Handout 8: Draft Climate Change Vulnerability Checklist

Meeting 6 – 9 July 2012, Woodland

This Climate Change Vulnerability Checklist for the Westside Region was provided by the Department of Water Resources (DWR) in its Climate Change Handbook found at http://www.water.ca.gov/climatechange/CCHandbook.cfm. Although not required to meet the Proposition 84 IRWM Plan Guidelines issued in August 2010, DWR recommends preparation of a climate change vulnerability assessment which is at least equivalent to this checklist in order to meet the anticipated Climate Change Standard for Round 2 and 3 of the Proposition 84 IRWM Implementation Grant.

The questions found in the checklist are identified by number and are not italicized. The draft responses are in italics below each numbered question. This checklist is intended to be an appendix to the IRWM Plan. Specific narrative relevant to climate change that is drawn from the responses to this checklist will be incorporated directly into a variety of IRWM Plan sections. Note: specific references to appendix numbers will be updated when this section is incorporated into the IRWM Plan.

1 Water Demand

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

- As average temperatures increase, cooling water needs may also increase.
- Identify major industrial water users in your region and assess their current and projected needs for cooling and process water.

Most industry within the Region is light industrial business that do not require large amounts of process water or have large cooling needs. One larger industrial business in the Region is the Woodland tomato processing facility which is likely to have seasonal process water needs. The only facility with large cooling demand that was identified is the UC Davis heating and cooling system.
UC Davis owns and operates a central heating and cooling plant to produce steam and chilled water for the campus. The plant uses a boiler infrastructure at the Central Heating and Cooling Plant (CHCP). The system provides steam for building heat, hot water, and process loads with a boiler at the Central Heating and Cooling Plant. Chilled water is also produced and distributed through the system. It is not known at this time the quantity of make up water needed for boilers and chillers at UC Davis and the potential magnitude of change to meet higher temperatures resulting from climate change.

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

- Seasonal water use, which is primarily outdoor water use, is expected to increase as average temperatures increase and droughts become more frequent.
- Where water use records are available, look at total monthly water uses averaged over the last five years (if available). If maximum and minimum monthly water uses vary by more than 25%, then the answer to this question is "yes".
- Where no water use records exist, is crop irrigation responsible for a significant (say >50%) percentage of water demand in parts of your region?

Water use within the Region consists of approximately 95% agricultural use which is highly seasonal. Water demand for agricultural water throughout the region was estimated using a DWR land use survey containing agricultural acreages by crop type with an estimated annual applied water factor for each crop type (compiled by DWR). Although the applied water factor was summarized annually, the model that DWR uses to calculate these yearly estimates uses monthly evapotranspiration data to estimate applied water for each crop type using the following equation:

Etc=Kc x Eto where Eto (reference evapotranspiration) varies based on local climate changes.

*Within the Valley Floor, which contains the majority of the agricultural water use within the Region, average Eto varies from 1 in January to 8.5 in July. The Kc (*crop coefficient*, a dimensionless number that is multiplied by the Eto value to arrive at a crop Etc estimate) for a crop varies based on its growth pattern. Many plants are only grown in the summer, because growth conditions are appropriate in that season. Plants that are grown annually require more water in the summer due to the higher Eto and the lack of rainfall to supplement the additional needed water for the plants. An exact estimation of seasonal water use was not calculated; however, based on the high seasonal variability of both Eto and Kc, it can be assumed that water use varies by at least 50% seasonally within the Region.*

Climate change is expected to increase average temperatures and cause droughts to become more frequent. This is likely to cause outdoor water use (primarily agriculture in this Region) to increase through increases in evapotranspiration and potential extension of growing seasons. These two factors could increase water demand within the Region, if no mitigating actions are taken such as increased irrigation efficiency and conversion to more water efficient crop types.

1.3 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?

- Fruit and nut crops are climate-sensitive and may require additional water as the climate warms.

Many of the Valley Floor's row crops are warm-season horticultural crops (e.g., tomato, cucumber, sweet corn, and pepper) that are climate-sensitive with an optimum temperature of 68°F to 77°F for yield, and an acceptable range of 53.6°F to 86°F, with a maximum tolerance of 95°F. Mean mid-summer maximum temperatures within the Valley Floor already slightly exceed this, suggesting that 1.8°F and 5.4°F temperature increase by mid-century may force a shift to hot-season crops such as melon and sweet potato which have higher acceptable temperature ranges (64°F to 95°F). Warmer winter temperatures, however, would favor cool season crops, such as lettuce and broccoli, that are now grown in winter/early spring further south, and which have an acceptable range of 41°F to 77°F. For field crops such as corn and rice, temperature extremes exceeding 41°F-95°F, respectively, decreases in pollen viability and pollen production could reduce yields. For corn, kernel development is reduced at temperatures greater than 86°F, but is less vulnerable to heat waves during the reproductive phase than grains such as wheat, barley, and rice. Fruit trees require 200 to 1,200 hours of winter chill to flower. Chill hours are computed on a daily basis relative to a reference temperature. Using climate predictions for the Central Valley, winter chill hours will decrease from a baseline of 1,000 hours, as observed in 1950, to about 500 hours by 2100. Under most climate scenarios, the winter climate in the Valley Floor will approach the critical thresholds for yield for many fruit tree species by the end of the century.

In the Upper Putah Creek and Upper Cache Creek Areas, there are large acreages of vineyards. High temperatures during the growing season can cause premature ripening and reduce grape quality. Temperature increases are expected to have only modest effect on grape quality in most regions over the next few decades. However, toward the end of the century, wine grapes could ripen as much as one to two months earlier.

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

- Droughts are expected to become more frequent and more severe in the future. Areas with a more hardened demand may be particularly vulnerable to droughts and may become more dependent on groundwater pumping.

Overall, groundwater supplies are resilient throughout the Region. In the Valley Floor, groundwater levels are generally considered high and stable with pumping and recharge in equilibrium. During droughts the groundwater level can decrease significantly. For example, during the1975-77 drought, water levels reached the lowest point ever recorded but have since recovered and are high again. Limited data are available regarding the groundwater basins in the upper watershed. The High Valley Groundwater Basin, near Clearlake Oaks in the Upper Cache Creek Planning Area, is one groundwater supply source that is slow to recover after

droughts because of low recharge rates to the basin; following the drought of 1976, it took 5 years for water levels in the High Valley Groundwater Basin to return to pre-1976 levels.

A large number of farmers throughout the Region rely on groundwater as their primary water supply during a normal year. This number is expected to increase under possible future drought and population growth conditions as water variability within the Region increases, causing inconsistency in surface water supplies. According to the California Department of Water Resources, rice, pasture, and hay have the highest applied water, and evapotranspiration (ET) of applied water, and are therefore most vulnerable to water shortages. In addition, as cropping patterns change from field and row crops to higher value permanent crops such as vineyard, olives, and fruit trees, water supply reliability becomes increasingly important to keep these permanent crops viable. At present, it is estimated that about 15% of the agricultural acreage in the Valley Floor is cultivated with permanent crops.

The known effect of climate change on water supply is higher variability and therefore uncertainty, and thus the effect of these variations in the water supply on agriculture is not fully understood. Groundwater overdraft could contribute to uncertainty in the quantity and sometimes the quality of irrigation water for agriculture and municipal and industrial supplies. Intermittent periods of dry years may not permit an easy rebound for irrigated crops, especially if groundwater is not available and affordable. Perennial crops are particularly vulnerable, but even growers of annual crops are also vulnerable, and may need to shift crops or set aside land. The prognosis of a drier Western United States suggests high vulnerability for crops that are abundant water users, especially if their cash value is low.

1.5 Are water use curtailment measures effective in your region?

- Droughts are expected to become more frequent and more severe in the future. Areas with a more hardened demand may be particularly vulnerable to droughts.

Curtailment measures can be effective in the Region because the majority of water demand in the Region is agricultural, and agricultural cropping patterns can be modified in response to reduced water availability. Annual crops can also be interchanged for more water efficient crops to reduce water use. If droughts become more frequent and severe, causing water supply to become threatened, growers may need to fallow lands and/or shift towards drip irrigation and crops that provide higher income per amount of applied water. These systems however require substantial investment, labor and energy for pressurization and are not effective on all crop types. In addition, crops with drip irrigation tend towards higher value permanent crops with resulting demand hardening which increases vulnerability to drought.

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

- Changes in snowmelt patterns in the future may make it difficult to balance water demands. Vulnerabilities for ecosystems and municipal/agricultural water needs may be exacerbated by instream flow requirements that are:
  1. not quantified,
  2. not accurate for ecosystem needs under multiple environmental conditions including droughts, and
  3. not met by regional water managers.

There are instream flow requirements for both Cache Creek and for Putah Creek. These requirements are currently being met within the Region through strategic operations of storage facilities to balance consumptive and non-consumptive demands.

2 Water Supply

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

- Snowmelt is expected to decrease as the climate warms. Water systems supplied by snowmelt are therefore potentially vulnerable to climate change.
- Where watershed planning documents are available, refer to these in identifying parts of your region that rely on surface water for supplies; if your region contains surface water supplies originating in watersheds where snowpack accumulates, the answer to this question is "Yes."
- Where planning documents are not available, identify major rivers in your region with large users. Identify whether the river's headwaters are fed by snowpack.

The Cache Creek and Putah Creek watersheds are the predominant sources of surface water within the Region and are not dependent on snowmelt. Other water sources in the Region include the Colusa Basin Drain, Willow Slough, Sacramento River, as well as deliveries from the California State Water Project (SWP) (via Oroville Reservoir and the Feather River), and the Federal Central Valley Project (CVP) (via Shasta Reservoir and the Sacramento River). The sources of water from the Sacramento River, SWP and CVP supplies come primarily from snowmelt. The sources and reliability of water supplies throughout the Region are described in a number of watershed and water system planning documents including:

- *Urban Water Management Plans (plans were prepared in 2010 for Vacaville, Dixon, Davis, Woodland, West Sacramento, and Solano County Water Agency)*
- *Lake County Water Inventory Analysis (2006) – Lake County Watershed Protection District*
- *Water Management Plan (2000) – Yolo County Flood Control and Water Conservation District*

Large variations in the weather would affect the municipalities and farmers receiving water from all of these water sources. In many cases, it is likely that improvements to infrastructure to better distribute supplies from the Cache Creek and Putah Creek watersheds to be used conjunctively with groundwater would improve resilience in the region to the effects of climate change. That said, the impacts climate change may have on the Region are highly variable; current information from climate change models is not sufficiently granular to demonstrate specific impacts to water supply reliability within the Region into the future when considering potential changes in hydrologic patterns in the watersheds.

2.2 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?

- Some imported or transferred water supplies are sources from climate-sensitive watersheds, such as water imported from the Delta and the Colorado River.

Portions of the Valley Floor area receive water through the SWP and CVP. Additionally, some of the local water purveyors along the Sacramento River divert water from the river. Some of the agencies and farmers relying on these source waters have additional groundwater supply wells, should the surface water supply be unavailable in a particular year; however, not all users have access to range of water supplies.

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

- Coastal aquifers are susceptible to salt intrusion as sea levels rise, and many have already observed salt intrusion due to over-extraction, such as the West Coast Basin in southern California.

There are no coastal aquifers in the Region.

2.4 Would your region have difficulty in storing carryover supply surpluses from year to year?

- Droughts are expected to become more severe in the future. Systems that can store more water may be more resilient to droughts.

Both Lake Berryessa and Indian Valley Reservoir have provided carryover storage in a normal year. Clear Lake is more limited in its storage. If the level is below 3.22 Rumsey on May 1, then Yolo County Flood Control and Water Conservation District does not receive water from Clear Lake for use as irrigation water and must rely on water supplied from Indian Valley Reservoir and groundwater. Water levels have been below 3.22 Rumsey on May 1, 13 times since 1900. (Can this information be confirmed? It was extrapolated from a document with historic high and low water levels of Clear Lake)

2.5 Has your region faced a drought in the past during which it failed to meet local water demands?

- Droughts are expected to become more severe in the future. Systems that have already come close to their supply thresholds may be especially vulnerable to droughts in the future.

Conjunctive use within the Region has allowed for meeting local water demands even in drought years.

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

- As invasive species are expected to become more prevalent with climate change, existing invasive species issues may indicate an ecological vulnerability to climate change.

Control of invasive species has been identified as a challenge for the region. Appendix XX,Table X identifies aquatic/riparian invasive plant species occurring in the Westside Region along with an assessment of the risk each species presents to the region. Invasive species that are common throughout the Westside Region are: Giant reed (Arundo donax), Hoary cress (Cardaria draba), Water hyacinth (Eichhornia crassipes), Perennial pepperweed (Lepidium latifolium), Eurasian watermilfoil (Myriophyllum spicatum), Himalayan blackberry (Rubus discolor), Ravenna grass (Saccharum ravennae) and Tamarisk (Tamarix spp.). Of these, giant reed, Himalayan blackberry and tamarisk have the greatest potential to intensify the Region's vulnerability to climate change because they consume large amounts of water. If these species continue to spread along the Region's water conveyance channels, they will further reduce the amount of water available to a Region that is already expected to face reduced water supplies as a result of climate change.

Colonization of water bodies by aquatic invertebrates such as quagga mussels, zebra mussels and New Zealand mud snails is another invasive species management issue that has been identified for the region. Appendix A, Table X-X identifies the status of these aquatic invertebrate invasive species within the Westside Region along with an assessment of the risk each species presents to the region. Quagga mussels and zebra mussels are not yet known to occur in the Region but are being closely monitored because of the threat they present to the water supply infrastructure.

3 Water Quality

3.1 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?

- Some areas are expected to become more vulnerable to wildfires over time. To identify whether this is the case for parts of your region, the California Public Interest Energy Research (PIER) Program has posted wildfire susceptibility projections as a Google Earth application at: http://cal-adapt.org/fire/. These projections are only the results of a single study and are not intended for analysis, but can aid in qualitatively answering this question. Read the application's disclaimers carefully to be aware of its limitations.

Increased wildfires are a threat to the Region, particularly in the upper watersheds, where the Region's reservoirs are located. The effects of climate change on wildfires in Northwestern California, which includes the Napa and Lake County portions of the Region, are not well understood, but some studies suggest that the probability of large wildfires (>200-ha) will increase. This increased threat of wildfire poses the greatest water quality risk for Lake Berryessa and Indian Valley Reservoir, as the predominant vegetation surrounding these two reservoirs is chaparral, which is highly susceptible to fire.

There is a slight increase in the probability of large wildfires (>200-ha) occurring in the Valley Floor. Because the increase is small and the Valley Floor lacks reservoirs, it is not a significant water quality concern.

3.2 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?

- Warming temperatures will result in lower dissolved oxygen levels in water bodies, which are exacerbated by algal blooms and in turn enhance eutrophication. Changes in streamflows may alter pollutant concentrations in water bodies.

Algal blooms are a recurring issue on Clear Lake but have occurred, at some level, in Clear Lake prior to human habitation. Of particular concern at present is the presence of toxic cyanobacteria from blue-green algae. Research suggest that higher temperatures favor the growth of toxic cyanobacteria species such as Microcystis aeruginosa over other algal species.

3.3 Are seasonal low flows decreasing for some waterbodies in your region? If so, are the reduced low flows limiting the waterbodies' assimilative capacity?

- In the future, low flow conditions are expected to be more extreme and last longer. This may result in higher pollutant concentrations where loadings increase or remain constant.

Decreases in seasonal low flows have not been noted within the Region as both Putah Creek and Cache Creek have controlled releases through upstream storage reservoirs. Upstream storage has allowed Putah and Cache Creeks to have summer flows when they did not typically occur under natural conditions.

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

- In the future, low flows are expected decrease, and to last longer. This may result in higher pollutant concentrations where loadings increase or remain constant.

There are beneficial uses in the Region that are not being met due to water quality impairment. However, because the pollutants causing the water quality impairment are often carried into the water bodies through stormwater or naturally occurring runoff, reduced flows as occurs during drought would also reduce pollutant loading.

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

- While it is unclear how average precipitation will change with temperature, it is generally agreed that storm severity will probably increase. More intense, severe storms may lead to increased erosion, which will increase turbidity in surface waters. Areas that already observe water quality responses to rainstorm intensity may be especially vulnerable.

Significant water quality shifts in response to rain events have not been documented in the region.

4 Sea Level Rise

4.1 Has coastal erosion already been observed in your region?

- Coastal erosion is expected to occur over the next century as sea levels rise.

The project area does not include coastline therefore coastal erosion will not occur. However, erosion has been observed on levees in the Delta and levee erosion may be exacerbated due to sea level rise. This concern is addressed further in Section 5, Flooding.

4.2 Are there coastal structures, such as levees or breakwaters, in your region?

- Coastal structures designed for a specific mean sea level may be impacted by sea level rise.

The project area does not include coastline. However, Delta levees may be threatened with higher sea level, particularly the levees protecting Delta islands, many of which are weak and built on a weak peat soil base. Higher water levels increase the water pressure on the levees, and will likely cause more failures. Much of the agricultural area in the Delta was created from swampland by building levees around the edges of the many islands and low lying tracts. Much of this area has subsided to below sea level elevations due to compression and oxidation of the peaty materials. The concerns associated with levee failure are addressed further in Section 5, Flooding.

4.3 Is there significant coastal infrastructure, such as residences, recreation, water and wastewater treatment, tourism, and transportation) at less than six feet above mean sea level in your region?

- Coastal flooding will become more common, and will impact a greater extent of property, as sea levels rise. Critical infrastructure in the coastal floodplain may be at risk.
- Digital elevation maps should be compared with locations of coastal infrastructure.

Cal-Adapt mapping does not indicate any additional threats due to sea level rise in the Westside region. However, some critical infrastructure in the floodplain is at-risk. These risks are discussed further in Section 5, Flooding.

4.4 Are there climate-sensitive low-lying coastal habitats in your region?

- Low-lying coastal habitats that are particularly vulnerable to climate change include estuaries and coastal wetlands that rely on a delicate balance of freshwater and salt water.

The habitat in the Delta includes estuaries that may be impacted by increasing salinity as a result of sea level rise, but the degree of impact is not well understood.

4.5 Are there areas in your region that currently flood during extreme high tides or storm surges?

- Areas that are already experiencing flooding during storm surges and very high tides, are more likely to experience increased flooding as sea levels rise.

The lower reaches of the Sacramento River are under the influence of tides. Rio Vista is prone to flooding when very high tides and a large volume of stream outflow occur coincidentally, and strong onshore winds generate wave action that would increase the flood hazard above that of the tidal surge alone. Impact on flood-prone areas of the Westside region is discussed further in Section 5, Flooding.

4.6 Is there land subsidence in the coastal areas of your region?

- Land subsidence may compound the impacts of sea level rise.

Much of the agricultural area in the Delta was created from swampland by building levees around the edges of the many islands and low lying tracts. Much of this area has subsided to below sea level elevations due to compression and oxidation of the peaty materials. The areas below sea level highly susceptible to flooding in the event of a levee failure, and the risk is likely to increase as sea levels rise. Section 5, Flooding, discusses these concerns.

There are additional areas in the region where subsidence due to groundwater pumping has been detected, including the northern Yolo-Zamora area of Yolo County between Zamora and Knights Landing, where subsidence is reported to be on the order of 5 feet and in the vicinity of Davis and Woodland, where subsidence is estimated at 2 to 3 feet.

4.7 Do tidal gauges along the coastal parts of your region show an increase over the past several decades?

- Local sea level rise may be higher or lower than state, national, or continental projections.
- Planners can find information on local tidal gauges at http://tidesandcurrents.noaa.gov/sltrends/sltrends_states.shtml?region=ca.

San Francisco and Port Chicago Stations both indicate a rise in mean sea level. Port Chicago is the most upstream station in the San Francisco Bay and is closest to the Westside Region

San Francisco: The mean sea level trend is 2.01 millimeters/year with a 95% confidence interval of +/- 0.21 mm/yr based on monthly mean sea level data from 1897 to 2006 which is equivalent to a change of 0.66 feet in 100 years

Port Chicago: The mean sea level trend is 2.08 millimeters/year with a 95% confidence interval of +/- 2.74 mm/yr based on monthly mean sea level data from 1976 to 2006 which is equivalent to a change of 0.68 feet in 100 years

5 Flooding

5.1 Does critical infrastructure in your region lie within the 200-year floodplain? DWR's best available floodplain maps are available at: *http://www.water.ca.gov/floodmgmt/lrafmo/fmb/fes/best_available_maps/*.

- While it is unclear how average precipitation will change with temperature, it is generally agreed that storm severity will probably increase. More intense, severe storms may lead to higher peak flows and more severe floods.
- Refer to FEMA floodplain maps and any recent FEMA, US Army Corps of Engineers, or DWR studies that might help identify specific local vulnerabilities for your region. Other follow-up questions that might help answer this question:
  1. What public safety issues could be affected by increased flooding events or intensity? For example, evacuation routes, emergency personnel access, hospitals, water treatment and wastewater treatment plants, power generation plants and fire stations should be considered.
  2. Could key regional or economic functions be impacted from more frequent and/or intense flooding?

Based on 200-yr floodplain mapping prepared in 2008 in accordance with SB-5, there are areas of the Valley Floor planning area, most of which is agricultural land, that lie within the 200-year floodplain. The urbanized areas within the 200-year floodplain are restricted to City of West Sacramento and City of Rio Vista. Within the City of West Sacramento, the Port of West Sacramento as well as a portion of West Capitol Avenue, a major arterial road into Sacramento; portions of Interstate 80, US-50, the Union Pacific main railroad line, the regional USPS mail processing center, the regional Department of Water Resources flood fight facility, and the California Highway Patrol Academy (a key facility in state emergencies) are all indicated as being within the inundation

area. Efforts are underway by the Army Corps of Engineers and the Central Valley Flood Protection Board to strengthen levees as part of the Corps' Sacramento River Bank Protection Project to reduce flood risk in West Sacramento including completion of a section of a setback levee in Fall 2011.

As of 2006, the City of Rio Vista has noted that two (2) miles of roadway and two (2) miles of pipeline are in the 100-year flood plain. Some of these areas also appear to be in the 200-year flood plain. Rio Vista has participated in multi-hazard mitigation planning with the Association of Bay Area Governments (ABAG) as well as tracking Bay-Delta activities including preparation of the Delta Risk Management Strategy and participating in the Delta Area Working Group. An update of the 200-year floodplain map is expected in the middle of 2012 and this narrative will be updated as appropriate. It should be noted that if a flood event were coincident with a high tide event that is exacerbated by climate change impacts, the extent of the flooding will likely be more extensive than estimated.

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

- The SSJDD contains lands that are susceptible to overflows from the Sacramento and San Joaquin Rivers, and are a key focus of the Central Valley Flood Protection Plan. (http://www.water.ca.gov/cvfmp/program.cfm).

Much of the Valley Floor Planning area east of I-5 and Highway 113, south to Rio Vista are within Sacramento-San Joaquin Drainage District under the jurisdiction of the Central Valley Flood Protection Board (CVFPB). The CVFPB cooperates with the US Army Corps of Engineers as well as other agencies to control flooding along the Sacramento and San Joaquin Rivers. As described in 5.1, much of the lands that will be flooded are agricultural but also include important urban areas as well.

5.3 Does aging critical flood protection infrastructure exist in your region?

- Levees and other flood protection facilities across the state of California are aging and in need of repair. Due to their overall lowered resiliency, these facilities may be particularly vulnerable to climate change impacts.
- DWR is evaluating more than 300 miles of levees in the San Joaquin and Sacramento Rivers Valleys and the Delta (http://www.water.ca.gov/levees/).

Portions of the Valley Floor Planning Area are located in the SSJDD as administered by the CVFPB. In addition, the Central Valley Flood Management Planning Program, a program of DWRs FloodSAFE California, has prepared the Flood Control System Status Report (FCSSR) in 2011 that identifies vulnerabilities to those facilities of the State Plan of Flood Control (SFPC) (i.e. those State-federal flood protection systems). There are also facilities that are maintained by reclamation districts and/or private parties that may not yet have been evaluated. The FCSSR report was developed using information from the DWR Levee Evaluations Program and includes facilities both in the Valley Floor and Upper Cache Creek Planning Areas. FCSSR indicates that many of the levees in the Valley Floor Planning Area and some levees in the Upper Cache Creek Planning Area have a relative levee condition of "higher concern" or are lacking sufficient data to assess. Based on the FCSSR, some of the specific concerns with the flood levees are that they: have a high persistence of animal burrow holes; have urban levees that do not meet freeboard, levee geometry, seepage, and/or stability criteria; have non-urban levees that could fail from under-seepage, through-seepage, slope stability, or erosion; and have potentially inadequate channel capacity. It should be noted that the City of Rio Vista is at risk for flooding as it is located on the Sacramento River at the downstream end of the Yolo Bypass but is not protected by the SPFC, although it is included in the Systemwide Planning area.

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

- Reservoirs and other facilities with impoundment capacity may be insufficient for severe storms in the future. Facilities that have been insufficient in the past may be particularly vulnerable.

Fifteen (15) flooding events with damage have occurred since 1937 in and around Clear Lake some of which is related to poor infrastructure including levee breaches/overtopping, but also due to development in the

floodplain, high stages of tributary creeks, and mostly a result of low outflow capacity at Grigsby Riffle, a naturally occurring feature that cannot be modified because of court decrees currently in place.

In addition, flooding also occurs as a result of insufficient levee heights and/or flood control facilities in the Valley Floor along the Sacramento River; the region also includes the Yolo Bypass a significant flood control feature that is instrumental in reducing flooding in the City of Sacramento, but does not provide flood protection to the Valley Floor. There are many flood-prone areas in the Region including:

- *The lower reaches of the Sacramento River (e.g. Rio Vista) under the influence of tides and storm induced wave action – this effect will be exacerbated by higher tides that are likely as a result of climate change.*
- *The lower Cache Creek near Woodland which is the site of some historic levee breaches and levee overtopping*
- *The Colusa Basin Drainage Canal, in the Cottonwood-Willow Slough watershed south of Cache Creek*
- *The Dry Sough/Davis watershed north of Putah Creek*
- *Flooding in the Davis area is a result of relatively flat topography and the backwater from Willow Slough Bypass and Yolo Bypass.*
- *West Sacramento, which is not protected from flooding by the Sacramento River and Yolo Bypass levees during high flood flows.*

Furthermore, the urbanization of Vacaville intensifies flood problems because of the decrease in the amount of open land available to absorb rainfall and runoff, thus increasing the volume of water that must be carried away by waterways.

5.5 Are wildfires a concern in parts of your region?

- Wildfires alter the landscape and soil conditions, increasing the risk of flooding within the burn and downstream areas. Some areas are expected to become more vulnerable to wildfires over time. To identify whether this is the case for parts of your region, the California Public Interest Energy Research Program (PIER) has posted wildfire susceptibility projections as a Google Earth application at: http://cal-adapt.org/fire/. These projections are the results of only a single study and are not intended for analysis, but can aid in qualitatively answering this question. Read the application's disclaimers carefully to be aware of its limitations.

The Upper Cache Creek planning area includes thousands of acres of land in the Mendocino National Forest and BLM land. USFS and BLM manage wildfires in accordance with guidelines, depending on the land use (wilderness vs. non-wilderness areas). Much of these federal lands and adjacent private lands drain to Clear Lake which could exacerbate tributary and lake flooding if a wildfire were to occur.

CalAdapt indicates that areas that will become more vulnerable to wildfires are the hills and mountains west of the Valley Floor Planning Area, with the highest increase in burned area occurring north, west and south of Clear Lake.

6 Ecosystem and Habitat Vulnerability

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

- Erosion is expected to increase with climate change, and sedimentation is expected to shift. Habitats sensitive to these events may be particularly vulnerable to climate change.

The region includes inland aquatic habitats that are vulnerable to erosion and sedimentation which in turn impacts fish habitat. The most vulnerable habitats are likely to be the tributaries to Clear Lake, Indian Valley Reservoir and Lake Berryessa which have natural flows into these water bodies. These water bodies control

releases in the lower Putah and Cache Creeks and can likely be managed to minimize erosion and sedimentation downstream of the dams.

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

- Seasonal high and low flows, especially those originating from snowmelt, are already shifting in many locations.

Estuarine habitats exist in the Delta. These habitats may be impacted by increasing salinity as a result of sea level rise (which would be similar to the impact of reduced freshwater flows), but the degree of impact is not well understood.

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

- Some specific species are more sensitive to climate variations than others.

Various fish species found in the Westside Region are sensitive to timing and volume of streamflows and water temperature. Reduced spring runoff would impact spawning species such as the Clear Lake hitch. Increasing temperatures could increase water temperatures, thereby threatening steelhead and salmon populations in the Valley Floor and cold water fish such as trout that are found in the Clear Lake watershed.

In general, the reduced availability of water will impact wildlife in the Region. Decreased water availability will decrease the quantity and quality of wetlands and the length of perennial streams, thereby eliminating habitat for fish, amphibians, reptiles and other species.

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

- Species that are already threatened or endangered may have a lowered capacity to adapt to climate change.

Endangered and threatened species do exist in the Region. Changes in the distribution of these species as a result of climate change have not been identified.

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

- Economic values associated with natural habitat can influence prioritization.

Kayaking, rafting and sport fishing are important water-dependent recreational activities offered by the Region. Kayakers and rafters are drawn to the Region for its whitewater runs, which would be impacted by decreases in stream flows as a result of decreased precipitation. At present, controlled releases from Indian Valley Reservoir are used to manage flow conditions for whitewater activities that occur in the lower Cache Creek. Increased temperature would impact the viability of cold-water fish species, but would still support sport fishing for warm-water fish species.

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

- Constrained water quality and quantity requirements may be difficult to meet in the future.

The Putah Creek Accord specifies minimum environmental flows that must be maintained along various reaches of the Lower Putah Creek. Because the environmental flows are regulated through releases at the Putah Diversion Dam, the environmental flows themselves may not be difficult to meet in the future, but maintaining the environmental flows while also meeting municipal and agricultural water demands that are diverted from Putah Creek may become a challenge in the future.

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

- Storm surges are expected to result in greater damage in the future due to sea level rise. This makes fragile coastal ecosystems vulnerable.

There are no coastal ecosystems in the Region.

6.8 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/)?*

- These ecosystems are particularly vulnerable to climate change.

The Westside Region includes a portion of the Bay-Delta, which is among the Endangered Species Coalition's Top 10 habitats vulnerable to climate change. As described in the Coalition's report, the main climate change threat to the Bay-Delta is the decrease in cold-water habitat needed for Central Valley steelhead and spring-run and winter-run salmon. There are several studies underway to evaluate the impacts of climate change to the Bay-Delta.

6.9 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?

- These ecosystems are particularly vulnerable to climate change.

Vernal pools, some of which are present in the Region, are fragmented habitats that are particularly vulnerable to climate change because the species are unable to emigrate if changes in temperature or water availability affect their habitat. It is not known whether there are movement corridors for natural species migration. At present, there are no infrastructure projects planned that could preclude species movement.

7 Hydropower

7.1 Is hydropower a source of electricity in your region?

- As seasonal river flows shift, hydropower is expected to become less reliable in the future.

There are currently three (3) hydropower plants within the Region; one installed on each of the major dams. The two operational hydropower plants are located at Monticello Dam at Lake Berryessa and Indian Valley Dam. The hydroelectric capacity is 11.5 MW for Monticello Dam and 3MW for Indian Valley Dam. The hydropower facility located on Clear Lake Dam is not currently functional. Although the Region is not largely affected by changes in snowpack, hydropower production could still be affected by greater variability of rainfall throughout the year causing inconsistency in the timing and availability of water releases. Changes in water release patterns could affect power production operations.

7.2 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?

- Energy needs are expected to increase in many locations as the climate warms. This increase in electricity demand may compound decreases in hydropower production, increasing its priority for a region.

As growth continues to occur within the Region, energy needs will most likely continue to increase. There are no current plans for additional hydropower production in the Region. However, a potential new source of hydropower generation within the Region would be the renovation of the Clear Lake hydropower facility. The current facility is no longer running due to technical issues that surfaced within the first few years of running the facility. Redesign of the hydro facility to mitigate these issues could allow for increased hydropower production within the Region.

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