- Deep Percolation to Mexico: Managed Wetlands.
- Deep Percolation to Oregon: Urban.
- Deep Percolation to Nevada: Urban.
- Deep Percolation to Mexico: Urban.
- Conveyance Deep Percolation to Oregon: Urban.
- Conveyance Deep Percolation to Nevada: Urban.
- Conveyance Deep Percolation to Mexico: Urban.

Although the items shown in this list potentially contribute to subsurface outflow, all values were null because the planning areas analyzed are not adjacent to California borders. The water supply and balance data do not have other subsurface outflow information. For the purposes of completing a water budget, zbudget data from C2VSIM version 1.01 was processed and compiled to obtain numbers for subsurface outflow.

6.3.2 Groundwater Extraction

Recharge of applied water comprises the following water supply and balance components:

- Groundwater Extraction – Unadjudicated: Agriculture.
- Groundwater Extraction – Unadjudicated: Managed Wetlands.
- Groundwater Extraction – Unadjudicated: Urban.
- Groundwater Extraction – Adjudicated: Agriculture.
- Groundwater Extraction – Adjudicated: Managed Wetlands.
- Groundwater Extraction – Adjudicated: Urban.

6.3.3 Stored Water Extraction

Recharge of applied water comprises the following water supply and balance components:

- Groundwater Extraction: Banked –Agriculture.
- Groundwater Extraction: Banked – Managed Wetlands.
- Groundwater Extraction: Banked – Urban.

6.3.4 Groundwater Loss to Stream

See Section 5.1.5, “Groundwater Loss to Stream.”

6.4 Discussion of Mass Balance and Possible Explanation of Discrepancies

Initial balance errors using the water supply and balance data were significant: PA 607 had a mass balance error of -267 taf, PA 608 had a mass balance error of -598 taf, PA 609 had a mass balance error of -1,635 taf.

With the addition of the subsurface flow, release of water resulting from subsidence, and change in groundwater storage components from C2VSim, the mass balance errors were much smaller: PA 607 had a mass balance error of 4 taf, PA 608 had a mass balance error of -169 taf, PA 609 had a mass balance error of -29 taf. The addition of C2VSim data brings the balances closer together. But it cannot be said that the water supply and balance data accurately represent the groundwater conditions in the area because of the water budget components discussed above that are not included.

7. Conclusion and Recommendations

The water balance to water budget pilot study in the Merced basin provides a detailed methodology for mapping water supply and balance data to the water accounting templates. The process exposed some limitations in the water supply and balance data and in the water accounting templates. Specifically, the water supply and balance data account for most, but not all, land system components. While surface water and groundwater used by the land system are well accounted, there are not enough surface water and groundwater components accounted for in the water supply and balance data to complete a water budget for those systems. Without supplemental information from other sources (stream gauges, river balance sheets, and C2VSim) the accuracy of water supply and balance data related to the surface water and groundwater systems cannot be assessed; even with those additional data sources a satisfactory balance could not be obtained. The water accounting templates also have deficiencies because they generally assume a single standalone water budget zone and do not have sufficient components for routing water that flows outside of the system boundaries, but do not go to a stream or a designated use. The accounting templates also do not deal with water budget zones where streams lie on, or outside of, the boundary of a water budget zone. And finally, groundwater interactions that do not involve direct use or recharge, such as the injection of groundwater to create a salinity barrier, or percolation that goes to unusable groundwater layers, could not be sufficiently identified by the water accounting templates in their current forms.

7.1 Recommendations for Improvements to the Water Supply and Balance Data

While the water supply and balance data are the most comprehensive statewide water dataset that exists, it is still insufficient to develop a complete water budget as it focuses only on developed water supply and use, generally focused on the land system. The following recommendations are made to substantively improve the utility of the water supply and balance data for water accounting:

- Boundaries of the water supply and balance data should be revisited to include streams within the area rather than on boundaries when possible.
    - If streams cannot be incorporated into the area for better tracking, stream balance sheets, such as those maintained by the South Central Region Office, should be incorporated into the water supply and balance data.
- Precipitation and runoff data are available from Cal-SIMETAW and used in

various steps of the balance but are not utilized by the final balances in the water supply and balance data. These data should be incorporated into water balances.

- Groundwater representation in the water supply and balance data are insufficient to characterize groundwater systems. While groundwater extraction is estimated by the water supply and balance data, other important groundwater interactions are not available which prevents accurately balancing the groundwater system. Additional groundwater information should be incorporated into the water supply and balance data. One potential source that could be considered for this purpose is the groundwater sustainability plan annual reports and integrated groundwater and surface water models developed for the area of interest.

7.2 Recommendations for Improvements to the Water Budget Accounting Template

As discussed in Section 3, the water budget accounting templates were also evaluated for how well they captured the water supply and balance data. Most of the water supply and balance data could be mapped into the water accounting templates. But, to ensure consistency with the water supply and balance data, the following components of the water accounting templates may need to be addressed:

- Update the surface water delivery term to account for additional components such as intentional conveyance seepage and imported waste waters.
- Add a conveyance return flow component for water that is diverted off the surface water system into conveyance facilities but ultimately returns to the surface water system.
- Update the recycled water export component to a more generic land system export component.
- Revisit wastewater tracking to account for wastewater produced within a region, including when wastewater does not go to applied water reuse or recycled water.
- Clarify accounting of snowpack.
- Rename existing conveyance seepage component to conveyance recharge component.
- Add optional tracking for water used to produce energy.

7.3 Recommendations for Future Work

The Merced basin pilot study highlighted several challenges for transitioning from water supply and balance data to comprehensive water accounting. The following recommendations are made to help overcome the challenges in a systematic way.

1. Expand the Merced basin pilot study to refine the water budgets developed in the pilot study by reviewing, assessing, and using available data and information from annual reports submitted for GSPs within the Merced basin, C2VSim, AWMPs, UWMPs, and other locally available data and information. The goal will be to close the loop for a complete water accounting of the basin by adding all other available data to the water supply and balance data.
2. Conduct additional pilot studies in selected California hydrologic regions. The studies should consider regional variability, data availability, and organizational capacity. These additional pilot studies will be conducted to provide a comprehensive water accounting based on the water budget information compiled in California Water Plan, California's Groundwater, GSPs, C2VSim, AWMPs, UWMPs, and other water management activities to the standardized water accounting templates and common vocabulary of the Water Budget Handbook.
3. Develop a roadmap for developing basin, watershed, regional, and statewide water budgets.
4. Refine the groundwater system in the water budget schematic to account for saline intrusion and potential saline intrusion barriers to reduce or prevent the saline intrusion by installing and operating dedicated groundwater injection wells.
5. Refine the groundwater system in the water budget schematic to account for the complex interactions in a multilayered groundwater system.

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Appendix A. Main Balance Spreadsheet

Appendix A is an extensive Excel spreadsheet with supporting data for this Pilot Project is available on the CNRA Open Data Platform at the following link: Water Balance to Water Budget Pilot Project Data - Datasets - California Natural Resources Agency Open Data (https://data.cnra.ca.gov/dataset/b85e0357-314f-4f22-ad5e-703a511b53a8?).


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