5. Historical Water Demands and Supplies

5.1 Overview

This section describes historical water demands and supplies in Butte County in the context of land surface water budgets quantifying flows into and out of irrigated, non-irrigated, and developed lands over time. Land surface water budgets, as described previously in Section 2 of this report (see Figure 2.1), are presented for the period 2000 to 2014 and illustrate the reliance on surface water, groundwater, and precipitation to meet consumptive and non-consumptive demands, while also providing estimates of the relative quantities of water consumed through evapotranspiration (ET) or returning to the system as deep percolation or surface runoff.

Variability in precipitation and available surface water supplies from year to year illustrate conditions in wet vs. dry years. In extreme dry years, curtailment of approximately 50 percent of Feather River supplies from Lake Oroville (the primary surface water supply in the County) can occur; however such conditions did not occur during the 2000 to 2014 period. Curtailment did occur in 2015, and the impacts on demands and supplies are described in a technical memorandum prepared for the Department by Davids Engineering and entitled *Assessment of Butte County Drought Impacts, 2012-2015* (2016). The assessment is included as Appendix D of this report. Results of the assessment are summarized as follows:

> *Dry years and drought correspond to below normal precipitation and resulting reduction in available water supplies to support agricultural, urban, and environmental water demands. All else equal, reduced precipitation in Butte County and the watersheds it relies upon results in decreased surface water supplies, increased irrigation demands, and decreased groundwater recharge, although these impacts do not occur in direct proportion to decreased precipitation. Impacts on surface water supplies depend upon dynamics in the timing and amount of precipitation received as snowfall, melting and runoff of accumulated snowfall, reservoir storage and operations, and water rights considerations. Similarly, irrigation demands are influenced primarily by the timing and amount of precipitation occurring on the valley floor, along with reference evapotranspiration as influenced by solar radiation, temperature, wind speed, humidity, and other factors. Net recharge of the underlying groundwater system is influenced by a combination of these factors.*
>
> *The recent 2012 to 2015 drought period is marked by a reduction in precipitation and surface water supplies, including important spring runoff from snowmelt. Reduced precipitation on the valley floor has led to increased irrigation demands, particularly for non-rice crops, which are more dependent on precipitation to meet irrigation water demands, particularly during the late winter/early spring. The reduction in surface water supplies has led to increased demand for groundwater to meet crop irrigation requirements. This is particularly true for 2015, when Butte Creek water supplies were*

curtailed and Feather River settlement contractor supplies were curtailed for the first time since 1992.

Over this same period, groundwater recharge from precipitation in the form of deep percolation of precipitation on irrigated and non-irrigated lands has decreased. The combination of the drought impacts of reduced supplies and reduced recharge from precipitation is that net recharge of the groundwater system has declined during the 2012 to 2015 period, as compared to the 2001 to 2007 baseline period. Additional information describing seepage from and accretions to streams, canals, and drains is needed to fully quantify impacts of drought on groundwater recharge; however observations can be made regarding the impact of drought on net recharge from the irrigated and non-irrigated land surfaces in the County.

County-wide, approximately 95 percent of developed water use[1] is for irrigated agriculture and managed wetlands, with the remaining 5 percent for developed lands. Almost all irrigated agriculture and managed wetlands water use and the majority of developed water use occurs on the valley floor, although both surface water and groundwater supplies are critical to the population of the Foothill and Mountain IUs.

Developed water supplies for the valley floor IUs include surface water diversions and groundwater pumping. Surface water supplies and diversions are described in Section 4.2, along with the amount of diversions delivered to meet irrigation or other demands. Well development and groundwater pumping in the County is discussed in Section 4.3. Primary demands in valley floor IUs are irrigation demands to meet crop ET requirements, managed wetlands, and developed lands. Estimation of ET, deep percolation, and runoff and return flows for irrigation is discussed in Section 2. Estimation of demands for developed (urban, residential, and M&I) lands is additionally described in Section 2.

A brief discussion of water supplies and demands in the Foothill and Mountain IUs is provided in the following section. Then, more detailed water budgets are presented for the valley floor IUs in the remaining sections, including overall water budgets and individual budgets for irrigated agriculture and wetlands, developed lands, and native lands. A more detailed evaluation of supplies and demands for the Foothill and Mountain IUs could be included as part of a future analysis to complement the evaluations for each valley floor IU.

5.2 Foothill and Mountain Inventory Units

Water supplies in the Foothill and Mountain IUs include surface water diversions by Paradise Irrigation District (PID) and groundwater pumping from fractured rock aquifers as described in Section 4.3. In the Foothill IU, surface water deliveries by PID have totaled approximately 7,500 af annually, on average between 2000 and 2014. Remaining water supplies in the Foothill IU

[1] Developed water use refers to the use of surface water diversion and groundwater pumping to meet agricultural, urban, managed wetlands, or other demands.

include pumping of an estimated 2,800 af annually by Del Oro Water Company and 6,700 af annually by others based on population and per capita water use estimates. Less than 30 af annually is pumped by Paradise I.D. (WYA 2016). Estimated private domestic pumping in the Mountain IU is 1,900 af annually based on population and per capita water use estimates. As described previously in Section 4.3, there are approximately 3,440 domestic wells and 40 M&I wells in the Foothill IU and 2,890 domestic wells and 30 M&I wells in the Mountain IU. Additionally, there are estimated to be approximately 90 irrigation wells in the Foothill IU and 30 irrigation wells in the Mountain IU.

Primary demands in the Foothill and Mountain IUs are for domestic and M&I use. A more detailed evaluation of water demands in the Foothill and Mountain IUs could be performed in the future to better quantify consumptive and non-consumptive uses of water.

5.3 Butte County Valley Floor

5.3.1 Overall Water Budget

Land surface inflows on the Butte County Valley Floor (Vina, West Butte, East Butte, and North Yuba IUs) average approximately 2.040 million acre-feet (maf) annually and include precipitation (914 taf), applied surface water (715 taf), and groundwater pumping (411 taf) (Figure 5.1, Figure 5.2, and Table 5.1). Precipitation varied from 562 taf in 2007 to 1.314 maf in 2011. Groundwater pumping varied from 316 taf in 2011 to 489 taf in 2008. Applied surface water varied from 641 taf in 2014 to 782 taf in 2007. Annual flows are provided in Table 5.1, along with the water year type as discussed in Section 4.2.

As indicated in Figure 5.2, applied surface water was relatively steady from year to year between 2000 and 2014, with greater variability in groundwater pumping. In general, pumping increases in dry years due to increased irrigation requirements resulting from decreased precipitation. With respect to outflows, total ET is relatively steady over time, with variability in deep percolation and surface water runoff varying largely in proportion to annual precipitation. For each water year, the water year type is indicated for each year in parentheses as described in Section 4.2[2].

[2] W – Wet, AN – Above Normal, BN – Below Normal, D – Dry, C – Critical.

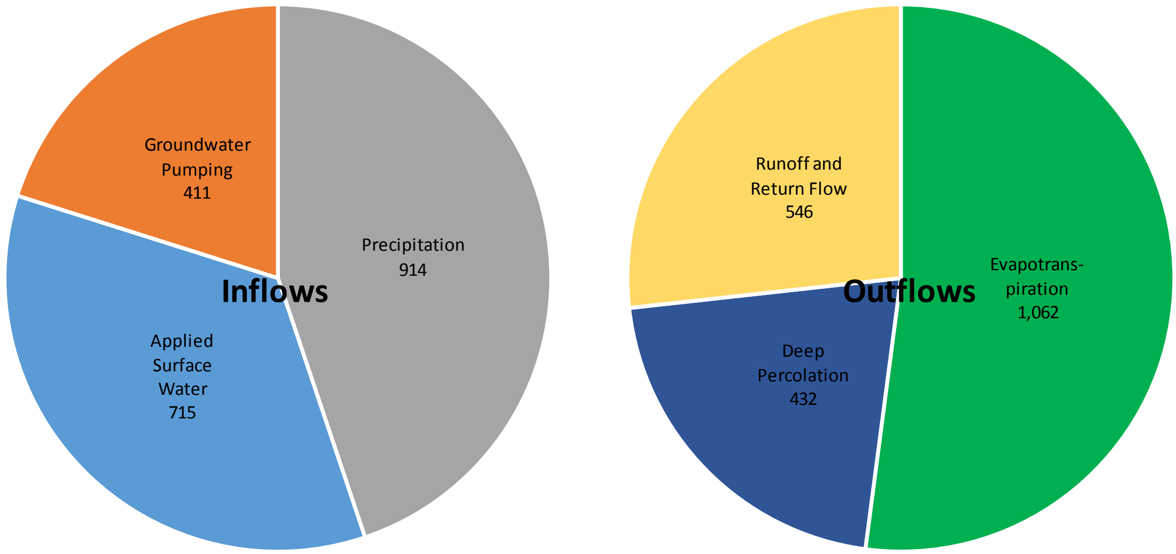

Figure 5.1. Butte County Valley Floor Overall Average Annual Inflows and Outflows, 2000-2014.

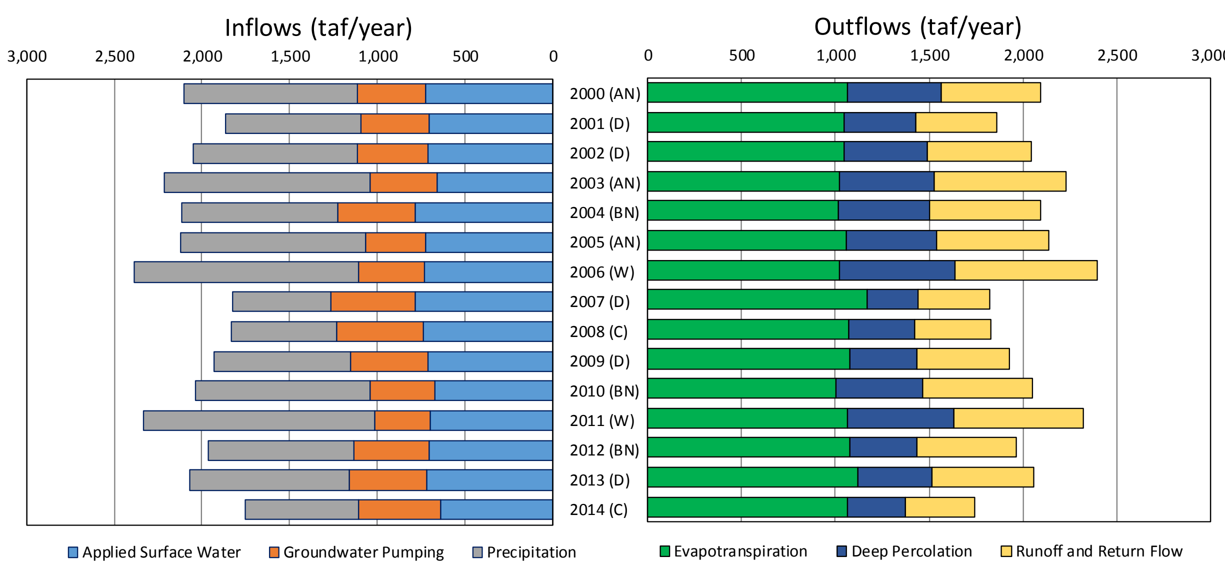

Figure 5.2. Butte County Valley Floor Overall Water Year Inflows and Outflows, 2000-2014.

Table 5.1. Butte County Valley Floor Overall Water Year Inflows, Outflows, and Change in Storage[3], 2000-2014.

Water Year	Inflows (taf)			Outflows (taf)			Change in Storage (taf)
	Precipi-tation	Surface Water	Ground-water	Evapotrans-piration	Deep Percolation	Runoff and Return Flow	
2000 (AN)	984	728	388	1,066	496	531	-5
2001 (D)	768	703	394	1,047	382	431	-3
2002 (D)	934	711	402	1,048	445	550	-8
2003 (AN)	1,172	662	382	1,022	504	707	23
2004 (BN)	891	782	443	1,015	486	596	-27
2005 (AN)	1,052	724	346	1,058	480	601	23
2006 (W)	1,275	732	376	1,023	613	760	6
2007 (D)	562	782	484	1,167	272	382	3
2008 (C)	605	740	489	1,073	348	407	-19
2009 (D)	775	713	440	1,074	363	492	7
2010 (BN)	998	672	368	1,005	458	591	17
2011 (W)	1,314	699	316	1,063	570	692	-1
2012 (BN)	835	709	423	1,080	356	530	-7
2013 (D)	908	722	436	1,118	398	545	21
2014 (C)	643	641	469	1,067	307	369	-24
Minimum	562	641	316	1,005	272	369	-27
Maximum	1,314	782	489	1,167	613	760	23
Average	914	715	411	1,062	432	546	0
Averages by Hydrologic Year Type							
Wet (W)	1,295	715	346	1,043	591	726	2
Above Normal (AN)	1,069	705	372	1,049	493	613	14
Below Normal (BN)	908	721	412	1,033	433	572	-6
Dry (D)	789	726	431	1,091	372	480	4
Critical (C)	624	691	479	1,070	328	388	-22

[3] For the land surface water budgets presented in the WI&A, Change in Storage refers to changes in water stored in the root zone at the Earth's surface, rather than changes in storage in the underlying groundwater system. On an annual basis, changes in root zone soil moisture storage are expected to be near zero, as compared to changes in the amount of water stored in the groundwater system, which may be appreciable.

5.3.2 Irrigated Agriculture and Wetlands Water Budget

Inflows to irrigated agriculture and wetlands on the Butte County Valley Floor average approximately 1.59 maf annually and include precipitation (504 taf), groundwater pumping (374 taf), and applied surface water (709 taf) (Figure 5.3, Figure 5.4, and Table 5.2). Precipitation varied from 295 taf in 2007 to 741 taf in 2011. Groundwater pumping varied from 282 taf in 2011 to 450 taf in 2007. Applied surface water varied from 635 taf in 2014 to 776 taf in 2004 and 2007. Annual flows are provided in Table 5.2, along with the water year type as discussed in Section 4.2.

As indicated in Figure 5.4, applied surface water was relatively steady from year to year between 2000 and 2014, with greater variability in groundwater pumping. In general, pumping increases in dry years due to increased irrigation requirements resulting from decreased precipitation. With respect to outflows, total ET is relatively steady over time, with variability in deep percolation and surface water runoff varying largely in proportion to annual precipitation.

5.3.3 Developed Lands Water Budget

Inflows to developed lands on the Butte County Valley Floor average approximately 140 taf annually and include precipitation (98 taf), groundwater pumping (36 taf), and applied surface water (6 taf) (Figure 5.5, Figure 5.6, and Table 5.3). Precipitation varied from 61 taf in 2007 to 148 taf in 2011. Groundwater pumping has been relatively consistent over time, varying from approximately 32 taf to 39 taf annually, with an average estimated pumping of 31 taf by water suppliers and 5 taf by rural residential pumpers. Annual flows are provided in Table 5.3, along with the water year type as discussed in Section 4.2.

As indicated in Figure 5.6, groundwater pumping was relatively steady from year to year between 2000 and 2014. Pumping for developed lands remains relatively steady due to insensitivity of indoor water demands to precipitation and less sensitivity of outdoor water use (irrigation) to precipitation than for irrigated agriculture. With respect to outflows, total ET is relatively steady over time, with variability in deep percolation and surface water runoff varying largely in proportion to annual precipitation.

Some runoff and return flow from developed lands returns to the groundwater system through septic systems and stormwater retention while other runoff and return flow enters local waterways. Additional analysis is needed to refine estimates of the relative proportion of non-consumed water use on developed lands that returns to the surface water systems rather than returning to the groundwater system.

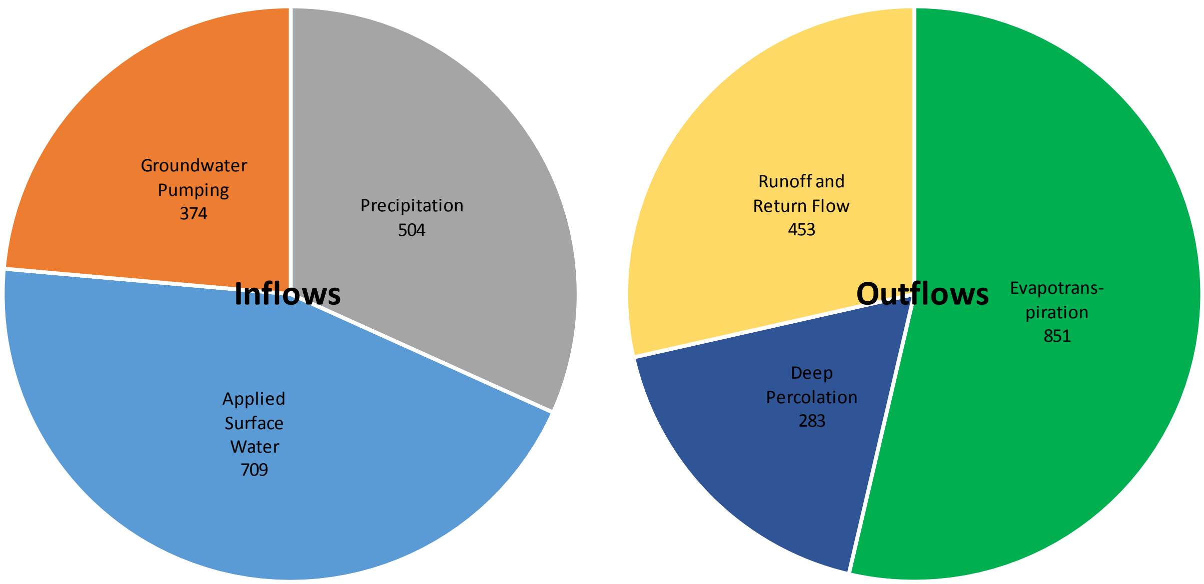

Figure 5.3. Butte County Valley Floor Irrigated Agriculture and Wetlands Average Annual Inflows and Outflows, 2000-2014.

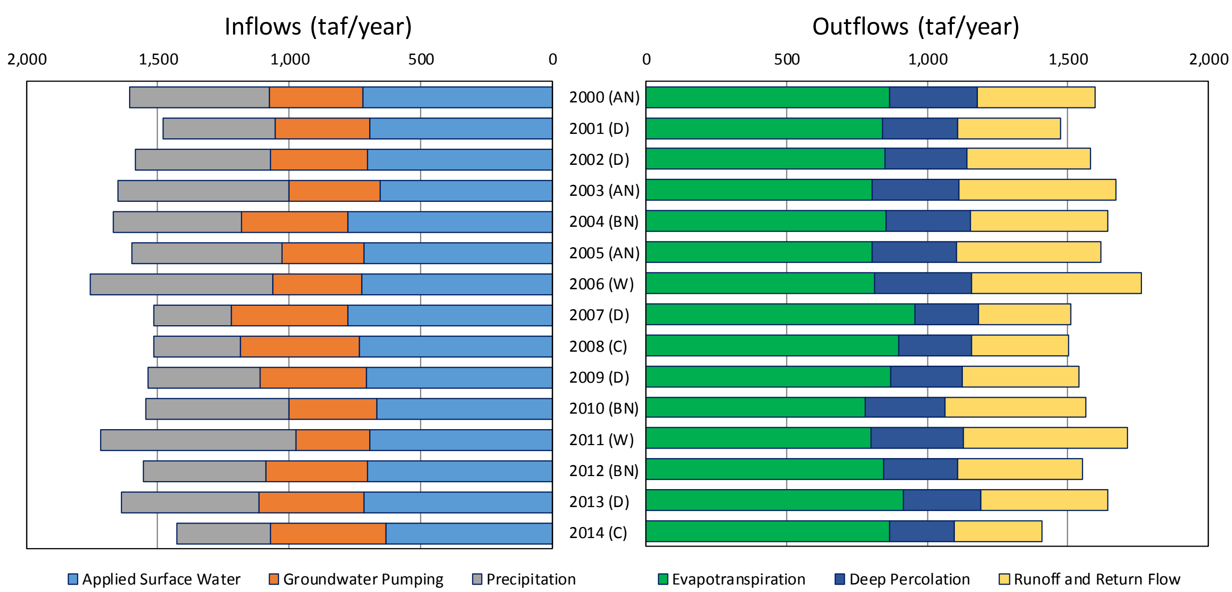

Figure 5.4. Butte County Valley Floor Irrigated Agriculture and Wetlands Water Year Inflows and Outflows, 2000-2014.

Table 5.2. Butte County Valley Floor Irrigated Agriculture and Wetlands Water Year Inflows, Outflows, and Change in Storage, 2000-2014.

Water Year	Inflows (taf)			Outflows (taf)			Change in Storage (taf)
	Precipi-tation	Surface Water	Ground-water	Evapotrans-piration	Deep Percolation	Runoff and Return Flow	
2000 (AN)	530	721	354	865	315	420	-6
2001 (D)	423	697	359	843	264	368	-4
2002 (D)	517	705	366	851	289	441	-6
2003 (AN)	651	655	346	806	306	561	20
2004 (BN)	489	776	404	852	303	489	-24
2005 (AN)	570	718	310	804	299	515	20
2006 (W)	692	726	337	812	346	606	9
2007 (D)	295	776	445	955	227	330	-4
2008 (C)	331	734	450	901	258	345	-11
2009 (D)	429	707	403	870	255	416	2
2010 (BN)	548	666	334	781	281	503	16
2011 (W)	741	693	282	799	329	585	-3
2012 (BN)	465	703	388	848	259	446	-3
2013 (D)	523	716	401	914	276	454	4
2014 (C)	354	635	437	864	234	312	-16
Minimum	295	635	282	781	227	312	-24
Maximum	741	776	450	955	346	606	20
Average	504	709	374	851	283	453	0
Averages by Hydrologic Year Type							
Wet (W)	717	710	310	806	338	595	3
Above Normal (AN)	584	698	337	825	306	499	11
Below Normal (BN)	501	715	375	827	281	479	-4
Dry (D)	437	720	395	887	262	402	-1
Critical (C)	343	684	443	883	246	329	-13

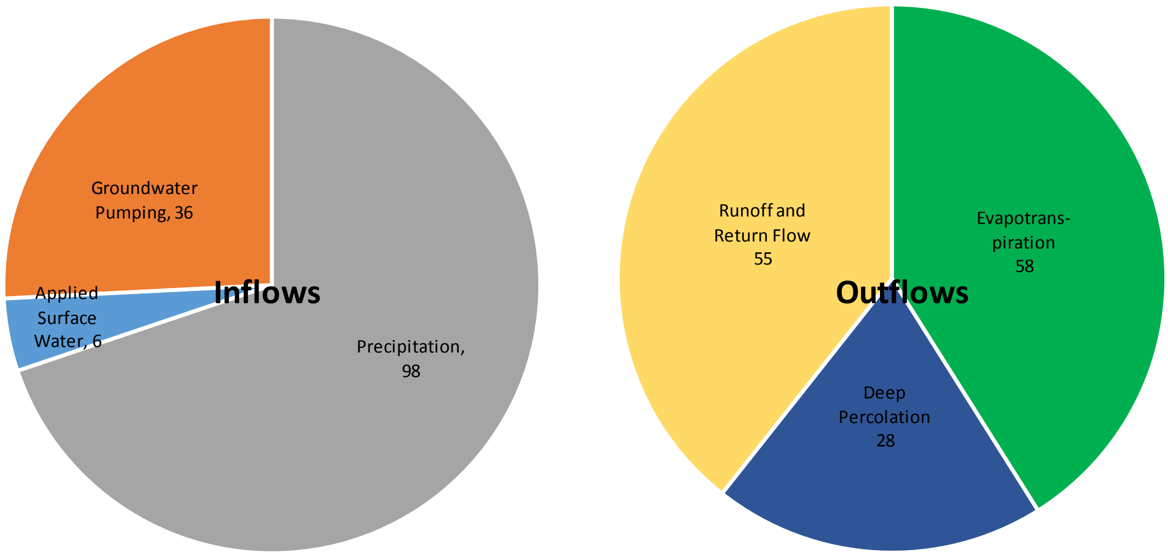

Figure 5.5. Butte County Valley Floor Developed Lands Average Annual Inflows and Outflows, 2000-2014.

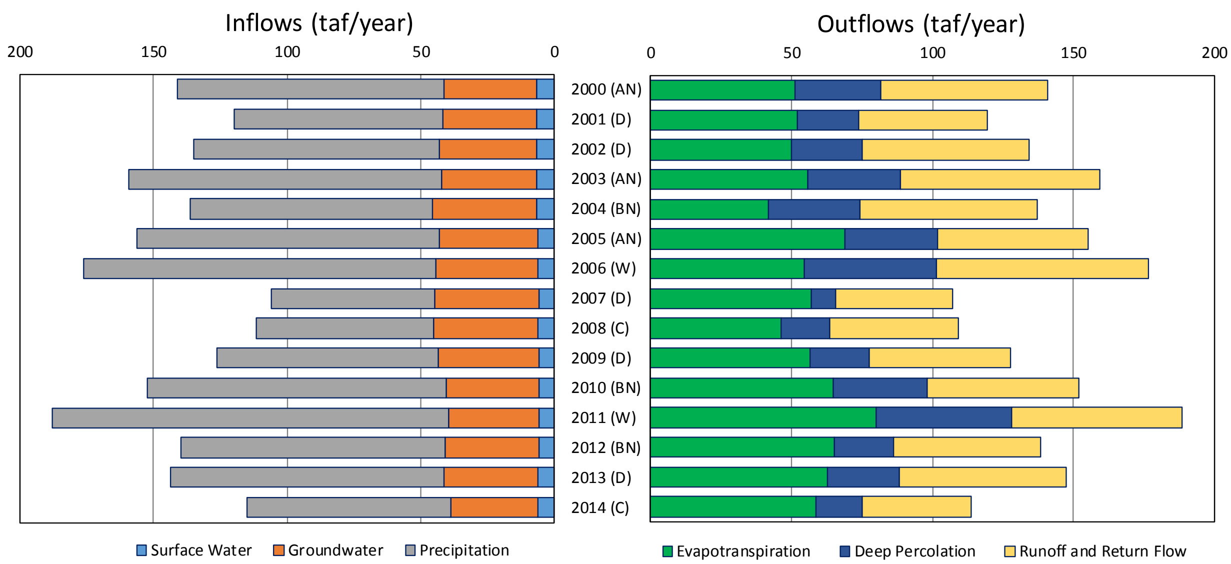

Figure 5.6. Butte County Valley Floor Developed Lands Water Year Inflows and Outflows, 2000-2014.

Table 5.3. Butte County Valley Floor Developed Lands Water Year Inflows, Outflows, and Change in Storage, 2000-2014.

Water Year	Inflows (taf)			Outflows (taf)			Change in Storage (taf)
	Precipi-tation	Surface Water	Ground-water	Evapotrans-piration	Deep Percolation	Runoff and Return Flow	
2000 (AN)	100	7	35	51	30	59	0
2001 (D)	78	7	35	52	22	46	0
2002 (D)	92	6	36	50	25	59	0
2003 (AN)	117	6	36	56	33	71	0
2004 (BN)	91	7	39	42	33	63	1
2005 (AN)	113	6	37	69	33	53	-1
2006 (W)	132	6	38	55	47	75	0
2007 (D)	61	6	39	57	9	42	1
2008 (C)	66	6	39	46	17	46	-2
2009 (D)	83	6	38	56	21	50	1
2010 (BN)	112	6	35	65	33	54	0
2011 (W)	148	6	34	80	48	60	1
2012 (BN)	99	6	35	65	21	53	-1
2013 (D)	102	6	35	63	25	59	4
2014 (C)	76	6	32	59	16	39	-1
Minimum	61	6	32	42	9	39	-2
Maximum	148	7	39	80	48	75	4
Average	98	6	36	58	28	55	0
Averages by Hydrologic Year Type							
Wet (W)	140	6	36	67	48	68	1
Above Normal (AN)	110	6	36	59	32	61	0
Below Normal (BN)	100	6	36	57	29	56	0
Dry (D)	83	6	37	56	20	51	1
Critical (C)	71	6	36	52	17	42	-2

5.3.4 Non-Irrigated Lands Water Budget

Inflows to non-irrigated lands on the Butte County Valley Floor average approximately 313 taf annually and include precipitation (Figure 5.7, Figure 5.8, and Table 5.4). Precipitation varied from 207 taf in 2007 to 451 taf in 2006. Annual flows are provided in Table 5.4, along with the water year type as discussed in Section 4.2.

As indicated in Figure 5.8, ET, deep percolation, and runoff vary over time largely in proportion to precipitation.

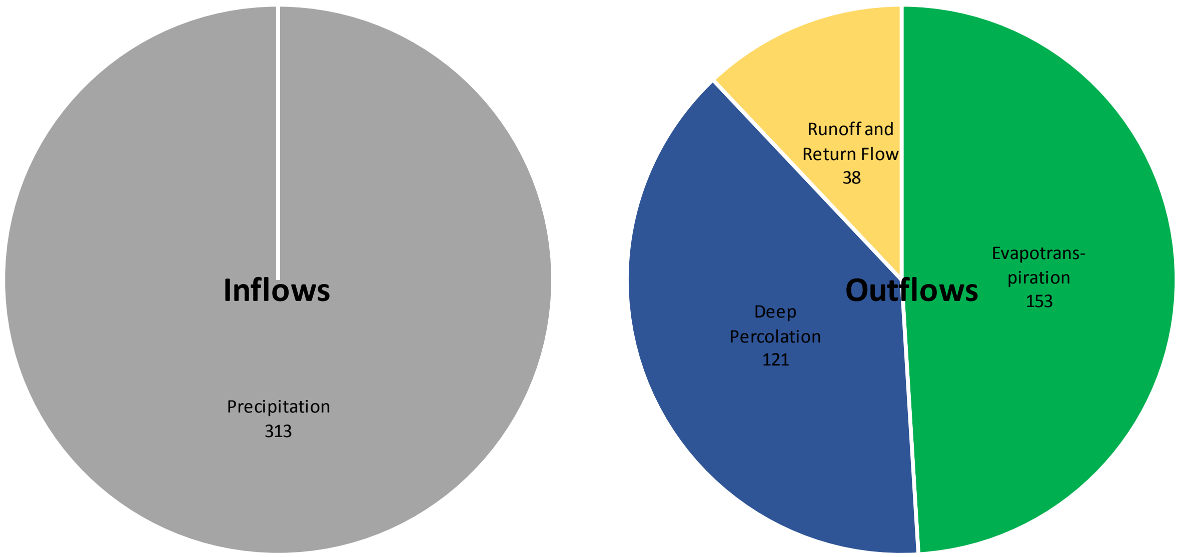

Figure 5.7. Butte County Valley Floor Non-Irrigated Lands Average Annual Inflows and Outflows, 2000-2014.

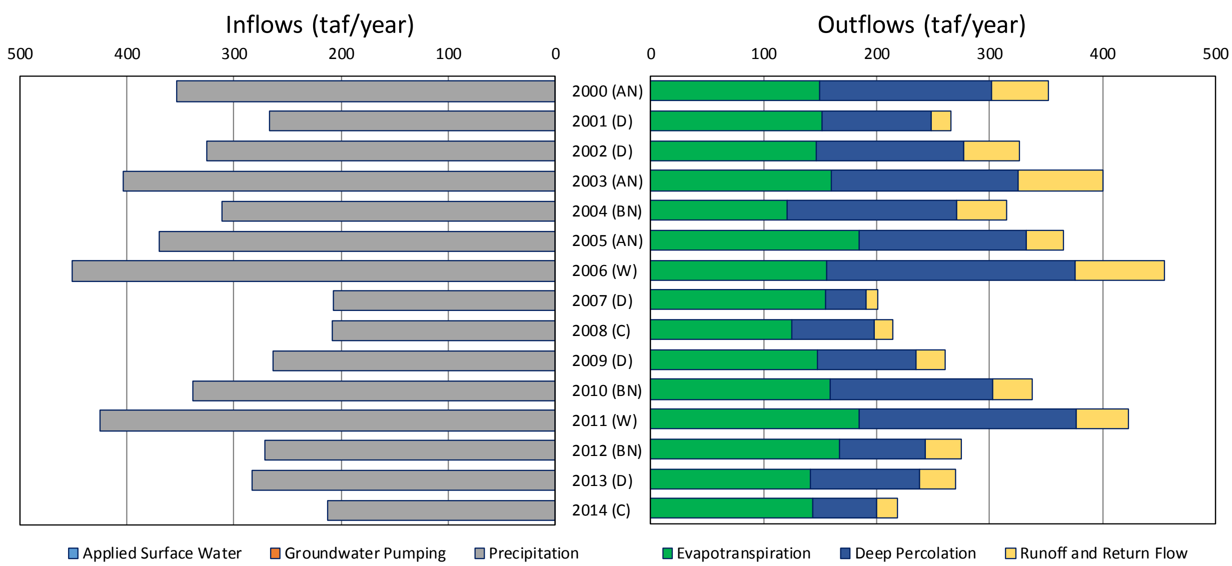

Figure 5.8. Butte County Valley Floor Non-Irrigated Lands Water Year Inflows and Outflows, 2000-2014.

Table 5.4. Butte County Valley Floor Non-Irrigated Lands Water Year Inflows, Outflows, and Change in Storage, 2000-2014.

	Inflows (taf)			Outflows (taf)			
Water Year	Precipi-tation	Surface Water	Ground-water	Evapotrans-piration	Deep Percolation	Runoff and Return Flow	Change in Storage (taf)
2000 (AN)	354	0	0	150	151	51	1
2001 (D)	266	0	0	152	96	17	1
2002 (D)	325	0	0	147	131	50	-1
2003 (AN)	404	0	0	160	165	75	3
2004 (BN)	311	0	0	121	150	44	-4
2005 (AN)	369	0	0	185	148	33	4
2006 (W)	451	0	0	156	220	79	-4
2007 (D)	207	0	0	155	36	10	6
2008 (C)	208	0	0	126	73	16	-7
2009 (D)	264	0	0	148	87	26	3
2010 (BN)	338	0	0	159	144	35	0
2011 (W)	425	0	0	185	192	46	2
2012 (BN)	271	0	0	167	76	32	-3
2013 (D)	283	0	0	141	97	31	13
2014 (C)	212	0	0	144	57	18	-7
Minimum	207	0	0	121	36	10	-7
Maximum	451	0	0	185	220	79	13
Average	313	0	0	153	121	38	1
Averages by Hydrologic Year Type							
Wet (W)	438	0	0	170	206	63	-1
Above Normal (AN)	376	0	0	165	155	53	3
Below Normal (BN)	307	0	0	149	123	37	-2
Dry (D)	269	0	0	149	89	27	4
Critical (C)	210	0	0	135	65	17	-7

5.4 Vina Inventory Unit

5.4.1 Overall Water Budget

Land surface inflows in Vina average approximately 297 thousand acre-feet (taf) annually and include precipitation (180 taf), groundwater pumping (109 taf), and applied surface water (8 taf) (Figure 5.9, Figure 5.10, and Table 5.5). Precipitation varied from 95 taf in 2007 to 265 taf in 2011. Groundwater pumping varied from 82 taf in 2011 to 128 taf in 2008. Applied surface water varied between 7 taf and 9 taf during this period. Annual flows are provided in Table 5.5, along with the water year type as discussed in Section 4.2.

As indicated in Figure 5.10, applied surface water was relatively steady from year to year between 2000 and 2014, with greater variability in groundwater pumping. In general, pumping increases in dry years due to increased irrigation requirements resulting from decreased precipitation. With respect to outflows, total ET is relatively steady over time, with variability in deep percolation and surface water runoff varying largely in proportion to annual precipitation.

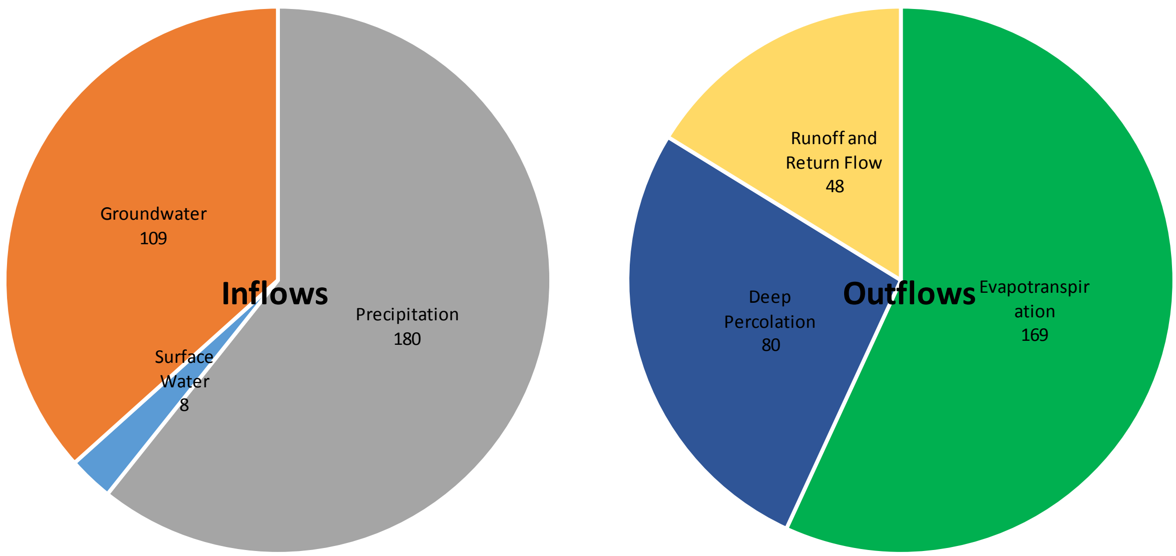

Figure 5.9. Vina Overall Average Annual Inflows and Outflows, 2000-2014.

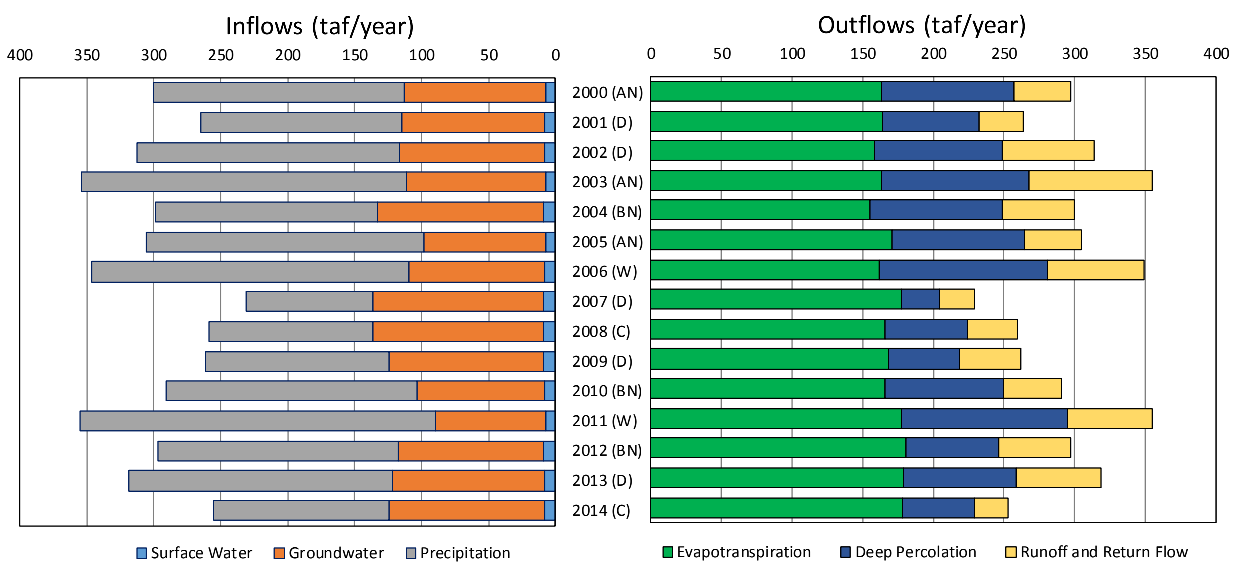

Figure 5.10. Vina Overall Water Year Inflows and Outflows, 2000-2014.

Table 5.5. Vina Overall Water Year Inflows, Outflows, and Change in Storage, 2000-2014.

	Inflows (taf)			Outflows (taf)			
Water Year	Precipi-tation	Surface Water	Ground-water	Evapotrans-piration	Deep Percolation	Runoff and Return Flow	Change in Storage (taf)
2000 (AN)	187	7	106	163	94	40	-2
2001 (D)	150	8	107	164	68	31	0
2002 (D)	196	8	109	158	91	65	-1
2003 (AN)	243	7	104	163	105	87	2
2004 (BN)	166	9	124	155	94	51	-1
2005 (AN)	208	7	91	171	93	40	2
2006 (W)	237	8	102	162	119	68	2
2007 (D)	95	9	127	177	27	24	-2
2008 (C)	122	9	128	166	59	35	-1
2009 (D)	136	9	116	169	50	43	2
2010 (BN)	188	8	96	166	84	41	1
2011 (W)	265	7	82	177	118	60	2
2012 (BN)	180	9	108	181	65	51	-1
2013 (D)	197	8	114	179	79	60	8
2014 (C)	131	8	116	179	50	24	-7
Minimum	95	7	82	155	27	24	-7
Maximum	265	9	128	181	119	87	8
Average	180	8	109	169	80	48	0
Averages by Hydrologic Year Type							
Wet (W)	251	7	92	169	119	64	2
Above Normal (AN)	213	7	100	166	97	56	0
Below Normal (BN)	178	8	109	167	81	48	0
Dry (D)	155	8	115	169	63	45	2
Critical (C)	127	8	122	172	55	30	-4

5.4.2 Irrigated Agriculture and Wetlands Water Budget

Inflows to irrigated agriculture and wetlands in Vina average approximately 170 taf annually and include precipitation (74 taf), groundwater pumping (88 taf), and applied surface water (8 taf) (Figure 5.11, Figure 5.12, and Table 5.6). Precipitation varied from 36 taf in 2007 to 113 taf in 2011. Groundwater pumping varied from 64 taf in 2011 to 106 taf in 2008. Applied surface water varied from 7 taf to 9 taf between 2000 and 2014. Annual flows are provided in Table 5.6, along with the water year type as discussed in Section 4.2.

As indicated in Figure 5.12, applied surface water was relatively steady from year to year between 2000 and 2014, with greater variability in groundwater pumping. In general, pumping increases in dry years due to increased irrigation requirements resulting from decreased precipitation. With respect to outflows, total ET is relatively steady over time, with variability in deep percolation and surface water runoff varying largely in proportion to annual precipitation.

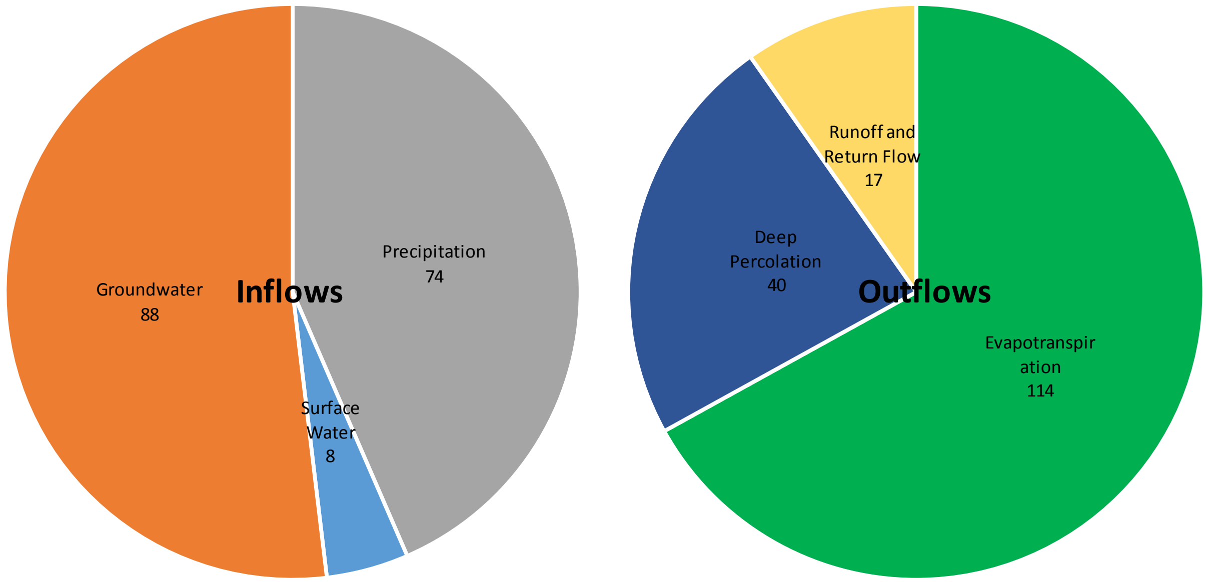

Figure 5.11. Vina Irrigated Agriculture and Wetlands Average Annual Inflows and Outflows, 2000-2014.

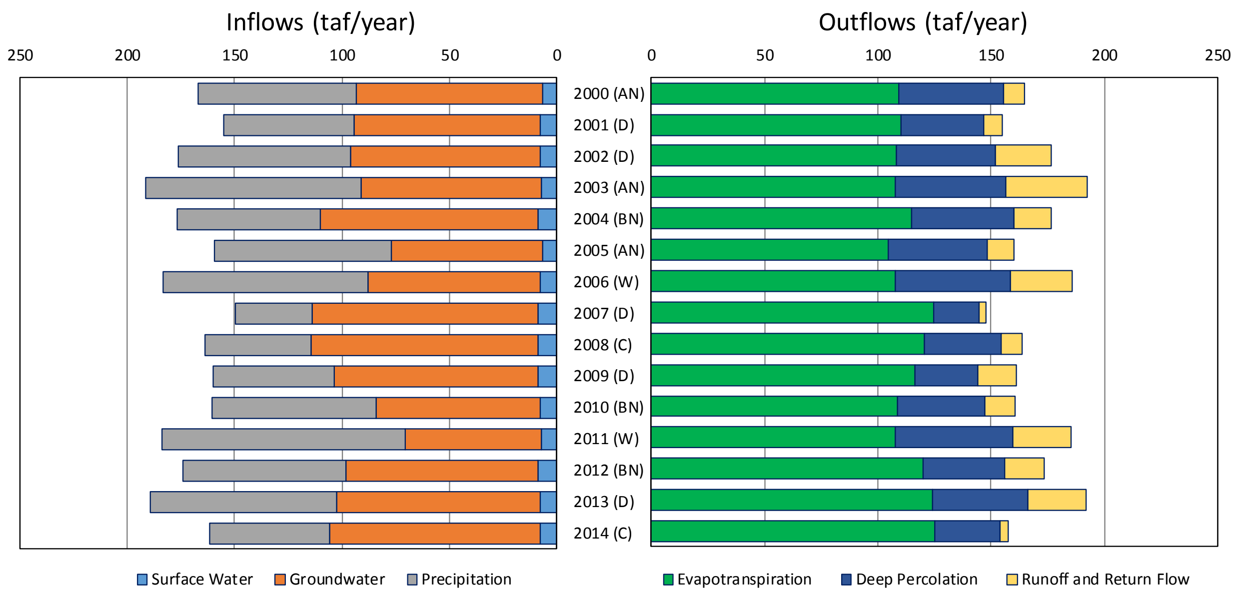

Figure 5.12. Vina Irrigated Agriculture and Wetlands Water Year Inflows and Outflows, 2000-2014.

Table 5.6. Vina Irrigated Agriculture and Wetlands Water Year Inflows, Outflows, and Change in Storage, 2000-2014.

	Inflows (taf)			Outflows (taf)			
Water Year	Precipi-tation	Surface Water	Ground-water	Evapotrans-piration	Deep Percolation	Runoff and Return Flow	Change in Storage (taf)
2000 (AN)	74	7	86	109	46	9	-2
2001 (D)	61	8	87	110	36	8	-1
2002 (D)	80	8	88	108	44	25	0
2003 (AN)	100	7	84	108	49	36	1
2004 (BN)	67	9	101	115	45	17	0
2005 (AN)	83	7	70	105	43	12	0
2006 (W)	96	8	80	108	51	27	2
2007 (D)	36	9	105	125	20	3	-2
2008 (C)	49	9	106	121	34	9	0
2009 (D)	57	9	95	116	28	17	1
2010 (BN)	76	8	76	109	39	14	1
2011 (W)	113	7	64	108	52	25	1
2012 (BN)	76	9	89	120	36	18	-1
2013 (D)	87	8	95	124	42	26	3
2014 (C)	56	8	98	125	29	3	-4
Minimum	36	7	64	105	20	3	-4
Maximum	113	9	106	125	52	36	3
Average	74	8	88	114	40	17	0
Averages by Hydrologic Year Type							
Wet (W)	104	7	72	108	51	26	2
Above Normal (AN)	86	7	80	107	46	19	0
Below Normal (BN)	73	8	89	115	40	16	0
Dry (D)	64	8	94	117	34	16	0
Critical (C)	52	8	102	123	31	6	-2

5.4.3 Developed Lands Water Budget

The Vina IU includes the City of Chico north of Big Chico Creek and the communities of Vina and Nord. Inflows to developed lands in Vina average approximately 48 taf annually and include precipitation (28 taf) and groundwater pumping (20 taf) (Figure 5.13, Figure 5.14, and Table 5.7). Precipitation varied from 14 taf in 2007 to 45 taf in 2011. Groundwater pumping has been relatively consistent over time, pumping varying from approximately 18 taf to 23 taf annually with an average estimated pumping of 20 taf by water suppliers and 1 taf by rural residential pumpers. No surface water is delivered to meet demands for developed lands in Vina. Annual flows are provided in Table 5.7, along with the water year type as discussed in Section 4.2.

As indicated in Figure 5.14, groundwater pumping was relatively steady from year to year between 2000 and 2014. Pumping for developed lands remains relatively steady due to insensitivity of indoor water demands to precipitation and less sensitivity of outdoor water use (irrigation) to precipitation than for irrigated agriculture. With respect to outflows, total ET is relatively steady over time, with variability in deep percolation and surface water runoff varying largely in proportion to annual precipitation.

Some runoff and return flow from developed lands returns to the groundwater system through septic systems and stormwater retention while other runoff and return flow enters local waterways. Additional analysis is needed to refine estimates of the relative proportion of non-consumed water use on developed lands that returns to the surface water systems rather than returning to the groundwater system.

5.4.4 Non-Irrigated Lands Water Budget

Inflows to non-irrigated lands in Vina average approximately 78 taf annually and include precipitation (Figure 5.15, Figure 5.16, and Table 5.8). Precipitation varied from 45 taf in 2007 to 108 taf in 2003. Annual flows are provided in Table 5.8, along with the water year type as discussed in Section 4.2.

As indicated in Figure 5.16, ET, deep percolation, and runoff vary over time largely in proportion to precipitation.

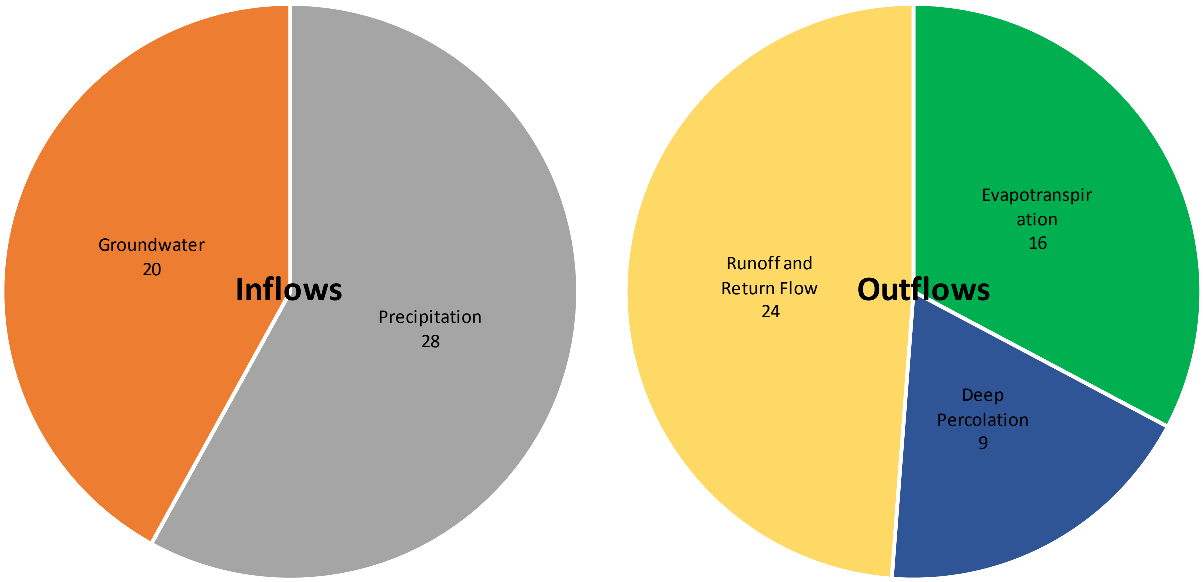

Figure 5.13. Vina Developed Lands Average Annual Inflows and Outflows, 2000-2014.

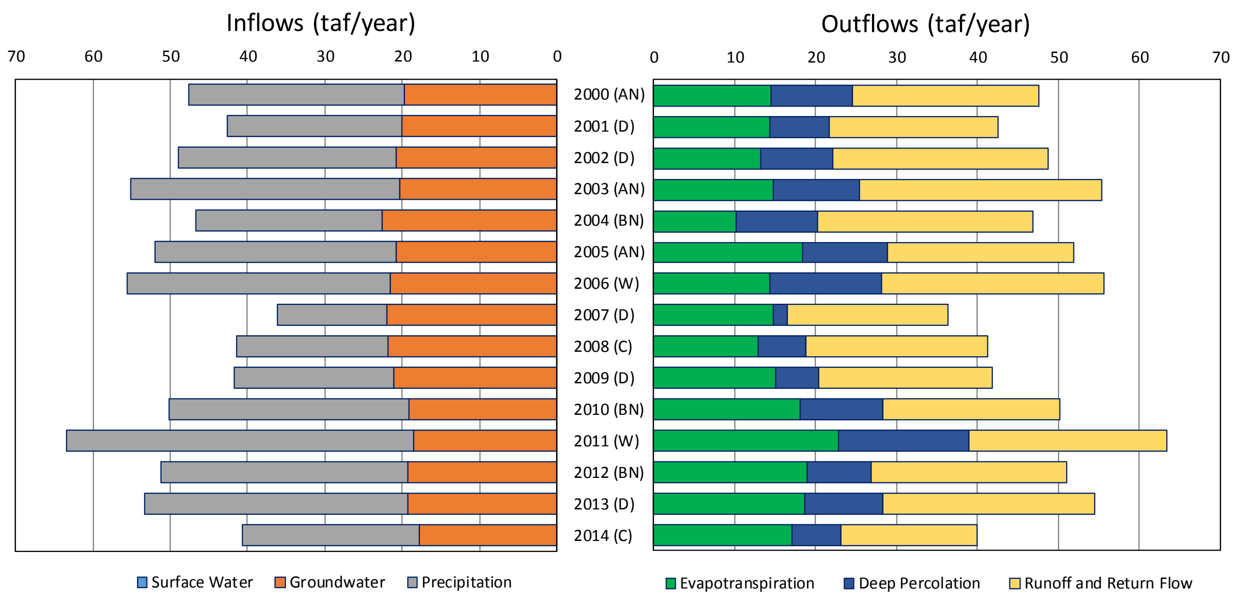

Figure 5.14. Vina Developed Lands Water Year Inflows and Outflows, 2000-2014.

Table 5.7. Vina Developed Lands Water Year Inflows, Outflows, and Change in Storage, 2000-2014.

Water Year	Inflows (taf)			Outflows (taf)			Change in Storage (taf)
	Precipi-tation	Surface Water	Ground-water	Evapotrans-piration	Deep Percolation	Runoff and Return Flow	
2000 (AN)	28	0	20	14	10	23	0
2001 (D)	23	0	20	14	7	21	0
2002 (D)	28	0	21	13	9	27	0
2003 (AN)	35	0	20	15	11	30	0
2004 (BN)	24	0	23	10	10	26	0
2005 (AN)	31	0	21	18	10	23	0
2006 (W)	34	0	22	14	14	28	0
2007 (D)	14	0	22	15	2	20	0
2008 (C)	19	0	22	13	6	22	0
2009 (D)	21	0	21	15	5	21	0
2010 (BN)	31	0	19	18	10	22	0
2011 (W)	45	0	18	23	16	24	0
2012 (BN)	32	0	19	19	8	24	0
2013 (D)	34	0	19	19	10	26	1
2014 (C)	23	0	18	17	6	17	-1
Minimum	14	0	18	10	2	17	-1
Maximum	45	0	23	23	16	30	1
Average	28	0	20	16	9	24	0
Averages by Hydrologic Year Type							
Wet (W)	39	0	20	19	15	26	0
Above Normal (AN)	31	0	20	16	10	25	0
Below Normal (BN)	29	0	20	16	9	24	0
Dry (D)	24	0	21	15	7	23	0
Critical (C)	21	0	20	15	6	20	0

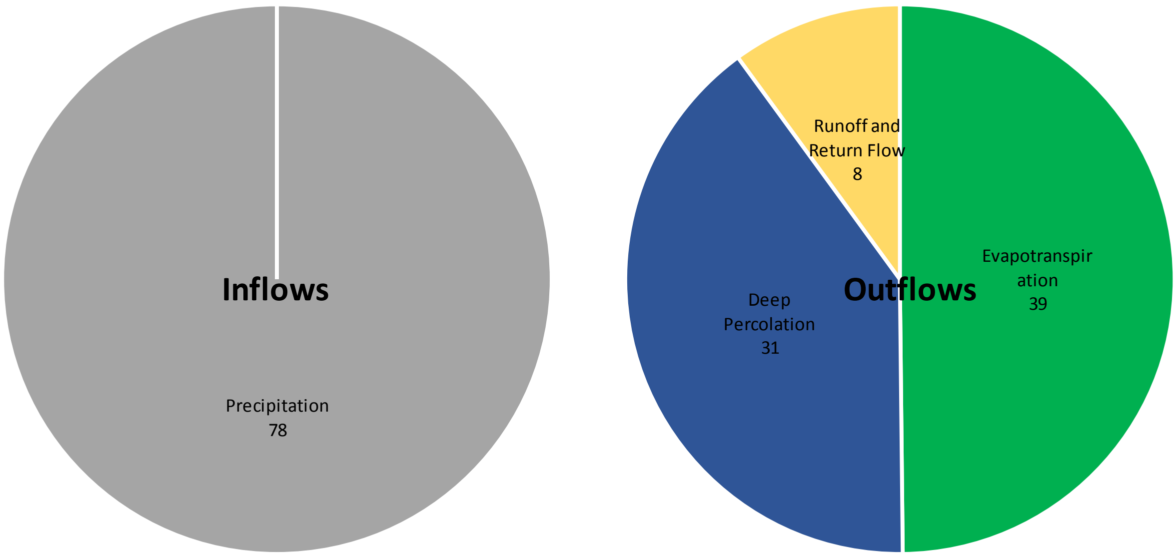

Figure 5.15. Vina Non-Irrigated Lands Average Annual Inflows and Outflows, 2000-2014.

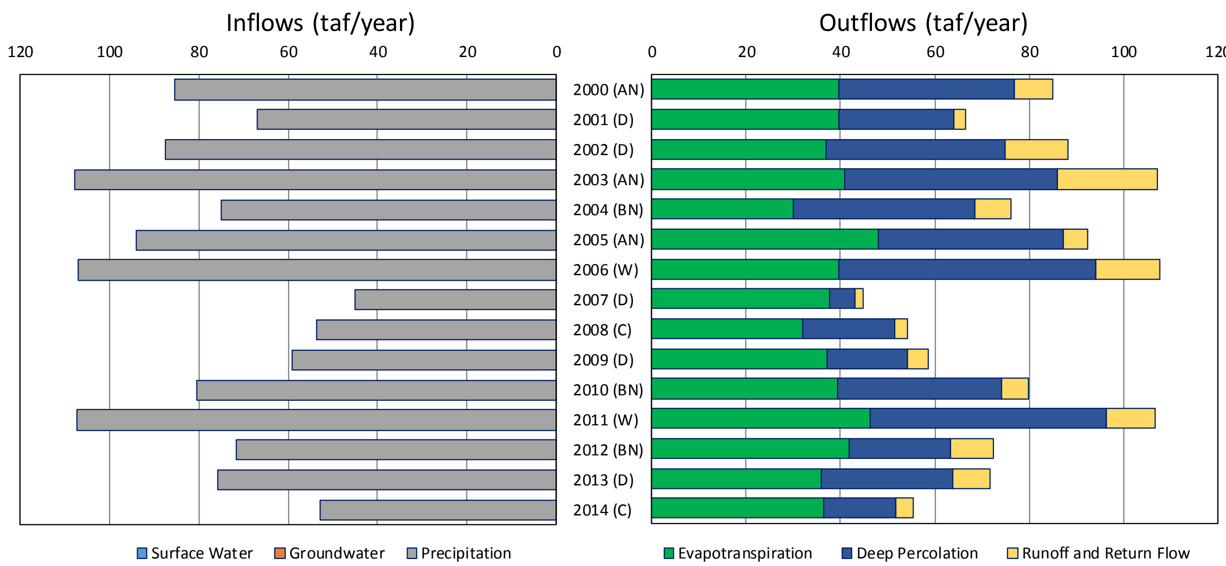

Figure 5.16. Vina Non-Irrigated Lands Water Year Inflows and Outflows, 2000-2014.

Table 5.8. Vina Non-Irrigated Lands Water Year Inflows, Outflows, and Change in Storage, 2000-2014.

Water Year	Inflows (taf)			Outflows (taf)			Change in Storage (taf)
	Precipi-tation	Surface Water	Ground-water	Evapotrans-piration	Deep Percolation	Runoff and Return Flow	
2000 (AN)	85	0	0	40	37	8	0
2001 (D)	67	0	0	40	25	2	0
2002 (D)	87	0	0	37	38	13	-1
2003 (AN)	108	0	0	41	45	21	1
2004 (BN)	75	0	0	30	38	8	-1
2005 (AN)	94	0	0	48	39	5	1
2006 (W)	107	0	0	40	54	14	-1
2007 (D)	45	0	0	38	5	2	0
2008 (C)	54	0	0	32	19	3	0
2009 (D)	59	0	0	37	17	4	0
2010 (BN)	80	0	0	39	35	6	1
2011 (W)	107	0	0	46	50	10	0
2012 (BN)	72	0	0	42	22	9	-1
2013 (D)	76	0	0	36	28	8	4
2014 (C)	53	0	0	36	15	4	-3
Minimum	45	0	0	30	5	2	-3
Maximum	108	0	0	48	54	21	4
Average	78	0	0	39	31	8	0
Averages by Hydrologic Year Type							
Wet (W)	107	0	0	43	52	12	0
Above Normal (AN)	96	0	0	43	41	12	1
Below Normal (BN)	76	0	0	37	32	7	0
Dry (D)	67	0	0	37	23	6	1
Critical (C)	53	0	0	34	17	3	-2

5.5 West Butte Inventory Unit

5.5.1 Overall Water Budget

Land surface inflows in West Butte average approximately 408 thousand acre-feet (taf) annually and include precipitation (188 taf), groundwater pumping (126 taf), and applied surface water (94 taf) (Figure 5.17, Figure 5.18, and Table 5.9). Precipitation varied from 98 taf in 2007 to 277 taf in 2011. Groundwater pumping varied from 88 taf in 2011 to 156 taf in 2007. Applied surface water varied from 81 taf in 2014 to 108 taf in 2000. Annual flows are provided in Table 5.9, along with the water year type as discussed in Section 4.2.

As indicated in Figure 5.18, applied surface water was relatively steady from year to year between 2000 and 2014, with greater variability in groundwater pumping. In general, pumping increases in dry years due to increased irrigation requirements resulting from decreased precipitation. With respect to outflows, total ET is relatively steady over time, with variability in deep percolation and surface water runoff varying largely in proportion to annual precipitation.

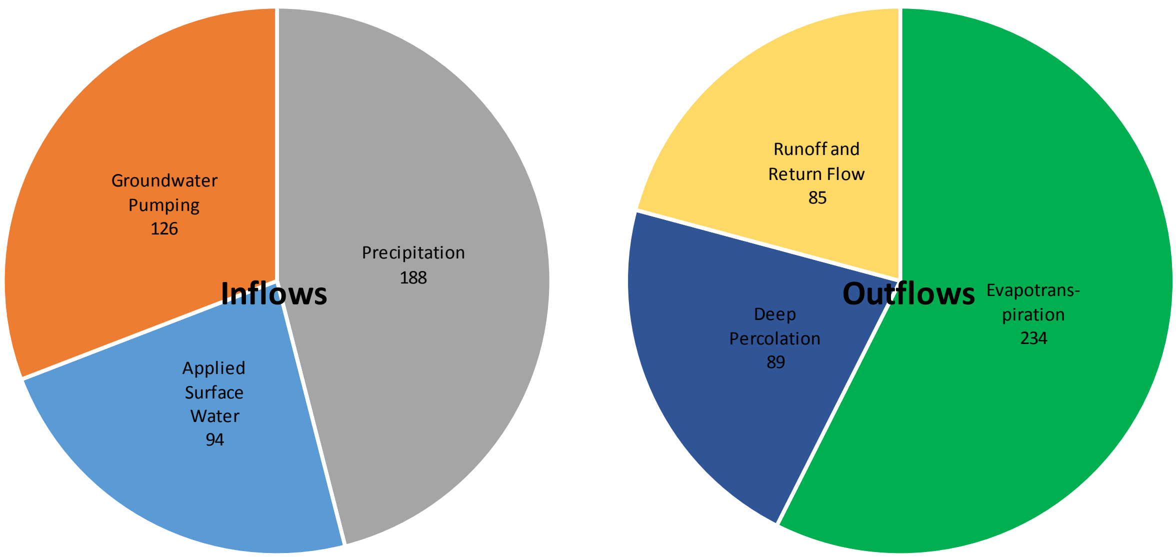

Figure 5.17. West Butte Overall Average Annual Inflows and Outflows, 2000-2014.

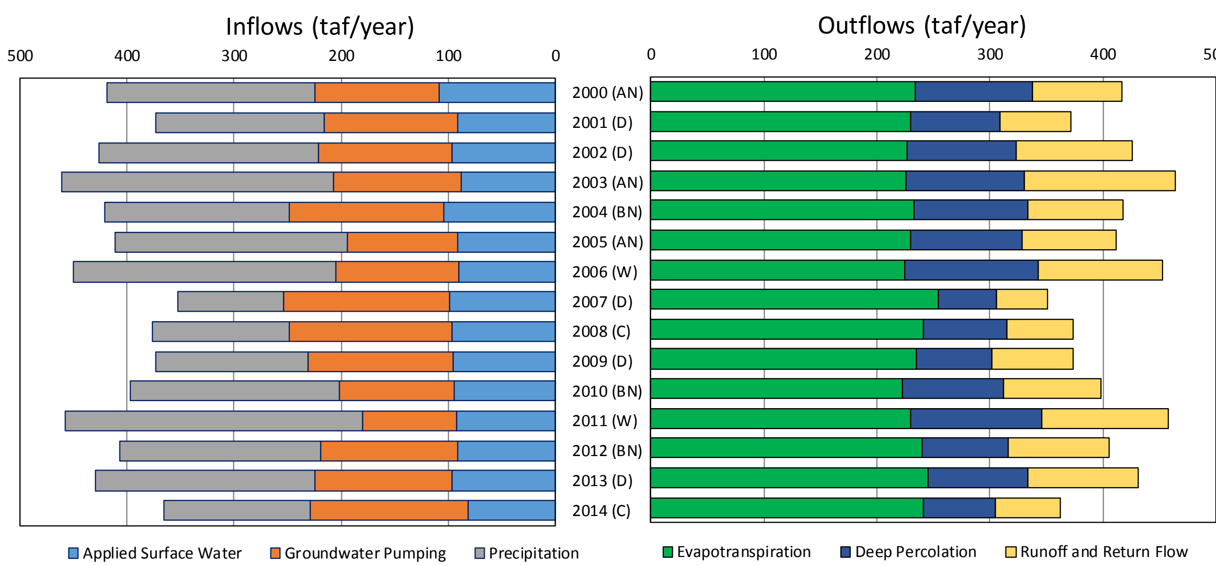

Figure 5.18. West Butte Overall Water Year Inflows and Outflows, 2000-2014.

Table 5.9. West Butte Overall Water Year Inflows, Outflows, and Change in Storage, 2000-2014.

Water Year	Inflows (taf)			Outflows (taf)			Change in Storage (taf)
	Precipi-tation	Surface Water	Ground-water	Evapotrans-piration	Deep Percolation	Runoff and Return Flow	
2000 (AN)	195	108	116	234	104	79	-2
2001 (D)	157	92	124	230	79	62	-1
2002 (D)	204	96	125	227	96	103	-1
2003 (AN)	253	88	120	225	106	134	4
2004 (BN)	173	104	144	233	101	84	-5
2005 (AN)	217	91	103	230	98	84	3
2006 (W)	246	90	115	224	118	110	0
2007 (D)	98	98	156	255	52	45	-2
2008 (C)	127	97	152	241	74	59	-3
2009 (D)	141	96	135	236	66	72	0
2010 (BN)	195	95	107	222	90	87	2
2011 (W)	277	92	88	230	116	113	-1
2012 (BN)	188	91	127	240	76	90	-1
2013 (D)	206	96	128	245	88	98	6
2014 (C)	137	81	148	241	64	57	-7
Minimum	98	81	88	222	52	45	-7
Maximum	277	108	156	255	118	134	6
Average	188	94	126	234	89	85	0
Averages by Hydrologic Year Type							
Wet (W)	261	91	102	227	117	111	-1
Above Normal (AN)	222	96	113	230	103	99	2
Below Normal (BN)	185	97	126	232	89	87	-1
Dry (D)	161	96	134	238	76	76	1
Critical (C)	132	89	150	241	69	58	-5

5.5.2 Irrigated Agriculture and Wetlands Water Budget

Inflows to irrigated agriculture and wetlands in West Butte average approximately 336 taf annually and include precipitation (126 taf), groundwater pumping (116 taf), and applied surface water (94 taf) (Figure 5.19, Figure 5.20, and Table 5.10). Precipitation varied from 62 taf in 2007 to 184 taf in 2011. Conversely, groundwater pumping varied from 79 taf in 2011 to

149 taf in 2007. Applied surface water varied from 81 taf in 2014 to 108 taf in 2000. Annual flows are provided in Table 5.10, along with the water year type as discussed in Section 4.2.

As indicated in Figure 5.20, applied surface water was relatively steady from year to year between 2000 and 2014, with greater variability in groundwater pumping. In general, pumping increases in dry years due to increased irrigation requirements resulting from decreased precipitation. With respect to outflows, total ET is relatively steady over time, with variability in deep percolation and surface water runoff varying largely in proportion to annual precipitation.

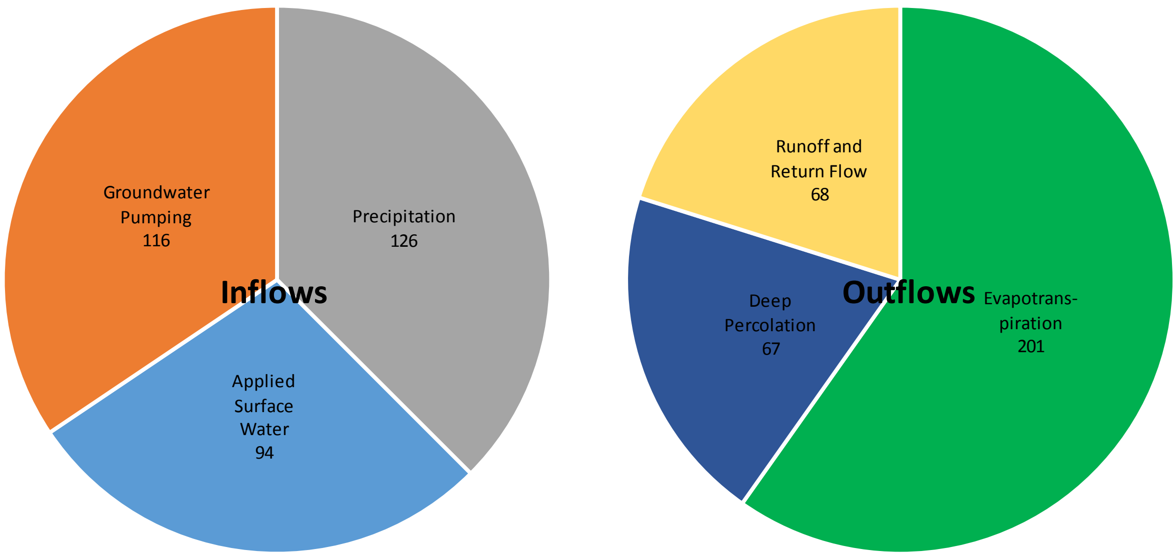

Figure 5.19. West Butte Irrigated Agriculture and Wetlands Average Annual Inflows and Outflows, 2000-2014.

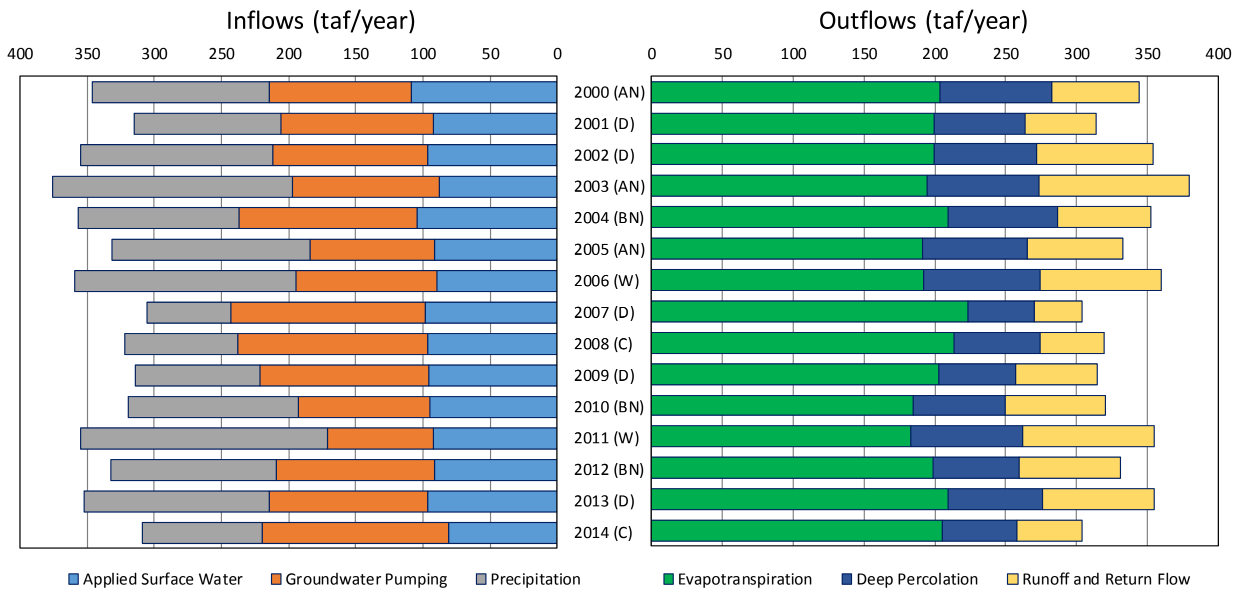

Figure 5.20. West Butte Irrigated Agriculture and Wetlands Water Year Inflows and Outflows, 2000-2014.

Table 5.10. West Butte Irrigated Agriculture and Wetlands Water Year Inflows, Outflows, and Change in Storage, 2000-2014.

Water Year	Inflows (taf)			Outflows (taf)			Change in Storage (taf)
	Precipi-tation	Surface Water	Ground-water	Evapotrans-piration	Deep Percolation	Runoff and Return Flow	
2000 (AN)	132	108	106	204	79	61	-2
2001 (D)	109	92	114	200	64	50	-1
2002 (D)	143	96	115	200	72	82	-1
2003 (AN)	178	88	110	195	78	106	4
2004 (BN)	119	104	133	210	77	66	-4
2005 (AN)	147	91	93	192	74	68	2
2006 (W)	165	90	104	192	82	85	1
2007 (D)	62	98	145	223	46	34	-2
2008 (C)	84	97	141	213	61	45	-2
2009 (D)	94	96	125	203	54	58	0
2010 (BN)	127	95	97	185	64	71	2
2011 (W)	184	92	79	183	79	93	0
2012 (BN)	123	91	118	199	61	71	-1
2013 (D)	137	96	118	209	67	79	3
2014 (C)	89	81	139	205	53	46	-5
Minimum	62	81	79	183	46	34	-5
Maximum	184	108	145	223	82	106	4
Average	126	94	116	201	67	68	0
Averages by Hydrologic Year Type							
Wet (W)	174	91	92	188	81	89	0
Above Normal (AN)	152	96	103	197	77	78	1
Below Normal (BN)	123	97	116	198	67	70	-1
Dry (D)	109	96	124	207	61	60	0
Critical (C)	86	89	140	209	57	46	-3

5.5.3 Developed Lands Water Budget

The West Butte IU includes the City of Chico south of Big Chico Creek and the community of Durham. Inflows to developed lands in West Butte average approximately 29 taf annually and include precipitation (19 taf) and groundwater pumping (10 taf) (Figure 5.21, Figure 5.22, and Table 5.11). Precipitation varied from 10 taf in 2007 to 29 taf in 2011. Groundwater pumping has been relatively consistent over time, varying from approximately 9 taf to 11 taf annually with an average estimated pumping of 9 taf by water suppliers and 1 taf by rural residential pumpers. No surface water is delivered to meet demands for developed lands in West Butte. Annual flows are provided in Table 5.11, along with the water year type as discussed in Section 4.2.

As indicated in Figure 5.22, groundwater pumping was relatively steady from year to year between 2000 and 2014. Pumping for developed lands remains relatively steady due to insensitivity of indoor water demands to precipitation and less sensitivity of outdoor water use (irrigation) to precipitation than for irrigated agriculture. With respect to outflows, total ET is relatively steady over time, with variability in deep percolation and surface water runoff varying largely in proportion to annual precipitation.

Some runoff and return flow from developed lands returns to the groundwater system through septic systems and stormwater retention while other runoff and return flow enters local waterways. Additional analysis is needed to refine estimates of the relative proportion of non-consumed water use on developed lands that returns to the surface water systems rather than returning to the groundwater system.

5.5.4 Non-Irrigated Lands Water Budget

Inflows to non-irrigated lands in West Butte average approximately 43 taf annually and include precipitation (Figure 5.23, Figure 5.24, and Table 5.12). Precipitation varied from 26 taf in 2007 to 64 taf in 2011. Annual flows are provided in Table 5.12, along with the water year type as discussed in Section 4.2.

As indicated in Figure 5.24, ET, deep percolation, and runoff vary over time largely in proportion to precipitation.

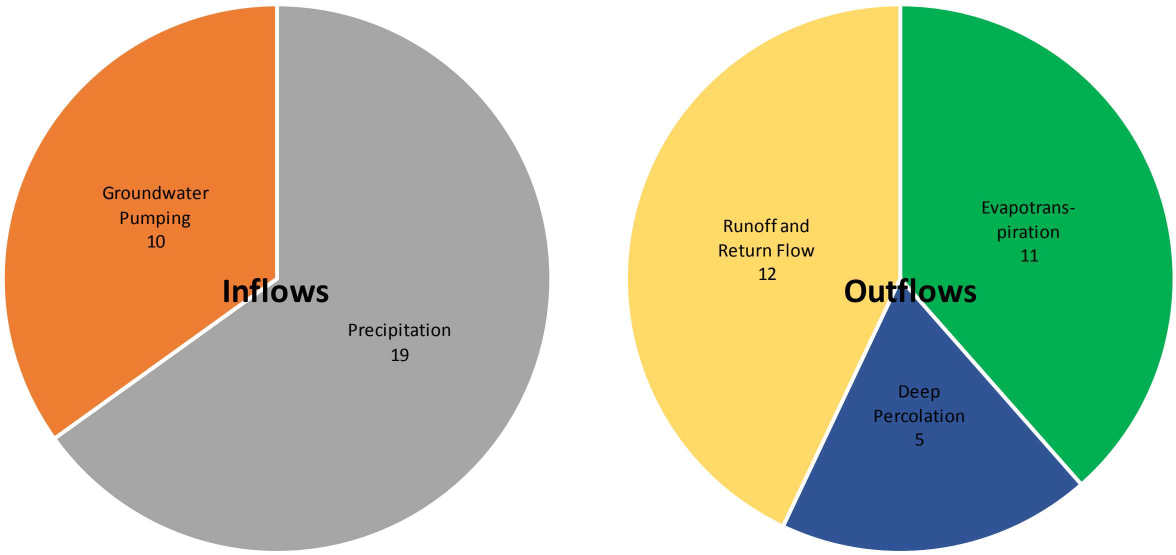

Figure 5.21. West Butte Developed Lands Average Annual Inflows and Outflows, 2000-2014.

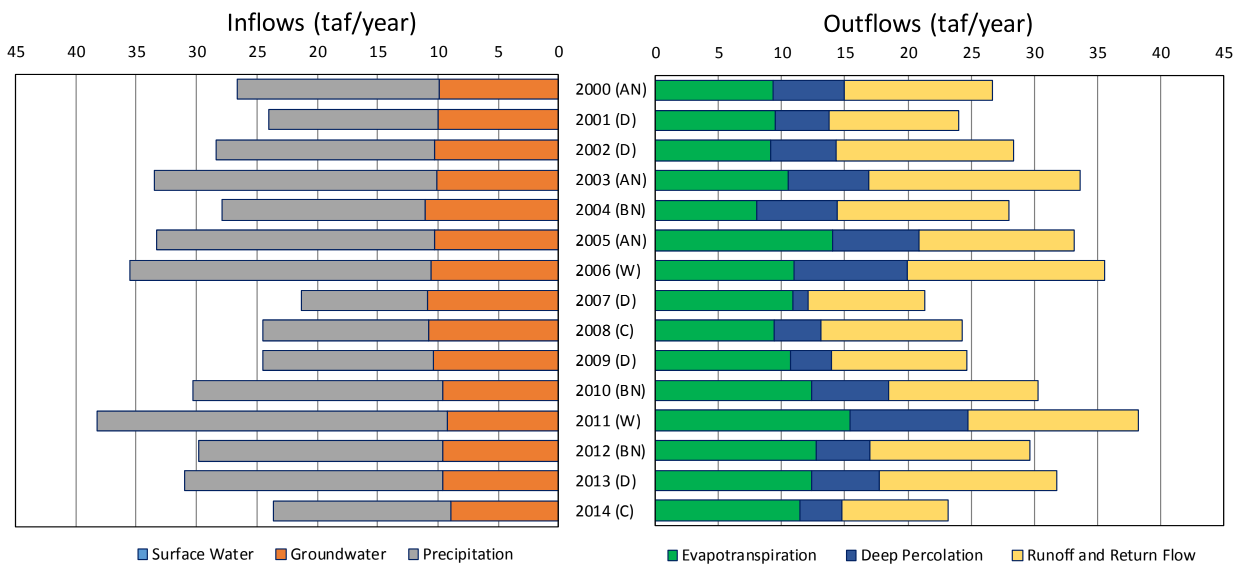

Figure 5.22. West Butte Developed Lands Water Year Inflows and Outflows, 2000-2014.

Table 5.11. West Butte Developed Lands Water Year Inflows, Outflows, and Change in Storage, 2000-2014.

Water Year	Inflows (taf)			Outflows (taf)			Change in Storage (taf)
	Precipi-tation	Surface Water	Ground-water	Evapotrans-piration	Deep Percolation	Runoff and Return Flow	
2000 (AN)	17	0	10	9	6	12	0
2001 (D)	14	0	10	10	4	10	0
2002 (D)	18	0	10	9	5	14	0
2003 (AN)	23	0	10	10	6	17	0
2004 (BN)	17	0	11	8	6	14	0
2005 (AN)	23	0	10	14	7	12	0
2006 (W)	25	0	11	11	9	16	0
2007 (D)	10	0	11	11	1	9	0
2008 (C)	14	0	11	9	4	11	0
2009 (D)	14	0	10	11	3	11	0
2010 (BN)	21	0	10	12	6	12	0
2011 (W)	29	0	9	15	9	14	0
2012 (BN)	20	0	10	13	4	13	0
2013 (D)	21	0	10	12	5	14	1
2014 (C)	15	0	9	11	3	8	0
Minimum	10	0	9	8	1	8	0
Maximum	29	0	11	15	9	17	1
Average	19	0	10	11	5	12	0
Averages by Hydrologic Year Type							
Wet (W)	27	0	10	13	9	15	0
Above Normal (AN)	21	0	10	11	6	14	0
Below Normal (BN)	19	0	10	11	6	13	0
Dry (D)	16	0	10	11	4	12	0
Critical (C)	14	0	10	10	3	10	0

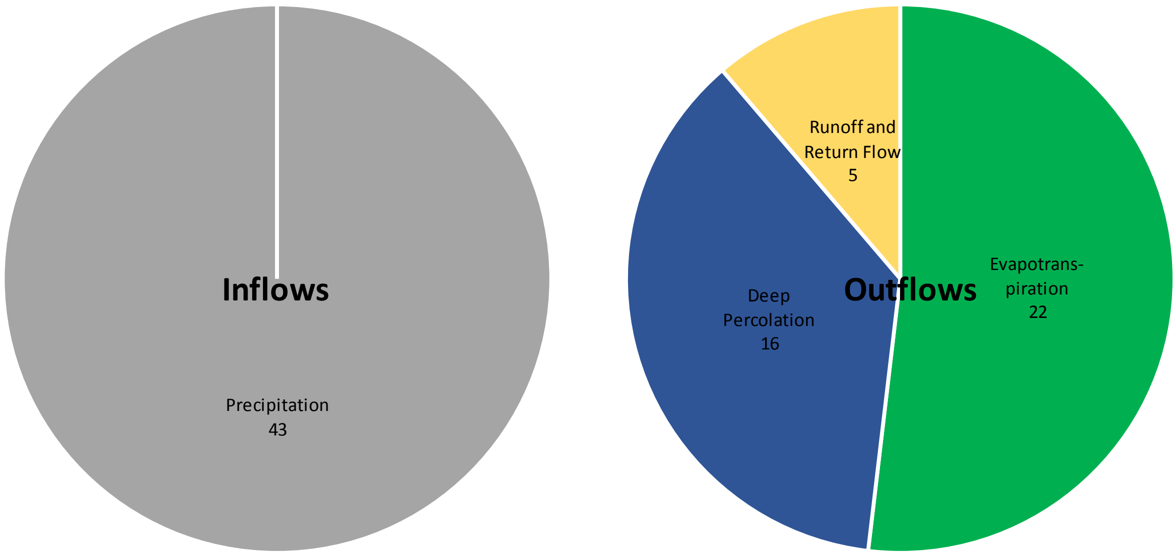

Figure 5.23. West Butte Non-Irrigated Lands Average Annual Inflows and Outflows, 2000-2014.

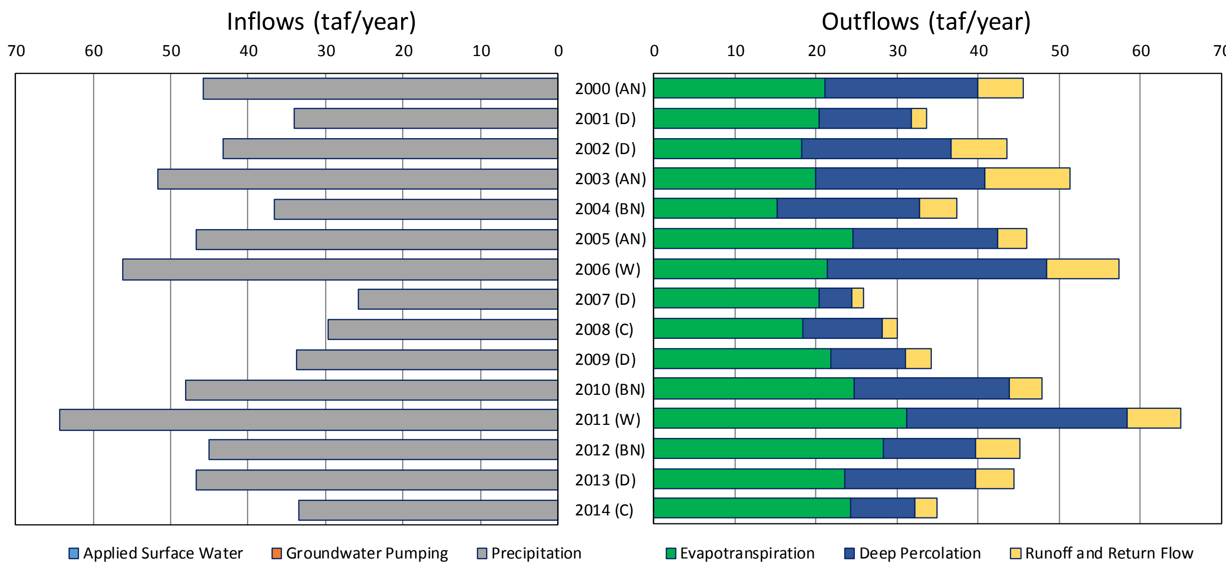

Figure 5.24. West Butte Non-Irrigated Lands Water Year Inflows and Outflows, 2000-2014.

Table 5.12. West Butte Non-Irrigated Lands Water Year Inflows, Outflows, and Change in Storage, 2000-2014.

Water Year	Inflows (taf)			Outflows (taf)			Change in Storage (taf)
	Precipi-tation	Surface Water	Ground-water	Evapotrans-piration	Deep Percolation	Runoff and Return Flow	
2000 (AN)	46	0	0	21	19	6	0
2001 (D)	34	0	0	20	11	2	0
2002 (D)	43	0	0	18	18	7	0
2003 (AN)	52	0	0	20	21	11	0
2004 (BN)	37	0	0	15	18	5	-1
2005 (AN)	47	0	0	25	18	4	1
2006 (W)	56	0	0	21	27	9	-1
2007 (D)	26	0	0	20	4	2	0
2008 (C)	30	0	0	18	10	2	0
2009 (D)	34	0	0	22	9	3	0
2010 (BN)	48	0	0	25	19	4	0
2011 (W)	64	0	0	31	27	6	-1
2012 (BN)	45	0	0	28	11	5	0
2013 (D)	47	0	0	23	16	5	2
2014 (C)	33	0	0	24	8	3	-1
Minimum	26	0	0	15	4	2	-1
Maximum	64	0	0	31	27	11	2
Average	43	0	0	22	16	5	0
Averages by Hydrologic Year Type							
Wet (W)	60	0	0	26	27	8	-1
Above Normal (AN)	48	0	0	22	19	7	0
Below Normal (BN)	43	0	0	23	16	5	0
Dry (D)	37	0	0	21	12	4	0
Critical (C)	32	0	0	21	9	2	-1

5.6 East Butte Inventory Unit

5.6.1 Overall Water Budget

Land surface inflows in East Butte average approximately 1.17 million acre-feet (maf) annually and include applied surface water (601 taf), precipitation (441 taf), and groundwater pumping (124 taf) (Figure 5.25, Figure 5.26, and Table 5.13). Precipitation varied from 291 taf in 2008 to 636 taf in 2006. Groundwater pumping varied from 105 taf in 2011 to 152 taf in 2014. Applied surface water varied from 540 taf in 2014 to 663 taf in 2007. Annual flows are provided in Table 5.13, along with the water year type as discussed in Section 4.2.

As indicated in Figure 5.26, applied surface water was relatively steady from year to year between 2000 and 2014. With respect to outflows, total ET is relatively steady over time, with variability in deep percolation and surface water runoff varying largely in proportion to annual precipitation.

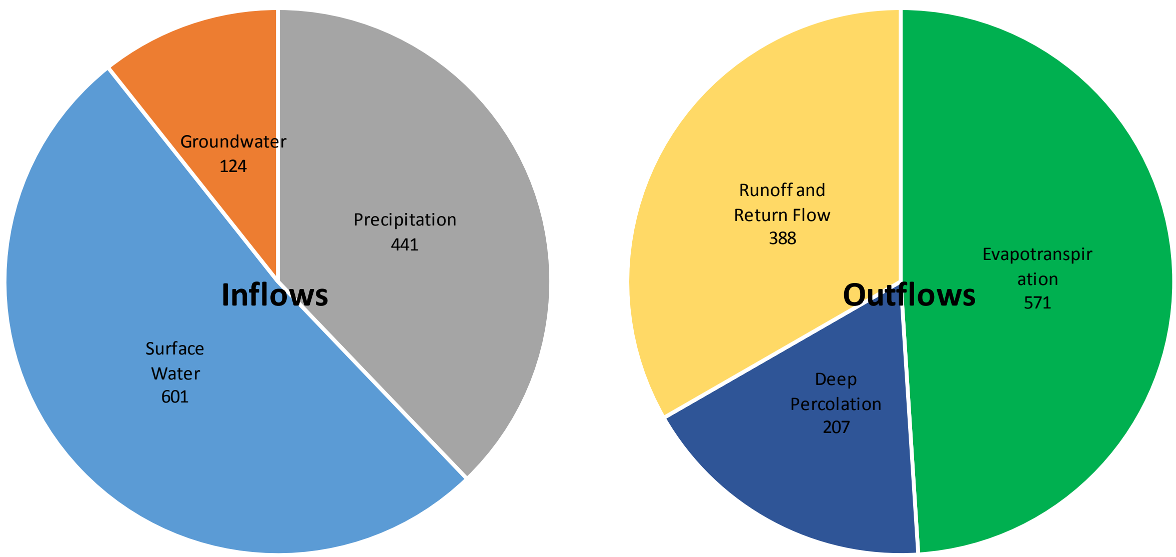

Figure 5.25. East Butte Overall Average Annual Inflows and Outflows, 2000-2014.

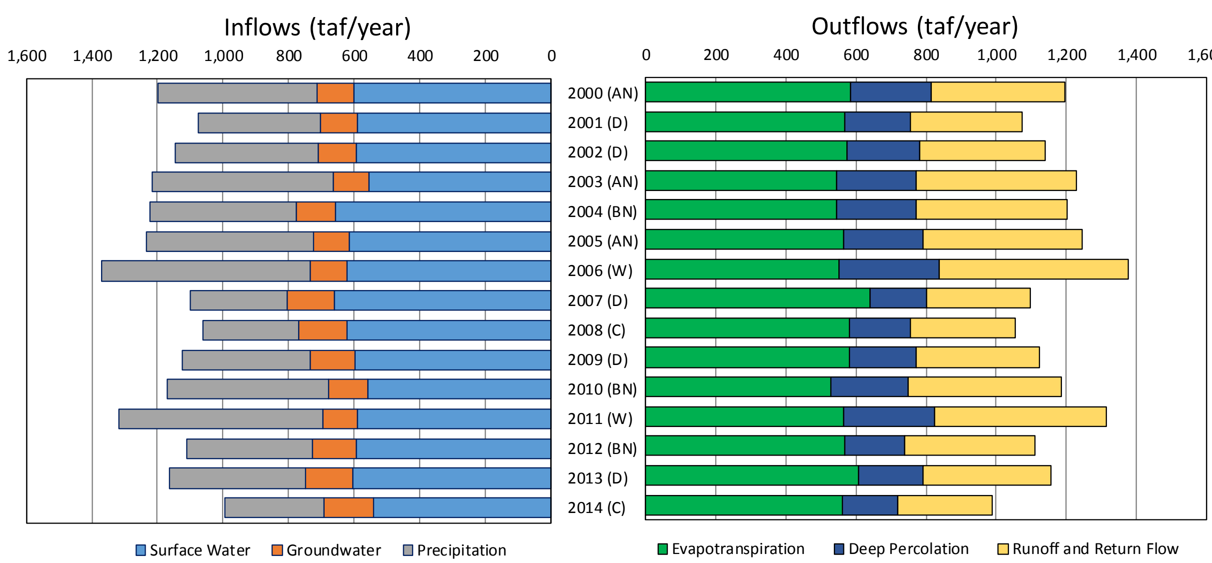

Figure 5.26. East Butte Overall Water Year Inflows and Outflows, 2000-2014.

Table 5.13. East Butte Overall Water Year Inflows, Outflows, and Change in Storage, 2000-2014.

	Inflows (taf)			Outflows (taf)			
Water Year	Precipi-tation	Surface Water	Ground-water	Evapotrans-piration	Deep Percolation	Runoff and Return Flow	Change in Storage (taf)
2000 (AN)	483	601	113	585	230	381	-1
2001 (D)	372	592	112	567	187	319	-2
2002 (D)	437	596	113	576	205	359	-8
2003 (AN)	550	556	108	544	226	458	16
2004 (BN)	443	657	121	546	224	433	-21
2005 (AN)	508	616	108	565	228	453	18
2006 (W)	636	622	112	552	285	540	5
2007 (D)	292	663	144	641	159	296	4
2008 (C)	291	622	147	581	175	298	-13
2009 (D)	391	596	137	581	191	352	4
2010 (BN)	493	558	120	528	221	437	14
2011 (W)	624	589	105	565	258	490	-2
2012 (BN)	381	596	133	566	172	371	-5
2013 (D)	414	606	142	607	184	366	5
2014 (C)	302	540	152	561	157	272	-9
Minimum	291	540	105	528	157	272	-21
Maximum	636	663	152	641	285	540	18
Average	441	601	124	571	207	388	0
Averages by Hydrologic Year Type							
Wet (W)	630	606	109	559	272	515	1
Above Normal (AN)	514	591	110	565	228	431	11
Below Normal (BN)	439	604	125	547	205	414	-4
Dry (D)	381	611	129	594	185	338	1
Critical (C)	297	581	150	571	166	285	-11

5.6.2 Irrigated Agriculture and Wetlands Water Budget

Inflows to irrigated agriculture and wetlands in East Butte average approximately 987 taf annually and include precipitation (269 taf), applied surface water (598 taf), and groundwater pumping (120 taf) (Figure 5.27, Figure 5.28, and Table 5.14). Precipitation varied from 172 taf in 2007 to 394 taf in 2011. Groundwater pumping varied from 100 taf in 2011 to 147 taf in

2014. Applied surface water varied from 538 taf in 2014 to 661 taf in 2007. Annual flows are provided in Table 5.14, along with the water year type as discussed in Section 4.2.

As indicated in Figure 5.28, applied surface water was relatively steady from year to year between 2000 and 2014, with greater variability in groundwater pumping. Variations result from varying cropped acreage, including idling-based water transfers and differences in annual precipitation timing and amounts and corresponding impacts on crop water requirements. In general, pumping increases in dry years due to increased irrigation requirements resulting from decreased precipitation. With respect to outflows, total ET is relatively steady over time, with variability in deep percolation and surface water runoff varying largely in proportion to annual precipitation.

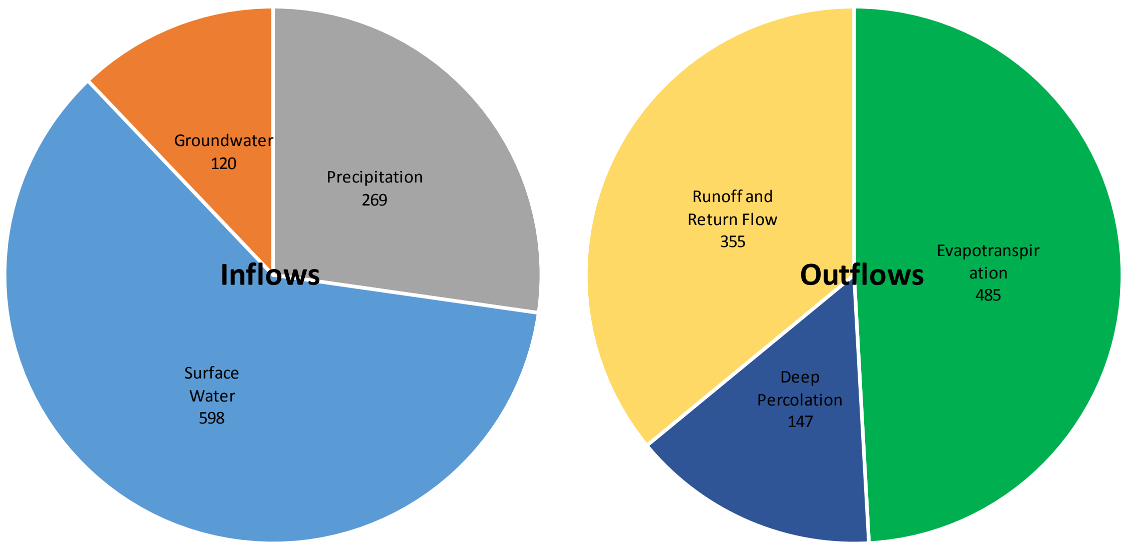

Figure 5.27. East Butte Irrigated Agriculture and Wetlands Average Annual Inflows and Outflows, 2000-2014.

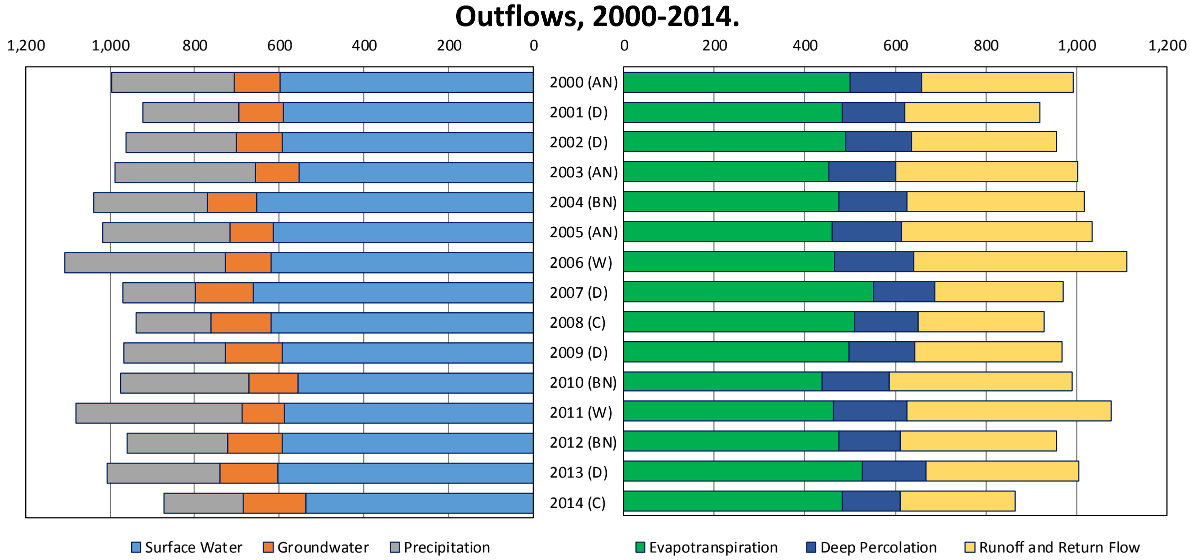

Figure 5.28. East Butte Irrigated Agriculture and Wetlands Water Year Inflows and Outflows, 2000-2014.

Table 5.14. East Butte Irrigated Agriculture and Wetlands Water Year Inflows, Outflows, and Change in Storage, 2000-2014.

	Inflows (taf)			Outflows (taf)			
Water Year	Precipi-tation	Surface Water	Ground-water	Evapotrans-piration	Deep Percolation	Runoff and Return Flow	Change in Storage (taf)
2000 (AN)	288	599	109	501	158	335	-2
2001 (D)	225	589	107	482	139	299	-2
2002 (D)	261	593	108	491	144	320	-7
2003 (AN)	330	553	104	452	148	402	15
2004 (BN)	267	654	117	476	150	392	-20
2005 (AN)	302	613	104	460	154	421	17
2006 (W)	380	620	107	465	175	472	6
2007 (D)	172	661	138	551	138	283	0
2008 (C)	177	620	142	511	139	280	-9
2009 (D)	241	594	132	498	145	326	1
2010 (BN)	305	556	115	438	148	403	14
2011 (W)	394	587	100	462	164	451	-4
2012 (BN)	238	594	127	475	136	346	-2
2013 (D)	267	604	136	527	141	338	-1
2014 (C)	187	538	147	483	129	253	-7
Minimum	172	538	100	438	129	253	-20
Maximum	394	661	147	551	175	472	17
Average	269	598	120	485	147	355	0
Averages by Hydrologic Year Type							
Wet (W)	387	604	103	463	170	462	1
Above Normal (AN)	306	588	105	471	153	386	10
Below Normal (BN)	270	601	120	463	145	380	-3
Dry (D)	233	608	124	510	141	313	-2
Critical (C)	182	579	144	497	134	267	-8

5.6.3 Developed Lands Water Budget

The East Butte IU includes the City of Oroville north and west of the Feather River, the cities of Gridley and Biggs, and the communities of Richvale and Thermalito. Inflows to developed lands in East Butte average approximately 38 taf annually and include precipitation (31 taf), groundwater pumping (5 taf), and applied surface water (2 taf) (Figure 5.29, Figure 5.30, and Table 5.15). Precipitation varied from 20 taf in 2008 to 43 taf in 2011. Groundwater pumping has been relatively consistent over time, varying from approximately 4 taf to 6 taf annually with an average estimated pumping of 3 taf by water suppliers and 2 taf by rural residential pumpers. Approximately 2 taf of surface water is delivered to meet demands for developed lands in East Butte. Annual flows are provided in Table 5.15, along with the water year type as discussed in Section 4.2.

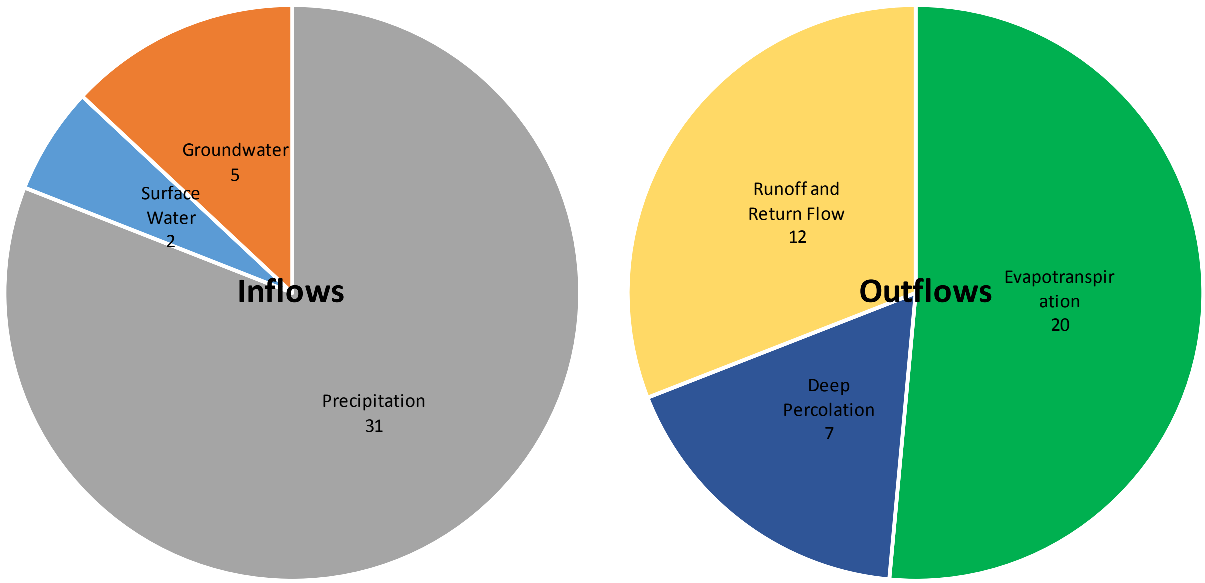

Figure 5.29. East Butte Developed Lands Average Annual Inflows and Outflows, 2000-2014.

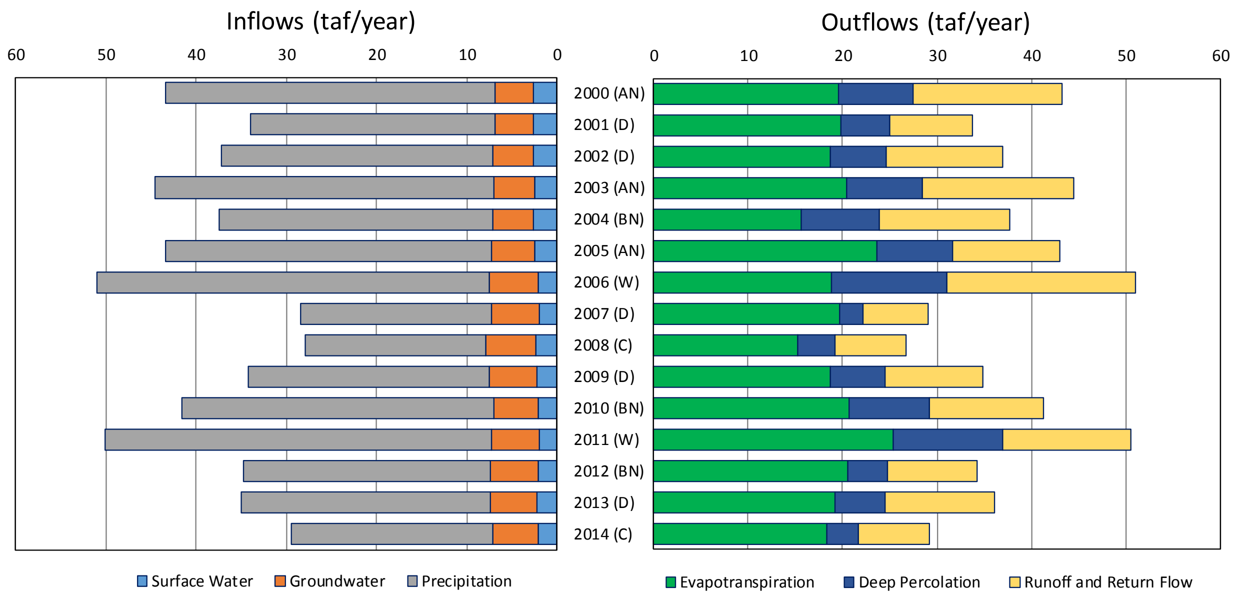

Figure 5.30. East Butte Developed Lands Water Year Inflows and Outflows, 2000-2014.

As indicated in Figure 5.30, groundwater pumping was relatively steady from year to year between 2000 and 2014. Pumping for developed lands remains relatively steady due to insensitivity of indoor water demands to precipitation and less sensitivity of outdoor water use (irrigation) to precipitation than for irrigated agriculture. With respect to outflows, total ET is relatively steady over time, with variability in deep percolation and surface water runoff varying largely in proportion to annual precipitation.

Table 5.15. East Butte Developed Lands Water Year Inflows, Outflows, and Change in Storage, 2000-2014.

Water Year	Inflows (taf)			Outflows (taf)			Change in Storage (taf)
	Precipi-tation	Surface Water	Ground-water	Evapotrans-piration	Deep Percolation	Runoff and Return Flow	
2000 (AN)	36	3	4	20	8	16	0
2001 (D)	27	3	4	20	5	9	0
2002 (D)	30	3	5	19	6	12	0
2003 (AN)	38	3	4	20	8	16	0
2004 (BN)	30	3	5	16	8	14	0
2005 (AN)	36	2	5	24	8	11	0
2006 (W)	43	2	5	19	12	20	0
2007 (D)	21	2	5	20	2	7	1
2008 (C)	20	2	6	15	4	8	-1
2009 (D)	27	2	5	19	6	10	1
2010 (BN)	34	2	5	21	8	12	0
2011 (W)	43	2	5	25	12	13	0
2012 (BN)	27	2	5	21	4	9	-1
2013 (D)	28	2	5	19	5	12	1
2014 (C)	22	2	5	18	3	8	0
Minimum	20	2	4	15	2	7	-1
Maximum	43	3	6	25	12	20	1
Average	31	2	5	20	7	12	0
Averages by Hydrologic Year Type							
Wet (W)	43	2	5	22	12	17	0
Above Normal (AN)	37	3	5	21	8	14	0
Below Normal (BN)	31	2	5	19	7	12	0
Dry (D)	26	2	5	19	5	10	0
Critical (C)	21	2	5	17	4	8	-1

Some runoff and return flow from developed lands returns to the groundwater system through septic systems and stormwater retention while other runoff and return flow enters local waterways. Additional analysis is needed to refine estimates of the relative proportion of non-consumed water use on developed lands that returns to the surface water systems rather than returning to the groundwater system.

5.6.4 Non-Irrigated Lands Water Budget

Inflows to non-irrigated lands in East Butte average approximately 141 taf annually and include precipitation (Figure 5.31, Figure 5.32, and Table 5.16). Precipitation varied from 93 taf in 2014 to 213 taf in 2006. Annual flows are provided in Table 5.16, along with the water year type as discussed in Section 4.2. As indicated in Figure 5.32, ET, deep percolation, and runoff vary over time largely in proportion to precipitation.

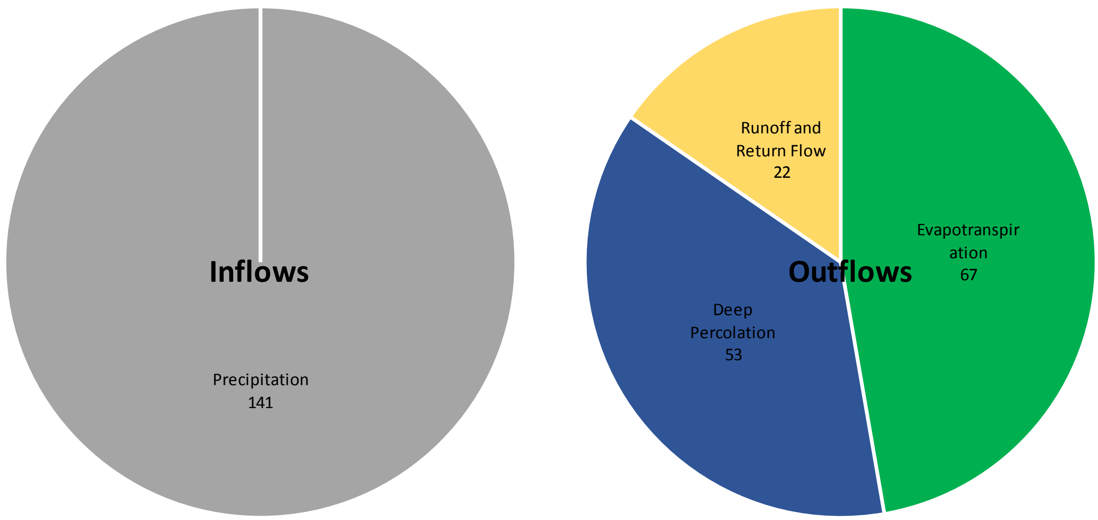

Figure 5.31. East Butte Non-Irrigated Lands Average Annual Inflows and Outflows, 2000-2014.

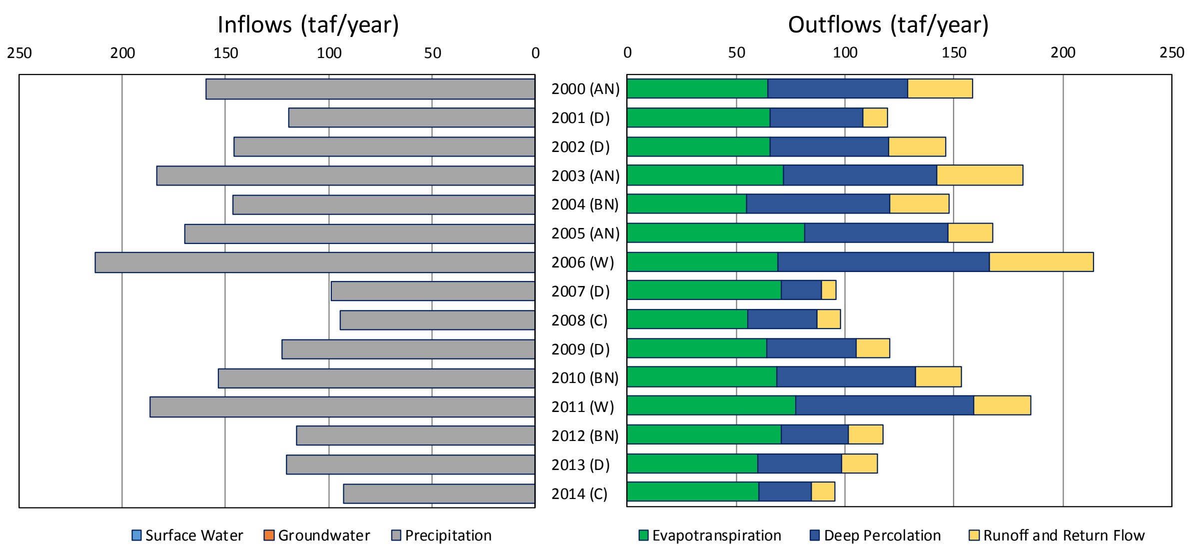

Figure 5.32. East Butte Non-Irrigated Lands Water Year Inflows and Outflows, 2000-2014.

Table 5.16. East Butte Non-Irrigated Lands Water Year Inflows, Outflows, and Change in Storage, 2000-2014.

Water Year	Inflows (taf)			Outflows (taf)			Change in Storage (taf)
	Precipi-tation	Surface Water	Ground-water	Evapotrans-piration	Deep Percolation	Runoff and Return Flow	
2000 (AN)	159	0	0	64	64	30	0
2001 (D)	119	0	0	66	42	11	0
2002 (D)	146	0	0	66	54	27	-1
2003 (AN)	183	0	0	72	70	40	2
2004 (BN)	146	0	0	55	66	27	-1
2005 (AN)	170	0	0	82	66	21	2
2006 (W)	213	0	0	69	98	48	-1
2007 (D)	99	0	0	71	19	6	3
2008 (C)	94	0	0	56	32	10	-4
2009 (D)	123	0	0	64	41	16	2
2010 (BN)	154	0	0	69	64	22	0
2011 (W)	187	0	0	77	82	26	1
2012 (BN)	115	0	0	70	31	16	-2
2013 (D)	120	0	0	60	38	16	5
2014 (C)	93	0	0	60	24	11	-3
Minimum	93	0	0	55	19	6	-4
Maximum	213	0	0	82	98	48	5
Average	141	0	0	67	53	22	0
Averages by Hydrologic Year Type							
Wet (W)	200	0	0	73	90	37	0
Above Normal (AN)	171	0	0	73	67	30	1
Below Normal (BN)	138	0	0	65	54	21	-1
Dry (D)	121	0	0	65	39	15	2
Critical (C)	94	0	0	58	28	11	-3

5.7 North Yuba Inventory Unit

5.7.1 Overall Water Budget

Land surface inflows in North Yuba average approximately 169 thousand acre-feet (taf) annually and include precipitation (106 taf), groundwater pumping (52 taf), and applied surface water (12 taf) (Figure 5.33, Figure 5.34, and Table 5.17). Precipitation varied from 64 taf in 2008 to 157 taf in 2006. Groundwater pumping varied from 41 taf in 2011 to 62 taf in 2008.

Applied surface water has been relatively steady over time, varying from 11 taf to 13 taf and averaging 12 taf. Annual flows are provided in Table 5.17, along with the water year type as discussed in Section 4.2.

As indicated in Figure 5.34, applied surface water was relatively steady from year to year between 2000 and 2014, with greater variability in groundwater pumping. In general, pumping increases in dry years due to increased irrigation requirements resulting from decreased precipitation. With respect to outflows, total ET is relatively steady over time, with variability in deep percolation and surface water runoff varying largely in proportion to annual precipitation.

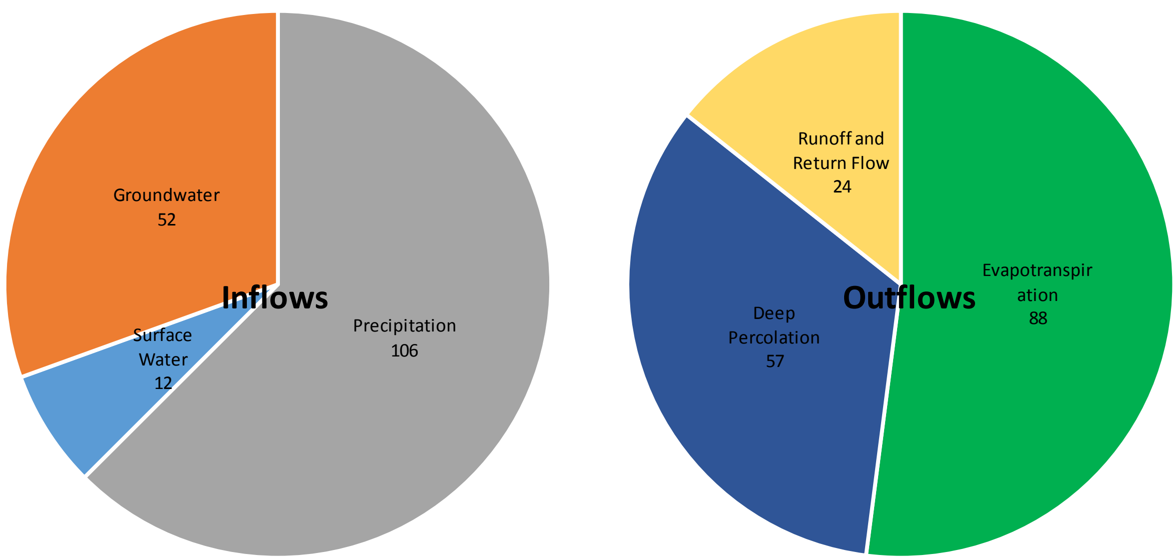

Figure 5.33. North Yuba Overall Average Annual Inflows and Outflows, 2000-2014.

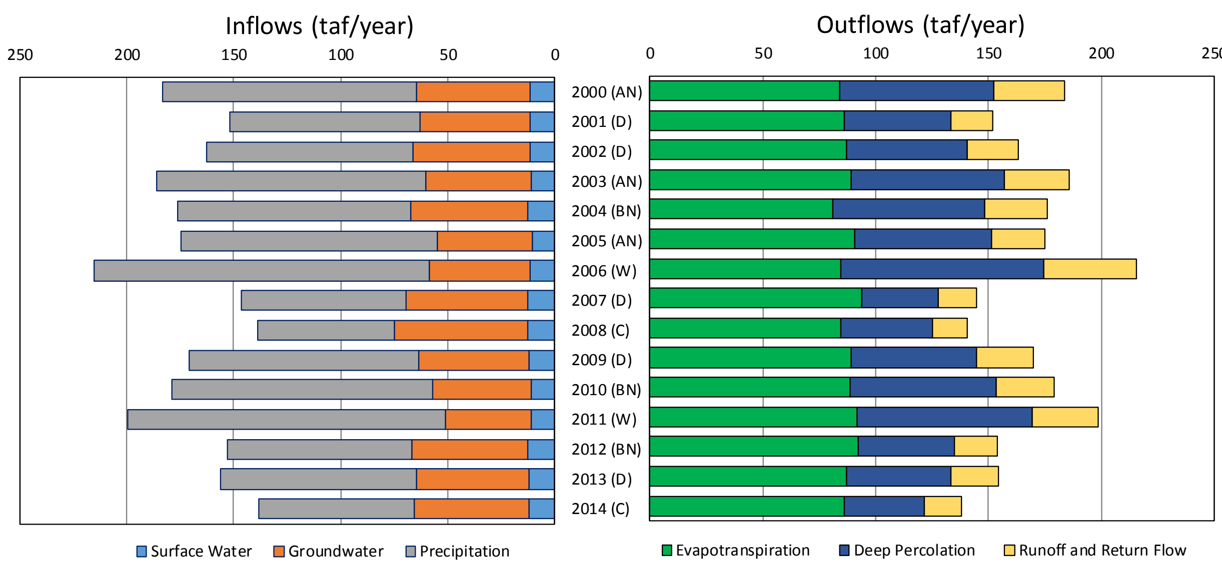

Figure 5.34. North Yuba Overall Water Year Inflows and Outflows, 2000-2014.

Table 5.17. North Yuba Overall Water Year Inflows, Outflows, and Change in Storage, 2000-2014.

Water Year	Inflows (taf)			Outflows (taf)			Change in Storage (taf)
	Precipi-tation	Surface Water	Ground-water	Evapotrans-piration	Deep Percolation	Runoff and Return Flow	
2000 (AN)	119	11	53	84	68	31	1
2001 (D)	89	12	51	86	47	18	0
2002 (D)	96	12	55	87	53	23	1
2003 (AN)	125	11	49	89	68	29	1
2004 (BN)	109	13	55	81	67	28	-1
2005 (AN)	120	11	44	91	61	24	1
2006 (W)	157	12	47	85	90	41	-1
2007 (D)	77	12	57	94	34	17	3
2008 (C)	64	13	62	84	41	16	-3
2009 (D)	107	12	51	89	55	25	1
2010 (BN)	122	11	46	89	65	26	0
2011 (W)	148	11	41	92	78	29	0
2012 (BN)	86	13	54	92	43	19	0
2013 (D)	91	12	53	87	46	21	1
2014 (C)	73	12	54	86	36	16	-1
Minimum	64	11	41	81	34	16	-3
Maximum	157	13	62	94	90	41	3
Average	106	12	52	88	57	24	0
Averages by Hydrologic Year Type							
Wet (W)	153	11	44	88	84	35	0
Above Normal (AN)	121	11	49	88	66	28	1
Below Normal (BN)	106	12	51	87	58	24	0
Dry (D)	92	12	54	89	47	21	1
Critical (C)	68	12	58	85	38	16	-2

5.7.2 Irrigated Agriculture and Wetlands Water Budget

Inflows to irrigated agriculture and wetlands in North Yuba average approximately 93 taf annually and include precipitation (35 taf), groundwater pumping (51 taf), and applied surface water (8 taf) (Figure 5.35, Figure 5.36, and Table 5.18). Precipitation varied from 21 taf in 2008 to 53 taf in 2006. Groundwater pumping varied from 40 taf in 2011 to 61 taf in 2008. Applied surface water has been relatively steady over time, varying from 7 taf to 9 taf and averaging 8 taf. Annual flows are provided in Table 5.18, along with the water year type as discussed in Section 4.2.

As indicated in Figure 5.36, applied surface water was relatively steady from year to year between 2000 and 2014, with greater variability in groundwater pumping. In general, pumping increases in dry years due to increased irrigation requirements resulting from decreased precipitation. With respect to outflows, total ET is relatively steady over time, with variability in deep percolation and surface water runoff varying largely in proportion to annual precipitation.

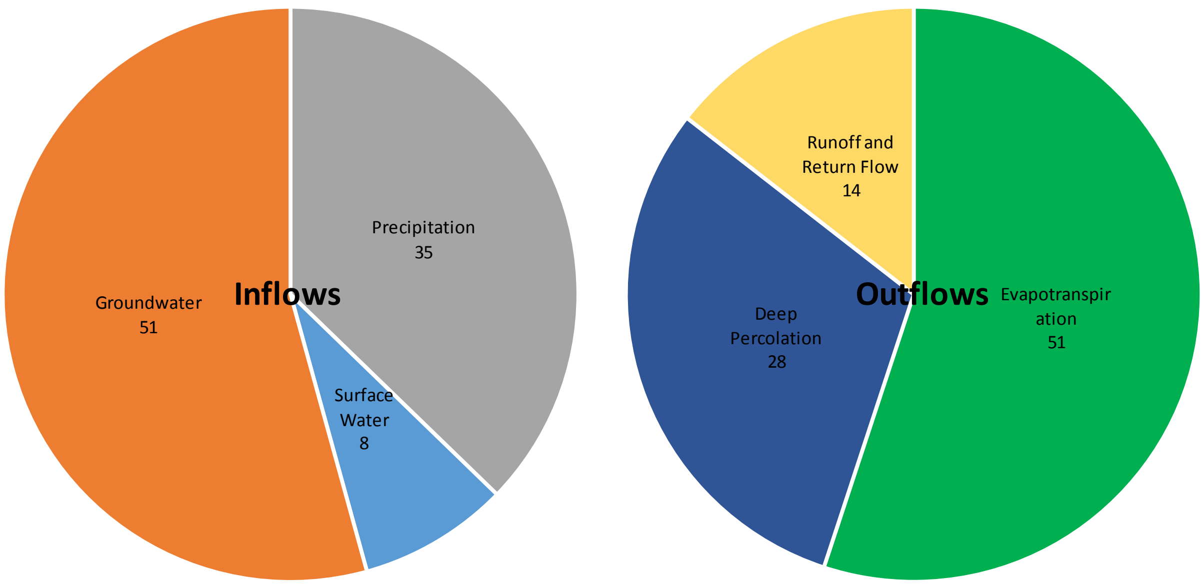

Figure 5.35. North Yuba Irrigated Agriculture and Wetlands Average Annual Inflows and Outflows, 2000-2014.

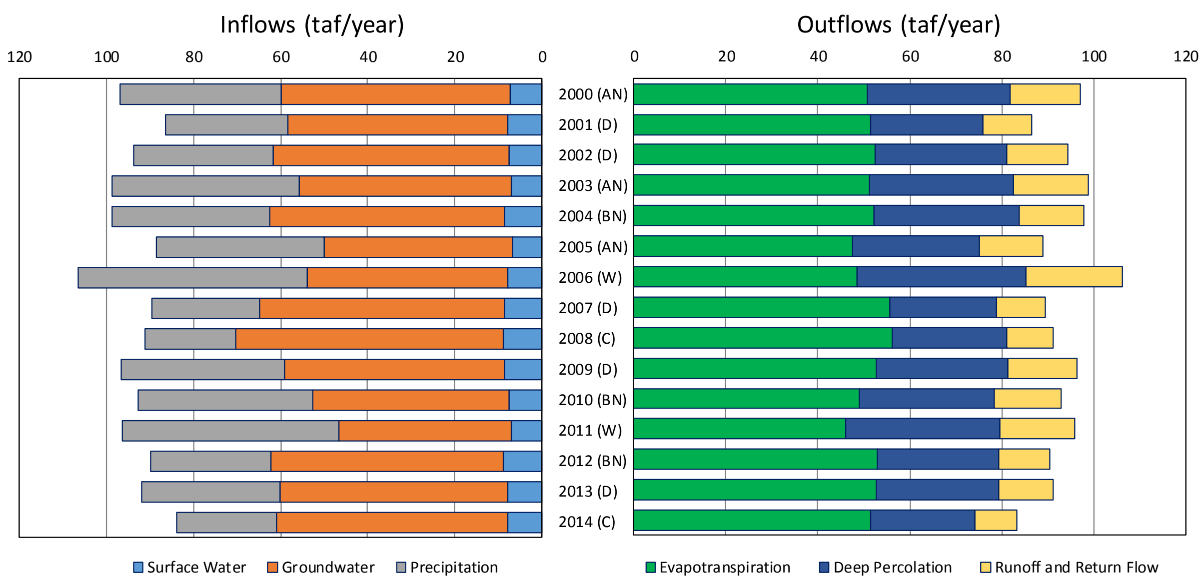

Figure 5.36. North Yuba Irrigated Agriculture and Wetlands Water Year Inflows and Outflows, 2000-2014.

Table 5.18. North Yuba Irrigated Agriculture and Wetlands Water Year Inflows, Outflows, and Change in Storage, 2000-2014.

	Inflows (taf)			Outflows (taf)			
Water Year	Precipi-tation	Surface Water	Ground-water	Evapotrans-piration	Deep Percolation	Runoff and Return Flow	Change in Storage (taf)
2000 (AN)	37	7	52	51	31	15	0
2001 (D)	28	8	51	52	24	11	0
2002 (D)	32	8	54	53	29	13	1
2003 (AN)	43	7	49	51	31	16	0
2004 (BN)	36	9	54	52	31	14	-1
2005 (AN)	38	7	43	47	28	14	0
2006 (W)	53	8	46	48	37	21	0
2007 (D)	25	9	56	56	23	11	0
2008 (C)	21	9	61	56	25	10	0
2009 (D)	37	9	51	53	29	15	0
2010 (BN)	40	8	45	49	29	15	0
2011 (W)	50	7	40	46	34	16	-1
2012 (BN)	28	9	53	53	26	11	0
2013 (D)	32	8	52	53	26	12	-1
2014 (C)	23	8	53	52	23	9	-1
Minimum	21	7	40	46	23	9	-1
Maximum	53	9	61	56	37	21	1
Average	35	8	51	51	28	14	0
Averages by Hydrologic Year Type							
Wet (W)	51	7	43	47	35	19	0
Above Normal (AN)	39	7	48	50	30	15	0
Below Normal (BN)	35	8	51	51	29	13	0
Dry (D)	31	8	53	53	26	12	0
Critical (C)	22	8	57	54	24	10	0

5.7.3 Developed Lands Water Budget

The North Yuba IU includes the City of Oroville south and east of the Feather River and the communities of Palermo and Honcut. Inflows to developed lands in North Yuba average approximately 25 taf annually and include precipitation (20 taf), applied surface water (4 taf), and groundwater pumping (1 taf) (Figure 5.37, Figure 5.38, and Table 5.19). Precipitation varied from 13 taf in 2008 to 32 taf in 2011. Surface water deliveries and groundwater pumping have been relatively consistent over time, averaging 4 taf and 1 taf, respectively. Approximately 100 af of groundwater is pumped by water suppliers annually, with 800 af pumped by rural residents. Annual flows are provided in Table 5.19, along with the water year type as discussed in Section 4.2.

As indicated in Figure 5.38, applied surface water and groundwater pumping were relatively steady from year to year between 2000 and 2014. Applied surface water and pumping for developed lands remain relatively steady due to insensitivity of indoor water demands to precipitation and less sensitivity of outdoor water use (irrigation) to precipitation than for irrigated agriculture. With respect to outflows, total ET is greatest in wet years and least in dry years, with variability in deep percolation and surface water runoff also varying largely in proportion to annual precipitation.

Some runoff and return flow from developed lands returns to the groundwater system through septic systems and stormwater retention while other runoff and return flow enters local waterways. Additional analysis is needed to refine estimates of the relative proportion of non-consumed water use on developed lands that returns to the surface water systems rather than returning to the groundwater system.

5.7.4 Non-Irrigated Lands Water Budget

Inflows to non-irrigated lands in North Yuba average approximately 51 taf annually and include precipitation (Figure 5.39, Figure 5.40, and Table 5.20). Precipitation varied from 30 taf in 2008 to 75 taf in 2006. Annual flows are provided in Table 5.20, along with the water year type as discussed in Section 4.2.

As indicated in Figure 5.40, ET, deep percolation, and runoff vary over time largely in proportion to precipitation.

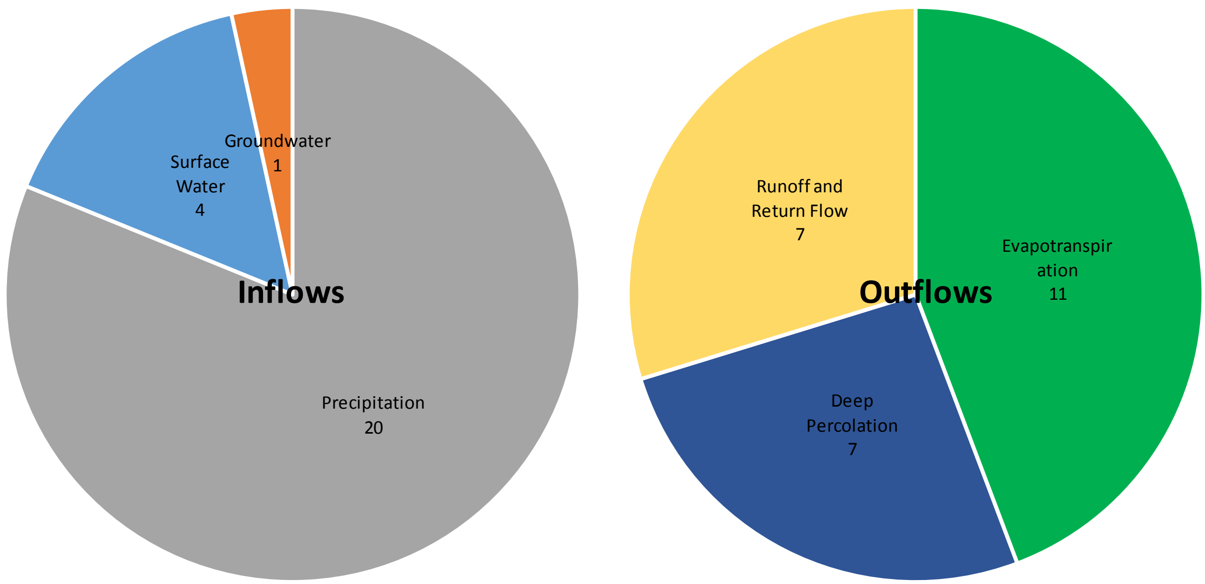

Figure 5.37. North Yuba Developed Lands Average Annual Inflows and Outflows, 2000-2014.

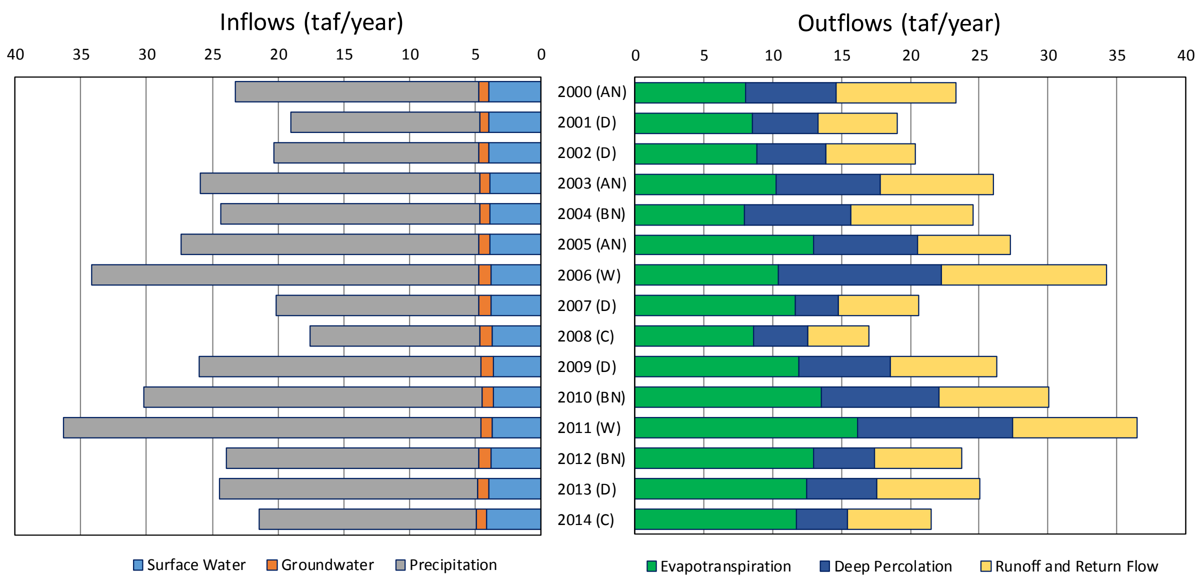

Figure 5.38. North Yuba Developed Lands Water Year Inflows and Outflows, 2000-2014.

Table 5.19. North Yuba Developed Lands Water Year Inflows, Outflows, and Change in Storage, 2000-2014.

Water Year	Inflows (taf)			Outflows (taf)			Change in Storage (taf)
	Precipi-tation	Surface Water	Ground-water	Evapotrans-piration	Deep Percolation	Runoff and Return Flow	
2000 (AN)	19	4	1	8	7	9	0
2001 (D)	14	4	1	9	5	6	0
2002 (D)	16	4	1	9	5	6	0
2003 (AN)	21	4	1	10	8	8	0
2004 (BN)	20	4	1	8	8	9	0
2005 (AN)	23	4	1	13	8	7	0
2006 (W)	29	4	1	10	12	12	0
2007 (D)	15	4	1	12	3	6	1
2008 (C)	13	4	1	9	4	5	-1
2009 (D)	21	4	1	12	7	8	0
2010 (BN)	26	4	1	14	9	8	0
2011 (W)	32	4	1	16	11	9	0
2012 (BN)	19	4	1	13	4	6	0
2013 (D)	20	4	1	13	5	7	1
2014 (C)	17	4	1	12	4	6	0
Minimum	13	4	1	8	3	5	-1
Maximum	32	4	1	16	12	12	1
Average	20	4	1	11	7	7	0
Averages by Hydrologic Year Type							
Wet (W)	31	4	1	13	12	11	0
Above Normal (AN)	21	4	1	10	7	8	0
Below Normal (BN)	22	4	1	11	7	8	0
Dry (D)	17	4	1	11	5	7	0
Critical (C)	15	4	1	10	4	5	0

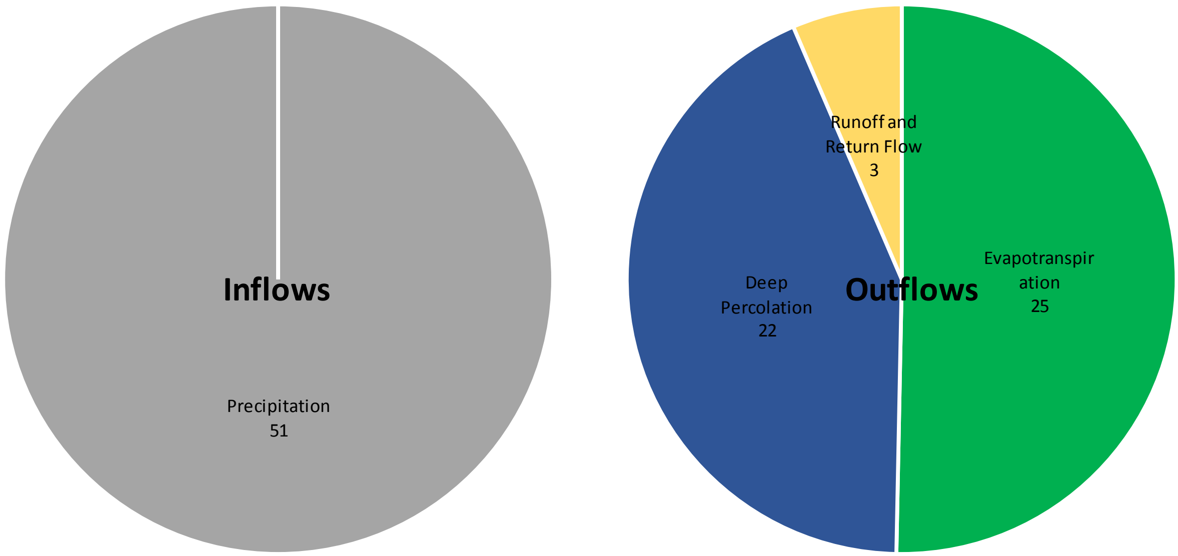

Figure 5.39. North Yuba Non-Irrigated Lands Average Annual Inflows and Outflows, 2000-2014.

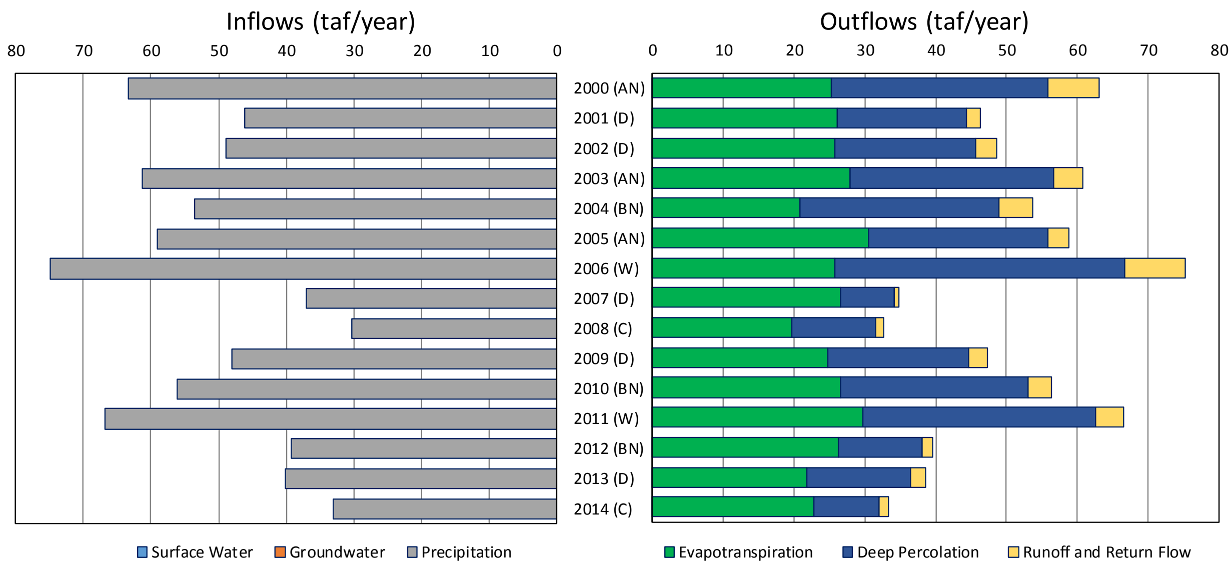

Figure 5.40. North Yuba Non-Irrigated Lands Water Year Inflows and Outflows, 2000-2014.

Table 5.20. North Yuba Non-Irrigated Lands Water Year Inflows, Outflows, and Change in Storage, 2000-2014.

Water Year	Inflows (taf)			Outflows (taf)			Change in Storage (taf)
	Precipi-tation	Surface Water	Ground-water	Evapotrans-piration	Deep Percolation	Runoff and Return Flow	
2000 (AN)	63	0	0	25	31	7	0
2001 (D)	46	0	0	26	18	2	0
2002 (D)	49	0	0	26	20	3	0
2003 (AN)	61	0	0	28	29	4	1
2004 (BN)	53	0	0	21	28	5	0
2005 (AN)	59	0	0	31	25	3	0
2006 (W)	75	0	0	26	41	8	0
2007 (D)	37	0	0	27	8	1	2
2008 (C)	30	0	0	20	12	1	-2
2009 (D)	48	0	0	25	20	3	1
2010 (BN)	56	0	0	27	27	3	0
2011 (W)	67	0	0	30	33	4	0
2012 (BN)	39	0	0	26	12	2	0
2013 (D)	40	0	0	22	15	2	1
2014 (C)	33	0	0	23	9	1	0
Minimum	30	0	0	20	8	1	-2
Maximum	75	0	0	31	41	8	2
Average	51	0	0	25	22	3	0
Averages by Hydrologic Year Type							
Wet (W)	71	0	0	28	37	6	0
Above Normal (AN)	61	0	0	28	28	5	0
Below Normal (BN)	50	0	0	25	22	3	0
Dry (D)	44	0	0	25	16	2	1
Critical (C)	32	0	0	21	11	1	-1

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