AQUA-Exhibit 33

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RE: Comments and Recommendations on the California Department of Water Resources and U.S. Bureau of Reclamation California WaterFix Project Joint Petition to Add Three New Points of Diversion

This letter provides comments and recommendations on the California Department of Water Resources (CDWR) and U.S. Bureau of Reclamation (BOR) joint petition to the State Water Resources Control Board (SWRCB) to add three new points of diversion to the water right permits for the State Water Project (SWP) and the Central Valley Project (CVP) associated with the California WaterFix Project in the Delta. The California WaterFix Project includes water conveyance facilities consisting of three new water diversion intakes along the Sacramento River between Clarksburg and Courtland that feed two new 30-mile-long, 40-foot-diameter tunnels to convey water to the existing pumping facilities near Tracy, California. Water would be diverted from the Sacramento River through three fish-screened intakes, each with a capacity of 3,000 cubic feet per second (cfs).

I have already provided AquAlliance with comments and recommendations on the potential groundwater impacts from the 10-Year Long Term Transfer Program by the Bureau of Reclamation and San Luis & Delta Mendota Water Authority (BOR/SLDMWA) (Custis, November 25, 2014 and April 8, 2015) and for the Supplemental Water Supply Project by the Glen-Colusa Irrigation District (GCID-SWSP) (Custis, July 29, 2015 and August 17, 2015). The comments and recommendations in those documents are still applicable and relevant to the proposed change in diversion for the WaterFix Project tunnels because the projects reviewed are on going projects that will likely utilize the tunnels in any transfer of water south of the Delta. My previous comment letters and exhibits are attached. The comments and recommendations given in this letter will provide an update of my previous BOR/SLDMWA and GCID-SWSP comments as well as provide addition information regarding potential groundwater impacts from the use of the WaterFix Project tunnels for transfer of water through the Delta.

The implementation of the WaterFix Project will set up a chain of events that has the potential to significantly impact the groundwater resources of the Sacramento Valley and the Delta. The WaterFix Project proponents, CDWR and BOR, are the same agencies that will implement the transfer of Sacramento Valley water under any groundwater substitution transfer program, and therefore have full control to prevent any impacts from such transfers. The following comments and recommendations address the issue of potential impacts to the groundwater resources in the Sacramento Valley and the Delta that may occur as a result of the WaterFix Project diversions, in particular, the conveyance of groundwater substitution transfer water south of the Delta from Sacramento Valley groundwater basins.

Comments and Recommendations

1. Groundwater levels in the Sacramento Valley have continued to decline during the past 11 years as shown in Table 1, attached as Exhibit 1. Changes in groundwater level since 2004 are particularly of interest because the computer simulation, done to evaluate the impacts from pumping Sacramento Valley groundwater as part of the groundwater substitution component of the BOR/SLDMWA's 10-Year Long-Term Transfer Program, stops the analysis at 2003. The impacts on the current groundwater conditions weren't analyzed. Table 1 summarizes information provide by the Northern Region Office of CDWR in a series of groundwater elevation change map sheets that were obtained from the web site: http://www.water.ca.gov/groundwater/data_and_monitoring/northern_region/GroundwaterLevel/gw_level_monitoring.cfm.

   Table 1 lists the maximum and average decreases in groundwater elevations from Spring 2004 to Spring 2014, Fall 2004 to Fall 2014, and the most recent elevations for Spring 2014 to Spring 2015, and Fall 2014 to Fall 2015 in wells screened in the shallow, intermediate and deep aquifer zones. Table 1 lists elevation changes for Butte, Colusa, Glenn, and the southern portion of Tehama counties, as well as for the total Sacramento Valley. Changes in Spring elevation are of particular importance because they're a measure of the ability of the aquifer system to recover from summer extractions. In addition to the values taken from the CDWR map sheets, the annual average decrease of the long-term 2004-to-2014 average was calculated, and then compared to the 2014-to-2015 decrease. While the average decrease in groundwater elevation isn't a true measure of the change in aquifer storage, it can be seen as a relative indicator of the direction and rate of change in groundwater storage. The two right-most columns in Table 1 provide the most recent, 2014-to-2015 annual average declines, and compare them to the average area-wide decreases by bolding values that exceed the 2004-to-2014 annual average, and by calculating recent differences as a percentage of the 2004-to-2014 annual average. Table 1 shows that:

   - For the shallowest aquifer zone, the Spring 2014 to Spring 2015 annual average change was both positive and negative. In Butte and the southern portion of Tehama counties the annual average groundwater elevation had no change or rose slightly. For Colusa and Glenn counties and basin wide, there was a decrease in groundwater level. In the case of Colusa County the decrease was 153% of the Spring 2004 to Spring 2014 annual average.

   - The most recent spring decrease in the annual average groundwater elevation in the intermediate aquifer ranged from -49% to -376% of the Spring 2004 to Spring 2014 annual average. The greatest annual average elevation decrease occurred in southern Tehama County. The maximum decrease in southern Tehama County also exceeded the Spring 2004 to Spring 2014 maximum decrease.

   - The most recent, Spring 2014 to Spring 2015, maximum change in the deep aquifer zone groundwater level in Colusa County and the southern portion of Tehama County were -829% and -798% of the historical Spring 2004 to Spring 2014 maximum, respectively. The most recent Spring decreases in the deep aquifer zone of Butte, Glenn and basin wide were -105%, -114% and -287%, of the Spring 2004 to Spring 2014 annual average, respectively.

- The most recent, Spring 2014 to Spring 2015, maximum decrease in the deep aquifer zone groundwater levels in Colusa County and southern Tehama County exceeded the historical Spring 2004 to Spring 2014 maximum decrease by 15.3 feet and 9.0 feet, respectively.

- For the shallowest aquifer zone, the Fall 2014 to Fall 2015 annual average change was entirely negative. The most recent change as measured against the Fall 2004 to Fall 2014 annual average ranged from -26% for Glenn County to -197% for Colusa County.

- For the intermediate aquifer zone, the decrease in the annual average change in groundwater levels from Fall 2014 to Fall 2015 were all greater than the long-term Fall 2004 to Fall 2014 annual average. The most recent Fall decrease ranged from -116% to -319%.

- Groundwater levels in the deep aquifer zone all decreased from Fall 2014 to Fall 2015 at rates that exceeded the than the long-term Fall 2004 to Fall 2015 annual average. The most recent Fall decrease ranged from -131% to -300%.

- The most recent change in basin wide shallow groundwater levels for both spring and fall were all negative. The basin wide shallow aquifer decline for Spring 2014 to Spring 2015 annual average was 47% of the Spring 2004 to Spring 2014 annual average, while the Fall decline was 82%.

- For the intermediate aquifer zone the basin wide annual average groundwater level decline for Spring 2014 to Spring 2015 was 166% of the Spring 2004 to Spring 2014 annual average, while the Fall decline was 201%.

- For the deep aquifer zone the basin wide annual average groundwater level decline for Spring 2014 to Spring 2015 was 287% of the Spring 2004 to Spring 2014 annual average, while the Fall decline was 212%.

The conclusions that can be drawn from Table 1 are: (1) the groundwater levels in the Sacramento Valley are continuing to decline across most of the basin, (2) in the intermediate and deeper aquifers zones the average annual decline from 2004 to 2014 generally exceeded 1 foot, and was a maximum of approximately 4 feet for the deep aquifer zones in Colusa and Glenn counties, and (3) in the intermediate and deeper aquifers zones the decline from 2014 to 2015 generally exceeds the 2004-to-2014 annual average from 2004 to 2014 by rates that are as high as approximately 800%. The decision by the BOR/SLDMWA to exclude the groundwater conditions in the Sacramento Valley for the most recent 11 years from the analysis of the impacts of groundwater substitution pumping under the 10-Year Long-Term Transfer Program likely results in a significant underestimate of the impacts to groundwater levels and the associated resources dependent on groundwater. This would also result in an underestimate of the impacts of using the WaterFix Project tunnels for Sacramento Valley groundwater substitution transfers to users south of the Delta.

I recommend that the environmental review of the WaterFix Project be required to acknowledge that many of the groundwater basins in the Sacramento Valley

have experienced historical decreases in groundwater level. The environmental review of the WaterFix Project should be required to analyze and provide mitigation measures for the potential impacts that will occur as a result of facilitating the transfer of water south of the Delta from Sacramento Valley, in particular transfers done under any the groundwater substitution program.

2. The WaterFix Project tunnels will be used to convey water from the Sacramento Valley to users south of the Delta. Some of this water will be involved in groundwater substitution transfers or crop idling transfers. These transfers will have an impact on the groundwater resources of Sacramento Valley. Transfers through the WaterFix Project have a direct link to sustainable groundwater management in the Sacramento Valley through the timing and duration of water transfers. Evaluation of the existing condition of Sacramento Valley groundwater aquifers and other associated resources, such as wildlife habitats, water supply reliability, and water quality, requires the collection of data from a variety of sources and generally relies on the use of models to analyze the data and make predictions of impacts from different pumping and land use scenarios. The recently passed Sustainability Groundwater Management Act of 2014 (SGMA) and the subsequent amendments require that the water budget of groundwater basins subject to the Act be evaluated and calculated as part of a demonstration that the groundwater resource of the basin is being sustainably managed. Water Code (WC) 10721(x) defines a water budget as an *accounting of the total groundwater and surface water entering and leaving a basin including the changes in the amount of water stored.* A water budget analysis will likely require the use of a numerical groundwater model at some point in the calculations because of the complexity and areal extent of a groundwater basin. SGMA also requires that sustainable groundwater management also prevent *undesirable results* as specified in WC10721. In particular, WC10721(w) requires, among other requirements, that management of the groundwater basin prevent one or both of the following:

   (1) Chronic lowering of groundwater levels indicating a significant and unreasonable depletion of supply if continued over the planning and implementation horizon. Overdraft during a period of drought is not sufficient to establish a chronic lowering of groundwater levels if extractions and recharge are managed as necessary to ensure that reductions in groundwater levels or storage during a period of drought are offset by increases in groundwater levels or storage during other periods.
   (2) Significant and unreasonable reduction of groundwater storage.

   A SGMA groundwater basin boundary generally aligns with the CDWR Bulletin 118 groundwater basin boundary, adjusted as provided by SGMA. Management of the water resources in SGMA basins will likely require use of a groundwater model to calculate the interbasin flow of groundwater, and flows between groundwater and surface water as part of the water budget calculation and demonstration of sustainability. The recently approved SGMA Groundwater Sustainability Plan (GSP) regulations (approved by Water Commission on 5_18_2016) requires in California Code of Regulations (CCR) Title 23 §352.4(f) that groundwater models used for the GSP shall meet, among other requirements, the following standards:

   (1) The model shall include publicly available supporting documentation.
   (2) The model shall be based on field or laboratory measurements, or equivalent methods that justify the selected values, and calibrated against site-specific field data.

   SGMA GSP regulations in CCR Title 23 §357.2 allow for two or more GSP Agencies to form an

Interbasin Agreement to establish compatible sustainability goals and understanding regarding fundamental elements of each Agency as they relate to sustainable groundwater management. The technical information requirements of an Interbasin Agreement include:

(1) An estimate of groundwater flow across basin boundaries, including consistent and coordinated data, methods and assumptions.

CCR Title 23, §354.18(f) requires that CDWR provide the California Central Valley Groundwater-Surface Water Simulation Model (C2VSIM) and the Integrated Water Flow Model (IWFM) for use by Agencies in developing the GSP water budget. A GSP Agency may choose to use a different groundwater and surface water model, pursuant to CCR Title 23, §352.4. There are currently two publically available published groundwater models of the Sacramento Valley, CDWR's California Central Valley Groundwater-Surface Water Simulation Model (C2VSIM) (Brush and others, 2013a, 2013b), and the U.S. Geological Survey's (USGS) Central Valley Hydrologic Model (CVHM) (Faunt and others, 2009). Each of these models has been calibrated and the results published. Based on the requirement for use of a model with publically available supporting documentation, I would assume that either of these two models would meet the requirements of CCR §352.4(f)(1). Thus a comparison of the published results from these two calibrated, government developed groundwater models would enlighten the complexity of evaluating impacts from pumping groundwater in the Sacramento Valley and provide an understanding of the current state of knowledge of the Sacramento Valley groundwater basins.

As part of my review of the BOR/SLDMWA 10-Year Long-Term Transfer Program EIS/EIR, I provided general comments on the results and differences between the C2VSIM and CVHM models and what impacts these differences might have on evaluating the impacts of proposed groundwater substitution transfer pumping (see comments nos. 11, 12, 13, 19 and 20 in Custis, November 24, 2014). A more comprehensive evaluation of these two models and their differences was prepared by Chou (2012) as part of a civil engineer Master's Thesis at UC Davis. The purpose of Chou's thesis was to update CALVIN, an economic optimization groundwater model developed by UC Davis. Chou concludes that CDWR's model values should be used in the update of CALVIN primarily because the period of the model (1921-2009) more closely matched that of CALVIN (1921-1993).

Chapter 3 of Chou's thesis provides an interesting comparison of the inputs and results of these two calibrated Central Valley models. Chou divides the results of the two models into the subregions as they were defined in the USGS CVHM model with subregions 1 to 9 being in the Sacramento Valley and Delta. Exhibits 2A and 2B are Figure 3 and Table A1 taken from the C2VSIM (Brush and others, 2013a) and the CVHM report (Faunt and others, 2009), respectively, which show the subregion boundaries and provide a brief description. I've taken data from some of the tables in Chapter 3 for the nine Sacramento Valley and Delta subregions and calculated subregion differences between the two models for some of the parameters that make up the External Flows. The External Flows used by Chou include deep percolation from precipitation, inter-basin flows, boundary flows, groundwater/surface water stream leakage, groundwater/surface water lake leakage, subsidence, diversion conveyance seepage, and non-recoverable losses (i.e. evapotranspiration and tile drain flows). In addition to these External Flows, Chou evaluated the subregion changes in groundwater storage calculated by each model, and the assumed groundwater pumping in each subregion.

The External Flow parameters make up a large portion of the water budget and accurate knowledge of each will be critical to developing a sustainable groundwater management plan. In addition, an accurate understanding of the current state of knowledge about the groundwater systems in the Sacramento Valley is critical to evaluating the potential impacts from the use of the WaterFix Project tunnels in any groundwater substitution transfer of water out of the Sacramento Valley. The results of my calculations of the model differences for selected water balance parameters are given in the attached Tables 2.1 to 2.7, attached as Exhibits 3A to 3G. Note that most of the tables consider a positive value as groundwater flowing into the subregion, and a negative value as flowing out. However, the values in Tables 2.4 and 2.6 are the opposite with pumping and overdraft being positive and gains to groundwater storage being negative. The following is a brief description of Tables 2.1 to 2.7 and the implications on evaluating groundwater conditions in the Sacramento Valley.

A. Table 2.1, attached as Exhibit 3A, gives the average annual net external flows in thousands of acre-feet per year (TAFY) for each of the eight Sacramento Valley subregions and the Delta subregion from the C2VSIM and CVHM models. Values are given for two periods for the C2VSIM model, 1921-2009 and 1980-1993, while the CVHM model has data for only one period, 1980 to 1993. The net external flow is the sum of all of the external flows that include: (1) deep percolation from precipitation, (2) inter-basin flows, (3) boundary flows, (4) stream leakage, (5) subsidence, (6) conveyance seepage, and (7) non-recoverable losses (i.e. evapotranspiration and tile drain flows). (See Figure 1.3 in Chow, 2012, for a graphic depiction of how external flows are evaluated in CALVIN.) The rightmost two columns of Table 2.1 give the differences between the CVHM and C2VSIM models for the two periods. The comparison for the 1980-1993 period shows that the CVHM model estimates approximately 142,000 acre-feet per year (AFY) more inflow to the Sacramento Valley subregions 2 to 8 groundwater basins than does the C2VSIM and approximately 329,000 AFY into the Delta groundwater basin, with a combined total for all nine subregions and the Delta of 461,600 AFY more inflow. It is interesting to note that the differences for each subregion vary; five CVHM model subregions have more inflow (+), while four have more outflow (-). The higher average annual net external flow estimated by CVHM, 2,302.8 TAFY, appears to translate into an increase in groundwater storage rather than overdraft as estimated by C2VSIM (see comment no. 2F and Table 2.6).

B. Table 2.2, attached as Exhibit 3B, gives a comparison of the C2VSIM model average annual net external flows for 1921-2009 and 1980-1993. The sum of the averages for the Sacramento Valley subregions during 1980-1993 is approximately 80% greater than the sum of the averages for 1921-2009; an 807,000 AFY gain. This may reflect the increased use of surface water for irrigation. Most Sacramento Valley subregions have greater inflow to the groundwater during 1980-1993 period, positive values in rightmost column. For two of the subregions, 3 and 4, the net external flows reversed direction becoming inflows during the 1980-1993 period.

C. Table 2.3, attached as Exhibit 3C, gives average annual interbasin flows and boundary flows for the Sacramento Valley and Delta subregions for C2VSIM model (1921-2009) and CVHM (1980-1993). The boundary flows are surface or groundwater basin flows from outside the model subregions. Chou notes on page 28 that the overall suml of the interbasin flows for the entire modeled area should equal zero, which is the case for both models. However, Table 2.3 shows that there are significant differences in the interbasin flows of the two models between the subregions. Some of this difference is likely due to the different model periods. The interbasin flow in four of the subregions changes direction (1, 2, 7 and 9). One of the always inflowing (+) subregions is greater in the CVHM model (4), while one is less (8). The values of interbasin flow for both of the always outflowing (-) subregions (3, 5 and 6) is greater for the CVHM model. Chou states that the comparison of the interbasin flow estimated by the two models is a good example of how different assumptions and methods of calculation still result in a mass balance, with the sum equal to zero. While the sum of the interbasin flows should equal zero for a balanced model, the fact that there are significant differences between the subregions in these two publically available government models raises a critical issue of how to implement modeling to achieve SGMA groundwater sustainability compliance.

Although the subregion boundaries in both these models are not the same as those of the GSPs there is likely a need under SGMA to estimate the groundwater flow between and within different SGMA Groundwater Sustainability Agency (GSA) planning areas in order to calculate a water balance and demonstrate sustainable groundwater management. In addition, an accurate estimate of interbasin flow will become very important in implementing SGMA because activities in one GSA planning area shouldn't create an impact on the sustainability of an adjacent GSA area (WC10733). In fact, CDWR is required to evaluate a GSP plan to determine whether it will adversely affect the ability of an adjacent groundwater basin to implement their GSP or impede achievement of sustainability goals in an adjacent basin [WC10733(c)]. I would expect that calculation of "baseline" and the ongoing impacts that different GSP activities have on the interbasin and boundary flows will likely highly contested because it's an impact that's outside the control of the plan's GSA. If these two accepted government models differ this much, how will a baseline and ongoing values of interbasin or boundary flow be determined? What happens when different models are used for adjacent GSAs? What happens within SGMA basin when there is more than one GSA?

D. Table 2.4, attached as Exhibit 3D, gives the difference in maximum monthly pumping rates for the Sacramento Valley and the Delta model subregions for the 1980 to 1993 period. There isn't a significant difference between the overall model values, but this is a list of maximums so the most recent times would likely dominate the estimate. Note that the annual pumping rates given in the C2VSIM model output that I used for Exhibit 10.7 in my BOR/SLDMWA 10-Year Transfer comment no. 20 (Custis, November 25, 2014) on historical changes in groundwater fluctuates around 1.5 million acre-feet per year from 1980 to 1993 and then rise to approximately 2.5 million acre-feet per year by 2010 (see Northern California Water Association, 2014).

E. Table 2.5, attached as Exhibit 3E, gives for the Sacramento Valley and the Delta model subregions the groundwater/surface water (GW/SW) interactions for streams and lakes and deep percolation due to precipitation. The GW/SW stream interaction for the CVHM model has approximately 90% more groundwater discharging to surface water in the Sacramento Valley subregions 2 to 8 than the C2VSIM model; -1,218,100 AFY for CVHM vs 628,900 AFY for C2VSIM, a difference of 589,200 AFY. For the Delta subregion, the stream interaction varies from flowing out of groundwater in the C2VSIM model at -3,100 AFY, to flowing into groundwater in the CVSM model at 551,800 AFY, a difference of 554,900 AFY. Neither model calculates a GW/SW lake interaction for the nine subregions. The deep percolation difference is significantly greater for the Sacramento Valley subregions 2 to 8 with the CVHM model estimating approximately 4.7 times greater inflow of precipitation by deep percolation; 3,576,400 AFY for CVHM vs 760,600 AFY for C2VSIM, a difference of 2,815,800 AFY. For the Delta subregion, the CVHM estimates approximately 3 times more deep percolation of precipitation;

263,200 AFY for CVHM vs 84,000 AFY for C2VSIM, a difference of 179,200 AFY. The CVHM model calculates over 3 million AFY more groundwater recharge from deep percolation of precipitation than the C2VSIM model. For the C2VSIM model, the overall deep percolation of precipitation for the Sacramento Valley and Delta subregions is slightly less than the overall maximum pumping rate of approximately 1 million AFY (Table 2.4). In contrast, the CHVM model has the overall deep percolation of precipitation that's significantly greater than the 1.2 million AFY of maximum pumping (Table 2.4). The large difference between pumping and deep percolation recharge is likely one of the reasons the CVHM model calculates an increase in groundwater storage for the Sacramento Valley, while the C2VSIM calculates overdraft.

F. Table 2.6, attached as Exhibit 3F, gives for the Sacramento Valley and the Delta model subregions the initial, maximum and change in groundwater storage from 1921 to 1993 (72 years). The maximum storage capacity for the C2VSIM model was set at the maximum storage at any time from 1980 to 2003 (page 34 in Chou, 2012). The maximum storage for the CVHM model was calculated using the maximum capacity and the effective storage in September 2003. Chou (2012) notes that *the actual groundwater storage capacity in California is unknown and is not accurately measured at this time,* and that the C2VSIM model Central Valley sum total storage is greater than the CDWR Bulletin 118 estimate for the entire state. The C2VSIM model sum of the maximum storage for the Sacramento Valley and Delta subregions is approximately 1 billion acre-feet, which is within range of the statewide storage in CDWR Bulletin 118, 850 million acre-feet to 1.3 billion acre-feet. The C2VSIM model assumes almost 700 million acre-feet more groundwater in storage in the Sacramento Valley than the CVHM model does.

The difference in groundwater storage between the C2VSIM and CVHM models is very significant. Taking the annual average for a shorter 1980 to 1993 period and multiplying by 72, the change in groundwater storage is calculated for the period from 1921 to 1993. This shows a major difference between the two models. An issue I tried to point out in my comments no. 20 on the BOR/SLDMWA 10-Year Long-Term Transfer EIR. The C2VSIM model calculates a loss in groundwater storage over 72 years of approximately 12.4 million acre-feet, where as the CVHM model calculates an increase in storage of approximately 8.4 million acre feet. A difference of approximately 20.8 million acre-feet.

The C2VSIM model value is consistent with the change in groundwater storage shown in my Exhibit 10.7 at approximately 13 million acre-feet between the 1920s and 2010; a value that taken from the Figure 35 in June 2013 C2VSIM User's Manual (Brush and others, 2013b) and Table 10 in the June 2013 Final Report for the C2VSIM model (Brush and others, 2013a). In addition, the overdraft condition calculated by C2VSIM is consistent with the measured changes in groundwater levels reported by Northern Regional office of CDWR and the SGMA designation that much of the Sacramento Valley has a medium to high CASGEM basin priority ranking and therefore requires development of a sustainable groundwater management plans.

G. Table 2.7, attached as Exhibit 3G, gives for the Sacramento Valley and the Delta model subregions average annual external flows due to subsidence changes in groundwater storage, diversion conveyance losses to groundwater, tile drain outflow, and evaporative (ET) losses. A two model comparison between these parameters can apparently only be done for subsidence changes because the CVHM model doesn't directly calculate conveyance losses to groundwater, tile drain losses, or ET loss. The CVHM model calculates significantly more flow into the groundwater system from subsidence, approximately 7 times greater than the C2VSIM model. The loss to groundwater storage from ET of approximately 1.2 million acre-feet per year when combined with the 12 million acre-feet of overdraft (Table 2.6) is likely a major source of the 20 million acre-feet total difference in the 72 year historical change in groundwater storage between the two models.

The conclusions that can be drawn from analysis of the two existing calibrated government approved groundwater models for the Central Valley are: (1) the models provide different assessments of the condition of the Sacramento Valley groundwater basins, and (2) several of the External Flows calculated by the models are significantly different which raises the issue of how these models might be used in development and manage the GSP required by SGMA. In particular, the differences in modeled interbasin flow between subregions may prevent achieving sustainability. SGMA requires that a groundwater basin be managed so that it doesn't adversely impact the ability of an adjacent groundwater basin to the extent it that prevents sustainability. If the rate and direction of interbasin flow can't determined accurately, then how will the pumping requirements for sustainability be determined? Similar issues are likely to occur with stream depletion and impacts to groundwater dependent ecosystems.

As I'll discuss below, the implementation of the WaterFix Project diversions using two tunnels whose intakes are in the northern part of the Delta will facilitate the transfer of water from the Sacramento Valley to points south of the Delta. This transfer of water, particularly water made available through groundwater substitution or crop idling, will have a significant impact on the Sacramento Valley groundwater basin's ability to achieve sustainability. Transfers through the WaterFix Project have a direct link to sustainable groundwater management in the Sacramento Valley through the timing and duration of water transfers. Any changes in the rate or timing of water transfers caused by the WaterFix Project should be evaluated in the project's environmental analysis.

I recommend that the environmental review of the WaterFix Project be required to analyze and provide mitigation measures for the potential impacts that will occur as a result of facilitating the transfer of water south of the Delta from Sacramento Valley groundwater basins, which are basins already impacted by historical pumping. The WaterFix Project environmental document should acknowledge that the two government groundwater models of the Sacramento Valley, C2VSIM and CVHM, have significant differences in the amount and direction of groundwater flow. The WaterFix Project environmental review should acknowledge that the activities of the project will impact the timing, rate and volume of groundwater substitution and crop idling transfers from the Sacramento Valley and may impact the how and when basins north of the Delta will achieve sustainability as required by SGMA. The WaterFix Project environmental document should provide mitigation measures that document how the WaterFix Project will contribute to the sustainability of the Sacramento Valley groundwater basins, and give monitoring and mitigation measures that ensure that the WaterFix Project doesn't result in a negative impact on groundwater sustainability.

3. As part of the SGMA process, CDWR has created a CASGEM ranking of Bulletin 118 groundwater basins in California and those with either medium or high rank must create a Groundwater Sustainability Plan. Attached as Exhibits 4A and 4B are two tables that list by

priority ranking the CASGEM basins that drain to the Sacramento River Valley. These two tables are taken from the Northern Region and North Central Region priority spreadsheets downloaded from CDWR's CASGEM web site: http://www.water.ca.gov/groundwater/casgem/basin_prioritization.cfm. Twenty-two of the groundwater basins in the Sacramento Valley are ranked medium (17) or high (5). Exhibits 5A and 5B are two figures for the Northern Region and North Central Region that show the Sacramento Valley CASGEM basins rankings by color, yellow for medium and light brown for high. Many of the Sacramento Valley SGMA groundwater basins with medium and high priority ranks will be involved in the transfer of water from the Sacramento Valley under the BOR/SLDMWA's 10-Year Long-Term Transfer Program. This program proposes to transfer annually up to 290,495 acre-feet by groundwater substitution (see Table 2-5 in the Final EIS/EIR of the Long-Term Transfer, March 2015). Groundwater substitution is a transfer process whereby the surface water is transferred and the crops are irrigated using pumped groundwater. This process causes an increase in groundwater extractions and a decrease in the volume of aquifer recharge because the pumped groundwater is substituted as the source for recharge that would normally occur as a result of applying surface water. The 290,495 acre-feet annual groundwater substitution transfer exceeds the 206,817 acre-feet of total north Delta water transferred to SLDMWA from 2004 to 2013 (see Table 1-3 in the Final EIS/EIR of the Long-Term Transfer, March 2015). Exhibit 5C is a map of the water and irrigation districts that are potential sellers under the BOR/SLDMWA's 10-Year Long-Term Transfer Program with the groundwater substitution pumping locations shown. Exhibit 5D is a composite map of Exhibits 5C, and a base map combining Exhibits 5A and 5B that shows that most of these potential sellers and the wells that will participate in BOR/SLDMWA's 10-Year Long-Term groundwater substitution transfers operate within the medium or high priority groundwater basins that require a Groundwater Sustainability Plan. Given the decreases in groundwater levels that have occurred over the decade since 2004 (see my comment no. 1) while less than 207,000 acre-feet of north-of-the-Delta water was transferred to SLDMWA, the pumping of an additional 290,000 acre-feet of groundwater each year to facilitate groundwater substitution transfers from north of the Delta will likely create significant impacts on groundwater levels and surface water resources that are dependent on groundwater. In addition, the removal of 290,000-plus acre-feet from groundwater storage each year as part of the groundwater substitution transfer project is significantly greater than the 72-year average long-term annual loss in storage estimated using the C2VSIM or CVHM models (see my comment 2F and Table 2.6, Exhibit 3F).

I recommend that the environmental review of the WaterFix Project analyze and provide monitoring and mitigation measures for the potential impacts that will occur as a result of facilitating the transfer of water south of the Delta from Sacramento Valley groundwater basins, which are basins already impacted by historical pumping. The WaterFix Project environmental document should acknowledge that the source basins for the groundwater substitution transfers are required under SGMA to prepare Groundwater Sustainability Plans. The WaterFix Project environmental document should provide mitigation measures that document how the WaterFix Project will contribute to the sustainability of the Sacramento Valley groundwater basins and give mitigation monitoring measures that ensure that the WaterFix Project doesn't result in a negative impact on groundwater sustainability.

4. As part of the C2VSIM modeling report, CDWR provided Figures 39, 81A, 81B and 81C that show in the historical change in the annual rate of groundwater flow between subregions (Brush and others, 2013a and 2013b). I've previous discussed these figures in my review of the

BOR/SLDMWA's 10-Year Long-Term Transfer Program EIS/EIR, see my comment no. 14 and my Exhibits 6.1a to c and 6.2. An issue that is important to address with the WaterFix Project is the potential for the diversion of surface water at the three tunnel intakes in the northern part of the Delta to reduce the water available for groundwater recharge in the Delta. Exhibit 6A shows the C2VSIM modeled annual average interbasin groundwater flow for water years 2000 to 2009 for each of the nine subregions that make up the Sacramento Valley and the Delta (taken from Figure 81C in Brush and others, 2013a). Exhibit 6B shows the annual net inflow and outflows between hydrologic subregions for water years 2000 to 2009 (taken from Figure 39 in Brush and others, 2013b). The recent direction of most groundwater flow from the Delta is generally outwards to the east and south. Exhibit 6C was taken from CDWR's interactive groundwater web site and shows the Spring 2016 groundwater contours for the Delta and southern Sacramento and northern San Joaquin counties, which make up most of subregion 8. The Exhibit 6C shows several groundwater pumping depressions in Sacramento County and northern San Joaquin County. These depressions are the likely cause of the eastward outflow of groundwater from the Delta.

The annual groundwater flow from the Delta eastward into subregion 8 is estimated by the C2VSIM model at 112,000 acre-feet. Groundwater flows north from subregion 8 into subregion 7 at an annual rate of 17,000 acre-feet. The continued decline in groundwater levels in the Sacramento Valley and the proposed additional pumping of up to 290,000-plus acre-feet per year as part of the BOR/SLDMWA 10-year Long-Term groundwater substitution transfer program will likely increase the flow of groundwater from subregion 8 into subregion 7. Table 2-5 in the BOR/SLDMWA 10-year Long-Term Transfer Project Final EIS/EIR proposes to extract under the groundwater substitution transfers up to approximately 75,000 acre-feet per year from subregions 7 and 8. The increase of 58,000 AFY groundwater extractions in subregion 8 is approximately 52% of the C2VSIM model estimated flow from the Delta to subregion 8. This increase in groundwater pumping in subregions 7 an 8 will likely reduce groundwater levels in those two subregions and thereby cause an increase in groundwater flowing eastward out of the Delta due to a increase in groundwater gradient.

The combination of a potential increase in groundwater flow out of the Delta as a result of groundwater substitution transfer in the Sacramento Valley combined with any reduction in Delta surface waters as a result of diversions at the WaterFix Project tunnel intakes may cause an impact to groundwater levels and groundwater quality in the Delta. Any reduction in the availability of surface water to recharge the groundwater aquifers in the Delta needed to replace groundwater flowing eastward will likely result in a loss of groundwater in storage. However, because the Delta is bound on the west by saline waters of Suisun Bay any reduction in fresh water recharge will likely be replaced by intrusion of saline waters. Any increases in groundwater salinity will have a significant negative impact on the use of groundwater as a water supply for agriculture, municipal and domestic beneficial uses.

I recommend that the environmental review of the WaterFix Project analyze and provide monitoring and mitigation measures for the potential impacts to the groundwater aquifer underlying the Delta as a result of facilitating diversions in the two tunnels from the north side of the Delta. The environmental review should include analysis of the potential increase in groundwater outflow from the Delta as a result of groundwater substitution transfer pumping from Sacramento Valley groundwater basins, which are basins already impacted by historical pumping. The WaterFix Project environmental document should provide specific monitoring and mitigation measures that need to be incorporated into all Sacramento Valley

Groundwater Sustainability Plans prepared as required under SGMA. The WaterFix Project environmental document should provide mitigation measures that document how the WaterFix Project will contribute to the sustainability of the Sacramento Valley groundwater basins.

Conclusions

The proposed WaterFix Project with the construction of the two diversion tunnels and associated intake structures in the northern part of the Delta will facilitate transfer of waters from the north to south of the Delta. Included in the diversions through the WaterFix tunnels will be waters made available through groundwater substitution and crop idling transfers from already impacted groundwater basins in the Sacramento Valley. The implementation of groundwater substitution transfers in the Sacramento Valley will increase stress on the already over pumped basins, which may cause increases in outflow from groundwater aquifer in the Delta. Any reduction in surface water flow in the Delta as a result of the WaterFix diversions north of the Delta may reduce recharge water available to backfill the groundwater flowing east and south from the Delta. If the groundwater flowing out of the Delta isn't adequately backfilled with freshwater, the saline waters of Suisun Bay will fill the void. Should the intrusion of saline water occur, the beneficial uses of groundwater in the Delta will likely be significantly impacted and may become unsuitable without extensive treatment.

The implementation of the WaterFix Project will set up a chain of events that has the potential to significantly impact the groundwater resources of the Sacramento Valley and the Delta. Because of the time lag and distance between cause-and-effect, and the fact that changes in the flow of groundwater that might be caused by the BOR/SLDMWA 10-year Long-Term Transfer Project or the WaterFix Project occur out of sight below the ground surface, the potential impacts on groundwater from the WaterFix Project are easily ignored and dismissed. The impacts are nevertheless real and potentially irreversibly significant. The WaterFix Project proponents, CDWR and BOR, are the same agencies that will implement the transfer of Sacramento Valley water under any groundwater substitution or crop idling transfer program, and therefore have full control to prevent any impacts from such transfers. The WaterFix Project EIS/EIR should analyze and present for public review all of the potential impacts to Sacramento Valley and Delta groundwater that might be the result of their actions, or the actions of any other participating water agency, in particular for groundwater substitution and crop idling transfers facilitated by the WaterFix Project. The WaterFix Project EIS/EIR should provide specific monitoring and mitigation measures to be implemented by CDWR and BOR, and any other agency involved in water transfers, to ensure that any potential environmental impacts from the WaterFix Project diversions are mitigated to less than significant. Included in the monitoring and mitigation measures should be operational and management requirements that should be included in any Sacramento Valley SGMA GSP to ensure that the WaterFix diversions are mitigated to less than significant.

I recommend that the environmental review of the WaterFix Project be required to:

1. **Acknowledge that many of the groundwater basins in the Sacramento Valley have experienced historical decreases in groundwater level and that the WaterFix Project may cause significant impacts a result of facilitating the transfer of water to south of the Delta from Sacramento Valley.**

2. **Acknowledge that the two government groundwater models of the Sacramento Valley, C2VSIM and CVHM, have significant differences in the amount and direction of groundwater flow and storage.**
3. **Acknowledge that the activities of the project will impact the timing, rate and volume of groundwater substitution and crop idling transfers from the Sacramento Valley and may significantly impact the how and when a groundwater basin north of the Delta can achieve sustainability as required by SGMA.**
4. **Provide monitoring and mitigation measures that document how the WaterFix Project will contribute to the sustainability of the Sacramento Valley groundwater basins.**
5. **Provide monitoring and mitigation measures that ensure that the WaterFix Project doesn't result in a negative impact on groundwater sustainability**
6. **Analyze and provide mitigation measures for the potential impacts that will occur to the groundwater aquifers in the Delta as a result of facilitating water diversions by the two tunnels from the north side of the Delta.**
7. **Analyze the potential for increase in groundwater outflow from the Delta as a result of groundwater substitution transfer pumping from Sacramento Valley groundwater basins, which are basins already impacted by historical pumping.**
8. **Provide specific monitoring and mitigation measures that need to be incorporated into all Sacramento Valley Groundwater Sustainability Plans prepared as required under SGMA.**

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List of Exhibits

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Exhibit 3F: Table 2.6 - Sacramento Valley CDWR-C2VSIM vs USGS-CVHM Maximum Storage Capacity, Initial Storage, and Change in Storage, modified after Table 3.5 in Chou, 2012.

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Exhibit 4A: CASGEM Groundwater Basin Prioritization Results for Northern Region Sacramento River Valley Basins, modified from CDWR CASGEM excel data file, NOR_Priority_052620014.xlsx, downloaded 6_6_2016.

Exhibit 4B: CASGEM Groundwater Basin Prioritization Results for North Central Region Sacramento River Valley Basins, modified from CDWR CASGEM Excel data file, NCOR_Priority_052620014.xlsx, downloaded 6_6_2016.

Exhibit 5A: CASGEM Groundwater Basin Prioritization – Northern Region, downloaded from CDWR Groundwater Basin Prioritization web site - http://www.water.ca.gov/groundwater/casgem/basin_prioritization.cfm, downloaded 6_6_2016.

Exhibit 5B: CASGEM Groundwater Basin Prioritization – North Central Region, downloaded from CDWR Groundwater Basin Prioritization web site - http://www.water.ca.gov/groundwater/casgem/basin_prioritization.cfm, downloaded 6_6_2016.

Exhibit 5C: Location of proposed sellers, from Figure 2-4 in the U.S. Bureau of Reclamation and San Luis & Delta Mendota Water Authority's Long-Term Transfer Program Final EIS/EIR, March 2015.

Exhibit 5D: Composite map of CASGEM priority basin in the Sacramento Valley and Exhibit 5C.

Exhibit 6A: Simulated average annual subsurface flows between subregions, 2000-2009, from Figure 81C in Brush and others, 2013a.

Exhibit 6B: Simulated net annual subsurface outflows between hydrologic regions for water years 2000-2009, from Figure 39 in Brush and others, 2013b.

Exhibit 6C: Groundwater contours Spring 2016 for the Delta and Sacramento, San Joaquin and Yolo counties, taken from CDWR Groundwater Information Center interactive map web site, https://gis.water.ca.gov/app/gicima/, downloaded 6_6_2016.

AQUA-Exhibit 33

Exhibit 1

Table 1

Changes in Groundwater Levels in Sacramento Valley (2004 to 2015)

County	Spring 2004 to Spring 2014			Spring 2014 to Spring 2015		
	Shallow Wells			**Shallow Wells**		
	Max. decrease in gwe	*Ave. decrease in gwe*		*Max. decrease in gwe*	*Ave. decrease in gwe*	
	Feet Total	*Feet Total*	*Feet/Year*	*Feet/Year*[1]	*Feet/Year*[2]	*% LT Ave.*[3]
Butte	-23.8	-7.6	-0.84	-3.2	0.1	12%
Colusa	-25.3	-12.9	-1.43	-13.4	**-2.2**	**-153%**
Glenn	-46.5	-12.6	-1.40	-20.7	-1.0	-71%
Tehema-so.	-38.6	-10.8	-1.20	-6.7	0.0	100%
Basin Wide	-46.5	-9.6	-1.07	-20.7	-0.5	-47%

County	**Intermediate Wells**			**Intermediate Wells**		
	Max. decrease in gwe	*Ave. decrease in gwe*		*Max. decrease in gwe*	*Ave. decrease in gwe*	
	Feet Total	*Feet Total*	*Feet/Year*	*Feet/Year*[1]	*Feet/Year*[2]	*% LT Ave.*[3]
Butte	-25.6	-12.8	-1.42	-3.1	-0.7	-49%
Colusa	-49.9	-15.4	-1.71	-33.0	**-2.3**	**-134%**
Glenn	-54.5	-21.7	-2.41	-18.6	**-4.0**	**-166%**
Tehema-so.	-16.2	-7.9	-0.88	**-18.9**	**-3.3**	**-376%**
Basin Wide	-54.5	-14.1	-1.57	-33.0	**-2.6**	**-166%**

County	**Deep Wells**			**Deep Wells**		
	Max. decrease in gwe	*Ave. decrease in gwe*		*Max. decrease in gwe*	*Ave. decrease in gwe*	
	Feet Total	*Feet Total*	*Feet/Year*	*Feet/Year*[1]	*Feet/Year*[2]	*% LT Ave.*[3]
Butte	-20.8	-14.6	-1.62	-16.8	**-1.7**	**-105%**
Colusa	-26.9	-12.6	-1.40	**-42.2**	**-11.6**	**-829%**
Glenn	-49.4	-29.2	-3.24	-26.9	**-3.7**	**-114%**
Tehema-so.	-6.1	-5.3	-0.59	**-15.1**	**-4.7**	**-798%**
Basin Wide	-49.4	-13.8	-1.53	-42.2	**-4.4**	**-287%**

County	Fall 2004 to Fall 2014			Fall 2014 to Fall 2015		
	Shallow Wells			**Shallow Wells**		
	Max. decrease in gwe	*Ave. decrease in gwe*		*Max. decrease in gwe*	*Ave. decrease in gwe*	
	Feet Total	*Feet Total*	*Feet/Year*	*Feet/Year*[1]	*Feet/Year*[2]	*% LT Ave.*[3]
Butte	-17.6	-5.9	-0.59	-4.7	**-0.8**	**-136%**
Colusa	-37.7	-7.6	-0.76	-14.4	**-1.5**	**-197%**
Glenn	-53.5	-15.1	-1.51	-9.1	-0.4	-26%
Tehema-so.	-30.2	-9.5	-0.95	-6.7	**-1.0**	**-105%**
Basin Wide	-53.5	-9.8	-0.98	-14.1	-0.8	-82%

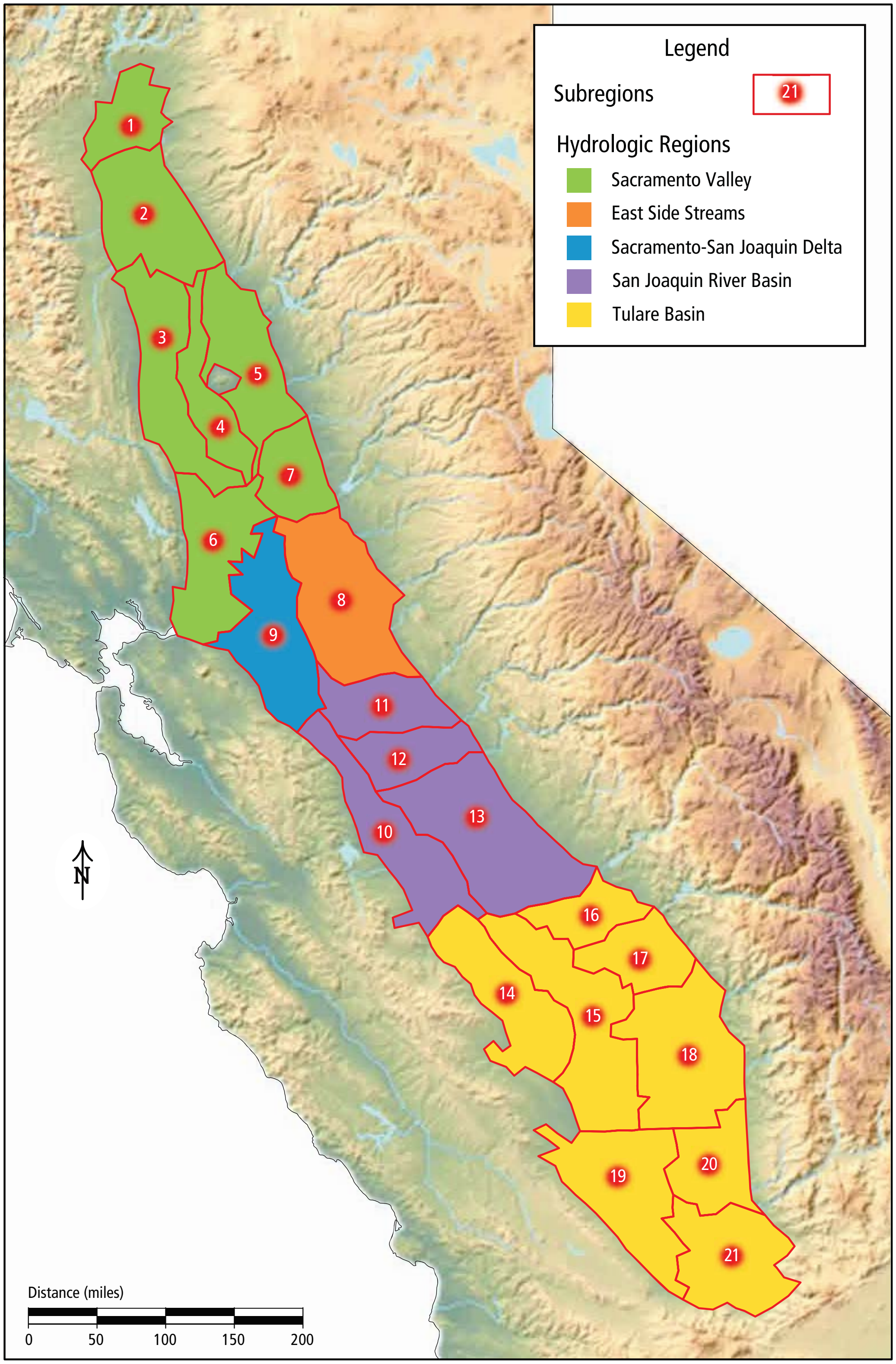
County	**Intermediate Wells**			**Intermediate Wells**		
	Max. decrease in gwe	*Ave. decrease in gwe*		*Max. decrease in gwe*	*Ave. decrease in gwe*	
	Feet Total	*Feet Total*	*Feet/Year*	*Feet/Year*[1]	*Feet/Year*[2]	*% LT Ave.*[3]
Butte	-23.0	-9.4	-0.94	-6.9	**-3.0**	**-319%**
Colusa	-40.6	-22.6	-2.26	-30.9	**-6.0**	**-265%**
Glenn	-57.2	-25.0	-2.50	-23.3	**-2.9**	**-116%**
Tehema-so.	-30.2	-12.4	-1.24	-9.9	**-2.0**	**-161%**
Basin Wide	-57.2	-16.4	-1.64	-30.9	**-3.3**	**-201%**

County	**Deep Wells**			**Deep Wells**		
	Max. decrease in gwe	*Ave. decrease in gwe*		*Max. decrease in gwe*	*Ave. decrease in gwe*	
	Feet Total	*Feet Total*	*Feet/Year*	*Feet/Year*[1]	*Feet/Year*[2]	*% LT Ave.*[3]
Butte	-15.5	-11.0	-1.10	-7.9	**-3.3**	**-300%**
Colusa	-59.5	-40.3	-4.03	-27.8	**-10.4**	**-258%**
Glenn	-79.7	-40.5	-4.05	-25.3	**-6.5**	**-160%**
Tehema-so.	-34.6	-13.0	-1.30	-9.4	**-1.7**	**-131%**
Basin Wide	-79.7	-22.6	-2.26	-27.8	**-4.8**	**-212%**

1. Values are bolded when 2014-2015 decrease greater than maximum long-term decrease.
2. Values are bolded when 2014-2015 average decrease is greater than long-term average decrease.
3. Values are bolded when 2014-2015 average decrease is greater than long-term average decrease.

Exhibit

Figure 3. C2VSim model subregions and hydrologic regions.



Exhibit

Table A1. Water-balance subregions within the Central Valley, California.

[General description based on depletion study area (DSA) names (where available) or subareas from Williamson and others (1989; fig. A27). DSA 49 is subdivided into four subregions A–D, and DSA 60 is subdivided into eight subregions A–H. Routed surface water deliveries are conveyed along streams or canals to a water-balance subregion. Non-routed surface water deliveries, or water transfers, are surface-water deliveries to a water-balance subregion not connected to a stream or major canal. This conveyance typically occurs through small canals or diversion ditches. DWR, California Department of Water Resources; mi^2, square mile]

Regions	Site identifier	General description	DWR DSA number	Total area (mi^2)	Routed surface-water deliveries	Non-routed surface-water deliveries
Sacramento Valley	1	Sacramento River above Red Bluff (Redding Basin)	DSA 58	611	2	None
	2	Red Bluff to Chico Landing (Red Bluff, Corning, Bend, Antelope, Dye Creek, Los Molinos, and Vina Basins)	DSA 10	1,163	3	None
	3	Colusa Trough (Most of Colusa Basin and Capay Valley Basin)	DSA 12	1,112	4	None
	4	Chico Landing to Knights Landing proximal to the Sacramento River	DSA 15	560	1	None
	5	Eastern Sacramento Valley foothills near Sutter Buttes (North and South Yuba, East Butte and eastern parts of West Butte and Sutter Basins)	DSA 69	957	2	6
	6	Cache-Putah area (Western Solano and most of Delta and Yolo Basins)	DSA 65	1,044	4	None
	7	East of Feather and South of Yuba Rivers (North American Basin)	DSA 70	534	4	4
Eastside Streams	8	Valley floor east of the Delta (Cosumnes and parts of South American and Eastern San Joaquin Basins)	DSA 59	1,362	6	None
Delta	9	Delta (parts of Solano, Eastern San Joaquin, South American, and most of Tracy Basins)	DSA 55	1,026	1	None
San Joaquin Basin	10	Delta-Mendota Basin	DSA 49A	1,083	1	7
	11	Modesto and southern Eastern San Joaquin Basin	DSA 49B	664	6	None
	12	Turlock Basin	DSA 49C	540	5	None
	13	Merced, Chowchilla, and Madera Basins	DSA 49D	1,648	6	2
Tulare Basin	14	Westside and Northern Pleasant Valley Basins	DSA 60A	1,071	None	3
	15	Tulare Lake and Western Kings Basin	DSA 60B	1,423	4	5
	16	Northern Kings Basin	DSA 60C	478	2	1
	17	Southern Kings Basin	DSA 60D	569	2	1
	18	Kaweah and Tule Basins	DSA 60E	1,358	4	4
	19	Western Kern County and Southern Pleasant Valley Basin	DSA 60F	1,365	2	3
	20	Northeastern Kern County Basin	DSA 60G	705	2	3
	21	Southeastern Kern County Basin (Arvin-Maricopa area)	DSA 60H	1,105	3	2
TOTAL	—	—	—	20,378	64	41

AQUA-Exhibit 33

Exhibit 3A

Table 2.1
Sacramento Valley CDWR-C2VSIM vs USGS-CVHM
Average Annual Net External Flow Averages (TAF/yr)

(Modified After Tables 3.3 and 3.3a, Chou, 2012)

Sac Valley Sub Region	C2VSIM 1921-2009	C2VSIM[a] 1980-1993	CVHM 1980-1993	'21-'09 vs '80-'93 Difference*	1980-93 Difference*
1	28.2	16.5	6.8	-21.4	-9.7
2	176.8	342.8	406.1	229.3	63.3
3	-8.9	0.5	30.9	39.8	30.4
4	-95.5	75.9	23.2	118.7	-52.7
5	66.9	199.6	64.2	-2.7	-135.4
6	180.4	250.4	453.5	273.1	203.1
7	168.2	224.8	186.2	18.0	-38.6
8	401.5	613.9	685.8	284.3	71.9
Sub-Total					
1-Redding	**28.2**	**16.5**	**6.8**	**-21.4**	**-9.7**
2 to 8	**889.4**	**1,707.9**	**1,849.9**	**960.5**	**142.0**
9-Delta	**84.8**	**116.8**	**446.1**	**361.3**	**329.3**
1 to 9 Total	**1,002.4**	**1,841.2**	**2,302.8**	**1,300.4**	**461.6**

a = C2VSIM averages are based on adjusted flows for 1980-1993
(+) = flow into subregion gw; (-) = flow out of subregion gw
* Difference = CVHM - C2VSIM

Exhibit 3B

Table 2.2
Sacramento Valley CDWR-C2VSIM
C2VSIM Average Annual Net External Flow Averages (TAF/yr)

(Modified Aftesr Table 3.3 and 3.3a, Chou, 2012)

Sac Valley Sub Region	C2VSIM 1921-2009	C2VSIM[a] 1980-1993	Difference*
1	28.2	16.5	-11.7
2	176.8	342.8	166.0
3	-8.9	0.5	9.4
4	-95.5	75.9	171.4
5	66.9	199.6	132.7
6	180.4	250.4	70.0
7	168.2	224.8	56.6
8	401.5	613.9	212.4
Sub-Total			
1-Redding	**28.2**	**16.5**	**-11.7**
2 to 8	**889.4**	**1,707.9**	**818.5**
9-Delta	**84.8**	**116.8**	**32.0**
1 to 9 Total	**1,002.4**	**1,841.2**	**838.8**

a = C2VSIM averages are based on adjusted flows for 1980-1993
(+) = flow into subregion gw; (-) = flow out of subregion gw
* Difference = C2VSIM(1980-1993) - C2VSIM(1921-2009)

AQUA-Exhibit 33

Exhibit 3C

Table 2.3
Sacramento Valley CDWR-C2VSIM vs USGS-CVHM
Average Annual External Flows - Interbasin and Boundary Flows (TAF/yr)

(Modified After Table 3.3b, Chou, 2012)

Sac Valley	Interbasin Flow-TAF/yr			Boundary Flow-TAF/yr		
Sub Region	C2VSIM[a]	CVHM[b]	Difference*	C2VSIM[a]	CVHM[b]	Difference*
1	25.7	-312.1	-337.8	84.0	0	-84.0
2	-26.8	44.2	71	132.0	0	-132.0
3	-18.5	-225.8	-207.3	45.6	0	-45.6
4	49.4	558.6	509.2	0.0	0	0.0
5	-7.6	-184.9	-177.3	17.5	0	-17.5
6	-24.3	-47.2	-22.9	25.0	0	-25.0
7	-9.9	19.4	29.3	75.3	0	-75.3
8	91.7	50.3	-41.4	111.7	0	-111.7
Sub-Totals				**491.1**	**0**	**-491.1**
1-Redding	**25.7**	**-312.1**	**-337.8**			
2 to 8	**54**	**214.6**	**160.6**			
9-Delta	**-18.1**	**237.7**	**255.8**	**13.8**	**-90.5**	**-104.3**
1 to 9 Total	**61.6**	**140.2**	**78.6**	**504.9**	**-90.5**	**-595.4**

a = 1921 to 2009; b = 1980 to 1993
(+) = flow into subregion gw; (-) = flow out of subregion gw
* Difference = CVHM - C2VSIM

Exhibit 3D

Table 2.4
Sacramento Valley CDWR-C2VSIM vs USGS-CVHM
Maximum Pumping Capacity (TAF/month)

(Modified After Table 3.4, Chou, 2012)

(1980 to 1993)

Sac Valley Sub Region	C2VSIM	CVHM	Difference*
1	7.2	2.3	-4.9
2	93.2	345.7	252.5
3	175.8	4.4	-171.4
4	109.2	2.4	-106.8
5	240.1	25.1	-215.0
6	85.7	181.8	96.1
7	120.5	73.8	-46.7
8	185.6	474.5	288.9
Sub-Total			
1-Redding	**7.2**	**2.3**	**-4.9**
2 to 8	**1010.1**	**1107.7**	**97.6**
9-Delta	**43.9**	**90.0**	**46.1**
1 to 9 Total	**1061.2**	**1,200.0**	**138.8**

* Difference = CVHM - C2VSIM

Exhibit 3E

Table 2.5
Sacramento Valley CDWR-C2VSIM vs USGS-CVHM
Average Annual External Flows - GW/SW-Stream, GW/SW-Lakes, and Deep Percolation-Precipitation (TAF/yr)

(Modified After Table 3.3c, Chou, 2012)

Sac Valley	GW/SW Interaction: Streams			GW/SW Interaction: Lakes			Deep Percolation from Precipitation		
Sub Region	C2VSIM[a]	CVHM[b]	Difference*	C2VSIM[a]	CVHM[b]	Difference*	C2VSIM[a]	CVHM[b]	Difference
1	-235.3	-131.5	103.8	0	0	0	137.3	440.2	302.9
2	-73.1	-293.1	-220.0	0	0	0	134.4	631.4	497.0
3	-161.0	-234.0	-73.0	0	0	0	87.8	613.5	525.7
4	-323.1	-533.4	-210.3	0	0	0	101.7	260.6	158.9
5	-190.7	-213.3	-22.6	0	0	0	144.8	690.1	545.3
6	45.2	13.8	-31.4	0	0	0	109.0	556.4	447.4
7	9.1	-42.9	-52.0	0	0	0	61.7	278.0	216.3
8	64.7	84.8	20.1	0	0	0	121.2	546.4	425.2
Sub-Total									
1-Redding	**-235.3**	**-131.5**	**103.8**	**0.0**	**0.0**	**0.0**	**137.3**	**440.2**	**302.9**
2 to 8	**-628.9**	**-1,218.1**	**-589.2**	**0.0**	**0.0**	**0.0**	**760.6**	**3,576.4**	**2,815.8**
9-Delta	**-3.1**	**551.8**	**554.9**	**0**	**0**	**0**	**84.0**	**263.2**	**179.2**
1 to 9 Total	**-867.3**	**-797.8**	**69.5**	**0.0**	**0.0**	**0.0**	**981.9**	**4,279.8**	**3,297.9**

a = 1921 to 2009; b = 1980 to 1993
(+) = flow into subregion gw; (-) = flow out of subregion gw
* Difference = CVHM - C2VSIM

Exhibit 3F

Table 2.6
Sacramento Valley CDWR-C2VSIM vs USGS-CVHM
Maximum Storage Capacity, Initial Storage, and Change in Storage (TAF)

(Modified After Table 3.5, Chou, 2012)

Sac Valley	Max Storage-TAF			Initial Storage-TAF			Total 72 Years Change Storage-TAF		
Sub Region	C2VSIM[a]	CVHM[b]	Difference*	C2VSIM[a]	CVHM[b]	Difference*	C2VSIM[a]	CVHM[b]	Difference*
1	38,510	19,543	-18,967	38,447	16,346	-22,101	-990	3,045	4,035
2	136,757	33,133	-103,624	136,494	19,031	-117,463	-882	3,077	3,959
3	133,958	22,782	-111,176	132,687	10,050	-122,637	939	-773	-1,712
4	61,622	15,730	-45,892	60,728	8,552	-52,176	220	-1,257	-1,477
5	92,020	23,850	-68,170	91,113	16,587	-74,526	656	-311	-967
6	175,719	34,350	-141,369	174,968	11,683	-163,285	-307	-3,457	-3,150
7	58,484	12,190	-46,294	56,539	10,180	-46,359	5,330	1,032	-4,298
8	193,433	31,153	-162,280	190,665	12,230	-178,435	7,836	1,595	-6,241
Sub-Total									
1-Redding	**38,510**	**19,543**	**-18,967**	**38,447**	**16,346**	**-22,101**	**-990**	**3,045**	**4,035**
2 to 8	**851,993**	**173,188**	**-678,805**	**843,194**	**88,313**	**-754,881**	**13,792**	**-94**	**-13,886**
9-Delta	**139,752**	**81,528**	**-58,224**	**139,472**	**18,419**	**-121,053**	**-362**	**-11,323**	**-10,961**
1 to 9 Total	**1,030,255**	**274,259**	**-755,996**	**1,021,113**	**123,078**	**-898,035**	**12,440**	**-8,372**	**-20,812**
				Annual Average Change in Storage-TAF			**172.8**	**-116.3**	**-289.1**

a = average change in storage from 1980 to 2009 (29 years); for long-term change multiplied by 72 years
b = average change in storage from 1980 to 1993 (13 years; for long-term change multiplied by 72 years
c = initial storage set equal to storage at the end of 2005
d = initial storage calculated base on Sept. 2003 effective storage
(+) = overdraft; (-) gains to groundwater storage.
* Difference = CVHM - C2VSIM

AQUA-Exhibit 33

Exhibit 3G

Table 2.7
Sacramento Valley CDWR-C2VSIM vs USGS-CVHM
Average Annual External Flows - Subsidence, Diversion Gains and Losses from GW (TAF/yr)

(Modified After Table 3.3d, Chou, 2012)

Sac Valley		Subsidence[1]			Diversion Losses to GW (Gains)			Tile Drain Outflow			Evaporation Loss	
Sub Region	C2VSIM[a]	CVHM[b]	Difference*	C2VSIM[a]	CVHM[b]	Difference*	C2VSIM[a]	CVHM[b]	Difference*	C2VSIM[a]	CVHM[b]	Difference*
1	-0.02	18.57	18.59	16.5	0	-16.50	0	-	0	-8.0	-	-8.0
2	0.01	23.61	23.60	10.4	0	-10.40	0	-	0	0.0	-	0.0
3	0.78	1.69	0.91	36.5	0	-36.50	0	-	0	-124.5	-	-124.5
4	0.90	-0.37	-1.27	75.6	0	-75.60	0	-	0	-262.2	-	-262.2
5	0.00	0.05	0.05	103.0	0	-103.00	0	-	0	-227.8	-	-227.8
6	5.13	-0.33	-5.46	20.2	0	-20.20	0	-	0	-69.3	-	-69.3
7	0.01	7.56	7.55	32.0	0	-32.00	0	-	0	-75.8	-	-75.8
8	0.05	5.07	5.02	12.1	0	-12.10	0	-	0	-0.7	-	-0.7
Sub-Total												
1-Redding	**-0.02**	**18.57**	**18.59**	**16.50**	**0.00**	**-16.50**	**0.00**	**-**	**0.00**	**-8.00**	**-**	**-8.00**
2 to 8	**6.88**	**37.28**	**30.40**	**289.80**	**0.00**	**-289.80**	**0.00**	**-**	**0.00**	**-760.30**	**-**	**-760.30**
9-Delta	**0.11**	**-0.60**	**-0.71**	**8.1**	**0**	**-8.10**	**0**	**-**	**0**	**-515.5**	**-**	**-515.5**
1 to 9 Total	**6.97**	**55.25**	**48.28**	**314.40**	**0.00**	**-314.40**	**0.00**	**-**	**0.00**	**-1,283.80**	**-**	**-1,283.80**

1 = Subsidence for CVHM was actually the Interbed Storage, which includes subsidence but is not entirely subsidence alone.
a = 1921 to 2009; b = 1980 to 1993
(+) = flow into subregion gw; (-) = flow out of subregion gw
* Difference = CVHM - C2VSIM

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Exhibit

CASGEM Groundwater Basin Prioritization Results
Northern Region Sacramento River Valley Basins

						Basin Area			Data Component Ranking Value					Groundwater Reliance						Overall Ranking			
Basin count	Basin Number	Basin Name	Sub-Basin Name	Hydrologic Region	DWR Region Office	Acres	Sq. Mile	2010 Population	Population	Population Growth	Public Supply Wells	Total Wells *	Irrigated Acreage	GW Use **	Percent of Total Supply **	GW Reliance Total	Impacts	Other Information	Actual Raw Score	Overall Basin Ranking Score ***	Overall Basin Priority	Impact Comments	Other Information Comments
1	5-21.57	SACRAMENTO VALLEY	VINA	Sacramento River	NRO	124,577	194.7	71,397	2	4	3	3.75	4	5	5	5	0	1	22.75	**22.8**	High		GW from this basin is a key source of sw inflow and serves eastside creeks which have endangered spring run.
2	5-21.58	SACRAMENTO VALLEY	WEST BUTTE	Sacramento River	NRO	181,479	283.6	36,152	1	4	2	3	5	5	2	3.5	2	1	21.5	**21.5**	High	Declining GW levels within the City of Chico and Durham areas (30-40' decline in mid-aquifer gw levels since 1998). High Nitrates in north and west Chico area. High density of GW contamination plumes surrounding City of Chico.	GW serves as a source of underflow to Butte Creek, which has endangered spring-run salmon.
4	5-21.54	SACRAMENTO VALLEY	ANTELOPE	Sacramento River	NRO	18,696	29.2	6,124	1	1	4	3.75	4	5	4	4.5	2	0	20.25	**20.3**	Medium	Nitrate issue in Domestic Wells.	
5	5-21.52	SACRAMENTO VALLEY	COLUSA	Sacramento River	NRO	917,793	1,434.1	48,369	1	3	1	2.25	5	2	1	1.5	3	3	19.75	**19.8**	Medium	Severely declining GW levels along the west-side of Glenn Co. Moderately declining GW levels in the Capay area. High TDS shallow aquifer in Maxwell- Williams area.	Increase in housing development along I5. GW- SW interaction is important to maintaining waterfowl refuges. Area is being highlighted as solution area for Delta outflow issues…proposed increase in CU and GW pumping.
6	5-21.51	SACRAMENTO VALLEY	CORNING	Sacramento River	NRO	205,473	321.1	18,852	1	2	1	3	4	5	4	4.5	2	2	19.5	**19.5**	Medium	Continued GW level decline over most of the basin.	This basin is becoming increasing dependent on GW due to uncertain reliability of CVP TCCA surface water supply.
9	5-14	SCOTTS VALLEY		Sacramento River	NRO	7,320	11.4	6,553	2	0	4	3.75	3	4	4	4	1	0	17.75	**17.8**	Medium	Boron exceeds EPA maximum. Strong GW-SW interaction with Clear Lake.	
10	5-21.59	SACRAMENTO VALLEY	EAST BUTTE	Sacramento River	NRO	265,312	414.6	38,465	1	4	2	3	4	4	1	2.5	0	1	17.5	**17.5**	Medium		GW basin provides underflow to Butte Creek which supports endangered spring-run salmon.
11	5-6.03	REDDING AREA	ANDERSON	Sacramento River	NRO	96,857	151.3	52,937	2	2	4	3.75	2	4	3	3.5	0	0	17.25	**17.3**	Medium		
13	5-6.04	REDDING AREA	ENTERPRISE	Sacramento River	NRO	60,862	95.1	68,627	2	3	4	3.75	2	2	1	1.5	0	1	17.25	**17.3**	Medium		Strong SW-GW interaction and endangered Sac River salmon runs
15	5-21.50	SACRAMENTO VALLEY	RED BLUFF	Sacramento River	NRO	274,489	428.9	28,053	1	2	2	3	3	3	3	3	2	0	16	**16.0**	Medium	Some gw quality impairments as per B-118, declining gw levels in west-side subdivision, and very high number of domestic gw use wells.	
16	5-6.01	REDDING AREA	BOWMAN	Sacramento River	NRO	78,426	122.5	7,165	1	5	2	3	2	2	2	2	1	0	16	**16.0**	Medium	Some localized high boron.	
17	5-15	BIG VALLEY		Sacramento River	NRO	24,212	37.8	6,344	1	2	2	3.75	3	4	4	4	0	0	15.75	**15.8**	Medium		
20	5-21.56	SACRAMENTO VALLEY	LOS MOLINOS	Sacramento River	NRO	33,148	51.8	2,220	1	0	2	2.25	3	2	2	2	1	3	14.25	**14.3**	Medium	Boron issues along east-side of basin.	GW basin provides underflow to Mill Creek which supports endangered spring-run salmon. High sw- gw interaction for much of the western basin.
21	5-21.55	SACRAMENTO VALLEY	DYE CREEK	Sacramento River	NRO	27,709	43.3	1,626	1	0	1	2.25	3	5	2	3.5	1	2	13.75	**13.8**	Medium	Some documented Boron issues along east-side of basin.	Strong SW-GW interaction. GW Basin provides underflow to Mill Creek which supports endangered spring-run salmon.
22	5-4	BIG VALLEY		Sacramento River	NRO	92,050	143.8	1,046	1	0	1	1.5	4	3	3	3	3	0	13.5	**13.5**	Medium	Declining GW Levels over much of the basin.	
23	5-5	FALL RIVER VALLEY		Sacramento River	NRO	54,803	85.6	1,629	1	0	1	2.25	5	3	2	2.5	1	0	12.75	**12.8**	Low	Locally high nitrates. Variable gw level trends with some regions showing declines. Strong sw-gw interaction and gw dependent fisheries. Ecosystem dependent basin (springs, fisheries)	
26	5-2.01	ALTURAS AREA	SOUTH FORK PITT RIVER	Sacramento River	NRO	114,164	178.4	4,429	1	0	1	1.5	4	2	2	2	1	0	10.5	**10.5**	Low	Declining GW Levels in some parts of the basin.	
27	5-2.02	ALTURAS AREA	WARM SPRINGS VALLEY	Sacramento River	NRO	68,009	106.3	964	1	0	1	1.5	3	2	2	2	0	1	9.5	**9.5**	Low		40' declining in GW levels since 2000, along the west side of the basin.
31	5-6.05	REDDING AREA	MILLVILLE	Sacramento River	NRO	65,226	101.9	2,640	1	0	1	2.25	2	0	0	0	0	0	**6.25**	**0.0**	Very Low		
33	5-6.02	REDDING AREA	ROSEWOOD	Sacramento River	NRO	46,455	72.6	1,009	1	0	0	2.25	2	1	2	0	0	0	5.25	**0.0**	Very Low		
35	5-1.01	GOOSE LAKE	GOOSE VALLEY	Sacramento River	NRO	35,966	56.2	57	0	0	0	0.75	4	0	0	0	0	0	4.75	**0.0**	Very Low		
36	5-6.06	REDDING AREA	SOUTH BATTLE CREEK	Sacramento River	NRO	33,835	52.9	48	0	0	0	0.75	2	1	2	0	0	0	2.75	**0.0**	Very Low		
38	5-66	CLEAR LAKE CACHE FORMATION		Sacramento River	NRO	29,717	46.4	7,960	1	5	1	1.5	1	0	1	0	0	0	**9.5**	**0.0**	Very Low		
39	5-9	INDIAN VALLEY		Sacramento River	NRO	29,413	46.0	1,718	1	0	2	3	4	0	1	0	0	0	**10**	**0.0**	Very Low		
41	5-21.53	SACRAMENTO VALLEY	BEND	Sacramento River	NRO	21,748	34.0	554	1	0	1	2.25	1	1	3	0	0	0	5.25	**0.0**	Very Low		
42	5-35	MCCLOUD AREA		Sacramento River	NRO	21,320	33.3	822	1	0	1	1.5	1	1	3	0	0	0	4.5	**0.0**	Very Low		
44	5-11	MOHAWK VALLEY		Sacramento River	NRO	18,987	29.7	1,375	1	0	3	3	2	1	1	0	0	0	**9**	**0.0**	Very Low		
45	5-1.02	GOOSE LAKE	FANDANGO VALLEY	Sacramento River	NRO	18,439	28.8	124	0	0	1	1.5	4	0	0	0	0	0	**6.5**	**0.0**	Very Low		
48	5-58	CLOVER VALLEY		Sacramento River	NRO	16,784	26.2	0	0	0	0	0.75	4	0	1	0	0	0	4.75	**0.0**	Very Low		
50	5-46	LAKE BRITTON AREA		Sacramento River	NRO	14,055	22.0	84	0	0	2	0.75	1	0	1	0	0	0	3.75	**0.0**	Very Low		
52	5-59	GRIZZLY VALLEY		Sacramento River	NRO	13,441	21.0	0	0	0	0	0.75	0	0	0	0	0	0	0.75	**0.0**	Very Low		
54	5-50	NORTH FORK BATTLE CREEK		Sacramento River	NRO	12,755	19.9	528	1	0	3	3	2	0	1	0	0	0	**9**	**0.0**	Very Low		
58	5-60	HUMBUG VALLEY		Sacramento River	NRO	9,979	15.6	3,299	1	0	4	3.75	2	0	3	0	0	0	**10.75**	**0.0**	Very Low		
60	5-64	BEAR VALLEY		Sacramento River	NRO	9,104	14.2	4	0	0	0	0.75	2	0	0	0	0	0	2.75	**0.0**	Very Low		
61	5-8	MOUNTAIN MEADOWS VALLEY		Sacramento River	NRO	8,145	12.7	0	0	0	0	0.75	4	0	0	0	0	0	4.75	**0.0**	Very Low		
63	5-12.02	SIERRA VALLEY	CHILCOOT	Sacramento River	NRO	7,551	11.8	308	1	0	3	3	3	1	1	0	0	0	**10**	**0.0**	Very Low		
64	5-36	ROUND VALLEY		Sacramento River	NRO	7,266	11.4	27	0	0	0	1.5	4	0	0	0	0	0	5.5	**0.0**	Very Low		
65	5-13	UPPER LAKE VALLEY		Sacramento River	NRO	7,260	11.3	2,055	1	3	4	3.75	4	0	0	0	0	0	**15.75**	**0.0**	Very Low		
66	5-7	LAKE ALMANOR VALLEY		Sacramento River	NRO	7,152	11.2	2,121	1	0	3	1.5	1	2	3	0	0	0	6.5	**0.0**	Very Low		
68	5-10	AMERICAN VALLEY		Sacramento River	NRO	6,799	10.6	3,931	2	0	5	3.75	4	2	1	0	0	0	**14.75**	**0.0**	Very Low		
69	5-3	JESS VALLEY		Sacramento River	NRO	6,708	10.5	13	0	0	0	0.75	5	1	1	0	0	0	**5.75**	**0.0**	Very Low		

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Exhibit 4A

CASGEM Groundwater Basin Prioritization Results
Northern Region Sacramento River Valley Basins

						Basin Area			Data Component Ranking Value					Groundwater Reliance						Overall Ranking			
Basin count	Basin Number	Basin Name	Sub-Basin Name	Hydrologic Region	DWR Region Office	Acres	Sq. Mile	2010 Population	Population	Population Growth	Public Supply Wells	Total Wells *	Irrigated Acreage	GW Use **	Percent of Total Supply **	GW Reliance Total	Impacts	Other Information	Actual Raw Score	Overall Basin Ranking Score ***	Overall Basin Priority	Impact Comments	Other Information Comments
70	5-18	COYOTE VALLEY		Sacramento River	NRO	6,528	10.2	2,252	1	5	2	3	2	0	0	0	0	0	13	0.0	Very Low		
72	5-19	COLLAYOMI VALLEY		Sacramento River	NRO	6,497	10.2	1,513	1	4	2	3	1	1	4	0	0	0	11	0.0	Very Low		
73	5-63	STONYFORD TOWN AREA		Sacramento River	NRO	6,437	10.1	183	1	0	3	2.25	3	0	0	0	0	0	9.25	0.0	Very Low		
76	5-54	ASH VALLEY		Sacramento River	NRO	6,008	9.4	3	0	0	0	0.75	3	0	1	0	0	0	3.75	0.0	Very Low		
77	5-43	ROCK PRAIRIE VALLEY		Sacramento River	NRO	5,740	9.0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	Very Low		
78	5-95	MEADOW VALLEY		Sacramento River	NRO	5,734	9.0	387	1	0	2	3	2	1	1	0	0	0	8	0.0	Very Low		
80	5-52	GRAYS VALLEY		Sacramento River	NRO	5,440	8.5	0	0	0	0	0	0	0	0	0	0	0	0	0.0	Very Low		
83	5-53	DIXIE VALLEY		Sacramento River	NRO	4,866	7.6	6	0	0	0	0	5	0	0	0	0	0	5	0.0	Very Low		
84	5-57	LAST CHANCE CREEK VALLEY		Sacramento River	NRO	4,659	7.3	0	0	0	0	0	0	0	0	0	0	0	0	0.0	Very Low		
86	5-86	JOSEPH CREEK		Sacramento River	NRO	4,458	7.0	13	0	0	0	1.5	3	2	3	0	0	0	4.5	0.0	Very Low		
87	5-87	MIDDLE FORK FEATHER RIVER		Sacramento River	NRO	4,342	6.8	177	1	0	2	3	1	0	1	0	0	0	7	0.0	Very Low		
88	5-47	GOOSE VALLEY		Sacramento River	NRO	4,208	6.6	10	0	0	0	0.75	5	1	1	0	0	0	5.75	0.0	Very Low		
89	5-41	EGG LAKE VALLEY		Sacramento River	NRO	4,101	6.4	0	0	0	0	0.75	0	0	0	0	0	0	0.75	0.0	Very Low		
93	5-93	NORTH FORK CACHE CREEK		Sacramento River	NRO	3,474	5.4	0	0	0	0	0.75	0	0	0	0	0	0	0.75	0.0	Very Low		
94	5-37	TOAD WELL AREA		Sacramento River	NRO	3,356	5.2	0	0	0	0	0	0	0	0	0	0	0	0	0.0	Very Low		
97	5-51	BUTTE CREEK VALLEY		Sacramento River	NRO	3,227	5.0	0	0	0	0	0.75	2	0	0	0	0	0	2.75	0.0	Very Low		
99	5-49	DRY BURNEY CREEK VALLEY		Sacramento River	NRO	3,074	4.8	0	0	0	0	0	0	0	0	0	0	0	0	0.0	Very Low		
100	5-90	FUNKS CREEK		Sacramento River	NRO	3,012	4.7	0	0	0	0	0.75	1	0	0	0	0	0	1.75	0.0	Very Low		
102	5-17	BURNS VALLEY		Sacramento River	NRO	2,873	4.5	2,691	2	4	0	3.75	1	1	2	0	0	0	10.75	0.0	Very Low		
103	5-31	LONG VALLEY		Sacramento River	NRO	2,799	4.4	194	1	0	0	2.25	3	2	5	0	0	0	6.25	0.0	Very Low		
105	5-40	HOT SPRINGS VALLEY		Sacramento River	NRO	2,404	3.8	12	0	0	0	1.5	4	2	1	0	0	0	5.5	0.0	Very Low		
106	5-30	LOWER LAKE VALLEY		Sacramento River	NRO	2,404	3.8	2,694	2	0	5	2.25	1	2	5	0	0	0	10.25	0.0	Very Low		
108	5-16	HIGH VALLEY		Sacramento River	NRO	2,356	3.7	34	1	0	3	2.25	3	1	4	0	0	0	9.25	0.0	Very Low		
109	5-48	BURNEY CREEK VALLEY		Sacramento River	NRO	2,352	3.7	1,466	2	1	0	2.25	5	3	1	0	0	0	10.25	0.0	Very Low		
110	5-56	YELLOW CREEK VALLEY		Sacramento River	NRO	2,311	3.6	2	0	0	0	0	5	0	1	0	0	0	5	0.0	Very Low		
113	5-92	BLANCHARD VALLEY		Sacramento River	NRO	2,221	3.5	0	0	0	0	0.75	2	0	1	0	0	0	2.75	0.0	Very Low		
115	5-38	PONDOSA TOWN AREA		Sacramento River	NRO	2,082	3.3	0	0	0	0	0	2	0	0	0	0	0	2	0.0	Very Low		
116	5-91	ANTELOPE CREEK		Sacramento River	NRO	2,040	3.2	3	0	0	0	0.75	3	0	1	0	0	0	3.75	0.0	Very Low		
118	5-62	ELK CREEK AREA		Sacramento River	NRO	1,438	2.2	174	1	0	0	0	1	0	1	0	0	0	2	0.0	Very Low		
119	5-61	CHROME TOWN AREA		Sacramento River	NRO	1,408	2.2	6	0	0	0	0.75	0	0	0	0	0	0	0.75	0.0	Very Low		
121	5-45	CAYTON VALLEY		Sacramento River	NRO	1,306	2.0	2	0	0	0	1.5	5	0	1	0	0	0	6.5	0.0	Very Low		
122	5-89	SQUAW FLAT		Sacramento River	NRO	1,294	2.0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	Very Low		
123	5-65	LITTLE INDIAN VALLEY		Sacramento River	NRO	1,269	2.0	112	1	0	0	3.75	2	3	4	0	0	0	6.75	0.0	Very Low		
124	5-44	LONG VALLEY		Sacramento River	NRO	1,088	1.7	0	0	0	0	0	0	0	0	0	0	0	0	0.0	Very Low		
125	5-88	STONY GORGE RESERVOIR		Sacramento River	NRO	1,065	1.7	0	0	0	0	0	3	0	1	0	0	0	3	0.0	Very Low		
129	5-94	MIDDLE CREEK		Sacramento River	NRO	705	1.1	10	1	0	0	3	2	4	5	0	0	0	6	0.0	Very Low		

NOTE: * Data component values were reduced by 25% due to data confidence, prior to calculating total GW basin ranking value
** Sub-fields that are used to determine the overal GW Reliance Total ((GW Use + GW %)/2)
*** Overall Basin Ranking Score = Population + Population Growth + PSW + (Total Wells x .75) + Irr Acreage + (GW Use + GW %)/2 + Impacts + Other

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CASGEM Groundwater Basin Prioritization Results
North Central Region Sacramento River Valley Basins

									Data Component Ranking Value											Overall Ranking			
Basin count	Basin Number	Basin Name	Sub-Basin Name	Hydrologic Region	DWR Region Office	Basin Area		2010 Population	Population	Population Growth	Public Supply Wells	Total Wells *	Irrigated Acreage	Groundwater Reliance			Impacts	Other Information	Actual Raw Score	Overall Basin Ranking Score ***	Overall Basin Priority	Impact Comments	Other Information Comments
						Acres	Sq. Mile							GW Use **	Percent of Total Supply **	GW Reliance Total							
2	5-21.64	SACRAMENTO VALLEY	NORTH AMERICAN	Sacramento River	NCRO	340,170	531.5	832,746	3	3	4	3	4	5	2	3.5	1	1	22.5	**22.5**	High	From B118: Elevated levels of TDS, chloride, sodium, bicarbonate, boron, fluoride, nitrate, iron manganese, and arsenic may be of concern in some locations (DWR 1997). There are 3 sites with significant groundwater contamination in the basin.	From B118: groundwater levels in southwestern Placer County and northern Sacramento County have generally declined with many wells declining at a rate of about one and one-half feet per year for the last 40 years or more (PCWA 1999).
3	5-21.65	SACRAMENTO VALLEY	SOUTH AMERICAN	Sacramento River	NCRO	247,745	387.1	718,113	3	3	4	3.75	3	3	2	2.5	3	0	22.25	**22.3**	High	From B118: Montgomery Watson (1997) listed seven sites within the subbasin with significant groundwater contamination. From Sac County GWMP: Overall decreasing groundwater level trend over past 50 years (~30ft).	
4	5-21.67	SACRAMENTO VALLEY	YOLO	Sacramento River	NCRO	225,718	352.7	194,158	2	3	3	3.75	5	5	2	3.5	2	0	22.25	**22.3**	High	Localized TDS problems preclude using gw for some M&I uses without treatment. Some subsidence in northeast of Davis and in northern Yolo.	
12	5-21.62	SACRAMENTO VALLEY	SUTTER	Sacramento River	NCRO	234,264	366.0	82,125	1	4	2	3	5	4	1	2.5	0	0	17.5	**17.5**	Medium		
17	5-21.66	SACRAMENTO VALLEY	SOLANO	Sacramento River	NCRO	424,832	663.8	119,263	1	3	2	3	5	2	1	1.5	0	0	15.5	**15.5**	Medium		
20	5-21.61	SACRAMENTO VALLEY	SOUTH YUBA	Sacramento River	NCRO	104,486	163.3	45,014	2	1	3	3	4	2	1	1.5	0	0	14.5	**14.5**	Medium		
21	5-21.60	SACRAMENTO VALLEY	NORTH YUBA	Sacramento River	NCRO	103,152	161.2	14,667	1	1	2	2.25	4	4	2	3	0	1	14.25	**14.3**	Medium		Strong SW-GW interaction with Feather and Yuba River
22	5-21.68	SACRAMENTO VALLEY	CAPAY VALLEY	Sacramento River	NCRO	24,970	39.0	550	1	0	1	3	3	2	3	2.5	1	0	11.5	**11.5**	Low	moderate to high levels of boron.	
44	5-68	POPE VALLEY		Sacramento River	NCRO	7,177	11.2	110	1	0	0	1.5	4	2	1	0	0	0	**6.5**	**0.0**	Very Low		
45	2-7	SAN RAMON VALLEY		San Francisco Bay	NCRO	7,053	11.0	30,112	4	2	0	3.75	1	1	1	0	0	0	**10.75**	**0.0**	Very Low		
73	2-27	SAND POINT AREA		San Francisco Bay	NCRO	1,405	2.2	43	1	0	5	0.75	0	1	4	0	0	0	**6.75**	**0.0**	Very Low		

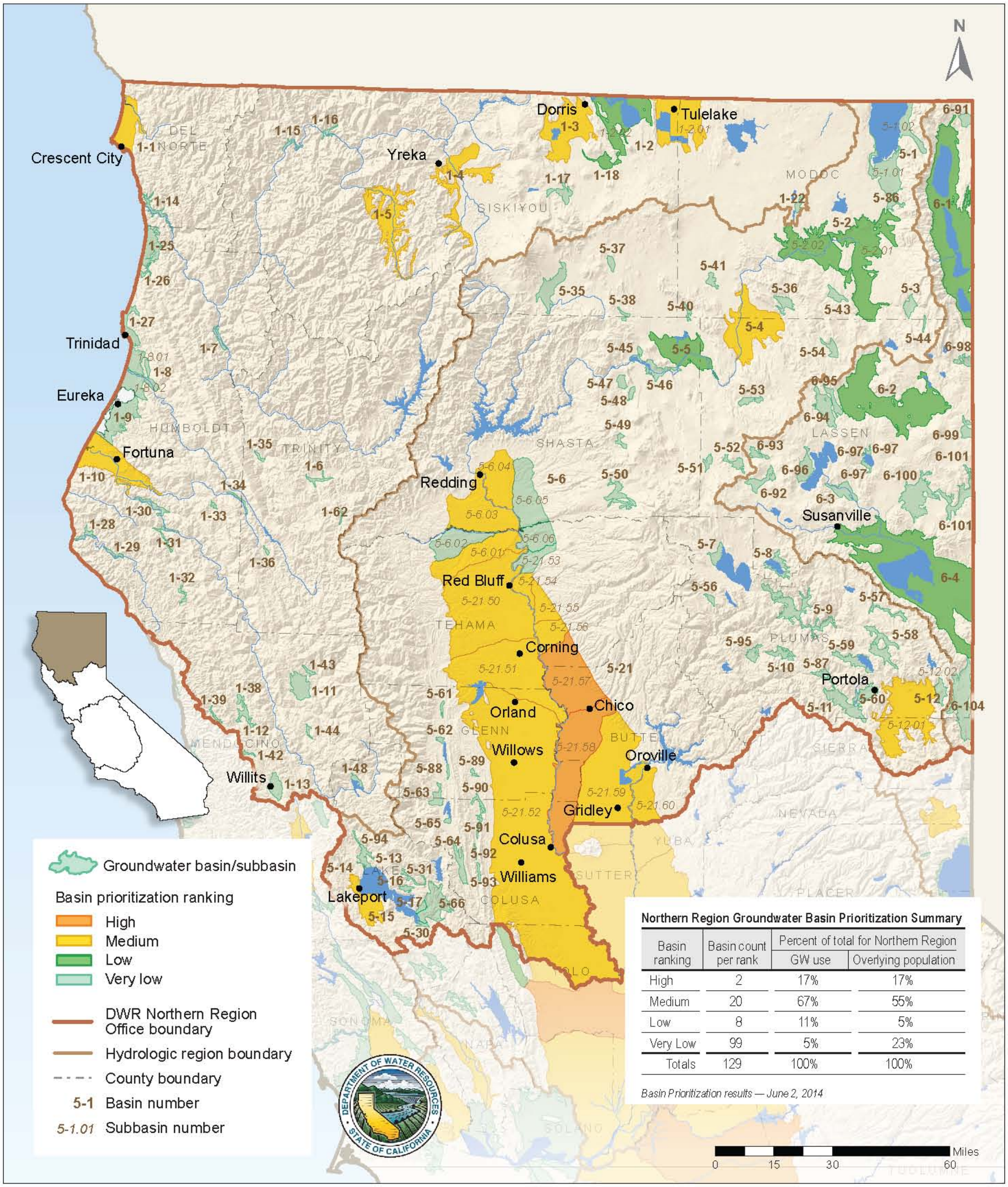
NOTE: * Data component values were reduced by 25% due to data confidence, prior to calculating total GW basin ranking value

** Sub-fields that are used to determine the overal GW Reliance Total ((GW Use + GW %)/2)

*** Overall Basin Ranking Score = Population + Population Growth + PSW + (Total Wells x .75) + Irr Acreage + (GW Use + GW %)/2 + Impacts + Other

Exhibit

CASGEM Groundwater Basin Prioritization — Northern Region



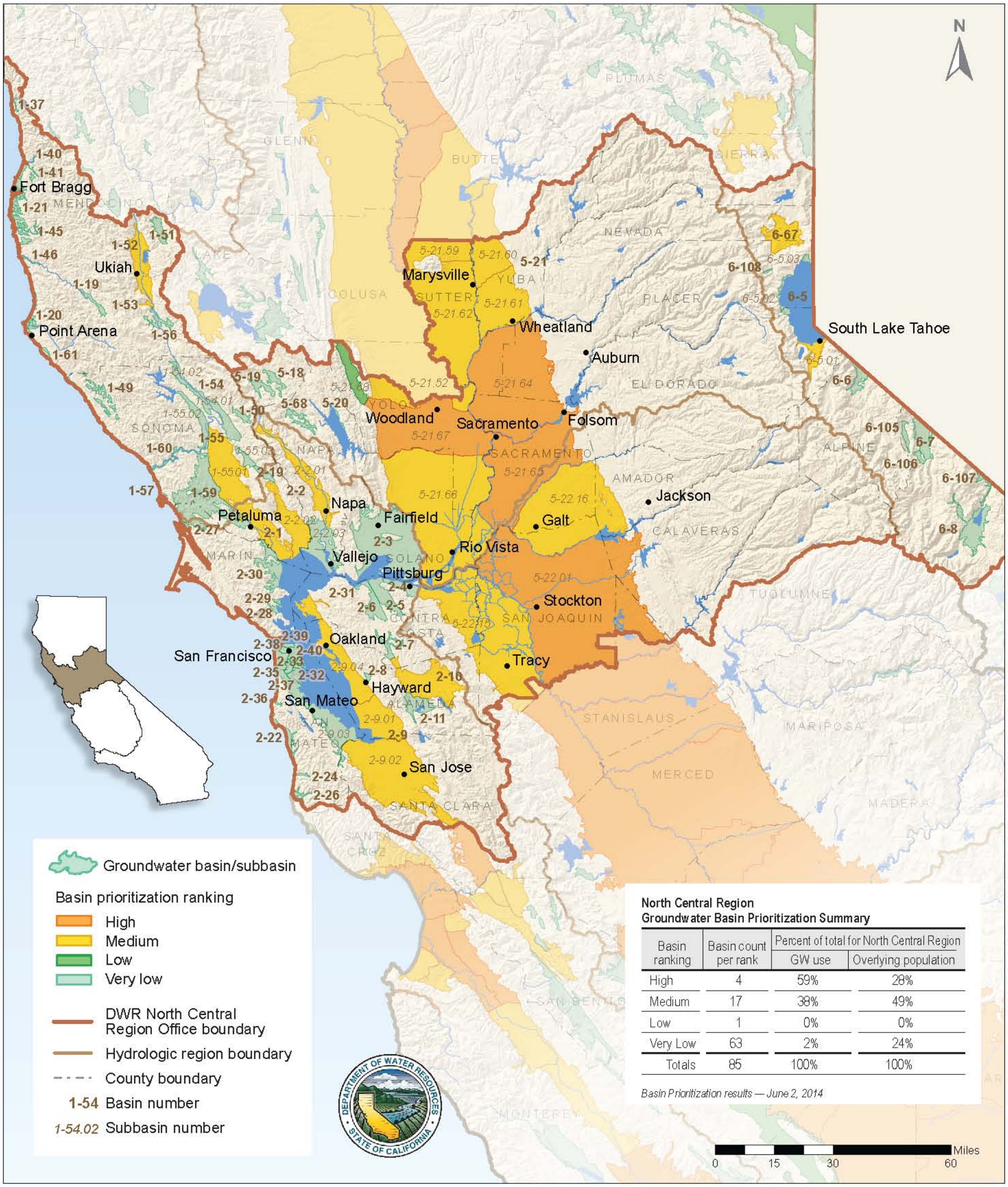
Northern Region Groundwater Basin Prioritization Summary

Basin ranking	Basin count per rank	Percent of total for Northern Region	
		GW use	Overlying population
High	2	17%	17%
Medium	20	67%	55%
Low	8	11%	5%
Very Low	99	5%	23%
Totals	129	100%	100%

Basin Prioritization results — June 2, 2014

Exhibit

CASGEM Groundwater Basin Prioritization — North Central Region



North Central Region
Groundwater Basin Prioritization Summary

Basin ranking	Basin count per rank	Percent of total for North Central Region	
		GW use	Overlying population
High	4	59%	28%
Medium	17	38%	49%
Low	1	0%	0%
Very Low	63	2%	24%
Totals	85	100%	100%

Basin Prioritization results — June 2, 2014

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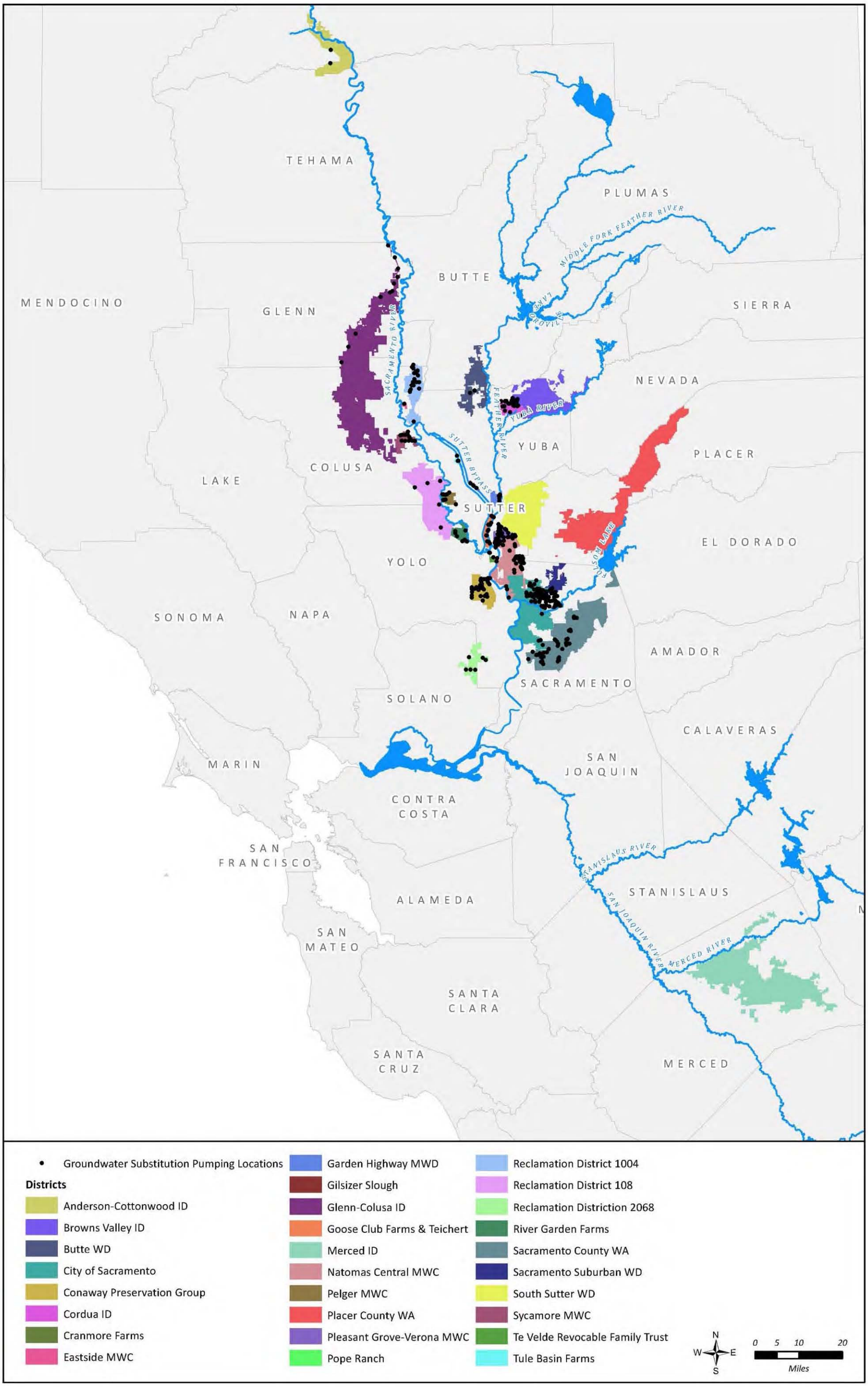

Figure 2-4. Locations of Potential Sellers

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Exhibit 5D

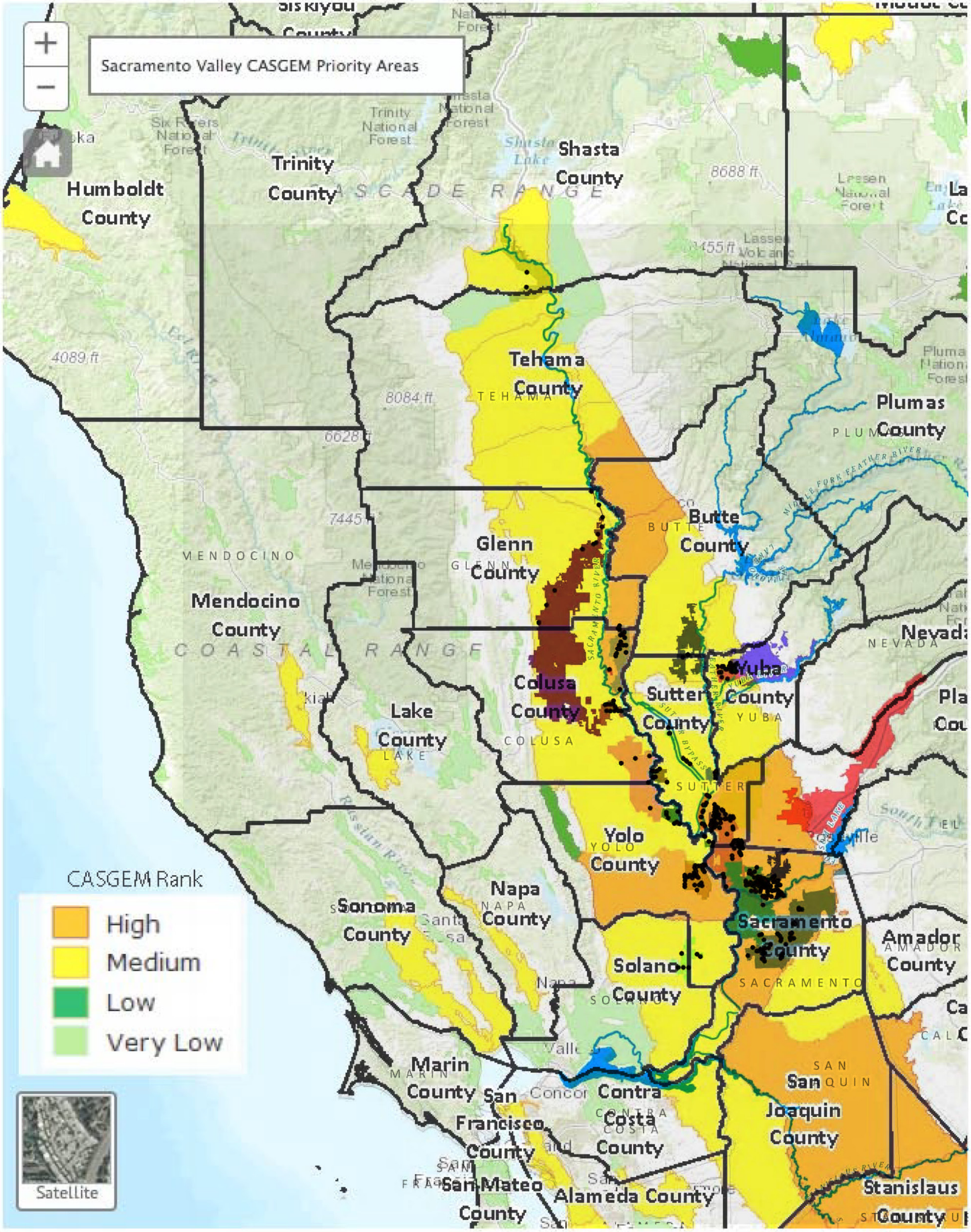
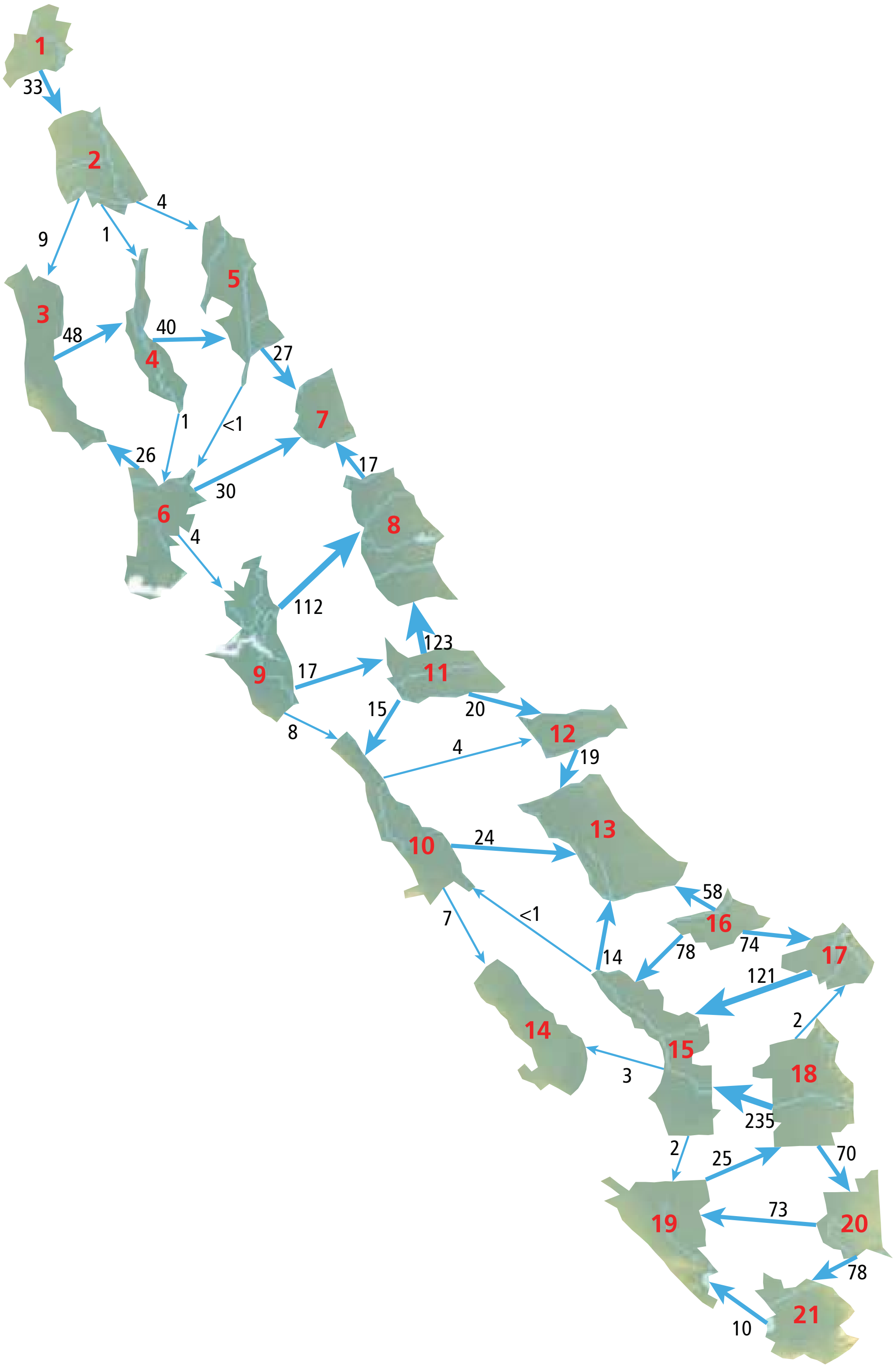


Figure 81C. Simulated average annual subsurface flows between subregions, 2000-2009.



[Thousand acre-feet per year]

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Exhibit

Figure 39. Simulated net annual subsurface flows between hydrologic regions for water years 2000-2009. [Million acre-feet per year]

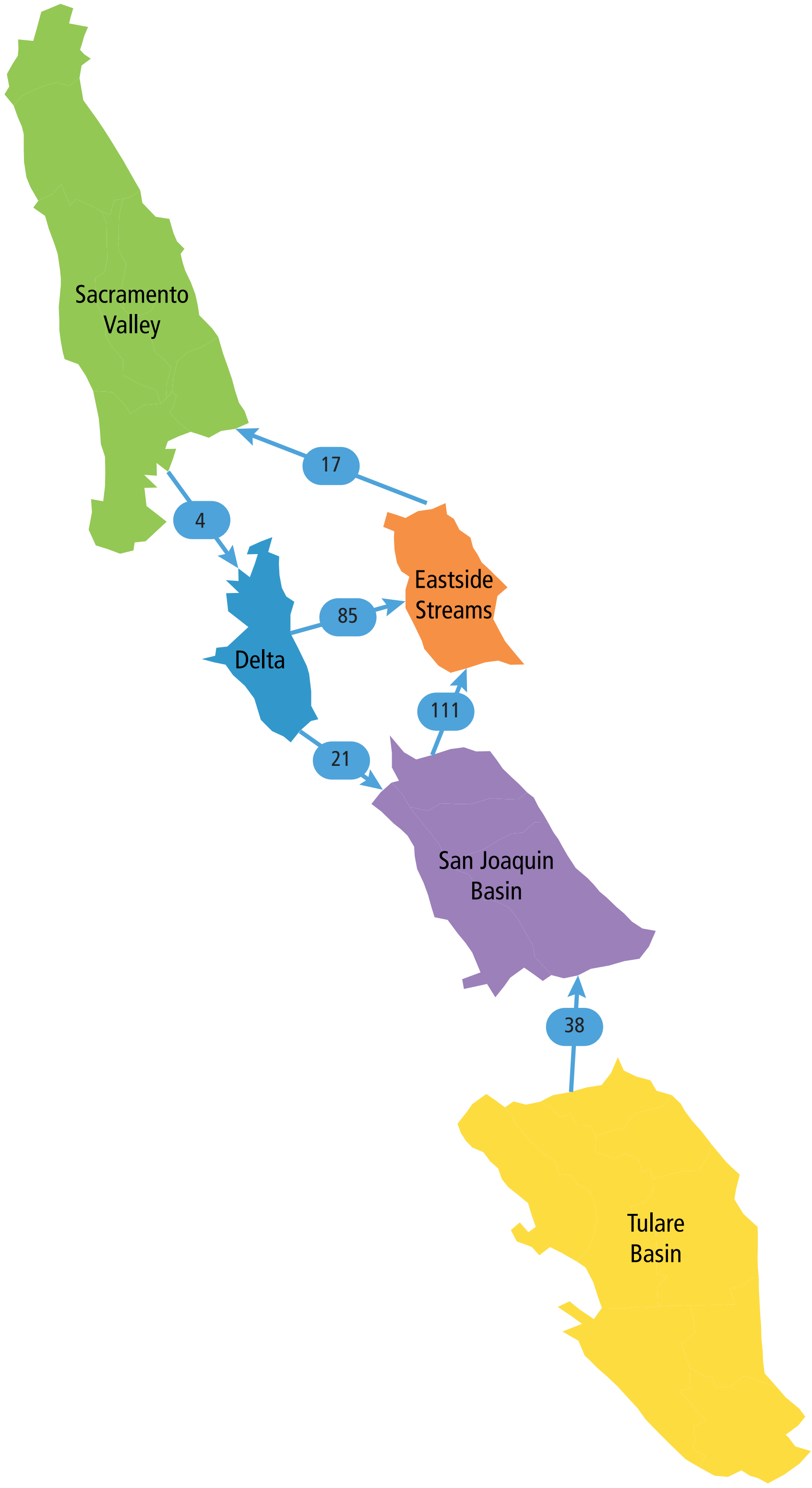

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Exhibit 6C

Spring 2015 Groundwater Contours
Sacramento, San Joaquin and Yolo Counties