BUREAU OF RECLAMATION

Appendix B: Biological Assessment

Sacramento River Settlement Contractors Water Reduction Program

Central Valley Project, California

Interior Region 10 California Great Basin

Mission Statements

The U.S. Department of the Interior protects and manages the Nation's natural resources and cultural heritage; provides scientific and other information about those resources; honors its trust responsibilities or special commitments to American Indians, Alaska Natives, and affiliated Island Communities.

The mission of the Bureau of Reclamation is to manage, develop, and protect water and related resources in an environmentally and economically sound manner in the interest of the American public.

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Acronyms and Abbreviations

AF	acre-feet
CEQA	California Environmental Quality Act
CDFW	California Department of Fish and Wildlife
CNDDB	California Natural Diversity Database
CVP	Central Valley Project
DWR	Department of Water Resources
GGS	Giant Garter Snake
M&I	municipal and industrial
MAF	million acre-feet
NEPA	National Environmental Policy Act
NOP	Notice of Preparation
PA	Proposed Action
Program	Water Reduction Program
SCADA	Supervisory Control and Data and Acquisition
SRSC	Sacramento River Settlement Contractors
TAF	thousand acre-feet
VFDs	Variable Frequency Drives
WERC	U.S. Geological Survey's Western Ecological Resource Center

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1 Introduction

1.1 Purpose of the Biological Assessment

This Biological Assessment has been prepared to address the effects of the Proposed Action (PA) in compliance with Section 7 of the Endangered Species Act (ESA) of 1973. Section 7 assures that, through consultation, Federal actions do not jeopardize the continued existence of threatened, endangered, or proposed species or result in the destruction or adverse modification of critical habitat.

Reclamation is the lead Federal agency for this consultation. This Biological Assessment documents the potential effects of the Proposed Action on Federally listed threatened and endangered species that have the potential to occur in the Action Area, as well as any potential effects on critical habitat for these species.

Reclamation's action under consideration is to execute an agreement with the Sacramento River Settlement Contractors (SRSC) to establish a water reduction program and implement drought resiliency actions. The Proposed Action will include reductions in Sacramento River Settlement Contractors diversions in certain years.

Reductions in diversions by SRSC could result in crop idling/crop shifting, where agricultural users idle land that would otherwise have been in production or shift to less water-intensive crops and groundwater substitution where water users forego diversion of surface water supplies and pump an equivalent amount of groundwater as an alternative supply.

1.2 Background

Reclamation's mission is to manage, develop, and protect water and related resources in an environmentally and economically sound manner in the interest of the American public. Reclamation is the largest wholesale water supplier in the United States, and the nation's second largest producer of hydroelectric power. Its facilities also provide substantial flood control, recreation, and fish and wildlife benefits.

The Central Valley Project consists of 20 dams and reservoirs that together can store nearly 12 million acre-feet (MAF) of water. Reclamation holds over 270 contracts and agreements for water supplies that depend upon CVP operations including the settlement contracts that have been executed with the SRSCs. The SRSCs were first signed in 1964, covering a 40-year term, and renewed in 2005 for another 40 years. The SRSCs are senior water rights holders on the Sacramento River downstream of Shasta Dam that are senior to Reclamation's water rights for Shasta Dam and the CVP. The executed settlement contracts provide that contract totals will be

reduced by 25% in a Shasta Critical Year. In accordance with the defined contract terms a Shasta Critical Year reduction to SRSC contract supply is responsive to shortages in water supplies due to normal hydrologic conditions, climatic variability, and climate change.

Hydrologic conditions, climatic variability, consumptive use within the watershed, and regulatory requirements for operation of water projects commonly affect water supply availability in California. This variability strains water supplies, making advance planning for water shortages necessary and routine while also presenting opportunities for advancing solutions for drought. In the past decades, Reclamation and water suppliers have coordinated on water management solutions that could be implemented that address drought impacts through drought mitigation and water conservation programs to address water management challenges in critical drought years.

In order to improve spawning, rearing, and migratory conditions for salmon species in the Upper Sacramento River, hatchery operations, and other spawning locations, and to otherwise support the recovery of salmon species, Reclamation proposes to enter into an agreement with the SRSC that will establish a Water Reduction Program (Program) to be implemented in two phases which that provide for water reductions by the SRSC, in years that meet certain criteria based on hydrologic conditions and investments in drought resiliency projects. By providing funding to the SRSC to reduce diversions and idle/shift their crops, and offset the need to divert surface water supplies through groundwater substitution and conservation efforts, thereby reducing the amount of water that is released from Shasta Reservoir and diverted by the SRSC, the Proposed Action would allow for additional flexibility in Reclamation's management of operation of the Central Valley Project (CVP) during drought conditions.

1.3 Key Considerations for this Consultation

1.3.1 2021 Long-Term Operations for the Central Valley Project and State Water Project

Shasta Reservoir is the largest reservoir in the CVP and the State of California. It is relied upon for meeting multiple and often competing objectives throughout the State but with limited ability to meet these objectives in drought years. As climate change has been affecting the hydrology and meteorology, the drought periods have become more severe with significantly less inflow as in previous droughts, higher evaporation and evapotranspiration due to increased temperature, and more extreme hydrological and meteorological events. In addition, the viability of critically endangered species and other salmon populations that rely on the Sacramento River is affected by multiple stressors and is being substantially impacted by these extreme events, particularly the lack of available water (including cold water) in droughts and high air temperatures. Additionally, since 2017, Reclamation has operated Shasta Reservoir to target lower temperatures at compliance locations in the Sacramento River (53.5° F versus 56°F), which has resulted in less flexibility in operations.

For potential effects that may occur to aquatic species and previously consulted on terrestrial species as a result of implementation of drought actions taken under the Proposed Action analyzed in this Biological Assessment, Reclamation is tiering from the following Biological Opinions or the governing Biological Opinion(s) in their place at the time of Proposed Action implementation:

- 2019 National Marine Fisheries Service Biological Opinion for the Reinitiation of Consultation on the Long-Term Operation of the Central Valley Project and State Water Project
- 2019 U.S. Fish and Wildlife Service Biological Opinion for the Reinitiation of Consultation on the Coordinated Operations of the Central Valley Project and State Water Project

1.3.2 Drought Resiliency Actions that may be undertaken by Sacramento River Settlement Contractors

The SRSC are expected to implement drought resiliency projects. Drought Resiliency projects are an integrated, broad range of actions intended to strengthen the resilience of the

Settlement Contractors' water system and long-term water delivery capabilities, thereby assisting Reclamation and the Settlement Contractors to withstand and recover from climatic variability in order to support healthy rivers and landscapes (including but not limited to terrestrial ecosystems) and create durable water savings while sustaining a more drought-resilient economy that retains its vitality. Drought resiliency projects that may be undertaken as part of the Program include but are not limited to the following actions: (1) making investments to conserve water supplies over the long-term; (2) diversifying water supplies; and (3) enhancing water management actions with improved data, forecasting, conveyance, and administration under the Settlement Contracts.

On May 17, 2024, Glenn-Colusa Irrigation District issued a California Environmental Quality Act (CEQA) Notice of Preparation (NOP) of Environmental Impact Report for the Water Reduction Program pursuant to its independent obligation to comply with the California Environmental Quality Act. Based on a description of the actions included in the NOP, SRSC expects that certain drought resiliency projects would be constructed and implemented over the course of the agreement. It is anticipated that with the implementation of drought resiliency projects, the need for the water reduction activities described in the Proposed Action (particularly crop idling/shifting and groundwater substitution) in this document may reduce over time. Because the drought resiliency projects are in the very early stages of planning, they remain speculative in regard to design, scope and locations. The Draft EIR will provide a general description of reasonably foreseeable actions that could occur. These actions are expected to be analyzed at a programmatic level in the Draft EIR. Future site-specific environmental compliance will be completed, if required.

Reclamation is proposing a framework programmatic action for the development of future drought resiliency actions that are anticipated to occur as a result of the Proposed Action. The use of a framework programmatic consultation for these projects provides information, to the

extent possible, on how these projects would be implemented, if approved after completing any necessary compliance with the National Environmental Policy Act (NEPA) and CEQA. Additional information on potential projects is discussed further in Section 2.1.3.

1.4 Species Considered

A species list for the potentially affected area was generated on May 21, 2024, from the Sacramento USFWS website at USFWS website (Project Code: 2024-0093832; see Appendix 1). Of the species identified, the Proposed Action has the potential to affect Giant Garter Snake (GGS), a species listed as threatened under the ESA.

Reclamation's Proposed Action is focused on water reductions in the action area generally occurring on agricultural lands and does not include ground disturbing activities. Therefore, due to the nature of the Proposed Action and based on an analysis of current information on the potential effects of the action, known existing populations and habitat requirements of the terrestrial species and critical habitat will not be considered further in this Biological Assessment:

- Northern Spotted Owl (Strix occidentalis caurina)
- Northwestern Pond Turtle (Actinemys marmorata)
- California Tiger Salamander (Ambystoma californiense
- Western Spadefoot (Spea hammondii)
- Monarch Butterfly (Danaus plexippus)
- Conservancy Fairy Shrimp (Branchinecta conservation)
- Shasta Crayfish (Pacifastacus fortis)
- Vernal Pool Fairy Shrimp (Branchinecta lynchi)
- Vernal Pool Tadpole Shrimp (Lepidurus packardi)
- Colusa Grass (Neostapfia colusana)
- Greene's Tuctoria (Tuctoria greenei)
- Hairy Orcutt Grass (Orcuttia Pilosa)
- Hartweg's Golden Sundburst (Pseudobahia bahilfolia)
- Hoover's Spurge (Chamaesyce hooveri)
- Keck's Checker-mallow (Sidalcea keckii)
- Lassics Lupine (Lupinus constancei)
- Palmate-bracted Bird's Beak (Cordylanthus palmatus)

- Slender Orcutt Grass (Orcuttia tenuis)

The species considered for this document is based on the iPac list of May 21, 2024, paired with the considerations in Section 1.3.1 of this document. As such, species previously consulted on, currently being consulted on or those identified with no effect under the following consultations were not considered in this document:

- 2019 U.S. Fish and Wildlife Service Biological Opinion for the Reinitiation of Consultation on the Coordinated Operations of the Central Valley Project and State Water Project
- 2021 Reinitation of Consultation on the Coordinated Operations of the Central Valley Project and State Water Project

1.5 Critical Habitat

Critical habitat has not been designated for GGS.

1.6 Action Area

The action area is defined in 50 CFR §402.02, as "all areas to be affected directly or indirectly by the federal action and not merely the immediate area involved in the action." For the proposed project, the action area includes the service area of the Sacramento River Settlement Contractors (Figure 1-1).

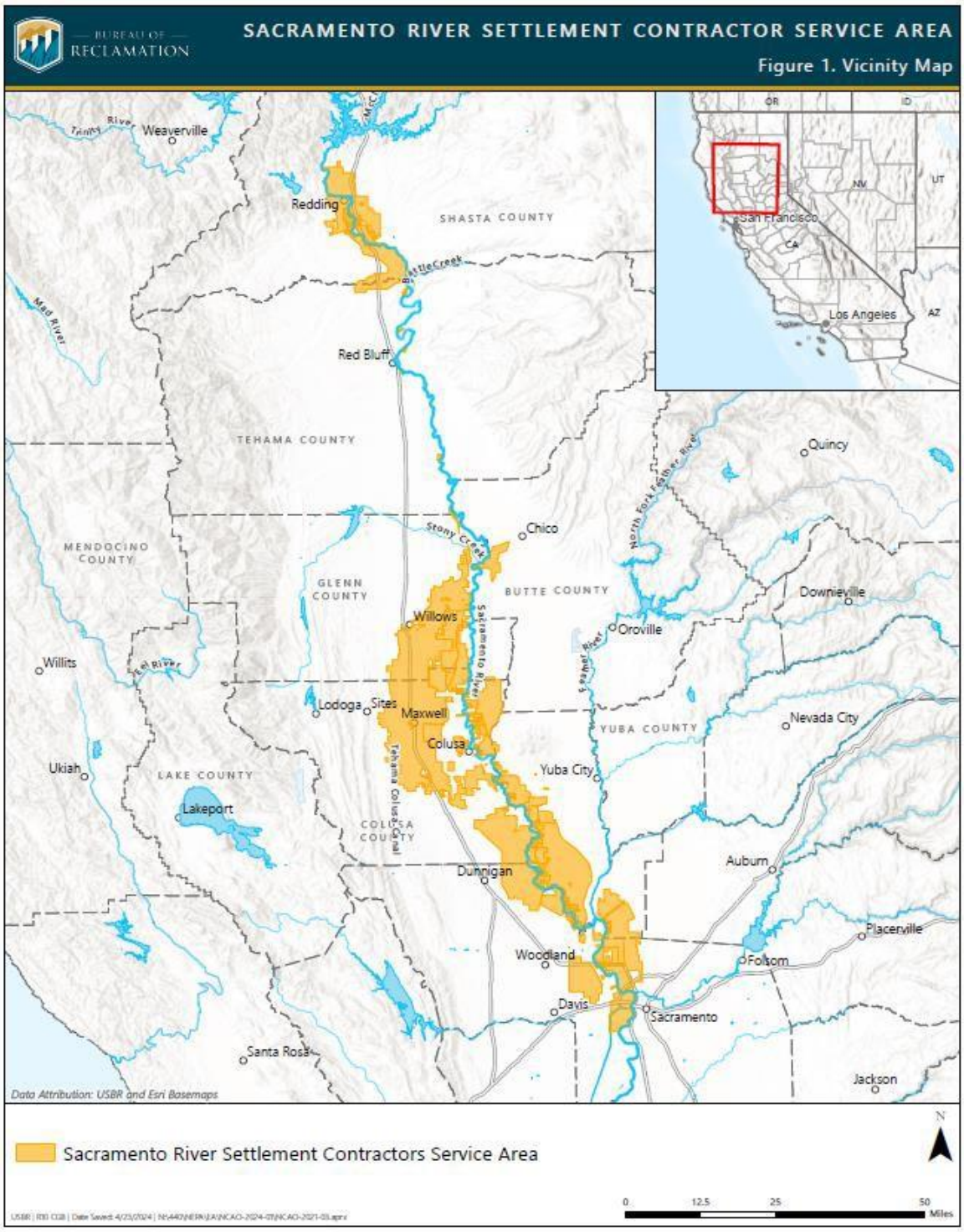

Figure 1-1. Map of Action Area which encompasses the Sacramento River Settlement Contractor Service Area.

2 Proposed Action and Conservation Measures

2.1 Water Reduction Program

Under the Proposed Action, Reclamation is proposing to enter into a contract between Reclamation and the Sacramento River Settlement Contactors for the establishment of a Water Reduction Program (see Appendix 2). The Proposed Contract would support a reduction in releases and diversions that would be in addition to Article 5 shortages included in the Sacramento River Settlement Contracts. The Proposed Contract would result in the Settlement Contractors forgoing a larger percentage of their contract supply in specified drought years under two phases. In addition, the SRSC will engage in drought resiliency projects to reduce potential impacts due to reduced contract supply. The Settlement Contractors shall use at least 50.1% of the proceeds to invest in drought resiliency projects.

During years when the Program is implemented, critically dry conditions exist, the system is stressed, and water resources are not available to meet all demands. There is low confidence to meet targeted water temperatures for winter-run Chinook salmon egg incubation and future drought protection is at risk. In these dry years, Shasta Reservoir is expected to be operated primarily for meeting public health and safety (including salinity management in the Delta), obligations to senior water right holders under the SRSC and minimum instream flows.

The Water Reduction Program would be implemented in a critical water year and is often within a series of drier years such as during a multi-year drought sequence. Under the conditions that trigger a Program Year, water temperature management is expected to be very challenging with minimal carryover which will result in little drought protection if the following year continues to be dry.

2.1.1 Program Phases

Under Phase 1 of the Program (February 2025–February 2035), the Settlement Contractors would collectively incur a reduced contract supply of up to 500,000 acre-feet under their aggregated contracts in any year if the following four conditions are met which are defined as Phase 1 Program Years:

- Forecasted end-of-April Shasta Reservoir storage is less than 3.0 million acre-feet;
- Forecasted end-of-September Shasta Reservoir storage is less than 2.0 million acre-feet;
- Combined actual and forecasted natural inflow to Shasta Reservoir from October 1 through April 30 is less than 2.5 million acre-feet; and
- Reclamation forecasts a Critical Year under the Settlement Contracts.

Under Phase 2 (February 2035–February 2045), the contractors may voluntarily incur a reduced contract supply of up to 100,000 acre-feet under their aggregated contracts in any year if the following two conditions are met which are defined as Phase 2 Program Years:

- Combined actual and forecasted natural inflow to Shasta Reservoir from October 1 through April 30 is less than 2.5 million acre-feet; and
- Reclamation forecasts a Critical Year under the Settlement Contracts.

Phase 1: Reductions in releases and diversions would be anticipated to occur in Phase 1 Program Years as shown in Table 2-1.

Table 2-1. Approximate Maximum Water Reduction per SRS Contractor per Phase 1 Program Year

SRSC Contractor	**Water Reduction acre- feet (AF) per Phase 1 Program Year)**
Glenn-Colusa Irrigation District	197,555
Reclamation District No. 108	55,555
Sutter Mutual Water Company	54,118
Anderson-Cottonwood Irrigation	29,933
Natomas Central Mutual Water	28,783
Reclamation District No. 1004	17,097
Princeton-Codora-Glenn Irrigation	16,238
Provident Irrigation District	13,106
Conaway Preservation Group, LLC	9,785
Meridian Farms Water Company	8,381
Sycamore Family Trust	7,615
RRG Garden Properties, LLC	7,136
Pleasant Grove Verona Mutual Water	6,295
City of Redding	5,029
Maxwell Irrigation District	4,305
M&T Chico Ranch	4,300
Pelger Road 1700	2,411
Woodland-Davis	2,395
Other	29,964
Total	500,000

Phase 2: Reductions in releases and diversions would be anticipated to occur in Phase 2 Program Years as shown in Table 2-2.

Table 2-2. Approximate Maximum Water Reduction per SRS Contractor per Phase 2 Program Year

SRSC Contractor	Water Reduction acre- feet (AF) per Phase 1 Program Year)
Glenn-Colusa Irrigation District	39,511
Reclamation District No. 108	11,111
Sutter Mutual Water Company	10,824
Anderson-Cottonwood Irrigation	5,987
Natomas Central Mutual Water	5,757
Reclamation District No. 1004	3,419
Princeton-Codora-Glenn Irrigation	3,248
Provident Irrigation District	2,621
Conaway Preservation Group, LLC	1,957
Meridian Farms Water Company	1,676
Sycamore Family Trust	1,523
RRG Garden Properties, LLC	1,427
Pleasant Grove Verona Mutual Water	1,259
City of Redding	1,006
Maxwell Irrigation District	861
M&T Chico Ranch	860
Pelger Road 1700	482
Woodland-Davis	479
Other	5,992
Total	100,000

2.1.2 Water Reduction Activities

2.1.2.1 Cropland Idling

Cropland idling occurs when water that would have been used for agricultural production is forgone. Under the Proposed Action, the SRSC would receive less water supply from Reclamation and then would go through the process of allocating that water supply to landowners and lands within their respective service areas. Cropland idling could occur as a result of receiving less supply since the SRSC would need to balance water supply and crop demand. Cropland idling would be temporary in nature and would not result in a permanent conversion of agricultural lands. Landowners would likely place fields back into production the following season.

The acreage of cropland idling would be calculated based on water application to crops which consists of both consumptive and non-consumptive uses. For rice in the Sacramento Valley, consumptive uses have ranged from 3.0–3.3 acre-feet per acre. Additionally, non- consumptive

components of irrigation water are also needed which may consist of irrigation delivery inefficiencies, soil types that effect groundwater recharge when water passes below the crop root zone, shallow groundwater moving laterally into non irrigated fields, uncapturable return flows, and other crop cultural practices. These components may require another additional 3.0–4.0 acre-feet per acre generally that is additive to the consumptive use component which results in a total water application factor of about 6.0–7.0 acre-feet per acre.

Additionally, there are SRSC canal conveyance losses which occur regardless of the amount of water supply; as water supply is reduced the conveyance loss becomes a larger percentage that must be deducted from the available water supply, with ranges from five to thirty percent of the water delivered from the SRSC points of diversion to landowner lands. Those conveyance losses will reduce the water available for cropping. Applying a range of 6.0 to 7.0 acre-feet per acre water application factor across the SRSC service area to the maximum 500,000 AF of Phase 1 Program Year and the maximum 100,000 AF of Phase 2 Program Year of reductions in diversions results in a maximum of 71,429 to 83,333 acres and 14,285 to 16,667 acres of rice acreage anticipated to be idled as a result of the Proposed Action, as shown in Table 2-3 and 2- 4, respectively.

Table 2-3. Maximum Annual Cropland Idling Acreages within Sacramento River Settlement Contractor Service Area Resulting from Phase 1

Phase	Sacramento River Settlement Contractor Max Reduction Volume (AF)	Assumed Water Application Factor (acre-feet/acre)	Maximum Annual Idling Acreages for Rice
Phase 1	500,000	6.0–7.0	71,429–83,333

Table 2-4. Maximum Annual Cropland Idling Acreages within Sacramento River Settlement Contractor Service Area Resulting from Phase 2

Phase	Sacramento River Settlement Contractor Max Reduction Volume (AF)	Assumed Water Application Factor (acre-feet/acre)	Maximum Annual Idling Acreages for Rice
Phase 2	100,000	6.0–7.0	14,285–16,667

2.1.2.2 Crop Shifting

For crop shifting, water is made available when farmers shift from growing a higher water use crop to a lower water use crop. The difference in evapotranspiration of applied water values would be the amount of water that is reduced. Water generated by crop shifting is difficult to account for. Farmers generally rotate among several crops to maintain soil quality, so water agencies may not know what type of crop would have been planted in a given year. To calculate water reduced from crop shifting, an estimate of what would have happened absent water reductions based on average water use during a 5-year baseline period would be made. The change in consumptive use between this baseline estimate and the lower water use crop determines the amount of acreage shifted to generate diversion reductions.

2.1.2.3 Groundwater Substitution

Groundwater substitution occurs when groundwater is pumped in lieu of diverting surface water supplies, thereby making the surface water available for other uses. Program participants that reduce surface water deliveries through groundwater substitution may choose to pump groundwater in lieu of or in addition to cropland idling/shifting. The maximum crop idling/shifting rice acreage described above may be reduced through groundwater substitution by the SRSC as part of the Program.

2.1.2.4 Water Conservation

Water conservation includes actions to reduce the diversion of surface water by improving water conservation and irrigation efficiencies. Water conservation actions will be based on an effective water conservation and efficiency program based on the Regional Water Management Plan and/or individual Contractor's water conservation plan as required under the applicable Contractors contract. For Contractors diverting less than 2,000 AF of project water, a written water conservation plan is not required, and water conservation actions would be based on state and local policies governing such actions.

2.1.3 Framework Programmatic Outline for Drought Resiliency Projects

The Program is a mixed programmatic action that requires a mix of standard consultation and programmatic consultation, as defined in 50 CFR 402.02 where a "[m]ixed programmatic action means, for purposes of an incidental take statement, a Federal action that approves action(s) that will not be subject to further section 7 consultation, and also approves a framework for the development of future action(s) that are authorized, funded, or carried out at a later time and any take of a listed species would not occur unless and until those future action(s) are authorized, funded, or carried out and subject to further section 7 consultation." This Proposed Action includes a framework programmatic action for the development of future drought resiliency actions that are anticipated to occur as a result of execution of the Contract. The use of a mixed programmatic framework consultation for these projects provides information, to the extent possible, on how these projects would be implemented, if approved after completing compliance with NEPA and CEQA.

For the drought resiliency projects which are defined as programmatic, this PA provides a framework for future site-specific actions that will be authorized, funded, or carried out at a later

time and that will be subject to section 7 consultations, as applicable. In the future, Reclamation proposes to initiate section 7 consultation for the drought resiliency projects, as required. Reclamation may initiate these future consultations and will provide sufficient information as outlined in 50 CFR 402.12(t) and as required. Conservation measures are included to avoid, minimize and offset any potential adverse effects of the proposed operations to listed species and critical habitat. In order to ensure effects of the drought resiliency projects are sufficiently addressed, those separate section 7 consultations, as necessary, will reference this framework when addressing effects.

Project descriptions for the proposed drought resiliency projects are provided below and are proposed to be addressed programmatically.

2.1.3.2 Qualitative Project Descriptions

Qualitative descriptions of the proposed projects and potential effects for the drought resiliency projects are included in this framework. Potential for effects are addressed at a programmatic level.

Drought-resiliency projects are a broad range of actions intended to strengthen the resilience of the SRSC's water system and long-term water delivery capabilities. The resiliency projects will assist Reclamation and the SRSC with withstanding and recovering from climatic variability in order to support healthy rivers and landscapes (including but not limited to terrestrial ecosystems) and create durable water savings while sustaining a more drought-resilient economy that retains its vitality. Drought-resiliency projects are expected to be constructed and implemented during Phase 1, but it is possible some may still be constructed in Phase 2. It is anticipated that with the implementation of drought resiliency projects, the need for the water reduction activities described in Section 2.1.2 may be reduced over time.

Sections 2.3.1.2.1 to 2.3.1.2.9 provide details on proposed drought-resiliency projects expected to be implemented as part of the Water Reduction Program. Because these projects are in the very early stages of planning, they remain speculative regarding design, scope, and locations.

2.3.1.2.1 Piping Open Ditches or Canals Open ditches or canals are artificial waterways that are used to transport water from a water source for a variety of purposes, including agriculture uses. Open ditches or canals were typically constructed by excavating sloped, linear features or building embankments to contain and transport the water, without the use of a cover. Some of these ditches and canals are made of earth, whereas others are made of concrete with varying levels of permeability. Piping open ditches or canals uses a series of interconnected pipes, valves, and pumps to convey water in an enclosed manner between the water source and the ultimate use. Piping offers numerous advantages for water conservation efforts. In comparison to open ditches or canals, piping allows for precise control and distribution of water, minimizing loss and ensuring optimal usage. Using pipelines instead of open ditches or canals reduces evaporation, and if maintained it can reduce leakages and seepages. Closed pipelines also protect water from external contaminants, which ensures better water quality. Compared to open channels, pipelines require less maintenance and have a longer lifespan.

2.3.1.2.2 Canal Lining Although piping canals is the most efficient option in terms of water savings, it may not be available for all canals based on length or other environmental considerations. In such cases, canal lining and modernization can also provide for water savings. Canal lining is the process of reducing seepage loss of irrigation water by adding an impermeable layer to the trench. Seepage can result in losses of irrigation water from canals, so adding lining can make irrigation systems more efficient. Existing canals can benefit even more than new structures from being lined. Although a new bare soil canal will work properly for some amount of time before it begins to erode or collapse, older canals are already well into the cycle of damage caused by erosion. There would be two ways of lining existing canals: 1) canals that are composed of bare soil can be lined with a material such as geomembrane or concrete; and 2) for canals that are already made of geomembranes or concrete, a sealant such as resin or spray-on polymer can be applied to fix cracks that are resulting in seepage. Additionally, existing canals already lined with concrete could be relined with new geomembranes or new concrete.

2.3.1.2.3 Canal Automation through Supervisory Control and Data Acquisition Systems Automation plays a crucial role in the management of irrigation canal networks to improve efficiency and optimize water use. Supervisory Control and Data and Acquisition (SCADA) systems are focused on the supervision and acquisition of real-time data from a network of irrigation canals. These systems allow centralized monitoring and control of devices and sensors in the network, such as gates, valves, and flow meters. The collected data are used to visualize network status, detect anomalies, and facilitate decision-making based on real-time information.

All SCADA systems have the following components at a minimum: a sensor; some type of on-site apparatus that creates and electrical signal that can be transmitted; a local power supply to power the sensor and transmission unit; some type of communication system, such as hard wire, radio, satellite, or phone; a receiving unit on the other end of the communication system; and a mechanism to display the information, such as an alarm bell or computer screen (Burt and Piao 2005). As mentioned, SCADA systems may require electrical connections to power sensors and transmission units, which may require some excavation, grading, and fill if electrical lines are buried. Besides these requirements and the actual SCADA system itself, SCADA systems would not result in any other construction or operational changes.

2.3.1.2.4 Automated Gates Installation Some contractors would likely install automated canal gates, such as Rubicon or Langemann gates, for more efficient, reliable, and accurate canal and ditch operations and water deliveries. In some instances, automated gates may be paired with SCADA systems, which would be expected to result in additional water distribution efficiency improvements.

2.3.1.2.5 On-Farm Improvements to Irrigation Systems This drought-resiliency project involves converting certain types of on-farm irrigation systems and methods to more efficient irrigation systems and methods. As an example, flood/row irrigation is about 50% efficient, where a sprinkler-based system can be 75% efficient. Similarly, a properly installed drip or subsurface irrigation system, which applies water directly to crop root zones using buried drip lines or drip tape can also be typically more efficient than other irrigation systems. Since drip tubing is placed in the soil between each crop row, this system only wets a small portion of the

soil. Small and controlled amounts of water help avoid water logging. Another improvement to irrigation systems including installing Variable Frequency Drives (VFDs). VFDs can be used to gradually ramp an irrigation pump motor to meet actual flow and pressure demands of the system, which can result in water savings.

The steps taken to implement on-farm improvements are dependent on the existing irrigation method and the proposed method. Construction would likely occur during the non-irrigation season to minimize the amount of time fields would be out-of-service.

2.3.1.2.6 Weirs or Check Structures Weirs or check structures, are small dams that obstruct ditches, drains, or canals to collect water runoff from agricultural fields. By slowing down runoff, weirs and check structures help conserve existing water resources by adding capacity to canals and make water available for reuse. Weirs are often the size of a drainage ditch, with a channel in the center for water drainage.

2.3.1.2.7 Pipeline Recirculation Projects Pipeline recirculation programs allow water to be used as efficiently as possible by recirculating it back to fields for irrigation purposes. The system consists of ditches for collecting runoff, a flow pump and power unit (either an electric motor or a diesel engine), and a pipeline to transport water to for reapplication to a field.

2.3.1.2.8 New Groundwater or Deep Aquifer Wells To add to their water supply, some SRSCs would construct new groundwater wells as part of the proposed project. A maximum of 30 new wells are assumed to be constructed as part of the Proposed Action and would all comply with the minimum construction standards in California set under California Department of Water Resources (DWR) Bulletin 74 and Executive Order N- 3-23, Paragraph 4.

DWR Bulletin 74 sets the minimum standards for water, monitoring, cathodic protection, and geothermal heat exchange wells, with the purpose of protecting California's groundwater quality. Coordination with the local applicable Groundwater Sustainable Agency would also occur to ensure that the well locations and related construction activities would not be inconsistent with the targets set by Groundwater Sustainability Plans under the Sustainable Groundwater Management Act and Executive Order N-3-23, Paragraph 4.

A new well consists of a bottom sump, well screen, and well casing surrounded by a gravel pack and appropriate surface and borehole seals. Water enters the well through perforations or openings in the well screen and is pumped to the surface with a motor that is typically located at the surface.

2.3.1.2.9 Conjunctive Use Program Conjunctive management is the coordinated operation of surface water, groundwater storage and use, and conveyance facilities to meet water management objectives. Although surface water and groundwater are sometimes considered to be separate resources, they are connected by the hydrologic cycle. Conjunctive management allows surface water and groundwater to be managed in an efficient manner by taking advantage of surface water supplies when they are available and groundwater supplies when surface water is less available. For example, this could mean that surface water gets diverted by

SRSCs in non-program years while groundwater is recharging, and then SRSCs and/or their landowners would pump groundwater in program years.

2.2 Giant Garter Snake Conservation Measures

2.2.1 Water Reduction Activities

- At the start of the irrigation season, when a Program Year is identified, the SRSC will provide a schedule of water diversions, including reductions under the Program, and coordinate on alternatives that may reduce impacts to the giant garter snake.
- Movement corridors for aquatic species (including giant garter snake) include major irrigation and drainage canals. Maintaining water in smaller drains and conveyance infrastructure supports key habitat attributes such as emergent vegetation for giant gartersnake escape cover and foraging habitat. SRSC will keep adequate water in major irrigation and drainage canals and smaller drains and conveyance structures where possible given water conditions in a Program Year. When possible, at least two feet of water will be considered sufficient.
- When a Program Year occurs, an annual meeting will be established to review the actions taken to implement the Program and to discuss incidental take reporting including occurrences of incidental take of GGS. These meetings will be scheduled prior to February 28 of the following year.
- Reclamation will ensure monitoring of the GGS distribution and occupancy research under the separate long-term water transfer program does not lapse. The research, conducted by USGS, includes annual sampling of GGS within the action area and focuses on their distribution and occupancy dynamics. The research is designed to evaluate the effectiveness of the conservation measures occupancy at sites forgoing water. The research is ongoing since 2015 and is expected to aid in maintaining effective conservation measures for actions that may impact GGS, including the Proposed Action, and identifying changes that may enhance their effectiveness in the future.

2.2.2 Framework Programmatic Drought Resiliency Projects

- **Erosion Control Plan.** Prior to implementing a project element that involves grading, vegetation removal, or other form of construction in irrigation and drainage canals or upland areas outside of established agricultural croplands with a history of discing, planting, and maintenance, an erosion control plan including erosion best management practices will be created and implemented prior to the wet season (November 1 through April 1) to avoid sediment from entering watercourses or aquatic habitat. To minimize the risk of sedimentation, surface disturbance will be limited to only those areas necessary for construction. Where natural topsoil occurs, it will be salvaged and stockpiled prior to construction and the soil stockpiles will be stabilized. Erosion control measures will include but not be limited to the use of straw bales, mulch or wattles, silt fences, and filter fabric.

- **Conduct Desktop GGS Habitat Evaluation.** Prior to implementing a project element that involves grading, vegetation removal, or other form of construction in irrigation and drainage canals or upland areas outside of established agricultural croplands with a history of discing, planting, and maintenance, a qualified biologist will conduct a desktop evaluation of the site using digital web-based aerial photography. The purpose of the desktop evaluation will be to determine the potential for GGS habitat to occur on site. A qualified biologist will also perform a review of the USFWS IPaC and CNDDB databases to identify known records or potential for GGS to occur in the project vicinity. If through this assessment, the biologist determines that potential habitat for GGS exists, then site-specific surveys will be conducted per the measures below.
- **Implement GGS Avoidance Measures.** If the need for a site survey is identified and the initial assessment indicates that that the project site provides habitat for GGS, avoidance measures must be implemented to avoid GGS during construction. Construction activities within GGS habitat will be restricted to between May 1 and October 1. If work must be conducted within GGS habitat between October 2 and April 30, two GGS pre-construction surveys will be conducted in any area within 200 feet of GGS aquatic habitat by a qualified biologist. The first survey will occur within 15 days prior to onset of construction and the second will occur within 24 hours prior to the onset of construction. The information collected from the first pre-construction survey will serve primarily to alert the biologist and construction crews of the general level of GGS activity at the site and borrow area, and the second survey will serve to minimize potential for take of GGS. If GGS is found in the project area, then to avoid direct impacts on GGS, the following measures will be implemented:
    - Temporary fencing will be installed to exclude GGS from the work area. The design of the fence will be approved by the California Department of Fish and Wildlife (CDFW) and USFWS prior to installation.
    - Fence installation will be supervised by a qualified biologist.
    - The qualified biologist will provide the contractor with worker environmental awareness training, including instructing the contractor on how to inspect the exclusion fence.
    - Prior to the initiation of work each day, the contractor will inspect the exclusion fence to ensure it is functional for the intended purpose.
    - If GGS is observed within the temporary fencing around the construction site, the contractor will stop work and allow the species to leave the site of its own volition or the snake will be captured by a qualified biologist with appropriate collecting/handling permits and relocated to the nearest suitable habitat beyond the influence of the project work area "Take" of a state or federal special status species is prohibited without appropriate permits from the USFWS and CDFW.
    - Construction-related vehicles and equipment will not exceed a 15 mile-per-hour speed limit at the construction site, staging areas, or on unpaved roads.

- Vegetation clearing will be limited to only those areas necessary for construction.
- Any excavated and stockpiled soils will be placed outside of designated GGS habitat.
- Temporarily disturbed areas will be restored when construction is complete. Pre- and post-construction photographic documentation of the project site will be collected to document conditions.
- All equipment will be removed from the project site following completion of construction.

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3 Potentially Affected Species

3.1 Giant Garter Snake

3.1.1 Status of the Species

The USFWS published a proposal to list the giant garter snake (Thamnophis gigas; see Figure 3-1) as an endangered species on December 27, 1991 (56 FR 67046). Critical habitat has not been designated for this species. USFWS reevaluated the status of the snake before adopting the final listing rule, and it was listed as a threatened species on October 20, 1993 (58 FR 54053). A Draft Recovery Plan was proposed for the snake on July 2, 1999 (Service 1999) and revised in 2015 (USFWS 2015). A 5-year review was conducted in 2006 where no change of status was recommended (USFWS 2006). An additional 5-year review was conducted in 2012 where no change of status was recommended (Service 2012). In 2017, USFWS issued the final Recovery Plan for the Giant Garter Snake (Recovery Plan). Please refer to the 2017 Recovery Plan for the species' description, habitat preference, and life history (USFWS 2017).

Figure 3-1. A giant garter snake (*Thamnophis gigas*) curled up in dry grass in Oregon, periscoping its head (U.S. Geological Survey/Marcus Rehrman)

3.1.2 Threats

3.1.2.1 Habitat Loss

Historical records suggest that the giant garter snake inhabited freshwater marshes, streams, and wetlands along with their adjacent associated upland habitats throughout the length of the Sacramento and San Joaquin valleys in Central California. Today only about five percent of its historical wetland/upland habitat acreage remains. Nine populations are recognized in the Recovery Plan following an update of the thirteen populations described in the original listing. This change is based on recent surveys, which indicate that two populations were extirpated, and on genetic research, which led to the grouping together of some of the previously described populations.

The loss and subsequent fragmentation of habitat is the primary threat to the giant garter snake throughout the Central Valley of California. Habitat loss has occurred from urban expansion, agricultural conversion, and flood control. Habitat fragmentation has ultimately resulted in the snake being extirpated from the southern one-third of its range in the San Joaquin Valley.

3.1.2.2 Other Threats

In addition to large landscape level habitat conversion, the Sacramento/San Joaquin Delta populations of giant garter snake are subject to a number of other existing and potential threats which include roads and vehicular traffic, climate change, and predation by non-native species. The recovery strategy is primarily focused on protecting existing, occupied habitat and identifying and protecting areas for habitat restoration, enhancement, or creation including areas that are needed to provide connectivity between populations. This strategy ultimately supports the recovery goal of establishing and protecting self-sustaining populations of giant garter snakes throughout the full ecological, geographical, and genetic range of the species.

Climate change has been linked to increases in the frequency and intensity of weather events, such as heat waves, droughts, and storms (Lenihan et al. 2003; California Environmental Protection Agency 2006; IPCC 2007). Extreme events, in turn may cause mass mortality of individuals (by affecting habitat or ecosystem characteristics, for example) and significantly contribute to determining which species will remain or occur in natural habitats (Whitfield et al. 2007). As California's average temperature and precipitation change, species ranges tied to climate dependent habitats are moving northward and upward, but in the future, range contractions are more likely than simple northward or upslope shifts (Loarie et al. 2008, 2009). Research has already revealed correlations between climate warming and declines in amphibians and reptiles in different parts of the world (Whitfield et al. 2007; McMenamin et al. 2008; Mitchell et al. 2008; Huey et al. 2010).

3.1.2.3 Habitat Requirements

There are three habitat components that appear to be most important to the giant garter snake (G. Hansen 1982, 1986, 1988; Wylie et al. 1996, 1997; Halstead et al. 2010). A freshwater aquatic component with protective emergent vegetative cover that will allow foraging, an upland component near the aquatic habitat that can be used for thermoregulation and for summer

shelter in burrows, and an upland refugia component that will serve as winter hibernacula. Further detailed descriptions of these habitat components can be found in the 2017 Recovery Plan.

The giant garter snake is considered a semi-aquatic species and due to its habitat preferences, giant garter snake is subject to the detrimental effects of floods and drought. This susceptibility is likely to be exacerbated with the increase in frequency and intensity of flood and drought events due to climate change. Giant garter snakes may be displaced during a flood, buried by debris, exposed to predators, and subject to drowning when burrows and over-wintering sites become inundated with water. Giant garter snakes are not known to occupy the area within the Sutter Bypass which is flooded regularly (Wylie et al. 2005); although snakes are known to occupy the Yolo Bypass during the active season when flooding is unlikely (E. Hansen 2009). Snakes appear to survive at least some inundation of their burrows. Wylie observed snakes emerging from burrows after a period of inundation (G. Wylie pers comm. 2016).

Because of the giant garter snake's dependence upon permanent wetlands, water availability will play a significant role in its survival and recovery. In a state where much of the wetland habitat is maintained by managed water regimes, the lack of sufficient water supply may preclude consistent and timely delivery of water to sustain suitable habitat for giant garter snake. Drought conditions place additional strains on the water allocation system. Where populations currently persist on only marginal habitat, emergent drought or higher temperature conditions are likely to result in high rates of mortality and low fecundity and survivorship persisting after the drought has ceased (McMenamin et al. 2008; Mitchell et al. 2008). It is unknown how quickly giant garter snake populations may rebound after severe climatic conditions, particularly since these conditions might further exacerbate the impact from existing threats to giant garter snake, such as habitat loss and fragmentation, and small, isolated populations. Giant garter snake as a species has survived recorded historic droughts, but presumably under conditions where fewer cumulative threats existed.

Nearly all of the research on movement for the giant garter snake has been conducted on individuals in the Sacramento Valley; however, the geography in the Sacramento/San Joaquin Delta is comparably different to the Sacramento Valley due to the island structure of the Delta. These islands are surrounded by numerous large water bodies, large tributaries and experiences a significant tidal influence from the San Pablo and San Francisco Bays. Giant garter snakes have been found on the various islands in the Delta and utilization and/or the frequency to which they use the large rivers and open tributaries surrounding these islands for dispersal is currently unknown. Giant garter snakes are apparently capable of long-distance movements, although less movement is observed when water is maintained on-site through the summer that supports their habitat (Wylie et al. 2002a, b).

Movement statistics of giant garter snakes vary greatly, and it is likely that their movement is different due to the geographical difference of the Delta to the Sacramento Valley. Based on the research conducted in the Sacramento Valley, Hansen (1986) reported that individuals move less than 100 ft (30.5 m) during the spring in favored habitat. At the Colusa Drain, distances between captures of individuals ranged from 0.7 to 3.3 km (Wylie 2003). Using radio telemetry at the

same location in 2006, individual mean movement distance was 63 m/day (range of 3–173 m/day), with a corresponding individual movement rate of 104 m/day (range of 12–287 m) during the "active season" (Wylie and Amarello 2006). Mean maximum individual movement distance was 862 m (range of 34–2,791 m), and total movement over the time radio-tracked averaged 4,761 m (range of 107–16,995 m) (Wylie and Amarello 2006). Active-season minimum total distance moved at the same site in 2004 ranged from 0.7 to 215 km (Wylie and Martin 2004).

3.1.3 Important Snake Populations

Important GGS populations, as defined in this document, have been previously identified by biologists from USFWS, USGS, and possibly contract biologists. These populations of GGS were identified as occurring in, or being connected to, areas that are considered public or protected (Figure 3-2). Additionally, most of these areas have specific management plans for GGS either for mitigation or as wildlife refuges. One factor influencing the importance of these areas is that they can provide a refuge for GGS independent of rice production. Connectivity between these snake populations is equally important. (B. Halstead pers comm. 2018, C. Goude pers. Comm. 2014). The following areas are considered important GGS populations:

- Little Butte Creek between Llano Seco and Upper Butte Basin Wildlife Area
- Butte Creek between Upper Butte Basin and Gray Lodge Wildlife areas
- Colusa Basin drainage canal between Delevan and Colusa National Wildlife Refuges
- Gilsizer Slough
- Colusa Drainage Canal
- the land side of the Toe Drain along the Sutter Bypass
- Willow Slough and Willow Slough Bypass in Yolo County
- Hunters and Logan Creeks between Sacramento and Delevan National Wildlife Refuges
- Lands in the Natomas Basin

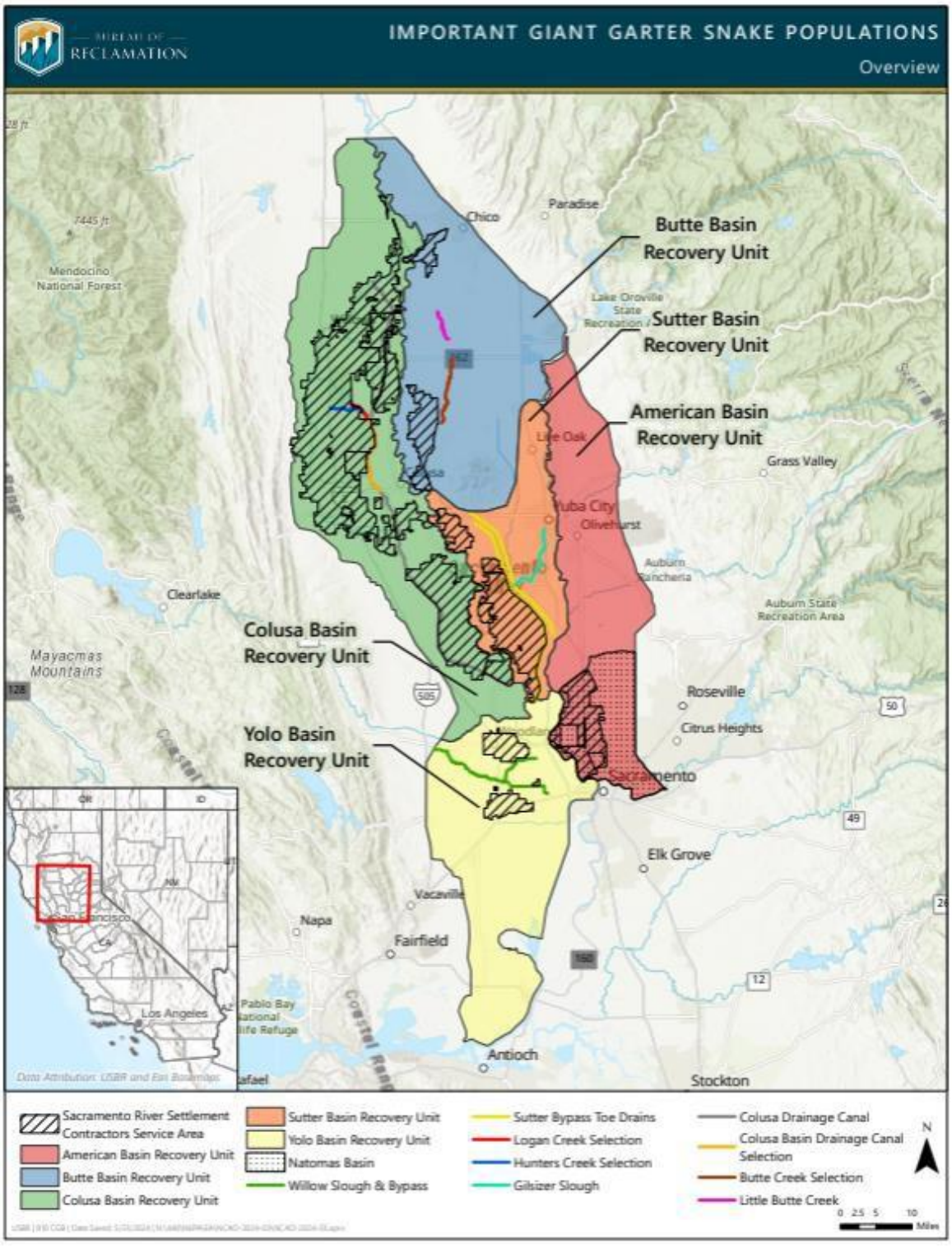

Figure 3-2. Recovery Units with Important Giant Garter Snake Populations overlayed with Sacramento River Settlement Contractor Service Area

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4 Environmental Baseline

4.1 Giant Garter Snake

In 2017, the Service finalized the Recovery Plan for the GGS. A total of nine Recovery Units are identified in the Recovery Plan. The nine Recovery Units are: Butte Basin, Colusa Basin, Sutter Basin, American Basin, Yolo Basin, Cosumnes-Mokelumne Basin, Delta Basin, San Joaquin Basin, and the Tulare Basin. The action area for the proposed project includes of the nine Recovery Units where the components of the Proposed Action will occur. These Recovery Units are described below:

1. Butte Basin Recovery Unit: The Butte Basin Recovery Unit encompasses the entire Butte Basin, extending from Red Bluff in the north to the Sutter Buttes in the south (Figure 3-1, Appendix A). The Butte Basin consists of 479,118 acres, including portions of Tehama, Butte, Sutter, and Colusa counties. Three management units have been defined for the Butte Basin Recovery Unit: Llano Seco, Upper Butte Basin, and Gray Lodge/Butte Sink. According to the California Natural Diversity Database (CNDDB), there are 28 known occurrences of the snake within the Butte Basin Recovery Unit (CNDDB 2018). The majority of these occurrences are located in the Upper Butte Basin Wildlife Area and the Gray Lodge Wildlife Area. In addition, within the Butte Basin Recovery Unit, there are two important snake populations that occur within this unit (portions of Little Butte Creek, Butte Creek) (Appendix 3-1).

    a. Two contractors are anticipated to implement crop idling/shifting of rice acreages under the Program within the Butte Basin Recovery Unit (Reclamation District No. 1004 and M&T Ranch). The area of the two districts in the Butte Basin Recovery Unit consists of 30,991 of the 479,118 acres. Of the 30,991 acres, 11.5 percent and 4.1 percent under Phase 1 and Phase 2, respectively would implement crop idling/shifting. Additionally, of the entire Recovery Unit only 0.7 percent under Phase 1 and 0.3 percent under Phase 2, would be idled/shifted under the Program (Table 4-1 and 4-2).

2. Colusa Basin Recovery Unit: The Colusa Basin extends from Red Bluff in the north to Cache Creek in the south (Figure 3-1, Appendix A). Its watershed is dominated by the Sacramento River. The Colusa Basin consists of 686,096 acres, including portions of the counties of Tehama, Glenn, Colusa, and Yolo. Three management units have been defined for the Colusa Basin Recovery Unit: Willows, Delevan and Colusa. There are 33 known occurrences of the snake that occur within the Colusa Basin Recovery Unit (CNDDB 2018). Within the Colusa Basin Recovery Unit there

are 4 important snake populations (portions of Colusa Drainage Canal, Logan Creek, Hunters Creek, and the Colusa Basin Drainage Canal) (Appendix 3-2).

   a. Eight contractors are anticipated to implement crop idling/shifting of rice acreages under the Program within the Colusa Basin Recovery Unit (Glenn-Colusa Irrigation District, Maxwell Irrigation District, Princeton-Codora Irrigation District, Provident Irrigation District, Reclamation District No. 108. M&T Chico Ranch, River Garden Farms Company, and Sycamore Family Trust). The area of the eight districts in the Colusa Basin Recovery Unit consists of 286,731 of the 686,096 acres. Of the 286,731 acres, 17.5 percent and 3.5 percent under Phase 1 and Phase 2, respectively would implement crop idling/shifting. Additionally, of the entire Recovery Unit only 7.3 percent under Phase 1 and 1.5 percent under Phase 2, would be idled/shifted under the Program (Table 4-1 and 4-2).

3. Sutter Basin Recovery Unit: The Sutter Basin extends south from the Sutter Buttes to the confluence of the Feather and Sacramento rivers (Figure 3-1, Appendix A). The Sutter Basin consists of 239,810 acres, including portions of Butte and Sutter counties. Three management units have been defined for the Sutter Basin Recovery Unit: Sutter, Gilsizer Slough, and Robbins. According to the CNDDB, there are 20 known occurrences in the Sutter Basin Recovery Unit with most of the known occurrences (9), located within the Robbins Management Unit (CNDDB 2018). Two important snake populations (portions of Willow Slough and Bypass, Sutter Bypass Toe Drain) are located within the Sutter Basin Recovery Unit (Appendix 3-3).

   a. Four contractors are anticipated to implement crop idling/shifting of rice acreages under the Program within the Sutter Basin Recovery Unit (Sutter Mutual Water Company, Meridian Farms Water Company, Pelger Road 1700, and RRG Garden Properties). The area of the four districts in the Butte Basin Recovery Unit consists of 64,574 of the 239,810 acres. Of the 64,574 acres, 16.8 percent and 3.4 percent under Phase 1 and Phase 2, respectively would implement crop idling/shifting. Additionally, of the entire Recovery Unit only 4.5 percent under Phase 1 and 0.9 percent under Phase 2, would be idled/shifted under the Program (Table 4-1 and 4-2).

4. American Basin Recovery Unit: The American Basin extends south from Folsom Reservoir to the confluence of the Sacramento and American rivers (Figure 3-1, Appendix A). The Basin is about 376,104 acres, including portions of Butte, Yuba, Sutter, Placer, and Sacramento counties. Four management units have been defined for the American Basin Recovery Unit: District 10, Olivehurst, Nicolaus, and Natomas Basin. The American Basin Recovery Unit contains the most known occurrences of the snake with 73 occurrences. The majority of these occurrences are located in the Natomas Basin (CNDDB 2018). The entire Natomas Basin is identified as an important snake population (Appendix 3-4).

a. Two contractors are anticipated to implement crop idling/shifting of rice acreages under the Program within the American Basin Recovery Unit (Natomas Central Mutual Water Company and Pleasant Grove-Verona Mutual Water Company). The area of the two districts in the American Basin Recovery Unit consists of 44,589 of the 376,104 acres. Of the 44,589 acres, 13.1 percent and 2.6 percent under Phase 1 and Phase 2, respectively would implement crop idling/shifting. Additionally, of the entire Recovery Unit only 1.6 percent under Phase 1 and 0.3 percent under Phase 2, would be idled/shifted under the Program (Table 4-1 and 4-2).

5. Yolo Basin Recovery Unit: The Yolo Basin extends from Cache Creek in the north to the Sacramento-San Joaquin River Delta in the south (Figure 3-1, Appendix A). The Yolo Basin includes portions of Yolo and Solano counties and is approximately 410,914 acres. Three management units have been defined for the Yolo Basin Recovery Unit: Ridgecut Slough, Willow Slough, and Yolo Bypass. There are 31 known occurrences within the Yolo Basin Recovery Unit, with 23 of the 31 known occurrences located in the Ridgecut Slough Management Unit (CNDDB 2018). Gilsizer Slough is the only important snake population in the entire unit (Appendix 3-5).

    a. Three contractors are anticipated to implement crop idling/shifting of rice acreages under the Program within the Butte Basin Recovery Unit (Conaway Preservation Group, LLC, Woodland-Davis Clean Water Agency, and Natomas Central Mutual Water Company). The area of the two districts in the Yolo Basin Recovery Unit consists of 42,671 of the 410,914 acres. Of the 42,761 acres, 4.7 percent and 0.9 percent under Phase 1 and Phase 2, respectively would implement crop idling/shifting. Additionally, of the entire Recovery Unit only 0.5 percent under Phase 1 and 0.1 percent under Phase 2, would be idled/shifted under the Program (Table 4-1 and 4-2).

There are 29,964 AF under Phase 1 and 5,993 AF in Phase 2 of approximate maximum water reduction categorized as "Other" (Table 2-1 and 2-2) which would be anticipated to result in 4,994 acres and 998 acres, respectively, that would likely implement crop idling/shifting. The "Other" amounts are not assigned to a specific District and could be implemented anywhere within the SRSC Service Area.

Table 4-1. Crop idling and Crop shifting within Recovery Units – Phase 1

Recovery Unit	Recovery Unit Total Acreage	Reduction Acreage of Rice	Reduction Acreage % of Recovery Unit
American Basin	376,104	5,846	1.6
Butte Basin	479,118	3,558	0.7
Colusa Basin	686,096	50,246	7.3

Recovery Unit	Recovery Unit Total Acreage	Reduction Acreage of Rice	Reduction Acreage % of Recovery Unit
Sutter Basin	239,927	10,834	4.5
Yolo Basin	410,915	2,030	0.5

Table 4-2. Crop idling and Crop shifting within Recovery Units – Phase 2

Recovery Unit	Recovery Unit Total Acreage	Reduction Acreage of Rice	Reduction Acreage % of Recovery Unit
American Basin	376,104	1,169	0.3
Butte Basin	479,118	3,558	0.7
Colusa Basin	686,096	10,057	1.5
Sutter Basin	239,927	2,167	0.9
Yolo Basin	410,915	406	0.1

4.2 Rice Production

The Sacramento Valley, primarily north and west of the city of Sacramento, is dominated by agricultural land. The average area of rice production in the Sacramento Valley from 1992 through 2022 was about 477,000 acres (Table 4-1; table updated by County annual crop report except for Colusa County from 1992–1998 where the numbers were carried forward from Table 10 of the 2019 U.S. Fish and Wildlife Service Biological Opinion on Long-Term Water Transfers 2019–2024). Total rice acreage varies based on economic conditions and farming practices. Crop rotation and fallowing are a standard rice farming practice that can reduce disease and improve soil and water quality. Since 1992, the acreage of planted rice in the Sacramento Valley has varied from a low of approximately 226,500 acres in 2022, to a high of over 617,000 acres in 2004.

The maximum annual decline of rice acreage was approximately 152,000 acres in 2022 (Table 4-3), but this was during ongoing critically dry hydrologic conditions. Rice acreage in most counties has increased since 1992, with the largest average increase being approximately 35,000 acres in Colusa County while there have been no declines in the average acreage of rice production from the 1992 levels in any County.

Table 4-3. Estimated Sacramento Valley Rice Production (acres) from 1992-2022 by County

Year	Butte	Colusa	Glenn	Sacramento	Sutter	Yolo	Yuba	Total	Total Annual Change
1992	78,700	94,800	78,700	920	73,780	21,680	33,797	382,377	--
1993	84,813	112,000	84,813	1,100	79,896	21,909	34,019	418,550	36,173
1994	95,100	123,000	95,100	1,300	102,589	20,917	35,800	473,806	55,256
1995	86,400	122,000	86,400	1,300	105,482	25,012	34,967	461,561	-12,245
1996	98,200	136,000	98,200	2,400	93,164	25,999	35,880	489,843	28,282
1997	98,500	137,000	98,500	9,400	90,437	25,800	36,509	496,146	6,303
1998	96,000	121,000	96,000	9,100	94,442	17,816	36,000	470,358	-25,788
1999	96,500	140,920	96,500	9,861	100,087	24,483	36,050	504,401	34,043
2000	98,000	147,270	98,000	7,606	107,704	36,229	36,620	531,429	27,028
2001	86,000	111,250	86,000	7,110	81,857	28,717	35,823	436,757	-94,672
2002	94,700	134,300	94,700	8,831	96,224	32,446	35,461	496,662	59,905
2003	92,500	127,350	92,500	10,768	93,654	37,303	35,580	489,655	-7,007
2004	150,000	150,130	105,000	9,851	121,131	45,655	35,256	617,023	127,368
2005	96,400	136,400	96,400	8,155	97,801	34,670	35,005	504,831	-112,192
2006	105,673	142,600	105,673	3,166	92,984	29,997	35,387	515,480	10,649
2007	101,634	148,550	101,634	2,935	108,241	32,660	35,984	531,638	16,158
2008	105,301	150,200	77,770	2,488	92,344	30,057	35,294	493,454	-38,184
2009	103,416	152,400	89,483	3,120	109,766	36,593	36,830	531,608	38,154
2010	93,800	154,000	88,209	4,184	115,449	41,372	38,600	535,614	4,006
2011	95,043	149,460	84,932	3,478	111,741	42,476	38,000	525,130	-10,484
2012	94,451	149,860	84,760	5,899	11,550	40,461	37,600	424,581	-100,549
2013	98,445	148,515	85,253	8,363	115,949	38,432	39,167	534,124	109,543
2014	77,800	111,113	73,318	8,589	75,903	39,325	38,988	425,036	-109,088
2015	87,700	100,475	68,400	8,260	88,591	23,000	38,967	415,393	-9,643
2016	95,045	135,355	77,400	8,840	113,084	25,800	37,924	493,448	78,055
2017	93,444	135,000	83,407	7,300	80,531	28,600	33,958	462,240	-31,208
2018	92,250	143,174	83,484	8812	103,705	33,300	37,624	502,349	40,109
2019	96,772	142,256	82,306	7889	126820	34700	37449	528,192	25,843
2020	96,915	125,504	72,455	8,597	108778	37700	38234	488,183	-40,009
2021	85,531	99,214	61,120	8,673	74506	15475	34322	378,841	-109,342
2022	85,444	16,958	21,492	6,162	50787	8478	37250	226,571	-152,270
Average	95,499	128,969	85,416	6,273	94,161	30,228	36,398	476,945	--

4.3 Hydrology

Water reductions would be implemented during years when water supplies and reservoir storages are low. Calculating a baseline for these years can be challenging because it is difficult to determine the actions that may be taken to accommodate participation in the Program. For example, the commodity price of rice in a particular year may be such that a farmer decides to grow rice using groundwater, and so a reduced allocation may not mean a directly proportional reduction in rice production. Participants may increase conservation efforts, increase groundwater pumping, increase cropland idling/crop shifting, or utilize a combination of conservation, groundwater pumping and cropland idling/crop shifting to address the reduction in releases and diversions.

Under the environmental baseline, rice acreage in Sacramento Valley would continue to vary based on economic conditions and normal farming practices. Any increased effects on rice acreage, including participation in the Program based on additional cropland idling/crop shifting, may adversely affect GGS habitat.

In addition to agricultural lands, the Sacramento Valley has more than 50,000 acres of managed wetlands designed primarily to benefit wintering waterfowl (Fleskes et al. 2005). GGS require water during the active phase of their life cycle. Irrigated rice land and wetlands in the Sacramento Valley provide potential habitat for GGS, which are presumed to be present in seven of the twelve Sacramento Valley counties (USFWS 1999). During critically dry years, these managed wetlands will also see reductions in water delivered, which may adversely affect GGS use of these habitats.

4.3.1 Groundwater Levels near Giant Garter Snake Habitat

In the Sacramento Valley, reductions in water supply have historically resulted in increased groundwater pumping and decreased groundwater levels (Faunt 2009). The Sacramento Groundwater Basin includes portions of Tehama, Glenn, Butte, Yuba, Colusa, Placer, and Yolo Counties and underlies the GGS populations in the Sacramento Valley. Cumulative change in groundwater storage has been relatively constant over the long term within the Sacramento Valley. Storage tends to decrease during dry years and increase during wetter periods (Faunt 2009).

4.3.2 Interaction between Groundwater and Surface Water

The implementation of groundwater substitution pumping can lower the groundwater table and may change the relative difference between groundwater and surface water elevations. The water pumped from a groundwater well could have impacts that reduce the amount of surface water compared with pre-pumping conditions. The two impact mechanisms are:

- Induced leakage: Lowering of the groundwater table causes a condition in which the groundwater table is lower than the surface-water level. This condition causes leakage out of surface water bodies and could increase percolation rates on irrigated lands.

- Interception of groundwater: A well used for groundwater substitution pumping can intercept groundwater that normally might have discharged to the surface water.

Known GGS populations within the action area occur in freshwater marsh wetland or rice land areas that have tight clay soils such that there is standing surface water for long periods of the year. Most of these rice lands or marsh areas have standing surface water that might experience some induced leakage or interception of groundwater during a very dry water year. However, typically there is only limited linkage between standing surface waters and the groundwater subbasins due to the heavy clay soils that make rice agriculture possible during California's long dry season. Most agricultural wells would be pumping water from at least 50 feet below the surface while nearly all drinking water wells are required to be much deeper to avoid contamination issues associated with shallow groundwater. Additional groundwater pumping from aquifers at least 50 feet below the surface has limited effect on the amount of groundwater that would normally discharge to surface water that provides GGS habitat due to the soil properties of GGS habitat.

Managed GGS habitat, including GGS preserves and conservation banks, such as Natomas Basin, Willey Wetlands, and Prichard Lakes Preserves, often depend on surface water supplies from the SWP or CVP to provide water to GGS habitat. In particular, Natomas Basin Preserve and Willey Wetlands utilize water provided by Natomas Central Mutual Water Company. As a Sacramento River Settlement Contractor, this water user is likely to receive less surface water in a critically dry year, and, therefore, Natomas Basin Preserve and Willey Wetlands are likely to rely more heavily on groundwater supplies to provide habitat for GGS. In these instances, the preserve or conservation bank is in the same situation as many of the Sacramento Valley water users who, in very dry years, may get part of their needed water supplies through groundwater extraction. As in the past, a moderate decline in groundwater level is expected in the Sacramento Basin due to groundwater utilization during droughts; however, levels are expected to return to pre-drought conditions following wet years (Faunt 2009).

4.4 Sacramento River Settlement Contractors

This consultation addresses the Program, which is in addition to diversion of water under existing water contracts. Reclamation previously consulted separately with USFWS and NMFS on the renewal and execution of individual contracts, primarily in 2004 and 2005. Consistent with the CVPIA Biological Opinion, Reclamation undertook a two-track process to analyze effects from executing and implementing water contracts, including water service and settlement contracts. Reclamation analyzed the effects of operating the CVP to deliver water under water contracts (contract implementation) on listed aquatic species as part of long-term operations in 2004/2005, 2008/2009, and 2019/2020. Through separate consultations, Reclamation consulted on the renewal/execution of the contracts and any effects on nonaquatic species. The contract renewal/execution consultations addressed the diversion of Sacramento River water by water contractors at prescribed diversion points and times for the use of that water on a specified land area (the contractors' service area).

The following is a non-exhaustive list of Section 7 consultations documenting effects on federally listed species. The USFWS Biological Opinions and letters of concurrence addressed potential effects on terrestrial species.

- NMFS 2005 (File No. 151422SWR03SA8377:MET) Letter from Rodney R. McInnis, Regional Administrator, NMFS to Michael J. Ryan, NCAO Area Manager, Reclamation Concerning the Renewal of 145 Sacramento River Settlement Contracts
- USFWS 2005 (File No. 1-1-05-I-0699) Conclusion of Informal Consultation on the Renewal of 138 Sacramento River Settlement Contracts, and Request for Supplemental Information on the Colusa Drain Mutual Water Company contract renewal
- USFWS 2005 (File No. 1-1-05-I-1165) Conclusion of Informal Consultation on the Renewal of the City of Redding and Anderson-Cottonwood Irrigation Districts Sacramento River Settlement Contracts
- USFWS 2005 (File No. 1-1-05-I-0699) Conclusion of Informal Consultation on the Renewal of the Natomas Central Mutual Water Company Sacramento River Settlement Contract
- USFWS 2015 Reinitiation of Section 7 Consultations for the Renewal of 138 Sacramento River Settlement Contracts (Service File No. 1-1-05-1-0699); (2) the Long-Term Renewal of Water Service contracts in the Delta-Mendota Canal Unit (Service File No. 1-1-04-1-0707); (3) the Natomas Central Mutual Water Company Sacramento River Settlement Contract (Service File No. 1-1-05-1-0699); and (4) the City of Redding and the Anderson-Cottonwood Irrigation District Sacramento River Settlement Contracts (Service File No. 1-1-05-1-1165) (File MP-152 ENV-7.00)
- NMFS 2005 (File No. 151422SWR04SA9164:HLB) Letter from Rodney R. McInnis, Regional Administrator, NMFS to Michael J. Ryan, NCAO Area Manager, Reclamation Concerning the Renewal of Water Service Contracts Within the Sacramento River Division of the CVP
- USFWS 2004 (File No. 1-1-04-F-0227) Conclusion of Informal Consultation on Long-Term Renewal of Sixteen Water Service Contracts in the Shasta, Trinity, and Sacramento River Divisions
- USFWS 2004 (File No. 1-1-04-12949) Conclusion of Informal Consultation on Long-Term Renewal of Six Water Service Contracts in the Shasta, Trinity, and Sacramento River Divisions
- USFWS 2005 (File No. 1-1-04-1-2978) Conclusion of Informal Consultation on Long-Term Renewal of the Proberta Water Service Contract in the Sacramento River Division
- USFWS 2005 (File No. 1-1-04-0721) Conclusion of Informal Consultation on Long-Term Renewal of Five Water Service Contracts in the Sacramento River Division

Each year, the SRSC divert water in accordance with their contracts. In years of critical drought, the contracts provide for a 25% reduction in supply. In drought years, the SRSC may take voluntary actions to reduce diversions that are outside Reclamation's discretion which may

include delayed spring diversions, reduced overall diversions, and water transfers that result in groundwater substitution, crop idling, and crop shifting. SRSC have reduced diversions lower than 75% in each drought year since 2014. Without the Proposed Action, actions taken by the SRSC to manage through drought would be unpredictable and speculative whereas under this approach drought management actions are transparent and planned for in advance.

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5 Effects of the Proposed Action

Effects of the action are all consequences to listed species or critical habitat that are caused by the proposed action, including the consequences of other activities that are caused by the proposed action but that are not part of the action. A consequence is caused by the proposed action if it would not occur but for the proposed action and it is reasonably certain to occur. Effects of the action may occur later in time and may include consequences occurring outside the immediate area involved in the action.

5.1 Effects on Giant Garter Snake

5.1.1 Water Reduction Activities

Snakes require water during the active season of their life (May 1–October 1). Ditches, canals, other agricultural conveyance features, and rice fields all provide suitable aquatic habitat for the snake. Rice fields in particular, provide additional aquatic habitat that snakes utilize for cover from predators and for foraging on fish and amphibians during the active season.

Phase 1: The proposed project is expected to result in the temporary loss of habitat from the cropland idling and shifting of a maximum of 83,333 acres of rice land each Phase 1 Program Year. Based on modeling results, Phase 1 Program Years are anticipated to occur on average .66 times over a ten-year period. The maximum potential to occur is four times over a ten-year period similar to 1924–1933 with prolonged droughts. No occurrence would occur through many 10 plus year periods similar to years such as 1934–1976, 1978–1990, and 1992–2013. These results are based on Calsim model simulation under 2022MED climate and Alt2v2 operations and are not meant to represent historical conditions.

Maximum cropland idling and shifting as a result of the Proposed Action could be approximately 31.6 percent (83,333/268,426) of the acres of rice within the SRSCs Service Area (action area) and 17.5 percent (83,333/ 476,945) of the average annual rice production acreage in the Sacramento Valley from 1992–2022 (Table 4-2). The reduced diversions and deliveries percentages of crop idling and shifting relative to the overall area of the Recovery Unit are relatively small. The largest water reduction percentage within any one of the Recovery Units occurs within the Colusa Basin Unit at 7.3 percent (50,246/686,096) of the entire Recovery Unit.

Phase 2: The proposed project is expected to result in the temporary loss of habitat from the cropland idling and shifting of a maximum of 16,667 acres of rice land each Phase 2 Program Year. Based on modeling results, Phase 2 Program Years are anticipated to occur on average .88 times over a ten-year period. The maximum potential to occur is four times over a ten-year period similar to 1924–1933 with prolonged droughts. No occurrence would occur through many 10 plus year periods similar to years such as 1934–1976, 1978–1989, and 1995–2013.

These results are based on Calsim model simulation under 2022MED climate and Alt2v2 operations and are not meant to represent historical conditions.

Maximum cropland idling and shifting as a result of the proposed project could be approximately 6.2 percent (16,667/268,426) of the acres of rice within the SRSC Service Area (action area) and 3.5 percent (16,667/ 476,945) of the average annual rice production acreage in the Sacramento Valley from 1992–2022 (Table 4-2). The reduced diversions and deliveries percentages of crop idling and shifting relative to the overall area of the Recovery Unit are relatively small. The largest water reduction percentage within any one of the Recovery Units occurs within the Colusa Basin Unit at 1.5 percent (10,057/68,6096) of the entire Recovery Unit.

This temporary loss of habitat is in the form of surface water that is not used for rice production as a result of cropland idling and shifting as part of the Program. This reduction in rice fields will likely make snakes relocate to other areas to find available foraging areas, which put them at a greater risk of predation, decreased fitness and reproduction, and injury from vehicles or farm equipment while they try to relocate from areas being idled to other aquatic habitats. While the percentages of land affected by cropland idling and shifting related to the Recovery Unit is relatively low, the temporary reduction in available suitable aquatic habitat in the form of rice lands will likely result in increased stress to snakes due to loss of areas that provide foraging opportunities, the loss of cover from known predators, and the potential for reduced reproduction and recruitment.

Conveyance features and mature rice fields provide essential cover for the snake to escape from known predators that occur within these habitats. Predators of the snake include large fish, egrets, and herons, all of which are known to occur within these aquatic habitats and are known to prey on the snake. The loss of rice lands will increase snake mortality from predation if they are limited to occur in these conveyance canals and ditches.

All of these factors will result in the loss of individual snakes through an increase in mortality or reduced or foregone reproduction by snakes in the 83,333 acres during Phase 1 years and 16,667 acres in Phase 2 of cropland/shifted areas when water is reduced under this program.

Reclamation has proposed conservation measures that will minimize effects to the snake. Particularly, conservation measure 2 will provide movement corridors for aquatic species (including the snake). These movement corridors include all major irrigation and drainage canals, as well as in smaller drains and conveyance canals, when possible. This will allow these movement corridors to be maintained during the snakes' active season, as well as maintain a prey base for the snake and maintain vegetation needed for cover during foraging and avoidance from predators.

The Sacramento Valley has seen large annual fluctuations in rice production over the last 30 years (Table 4-2). This fluctuation is likely based on market conditions and other variables including crop idling and shifting. However, in 2017, when rice production was less in counties that had reported data, the studies found an increase in snakes from the previous year. While these fluctuations in rice production continue in the Sacramento Valley, the two years of studies

indicate that snake populations in the Sacramento Valley are not declining in sampled locations when rice production is less. The proposed project includes a maximum annual crop idling and shifting of 83,333 acres during Phase 1 Program Years estimated to occur on average .66 times, zero to four depending on hydrology and 16,667 acres in Phase 2 Program Years estimated to occur on average .88 times, zero to four depending on hydrology.

Limited data exists on the actual distribution and occurrence of the snake within the rice lands to determine how crop idling and shifting may affect the snake populations. Data is being collected by U.S. Geological Survey's Western Ecological Resource Center (WERC). The data being collected by WERC to date is targeted at determining the effects of water transfers on the snake. To determine the effects to the snake from crop idling and the effectiveness of the conservation measures, multiple years of data should be collected and analyzed. Conservation Measures 3 and 4 will contribute to monitoring and fill any gaps in funding for research to better help determine the potential effects of cropland idling/ shifting on the snake.

5.1.2 Future Drought Resiliency Projects

Potential future drought resiliency projects are anticipated to be small scale water infrastructure improvement projects with a construction component. Construction activities that could occur as a result of future drought resiliency project in suitable habitat may increase the risk of injury or mortality to GGS. Noise and vibrations from construction activities could cause GGS's to leave the project area and could make them more vulnerable to predation. Equipment traveling between construction areas can run over GGS if it is basking within the exclusion fencing and does not move away.

Construction activities may result in the permanent loss of suitable aquatic habitat and suitable upland habitat. The permanent loss of aquatic habitat could remove opportunities for GGS to forage. Additional suitable aquatic habitat may be available adjacent to project areas. However, traveling to the nearby aquatic habitat could increase the amount of time that a GGS must travel, thereby increasing its risk of exposure to predation. The permanent loss of upland habitat could remove burrows GGS may use for brumation, which could increase the amount of time in which a snake travels to find other suitable burrows, thereby increasing its risk of exposure to predation. This type of effect would be anticipated to be a one-time effect from permanent loss of habitat which would be limited to the snake relocation following habitat conversion.

Construction could also result in the temporary loss of suitable aquatic habitat and suitable upland habitat. Temporary losses of suitable aquatic habitat may occur due to any dewatering that may be needed for construction activities. Any reductions of suitable aquatic habitat that would be temporarily dewatered would be anticipated to be available to GGS when the water returns to its normal flow during the next active season. The upland areas that could be temporarily affected during construction activities would be restored to as close to pre-project conditions as practicable. Fossorial mammals would likely be able to start creating burrows for use for brumation after the completion of the potential future project. The new burrows may be available for use by GGS the following inactive season.

These effects would be reduced, but not eliminated, by implementing the conservation measures proposed, including implementing an erosion control plan, conducting desktop GGS habitat evaluations, conducting pre-construction surveys, as needed, implementing GGS avoidance measures that include the expertise of qualified biologists and relocation of GGS from within the project area. Exclusion fencing would also be installed which is anticipated to help keep GGS from being within the project area. A relocation strategy will be implemented to relocate GGS by a qualified biologist with appropriate collecting/handling permits and relocated to the nearest suitable habitat beyond the influence of the project work area if they don't move away on their own volition.

5.2 Cumulative Effects

Cumulative effects include the effects of future State, Tribal, local, or private actions that are reasonably certain to occur in the action area. Future federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the Act.

In Phase 1 and 2 Program Years, water reductions are likely to occur using some of the same methods used for the proposed project and would be expected to be subject to most of the same regulatory qualifications and restrictions. It is difficult to estimate the water that may be made available from State, Tribal, local, or private individuals via cropland idling/ crop shifting as the decision to idle or shift crops is often a complex business decision made by individual landowners. Each landowner weighs the economic value of irrigating land with surface water, forgoing surface water and idling a field or shifting crops, or by forgoing surface water and substituting irrigation with pumped groundwater.

Additional rice land idling/crop shifting actions that are not considered as part of the proposed project will likely be implemented. The cumulative loss in addition to the proposed project of available rice foraging habitat for the snake is anticipated to be an adverse effect on the snake. However, this considers all rice production acreage and does not factor in the importance of snake habitat within canals and other water conveyance features. The conservation measures associated with the proposed project are intended to help minimize the potential for adverse effects.

Large-scale investments in drought resiliency actions that are not considered as part of the proposed project are not anticipated to be implemented. However, many of the future drought resiliency project types are water infrastructure type projects that occur on the landscape on small or on farm scale as a matter of standard irrigation and farming practices. The cumulative potential permanent and temporary losses of suitable aquatic and upland habitat in addition to the consideration of the framework programmatic future drought resiliency projects on GGS could result in an adverse effect. However, this considers only the available suitable habitat within the SRSC service area and does not factor in the importance of GGS habitat within the

range of the species. The conservation measures associated with the proposed project are intended to help minimize the potential for adverse effects.

5.3 Conclusion

The loss of suitable habitat resulting from crop idling could result in increased competition for resources, reduced reproductive rates, and increased mortality from predation. Idling crops up to approximately 83,333 acres during Phase 1 years and 16,667 acres in Phase 2 of rice lands under the Proposed Action is likely to reduce the ability of individual GGS to forage, reproduce, and find shelter. Potential construction activities related to future drought resiliency projects may result in the permanent and temporary loss of suitable aquatic habitat and suitable upland habitat. Under the framework programmatic evaluation, the implementation of potential future drought resiliency projects may increase the risk of injury or mortality to GGS.

Reclamation cannot accurately predict the number of individual GGS that may be lost because there are no population data available for the action area. To avoid and minimize effects on GGS resulting from temporal loss of habitat, Reclamation will implement the Conservation Measures identified as part of the Proposed Action. Implementation of the conservation measures related to the water reduction activities include coordination with the USFWS, maintaining water in canals and drains, when possible, which maintains movement corridors and habitat associated with cover, and foraging, and ensuring there is no lapse in funding of the ongoing USGS GGS monitoring. Implementation of the conservation measures related to the potential future drought resiliency projects include an implantation of an erosion control plan, conducting desktop GGS habitat evaluations, conducting pre-construction surveys, as needed, and implementing GGS avoidance measures.

Reclamation has determined that implementation of the Proposed Action is likely to adversely affect GGS as a result of increased mortality from reduction in available habitat for the species.

Critical habitat has not been designated for this species; therefore, none will be affected.

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6 References

6.1 References

Piao, X. and C.M. Burt. 2005. Tuning Algorithms for Automated Canal Control. Irrigation Training & Research Center, California Polytechnic State University, San Luis Obispo, California, USA. ITRC Report No. R 05-005. 94 pp. *California Environmental Protection Agency. 2006. Climate Action Team Report to Governor Schwarzenegger and the Legislature*.

California Natural Diversity Database (CNDDB). 2018. *Biogeographic Data Branch, Department of Fish and Wildlife*. Sacramento, California. Accessed July 10, 2018

Faunt, C. C., ed. 2009. *Groundwater Availability of the Central Valley Aquifer*, California. U.S. Geological Survey Professional Paper 1766.

Fleskes, J. P., J. L. Yee, M. L. Casazza, M. R. Miller, J. Y. Takekawa, and D. L. Orthmeyer. 2005. *Waterfowl Distribution, Movements, and Habitat Use Relative to Recent Changes in the Central Valley of California: A Cooperative Project to Investigate Impacts of the Central Valley Joint Venture and Changing Agricultural Practices on the Ecology of Wintering Waterfowl*. Final Report. U.S. Geological Survey–Western Ecological Research Center, Dixon Field Station, Dixon, CA.

Halstead, B.J., G.D. Wylie, and M.L. Casazza. 2010. *Habitat suitability and conservation of the giant garter snake (Thamnophis gigas) at the landscape scale*. Copeia 2010(4): 591-599.

Hansen, E. 2009. *Giant garter snake (Thamnophis gigas) surveys on the Capital Conservation Bank Site: Yolo County, CA*. Draft report prepared by Eric Hansen. Dated October 15, 2009.

Hansen, G.E. 1982. *Status of the giant garter snake Thamnophis couchi gigas along portions of Laguna and Elk Grove Creeks, Sacramento County, California*. Report by George E. Hansen, Consulting Environmental Biologist.

Hansen, G. E. 1986. *Status of the giant garter snake Thamnophis couchi gigas (Fitch) in the Southern San Joaquin Valley During 1986*. Final report for California Department of Fish and Game, Standard Agreement No. C-1433. Unpublished. 31 pp.

Hansen, G. E. 1988. *Review of the status of the giant garter snake (Thamnophis couchi gigas) and its supporting habitat during 1986-1987*. Final report for California Department of Fish and Game, Contract C-2060. Unpublished. 31 pp.

Huey, R.B., Deutsch, C.A., Tewksbury, J.J., Vitt, L.J., Hertz, P.E., Pérez, H.J.Á. and Garland, T., 2009. *Why tropical forest lizards are vulnerable to climate warming*. Proceedings of the Royal Society of London B: Biological Sciences 276(1664):1939–1948.

Intergovernmental Panel on Climate Change (IPCC). 2014. *Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*. IPCC, Geneva, Switzerland. https://www.ipcc.ch/site/assets/uploads/2018/02/SYR_AR5_FINAL_full.pdf

Lenihan, J.M., Bachelet, D., Neilson, R.P. and Drapek, R., 2008. *Response of vegetation distribution, ecosystem productivity, and fire to climate change scenarios for California*. Climatic Change 87:215–230.

Loarie, S.R., B.E. Carter, K. Hayhoe, S. McMahon, R. Moe, C.A. Knight, D.D. Ackerly. 2008. *Climate change and the future of California's endemic flora*. PloS ONE 3(6): e2502

McMenamin, S.K., Hadly, E.A. and Wright, C.K., 2008. *Climatic change and wetland desiccation cause amphibian decline in Yellowstone National Park*. Proceedings of the National Academy of Sciences 105(44):16988–16993.

Mitchell, K.M., Churcher, T.S., Garner, T.W., and Fisher, M.C., 2008. *Persistence of the emerging infectious pathogen Batrachochytrium dendrobatidis outside the amphibian host greatly increases the probability of host extinction*. Proceedings of the Royal Society of London, Series B, 275, 329–334.

U.S. Fish and Wildlife Service (USFWS). 1999. *Draft Recovery Plan for the Giant Garter Snake (Thamnophis gigas)*. Portland, OR.

U.S. Fish and Wildlife Service. 2015. *Reinitiation of Programmatic Formal Consultation for Bureau of Reclamation's Proposed Central Valley Project Long Term Water Transfers (2015–2024) with Potential Effects on the Giant Garter Snake within Sacramento Valley, California*. U.S. Fish and Wildlife Service, Sacramento Fish and Wildlife Office, Sacramento, CA.

U.S. Fish and Wildlife Service. 2006. *Giant Garter Snake (Thamnophis gigas) 5-Year Review: Summary and Evaluation*. U.S. Fish and Wildlife Service, Sacramento Fish and Wildlife Office, Sacramento, CA.

U.S. Fish and Wildlife Service. 2012. *Giant Garter Snake (Thamnophis gigas) 5-Year Review: Summary and Evaluation*. U.S. Fish and Wildlife Service, Sacramento Fish and Wildlife Office, Sacramento, CA.

U.S. Fish and Wildlife Service. 2017. *Recovery Plan for the Giant Garter Snake (Thamnophis gigas)*. U.S. Fish and Wildlife Service, Sacramento Fish and Wildlife Office, Sacramento, CA.

Whitfield, S.M., Bell, K.E., Philippi, T., Sasa, M., Bolaños, F., Chaves, G., Savage, J.M. and Donnelly, M.A., 2007. *Amphibian and reptile declines over 35 years at La Selva, Costa Rica*. Proceedings of the National Academy of Sciences 104(20):8352–8356.

Wylie, G. D., T. Graham, and M.L. Casazza. 1996. National Biological Service. *Giant garter snake study progress report for the 1995 field season*. Preliminary report, U. S. Geological Survey, Biological Resources Division, Dixon Field Station, Dixon, California.

Wylie, G. D., M. L. Casazza, and J. K. Daugherty. 1997. *1996 Progress report for the giant garter snake study*. Preliminary report, U.S. Geological Survey, Biological Resources Division, Dixon Field Station, Dixon, California.

Wylie, G. D., M. L. Casazza, and N. M. Carpenter. 2002a. *Monitoring giant garter snakes at Colusa NWR: 2001 progress report*. U.S. Geological Survey, Western Ecological Research Center, Dixon Field Station, Dixon, California.

Wylie, G. D., M. L. Casazza, and N. M. Carpenter. 2002b. *Monitoring giant garter snakes at Colusa National Wildlife Refuge: 2001 progress report*. Unpublished report. U.S. Geological Survey, Biological Resources Division, Dixon Field Station, Dixon, California. April 2002. 10 pp.

Wylie, G.D., 2003. *Results of 2003 monitoring for giant garter snakes (Thamnophis gigas) for the bank protection project on the left bank of the Colusa Basin Drainage Canal in Reclamation District 108, Sacramento River Bank Protection Project, Phase II*. Progress report prepared by U.S. Geological Survey Western Ecological Research Center, Dixon Field Station, for the U.S. Army Corps of Engineers and Reclamation District 108, Sacramento California, 14 p.

Wylie, G.D., and L. Martin. 2004. *Results of 2004 monitoring for giant garter snakes (Thamnophis gigas) for the bank protection project on the left bank of the Colusa Basin Drainage Canal in Reclamation District 108. Sacramento River Bank Protection Project, Phase II*. Progress report for the U.S. Army Corps of Engineers.

Wylie, G. D., M. L. Casazza, L. L. Martin, and N. M. Carpenter. 2005. *Identification of key GGS habitats and use areas on the Sacramento NWR Complex*. Prepared for the U.S. Fish and Wildlife Service and the U.S. Bureau of Reclamation by the U.S. Geological Survey, Western Ecological Research Center, Dixon Field Station, Dixon, California.

Wylie, G.D., and Amarello, M., 2006, *Results of 2006 monitoring for giant gartersnakes (Thamnophis gigas) for the bank protection project on the left bank of the Colusa Basin Drainage Canal in Reclamation District 108, Sacramento River Bank Protection Project, Phase I*. Prepared by U.S. Geological Survey Western Ecological Research Center, Dixon Field Station, Dixon, California, for the U.S. Army Corps of Engineers, Sacramento, California, 20 p

6.2 Personal Communications

Goude, C. 2014. Assistant Field Supervisor, U.S. Fish and Wildlife Service, Sacramento Field Office

Halstead, B. 2018. Research Wildlife Biologist, U.S. Geological Survey, Western Ecological Research Center, Dixon, CA

Wylie, Glenn. U.S. Geological Survey, Western Ecological Research Center, Dixon Field Station, personal communication. 2006, 2009.

Appendix A: Species List

Available upon request

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Appendix B: Sacramento River Settlement Contractors Water Reduction Program Contract

Available Upon Request

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Appendix C: Giant Garter Snake Recovery Unit with Project Overlay

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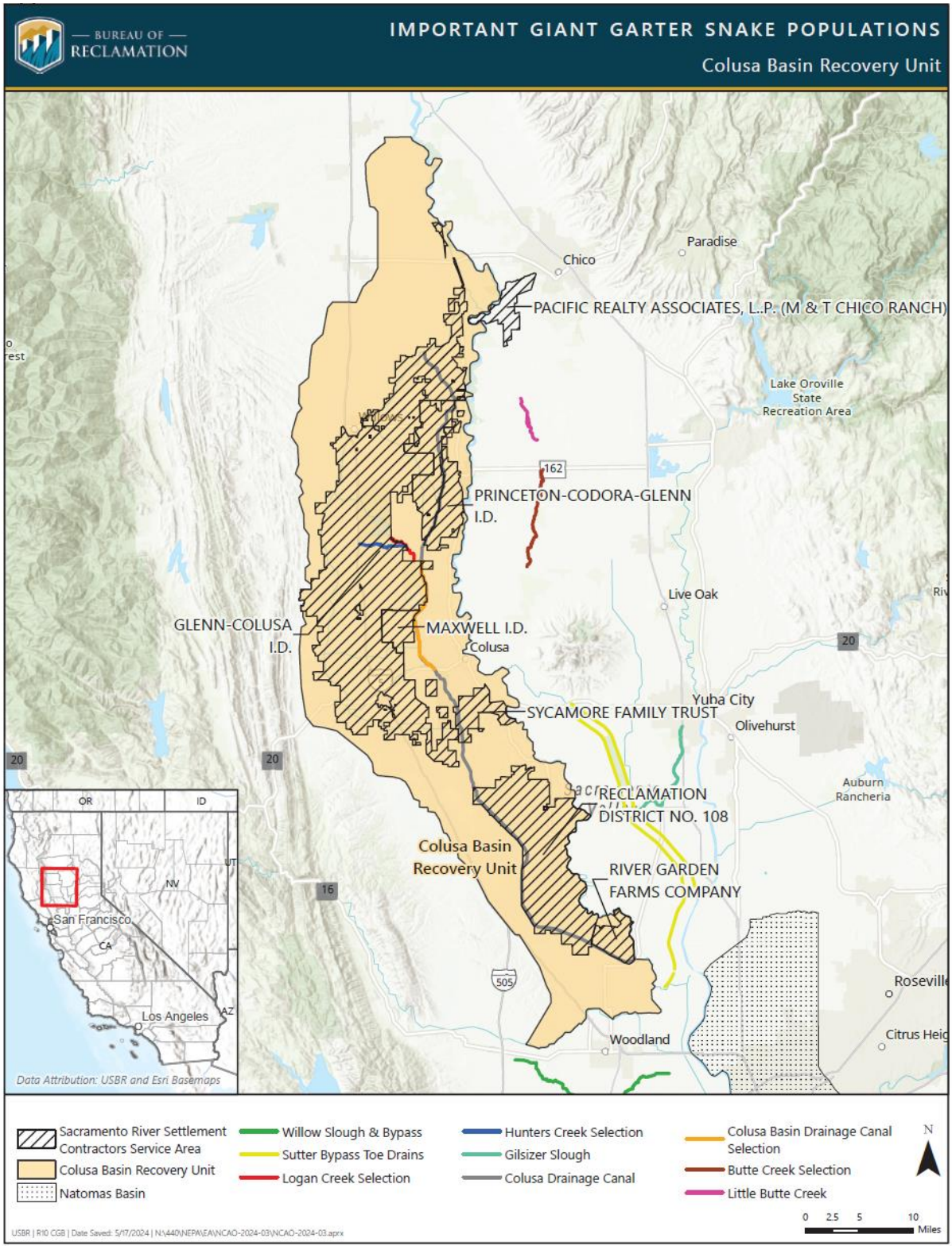
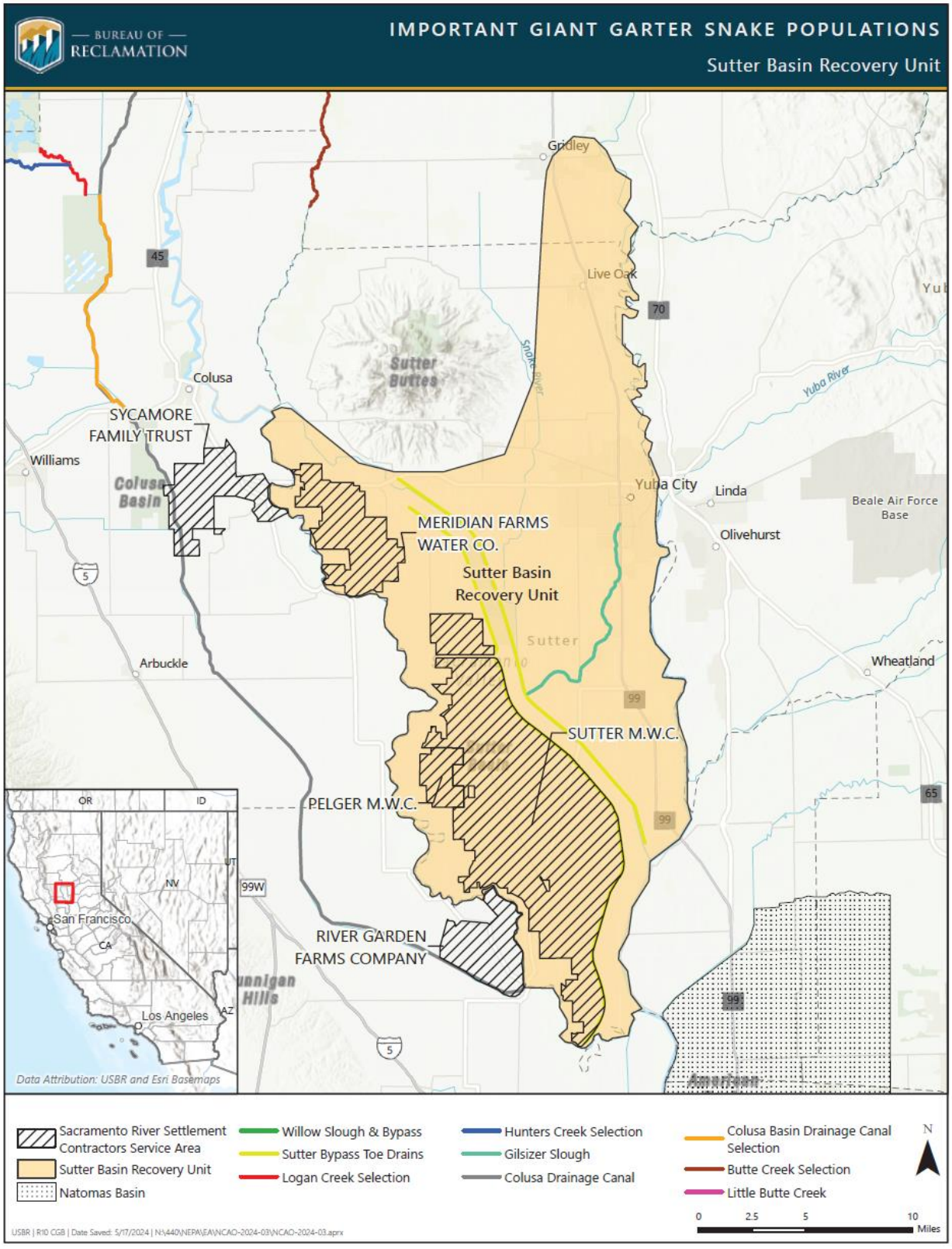
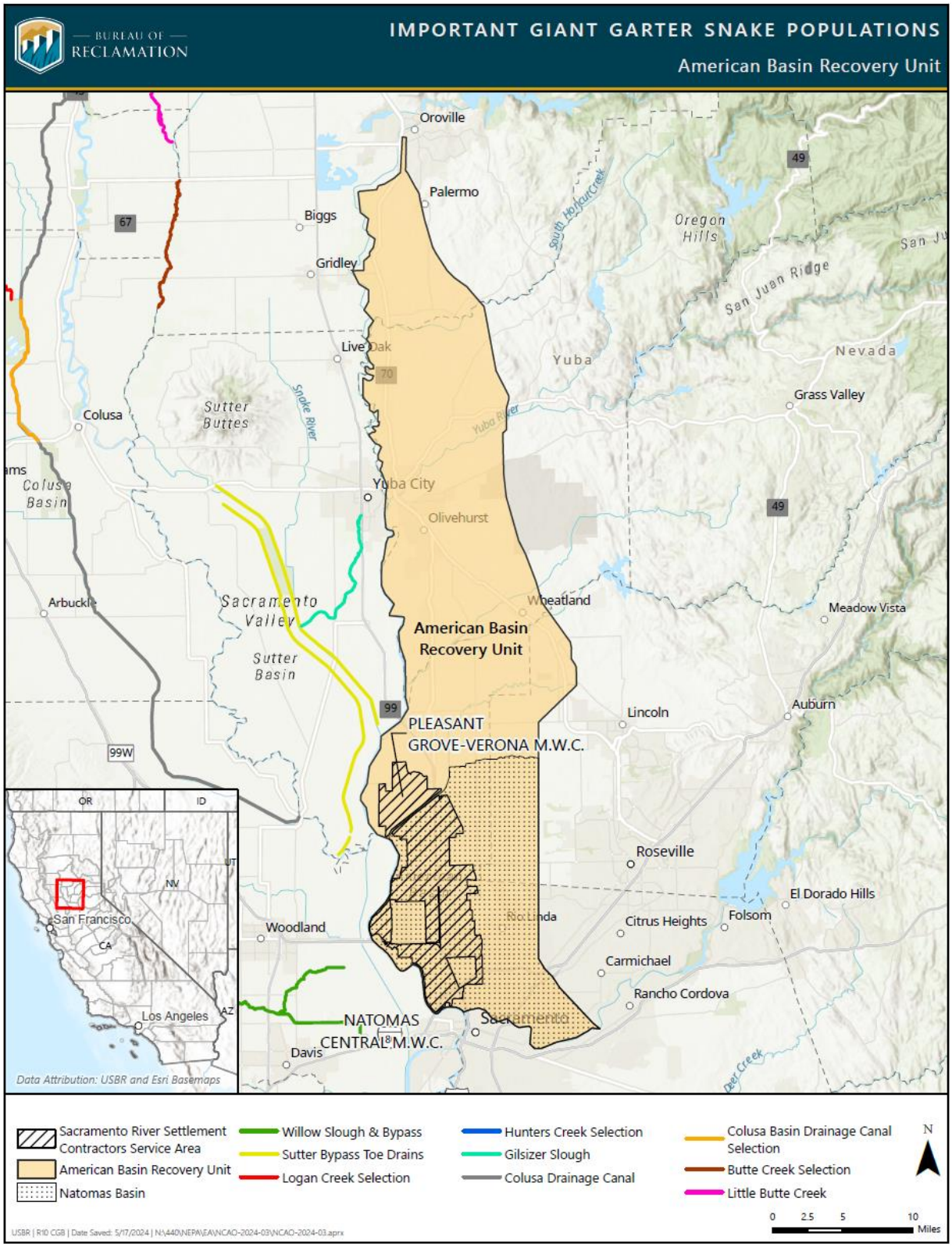
Appendix C-2a



Appendix C-2b



Appendix C-2c



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