity in the Basin Plan have been adopted by the GSA as Sustainable Management Criteria for the water quality sustainability indicator (see Chapter 3). NCRWQCB operations may limit operational flexibility and the GSA will seek to coordinate with the NCRWQCB throughout GSP implementation.

North Coast Region Total Maximum Daily Loads (TMDLs)

Section 303(d) of the Clean Water Act (CWA) requires that states maintain a list of impaired water bodies not attaining water quality standards. Under the CWA, Total Maximum Daily Loads (TMDLs) must be established for impaired waters. TMDLs regulating sediment and temperature in the Scott River watershed were first promulgated in 2005 (NCRWQCB 2005). The State of California has determined that the water quality standards for the Scott River are exceeded due to excessive sediment and elevated water temperature. In 2006, the NCRWQCB incorporated these TMDLs into the Basin Plan (NCRWQCB 2006b). In 2011, fulfilling a directive set forth in the Basin Plan update, the NCRWQCB created a monitoring plan to determine compliance with water quality standards and the presence or absence of trends (NCRWQCB 2011). The plan proposed monitoring parameters (e.g., specific measurements related to sediment load and stream temperature), sampling locations, and measurable milestones. The extent to which monitoring has been carried out in years after plan adoption is unclear.

Since 2006, the NCRWQCB has waived the requirement for dischargers (entities or individuals that may discharge waste to the Scott River, or that are responsible for controlling such discharge), if they were not already covered by an existing permit, to file a Report of Waste Discharge (ROWD) and obtain Waste Discharge Requirements (WDRs) (NCRWQCB 2006a). The waiver was updated in 2012 and 2018 (NCRWQCB 2012, NCRWQCB 2018c). The 2018 Order "waives the requirement for Dischargers to file a ROWD and obtain WDRs for parties who implement the required conditions of this Order", which include "specific implementation actions that apply to Dischargers responsible for road and sediment waste discharge sites, Dischargers responsible for vegetation that shades water bodies, and Dischargers that conduct grazing activities" (NCRWQCB 2018a). The 2018 Order also "waives the need for WDRs for Discharges of pollutants for all activities not already regulated through an existing program," such as timber harvest, dredge and fill in-stream mining activity, construction activities disturbing more than an acre, and county road maintenance (NCRWQCB 2018a). The Order instead relies on parties to participate in a collaborative program with NCRWQCB to implement conditions and measures identified in the TMDL action plan (Table 4-10 of the Basin Plan). The TMDL action plan does not set any measures for groundwater management. Instead, the actions focus on increasing riparian shading, limiting warm return flows, and avoiding sediment load.

The rationale and development history of the TMDL program in the Scott Valley was summarized in the Community Groundwater Study Plan (Harter and Hines 2008):

> Elevated water temperatures in the Scott River and its tributaries have resulted in the impairment of beneficial uses of water and have exceeded water quality objectives. The primary beneficial uses impaired in the Scott River watershed are in relation to the cold water salmonid fishery, including the migration, spawning, reproduction, and early development of cold water fish such as coho salmon (Oncorhynchus kisutch), Chinook salmon (O. tshawytscha), and steelhead trout (O. mykiss), as well as contact and non-contact recreational uses. The coho salmon population in this watershed is listed as threatened under the federal Endangered Species Act and the California

> Endangered Species Act. The water quality objective for temperature that applies to the Scott River is stated in the Basin Plan: “The natural receiving water temperature of intrastate waters shall not be altered unless it can be demonstrated to the satisfaction of the Regional Water Board that such alteration in temperature does not adversely affect beneficial uses. At no time or place shall the temperature of any COLD water be increased by more than 5° F above natural receiving water temperature.” The purpose of the Scott River Temperature TMDL is to estimate the assimilative capacity of the system by identifying the total loads of thermal inputs that can be delivered to the Scott River and its tributaries without causing an exceedance of water quality standards. The TMDL also allocates the total loads among the sources of thermal loading in the watershed. The TMDL’s temperature source analysis identifies the various water heating and cooling processes and sources of elevated water temperatures in the Scott River watershed. The NCRWQB’s source analysis found that the primary human-caused factor affecting stream temperatures is increased solar radiation resulting from reductions of shade provided by vegetation. Groundwater inflows are also a primary driver of stream temperatures in the Scott Valley. Diversions of surface water led to relatively small temperature impacts in the mainstem Scott River, but have the potential to affect temperatures in smaller tributaries, where the volume of water diverted is large relative to the total flow. Microclimate alterations also have the potential to impact stream temperatures. To define stream shade requirements in the context of the water quality objective for temperature, the Regional Board and its contractor, the Information Center for the Environment at UC Davis, estimated the amount of shade that would be produced by riparian vegetation under natural conditions. The estimates were developed based on historic photos, current vegetation, the location of streams, and a digital representation of topography. The resulting calculations of stream shade were used to define the load allocation for stream shade.

Chapter 4 of the “Staff Report for the Action Plan for the Scott River Watershed Sediment and Temperature Total Maximum Daily Loads” further identifies groundwater accretion to be a source of cold water to the Scott River that provides for significant temperature control in the stream. Groundwater entering the stream system is relatively cold (about 57ºF to 67ºF) and plays a significant role in cooling the stream during the summer months. Using a stream temperature model, the report quantifies the impact of varying, albeit hypothetical amounts of groundwater accretion on stream temperature to demonstrate the significance of groundwater accretion to stream temperature. In addition, groundwater indirectly affects stream temperature as water level elevation affect the quality of the riparian forest, which in turn affects the exposure of the stream to direct solar radiation.

The report also identifies factors other than groundwater that significantly affect stream temperature in the tributaries and in the main stem: historic reduction of the beaver population, historic straightening and levying of the main-stem Scott River, flow diversions, the limited extent of the modern riparian forest, and increased sediment load.

For purposes of this Groundwater Sustainability Plan, groundwater impacts on stream temperature (a stream water quality parameter) will be considered in the context of groundwater accretion to the stream (depletion of interconnected surface water sustainability indicator) and in the context of water level elevation, affecting riparian vegetation and other groundwater-dependent ecosystems.

Siskiyou County Environmental Health Division

As the local enforcement agency (LEA), the County of Siskiyou, Environmental Health Division (CSEHD) carries out well permitting and enforcement of the County’s well ordinances (DWR 2020b). Well permit applications must be submitted to CSEHD, as well as well completion reports, which are also required to be submitted to DWR. The CSEHD maintains records of well permit applications and well completion reports from the County dating back to 1991; reports prior to this are maintained by DWR (County of Siskiyou 2020a).

Information from CSEHD has been used in the development of the GSP, particularly in characterizing the regulatory environment and groundwater quality, as well as groundwater quality programs within the Basin (see Section 2.2.2). Ongoing monitoring is expected to inform future GSA management decisions. No limitations to operational flexibility in GSP implementation are expected in the Basin due to CSEHD operations, though coordination is expected to be required throughout GSP development and implementation.

Scott River Adjudication, Interconnected Groundwater Zone, and Previous Surface Water Adjudications

The Scott River Adjudication Decree, issued in 1980, set forth rights to divert surface waters in the "Scott River stream system", all rights to supporting underflow, and rights to extract "groundwater that is interconnected with the Scott River as delineated on the State Water Resources Control Board map" (Superior Court of Siskiyou County 1980). In order for these rights to be issued, the California Water Code was modified to include interconnected groundwater as part of the Scott River stream system (§ 2500.5), making Scott River Valley Basin the first with legally determined hydrologic interconnection. The "Scott River stream system" was defined as "the watershed comprising the Scott River drainage area, except French Creek and Shackleford Creek and their tributaries, from the headwaters to the USGS gauging station on the Scott River below Fort Jones… and the mainstem of the Scott River from this gauging station to the Scott River's confluence with the Klamath River, excluding all streams tributary to the Scott River downstream from said gauging station" (Superior Court of Siskiyou County 1980).

The zone delineated in the Decree is generally referred to as the Interconnected Zone and shown as the Adjudicated Area. In the 1980 Decree it was identified using the definition below:

> Interconnected ground water means all ground water so closely and freely connected with the surface flow of the Scott River that any extraction of such ground water causes a reduction in the surface flow in the Scott River prior to the end of a current irrigation season. The surface projection of such interconnected ground water as defined herein is that area adjacent to the Scott River as delineated on the SWRCB map in the reach from the confluence of Clarks Creek and Scott River to Meamber Bridge. (Superior Court of Siskiyou County 1980).

The determination of interconnected groundwater, as required by Water Code Section 2500.5 is detailed in a 1975 SWRCB report where interconnected groundwater was delineated as the "surface projection overlying the groundwater reservoir from which pumping could tend to cause a reduction in Scott River flow before the end of the current irrigation season" (SWRCB 1975). This delineation was based on review of existing geologic and hydrologic data, along with minor fieldwork; an exact demarcation of this zone was not possible due to a lack of available data and extensive transition zone between interconnected groundwater and groundwater that was obviously not interconnected (SWRCB 1975). The delineation is consistent with the location of the high permeability floodplain deposits in the Basin and does not include lower permeability units in the Basin (SWRCB 1975). Water rights for surface waters, rights supporting underflow and rights to interconnected groundwater are included in the Scott River Adjudication; groundwater that is not defined as interconnected, as shown on the 1975 SWRCB map, is not adjudicated.

Water rights to interconnected groundwater are listed under "Schedule C" of the adjudication. The amount of allocated water is that "reasonably required to irrigate the acreage shown […]. Rights for lands in Schedule C are not related to rights in Schedule D and may be exercised independently from rights in Schedules B, D, and E […]", where Schedules B, D, and E refer to water rights holders to surface water on tributaries, the main-stem Scott River, and the Scott River below the Fort Jones gauge, respectively (paragraph 20 of the Scott River Adjudication).

Since 2016, the County has submitted a Scott River Stream System Annual Report to DWR through the Adjudicated Basins Annual Reporting System (DWR- California Department of Water Resources (DWR) 2018b).

An estimate of year-over-year change in groundwater storage is calculated using water levels measured in the private monitoring network described below (see section on Cooperative Community Groundwater Measuring Program for the Scott Valley Groundwater Advisory Committee), and water level-storage relationships simulated using the Scott Valley Integrated Hydrologic Model (SVIHM). An estimate of total annual groundwater and surface water use is calculated using average annual totals assessed using the SVIHM (see Section 2.2.3).

It is expected that available groundwater monitoring data associated with the Scott River Annual Report will be used to characterize historical Basin conditions and water resources (see Section 2.2.2) and will inform future management decisions. In addition, the GSP may use groundwater pumping data from recorded water rights to corroborate water budget estimates (see Section 2.2.3), though existing publicly available data on groundwater pumping may be out of date.

Specifically, within the Adjudicated Zone, groundwater pumpers that extract from "groundwater that is interconnected with the Scott River" are subject to reporting extraction rates, required by SRWCB since 1980 (SWRCB 1980). Requirements for measuring and reporting diversions of water were added under Senate Bill 88, that mandated metering for diversions over 10-acre feet per year (AFY) (California State Senate 2015; SWRCB 2018).

Water rights allocated in the 1980 Decree, which are not required to be subject to this GSP, may affect operational flexibility in GSP implementation in the Basin. The GSA will seek to coordinate GSP management actions or projects with water right holders in the Adjudicated Zone to the degree that their water rights may be affected. While the Adjudicated Zone is not organized into a water district or similar organization, water rights holders in the Adjudicated Zone are represented through some members of the GSA Advisory Committee.

Other Scott River Watershed Surface Water Adjudications

Surface water diversion rights for multiple Scott River tributaries were set forth in adjudication decrees in the mid-twentieth century. Specifically, decrees were issued for Shackleford and Mill Creeks (Superior Court of Siskiyou County 1950) and for French Creek and its tributaries (Superior Court of Siskiyou County 1958).

Prior to 2012, DWR served as the Watermaster for French, Oro Fino, Shackleford, Sniktaw and Wildcat Creeks. The Scott Valley and Shasta Valley Watermaster District (SSWD) took over Watermaster responsibilities from DWR in 2012. In 2012 and 2013, the Scott River Watermaster Service Area was reduced to exclude Shackleford, Mill, Oro Fino, and Sniktaw Creeks (Superior Court of Siskiyou County 2018). This reduction did not affect the water rights adjudicated in relevant decrees. As of July 2020, Watermaster service areas were still operational for French and Wildcat Creeks.

Public Trust Doctrine

The public trust doctrine is a legal doctrine under which the State is a Trustee to protect resources including waters, tidelands, and wildlife resources of the state, which are held in a trust for all people. In 2010, the Environmental Law Foundation (ELF), Pacific Coast Federation of Fisherman's Associates, and the Institute for Fisheries Resources filed against the SWRCB and the County of Siskiyou over permitting of wells near Scott River, alleging that these wells decreased flows in Scott River, diminishing suitability for recreational uses of Scott River and harming fish populations. The petitioners argued that the public trust doctrine applies to groundwater that is hydrologically connected to navigable surface water and sought an injunction to stop the County from issuing permits for groundwater wells until it complied with the public trust doctrine. The ruling by the trial court affirmed that the County had a duty to consider the public trust doctrine prior to issuing well permits and that the doctrine "protects navigable waters from harm caused by extraction of groundwater, where the groundwater is so connected to the navigable water that its extraction adversely affects public trust uses". After an appeal, the Third Appellate District published an opinion in 2018 on the *Environmental Law Foundation v. State Water Resources Control Board ("ELF")* which noted that the County has a public trust duty, when issuing well permits, to consider if groundwater extractions impact public trust uses and that SGMA does not supersede, fulfill, or replace the County's public trust duties.

The public trust doctrine was considered throughout development of the GSP, especially in relation to the interconnected surface water sustainability indicator, as discussed in Chapter 3. Consideration will be given to the public trust doctrine throughout GSP implementation and limitations to operational flexibility may occur due to the public trust doctrine. The GSA will seek to ensure that any project and management actions implemented are in compliance with the public trust doctrine.

Scott Valley and Shasta Valley Watermaster District

The Watermaster manages the diversion of surface water in accordance with court adjudications or agreements, with service areas that are court-appointed or requested by water users. Regulatory activities conducted by the watermaster include adjusting headgates at diversion points to reduce diversion rates in the event that flows are too low to fulfill all rights on a given tributary. The Scott Valley and Shasta Valley Watermaster District (SSWD) provides Watermaster service to water diversion owners in the Shasta River and Willow Creek watersheds, and in the watersheds of two Scott River tributaries, Wildcat and French Creeks (SSWD 2020).

Created in 2007 through Assembly Bill 1580, the SSWD is a public entity and considered a special district (Langridge et al. 2016). The SSWD was appointed by the Siskiyou County Superior Court as Watermaster for the Scott and Shasta Valley Service Areas in December 2011 and took over Watermaster responsibilities from DWR in 2012. Prior to 2012, DWR provided Watermaster service to Oro Fino, Sniktaw and Wildcat Creeks, in addition to Shackleford Creek and French Creek. Under the 1980 Scott River Adjudication Decree, Watermaster service was only appointed for two water users on Wildcat Creek; Watermaster service was requested from DWR by water users on Oro Fino and Sniktaw Creeks. Petitions for reduction in the SSWD service area resulted in the discontinuation of Watermaster service to Oro Fino and Sniktaw Creeks in April 2012, and to Shackleford and Mill Creeks in April 2013 (Superior Court of Siskiyou County 2018). This reduction did not affect the water rights adjudicated in relevant decrees. Currently, the SSWD provides Watermaster services to French Creek and Wildcat Creek.

Recently, the SSWD introduced a voluntary monitoring program to provide affordable monitoring services for water diversions that are not regulated by the Watermaster, within the boundaries of the Scott River and Shasta River watersheds (SSWD 2018).

No limitations to operational flexibility in GSP implementation are expected in the Basin due to Watermaster activities, though it is expected that coordination will be required to align management and monitoring activities with ongoing Watermaster services.

Quartz Valley Indian Reservation

The Quartz Valley Indian Reservation (QVIR) Environmental Department began developing a Water Pollution Control Program in 2005 with the objective of protecting local water resources (Robinson 2017). The QVIR has conducted water quality monitoring throughout the Basin since 2007.

Water quality is assessed annually using water quality standards and objectives from sources including federal, state, tribal, and, relevant literature values. The water quality monitoring encompasses both surface and groundwater. Nutrient and bacteria grab samples have been collected (2007–present) from 10 surface water sites either every two weeks or monthly. Discharge measurements have been taken at these 10 sites during grab sampling. Two real-time continuous flow gauges were installed in 2019 at Shackleford and Mill Creeks. Starting in 2007, stream temperature is measured continuously at fourteen sites: upstream of QVIR, the East and South Fork of Scott River, the mainstem Scott River, and seven tributaries sites within the Quartz Valley subbasin. Twenty-six drinking water wells have been sampled since 2007 for total coliform, E.coli, pH, temperature, specific conductivity, and dissolved oxygen. Six of these drinking water wells have monthly static water level data. Static groundwater levels and temperature have been measured hourly since 2012 at 13 monitoring wells (Robinson 2017). QVIR was approved by U.S. EPA for treatment as a state status for regulating water quality within the tribal trust lands.

QVIR and Riverbend Sciences have developed a statistical model to predict daily water temperatures at Scott River USGS gauge using flow and air temperature data. The model was calibrated with 24 years of data is currently undergoing peer review (Asarian and Robinson 2021). It is freely available from an online repository.

The QVIR Environmental Department has made this water quality and water level monitoring data and statistical model available for use in GSP development. QVIR data have been used to characterize historical Basin conditions and water resources (see Section 2.2.2), and ongoing monitoring is expected to inform future GSA management decisions. No limitations to operational flexibility in GSP implementation are expected in the Basin due to the QVIR monitoring program.

University of California, Davis

Groundwater Study Plan

Following completion of the stream shade work under the TMDL program, the Regional Water Board, in collaboration with the UC Davis Groundwater Cooperative Extension Program, developed the Scott Valley Community Groundwater Study Plan (Groundwater Study Plan) (Harter and Hines 2008) that identified additional research needed to study the connection between groundwater and surface water in the Scott River watershed; the impacts of groundwater use on surface water flow and on the beneficial uses associated with the cold water fishery; and the impacts of groundwater levels on the health of riparian vegetation. The plan recommended development of the Scott Valley Integrated Hydrologic Model (SVIHM) as a key decision-making tool to evaluate the potential for alternative groundwater management measures to improve streamflow and temperature.

The Groundwater Study Plan also promoted additional research on irrigation water use in and evapotranspiration from alfalfa fields in the Scott Valley (B. Hanson et al. 2011; Foglia et al. 2018; Snyder et al., n.d.), aquifer hydraulic conductivity (Tolley 2014), and SVIHM applications to provide decision-support to the Scott Valley Groundwater Advisory Committee. The Groundwater Study Plan was adopted by the County of Siskiyou Board of Supervisors in 2008.

Scott Valley Integrated Hydrologic Model.

The initial SVIHM, recommended in the Groundwater Study Plan, was developed and calibrated by Dr. Foglia and Dr. Harter (2013) and Foglia et al. (2018). Significant model updates and improved sensitivity analysis and model calibration are documented in Tolley et al. (2019), which includes a public online repository of the modeling system. An initial application of SVIHM to demonstrate the benefits of winter recharge and in lieu recharge during late winter and spring showed that significant improvements in streamflow would be possible using large-scale recharge projects (Tolley, Foglia, and Harter, n.d.a). Both the initial SVIHM and the current SVIHM were employed to better understand the link between groundwater pumping in the Basin and potential stream depletion dynamics (Foglia, McNally, and Harter 2013; Tolley, Foglia, and Harter, n.d.b).

The data collected and the tools developed by UC Davis are expected to be used throughout GSP development and to inform management options. No limitations to operational flexibility in GSP implementation in the Basin are expected due to UC Davis activities.

University of California Cooperative Extension.

The University of California Cooperative Extension (UCCE) in Siskiyou County is jointly funded by the University of California, the U.S. Department of Agriculture (USDA), and the County of Siskiyou. This office includes the Farm Advisor who works with the County of Siskiyou Agriculture Department and conducts research and educational programs for growers of primary crops to improve profitability and minimize environmental impacts (Regents of the University of California 2020). The Siskiyou County Cooperative Extension office has contributed valuable research and educational materials including an assessment of irrigation water conservation potential (Orloff 1998); irrigation strategies under drought conditions (Orloff and UCCE 2009; B. Hanson, Orloff, and Putnam 2011); and soil-moisture monitoring (Orloff, Hanson, and Putnam 2003; Hanson, Orloff, and Peters 2000). Other UCCE investigations have included study of potential climate effects on Scott River fall flows (Drake, Tate, and Carlson 2000). The UCCE has contributed to other efforts in Scott Valley including development of the SVIHM by researchers at UC Davis. In 2012-2014, UCCE measured applied water use on 7-8 alfalfa farms in Scott Valley, to better inform irrigation rules in the Scott Valley Integrated Hydrologic Model. Reports and data from UCCE are used in the GSP to characterize historical Basin conditions, and to identify and assess potential management actions.

Siskiyou Resource Conservation District

The Siskiyou Resource Conservation District (RCD) is a special district that was formed in May 1949 (Siskiyou RCD 2019). Managed by a Board of Directors, five members appointed by the County Board of Supervisors, the RCD manages soil, water, and related resources and has the authority to carry out conservation efforts within its boundaries, which include private and public land in the Scott and Salmon River watersheds and sections of the Klamath River. The mission of the RCD is to “identify conservation and watershed enhancement needs and offer assistance to landowners and resource managers to meet those needs through technical, financial and educational leadership” (Siskiyou RCD 2019). Water monitoring and management activities focus on surface water supply and quality. The RCD also houses and maintains a library of materials relating to the Scott River watershed. The RCD sponsored the Scott River Watershed Coordinated Resource Management Planning (CRMP) Committee during its existence from 1992 to 1999 (CRMP and SRWC 2000). The CRMP was composed of a diverse group of representatives with interests in addressing local natural resource issues (CRMP and SRWC 2000). The CRMP Committee sought to address natural resource problems through development of plans, for which the RCD was the implementing agency. Through four subcommittees, focused on water, upland vegetation management, fisheries riparian habitat, and agriculture, the CRMP Committee generated plans and strategies in addition to facilitating data collection and monitoring systems (Hoben 1999).

Grant-supported monitoring activities by the RCD include the operation of streamflow gauging stations on tributaries and the mainstem Scott River between 2002 and 2016 (funding to operate the streamflow stations lapsed in January 2016); monitoring of stream temperature since 1997; and monitoring of aquatic species, with a focus on anadromous fish species (Siskiyou RCD 2019). In particular, the RCD has produced annual reports on the condition of Scott River coho salmon spawning ground since 2001 (Siskiyou RCD 2019). In 2005-06, the RCD partnered with others to develop the Community Groundwater Measuring Program.

Management activities by the RCD include stream bank stabilization and riparian plantings, which have been conducted on more than 300 acres of the Scott River and its tributaries (Siskiyou RCD 2019); agricultural-focused projects such as riparian fencing and irrigation water conservation; and work associated with improving the condition of Scott River watershed fisheries, including the construction of off-channel rearing ponds, the addition of large woody debris to stream channels to create complex habitat, and the improvement of fish passage by installing fish screens on all diversions. In 2014, the RCD worked together with the Scott River Watershed Council to produce the Scott River Watershed Riparian Restoration Strategy and Schedule (SRWC and RCD 2014). The purpose of the document is “to identify the most appropriate locations and restoration methods to enhance the river ecosystem to benefit the wildlife and aquatic health of the Scott River” and “outline methods to meet the intentions of the Scott River TMDL [see below], to the fullest extent possible" (SRWC and RCD 2014).

RCD reports and data are used in the GSP to characterize historical Basin conditions (see Section 2.2.2), and it is anticipated that the RCD will be a key partner for the GSA in future operations related to sustainable management, including monitoring and potential management actions identified in the GSP. No limitations to operational flexibility in GSP implementation are expected due to RCD projects are expected in the Basin, though coordination may be needed to ensure management activities associated with GSP implementation are harmonized with ongoing RCD projects.

Scott Valley Groundwater Advisory Committee

After the Siskiyou County Board of Supervisors adopted the Community Groundwater Study Plan (Harter and Hines 2008), the Board appointed the Scott Valley Groundwater Advisory Committee (GWAC) in January 2011. The GWAC met on a monthly schedule to provide technical assistance and stakeholder input regarding the implementation of the 2008 Plan. Specifically, the GWAC worked with UCCE to develop local water use data, including a 3-year soil moisture study (Snyder et al., n.d.). In 2012 the GWAC produced the "Voluntary Groundwater Management & Enhancement Plan for Scott Valley" (GWAC Plan; Scott Valley Groundwater Advisory Committee (GWAC) 2012), which was adopted by the Siskiyou County Board of Supervisors in 2013 as an initial strategy. Although the GWAC is acknowledged here, the committee has not been active or held meetings since the SGMA groundwater committee under the GSA was formed.

The GSA expects that water use data developed by the GWAC, and the management options outlined in the GWAC Plan, will be used to inform GSP development. No limitations to operational flexibility in GSP implementation in the Basin are expected due to GWAC activities.

Scott Valley Community Groundwater Measuring Program

Created through a MOU between Siskiyou Resource Conservation District (RCD), Natural Resource Conservation Service (NRCS), Scott River Watershed Council (SRWC), University of California Cooperative Extension (UCCE), and the County of Siskiyou, the Scott Valley Community Groundwater Measuring Program has coordinated groundwater monitoring in Scott Valley since 2006 (Scott Valley Groundwater Advisory Committee (GWAC) 2012). Private well owners participate voluntarily in this groundwater elevation measurement program and participation has ranged over time from 24 to 42 wells. Current wells in the groundwater elevation measurement program are shown in 7.

The monthly data from the Scott Valley Community Groundwater Measuring Program is submitted to UCCE and has been extremely valuable for groundwater management in Scott Valley. It has been used extensively to date to estimate annual change in groundwater storage for the Basin, including in the Scott River Interconnected Zone (see above section on Adjudication for the Scott River Interconnected Zone), to develop and calibrate the SVIHM numerical groundwater model (see Section 2.2.3), and to characterize historical Basin conditions (see Section 2.2.2). Although the program underwent significant turnover and reduction in enrollees in 2018, monitoring data is expected to inform future GSP management decisions. No limitations to operational flexibility in GSP implementation in the Basin are expected due to the cooperative groundwater monitoring program.

Scott Valley Irrigation District (SVID)

The Scott Valley Irrigation District (SVID) is a special district in Scott Valley that diverts an allocated amount of water from the Scott River and controls distribution to 25 landowners and 3,000 acres served by SVID. SVID delivers water to landowners via an irrigation ditch, dating back to the 1920s, that spans 14 mi (12 km)

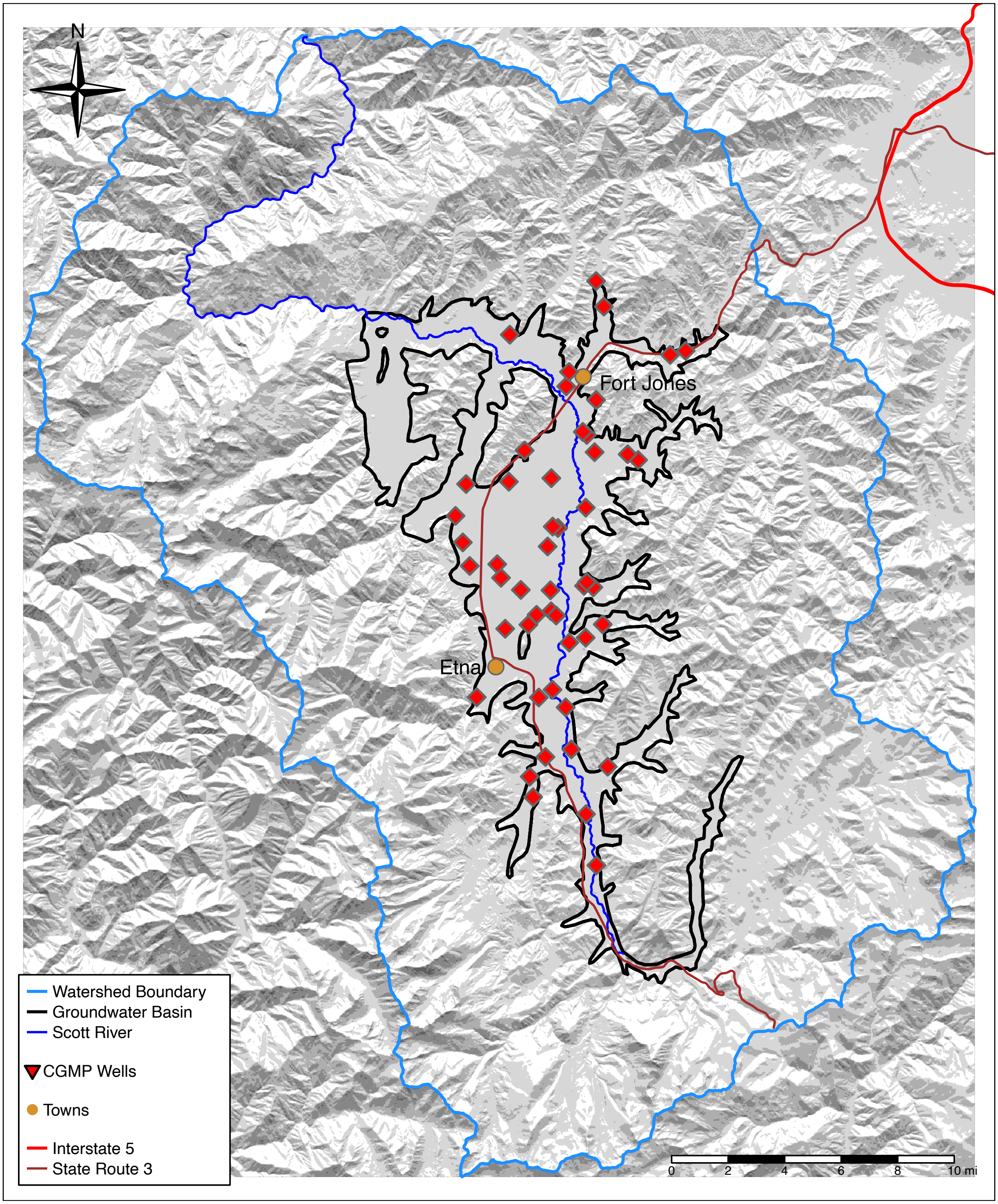


Figure 7: In the Community Groundwater Measuring Program (CGMP), water levels were measured between 2006 and 2021 in the wells shown, though the distribution and total number of wells being measured has varied over time.

between Fort Jones and Etna on the east side of Scott Valley. The diversion dam at Young's Point, east of Etna at river mile 46, has a large fish ladder to provide passage for adult and juvenile salmon and steelhead. SVID has three board members, elected by members of the district, in addition to a ditch manager and a combined secretary and treasurer (NRCS 2010). Water is diverted from the Scott River and transferred to landowners on a rotation schedule, with one hour of water received for every ten acres of property (Parry 2013; NRCS 2010). Landowners along the ditch are charged based on the irrigated acreage below the ditch. The SVID ditch, like other ditches in Scott Valley is unlined and subject to significant ditch losses that recharge groundwater. SWRCB (1974) reports individual ditch losses ranging from 0.1 cfs to over 10 cfs for larger ditches. NRCS and the Scott Valley RCD (NRCS 2009; Siskiyou RCD and NRCS 2013) analyzed ditch losses in the SVID ditch, which amounted to an average of 2.4 cfs per mile or a total of 15 cfs over the length of the canal.

SVID operations and management will likely affect operational flexibility in GSP implementation in the Basin. Any management actions or projects implemented by the GSA must avoid impacting the SVID water right, which is a post-1914 appropriative right. In 2015-2016 a recharge study was conducted with SVID and the University of California, Davis (Dahlke 2016). SVID is part of the active Scott Recharge Project (as described in Chapter 4), and it is anticipated that additional recharge projects will be conducted with SVID during implementation of this GSP.

Scott River Watershed Council (SRWC)

As an outgrowth of the original Scott River Coordinated Resource Management Planning (CRMP) Committee that started in 1992, the Scott River Watershed Council has provided a process for collaboration with the many entities involved in the Watershed, such as through the development of the 2005 SRWC Strategic Action Plan. This plan lists a summary of the Scott River Monitoring Program activities by various groups and agencies.

In 2014, the SRWC with the Siskiyou RCD produced the Scott River Watershed Riparian Restoration Strategy and Schedule (SRWC and RCD 2014). As noted above, the purpose of the document is "to identify the most appropriate locations and restoration methods to enhance the river ecosystem to benefit the wildlife and aquatic health of the Scott River" and "outline methods to meet the intentions of the Scott River TMDL, to the fullest extent possible" (SRWC and RCD 2014).

Since 2015, the SRWC built and monitors pilot Beaver Dam Analogue (BDA) projects in several locations on Scott River tributaries, including Moffett, French, Miners, and Sugar Creeks. Monitoring at these projects includes continuous water elevation in shallow groundwater and/or the hyporheic zone beneath the stream, as well as stream temperature. The SRWC conducts public outreach including project tours and participation in the Scott Watershed Informational Forum (SWIF).

SWRC reports and data are used in the GSP to characterize historical Basin conditions (see Section 2.2.2), and it is expected that ongoing monitoring data may be used during GSP implementation. No limitations to operational flexibility in GSP implementation in the Basin are expected due to SRWC operations, though coordination may be needed to ensure management activities involved with GSP implementation are harmonized with ongoing SRWC projects.

Scott River Water Trust (SRWT)

As stated on its official website, the Scott River Water Trust (SRWT), formed in 2007, "is a community-supported organization that operates with the cooperation of local farmers, ranchers, agencies, and businesses" with a mission to "improve stream flow in priority fish habitat reaches of the Scott River and its tributaries through the development of voluntary long-term and permanent water dedications with agricultural producers" (SRWT 2019). As of September 2019, the priority fish habitat reaches include:

• Shackleford Creek and its Mill Creek tributary • French Creek and its Miner's Creek tributary • Patterson Creek (west) - upper • South Fork Scott River • East Fork Scott River • Sugar Creek • Mainstem Scott River

To enhance habitat in these priority reaches, the SRWT conducts a Seasonal Water Leasing Program, which requests "landowners to forbear all or part of their decreed water right in exchange for fair financial compensation" (SRWT 2018). To assess "physical and biological changes resulting from the water leases", the SRWT performs regular monitoring. Since 2007, the SRWT has summarized the results of this monitoring in annual reports (SRWT 2019).In addition, beginning in 2015 the SRWT expanded its focus to include Scott Valley groundwater, participating in groundwater meetings and assisting with the groundwater recharge pilot project in 2015 (SRWT 2019).

SRWT reports and data have been used in the GSP to characterize historical Basin conditions (see Section 2.2.2), and it is expected that ongoing monitoring data may be used during GSP implementation. No limitations to operational flexibility in GSP implementation in the Basin are expected due to SRWT operations, though coordination may be needed to ensure management activities involved with GSP implementation are harmonized with ongoing SRWT projects.

2.1.4 Land Use Elements or Topic Categories of Applicable General Plans

2.1.4.1 General Plans

The overarching framework for land use and development in the County of Siskiyou is the County of Siskiyou General Plan (General Plan). Within this countywide General Plan, a component entitled the Scott Valley Area Plan (SVAP; SVAP 1980) was created by a citizens committee specifically for Scott Valley. The SVAP was supported in an advisory vote by members of the Scott Valley community and was later adopted in 1980 in a joint resolution of the Siskiyou County Board of Supervisors and the Siskiyou County Planning Commission (SVAP 1980). Community-specific General Plans have also been developed in Scott Valley for the municipalities of Fort Jones and Etna. Elements of the General Plans outline goals for land use and development, and mechanisms for achieving those goals include policies and zoning regulations.

County of Siskiyou General Plan

The County's General Plan serves as a guide for land use decisions within the County, ensuring alignment with community objectives and policies. While the General Plan does not prescribe land uses to parcels of land, it does identify areas that are not suitable for specific uses. The components of the General Plan with the most relevance to the GSP include the Conservation Element, Open Space Element, and SVAP (SVAP 1980). Many of the objectives and policies within the General Plan align with the aims of the GSP and significant changes to water supply assumptions within these plans are not anticipated.

The Conservation Element of the General Plan recognizes the importance of water resources in the County and outlines objectives for the conservation and protection of these resources to ensure continued beneficial uses for people and wildlife. Methods for achieving these objectives include local legislation, such as floodplain zoning and mandatory setbacks, subdivision regulations, grading ordinances, and publicly managed lands to ensure preservation of open spaces for recreational use. The importance of water resources is clearly noted: "Groundwater resources, water quality and flood control remain the most important land use determinants within the county" (County of Siskiyou 1973). Specific topics addressed include: preventing pollution from industrial and agricultural waste, maintaining water supply and planning for future expansion, reclaiming and recycling wastewater, and protecting watershed and recharge lands from development. These objectives in the Conservation Element mirror the objectives of the GSP, namely ensuring a sustainable water supply, the protection and preservation of watershed and water recharge lands, and prevention of degradation of water quality.

The Open Space Element of the General Plan (County of Siskiyou 1972) includes in its definition of open space any area of land that serves as open space, watershed, and groundwater recharge land, among other uses. The importance of protecting these lands is recognized for maintaining water quality and quantity. Mechanisms to preserve these spaces include maintaining or creating scenic easement agreements, preserves, open space agreements, and designation of lands for recreational or open space purposes. A policy for open space requirements is included with minimum thresholds of 15% of proposed developments as open space. Protection of open space for habitat, water quality, and water quantity align with the objectives of the GSP.

Scott Valley Area Plan

Under the General Plan, a land use element was adopted specifically for Scott Valley. The Scott Valley Area Plan (SVAP) was created by a committee of Scott Valley residents with public input and assistance from the County Planning Department and other public agencies. The SVAP contains both the Land Use Element of the General Plan for Scott Valley and the associated Environmental Impact Report. Seven maps of Scott Valley outlining deer wintering areas, excessive slopes, floodplains, government lands, landslide areas, and prime agricultural lands within Scott Valley are also included in the General Plan. Established in response to a planned subdivision development, the SVAP was created with the intent of protecting the prime agricultural land and natural resources of Scott Valley while managing growth. It was ratified on November 13, 1980, as part of the County of Siskiyou General Plan (SVAP 1980). The SVAP includes land use policies to ensure alignment with community goals; namely, protection of the economic interests, natural resources, wildlife, and safety of the residents of Scott Valley. These policies include guidelines for land use and development in areas at risk for natural hazards including geologic hazards, flooding, and wildfire. Specifications for these areas include permitted land use, residential densities, and requirements for development. For areas with excessive slopes, runoff, water quality, and erosion are considered in addition to safety concerns. Concentration of growth near communities and the low-density development policies included in the plan are included to avoid strain on public services, in addition to environmental, aesthetic, and economic interests. The SVAP includes many of the policies found in the land use element of the General Plan but contains more stringent policies for development of prime agricultural land. These stricter policies include minimum parcel size of 80 acres on prime agricultural lands and restriction of land use on prime agricultural soils to public and agricultural uses.

Supplementary, community-specific policies for growth are included in the SVAP. These include permitted densities and land uses, as well as growth limits or “spheres of influence” around the cities of Fort Jones and Etna. Community plans are also included for Greenview and Callahan. Density specifications for these cities are included to avoid strain on public services, water quality, and water quantity.

The SVAP includes multiple goals and policies that align with those in the GSP. Specifically, the focus on managing growth in a sustainable way while protecting prime agricultural land, priority habitats, and natural resources is an overarching theme in both the SVAP and the GSP. Given this alignment of the objectives in the GSP and General Plan, significant changes to current water supply assumptions are not anticipated.

County of Siskiyou Land Use and Zoning

Many of the purposes and policies in the Land Use element of the General Plan align with the objectives of the GSP. In particular, the “wise use, conservation, development and protection” of the County’s natural resources, protection of wildlife, and prevention of pollution support the objectives of the GSP. Mechanisms to achieve these goals include permitted and restricted uses for land parcels, and requirements and stipulations for land use and development.

While the General Plan contains standards, policies, and objectives related to zoning, it does not regulate land use. Land use is regulated through the Siskiyou County Municipal Code Zoning Ordinance, in Title 10, Chapter 6, beginning with Article 37 (Siskiyou County 2019). The County of Siskiyou Zoning Ordinance outlines the permitted types of land use within each zoning district. Zoning categories include residential, commercial, industrial, agricultural, forestry, open space, and floodplains.

2.1.4.2 Community Plans

Fort Jones General Plan

The Town of Fort Jones General Plan (FJGP; Pacific Municipal Consultants 2006) was developed to guide community decisions related to land use and development. The 2006 version of the FJGP incorporates a long-term view of planning decisions, extending to the year 2025 and includes the required elements of land use, open space, noise, safety, circulation, housing, and conservation (Pacific Municipal Consultants 2006). Areas subject to the FJGP include the Town's jurisdiction and sphere of influence, as defined by the County of Siskiyou Local Agency Formation Commission (LAFCO). Fort Jones is dependent on groundwater for water supply with its primary well located in the interconnected zone.

The unincorporated areas surrounding Fort Jones, outside of the sphere of influence, are guided by the land use policies in the SVAP. The SVAP also includes policies for land use and development within the spheres of influence of Fort Jones and Etna, including requirements for flood hazard areas, allowance for increased residential densities, and exclusion from policies relating to resource maps. Additionally, the SVAP specifies that decisions within the spheres of influence must be referred to the relevant municipality prior to any decisions by the County. There is flexibility in zoning as the Town can zone the land following annexation, as opposed to pre-zoning. The Land Use Goals and Policies in the FJGP describe permitted densities, lot coverages, land use designations, and consistent zoning designations. Assumptions related to water supply included in this plan are not anticipated to change as a result of GSP implementation.

Etna General Plan

The City of Etna's General Plan (EGP; Pacific Municipal Consultants 2005) describes objectives and programs to guide decision-making as it relates to land use and development to ensure the physical, economic, and social well being of the community. The EGP is applicable through Year 2024 and incorporates all elements, as required by Section 65402 of the California Government Code: land use, circulation, housing, conservation, open space, noise, and safety. Goals included in the EGP that are particularly relevant to the GSP include Goal LU-4 to preserve the small-town atmosphere through protection of scenery and open spaces (Pacific Municipal Consultants 2005). Etna relies on surface water for its water supply, diverting water off of Etna Creek.

2.1.4.3 Williamson Act Land

Contracts under the California Land Conservation Act of 1965, commonly known as the Williamson Act, are used to preserve open space and agricultural lands. Local governments and private landowners enter into voluntary agreements to restrict land for use in agriculture or as open space. Private landowners that enter into a Williamson Act contract benefit from lower property taxes. Lands that are eligible to be enrolled under these contracts must be a minimum of 100 acres and can be enrolled as either Prime or Non-Prime Williamson Act Farmland, based on the productivity specifications outlined in Government Code § 512021. In the County of Siskiyou, as of 2014, 96,993 acres (393 sq km) were enrolled as Prime Land and 324,300 acres (1,312 sq km) were enrolled as Non-Prime Land (California Department of Conservation (DOC) 2016).

2.1.4.4 Siskiyou Land Trust Conservation Easements

Several ranches and other landowners in Scott Valley have entered conservation easements with the Siskiyou Land Trust. These conservation easements are legal agreements by a landowner that specify the future use of the land. Restrictions on land uses primarily limit non-agricultural development beyond existing governmental land use plans. Conservation easements are acquired through a variety of approaches, including in exchange for financial compensation.

2.1.5 Additional GSP Elements

2.1.5.1 Policies governing wellhead protection, well construction, destruction, abandonment and well permitting

In the Scott Valley Basin, wellhead protection and well construction, destruction, and abandonment are conducted according to relevant state guidelines.

Well standards are codified in Title 5, Chapter 8 of the County Code based on an ordinance adopted in 1990. These well standards define minimum requirements, including those for monitoring wells, well construction, deconstruction, and repair, with the objective of preventing groundwater pollution or contamination (County of Siskiyou 2020b). Processes and requirements for well permitting, inspections, and reporting are included in this chapter.

The CSEHD is the local enforcement agency with the authority to issue well permits in the County. Well permit applications require information from the applicant and an authorized well contractor, along with a fee.

The County has worked on obtaining hydrological data/modeling to help inform individual well permitting decisions beginning with the Scott Valley; and public discussion and decision making related to the impacts of the public trust doctrine on groundwater management is on-going. The GSA will look for opportunities to coordinate with the County on providing collected hydrologic information that may assist the County.

2.1.5.2 Groundwater Use

Effective August 4, 2020, Ordinance 20-13 amended Chapter 13 of Title 3 of the County Siskiyou Code of Ordinances to add Article 7. Article 7 defines use of groundwater for cultivation of cannabis to be a waste and/or unreasonable use of groundwater and prohibits extraction and discharge of groundwater underlying the County for this activity.

2.1.5.3 Groundwater Extraction and Illegal Cannabis

On August 4, 2020, Ordinance 20-13 amended Chapter 13 of Title 3 of the County Siskiyou Code to add Article 7. Article 7 finds extracting and discharging groundwater for illegal cultivation of cannabis to be a public nuisance and a waste and/or unreasonable use of groundwater and prohibits this activity. Ordinance 20-13 was replaced by Ordinance 20-15 in the fall of 2020; however, the substantive provisions of the ordinance remain the same.

Siskiyou County has adopted multiple ordinances relating to the regulation of cannabis. Chapter 15 of Title 10 of the Siskiyou County Code prohibits all commercial cannabis activities, and Chapter 14 limits personal cannabis cultivation to the indoor growth of a maximum of 12 plants on premises with a legal water source and an occupied, legally established residence connected to an approved sewer or septic system. Personal cultivators are also prohibited from engaging in unlawful or unpermitted surface drawing of water and/or permitting illegal discharges of water from the premises.

2.1.5.4 Groundwater Export

Groundwater export is regulated in the County under Title 3, Chapter 13 of the Siskiyou County Code. Since 1998, Chapter 13 has regulated the extraction of groundwater from Bulletin 118 basins underlying the County for use outside of the basin from which it was extracted. Exceptions include 1) groundwater extractions by a district purveyor of water for agricultural, domestic, or municipal use where the district is located partially within the County and partially in another county, so long as extracted quantities are comparable to historical values; and 2) extractions to boost heads for portions of these same water purveyor facilities, consistent with historical practices of the district . Groundwater extractions for use outside the County that do not fall within the exceptions are required to obtain a permit for groundwater extraction. Permit application processes, timelines, and specifications are described in this ordinance.

In May of 2021, Title 3, Chapter 13, was amended to add Article 3.5, which regulates, through ministerial permitting, the extraction of groundwater for use off the parcel from which it was extracted. This provision requires extracted groundwater be for uses and activities allowed by the underlying zoning designation of the parcel(s) receiving the water and does not apply to the extraction of water for the purposes of supplying irrigation districts, emergency services, well replenishment for permitted wells, a “public water system,” a “community water system,” a “noncommunity water system,” or “small community water system” as defined by the Health and Safety Code, serving residents of the County of Siskiyou.

2.1.5.5 Policies for dealing with contaminated groundwater

Migration of contaminated groundwater from point sources, such as leaking fuel tanks, is managed through coordination with NCRWQCB or DTSC. Open cleanup sites are discussed in Section 2.2.2.3, subsection “Contaminated Sites”. Non-point sources of contaminated groundwater, such as may occur with the application of pesticides, are described in Section 2.2.2.3.

2.1.5.6 Replenishment of groundwater extractions and conjunctive use

No artificial groundwater replenishment or conjunctive use projects in Scott Valley are currently operational. Groundwater recharge experiments were conducted in Scott Valley in 2015 and 2016 (Dahlke et al. 2018) and the SVID is actively exploring the feasibility of a Managed Aquifer Recharge pilot project. To conduct the groundwater recharge experiments in 2015 and 2016, the SWRCB granted a temporary groundwater storage permit, the first for this application of water diversion and use, to allow SVID to divert a maximum volume of 5,400 acre-feet of water during high flows (SWRCB 2016). The diverted water was applied at varying amount and timings, to alfalfa fields to evaluate groundwater recharge and crop effects (Dahlke et al. 2018).

2.1.5.7 Coordination with land use planning agencies

Land use planning agencies may limit operational flexibility in GSP implementation. Land use planning agency policies or guidance may limit locations and/or size of proposed projects (see Chapter 4). Coordination will likely be required with relevant planning, public works and/or zoning commissions.

2.1.5.8 Relationships with state and federal regulatory agencies

The GSA has relationships with multiple state, federal and tribal agencies, as described in the Section 2.1.2 Monitoring and Management Programs. These state and federal agencies include CDFW, NCRWQB, USFS, DWR and QVIR. The GSA will continue to coordinate and collaborate with these agencies throughout GSP development and implementation.

2.2 Basin Setting

2.2.1 Hydrogeologic Conceptual Model

2.2.1.1 Geography

The Scott River watershed (8-digit Hydrologic Unit Code 18010208) encompasses 814 sq mi (2,108 sq km) of mountainous terrain centered on 100 sq mi (259 sq km) of valley floor (Figure 8). Along the course of the mainstem of the Scott River, the valley floor slopes from 2900 ft (884 m) amsl near the confluence with Sugar Creek to 2620 ft (799 m) amsl at the north end of the Valley (Figure 17). The area that overlies the aquifer (the Scott River Valley Groundwater Basin, hereafter the Basin) includes the broad central area between the cities of Fort Jones and Etna and the mouths of multiple canyons which convey tributaries on the western side of the Basin and are typically dry gulches on the eastern side (Figure 8).

The valley floor transitions sharply to the mountains bordering the Valley, all of which are subranges of the Klamath Mountain Range. The Scott Bar, Marble, Salmon, and Scott Mountains bound the Watershed to the north, west, southwest, and south, respectively. The mountains on the west side of Scott Valley are steeper and reach higher elevations (8,000 to 8,551 ft amsl; 2438 to 2606 m amsl) than the hills that border the east side of the Valley, known as the Mineral Range (6,000 to 7,000 ft amsl; 1,828 to 2,134 m amsl). Elevations in the Watershed range from 8,551 ft (2,606 m) amsl on China Mountain, part of the Scott Mountains, to 1,535 ft (468 m) amsl where the Scott River joins the Klamath at River Mile 143. Tributaries to the Scott River from the western mountains have deposited steep alluvial fans on the valley floor (Mack 1958).

Vegetation on the mountains to the north, south, and west of Scott Valley mainly consists of mixed conifer and hardwood tree species (Harter and Hines 2008; NCRWQCB 2005). The mountains on the eastern side of the Watershed host annual and perennial grasses and shrubs, in addition to conifer stands with ponderosa pine (Harter and Hines 2008). The Valley and headwater tributaries of the mountains surrounding Scott Valley provide key spawning and rearing habitat for native anadromous fish species, including *Oncorhynchus tschawytscha* (Chinook salmon) and *Oncorhynchus kisutch* (coho salmon). Coho salmon in the Southern Oregon Northern California Coast Evolutionary Significant Unit (SONCC ESU) are listed as threatened at both the federal and state levels (NCRWQCB 2005).

Six subwatersheds, grouped by geographic region, have been defined in Scott Valley: the East Headwaters, West Headwaters, the Valley, Westside Mountains, the Eastside foothills and Moffett Creek, and the Canyon (SRWC 2005).

The East Headwaters encompass the East Fork of the Scott River above Callahan, which drains a 113.5 sq mi (294 sq km) area in the Scott Mountains and converges with the South Fork at River Mile 58. Elevations range from 8,540 ft (2603 m) on China Mountain to 3,120 ft (951 m) at Callahan; tributaries tend to be small and steep, flowing into low gradient channels at the base of valleys (SRWC 2005). Land uses in the surrounding areas are predominantly forest, rangeland, and irrigated agriculture.

The West Headwaters encompass the South Fork of the Scott River above Callahan, which drains a 39.3 sq mi (101.8 sq km) area with elevations from 7,400 ft (2,256 m) to 3,120 ft (951 m) at Callahan (SRWC

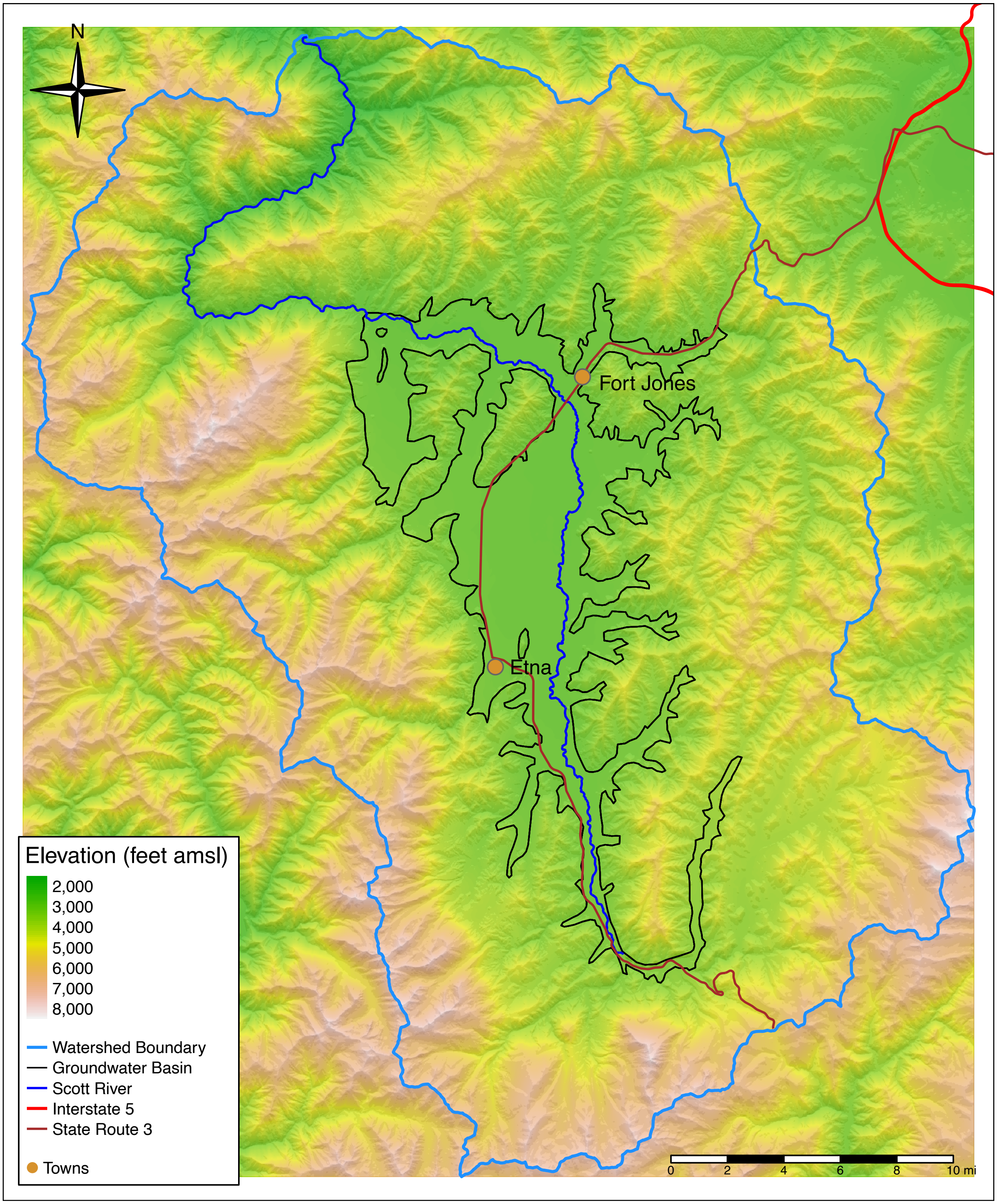


Figure 8: Topography of the Scott River Valley Groundwater Basin and surrounding watershed.

2005). Tributaries are generally small and steep and are impacted by snow pack and runoff. Land in this subwatershed is predominantly used for commercial forestland and wilderness areas.

The Valley encompasses the area from Callahan to the lower end of Scott Valley. Land in this area is predominantly used for agriculture. This subwatershed includes 60, 000 acres (243 sq km) and includes the alluvial deposits by tributaries to Scott Valley (SRWC 2005). Flood control and bank stabilization measures have been implemented along much of the channel in this subwatershed. Main tributaries include French, Etna, and Kidder Creeks. The mainstem of the Scott River in this subwatershed has a sinuous channel pattern, with a wide, flat floodplain and off-channel habitat. The average slope of the Scott River in this subwatershed is less than 0.1% (SRWC 2005). Streambed composition varies throughout this section from cobble-dominated in the steeper reaches near Callahan, sand-dominated in the low-slope reaches by Fort Jones and cobble-dominated in the rest of the channel (SRWC 2005; Sommarstrom, Kellogg, and Kellogg 1990).

The Westside Mountains are the source of some of the major tributary streams to Scott River including: Sugar Creek, French Creek, Etna Creek, Kidder/Patterson Creeks and Shackleford/Mill Creeks. Elevations fall in the range of 2,700 ft (823 m) in Quartz Valley to 8,200 ft (2,499 m) at Boulder Mountain. This subwatershed drains 181 sq mi, with precipitation at elevations above 5,000 ft (1,524 m) falling as snow (SRWC 2005). Headwater tributaries in this area are mostly steep, small, and low order with streamflows heavily influenced by snowfall. These high-gradient streams flow into lower gradient alluvial channels at valley bottoms. Most of the land in this area is wilderness and commercial forestland with some residences in the lower areas.

The largest watershed in the Eastside Foothills is Moffett Creek which drains 227.1 sq mi (588 sq km) with elevations ranging from 2,700 to 6,050 ft (823–1,844 m) (SRWC 2005). Other streams in the eastside foothills are ephemeral. The Canyon is a small subwatershed that includes 20 mi (32 km) of the Scott River that flows through a steep canyon, and is fed by perennial tributaries of Canyon, Kelsey, Middle, Tompkins, and Mill Creeks (SRWC 2005).

2.2.1.2 Climate

Scott Valley has a Mediterranean climate with distinctive seasons of cool, wet winters and warm, dry summers. The orographic effect of the mountains to the west and south of the Valley creates a rain-shadow in eastern areas of the Valley. Long-term records are available from National Oceanic and Atmospheric Administration (NOAA) weather stations in and around Scott Valley; relevant stations are listed in Table 7. The higher elevation areas to the west and south of the Valley historically receive greater annual precipitation (60–80 inches [in]; 152–203 centimeters [cm]) in comparison to annual precipitation on the east side of the Valley (12–15 ins; 30–38 cm) (SRWC 2005). At elevations below 4,000 ft (1219 m), precipitation mostly occurs as rainfall, as is the case on the valley floor. Precipitation accumulates as snow in the surrounding mountains, with a rain-snow transition zone between 4,000 and 5,000 ft (1219 and 1524 m) (McInnis and Williams 2012). Accumulation of snowfall in the surrounding mountains results in runoff during spring melting (Deas and Tanaka 2006). Long-term mean annual precipitation on the valley floor is 18 in (46 cm) with most accumulation occurring during the winter and early spring months (October–May), with peak precipitation in December and January (Figure 9). Mean daily low and high temperatures for January and July are -5 to 7°Celsius (C) (23 to -45°Fahrenheit (F)) and 9 to 33°C (48 to -92°F), respectively (Figure 10). Reference evapotranspiration (ET) ranges from 0.01 to 0.31 in/day (0.03 to 0.79 cm/day) (Figure 10).

The long-term historical precipitation record indicates that recent average precipitation and snowfall are lower than levels recorded in the middle of the 20th century. Between 1945 and 1979, the 10-year trailing rolling average precipitation ranged from 19.1 to 23.5 in (48.5–59.7 cm; water years 1950 and 1959, respectively); since 1980, it has ranged between 11.5 and 18.7 inches (48.5-59.7 cm;water years 1989 and 1980, respectively; Figure 9). Additionally, average snow depth at snow measurement stations near the western boundary of the Watershed has gradually decreased over time. Although, at three stations near the southern boundary of the Watershed the snow depths have remained relatively stable. Regression lines fit through the record of each station suggest that the average snow depths in the five western stations have declined by 0.5 to 1.11 in (1.3 to 2.8 cm) per year. In the southern part of the Watershed, long-term average snow depths at three stations have remained stable, increasing at a rate between 0.01 and 0.06 in (0.03 to 0.2 cm) per year (Figure 11; Table 8). There has also been a decrease in the percentage of precipitation falling as snow on a regional scale over the past 70 years, as noted by Lynn et. al (2020).

Station ID	Station Name	Elevation (ft amsl)	Start Date	End Date	Record Length (years)	No. Missing Days
US1CASK0005	YREKA 0.9 WNW, CA US	2692	2008-12-01	2021-06-27	12.6	65
USC00041316	CALLAHAN, CA US	3085	1943-10-01	2018-11-30	75.2	62
USC00042899	ETNA, CA US	2960	1930-01-29	1951-09-30	21.7	10
USC00043182	FORT JONES RANGER STATION, CA US	2729	1936-01-09	2021-06-14	85.4	2072
USC00043614	GREENVIEW, CA US	2820	1941-08-01	2008-05-31	66.8	738
USC00049866	YREKA, CA US	2709	1893-02-01	2021-06-27	128.4	1691

Table 7: Station details and record length for NOAA weather stations in and near Scott Valley. Record end dates within the year 2020 simply reflect the last date of download of information from those databases and do not reflect the actual end of the record.

Station ID	Station Name	Elevation (ft amsl)	Operator	First Year	Last Year	Avg. Max. Depth
mbl	middle boulder 1	6,600	Salmon/Scott River Ranger District	1947	2022	60.2
bxc	box camp	6,450	Salmon/Scott River Ranger District	1980	2022	75.6
mbv	marble valley	5,900	KNF Ranger District	1952	1983	104.0
mb3	middle boulder 3	6,200	US Bureau of Reclamation	1949	2022	52.6
log	log lake	5,300	KNF Ranger District	1952	1979	73.8
sct	scott mountain	5,900	US Bureau of Reclamation	–	–	–
dym	dynamite meadow	5,700	Salmon/Scott River Ranger District	1956	2022	42.0
etn	etna mountain	5,900	Salmon/Scott River Ranger District	1952	2022	63.1
swj	swampy john	5,500	Salmon/Scott River Ranger District	1952	2022	68.7

Table 8: Station details for CDEC snow measurement stations in the Scott River watershed.

2.2.1.3 Geology

A portion of the California Geologic Survey (CGS) digitized geologic map (CGS 2010), centered on Scott Valley, is shown in Figure 12. Descriptions of the geologic formations are provided below in Table 9.

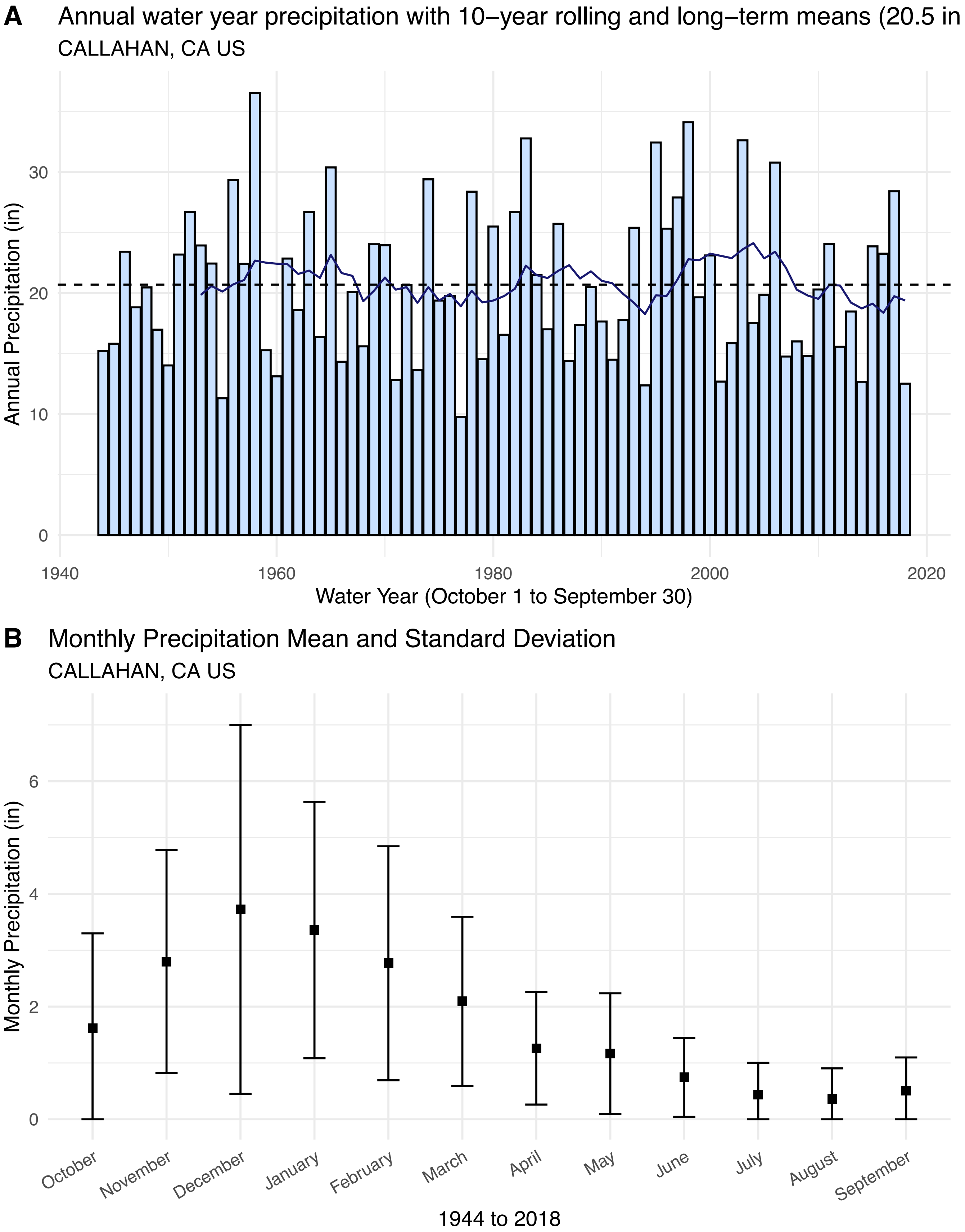


Figure 9: Annual (Panel A) and monthly precipitation (Panel B) over the 1936-2019 record as measured at the Fort Jones Ranger weather station (USC00043182).

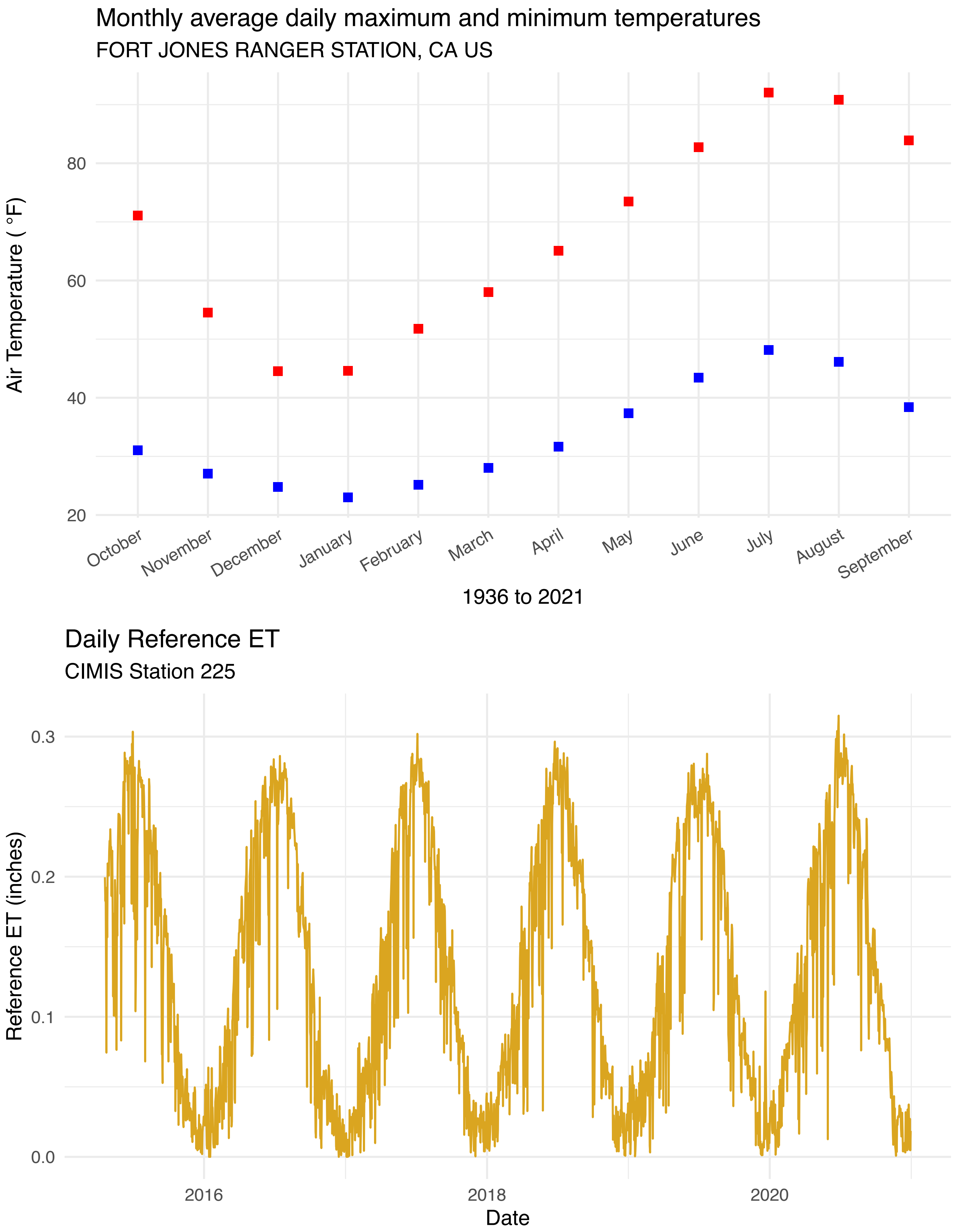
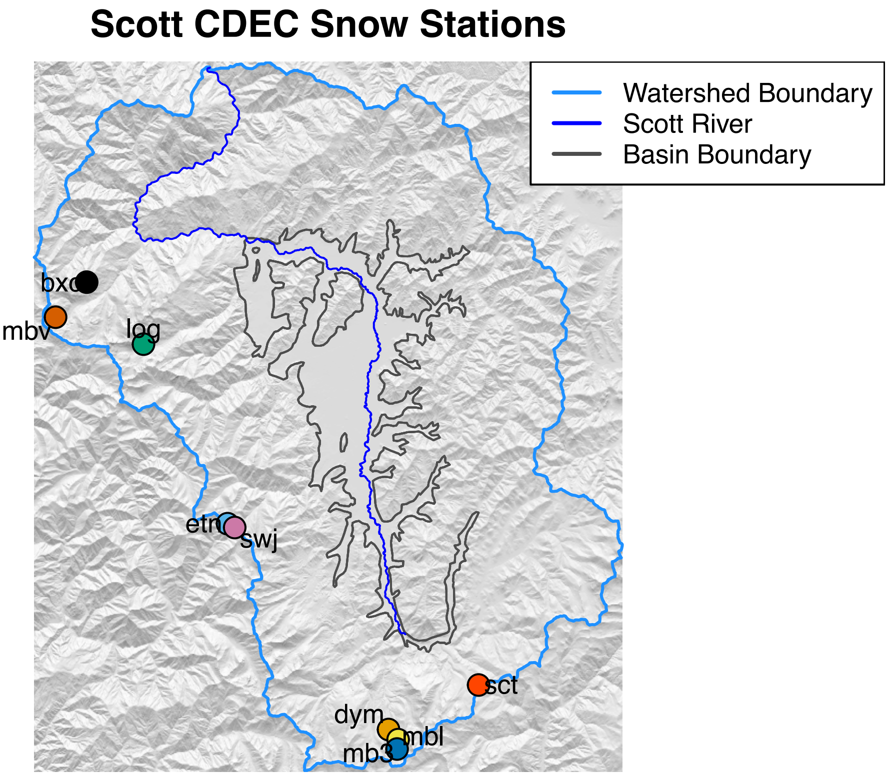


Figure 10: Monthly averages of daily maximum and minimum air temperature (top panel) over the 1936-2019 record at the Fort Jones Ranger Station (USC00043182), and reference evapotranspiration (ET) from 2015-2019 calculated at CIMIS Station 225 near Fort Jones.



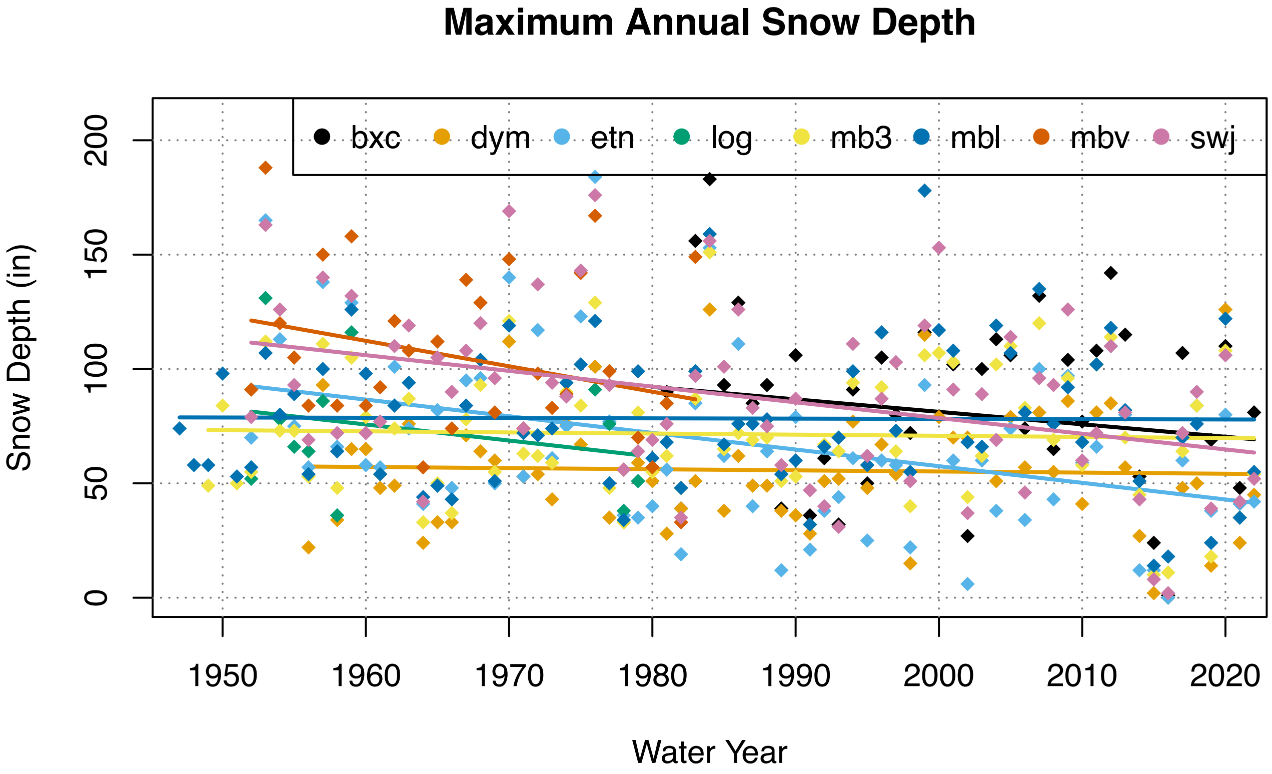


Figure 11: Annual maximum snow depth measured at eight California Data Exchange Center (CDEC) snow stations in the Scott Valley watershed. For more information see table below.

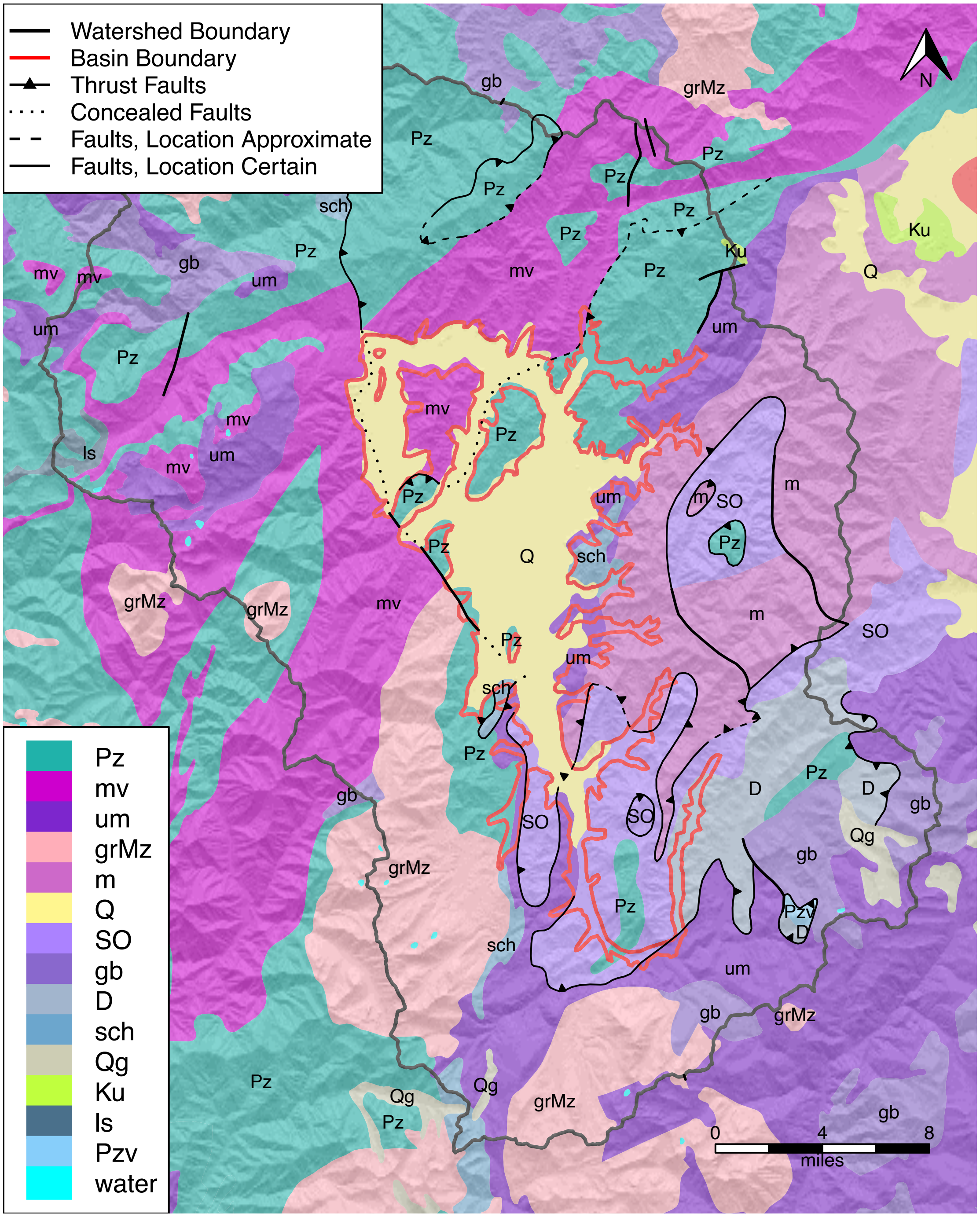


Figure 12: Geologic formations and faults mapped in the vicinity of the Scott Valley watershed. The mapped geologic data are taken from the 2010 Geologic Map of California (CGS 2019). In the legend, geologic formations are listed in order from highest to lowest proportional area visible in the vicinity of the Watershed. Formation details included in Table 6.

The Basin boundary generally corresponds to the area covered by valley alluvium, bounded by the contact between the alluvium and older bedrock, as seen in Figure 12. The complex geology of Scott Valley has previously been simplified by grouping geologic units into four main categories: Quaternary deposits, granitic bedrock, mafic and ultramafic bedrock, and sedimentary bedrock (NCRWQCB 2005) . Generally, Quaternary deposits are composed of unconsolidated gravel sand and soils and make up the low gradient valley floor, extending up some tributary valleys. The granitic bedrock is in the mountains to the west of the Valley, ranging in composition from granite to granodiorite (NCRWQCB 2005; Mack 1958). Mafic and ultramafic bedrock is largely altered to serpentine and is found in the Marble Mountains in the northeast part of the Watershed and the Scott Mountains in the southeast part of the Watershed. Mafic and ultramafic bedrock also form a discontinuous band, extending from the southeast to northeast regions of the Watershed. Most of the Watershed is composed of sedimentary and metamorphic bedrock that ranges in age and composition. This includes metasedimentary rocks, largely Mesozoic and Paleozoic in age, that are part of the Western Paleozoic and Triassic belt; and parts of the Eastern Klamath belt, including metasedimentary, metavolcanics, and Silurian-Ordovician marine rocks (Wagner and Saucedo 1987). A more detailed description of the geology is provided below.

Geologic History

Scott Valley has two major geologic components, the alluvial deposits in the valley and the underlying bedrock, which also forms the surrounding mountains. The Basin is part of the Klamath Mountain Province, one of the eleven geomorphic provinces within California. The Klamath Mountain province was created through a series of accretionary events during the Paleozoic and Mesozoic. Terranes that form the bedrock in the Scott Valley area were accreted from 450 to 130 million years ago (Ma) and include Yreka terrane, Central Metamorphic belt, Stuart Fork terrane, and the terranes of the Western Paleozoic and Triassic Belt (Foglia et al. 2013). Intrusive events resulted in the formation of major plutons, including Russian Peak, located to the southwest of Scott Valley. Bedrock in the Scott Valley area is composed of slightly metamorphosed volcanic and sedimentary rocks, medium to high grade metamorphic rocks, a suite of granitic rocks with compositions from granite to granodiorite, mafic and ultramafic rocks that are mostly altered to serpentine, and minor amounts of limestone (NCRWQCB 2005; Mack 1958).

The oldest of the geologic formations that form the bedrock in Scott Valley include the Abrams sedimentary sequence and Salmon volcanic deposits, formations that likely date back to the pre-Silurian (Mack 1958). Subsequent marine deposits of the Chanchelulla formation accumulated during the Silurian, coinciding with a period of subsidence. Following deposition of the Chanchelulla, there was uplift, metamorphism, and erosion, followed by a period of intense volcanic activity. The Nevadan orogeny, beginning in the Jurassic, resulted in intense folding, faulting, and uplift. Igneous intrusions were common throughout, and following this orogeny. During the Cretaceous period, the Scott Valley area may have been completely underwater, covered by a Late Cretaceous sea. By the end of this period, uplift resulted in elevation of the mountains above sea level. Subsequent periods of erosion and uplift occurred, with the formation of Scott Valley thought to have taken place during the Quaternary (Mack 1958).

Folding, faulting, and shearing have caused deformation which has, in the last 1–2 million years, caused subsidence of the valley floor and uplift of the mountains (NCRWQCB 2005). In the Quaternary and late Tertiary, faulting resulted in a depression in the middle portion of Scott Valley, which lies several hundred feet lower than the bedrock in the northern part of the valley. Streams have deposited sediment throughout this area, resulting in the alluvial fill that comprises the main water bearing units today.

Tributaries on the western side of the valley that converged with the Scott River eroded the ridges between the western tributaries and main valley. Recently, the bedrock below the valley moved downward along the western mountain fault as the Scott River began to aggrade, and the course of the Scott River shifted to flow along the eastern side of the valley.

Geologic Units

Descriptions of the main stratigraphic units in the Scott Valley area, as described by Mack (1958), are listed below from oldest to youngest.

Salmon and Abrams (Pre-Silurian)

The Salmon hornblende schist and Abrams mica schist are highly metamorphosed units thought to be Pre-Silurian in age. These formations are distinguished by their high degree of metamorphism and represent the oldest formations in the area (Mack 1958). The Abrams is a metasedimentary sequence predominantly comprised of quartz-mica schist, though lithology varies with location. Although highly metamorphosed, the schistosity mirrors the bedding planes of the original sedimentary deposits. The Salmon hornblende schist unconformably overlies the Abrams. Primarily composed of metamorphosed volcanic deposits with interbedded metasedimentary white marble, the Salmon formation shows relatively uniform lithology throughout Scott Valley (Mack 1958).

These two formations form most of the bedrock of the mountains surrounding Scott Valley; water flows through fractures in these units to form springs.

Chanchelulla (Silurian)

The Chanchelulla formation, composed of greenstone and greenstone schist, unconformably overlies the Abrams and Salmon formations. This Silurian-age formation has been tentatively correlated with Hinds's Chanchelulla formation. These strongly folded, interbedded layers of chert, quartzite, slate, phyllite, chlorite-sericite schist and limestone exceed thicknesses of 5,000 ft (1524 m) and make up most of the bedrock in the southern portion of Scott Valley, extending between Callahan and Shasta Valley. Within Scott Valley the Chanchelulla has undergone slight metamorphism. Jointing in this formation provides pathways for water to flow and form springs.

Greenstone (Devonian)

Greenstone and greenstone schists have been identified as possibly Devonian in age and unconformably overlie the Abrams and Salmon formations in the north and western portions of Scott Valley. The greenstone and greenstone schists of volcanic origin contain lens-shaped older sedimentary beds, comprised of chert, argillite, and limestone. This formation is strongly jointed, allowing water to flow to springs.

Serpentine (Late Jurassic)

These intrusive masses were originally peridotite and have been altered to serpentine. The largest intrusions are in the northern part of Scott Valley with smaller masses in the area around Callahan. The serpentine is strongly sheared and fractured, allowing water to flow to springs.

Granodiorite (Early Cretaceous or Late Jurassic)

Predominantly composed of granodiorite, this body intrudes the Abrams, Salmon, and Greenstone formations. The granodiorite is commonly sheared and strongly jointed and water travels through these joints to feed western tributary streams.

Alluvial Fill

Older Alluvium (Pleistocene)

The older alluvium is composed of poorly sorted fan and terrace deposits, less than 50 ft (15 m) in thickness. These deposits were likely formed between periods of uplift and are mostly concentrated along the edges of Scott Valley. The older alluvium is continuous in the southern sections of Scott Valley and is present in discontinuous patches near Quartz Valley and Etna Creek.

The older alluvium, poorly sorted and limited in extent, is not known to be a productive aquifer and water wells are predominantly located in the younger alluvium.

Younger Alluvium (Recent)

The younger alluvium is composed of concurrent stream channel, floodplain, and alluvial fan deposits. Forming alluvial plains of Oro Fino, Quartz Valley, and Scott Valley, the younger alluvium extends up tributaries. Thinning towards the valley margins, the younger alluvium can reach thicknesses greater than 400 ft (122 m) near the center of Scott Valley. Spatially, the composition of the alluvium is variable throughout Scott Valley. Along the west side of the Valley, north of Etna, the alluvial fan deposits are composed of boulders and cobbles. Compositions in channel deposits of tributary streams have varying proportions of boulders, gravel, sand, and clay. Seasonal flow, as in Patterson Creek and Kidder Creek, may infiltrate more permeable channel deposits, while the channel deposits underlying Crystal Creek are more impermeable and may allow for sustained flow throughout the summer season (Mack 1958). With increasing distance downslope in the valley, percentages of finer particles such as sand, silt, and clay increase. These areas are less permeable due to the presence of clay beds. The floodplain deposits between Etna and Fort Jones have been found to be highly permeable, composed predominantly of sand and gravel with alternating clay beds. Water wells drilled into the lenses of sand and gravel between these clay layers have been productive.

Structures

Scott Valley is strongly metamorphosed, folded, and faulted. Notably, a northwestward-trending normal fault, dipping steeply to the east, is located along the western mountains, extending from south of Crystal Creek to Quartz Valley (Mack 1958). The fault trace passes under the alluvium of Scott Valley south of Crystal Creek (Figure 17). Relative displacement between the upthrown side on the west, and the downthrown side on the east could be thousands of feet [Mack (1958); Figure 12]. This fault, and subsequent cross faulting, are thought to have originated during the Jurassic, a result of the Nevadan orogeny. Wildcat Creek follows the fault zone of a high-angle, northeastward-striking reverse fault, located 1 mile to the north of Callahan. There are many smaller, less extensive faults throughout the valley. Movement along the western Scott Valley fault and the Greenhorn fault, located to the north of the valley, is the main mechanism for the formation of a tectonic graben, of which Scott Valley forms the western portion (Foglia et al. 2013).

Aquifers

The Basin underlying the alluvial floodplain is the primary groundwater feature in the area. Valley alluvium is mostly Recent in age with a few isolated Pleistocene sections along the edges of the Valley. As defined by DWR (2004), the Basin is 28 mi (45km) in length, 0.5 to 4 mi (0.8 to 6 km) in width and covers a surface area of 100 sq mi (259 sq km). The predominant water-bearing units in Scott Valley are Quaternary stream channel, floodplain, and alluvial fan deposits (DWR 2004). The combined thickness of the water-bearing units is somewhat irregular, with the greatest thicknesses (estimated at 200 feet in Tolley, Foglia, and Harter 2019), located in central-western region of the Basin, and thinning out towards the Basin boundary (Figures 13-15).

The Basin is recharged by infiltration from Scott River and its tributaries, snow melt, precipitation, and water used for irrigation (Mack 1958). Recharge affects the groundwater levels, locally determining if sections of the Scott River are gaining or losing streams. In dry years, sections of the Scott River have become dewatered and channels have run dry as the water table dropped to a level beneath the bottom of the river channel (NCRWQCB 2005).

The Holocene stream channel deposits, comprised of unconsolidated sands, gravels, and clays that were deposited by the Scott River, are up to 260 ft (79 m) in thickness (SWRCB 1975). Permeability varies throughout these deposits with the highest permeability noted in the alluvium in the eastern portion of Scott Valley, a 1.5 mi (2.4 km) wide region between Etna and Fort Jones. This area is noted to have high permeability of up to 1,000 gallons per day (gpd) (SWRCB 1975), with specific capacities of 67 to 100 gallons per minute (gpm) per foot of drawdown (Mack 1958). Wells in this region are mostly used for irrigation. Lower permeability areas located on the floodplain have been found to contain poorly sorted gravel and clay, potentially representative of alluvial deposits form intermittent streams from Hamlin Gulch (Mack 1958). Regions to the west of Fort Jones and to the south of Etna contain mostly shallow, domestic wells.

To the west of the Scott River floodplain are the lower permeability alluvial fans, deposited by streams that discharge from mountains west of the valley (Mack 1958). Gravelly deposits in stream channels and fans from West Patterson, Kidder, Etna, and Shackleford Creeks are the most permeable of these deposits (Mack 1958). Discharge from the base of the alluvial fan deposits in the western portion of Scott Valley, between Etna and Greenview, has resulted in a series of wet areas, with the water table close to or at land surface. The most notable of these areas is due to discharge of water from the West Patterson and Kidder Creek alluvial fans. Wells in the alluvial fan deposits generally tap permeable sand and gravel deposits, confined by impermeable clay layers above and below. On the western side of the valley, a perched water table of approximately 100 acres (0.4 sq km) is comprised of permeable alluvial fan material deposited by Kidder and West Patterson Creeks and is located above silty clay deposits. Sources of water inputs include precipitation and seepage from the springs in the surrounding bedrock. The older alluvium is not a significant aquifer as it is generally situated in localized areas above the water table and at the margins of the Basin boundary, and is limited in extent (Mack 1958). Within the hydrogeologic units identified by Mack (1958), the sediment structure is highly heterogeneous. Digitization and review of over five hundred well logs did not indicate the presence of laterally extensive, identifiable confining units (Foglia et al. 2013).

Label	General Lithology	Age	Description
Pz	Marine sedimentary and metasedimentary rocks	Paleozoic	Undivided Paleozoic metasedimentary rocks. Includes slate, sandstone, shale, chert, conglomerate, limestone, dolomite, marble, phyllite, schist, hornfels, and quartzite.
mv	Metavolcanic rocks	pre-Cenozoic	Undivided pre-Cenozoic metavolcanic rocks. Includes latite, dacite, tuff, and greenstone; commonly schistose.
um	Plutonic rocks	Mesozoic	Ultramafic rocks, mostly serpentine. Minor peridotite, gabbro, and diabase; chiefly Mesozoic.
grMz	Plutonic rocks	Mesozoic	Mesozoic granite, quartz monzonite, granodiorite, and quartz diorite.
m	Mixed rocks	pre-Cenozoic	Undivided pre-Cenozoic metasedimentary and metavolcanic rocks of great variety. Mostly slate, quartzite, hornfels, chert, phyllite, mylonite, schist, gneiss, and minor marble.
Q	Marine and nonmarine (continental) sedimentary rocks	Pleistocene-Holocene	Alluvium, lake, playa, and terrace deposits; unconsolidated and semi-consolidated. Mostly nonmarine, but includes marine deposits near the coast.
SO	Marine sedimentary and metasedimentary rocks	Silurian-Ordivician	Sandstone, shale, conglomerate, chert, slate, quartzite, hornfels, marble, dolomite, phyllite; some greenstone.
gb	Plutonic rocks	Mesozoic	Gabbro and dark dioritic rocks; chiefly Mesozoic.
D	Marine sedimentary and metasedimentary rocks	Devonian	Limestone and dolomite, sandstone and shale; in part tuffaceous.
sch	Marine sedimentary and metasedimentary rocks	Paleozoic or Mesozoic	Schists of various types; mostly Paleozoic or Mesozoic age; some Precambrian.
Qg	Nonmarine (continental) sedimentary rocks	Pleistocene-Holocene	Glacial till and moraines. Found at high elevations mostly in the Sierra Nevada and Klamath Mountains.
Ku	Marine sedimentary and metasedimentary rocks	Upper Cretaceous	Upper Cretaceous sandstone, shale, and conglomerate.
ls	Marine sedimentary and metasedimentary rocks	Paleozoic or Mesozoic	Limestone, dolomite, and marble whose age is uncertain but probably Paleozoic or Mesozoic.
Pzv	Metavolcanic rocks	Paleozoic	Undivided Paleozoic metavolcanic rocks. Mostly flows, breccia, and tuff, including greenstone, diabase and pillow lavas; minor interbedded sedimentary rocks.
water			Lakes or ponds

Table 9: Details for geologic formations mapped in the vicinity of the Scott River watershed.

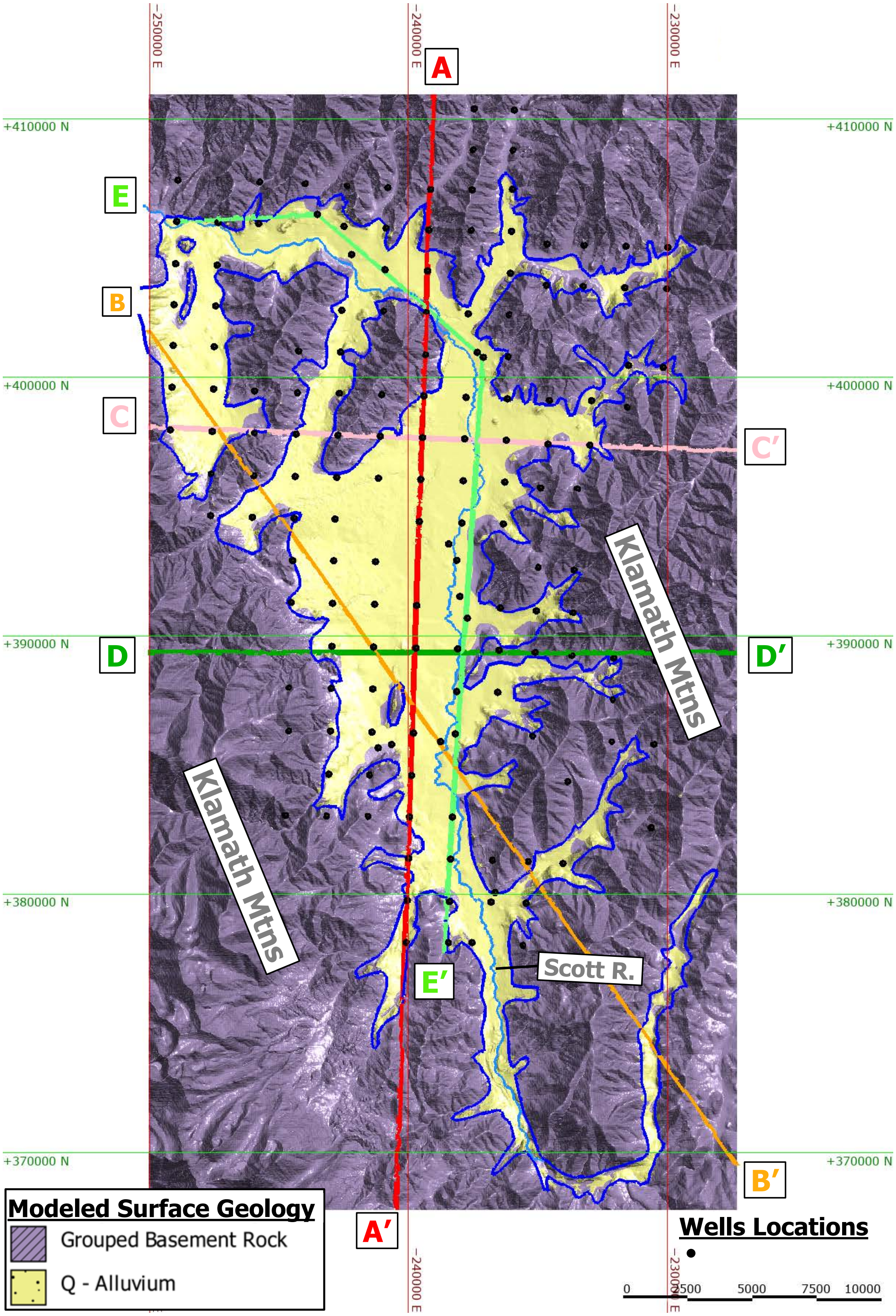
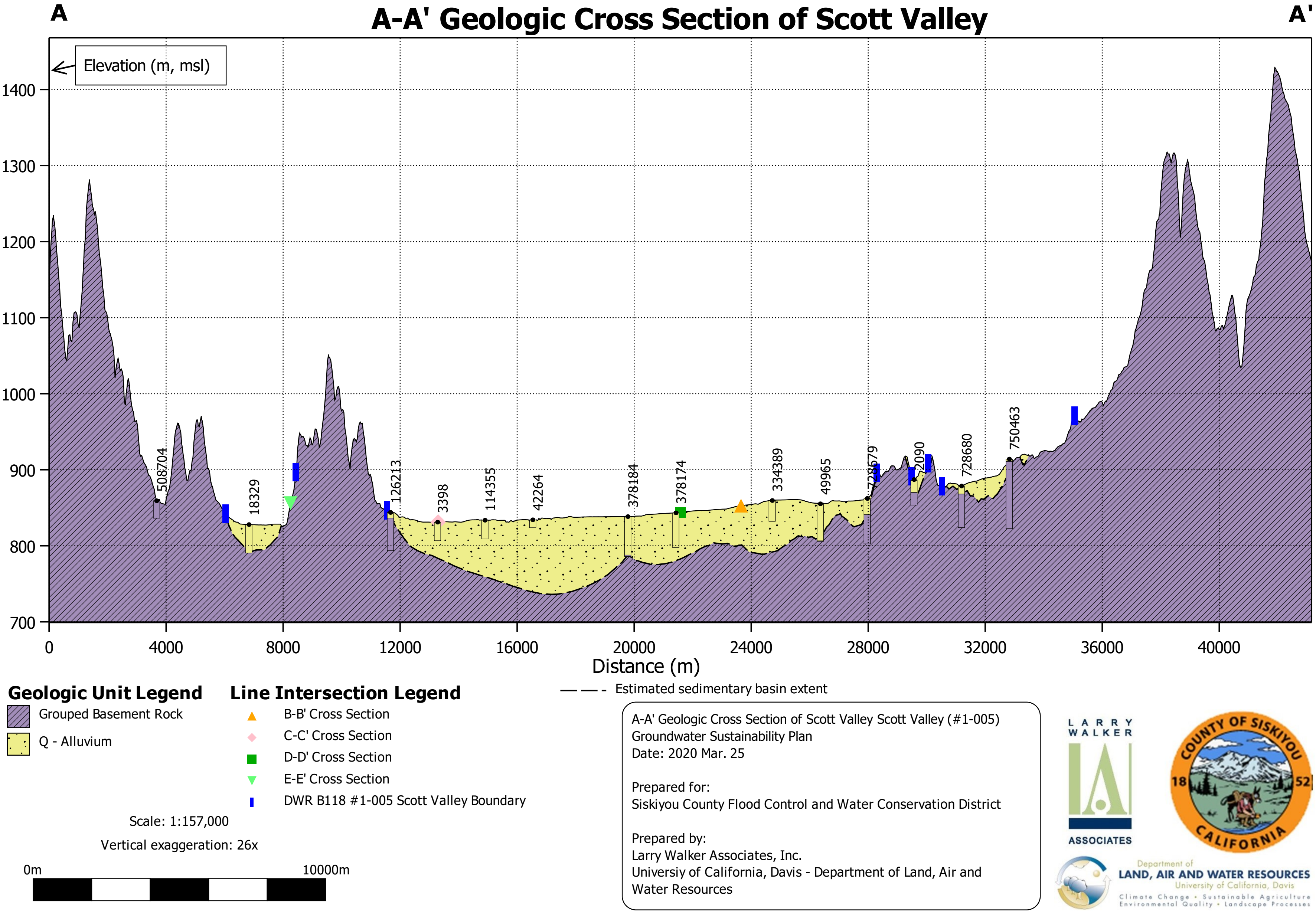


Figure 13: Scott River Valley Groundwater Basin Map of Cross Section Locations'



A-A' Geologic Cross Section of Scott Valley Scott Valley (#1-005)
Groundwater Sustainability Plan
Date: 2020 Mar. 25

Prepared for:
Siskiyou County Flood Control and Water Conservation District

Prepared by:
Larry Walker Associates, Inc.
Universiy of California, Davis - Department of Land, Air and
Water Resources

Figure 14: Scott River Valley Groundwater Basin Cross Section A-A’

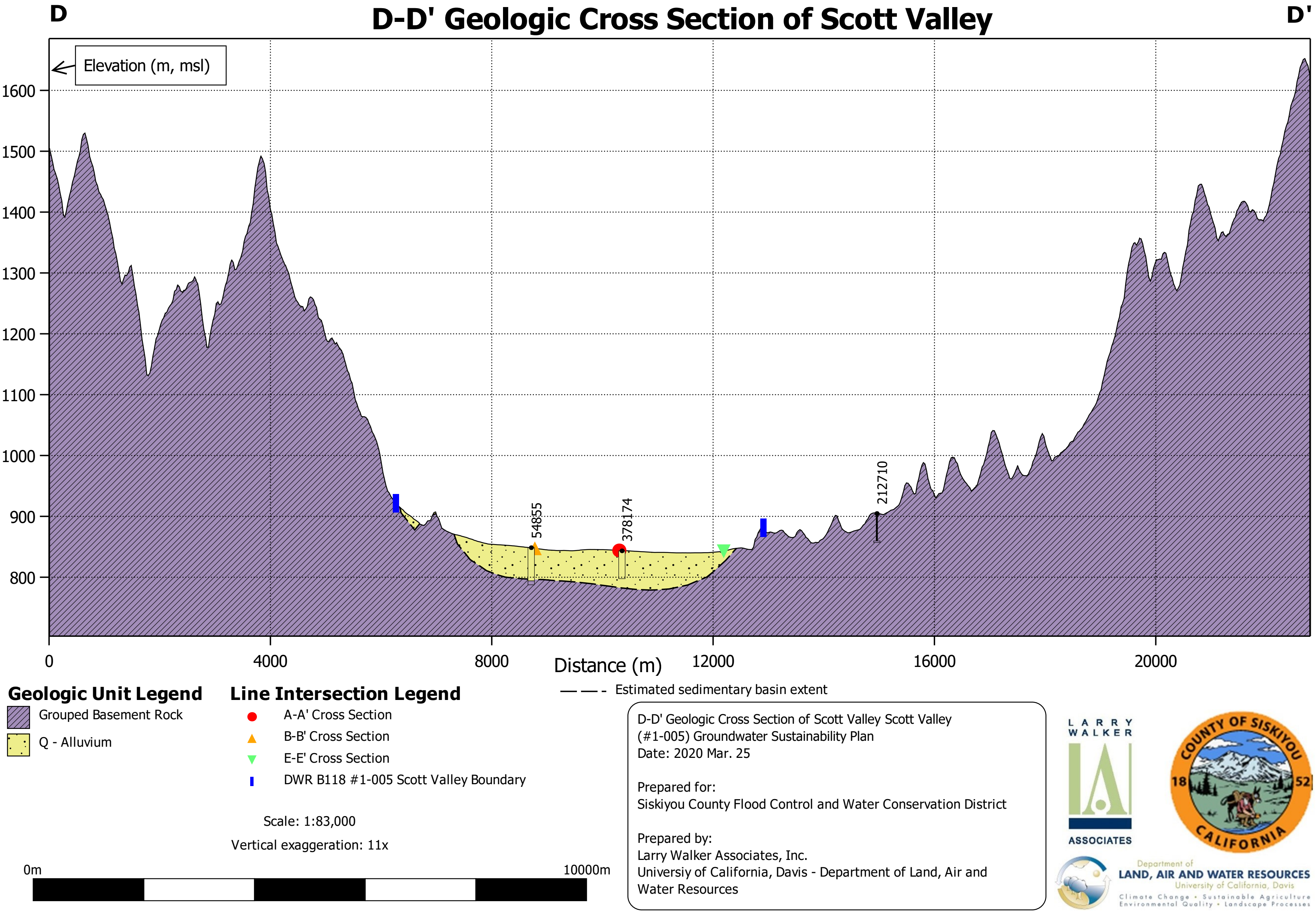


Figure 15: Scott River Valley Groundwater Basin Cross Section D-D’

2.2.1.4 Soils

Soils in Scott Valley have developed on the floodplains, alluvial fans, and mountain slopes, with distinct characteristics in each location. The following discussion references map units, named for major soil components, in the 1983 soil survey of central Siskiyou County (USDA 1983). A map of soil orders in the Watershed is shown in Figure 16. The soil series discussed below are members of the soil orders shown on this map. The Settlemeyer, Diyou, Stoner, Duzel, Copsey, Bonnet, and Esro soils are Mollisols; the Stoner and Odas soils are Inceptisols; the Pit soils are Vertisols and the Deetz soils are Entisols (USDA 2019).

Floodplain Soils

The floodplain soils are deep and level to gently sloping. These soils consist of poorly to somewhat poorly-drained loams derived from medium to moderately fine-textured alluvium derived from various source rock. These soils tend to have a high water table and are prone to flooding in the winter and spring when contributions from rainfall and snow melt are high. Present on the floodplains to the south of Fort Jones, Settlemeyer and Diyou soils have low slopes of 0 to 5% and 0 to 2% respectively and drainage is generally poor (USDA 1983). Both the Settlemeyer and Diyou soils have a stratified loam profile with fine sandy loam, silt loam, and sandy clay loam (USDA 1983). The floodplain soils also include minor amounts of poorly drained soils including Copsey, Odas, Pit, and Settlemeyer Variant soils, concentrated near streams and in higher areas in the floodplain in addition to Bonnet and Deetz soils. The very poorly-drained Esro soils, Xerofluvents, and Riverwash are present in the lower areas of the floodplain (USDA 1983). The Settlemeyer-Diyou map unit was identified as providing excellent habitat for birds and mammals (USDA 1983).

Alluvial Fan Soils

Alluvial fans form from steep tributary streams that flow onto alluvial deposits of the mainstem and tributaries. The predominant tributaries form expansive alluvial fans, which spread into the valley (ESA 2009). Soils that are formed on alluvial fans are nearly level to strongly sloped gravelly sandy loams that are very deep and well drained. The alluvium from which these soils formed is moderately coarse to medium textured and is derived from a variety of rock sources from tributary source areas. Stoner Soils are primarily located on alluvial fans in Scott Valley and have slopes ranging from 0 to 15%. These soils usually have a profile with a gravelly sandy loam and a very gravelly loam subsoil (USDA 1983). This unit also includes minor amounts of the Atter soil, which is somewhat excessively drained and contains rock fragments, and the well drained Duzel, Kinkel, and Kindeg soils that are located on the upper slopes of the alluvial fans. In the upper Moffett Creek area, Bonnet soil can also be present. It is a gravelly loam and a gravelly loam subsoil with accumulation of lime (USDA 1983).

Klamath Mountain Soils

Soils that develop on the slopes of the Klamath Mountain Range vary in character from shallow to very deep, well drained to excessively drained and medium to moderately coarse textured (USDA 1983).

Soil Agricultural Banking Index (SAGBI)

The Soil Agricultural Banking Index (SAGBI) identifies the potential for groundwater recharge on areas of land based on five factors: deep percolation, root zone residence time, topography, chemical limitations, and the condition of soil surfaces (O'Geen et al. 2015). SAGBI ratings for the soil series in the Scott Valley area can be viewed on a web application (app), developed by the California Soil Resource Lab at the University of California at Davis and University of California Agriculture and Natural Resources (UC Davis Soil Resource Lab and University of California Agriculture and Natural Resources 2019). The soils on the valley floor, predominantly of the Settlemeyer and Diyou type , have SAGBI ratings of “poor”. In contrast, areas that are primarily composed of Stoner soils, located on the alluvial fans at the edges of the valley floor, have a SAGBI Rating of “good”, and the isolated patches of soils of the Atter series have SAGBI ratings of “excellent”.

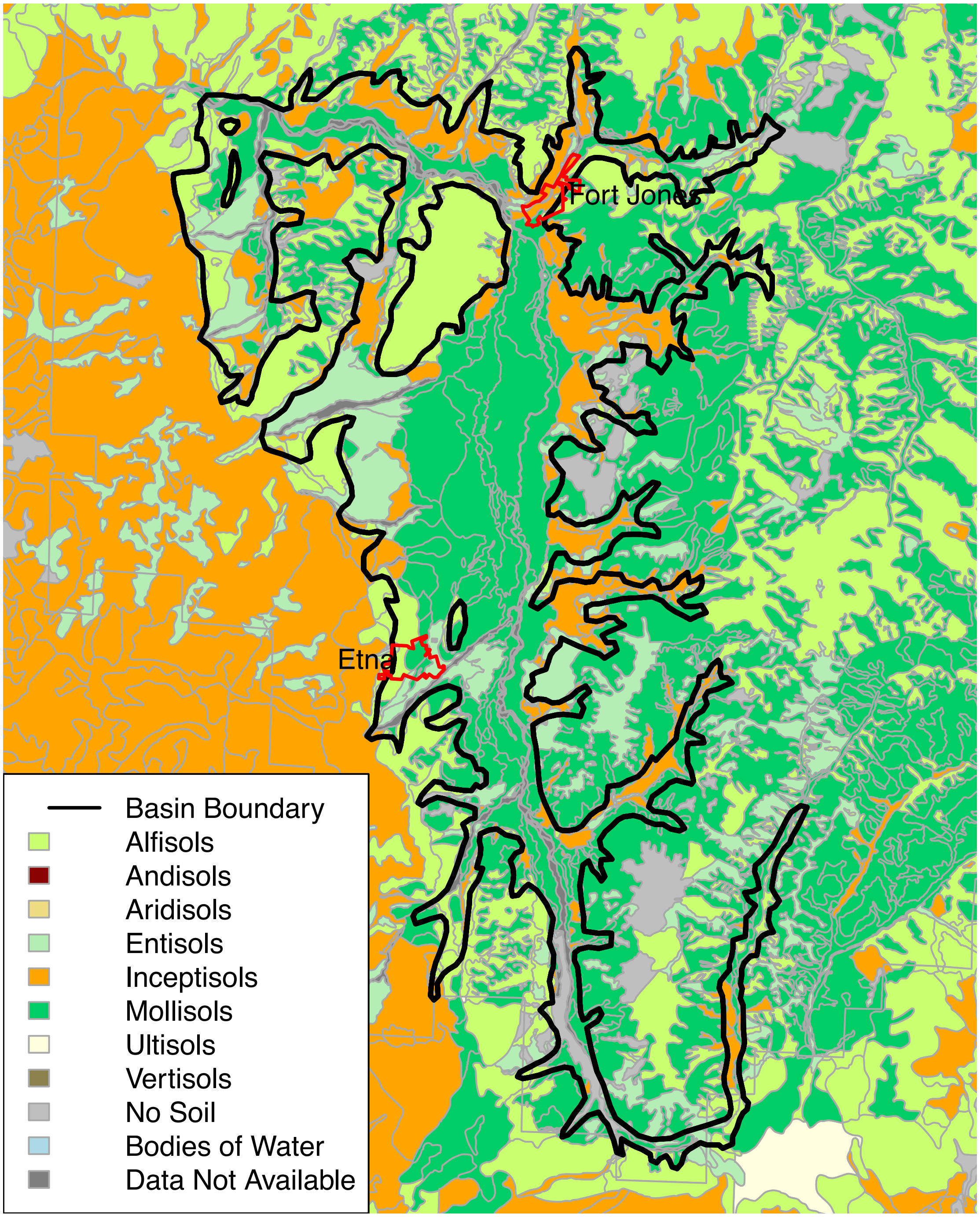


Figure 16: Soil classifications in Scott Valley.

2.2.1.5 Development of Land and Water Use

Historic Development of Land Use

Land management practices in the Scott Valley and the surrounding upland areas have had significant impacts on the hydrology and geomorphology of Scott Valley (ESA 2009). Practices such as beaver removal, mining, timber, flood control, population growth, and agriculture methods have altered the natural landscape and influenced current conditions in the Watershed (ESA 2009).

Historically inhabited by the Shasta Tribe, abundant natural resources drew additional people to the Scott Valley area. Hudson's Bay Company trappers arrived in Scott Valley in the 1830s, at a time when beaver were so abundant that Scott Valley was referred to as "Beaver Valley" (SRWC 2005). The subsequent decline in beaver population resulted in the loss of beaver ponds and dams (SRWC 2005).The removal of beaver populations from the area represented the first major anthropogenic change to the Scott River stream system, likely altering the channel morphology and influencing timing and duration of groundwater recharge (Kennedy, Shilling, and Viers 2005).

Coinciding with the California Gold Rush, gold miners reached Scott Valley in the early 1850s (SRWC 2005). Mining methods, and corresponding impacts to streams and the surrounding landscape, changed over time. Placer gold mining in the 1850s took place in Shackleford Creek, Oro Fino Creek, French Creek, and in the East and South Forks of Scott River (Sommarstrom, Kellogg, and Kellogg 1990). Hydraulic and sluice mining were predominant in the 1880s; later dredging activities on the upper Scott River and Wildcat Creek in the 1930s to early 1950s resulted in extensive movement of material that resulted in tailings piles in the upper Scott River Floodplains (SRWC 2005; Sommarstrom, Kellogg, and Kellogg 1990). Hydraulic and dredge mining activities disturbed portions of the river channel (notably the 5-mile reach below the East and South Fork confluence known as the "Dredger Tailings"). This disturbance left the Dredger Tailings streambed composed of primarily cobbles (with implications for water retention and stream connectivity), and significantly increased sediment loads in the streams, increasing the susceptibility of the main channel to flooding (Kennedy, Shilling, and Viers 2005). Small-scale gold mining activity has continued since 1950 near Scott Bar, and mining of gravel and sand continued in the mainstem of Scott River and Kidder Creek (SRWC 2005).

Following influx of residents during the Gold Rush, farmers and ranchers cultivated Scott Valley to support the local population. Land was used for cattle ranching, pasture, and crop cultivation, primarily growing alfalfa hay and grain (SRWC 2005). Irrigated acreage in Scott Valley fluctuated between 31,664 and 33,795 acres between 1958 and 2000 (ESA Associates 2009). Irrigated acreage in 2016, based on DWR land use data, was 37,195 (DWR- California Department of Water Resources (DWR) 2017). The most recent estimates for total water use in the Scott River watershed included a range of 55,240 to 78,040 AF per year in the years 2011-2015 (DWR (2021); Table 10).

Year	Grain	Alfalfa	Pasture	Truck Crops	Other Deciduous	Total AF/yr
2011	1,218	24,500	29,398	28.00	96	55,240
2012	2,716	38,476	34,277	20.00	104	75,592
2013	2,542	35,982	39,485	30.00	-	78,040
2014	2,739	38,040	36,383	29.00	-	77,191
2015	2,412	32,238	38,214	24.00	-	72,887

Table 10: Recent total water use estimates (in acre-feet) by DWR in the Scott River watershed (DWR 2021).

Timber harvest has historically been a major industry in Scott Valley. However, a decline in the timber industry, combined with increased regulations and protections resulted in reductions in timber harvests since the 1970s with the final two timber mills closing in 2002 (SRWC 2005; Charnley et al. 2006). In a 1990 watershed analysis, logging roads, skid trails, and other roads constructed on highly erosive granitic soils were found to contribute significant sources of sediment to the streambeds of the Scott River and certain tributaries. These human activities caused about a 60% increase in accelerated sediment yield to the streams. Resulting sedimentation in lower gradient reaches negatively impacted the quality of spawning gravels and egg survival for salmon and steelhead (Sommarstrom, Kellogg, and Kellogg 1990). Clear-cutting practices in upland forests increased sediment and erosion and resulted in channel aggradation (Kennedy, Shilling, and Viers 2005). In Scott Valley, the impacts from roads constructed on steep and erodible soils, particularly in the steeper western and northwestern sections of the Watershed, contributed to erosion and sediment loading to streams (NCRWQCB 2005).

Natural events, specifically major floods, have contributed to altering the landscape and stream system in Scott Valley. Floods have been recorded in Scott Valley since the 1800s and large flooding events, such as the 1955 and 1964 floods, had profound effects on the Scott River, moving large quantities of sediment to the Valley floor (Sommarstrom, Kellogg, and Kellogg 1990). Following flooding that occurred in 1937–1938, the United States Army Corps of Engineers implemented flood control measures including construction of levees along the middle section of the Scott River, channel straightening, and removal of riparian vegetation and debris (SRWC 2005). Further flooding events that occurred from 1940 to 1974 caused increased erosion and widening of the channel, prompting application of riprap for bank stabilization and levee construction along Etna, Kidder, and Moffett Creeks (Kennedy, Shilling, and Viers 2005).

Irrigation Practices

Early agricultural activities, prior to the late 1960s, were supported mostly through surface water diversions from the mainstem of the Scott River and its tributaries. In 1953, irrigated acreage was reported to total around 30,370 acres (123 sq km), with approximately 15,000 acres (61 sq km) relying on surface water for irrigation, 15,000 (61 sq km) acres relying on natural sub-irrigation, and 370 acres (1.5 sq km) dependent on wells (Mack 1958). Very little groundwater pumping occurred until the 1960s. In the early 1960s, groundwater reportedly supplied only 3,400 acre-feet of irrigation water (DWR 1960 [Table 58], 1965)

During the 1960s and 1970s, efficient wheel-line irrigation with sprinkler systems were introduced to Scott Valley, necessitating pressurization. Water pumped from wells provided the necessary pressure, but also a more certain water supply, allowing to expand crop acreage and the cropping season for alfalfa, but at much higher irrigation efficiency than flood irrigation with surface water: Prior to the 1970s, growers typically obtained two cuttings, with irrigation in average and dry years seizing sometime in July. After the 1960s, groundwater-irrigated alfalfa produced three cuttings with irrigation extended into August and early September. Furthermore, well drilling increased following periods of drought, with the most wells drilled following the drought of 1976 to 1977 and increasing again in 1992 (ESA Associates 2009). Reliance on groundwater for irrigation has increased from less than 3% in 1953 (1,000 acre-feet of groundwater and 38,000 acre-feet of surface water used for irrigation) (Mack 1958) to closer to 65%, on average, of water for irrigation from groundwater in recent years, under the simulated period of October 1991-September 2018, as estimated by SVIHM (see Table 17 in Appendix 2-E). By 2013, a survey of irrigation wells in Scott Valley, using California DWR well completion reports and some on-site validation, found 247 active irrigation wells (Foglia et al. 2013).

While the irrigated acreage has not significantly changed in Scott Valley since the late 1950s, crop types have transitioned with decreasing amounts of small grains and increasing alfalfa through the 1990s (Harter and Hines 2008). In the past two decades, the center pivot method has been applied for irrigation, a change from the traditionally used and less efficient wheel-line irrigation method (Harter and Hines 2008). Primary irrigation methods used in the Valley are flood, wheel-line, and center-pivot. One area of the Valley known as the “Discharge Zone” also uses sub-irrigation, or direct uptake of water from the aquifer, as groundwater levels are at or near the land surface.

Typical irrigation application efficiencies of these technologies are 60% for flood (Brouwer, Prins, and Heibloem 1989) and 40-75% for wheel-line (Hill 1994). Increased irrigation efficiencies for wheel-line irrigation, when compared to flood irrigation, are primarily the result of reduced return flows to groundwater (less recharge). For center-pivot the efficiency depends on the application method (Mitchell et al. 2016). The most common is a center-pivot with a mid-elevation spray application (MESA). Higher-efficiency application methods, such as low-elevation spray application (LESA) and low-energy precision application (LEPA), have been installed in some areas of the Valley in recent years. An estimated 10% of fields in Scott Valley were being irrigated with these higher-efficiency technologies as of November 2021 (Galdi (2021), pers. comm.), though a full inventory would be necessary to make a more detailed estimate of current adoption rates. Irrigation application efficiencies for MESA, LESA and LEPA have been estimated at 78%, 88% and 95% (Mitchell et al. 2016). These higher efficiencies are largely due to reduced losses to evaporation; in particular LESA and LEPA systems therefore lead to measurable reductions in consumptive water use.

Water Diversions

Stream diversions began during the early gold mining era of the 1850s to deliver water through mining ditches and flumes on almost every stream from the South Fork down to Scott Bar. Hydraulic and sluice mining in the 1880s diverted large volumes of water to wash hillsides for gold recovery. Some of these ditches were later converted for irrigation use to fields. (SRWC 2005). Diversions are currently used for stock watering and domestic purposes throughout the year and irrigation diversions generally occur in the spring, summer, and early fall (ESA Associates 2009). Most of the diversions in Scott Valley are not monitored or managed by a watermaster.

Under the Scott River Decree of 1980, water rights were determined for the Scott River, the South Fork and East Fork of the Scott River, Wildcat Creek, Oro Fino Creek, other tributaries and lakes, and a defined zone of interconnected surface and groundwater. This is discussed in detail in Section 2.1.3. under “Scott River Adjudication”. Under this decree, water is diverted for irrigation from April through mid-October. Allocations to USFS land for instream uses for fish and wildlife are also included under this decree (Superior Court of Siskiyou County 1980). The Scott River Adjudication includes groundwater users within the adjudicated zone, a zone extending approximately 1,000 feet to either side of the Scott River (see Section 2.1.3). Of the approximately 247 irrigation wells, 47 wells are estimated to be located within the adjudicated zone. Wells in this zone are often among the highest yielding wells within Scott Valley. On average, nearly half of groundwater pumping in Scott Valley occurs within the adjudicated zone, as estimated with SVIHM (see water budget details in Section 2.2.3).

There is only one permanent diversion dam on Scott River, SVID’s Young’s Dam near River Mile 46. The SVID ditch diverts water at Young’s point and has an allocation of 43 cfs (Superior Court of Siskiyou County 1980). Also located on the mainstem of Scott River, Farmers Ditch is allocated 36.0 cfs from the Scott River Decree and supplies water to 10 users for irrigated pasture (Superior Court of Siskiyou County 1980).

2.2.1.6 Hydrology

The major surface water feature in Scott Valley is the Scott River. Contributing 5% of the Klamath’s total annual runoff, the Scott River is one of the four main tributaries to the Klamath River, with the confluence at River Mile 143 (Harter and Hines 2008). Major tributaries to the Scott River, shown in Figure 17, include Shackleford/Mill, Kidder, Etna, French, and Moffett Creeks, as well as the East and South Forks of Scott River (ESA 2009). The East Fork of the Scott River originates on China Mountain and the South Fork originates in the mountain lakes to the southwest of Callahan (ESA 2009). After the two forks converge at Callahan, the Scott River meanders through the flat lands of the valley and then descends into a canyon prior to joining the Klamath River. The Scott River is 58 mi (93 km) in length, 30 mi (48 km) of which are located in Scott Valley, from the convergence of the East and South Forks to the head of the canyon. The portion of Scott River that flows through Scott Valley is a lower grade area between the steeper headwaters and the canyon reach of the river (ESA 2009).

Precipitation stored in the snow pack is an important water source of both stream flows and groundwater recharge. The mountains to the west of Scott Valley are drained by perennial streams which tend to flow southwest-to-northeast (Figure 17). The most significant of these tributaries have formed alluvial fans, on which the stream channels become braided or anastomosing prior to joining the Scott River (ESA 2009). These alluvial fans are locations where groundwater recharge occurs. (For more details on interconnected surface and groundwater dynamics, including areas of groundwater discharge and seasonal dry reaches, see the description under Aquifers in Section 2.2.1.3.) The mountains to the east of the Valley receive less precipitation than the higher elevation western mountains and many of the eastern streams are ephemeral for most of their length and do not reach the Scott River, with the notable exception of Moffett Creek (ESA 2009; NCRWQCB 2005).

Stream flow records for numerous tributaries and river reaches have been maintained by multiple government agencies, primarily the USGS and DWR (Table 11). The flow record relied on most for regional water resource planning is located on the Scott River near Fort Jones (USGS 11519500), spanning from 1941 to the present day. The earliest records in the watershed date back to 1911. In addition, other organizations or individuals may have maintained flow records that are not accessible on public websites.

Median annual runoff from Scott Valley, measured at the Fort Jones USGS stream gauge (11519500) located in the Scott River Canyon[2], is 355 thousand acre-ft (TAF; Figure 18). Discharge can be variable between different years, as illustrated in the Basin's history of floods and droughts. The total average annual Scott River flows range widely - from 54 to 1082 thousand acre-feet per year. For comparison, average annual applied water needs in Scott Valley are about 67 thousand acre-feet (with a range of 53-84 TAF; see Appendix 2-E for more estimated water budget values).

Flows vary widely within the same year. Winter and spring flows (December–May) average about 1,000 cubic feet per second (cfs) (28 cubic meters per second (cms)) but have peaked at 39,500 cfs (1,119 cms). Mean summer streamflow is 30 cfs (0.8 cms), but commonly drops below 20 cfs (0.6 cms) in the late summer and early fall. Minimum flows observed since the drought of 1977 have generally been lower than the minimum flows observed previously (Figure 19). Most of the tributaries contributing to the Scott River come from the western side of the Valley, due to the eastern mountains experiencing a rain shadow effect as storms generally tend to track from west to east in the area. The streamflow record at the Fort Jones gauge from water years 1942 through 2021 is shown in Figure 19.

In contrast with the record at the Fort Jones gauge, much shorter stream flow records (one season to two dozen seasons) were used to characterize flow in the following tributaries Figure 17. Gauges on Shackleford, French, and Sugar Creeks, and East and South Forks are currently active or have recently been reactivated. However, at the time of this analysis, only the years listed below were used as inputs to this version of the SVIHM:

- Shackleford Creek (1955-1960),
- Mill Creek (2004-2005),
- Moffett Creek (1958-1972),

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[2] Only 690 square miles (1,786 square km, or 84.7%) of watershed area drains to this gauge, so the flow measured here does not represent the Scott River's ultimate discharge to the Klamath River. However, because the Fort Jones gauge falls downstream of the vast majority of water pumping or diversions in the watershed, and because of its long period of record, flows measured at this gauge are used to inform management decisions, evaluate watershed conditions and assess the impacts of Scott Valley land and water management.

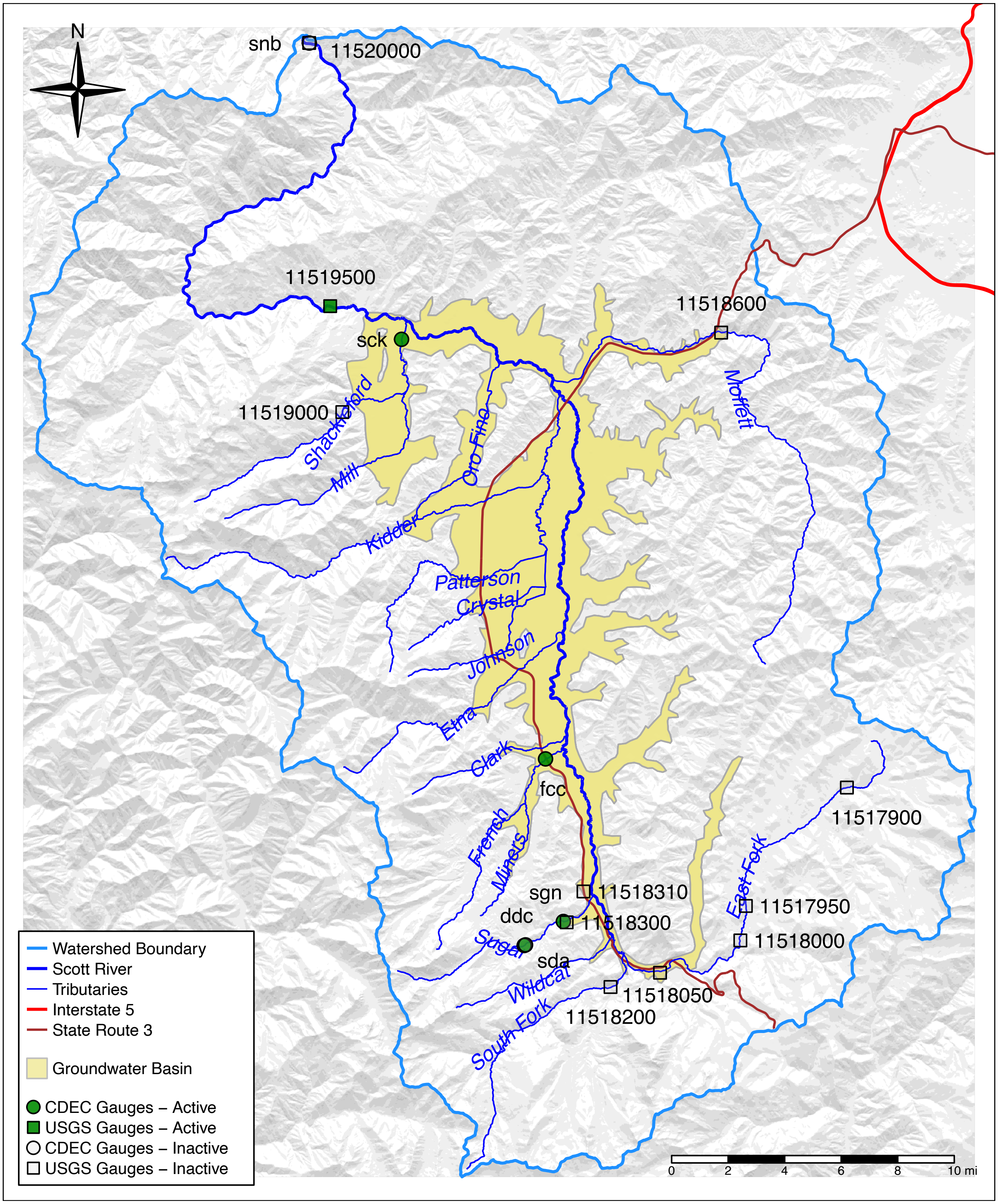


Figure 17: Main tributaries to the Scott River and locations of stream gauges. Some gauges maintained by Siskiyou RCD are not available on CDEC and have not been depicted here. For additional information on each gauge, see stream gauge record table.

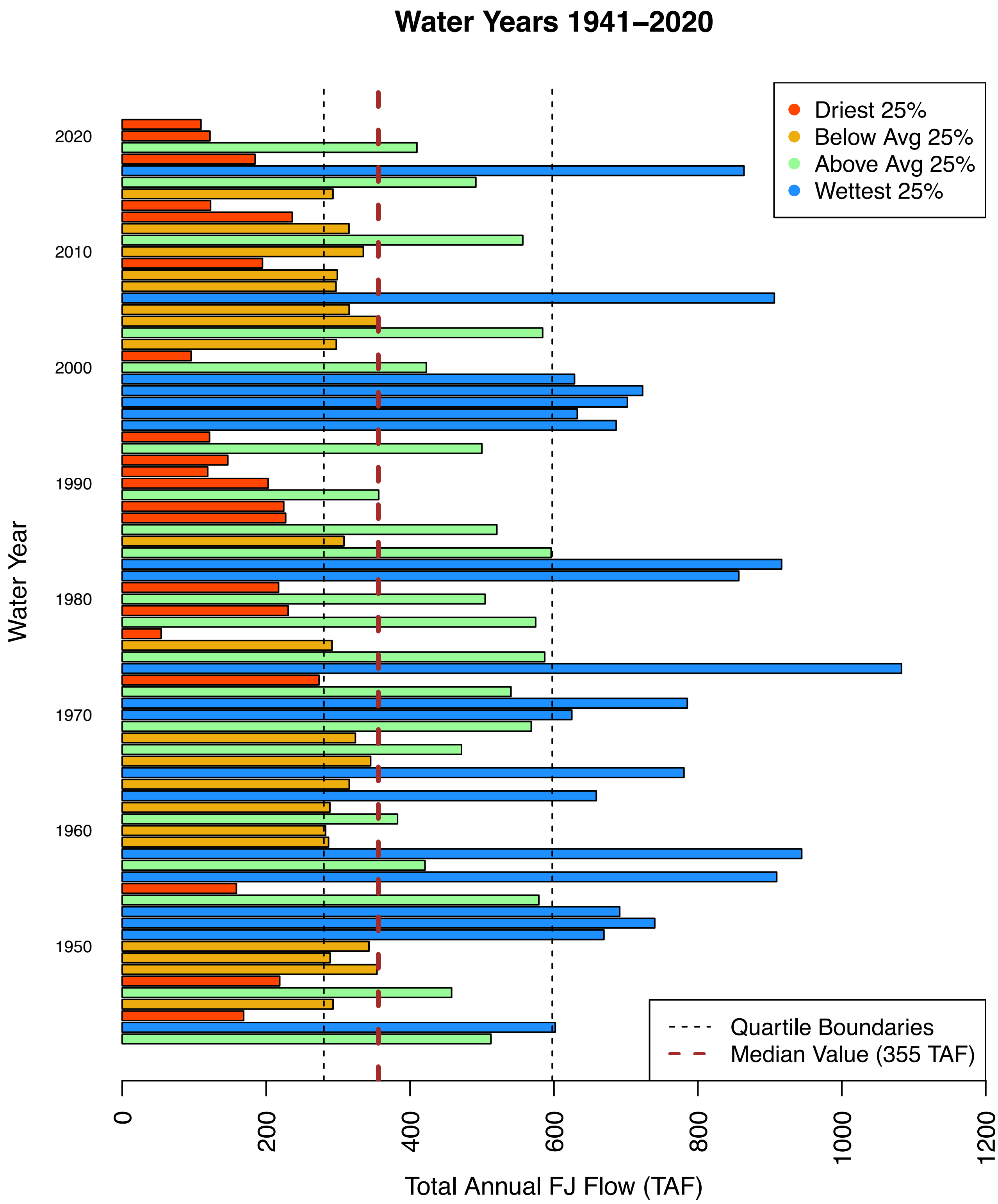
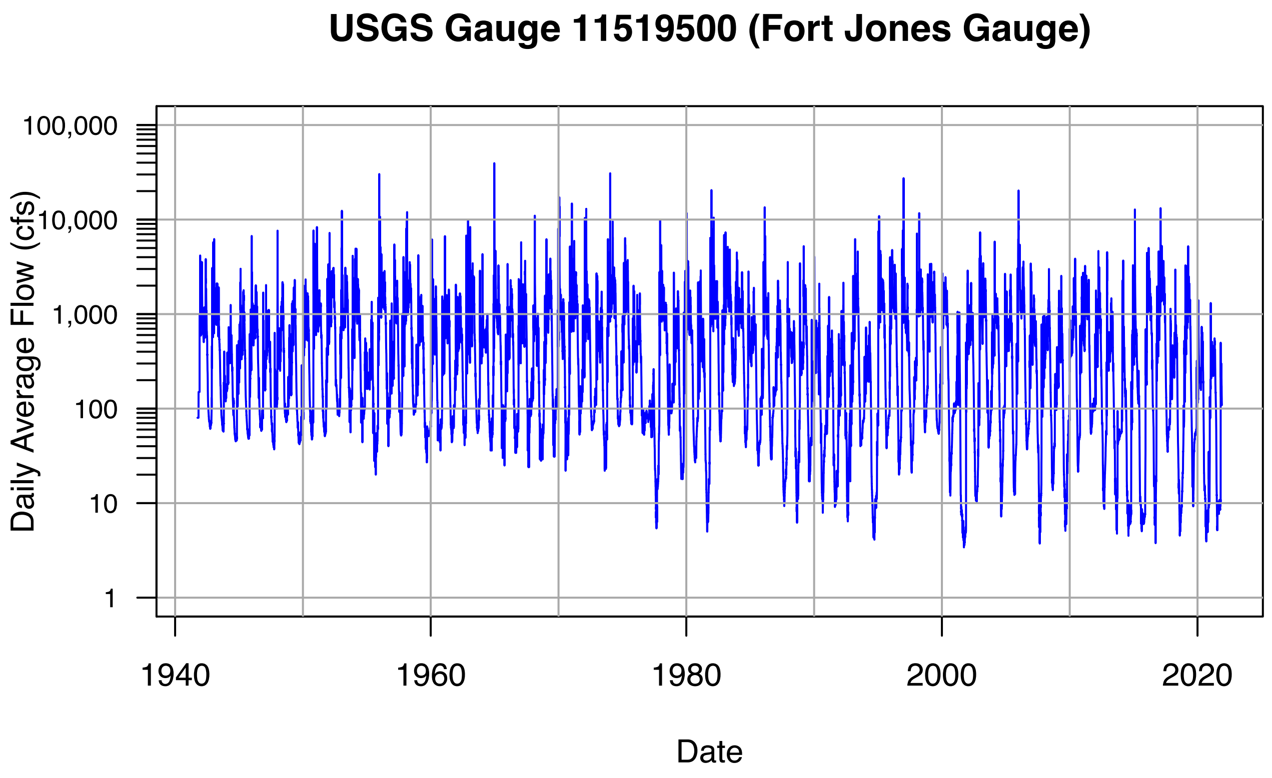


Figure 18: Total annual flow recorded at the Fort Jones USGS Stream Gauge (11519500) from water year 1942 through 2021. The median value for the record 1941-2021 is indicated as a dashed brown line at 355 TAF per year; the boundaries between the other quartiles are shown as dashed black lines at 280 and 598 TAF per year.



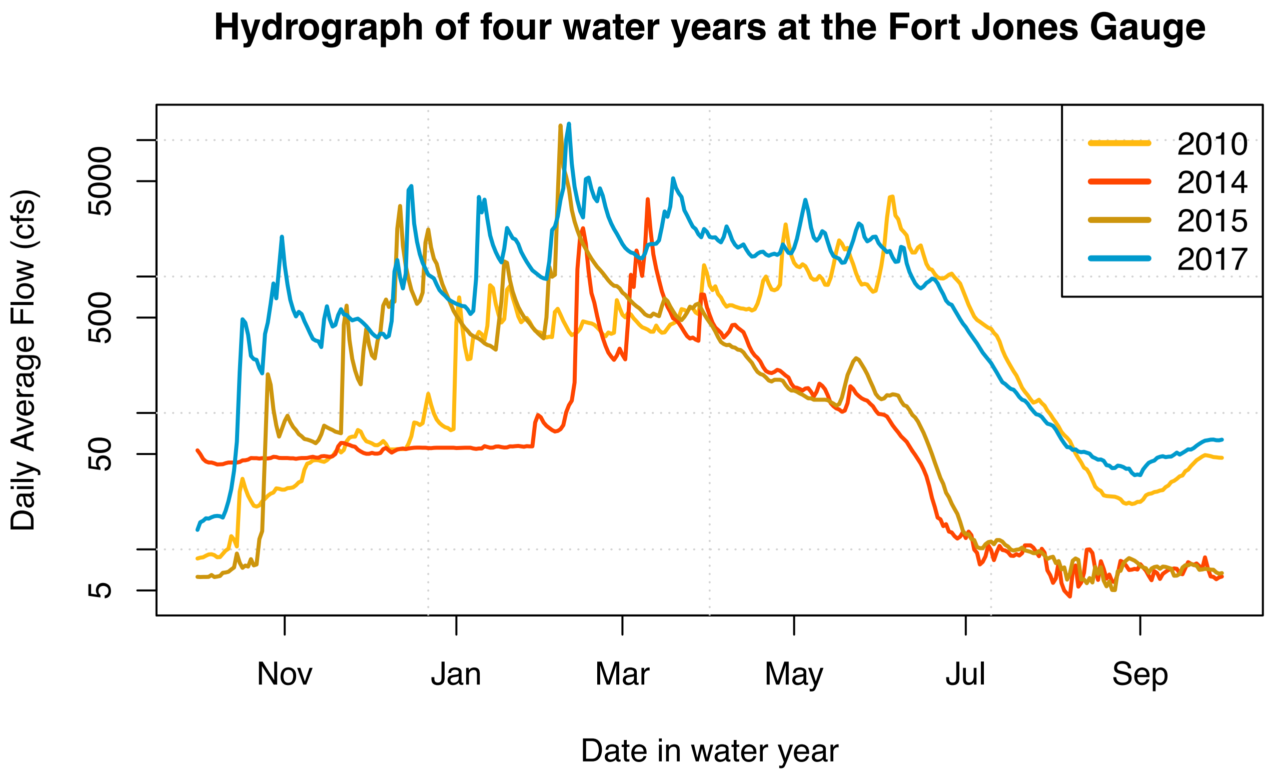


Figure 19: Streamflow record at the Fort Jones USGS Stream Gauge (11519500) from 1937 through 2019. Water years shown are examples of wet and dry years (2017 and 2014, respectively), and two years which received average total annual rainfall (2010 and 2015).

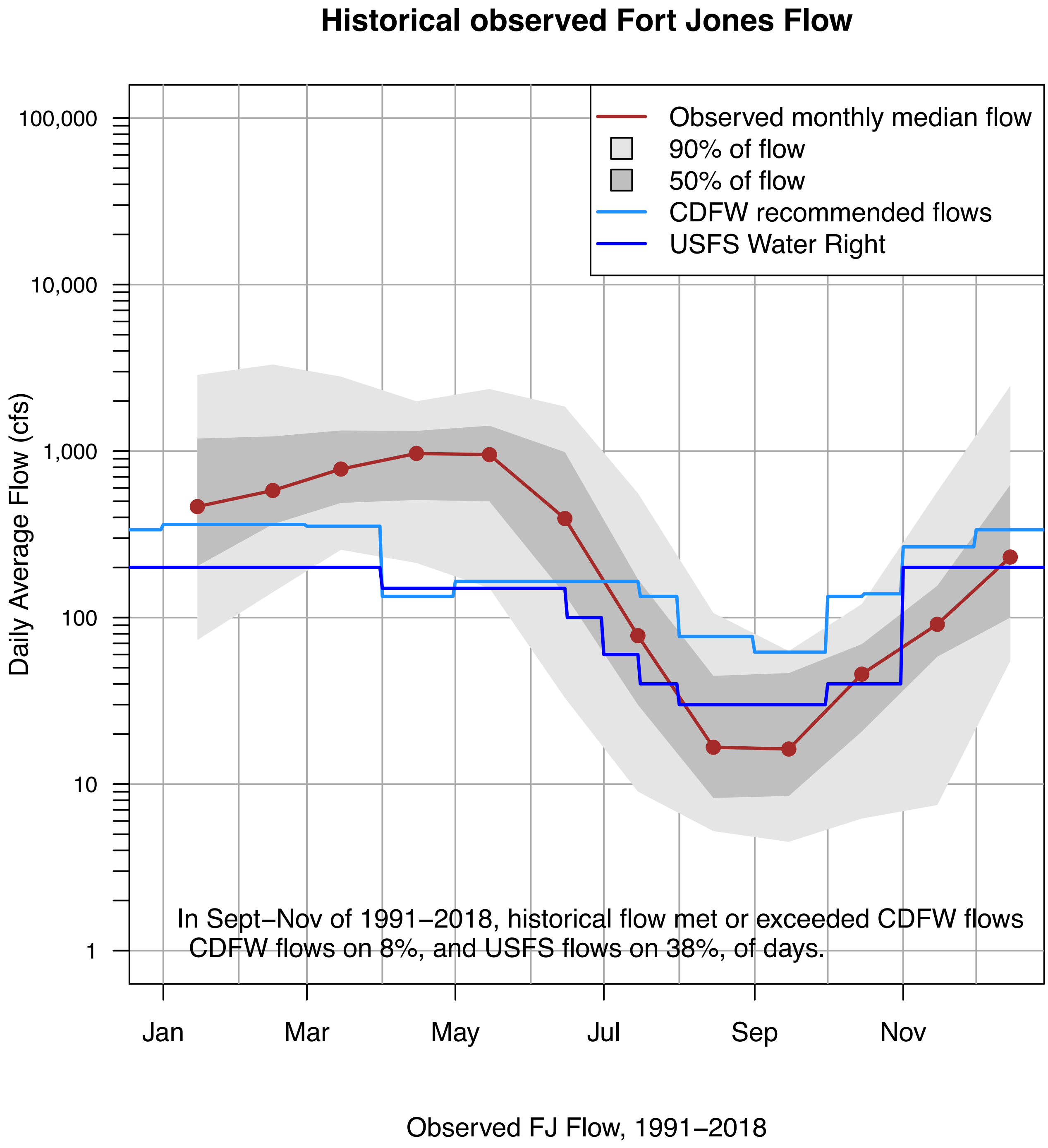


Figure 20: Historical flows, as measured at the Fort Jones gauge, in comparison to CDFW interim recommended flows (CDFW 2017) and the USFS water right.

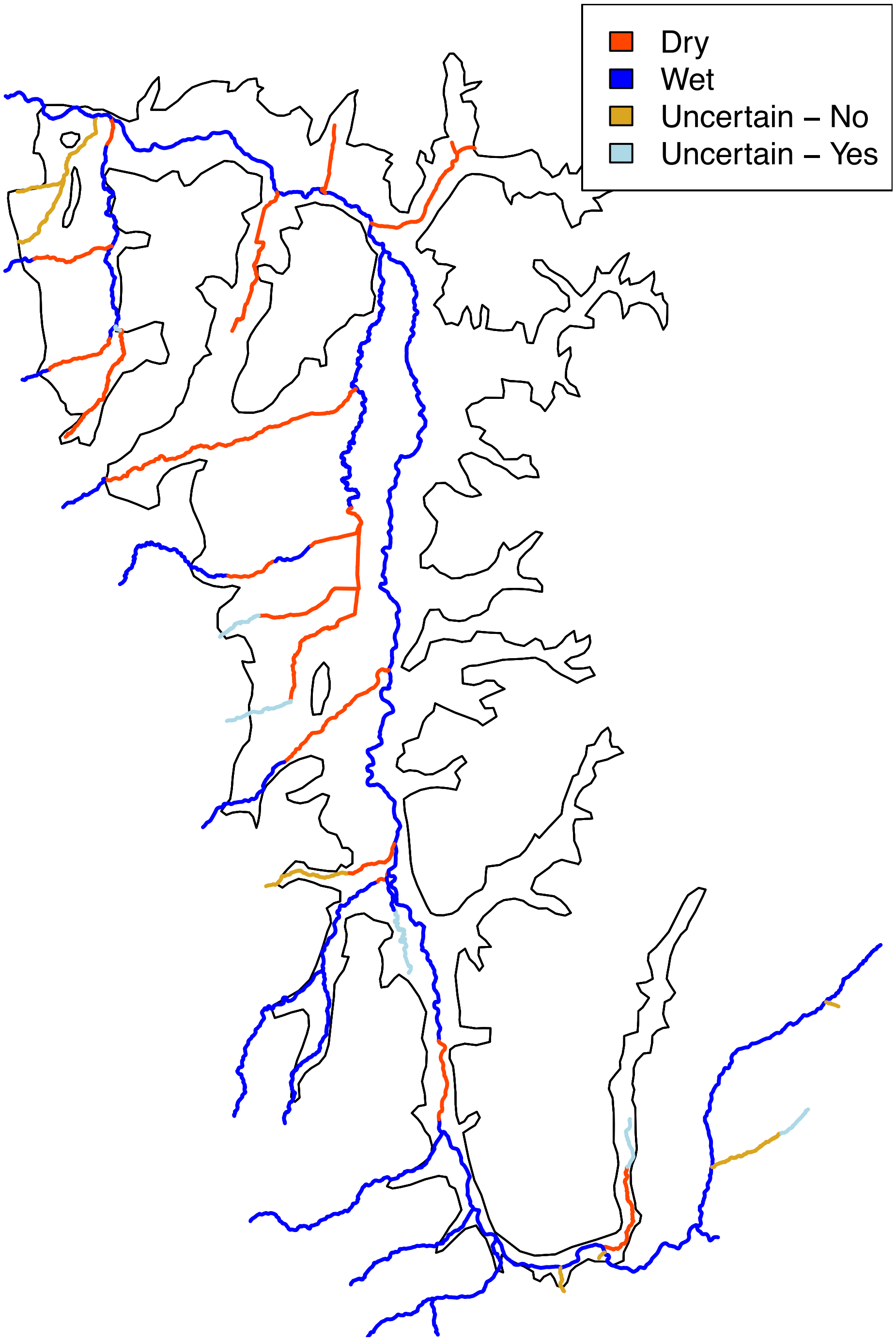


Figure 21: Baseflow (i.e., late summer and fall) conditions in the Scott River stream system, during an average water year. Data from SRWC 2018.

Site No.	Station Name	Start Date	Latest Date	Days in Record	Agency Code
11518000	ef scott r nr callahan ca	1910-10-01	1911-09-30	365	USGS
11520000	scott r nr scott bar ca	1911-10-01	1913-09-29	730	USGS
11518200	sf scott r nr callahan ca	1958-10-01	1960-09-29	730	USGS
11518300	sugar c nr callahan ca	1957-09-01	1960-09-29	1,125	USGS
11519000	shackleford c nr mugginsville ca	1956-10-01	1960-09-29	1,460	USGS
11518600	moffett c nr fort jones ca	1958-10-01	1967-09-29	3,286	USGS
11517900	ef scott r bl houston c nr callahan ca	1970-08-30	1973-07-06	1,042	USGS
11517950	ef scott r ab kangaroo c nr callahan ca	1970-09-01	1973-07-06	1,040	USGS
11518310	cedar gulch nr callahan ca	1966-02-01	1973-09-29	2,798	USGS
11518050	ef scott r calahan ca	1959-10-01	1974-09-29	5,478	USGS
11519500	scott r nr fort jones ca	1941-10-01	2021-11-11	29,262	USGS
SDA	sugar ck blw darbee ditch nr callahan	2010-05-11	2021-11-11	6,381	DWR/NRO
SGN	sugar ck nr callahan	2005-12-20	2021-11-12	5,663	DWR/NRO
FCC	french creek at hwy 3 near callahan	2004-07-01	2021-11-12	6,215	DWR/NRO
SCK	shackleford ck nr mugginsville	2004-06-30	2021-11-12	5,853	DWR/NRO
DDC	darbee ditch nr callahan	2010-09-18	2018-05-15	6,659	DWR/NRO

Table 11: Scott Valley daily flow records for stream gauges that are both historical (inactive) and actively recording data.

- Kidder Creek (1972, 2002-2010),
- Patterson Creek (1972),
- Etna Creek (1955-1965, 1972),
- French Creek (2004-2016),
- Sugar Creek (1957-1972, 2009-2016),
- South Fork Scott River (1955-1972, 2001-2015), and
- East Fork Scott River (1955-1974, 2002-2015).

The magnitude of flows on these tributaries is correlated to the magnitude of flow at the Fort Jones gauge (Foglia et al. 2013; Deas and Tanaka 2005). Although several of these streams are ephemeral (notably Moffett), the majority are perennial in the upper watershed before they reach the valley floor (see Figure 21 illustrating baseflow conditions), and thus are year-round inflows to the surface-aquifer system.

The natural flow regime in the Basin determines the key ecosystem functions and supports aquatic species in the Basin (Section 2.2.1.7). Within the recently developed functional flows framework for managing California rivers (Grantham et al. 2020), the Scott River system flows exhibit five main natural functional flow components: fall pulse (or “flush”) flow, winter storm flows, winter baseflow, spring recess, and summer baseflow (see Figures 19 and 20). These five flow components characterize the strong seasonal variations in flows in the Scott River system. Fall pulse flow in this Basin is the increasing discharge after the first significant period of fall precipitation, typically beginning sometime between September and November; winter storm discharge refers to peak discharge periods, typically in January or February, fed by winter storms, with intervening conditions of winter baseflow (typically several 100 cfs); spring recess is a period of mostly decreasing baseflow, as the snow pack melts off, from April to July; summer baseflow (from less than 10 cfs to over 50 cfs) is a period of relatively steady flow conditions, fed mostly by groundwater discharge into the Scott River system, observed in August and September (USFS 2000).

Each of these five flow regime components has key implications for the ecological functions of aquatic species in the Basin, particularly anadromous fish (migration timing and life histories of anadromous fish in the Basin are provided in Section 2.2.1.7). Of the five functional flow components, the timing of the spring recess, the amount of summer baseflow, and the timing of the fall pulse flow are particularly important to anadromous fish in the Scott River system (Section 2.2.1.7) and most sensitive to depletion of surface water due to groundwater pumping. Spring recession flows are vital for reproduction and migration and play a role in sediment redistribution. Summer and fall baseflows support species by providing water quality and quantities during the dry season. Finally, the fall pulse flow is important for fall migrations, instream water quality and transportation of nutrients (CEFF 2020).

Streams in the Scott River watershed include both naturally perennial and naturally ephemeral reaches (Mack 1958). In particular, the upper reaches of most major tributaries are perennial, while lower reaches of some major tributaries in the Scott Valley dry out every year (e.g., Kidder Creek between the Basin boundary and the confluence with Big Slough, or Moffett Creek from the Basin boundary to the confluence with the mainstem; see Figure 21). The duration of flow in these ephemeral reaches is highly dependent on precipitation timing and volume. During the summer baseflow season, most tributaries are dry or include dry sections, and surface flow in some reaches is sustained by groundwater discharge. Perennial reaches include the East and South Forks and portions of French and Shackleford Creeks (Figure 21).

Since the introduction of groundwater pumping in the 1970s (see Section 2.2.1.5), minimum summer baseflow at the Fort Jones gauge has been measurably lower compared to gauge measurements from the 1940s to the 1960s, for comparable water year types. Notably, in Figure 19 the minimum flows rarely dip below 40 cfs prior to the dry year of 1977; in the decades since 1977, minimum flows below 20 are routine. In the 28 years covered by the SVIHM model period (1991-2018), median flows in August and September have been less than 20 cfs (Figure 20), with much of the Scott River and lower tributaries (within the GSA boundaries) falling dry until the first major fall precipitation events (fall pulse flow). Low stream flows have ecological implications, particularly for anadromous fish in the Basin that rely on sufficient flows for fall migrations and for suitable habitat (see discussion in Sections 2.2.1.7 and 2.2.1.8).

Lower baseflow conditions since the 1970s have also been attributed to climate change in addition to the onset of groundwater pumping after the 1960s (see Section 2.2.1.5), among others. Groundwater pumping has been shown to be the most significant factor causing the decline in base flow during July and August after the 1960s relative to the period prior to the 1970s (Van Kirk and Naman 2008). In contrast, lower baseflow in September and October since the 1970s has been attributed to climate change as the dominant factor (Drake, Tate, and Carlson 2000), although Asarian and Walker (2016) found that flow declines in August, September, and October were much larger than could be explained by precipitation alone. Over the past two decades, the relative frequency of years with low flows has been higher than in most periods in the 20th century during which Scott River flows at Fort Jones have been measured (Figure 18). Additionally, the onset of the wet season, where flows rise above their <20-to-40 cfs baseflow conditions, has tended to fall later in the year, with the average date of onset shifting from mid-to-late September in water years 1977-2000 to early-to-mid-October in water years 2001-2021. This has resulted in more frequent occurrence of baseflow conditions of less than 20 cfs (Figure 20).

2.2.1.7 Identification of Interconnected Surface Water Systems

SGMA calls for the identification of interconnected surface waters (ISWs) in each GSP. Interconnected streams overlying the Basin are identified in Figure 22.

The definition of an ISW is:

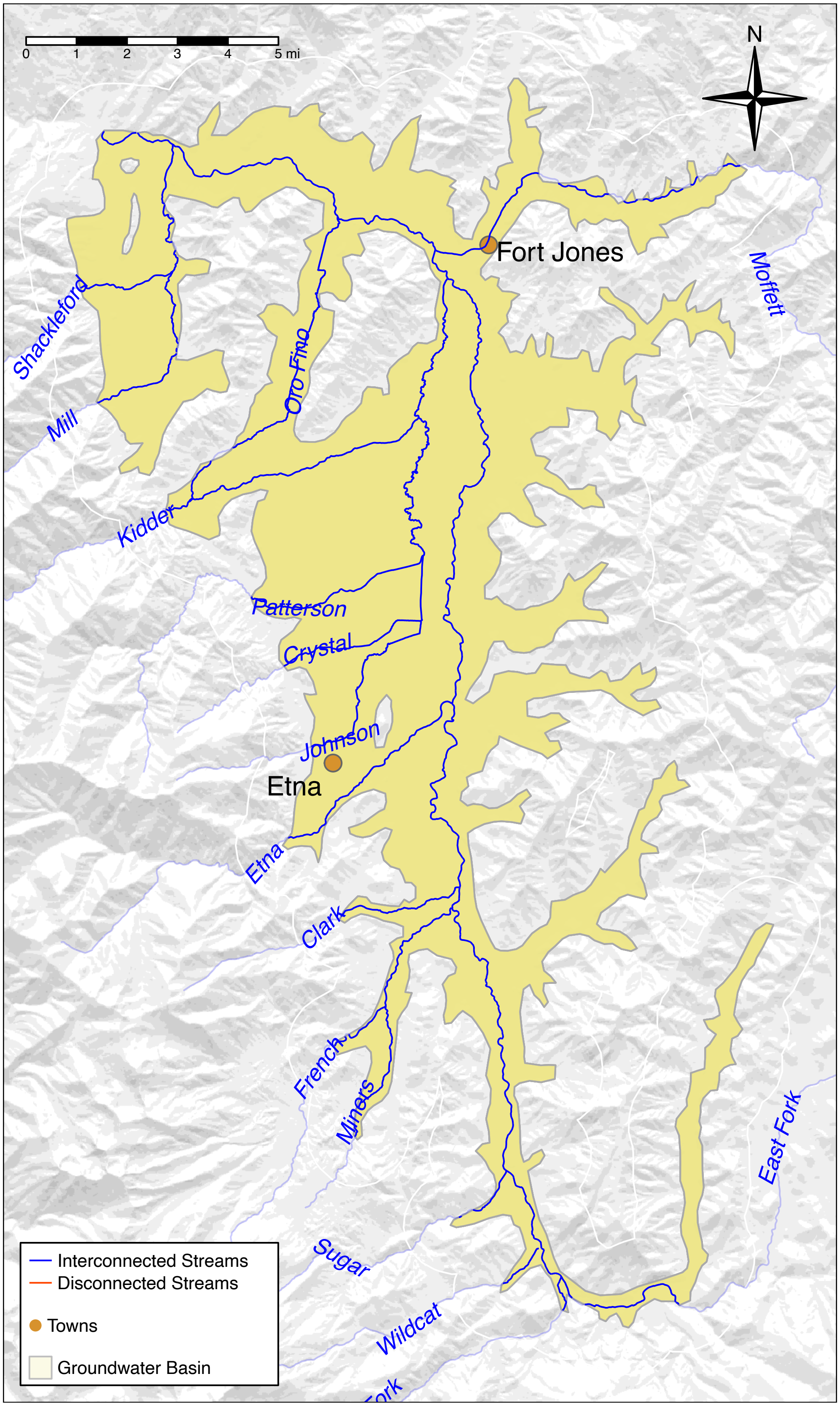


Figure 22: Interconnected Surface Waters (ISWs) in the Scott Valley. All surface water reaches overlying the Scott Valley groundwater basin have been designated as ISWs for purposes of this GSP.

> 23 CCR § 351 (o): “Interconnected surface water” refers to surface water that is hydraulically connected at any point by a continuous saturated zone to the underlying aquifer and the overlying surface water is not completely depleted.

Because the water table in many parts of Scott Valley can be relatively shallow, the Scott River surface water network contains many miles of stream channel that are connected to groundwater. The direction of flow exchange (i.e., gaining vs losing stream reaches) varies over both space and time, and simulated rates of stream leakage or groundwater accretion to tributaries and the Scott River can vary by orders of magnitude.

Figure 23 illustrates the monthly variations in the amount and direction of estimated water exchange between groundwater and surface water (after Tolley, Foglia, and Harter 2019). Losing sections are indicated by red colors and the positive value of the logarithm of the rate of stream leakage to groundwater. Gaining stream sections are indicated by blue colors and the negative value of the logarithm of the rate of stream accretion from groundwater. The vertical axis indicates the stream mileage location along the main stem of the Scott River with the lowest, most downstream location near the Fort Jones USGS stream gauge at the top and the highest, most upstream location near Callahan at the bottom. The horizontal axis indicates the time, beginning with October 1990 and ending with September 2018. White areas indicate locations and times when flow in the streambed is insignificant (effectively dry streambed conditions), although local, disconnected pools may exist (not explicitly modeled).

Similar varying conditions exist along the tributaries of the Scott River where they flow over the groundwater basin. However, the uppermost section of tributaries, near the apex of their alluvial fans (e.g., near Etna and Greenview, close to the mountain front) are generally losing streams contributing significant recharge to the groundwater system.

Over the entirety of the basin, the streamflow system generally makes a net gain during wet years, but has a net loss to groundwater during dry years (see Figure 33 in the Water Budget section). Gains and losses also fluctuate seasonally (see Figure 34 in the Water Budget section) with most losses during the late rainy season (January through May) due to the large amount of recharge from tributaries when they first enter the basin, over the upper alluvial fans. Largest net accretion occurs during the dry season. During that period, recharge from the tributaries near the mountain front is small.

Across the stream system in Scott Valley (Figure 22), there are no known stream reaches that are flowing and also entirely and permanently disconnected from groundwater, i.e., reaches that are separated from the water table by thick unsaturated zones. For purposes of this plan, the Scott River and its major tributaries (Mill, Shackleford, Oro Fino, Moffett, Kidder, Patterson, Crystal, Johnson, Etna, French, Miners, Sugar, and Wildcat Creeks, South Fork and East Fork Scott River, Figure 17) are therefore all considered part of a single interconnected surface water system in the basin. The interconnected surface water system supports significant fish habitat and riparian vegetation (see Section 2.2.1.7).

Attributing Stream Depletion to Groundwater Use

The Scott Valley Integrated Hydrologic Model (see Section 2.2.3.1, Tolley, Foglia, and Harter (2019)) was used to compute the amount of stream depletion in interconnected surface water due to groundwater pumping within the basin as a whole, but also separately for both, the areas outside and within the adjudicated zone. The amount of stream depletion is computed for the location of the Fort Jones gauge, by month, for the period 1990 – 2018. It is computed by comparing simulation of actual 1990 – 2018 conditions (base case conditions) to hypothetical no-pumping scenarios, either outside or inside the adjudicated zone or across the entire basin.

In the no-pumping scenarios, individual fields that partly or fully depend on groundwater for irrigation are assumed to revert to natural vegetation. Natural vegetation is assumed to depend on rainfall and soil moisture to meet its ET demand. For the reference scenario used in the GSP, only vegetation in the Discharge Zone

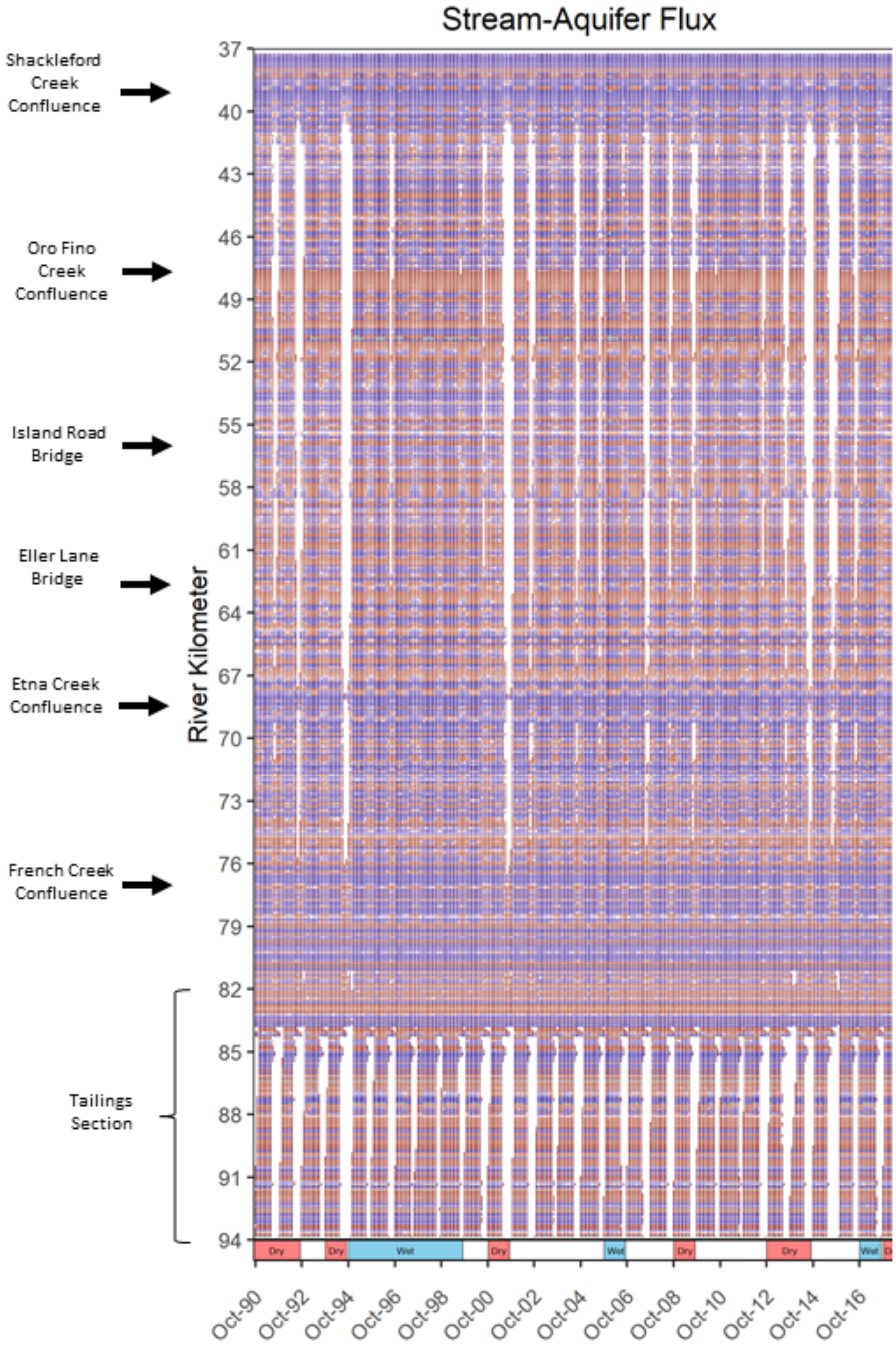


Figure 23: Spatiotemporal heat map of simulated flowrates between groundwater and surface water for the Scott River with geographic locations noted. After Tolley 2019.

is assumed to be able to consume groundwater for ET. The Discharge Zone is a known area of very shallow groundwater in the western central Basin, in a contiguous area of sub-irrigated pasture east of Highway 3 between Greenview and Etna (Figure 4). Natural vegetation growing elsewhere, in lieu of agriculture, is assumed to rely on precipitation and stored soil moisture only, with no access to groundwater. The potential ET of natural vegetation is assumed to be 60% of reference ET (well-watered grass). These assumptions are consistent with recent studies of natural vegetation (such as oak savannah and rainfed grasslands) transpiration (Maurer et al. 2006; Howes, Fox, and Hutton 2015). Actual ET is computed by SVIHM based on available soil moisture and may be lower than potential ET due to soils drying out during the summer and fall.

With simulation of these no-pumping scenarios it is possible to estimate the stream depletion attributable to groundwater irrigation inside the adjudicated zone (IAZ), outside the adjudicated zone (OAZ), and in the valley overall, by simple differencing:

$FJ_{NPA1} - FJ_{Basecase} = Depletion_{Pumping,A1}$ (all in cfs)

Where:

FJ_{NPA1} is the Flow at Fort Jones Gauge, No-Pumping in Area 1 Scenario;

$FJ_{Basecase}$ is the Flow at Fort Jones Gauge, Basecase; and

$Depletion_{Pumping,A1}$

is the Stream Depletion at Fort Jones Gauge due to groundwater irrigation in Area 1, where “Area 1” either corresponds to the entire basin, to the adjudicated zone, or to the area outside of the adjudicated zone.

The depletion is an important metric related to summer baseflow. But equally important from a functional flows perspective are changes in the timing of the spring recess and fall flush flow that may occur due to groundwater pumping. The same simulation scenarios used to compute stream depletion can also be used to compute the change in date, for a given year, at which flows first fall below (spring recess) or exceed (fall flush flow) various streamflow thresholds. Table 12 shows the difference, measured in number of days, of the fall date at which simulated streamflow at the Fort Jones gauge first exceeds 20 cfs (“Days of Earlier Reconnection (FJ Flow > 20 cfs)”), between the no-pumping reference scenario described above and the calibrated basecase scenario (where the latter most closely simulates actual conditions over the 1991-2018 period). Table 12 provides both the average stream depletion from September 1-November 30 and the range of days of earlier reconnection, between water years 1991 and 2018. September through November represents the “critical dry window” in which low flowrates most impact ecological conditions for spawning fish.

The average September-November mean stream depletion attributable to pumping in wells regulated under this GSP is 28 cfs. (For a complete table of simulated daily streamflow and stream depletion results, see Digital Appendix 2-A.) It is of similar magnitude (26 cfs) for wells in the adjudicated zone. Their combined September-November stream depletion effect (i.e., the stream depletion attributable to groundwater pumping in all wells) has a mean value of 49 cfs. In years when flows do not already exceed 20 cfs throughout August, flows climb above 20 cfs about 4 to 5 weeks earlier under the no-pumping scenario.

In Table 12, “Stream Depletion” in cfs is calculated as the average (mean) value of the simulated average daily flowrates on all days in the critical dry window of Sep-Nov, in all 28 years (1991-2018). “Days of Earlier Reconnection (FJ Flow > 20 cfs)” refers to the number of days between (a) the first fall date in the no-pumping scenario simulation when stream flow at the Fort Jones gauge exceeds 20 cfs and (b) the date for the same event in the basecase simulation. The date is later in the basecase simulation due to groundwater pumping during the summer. It is calculated as the average (mean) of the 28 yearly values for “days of earlier reconnection”. We find that similar numbers of “Days of Earlier Reconnection” occur when flow thresholds of 10 cfs, 30 cfs, and 40 cfs are considered rather than 20 cfs.

Well Area	Average (Mean) Stream Depletion, Sep-Nov '91-'18, due to groundwater irrigation in this area (cfs)	Average (Mean) Days of Earlier Reconnection (FJ Flow $>$ 20 cfs), in years '91-'18, if no pumping occurred in this area
SGMA Wells (Wells outside Adjudicated Zone, OAZ)	28 cfs	30 days
Adjudicated Zone Wells (Wells Inside Adjudicated Zone, IAZ)	26 cfs	38 days
All pumping (all wells)	49 cfs	38 days

Table 12: Estimated stream depletion, in September and October of 1991-2018, due to groundwater pumping in three geographic areas defined by the Adjudicated Zone (Superior Court of Siskiyou County 2018).

2.2.1.8 Identification of Groundwater Dependent Ecosystems

Section 354.16(g) of the GSP Regulations (23 CCR § 350 et seq.) requires identification of groundwater dependent ecosystems (GDEs). Section 351(m) of these regulations refers to GDEs as "ecological communities or species that depend on groundwater emerging from aquifers or on groundwater occurring near the ground surface."

SGMA calls for an identification of groundwater dependent ecosystems, including "potentially related factors such as instream flow requirements, threatened and endangered species, and critical habitat" (23 CCR § 354.16).

This definition could theoretically cover both areas of vegetation and flowing surface waters supporting aquatic ecosystems. For purposes of this GSP, "GDE" is used to refer to a spatial area covered by vegetation that is observably distinct from dry-land terrestrial vegetation. GDEs consisting of perennial flowing streams, ephemeral streams which are periodically connected to the water table, and non-riparian groundwater-dependent vegetation are mapped under Interconnected Surface Waters (see previous section). Species occupying these GDEs are addressed later in this section.

GDEs are considered throughout the GSP; in this section, through identification of GDEs, definition of the nature and degree of reliance on groundwater, and plans for management; in Section 3, through consideration in development of sustainable management criteria and associated monitoring networks; and in project and management actions described in Section 4. Based on this inventory and mapping exercise, the SMCs developed to address sustainability indicators for groundwater levels (Section 3.4.1) and interconnected surface waters (Section 3.4.5) are expected to foster groundwater conditions that support GDEs.

While a preliminary analysis of the presence, extent, and habitat requirements of the species in the Basin has been conducted here, data gaps were identified for this section. These are discussed in detail in Appendix 3-A and are summarized here. Approaches, including studies, implementation of additional monitoring activities and other projects, to fill these data gaps are discussed in Chapter 4. The data gaps identified include:

- Existence of groundwater-dependent vegetation such as cottonwood trees on Moffett Creek, potentially difficult to observe using remote methods.
- Ecological information, such as:
  - flow requirements for juvenile salmon outmigration
  - steelhead migration population counts
- Confirmation of the extent of the Interconnected Surface Water network (i.e., the extent of the surface water system beneath which, during at least part of the year, a continuous saturated zone exists)
- Ongoing evaluation of satellite imagery (captured at least twice per year) could provide information on GDE conditions over time

Environmental Beneficial Water Uses and Users within the Basin

To establish sustainable management criteria for the depletion of surface water sustainability indicator, GSAs are required to prevent adverse impacts to beneficial users of surface water, including environmental and recreational uses and users. Thus, identifying these users and uses of surface water is the first step to address undesirable results due to surface water depletion.

The Basin is located in the California ecoregion of Klamath Mountains/California High North Coast Range (Ecoregion 78), as identified by USEPA Level III Ecoregions of California[3]. This region is characterized by diverse flora, a mild, subhumid climate, and long periods of drought in summer months.

A review of the information available on CDFW's lands website[4], that catalogues Department properties and their managed habitat importance, shows there are no CDFW lands in the Watershed.

According to the National Wetlands Inventory (NWI)[5], habitat in the mainstem and tributaries is identified as "riverine" and freshwater emergent wetlands are noted on the west side of the valley, most notably between Kidder Creek and Patterson Creek (in the central-western region of the Basin).

As a first step in considering the potential effects of Basin operations on groundwater dependent ecosystems, the types and geographic extent of GDEs in the Basin were identified and mapped. Spatial datasets indicating the presence of potential GDEs, made available by the Nature Conservancy (the iGDE dataset; Klausmeyer et al. (2018)), were used as a starting point. These datasets were evaluated against groundwater depth data, local expertise, and satellite imagery and categorized to produce the maps in Figure 24 (and Appendix 2-B). More specifically, the iGDE dataset was mapped against an interpolated averaged depth-to-groundwater level. An iGDE polygon located on top of an interpolated groundwater level > 20 feet below ground surface (bgs) was classified as "disconnected" and is not mapped. This applied to a relatively small number of polygons. Where groundwater was < 20 feet bgs, and aerial evidence of vegetation was present, iGDE polygons were classified as either Riparian or Non-Riparian Groundwater Dependent Vegetation, depending on proximity to a riparian corridor.

Of course, this map may become outdated, and ground-based observations of GDEs may be more reliable than remote data assessment, so this map may be updated in the 5-year update of the GSP.

Groundwater Dependent Vegetation Types

The Natural Communities Commonly Associated with Groundwater (NCCAG) dataset[6] provides vegetation and wetland layers for each of the groundwater basins identified in Bulletin 118. These layers identify indicators of GDEs (iGDEs), which identify the phreatophytic vegetation, perennial streams, and regularly flooded natural wetlands, in addition to springs and seeps that most likely indicate the presence of, and dependence on, groundwater.

Vegetation types included in the dataset are listed in Table 13 along with their maximum rooting depth. None of these vegetation types are listed as endangered, threatened, or rare at the state or federal level (CNDDB 2021). A restoration analysis for Scott River riparian vegetation (RCD 2009) also identifies willow and cottonwood as native vegetation.

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[3] Griffith, G.E., Omernik, J.M., Smith, D.W., Cook, T.D., Tallyn, E., Moseley, K., and Johnson, C.B., 2016, Ecoregions of California (poster): U.S. Geological Survey Open-File Report 2016–1021, with map, scale 1:1,100,000, //dx.doi.org/10.3133/ofr20161021.

[4] https://www.wildlife.ca.gov/Lands

[5] https://www.fws.gov/wetlands/data/Mapper.html

[6] https://gis.water.ca.gov/app/NCDatasetViewer/

Vegetation Scientific Name	Vegetation Common Name	Max Rooting Depth (m)	Max Rooting Depth (ft)	Soil Type	Growth Form	Reference
Populus fremontii	Fremont cottonwood	0.2	0.66	half gravel half sand, coarsest	tree	Shafroth et al., 2000
Populus fremontii	Fremont cottonwood	0.65	2.13	sands and gravel	tree	Shafroth et al., 2000
Populus fremontii	Fremont cottonwood	1.4	4.59	strata of coarse and medium	tree	Shafroth et al., 2000
Populus fremontii	Fremont cottonwood	2.1	6.89	NR	tree	Stromberg, J. 2013
-	Riparian Mixed Hardwood	variable	-	-	tree	
Salix spp.	Willow	variable	-	-	tree	
Salix spp.	Willow (shrub)	variable	-	-	shrub	
Quercus lobata	Valley Oak	7.41	24.31	fractured rock	tree	Lewis & Burgy 1964
Quercus lobata	Valley Oak	7.32	24.02	fractured rock	tree perennial	Schenk, H. J. and Jackson, R. B. 2002

Table 13: Vegetation types within the Basin identified by the NCCAG Dataset along with their maximum rooting depth.

GDE Mapping and Inventory Methods

Four members of the Scott Valley Groundwater Advisory Committee agreed to form a Surface Water Ad Hoc Committee. The group was created to assist with the identification of high-priority habitat, define a healthy hydrologic system in the Basin, and define metrics indicative of ecosystem health to assist in the definition of measurable objectives, undesirable results, and associated monitoring activities. A total of seven meetings were held between February 2020 and March 2021. The ad hoc committee provided detailed consultation on the presence or absence of potential GDEs or general vegetation conditions in the GDE mapping exercise.

The Surface Water Ad Hoc Committee defined GDEs operationally as surface water ecosystems that can be affected by pumping or artificially recharging groundwater and/or riparian vegetation. The GDEs in the basin were categorized into two major groups.

1. GDEs that are adjacent to flowing surface water for most or all of the time, and which may rely on groundwater supplementation of surface waters (category name: Riparian Vegetation); and
2. GDEs that are never or rarely adjacent to flowing surface water, but which rely directly on shallow groundwater (category name: Non-Riparian Groundwater-Dependent Vegetation).

The iGDE dataset[7], a data product created by the Nature Conservancy (TNC) to assist GSAs complete this component of their GSPs (Klausmeyer et al. 2018), was used as a starting point for the GDE inventory exercise. The presence and geographic extent of this groundwater dependent vegetation were verified through an evaluation by the ad hoc committee. Changes to the initial dataset were reflected in the GDE map by adding locally recognized GDEs or removing some GDE polygons. The resulting map is shown in Figure 24 and additional information about the categorization process is described below.

- *Riparian Vegetation* category: Most of the GDEs identified in the Basin fall into this category. Using the best currently available data, it is difficult to identify whether the presence of riparian vegetation is dependent on groundwater discharge or if it is sustained entirely by surface flow (e.g., if riparian vegetation is pulling water from the hyporheic zone in areas where groundwater availability is not a control on vegetation presence). Because the stream-aquifer system in the Basin is so interconnected, most of the surface flow in major tributaries could theoretically be affected by groundwater extraction, so all riparian vegetation could be indirectly dependent on groundwater. Consequently, all Riparian Vegetation mapped in the Basin was conservatively included in the GDE map.
- *Non-Riparian Groundwater Dependent Vegetation* category: Where the committee could tentatively rule out the dependence of the vegetation on surface water, either because of sufficient distance to a stream channel or obvious lack of lush riparian vegetation, the committee designated some polygons as a second vegetation category of Non-Riparian Groundwater-Dependent Vegetation (NR-GDV). To qualify for this category, it was necessary that a GDE area be observably distinct from surrounding dry-land terrestrial vegetation.

The NR-GDV category would include:

- wetlands or swamps;
- vegetation features that appear on satellite imagery to trace subsurface drainage features but do not appear to be adjacent to running water; and
- patches of unusually lush or dense vegetation or trees that are uphill of, or sufficiently distant from, a stream channel.

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[7] https://groundwaterresourcehub.org/sgma-tools/mapping-indicators-of-gdes

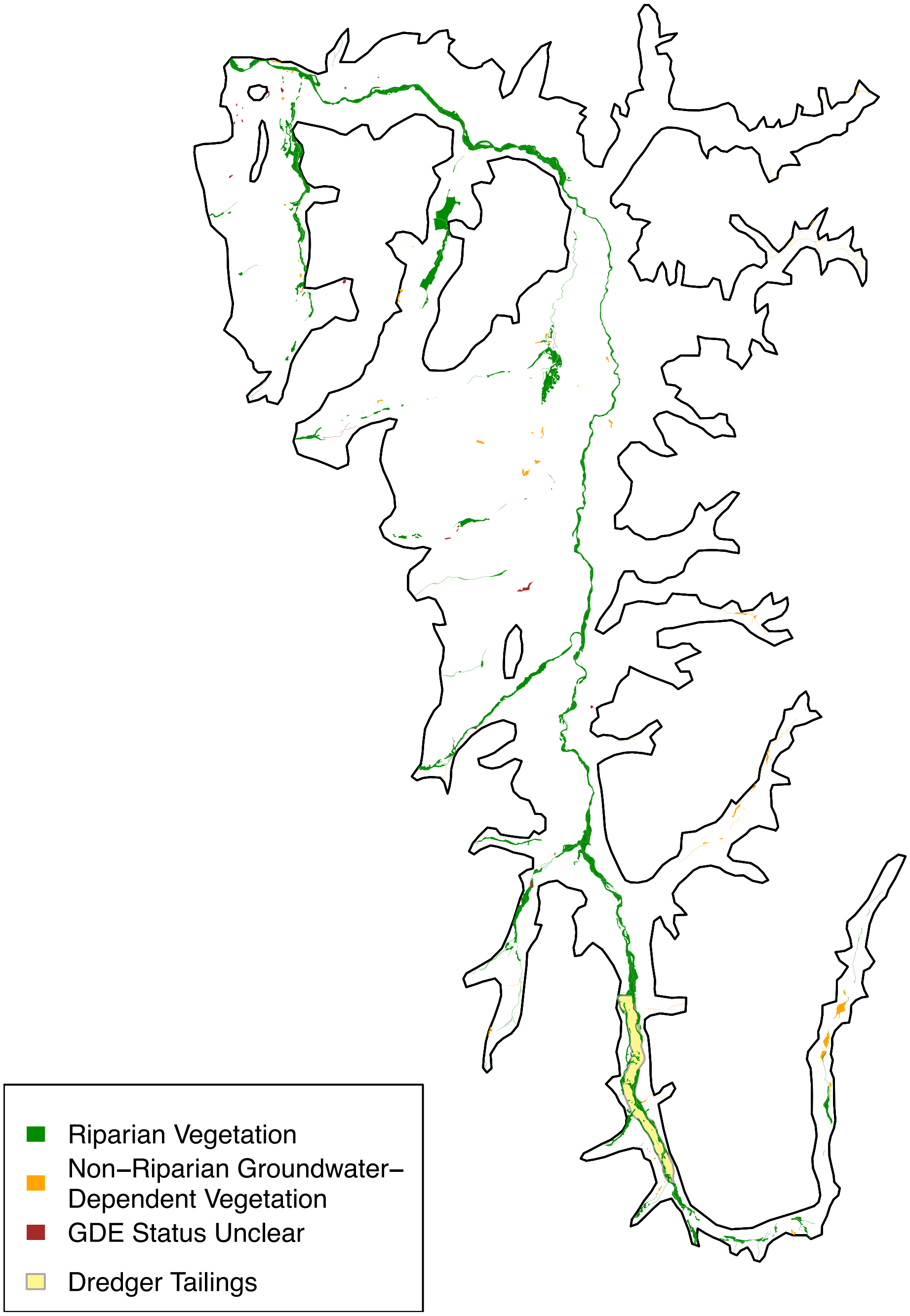

Figure 24: GDE inventory generated for the Basin. An enlarged version, which includes parcel boundaries, is attached as Appendix 2-B.

Groundwater Dependent Species

This section discusses fauna species that occupy GDEs consisting of perennial flowing streams (aquatic ecosystems), as mapped under Interconnected Surface Waters (see previous section). TNC has provided a list of freshwater species located within each groundwater basin in California[8]. Based on this list, there are a total of eleven species identified by the State as endangered, threatened, or species of special concern within the Basin, including those under review or in the candidate or petition process (Table 14). Of the eleven total species with one of these designations, two are threatened species, one is an endangered species, four are special species, and four are species of special concern. Though not included on the TNC list, the cascade frog, which is under review for listing at the state level, and the willow flycatcher, listed as endangered at the state level were also suggested for inclusion.

Species	State of California Listing	Federal Listing
Bank Swallow	Threatened	
Western Pond Turtle	Special Concern	
Foothill Yellow-legged Frog	Special Concern	Under Review in the Candidate or Petition Process at the Federal level
Tricolored Blackbird	Special Concern	Bird of Conservation Concern, habitat range not within the Basin
Greater Sandhill Crane1	Threatened	
Yellow-breasted Chat	Special Concern	
A Cave Obligate Amphipod	Special	
California Floater	Special	
Western Ridged Mussel	Special	
Western Pearlshell	Special	
Bald Eagle	Endangered	Bird of Conservation Concern

Table 14: Freshwater species in Scott Valley of special concern, based on information provided by the Nature Conservancy and stakeholder input, and as noted in Ivey and Herzinger (2001).

The habitat ranges for each of these species were evaluated using CDFW's Biogeographic Information and Observation System (BIOS) Viewer[9]. BIOS houses many biological and environmental datasets including the California Natural Diversity Database (CNDDB), which is an inventory of the status and locations of rare plants and animals in California. The presence of the Greater Sandhill crane in Scott Valley is also noted in Ivey and Herziger (2001).

A preliminary visual analysis of the data indicated that the Tricolored Blackbird's habitat range is not within the Basin's area this species is therefore not included in the list of GDE species for the Basin. The entire Basin area is within the habitat range of the foothill Yellow-legged Frog, western pond turtle, bald eagle, and yellow-breasted chat. The habitat range for the bank swallow within the Basin borders the Scott River. The ranges of the mussel species (California floater, western ridged mussel, and western pearlshell), are classified as "unknown" in the TNC Freshwater Species List and their presence in the Basin is based on reported presence in a freshwater mussel survey[10]. The TNC Freshwater Species List was used to determine the presence of the cave obligate amphipod based on the NatureServe Explorer descriptions[11] and Subterranean Institute database[12].

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[8] Can be obtained from https://groundwaterresourcehub.org/sgma-tools/environmental-surface-water-beneficiaries/

[9] https://apps.wildlife.ca.gov/bios/

[10] Howard, JK. 2010. Sensitive Freshwater Mussel Surveys in the Pacific Southwest Region: Assessment of Conservation Status ("Mussel Sites Final"). The Nature Conservancy, San Francisco, CA.

[11] NatureServe. 2012. NatureServe Explorer: An online encyclopedia of life [web application]. Version 7.1. NatureServe, Arlington, Virginia. Available http://www.natureserve.org/explorer.(Accessed: 7/16/2012)

[12] Graening, G.O. et al. 2012. Unpublished data, database report. The Subterranean Institute, Citrus Heights, CA.

For species with habitat within the Basin, descriptions of groundwater reliance, water demand, and other habitat requirements are provided below:

- Bank swallows seasonally use areas along bodies of water, such as rivers, streams, reservoirs, and ocean coasts, for nesting. This species is highly colonial and breeds in nesting burrows that are constructed in near-vertical banks. Their diet consists of aquatic and terrestrial insects that they catch over water bodies and associated floodplain grasslands. Bank swallows' reproductive success appears to be positively associated with the previous winter's streamflow, suggesting that higher flows in winter (prior to the initiation of nesting) improve nesting habitat and foraging conditions. If groundwater depletion results in reduced streamflow, the foraging success of bank swallows may be diminished due to the reduced availability of aquatic insects.
- The western pond turtle's preferred habitat is permanent ponds, lakes, streams, or permanent pools along intermittent streams associated with standing and slow-moving water. A potentially important limiting factor for the Western pond turtle is the relationship between water level and flow in off-channel water bodies, which can both be affected by groundwater pumping.
- The Northwest/North Coast clade of foothill yellow-legged frog is rarely encountered far from permanent water. Tadpoles require water for at least three or four months while completing their aquatic development. Adults eat both aquatic and terrestrial invertebrates, and the tadpoles graze along rocky stream bottoms. Groundwater pumping that impairs streamflow could have negative impacts on foothill yellow-legged frog populations.
- The yellow-breasted chat is a seasonal resident of California that relies on riparian habitat and food sources of insects and fruit. The yellow-breasted chat spends summer months in California, arriving around April and migrating to Mexico and Guatemala by the end of September. A key threat to populations is loss of riparian habitat (Green 2005).
- Greater Sandhill cranes were added to the State list of threatened bird species in 1983. A subspecies of the sandhill crane, they predominantly reside in freshwater wetlands, relying on these areas for nesting grounds. As such, Greater Sandhill cranes are susceptible to degradation of wetland habitat and are threatened by lowered groundwater tables, stream downcutting, and the associated impacts to wetland habitats.
- The freshwater mussels on the list (the California floater, western ridged mussel, and western pearlshell) all live in lakes and streams and are often found in areas with slow currents and soft substrates. Juvenile mussels use fish as hosts. Threats to populations include habitat loss, changes to water quality and temperature, and loss of fish host species.
- Bald eagles live near water bodies including estuaries, lakes, reservoirs, rivers, and occasionally along coastlines. They rely on a diet predominantly comprised of fish, but that also may include smaller colonial waterbirds, waterfowl, and small mammals. Historically, populations have been threatened by hunting, loss of nesting habitat, and poisoning from the pesticide DDT[13].

Fisheries and Aquatic Habitat

The Scott River watershed contains important habitat for coho salmon (Oncorhynchus kisutch). Coho salmon in the Southern Oregon Northern California Coast Evolutionary Significant Unit (SONCC ESU) have been federally listed as threatened since 1977 and have been listed as threatened by the California Fish and Game Commission since 2002 (SRWC 2005). Four other species of special concern, as listed by CDFW[14], rely on the watershed for habitat; these include Chinook salmon (Oncorhynchus tschawytscha), steelhead trout (Oncorhynchus mykiss), Pacific lamprey (L. tridentata), and Klamath River lamprey (Lampetra similis).

Anadromous fish in Scott Valley depend on access to and suitable habitat in Scott River and the surrounding tributaries for spawning. Of particular concern is coho salmon due to its listing under both the California

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[13] https://www.fws.gov/midwest/eagle/Nhistory/biologue.html

[14] https://wildlife.ca.gov/Conservation/SSC/Fishes

Endangered Species Act and Federal Endangered Species Act and the identification of Scott River as a high priority watershed for coho salmon recovery[15]. Key threats to anadromous fish in the Basin include insufficient flows for fish passage and high stream temperatures during critical life stages. Priority habitat in Scott Valley utilized by each species is discussed below along with threats to their populations.

Fisheries monitoring in Scott Valley includes: Siskiyou RCD's Scott River coho and Chinook salmon spawning ground surveys, CDFW's juvenile salmonid outmigrant monitoring using the Scott River rotary screw trap (e.g., Knechtle and Giudice 2021), CDFW's Klamath River Project video fish counting and cooperative spawning ground surveys.

Coho Salmon

Life Cycle

Of their three-year life cycle, coho salmon spend the first 18 months of life in fresh water followed by migration out to the ocean to finish development and, after 18 months, a return to the freshwater stream in which they were born in order to spawn (SRWC 2006). Adult coho salmon migrate from the ocean, entering the Klamath River in the fall, usually spawning in Scott River from mid-October to early January (Knechtle and Giudice 2021). The three-year cycle from coho salmon are laid as eggs, to when they return to spawn results in brood years or the year in which the majority of the returning fishes' parents spawned. Hundreds of thousands of eggs are deposited into nests in the gravel, fertilized and buried, with incubation generally occurring from November to April (ESA Associates 2009). After a period of up to two weeks spent in the gravel, fry emerge between February and June into shallow, slow-flowing water, moving into deeper water by July and August (ESA Associates 2009). Juvenile coho spend a full year in fresh water before beginning their migration to the ocean from late March to June (ESA Associates 2009). In Scott River, coho spawn in accessible cold water, perennial sections of tributaries where juvenile coho salmon can survive the summer; priority habitat is discussed further under the "Priority Habitat in the Basin" section, below.

Habitat Requirements

Coho salmon have specific habitat requirements for the migration, spawning, and rearing phases of their life cycle that are spent in fresh water. To migrate to the desired freshwater rivers and tributaries, sufficient flows must be present. Desirable spawning habitat consists of smaller streams with gravel less than 15 cm in diameter, and circulating, oxygen-rich water (SRWC 2006). Additionally, healthy riparian vegetation, the presence of large woody debris (LWD) in the stream channel, appropriate channel substrate, water velocity, flow volumes and timing, and appropriate water temperatures and dissolved oxygen levels are all factors in defining suitable habitat for coho salmon (ESA Associates 2009).

Priority Habitat Identified in the Basin

There have been multiple efforts to evaluate habitat utilization in the Basin by coho salmon. At the federal level, as stated in the 2014 SONCC Coho Recover Plan (NMFS 2014), Critical Habitat for coho salmon was designated as "all accessible reaches of rivers (including estuarine areas and tributaries) between Cape Blanco, Oregon, and Punta Gorda, California (64 FR 24049, May 5, 1999)." Thus, all accessible reaches in the Scott River watershed are included in this critical habitat designation. At the regional and local level, the annual Scott River coho salmon spawning ground surveys highlight reaches with high coho utilization across multiple years. Recovery strategies for coho salmon developed by agencies including CDFW (California Fish and Game Comission 2004) include analyses of critical habitat in the watershed. High-quality habitats for coho also have been characterized as part of recovery efforts and used to prioritize locations for restoration. A table summarizing these results is shown in Table 15.

Coho spawning ground surveys were conducted in the Scott River watershed beginning in the winter of 2001–2002. Certain reaches show consistent spawning activity over multiple years. For the first five survey

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[15] https://wildlife.ca.gov/Conservation/Watersheds/Instream-Flow/Studies/Scott-Shasta-Study

Location	Final SONCC Coho Recovery Plan (NMFS 2014)	CDFW Recovery Strategy for coho salmon (CDFG 2004)	Coho Spawning Ground Surveys	High Intrinsic Potential (NMFS 2014)	Restoration Prioritization (SRWC 2018)	Scott River Water Trust (SRWT 2021)
East Fork Scott River	X	X				X
South Fork Scott River	X	X		X	X	X
Sugar Creek	X	X	X	X	X	X
French Creek	x	X	X	X	X	X
Miners Creek	X	X	X	X		X
Etna Creek	X	X		X		
Kidder Creek	X					
Patterson Creek	X	X				X
Shackleford Creek	X	X	X	X	X	X
Mill Creek	X	X	X	X	X	X
Canyon Creek	X	X		X		
Wooliver Creek		X		X		
Kelsey Creek		X		X		
Big Mill Creek		X				
Wildcat Creek				X		
Boulder Creek				X		
Noyes Valley Creek				X		
Moffett Creek				X		
Tompkins Creek				X		

Table 15: Locations noted in various studies and plans as high priority, high utilization, or high potential for coho salmon habitat, as described in the preceding text.

seasons, 2001 through 2005, “hotspots” for coho spawning were identified as Mid-French Creek, Miner’s Creek, Lower Mill Creek, Lower Shackleford Creek, and Lower Sugar Creek (Siskiyou RCD 2006). Similar observations are included in reports from subsequent years. The 2010-2011 annual report (Siskiyou RCD 2011) lists Lower Mill and Lower Shackleford creeks as locations with the highest spawning densities, followed by Lower Sugar Creek and Lower French Creek. The eleven most productive tributaries were identified in the Final SONCC Coho Recovery Plan (NMFS 2014): East Fork Scott River, South Fork Scott River, Sugar Creek, French Creek, Miner’s Creek, Etna Creek, Kidder Creek, Patterson Creek, Shackleford Creek, Mill Creek, and Canyon Creek.

The CDFW recovery strategy for coho salmon (California Fish and Game Comission 2004) included tributaries with key populations that need to be improved or maintained and locations to establish populations. In the Scott River Coho Salmon Recovery Unit, streams listed as having key populations to maintain or improve include: Mill Creek (near Scott Bar), Wooliver Creek, Kelsey Creek, Canyon Creek, Shackleford Creek, Mill Creek, Patterson Creek, Etna Creek, French Creek, Miners Creek, Sugar Creek, South Fork Scott River, East Fork Scott River, and Big Mill Creek.

The intrinsic potential (IP), the potential of a habitat to support coho salmon rearing or spawning, of tributaries in the watershed were assessed, primarily through use of GIS. Tributaries identified as having high IP reaches (IP>0.66) include: Shackleford Creek, Mill Creek, French Creek, Miners Creek, South Fork Scott River, Sugar Creek, Wooliver Creek, Big Mill Creek, East Fork Scott River, Patterson Creek, Wildcat Creek, Etna Creek, Boulder Creek, Noyes Valley Creek, Moffett Creek, Canyon Creek, Kelsey Creek, Mill Creek (near Scott Bar), and Tompkins Creek (NMFS 2014).

Identification of key salmon spawning habitat has also been conducted to support prioritization of restoration activities. A 2014 Restoration Report produced by the SRWC and Siskiyou RCD (SRWC and Siskiyou RCD 2014) identified Reach II of Scott River (downstream end of tailings to SVID diversion structure) as a priority area for bank stabilization to protect critical fish habitat. A study completed in 2018 examined the mainstem Scott River and its tributaries to evaluate and prioritize potential sites for restoration based on value for coho rearing habitat (SRWC 2018). In addition to evaluating potential restoration sites, this report classified streams for planning prioritization and evaluated habitat conditions for reaches in streams classified in the top two tiers for prioritization. Potential sites were scored based on four factors: the potential inundation area at 1.0 m and 1.5 m water levels, the riparian condition, the presence of water during base flow of an average water year, and the presence of coho. Streams in the project area were categorized by tiers for planning prioritization. Tiers were developed using the CDFW key streams, NOAA intrinsic potential, documented coho utilization, and existing temperature impairments. The condition of the existing physical habitat was evaluated for all reaches in Tier 1 and 2 streams using stream gradient, base flow connectivity during an average water year, current stream confinement, and riparian condition. Reaches with “excellent existing physical habitat” were noted for Shackleford Creek, Mill Creek, French Creek, Sugar Creek, and the South Fork Scott River (SRWC 2018).

Scott River Water Trust also identifies priority reaches on their website which include: Shackleford Creek and its Mill Creek tributary, French Creek and its Miner’s Creek Tributary, Patterson Creek (west)_- upper, South Fork Scott River, East Fork Scott River, Sugar Creek, Mainstem Scott River (SRWT 2019).

Population Trends

Estimated escapements of coho salmon returning to the Scott River has varied since the start of video operations in Scott River in 2007 (Knechtle and Giudice 2021). Due to the three-year cycle between when coho salmon are eggs and when they return to the freshwater location in which they hatched, brood years are important to identifying population trends as decreases to a particular brood year can impact future populations in the same brood year. In Figure 25 (Knechtle and Giudice 2021), brood years are shown in different colors and the blue brood year returning in 2020 increased from that observed in 2017.

Chinook Salmon

Though the Scott River is historically rumored to have supported spring-run Chinook salmon populations, it now only supports fall-run Chinook salmon.

Life Cycle

Fall-run Chinook salmon primarily migrate to the Scott River in September and October during adulthood (aged 3 to 5 years). Spawning occurs mid-September to late December, followed by incubation and a period of two to ten weeks in the gravel before emergence in in the spring (Knechtle and Giudice 2021). The juvenile fish usually outmigrate in the spring or early summer, generally in April to June, following a few months spent in freshwater (ESA Associates 2009). Juvenile fish then make the journey through 143 miles of the Klamath River before entering the Pacific Ocean.

Priority Habitat

The mainstem of the Scott River, from the confluence with the Klamath River to Faye Lane, is the main area used by Chinook salmon in the Basin (ESA Associates 2009). Habitat requirements are similar to those for coho salmon with sufficient streamflow, water temperatures, and instream cover all important components determining suitable habitat, though Chinook salmon prefer the larger gravels in the mainstem of Scott River for spawning (ESA Associates 2009). Notable concerns include insufficient streamflow during migration for Chinook salmon to ascend into the valley (Knechtle and Giudice 2021).

Population Trends

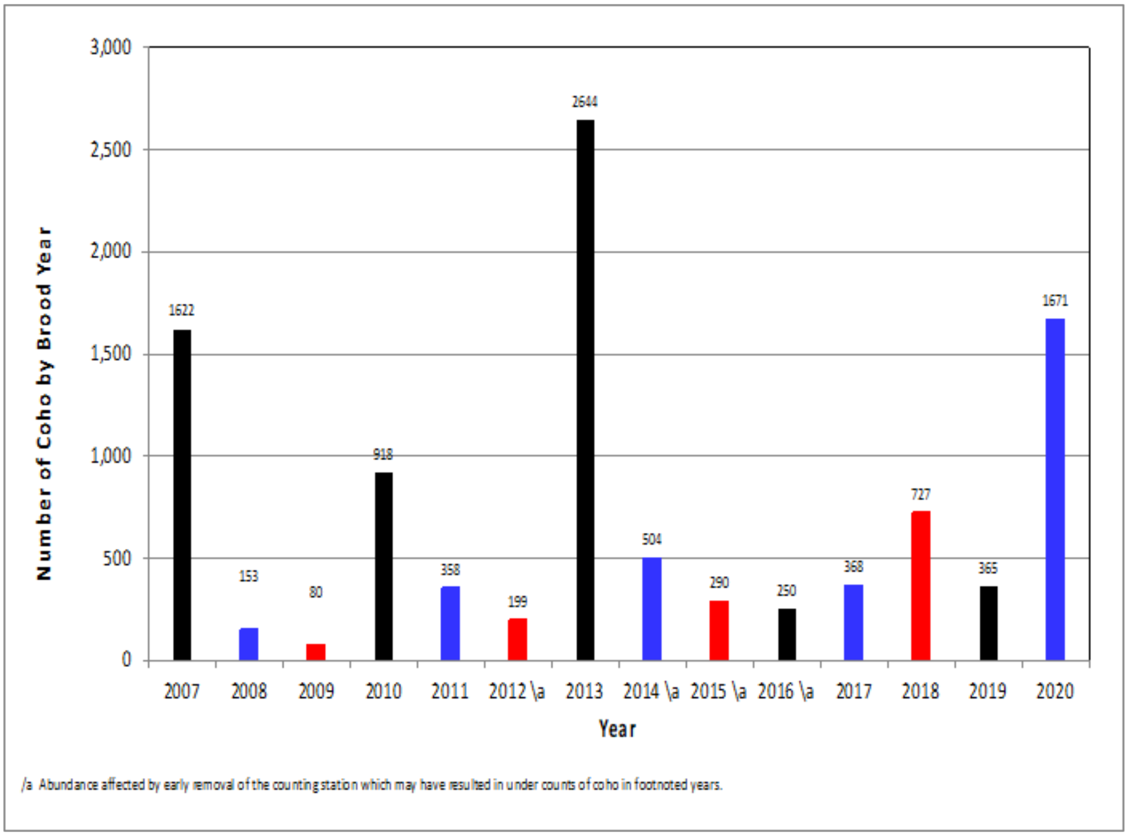

Figure 25: From Knechtle (2021), Figure 19. Estimated escapement by Brood Year of adult and grisle Coho Salmon salmon returning to the Scott River from 2007-2020. Individual Brood Years are represented by different colors.

Population estimates of Chinook salmon returning to the Scott River to spawn has varied since 1978, with an average number of 4,977 fish (Knechtle and Giudice 2021). The 2020 Chinook salmon run, at 855 fish, is significantly lower than the average, and continues a decreasing trend over the past 5 years as shown in Figure 26 (Knechtle and Giudice 2021).

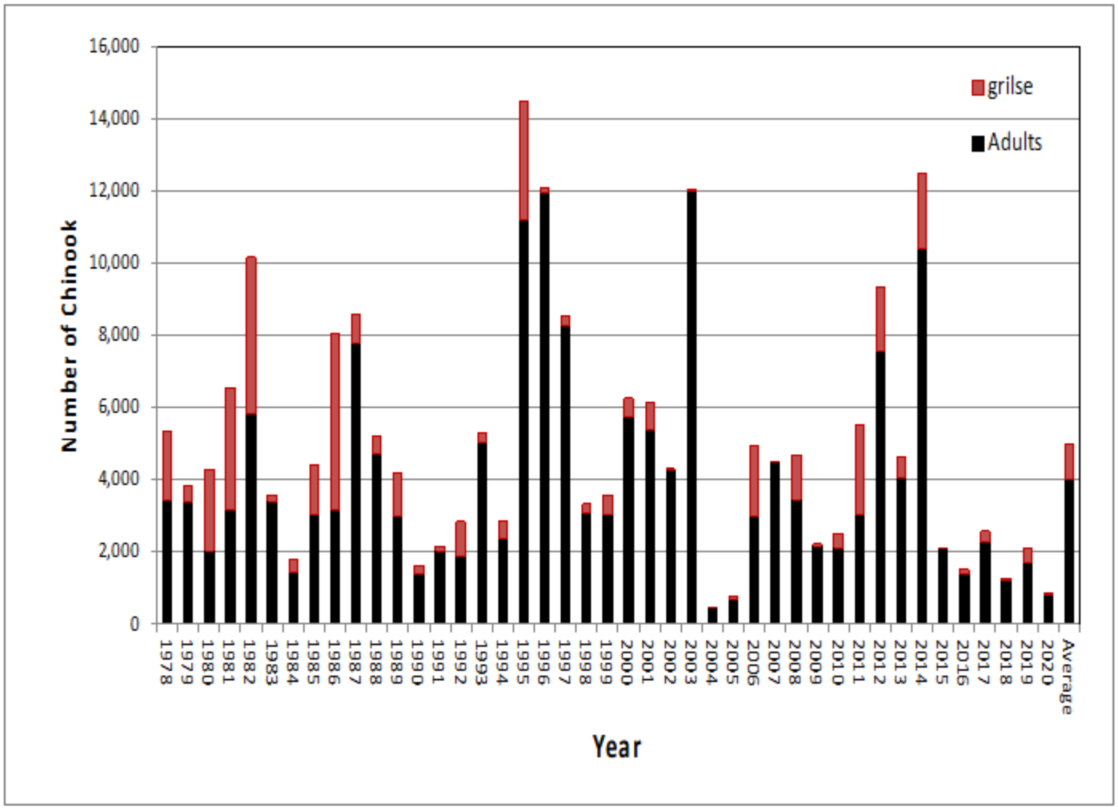

Figure 26: From Knechtle 2021, Figure 14. Estimated escapement of Chinook Salmon returning to the Scott River from 1978-2020.

Steelhead Trout

Life Cycle

Within the Basin, there are multiple variations of steelhead life histories. Steelhead life cycles vary, with the anadromous fish migrating while others spend their entire lives in freshwater environments. Further variation includes the developmental stage at which steelhead return to freshwater, with the summer run, stream-maturing, and winter run, ocean-maturing as the two categories (ESA Associates 2009). Steelhead can spawn multiple times throughout their life (ESA Associates 2009), generally spending one to four years in the ocean and returning to their natal streams to spawn. Generally, summer steelhead migrate to the Scott River April to June, fall steelhead migrate August through October, and winter steelhead migrate November through March with spawning spanning from January to April. The incubation period lasts through mid-June with fry emergence through mid-July. The majority of steelhead spend two years in freshwater, migrating to the ocean at around three years of age.

Priority Habitat

Steelhead habitat requirements are very similar to those for coho and Chinook salmon. Monitoring of juvenile steelhead in the French Creek Watershed from 1992-2005 indicated the lower reaches of the watershed had a higher abundance of steelhead and that larger individuals were located in the steeper, higher velocity reaches (California Department of Fish and Game (CDFG) 2006). Since 2005, Siskiyou RCD, CDFW, and SRWC have collected more habitat and population data.

Lampreys

The River lamprey, Klamath River lamprey, and Pacific lamprey are listed under CDFW's fish species of special concern (Moyle, Quiñones, and Katz 2015).

Life Cycle

Pacific lampreys have diverse life histories, with some lampreys migrating to the ocean and others remaining in freshwater environments. Migration from the ocean to freshwater environments generally occurs from January through March, though migrations have been noted during summer and winter months as well (Moyle, Quiñones, and Katz 2015). Spawning occurs up until the month of June. Following emergence, larvae are transported downstream and burrow into the sand or mud, where they reside for 5–7 years until they mature into adults, at which point they outmigrate to the ocean. Outmigration is thought to peak in the spring (Moyle, Quiñones, and Katz 2015).

Priority Habitat

In the Basin, spawning primarily occurs in the mainstem of the Scott River or the larger tributaries (ESA Associates 2009). Habitat requirements that are similar to salmonids include the need for cold, clear water of suitable temperature. The requirement for sand and mud for larvae is distinct from salmonid requirements.

Population Trends

Return numbers of steelhead are not well-known for Scott River as steelhead migration occurs largely outside of the time that the Scott River Fish County Facility is operational (Knechtle and Giudice 2021).

Threats to Prioritized Fish and Aquatic Species in the Basin

Due to the similarities in life histories and habitat, anadromous fish species in the Basin are facing similar threats. Steps have been taken to address requirements for, and the threats to, anadromous fish species in the Basin (particularly for coho salmon), including the instream flow criteria developed by CDFW and the temperature TMDL requirements.

An analysis of limiting factors to coho salmon completed in 2005 (SRWC 2006) highlighted limiting factors to coho in all life stages, including the spawning and incubation phases, the summer/fall rearing phase, winter/spring rearing phase, and smolt outmigration phase. Limiting factors known in the Basin were noted to include:

- **Habitat** - lack of suitable habitat, particularly flood plain and side-channel habitat due to channel alteration, removal of riparian vegetation, and reduction in large woody debris (LWD).
- **Flow** - lower summer and fall flows can impede or delay access to suitable habitat, reduce the habitat available, and increase stream temperatures that are outside the preferred temperature range.
- **Water Quality** - increased sediment in the stream which can result in reduced connectivity and reductions in suitable spawning habitat due to alterations in the substrate size distribution.
- **Population Structure** - due to the three-year cyclical brood year structure, decreases in populations in brood years can be persist in future years.

This list is not exclusive and other factors may affect fish populations.

Management Approach

Groundwater dependent species were prioritized for management, primarily focusing on anadromous fish species (coho salmon, Chinook salmon and Steelhead) and GDEs located along the Scott River, tributaries, and riparian corridors. Addressing the needs of these species cover the needs of other special-status species such as the bank swallow, western pond turtle, and bald eagle that use riverine habitats during their various life stages. Additionally, special status species that were not prioritized for management may exhibit flexible life-history strategies, are less susceptible to changing groundwater conditions, and/or have a different nature or lower degree of groundwater dependency. The species prioritized for management, and by extension, the species whose needs are covered through management for prioritized species (Table 16), are considered throughout this GSP. In particular, the inclusion of metrics in monitoring that are related directly and indirectly to the conditions of priority species, and in development of sustainable management criteria that directly or indirectly improve conditions for these species.

Species Prioritized for Management	Species whose needs are covered through the management for prioritized species
Coho salmon	Bank swallow
Chinook salmon	Western pond turtle
Steelhead trout	Foothill yellow-legged frog
Riparian vegetation	Greater sandhill crane
	Yellow-breasted chat
	cave obligate amphipod
	Mussel (California floater, Western ridged mussel, and Western pearlshell)
	Bald Eagle

Table 16: GDE species prioritization for management.

2.2.2 Current and Historical Groundwater Conditions

2.2.2.1 Groundwater Elevation Data

Groundwater elevation contours for April and September of 2015, interpolated from water level data collected in the Scott Valley Community Groundwater Measuring Program, are plotted on Figures 27 and 28. The elevation of the static water table in the Basin broadly mimics the topography, meaning that it slopes towards the river from the east and west, and declines more gradually northward along the longitudinal axis of the valley. Water levels are deepest closer to the margins of the Basin and the hydraulic gradient is steeper on the western margin of the valley floor than on the eastern. These spatial patterns are evident in both the wet and dry seasons. However, in the dry season the hydraulic gradient predictably becomes shallower in some areas, such as near Greenview (Figures 27 and 28).

Groundwater recharge occurs as stream leakage, as percolation through the soil zone (including under irrigated agricultural fields), and along the valley margin as mountain front recharge (MFR). Groundwater leaves the aquifer through groundwater pumping for irrigation, discharge to streams, and by direct evapotranspiration in areas where the water table is near the land surface.

As discussed under Section 2.2.1.5, Irrigation Practices, groundwater pumping in Scott Valley has increased from the 1950s to present day. Reliance on groundwater as a source for irrigation water has also increased from over this same time period (see Irrigation Practices discussion).

Based on well data collected from 1965 to 2003, groundwater levels in Scott Valley remained relatively consistent, with seasonal cycling of lowered groundwater levels in the summer followed by increases in the winter months (Harter and Hines 2008). This trend is observed throughout the Basin. Though annual precipitation in the Basin has been lower over the past 20 years, water levels have remained steady, with seasonal fluctuations, as seen in the long-term hydrographs of groundwater wells displayed in Figure 29. Over this period (2000-2020), there were a few wells with declines in fall water levels but no wells with spring water level declines. Based on data from the Scott Valley Community Groundwater Measuring Program, collected from 2006 to 2018, water levels measured during dry years were lower than in average or wet years and, with the exception of 2015 and 2016, continued to decrease throughout drought periods (i.e., 2007-2009 and 2012-2016). Hydrographs for wells in Scott Valley are included in Appendix 2-C. The availability of water is most critical during summer and beginning of fall, a key concern in Scott Valley for agricultural uses and for instream flows for fish. Lowest water levels were generally observed in 2001 (for the few wells for which long-term water level data are available) or 2014 (Community Groundwater Measuring Program), with some wells having lowest water level measurements in 2020. A well with long-term observation records indicates lower fall water levels after the 1970s, when compared to the period between the 1950s and 1960s. Otherwise, no significant trend in water levels was noted over this period. Historic and recent water level data do not indicate overdraft or long-term declines in groundwater data. However, the past 22 years have seen a higher frequency of dry years and more frequent occurrence of low fall water levels than has been observed on few wells during the previous 40 years (Figure 18).

2.2.2.2 Estimate of Groundwater Storage

Overall groundwater storage in Scott Valley has been estimated at 400,000 acre-feet (AF) (4.9×10^8 m^3), distributed throughout six different groundwater units (Mack 1958). The properties associated with each unit are listed in Table 17. The six identified groundwater storage units include the following (Mack 1958; Harter and Hines 2008) (Figure 30):

1. The Scott River Floodplain
2. Western Mountain Alluvial Fan Discharge Zone
3. Western Mountain Alluvial Fans and Oro Fino Valley
4. Quartz Valley
5. Moffett-McAdam Creek
6. Hamlin Gulch

The largest of the six units is the Scott River floodplain, with an estimated groundwater storage capacity of 220,000 AF (2.7×10^8 m^3) (Mack 1958). Deposited by the Scott River and its tributaries, the stream channel and floodplain deposits are predominantly comprised of unconsolidated sand and gravel with clay (per DWR (2004), Bulletin 118). The most permeable floodplain deposits lie between Etna and Fort Jones. This area, with an average width of 1.5 mi (1.6 km), is estimated to represent most of the groundwater storage in Scott Valley (Mack 1958; DWR 2004). Units 2, 3, and 4 are all situated along the western edge of the valley. Unit 2 is situated along the western mountain fans and is underlain by finer alluvium deposited by tributaries. Unit 3 is located along the western mountains north of Etna to Greenview. The permeability is high in gravelly sediments at the apex of the fan and decreases downslope with increasing proportions of clay and silt. Unit 4 encompasses Quartz Valley and includes rounded boulders, thought to be moderately permeable. Comprised of the land adjacent to Moffett Creek and McAdam Creek, Unit 5 is moderately permeable. Streams in Unit 6, located in the Hamlin Gulch area, are ephemeral and Unit 6 is thought to be the least permeable of the storage units in Scott Valley (Mack 1958). The groundwater storage values that have been reported only reflect the amount of groundwater in storage and do not represent the amount of usable groundwater in Scott Valley, which is estimated to be less than 400,000 AF (4.9×10^8 m^3) (Mack 1958).

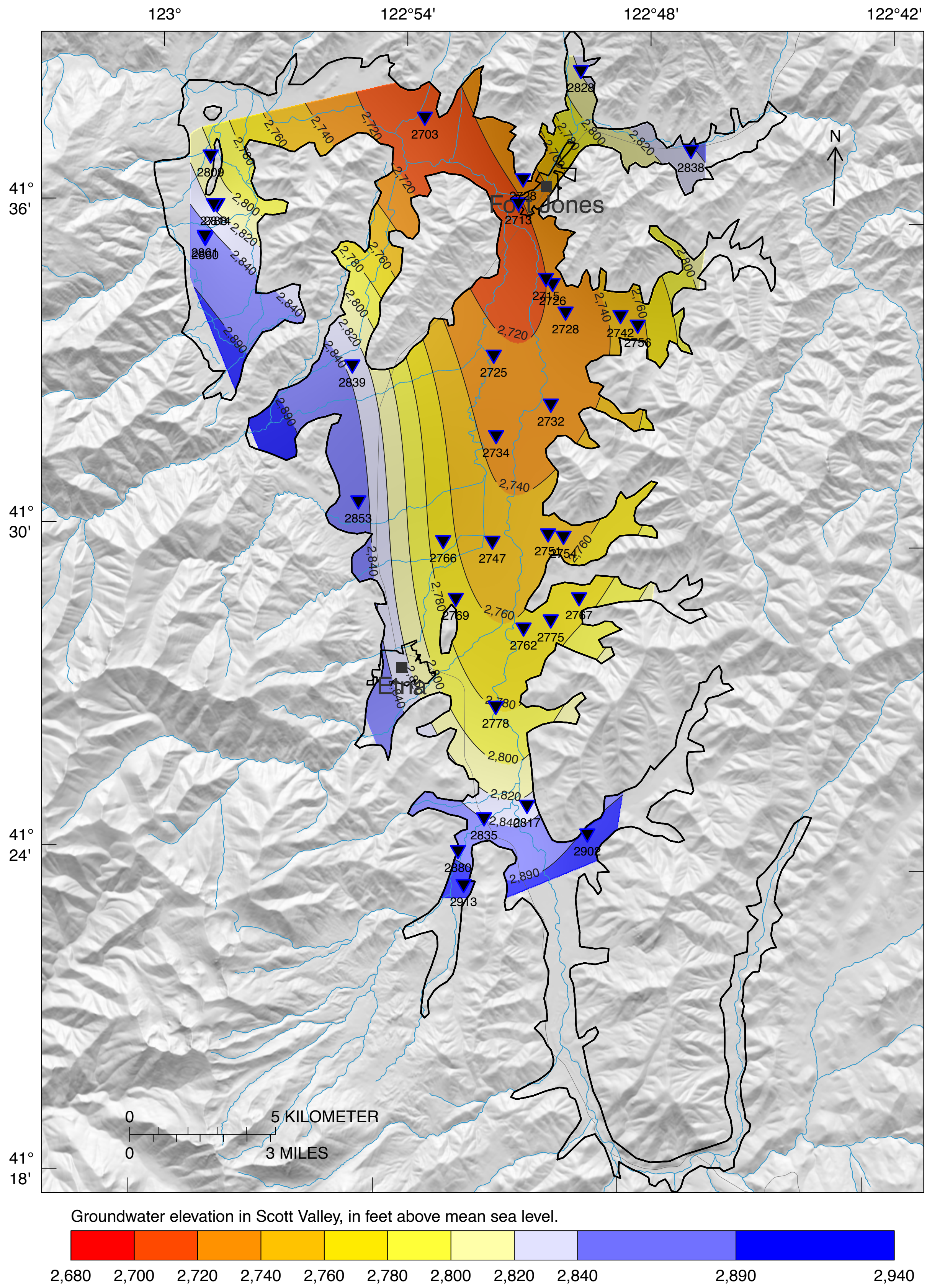

Figure 27: Scott Valley Groundwater Elevations, March 2015.

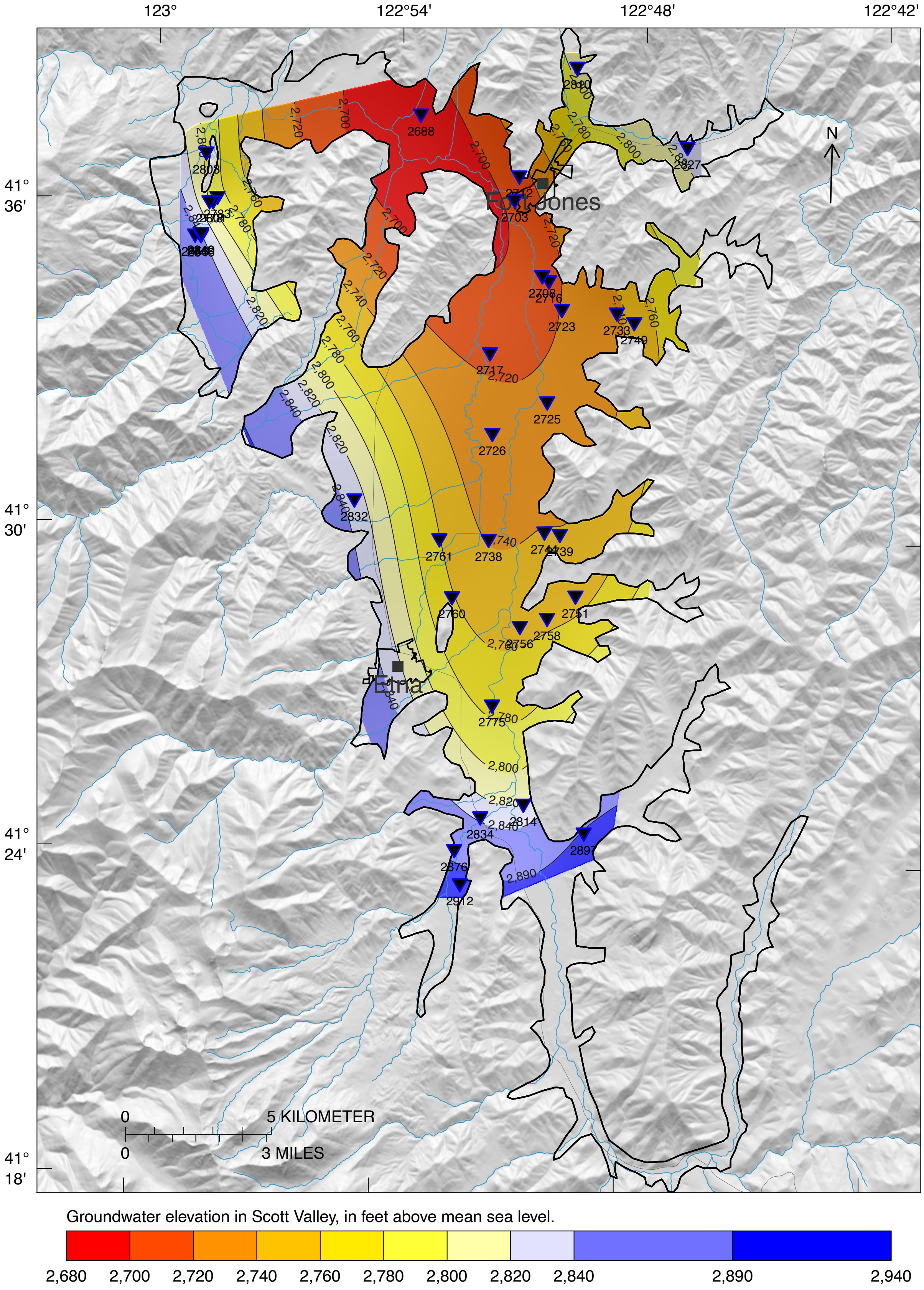

Figure 28: Scott Valley Groundwater Elevations, September 2015.

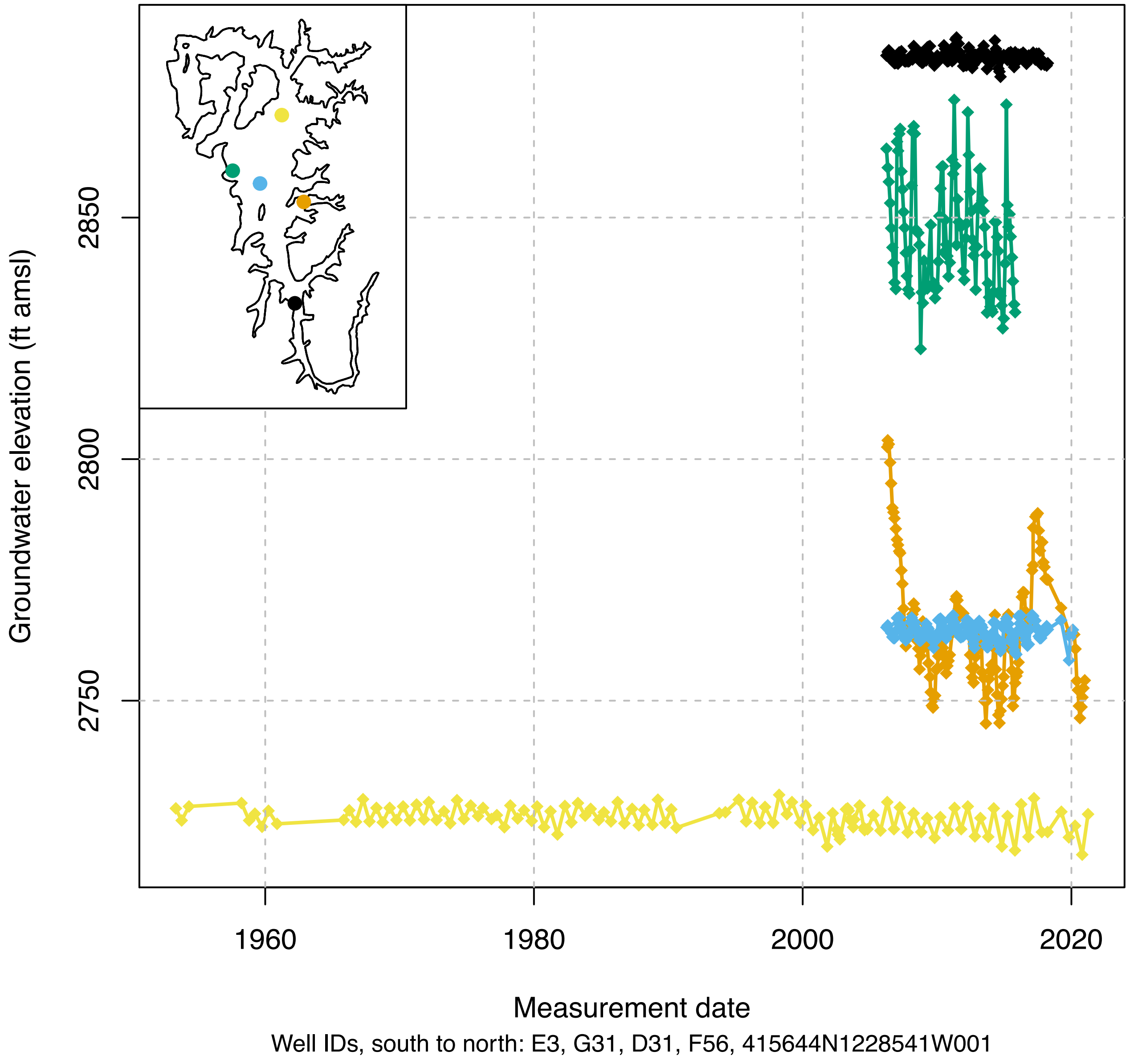

Figure 29: Selected long-term groundwater elevation measurements over time in five wells, one located in each hydrogeologic zone of the Scott River Valley Groundwater Basin.

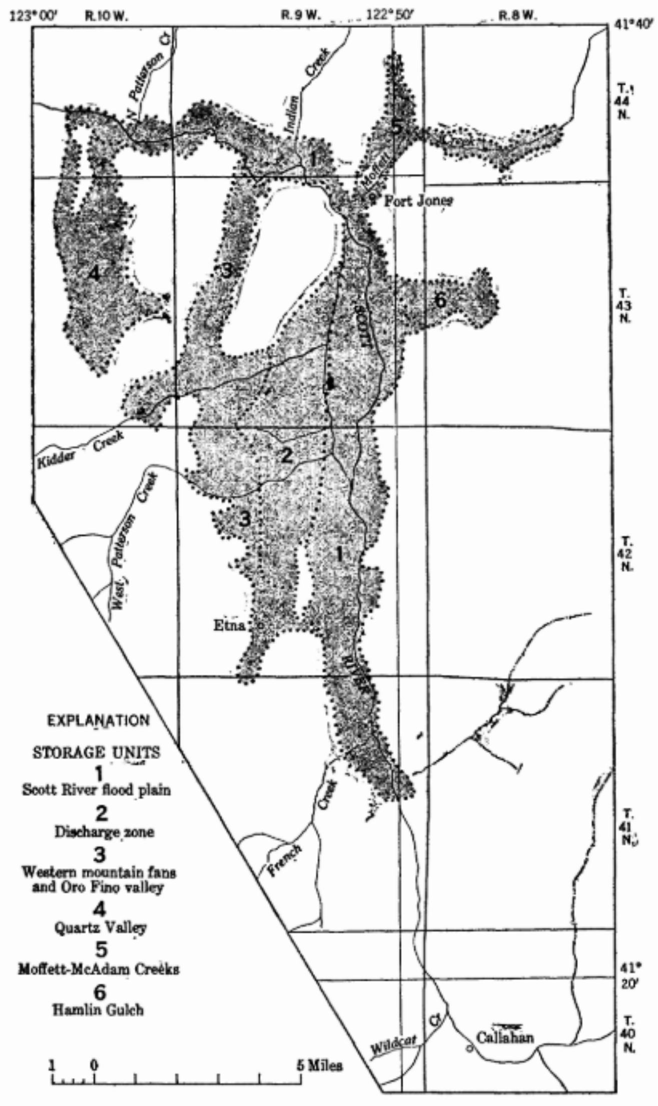

FIGURE 13.—Map of Scott Valley showing ground-water storage units.

Figure 30: Scott Valley groundwater storage units, as published in Figure 13 in Mack 1958.

Storage Unit	Average Specific Yield (%)	Groundwater Storage Capacity (acre-feet)
1	15	220,000
2	5	31,000
3	7	50,000
4	15	61,000
5	15	25,000
6	7	10,000

Table 17: Properties of groundwater storage units in the Scott River Valley Groundwater Basin as defined by Mack (1958)

Specific yield and storativity has been estimated using the Scott Valley Integrated Hydrologic Model (SVIHM). Seasonal changes in observed water levels were used to calibrate specific yield and storativity in the basin. Seasonal changes in water levels are due to local groundwater pumping for irrigation during April through September only.

Using the calibrated specific yield and storativity in SVIHM, the model provides a time series of groundwater storage change relative to 1991, for the period from 1991 to 2018 (Figure 33).

2.2.2.3 Groundwater Quality

Basin Overview

Water quality includes the physical, biological, chemical, and radiological quality of water. The physical property of water of most interest to water quality is temperature. An example of a biological water quality constituent is *E.coli* bacteria, commonly used as an indicator species for fecal waste contamination. Radiological water quality parameters measure the radioactivity of water. Chemical water quality refers to the concentration of thousands of natural and manufactured inorganic and organic chemicals. All groundwater naturally contains some microbial matter, chemicals, and usually has low levels of radioactivity. Inorganic chemicals that make up more than 90% of the “total dissolved solids” (TDS) in groundwater include calcium (Ca^{2+}), magnesium (Mg^{2+}) sodium (Na^{+}), potassium (K^{+}), chloride (Cl^{-}), bicarbonate ($HCO_3{}^{-}$), and sulfate ($SO_4{}^{2-}$) ions. Water with a TDS concentration of less than 1,000 mg/L is generally referred to as “freshwater”. Brackish water has a TDS concentration between 1,000 mg/L and 10,000 mg/L. In saline water, TDS exceeds 10,000 mg/L. Water hardness typically refers to the concentration of calcium and magnesium cations in water.

When one or multiple constituents become a concern for either ecosystem health, human consumption, industrial or commercial uses, or for agricultural uses, the water quality constituent of concern becomes a “pollutant” or “contaminant”. Groundwater quality is influenced by many factors – polluted or not – including elevation, climate, soil types, hydrogeology, and human activities. Water quality constituents are therefore often categorized as “naturally occurring”, “point source”, or “non-point source” pollutants, depending on whether water quality is the result of natural processes, contamination from anthropogenic point sources, or originates from diffuse (non-point) sources that are the result of human activity.

Groundwater in Scott Valley has been characterized as calcium-magnesium bicarbonate water (Mack 1958). Groundwater quality is correlated to the four major bedrock types in the Basin, the crystalline rocks of the western mountains, serpentine, limestone and greenstone; the first three bedrock types are associated with high sodium and potassium waters, high magnesium waters, and waters with high salinity and hardness, respectively (Mack 1958). A study conducted in the spring and fall of 1953 found that concentrations of potassium, sulfate, nitrate, fluoride, and boron were generally negligible, and locally elevated concentrations of chloride and nitrate were attributed to anthropogenic causes (Mack 1958). TDS in the Basin has been estimated to range in concentration from 47 to 1,510 mg/L with an average of 258 mg/L (DWR 2004).

Groundwater hardness has historically been variable throughout the Basin and is highly dependent on the bedrock (Mack 1958). Hard waters have previously been documented on the eastern side of the valley and in specific areas including Moffett Creek, and McConnahue and Hamlin Gulches (Mack 1958).

A study by the NCRWQCB in 2020, prioritizing 62 groundwater basins in the North Coast Region with threats to groundwater quality due to excessive salts and nutrients categorized Scott Valley as “high” priority (NCRWQCB 2020). Based on the water quality analysis completed by the NCRWQCB (2020), the percentage of wells in the Basin from 2010-2020 exceeding 5 mg/L nitrate as N(<10%), 10 mg/L nitrate as N (<10%), 250 mg/L TDS (20-40%) and 500 mg/L TDS (0-20%) were not high. The Basin was assigned a score, for “status and trends in the concentration of salts and nutrients in groundwater”, of 5 out of a possible range of 1-10. Categories in which the Basin had high scores (higher scores correspond to higher risk) included: sources of salts and nutrients (e.g., irrigated agriculture and concentrated animal feeding operations (CAFOs)/ dairy operations), open cleanup cases, and hydrogeologic factors including depth to groundwater and the hydrogeologically vulnerable area. The information used in the prioritization process included the GAMA database, the DWR SGMA Basin Prioritization Process and the seven evaluation factors listed in the Recycled Water Policy (NCRWQCB 2020).

Existing Water Quality Monitoring Networks

Water quality data for least one constituent – sometimes many – are available for some wells in the Basin but not most. Of those wells for which water quality data are available, most have only been tested once, some are or have been tested multiple times, and in few cases are tested on a regular basis (e.g., annual, monthly). The same well may have been tested for different purposes (e.g., research, regulatory, or to provide owner information), but most often, regulatory programs drive water quality testing.

For this GSP, all available water quality data, obtained from numerous available sources, are first grouped by the well from where the measurements were taken. Wells are then grouped into monitoring well type categories. These include:

Public water supply wells: A public water system well provides water for human consumption including domestic, industrial, or commercial uses to at least 15 service connections, or serves an average of at least 25 people for a minimum of 60 days per year. A public water system may be publicly or privately owned. There are three public supply wells in the Basin with water quality data collected in the past ten years. These include a permanent water supply well, one emergency supply well in Fort Jones, and one well for Kidder Creek Orchard Camp. Monitoring is conducted at these wells in accordance with California Division of Drinking Water (DDW) standards and these wells are tested at regular intervals for a variety of water quality constituents. Data are publicly available through online databases.

State small water supply wells: Wells providing water for human consumption, serving 5 to 14 connections. These wells are tested at regular intervals – but less often than public water supply wells – for bacteriological indicators and salinity. Data are publicly available through the County of Siskiyou Environmental Health Division (CSEHD) but may not be available through online databases.

Domestic wells: For purposes of this GSP, this well type category includes wells serving water for human consumption in a single household or for up to 4 connections. These wells are not typically tested. When tested, test results are not typically reported in publicly available online databases, except for when these data are used for individual studies or research projects.

Agricultural wells: Wells that provide irrigation water, stock water, or water for other agricultural uses, but are not typically used for human consumption. When tested, test results are not typically reported in publicly available online databases, except for when these data are used for individual studies or research projects.

Contamination site monitoring wells: Monitoring wells installed at regulated hazardous waste sites and other potential contamination sites (e.g., landfills) for the purpose of site characterization, site remediation, and regulatory compliance. These wells are typically completed with 2 in (5 cm) or 4 in (10 cm) diameter polyvinyl chloride (PVC) pipes and screened at or near the water table. They may have multiple completion depths (multi-level monitoring), but depths typically do not exceed 200 ft (60 m) below the water table. Water samples are collected at frequent intervals (monthly, quarterly, annually) and analyzed for a wide range of constituents related to the type of contamination associated with the hazardous waste site.

Research monitoring wells: Monitoring wells installed primarily for research, studies, information collection, ambient water quality monitoring, or other purposes. These wells are typically completed with 2 in (5 cm) or 4 in (10 cm) diameter PVC pipes and with screens at or near the water table. They may have multiple completion depths (multi-level monitoring), but depths typically do not exceed 200 ft (60 m) below the water table.

Data Sources for Characterizing Groundwater Quality

The assessment of groundwater quality for the Basin was prepared using available information obtained from the California Groundwater Ambient Monitoring and Assessment (GAMA) Program Database, which includes water quality information collected by the California Department of Water Resources (DWR); State Water Resources Control Board (SWRCB), Division of Drinking Water (DDW); Lawrence Livermore National Laboratory (LLNL) special studies; and the United States Geological Survey (USGS). These data were augmented with data from QVIR's monitoring program (described in Section 2.1.3), obtained from the USEPA Storage and Retrieval Data Warehouse (STORET), accessed through the National Water Quality Monitoring Council's (NWQMC) Water Quality Portal. In addition to utilizing GeoTracker GAMA for basin-wide water quality assessment, GeoTracker was searched individually to identify data associated with groundwater contaminant plumes. Groundwater quality data, as reported in GeoTracker GAMA, have been collected in the Basin since 1953. Within the Basin, a total of 131 wells were identified and used to characterize existing water quality based on a data screening and evaluation process that identified constituents of interest important to sustainable groundwater management.

Classification of Water Quality

To determine what groundwater quality constituents in the Basin may be of current or near-future concern, a reference standard was defined to which groundwater quality data were compared. Numeric thresholds are set by state and federal agencies to protect water users (environment, humans, industrial, and agricultural users). The numeric standards selected for the current analysis represent all relevant state and federal drinking water standards and state water quality objectives for the constituents evaluated and are consistent with state and Regional Water Board assessment of beneficial use protection in groundwater. The standards are compared against groundwater quality data to determine if a constituent's concentration exists above or below the threshold and is currently impairing or may impair beneficial uses designated for groundwater at some point in the foreseeable future.

Although groundwater is utilized for a variety of purposes, the use for human consumption requires that supplies meet strict water quality regulations. The federal Safe Drinking Water Act (SDWA) protects surface water and groundwater drinking water supplies. The SDWA requires the United States Environmental Protection Agency (USEPA) to develop enforceable water quality standards for public water systems. The regulatory standards are named maximum contaminant levels (MCLs) and they dictate the maximum concentration at which a specific constituent may be present in potable water sources. There are two categories of MCLs: Primary MCLs (1^{o} MCL), which are established based on human health effects from contaminants and are enforceable standards for public water supply wells and state small water supply wells; and Secondary MCLs (2^{o} MCL), which are unenforceable standards established for contaminants that may negatively affect the aesthetics of drinking water quality, such as taste, odor, or appearance.

The State of California has developed drinking water standards that, for some constituents, are stricter than those set at the federal level. The Basin is regulated under the North Coast Regional Water Quality Control Board (Regional Water Board) and relevant water quality objectives (WQOs) and beneficial uses are contained in the Water Quality Control Plan for the North Coast Region (Basin Plan). For waters designated as having a Municipal and Domestic Supply (MUN) beneficial use, the Basin Plan specifies that chemical constituents are not to exceed the Primary and Secondary MCLs established in Title 22 of the California Code of Regulations (CCR) (hereafter, Title 22). The Basin Plan also includes numeric WQOs and associated calculation requirements in groundwater for select constituents in the Scott Valley aquifer.

Constituents may have one or more applicable drinking water standards or WQOs. For this GSP, a prioritization system was used to select the appropriate numeric threshold. This GSP used the strictest value among the state and federal drinking water standards and state WQOs specified in the Basin Plan for comparison against available groundwater data. Constituents that do not have an established drinking water standard or WQO were not assessed. The complete list of constituents, numeric thresholds, and associated regulatory sources used in the water quality assessment can be found in Appendix 2-D. Basin groundwater quality data obtained for each well selected for evaluation were compared to a relevant numeric threshold.

Maps were generated for each constituent of interest showing well locations and the number of measurements for a constituent collected at a well (see Appendix 2-D). Groundwater quality data were further categorized by magnitude of detection as a) not detected, b) detected below half of the relevant numeric threshold, c) detected below the relevant numeric threshold, and d) detected above the relevant numeric threshold.

To analyze groundwater quality that is representative of current conditions in the Basin, several additional filters were applied to the dataset. Though groundwater quality data are available dating back to 1953 for some constituents, the data evaluated were limited to those collected from 1990 to 2020. Restricting the time span to data collected in the past 30 years increases confidence in data quality and focuses the evaluation on information that is considered reflective of current groundwater quality conditions. A separate series of maps was generated for each constituent of interest showing well locations and the number of groundwater quality samples collected among the wells during the past 30 years (1990-2020).

Finally, for each constituent, an effort was undertaken to examine changes in groundwater quality over time at a location. Constituent data collected in the past 30 years (1990-2020) were further limited to wells that have three or more water quality measurements. A final series of maps and time series plots showing data collected from 1990 to 2020 were generated for each constituent and well combination showing how data compare to relevant numeric thresholds.

The approach described above was used to consider all constituents of interest and characterize groundwater quality in the Basin. Appendix 2-D contains additional detailed information on the methodology used to assess groundwater quality data in the Basin.

Basin Groundwater Quality

All groundwater quality constituents monitored in the Basin that have a numeric threshold were initially considered. The evaluation process described above showed the following parameters to be important to sustainable groundwater management in the Basin: benzene, nitrate and specific conductivity. The following subsections present information on these water quality parameters in comparison to their relevant regulatory thresholds and how the constituent may potentially impact designated beneficial uses in different regions of the Basin. Table 18 contains the list of constituents of interest identified for the Basin and their associated regulatory threshold.

Maps and time series plots for the groundwater quality constituents of interest are presented in Appendix 2-D.

BENZENE

Constituent	Regulatory Basis	Water Quality Threshold
Benzene (µg/L)	Title 22	1
Nitrate (mg/L)	Title 22	10
Specific Conductivity (µmhos/cm)	Basin Plan 90% Upper Limit	500
Specific Conductivity (µmhos/cm)	Basin Plan 50% Upper Limit	250

Table 18: Regulatory water quality thresholds for constituents of interest in the Scott River Valley Groundwater Basin.

Benzene in the environment generally originates from anthropogenic sources, though lesser amounts can be attributed to natural sources including forest fires (Tilley and Fry 2015). Benzene is primarily used in gasoline and in the chemical and pharmaceutical industries and is commonly associated with leaking underground storage tank (LUST) sites. Classified as a known human carcinogen by USEPA and the Department of Health and Human Services, exposure to benzene has been linked to increased cases of leukemia in humans (ASTDR 2007). Long term exposure can affect the blood, causing loss of white blood cells and damage to the immune system or causing bone marrow damage, resulting in a decrease in production of red blood cells and potentially leading to anemia. Acute exposure can cause dizziness, rapid or irregular heartbeat, irritation to the stomach and vomiting and can be fatal at very high concentrations (ASTDR 2007). The 1^{o} MCL for benzene is 1 microgram per liter(µg/L), as defined in Title 22.

Recent monitoring for benzene (between 1990 and 2020) includes background monitoring in municipal wells and site monitoring at observation wells associated with known LUST sites. Monitoring data collected in the municipal wells, all of which are near Fort Jones, are all below the 1^{o} MCL. Measurements that exceed 1 µ/L are found in the monitoring wells associated with the two open LUST (LUST) sites near Etna. Based on available monitoring data, these exceedances are highly localized and are attributed to the contaminant plumes from these LUST sites, currently overseen by the NCRWQCB. Well locations and detection magnitudes of benzene data, and associated time series, are shown in Appendix 2-D.

SPECIFIC CONDUCTIVITY

Specific conductivity (electrical conductivity normalized to a temperature of 25^{o} C) quantifies the ability of an electric current to pass through water and is an indirect measure of the dissolved ions in the water. Natural and anthropogenic sources contribute to variations in specific conductivity in groundwater. Increases of specific conductivity in groundwater can be due to dissolution of rock and organic material and uptake of water by plants, as well as anthropogenic activities including the application of fertilizers, discharges of wastewater, and discharges from septic systems or industrial facilities. High specific conductivity can be problematic as it can have adverse effects on plant growth and drinking water quality.

Specific conductivity measurements obtained between 1990 and 2020 are mostly located near Fort Jones, with additional monitoring locations near the Basin boundaries and limited measurements in the central portion of the Basin. Exceedances of the 500 micromhos per centimeter (µmhos/cm), 50% upper limit (UL) and 250 µmhos/cm 90% upper limit UL specified in the Basin Plan were noted. One well with consistent measurements shows specific conductivity to be fairly stable over time. Historical data for specific conductivity are also available. A mineral analysis of groundwater in Scott Valley from five wells between October 1965 and September 1966, shows specific conductivity values ranging from 74 to 517 µmhos/cm (DWR 1968). Additional wells with consistent measurements, and in different areas of the Basin, are needed to evaluate spatial and temporal trends in specific conductivity. Well locations and detection magnitudes of specific conductivity data collected over the past 30 years, and associated time series, are shown in Appendix 2-D.

NITRATE

Nitrate is one of the most common groundwater contaminants and is generally the water quality constituent of greatest concern. Natural concentrations of nitrate in groundwater are generally low. In agricultural areas, application of fertilizers or animal waste containing nitrogen can lead to elevated nitrate levels in groundwater. Other anthropogenic sources, including septic tanks, wastewater discharges, and agricultural wastewater ponds may also lead to elevated nitrate levels. Nitrate poses a human health risk, particularly for infants under the age of 6 months who are susceptible to methemoglobinemia, a condition that affects the ability of red blood cells to carry and distribute oxygen to the body. The 1^{o} MCL for nitrate is 10 milligrams per liter as nitrogen (mg/L as N).

Recent nitrate measurements in the Basin have mostly been obtained near the cities of Fort Jones and Etna and along the edges of the Basin boundary, but are limited throughout the center of the Basin (see Appendix 2-D). Data throughout the center of the Basin are available prior to 1990 but may not be representative of current conditions. Nitrate concentrations measured in wells between 1990 and 2020 have historically been below 5.0 mg/L as N and are well below the 10 mg/L as N 1^{o} MCL with no noted exceedances. In addition, concentrations have been relatively stable over time, with little or no variation in the wells selected for evaluation. A recent study evaluating trends in groundwater quality for 38 constituents in public supply wells throughout California has shown similar findings; concentrations of nitrate were categorized as "low", or less than 5mg/L as N, for all public supply wells in the Basin with data collected between 1974 and 2014 (Jurgens et al. 2020). Overall, available data indicate that the Scott River Basin is well below the 1^{o} MCL of 10 mg/L for nitrate as N. However, additional current monitoring data near the center of the Basin are needed for a complete determination of nitrate concentrations in the Basin. Well locations and detection magnitudes of nitrate data collected over the past 30 years, and associated time series, are shown in Appendix 2-D.

Contaminated Sites

Groundwater monitoring activities also take place in the Basin in response to known and potential sources of groundwater contamination, including from LUST sites. These sites are subject to oversight by regulatory entities, and any monitoring associated with these sites can provide information and opportunities to improve the regional understanding of groundwater quality.

To identify known plumes and contamination within the Basin, SWRCB GeoTracker was reviewed for active clean-up sites of all types. The GeoTracker Database shows two open LUST sites with potential or actual groundwater contamination located within the Basin, shown in Figure 31. Under the "open" category, a clean-up status is listed for each site which provides additional detail on the current phase of the investigation and remediation activities at the site. The LUST sites in the Basin categorized as "closed" are sites where corrective action has been taken and the case at the site has been formally closed; these sites are not shown on Figure 31.

Underground storage tanks (UST) are containers and tanks, including piping, that are completely or significantly below ground and are used to store petroleum or other hazardous substances. Soil, groundwater, and surface water near the site can all be affected by releases from USTs. A UST becomes a potential hazard when any portion of it leaks a hazardous substance at which point it is classified as a leaking underground storage tank (LUST). The main constituents of concern in contaminant plumes include benzene, toluene, ethylbenzene, and xylenes (this collection of organic compounds is commonly referred to as "BTEX"), which are found in gasoline, and the gasoline additive, methyl tert-butyl ether (MTBE). In addition to benzene, other constituents in the monitoring wells associated with the two open LUST sites that were found to exceed water quality objectives include: ethylbenzene, MTBE, tert-Butyl alcohol (TBA), toluene, and xylenes.

A brief overview of notable information is provided below; however, an extensive summary for each of the contamination sites is not presented.

Chevron #9-6012

This site is located at a former fueling facility near Etna. The case (number 1TSI025) has been open since 1988. Three USTs used for gasoline have been removed from the site; one in December 1978 and two in 1988 following a reported unauthorized release of petroleum. Two USTs remained at the site until November 1998. Remediation efforts have included soil excavation, and monitoring has been conducted in seven groundwater wells adjacent to the site since 1993. The petroleum release is known to have occurred in the soil and shallow groundwater, but the full extent of the contamination is not known; a work plan was submitted to the NCRWQCB in August 2019 that proposed to install four additional groundwater monitoring wells to define the extent of contamination (SWRCB 2019b).

Steve's Mobil

This site was previously a commercial fueling facility and is now vacant. The case (number 1TSI159) opened in 1991 after an unauthorized release of petroleum occurred following the removal of three gasoline USTs. Remediation efforts have included soil excavation in 1991, 1996, and 1997, and ozone injections in 2014 and between 2016 and 2020 (SWRCB 2019a). The most recent summary report for the site from November 2019 concluded that the site does not meet the criteria for closure due to a lack of soil vapor and shallow soil data, continued exceedance of groundwater quality objectives, and the length of the plume (SWRCB 2019a).

Additionally, two California Department of Toxic Substances Control (DTSC) sites are located in the Basin. Both of these sites are an “evaluation” type site, signifying that contamination is suspected but has not been thoroughly investigated or confirmed. These sites are Quartz Valley Stamp Mill and Hjertager Mill, both discovered in 1988. Quartz Valley Stamp Mill has arsenic and mercury as potential contaminants of concern in the soil surrounding the facility (DTSC 2020b). This site has undergone screening and has been inactive since 2012. Oil and waste that potentially contain dioxins are the contaminants of concern at the Hjertager Mill site (DTSC 2020a). A preliminary assessment of this site found no evidence of chemical use or disposal and this site was referred to another agency in 1988.

Based on available water quality data, groundwater in the Basin is generally of good quality and has relatively consistent water quality characteristics which meet local needs for municipal, domestic, and agricultural uses (see Appendix 2-D). Ongoing monitoring programs show that some constituents, including benzene and specific conductivity, exceed water quality standards in parts of the Basin. Exceedances may be caused by localized conditions and may not be reflective of regional water quality.

Available monitoring data indicate that, salt and nutrient concentrations are below levels of concern, with no upward trends. A few isolated areas have higher concentrations. A summary of information and methods used to assess current groundwater quality in the Basin, as well as key findings, are presented below. A detailed description of information, methods, and all findings of the assessment can be found in Appendix 2-D – Water Quality Assessment.

While current data are useful to determine local groundwater conditions, additional monitoring is necessary to develop a basin-wide understanding of groundwater quality and greater spatial and temporal coverage would improve the ability to evaluate trends in groundwater quality. From a review of all available information, none of the contaminated sites described above have been determined to have an impact on the aquifer, and the potential for groundwater pumping to induce contaminant plume movement towards water supply wells is negligible. Currently, there is not enough information to determine if the contaminants are sinking or rising with groundwater levels.

2.2.2.4 Land Subsidence Conditions

Land subsidence is not known to be significant in Scott Valley. The TRE Altamira Interferometric Synthetic Aperture Radar (InSAR) dataset provides estimates of vertical displacement from January 2015 to June 2018. The majority of the vertical displacement estimates in the Basin are positive, within the range of 0 to 0.5 ft (15.2 cm), while estimates in other ranges are between 0 and -0.25 (-7.6 cm) ft (ESA 2018).

Land subsidence is the lowering of the ground surface elevation. This is often caused by pumping groundwater from within or below thick clay layers. Land subsidence can be elastic or inelastic, meaning that the lithologic structure of the aquifer can compress or expand elastically due to water volume changes in the pore space or is detrimentally collapsed when water is withdrawn (inelastic). Inelastic subsidence is generally

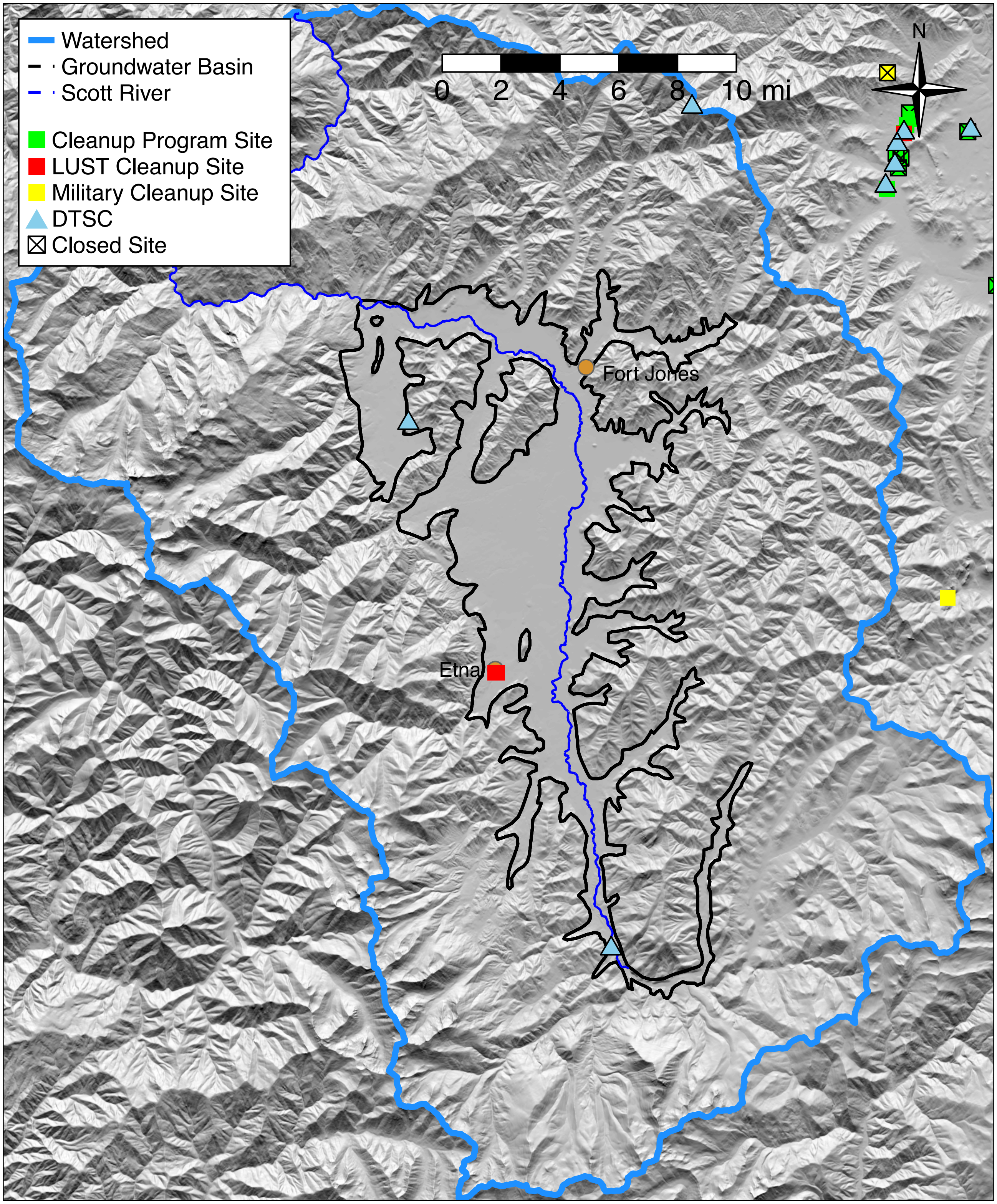

Figure 31: Location of known ‘open’ contaminated sites in the Scott River Valley Groundwater Basin.

irreversible. Elastic subsidence is generally of a smaller magnitude of change, and is reversible, allowing for the lowering and rising of the ground surface and can be cyclical with seasonal changes. Land subsidence, particularly inelastic subsidence, is not known to be historically or currently significant in Scott Valley. The lithology that may cause subsidence, particularly thick clay units that typically define the confining layers of aquifers found in the Central Valley of California, are not present in Scott Valley. The geologically recent, shallow alluvial aquifers of Scott Valley are largely insusceptible to inelastic subsidence.

Data Sources and Quality

DWR has made Interferometric Synthetic Aperture Radar (InSAR) satellite data available on their SGMA Data Viewer web map (ESA 2018), as well as downloadable raster datasets to estimate subsidence (DWR contracted TRE Altamira to make these data available). These are the only data used for estimating subsidence in this GSP as they are the only known subsidence-related data available for this Basin. The TRE Altamira InSAR dataset provides estimates of total vertical displacement from June 2015 to September 2019 and is shown in using raster data from the TRE Altamira report ((ESA 2018). It is important to note that the TRE Altamira InSAR data reflect both elastic and inelastic subsidence and it can be difficult to isolate a signal solely for only the elastic subsidence amplitude. Visual inspection of monthly changes in ground elevations typically suggests that elastic subsidence is largely seasonal and can potentially be factored out of the signal, if necessary.

Data Quality

The TRE Altamira InSAR data provided by DWR are subject to compounded measurement and raster conversion errors. DWR has stated that for the total vertical displacement measurements, the errors are as follows (Brezing, personal communication):

1. The error between InSAR data and continuous GPS data is 0.052 ft (16 millimeters [mm]) with a 95% confidence level.
2. The measurement accuracy when converting from the raw InSAR data to the maps provided by DWR is 0.048 ft (14 mm) with 95% confidence level.

The addition of these two errors results in a combined error of 0.1 ft (30 mm). While not a robust statistical analysis, it does provide a potential error estimate for the TRE Altamira InSAR maps provided by DWR. A land surface change of less than 0.1 ft is within the noise of the data and is likely not indicative of groundwater-related subsidence in the Basin.

Data Analysis

Using the TRE Altamira InSAR dataset provided by DWR, it is observed that the majority of the vertical displacement values in the Scott Valley are essentially near-zero, with the maximum subsidence of -0.05 ft (15 mm) (see Figure 32). These values are largely within or less than the same order of magnitude of the combined data and raster conversion error, suggesting essentially noise, or at least non-groundwater related activity in the data. Any actual signals at this level could be due to a number of possible activities, including land use change and/or agricultural operational activities at the field scale. For perspective, during this same period, sections of the San Joaquin Valley in California's Central Valley experienced up to ~3.5 ft (1.1 m) of subsidence (ESA 2018).

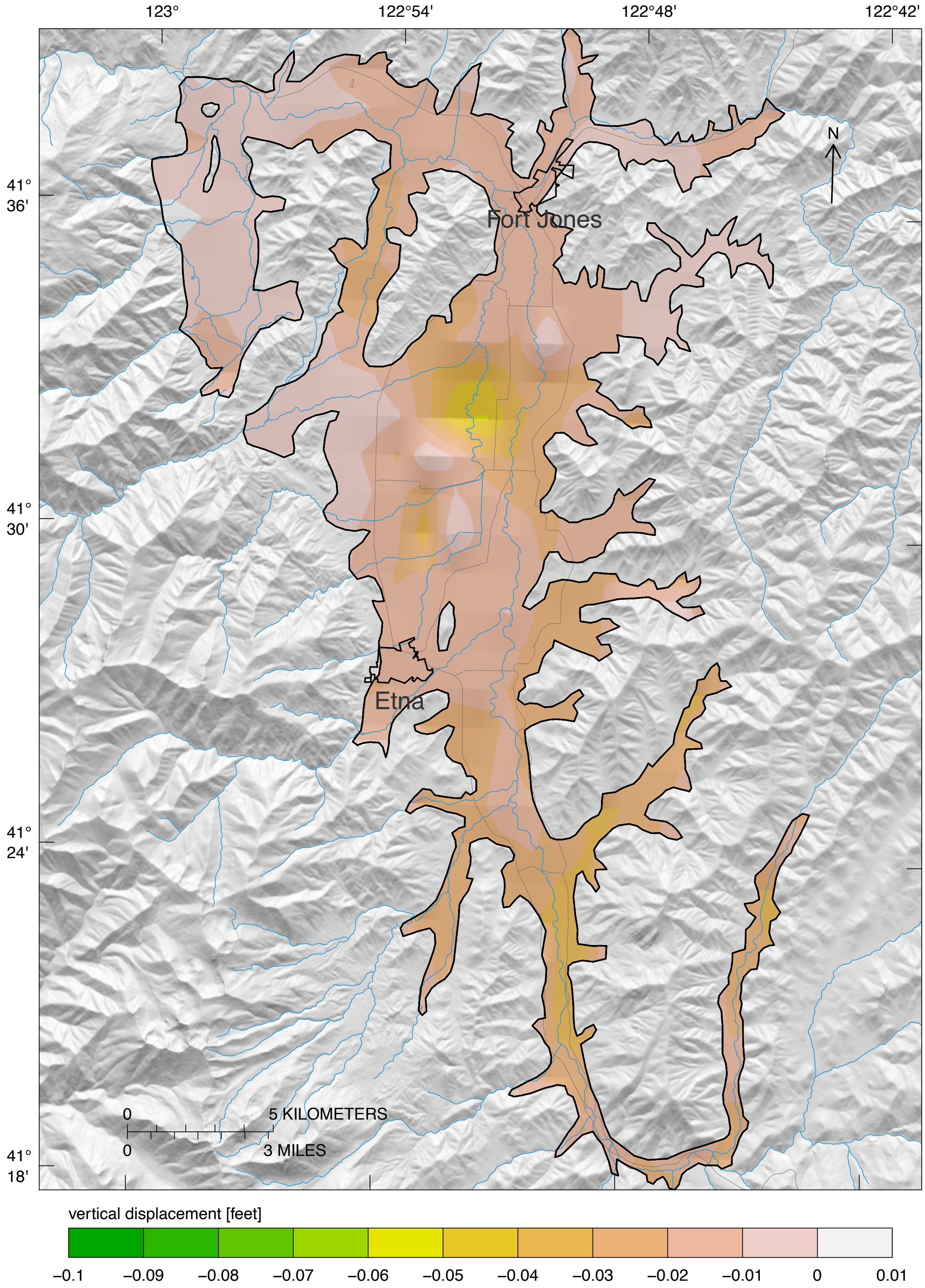

Figure 32: InSAR Total Subsidence in the SCott River Valley Groundwater Basin Between June 2015 and September 2019.

2.2.2.5 Seawater Intrusion

Due to the distance between the Scott River Valley Groundwater Basin and the Pacific Ocean, seawater intrusion is not evident nor of concern and therefore, is not a sustainability indicator applicable to the Basin.

2.2.3 Water Budget Information

2.2.3.1 Historical Water Budget Information

The historical water budget for the Basin was estimated for the period October 1991 through September 2018, using the Scott Valley Integrated Hydrologic Model (SVIHM). This 28-year model period includes water years ranging from very dry (e.g., 2001 and 2014) to very wet (e.g., 2006 and 2017). On an interannual scale, this period includes one multi-year wet period in the late 1990s and two multi-year dry periods in the late 2000s and mid-2010s. The DWR SGMA Water Year Type dataset for Scott Valley was used to identify water year types for the water budget analyses.

Because surface water conditions and the potential occurrence of undesirable results (defined in Chapter 3.1) are heavily dependent on water year type, this section will include water budget quantities during example wet (2017), dry (2014) and average rainfall years, as well as in the overall 28-year model period. Two years with near-average annual rainfall (2010 and 2015) are used to illustrate the effect of temporal distribution of rainfall within a water year. In 2015 the rainy season ended earlier and rain fell in a smaller number of larger storms than in 2010.

Annual water budgets for the full model period are shown in Figure 33 and monthly values of selected budget components are shown in Figure 34 for each of the four example water years. Tables 19 - 21 show a summary of these budgets, and details are provided in Appendix 2-E. The following two sections provide an overview of the Scott Valley Integrated Hydrologic Model, which is used to determine the full water budget for the three hydrologic subsystems of the Basin: the surface water subsystem, the land subsystem, and the groundwater subsystem. The budget also includes the total water budget of the Basin. The second section provides a description of the water budget shown in the Figures and Tables below and explains the water budget dynamics in the context of the basin hydrogeology and hydrology described in previous sections. This sub-chapter provides critical rationale for the design of the monitoring networks, the design of the sustainable management criteria, and the development of project and management actions (Chapters 3 and 4).

Statistic	Inflow	Overland	Farmers Div.	SVID Div.	Stream Leakage	Outflow	Storage
Minimum	115	0	-2	-4	5	-115	0
25th %ile	133	0	-2	-4	-8	-120	1
Median	384	0	-2	-4	-7	-371	0
Mean	118	0	-2	-4	-2	-111	1
75th %ile	504	0	-2	-4	8	-506	0
Maximum	472	0	-2	-4	27	-494	0

Table 19: Summarized annual values (TAF) for water budget components simulated in the Surface Water (SW) subsystem of the SVIHM. Positive values are water entering the stream network as inflows from tributary streams and overland flow entering streams; negative values are water leaving the stream network as diversions to the Farmers and SVID ditches and outflow from the valley through the Scott River. The net direction of stream leakage and the overall change in water stored in the stream system can be both negative and positive in different water years.

Statistic	Precip.	SW Irrigation	GW Irrigation	ET	Recharge	Storage
Minimum	49	21	41	-102	-9	-1
25th %ile	53	24	48	-112	-13	0
Median	90	31	36	-121	-31	-5
Mean	34	21	54	-107	-9	7
75th %ile	117	29	34	-118	-57	-6
Maximum	97	32	45	-121	-55	1

Table 20: Annual values (TAF) for water budget components simulated in the Land and soil subsystem (L) of the SVIHM. Positive values are water entering the soil volume as precipitation and surface water (SW) or groundwater (GW) irrigation; negative values are water leaving the soil volume as evapotranspiration (ET) and recharge to the aquifer. The overall change in storage in the soil volume can be both negative and positive in different water years.

Statistic	Recharge	ET	Storage	Overland	Stream Leakage	Wells	Canal and MFR
Minimum	9	-1	19	-1	-5	-39	18
25th %ile	13	-1	8	-1	8	-45	18
Median	31	-0	-18	-3	7	-34	18
Mean	9	-1	24	-1	2	-51	18
75th %ile	56	-1	-29	-5	-8	-32	18
Maximum	54	-1	5	-6	-27	-43	18

Table 21: Annual values (TAF) for water budget components simulated in the Groundwater (GW) subsystem of the SVIHM. Positive values are water entering the aquifer as recharge from the soil zone, canal seepage, and mountain front recharge (MFR); negative values are water leaving the aquifer as evapotranspiration (ET), discharge to overland flow, and pumped water from wells. The net direction of stream leakage and the overall change in water stored in the aquifer can be both negative and positive in different water years..

Summary of Model Development

A four subsystem model was used to represent the hydrology of the Basin and its connection to the surrounding watershed. The four sub¬systems are as follows:

- Upper watershed
- Basin surface water system (SW)

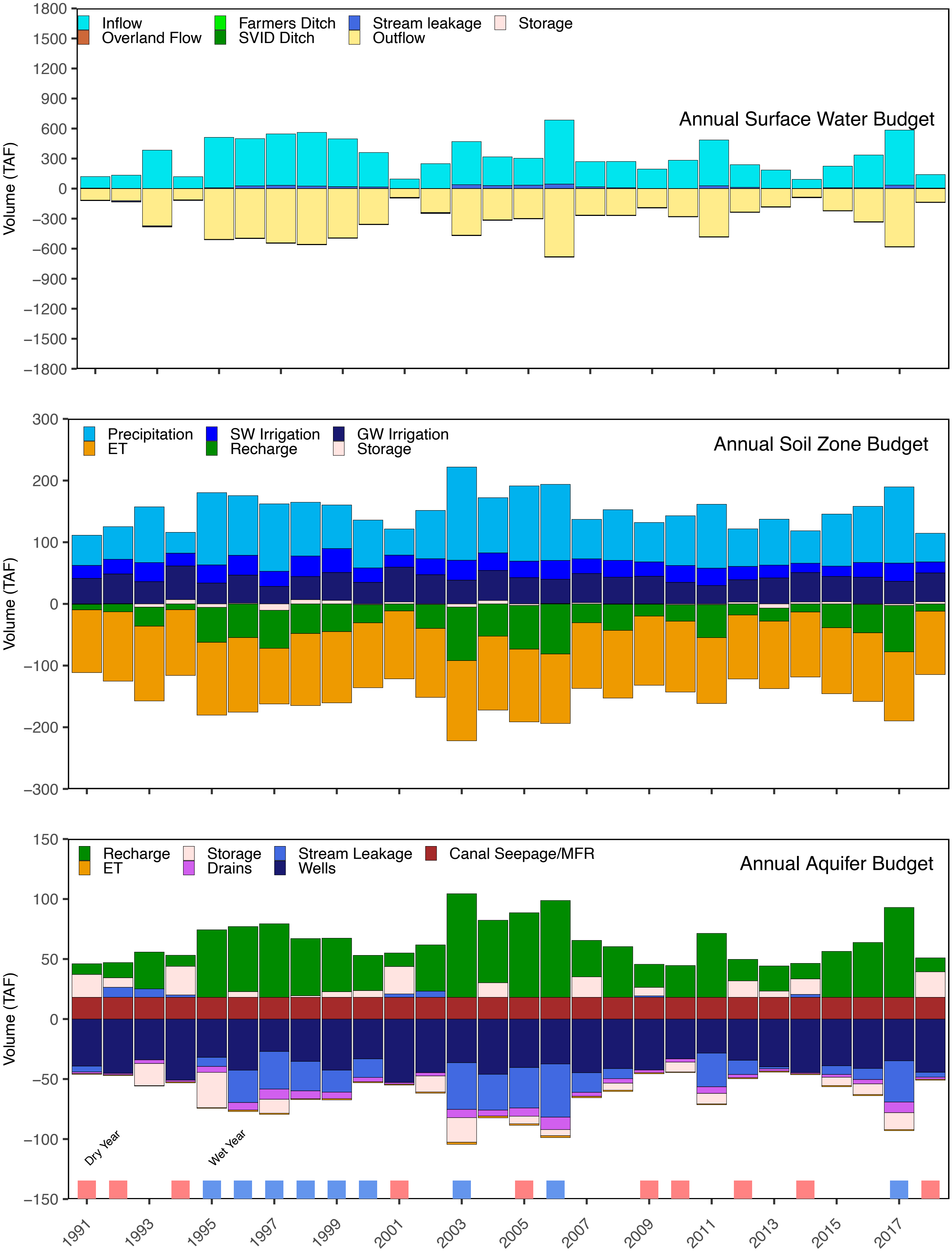

Figure 33: Annual water budgets for the three conceptual subsystems used to represent the hydrology of the Basin: the surface water system, the soil zone, and the aquifer.

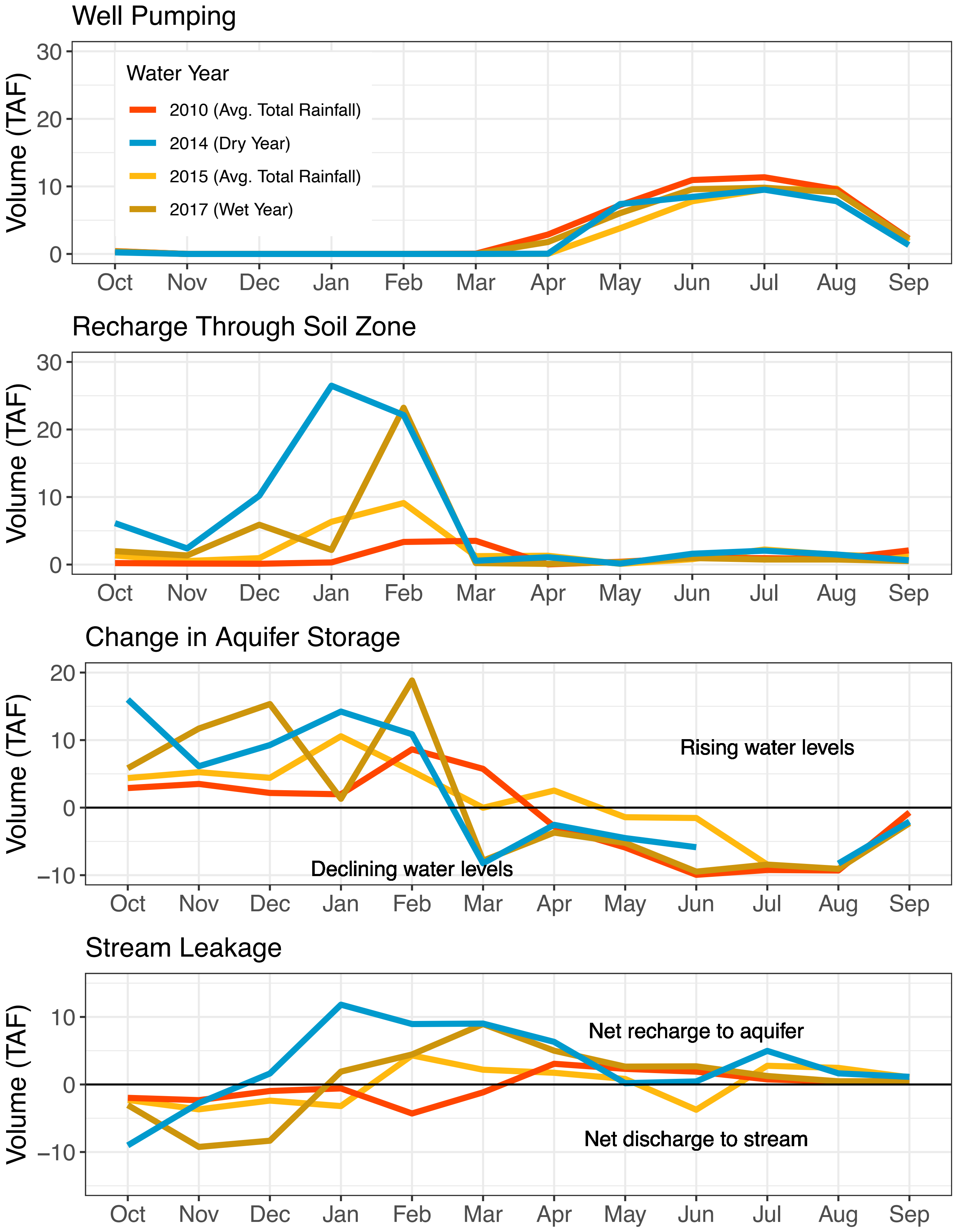

Figure 34: Monthly values of selected water budget components in 4 example water years.

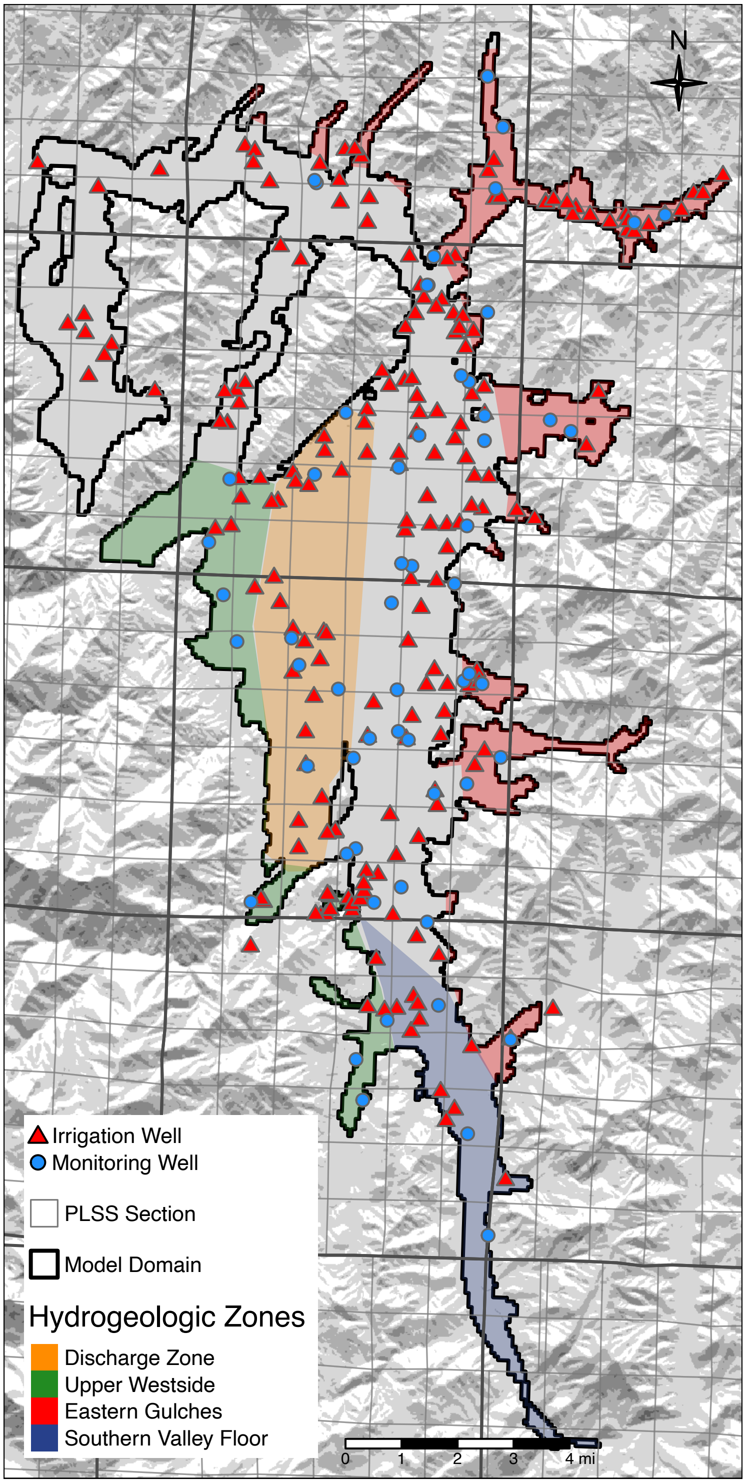

Figure 35: The model domain boundary and wells used in the SVIHM simulation of Basin hydrology. Additionally, generalized hydrogeologic zones (adapted from Mack, 1958) are shown. These areas represent general zones in which observed water level records tend to have similar characteristics (e.g., seasonal variability and overall depth to water). For more information see selected hydrographs in Section 2.2.2.1, the full hydrographs collection in Appendix 2-C, and Tolley et. al 2019.

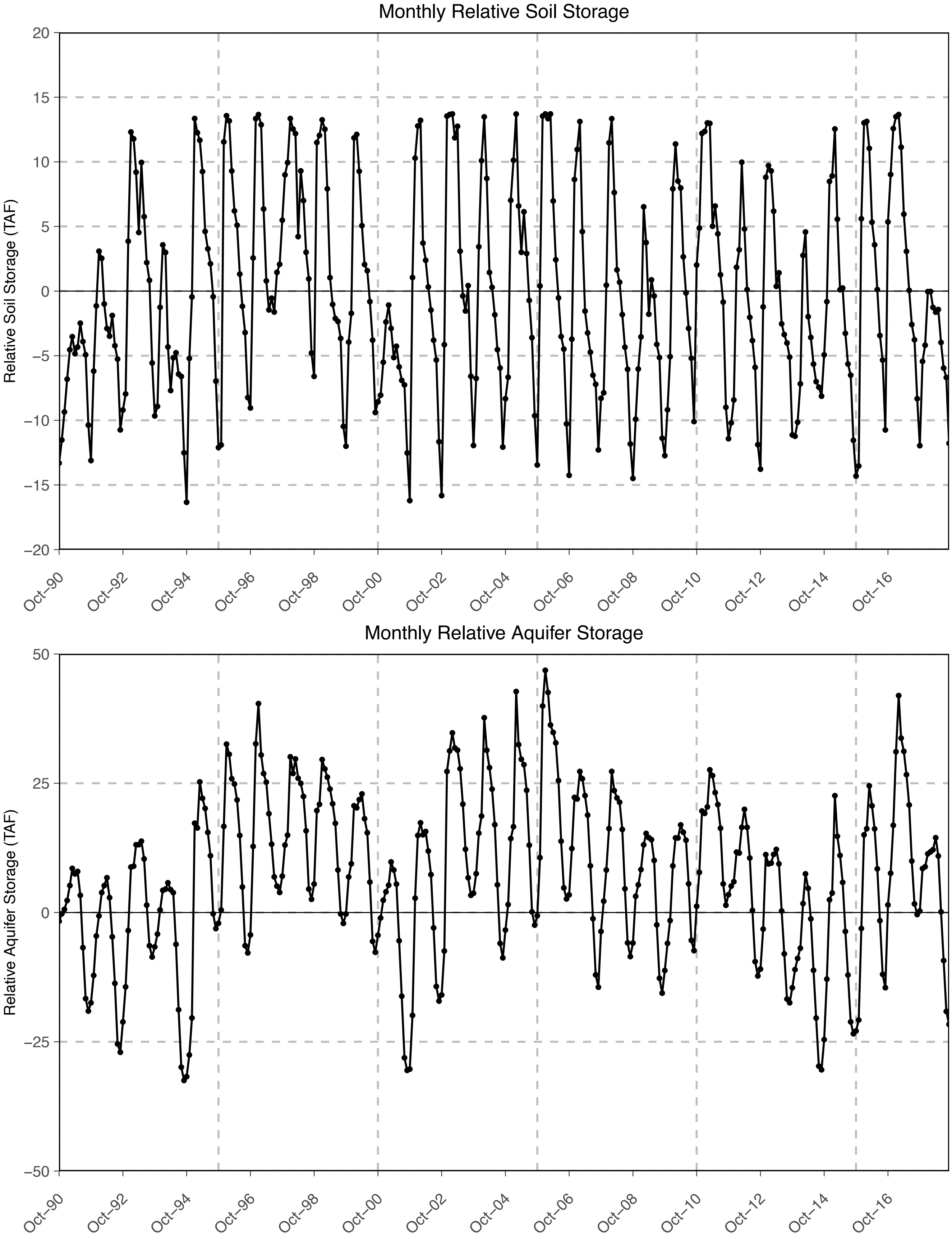

Figure 36: CAPTION.

- Basin land system (land use and soil/vadose zone) (L)
- Basin groundwater (aquifer) (GW)

The SVIHM was used to estimate the value of inflows from the upper watershed to the Basin ("Inflow" in Table 19), and the fluxes into, out of, and between the three sub-systems within the Basin (Tables 19 - 21). Full documentation on SVIHM can be found in Appendix 2-E and Appendix 2-F.

In brief, the integrated model consists of three cascading sub-models: a streamflow regression model that effectively represents the hydrology of the upper watershed for the specific purpose of generating daily surface inflows to the Basin, a soil water budget model that represents the land (land use and soil) subsystem (L) of the basin, and a groundwater-surface water model that represents both, the surface water (SW) and groundwater (GW) water budget subsystems of the Basin.

The SVIHM model domain for the L, SW, and GW subsystems corresponds approximately with the contact between alluvial fill and basement rock; the model domain boundary is illustrated in Figure 35. This boundary is therefore consistent with (but not exactly identical to) the Basin boundary. Water budget differences due to SVIHM model boundaries not being identical to Basin boundaries are considered negligible for all purposes of the GSP. The narrow (< 0.5 mile), nearly 10 miles long but shallow Basin alluvium in the East Fork Scott River and Noyes Valley Creek, above Callahan, is included in SVIHM as part of the upper watershed, but not as part of the SW, L, or GW calculations. Groundwater use in the East Fork Scott River and Noyes Valley Creek portion is limited to domestic water use. Less than 5 domestic wells are listed for this portion of the Basin in the DWR well completion reports database.

The **streamflow regression model** is a statistical tool used to estimate tributary inflows at the valley margins, supplemented by gauged upper watershed flows when data are available (Foglia et al. 2013). These estimates are based on statistical correlations with the flow at the USGS Gauge 11519500 (Fort Jones Gauge).

The landscape, soil, and underlying vadose zone of the Basin and their hydrologic fluxes (L) are simulated in the **soil water budget model** (SWBM) (Foglia et al. 2013). SWBM computes groundwater needs and evapotranspiration of crops and native vegetation for 2,119 individual parcels, each characterized by soil type, crop or other land use, whether or not it is irrigated, the source of irrigation water (surface water diversion, groundwater pumping, or both, depending on availability of surface water), and the type of irrigation (subsurface irrigation, flood irrigation, wheel-line sprinkler irrigation, center pivot sprinkler irrigation). Agricultural irrigation is calculated based on daily crop demand, with an efficiency assigned to each field based on source of irrigation water and type of irrigation. Perfect farmer foresight is assumed. Irrigation needs are assumed to be met daily, and the water volume is attributed to either diverted surface water (i.e., Surface Water Irrigation in Figure 33) or pumped groundwater (i.e., Groundwater Irrigation and Wells in Figure 33) depending on which source(s) is (are) available for each field. Groundwater pumping needs for a specific parcel are assigned to a known irrigation well closest to the parcel. Additionally, all precipitation falling on cultivated fields or native vegetation is assumed to infiltrate into the soil column (i.e., runoff) is neglected, with the exception of the zone of known shallow groundwater referred to as the "Discharge Zone." Discharging groundwater in this area is referred to as "Overland Flow" in the water budget figures). Water in excess of the water holding capacity of the root zone, after accounting for daily precipitation, irrigation, and evapotranspiration from a parcel, percolates to below the root zone to recharge groundwater. Given that depths to groundwater are typically less than 10 to 20 feet, and because of the stress period length in MODFLOW (see below) the travel time in the deep unsaturated zone is neglected.

A finite difference **groundwater-surface water model** simulates spatial and temporal groundwater (GW) and surface water (SW) conditions in the valley overlying the alluvial basin (**MODFLOW model**). The MODFLOW model simulates the spatially and temporally variable dynamics:

- of streamflow in the Basin tributaries and the main-stem Scott River
- of groundwater fluxes

- of water level elevations, and
- of the groundwater-surface water exchanges

These simulation results are driven in the model by the Basin's hydrogeologic properties and by the spatially and temporally variable dynamics of:

- the surface inflows at the Basin margins, flowing into the Basin in tributaries emanating from the surrounding watershed (computed by the streamflow regression model of the upper watershed),
- groundwater pumping and recharge (computed by SWBM),
- groundwater evapotranspiration in sub-irrigated systems in the Discharge Zone between Etna and Greenview (determined by land use ET demand as model input),
- and canal and mountain front recharge near the Basin margins (model input).

The integrated SVIHM is weakly coupled in that calculated fluxes are passed from the first two sub-models to the MODFLOW model, but there are no direct feedbacks from the MODFLOW model to the streamflow regression model or to the SWBM (Tolley, Foglia, and Harter 2019). In other words, the outcome of the MODFLOW model simulation does not affect the outcome of SWBM or the (upper watershed) streamflow regression model. (A "fully coupled" model would solve for all flux values simultaneously, for each timestep.)

SVIHM covers a period of 28 years, from October 1, 1990 to September 30, 2018. The model was calibrated for a period of 21 years, from October 1, 1990 to September 30, 2011 (Tolley, Foglia, and Harter 2019). Temporal discretization in the streamflow regression model, the SWBM, and in the MODFLOW model is daily. However, for the MODFLOW model, daily values of stream inflow from the upper watershed, pumping, and recharge, including canal and mountain front recharge, are aggregated (averaged) to each calendar month and held constant within a calendar month. In MODFLOW, the calendar month is referred to as a "stress period".

The spatial discretization in SWBM largely follows the digital land use maps published to date by the California Department of Water Resources. The spatial discretization in MODFLOW is 328 ft (100 m) horizontally for both, the aquifer and the overlying stream reach. Vertically, the aquifer is represented in two layers, where the first layer has a thickness of 50 feet, and the second layer is up to 200 feet thick, corresponding to the depth of the alluvial basin. Actual stream length and width overlying each 100 m aquifer grid cell is explicitly represented in the stream flow routing package (module) input for MODFLOW.

Historical Water Budget Components

This section describes the full water budget of the Basin including inflows to the Basin, outflows from the Basin, and the internal fluxes between the three hydrologic subsystems of the Basin: the surface water subsystem, SW, the land subsystem, L, and the groundwater subsystem, GW (DWR- California Department of Water Resources (DWR) 2020a). The subsystems into, out of, or between which the fluxes occur are explicitly identified using the SW, L, and GW notation.

Water budget components are described in the following categories:

1. Basin Inflows
2. Basin Outflows
3. Flows Between Surface Water and Soil Zone (SW and L)
4. Flows Between Surface Water and Groundwater (SW and GW)
5. Flows Between Soil Zone and Groundwater (L and GW)
6. Change in Storage

Figure 33 shows the water budgets of each of those three subsystems. Fluxes between subsystems are shown twice: in the subsystem from where the flux originates as output (negative flux, analogous to an account withdrawal at a bank), and in the subsystem into which the flux occurs as input (positive flux, analogous to an account deposit at a bank).

This section also describes storage changes in the subsystems. An increase in storage over a period of time occurs when fluxes into a subsystem exceed fluxes out of the subsystem over that period of time (similar to deposits exceeding the amount of withdrawals in a bank account: the account balance increases). In Figure 33, a storage increase is depicted as additional negative bar length needed to balance the negative bar length (fluxes out of the subsystem) with the positive bar length (fluxes into the subsystem). In other words, storage increase is depicted as if it were a negative flux. This is consistent with accounting principles in hydrologic modeling.

Similarly, a decrease in storage over a period of time occurs when fluxes into a subsystem are less than the fluxes out of the subsystem over that period of time (similar to withdrawals from a bank account exceeding the deposits into the bank account: the account balance decreases). In Figure 33, a storage decrease is depicted as additional positive bar length needed to balance the positive bar length (fluxes into the subsystem) with the negative bar length (fluxes out of the subsystem). In other words, storage decrease is depicted as if it were a positive flux, consistent with hydrologic modeling practice.

1. Basin Inflows

There are three inflows in the historic water budget: precipitation on the valley floor (to L), surface water inflow to the Basin from the upper watershed (to SW), and subsurface inflow or mountain front recharge from the surrounding bedrock underlying the upper watershed (to GW).

Precipitation

Rainfall on the valley floor is a key input in the SWBM. SVIHM assumes that all precipitation falling on cultivated fields or native vegetation infiltrates into the soil column (i.e., runoff is neglected) (Tolley, Foglia, and Harter 2019).

Although a west-to-east decreasing rainfall gradient has been observed by Scott Valley residents, the locations of weather stations in the Scott Valley does not allow for robust calculation of this gradient. As a result, uniform daily precipitation value for the entire model domain is assumed (Foglia et al. 2013). That uniform daily value is the mean of the values observed or estimated at the Fort Jones and Callahan stations.

Missing days exist in the rainfall record for the Fort Jones and Callahan stations over the model period. On days with missing data, the value at the Fort Jones or Callahan station was estimated using data from six NOAA weather stations in the Scott Valley and immediate vicinity (see Table 7 and Foglia et al. (2013) in Appendix 2-F for more details). On days where precipitation is less than 20% of the atmospheric water demand (reference ET), it is assumed that the water evaporates before it infiltrates below the surface of the soil, so no infiltration is simulated (Tolley, Foglia, and Harter 2019).

Surface Water Inflow

The surface water inflows are derived from monthly tributary flow volumes that are calculated using the streamflow regression model (Foglia et al. 2013). These values are passed to the SWBM (L budget) as the monthly volume of surface water available for irrigation. Surface water irrigation diversions are computed as a function of irrigation demand. Fall and winter diversions for stock water are not monitored and are not included in the current version of SVIHM; if this data gap is filled in the future, updates to the SVIHM may attempt to incorporate these diversions. The conceptual diversion points from tributary flows are just outside the Basin boundary, except for two internal diversions (6 TAF, see below), which is consistent with most diversions occurring near the Basin margin. The remaining inflow from the upper watershed (streamflow regression model) is passed to the MODFLOW model domain as stream inflows (SW budget) (Foglia et al.

2013; Tolley, Foglia, and Harter 2019). In the water budget shown in Figure 33, the total surface water inflow is the sum of "Inflow" into the SW budget and "SW Irrigation" in the L budget, minus 6 TAF that are diverted from the mainstem Scott River to "SW Irrigation" from within the Basin.

Subsurface Inflow or Mountain Front Recharge (MFR)

Mountain Front Recharge, the phenomenon of diffuse water flow through mountain soil or fractured bedrock into the alluvial sediments of an aquifer along a valley margin, is simulated along the western edge of the model domain. It is estimated to be a volume that changes month-to-month (i.e., greater recharge during the wet season) but which is identical year over year (see Appendix 2-F for more details).

Discussion - Basin Inflows

Among the three inflows, canal and mountain front recharge is a relatively small amount, estimated to average 18 TAF. Stream inflow (Inflow plus SW Irrigation) is the largest source of water for the Basin, with a median inflow of 295 TAF, nearly 4 times larger than median precipitation of 81 TAF. Both of these sources of water vary widely between years. Precipitation varies, from less than half the median to nearly twice the median value (34 TAF to 151 TAF). Stream inflow varies even more widely from 100 TAF to 664 TAF. Water year 2006 had the highest combined inflow and precipitation (788 TAF). Water year 2001 was the driest year, with a combined upper watershed stream inflow and valley precipitation of 149 TAF. The variability in precipitation and upper watershed inflows is entirely driven by climate variability.

2. Basin Outflows

The three outflows in the historic water budget component are the surface water outflow, subsurface outflow, and evapotranspiration.

Surface Water Outflow

The surface outlet of the Scott Valley is near the USGS Gauge 11519500 (Fort Jones Gauge; Figure 17). The record of flow at this location dates back to the 1940s and continues to the present day (Figure 19).

Subsurface Outflow

Subsurface outflow is assumed to be negligible, and all water leaving the Scott Valley in liquid phase does so through the Scott River.

Evapotranspiration

Evaporative demand, or evapotranspiration by crops and native vegetation (ET), is a key variable affecting the hydrology of the basin. Reference ET (ET_0) is measured at CIMIS Station 225 and was modeled for the period prior to CIMIS station installation in 2015 (Foglia et al. 2013; Snyder, Orang, and Matyac 2002). (ET_0) is multiplied by crop coefficients on each day of their growth cycle to calculate daily water demand for each crop or vegetation type (Foglia et al. 2013). ET is primarily simulated in the SWBM, but a small amount of ET is also simulated as direct plant uptake from groundwater in the MODFLOW model (Section 2.2.1.5).

Discussion – Basin Outflows

Among the two Basin outflows, surface water outflow is the largest over the long term: median surface water outflow is 292 TAF, slightly more than median inflow after surface water diversions are subtracted (276 TAF). Median evapotranspiration is 112 TAF, mostly – but not exclusively – from agricultural crops grown in the Basin.

The magnitude of stream outflow closely follows the magnitude of stream inflows from the upper watershed, after subtracting surface water diversions. In 19 of 28 years, stream outflows exceed stream inflows in the SW budget (Figure 33). The largest differences between inflow and outflow occur in the wettest years (2006, 2017), when outflow exceeds inflow by nearly 50 TAF. In 9 of 28 years, mostly among the driest years

(1992-1994, 2001-2002, 2009-2010, 2013-2014), stream outflow is slightly less than stream inflow, with the largest difference being 12 TAF in 1992 (Figure 33). Except in some of the driest years, the Scott Valley Basin therefore is a net contributor to stream outflow from the Scott Valley watershed

Like surface water inflows, surface water outflows are highly variable between years, ranging from 85 and 89 TAF (in 2014 and in 2001) to 689 TAF (in 2006). In contrast, evapotranspiration is much less variable from year to year, ranging from 90 TAF (in 1997) to 130 TAF (in 2003). In half of years, evapotranspiration lies within the narrow range of 107 TAF to 116 TAF. The existing variability in evapotranspiration largely reflects year-over-year differences in average temperature and in the number of days with precipitation and significant cloud cover. The lack of larger variability in evapotranspiration reflects the land use in Scott Valley. Perennial crops (alfalfa and pasture) and perennial natural vegetation in the Basin make up most of the land surface.

Even in the driest year (2001), stream outflow is only about 5% (5 TAF) less than stream inflow. Since the net stream contribution even in 2001 (5 TAF) to valley evapotranspiration in that year (110 TAF) is minimal, the remaining contributions to ET come from surface water irrigation (19 TAF), mountain front recharge (18 TAF), precipitation (42 TAF), and the depletion of groundwater and soil storage (23 TAF and 3 TAF, respectively).

3. Flows Between Surface Water and Soil Zone

Surface Water Diversion for Irrigation

SVIHM simulates the diversion of surface water and the application of that water to fields as irrigation. The number and type of available water sources varies between fields; in fields with access to both surface and groundwater, it is assumed that irrigators will use surface water whenever it is available. In the water budget figures and tables, surface water diversion for irrigation is considered an inflow to the Basin, not a diversion from streams within the Basin. It is therefore separate from the inflow to the stream channels (“Inflow” in the SW budget), as most diversions occur near the Basin margins (see discussion above). In SVIHM, the diversions are conceptually located at or just outside the Basin boundary. In the water budget, these appear as surface water irrigation, which also include 6 TAF from the Farmers Ditch and Scott Valley Irrigation District diversion (see below).

Farmers Ditch and Scott Valley Irrigation District Diversion

These are the largest diversions within Scott Valley, located along the mainstem of the Scott River. The amount is assumed constant each year, 2 TAF to Farmers Ditch and 4 TAF to the Scott Valley Irrigation District. In SVIHM, these diversions are explicitly represented at the actual diversion location. This is an outflow from the SW budget and an inflow to the L budget, where it is counted as part of surface water irrigation.

4. Flows Between Surface Water and Groundwater

Stream Leakage and Groundwater Discharge to Stream

The flux of water between the surface water system and the aquifer is simulated in the MODFLOW model using the SFR (Streamflow Routing) package (Prudic, Konikow, and Banta 2004; Tolley, Foglia, and Harter 2019). When this flux is net positive into the aquifer, it is commonly referred to as stream leakage; when it is net positive into the stream, it is often referred to as groundwater discharge or baseflow.

The annual net exchange between groundwater and streams across the basin varies from 8 TAF of groundwater discharge into the stream (1992) to 44 TAF of stream losses to groundwater (2006). A net groundwater discharge to the stream system occurs only in 1992-1994, 2001-2002, 2009, 2014, which are among the driest years. The largest net groundwater replenishment from streams occurs in wet years, with 1997, 2004-2006, and 2017 exceeding 30 TAF. The majority of the replenishment occurs along the upper alluvial fans of the tributaries. Most of the groundwater contribution occurs along the valley trough (main-stem Scott River).

Drains / Overland Flow

To simulate groundwater seepage in a region known to have an elevated water table, “drains” were placed at the land surface in the Discharge Zone on the western sided of the Basin (Figure 35). Groundwater entering these drains is routed to a nearby stream segment, approximating overland flow (Tolley, Foglia, and Harter 2019). “Overland” flow appears as a negative term in the GW budget and as a positive term in the SW budget. It ranges from 1 to 10 TAF with a median value of 3 TAF.

Canal Seepage from Farmers Ditch and SVID Ditch

Two unlined canals are used to transport surface water from the Scott River to diversion points along the eastern side of the Basin margin (Figure 35). Seepage from these canals into the aquifer is estimated to be a volume that changes month-to-month (i.e., greater seepage during the growing season) but which is identical year-over-year (see Appendix 2-F for more details). Together with mountain front recharge (an inflow to the Basin), this amounts to 18 TAF of inflow to the GW budget.

5. Flows Between Soil Zone and Groundwater

Recharge to Aquifer

Each day, a field-by-field tipping-bucket method in the SWBM sub-model of SVIHM is used to calculate recharge through the soil zone to the aquifer. Soil zone inputs are infiltrating precipitation and irrigation water, and the driving output is ET. The “bucket” is the assumed water storage capacity in the soil rooting zone, which is dependent on the soil type of the field. Any soil moisture in excess of the field capacity (the amount retained in gravity-drained soil through capillary forces) at the end of each day is assumed to recharge to groundwater.

Recharge from the land surface occurs primarily in winter months but is limited – except under flood irrigation – during the summer months. Like precipitation, recharge from the landscape is highly variable, ranging from 9 TAF to 87 TAF with a median of 39 TAF.

Groundwater Pumping

Groundwater pumping is computed by the SWBM sub-model of SVIHM to meet ET demand in irrigated crops that is not met by precipitation, surface water irrigation, or – prior to the beginning of the irrigation season - by soil water storage. Groundwater pumping is limited to fields with groundwater as the source of irrigation water. Pumping also occurs in fields designated as having access to surface water and groundwater, after streamflow inflow from the upper watershed is insufficient to meet irrigation demands. The pumping amount varies as a function of soil type, crop, and irrigation type, which in turn determine soil moisture, irrigation efficiency, ET, among others. Groundwater pumping only occurs during the irrigation season, which is a function of the crop type and the dynamics of spring soil moisture depletion (see Foglia et al. (2013) for details).

Annual groundwater pumping varies in response to available precipitation and ET demand, from 27 TAF to 53 TAF, with a median of 40 TAF. The largest amount of pumping occurs in 2001 (53 TAF) and other dry years (at or above 45 TAF: 1992, 1994, 2001-2002, 2004, 2007, 2014). The least amount of pumping is observed in years with exceptionally wet springs (1997 and 2011).

Groundwater Uptake by Crops

In the Discharge Zone of the western Scott Valley, water table is sufficiently shallow that sub-irrigation (direct crop uptake of water from the water table) is used to grow pasture. In SVIHM, the use of groundwater by crops is explicitly simulated to supplement soil moisture contribution to ET, which is accounted for in SWBM (Tolley, Foglia, and Harter 2019). Annually, this flux term is 2 TAF or less.

6. Change in Storage

Change in the stored volume of water is illustrated in Figure 36.

Surface Water Storage

Change in storage in the surface water system is calculated is SVIHM. At an annual timescale, this budget component is negligible (Figure 33); consequently it is not shown in Figure 36.

Soil Zone Storage

The inter-annual change in the water stored in the soil zone (defined as the top of the soil to the bottom of the rooting zone, or 8 ft (2.4 m) below ground, in SVIHM) ranges from annual net loss as high as 7 TAF to an annual net gain as high as 10 TAF (Figure 36). Storage gains are typically associated with wet and near average years, storage losses occur during near average and dry years.

Aquifer Storage

Groundwater is the largest storage component in the Basin. Annual changes in groundwater storage range from as much as 29 TAF increase to as much as 24 TAF in decrease over a 12-month period. On September 30, 2018, total groundwater storage was 23 TAF lower than at the beginning of the simulation period (October 1, 1991). One year earlier, in 2017, total groundwater storage was 2 TAF lower than at the beginning of the simulation period (Figure 36). Lowest groundwater storage during the simulated period was in fall of 1994 and in fall of 2001. The third lowest storage occurred in fall of 2014. Aquifer storage dynamics do not indicate long-term overdraft conditions.

2.2.3.2 Groundwater Dynamics in the Scott Valley Aquifer System: Key Insights

The Scott Valley groundwater basin is an intermontane alluvial basin surrounded by an upper watershed that has highly variable natural runoff, but no surface storage reservoirs. The Basin itself generates additional discharge to the stream system that exits the Basin and the larger upper Scott River watershed just above the Fort Jones gauge on the Scott River. The groundwater system receives recharge from both, the stream system, especially along the upper alluvial fans of the tributaries, and from the landscape. Groundwater discharges into the main-stem of the Scott River, and into the lower sections of the tributaries, but also emerges in springs and drainages within the Discharge Zone. Riparian vegetation along the tributaries and the main-stem Scott River taps into shallow groundwater.

Precipitation occurs predominantly in the winter months, from October through April. Irrigation with surface water and groundwater between April and September is used to grow perennial crops (alfalfa, in occasional rotation with grains, and pasture). Groundwater has been used for irrigation since the 1970s and has allowed for an extended irrigation season, especially on alfalfa. Groundwater pumping significantly affects baseflow conditions during the summer.

Winter rains and winter/spring runoff fill the aquifer system between October and April (Figure 34). Groundwater discharge to streams along the thalweg drains the aquifer system year-round. Groundwater pumping further enhances the natural lowering of water levels during the dry season, leading to less baseflow.

Water levels are highest near the valley margin and slope from both sides of the valley toward the valley thalweg, along the main-stem Scott River. Higher recharge during the winter months increases the slope of the water table from the valley margins toward the thalweg. The lack of recharge for most of the dry period lowers the slope of the water table toward the thalweg over the summer months, decreasing discharge from groundwater into the Scott River system. Because the water table slopes toward the main-stem Scott River, seasonal water level fluctuations are largest near the valley margin and least near the Scott River (see Section 2.2.2.1).

Seasonal variability of recharge is accentuated by year-to-year climate variability: Years with low precipitation lead to a smaller snow pack and lower runoff from the surrounding watershed, hence less recharge from the tributaries into the alluvial fans, less recharge across the landscape of the Basin, and therefore less winter groundwater storage increase in the aquifer system. This in turn leads to a reduced slope of the water table to the Scott River at the beginning of the irrigation season when compared to wetter years, and lower winter and spring water levels, particularly near the margins of the Basin.

Any significant long-term decrease or increase of long-term precipitation totals over the watershed will lead to commensurate lowering or raising, respectively, in the average slope of the water table from the valley margins toward the Scott River thalweg, leading to a dynamic adjustment of water levels, even under otherwise identical land use and land use management conditions. These climate-induced adjustments will be relatively small near the main-stem Scott River, but larger near the valley margins. Such changes, however, are unlikely to lead to groundwater overdraft. However, they will affect baseflow conditions, the timing of the spring recess in Scott River flows and the arrival of the first fall flush flows in the river system.

Similarly, any increase or reduction in groundwater pumping leads to an equal decrease or increase in groundwater discharge to the stream systems. Any managed increase in recharge will also lead to an equal increase in groundwater discharge to the stream system within the Basin. The response of the groundwater discharge to the stream system will be delayed relative to the timing of the changes in pumping or recharge – by a few days if changes occur within a few tens or hundreds of feet of a stream, by weeks to months if they occur at larger distances from the stream. But when these changes occur permanently (even if only seasonally each year), the annual total change to groundwater discharge into the stream system will be approximately the same as the change in pumping (leading to less discharge) or in recharge (leading to more discharge).

This delay in timing can be taken advantage of with managed aquifer recharge or in-lieu recharge during periods of excess flows in the stream system, used for recharge or irrigation (in lieu of pumping), but creating additional discharge of groundwater to the stream during the critical low flow period in the summer and (early) fall.

2.2.4 Future Water Budget

The future projected water budget contains all of the same components as the historical water budget; for a description of those terms, see Section 2.2.3. To inform long-term hydrologic planning, the future projected water budget was developed using the following method:

1. Observed weather and streamflow parameters from water years 1991-2011 were used multiple times to make a 50-year “Basecase” climate record (see Appendix 2-E for details). The Basecase projection represents a hypothetical future period in which climate conditions are the same as conditions from 1991-2011.
2. The climate-influenced variables Precipitation (as rain), Reference Evapotranspiration (ET_{ref}), and tributary stream inflow were altered to represent four climate change scenarios:
    - Near-future climate, representing conditions in the year 2030 (held over the entire 50-year projection)
    - Far-future climate, representing central tendency of projected conditions in the year 2070 (held over the entire 50-year projection)
    - Far-future climate, Wet with Moderate Warming (WMW), representing the wetter extreme of projected conditions in the year 2070 (held over the entire 50-year projection)
    - Far-future climate, Dry with Extreme Warming (DEW), representing the drier extreme of projected conditions in the year 2070 (held over the entire 50-year projection)
3. The SVIHM was run for the 50-year period of water years 2022-2071 for the Basecase and all four projected climate change scenarios.

For convenience, the scenarios described in points 2a-2d above will be referenced as the **Near**, **Far**, **Wet** and **Dry** future climate scenarios. Additional tables and figures for all five future climate scenarios are included in Appendix 2-E.

Method Details

The climate record for the projected 50-year period of water years 2022-2071 (October 2021-September 2071) was constructed from model inputs for the years 1991-2011. The minimum bound of 1991 was imposed by ET_{ref} data, which is not available prior to the SVIHM historical model period; the maximum bound of 2011 was imposed by DWR change factors, which are only available through 2011 (see Appendix 2-E).

Under their SGMA climate change guidance, DWR provided a dataset of “change factors” which each GSA can use to convert local historical weather data into 4 different climate change scenarios (DWR- California Department of Water Resources (DWR) 2018a). Change factors are geographically and temporally explicit. Geographically, a grid of 1/16-degree resolution cells covers the extent of California; for each of these cells, one change factors applies to each month, 1911-2011.

The change factor concept is intended to convert all past years to a single near or far future year; for example, imagining that in a hypothetical grid cell, the 2030 (Near) scenario change factor for ET ref in March 2001 was 5%. This would imply that, under the local results of the global climate change scenario used to inform this guidance, if March 2001 had occurred in the year 2030, there would be 5% more ET in that grid cell than historically observed.

Implications

The 2030 (Near) and 2070 central tendency (Far) scenarios predict similar rainfall conditions to the Basecase, while the 2070 DEW (Dry) and 2070 WMW (Wet) scenarios show less and more cumulative rain, respectively. Conversely, all scenarios predict higher future ET than the Basecase (Figure 37).

Historical rainfall for three selected periods (1936-2020, 2000-2020, and 2010-2020, with 20.8, 19.8 and 19.3 inches respectively) demonstrate that conditions in the last 10 years have been drier than the last 20, which have been drier than the full record period since 1936. The Basecase and three of the four future scenarios exceed the historic averages, while the DEW (Dry) future scenario (19.2 inches) is on par with the average of the last 10 years (19.3 inches) (Figure 38).

More groundwater is held in aquifer storage in the Wet scenario, and less in the Dry scenario (Figure 39). However, interannual variability is a greater driver of storage change than which climate change scenario is selected; i.e., in future year 2045 the difference between the Wet and Dry scenarios was ~5 TAF, but the range in overall interannual variability in each scenario is greater than 40 TAF (Figure 39), Importantly for sustainable groundwater management, none of the future climate scenarios indicate that the lowest groundwater storage points decrease over time, even through repeated decadal wet-dry cycles (Figure 39). This suggests that long-term overdraft and subsidence are unlikely in an aquifer system as seasonally dynamic as the Scott River watershed, at least under climate conditions as extreme as the Dry scenario. However, the lowest point in the cumulative aquifer storage curve for the Dry scenario is typically several TAF below the lowest point in the Far or Basecase scenarios, suggesting that deeper seasonal deficits of groundwater storage under some climate change scenarios may lead to lower dry-season flows.

Overall, the effects of all four climate change on groundwater appear to be somewhat moderate and a matter of degree; conversely, the impact of future climate conditions on surface flows is highly variable depending on which scenario is selected (Figure 39). Near and Far scenarios show minimal differences from historical basecase flow conditions. The Dry scenario shows some periods of notably reduced flow, while the Wet scenario shows some years with much higher flow than historical basecase flow conditions.

While this initial climate analysis is a GSP requirement, it does not provide substantial information to inform sustainable management, in part because the “Dry” scenario more or less matches the climate of the most recent historic decade, while the “Wet” scenario seems unlikely based on the past 20 years of climate patterns. Additional climate analysis will be incorporated into the feasibility assessment stage of implementing Projects and Management Actions (see Ch. 4).

Analysis Limitation and Future Improvement

The primary limitation of the future water budget analysis is that it likely does not explicitly simulate expected future changes in snow melt dynamics. The tributary inflows have been altered by the application of streamflow change factors provided by DWR. Even in the Dry with Extreme Warming (DEW) scenario, the most significant change in the overall hydrograph of Shackleford, a major tributary, is a lengthening of the dry season later into the fall (Figure 41). The timing of the spring recession remains extremely similar between the basecase and DEW.

This does not reflect known and recently observed changes in spring recession timing; namely, that higher temperatures will cause snow melt to occur earlier in the year. In future GSP updates, additional climate change analysis that explicitly models regional snow pack dynamics may allow for tributary inflow estimates that incorporate this phenomenon.

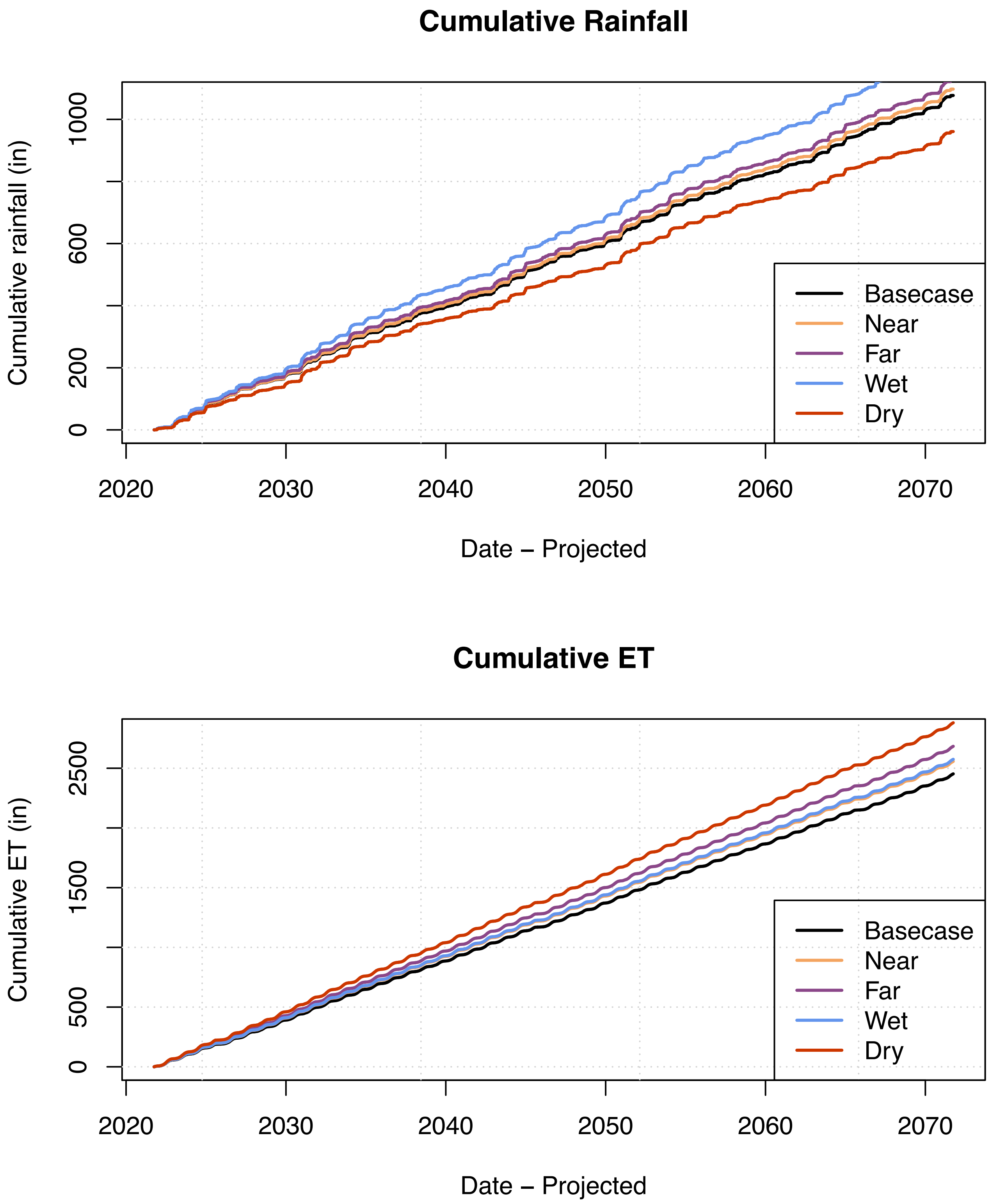

Figure 37: Cumulative precipitation and reference ET for the future projected climate conditions, with basecase and four DWR climate scenarios. The 2030 (Near) and 2070 central tendency (Far) scenarios predict similar rainfall conditions to the Basecase, while the 2070 DEW (Dry) and 2070 WMW (Wet) scenarios show less and more cumulative rain, respectively. Conversely, all scenarios predict higher future ET than the Basecase.

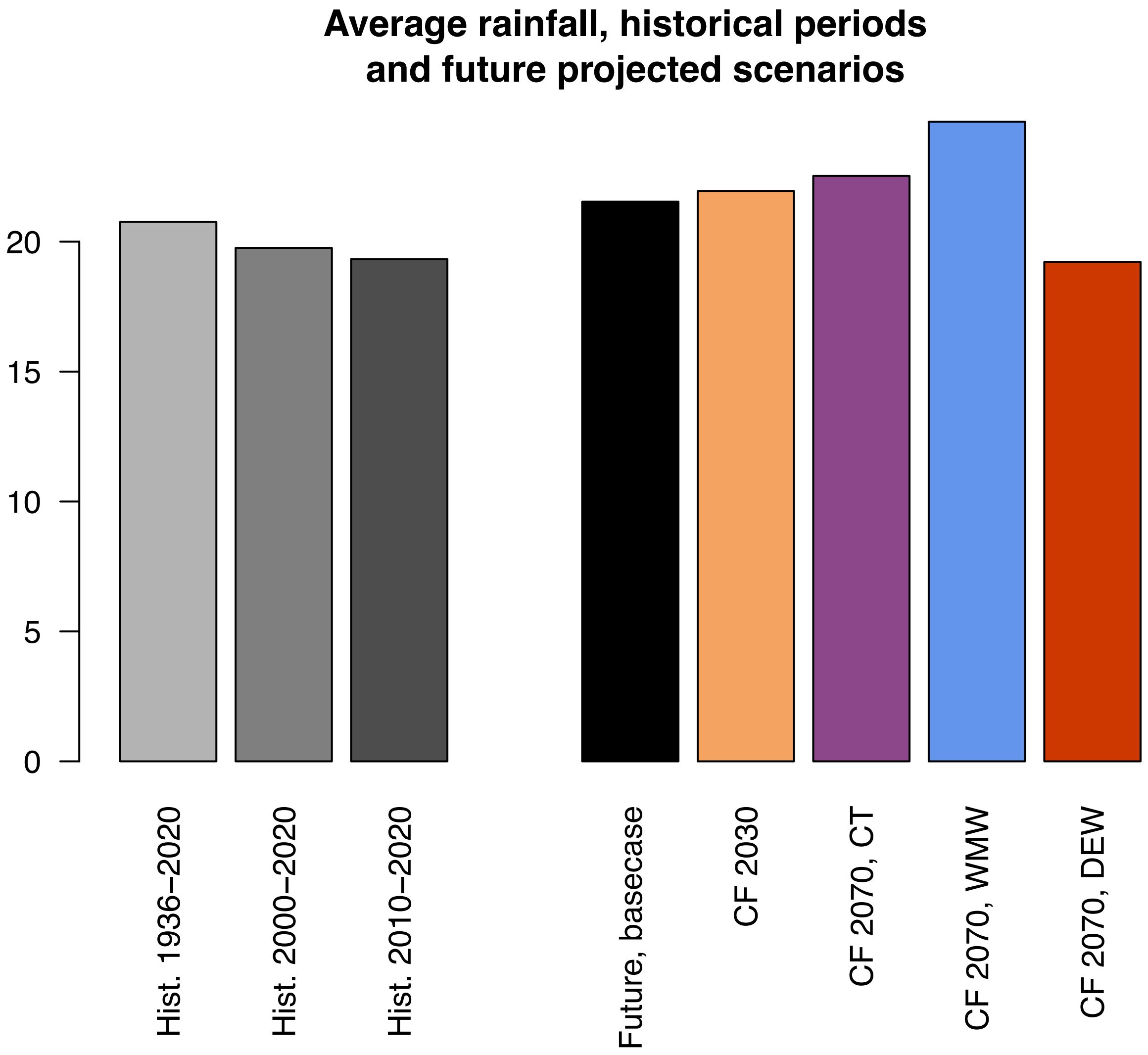

Figure 38: Historical rainfall for three selected periods (1936-2020, 2000-2020, and 2010-2020, with 20.8, 19.8 and 19.3 inches respectively) demonstrate that conditions in the last 10 years have been drier than the last 20, which have been drier than the full record period since 1936. The basecase and three of the four future scenarios exceed the historic averages, while the DEW (Dry) future scenario (19.2 inches) is on par with the average of the last 10 years (19.3 inches).

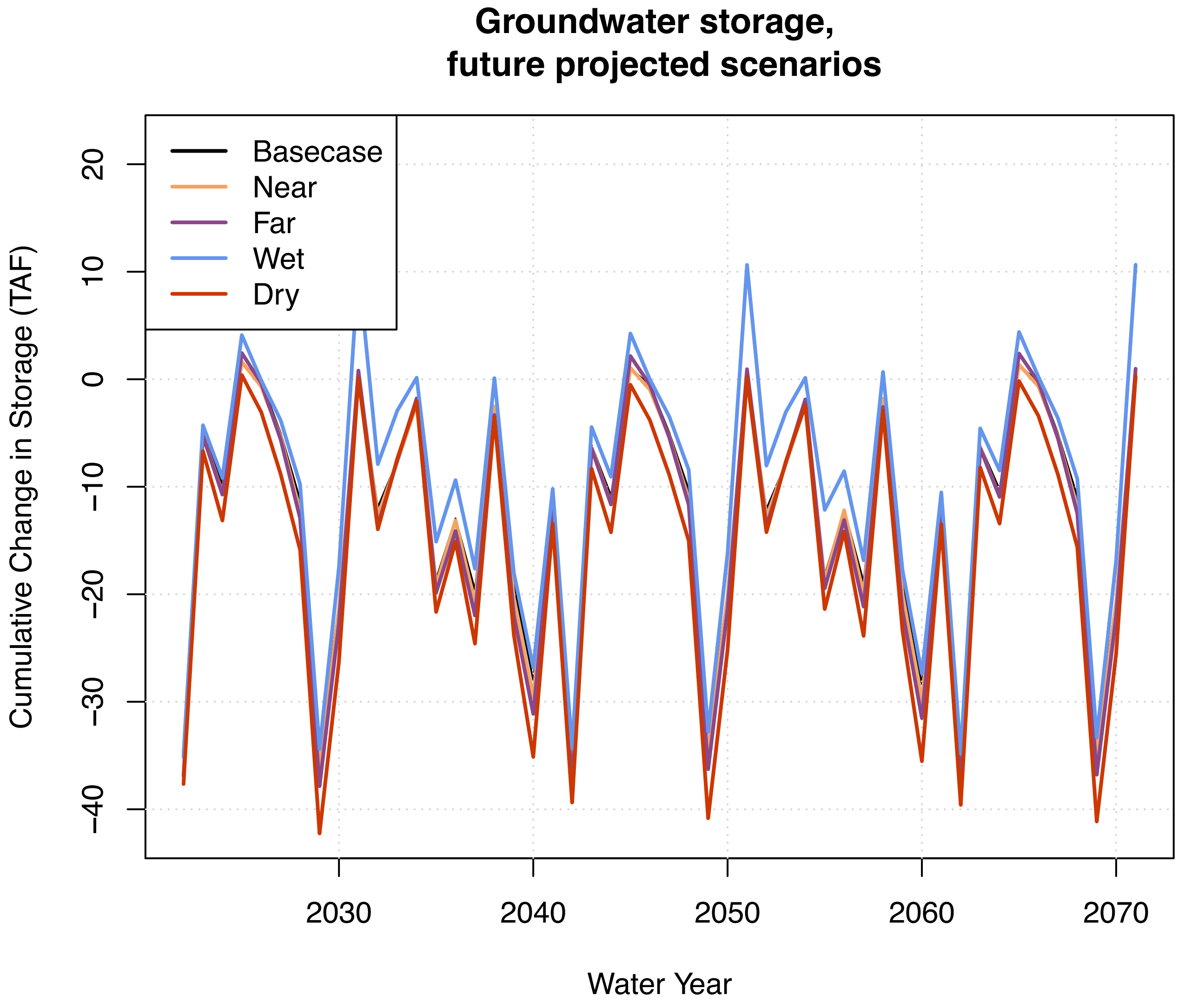

Figure 39: Cumulative groundwater storage for the future projected climate conditions, with basecase and four DWR climate scenarios.

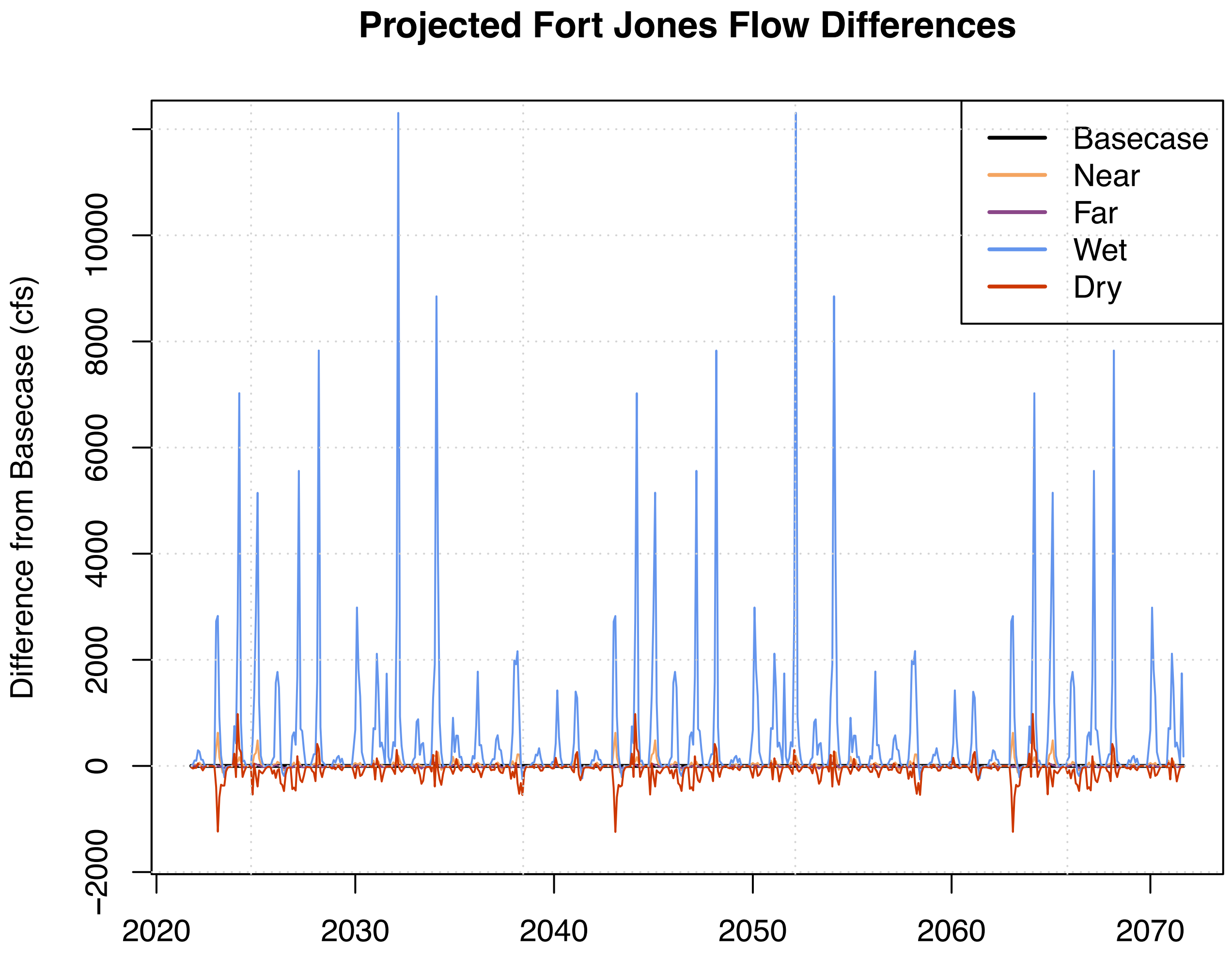

Figure 40: Projected flow at the Fort Jones Gauge, in difference (cfs) from Basecase, for four future projected climate change scenarios. Near and Far scenarios show minimal differences from historical basecase flow conditions. The Dry scenario shows some periods of notably reduced flow, while the Wet scenario shows some years with much higher flow than historical basecase flow conditions.

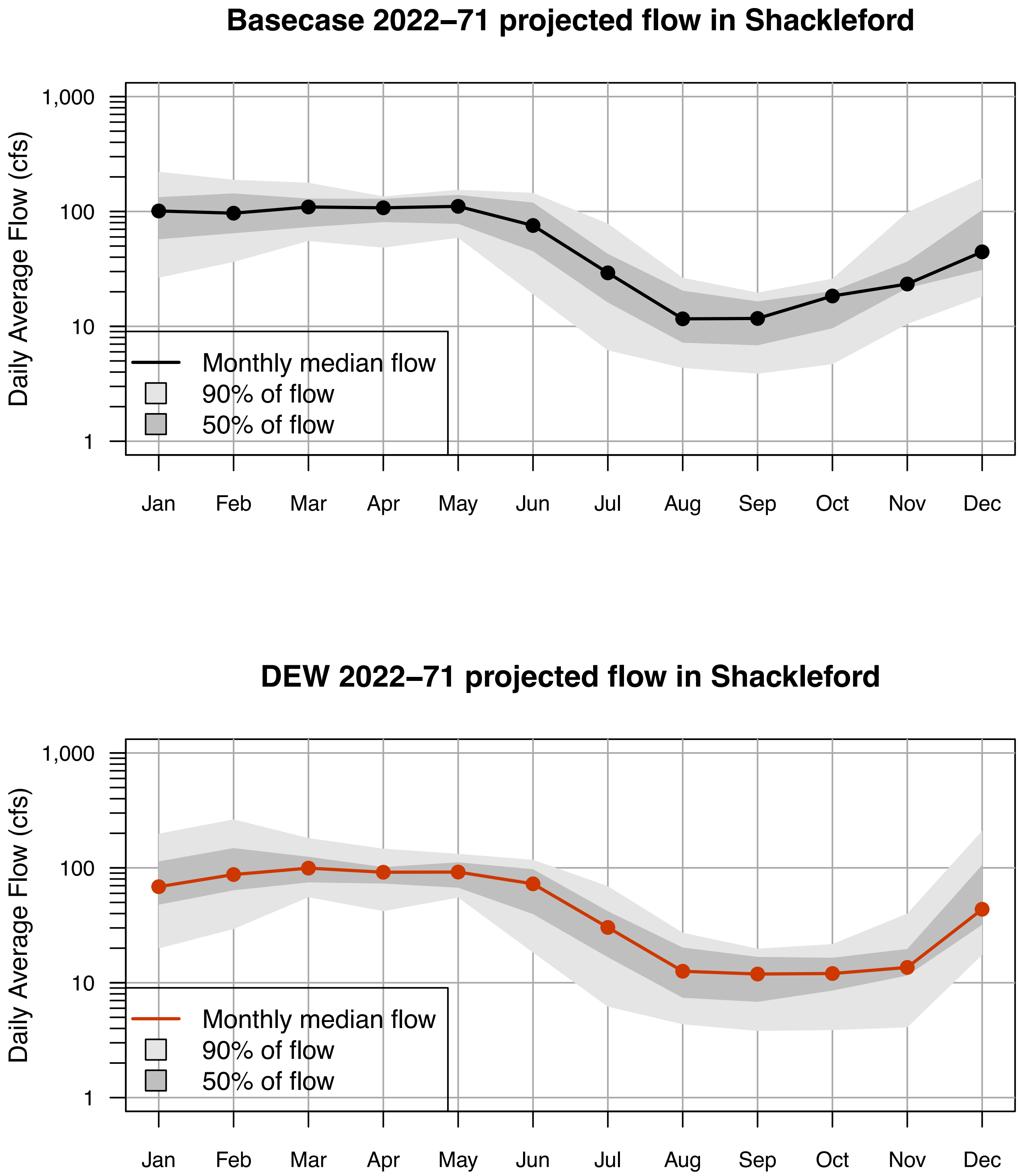

Figure 41: Median flow values for Shackleford tributary inflow, and shaded areas covering the 25th-75th and 5th-95th percentiles, for each month in the 50-year projected model period.

2.2.5 Sustainable Yield

The sustainable yield "means the maximum quantity of water, calculated over a base period representative of long-term conditions in the basin and including any temporary surplus, that can be withdrawn annually from a groundwater supply without causing an undesirable result." (California Water Code Section 10721).

In this plan, the sustainable yield is defined as the long-term average annual groundwater pumping rate, as defined by the water budget process, that does not cause an undesirable result. Chapter 2 defines the water budget process and chapter 3 defines undesirable results. With respect to the sustainability indicators for water level and groundwater storage, the Basin is not in overdraft and has not incurred undesirable results. Since 2014, ongoing groundwater pumping and ongoing groundwater management actions have also not incurred new undesirable results with respect to sustainability indicators for land subsidence, water quality, and terrestrial GDEs. Water levels and groundwater storage have been in a long-term dynamic equilibrium between inflows to and outflows from the aquifer system. For the Scott Valley, **the sustainable yield with respect to all but the interconnected surface water sustainability indicator would be equal to the 28-year average annual groundwater pumping of 42 thousand acre-feet** as estimated with SVIHM for the 1992-2018 period.

Chapter 3 defines undesirable results for the interconnected surface water (ISW) sustainability indicator that existed during the baseline period and continue to exist. The undesirable result occurs due to intermittent adverse stream flow conditions during the summer and fall of dry and some average water years. Adverse stream flow conditions are those that negatively affect the habitat of anadromous fish in the Scott River. The GSP sets a minimum threshold for 2042 and thereafter. The minimum threshold requires that current long-term average stream depletion of ISW during the critical September to November period is reversed by at least 15% (see chapter 3.4.5) through a combination of projects and management actions (PMAs). The effect of specific PMAs or combinations of PMAs on stream depletion reversal is quantified using SVIHM scenario analysis (see chapters 3.3.5 and 3.4.5). Importantly, PMAs to reverse stream depletion may include managed aquifer recharge, some reduction of pumping demand, both, or neither (see Chapter 4).

SVIHM simulations of various PMA scenarios have been performed to quantify the amount of stream depletion reversal accomplished (Appendix 4-A). At 5-year plan updates, updated SVIHM simulations will be used to quantify the amount of stream depletion reversal accomplished by actual PMAs that will be implemented at that time. Each of these (future) scenario simulations also provides an estimate of the difference in long-term average annual groundwater pumping that would occur for a particular PMA or combination of PMAs when they are implemented (see Chapter 3.3).

The existing portfolio of scenario simulations (Appendix 4-A) indicate that the amount of long-term average groundwater pumping that can occur without causing undesirable results to the ISW depends on the timing and location of pumping reductions or recharge associated with PMAs, if any. This is due to the fact that adverse conditions occur intermittently and only in some water years. These complexities also exist because adverse conditions in interconnected surface water are caused not only by stream depletion due to groundwater pumping, but also are affected by surface water diversions, natural recharge conditions in the preceding spring and winter, return flows from surface water and groundwater irrigated fields, and by other factors (see Chapter 3.3).

As a consequence, the sustainable yield will vary with the selected portfolio of PMAs that allow the basin to meet the sustainable management criteria. For example,

- The GSA may choose to build off-stream surface water storage to reverse stream depletion during critical periods. That would require neither a reduction in pumping nor an increase in recharge to avoid the ISW undesirable result. The sustainable yield under this PMA implementation would remain at 42,000 acre-feet/year.
- The GSA may implement MAR and ILR to the extend documented in Appendix 4A. The resulting reversal of stream depletion would meet and exceed the minimum threshold requirements. SVIHM

simulations indicate that this PMA increases long-term average streamflow by approximately 4,700 acre-feet/year through a combination of an average 12,600 acre-feet/year of additional recharge and 3,800 acre-feet/year less pumping. Since additional recharge during winter and spring is dedicated to enhance summer and fall stream flow (depletion reversal), it does not add to the sustainable yield of the basin. With 3,800 acre-feet/year less pumping (due to the in-lieu recharge process), the sustainable yield under this PMA implementation would be 38,200 acre-feet/year.

- The GSA may implement a program to increase average irrigation efficiency by 20%, as documented in Appendix 4-A. This PMA would result in an average 12% stream depletion reversal during September to November. This would achieve most – but not all – of the minimum threshold depletion reversal (15%). SVIHM simulations indicate that this PMA increases long-term average streamflow by approximately 5,300 acre-feet/year through a reduction in groundwater demand that averages 5,400 acre-feet/year. Return flow from irrigated lands to groundwater would also be reduced by 4,700 acre-feet/year, on average. Total long-term average groundwater pumping under this PMA implementation would be 36,600 acre-feet/year (5,400 acre-feet/year less than the current average annual baseline pumping). Additional PMAs would be needed to meet the minimum threshold and measurable objective requirements for depletion reversal. The additional PMA to meet the sustainability criteria for ISW may be MAR. MAR does not increase groundwater pumping demand. The sustainable yield for this combination of PMAs would therefore be 36,600 acre-feet/year.

As these examples illustrate, the sustainable yield that addresses the undesirable result for the ISW will be a function of the specific PMAs that will be selected over the implementation period. The sustainable yield will therefore be an adjustment to the 1991 – 2018 baseline average annual groundwater pumping of 42 thousand acre-feet, given the reduction (or increase) in groundwater pumping associated with PMAs that are implemented over the coming twenty years to meet the measurable objective for the ISW sustainability indicator and to avoid ISW undesirable results.

The **long-term average groundwater pumping rate** will be recomputed at each 5-year plan update, given the then-implemented PMAs. The **sustainable yield** will be the amount of long-term average groundwater pumping needed under the PMAs implemented by and after 2042 that avoid the minimum threshold and achieve the measurable objective for the ISW sustainability indicator as well as the other sustainability indicators. Future simulations and assessments will also consider measured changes in climate and update future climate predictions. Climate change may further impact the sustainable yield of the Basin.

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