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Chapter 4
Resource Management Strategies

The purpose of this chapter is to discuss the Resource Management Strategies (RMS) that were considered during the project selection process, discuss resource integration, and examine climate change vulnerability, including presenting the climate change vulnerability assessment.

4.1 RESOURCE MANAGEMENT STRATEGIES

The intent of the RMS Standard is to encourage diversification of water management approaches as a way to mitigate for uncertain future circumstances and comply with PRC §75026.(a) and CWC §10541(e)(1). An RMS, as defined in the California Water Plan (CWP) Update 2009, is a project, program, or policy that helps local agencies and governments manage their water and related resources. An IRWMP must consider each of the 29 RMSs included in the CWP Update 2009 which are listed below in Table 4-1.

Table 4-1 California Water Plan Update 2009 Resource Management Strategies [a]

Agricultural Water Use Efficiency	Conjunctive Management & Groundwater Storage
Urban Water Use Efficiency	Desalination
Crop Idling for Water Transfers	Precipitation Enhancement
Irrigated Land Retirement	Recycled Municipal Water
Conveyance – Delta	Surface Storage – CALFED
Conveyance – Regional/local	Surface Storage – Regional/local
System Reoperation	Drinking Water Treatment and Distribution
Water Transfers	Groundwater Remediation/Aquifer Remediation
Flood Risk Management	Land Use Planning and Management
Agricultural Lands Stewardship	Matching Quality to Use
Economic Incentives (Loans, Grants and Water Pricing)	Pollution Prevention
Ecosystem Restoration	Salt and Salinity Management
Forest Management	Urban Runoff Management
Recharge Area Protection	Water-Dependent Recreation
	Watershed Management

[a] Table 3 of the IRWM Guidelines, November 2012.

In addition to the 29 RMSs listed above, four RMSs were included in earlier DWR IRWM Guideline RMS lists and in the NSV project solicitation checklist (for a total of 33 RMSs). The four additional RMSs are discussed later in this chapter. As will be discussed in Chapter 5 Potential Projects and Prioritization, individual projects were ranked depending on how many of the RMSs were listed in the project application, submitted by the project proponents, as being achieved by each project. The RWMG did not evaluate the RMS claims of the project applicants. Each RMS was awarded one point, up to a total of seven points. The entire list of the 113 Ranked projects adopted through June 2013 and the 33 RMSs that would be achieved as reported by project proponents is shown in Table 4-2. A summary of the percentage of projects that would achieve each of the 29 required RMSs is shown in Table 4-3, in order of greatest to least.

Table 4-2. Resource Management Strategies by Ranked Project[a]

Project ID	Project Title	Agricultural Water Use Efficiency	Urban Water Use Efficiency	Crop Idling for Water Transfers	Irrigated Land Retirement	Conveyance – Delta	Conveyance – Regional/local	System Reoperation	Water Transfers	Flood Risk Management	Agricultural Lands Stewardship	Economic Incentives (Loans, Grants and Water Pricin	Ecosystem Restoration	Forest Management	Recharge Area Protection	Conjunctive Management & Groundwater Storage	Desalination	Precipitation Enhancement	Recycled Municipal Water	Surface Storage – CALFED	Surface Storage – Regional/local	Drinking Water Treatment and Distribution	Groundwater Remediation/Aquifer Remediation	Land Use Planning and Management	Matching Quality to Use	Pollution Prevention	Salt and Salinity Management	Urban Runoff Management	Water-Dependent Recreation	Watershed Management	Rainfed Agriculture	Dewaporation or Atmospheric Pressure Desalination	Fog Collection	Waterbag Transport/Storage Technology	Total Number of RMSs
1	Hydronium Acid & Rice Water Holding Times	1	1		1						1											1	1			1	1								8
2	Lower Stony Creek Watershed Restoration Plan									1			1		1											1				1					5
3	Improve Surface and Ground Water Quality and Quantity	1									1														1					1					4
4	Modeling the "Lower Tuscan Aquifer"															1																			1
5	Irrigation Delivery Automation Program	1					1	1	1																										4
6	Community Wildfire Protection Plan									1			1	1	1						1					1				1					7
7	RAWD Wastewater Treatment Plant & Constructed Wetlands Proje												1													1			1	1					4
8	Program of Modeling & Monitoring in Support of Groundwater M	1													1															1					3
9	In-lieu Recharge in North-Eastern Glenn County						1									1																			2
10	WSRCD NSV IRWMP Grants Specialist	1	1							1	1	1	1	1	1											1		1	1	1					12
11	Climate Stewardship Coordinator	1	1								1	1	1	1	1														1	1					9
12	Inventory/Analysis Report Update														1															1					2
13	Table A Options						1		1																										2
14	Groundwater Model Evaluation and Update								1						1												1			1					4
15	Groundwater Management Plan Update	1	1	1			1		1	1						1						1	1				1		1						11
16	Well Monitoring Network								1		1					1											1			1					5
17	Environmental Monitoring Program												1		1																				2
18	Identification and Evaluation of Groundwater Recharge														1	1																			2
19	Tormey Drain Rehabilitation						1			1																		1							3
20	Anderson River Park Restoration												1																	1					2
21	Irrigated Cropland Water Efficiency Projects	1					1				1																								3
22	ACID Main Canal Modernization Project	1					1	1												1															4
23	Kids and Watershed Stewardship	1	1								1		1	1	1				1					1		1		1		1	1				12
24	Packer Ranch Pump Station and Fish Screen Project	1					1		1		1		1			1																			6
25	Foothill Stream Restoration and Recharge Enhancement												1		1	1														1					4
26	IRWM Outreach and Education	1	1				1			1	1	1	1	1	1	1					1		1			1	1	1		1					16
27	Cortina Rancheria Water Assistance Plan		1				1	1					1	1	1				1			1	1		1	1				1					12
28	Groundwater Management Plan for the North Fork Battle Creek																									1									1
29	Town of Paradise Community Wastewater Collection System Proj						1						1							1	1								1	1					6
30	Feasibility Study-Town of Paradise Wastewater System						1						1							1	1								1	1					6
31	Pump House No. 1 Fish Protection Project		1				1	1				1	1									1								1					7
32	Well Contaminant Treatment System							1														1													2
33	Magalia Dam Replacement		1																		1														2
34	Magalia Fault Study																				1														1
35	Paradise Bladder Dam																				1														1
36	Drought Supply Project						1		1												1	1													4
37	Watershed Forestheath Project													1								1				1				1					4
38	Waterline Replacements																					1													1
39	Detention Basin & Lateral		1				1			1			1													1	1	1							7
40	Flood Hazard Preparation Plan									1																									1
41	Water Supply Reliability Well																					1													1
42	Wastewater Plant Improvements																					1			1										2
43	North Sac Valley Regional Water Quality Assessment Project		1							1			1	1	1			1								1		1	1	1					10
44	K-12 Watershed Education and Science Ambassador Project		1										1	1	1			1								1	1		1	1					9
45	Regional K-12 Watershed Education		1										1	1	1			1								1		1	1	1					9
46	Water Tank Improvement						1	1														1													3
47	Recycle Residuals Dewatering		1																1							1									3
50	Northern Sacramento Valley Mobile Irrigation Lab	1	1								1															1		1							5
51	Influent Pump Station																		1							1									2
52	Biggs WWTP Improvement Project																		1							1									2
53	Cottonwood Creek Invasives Control Follow Up									1	1		1													1				1					5
54	Battle Creek Stream Monitoring Plan												1																	1					2
55	Clover Creek Millville Diversion Restoration Project	1					1			1	1		1													1				1					7
56	Deer Creek Fish Passage Project, DCID Dam	1					1	1			1	1	1																	1					7
57	Impacts of Illegal Marijuana Activity on Fish										1		1	1								1				1		1		1					7
58	Antelope Creek Juvenile Fish Passage Improvement Project	1					1	1			1		1																	1					6
59	Mill Creek Fish Passage	1					1			1	1		1																	1					6
60	Cow Creek Riparian Assessment and Restoration												1	1												1		1		1					5
61	Mill Creek Riparian Assessment and Restoration Projects	1			1						1		1													1				1					6
62	SF Cottonwood Hammer Diversion Fish Passage Project		1					1					1	1												1				1					6
63	Antelope Creek Distributary/Fish Passage Improvement Project	1											1			1														1					4
64	Small Sac River Tributary Habitat & Passage Project		1							1			1													1			1	1					6
65	Deer Creek Instream Habitat Improvement												1																	1					2
66	Bear Creek Fish Passage and Screening Project												1																	1					2
67	Payne's Creek Fish Passage						1						1																	1					3
68	Elder Creek NIS Plant Control									1			1													1				1					4
69	Tehama West NIS Plant Control									1	1		1													1			1	1					6
70	Clear Creek NIS Plant Control												1																	1					2
71	Sacramento River Redd Dewatering Study												1							1	1									1					4
72	Sacramento River Juvenile Salmonid Limiting Factor Analysis												1							1										1					3
73	Sacramento River Fish Screens	1								1			1																	1					4
74	Sacramento River Spawning Gravel Augmentation												1							1										1					3
75	Cottonwood Creek Gravel Man. Project									1			1	1		1										1				1					6
76	Cow Creek Fish Habitat Improvement	1											1																	1					3
77	Cottonwood Creek Riparian Habitat Restoration												1	1															1	1					4
78	NF Cottonwood Creek Fish Habitat Improvement	1						1		1			1	1																1					6
79	Tehama-Colusa Canal Authority Canals Automation Project	1					1	1	1																					1					5
80	Robbins Water Main & Meters		1				1					1										1				1									5
81	Robbins Water Tower Demo						1								1											1	1			1					5
82	Robbins Water Treatment Plant						1								1							1			1										4
83	Live Oak Canal Master Plan						1			1	1															1									4
84	SWIM Project IRWM Support	1	1	1	1		1	1	1	1	1	1	1	1	1	1		1	1	1	1	1	1		1	1	1	1	1	1	1	1	1	1	30
85	Creeks of Chico Salmon Education Mural												1													1		1	1	1					5
87	OAWD Canal Pre-Screen Project							1							1	1									1										4
88	WCWD Agricultural Efficient Water Management Implementation	1																																	1
89	USBR Lateral 30 Underground Project	1					1																												2
90	USBR Lateral 51 Underground Project Phase 1	1					1																												2
91	USBR Lateral 51 Underground Project Phase 2	1					1																												2
92	USBR Lateral 40 Underground Project	1					1																												2
93	USBR Lateral 43 Underground Project	1					1																												2
94	USBR Lateral 50 Underground Project	1					1																												2
95	Eva Drive Well							1							1	1						1			1										5
96	Tehama Flood Reduction and GW Recharge									1						1																			2
97	Water Quality Assessment of NSV Watersheds												1																	1					2
98	Butte County Well Abandonment Program																						1		1	1									3
99	Water Stories	1	1								1	1	1		1											1				1					8
100	Stirling Reservoir Feasibility Study						1	1												1	1														4
101	Bear Creek Watershed Group Shingletown Groundwater Study																													1					1
102	PID Treatment Process Reuse							1											1		1					1	1			1					6
103	Misselbeck Dam Spillway - Repair and Improve									1											1														2
104	Rock and Sand Creek Flood Mitigation									1	1		1																	1					4
105	Feather River Pump Station Fish Screen Feasibility Study						1				1		1																	1					4
106	Northern Sacramento Valley Regional Atlas	1	1	1	1		1	1	1	1	1	1	1	1	1	1		1	1	1	1	1	1		1	1	1	1	1	1	1	1	1	1	30
107	Preliminary Intermittent Tributary Analysis									1	1	1	1	1	1								1							1					8
108	IRWMP Cooperative Environmental Services Program						1	1			1		1	1	1	1		1		1	1					1		1	1	1					14
109	Robbins Backup Power Supply														1											1									2
110	Robbins Wastewater Collection System Improvements														1											1									2
111	Robbins Trailer Park Project														1											1									2
112	Lwr Deer Creek Levee Improvements & Habitat Restoration Ph1									1			1																						2
113	Lwr Deer Creek Levee Improvements & Habitat Restoration Ph2									1			1																						2
114	Lwr Deer Creek Levee Improvements & Habitat Restoration Ph3									1			1																						2
115	Lwr Deer Creek Levee Improvements & Habitat Restoration Ph4									1			1																						2
116	Lwr Deer Creek Levee Improvements & Habitat Restoration Ph5									1			1																						2
	Total Number of Approved Projects	33	21	3	4	0	37	18	10	30	26	10	59	20	28	16	0	6	8	10	15	17	9	0	9	41	11	14	16	61	3	2	2	2	

Deleted Project #48: Lower Deer Creek Flood Protection and Restoration - Phase II
Deleted Project #49: Lower Deer Creek Flood Protection and Restoration - Phase III
Deleted Project #86: Sacramento River Watershed Regional GIS
[a] Resource Management Strategies to be achieved are based on the project applications submitted by the project proponents. Project data are accurate as of March 3, 2014.

Table 4-3. Resource Management Strategies to be Achieved through the NSV IRWMP Ranked Projects[a]

Resource Management Strategy	Percent of Ranked Projects Achieving
Watershed Management	54%
Ecosystem Restoration	52%
Pollution Prevention	36%
Conveyance – Regional/local	33%
Agricultural Water Use Efficiency	29%
Flood Risk Management	27%
Recharge Area Protection	25%
Agricultural Lands Stewardship	23%
Urban Water Use Efficiency	19%
Forest Management	18%
System Reoperation	16%
Drinking Water Treatment and Distribution	15%
Conjunctive Management & Groundwater Storage	14%
Water-Dependent Recreation	14%
Surface Storage – Regional/local	13%
Urban Runoff Management	12%
Salt and Salinity Management	10%
Water Transfers	9%
Economic Incentives (Loans, Grants and Water Pricing)	9%
Surface Storage – CALFED	9%
Groundwater Remediation/Aquifer Remediation	8%
Matching Quality to Use	8%
Recycled Municipal Water	7%
Precipitation Enhancement	5%
Irrigated Land Retirement	4%
Crop Idling for Water Transfers	3%
Conveyance – Delta	0%
Desalination	0%
Land Use Planning and Management	0%

[a] Resource Management Strategies to be achieved are based on the project applications submitted by the project proponents. Project data are accurate as of March 3, 2014.

As shown in Table 4-3, all of the RMSs were considered in the development of the projects except for Conveyance through the Delta, Desalination, and Land Use Planning and Management. While Delta Conveyance is an issue with potential to greatly impact the NSV Region, this region is upstream of the Delta and this IRWMP does not currently include projects that specifically address Conveyance through the Delta.

For most of the NSV region, desalination is not feasible since there are few high salinity waters in the region, or within easy import distance. Although the Redding Basin and the Sacramento Valley Basin are both underlain by a saline aquifer that could be tapped and desalinated, the aquifer is generally far below the ground surface and desalination costs would likely exceed the local value of water. Some areas do have poor groundwater quality and may not have other water supply options other than desalination.

Many of the projects will also achieve the Land Use Planning and Management RMS, but none of the projects indicated on the application submittals because this particular RMS was added in the CWP Update 2009 and in the final IRWM Guidelines in November 2012, after all project applications were submitted.

Several RMSs identified in the 2010 draft IRWM Guidelines have been included in previous CWP Updates as "Other RMS". These RMSs include Rainfed Agriculture, Dewvaporation, Fog Collection, and Waterbag Transport. These "Other RMS" were listed individually in the draft 2010 IRWM Guidelines, but removed during the updates for the final 2012 IRWM Guidelines. Because the project applications were based on the draft 2010 IRWM Guidelines, some of the projects included achieving the "Other RMS". These RMSs are listed in Table 4-4.

Table 4-4. 2010 Guideline Resource Management Strategies to be Achieved through the NSV IRWMP Ranked Projects

Resource Management Strategy	Percent of Ranked Projects Achieving
Rainfed Agriculture[a,b,c]	3%
Dewvaporation or Atmospheric Pressure Desalination[b,c]	2%
Fog Collection[b,c]	2%
Waterbag Transport/Storage Technology[b,c]	2%

[a] Project: Kids and Watershed Stewardship
[b] Project: SWIM Project IRWM Support
[c] Project: Sacramento River Watershed Regional GIS

As indicated in Chapter 2 Objectives, the RWMG goals for the IRWMP are:

1. Water Supply Reliability
2. Flood Protection and Planning
3. Water Quality Protection and Enhancement
4. Watershed Protection and Management
5. Integrated Regional Water Management Sustainability
6. Public Education and Information Dissemination

The RMSs developed for the California Water Plan Update 2009 closely match the NSV's IRWMP goals.

As indicated by the NSV's IRWMP goals, and the number of projects submitted to the NSV Board that focus on watershed management and ecosystem restoration RMSs, the IRWMP will be doing as much as it can to address the potential impacts of climate change. As the surface water resources in the NSV IRWM region are significant water supply elements of the Central Valley Project and the State Water Project, water users in the IRWM region adjacent to or receiving surface water supplies are compelled to rely on federal and State operators to offset many of the potential impacts of climate change. In addition to potential impacts on water supply, some climate change models also predict a potential for more severe flooding. To address this, 24 of the NSV proposed projects address Flood Risk Management. Given the uncertainty of the climate change models, the effectiveness of the RMSs in mitigating the impacts of climate change may not be known for decades.

4.2 RESOURCE INTEGRATION

As indicated in the IRWM Guidelines, the term "Resource Integration" can take many forms, including data and education integration, and the integration of natural water resources (*e.g.* snowpack, rivers, lakes, groundwater, *etc*.) and manmade water resource infrastructure (*e.g.* various storage and conveyance systems, *etc*.). There is already a substantial amount of resource integration in the IRWM region, and it is the intent of the RWMG to expand that integration. Current resource integration takes the form of data and education, water resources, and flood control. The Northern Sacramento Valley Water Forum[1] is a regional educational forum, including representatives from each county, which meets periodically and provides educational presentations and information to meeting attendees. As indicated in Chapter 1, it is the intent of the RWMG to take advantage of the existing data and educational resource opportunities through integration with the Northern Sacramento Valley Water Forum. Announcements are posted on many of the NSV IRWMP members' websites, such as http://buttecounty.net and http://rd108.org.

Because the IRWM region is part of the Central Valley Project and the State Water Project, there is substantial integration of water resources. The irrigation districts also provide water resources integration within the IRWM region and adjacent areas.

State and federal flood protection programs also provide integration of flood protection resources in the IRWM region, mostly along the Sacramento River and its major tributaries, but also on smaller, flood prone tributaries. The on-going efforts of the Regional Flood Management Plan will also be integrated (to the degree this information is available) for use in this NSV IRWMP, as this Regional Flood Management Plan is looking at flood management within major areas that are also within the NSV IRWMP region.

[1] The Northern Sacramento Valley Water Forum is a diverse group from Shasta, Tehama, Glenn, Butte, Colusa, Sutter, Yolo and Yuba counties representing local government, agriculture, business and the environment that came together to provide an arena to discuss, promote and support the common interests of local elected officials and water users through educational public forums.

4.3 CLIMATE CHANGE VULNERABILITY

Throughout the region there is some skepticism about the existence and/or mechanisms of climate change. The bottom line concern, regardless of how it is characterized, is how the region can respond to changes in hydrology and temperature that go beyond what we have experienced during recorded history. This concern is nothing new to the Sacramento Valley, which has experienced extreme variability over the past 150 years of climate record. California's largest water projects, including the federal Central Valley Project and State Water Project, were built assuming that water needs would be met during a recurrence of the assumed worst-case drought (similar to the extended 1928-1934 drought), as well as the historic peak floods that existed as of the 1940s, 1950s and 1960s. But we have continued to see new records broken for both drought and flood events. For example, the 1976-1977 drought was short but very severe (1977 is still the driest year in recorded history in the State). The more recent 1987–1994 drought was extreme in its unprecedented duration in modern California history, and saw the development of new water management tools to cope with extended and severe drought. These more recent droughts resulted in more stress on every region of California, including the surface and groundwater resources of the NSV.

The last half of the 19th century was a remarkable period of droughts and floods in the Sacramento Valley. The flood issues were captured well in Robert Kelley's book, *Battling the Inland Sea*, which focuses on historic flood control issues in the Sacramento Valley. The book has a predominant observation that "floods of record" were periodically surpassed to establish new "worst case" conditions. In the 1880s (130 years ago), State Engineer William Hammond Hall said that we would always face larger storms and bigger floods. Record floods in 1907 and 1909 were the basis for design of the Sacramento River Flood Control Project. With construction of reservoirs in the Sacramento River watershed with flood control storage in the second half of the 20th century, the system was able to accommodate flood flows larger than originally envisioned. Even so, record floods in 1983 and 1986 were so extreme that they pushed the total flood system – levees, bypasses and reservoirs – to maximum capacity and required reevaluation of the operations of flood control facilities throughout California. Evaluation of the extraordinary February 1986 series of storms resulted in changes to flood control plans at major reservoirs in northern California. And yet a decade later in January 1997, the largest Sacramento River flows in the State's history again pushed the system beyond capacity and resulted in two major levee breaks in the Sacramento River system. An important lesson that this region has learned over the past 150 years is to plan for worst-case conditions, whatever the causes.

Whether we are addressing the IRWMP requirements related to climate change or focusing on variable hydrology and rising temperatures, there are important issues to confront that will continue to affect the water future of the NSV. State regulations require that integrated regional water management plans address climate change and provide the tools to do so in four steps (Climate Change Handbook for Regional Water Planning, USEPA and California DWR, November 2011):

1. Assess vulnerability of the region's water resources to climate change, essentially an analysis of risk;
2. Quantify any climate change impacts to the region's most vulnerable water resources;

3. Evaluate water resource management strategies in the context of effectiveness in adapting to and/or mitigating the impacts of climate change; and
4. Incorporate the uncertainties associated with climate change into IRWMP implementation.

This section addresses vulnerability, and the other three steps are incorporated into the discussion of resource management strategies in this chapter.

The way in which climate change vulnerability and greenhouse gas (GHG) emissions are considered in the project review process is also discussed in the Project Review Process section of Chapter 5.

4.3.1 Climate Change Vulnerability Assessment

Figure 4-1, below, is an overview of the suggested process for assessing climate change vulnerability of a region as part of an IRWMP. This figure is taken from page 4-1 of DWR's November 2011 handbook.

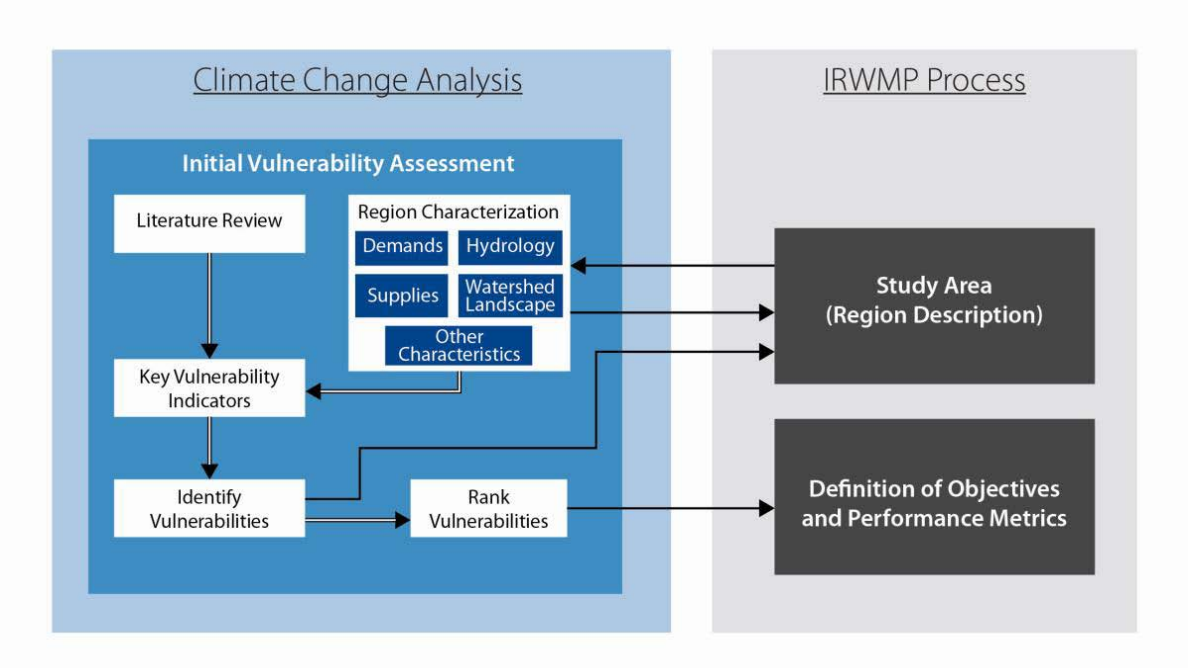

Figure 4-1. Process for Assessing Vulnerability to Climate Change as part of an IRWMP

Rather than taking a rigorous approach to the elements of climate change analysis shown in Figure 4-1, we have taken a modified approach of incorporating these elements into responses to the Climate Change Vulnerability Checklist in DWR's November 2011 Climate Change Handbook (http://www.water.ca.gov/climatechange/CCHandbook.cfm). Our responses to the Checklist incorporate appropriate elements from Figure 4-1 specific to each of the Checklist items. The DWR Climate Change Vulnerability Checklist is consistent with DWR's IRWM 2012 Proposition 84 and 1E IRWM Guidelines: http://www.water.ca.gov/irwm/grants/guidelines.cfm, which add to the draft 2010 IRWM Guidelines to require greater attention to vulnerability assessment of an IRWM region to climate change.

As discussed in the Region Description chapter of this IRWMP, the NSV encompasses a large rural area with a few prominent population centers. Those population centers include (from north to south) the cities of Shasta Lake, Redding, Anderson, Red Bluff, Chico, Oroville and Yuba City. Almost all urban areas in the region are supplied solely with groundwater, with the exception of the City of Shasta Lake (100 percent surface water), Redding (which receives the majority of its water from the Sacramento River and Whiskeytown Lake), Oroville (which receives the majority of its water from Lake Oroville), and Yuba City (which receives all of its water from the Feather River). Water use in the region is a mix of large-scale irrigated agriculture and municipal water supplies, in addition to domestic use in rural areas. Rural residential needs are met by groundwater, as are supplies to agricultural areas that are not within an irrigation or water district that have rights to surface water.

As an "area-of-origin" with protections under State law, the NSV has very high priority water rights to its surface water supplies. This means that the first priority for much of the water supplies in the Northern Sacramento Valley will be for meeting direct rights-holders in our region. However, there will continue to be water supply, flood and other vulnerabilities associated with varying hydrology and a changing climate. It is important to note that this region's water supply vulnerabilities for meeting our regional water needs are far less than would be expected in most other regions of California and most of the western United States. Historically, the Northern Sacramento Valley has had significant water supplies even in dry years, which is the principal reason why the Sacramento River system is a major source of water supplies for SWP and CVP water service areas. However, there are areas within the NSV region now experiencing water supply cut-backs in dry years, so caution must be taken when deciding on potentially exporting water supplies. As explained in Chapter 1, Section 1.4, through management of the available surface and groundwater resources, the region's water supplies have historically been in balance. Additional export without additional supply could upset that water supply balance and potentially damage the region's economy. Because of these issues, “yes” answers in “Water Supply” in the following survey will be given additional weight in the scoring provided in Table 4-5.

Climate change is receiving increasing attention in planning documents and processes throughout the region, as exemplified by the following list.

- The City of Chico’s 2030 General Plan (City of Chico, 2030 General Plan, April 2011) has a specific “Sustainability Element” that emphasizes reducing contributions to climate change (page 2-2) and provides “…goals, policies and actions that address the City’s role in statewide climate change mitigation efforts.” (Page 2-6). While this text falls into the category of climate change mitigation rather than vulnerability, it is an important climate change policy emphasis by Chico.
- The Colusa County Resource Conservation District has developed a Colusa Basin Watershed Management Plan, which was adopted in December 2012 (http://www.colusarcd.org/nodes/projects/WatershedManagementPlan.htm). The plan has as one of its eight goals (Goal #8) the need to address unknown future impacts from climate change.

- The Shasta County Department of Resource Management's Planning Division is developing a Regional Climate Action Plan (http://www.co.shasta.ca.us/index/drm_index/aq_index/programs/RCAP.aspx).
- The City of Yuba City's Environmental Impact Report on the Lincoln East Specific Plan includes an extensive discussion of climate change concerns, laws and requirements. The EIR also includes an analysis of the potential impacts of the Specific Plan on greenhouse gas emissions.
- Sutter County has both a Climate Action Plan and a Climate Change element of the Sutter County General Plan Update, both adopted by the Sutter County Board of Supervisors in March 2011. Both include specific actions to address potential impacts of climate change.

While not explicitly characterized as climate change response, the new 2030 General Plan Update for Colusa County (adopted July 31, 2012) does have policies in its Conservation Element that support efforts to maximize agricultural resources efficiency including efforts to conserve energy and focus on renewable energy technologies.

In the following pages, we list the seven potential areas of vulnerability (water demand, water supply, water quality, sea level rise, flooding, ecosystem and habitat, and hydropower), along with the specific questions for each area. The responses for the NSV region follow each question. The only exception is for sea level rise, where we provide a general answer on that topic due to the inland location of the NSV region. The seven areas of potential climate change vulnerability are scored and prioritized in the section following the survey.

1. Water Demand

a. Are there major industries that require cooling/process water in your planning region?

☒Yes ☐No ☐Perhaps/Uncertain

- Energy production (City of Redding natural gas, and Wheelabrator peaking plant)
- Colusa Generating Station in Maxwell
- Tomato processing plants (Olam, Morning Star)
- Other Ag processors

b. Does water use vary by more than 50% seasonally in parts of your region?

☒Yes ☐No ☐Perhaps/Uncertain

The NSV region's water use is dominated by agricultural water use, which by its nature has a higher late spring through summer peak irrigation demand period than other times during the year.

c. Are crops grown in your region climate-sensitive? Would shifts in daily heat patterns, such as how long heat lingers before night-time cooling, be prohibitive for some crops?

☒Yes ☐No ☐Perhaps/Uncertain

The region's water use is dominated by irrigated agriculture, which is rather temperature sensitive. As described in the Climate Change Handbook, climate change model

projections for California generally agree that warming will be greater in summer months (primary irrigation season) than in the winter (page 2-9). The Climate Change Handbook goes on to conclude that "…without accounting for changes in evapotranspiration rates, agricultural crop and urban outdoor demands are expected to increase in the Sacramento Valley by as much as 6%..." (page 2-11). Warmer temperatures for longer periods of time would be associated with higher ET rates, and may lead to shifts in timing of crops. Also, warmer winter temps could reduce the freeze hours, greatly affecting many fruit and nut crops. Although some studies have indicated that warmer nighttime temperatures may lead to reduced rice yields, it is not anticipated that shifts in daily heat patterns would be prohibitive for crops currently grown in the IRWM Region.

d. Do groundwater supplies in your region lack resiliency after drought events?

☐Yes ☒No ☐Perhaps/Uncertain

Not in most areas of the region. Below is a general description of groundwater supplies and basins in the larger Sacramento Valley (most of which is within the NSV region), from DWR's Bulletin 118, 2003 Update:

> *Groundwater provides about 31 percent of the water supply for urban and agricultural uses in the region, and has been developed in both the alluvial basins and the hard rock uplands and mountains. There are 88 basins/ subbasins delineated in the region. These basins underlie 5.053 million acres (7,900 square miles), about 29 percent of the entire region. The reliability of the groundwater supply varies greatly. The Sacramento Valley is recognized as one of the foremost groundwater basins in the State, and wells developed in the sediments of the valley provide excellent supply to irrigation, municipal, and domestic uses. Many of the mountain valleys of the region also provide significant groundwater supplies to multiple uses.*
>
> *Geologically, the Sacramento Valley is a large trough filled with sediments having variable permeabilities; as a result, wells developed in areas with coarser aquifer materials will produce larger amounts of water than wells developed in fine aquifer materials. In general, well yields are good and range from one-hundred to several thousand gallons per minute. Because surface water supplies have been so abundant in the valley, groundwater development for agriculture primarily supplement the surface supply. With the changing environmental laws and requirements, this balance is shifting to a greater reliance on groundwater, and conjunctive use of both supplies is occurring to a greater extent throughout the valley, particularly in drought years. Groundwater provides all or a portion of municipal supply in many valley towns and cities. Redding, Anderson, Chico, Marysville, Sacramento, Olivehurst, Wheatland, Willows, and Williams rely to differing degrees on groundwater. Red Bluff, Corning, Woodland, Davis, and Dixon are completely dependent on groundwater. Domestic use of groundwater varies, but in general, rural unincorporated areas rely completely on groundwater. (page 159, DWR Bulletin 118-03).*

While groundwater supplies are resilient in the NSV region as a whole, there have been and continue to be localized areas where groundwater demand puts a great deal of stress on local groundwater resources and results in declining water levels. Some small area

(for example, on the Cortina Rancheria in southwestern Colusa County) do not overlie an identified groundwater aquifer but rely on water wells for their very limited water supplies. The extreme north end of the Redding Basin also does not overly aquifers sufficient to provide municipal supplies to the City of Shasta Lake or Mountain Gate Community Services District.

e. Are water use curtailment measures effective in your region?

☐Yes ☐No ☒Perhaps/Uncertain

As indicated earlier, water use in the region is dominated by irrigated agriculture. The region also has significant groundwater supplies. Groundwater use typically increases during times when there are curtailments or limitations in surface water deliveries. Since the NSV is in what is often described as the "area-of-origin", most surface water supplies have very high reliability. Curtailment of surface water supplies is largely provided for in water right settlement contracts with both the U.S. Bureau of Reclamation and DWR. Since water demand is dominated by irrigated agriculture and there are significant groundwater resources, crop production is expected to continue to be reliable due to the wide range of water supply options available and ability to change crops depending on water reliability each irrigation season. A notable exception is the service area of the TCC, which continues to experience significant cutbacks in contract water supplies from the U.S. Bureau of Reclamation. In Shasta County, water purveyors that are wholly or mostly reliant on CVP water have been able to meet demand during cutbacks through transfers with other in-basin purveyors with more secure Settlement or Exchange supplies. Finally, in Colusa County, in many instances permanent crops are replacing row crops. Permanent crops require sufficient irrigation every year, which poses a water management challenge due to TCC water supply deficiencies in dry years. The conversion to permanent crops in many areas will make it more difficult to meet future curtailments without associated impacts through greater groundwater pumping. Loss of perennial and annual crops would result in economic loss in the local regional economy.

f. Are some instream flow requirements in your region either currently insufficient to support aquatic life, or occasionally unmet?

☐Yes ☐No ☒Perhaps/Uncertain

Instream flow requirements in the region are mandated by regulation to protect migrating, spawning, and juvenile rearing of salmon and steelhead. Provision of suitable water temperatures is an associated element of instream flow requirements in several NSV streams. Stream temperatures are largely controlled by the temperature of releases from upstream reservoirs such as USBR's Shasta Dam and DWR's Oroville Dam, both of which have temperature control devices to regulate temperatures of releases. To date, there have been few problems in meeting temperature requirements, particularly since the installation of the Shasta temperature control facilities more than fifteen years ago. However, some uncertainty and concerns remain among the resource agencies about minimum flow targets and ramping rates for protecting spawning areas and preventing stranding of salmon fry along the Sacramento River. For instance, the USBR has denied water transfers to the City of Shasta Lake because its intakes on the face of Shasta Dam might impact the cold water pool. And, there have been problems in the past in meeting stream flow needs during extreme and/or prolonged drought conditions, such as experienced in the 1976-1977 and 1987-1994 droughts. During 1977, for example, total

rainfall was roughly 1/3 of average and followed the critical water year of 1976. In 1991 (the fifth consecutive drought year), storage amounts in Shasta and Oroville reservoirs had decreased to critical low levels and were not capable of effectively controlling downstream water temperatures to meet the needs of migratory fish.

2. **Water Supply**

a. Does a portion of the water supply in your region come from snowmelt?

☒Yes ☐No ☐Perhaps/Uncertain

A substantial portion of the region's surface water supplies come from snowmelt, particularly from the Sacramento and Feather Rivers. Snowmelt runoff on both river systems is regulated by Shasta Dam and Oroville Dam (and to some extent by Yuba County Water Agency's Bullards Bar Dam on the Yuba River, tributary to the Feather River), which are all located below the snow line at around 1,000 feet above sea level. In addition, water imported into the region from the Trinity River watershed comes, in part, from snowmelt. However, such imported water supplies are used primarily to support contract water deliveries (mostly to the south of the region) rather than water rights settlement deliveries.

b. Does part of your region rely on water diverted from the Delta, imported from the Colorado River, or imported from other climate-sensitive systems outside your region?

☐Yes ☒No ☐Perhaps/Uncertain

Mostly no. The NSV is upstream of the Delta and consequently does not rely on imported water supplies. There are some limited CVP supplies imported from the Trinity River into the Sacramento Valley. However, the region exports large quantities of water to and through the Delta to augment statewide needs.

c. Does part of your region rely on coastal aquifers? Has salt intrusion been a problem in the past?

☐Yes ☐No ☒Perhaps/Uncertain

The NSV is not adjacent to the coast or any coastal aquifers. However, most of the region overlies ancient seabeds and deeper aquifers and some fractured rock aquifers have high saline and/or mineral contents and are generally not suitable for human consumption or agriculture.

d. Would your region have difficulty in storing carryover supply surpluses from year to year? Has your region faced a drought in the past during which it failed to meet local water demands?

☒Yes ☐No ☐Perhaps/Uncertain

Regional carryover storage is dominated by Shasta Dam and Oroville Dam, which have a combined storage capacity of about 8 million acre-feet. System-wide carryover storage is a primary purpose of these reservoirs, with water carried over from one year to the next to meet local and export water demands. The Bureau of Reclamation, which operates Shasta Dam, and the Department of Water Resources, which operates Oroville Dam, have generally declined to allow contracting water districts to carry over unused

allocations from the previous water year as they do for South-of-Delta contractors. Other than the exception of the Tehama-Colusa Canal service area, surface water use in the region has a prevailing water right priority to downstream and export water demands and therefore has not faced the inability to meet local water demands. The availability of groundwater in much of the region has historically allowed most surface water users to meet a portion of their demands from groundwater when surface water supplies are reduced during droughts. The other exception is some localized problems with groundwater pumping during drought conditions, where a switch from surface water to ground water has aggravated groundwater pumping by some smaller water users who historically rely solely on groundwater.

e. Does your region have invasive species management issues at your facilities, along conveyance structures, or in habitat areas?

☒Yes ☐No ☐Perhaps/Uncertain

Creeping yellow primrose, European watermilfoil, Brazilian waterweed, and purple loosestrife are problematic aquatic species in irrigation canals. Arundo, and Tamarisk, Alanthus, and purple loosestrife are major invasive species along ephemeral, intermittent, and perennial streams of the region – utilizing excessive amounts of water and degrading habitats. Yellow starthistle, barbed goatgrass, perennial pepperweed, Scotch broom, and rattlebush are problematic in habitat areas. Himalayan blackberry is an invasive species problem within Anderson-Cottonwood Irrigation District in Shasta County, and in many riparian and other wetland habitats throughout the region. The New Zealand mudsnail, an invasive mollusk, is known to have recently been introduced to the region, probably by unaware fishermen, in the upper Sacramento River near Red Bluff and some of its tributaries. Additionally, several aquaculturally-important aquatic plants, mollusks, and fish species with the potential for release from ornamental ponds and aquaria have been discovered in waterways at several locales within the region. Currently, the highly invasive quagga and zebra mussels have not been reported to occur in the region; however, awareness is high as to their potential for adverse effects to the environment, water supplies, and economy of the region.

3. **Water Quality**

a. Are increased wildfires a threat in your region? If so, does your region include reservoirs with fire-susceptible vegetation nearby which could pose a water quality concern from increased erosion?

☒Yes ☐No ☐Perhaps/Uncertain

Much of the landscape surrounding the major reservoirs of the NSV region, including Shasta Lake, Whiskeytown Lake, Lake Oroville, Englebright Reservoir, New Bullards Bar Reservoir, and Black Butte Reservoir, is dominated by fire-susceptible oak and conifer woodlands and grasslands. These reservoirs are located in the steep foothill and mountainous terrain of the Sierra Nevada, Klamath Mountains, and Coast Ranges where large wildfires are common and where wildfire suppression is a major challenge. In the short term, wildfires can lead to increased sediment loads and turbidity, which require increased filtration at water treatment plants. In the long term, increased debris and sediment entering reservoirs after wildfires will reduce a reservoir's lifespan.

b. Does part of your region rely on surface water bodies with current or recurrent water quality issues related to eutrophication, such as low dissolved oxygen or algal blooms? Are there other water quality constituents potentially exacerbated by climate change?

☒Yes ☐No ☐Perhaps/Uncertain
In the six-county region, there are 126 impairment listings, primarily associated with metals, pathogens and pesticides. Only 11 listings are associated with eutrophication (excessive nutrients which leads to low dissolved oxygen), 6 of those in sloughs. Increased erosion associated with increased wildfires (see previous item) will increase ambient turbidity (decreasing predation for site feeders) and sediment loads (sedimentation of fish beds). Another "constituent" exacerbated by climate change is temperature. Only the North Fork Feather River is currently listed as impaired by high temperatures. Higher regional temperatures will reduce reservoir operational flexibility needed to meet fisheries habitat criteria, decrease equilibrium dissolved oxygen concentrations, and decrease available nutrients.

c. Are seasonal low flows decreasing for some water bodies in your region? If so, are the reduced low flows limiting the water bodies' assimilative capacity?

☒Yes ☐No ☐Perhaps/Uncertain
Over the past 100 years, the fraction of the annual runoff that occurs during April-July has decreased by 23% in the Sacramento River watershed (California Climate Change Center, 2009. "The Future is Now: An Update on Climate Change Science Impacts and Response Options for California." May. http://www.energy.ca.gov/2008publications/CEC-500-2008-071/CEC-500-2008-071.PDF). Lower summer-season flows decrease our water bodies' assimilative capacity by both reducing the diluting flow volume and reducing the ambient water quality.

d. Are there beneficial uses designated for some water bodies in your region that cannot always be met due to water quality issues?

☒Yes ☐No ☐Perhaps/Uncertain
The same response to question b above applies here. Water quality issues are identified when monitoring data exceed standards set to protect beneficial uses.

e. Does part of your region currently observe water quality shifts during rain events that impact treatment facility operation?

☐Yes ☐No ☒Perhaps/Uncertain
The Sacramento River and Whiskeytown Lake provide 71% of Redding's water supply. Whiskeytown Reservoir has a small, protected watershed covered largely with pine forest. Sacramento River water is discharged through Lake Shasta, the state's 6th largest reservoir. City of Yuba City's surface water source is the Feather River, downstream of Lake Oroville (the state's largest reservoir). These reservoirs are largely immune from long-term water quality shifts though rain events may lead to short term operational changes. Municipal treatment costs are increased proportional to turbidity. Some agricultural users, even on the GCID and TCCA canals, experience short term increases

in turbidity that foul drip irrigation systems. Other water supply systems rely on groundwater, which is substantially buffered by natural filtration from short-term water quality effects associated with rain events.

4. **Sea Level Rise**

The NSV is far from the coast, and is not expected to be subject to changes in sea level. The lowest elevations in the region are in the proximity of the City of Colusa, approximately 50 feet above sea level and the City of Yuba City, approximately 60 feet above sea level. Most of the region is at a much higher elevation, with elevations in the region increasing to the north up to an elevation of about 500 feet in Redding. Areas above the floor of the Sacramento Valley to both the west and east are at even higher elevations.

5. **Flooding**

a. Does critical infrastructure in your region lie within the 200-year floodplain? Other follow-up questions that might help answer this question: (1) what public safety issues could be affected by increased flooding events or intensity; and (2) could key regional or economic functions be impacted from more frequent and/or intense flooding?

☒Yes ☐No ☐Perhaps/Uncertain

The Cities of Chico and Yuba City are urban areas in the NSV that are protected by features of the State Plan of Flood Control (SPFC). Urban and rural communities protected by features of the SPFC include the Cities of Colusa, Gridley, and Biggs and the communities of Princeton, Meridian, Grimes, and Robins. The respective areas are within the 200-year floodplain. Infrastructure critical to the public health and safety of the residents including hospitals, nursing homes, and state highways, plus water supply and wastewater facilities would be at risk from flooding and be subject to lengthy recovery times.

Urban areas within the NSV that are not protected by features of the SPFC but would be adversely impacted by a 200-year flood event include the cities of Redding, Red Bluff, Corning, and Williams.

The NSV is a highly productive agricultural area with substantial amounts of land protected by features of the SPFC. Critical infrastructure including agricultural water supply and drainage facilities and processing facilities would be subject to flooding for extended periods of time in the event of a 200-year or even a 100-year flood event. As a consequence, the ability and time to recover and become productive is uncertain thereby adversely impacting the economic functions in the NSV.

b. Does part of your region lie within the Sacramento-San Joaquin Drainage District?

☒Yes ☐No ☐Perhaps/Uncertain

A map of the Sacramento-San Joaquin Drainage District (SSJDD) is reproduced below in Figure 4-2, taken from their web site (http://www.cvfpb.ca.gov/ssjdd_maps/):

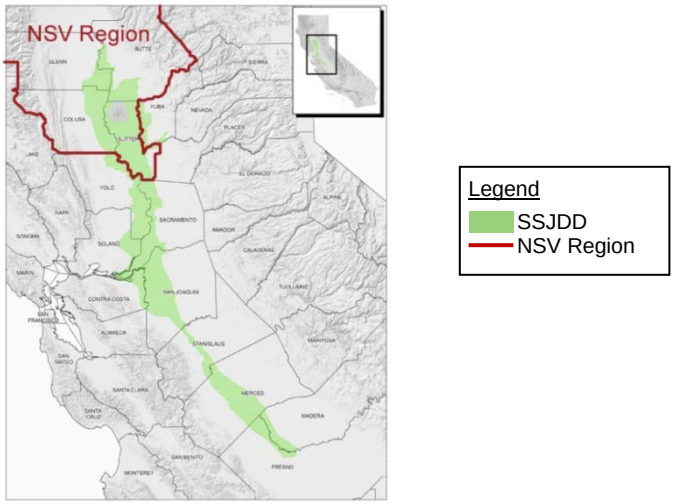

Figure 4-2. Boundaries of Sacramento-San Joaquin Drainage District

As shown in this figure, most of Sutter County, the far eastern portion of Colusa County and portions of Glenn and Butte counties adjacent to the Sacramento River are within the boundaries of SSJDD.

c. Does aging critical flood protection infrastructure exist in your region?

☒Yes ☐No ☐Perhaps/Uncertain
The majority of the land within the SSJDD is protected by features of the SPFC. These features including levees, weirs, and bypasses are insufficient in integrity and capacity to handle large floods in the Sacramento River Basin.

d. Have flood control facilities (such as impoundment structures) been insufficient in the past?

☒Yes ☐No ☐Perhaps/Uncertain
The flood control system along the Sacramento and Feather Rivers combines upstream flood regulation by Shasta Dam and Oroville Dam, with protection of lands by levees and the diversion of higher flood flows into the Sutter Bypass and the downstream Yolo Bypass (located just south of the NSV region). The 1986 and 1997 storms pushed the total flood system to maximum capacity. Some levees failed and areas were flooded. In 1997 some reaches of the Sacramento River system were pushed beyond their capacity resulting in levee breaks and substantial flooding. There continues to be localized flooding along tributaries to the Sacramento River, since they cannot (by virtue of their locations) benefit from reservoir and Bypass flood operations. Flooding along such stream systems continues to be a problem in areas throughout the region, particularly in Tehama County in areas outside of the floor of the NSV.

e. Are wildfires a concern in parts of your region?

☒Yes ☐No ☐Perhaps/Uncertain
Wildfires occur periodically in forest areas on both sides of the Sacramento Valley. Most of the surface water in the region originates in national forests to the east and north of the NSV. Approximately 63% of the NSV Region is forests, oak woodlands, or rangelands

which are all susceptible to wildfires. Large catastrophic wildfires leave vast landscapes barren of vegetation which can lead to localized flooding, increased siltation of waterways and flood control structures, reduction of surface water quality, and exacerbated erosion. These impacts have the potential to threaten and damage the region's water distribution systems.

6. **Ecosystem and Habitat Vulnerability**

a. Does your region include inland or coastal aquatic habitats vulnerable to erosion and sedimentation issues?

☒Yes ☐No ☐Perhaps/Uncertain
Erosion and sediment deposition are natural and important processes that shape landscapes and aquatic habitats and have contributed to the incredible fertility of the Sacramento Valley floor. Flood control operation of the large reservoirs and bank protection along the Sacramento River and its tributaries greatly limit large-scale erosion in the NSV region. However, some agricultural land drainage, forestry, and urban stormwater management practices have resulted in imbalances that contribute locally to excessive erosion and sedimentation, especially in some tributaries to the Sacramento River. Salmon spawning habitat in the upper Sacramento River and its smaller tributaries is particularly vulnerable to the effects of excessive fine sediment deposition on the streambed, which can smother salmon nests and reduce salmon production.

b. Does your region include estuarine habitats which rely on seasonal freshwater flow patterns?

☐Yes ☒No ☐Perhaps/Uncertain
The region does not have substantial estuarine environments. However, there are a number of state and federal wildlife refuges that serve as managed wetlands for both migratory waterfowl and terrestrial wildlife species. There are also important privately-managed wetlands – NRCS has restored and protects just over 10,000 acres of wetlands in the Colusa Basin Watershed (Colusa, Glenn & Yolo Counties) through their Wetlands Reserve Program. All refuges rely on seasonal freshwater supplies.

c. Do climate-sensitive fauna or flora populations live in your region?

☒Yes ☐No ☐Perhaps/Uncertain
A number of climate-sensitive species occur in the NSV region including anadromous salmonids, which require cold water streams, and migrating waterfowl, which depend on seasonal wetlands. A number of endemic invertebrate and plant species that are adapted to the region's seasonal rainfall cycles, such as vernal pool-dependent species, would be vulnerable to protracted droughts.

d. Do endangered or threatened species exist in your region? Are changes in species distribution already being observed in parts of your region?

☒Yes ☐No ☐Perhaps/Uncertain
Species in the region occurring for all or a portion of their lives and listed under either the Federal Endangered Species Act or the California Endangered Species Act, include but are not limited to winter-run and spring-run Chinook salmon, steelhead, green sturgeon,

giant garter snake, valley elderberry longhorn beetle, vernal pool fairy shrimp and tadpole shrimp, California red-legged frog, tricolored blackbird, Swainson's hawk, bank swallow, greater sandhill crane, California tiger salamander, western yellow-billed cuckoo, and the conservancy fairy shrimp. Changes in species distribution for salmon and steelhead are well-documented by the National Marine Fisheries Service and the California Department of Fish and Game, who continue through a variety of state and federal programs to take actions to improve conditions for all stages of the life cycles of these species.

e. Does the region rely on aquatic or water-dependent habitats for recreation or other economic activities?

☒Yes ☐No ☐Perhaps/Uncertain
Aquatic recreation is a substantial activity in the region, both in reservoirs as well as along river systems. Examples include substantial new recreational facilities developed near the City of Oroville along the Feather River, wildlife viewing and photography, and waterfowl hunting on refuges, rice fields and private wetlands.

f. Are there rivers in your region with quantified environmental flow requirements or known water quality/quantity stressors to aquatic life?

☒Yes ☐No ☐Perhaps/Uncertain
As discussed elsewhere, the NSV region includes major migratory pathways for anadromous fish, such as sturgeon, salmon and steelhead. They begin and end life in the region, while spending most of their lives in the Pacific Ocean as well as migrating out of and back into the region by way of the Sacramento and Feather Rivers. While spawning habitat has been a significant limiting factor in the past, the recent replacement of the Red Bluff Diversion Dam with a new pumping plant, combined with many other recent and planned fish migrating barrier removal projects, are expected to continue the trend of improving anadromous and resident fish populations. The substantial limiting factor continues to be water temperature, which affects mortality for early life stages of both salmon and steelhead.

g. Do estuaries, coastal dunes, wetlands, marshes, or exposed beaches exist in your region? If so, are coastal storms possible/frequent in your region?

☐Yes ☒No ☐Perhaps/Uncertain
Coastal storms may impact the region, but there are no estuaries, coastal dunes or exposed beaches. Wetlands and marshes exist in several state and federal wildlife refuges, as well as along tributary creeks to major rivers in the region.

h. Does your region include one or more of the habitats described in the Endangered Species Coalition's Top 10 habitats vulnerable to climate change (http://www.itsgettinghotoutthere.org/)?

☒Yes ☐No ☐Perhaps/Uncertain
Yes (qualified). The only two potential habitats on this list are the Sierra Nevada and the Bay-Delta. The focus on the Sierra Nevada in this reference is on higher elevation areas, which in general are above the floor of the Northern Sacramento Valley and outside (and tributary to) the region. The Bay-Delta brings forward more complex issues. While the

NSV is far above the Delta, it contributes a major portion of the surface water inflow to the Delta with major characteristics being flow (very high), water quality (generally very good) and the specific water quality characteristic of temperature. Based on review of the referenced information, the primary "habitat" applicable to the NSV is related to spawning and survival of sturgeon, salmon and steelhead as they pass through the region at various life cycles. These fish are migratory and go through the Delta.

i. Are there areas of fragmented estuarine, aquatic, or wetland wildlife habitat within your region? Are there movement corridors for species to naturally migrate? Are there infrastructure projects planned that might preclude species movement?

☒Yes ☐No ☐Perhaps/Uncertain

Less than 5-10 percent of the historic riparian wetlands continue to exist in the NSV region; however, acquisition of large tracts of the riparian corridor along the Sacramento River and its tributaries over the past 20 years for the express purpose of conservation management has prevented further reduction and fragmentation of this important habitat. Central Valley riparian and marsh wetlands are particularly important to neotropical birds and waterfowl, respectively, migrating along the Pacific Flyway. So, continuing conservation and, ultimately, restoration of these habitats are very important for migratory birds in view of the potential effects of global climate change in the NSV region in the future. Farming and agricultural operations in the region also provide thousands of acres of migratory bird habitat when water is available for rice straw decomposition. This migratory bird habitat also provides habitat for giant garter snakes and other local fauna. Furthermore, the recent removal of Red Bluff Diversion Dam on the Sacramento River, several diversion dams on Battle Creek, and McCormick-Seltzer Dam on Clear Creek have eliminated numerous impediments to anadromous fish migration and increased accessibility to presently important cold water spawning habitats. However, under some of the most severe climate change scenarios, blockage of anadromous salmonids from access to high-elevation, cold water habitat above Shasta Dam (Sacramento River), Whiskeytown Dam (Clear Creek), Centerville Dam (Butte Creek), and Englebright Dam (NF Yuba River) is thought to limit the long-term survival probabilities of salmon and steelhead in these streams.

7. Hydropower

a. Is hydropower a source of electricity in your region?

☒Yes ☐No ☐Perhaps/Uncertain

The region is served by the Pacific Gas and Electric Company (PG&E) and two municipal utilities, the Cities of Redding and Shasta Lake, which have varied sources of electricity that make up their energy generation portfolio. In wetter years a higher percentage of electricity is from hydropower generated within California from Shasta Lake Power Plant and Lake Oroville's Hyatt Power Plant, and also imported hydropower supplies from the Pacific Northwest. Other sources include fossil fuels (principally natural gas), nuclear, solar and wind. While other sources provide fairly constant supplies from year to year, hydropower generation decreases during dry years as well as prolonged drought years. When this relatively inexpensive source of power (at least as compared to other energy sources) is diminished, energy rates at the consumer level have

historically increased. Hydropower is unlike fossil fuel sources, which are always available although energy costs vary with fuel prices.

b. Are energy needs in your region expected to increase in the future? If so, are there future plans for hydropower generation facilities or conditions for hydropower generation in your region?

☐Yes ☐No ☒Perhaps/Uncertain

Whether energy needs will increase in the future is uncertain, but opportunities for greater hydropower generation in the region do exist. At the same time Californians are increasing their efficiency of electrical use, we expect after the economy improves to see continued population increases. At present the net impacts on increased energy use are difficult to forecast.

The source of water supplies for reservoirs is largely snowmelt runoff, and indications are that timing of snowmelt runoff is shifting to earlier in the year. In addition, any decrease in the volume of snowpack (whether from changes in precipitation or temperature) will decrease summer inflow to reservoirs. Consequently it is possible that there will be a shift in the timing for hydropower generation. This is particularly the case under circumstances where, in any year, a greater percentage of total precipitation comes as rain. Reservoir hydropower generation is further restricted by environmental flow restrictions and flood control requirements.

There may be future opportunities to expand hydropower generation to take advantage of future changes in reservoir releases, particularly those releases for flood control. Investing in expansion of hydropower generation will depend on a number of factors, such as:

- Can the impoundment and generation facilities be built at a cost that will result in competitively priced energy?
- Is there the political will to move forward with such a project?
- Will the extensive environmental challenges that would be expected to occur be worth the effort?

4.3.2 Prioritization of Potential Climate Change Vulnerabilities

The potential climate change sensitivities listed in the survey were scored and ranked according to the following criteria:

1. For most questions, a “Yes” answer indicated vulnerability and a “No” answer indicated a lack of vulnerability. One exception to this was question 1.e. For Question 1.e, the scoring was reversed because a “No” answer indicated vulnerability.
2. In general, “Yes” answers were given a score of 10. “No” answers were given a score of 0. “Uncertain/Perhaps” answers were given a score of 5.

3. The scores for each question were totaled by category and a percent vulnerability was calculated by dividing the score by the maximum possible score (number of questions times 10).
4. The potential climate change vulnerabilities were then prioritized by percent vulnerability.

The scoring process is shown in Table 4-5.

As shown in Table 4-5, the NSV region is most potentially sensitive to water supply and flooding impacts that may be exacerbated by climate change. Potential impacts to water quality and ecosystem and habitat vulnerability also scored high. Based on the responses to the DWR Climate Change Vulnerability Checklist and as shown in Table 4-5, the "Flooding" climate change sensitivity category scored 100%, the "Water Supply" category scored 100%, the "Water Quality" category scored 90%, the "Ecosystem and Habitat Vulnerability" category scored 78%, the "Hydropower" category scored 75%, the "Water Demand" category scored 67%, and the "Sea Level Rise" category scored 0%. Therefore, based on this vulnerability assessment, the NSV region's vulnerabilities to climate change, in order of sensitivity, are flooding, water supply, water quality, ecosystems and habitat, hydropower, and water demand. These climate change vulnerability ratings should not be confused with the NSV region priorities, or the IRWM Goals and Objectives described in Chapter 2.

Table 4-5. Climate Change Sensitivity Survey Scoring Sheet

Climate Change Survey Category	Climate Change Survey Question	Score[a]
1. Water Demand		
a	Are there major industries that require cooling/process water in your planning region?	10
b	Does water use vary by more than 50% seasonally in parts of your region?	10
c	Are crops grown in your region climate-sensitive? Would shifts in daily heat patterns, such as how long heat lingers before night-time cooling, be prohibitive for some crops?	10
d	Do groundwater supplies in your region lack resiliency after drought events?	0
e	Are water use curtailment measures effective in your region?	5
f	Are some instream flow requirements in your region either currently insufficient to support aquatic life, or occasionally unmet?	5
	Total	40
	Percent	67%
2. Water Supply		
a	Does a portion of the water supply in your region come from snowmelt?	15
b	Does part of your region rely on water diverted from the Delta, imported from the Colorado River, or imported from other climate-sensitive systems outside your region?	0
c	Does part of your region rely on coastal aquifers? Has salt intrusion been a problem in the past?	5
d	Would your region have difficulty in storing carryover supply surpluses from year to year? Has your region faced a drought in the past during which it failed to meet local water demands?	15
e	Does your region have invasive species management issues at your facilities, along conveyance structures, or in habitat areas?	15
	Total	50
	Percent	100%
3. Water Quality		
a	Are increased wildfires a threat in your region? If so, does your region include reservoirs with fire-susceptible vegetation nearby which could pose a water quality concern from increased erosion?	10
b	Does part of your region rely on surface water bodies with current or recurrent water quality issues related to eutrophication, such as low dissolved oxygen or algal blooms? Are there other water quality constituents potentially exacerbated by climate change?	10
c	Are seasonal low flows decreasing for some water bodies in your region? If so, are the reduced low flows limiting the water bodies' assimilative capacity?	10
d	Are there beneficial uses designated for some water bodies in your region that cannot always be met due to water quality issues?	10
e	Does part of your region currently observe water quality shifts during rain events that impact treatment facility operation?	5
	Total	45
	Percent	90%
4. Sea Level Rise (Not Applicable)		
	Total	0
	Percent	0%
5. Flooding		
a	Does critical infrastructure in your region lie within the 200-year floodplain? Other follow-up questions that might help answer this question: (1) what public safety issues could be affected by increased flooding events or intensity; and (2) could key regional or economic functions be impacted from more frequent and/or intense flooding?	10
b	Does part of your region lie within the Sacramento-San Joaquin Drainage District?	10
c	Does aging critical flood protection infrastructure exist in your region?	10
d	Have flood control facilities (such as impoundment structures) been insufficient in the past?	10
e	Are wildfires a concern in parts of your region?	10
	Total	50
	Percent	100%
6. Ecosystem and Habitat Vulnerability		
a	Does your region include inland or coastal aquatic habitats vulnerable to erosion and sedimentation issues?	10
b	Does your region include estuarine habitats which rely on seasonal freshwater flow patterns?	0
c	Do climate-sensitive fauna or flora populations live in your region?	10
d	Do endangered or threatened species exist in your region? Are changes in species distribution already being observed in parts of your region?	10
e	Does the region rely on aquatic or water-dependent habitats for recreation or other economic activities?	10
f	Are there rivers in your region with quantified environmental flow requirements or known water quality/quantity stressors to aquatic life?	10
g	Do estuaries, coastal dunes, wetlands, marshes, or exposed beaches exist in your region? If so, are coastal storms possible/frequent in your region?	0
h	Does your region include one or more of the habitats described in the Endangered Species Coalition's Top 10 habitats vulnerable to climate change (http://www.itsgettinghotoutthere.org/)?	10
i	Are there areas of fragmented estuarine, aquatic, or wetland wildlife habitat within your region? Are there movement corridors for species to naturally migrate? Are there infrastructure projects planned that might preclude species movement?	10
	Total	70
	Percent	78%
7. Hydropower		
a	Is hydropower a source of electricity in your region?	10
b	Are energy needs in your region expected to increase in the future? If so, are there future plans for hydropower generation facilities or conditions for hydropower generation in your region?	5
	Total	15
	Percent	75%

[a] Yes = 10, No = 0, and Uncertain/Perhaps = 5, except for question 1e where Yes =0, No = 10, and Uncertain/Perhaps = 5.

For More Information

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