Merced River 2022 Dry Conditions Analysis

PREPARED BY:

State Water Resources Control Board, Division of Water Rights

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CALIFORNIA
Water Boards

Introduction

In 2022, the Merced River went dry from early June through early October, approximately five miles upstream of where it joins the San Joaquin River (river mile 5), see Figures 1, 2, and 3. The State Water Resources Control Board (State Water Board) analyzed Merced River flows and diversions during the summer of 2022 to gain a better understanding of the factors that contributed to dry river conditions. This analysis, covering 62 miles of the river for July, August, and September 2022, concludes that diversions reported by water rights on the Merced River were sufficient to cause the river drying event. Existing water rights allocate all the available flow on the Merced River during dry hydrologic conditions. Additional protections are necessary for flows to be maintained in similarly dry conditions. In water year 2022, the Merced River and the watershed surrounding the Sacramento-San Joaquin Delta and San Francisco Bay (Bay-Delta watershed) were in the third consecutive year of extreme drought. An emergency drought regulation was in effect for the entire Bay-Delta watershed, including the Merced River, with associated water right curtailments (reduced diversions) and additional water diversion reporting requirements.



Figure 1. Merced River Dry River Channel at Hatfield Recreation Park, River Mile 1. Photographs courtesy of CDFW. Flows measured at nearest gage, Stevinson, at river mile 4.5 (gage code MST).

In the summer and fall of 2022, the State Water Board received a complaint from a local landowner and letters from the National Marine Fisheries Service (NMFS), California Department of Fish and Wildlife (CDFW), Merced Irrigation District, and other parties

identifying concerns about dry river channel conditions on the Merced River in 2022, and prior years, and the negative impacts of dry river conditions on fish and wildlife and water right diverters that depend on maintaining flow in the Merced River.[1] Several letters describe concerns that the dry river conditions were caused by "unlawful" or "improper" diversions that lack a valid basis of right or water right documentation, diversions that may use water in an unreasonable manner, or a combination of these factors.[2] Many letters included requests the State Water Board investigate the reasons flow was eliminated from the river and take necessary actions to prevent the river from drying again in the future including adoption of an instream flow requirement on the Merced River near the confluence with the San Joaquin River.

In response to these concerns and requests, the State Water Board Division of Water Rights (Division) completed this analysis of Merced River flows and diversions to evaluate and document the known factors that did or may have contributed to the drying of the Merced River and to inform options for preventing dry river conditions in the future.[3] The State Water Board continues to receive letters about Merced River flow management, concerns about future drying of the river, and efforts to maintain flows.[4]

This analysis evaluates flows and diversions on 62 miles of the Merced River from New Exchequer Dam (inclusive of Lake McClure) downstream to the confluence with the San Joaquin River, see Figure 2. The analysis divided the river into ten reaches defined by an upstream and downstream flow gage. All flow data are publicly available on the California Data Exchange Center (CDEC), United States Geological Survey (USGS), and California Water Data Library (WDL) websites.

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[1] Complaint Report redacted (July 28, 2022); NMFS (October 27, 2022; March 1, 2023); CDFW (November 22, 2022); Merced Irrigation District (December 5, 2022; August, 9 2023; June 6, 2024); The Nature Conservancy (November 16, 2023); Friends of the River (January 8, 2024); San Francisco Bay Keeper (June 27, 2024).

[2] CDFW completed a case study on the Merced River that documented dry river conditions in 2016 and 2022.

[3] State Water Board (January 16, 2024; May 27, 2026). Available at https://www.waterboards.ca.gov/waterrights/water_issues/programs/bay_delta/merced/index.html.

[4] Merced Irrigation District (January 8, 2026); Friends of the River (February 24, 2026); Merced Irrigation District (July 6, 2026).

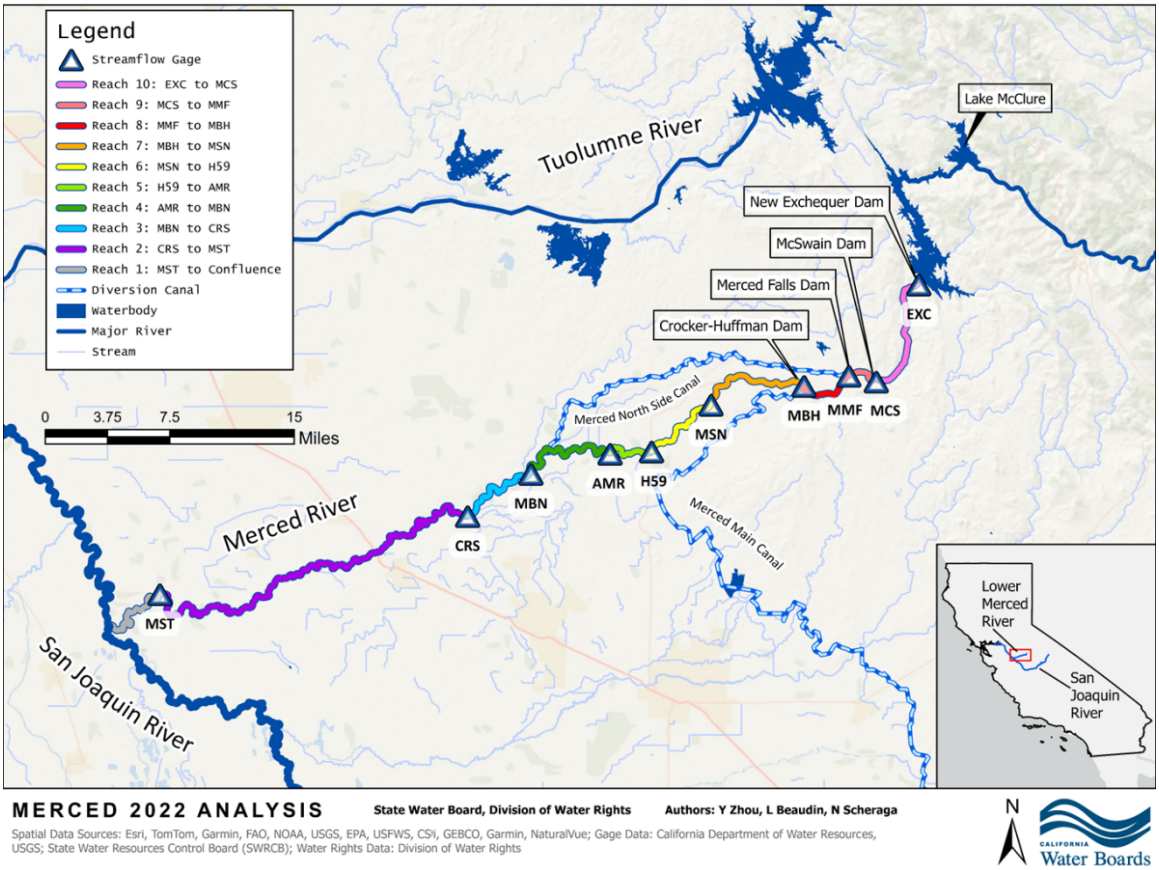


Figure 2. Merced River Location Map and River Reaches

Although the Merced River was dry for portions of June and October, this analysis of flows and diversions evaluated the months of July through September because diversion data are limited to a monthly volume and the river was dry for all days of these months allowing for a direct comparison between monthly diversion volume and monthly flow volume. The gage on the Merced River nearest the confluence with the San Joaquin River, the Stevinson gage (CDEC gage code MST), is approximately 5 miles upstream of the San Joaquin River confluence. This gage is the location of dry conditions[5] in the river that occurred from early June through early October, see Figure 3. The data at New Exchequer Dam (CDEC gage code EXC) provides the outflow from Lake McClure and serves as the upstream boundary of the 62-mile analysis, see Figures 2 and 3. Outflow from Lake McClure is assumed to provide the only inflow to this 62-mile reach of the Merced River in this analysis.

[5] The Stevinson gage recorded a few days with extremely low flows, but most days recorded zero flows.

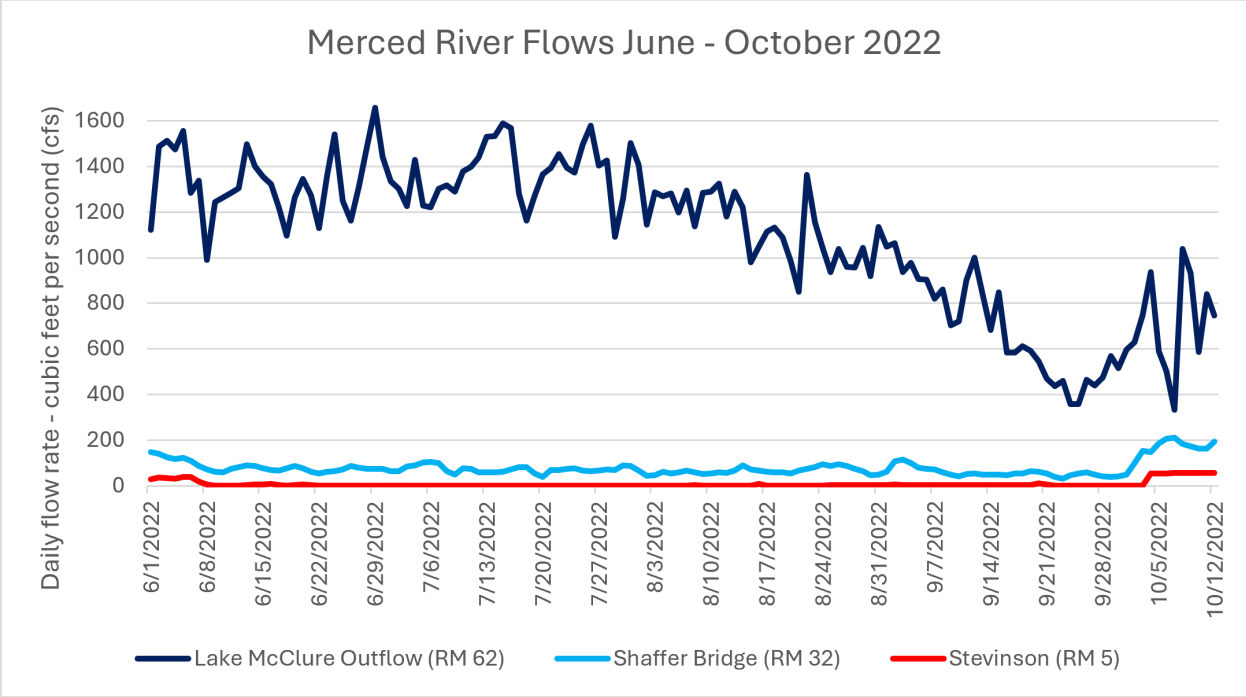


Figure 3 Merced River Flows June – October 2022.

Diversions were evaluated from 110 water rights with 122 points of diversion (PODs) on the 62-mile reach of the Merced River. The water right types in the analysis include 22 post-1914 appropriative licenses, 1 pre-1914 (only) appropriative claim, 41 riparian (only) claims, 36 overlapping pre-1914 and riparian claims, and 10 water right identification numbers (WRID) with inactive status that did not submit diversion reports.[6] Emergency water right curtailments were in effect for Merced River diversions with a priority date of 1859 during July, August, and September 2022. Curtailments were issued to all 22 post-1914 appropriative WRIDs, 1 pre-1914 (only) WRID, and 2 WRIDs with overlapping claims of right. Forty-two WRIDs reported diversion in at least one month from July, August, and September 2022. Curtailments did not apply to riparian diverters in the Merced River watershed (including WRIDs with overlapping claims of right) and did not apply to diversions of previously stored water. Even with curtailments in place, the river went dry approximately five miles upstream of the confluence with the San Joaquin River.

[6] In water year 2022, 18 claims with inactive status submitted annual reports of diversion and use (3 reported diverting water, 15 reported zero diversion) and 10 inactive claims did not submit annual reports.

Information about diversion structures in the Merced River that lack water right documentation on file with the State Water Board[7] was submitted to the State Water Board in response to dry river conditions in 2016 and 2022. Some of this information was initially developed by CDFW and continues to be further developed by Merced Irrigation District and the Lower Merced River Coalition (LMRC).[8] In 2024 and 2025, Division staff conducted a survey of the Merced River with CDFW and identified landowners with potentially unauthorized diversions in the Merced River. Most undocumented diversion structures were generally located on the Merced River between the Stevinson (MST) and Cressey (CRS) flow gages. Unreported diversions that may have occurred at these undocumented diversion structures or other locations from July through September 2022 are not directly included in this analysis because there wasn't any report or documentation of their diversion volumes. However, the potential role of unreported diversions in the drying of the Merced River is addressed in the context of the water balance developed from available flow and diversion information in summer 2022.

Data

The water balance relies upon three types of data: 1) gaged river flows, reservoir storage, and reservoir outflow; 2) reported water diversions, water right information, and curtailment status; and 3) evaporation data. The full set of data used in this analysis is included as a supplemental spreadsheet available on the Board's website.

Flow and Reservoir Data

Gaged river flows and reservoir data used in the analysis are from the following sources: CDEC, WDL, USGS, and annual reports of diversion and use submitted to the State Water Board. Reservoir outflow data are from CDEC and USGS. Reservoir storage data are from CDEC, and time series data files submitted to the State Water Board in annual reports of water diversion and use (annual reports). Data from multiple sources were reviewed to determine the most reliable source of data. Although these different data repositories may rely upon the same set of raw gaged flow data, different quality control and sampling times can have a large effect on the reported flow data.

River flow gage, reservoir outflow, and storage data are reported in 15-minute, hourly, and daily time steps, depending on the gage. The best available data has been used to determine daily flows which are then aggregated to determine monthly flows to allow a

[7] Water right information is contained in the State Water Board's electronic Water Right Information Management System (eWRIMS) and its successor the California Water Accounting, Tracking, and Reporting System (CalWATRS). eWRIMS and all associated data systems were replaced by CalWATRS in summer 2025. https://ciwqs.waterboards.ca.gov/ciwqs/ewrims/EWMenuPublic.jsp

[8] Letter to State Water Board from Merced Irrigation District June 5, 2024.

comparison to monthly diversion data. Reservoir outflow data provides the only source of inflow data to the Merced River downstream of New Exchequer dam used in the water balance.

Water Right Diversion Data and Curtailment Status

Water rights with the potential to divert Merced River flows directly from the river channel at or below New Exchequer Dam to the confluence with the San Joaquin River were evaluated in this analysis. Water rights are identified by their WRID. Each water right in the analysis has at least one POD which is the location at which water diversion occurs. PODs located on the Merced River and their associated WRIDs were identified using geographic data from eWRIMS[9] (successor system is CalWATRS) which found 122 PODs and 110 WRIDs on the Merced River at or downstream of New Exchequer Dam to the confluence with the San Joaquin River, Table 1. The number of PODs is greater than WRIDs because WRIDs can have multiple PODs.[10]

Diversion data associated with the 110 WRIDs in the analysis were extracted from eWRIMS. Currently, all water right diverters are required to submit annual reports to the State Water Board. For water year 2022, annual reports were submitted through the eWRIMS Report Management System (RMS). The annual reports are mandatory filings that document water diversions and use for each month of the previous water year, including monthly direct diversion volumes, monthly diversion to storage volumes, and monthly water use volumes.[11] Reported diversions that removed water from the Merced River for consumptive purposes like agriculture or municipal supply were included in the analysis as diversions. Reported diversions for non-consumptive uses, such as hydropower, were not included in the analysis because these diversions did not remove water from the Merced River.

This analysis did not assess the validity of riparian and pre-1914 claims of right or verify that diversions were made within the authorized parameters of their individual rights or claims. Similarly, this analysis did not comprehensively assess reported diversion data for accuracy and assumed most diversion data in annual reports were accurate. For WRIDs with multiple PODs, shared PODs, storage, or hydropower facilities, information from annual reports was used in combination with data files from measurement devices to quantify diversions that removed water from the river.

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[9] The eWRIMS database is available at: https://ciwqs.waterboards.ca.gov/ciwqs/ewrims/EWMenuPublic.jsp

[10] Eight WRIDs have multiple PODs in the analysis. WRID (number of PODs): A016895 (2), A016187 (2), A016186 (4), A010572 (2), A003664(2), A001885 (3), A001224 (3), and A001221 (2). These eight WRIDs have a total of 20 PODs.

[11] CCR, Title 23, Division 3, Chapter 2.7 Water Diversion and Use Reports https://govt.westlaw.com/calregs/Browse/Home/California/CaliforniaCodeofRegulations?guid=IC5C959055B6E11EC9451000D3A7C4BC3&originationContext=documenttoc&transitionType=Default&contextData=(sc.Default)

Information describing curtailment status for the WRIDs in the analysis was paired with reported diversion data in the supplemental spreadsheet and summarized in Table 2. Curtailment information for the 2021-2023 drought in which emergency curtailment regulations were in place is available on the State Board's website.[12] For this analysis the period of July through September of 2022 was extracted which can be seen on the Diversion and Curtailment Status tabs in the supplemental spreadsheet.

Curtailments were issued to post-1914 appropriative water right holders and pre-1914 appropriative water right holders (including WRIDs with overlapping claims of right) in the summer months of 2022 due to critically dry conditions and pursuant to the emergency drought regulation. Drought curtailments were based on Water Unavailability (WUA) methodology.[13] The majority (over 95 percent) of the Statements of Diversion and Use included in the WUA methodology were categorized as either Riparian, Pre-1914, or "Riparian or Pre-1914." For the purposes of assigning priority within the WUA Methodology, those water right claims categorized as "Riparian or Pre-1914" were assumed to have the more senior priority of right (i.e., Riparian). Table 1 shows that the majority of WRIDs in this Merced River analysis are riparian or pre-1914 claims and were not curtailed.

Curtailments applied to 25 of the 110 WRIDs in the analysis including 22 post-1914 licenses, 1 WRID that claims pre-1914 (only) classification, and 2 WRIDs that claim both pre-1914 and riparian classification, see Table 1. Curtailments did not apply to re-diversion or use of previously stored water by water right holders including re-diversions of previously stored water by diverters under agreement with Merced Irrigation District (contractors) and transfers of previously stored water. Exceptions to curtailment for non-consumptive uses (e.g., direct diversion for run of the river power generation, diversions that do not change the volume or timing of flows) and public health and safety (e.g., minimum water supplies for human uses) were in effect for some curtailed rights on the Merced River during the summer months of 2022. Riparian and inactive claims in the lower Merced watershed did not receive curtailment orders during this time.

[12] Curtailment data pursuant to 2021-2023 Delta Drought Curtailment Regulations: https://www.waterboards.ca.gov/drought/delta/#tableau

[13] Summary Report for Water Unavailability Methodology for the Delta Watershed (updated January 19, 2023) and the spreadsheet, which are available at https://www.waterboards.ca.gov/drought/drought_tools_methods/delta_method.html.

Table 1. Count of Water Right Types and July-September Curtailment Status[14]

WRID Type	WRID Count	Curtailed Count
Post-1914 appropriative licenses[15]	22	22
Pre-1914 (only) claims	1	1
Riparian (only) claims	41	0
Overlapping claims of right	36	2
Inactive claims & no 2022 annual report	10	0
Total	**110**	**25**

There are 22 post-1914 appropriative licenses in this analysis, see Table 1. Appropriative water right permits and licenses issued after December 19, 1914, (the effective date of the Water Commission Act of 1914, which established the water right permitting system) are referred to as post-1914 appropriative water rights. The use of water under appropriative water rights is not limited to riparian land, and appropriators are allowed to use so-called "foreign water," which is water that would not be present under natural conditions, provided that the water is abandoned by the water right holder who caused the water to be present in the stream system. Examples of river flow that would not be present under natural conditions include, but are not limited to, reservoir releases of stored water during dry season months and imports of water from other river systems.

Pre-1914 (only) claims in Table 1 are WRIDs that were identified as pre-1914 in the WUA methodology with a priority date and pre-1914 was identified as the only basis for water use in the "water is used under" form field of the 2022 annual report (first row in the annual report) for that WRID. A pre-1914 water right is an appropriative water right that was initiated before December 19, 1914. Pre-1914 water rights do not need a permit from the State Water Board, provided that water diversion and use under the right has not increased since December 19, 1914, or any increase in use is consistent with a plan of development established prior to December 19, 1914. Pre-1914 water rights are a type of appropriative right, and therefore holders of pre-1914 rights are allowed to use natural river flow and river flow that would not be present under natural conditions (if it is abandoned) and water can be used on riparian and non-riparian land. There is one pre-1914 (only) claim in this analysis, see Table 1.

Riparian (only) claims in Table 1 are WRIDs that are classified as riparian in the WUA methodology and in the 2022 annual report for that WRID as the basis for use of water.

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[14] The Diversions tab in the supplemental spreadsheet includes summary tables with counts of each type of WRID, starting at row 153.

[15] The count of unique WRIDs for appropriative licenses removes 12 duplicate WRIDs that occur due to 8 WRIDs having 20 PODs, as shown in column A (rows 3 – 124) and summary count tables starting at row 153.

A riparian water right is a right to use the natural flow of water on riparian land. Riparian land is land that touches a lake, river, stream, or creek. Riparian rights are not lost through non-use. There are 41 riparian (only) WRIDs in this analysis, see Table 1. Three WRIDs identified as riparian (only) did not submit annual reports in 2022 and additional references were checked to confirm the basis of right is riparian (only). Some riparian (only) claims are also identified as inactive in eWRIMs but were identified as riparian and included in the WUA methodology because annual reports continue to be submitted for these WRIDs.

WRIDs that list pre-1914 and riparian in their documentation on file with the State Water Board are referred to as having overlapping claims of right. Overlapping claims of right in Table 1 are WRIDs that were identified as: 1) pre-1914 and riparian in the 2022 annual report for that WRID and 2) WRIDs that were identified as riparian in the WUA methodology for curtailment purpose but were identified as pre-1914 in the water use field in the 2022 annual report for that WRID. One WRID included in the list of overlapping claims of right was identified as riparian in the 2022 annual report, but the WUA methodology did not identify the WRID as riparian or provide a priority date. For purposes of this analysis, references to the Cowell Agreement or court decrees in the water use field on annual reports were interpreted as a pre-1914 claim of right under which water was used.[16] Some overlapping claims are also identified as inactive in eWRIMs but were included in the WUA methodology because annual reports continue to be submitted for these WRIDs. There are 36 overlapping claims of right in this analysis, see Table 1.

Finally, there are 10 WRIDs in the analysis that are identified as inactive in eWRIMS and did not submit annual reports in water year 2022, see Table 1. These 10 WRIDs also appear to have not been included in the WUA methodology because of their inactive status.

Evaporation Data

Daily evaporation data from two California Irrigation Management Information System (CIMIS) sites was used and augmented by monthly evaporation data reported at a CDEC river flow gage location. All daily evaporation data was summed to monthly data to use in the water balance. Reported water diversions and evaporation are the only losses accounted for in this water balance.

Methods

The water balance is comprised of three parts: 1) a simple water balance of the entire 62-mile reach of the Merced River from New Exchequer Dam to the confluence with the San Joaquin River; 2) a water balance of ten stream reaches, from New Exchequer

[16] This assumption was made because Cowell Agreement diverters may take stored water at times and natural flows at other times.

Dam to the confluence with the San Joaquin River (see Table 2); and 3) Lake McClure and McSwain Reservoir water balances. Each part of the analysis considers accretions (gains or additions of water) as positive numbers, and depletions (losses or removals of water) as negative numbers. The only accretions considered are increases in gaged river flows from an upstream gage to a downstream gage. The only depletions considered are reported diversions and evaporation.

All 15-minute and hourly raw data was summed to daily data, and daily data was summed to monthly data. Water balances used a monthly time step and did not account for travel times between reaches.[17] On a monthly time-step, travel times of one to three days is assumed to have little effect on the water balance.

The simple water balance of the entire 62-mile reach of the Merced River from New Exchequer Dam to the confluence with the San Joaquin River is based on monthly inflows to Lake McClure, outflow from Lake McClure at New Exchequer Dam, the observation of zero flows in the Merced River near the San Joaquin River confluence, the sum of monthly reported diversions along the Merced River from Lake McClure to the San Joaquin River confluence, and the sum of monthly evaporation from the Merced River from Lake McClure to the San Joaquin River confluence. Outflow from Lake McClure at New Exchequer Dam is the upstream node or source of total flow to the Merced River from July through September in this analysis. There are no known or recorded substantive inflows to the river downstream of New Exchequer Dam and upstream of the San Joaquin River confluence during the period of the analysis. Outflow from Lake McClure and zero (or near zero) river flows at the Stevinson gage establish that all the flow is lost (depleted) from the river channel between New Exchequer Dam and the Stevinson Gage near the San Joaquin River confluence.

The water balance of ten stream reaches, from New Exchequer Dam to the confluence of the San Joaquin River, is similar to the simple water balance for the entire 62-mile reach, except that the known depletions (evaporation and diversions) are discretized for each reach as shown in Table 2, and net accretions (flow gains) or depletions (flow losses) for each reach are determined by subtracting the gaged flow at each downstream node from the gaged flow at the upstream node.

[17] For flow velocities of two to five feet per second, travel times from Lake McClure to the San Joaquin River confluence would take up to two, to a little less than, one day.

Table 2. Merced River Reaches

Reach	Data Source	Upstream Name	Upstream Node	Downstream Node	Reach Length (miles)	POD Count	River Mile (miles from confluence)
10	CDEC *1	New Exchequer	EXC	MCS	6	10	62
9	calculated *2	McSwain	MCS	MMF	1	7	56
8	USGS / CDEC *3	Merced Falls	MMF	MBH	3	4	55
7	CDEC	Crocker Huffman	MBH	MSN	6	12	52
6	WDL	Snelling	MSN	H59	4	5	46
5	CDEC	Highway 59	H59	AMR	3	4	42
4	CDEC	Amsterdam Road	AMR	MBN	7	8	39
3	CDEC	Shaffer Bridge	MBN	CRS	5	11	32
2	WDL	Cressy	CRS	MST	22	53	27
1	CDEC	Stevinson	MST	San Joaquin River confluence	5	8	5

*1 Outflow from Lake McClure
*2 Storage data is reported but flow is not; McSwain outflow is calculated using Lake McClure outflow, McSwain evaporation, and changes in McSwain storage
*3 Both CDEC and USGS gage informantion is considered

For example, if the monthly flow for July at the upstream end of Reach 7, below Crocker Huffman Dam (MBH), is 11,785 acre-feet, and the flow at the downstream end of Reach 7 at Snelling (MSN) is 7,557 acre-feet, then the change in flow for Reach 7 is -4,228 acre-feet, (a decrease of 4,228 acre-feet). This is a calculated depletion, or loss of water that occurs within the river reach between upstream and downstream points. As shown in the results section of this analysis, there is sometimes a calculated increase (gain) in flow from an upstream point to a downstream point, resulting in a calculated accretion for that river reach. The discrepancy between calculated changes in flow that are accretions and depletions and the known depletions (diversions) in the river reaches resulted in additional review of gage accuracy and rating curves that are included on gage data worksheets in the supplemental spreadsheet.

Evaporation is calculated by multiplying water surface area by pan evaporation (ET). Pan ET is a measure of the quantity of water that evaporates from a pan of water, measured in inches per day. Although the amount of water lost via evaporation is relatively small, it can still be significant for bodies of water with a large surface area

such as Lake McClure and Lake McSwain, which each have known surface areas. The surface areas for river reaches assume a 50-foot width multiplied by the length of each reach.

The Lake McClure and Lake McSwain water balances use reported inflows, outflows, and changes in storage at Lake McClure, along with reported evaporation data from Lake McClure and Lake McSwain to confirm and, if necessary, adjust inflows to, or outflows from, Lake McClure Reservoir. This part of the analysis is also used to account for non-trivial evaporative losses of water between Lake McClure outflow and Lake McSwain outflow.

Results

Simple Water Balance from New Exchequer Dam to San Joaquin River Confluence

Table 3 shows the monthly flows, reported diversions, and calculated evaporation for July through September 2022. Although a relatively small component of the water balance in downstream river reaches, evaporation is included because it has a large effect on the water balance for Lake McClure and Lake McSwain, as discussed below.

Table 3. 2022 Merced River Flows, Diversions, and Evaporation in acre-feet

Month	Flow	Diversions	Evaporation	Sum of Depletions
July	84,352	83,989	296	84,285
August	70,129	69,955	351	70,306
September	41,017	40,063	301	40,363
Sum	**195,498**	**194,006**	**948**	**194,954**

Figure 4 visually illustrates that reported diversions plus evaporation are approximately equal to the flows released from Lake McClure in each month of the analysis.

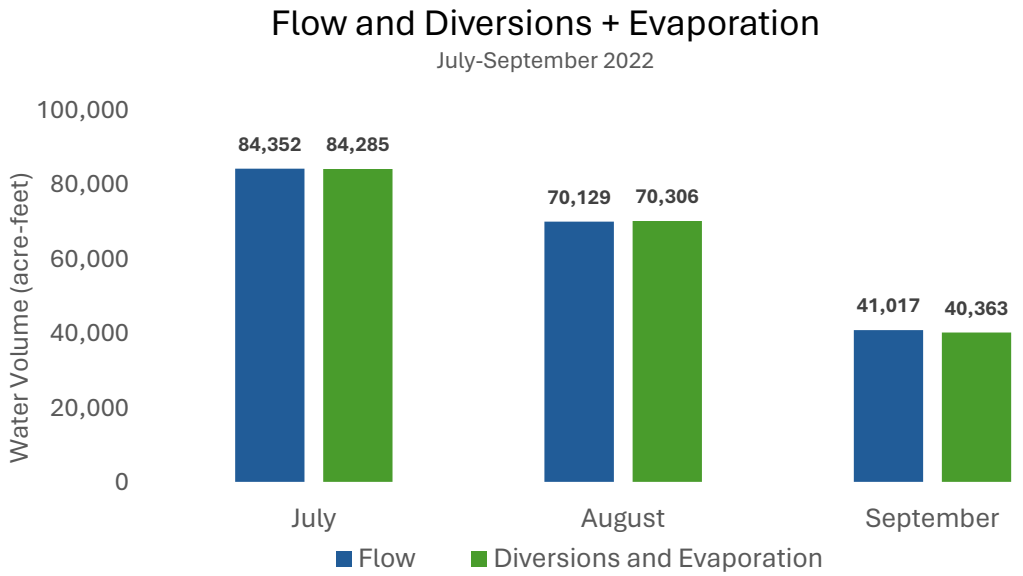


Figure 4. 2022 Merced River Flows and Diversions Plus Evaporation

Table 4 shows monthly flows and monthly diversions plus evaporation, and the difference between monthly flows and diversions plus evaporation which is referred to as missing accretions (or depletions). When the monthly flow volume (blue bar) is greater than monthly volume of diversion plus evaporation (green bar), there is a missing volume of depletion or loss of river flow (negative value). When the monthly flow volume (blue bar) is less than the monthly volume of diversion plus evaporation (green bar), there is a missing accretion or gain of river flow (positive value). Table 4 shows the missing monthly accretions or depletions as a volume and as a percentage of the monthly flow. This simple water balance shows that the sum of diversions and evaporation accounts for nearly all, or a little bit more than, the gaged inflow to the Merced River in each month, and that the missing accretion or depletion is a small fraction of the flow -- no greater than 1.6 percent.

Table 4. 2022 Merced River Flows, Depletions, and Missing Accretions and Depletions

Month	Flows (acre-feet)	Sum of Diversions and Evaporation (acre-feet)	Missing Accretions / (Depletions) (acre-feet)	Missing Percent of Flow
July	84,352	84,285	(67)	-0.1%
August	70,129	70,306	177	0.3%
September	41,017	40,363	(653)	-1.6%
Sum	**195,498**	**194,954**	**(543)**	**-0.3%**

Although the sum of diversions and evaporation are roughly equal to inflows over the entire length of the Merced River in this analysis, Figure 5 shows that flow losses do not occur evenly over the entire 62 miles of the river. Consistent with Table 4, the flow from Lake McClure at New Exchequer Dam (EXC) in July 2022 was 84,285 acre-feet, and Merced River flows became successively lower downstream, until it was near zero at the Stevinson gage (MST), five miles upstream of the San Joaquin River confluence. Although the flows decreased in August and September (see Table 4), the same flow pattern observed in Figure 5 is also observed in August and September.

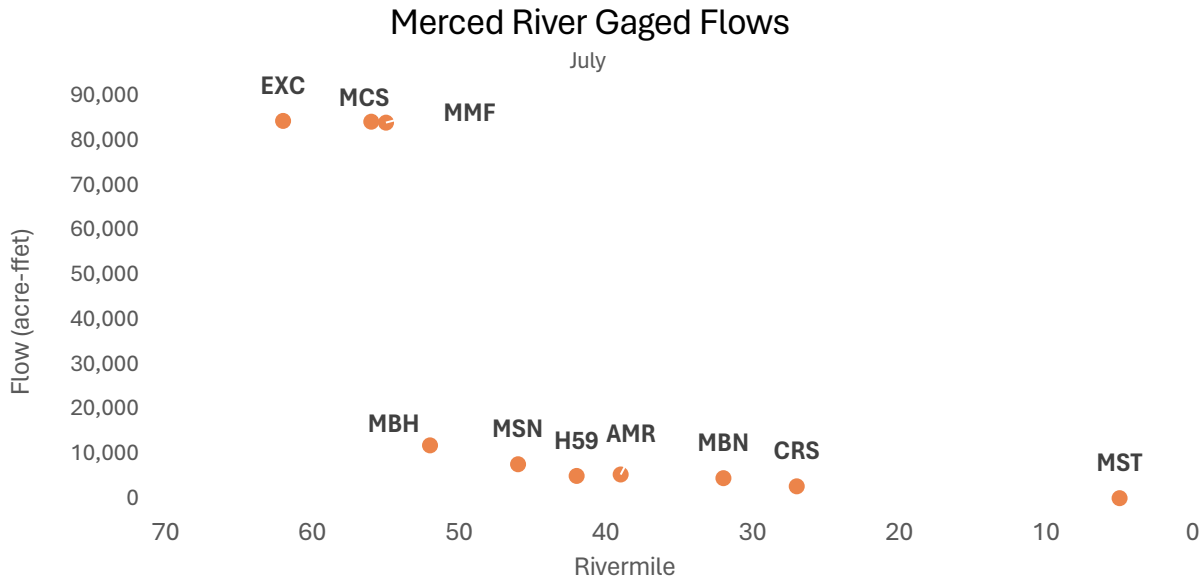


Figure 5. Merced River July 2022 Gaged Flows, in acre-feet

A large decrease in gaged flows is apparent in Figure 5 between Merced Falls (MMF) and below Crocker-Huffman Dam (MBH). This big decrease occurred because most of the river flows are diverted into Main Canal, owned by Merced Irrigation District, just upstream of Crocker-Huffman Dam (MBH). The reach-by-reach water balance in the following section explores the changes in flow by reach, compared to the reported diversions and evaporation in each reach.

Water Balance of Ten Stream Reaches - New Exchequer Dam to the San Joaquin River

Figure 6 shows the 3-month sum of flow volume in each of ten river reaches (defined in Figure 3 and Table 2) from New Exchequer Dam to the San Joaquin River confluence. Figure 6 shows that flows are highest in Reaches 8, 9, and 10, at approximately 200,000 acre-feet and drop by 85 percent in Reach 7 to approximately 29,000 acre-feet. Flows generally decrease downstream of Reach 8 to the confluence in Reach 1.

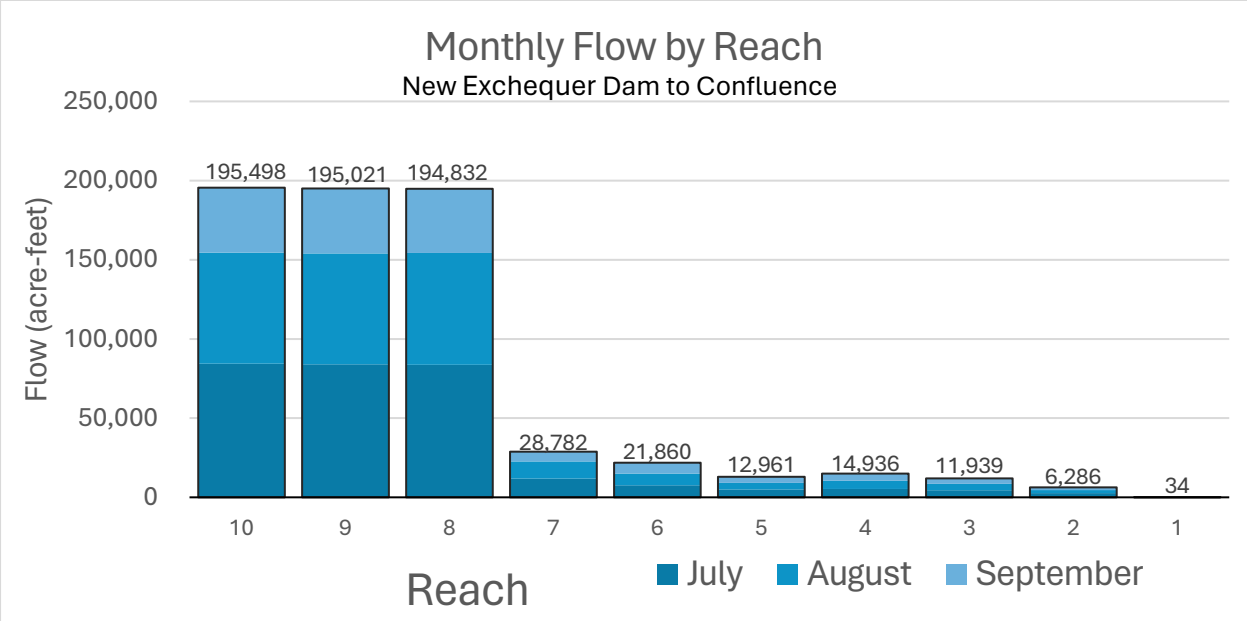


Figure 6. 2022 July – September Monthly Flow Volume by Reach, New Exchequer Dam to San Joaquin River Confluence

Figure 7 shows the 3-month calculated change in reported flow volume between the upstream and downstream flow gages that define each reach. In most cases, there is a decrease in reported flow from upstream to downstream, indicated by a negative number (in red parentheses), and bars below the zero y-axis. In Reach 5, however, there is an increase in reported flow from upstream to downstream, where the 3-month difference in flow is an increase of 1,975 acre-feet.

Figure 8 shows the sum of evaporation and reported diversion by reach. Evaporation is a small portion of flow losses in the river water balance (see Table 3), but it is the only source of flow loss in Reach 10 due to evaporative losses at McSwain Reservoir and zero reported diversions in that reach. It is noteworthy, however, that although zero diversions to storage are reported at Lake McSwain in Reach 10, an amount equal to the water lost to evaporation in this reach is needed to maintain the same level of storage, see the section describing the Lake McClure and Lake McSwain water balance for an expanded discussion.

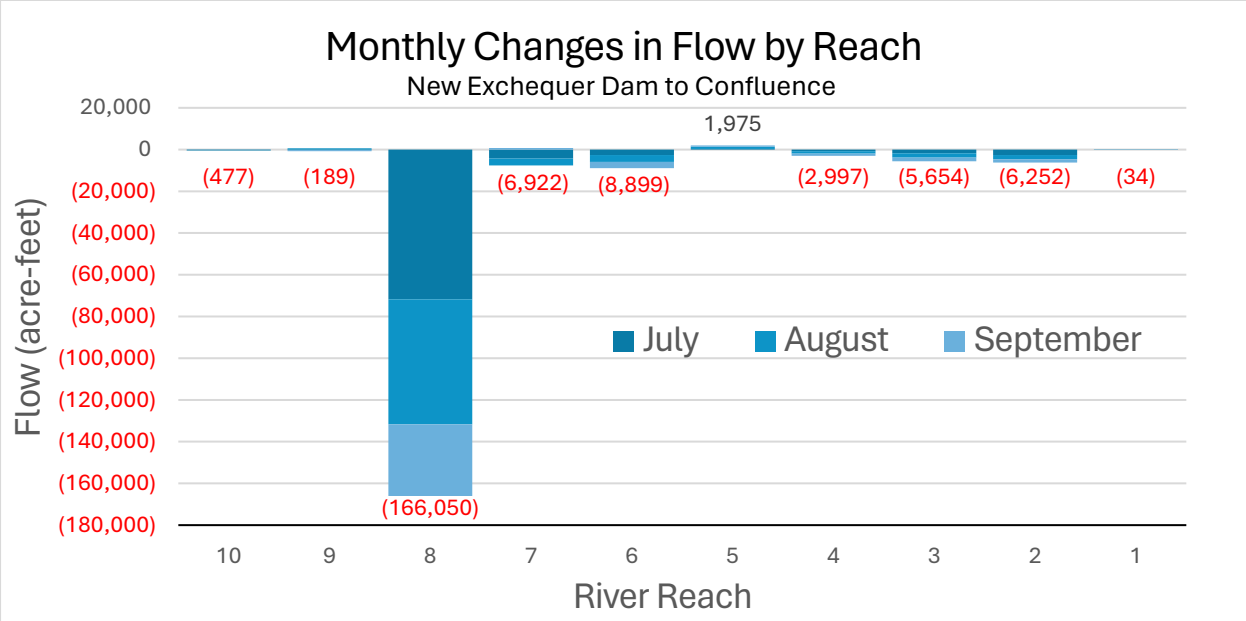


Figure 7. 2022 July – September Monthly Changes in Merced River Flow Volume by Reach, New Exchequer Dam to the San Joaquin River Confluence

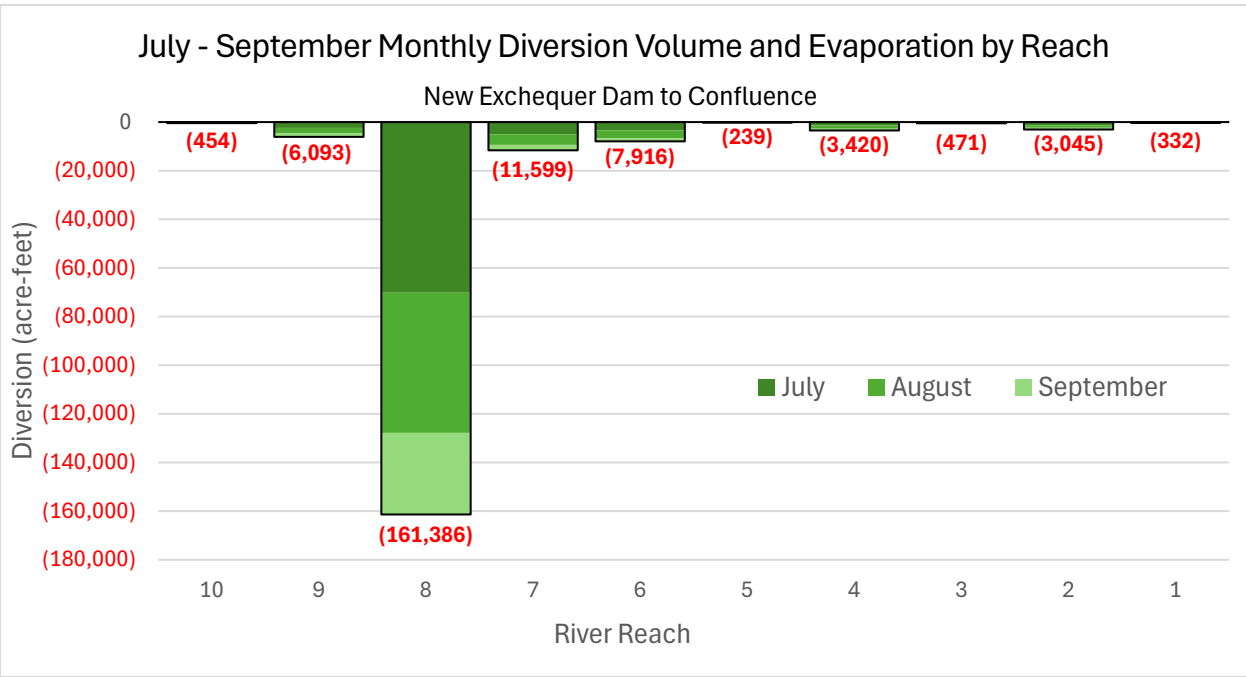


Figure 8. 2022 Monthly Sum of Diversions and Evaporation by Reach, New Exchequer Dam to San Joaquin River Confluence

Forty-two of the 110 WRIDs (38 percent) in the analysis reported diversion from July through September 2022. The largest diversions are reported by two WRIDs (A001224 and S004718) with PODs in Reaches 9 and 8 at Northside Canal and Main Canal,

respectively (A001224 reported diversion at Northside and Main Canal). These two WRIDs diverted 85 percent (167,443 acre-feet) of the total July through September diversion volume of 194,006 acre-feet.[18] Downstream of Reach 8, 40 WRIDs diverted 15 percent (26,563 acre-feet) of the total July through September diversion volume.[19] The remaining WRIDs in the analysis (68) reported 0 diversion, were inactive, or did not submit annual reports of diversion and use (see Diversions tab in supplemental spreadsheet).

The calculated change in flows between reaches is compared to the sum of diversions and evaporation in Figure 9 for the month of July. Consistent with the simple water balance for the 62-mile river reach, it was assumed that there were no other sources of flow, the flow gages were recording accurate flow metrics, and there were no other depletions other than evaporation and diversions. Based on these assumptions and the close match between flows and diversions plus evaporation in the simple water balance, the changes in flow in each reach should be the same as the sum of diversions and evaporation in each reach. Inspection of Figure 9, however, shows that this is not the case; flow changes are not equal to diversions plus evaporation (the green and blue bars are not equal) in each reach.

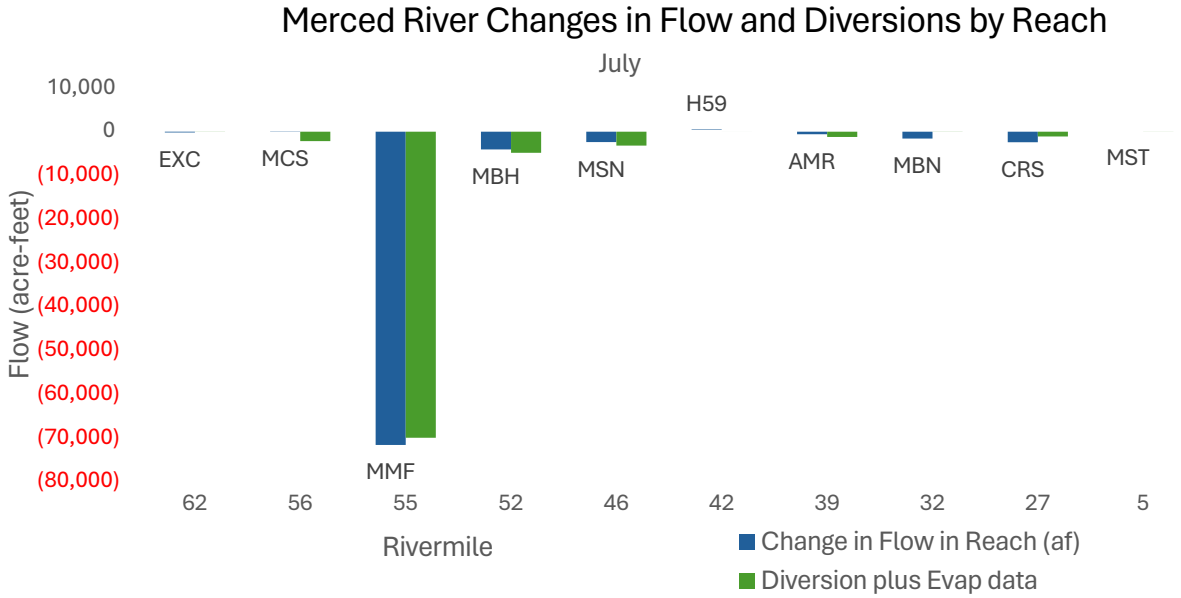


Figure 9. Changes in Flow and Sum of Diversions and Evaporation in each Reach of the Merced River in July 2022

[18] Refer to "Summary" tab in the supplemental spreadsheet for calculation of monthly diversions in each reach without evaporative losses.
[19] Refer to "Diversions" tab in the supplemental spreadsheet for diversion volumes associated with WRIDs.

Figure 10 shows the same information as shown in Figure 9 for only the seven river reaches downstream of Reach 8 from MBH to MST to allow better scaling and view of difference between green and blue bars.

The differences between calculated changes in flow (blue bars) and reported diversions plus evaporation (green bars) can be shown as missing accretions or depletions. It is a missing accretion if the change in flow (blue bar) in a reach is less than (shorter than) the reported diversion plus evaporation as shown on Figure 10. Conversely, it is a missing depletion if the change in flow (blue bar) in a reach is more than (taller than) the reported diversion plus evaporation (green bar) as shown on Figure 10.

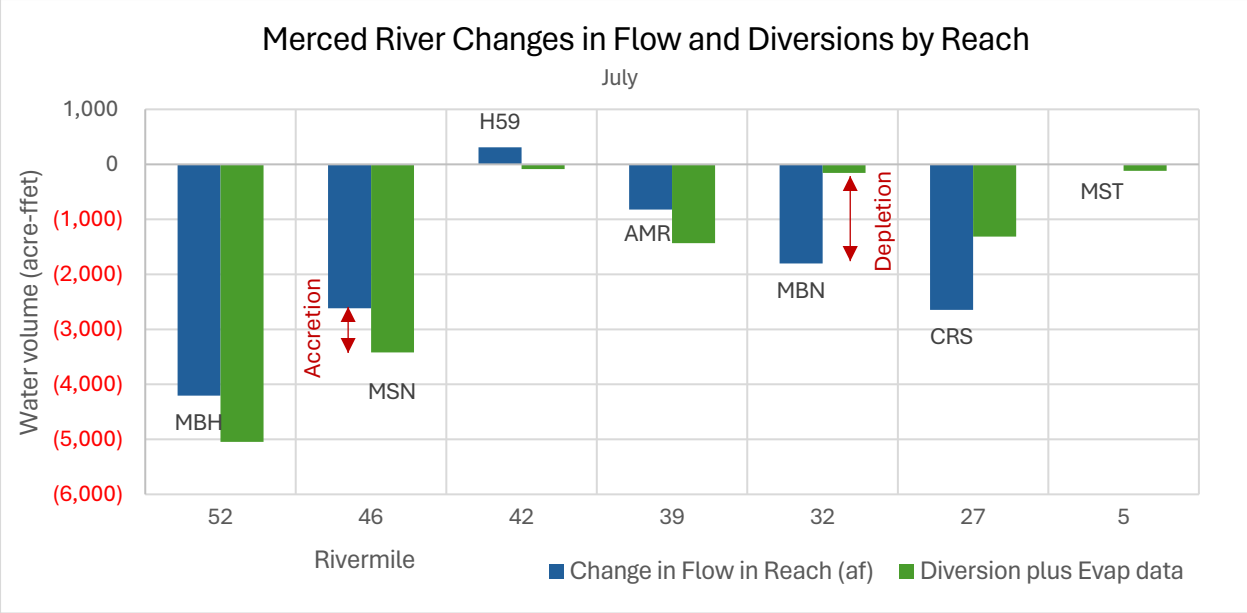


Figure 10. Changes in Flow and Sum of Diversions and Evaporation downstream of MBH in July 2022

The differences between changes of flow between gages (blue bars) and the sum of diversions and evaporation (green bars) in each reach are attributable to a combination of unaccounted for accretions and depletions and errors in all the data sources (flows, diversions, and evaporation).

Figure 11 shows the difference between flow loss (blue bars in Figure 9) and diversion (green bars in Figure 9) in each of the ten river reaches from New Exchequer to the San Joaquin River confluence. Consistent with Figure 10, the positive differences are labeled “accretions,” and the negative differences are labeled “depletions” for convenience. Assigning the labels “accretion” or “depletion” assumes that both the gaged flows, and therefore the difference between upstream and downstream flows, and reported diversions and evaporation are all accurate. This is not likely the case, as both reported flow and diversion data may include erroneous data attributable to various measurement and estimation flaws and errors.

For example, the USGS assigns different accuracy ratings for measured flows (stage & rating curve) ranging from 2 to 5 percent for excellent and good gages, and up to 8 and more than 8 percent for fair and poor gages.[20] Inspection of Merced River rating curves for the seven low flow gages in the analysis (downstream of Merced Falls, MMF) shows that error can equal or exceed 50 to 100 percent of the reported flow (see supplemental spreadsheet flow gage tabs) due to small changes in the flow versus stage relationship. Flows calculated for wide shallow channels are prone to significant errors because small changes in stage height can have a very large effect on calculated flows. Application of just five percent error margins to the three higher flow upstream gages (EXC, MCS, and MMF), and 50 percent to the remaining gages would fully account for the apparent unaccounted-for depletions and accretions shown in Figure 11. It is notable that if the actual flows at Merced Falls were approximately 5,000 acre-feet lower than July through September reported flows (an average of 27 cfs per day), the apparent unaccounted-for accretions and depletions in reaches 9 and 8 would be close to zero.

The diversion data used in this analysis are also subject to errors attributable to unreported diversions including any WRIDs that did not submit reports of diversion and use and diversions that are not registered in eWRIMS, misreported diversions including under or overestimated volumes in diversion reports, or a combination of these errors.

The reach-specific accretions and depletions shown in Figure 11 are therefore considered an artifact of errors in flow and diversion data, even though some actual flow gain or loss could also have occurred within each reach. More accurate flow and diversion data would be required in a reach-by-reach analysis to distinguish actual accretions (gains) or depletions (losses) of flow in the river from measurement and estimation error.[21] And for use in near real-time, accurate diversion data would need to be available within days instead of once per year in annual reports of diversion and use.

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[20] USGS (1992) Determination of Error in Individual Discharge Measurements, Open File Report 92-144, 1992. Available at https://pubs.usgs.gov/of/1992/ofr92-144/pdf/ofr92-144.pdf

[21] For example, higher quality data are from gages with established maintenance protocols that are implemented reliably on a regular time interval and established data quality protocols that are followed by all publishers of data.

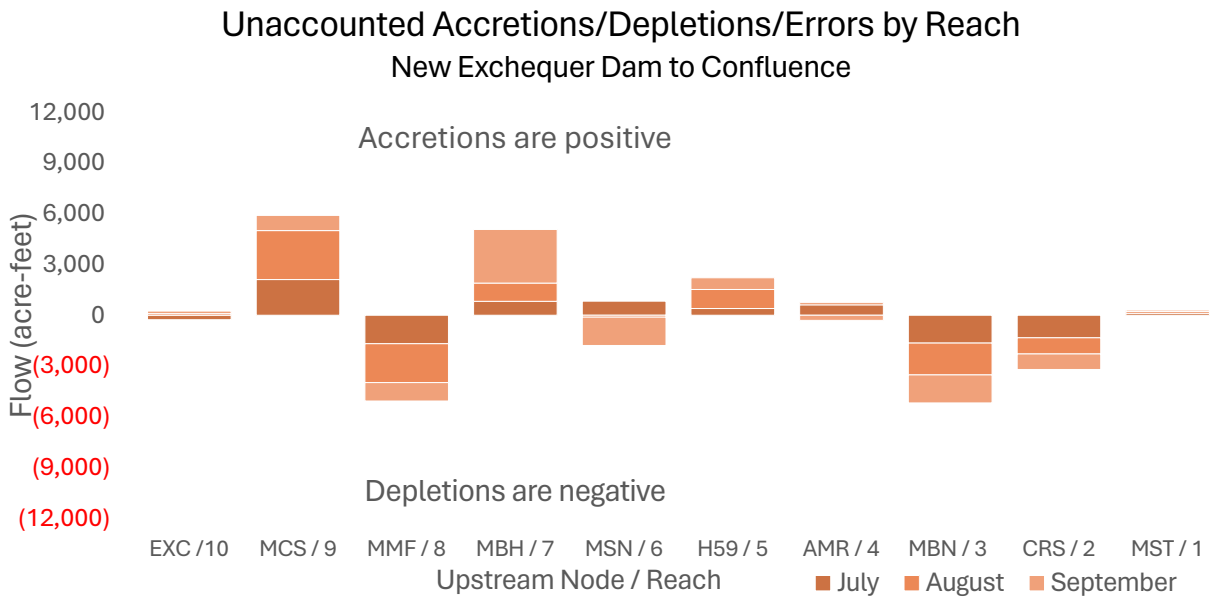


Figure 1. Unaccounted Accretions/Depletions/Errors by Reach

Lake McClure and Lake McSwain Water Balance

A water balance for Lake McClure and Lake McSwain was developed to calculate and confirm outflow from Lake McClure and Lake McSwain which was needed to support the reach-by-reach water balance. The reservoir water balance calculates, confirms, or adjusts as necessary the volume of natural flow in the system[22] and reservoir storage change. Confirming the volume of inflow to Lake McClure is needed for an accurate estimate of the natural flow available to downstream diversions that rely on riparian claims.

In addition, the Lake McClure and Lake McSwain water balances are needed to quantify the natural flow and previously stored water in the river system during the time of the analysis. This information is used to generally assess whether diverters are taking water consistent with the limitations of their water right types. For example, riparian claims are only entitled to divert natural flows, whereas appropriative rights are entitled to divert natural flow and flows that are foreign in time or source, including previously stored water (release of stored water from a reservoir), and imported flows from other river systems, provided that the foreign water has been abandoned by the water right holder who released it from storage or imported it from another source.

[22] Natural flow represents the water flowing through a river that was not previously stored or imported from another water body. On the Merced, natural flow is equal to inflow to Lake McClure which is also equal to unimpaired flow because there are no major water infrastructure facilities upstream of Lake McClure.

The CDEC New Exchequer Dam gage station, EXC, has daily data for the following parameters for Lake McClure: daily storage, inflow, outflow, change in storage.

The change in storage can be determined by the following formula:

Change in Storage = Input minus Output (equation 1)

The outflow reported to CDEC for Lake McClure from July 1 through September 30 was approximately 195,000 acre-feet. The daily inflow reported to CDEC was 20,000 acre-feet from July 1 through September 30. Using daily inflow as input and outflow as output in equation 1, the calculated change in storage is equal to 20,000 acre-feet of inflow, minus 195,000 acre-feet of outflow, resulting in a calculated change in storage of -175,000 acre-feet. This calculated change in storage agrees with a simple calculation of the change in storage using the beginning storage on July 1 as reported to CDEC and the ending storage on October 1 as reported to CDEC. October 1 storage was 225,182 acre-feet and July 1 storage was 399,811 acre-feet. The change in storage was therefore -174,629 acre-feet (225,182 acre-feet minus 399,811 acre-feet).

This simple analysis, however, does not consider the non-trivial loss to evaporation over three months. Lake McClure, when full, has a surface area of 7,147 acres.[23] Based on CIMIS ET data, evaporative losses could be as high as approximately 13,000 acre-feet for July through September.[24] Evaporative losses from July through September 2022 were likely lower than this estimate because the reservoir was not full during this time and the water surface area was smaller. Given lower reservoir levels and less surface area, evaporative losses were likely between 6,000 and 10,000 acre-feet. This approximation of evaporative losses agrees with the monthly Lake McClure ET losses reported on CDEC, 10,400 acre-feet for July through September.

Equation 1 is a simple mass balance in which reservoir volume (storage) change is equal to reservoir input (inflow) minus output (outflow). Accordingly, storage change minus reservoir input and reservoir output should equal zero. With the addition of evaporation to reservoir outflow, the sum of inflow, outflow, and evaporation is greater than storage change. If the sum of input and output is not equal to storage change then the water balance is off in some way and one or more terms need to be adjusted based on available information to restore the balance.

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[23] CDEC https://cdec.water.ca.gov/dynamicapp/profile?s=EXC&type=dam

[24] The two nearest CIMIS stations are Five Points and Denair. The lower ET reported at Denair was used. The ET data reported at Lake McClure was not used because there appears to be a problem with the recorded data. Many days are recorded as zero and others with very high ET. Both are improbable. Monthly ET data is also reported, although the data used to determine these monthly amounts is not reported. July, August, and September ET data is reported as 3,250, 3,850, and 3,300 acre-feet, respectively.

Of the metrics used in Equation 1 (inflow, outflow, and change in storage), the monthly change in storage for Lake McClure is the variable that is least prone to error because it may be confirmed by making a simple calculation of storage on October 1 minus storage on July 1 using reservoir data reported to CDEC. The largest possible error in the storage calculation could occur if the starting or ending storage amounts are incorrect, however, this appears to not be the case based on inspection of reported storage amounts in the week prior to July 1 and the week after October 1.[25]

If monthly storage change is known with high confidence, then to preserve the mass balance, the 10,000 acre-feet attributable to evaporation must either be added to inflow or subtracted from outflow. There are an infinite number of inflow and outflow combinations that could resolve the mass balance. Based on the simple Merced River water balance, however, it is likely that the mass balance should be corrected by adding 10,000 acre-feet to the reported inflow (instead of lowering outflow) because lowering outflow from Lake McClure would result in the river water balance not having enough water to meet the reported diversions. It would also result in lower outflow from Lake McClure than reported at the two river gages immediately downstream, which is unlikely unless caused by gage errors that all suggested lower flows than the outflow from Lake McClure. In addition, monthly unimpaired flow calculated by DWR and reported to CDEC was estimated to be 33,000 acre-feet.[26] Inflow into Lake McClure was therefore more likely to be 30,000 acre-feet rather than the 20,000 acre-feet reported to CDEC[27] as daily inflow to Lake McClure. This means that for this analysis from July 1 through September 30 there were 30,000 acre-feet of natural flow in the Merced River, rather than the 20,000 acre-feet reported to CDEC for daily inflow to Lake McClure.

Water released from Lake McClure is used to generate hydropower to satisfy daily peak electrical demand. McSwain Reservoir is operated as a regulating reservoir, to even out this large daily flow variation. Outflow from Lake McSwain is not reported to CDEC and flow immediately below McSwain is not gaged and reported to CDEC. McSwain storage, however, is reported by Merced Irrigation District and published on CDEC.

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[25] Anomalous values would be indicated by large daily changes in storage. Such anomalous measurements could be caused by recording unusually high or low water elevations, which can be caused by winds piling up the water in one direction or the other. Calculating a change is storage from June 30 to September 30, for example results in a change in storage of 176,000 acre-feet (1,000 acre-feet higher than the change from July 1 to October 1).

[26] CDEC gage MRC (Merced River near Merced Falls) sensor number 65 for monthly full natural flow. https://cdec.water.ca.gov/dynamicapp/selectQuery?Stations=MRC&SensorNums=65&dur_code=M&Start=2022-07-01&End=2022-09-30

[27] Merced Irrigation District calculated daily inflow to Lake McClure and reported to DWR for posting to CDEC during 2022 using the sum of flow from the Briceburg gage (MBG) and 10 percent of the flow from the North Fork Merced gage (NFM), communication in meeting on March 7, 2024.

Although it has a far smaller volume than Lake McClure, Lake McSwain also has a relatively large surface area of 312 acres; and as Lake McSwain remains far fuller than Lake McClure, the entire surface area is subject to evaporation. Monthly evaporation was calculated to be 142, 168, and 144 acre-feet in July, August, and September, respectively, with a three-month sum of 454 acre-feet.[28]

Monthly changes in Lake McSwain storage were calculated to be -269, 93, and 153 acre-feet in July, August, and September, respectively, based on time series data from Merced Irrigation District submitted with annual reporting (see tab "9 MCS" in supplemental spreadsheet). The net change in storage over three months is a decrease of 23 acre-feet. The daily flow out of Lake McSwain was calculated using the outflow from Lake McClure minus the daily change in storage and minus daily evaporation. Although the three-month change in storage was a decrease of 23 acre-feet, this net change in storage was achieved by replenishing storage to offset 454 acre-feet of water lost to evaporation, resulting in a net 431 acre-foot increase in storage over three months.

Reporting and Curtailment Compliance

Diversion and curtailment status data in the analysis identified WRIDs that did not submit annual reports of diversion and use for water year 2022 and WRIDs that reported diversion while under curtailment.

Most WRIDs in the analysis, 105 out of 110 (95 percent), submitted annual reports of diversion and use for water year 2022. However, six active status WRIDs did not submit annual reports for water year 2022.[29] Missing diversion volume for water year 2022 is one potential source of error in the analysis to the extent that water was actually diverted but not reported. In addition, missing diversion reports cannot be used to assess whether water right holders reported their diversions consistent with their curtailment status. Two of the six WRIDs that did not submit reports were curtailed from July through September 2022.

Ten WRIDs reported diversion from July through September while under curtailment. Eight of these WRIDs were entitled to divert previously stored water to which curtailments did not apply, had exceptions to curtailment, or both. Curtailment exceptions included non-consumptive use such as hydroelectricity production, and public health and safety uses such as demand for water for fire control.

Two WRIDs that do not appear to be entitled to divert previously stored water and had not submitted curtailment exception requests, reported diversion in at least one month

[28] McSwain evaporation is calculated using the same methods used for Lake McClure, however, since Lake McSwain is more full than McClure, the three-month evaporative losses could be slightly higher. The 454 acre-feet may be closer to 600 acre-feet over three months.

[29] Section 7 (MBH – MSN) S018929; Section 3 (MBN – CRS) S017449; S017432; and Section 2 (CRS – MST) A001442B, A01442F, and S0289026

from July through September while under curtailment. Total reported diversion from July through September for these two WRIDs was 377 acre-feet which is a relatively small amount (0.2 percent) of the total water available to the Merced River (195,498 acre-feet) from July – September 2022. One WRID that was curtailed reported zero diversion to storage in the annual report, however the time series data submitted from the storage measurement device shows that storage decreased by 269 acre-feet in July but increased by 93 and 153 acre-feet in August and September respectively. In addition, when refill of storage lost to evaporation is considered for all three months (454 acre-feet), storage increased by 431 acre-feet from July to September. Although diversion to storge of natural and abandoned flow was not authorized curtailments did not apply to previously stored water. It is reasonable to assume that the observed increase in storage was a re-diversion of previously stored water, to which curtailments did not apply.

Diversion of Previously Stored Water and Natural Flow

The reservoir and reach-by-reach water balances provide information to assess whether riparian claims and pre-1914 claims as categories of WRIDs diverted more than the natural flow of the river and whether riparian claims diverted flow that was previously stored water, which is not allowable under a riparian claim. This broad comparison is intended to inform whether “unlawful” or “improper” diversions of previously stored water may have occurred and whether they contributed to dry river conditions. This aggregate assessment compares the type of available river flow to diversions by types of water rights; it is not a compliance assessment of individual WRIDs and their reported diversions.

Table 5. Merced River Flow Type and Diversions by Water Right Type July – September 2022

Water Right or Depletion Type, WRID Count, and River Reach			Flow (acre-feet)	
			Natural Flow	Previously Stored Water
			30,000	165,498
WRID Type	WRID Count	River Reach	Diversions / Losses (acre-feet)	
License	1	8, 9		(148,382)
Pre-1914	1	8	(19,061)	
License	3	2, 7	(377)	
Riparian (only)	17	1, 2, 3, 5	(1,597)	
			8,965	17,116
			Remaining flow	26,081
Overlapping	20	2, 4, 5, 6, 7		(24,589)
Evaporation	n/a	1 - 10		(948)
			Remaining flow	544

The volume of previously stored water in the river was sufficient to supply the diversions reported by appropriative licenses as shown in Table 5 though only one license was clearly allowed to divert previously stored water. Merced Irrigation District holds License 2685 (A001224), which authorizes storage in Lake McClure, and both the direct diversion of natural flows (March 1- October 31) and the re-diversion of previously stored water at Northside Canal and Main Canal. Under WRID A001224, Merced Irrigation Districted reported diverting 148,382 acre-feet (July-September 2022) at Northside and Main Canals, see Table 5, which was 90 percent of the previously stored water (165,498 acre-feet) available in the river. Downstream of these diversions there were approximately 17,116 acre-feet of previously stored water in the river that served the purpose of achieving instream flow requirements at Shaffer Bridge and contract obligations with WRIDs entitled to divert stored water through agreements with Merced Irrigation district. The remaining stored water supported a flowing river and supplied some of the flow diverted by riparian or pre-1914 diverters.

Diversions of previously stored water under WRID A001224 were consistent with the type of water right under which they were reported, and they were the largest reported diversion under a single WRID that removed flow from the Merced River in July, August, and September 2022. The second largest diversion was also at Main Canal under a different WRID that is assumed to be a diversion of natural flow, as discussed below, not previously stored water released from Lake McClure. Diversions of stored water did not reduce natural flows in the river system but did reduce flows in the Merced River

downstream of Main Canal and Crocker-Huffman Dam that could have been used to maintain a flowing river and improve flow conditions at the confluence.

The volume of natural flow available in the river was sufficient to supply the diversions reported by 21 WRIDs, including 17 riparian (only) claims that are limited to diversion of natural flow, 3 licenses (WRIDs A028626, A013344, A001322), and 1 overlapping claim of right (WRID S004718). For this assessment, WRID S004718, was evaluated as a pre-1914 appropriative claim of right instead of an overlapping claim (as identified in annual reports) because the supplemental statement of diversion and use on file for S004718 identified pre-1914 appropriative claim as the basis of right.[30]

Seventeen riparian (only) claims reported diverting 1,597 acre-feet of river flow and three licenses reported diverting 377 acre-feet of river flow, see Table 5. WRID S004718 reported diversion of 19,061 acre-feet of water at Main Canal. Although previously stored water released from Lake McClure was available for diversion at Main Canal and Merced Irrigation District owns S004718, this analysis considered diversion reported under S004718 as removal of natural flow from the Merced River. Diverting or re-diverting stored water should be reported under the right that initially stored the water, in this case WRID A001224, which has a point of re-diversion at Main Canal. Since diversion of 19,061 acre-feet of water at Main Canal was reported under S004718 instead of A001224, it is considered diversion of natural flow in this analysis.

Two of the licenses reported diversion despite being under curtailment orders. WRIDs A013344 and A001322 reported diversion of 376 acre-feet and less than 1 acre-foot of diversion, respectively, as shown in Table 5. These licenses were curtailed (not allowed to divert natural flow) and no information was available to the Division of Water Rights that indicates that either of these licensees were entitled to divert previously stored water. The third license, WRID A028626, reported 0.41 acre-feet of diversion but had a health and safety exception to curtailment.

Collectively, diversions by these 21 WRIDs removed 21,035 acre-feet of natural flow from the Merced River July through September 2022 leaving 8,965 acre-feet of natural flows in the river for diversion by other WRIDs and to maintain a flowing river, see Table 5. Diversions reported under riparian (only) claims removed approximately 5 percent (1,597 acre-feet) of the natural flows and collectively did not remove more natural flow than allowed by riparian claims. Diversions reported under two licenses were not allowed under curtailment orders; however, they removed approximately 1 percent (377 acre-feet) of the natural flow. Diversions reported under the pre-1914 claim at Main Canal (19,061 acre-feet) were consistent with water right type and removed 64 percent of the natural flow. All diversions of natural flow contributed to dry river conditions.

Downstream of Main Canal and Crocker-Huffman Dam, 20 WRIDs with overlapping claims of right reported diverting 24,586 acre-feet of river flow from July through

[30] Supplemental Statement of Diversion and Use, Statements 4718 and 4719, September 24, 2003. https://calwatrs.waterboards.ca.gov/portal/s/search-information

September 2022, see Table 5. The available remaining river flow was 26,081 acre-feet, which was a blend of natural flow (8,965 acre-feet) and previously stored water (17, 116 acre-feet), see Table 5. Diversions reported under overlapping claims of right were equal to 24,596 acre-feet, removed 95 percent of the 26,081 acre-feet of remaining river flows, and contributed to dry river conditions.

It is not clear whether diversions reported under these overlapping claims were consistent with riparian or pre-1914 claims for several reasons. First, it is not clear if diversions were reported under a riparian or pre-1914 claim since annual reports list both but do not identify whether reported diversions were made subject to a riparian or pre-1914 claim. Second, some of the diverters with WRIDs with overlapping claims may have been allowed to divert previously stored water from Lake McClure, not under their independent claims of right but pursuant to agreements with Merced Irrigation District. In addition, some of the previously stored water may have become abandoned flow downstream of Shaffer Bridge, the point at which previously stored water from Lake McClure had served the purposes of meeting a flow requirement or contract obligation, in which case the water could have been diverted under any valid pre-1914 appropriative right.

WRIDs with overlapping claims of right would not have been authorized to divert previously stored water in the absence of contracts with Merced Irrigation District to divert stored water released from Lake McClure, unless the previously stored water had been abandoned (e.g., potentially downstream of Shaffer Bridge). In the absence of additional information, it is not clear whether diversions reported under overlapping claims of right were consistent with water right type or established contracts, or whether the remaining volume of previously stored water and natural flow was adequate to satisfy those rights.

Of the 42 WRIDs in the analysis that reported diversion in July, August, and September 2022, 20 WRIDs appear to have diverted previously stored water or natural flow as allowed by their water right type. Diversions reported under these 20 WRIDs were approximately 169,417 acre-feet, which was 87 percent of total reported diversion (194,006 acre-feet) and available river flow (195,498 acre-feet). Two WRIDs diverted 377 acre-feet while under curtailment, which was not allowed by curtailment orders but was a small percentage of reported diversion and river flow. 20 WRIDs with overlapping claims of right reported diverting 24,589 acre-feet, which was 13 percent of total reported diversion (194,006 acre-feet), but 95 percent of the remaining river flow downstream of Crocker-Huffman Dam.

If 19,061 acre-feet of diversions at Main Canal had been reported under WRID A001224 instead of S004718, these diversions could have been considered re-diversion of the remaining 17,116 acre-feet previously stored water (e.g., subtracted from the previously stored water column in Table 5) and 1,945 acre-feet of natural flow. This would have left 28,055 acre-feet of natural flow in the river downstream of Crocker-Huffman that could have been diverted by the uncurtailed WRIDs with riparian and overlapping claims of

right. However, based on reported diversions, a mix of previously stored water and natural flow was available downstream of Crocker-Huffman Dam, and it is not clear whether diversions reported by WRIDs with overlapping claims were consistent with riparian or pre-1914 claims or contractual agreements, or whether they constituted unauthorized diversions.

Discussion

Water Balance

Reported diversions alone explain the flow losses from the Merced River in the summer of 2022. The reported diversions plus evaporation account for all the Merced River flow lost from New Exchequer Dam to the San Joaquin River confluence within a fraction of one percent (see Table 4). The simple water balance results in only 543 acre-feet of missing depletions from July through September, with only slight variability in missing accretions/depletions for each month. The largest difference between monthly flows and depletions (sum of diversions and evaporation) is only 1.6 percent. The simple water balance fully explains the dry river channel near the San Joaquin River confluence in July, August, and September 2022. There is high confidence in the total volume of water available in the river (outflow from Lake McClure at New Exchequer Dam) and it is also known that the river was dry near the San Joaquin River confluence. Since diversion volumes match the volume of flow lost from the river, reported diversions alone are sufficient to explain the reason the river went dry.

The more detailed water balance for the ten, smaller, river reaches shows that flow losses and diversions plus evaporation are unequal by various amounts within each reach. For the reach-by-reach balance to remain consistent with the simple (62-mile) water balance, the actual flows would have been lower than recorded by some gages while higher at others. This may appear to complicate or weaken simple water balance, however, the potential for errors in reported gage flows can explain the apparent missing accretions and depletions within each reach.

Alternatively, there could be more complexity in the individual river reaches that cannot be identified using the data available. There could be unrecorded and unknown accretions and depletions in each reach. These could include groundwater gains or losses; agricultural return flows and canal spills; tributary inflows; unreported diversions of water including any diversions made without a valid basis of right or documentation in in the State Water Board water right system, other diversion reporting errors; or a combination of these accretion and depletion (gain and loss) factors.

Diversion and Use

Multiple letters described concerns about “unlawful,” “improper,” and “unreasonable” use of water as causing or contributing to dry conditions in the Merced River in the summer of 2022. Complaints and concerns about these issues fell in three general categories: 1) diversions that were not documented in the water right system and/or lack

a valid basis of right; 2) diversions that were not in compliance with reporting requirements; and 3) diversions that were taking too much water, in excess of their basis of right. Each of these categories is discussed in the following sections.

Unreported Diversions and Reporting Compliance

The water balance in this analysis did not include any unreported diversions that could have occurred during the months of July through September 2022. Surveys of the Merced River identified multiple diversion structures that did not have a claim of right on file with the State Water Board but appeared to be able to divert water. Many of these structures have now been documented in the water right system,[31] however, it is not known whether unreported diversions occurred through these structures in the months of July through September 2022. The water balance analysis shows that the river would have dried based on reported diversions and evaporative losses alone. This result indicates that if any unreported diversions occurred in July, August, or September 2022, additional river flow that was not detected by flow gages must have been in the river. Accordingly, unreported diversions could have occurred, but the source water was not detected in the existing measurement devices and or the analysis. If unreported diversions did occur, they would have contributed to dry conditions, but do not appear to have been a significant consumer of the river flow on their own. All diversions from the Merced River should be documented in the State Water Board water right system and accurately reported to the State Water Board by the regulatory deadline.

Concerns that many diverters on the Merced River were not in compliance with water right reporting requirements were also described to the State Water Board. As discussed in the results section, most of the WRIDs in the analysis had submitted annual reports of diversion and use for water year 2022. However, compliance with water measurement and reporting regulations that require more frequent reporting was not as developed on the Merced River in 2022. Regardless, the water balance analysis shows that the river would have dried based on reported diversions and evaporative losses even if compliance with water measurement and reporting regulations had been better in water year 2022. Improved water measurement and reporting compliance, improved diversion data quality, and more frequent diversion data availability are needed to manage flow and diversion conditions in real-time to avoid dry river conditions in the future.

Previously Stored Water & Natural Flow

Some parties described concerns about water right diversions that may have exceeded the legal limitations of their rights and caused or contributed to dry river conditions in 2022. To address this issue, the water balance compared the supply of natural flow and previously stored water to diversions by WRIDs that were allowed to divert these types of water. WRIDs with overlapping claims created ambiguity in determining whether

[31] Merced Irrigation District, letter to State Water Board members, dated May 12, 2025.

riparian and pre-1914 claims diverted more than the available natural flow, and whether they diverted previously stored water that they are not authorized to divert.

Most natural flow and previously stored water in the analysis appears to have been diverted as allowed by the applicable water right types. Forty-two WRIDs in the analysis reported diversion in at least one month from July through September 2022. Of these, 20 WRIDs reported combined diversions of 169,417 acre-feet, or 87 percent of July through September total river flow. These diversions could be evaluated under a single basis of right and consisted of 148,382 acre-feet of previously stored water reported under WRID A001224 and 21,035 acre-feet of natural flow of which 19,061 acre-feet were reported under WRID S004718 (discussed further in the next section) and 1,597 acre-feet were reported under 17 riparian (only) claims. These diversions appear to be consistent with water right type and the available supply of previously stored water and natural flow (see Table 5). Two WRIDs reported 377 acre-feet of diversions (less than 1 percent of July – September total river flow) while under curtailment orders and do not appear to be authorized diversions.

The remaining 20 WRIDs reported 24,589 acre-feet of diversion under overlapping claims of right. The total diversion volume reported under overlapping claims of right is approximately 12 percent of total river flow from July through September, however, these diversions occurred downstream of Crocker-Huffman dam and are 95 percent of the total river flow downstream of Crocker-Huffman dam, see Table 5. Since these diversions were reported under overlapping claims of right, it is unclear whether they were consistent with riparian or pre-1914 water right types or contractual agreements, or whether they constituted unauthorized diversions.

All the WRIDs that reported diversion, as well as any unreported or unauthorized diversions, contributed to dry river conditions near the confluence. At present, diverters do not know whether water in the river is natural flow or previously stored water and, in most years, do not know if water is unavailable at their priority of right. When the emergency drought regulation was in place, curtailments were based on the WUA methodology and diverters were notified when water was not available at their priority of right.

Curtailment orders were not issued to diverters with riparian claims on the Merced River from July through September 2022. Except when authorized by drought emergency regulations, a regulatory system for determining when water is unavailable at a diverter’s priority of right that includes a method for correlative distribution of shortages between riparian claims (and notifying diverters when water is unavailable for diversion) has not been established in the Bay-Delta watershed. In other words, there currently isn’t a system in place to administer the water right priority system in real-time (or near-

real time) to regulate diversions in the Bay-Delta watershed consistent with water right limitations and for the purpose of managing flow conditions in rivers.

Overlapping Claims and Water Right Information

Overlapping claims and unvalidated or conflicting water right information resulted in ambiguity in assessing whether water was available at a diverter's priority of right, whether diversions were made consistent with legal limits of their water rights, and the role these factors played in drying of the river. For example, one claim for direct diversion at Main Canal (S004718) lists both riparian and pre-1914 as water right types in annual reports. For the purpose of assigning priority, the WUA methodology assumed the more senior priority of right (riparian) for claims listing both riparian and pre-1914. However, this claim (S004718) is identified as a pre-1914 claim of right in its supplemental statement of diversion and use.[32] This WRID does not appear to be a riparian claim because Main Canal distributes water to parcels of land, places of use, that are not riparian to the Merced River as shown on Figure 2.

If this WRID was treated as a pre-1914 appropriative claim by the WUA methodology, its curtailment status in the months of July through September 2022 would have been based on priority date which the WUA methodology estimated based on the first year of water diversion, unless information substantiating a different priority date was available. The first year of water diversion for this WRID is listed as 1911 in the Supplemental Statement of Water Diversion and Use filed in 2003. The priority date was later identified as 1857 in response to a 2015 information order[33] however the priority date is listed as 1853 in annual reports from 2014 through present.

Curtailments on the Merced River from July through September 2022 were in effect for appropriative water rights and claims with a priority date of 1859 or later. If the S004718 claim had been listed as pre-1914 with a priority date of 1853 or 1857, it would not have been curtailed from July through September 2022 under the WUA methodology. If this claim had been identified as pre-1914 with a priority date of 1911, it would have been curtailed and not allowed to divert the 19,061 acre-feet of reported diversion during the months of July through September 2022 based on the WUA methodology. Since there are three priority dates associated with this claim that differ by 58 years, it was not clear which priority date should have been used in the WUA methodology. The WUA

[32] Supplemental Statement of Diversion and Use, Statements 4718 and 4719, September 24, 2003. https://calwatrs.waterboards.ca.gov/portal/s/search-information

[33] S004718 pre-1914 claim supporting documents submitted to the State Water Board in response to water right order 2015-0002, https://waterboards.ca.gov/waterrights/board_decisions/adopted_orders/orders/2015/wro2015_0002.pdf

methodology includes over 17,000 WRIDs and was developed based on the best information available at the time to address emergency drought conditions.

From July through September 2022, 19,061 acre-feet of water was reported as diverted at Main Canal under WRID S004718. Although there is ambiguity in the overlapping claim of right and priority date for S004718, it is reasonable to assume, for purposes of this report, that S004718 is a pre-1914 claim of right, that it was not curtailed, and that natural flows were diverted under this right because the stored water released from Lake McClure had been stored under a different right and was not abandoned. It is also possible that this claim of right should have been curtailed, in which case diversion of natural flow would not have been authorized under this right.

Most of the water reported as diverted under S004718 could have been diverted and reported under WRID A001224 and considered a re-diversion of stored water released from Lake McClure. Re-diversion of stored water that had not been abandoned was not subject to curtailments. Merced Irrigation District re-diverts water at Main Canal that was previously diverted and stored in Lake McClure under Merced Irrigation District's appropriative licenses.[34] From July through September, there was 165,498 acre-feet of river flow that was released from Lake McClure storage and considered previously stored water, see Table 5. WRID A001224 reported diverting 148,382 acre-feet of previously stored water. The remaining 17,116 acre-feet of previously stored water, or 90 percent of the 19,061 acre-feet of diversion reported under S004718, could have been reported under A001224 as a re-diversion of previously stored water and not subject to curtailments. Under this scenario, if S004718 had been curtailed, the other 10 percent of reported diversion by S004718 (1,945 acre-feet) would have been unavailable for diversion by this claim. In this scenario, the 1,945 acre-feet of flow unavailable to this WRID would have been available as natural river flow downstream of Crocker-Huffman dam.

There were 33 overlapping claims of right downstream of Crocker-Huffman dam in the analysis, and 20 of these claims reported diversion in at least one month from July through September 2022. Since most overlapping claims were treated as riparian in the WUA methodology, it is not clear whether diversions by claims that are pre-1914 (not riparian) would have been curtailed at their priority of right during the months of July through September 2022. If an additional 1,945 acre-feet of natural flow had been available downstream of Crocker Huffman dam, it could have contributed to a flowing river at an average of approximately 10 cfs per day.[35]

Given the dry conditions and high diversion demand, this additional 10 cfs of daily natural flow could also have been diverted by uncurtailed rights as they were not

[34] Original storage of water must have occurred under a different appropriative WRID held by Merced Irrigation District because S004718 does not authorize storage.
[35] 1,945 acre-feet for July, August, and September (92 days) is equal to 10 cfs average daily flow.

prohibited from diverting natural flow. The 20 overlapping claims and 17 riparian (only) claims that reported diversion downstream of Crocker-Huffman dam diverted the remaining river flow until the river was dry as allowed by the WUA methodology and curtailment status in the absence of any regulatory action taken to preserve instream flows consistent with the public trust doctrine and the constitutional prohibition against the unreasonable use of water.

Flow requirement near the confluence with the San Joaquin

Multiple comment letters requested that the State Water Board adopt a flow requirement for the Merced River at or near the confluence with the San Joaquin River to maintain a flowing river, protect fish populations, and prevent dry river conditions from occurring again in the future. Other letters requested that the State Water Board avoid adopting a flow requirement and instead rely on a developing local process to manage diversions and river flows to maintain a flowing river.

Several actions need to occur to prevent dry river conditions independent of whether the State Water Board or a local process complete these actions. First, a numeric flow value needs to be identified to serve as a river flow threshold that initiates the need for reductions in water diversions to maintain a flowing river. Second, a system for reducing diversions needs to be developed to maintain the flow threshold. The WUA methodology, water right priority date, and curtailment orders were the system that reduced diversions (in order of priority) during the 2021-2022 drought years for the purpose of protecting previously stored water and flows for senior diverters but did not include stream flow requirements. Fourth, a formula that determines a correlative reduction in diversions for riparian (only) WRIDs will need to be developed and included in a water unavailability methodology or other system for reducing diversions to achieve a flow requirement or target. Finally, a notification system that tells water right holders when water is not available for diversion needs to be developed and administered.

The water balance shows that reported diversions were sufficient to consume all the available river flow and the water type assessment indicates that most of the flow was diverted as allowed by the applicable water right types (~87 percent) while it was not clear whether flow diverted under overlapping claims (~12 percent) was allowed within the limitations of their water right types. Multiple beneficial uses designated for the Merced River such as irrigation, municipal supply, recreation (e.g., canoeing and rafting), and freshwater habitat for fish and wildlife[36] rely on flowing river conditions, however a numeric flow requirement that reasonably protects these uses on the Merced River to the confluence with the San Joaquin River from July through January has not been established. In the absence of a numeric flow requirement, the water right priority

[36] Water Quality Control Plan for the Sacramento River Basin and the San Joaquin River Basin https://www.waterboards.ca.gov/centralvalley/water_issues/basin_plans/ and the Water Quality Control Plan for the San Francisco Bay/Sacramento-San Joaquin Delta https://www.waterboards.ca.gov/waterrights/water_issues/programs/bay_delta/wq_control_plans/

system will allocate all the available river flow to water right holders (diverters), as it did during the months of July through September 2022 on the Merced River.

River flows can be protected when the water right priority system is paired with a numeric flow requirement which identifies times when diversions need to be reduced to maintain a flowing river, reasonably protect flow-dependent beneficial uses, or both. The State Water Board has the authority to adopt a flow requirement, and a local watershed group may have the ability to manage flows and diversions to meet an agreed upon numeric flow value. With either approach, the goal is to manage flows and diversions to support diversions, instream beneficial uses, and maintain a flowing river.

Summary

The simple water balance shows that the drying of the Merced River from July through September 2022 can be fully explained by the reported diversions and estimated evaporation, see Figure 12. From July through September 2022, Lake McClure releases were used to meet water delivery obligations and an instream flow requirement at or upstream of Shaffer Bridge, which is located 27 miles upstream of the location at which the Merced River went dry. Losses of the remaining natural flows or previously stored water in the Merced River downstream of Shaffer Bridge during these months can be explained by reported diversions from uncurtailed water rights plus evaporation.

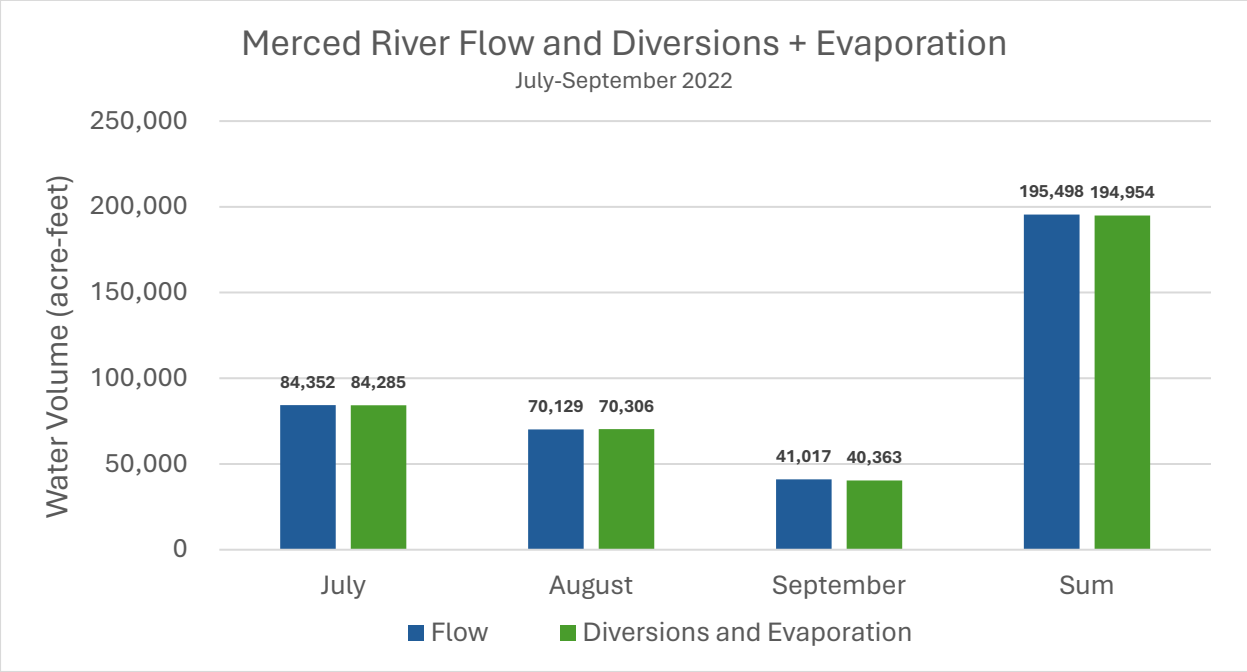


Figure 22. Merced River Flow and Diversion Plus Evaporation Volume for July through September 2022

The reach-by-reach water balance suggests that greater accuracy, resolution, and availability of flow and diversion data are needed to rely on a water balance approach within each reach to understand diversions and available river flows. These data quality and availability improvements are also needed to develop real-time (or near real-time) management tools to monitor diversions for purposes of compliance with water right requirements and maintaining flowing river conditions. Additional flow gages and improved maintenance of flow gages, channel cross sections, and regular updates to rating curves would improve accuracy and reliability of flow data. Measurement devices and telemetry for measurements would also improve accuracy and reliability of

diversion data and near real-time availability would support near real-time flow and diversion management in the river.

The reservoir water balance shows that reliable and validated methods for estimating daily and monthly unimpaired flow need to be established and documented to provide estimates of natural flows available for riparian and appropriative diverters. Similarly, methods for calculating reservoir outflow need to be documented and easily available to the public, so diverters understand the amount of previously stored water in the system.

Overlapping claims and unvalidated or conflicting water right information generated ambiguity in assessing whether diversions were made consistent with water right types and the role these factors played in drying of the river. At the aggregate level, most of the available river flow (~87 percent of the July – September flow volume) was diverted by 20 WRIDs as allowed by water right types and their curtailment status. A small volume of water (less than 1 percent of the July – September flow volume) was diverted by 2 WRIDs that were under curtailment and did not have an exception to curtailment. It was not clear whether the remaining 20 WRIDs that reported diversion under overlapping claims of right (~ 12 percent of the July – September flow volume) diverted the type of flow allowed by their claimed rights.

Ambiguity about water right type and inconsistency with priority dates on file for WRIDs may have resulted in fewer curtailments of WRIDs consistent with the WUA methodology, however, any additional natural flow in the river could have been diverted given the high diversion demand and lack of a flow requirement that would have prevented all flows from being diverted. Specifically, the absence of a method or system in the Bay-Delta watershed to curtail riparian claims may have resulted in fewer curtailments and contributed to dry river conditions. However, the purpose of curtailing riparian claims in the 2022 water year, absent an instream flow requirement, would have been to maintain flow for downstream diversions, not for the purpose of maintaining a flowing river.

In the absence of a numeric flow requirement, the water right priority system does not prohibit diversion of all available river flow and drying of the river. The emergency drought regulation and associated water right curtailments were not issued to maintain river flows, but to make water available for senior water right holders and claimants, and to prevent unlawful diversion of storage releases, which were intended to meet water quality and flow requirements, re-diversions under those same rights, or contract demands. In this analysis, the water balance and associated water right information show that all the available flow was diverted, which was not prohibited by the water right priority system or the curtailment orders. Of the 110 WRIDs in the analysis, 42 WRIDs, less than half, reported diversion in the months from July through September 2022,

suggesting that diversion demand could increase and contribute to more frequent dry river conditions in the future unless a solution for protecting river flows is implemented.

River flows can be protected when the water right priority system is paired with a numeric flow requirement which identifies when diversions need to be reduced to maintain a specific flow rate in the river. For example, curtailment tools that apply the water right priority system, such as the WUA Methodology, can be revised to incorporate instream flow requirements to determine when water is unavailable at diverters' priority of right. The Division continues to improve curtailment tools and methods including incorporating existing instream flow requirements, improving diversion demand estimates, developing demand forecast methods, and improving estimates of watershed accretions and depletions. Other possible improvements include developing methods for correlative curtailment of riparian claims and to the extent possible, improving water right information such as identifying a single claim of right for each WRID instead of allowing for multiple (overlapping) claims of right and confirming priority dates and places of use.

Response & Next Steps

Since the fall of 2022, Division staff have analyzed available flow and diversion information to understand the factors that contributed to dry conditions on the Merced River in 2022, conducted field surveys, reviewed compliance with water measurement and reporting requirements, communicated with many of the parties that submitted letters of concern, and identified multiple actions needed to support a flowing Merced River. In addition, the Merced Irrigation District has worked with local Merced River diverters through the LMRC to improve diversion reporting and maintain Merced River flows to the confluence with San Joaquin River as part of a pilot program.

The Division maintains a webpage to serve as an information source for the drying of the Merced River and response actions.[37] The Division developed fact sheets describing the core principles of California water rights and water use reporting that apply to all diverters and worked with the Merced Irrigation District to mail the fact sheets to 1,250 landowners and diverters along the Merced River. The Division created an interactive map of riparian and pre-1914 claims on the Merced River to help water right holders understand their water rights, to verify that State Water Board records are current for each WRID, and to verify locations of PODs and places of use. Division staff participated in a workshop with Merced River diverters, hosted by Merced Irrigation

[37] Merced River Conditions in 2022 https://www.waterboards.ca.gov/waterrights/water_issues/programs/bay_delta/merced/index.html

District, on November 7, 2024, to review the fact sheets, interactive map, and the preliminary flow and diversion analysis.

Division staff conducted a detailed review of water rights along the Merced River downstream of Lake McClure to evaluate compliance with reporting and measurement regulations. As a result of this review, the Division issued 14 Notices of Violation (NOVs) for failure to file annual reports.[38] Thirteen of these diverters came into compliance with reporting requirements. The Division issued an administrative civil liabilities complaint to the remaining diverter for failure to file an annual report for 4 WRIDs.[39] The Division issued NOVs to diverters for another 55 water rights that were in violation of water measurement and reporting regulations for failure to install a measurement device, failure to upload data from the device, failure to monitor at the correct frequency, or failure to install telemetry.[40] Ninety percent of the water right holders on the Merced River that received NOVs came into compliance; some inactivated their statements; and Division staff continue to work with Merced River water right holders to achieve and maintain compliance with water measurement and reporting requirements.

In 2024 and in 2025, the Division collected data from a survey of the Merced River with CDFW and individual Division field inspections of diversion structures. These field data identified 29 landowners with potentially unauthorized diversions. After staff outreach, 13 diverters came into compliance by filing statements for their riparian claims. The remaining locations were dismissed because there was insufficient evidence to confirm that the diversion structures were in use.

In December 2025, the State Water Board approved updates to water measurement and reporting regulations to improve the accuracy and availability of diversion data.[41] Approved changes include, but are not limited to, requirements to use standardized data templates, provide descriptions of data conversions, data accuracy requirements,

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[38] Water Rights Enforcement: Notices of Violation (NOVs): Statewide Annual Use Reporting https://www.waterboards.ca.gov/waterrights/water_issues/programs/enforcement/compliance/notices/statewide-annual.html

[39] File names 2024-0036-DWR and 2024-0039-DWR available at https://www.waterboards.ca.gov/waterrights/water_issues/programs/enforcement/compliance/acl_complaint_actions/

[40] List of NOVs for failure to comply with diversion measurement and reporting regulations is available at https://www.waterboards.ca.gov/waterrights/water_issues/programs/enforcement/compliance/notices/sacramento-san-joaquin.html

[41] Amendments to Title 23. Waters. Division 3. State Water Resources Control Board and Regional Water Quality Control Boards https://waterboards.ca.gov/waterrights/water_issues/programs/diversion_use/docs/2026/20260116-chapter-2-8-clean-copy.pdf

identifying locations of measurement devices, and describing methods to apportion flow measurements to individual water rights.

In 2024, the Merced Irrigation District formed a local watershed group, the LMRC,[42] to engage water right diverters along the Merced River on the shared goals of adhering to water right requirements and maintaining a flowing river. Merced Irrigation District and the LMRC worked with diverters to file water right documentation, remove diversion structures, and reduce the number of unregistered diversions on the Merced River. Merced Irrigation District and the LMRC report that they are developing plans to install additional flow measurement devices to measure smaller diversion structures, and they are investigating the possibility of supporting telemetered data for all diversions on the lower Merced River.[43] Updated measurement and telemetering devices could improve the quality, availability, and reliability of reported diversion data.

In 2025 and 2026, Merced Irrigation District lead a pilot program with the LMRC to maintain Merced River flows in dry months. The pilot program operates on a weekly cycle and uses water demand estimates provided by LMRC diverters, Lake McClure inflows, determination of available water supply by water right priority, and a notification system. Merced Irrigation District reports that the pilot program resulted in maintaining flows in the range of 44 – 110 cfs at the Stevinson gage from mid-July through mid-October 2025. Merced Irrigation District reports that the LMRC committee approved a pilot program in 2026 from early June to mid-October and is preparing an agreement for the LMRC to operate in the future.[44] Better communication, information, and data sharing between the largest diverters in the watershed are needed to improve water supply efficiency and river flow management to avoid dry river conditions in the future and are critical components of future voluntary actions proposed for Board consideration.

The State Water Board is also in the process of implementing the Bay-Delta Plan Lower San Joaquin River (LSJR) flow requirements on the Stanislaus, Tuolumne, Merced, and Lower San Joaquin Rivers (LSJR flow requirements). The February through June flow requirements on the Stanislaus, Tuolumne, and Merced Rivers apply at the flow gage nearest the confluence with the Lower San Joaquin River, which will maintain flows on these tributaries to the confluence with the San Joaquin River during February through June. The LSJR flow requirements include adaptive implementation options that allow shifting flows to drier months which could help to maintain flowing river conditions.

As part of the process to implement the Bay-Delta Plan, the Division is developing a curtailment methodology that includes instream flow requirements and identifies when water is not available at a WRID's priority of right. This methodology is expected to include procedures for estimating unimpaired flow (water supply) and determining

[42] Lower Merced River Coalition https://lowermercedrivercoalition.org
[43] Merced Irrigation District, letter to State Water Board members, dated May 12, 2025.
[44] Merced Irrigation District, letter to State Water Board members, dated July 6, 2026.

correlative shortages to riparian diversions when there is not adequate natural flow available to supply all riparian users, incorporate improved diversion demand data, minimize or eliminate occurrence of overlapping claims of right to the extent possible, and use the best available water right information.

The Division will continue efforts to ensure that all water right holders report their diversion and use in accordance with reporting regulations, improve the availability and quality of diversion reporting data, invest in tools that use these data for real-time water management, implement the Bay-Delta Plan, and explore regulatory and voluntary options for maintaining flowing rivers. Collectively, these actions are intended to improve transparency and accountability, provide accurate water diversion reporting data, support local water management efforts, and provide a regulatory structure to ensure the Merced River flows continuously into the San Joaquin River, through the Bay-Delta, and to the Pacific Ocean.

Next steps to support flowing rivers include:

- Help water right holders comply with measurement and reporting regulations to improve diversion data availability, accuracy, and reliability. Support maintenance of flow gages, channel cross sections, and rating curves and validate unimpaired flow estimates through voluntary efforts and regulatory actions.
- Improve protection of fish and wildlife beneficial uses and maintain connected rivers through water right and water quality proceedings to maintain flows throughout the year and for the entire length of the river.
- Coordinate with watershed groups, such as resource agencies, conservation groups, and the Lower Merced River Coalition, to improve availability and quality of diversion data and support local pilot program to maintain continuous Merced River flows to the San Joaquin River.