Owens Valley Groundwater Basin Water Budgets Technical Memorandum

Prepared for

Owens Valley Groundwater Authority

OWENS VALLEY GROUNDWATER AUTHORITY

Prepared by

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Certification

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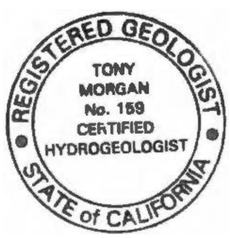

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1. Introduction

This section provides a quantitative description of the water budget for the Owens Basin, which includes the headwater basin and the Owens Valley groundwater basin. DWR GSP regulations was used to develop this water budget analysis. The Basin Characterization Model (BCM) was used to develop the water budget. The Department of Water Resources handbook for Water Budget Development recommends using BCM for basins with no existing models. Los Angeles Department of Water and Power (LADWP) has developed a groundwater model based on MODFLOW but OVGA was not granted access to this model and hence BCM was chosen to quantify the water budget.

BCM is a regional water balance model (Flint et al., 2013) that mechanistically models the transformation of precipitation into evapotranspiration, infiltration into soils, runoff, or recharge below the root zone. BCM primarily quantifies the land system budget, but also quantifies recharge that is an important hydrologic input to the Owen Valley groundwater basin. Since LADWP model of the Owen's Valley groundwater basin was not available for use in developing the water budget, BCM simulated total runoff, recharge when compared to LADWP reported export of surface water, and pumped groundwater provides a measure of sustainability of the system. When the BCM simulated total runoff and recharge are higher than the water export from the Owens Valley groundwater basin it is reasonable to assume that the surface water and groundwater system are in balance. This criterion is used to demonstrate that the surface water budget derived from BCM and export of both surface and groundwater by LADWP from the groundwater basin are sustainable in the recent (1986-2016) historical period.

2. Historical and Current Water Budget

BCM output archived by USGS at https://ca.water.usgs.gov/projects/reg_hydro/basin-characterization-model.html (accessed, August 2020) were used in the development of the water budget. The historical period for the water budget spans 1986-2016 and the current period spans from 2006-2016.

The BCM is a grid-based model that calculates water balance at each grid at the monthly time step. Numerous grids each with spatial resolution of 300 m x 300m represent the Owens Basin. The Owens Basin is spatially divided into the headwater basin where most of the runoff and recharge is generated and the water budget for this spatial area is referred to as the contributing area water budget. Water budget outputs from the BCM grids within the Owens Valley groundwater basin are computed and are referred to as the groundwater budget. Figure 1 below shows the spatial areas that represent the headwater/contributing area and the groundwater basin.

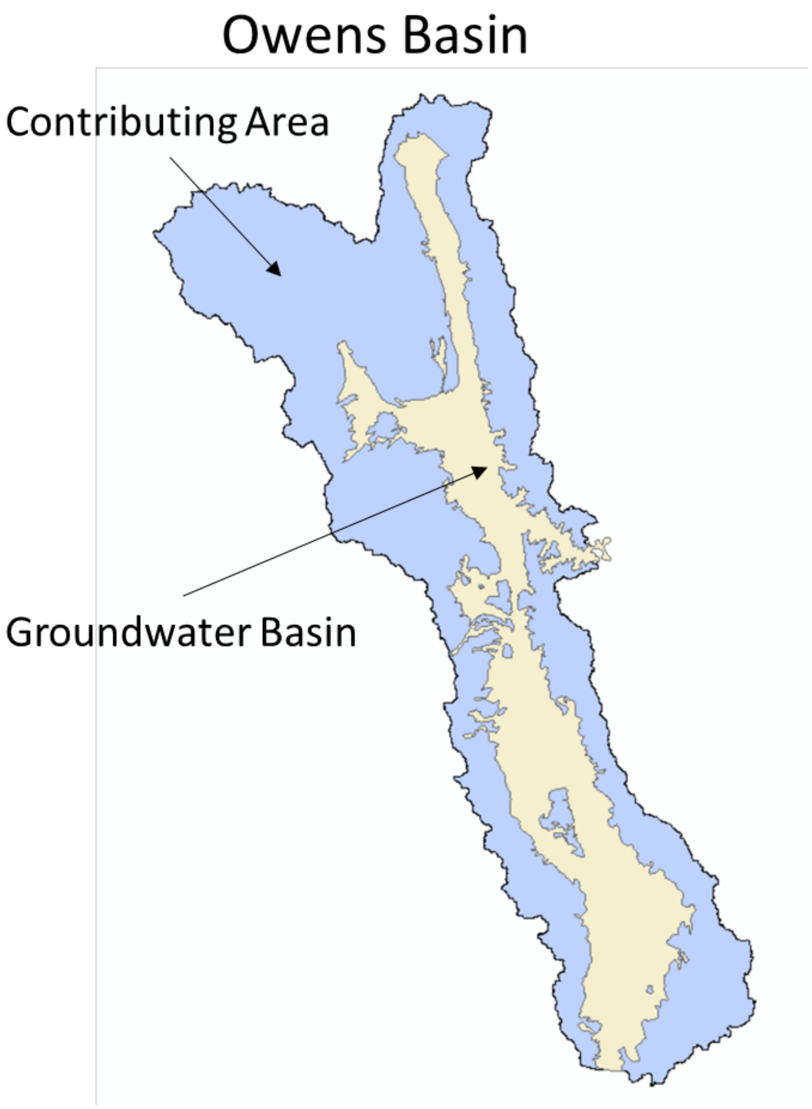

Figure 1. Map showing contributing area (headwater) and the groundwater basin for Owens Basin.

Water budget for the contributing area for the historical and current periods are shown below in Figure 2 and Figure 3.

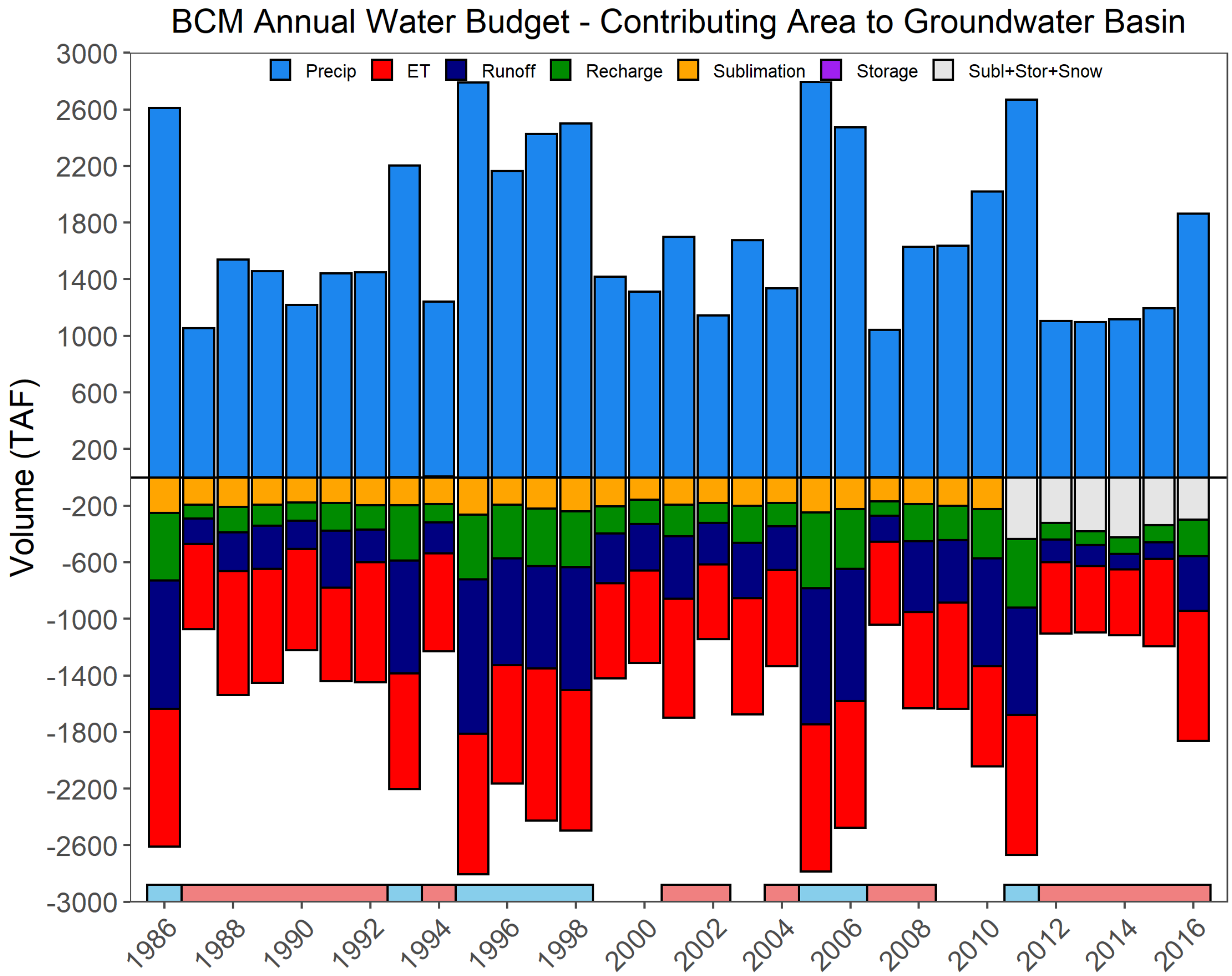

Figure 2. Historical water budget for the contributing area (headwater) to groundwater basin. Wet and dry years shown as blue and red bars at the bottom of the graph.

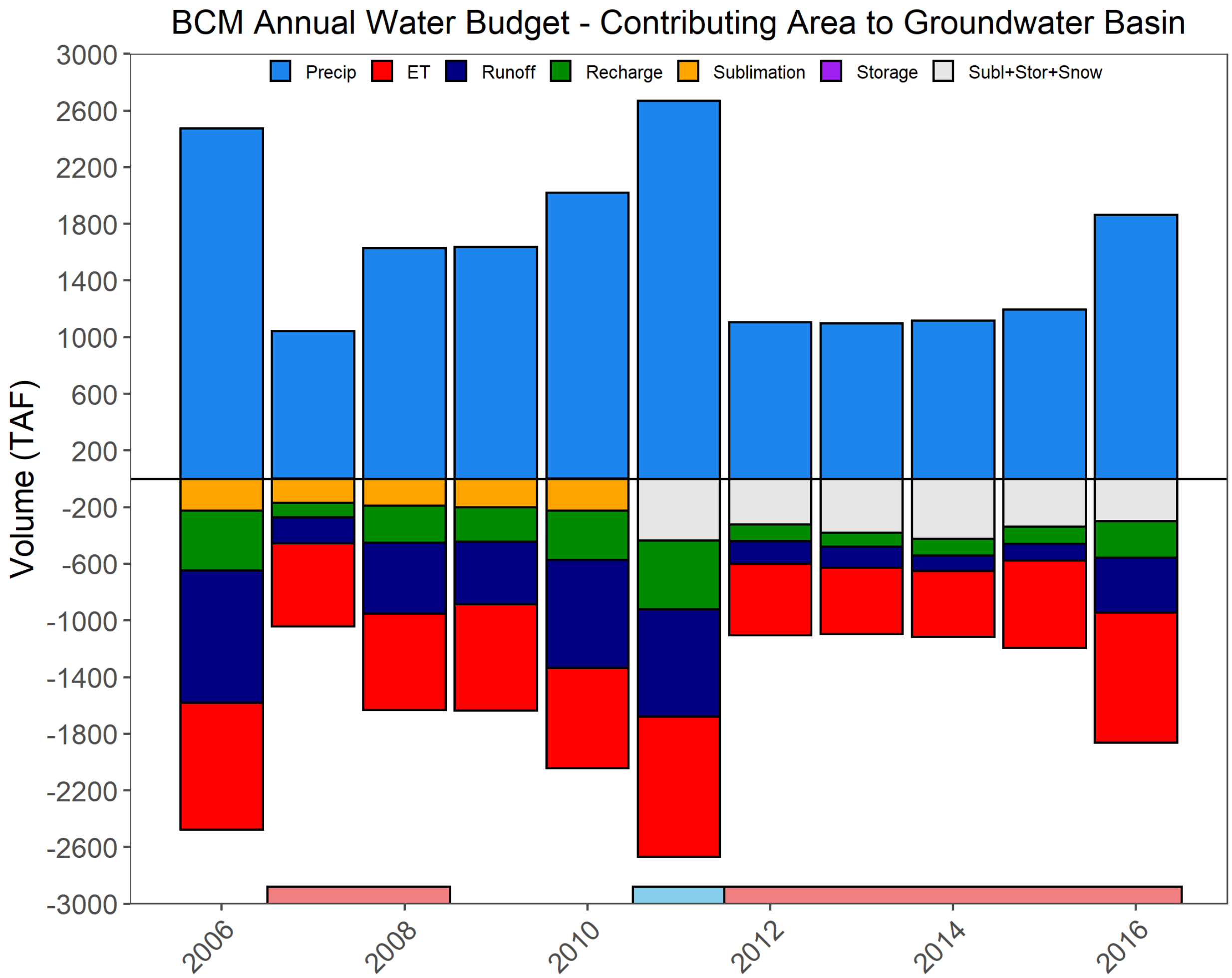

Figure 3. Current water budget for the contributing area (headwater) to groundwater basin. Wet and dry years shown as blue and red bars at the bottom of the graph.

Water budget for the Owens valley groundwater basin for the historical and current periods are shown below in Figure 4 and Figure 5

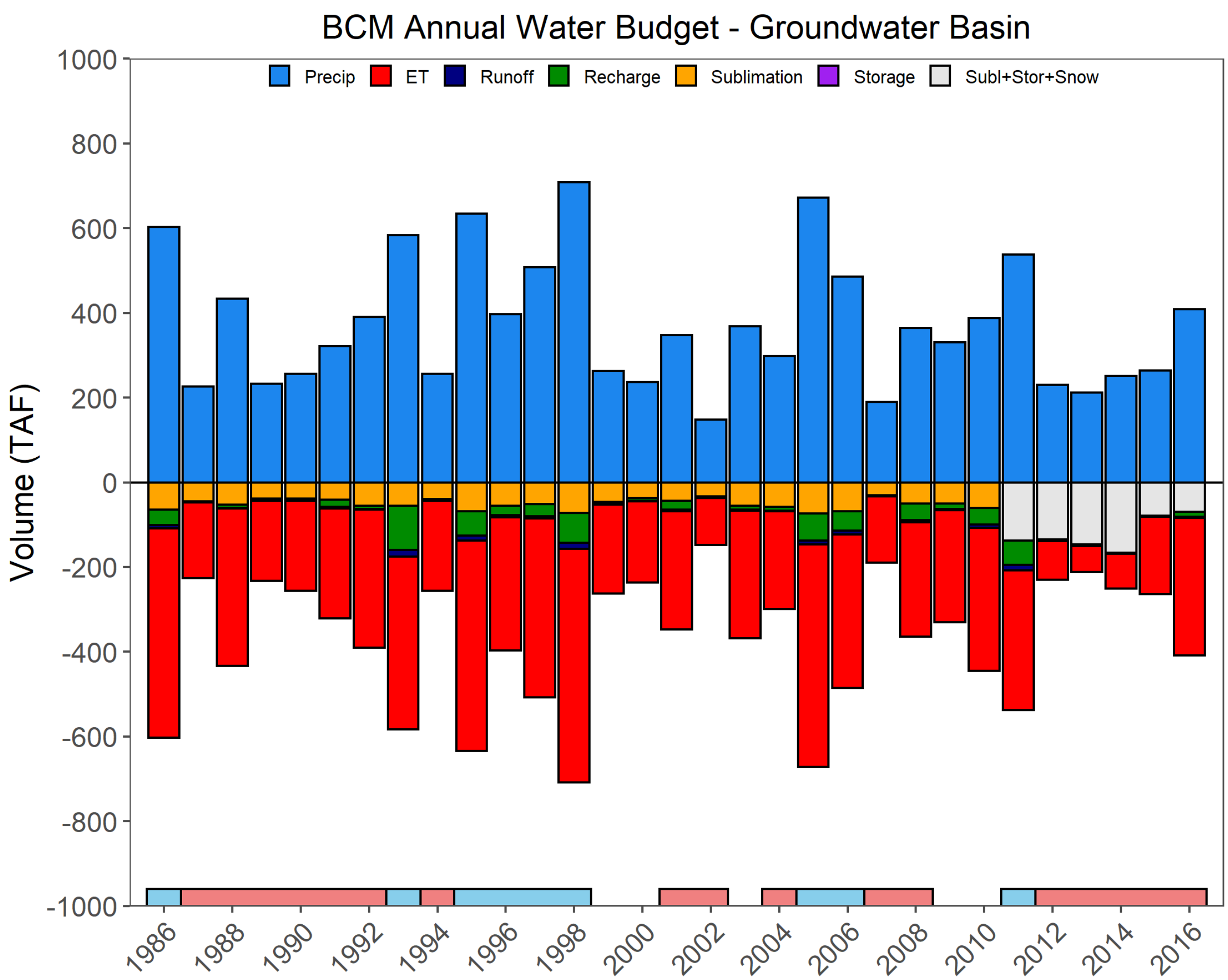

Figure 4. Historical water budget for the Owens Valley groundwater basin. Wet and dry years shown as blue and red bars at the bottom of the graph.

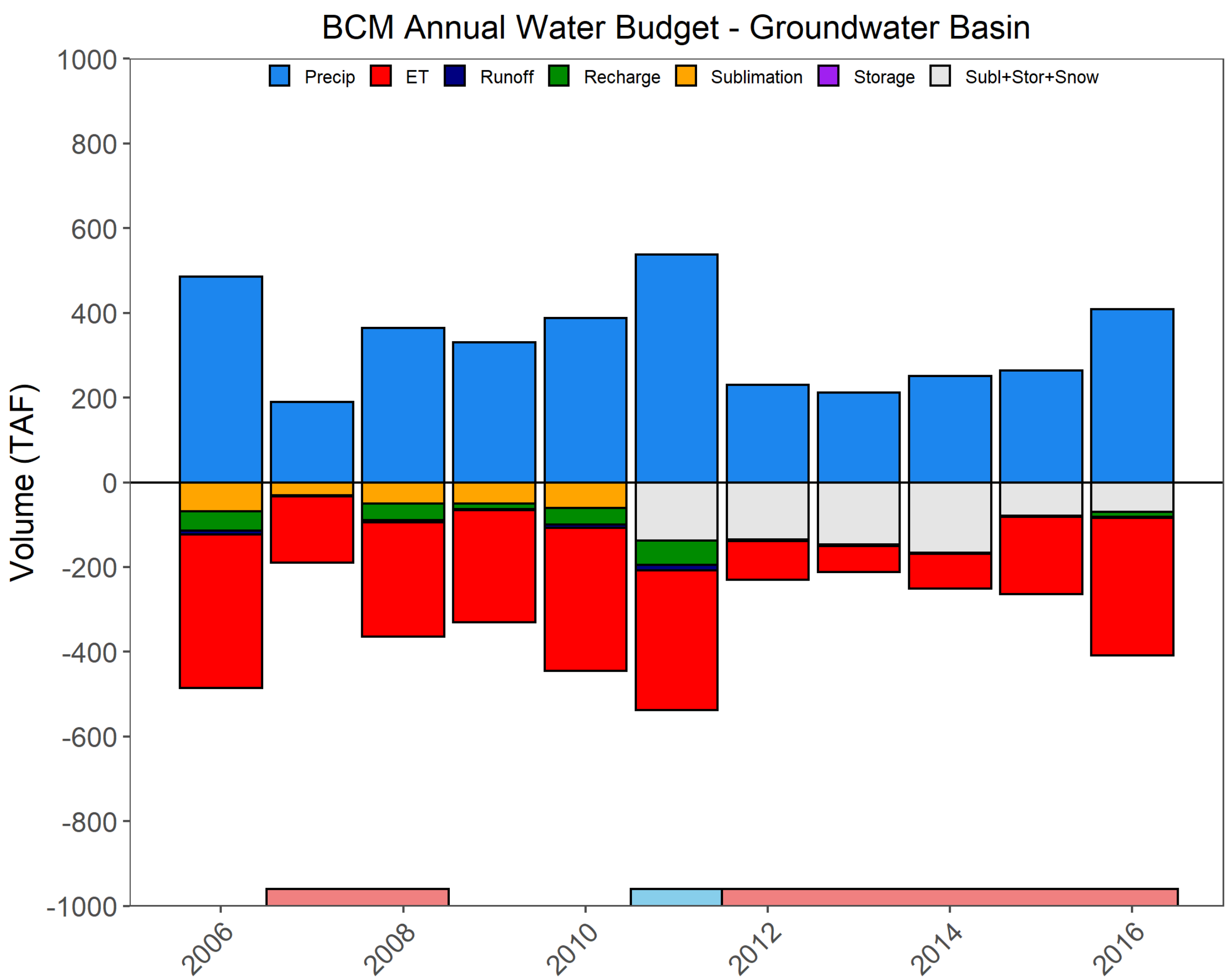

Figure 5. Current water budget for the Owens Valley groundwater basin. Wet and dry years shown as blue and red bars at the bottom of the graph.

The Owens basin was further divided into three management areas, Owens Valley, Fish Slough and Tri Valley and Owens Lake. Figure 6 shows a map of the contributing and groundwater basin for the three-management areas.

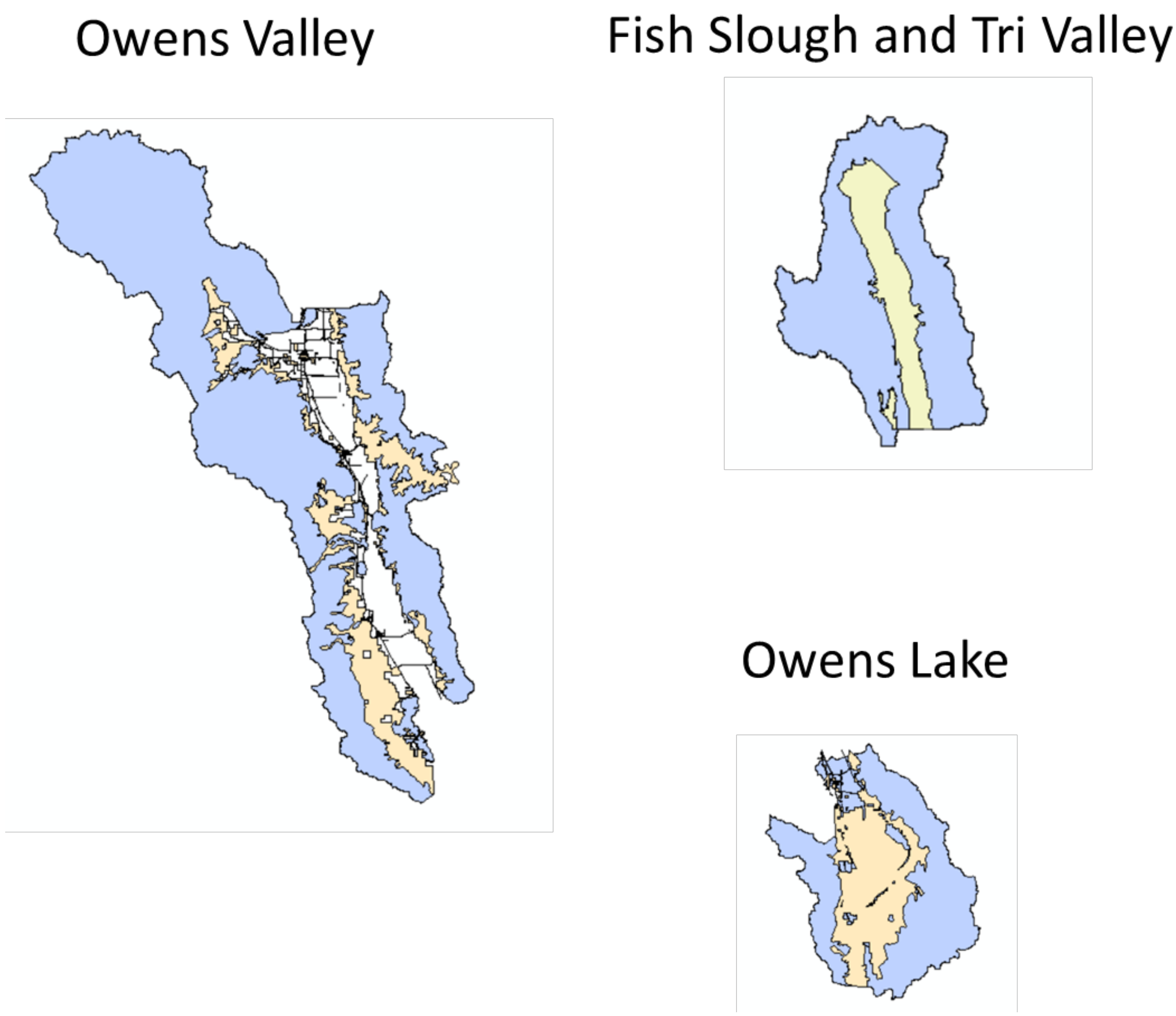

Figure 6. Map showing contributing area (headwater) shown in blue and the groundwater basin for the three management areas within the Owens Basin.

The historical and current water budget for the contributing area to the Owens Valley project management area is shown in Figure 7 and Figure 8.

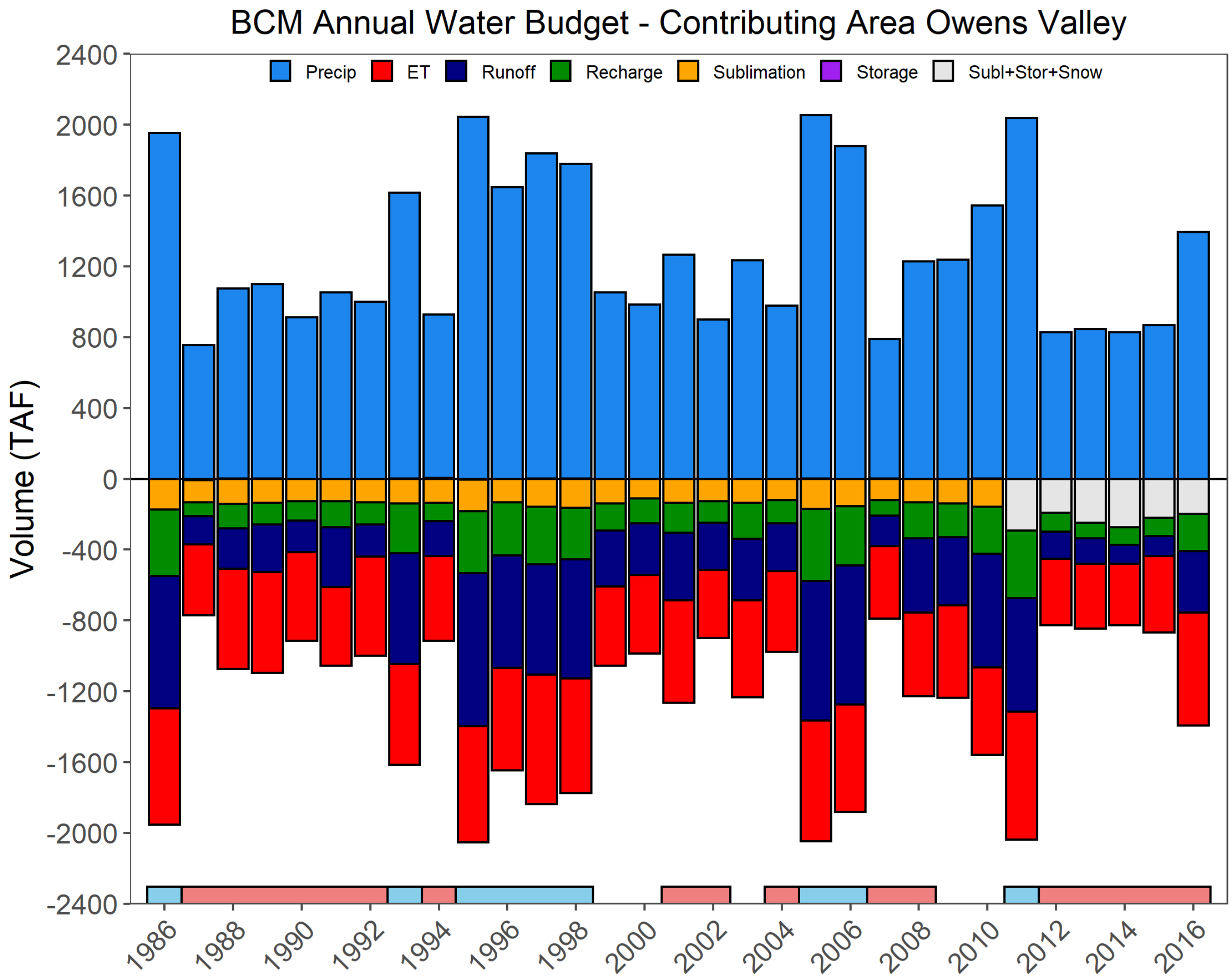

Figure 7. Historical water budget for the Owens Valley management area contributing area (headwater). Wet and dry years shown as blue and red bars at the bottom of the graph.

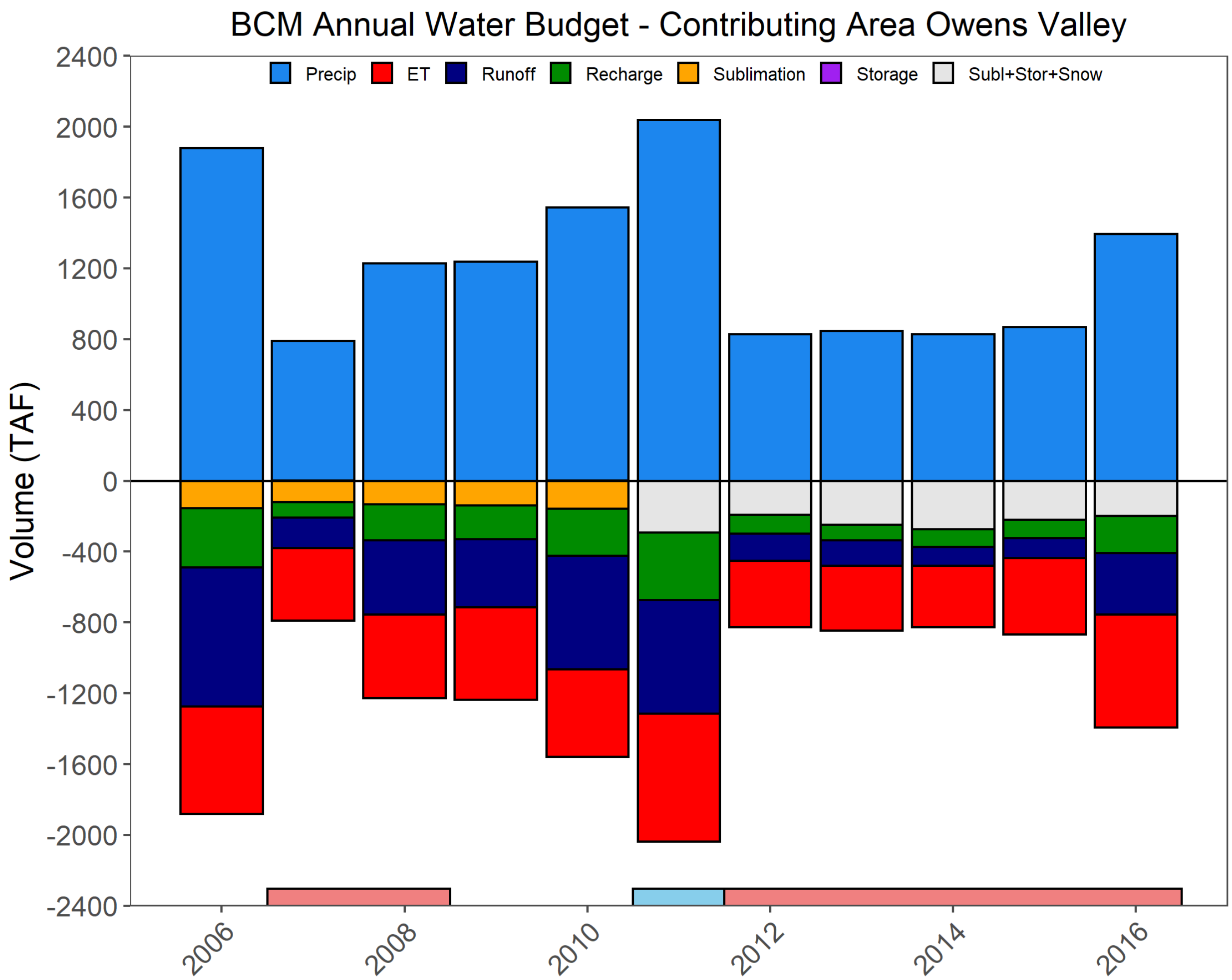

Figure 8. Current water budget for the Owens Valley management area contributing area (headwater). Wet and dry years shown as blue and red bars at the bottom of the graph.

The historical and current water budget for the groundwater basin in the Owens Valley project management area is shown in Figure 9 and Figure 10.

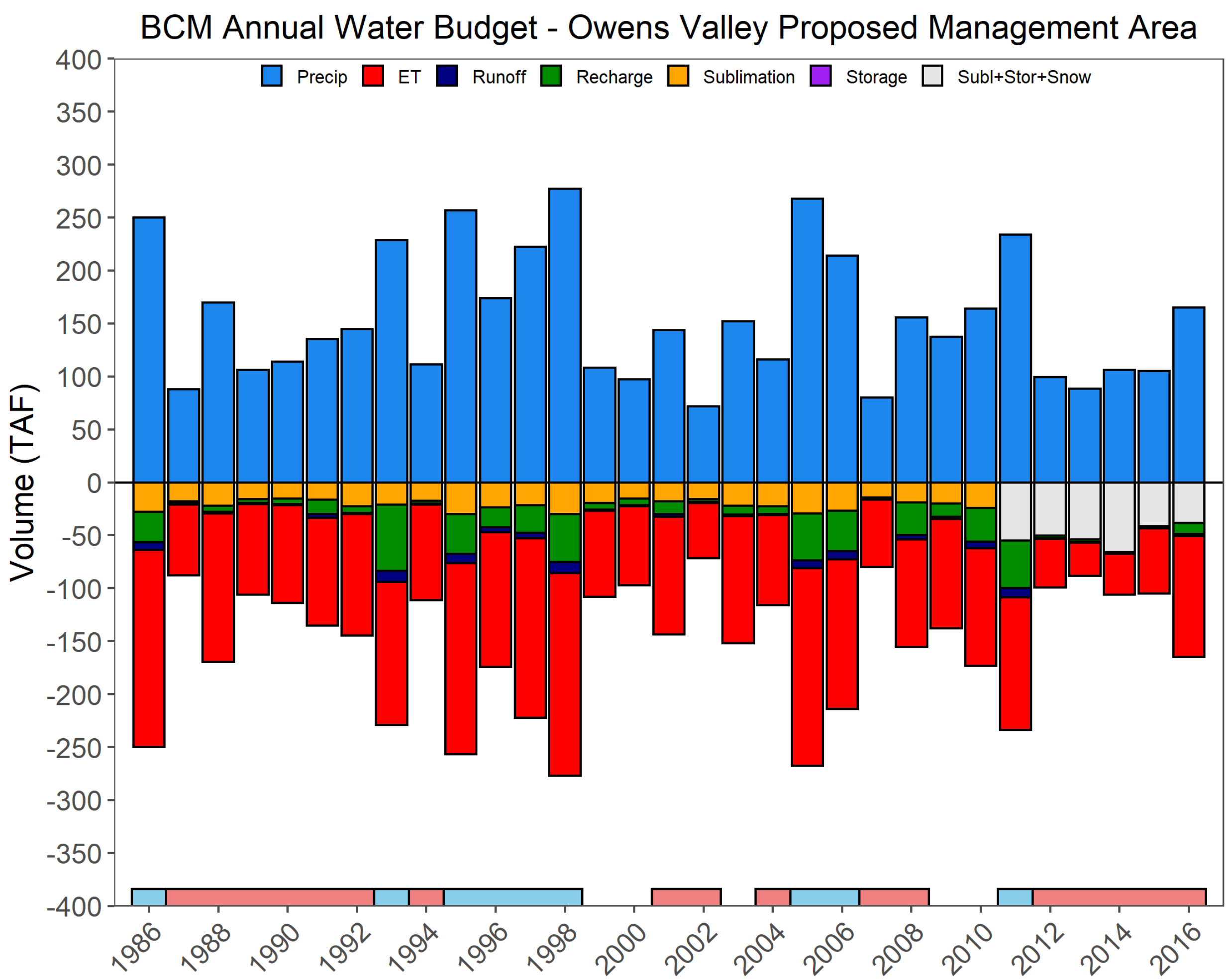

Figure 9. Historical water budget for the groundwater basin in the Owens Valley management area. Wet and dry years shown as blue and red bars at the bottom of the graph.

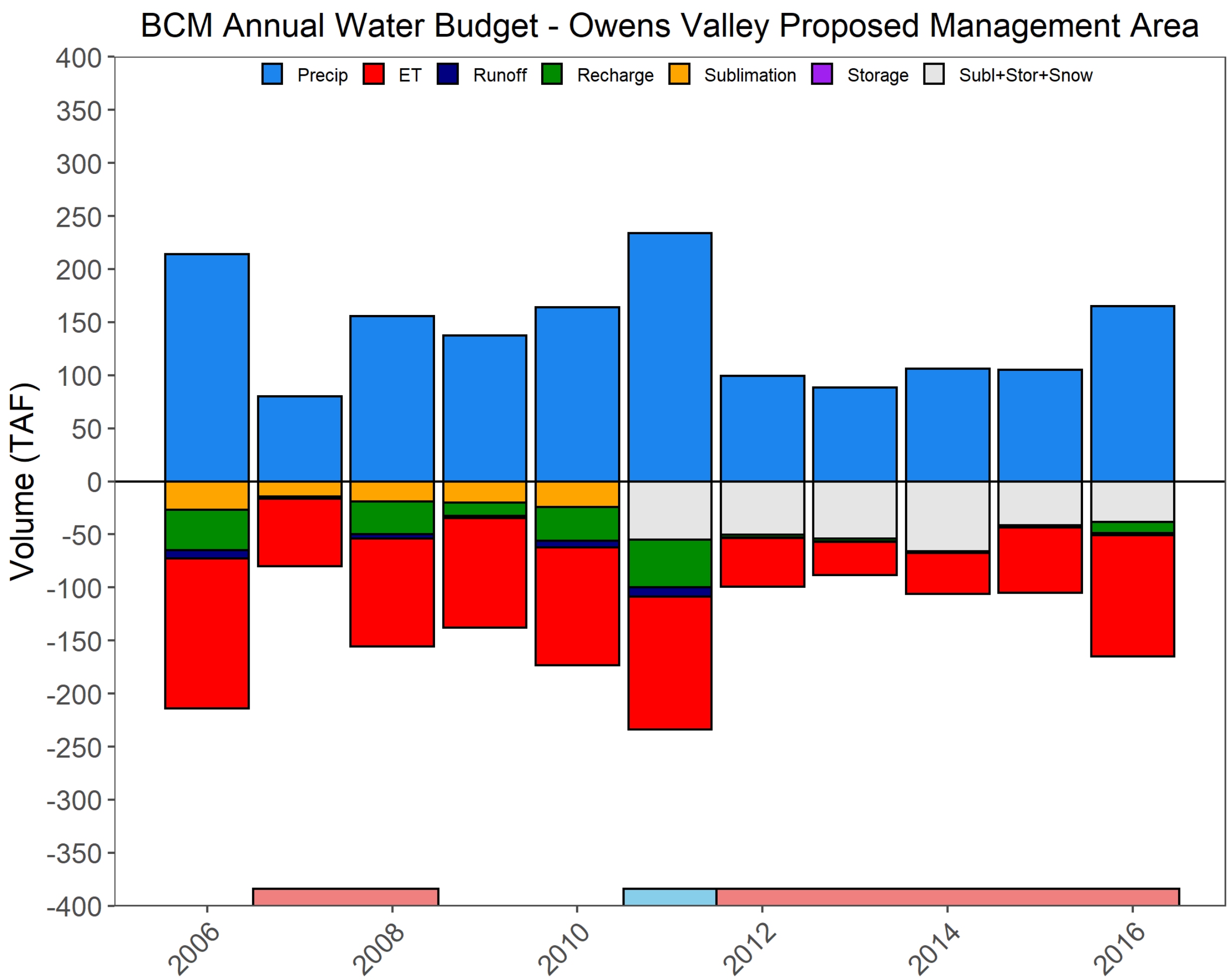

Figure 10. Current water budget for the groundwater basin in the Owens Valley management area. Wet and dry years shown as blue and red bars at the bottom of the graph.

The historical and current water budgets for the contributing area to the Fish Slough and Tri-Valley project management area are shown in Figure 11 and Figure 12.

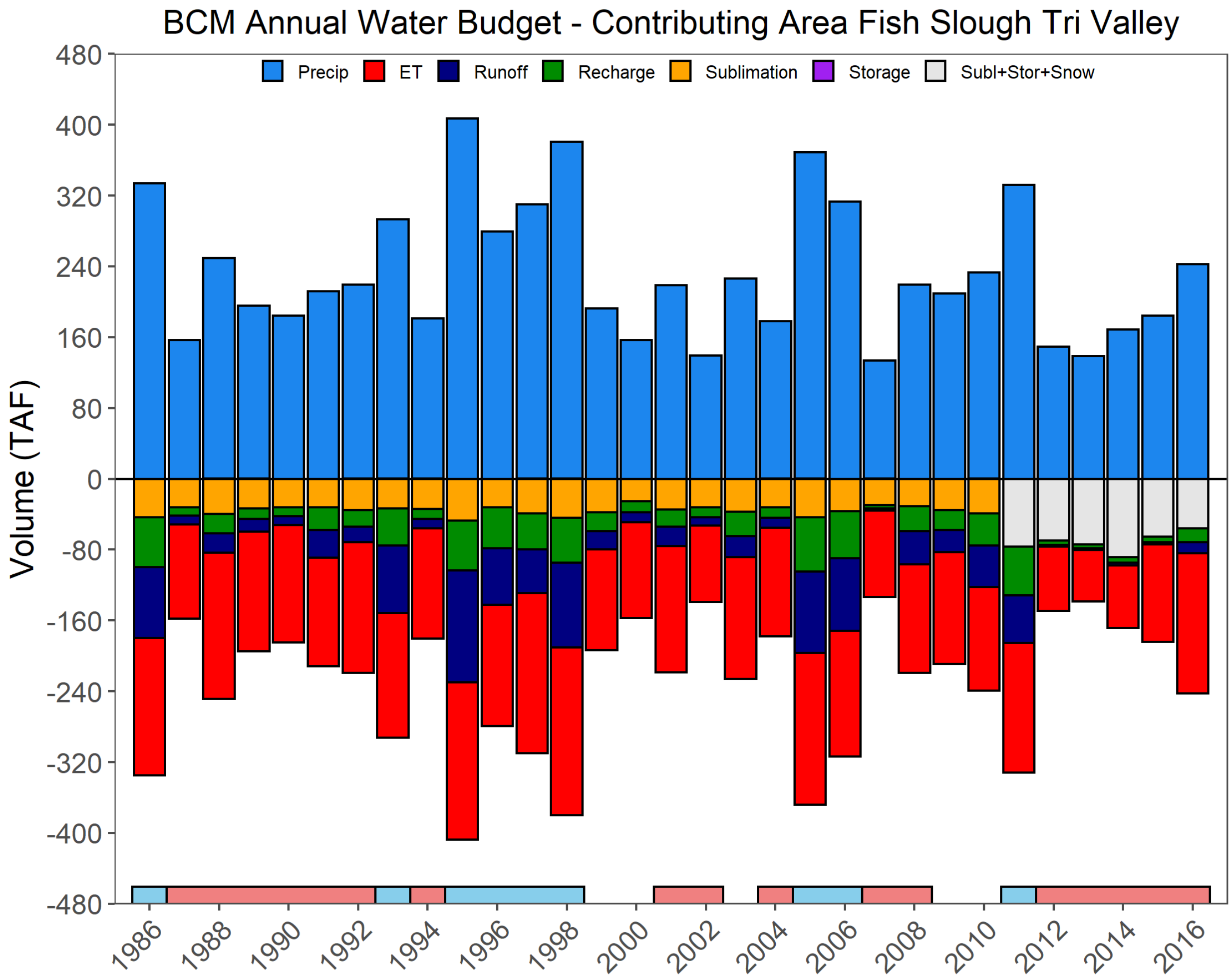

Figure 11. Historical water budget for the Fish Slough and Tri-Valley management area contributing area (headwater). Wet and dry years shown as blue and red bars at the bottom of the graph.

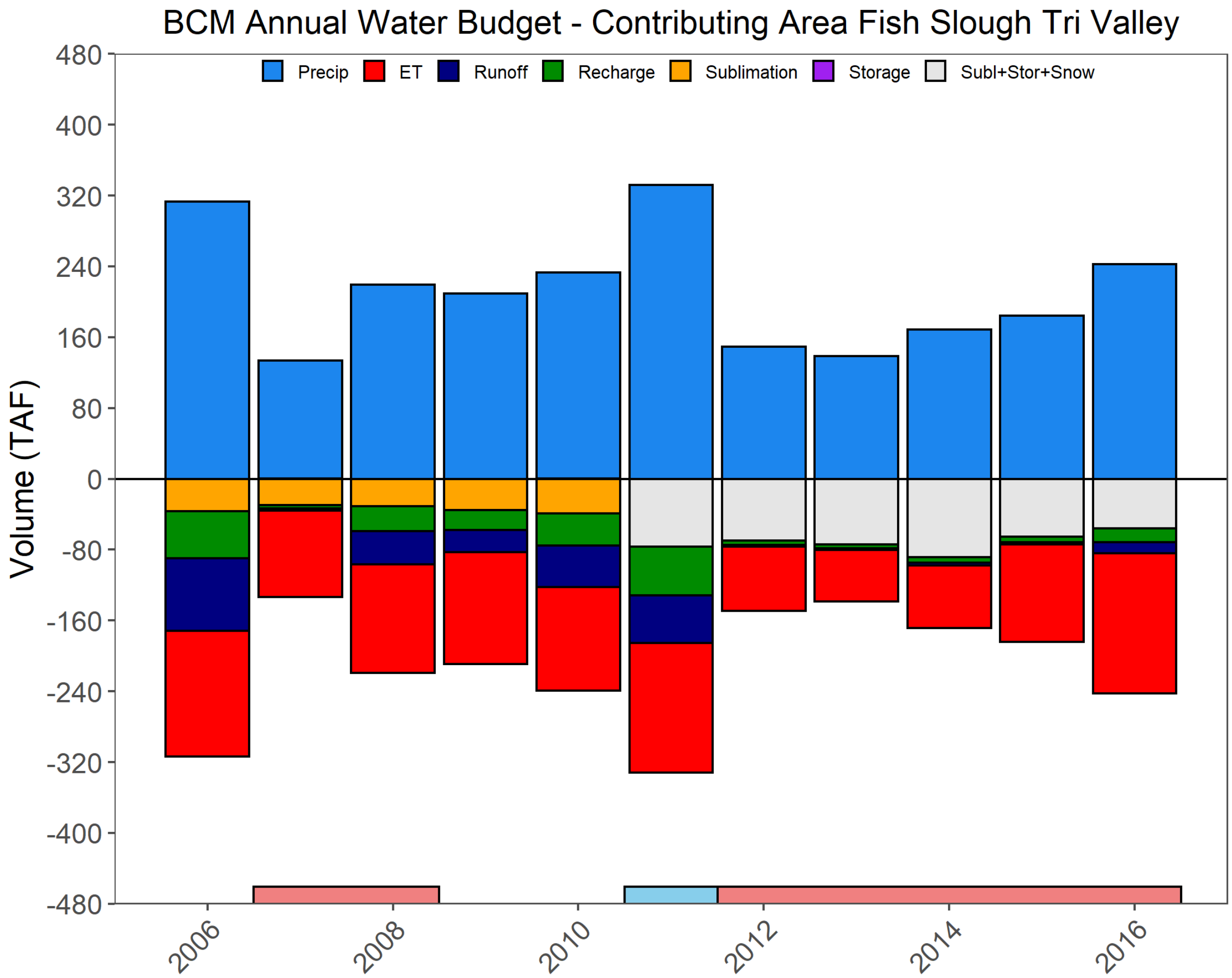

Figure 12. Current water budget for the Fish Slough and Tri-Valley management area contributing area (headwater). Wet and dry years shown as blue and red bars at the bottom of the graph.

The historical and current water budgets for the groundwater basin in the Fish Slough and Tri-Valley project management area are shown in Figure 13 and Figure 14.

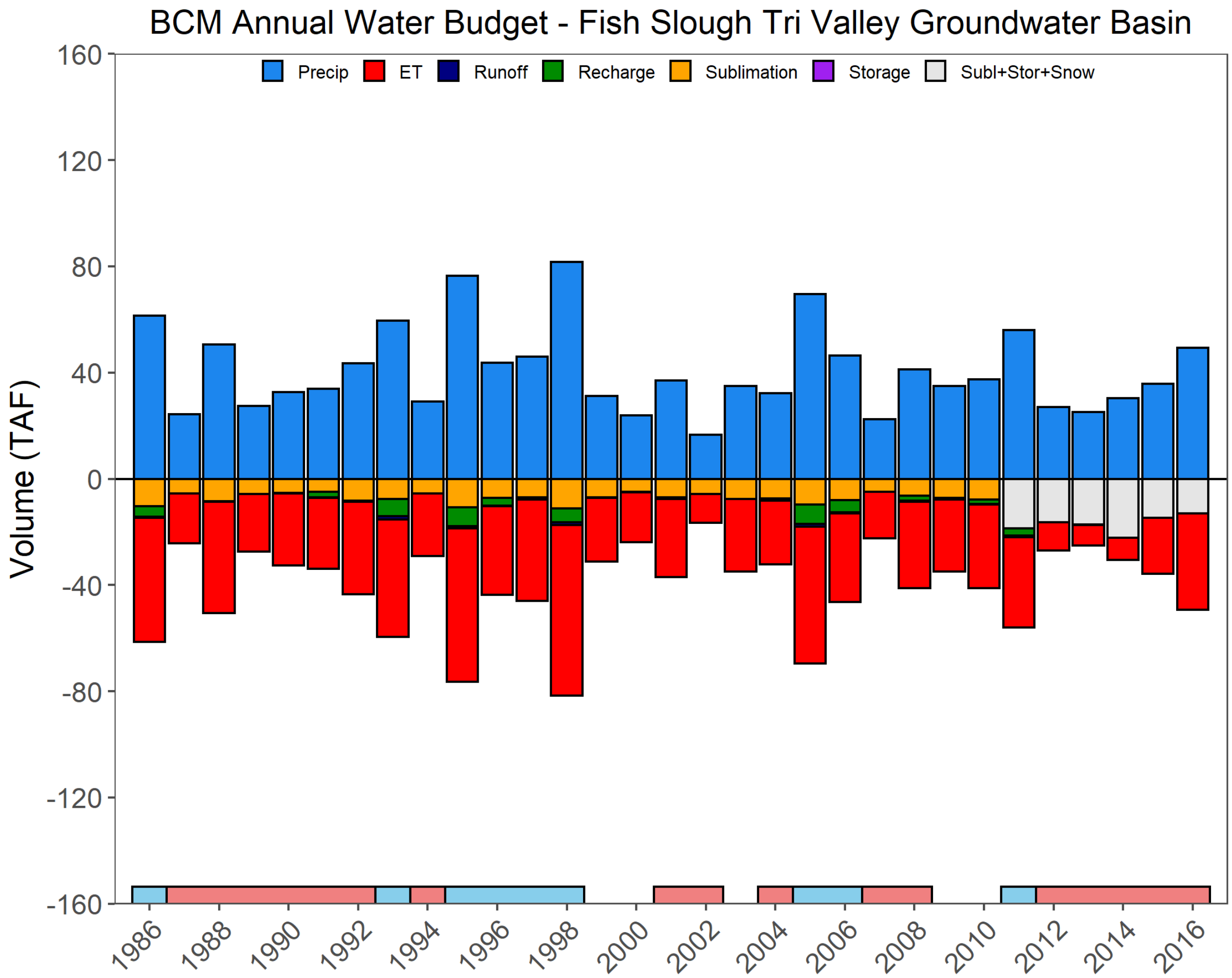

Figure 13. Historical water budget for the groundwater basin in the Fish Slough and Tri-Valley management area. Wet and dry years shown as blue and red bars at the bottom of the graph.

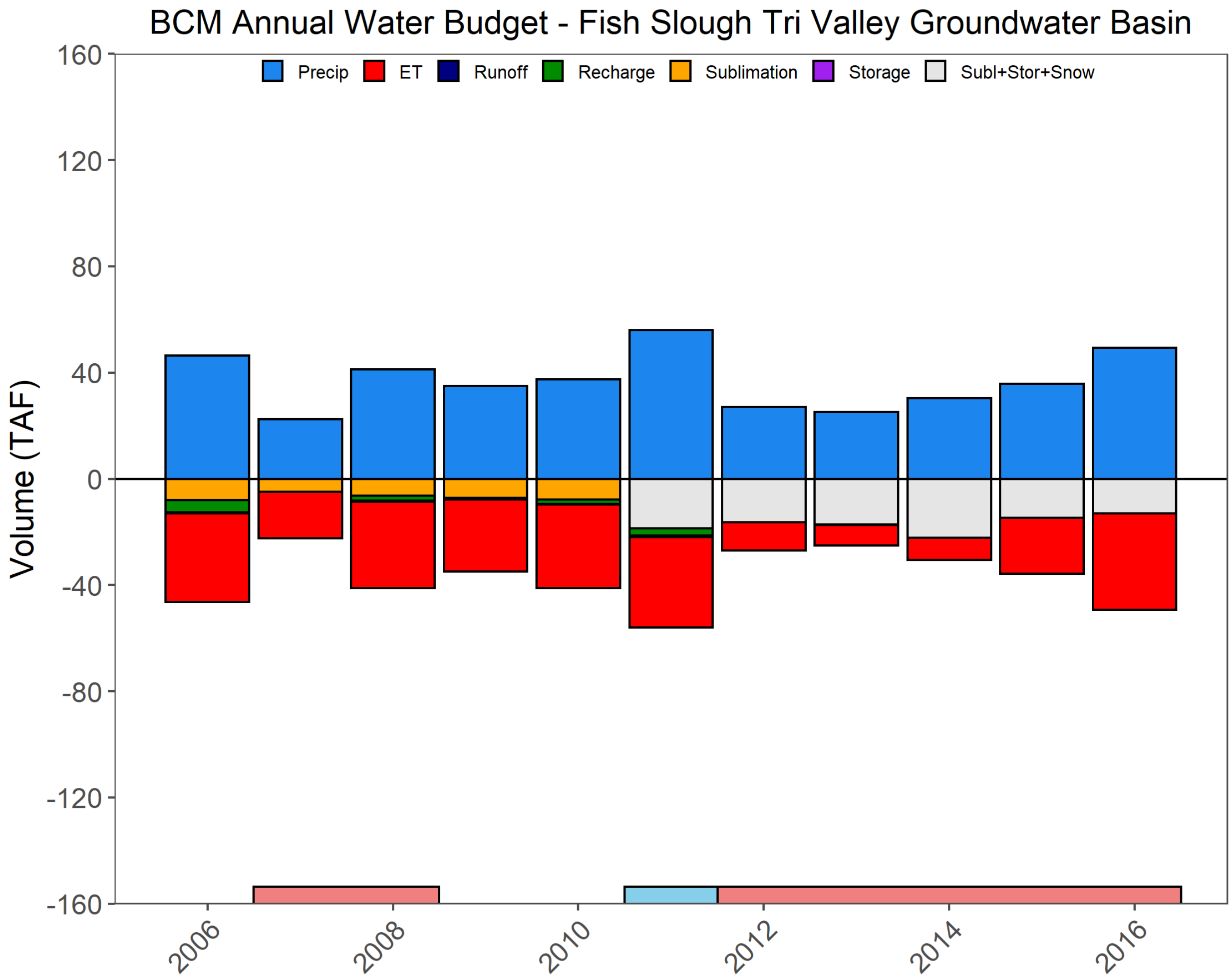

Figure 14. Current water budget for the groundwater basin in the Fish Slough and Tri-Valley management area. Wet and dry years shown as blue and red bars at the bottom of the graph.

A Distributed Parameter Watershed Model (DPWM) was also developed for the Fish Slough and Tri-Valley areas. The modeling domain for this DPWM model is different from the BCM model. Figure 15 shows an annual water budget from the DPWM for Fish Slough and Tri-Valley. Since this is a different model from BCM the accounting for the water budget is different so many of the water budget fluxes are not directly comparable between DPWM and BCM. However, the average recharge simulated by both DPWM and BCM are approximately in the range of 20 - 30 TAF in both models (see Figure 15 and Figure 11).

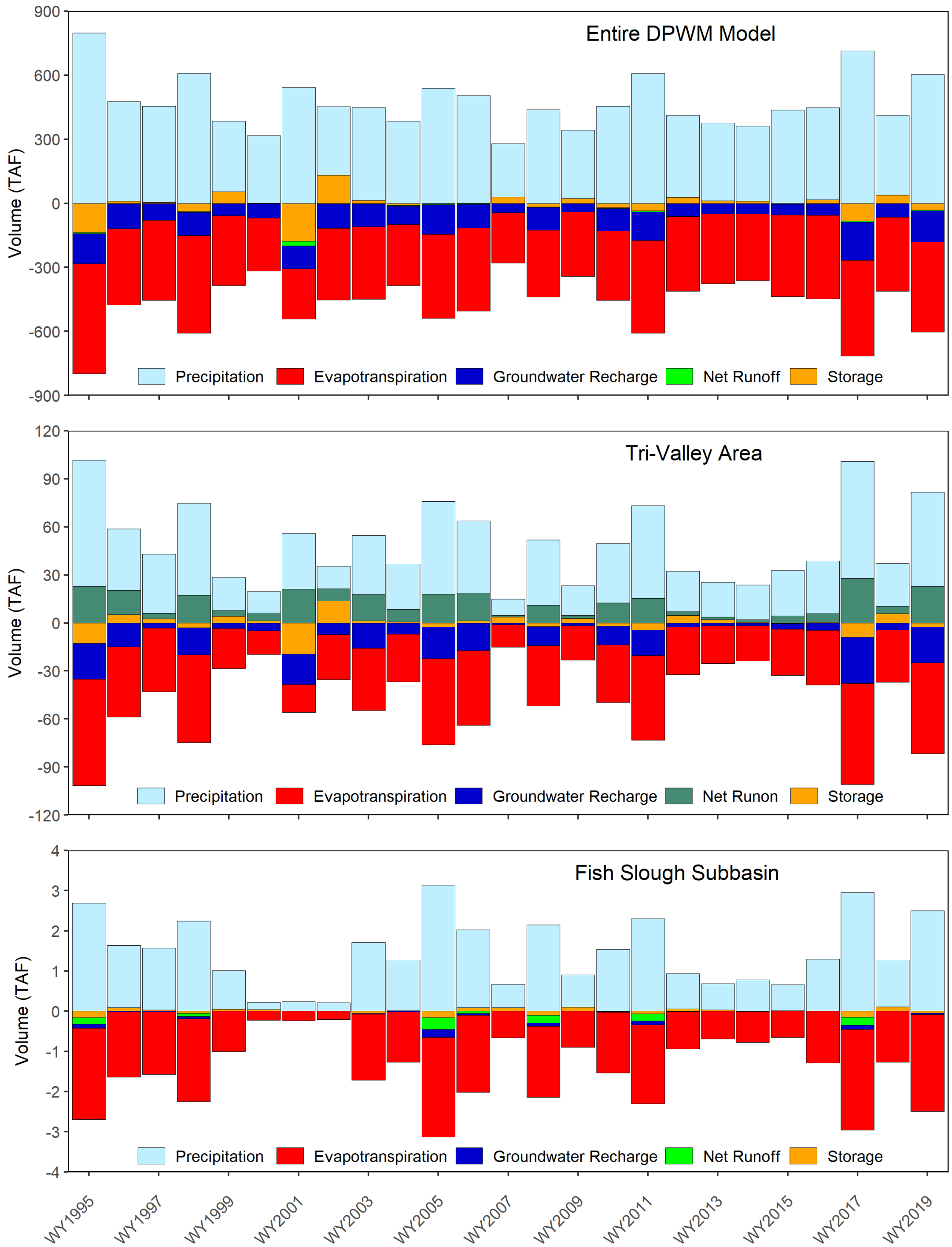

Figure 15. DPWM annual water budget for Fish Slough and Tri-Valley

The historical and current water budget for the contributing area to the Owens Lake project management area is shown in Figure 16 and Figure 17.

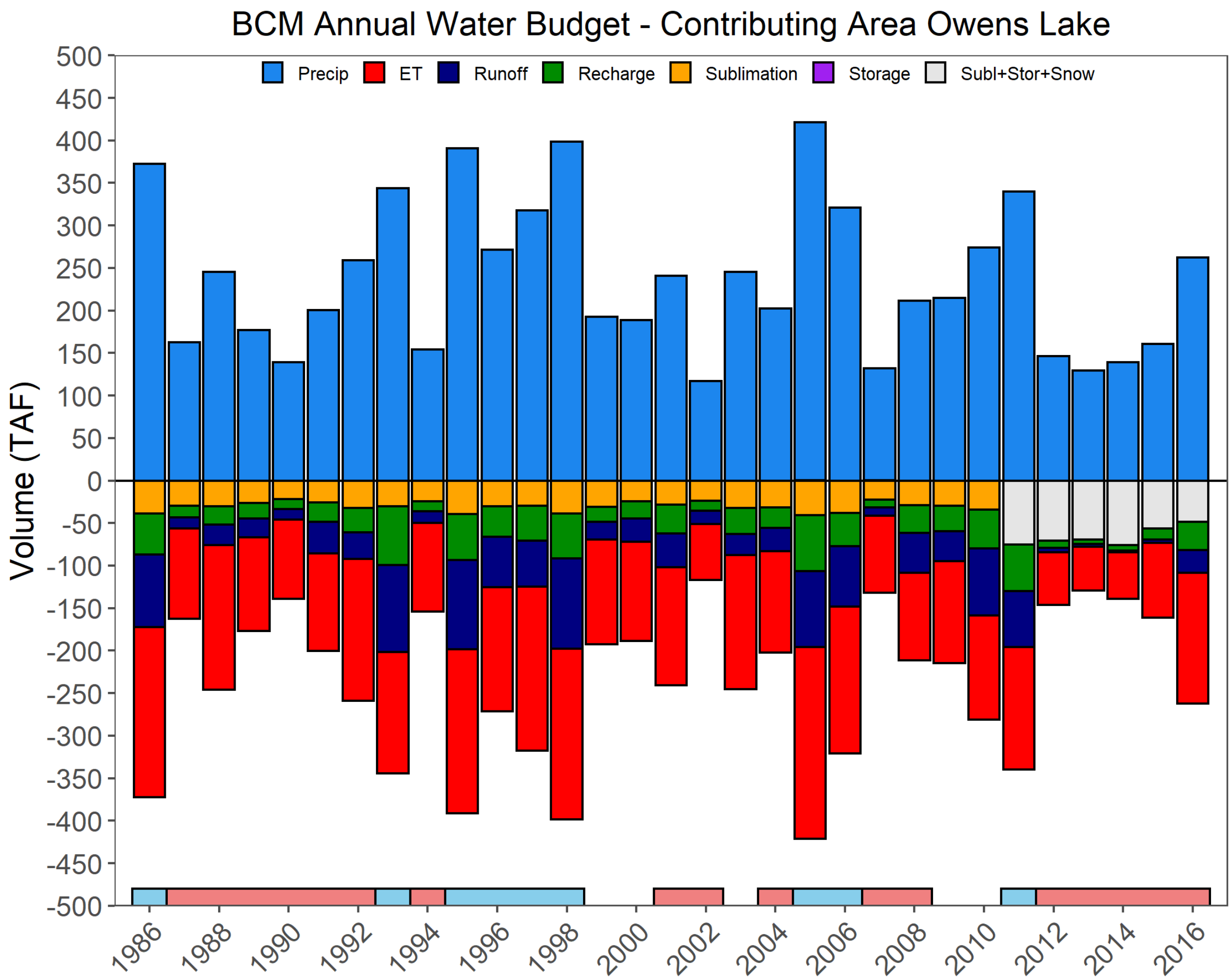

Figure 16. Historical water budget for the Owens Lake management area contributing area (headwater). Wet and dry years shown as blue and red bars at the bottom of the graph.

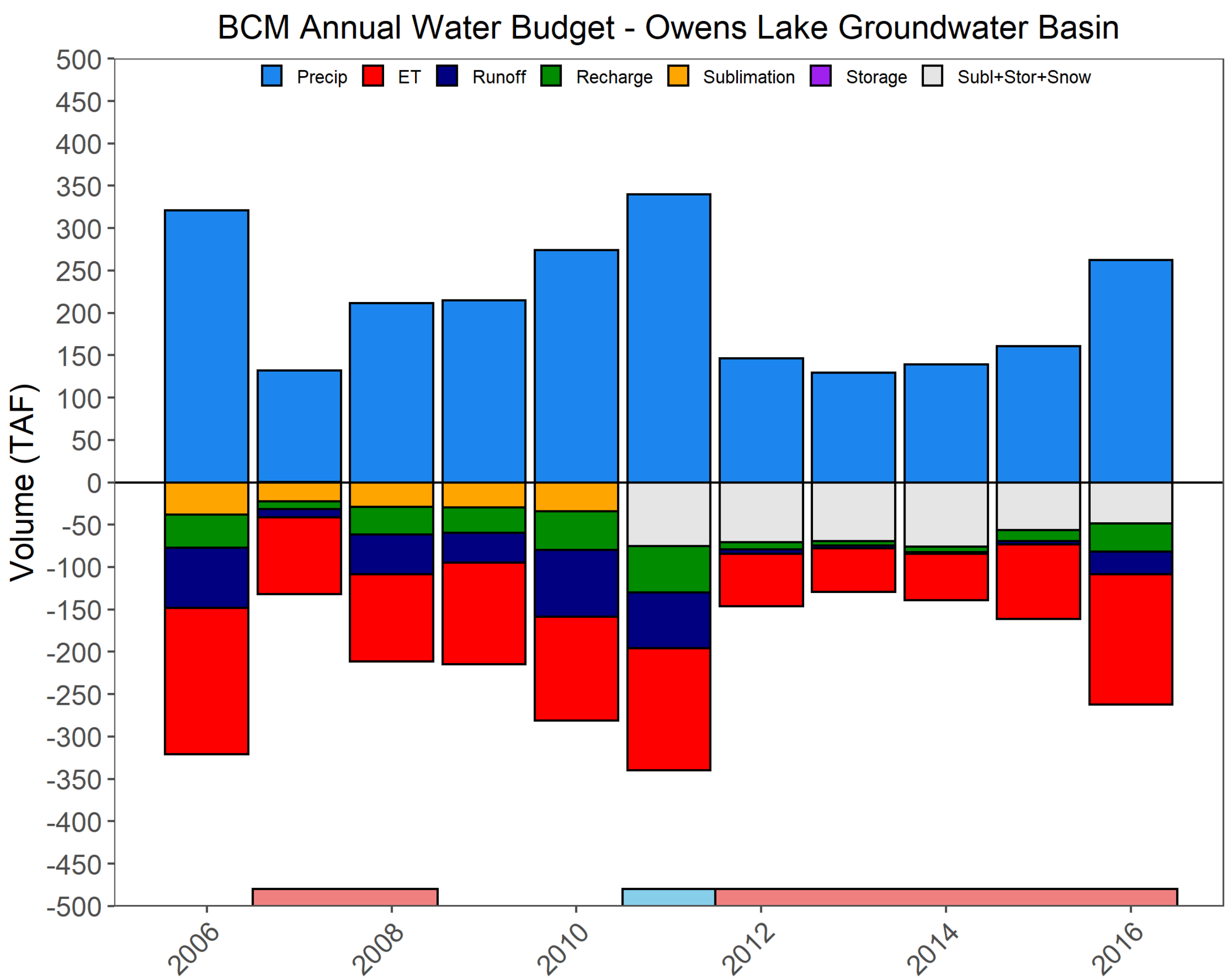

Figure 17. Current water budget for the Owens Lake management area contributing area (headwater). Wet and dry years shown as blue and red bars at the bottom of the graph.

The historical and current water budgets for the groundwater basin in the Owens Lake project management area are shown in Figure 18 and Figure 19.

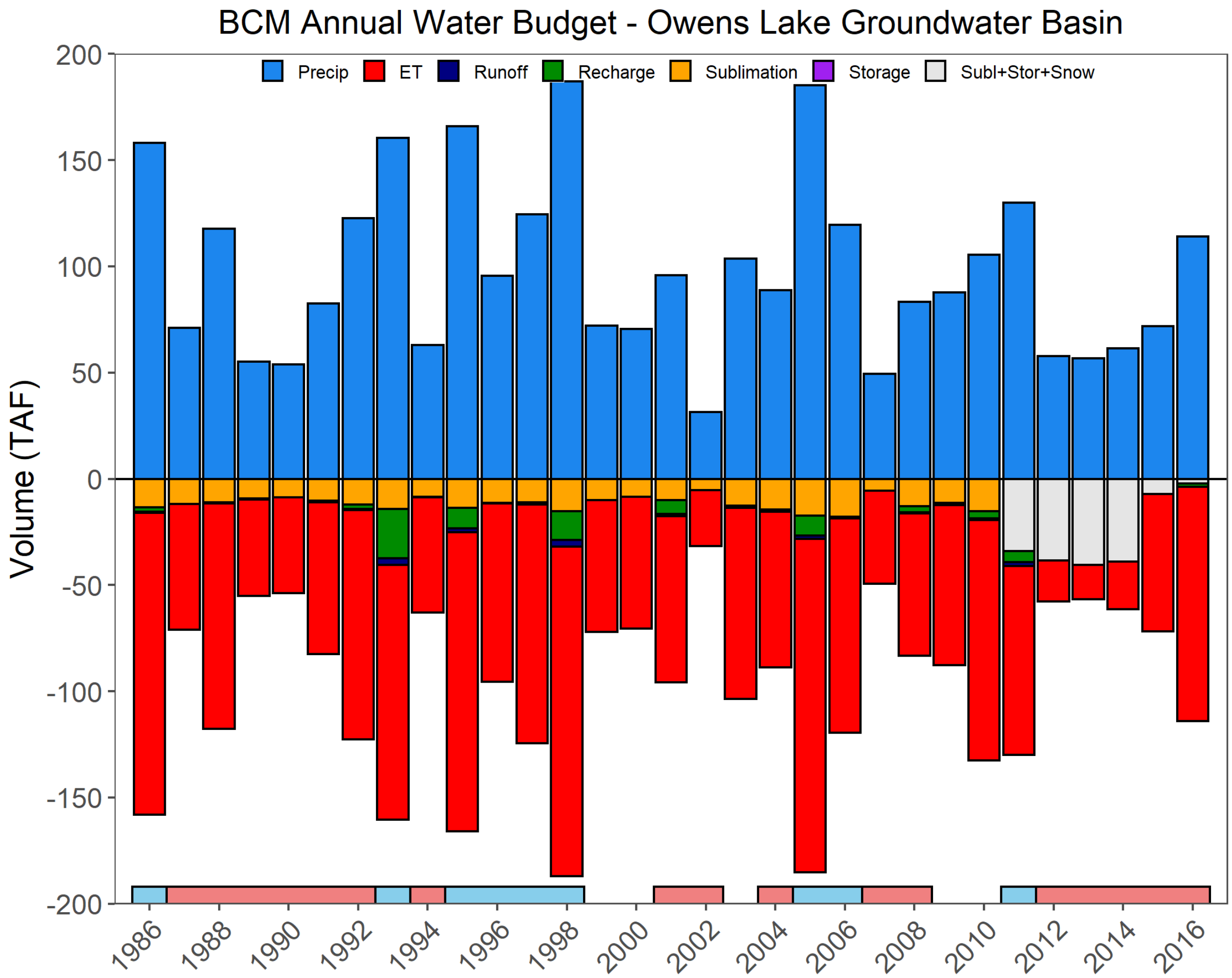

Figure 18. Historical water budget for the groundwater basin in the Owens Lake management area. Wet and dry years shown as blue and red bars at the bottom of the graph.

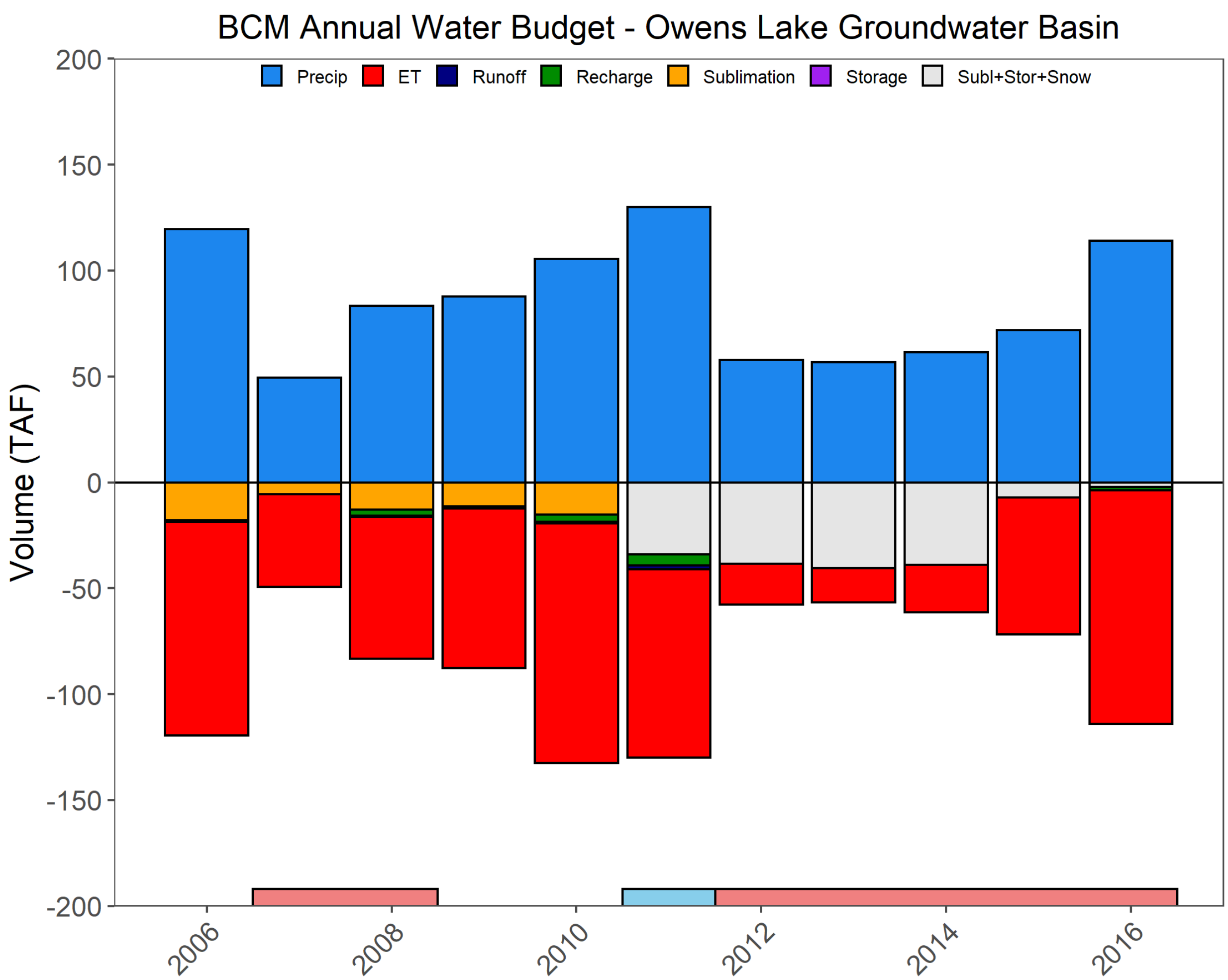

Figure 19. Current water budget for the groundwater basin in the Owens Lake management area. Wet and dry years shown as blue and red bars at the bottom of the graph.

2.1 Summary of current land system water budget

The land system water budget are presented in graphical format thus far. Table 1 presents a summary of the current (2006-2016) land system water budget for Owens basing and the three management areas.

Table 1. Summary of current land system water budget

Area	Average Annual Volume (TAF)				
	Precip	ET	Runoff	Recharge	Storage
Owens Basin CA	1622	689	410	234	289
Owens GWB	333	224	4	20	85
Owens Valley CA	1225	489	356	188	192
Owens Valley MA	141	85	3	16	36
Fish Slough and Tri-Valley CA	211	111	25	22	54
Fish Slough and Tri-Valley MA	37	24	0	1	12
Owens Lake CA	212	106	32	25	49
Owens Lake MA	85	66	0	1	18

CA = Contributing Area; MA = Management Area

3. Sustainability in Owens Basin

The criteria used to ascertain if the Owens Basin is in balance is based on runoff and recharge from the contributing area (headwater basin) entering the Owens Valley groundwater basin is in excess of the export of water by LADWP. This criterion is simple to evaluate since the BCM model water budget outputs provide the values of runoff and recharge entering the groundwater basin. Since LADWP did not provide access to the groundwater model for Owens Valley, we had to rely on LADWP annual reports to estimate the amount of water transferred outside the basin. Figure 20 shows the annual amount of water pumped by LADWP and Figure

21 shows the total export of water via the LA Aqueduct. LADWP pumping in the most recent thirty years 1986-2016 has been below 100 TAF and the export of water via the LA Aqueduct has been below 400 TAF. From the BCM model water budget analysis the total long term average runoff entering Owens valley is 470 TAF and the recharge from the contributing area (headwater) to the valley is 252 TAF. Since the BCM estimated runoff and recharge are higher than the reported pumping and export of water it is reasonable to assume that the basin is in balance if these historical values are accurate and are maintained in the future.

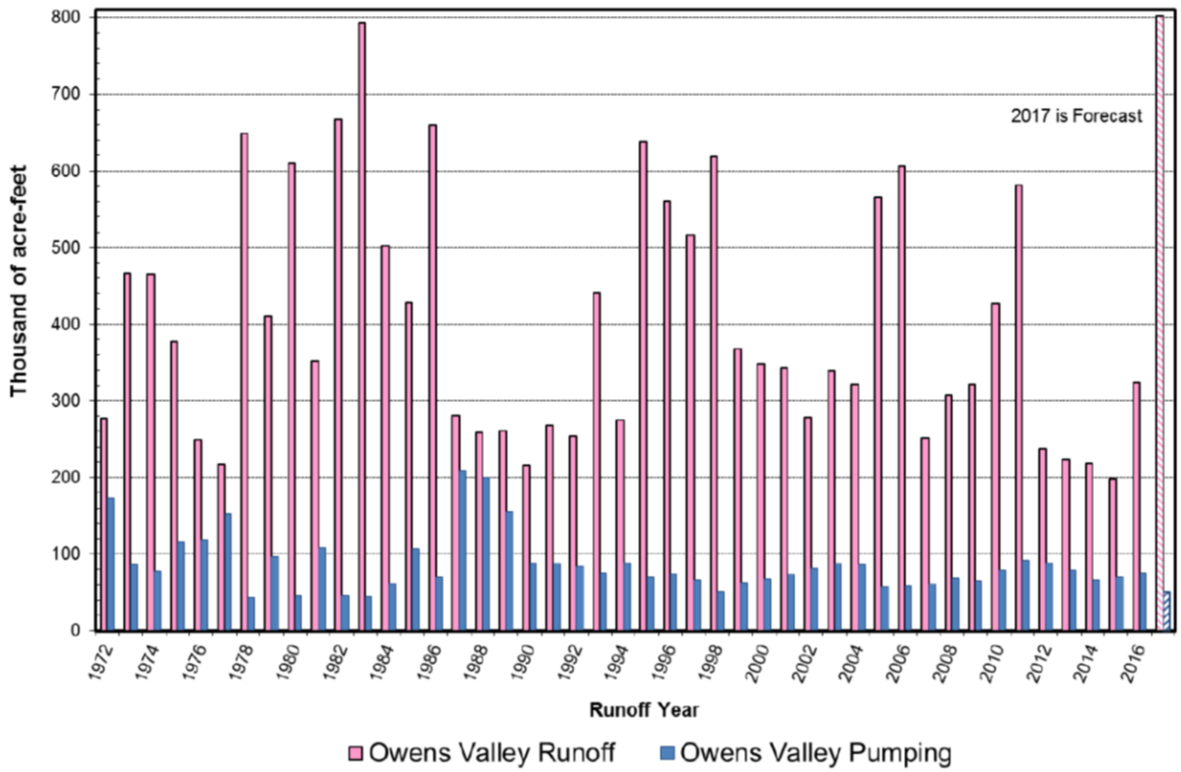

Figure 20. Groundwater pumping in Owens Valley. Source: 2017 LADWP Annual Report

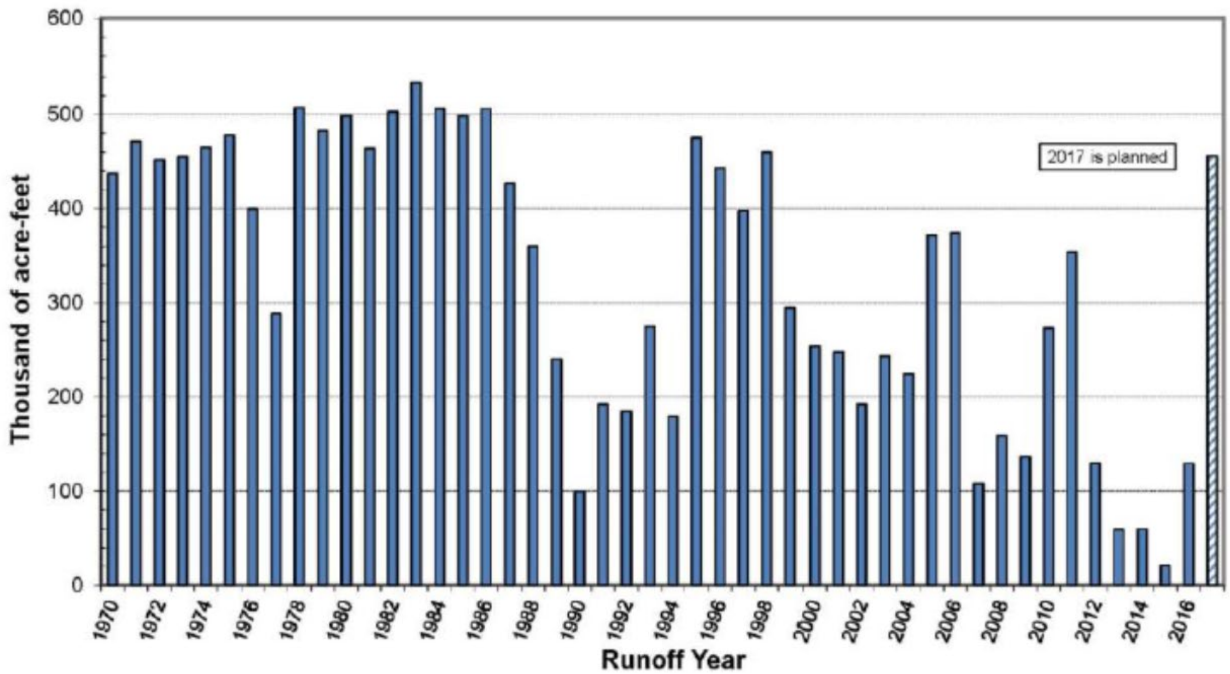

Figure 21. Water export from the Owens Basin via the LA Aqueduct. Source: 2017 LADWP Annual report

4. Future water balance

DWR future climate change factors for the Owens basin suggest that the temperatures will increase by approximately 2.6 degree F by mid-century and precipitation increases by 0.3%. The USGS has already made future climate runs using the BCM model for a subset of climate model inputs, CCSM4; CNRM-CM5; GFDL-CM3; MIROC5. For the purpose of this GSP the CCSM4 scenario 8.5 was selected for the Owens Basin to evaluate future water budget as this scenario showed similar delta change in temperature as suggested by DWR.

Figure 22 shows the future (mid-century) water budget for the contributing area to the groundwater basin. Figure 23 shows the future water budget for the groundwater basin.

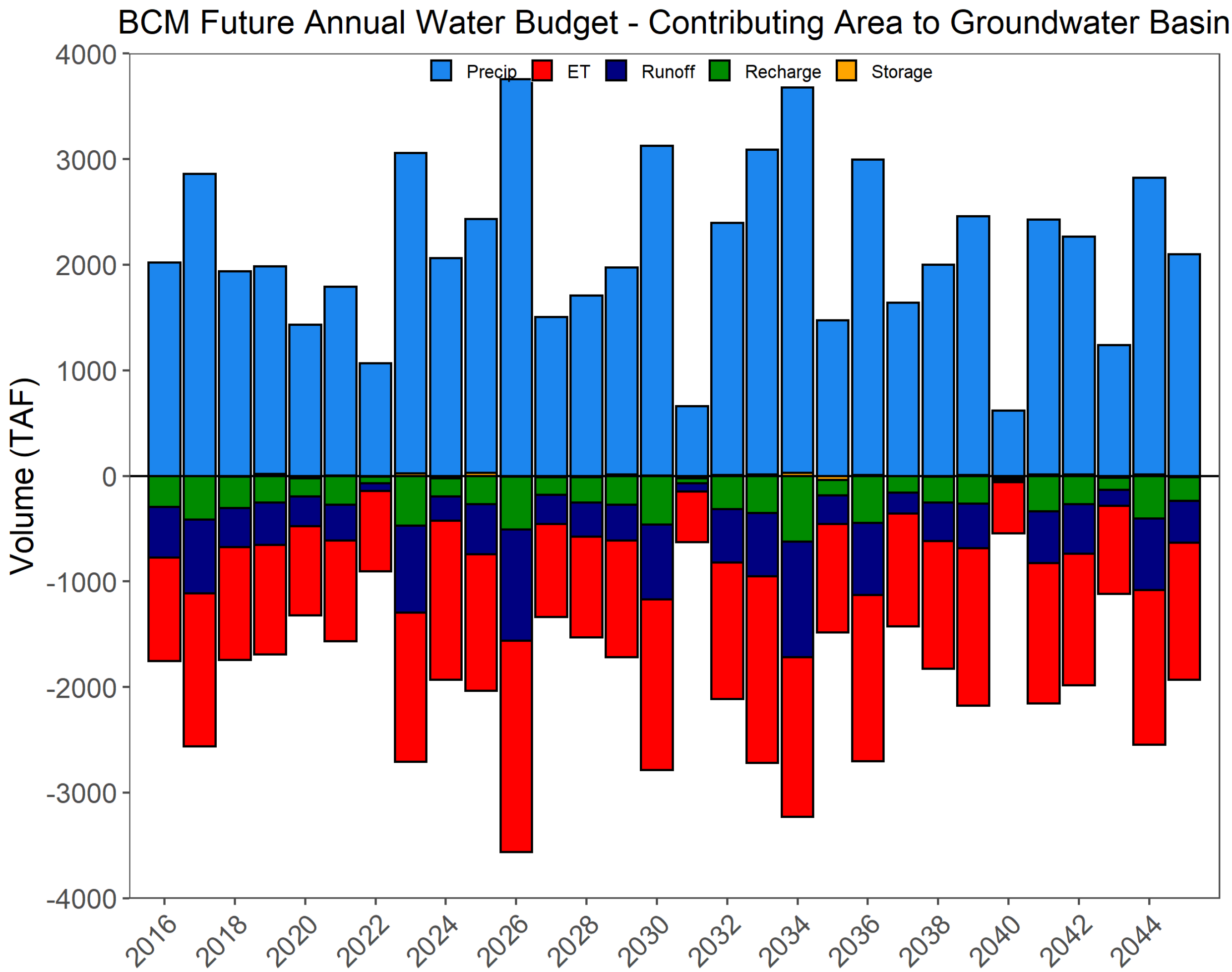

Figure 22. Future water budget for the Owens basin contributing area (headwater).

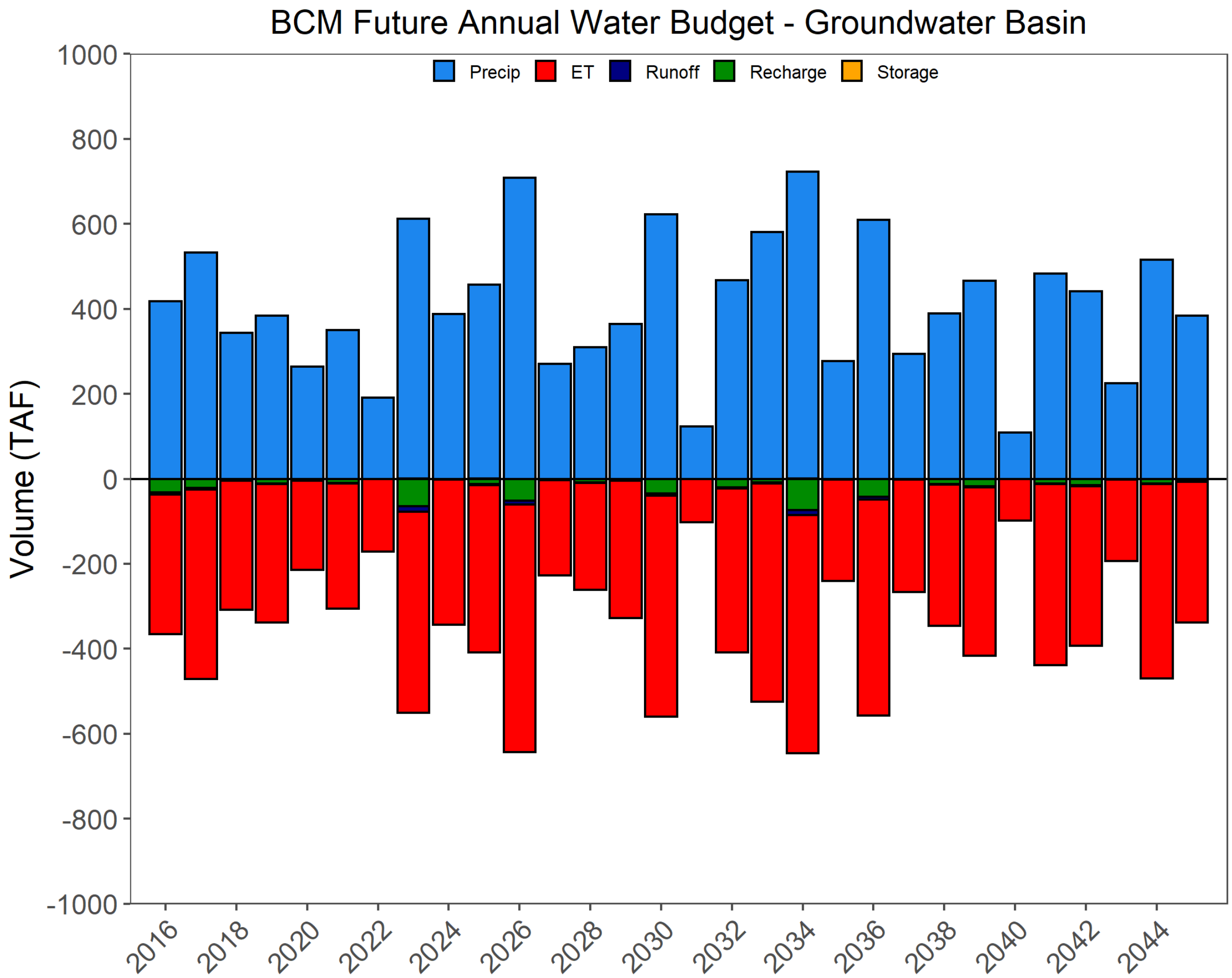

Figure 23. Future water budget for the Owens groundwater basin.

References

Flint, L.E., Flint, A.L., Thorne, J.H., and Boynton, R., 2013, Fine-scale hydrologic modeling for regional landscape applications: the California Basin Characterization Model development and performance: Ecol. Processes 2:25.